Pacific Ballast Water Group

WORKING DRAFT

Report and Recommendations

Acknowledgments

Recent history is filled with examples of nasty battles over environmental problems. Many of which the parties involved knew, nor cared little about understanding all sides of the issue. Communication occurred through lawyers or in a courtroom. The Pacific Ballast Water Group is laudably striving to find a better way solve the problems associated with ballast water management.

The members of the Pacific Ballast Water Group are taking the initiative to cooperatively seek solutions that will contribute to the resolution of a major international environmental and economic issue. No government entity or private organization required us to form. Every member is at the table because they saw a need and chose fill it. Each has conducted themselves with dignity and respect for others while openly and honestly perusing solutions.

We appreciate the extra efforts of the following participants who assisted in writing this report: Marion Ashe, CA Department of Fish and Game; Jodi Cassell, U.C. Sea Grant Extension; Jason Hamilton, University of Washington Law Student; Karen Hart, U.C. Sea Grant Extension; Harry Hutchins, Puget Sound Steamship Operators Association; Joel Kopp, PWS Regional Citizen's Advisory Council; Kenneth Levin, Pacific Merchant Shipping Association; Penny Lockwood; Lt. Jim Pruett, U.S. Coast Guard; Gregory Ruiz, Smithsonian Environmental Research Center; Linda Sheehan, Center for Marine Conservation; Scott Smith, Washington Department of Fish and Wildlife; Mark Sytsma, Portland State University; Lt. Chris Woodley, U.S. Coast Guard; Jodi Zaitlin, Port of Oakland.

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Executive Summary

(To be included)

Introduction

Cornell University ecologist David Pimentel estimates that invasive species cost the U.S. more than $122 billion annually. A report by the Environmental Defense Fund shows that roughly 400 of the 958 species listed as threatened or endangered by the U.S. Interior Department are at risk from invasive species. Studies have shown that many species of bacteria, plants and animals can survive in ballast water and sediment carried on ships. The discharge of ballast water is a major pathway for the transfer of potentially harmful aquatic organisms and pathogens around the world.

The Pacific Ballast Water Group (PBWG) was formed by representatives from the shipping industry, state and federal agencies, environmental organizations, and others who recognized the need for a cooperative and coordinated regional approach to solving the problem. Shipping is an international industry. Conflicting port or state regulations can create a complicated set of rules that make compliance difficult. The International Maritime Organization (IMO), the federal government, the shipping industry and the ports advocate that a consistent international or national approach is more preferable than local approaches, and will avoid the regulatory confusion and competition issues that may occur under a "patch work" regulatory approach. However, it is generally recognized that international and national efforts are ponderously slow in development and current programs do not adequately address the problem. The significant and mounting damages and costs associated with aquatic nuisance species have prompted increasing activity at the international, national, regional, state and local levels to regulate ballast water. Focused and effective action is needed to prevent further damage to coastal environments and economies, while minimizing regulatory complexity, shifts in competitive advantage, and economic impacts to the shipping industry.

The PBWG quickly recognized many gaps in our knowledge. We had little information on existing or proposed ballast water research projects. What efforts had been made by others to manage ballast water and with what success? Do all ships pose a risk, if not what types and where do they operate? How do we monitor the success of a ballast water management program? What are the current regulations relating to ballast water and how could they be improved? Finally, what steps should be taken to resolve the problem? This report was produced by members of the PBWG (Appendix A) to begin answering these questions and to serve as a reference/educational document that is capable of bringing anyone up to speed on the issue. This document was written to foster the prompt implementation of practical solutions that will continue to reduce the risk of new introductions from ballast water.

Ballast water management is evolving rapidly. Parts of this report will quickly become dated. References within the report should provide the reader with sources that can supply current information.

Scope of the Problem

An estimated 21 billion gallons of ballast water is dumped into US ports each year – that's 58 million gallons a day or 2.4 million gallons an hour[1]. Ballast water is the most important pathway for marine species transfer throughout the world. Ballast water dumping has resulted in the introduction of tens to hundreds of freshwater and marine species to the U.S. and elsewhere. The rate of new invasions from ballast water has increased in recent years[2].

Ballast water transports a wide variety of healthy species, including viruses, bacteria, protists, fungi and molds, plants and animals and their various life stages. For example, ballast water taken on in Japan and released in Port of Coos Bay, Oregon contained 367 taxa, which essentially composes an entire coastal planktonic assemblage[3].

There are more introduced non-indigenous marine species reported in California than in Washington or Alaskan waters, but California bays and estuaries have been studied far more than other west coast waters. San Francisco Bay has 234 identified nonnative species[4], Puget Sound has 52 nonnative marine species[5] and Prince William Sound has at least five[6]. These species were introduced from many sources, including ballast water discharges.

West Coast Shipping Patterns

Based on 1998 marine exchange data provided by the U.S. Coast Guard, a total of 8950 deep water draft vessels visited or transited through west coast ports. Los Angeles/Long Beach ports

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1 J. T. Carlton, D. M. Reid and H. Van Leeuwen, 1995. 'Shipping Study: The Role of Shipping in the Introduction of Nonindigenous Aquatic Organisms to the Coastal Waters of United States and an Analysis of Control Options" National Sea Grant

2 A. N. Cohen and J. T. Carlton, "Accelerating Invasion Rate in a Highly Invaded Estuary," Science 279 January 1998

3 J. T. Carlton and J. B. Geller, "Ecological Roulette: Biological Invasions and the Global Transport of Non-indigenous Marine Organisms," Science 261 *1993): 78-82.

4 A. N. Cohen and J. T. Carlton, 1998, "Accelerating Invasion Rate in Highly Invaded Estuary" Science 1998: 555-558.

5 A. Cohen, et al. Puget Sound Expedition: A Rapid Assessment Survey of Non-Indigenous Species in the Shallow Waters of Puget Sound, November 1998.

6 A. N. Himes and G. M. Ruiz, 1998. Biological Invasions of Cold Water Coastal Ecosystems: Ballast-Mediated Introductions in Port Valdez/Prince William Sound, Alaska. 1998 Progress Report Presented to Regional Citizens Advisory Council of Prince William Sound.

receive about one and half times more traffic than the combined total of Puget Sound and Columbia River ports. Fifty-six percent of all traffic originated from outside the Economic Exclusion Zone (EEZ). These vessels are subject to the U.S. Coast Guard's voluntary ballast water exchange program and reporting requirements (herein after referred to as 'regulated' vessels). Forty-four percent originate from U.S. ports of call. Most of these vessels manage ballast according to company or shipping association policies (Table 1).

Bulk carriers, because of their high demand for ballast, pose a significant risk of introducing non-indigenous species through ballast discharges. Based on information available, about 14 percent of the vessels that arrive in Puget Sound ports and 19 percent in Columbia River ports are bulk vessels (Table 1).

Table 1: 1998 Deep Draft Vessel Traffic from marine exchange data

USCG Port Zone	All vessels	From outside EEZ	From US ports of call	High risk vessels*	
				Total	Unregulated**
LA/Long Beach	5241	3416 (65%)	1825 (35%)	--	--
San Francisco Bay ports	More	--	--	--	--
Columbia River ports	1879	827 (43%)	1052 (56%)	990 (19%)	671 (68%)
Puget Sound ports	1830	785 (43%)	1047 (57%)	264 (14%)	133 (50%)
Other (BC, Alaska)	Don't know	--	--	--	--
Total	8950	5028 (56%)	3924 (44%)	--	--
Source: USCG, 1999	* Identified as bulk carriers ** Originating inside EEZ				

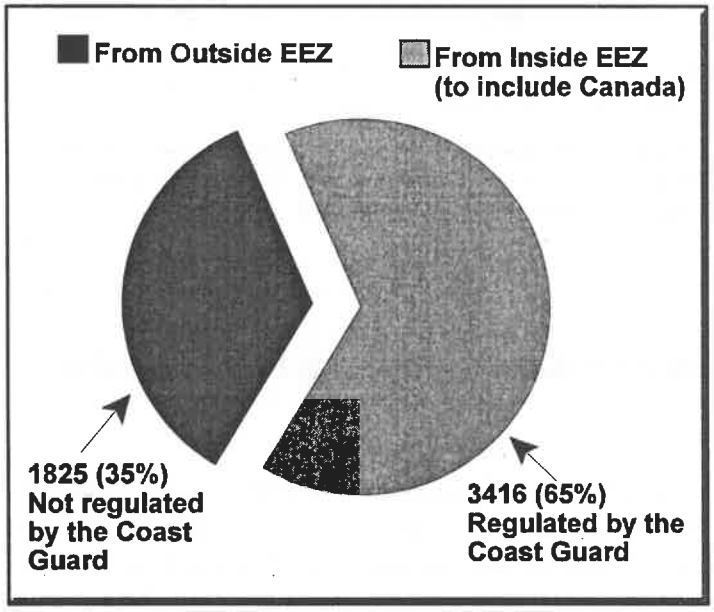

Figure 1. Vessels arriving into the ports of Los Angeles and Long Beach, CA (1998).

The west coast's chief trading partners are Japan, Canada and neighboring states (Table 2). Other trading partners include central and South American countries and other Pacific Rim countries and Australia.

Table 2. Top four last ports of call by U.S. Coast Guard Port Zone

Port Zone	Japan	Canada	California	Washington	Alaska	Mexico
LA/Long Beach	*	*	*	*	*	*
San Francisco	*	*	*	*	*	*
Puget Sound	402 (22%)	253 (14%)	338 (18%)	--	172 (10%)	--
Columbia River	432 (23%)	396 (21%)	367 (19%)	232 (12%)	--	--
Add others	*	*	*	*	*	*

Source: USCG, 1999 * Add marine exchange data as it becomes available

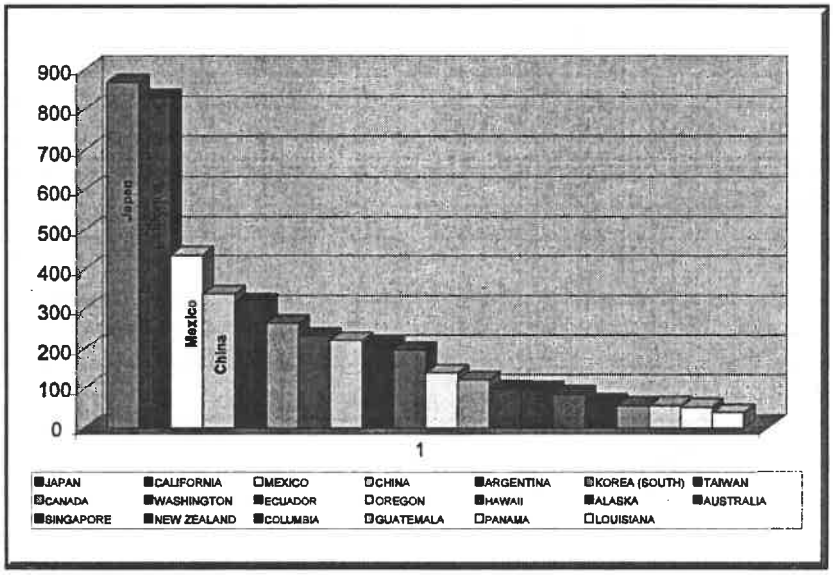

Figure 2. Nations of last Port of Call for vessels arriving into the ports of Los Angeles and Long Beach, CA (1998).

Puget Sound/Georgia Basin Shipping Patterns and Ballast Water Information

The Puget Sound Action Team completed an initial assessment of current ballast water practices in Puget Sound and the Georgia Basin[7]. This summary is based on information provided by the Puget Sound Steamship Operators Association. The Puget Sound Action Team will also identify environmental factors for locating alternative ballast water discharge zones.

[7] Jessica Gramling, unpublished, August 1999

The following points summarize shipping and ballast water data from Puget Sound ports and British Columbia ports.

Puget Sound Ports

- 3861 vessels called on Puget Sound ports in 1998. Container vessels represent the highest number of port calls followed by tanker and bulk vessels and roll-on/roll-off ships.
- 54% of the vessels entering Puget Sound originated from Pacific coast ports of call. 658 vessels – 17 percent of the total number of vessel calls – loaded, but did not off load cargo. It is likely these ships arrived with ballast on board and discharged it in port.
- Over 500 of these 658 were bulk or tanker vessels. The most common last port of call for the 658 vessels was other Washington ports, followed by Japan, California and Canada.
- Overall, 73% of these vessels originated along the Pacific coast and are not 'regulated' by the U.S. Coast Guard.
- Bulk vessels and tankers discharged nearly 90% of all total ballast water discharged in Puget Sound. The total volume discharged by all vessels is estimated at 9.5 million metric tons per year.

British Columbia Ports

- Marine exchange data are not currently available for any Georgia Basin port.
- The Port of Vancouver is a major export port – exporting 61.4 million tons annually.
- As an export port, it is reasonable to assume that a greater number of vessels will arrive with ballast, discharge it in port before loading cargo for export.
- About 84% of the total cargo handled by the port in 1998 was bulk cargo.
- The port's principal trading partner is Japan, followed by South Korea, China, U.S., Taiwan, Brazil, Mexico, Great Britain, Indonesia and Italy.
- Port of Vancouver currently has a mandatory ballast water exchange program in place.

Risk Assessment

To properly manage risks, several categories of risk can be defined based on current information. These are listed below:

Risk posed by vessels (Only a small percentage of all vessels entering west coast ports are considered a high risk for ballast water discharge):

- Unregulated high-risk vessels: Bulk carriers and tanker vessels originating from west coast U.S. ports of call fall into this category. Between 50-68 percent of the high-risk vessels entering Puget Sound and Columbia River ports are not 'regulated' by the Coast Guard – about 807 ships a year. (Using the Puget Sound case study as an example, 480 (73%) high-risk vessels that entered Puget Sound ports in 1998 were not 'regulated').

- 'Regulated' high-risk vessels: Bulk carriers and tanker vessels originating from outside the EEZ fall into this category. Between 32 to 50 percent of the high-risk vessels entering Puget Sound and Columbia River ports are 'regulated' by the Coast Guard – about 450 ships a year. (Using the Puget Sound case study as an example, 158 (27%) high-risk vessels that entered Puget Sound ports in 1998 were 'regulated').

- Moderate risk vessels: The majority of 'regulated' or unregulated ships entering or transiting through Pacific coast ports fall into this category. All represent a potential risk for discharging ballast and associated undesirable invasive species.

- Low risk vessels: Ships that generate ballast onboard, that heat treat ballast or have "no discharge" onboard ballast management systems fall into this category.

Risk based on location: Some estuaries are more heavily invaded by non-native species than others. California bays and estuaries have a higher level of invasion than those of Washington and Alaska. Unregulated high-risk ships originating from California ports of call bound for northern terminals pose a higher risk than ships moving in the opposite direction.

Risk based on shipping volume: Certain locations along the coast receive more high-risk traffic than others. These ports receive higher volumes of discharged ballast than other ports -- increasing the risk of introduced invasive species. Based on available 1998 marine exchange data, the Los Angeles/Long Beach port zones area receives a significantly larger volume of traffic than other Pacific coast ports. (*What proportion of this traffic is high-risk and how does it compare to San Francisco's traffic.--Fill in the blanks when data are available)*

Undetermined risk: 'Regulated' vessels that participate in the voluntary exchange of ballast water may still pose unacceptable risks for introducing invasive species. Ballast water exchange efficiencies may not fully eliminate water borne invasive species. Full tank re-ballasting methods (emptying and refilling each ballast tank in turn) are 70-90 percent efficient at replacing original ballast[8]. Flow-through re-ballasting – flushing original ballast out with replacement

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[8] Dames and Moore, 1999, Ballast Water Exchange and Treatment Executive Summary prepared for CAPA, PSMSA, SASC and WSPA (25835-003-086).

water – can achieve about a 95 percent exchange rate. However, 25 percent of the original plankton and sediment remained in the flushed tanks[9].

Many ships enter west coast ports from outside the EEZ. They then move from port-to-port delivering and loading cargo. The quantity and quality of the ballast discharged during these stops is not known.

Seasonal risk: Ship captains in transit during unfavorable weather conditions will prioritize ship safety over ballast exchange. Winter is the predominate season for bad weather. Ships, during winter, are more likely to retain ballast from the last port of call and discharge it in the port of destination.

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[9] Dames and Moore, 1999. Ballast Water Exchange and Treatment Executive Summary prepared for CAPA, PSMSA, SASC and WSPA (25835-003-086)

Ballast Water Management Programs

The U.S. Coast Guard Ballast Water Management Program

Purpose of Regulations

The Coast Guard Interim Rule on ballast water management, Implementation of the National Invasive Species Act of 1996,@ was published in the Federal Register on May 17, 1999. The new regulations amend 33 Code of Federal Regulations (CFR) Part 151, Vessels Carrying Oil, Noxious Liquid Substances, Garbage, Municipal or Commercial Waste, and Ballast Water. These regulations are intended to limit the introduction and spread of aquatic nuisance species into the waters of the United States. Presently, the primary means of preventing this is to replace ballast water taken on in foreign ports with deep ocean water through an at sea ballast water exchange. The new Coast Guard rule establishes voluntary ballast water management guidelines for all waters (except the Great Lakes and sections of the Hudson River) of the U.S. and establishes mandatory reporting and sampling procedures for nearly all vessels entering U.S. waters.

Key Provisions of the Coast Guard Ballast Water Management Program

1. Voluntary Guidelines & Recommended Practices: These guidelines include suggested precautionary practices that should be taken by every vessel to minimize the uptake and release of harmful aquatic organisms, pathogens, or sediments. Additionally, the rule recommends that vessels carrying ballast water into the waters of the U.S. after having operated beyond the Exclusive Economic Zone (EEZ) to employ one the following ballast water management practices:

    - Conduct an exchange of ballast water beyond the EEZ, in an area no less than 200 miles from any shore and where the water depth exceeds 2000 meters
    - Retain the ballast water on board
    - Use an alternative method of ballast water management
    - Discharge ballast water to an approved reception facility
    - Conduct the exchange in an approved Alternative Exchange Zone.

2. Mandatory Requirements: All vessels calling in west coast U.S. port must submit a completed Ballast Water Report Form (Appendix to 33 CFR 151, Subpart D) to the Smithsonian Environmental Research Council (SERC). Submission of the International

Maritime Organization ballast Water Reporting Form will also fulfill this reporting requirement. The reports must be kept on board the vessel and available for inspection for two years.

3. Compliance Boardings & Monitoring: Random ballast water boardings will be conducted at the rate of 2-3 boarding per week per Coast Guard Marine Safety Office (MSO) as directed by the matrix provided in reference (a). Boardings will generally take place during normal business hours. To monitor compliance with both the mandatory and voluntary aspects of the Coast Guard ballast water management program, ballast water boarding officers will examine documents, take samples of ballast water and sediments, and make other inquiries to access compliance.

    - Ballast Water Sampling: At least 10%, but no less than two of the vessel's ballast water tanks will be tested in order to confirm compliance. Ballast water salinity test samples of above 29.0 ppt will be considered to be in compliance.

    - Documentation Check: Ballast water inspection personnel will conduct an interview with a member of the ships crew. These questions regarding ballast water management history will complement those on the Ballast Water Reporting Form. The approximately 20 questions are contained in an electronic format of a handheld computer. This information collected by Coast Guard boarding officers, will be submitted to the National Ballast Water Management Survey that is administered by the Coast Guard and the SERC.

4. National Ballast Water Management Survey: The Coast Guard must report to Congress no later than 30 months after voluntary guidelines are implemented as to whether these guidelines are effective in controlling the introduction and spread of ANS. To substantiate the findings of this report, the Coast Guard will utilized the information collected from the Ballast Water Reporting Forms and from the ballast water compliance boardings conducted by the Coast Guard.

Effectiveness Criteria

If the Coast Guard determines that the voluntary program is ineffective at controlling the introduction or spread of non-indigenous species, the rate of effective compliance is found to be inadequate, or vessel operators do not report in sufficient numbers to permit the Coast Guard to assess the effectiveness, the guidelines will become mandatory and carry civil and criminal penalties.

Port Programs

A number of ports and harbor districts have established ballast control programs independent of federal and state rules and regulations. These entities have used the authority of such

mechanisms as the port tariff system to implement ballast exchange and discharge requirements designed to prevent the introduction of exotic species into their local waters. Following is a brief summary of the programs that are currently in place at U. S. ports along the Pacific Coast.

Humboldt Bay Harbor, Recreation and Conservation District, California

The Humboldt Bay Harbor, Recreation and Conservation District adopted a resolution in 1996 that established ballast water management requirements for all vessels entering the Bay. The language of the resolution is as follows:

> *All vessels entering Humboldt Bay with ballast originating from a foreign port shall perform a mid-ocean exchange of ballast with due regard for the safety of the vessel. This shall be accomplished by voiding each ballast tank and refilling each ballast tank with mid-ocean water.*
>
> *A "foreign port" as defined here shall include any port except those located on the west coast of North America.*
>
> *If the Master deems the situation not safe for voiding tanks due to weather conditions or hull stress parameters, he may partially empty tanks, fill with mid-ocean water, and continue pumping through the overflow or vent until full exchange is reasonably assured.*
>
> *The Master shall keep a record of all ballasting activities and file a statement of such activities with the Humboldt Bay Harbor, Recreation and Conservation District of its designee upon arrival in Humboldt Bay.*

Port of Oakland, California

In Oakland, port expansion necessitated a study of the environmental impact of increasing vessel calls and the resultant increase in the volume of ballast water discharged into the waters of the San Francisco Bay. The Board of Port Commissioners established Tariff No. 2-a to address the need to find mitigation for the impact of their expanded facilities. The tariff provisions, summarized below, were adopted in June of 1999 with an effective date of August 1, 1999.

General requirements: *No vessel using Port terminal facilities shall discharge water ballast from the vessel into San Francisco Bay or the Gulf of the Farallones National Marine Sanctuary offshore of San Francisco Bay, including open waters within the Port Area of the City of Oakland, unless the vessel immediately before arrival in the San Francisco Bay has carried out an ocean ballast water exchange to limit the possibility of transferring non-indigenous species into San Francisco Bay. Exchange shall occur in the oceans westerly of the western boundaries of established marine sanctuaries adjacent to the West Coast of California.*

Exceptions to the general requirement: Vessels arriving from ports located between the southern boundary of Baja California and the northern boundary of Alaska, if the ballast water to be discharged originated from those waters.

Vessels providing proof of compliance with International Maritime Organization (IMO) Resolution A774(18) (Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens form Ships' Ballast Water and Sediment Discharges);

Vessels that do not exchange ballast because of safety concerns.

Reporting requirements: *Each owner/operator must submit a copy of their ballast water management policy to the Port by December 1st of each calendar year in which their vessel uses the Port.*

At or before each vessel call, a Ballast Water Reporting Form must be submitted. The form will be prescribed by Port authorities and must show details of ocean exchange and the actual or planned discharge within the Bay or Gulf of the Farallones.

If a complete report form is not submitted, the vessel may not discharge ballast within the Bay or Gulf of the Farallones until the ballast water is sampled and analyzed, at cost to the vessel, and deemed to comply with Port standards. This prohibition becomes effective 12 months after the tariff becomes effective in order to allow sufficient time to disseminate and observe the application of this provision.

Port of Los Angeles, California

The Port of Los Angeles does not currently have an established program to control the introduction of exotic species from ballast water. The port does have a policy of encouraging its customers to comply with the USCG's (voluntary) exchange guidelines.

Port of Long Beach, California

The Port of Long Beach does not currently have an established program to control the introduction of exotic species from ballast water. However, like Los Angeles, they do have a policy of encouraging their customers to comply with the USCG's (voluntary) exchange guidelines.

Port of Valdez, Alaska

North America's largest crude oil loading terminal is on the south shore of Port Valdez, Alaska, and has been operational since 1977. Until 1996 exporting of crude oil from Valdez was not allowed, so the 14,000 tankers loaded during those 20 years delivered more than 11 billion

barrels of oil to U. S. ports only. No ballast water treatment or management plan—including ballast exchange—was required.

On May 28, 1996, Public Law 104-58 went into affect, effectively lifting the ban on the export of Alaska's North Slope crude. There are several conditions in the law, one of which requires exporting tankers to " adopt a mandatory program of deep water ballast exchange (i.e., at least 2,000 meters water depth). Exceptions can be made at the discretion of the captain only in order to ensure the safety of the vessel and crew. Specified records shall be maintained and made available for audit by government officials" (15 CFR 754.2).

Thus, since the summer of 1996, exporting tankers have exchanged their ballast water at sea before returning to Valdez. However, the vast majority of tankers (c. 95%) still sail to domestic ports (which are themselves invaded with exotic species) and have never been required to exchange their ballast. Nor are they required to participate in the U. S. Coast Guard's new voluntary ballast management program because they were specifically exempted from the language in the National Invasive Species Act of 1996 upon which that program is based.

Ports of Seattle/Tacoma, Washington

The Ports of Seattle and Tacoma have addressed the ballast water issue in Environmental Impact Statements for other port projects. However, neither port currently has a policy on ballast water. There is some action on this front. I have some calls into people, but I don't have responses yet. I will add to this section as information becomes available.

Existing State Programs

There are a few ballast control programs being developed at the state level in California. Each is based on federal water quality laws that are implemented by the State and Regional Water Boards. Both are in the initial planning stages and won't be fully implemented for several years.

The Ocean Plan prepared by the California State Water Resources Control Board

The California Ocean Plan was first adopted in 1972 and is subsequently revisited on a triennial basis. The Ocean Plan sets water quality objectives for protecting the beneficial uses of California's near-shore waters (Near-shore waters are those from the coastline out three miles. The Ocean Plan does not cover bays and estuaries). Based on these water quality objectives, effluent standards are established for the discharge of waste into the coastal waters of the state.

During each triennial review cycle, old and new issues are presented and then either included or deleted as an action-item for the subsequent period. A workplan is then developed for those issues that will be dealt with during any given three–year period. The 1999-2002 Triennial Review and Workplan is scheduled for adoption in July 1999.

The 1999-2002 Workplan includes, among many other things, a recommendation to amend the Ocean Plan to regulate the discharge of ballast water containing non-indigenous marine plants and organisms. The Workplan proposes defining non-indigenous species (NIS) as a waste that impairs the beneficial uses of the ocean waters. To address this newly-defined waste, the Plan recommends: monitoring current efforts by other agencies already addressing NIS issues; collecting and evaluating existing information on the magnitude and extent of NIS invasions within coastal marine waters; and identifying and mapping the geographic extent of known invasions.

Generally, the Plan would address the NIS issue by studying it further in order to better understand the degree to which non-indigenous species are effecting the beneficial uses of coastal waters.

TMDL Plan prepared by the San Francisco Regional Water Quality Control Board

Section 303(d) of the federal Clean Water Act requires states to identify specific water bodies where water quality standards are not being attained, and specify the pollutants that are impairing the beneficial uses of that body of water. Once such a designation is made the Regional Board must then determine the total maximum daily load (TMDL) of the specified pollutant that the named water body can safely assimilate before beneficial uses are impaired. A TMDL is then established and allocated to all of the sources of the pollutant, usually requiring reductions to achieve an ambient level of the pollutant that is protective of beneficial uses.

In February 1998, the San Francisco Regional Water Quality Control Board listed exotic species under Section 303(d) as a pollutant that was impairing the beneficial uses of the San Francisco Bay and estuary system. In May 1999, the U.S. EPA Region IX concurred with this listing. A TMDL Plan has been written that identifies ballast water as a primary source of the pollutant, and recommends a total maximum daily load of zero exotic species, on the basis that the San Francisco Bay and estuary system cannot assimilate certain exotic species without significant degradation of biological integrity. The exact mechanism for achieving this level will be developed over the next few months to years. The Regional Board's Basin Plan will likely be amended to prohibit the discharge of untreated ballast. There will, however, be specified exceptions to the prohibition to allow the maritime industry time to develop treatment alternatives and more effective discharge procedures.

Proposed State Program

In California, a bill has been introduced by Assembly member Ted Lempert that will amend the State Water Code to establish a ballast water management program to control the introduction of non-indigenous species into California marine waters. The program will be under the jurisdiction of the State Water Resources Control Board (the board), and will be established in consultation with the Department of Fish and Game (DFG), the State Lands Commission (SLC)

and the U.S. Coast Guard (USCG). Following are the principle provisions of the bill and the time frames for implementation:

Ballast Report Form

On or before March 1, 2000, the board shall develop a ballast water report form to be used by vessels entering the waters of the state. The report form must be consistent with the form developed by the USCG in compliance with the National Invasive Species Act of 1996. On or after April 1, 2000, the bill would require the master of any vessel that enters the waters of the state to complete and submit a copy of the ballast report form to the board.

Discharge Requirements

By July 1, 2000, in consultation with the DFG, SLC and the USCG, the board must develop *statewide general waste discharge requirements*, and a form to be used as a "notice of intent to operate" under those requirements. The requirements must be presented for comment during a public hearing and shall be in effect for a period of five years. At the end of the five year period the board may revise and reissue the requirements, again in consultation with the DFG, SLC and USCG, and after a public hearing.

Discharge Prohibition

Between September 1, 2000 and December 31, 2002, the bill would prohibit any vessel from discharging ballast, loaded from outside the Pacific Coast region, into the waters of the state unless the discharger has complied with the board's statewide general waste discharge requirements, and submitted a notice of intent to comply with those requirements. The discharge requirements shall include a provision to either conduct an exchange that replaces at least 95% of the original volume of ballast with open ocean water, or use an 'environmentally sound' alternative method.

Sampling and Monitoring

The board, or its designee, in coordination with the USCG, shall sample and monitor ballast water in order to assess the accuracy of the information provided on the ballast report forms and the notice of intent forms. At a minimum, samples must be taken from 10 percent of the vessels carrying ballast that was initially loaded from outside the Pacific Coast Region.

Report on Alternative Technologies

On or before December 31, 2001, the board, in consultation with DFG, SLC and the USCG, must complete and submit a report to the Legislature evaluating alternatives for treating and managing ballast water. The report must include a recommendation of the best available technologies that

will provide the greatest degree of reduction in the release of exotic organisms that is economically feasible.

Report Form Summary

On or before September 1, 2002, the board, in consultation with DFG, SLC and the USCG, must complete and submit a report to the Legislature and the general public detailing the information gathered from the ballast discharge report forms and the notices of intent. This report shall be the first in a series of biennial reports that provides this summary data. The biennial reports must also include an analysis of the monitoring and inspection information, and an evaluation of the effectiveness of the measures taken to reduce or eliminate exotic organisms from vessel ballast water.

Funding

The bill establishes an Exotic Species Control Fund and authorizes the board to collect an annual fee. The total fees assessed shall be sufficient to cover the costs incurred by the board, the regional board and, as determined by the board, other state agencies in carrying out duties relative to the ballast management program.

The bill has passed in the California Assembly and will be heard and debated in the Senate sometime in August. If the bill passes both houses, it will become effective the first of next year (January 1, 2000). The provisions detailed above may be amended before the bill is finalized.

Regional Programs

In California an organization known as *CalFed* was established to develop a long-term solution to problems affecting the San Francisco Bay-Delta system. The organization is comprised of representatives from state and federal agencies. These agencies came together to build on the spirit of cooperation reflected in the December 1994 Bay-Delta Accord. The goal of the organization is to work cooperatively to develop and implement a long–term comprehensive plan to rehabilitate the ecological health and improve water management for the beneficial uses of the Bay-Delta.

CALFED Member Agencies:

California	*Federal*
Department of Fish and Game	Environmental Protection Agency
Department of Water Resources	Fish and Wildlife Service
California Environmental Protection Agency	Bureau of Reclamation
State Water Resources Control Board	Army Corp of Engineers
	Department of Agriculture
	National Marine Fisheries

The Ecosystem Restoration Program (ERP) is the principal program component designed to rehabilitate the ecological health of the Bay-Delta ecosystem. The ERP represents one of the most ambitious and comprehensive ecosystem restoration projects ever undertaken in the United States. The goal of the ERP is to restore or mimic ecological processes and to increase and improve aquatic and terrestrial habitats to support stable, self-sustaining populations of diverse and valuable species.

As the threat of nonnative invasive species to healthy ecosystems and restoration efforts becomes more and more apparent, the CalFed organization has come to realize the importance of addressing this environmental stressor as part of the restoration work. As part of the ERP, the U.S. Fish and Wildlife Service has accepted the responsibility of developing, implementing, and coordinating a nonnative invasive species (NIS) program in the San Francisco Bay-Delta estuary which will include terrestrial as well as aquatic species. This program, with the coordination of CalFed staff, agencies and interested stakeholders, will focus on the San Francisco Bay-Delta, the Sacramento and San Joaquin Rivers and their watersheds. The program objectives are as follows:

Develop a long-term strategy to manage non-native invasive species in the Bay-Delta estuary and its watersheds.

Support prevention-oriented management and research projects to prevent or minimize additional invasive species from being introduced into the Bay-Delta estuary and its watersheds.

Support control-oriented management and research projects to eradicate or manage invasive species once they have arrived and prevent or delay their proliferation.

An NIS Agency Team and Technical Team have been formed and have cooperatively developed draft planning documents for this program. Strategic planning for the ERP and the NIS work teams have identified ballast water releases as a pathway of NIS introduction that represents significant risk to the ecosystem. One objective of the ERP Strategic Plan is to "Eliminate further introduction of new species in ballast water of ships." Team members are working through their agencies and various other working groups on efforts to make progress on this complex and challenging objective.

The Strategic Plan will also provide a basis for a directed project to establish a Non-native Invasive Species Advisory Council (NISAC) that will address a broad array of exotic species issues including introduction from the ballast of ships. Representatives from the U. S. Department of Agriculture, Calif. Department of Fish & Game and Calif. Department of Food and Agriculture will sit as lead agencies on the Council. The immediate tasks of the NISAC will include the following: identify particular problems and evaluate pathways; coordinate, establish and streamline the authorities and responsibilities of state and federal agencies to regulate and enforce NIS introductions; and develop a "Rapid Response Plan" to facilitate immediate action to address an exotic species in the early stage of infestation.

International Programs

Port of Vancouver, British Columbia, Canada

The Vancouver Port Corporation adopted a Harbor Master Department Standing Order establishing mid-ocean ballast water exchange requirements for all vessels entering the port in March 1997. The mid-ocean exchange requirements were voluntary during a nine month 'grace period'. However, the requirements became mandatory on January 1, 1998.

General requirements: All vessels destined to arrive at the Port of Vancouver in ballast condition will be required on and from March 1, 1997 to carry out a Mid Ocean Ballast Water Exchange prior to arriving in Canadian Waters.

The purpose of this exchange is to limit the possibility of transferring non-indigenous species into Canadian waters.

Any vessel conforming to IMO Resolution A 774(18), (Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships' Ballast Water and Sediment Discharges), will be considered in compliance with these procedures.

Exceptions to the general requirements: Vessels arriving in Vancouver from Ports on the west Coast of the United States of America (North of Cape Mendocino), British Columbia and Alaska, wishing to discharge ballast water do not have to adhere to policy if the ballast water to be discharged originated from these waters;

Vessels wishing to discharge less than 1000 metric tonnes of ballast water;

Vessels that do not exchange ballast water because of safety concerns.

Reporting requirements: Harbor Master's representatives when boarding vessels to conduct ballast checks will require to see one of the following: log book entry (In English); abstract of the log book entry; Company or other administrative form giving details of the mid ocean exchange of ballast water. These details must include the following information:

- Position of exchange, latitude and longitude
- Placed where ballast water originally taken
- Amount of ballast water
- Ballast tanks which have had water exchanged
- Details if ballast not exchanged

This information may be faxed to the Harbor Master's Office, however a Harbor Master representative must be in attendance prior to the discharge.

Compliance procedures: The Harbor Master representatives test for compliance using a salinity test as well as a biological test comparing samples with known indicators, such as "harpacticoid

copepods". Sampling takes 1 to 2.5 hours, depending on the physical set-up on the vessel. The Standing Order states:

> In the event that the vessel is unable to supply the above information in the prescribed manner, then no ballast water will be allowed to be discharged to the harbor until the following procedures have been forwarded.
>
> Samples of the ballast water will be drawn and analyzed by a Harbor Master Representative.
>
> Ballast water found not meeting VCP test standards, will require the vessel depart the port and exchange ballast water in the outgoing current of the North side of the Strait of Juan de Fuca, West of Race Rocks.

Other British Columbia Ports

Several smaller British Columbia Ports including Port Alberni, Nanaimo, Prince Rupert and Fraser Port have adopted a ballast water program resembling the Port of Vancouver policy. However, not all of these ballast water exchange programs are mandatory.

Australia

At a Pacific Coast Ballast Water Group meeting on June 17, 1999 in Oakland, California, Penny Lockwood agreed to provide information regarding some of Australia's ballast water management initiatives. Until a recent career move, Penny managed Australia's Ballast Water Program, including policy and operational development, IMO representation, and the Australian Ballast Water Research and Development Program.

Penny indicate that the Australian ballast water management program is now managed by Jonathon Barrinton and further information can be obtained from the Australian Quarintine and inspection Service (AQIS). By emailing: ballastwater@aquis.gov.au. Penny will also provide information on past initives (Email: Penny@dynamite.com)

Australian Guidelines and "Newcastle" Ballast Exchange Verification Method

Following adoption by the IMO in November 1997 of revised ballast water management guidelines and a new IMO standardized ballast water reporting form, Australia revised its guidelines and reporting form in 1998. From 1 July 1998, the revised arrangements apply to all ships traveling to an Australian port from outside the Australian EEZ. The Australian reporting form is based on the IMO reporting form, and the Australian guidelines and reporting form can be found on the Australian Quarantine and Inspection Service (AQIS) home page (www.aqis.gov.au).

In order to determine compliance with the guidelines, and accuracy of data provided by ships on the ballast water reporting form, and in the absence of alternate scientific methods, Australia developed an interim ballast exchange verification method which relies on determining ship-board electrical loading variations during a ship's voyage. This method, known as the "Newcastle" method was trialed in 1998 at the Australian port of Newcastle on several hundred ships. The method was developed by a marine engineer and the trial conducted by AQIS.

Only those ships reporting full exchange (ie more than 95% used in this case), were included in the trial. However, it should be noted that no control ships were used in the trial and therefore the results need to be considered with this in mind. Preliminary unpublished results on the first 198 ships trialed using the "Newcastle" method of ballast exchange verification indicate a significant degree of inaccurate reporting.

The "Newcastle" method was designed to help mariners understand Australia's Ballast Water Management requirements of mandatory and accurate reporting, as much as it was to verify, for regulatory purposes, the accuracy of ballast water reports. It became clear during the trials that a significant proportion of the inaccurate reporting resulted from a misunderstanding by mariners of what constituted a "full exchange". During the trial it was observed that a number of ships' masters and engineers believed that replacing one full tank volume of ballast water using the flow-through method was a full exchange, whereas the Australian and IMO guidelines make it clear that the equivalent of three tank volumes needs to be flowed-through to achieve full exchange. This observation points to the need for a comprehensive maritime awareness program to achieve full compliance (see below) .

For futher information on the "newcastle" method contact: leanne.horsnell@aqis.gov.au

Penny has indicated that she would be happy to produce the operational check list on an excel file.

Maritime Awareness Program

Advice in Australia from the international and national shipping industries, prior to the introduction of the new AQIS ballast water management measures, was that if mariners were adequately informed of Australia's ballast water management requirements and guidelines, they would be more likely to fully comply. This message was reinforced following the outcomes of the "Newcastle" verification method trials.

Consequently, a Ballast Water Maritime Awareness Program was developed by a committee including shipping interests, PR experts, AQIS and the Department of Environment which provided funding for the project.

The Program commenced with a series of press releases, advertisements in national and international shipping journals, and the development of a Maritime Awareness Package. A targeted address data base of national and international maritime industry contacts was also developed to facilitate the distribution of the Package. The package is available from AQIS.

Biological Port Survey Protocols

Australia embarked on a program of port biological surveys in 1996 in order to gain a better knowledge of the current distribution and abundance of invasive marine pest species in Australian ports, thereby allowing for more effective management of ships' ballast water in relation to coastal shipping. Since a number of different research organizations and agencies would be participating in the surveys, and to ensure data consistency, the Australian Ballast Water Management Council (ABWMAC) considered it important to have standardized survey and port sampling protocols. These were developed by the Commonwealth Scientific and Industrial Research Organization's (CSIRO) Centre for Research on Introduced Marine Pests (CRIMP). The protocols take into account scientific, cost and logistical constraints.

The Australian port biological survey protocols are available from CRIMP. Since the commencement of the port survey program, approximately one third of Australia's 64 international shipping ports have now been surveyed for targeted marine invasive species.

Ballast Water Sampling Protocols

Sampling ships' ballast water is an important tool for scientific and management verification, and for this reason it is equally important to determine the most effective and representative method of sampling. A study of sampling methods was initiated by ABWMAC which involved: 1) a review of sampling protocols currently in use by national and international ballast water research and management groups, and 2) field trials and evaluations of a range of sampling methods.

A report of this study is available from CRIMP (see below), and in summary indicates that "access to ballast tanks and the stage of the ballasting cycle at which sampling occurs impose major restraints on the types of methods that can be employed. Operationally, net sampling through tank top covers was preferred for ease and speed of sampling, but this method is only appropriate for cargo holds and wing tanks (when full). Sampling with pumps via sounding pipes or air vents provides access to a greater range of tanks, but requires more cumbersome equipment and longer sampling times. In-line (ballast pump) sampling techniques also require relatively long sampling times and can only be used when ballast pumps are in operation, either during ballasting or deballasting. ..... no single method effectively sampled all taxa.....[but] overall, nets were most effective at sampling..." It should be noted that slow flow rates of pumps used in sounding pipes and/or in-line resulted in some under sampling. AQIS has adopted only net sampling to test for the presence of toxic dinoflagellates or cholera in ships' ballast water, largely due to the ease of operational procedures, and recommendations of the CRIMP study.

Ballast Water Research/Policy Publications

A number of ballast water R&D publications are available from the following sources:

CRIMP: www.marine.csiro.au/CRIMP is the web site address. Check it out to determine which research publications you are interested in (scroll down to 'research and publications'). You can order the CRIMP publications by e-mail through: Sue.Spinks@marine.csiro.au or Chad.Hewitt@marine.csiro.au.

AQIS: AQIS has a series of around 11 R&D publications. Check out the AQIS web site (www.aqis.gov.au) to determine which publications you would like to order, then order from Janet.Cant@aqis.gov.au. When you get to the AQIS home page, click on 'shipping' and then scroll down to ballast water, and select 'AQIS ballast research series'. AQIS may request pre-payment of $AUD20 for each publication before sending them to you. Payment can be made with money orders, cheques etc. but must be in Australian dollars.

PCQ: Ports Corporation Queensland has undertaken a number of studies on the ballast water and invasive species issue, including a very large one by Dames and Moore (about 5 reports) on the ballast issue, the risks, shipping routes, ballast sources, etc. PCQ has also surveyed most of its ports using the CRIMP survey protocols, and has, or will soon have, reports of those surveys. In addition, the PCQ report, 'The Ballast Water Issue: Implications for Australian Bulk Exports" is a useful and thoughtful document, for the first time discussing the issue of near coastal exchange by vessels en-route to a another destination (ie the near coastal waters of the Pacific Islands receive ballast from Japanese ships en-route to Australia) . The PCQ web site is: www.pcq.com.au. Click on 'environment' at the top of the web page, then scroll down below Eco Ports where there is an embedded e-mail facility. Ask for a list of their reports, and how they can be ordered.

Another of the PCQ reports (funded by PCQ/JCU and published by AQIS) is of the outcomes of a study by Dr Darren Oemcke of a number of ballast treatment methods currently under consideration throughout the world, ballast water characteristics, and the results of ozone treatment tests. The results indicate that ozone treatment is probably not appropriate for ballast water. Darren who is very informed on treatment methods, can be contacted on: doemcke@ghd.com.au.

SPECIES SURVIVABILITY: The Australian Museum in Sydney (AMBS Consulting) was commissioned by AQIS to review the literature on species survivability in ships' ballast water (given length of voyage etc.). The conclusions of this study are interesting, but have not yet been published. A copy of the draft report can be obtained either from Janet.Cant@aqis.gov.au, or from the author of the report, Dr Pat Hutchings, AMBS Consulting, Australian Museum, College Street, Sydney, NSW, Australia. Alternatively, see item 9.

VUT: Dr Trevor Burridge at the Victorian University of Technology has been involved in invasive species research, and as I understand it, particularly on *Undaria pinnatifida.* The VUT web site is: www.vut.edu.au. Good luck finding any invasive species stuff, I found it a difficult site to get through.

(NZ) NIWA: The New Zealand National Institute of Water and Atmospheric Research Ltd has been involved in invasive species/ballast water research. In particular NIWA technical report 34, outlines vectors for introduction of exotic species, including ballast water, hull fouling and oil platforms. NIWA has a web site (don't forget the '.nz').

(NZ) CAWTHRON INSTITUTE: Has a strong focus on invasive species/ballast research. The Cawthron web site is: www.cawthron.org.nz - click on 'what do we do' and then 'biosecurity'. However, it is difficult to find reference to much of the work I know they have already done on the ballast/invasive species issue. It might be a good idea to use the embedded e-mail facility on the web site to ask for a list of relevant publications.

Port Ballast Water Management Plans and Coastal Transfers

The Australian Ballast Water Management Advisory Council currently includes representatives from each Australian State (all States and the northern territory are coastal). To address the issue of managing coastal ballast water transfers, the States, who are responsible for coastal shipping and ports in Australia, set up a sub-committee of ABWMAC called the Coastal Group. This group developed coastal ballast water management guidelines, and considered port ballast water management plans to be a key component of those guidelines. A model plan was drawn up by the Group, which lists key issues that should be addressed by the ports. The chair of the Group was Ms Pauline Semple of the Queensland Environment Protection Agency.

In 1998 the Australian Minister for Environment funded a trial of the guidelines across three south eastern Australian ports, which also involved the development of port ballast water management plans for those ports. The consultancy firm, PPK, was contracted to design and

manage the trial, and has reported on the outcomes. A copy of the report is available from Environment Australia through Robert Ferguson, Manager, Introduced Marine Pests Program. His e-mail is: robert.ferguson@ea.gov.au.

Tthe Victorian government has been very proactive on the ballast water issue (ref. Report of Parliamentary Inquiry into Ballast Water and Hull Fouling - www.parliament.vic.gov.au : click on Committees, then on Environment and Natural Resources Committee, then on obtaining reports of the Committee. The Report is listed there as well as an embedded e-mail address for ordering).

Port Contingency Planning

Concerned at the significant costs to shipping of returning from a port to open ocean to exchange ballast water and the lack of any port contingency plans for alternate exchange areas, AQIS commissioned Thompson Clarke Shipping (Melbourne) to examine the issue of port contingency planning. A draft report was issued in November 1997 a copy can be obtained from the Northeast Midwest Institute.

Other Ballast Water Activities

On-Shore Ballast Water Treatment: Australia has not studied on-shore treatment options, considering it at this stage to be impractical and expensive.

Penny Lockwood has written a report on this issue and a copy can be obtained from her at penny@dynamite.com.au.

Community Monitoring for Introduced Marine Pests: CRIMP, Environment Australia (Department of Environment) and AQIS have jointly examined the effectiveness of establishing a community monitoring program for marine pests in the belief that early detection might allow eradication. An interactive web page providing information to the community was recommended and more information can be obtained on this by contacting: robert.ferguson@ea.gov.au or CRIMP.

Economic Incentives for Improving Compliance: The Victorian Department of Natural Resources and Environment has issued a report on "An Analysis of Economic Instruments to Minimize the Detrimental Effects of Ballast Water on Australia's Marine Environment". I haven't read it. The author is Gina Pitsivoris, and the report is Economics Branch, Working Paper 9704. The web site address is: www.nre.vic.gov.au. Click on publications/sales and service/library and e-mail the head librarian, or use the full address: www.nre.vic.gov.au/about/econ/pubs/pubs.htm.

Publications Available from the Northeast Midwest Institute

- Thompson Clarke Shipping Pty Ltd and Gutteridge Haskins and Davey, *Ballast Water - Port Contingency Plan*, final draft report November 1997 (unpublished).
- Australian Museum Business Services, *Ability of Target Organisms to Survive in Ballast Water,* final draft report February 1997 (unpublished).
- Darren Oemcke and J van Leeuwen, *Chemical and Physical Characteristics of Ballast Water: Implications for Treatment Processes and Sampling Methods*, CRC Reef Research Centre, Technical Report No. 23.
- *Ballast Water-Technical Overview Report*, AQIS Ballast Water Research Series No.9
- Zebra Mussels in Ireland, Dan Minchin and Christopher Moriarty, Dublin Marine Institute, February 1998.
- *Australian Ballast Water Management Strategy*, AQIS, January 1997.
- *Ballast Water Symposium Proceedings*, AQIS, 1994
- *Invasive Marine Species*, AQIS Paper presented to Alien Species and Marine Litter Seminar, EXPO 98, Lisbon
- *The Current Status of Ballast Treatment Research at Cawthron Institute*, NZ, a situation paper prepared for AQIS, May 1998
- Dr Ron Thresher, *Introduced Marine Pests - the Scale of the Problem in the Asia-Pacific Region and Practical Options to Manage It*, 1998 (9pp, can be faxed)
- Ballast water management, operational training manual 1998

Non-specific, but related documents:

- Guidelines for Establishing the National Representative System of Marine Protected Areas, Australia and New Zealand Environment and Conservation Council (ANZECC), December 1998.
- Australia's Oceans Policy - An Issues Paper for Public Comment, May 1998.
- Australia's Oceans Policy, Reports 1&2, for final comment by July 1999

Ballast Water Management and Treatment Technology Options

Theoretically there are many different ways to reduce the amount of foreign ballast water that is introduced into a port and its adjacent coastal community. The only approved method of addressing this problem to date is open ocean exchange. Currently, the efficiency of ballast water exchange is too low and it poses a safety hazard for the ship. Because of this, people have been coming up with a variety of methods to reduce the risk of invasive species introductions including: more efficient and safer methods of ballast exchange, ballast water treatment technologies, and ballast management options. Due to the wide range of ship types, sizes, and functions, the answer to the ballast water problem will probably not consist of one technology, but will be a combination of some of the solutions listed below. This section will summarize the current status of different management options and ballast water treatment technologies.

Ballast Exchange/Open Ocean Exchange

Open Ocean Exchange involves exchanging the ballast water that was picked up at a port with water from the open ocean. Organisms that are picked up at the port will not survive in the open ocean, and the organisms picked up in the open ocean will not survive in a coastal environment. The two major problems with this method are that it poses a safety hazard and the efficiency is not as high enough to completely remove the potential for invasion.

The ships operating on the water today were not designed to exchange their ballast water. The "traditional" location of the intake and outflow pipes do not allow for efficient mixing of the water and sediments in the ballast tanks. In addition, the ballast tanks are usually lined with baffles and partitions which lead to the accumulation of sediment and create "refuges" for organisms to "hide". The efficiency of ballast exchange could be increased by redesigning the piping for the ballast tanks. Although ballast exchange can be improved, most people still believe that ballast exchange is just a temporary answer to the invasive species problem. Even if efficiency is increased, there still could be enough organisms to allow for a successful invasion (although the probability would be low), and it would still create a safety concern for the ship.

1. Empty-Refill

   Description: This method consists of the ballast tanks being emptied and subsequently refilled. In various field tests researchers have found that 70 - 90% of the ballast water is exchanged when this method is conducted properly[10]. These results are not as high as one would expect because the positioning of the pipes does not allow the ballast tanks to be

[10] Oemcke, D.J., 1999. Review of Options for the Management and Treatment of Ships' Ballast Water. Ports Corporation of Queensland EcoPorts Monograph Series No. 18.

completely emptied. This process is also unlikely to remove the sediment at the bottom of the ballast tank, which can act as a "refuge" for organisms.

Advantages

Costs: Relatively low cost when compared with other potential treatment systems. Costs would include the development of a ballast water exchange management plan for each ship, pumping (fuel), and labor costs. The costs have been estimated to be 2.1 cents per metric ton of ballast water[11].

Approved Method: This is one of the few approved methods for ballast water management. Most ships are capable of conducting this process if they are in relatively calm seas.

Disadvantages

Effectiveness: Although this process significantly decreases the likelihood of an invasion, the potential for invasion still exists.

Safety: This process compromises the stability of ship, therefore ships traveling in rough seas will not be able to use this method. The stability problems that are created by this process can be reduced if the ballast tanks are emptied and refilled in a particular sequence. Stability can be managed more easily with ships that have a higher number of small volume ballast tanks, rather that a low number of large volume ballast tanks.

Outlook: This method is generally viewed as interim solution to the problem which will be used until a more efficient method is available.

2. Flow-through

Description: This method consists of pumping ballast water (3 times the capacity of the ballast tank) through the tanks, allowing it to overflow through air vents or deck hatches. This method exchanges approximately 95% of the ballast water, and 75% of the original plankton and sediment under optimal conditions[12].

Advantages

Costs: Relatively low cost when compared with other potential treatment systems. Costs would include the development of a ballast water exchange management plan for each ship,

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[11] Dames & Moore, 1999. Ballast Water Exchange and Treatment Executive Summary; prepared for CAPA, PMSA, SASC, and WSPA, Job No. 25835-003-086.

[12] Rigby, G. and G. Hallegraeff, 1994. The Transfer and Control of Harmful Marine Organisms in Shipping Ballast Water: Behaviour of Marine Plankton in Ballast Water Exchange trials on the MV "Iron Whyalla." Journal of Marine Environmental Engineering 1:91-110.

pumping (fuel), and labor costs. The costs have been estimated to be 5.8 - 8.1 cents per metric ton of ballast water[13].

Approved Method: This is one of the few approved methods for ballast water management. The stability of the ship is not compromised as much as in the "empty-refill" method.

Disadvantages

Effectiveness: Although this is an improvement over the previous method (only one method has been discussed thus far) of ballast exchange, a significant potential for invasion still exists.

Safety: Although stability is not as much of an issue during this process, the integrity of the ship is still compromised, therefore ships traveling in rough seas will not be able to use this method. There are additional safety hazards problems including potential tank over pressurization, and water overflowing on the deck.

Time: It usually takes most ships 3 to 4 days to complete this process.

Outlook: This method is generally viewed as interim solution to the problem which will be used until a more efficient method is available.

3. Brazilian Dilution Method

Description: This process was developed by naval engineers at PETROBRAS (a Brazilian Oil Company)[14]. This technique is a modification of the "empty-refill" method. This process involves loading ballast into the top of the tanks through a special deck pipeline, while simultaneously unloading water through the bottom of the tanks (by pumps or gravity).

Advantages

Effectiveness: This method should be more effective than other methods of exchange for removing organisms and sediment, due to improved mixing and flow regimes.

Safety: Removes the problems of tank over pressurization and water flowing on the deck.

Approved Method: This is one of the few approved methods for ballast water management.

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[13] Dames & Moore, 1999. Ballast Water Exchange and Treatment Executive Summary; prepared for CAPA, PMSA, SASC, and WSPA, Job No. 25835-003-086.

[14] Claudio G. Land and Jose M. Pimenta, PETROBRAS, dtv6@petrobras.com.br.

Disadvantages

Effectiveness: Although this process significantly decreases the likelihood of an invasion, the potential for invasion still exists.

Safety: Similar to the "flow through" method, stability is not as much of an issue during this process, the integrity of the ship is still compromised, therefore ships traveling in rough seas will not be able to use this method.

Costs: The operational costs for this method would be similar to the "flow through" method, but initial costs would be higher because the ships would have to be fitted with a new piping system that would allow for the ballast tanks to be filled from the top. PETROBRAS has estimated these costs to be up to 1% of new tanker costs (for installation) and 3% of old tanker value (for retro-fitting).

Outlook: This method is generally viewed as interim solution to the problem which will be used until a more efficient method is available.

Ballast Water Treatment Techniques

The treatment technologies that will be described below are in various stages of development. Although most of these technologies can be applied to onshore treatment or onboard treatment (while ballasting, during transit, or while deballasting), most technologies are better suited for one type or the other. This section will describe the advantages and disadvantages of each technology, and the technical problems that still need to be resolved before it could become an approved technique.

1. Filtration

Description: All the results from this section come from the Great Lakes Demonstration Project which has conducted several years of field testing to determine the effectiveness of a filtration system that is used while ballast is being loaded into the tanks[15]. They determined that a 5 mm pre-screen with a 50 or 25 micrometer filter worked the best. The system successfully eliminates the majority of the zooplankton and some of the phytoplankton.

Effectiveness: Removes the majority of zooplankton and some phytoplankton.

Safety: This process is safe for the ship and crew.

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[15] This project is co-chaired by Allegra Cangelose, senior policy analyst for the Northeast Midwest Institute, and Richard W. Harkins, vice president of operations for the Lake Carriers' Association. The most recent data comes from R. W. Harkins et al. (1999), *Great Lakes Ballast Technology Demonstration Project Findings*; presented at the Ninth International Zebra Mussel and Aquatic Nuisance Species Conference, April 26-30 in Duluth, Minnesota.

Size: Footprint small enough for onboard installation.

Disadvantages

Effectiveness: The filter did not remove small organisms, including small sized phytoplankton and bacteria. To overcome this problem the project plans to test a variety of secondary treatment systems (i.e., UV irradiation).

Time: The back wash cycles took up too much time (especially with the 25 micrometer mesh), and there was significant loss in pressure after the water passed through the system. The researchers plan on testing an upgraded filter that is supposed to reduce these problems.

Maintenance: For the system to run properly, the crew would be responsible for changing the filters and completing routine maintenance.

Costs: Currently, the rough estimate for retrofitting a ship with a filtration system is approximately $1 million. The Great Lakes Demonstration Project is going to run a design competition for the filter treatment installation, which will provide a much more accurate cost estimate for this system.

Outlook: With the proper modifications to the system and the addition of a secondary treatment system (i.e., UV irradiation), this technology has the potential for being an effective treatment system for the West Coast Region of the United States, although the cost might be fairly prohibitive.

2. Hydrocyclone

Description: Hydrocyclonic treatment is a technology that has been applied to the oil industry for many years, but only recently has been applied to the ballast water problem. The system basically vortexes the water, forcing the heavier particles to the outer portion of the pipe. Once this occurs, then the outer portion of the water can be separated out or the particles can be collected in some type of collection system. Currently, there are tow companies that are working on hydrocylonic ballast water treatment systems: Marine Physics Corporation of Massachusetts[16] and Velox Technologies of Canada (Velox pairs the hydrocyclone system with the Tech Trade A/S UV irradiation system to create the Velox Ballast Water Management System[17]).
Advantages

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[16] Stan Ross, Marine Physics Corporation, Chestnut Hill, MA.

[17] The Velox Ballast Water Management System combines the hydrocyclone technology from Velox Technology of Calgary, Alberta Canada, and the UV treatment system from Tech Trade A/S of Norway. More information about this system can be obtained from the following web pages: www.veloxtechnology.com and www.ballastwater.com.

Effectiveness: Currently unknown, but results from the study conducted with the Velox system are due out in August 1999.

Time: This system can operate at high flow rates and does not result in a large decrease in water pressure after it passes through the system.

Safety: This process is safe for the ship and crew.

Size: Footprint is small enough for on-board installation.

Disadvantages

Costs: Cost are unknown at this time, but some estimates have been as high as $1 million to retrofit one ship with this system.

Other: Other significant disadvantages might exist, but these have not been identified yet, due to the lack of information on hydrocyclonic ballast water treatment systems. Studies are currently being conducted by Velox Technologies and Marine Physics Corporation.

Outlook: With the development and testing of these systems, this technology has the potential for being an effective treatment technology for the West Coast Region of the United States, although the costs might be substantial.

3. UV irradiation

Description: UV irradiation can be used to kill organisms in ballast water. This treatment is most effective against smaller organisms, especially when the larger particles that can interfere with transmission are removed. This make UV irradiation a good candidate for a secondary treatment system. UV is being used as a secondary treatment in the Velox Ballast Water Management System (developed by Tech Trade A/S in Norway), and is tested as a secondary treatment in the Great Lakes Demonstration Project.

Advantages

Effectiveness: Generally, it should work well against smaller organisms. Results from research projects are not available to date.

Time: This system can operate at high flow rates and does not result in a large decrease in water pressure after it passes through the system.

Safety: This process is safe for the ship and crew.

Size: Footprint is small enough for on-board installation.

Disadvantages

Effectiveness: This technology does not work against larger organisms. Large particles and organisms would have to be removed from the water before passing through the UV system to insure effective killing of the small organisms.

Maintenance: The system must be properly maintained to retain its effectiveness.

Costs: Unknown at this time, but they probably will be considerable.

Outlook: This system has great potential as a secondary treatment system, although the costs of this system could be fairly substantial.

4. Heat Treatment

Description: The concept of this treatment is to utilize the waste heat produced by the engine to head the ballast water. Heating the ballast water will kill the majority of the species, but would not effect most pathogenic bacteria or viruses. During on-board trials in Australia, researchers determined that raising the temperature to 37-38 degrees Celsius killed a broad spectrum of organisms present in the ballast water[18].

Advantages

Effectiveness: This technology can kill the majority of organisms in the ballast water.

Size: Footprint small enough for on-board installation.

Safety: This process is safe for the ship and crew on ships designed for heat treatment.

Disadvantages

Effectiveness: This process does not kill many pathogenic bacteria, viruses, or encysted stages.

Safety: Heating the water in the ballast tanks of older ships may create serious safety problems due to the unknown effects of local expansion or corrosion.

Costs: The costs are unknown. A more efficient heat exchanger would probably have to be installed, and there would be additional costs for burning excess fuel that would be required to raise the temperature of the ballast water to the appropriate level.

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[18] Rigby, G.R. & G. M. Hallengraeff, 1994. Strategies to Minimize the Transfer of Harmful Marine Plankton Via Ship's Ballast Water. In: "Harmful Algae." B. Reguera, J. Blanco, M.L. Fernadez, and T. Wyatt (eds.), Xunta de Galigia and Intergovernmental Oceanographic Commission of UNESCO.

Outlook: Larger ships and ships with cold water shipping routes might not be able to raise the temperature of the ballast water high enough to kill the majority of organisms. Since the majority of the ships travel to the Pacific Coast of the United States fit into these two categories, heat treatment will probably not be a viable option for this region.

5. Chemical Treatment

Description: Chemical treatment of ballast water would involve adding chemicals into the ballast tanks to kill the organisms. The chemicals would have to be effective in killing a broad range of organisms, have quick decay rate, and degrade into non-toxic compounds. There are a variety of compounds that are being studied: ozone, glutaraldehyde, periacetic acid, chlorine, and Formulation III. Groups that are studying various chemicals will be listed in the table in Section D. A general concept of biocides will be addressed in this section.

Advantages

Effectiveness: Can be effective in killing a broad range of organisms. It is a proven technique in industrial system on land (although most of these systems are treating fresh water).

Disadvantages

Safety: Poses a safety threat to the crew that would be handling the chemicals. The chemicals could also lead to corrosion in the tanks, which would compromise the safety of the vessel.

Environmental Hazard: Chemicals could still be active when released from the ballast tanks, killing or bio-accumulating in organisms at the discharge site.

Costs: Estimates are prohibitively expensive to treat full ballast tanks. Outlook Biocides are primarily being examined to be a temporary measure against NOBOB ships (ships "without" ballast on board). These ships carry as much as 10% of the capacity of the ballast tanks, and have been a vector for invasions in the Great Lakes. In these cases, only a small amount of the chemical would be needed to treat the residual ballast water in the tanks. There is still concern about the long-term effects of dumping chemicals into the coastal environment. Chemical treatment is probably not a viable option for the West Coast Region of the United States.

6. Plasma Pulse Technology

Description: This technology is in the early stages of development. This system consists of a power supply, a capacitor storage bank, and a submersible unit. The discharge process consists of an intense shock wave, a steam bubble, and UV light. Organisms will be primarily killed by the shockwave, but could also be killed by chemicals (i.e., ozone) created in the process, or UV light. This technology was developed by Sparktech Environmental[19]. This technology is being tested in industrial intake systems to prevent the settlement of zebra mussels, and has recently been applied to on-board treatment.

Advantages

Effectiveness: Since this technology is in the early stages of development, there is not enough information to evaluate effectiveness.

Disadvantages

Safety: This process produces a shock wave that could effect the integrity of the pipes and the tank walls. A loud sound is also produced that could be harmful and/or annoying to the crew.

Costs: The costs are unknown, but could be considerable. The majority of the costs would come from the installation of the system and energy production to run the system.

Outlook: Not enough information is known about this product to evaluate this technology. Although it is a potentially viable treatment option, it is not generally thought of as one of the more promising options.

7. On-shore Treatment

Description: Many of the treatment options listed in this section could be applied in either a ship-board or an on-shore treatment facility, although some options are much more suitable to one type or the other. This section will discuss the advantages and disadvantages of treating ballast water at on-shore facilities.

Advantages

Regulation: It would be vary easy to regulate a shore-based treatment facility. The facility would only need relatively few highly trained individuals to operate the system, rather than having to depend on the ship's crew to operate the treatment system.

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[19] Mackie, G. G., J. P. Lowry, and C. Cooper, 1999. Use of Plasma Pulse Technology for Controlling Zebra Mussel Settlement. Presented at the 9th International Zebra Mussel and Aquatic Nuisance Species Conference in Duluth, MN.

Time: The system would also not be as restrictive in regard to the amount of time ti takes to treat the ballast water.

Size: The on-shore treatment system would not have the same size constrictions as an on-board treatment system.

Disadvantages

Transferring Ballast Water to the Treatment Facility: Each dock would have to be fitted with a piping system and the ships would have to be retrofitted to allow for the discharge of ballast water through a pipe above the waterline (most ships currently discharge their ballast water through the sea chests, which are located below the waterline). The piping system would have to be flexible and strong, compensating for changes in ship height in relation to the dock while loading cargo without compromising the strength of the pipe that is required for the high flow rates.

Capacity: The treatment facility would have to have a large enough facility to treat the ballast water, without delaying ships. Some ports do not have enough space to construct an on-shore treatment system.

Costs: Setting up the infrastructure for a treatment could be prohibitively expensive. If the port charged ships a significant fee to help support the facility, ships might be discouraged from coming to the port, causing the port to lose its business to adjacent ports that don't have fees. If a significant portions of the ships have a ship-board treatment system, it might not be economically feasible for a port to operate an on-shore treatment facility.

Outlook: An in depth study on the feasibility of on-shore treatment is needed to determine if this is going to be a viable treatment option.

Ballast Water Management Options

The ideas listed in this section are management options that would reduce the amount of ballast water that would need to be treated. Reducing the amount of ballast water that needs to be treated and the number of ships that need to treat their ballast water, will reduce the impacts of future ballast water regulations on the shipping industry while reducing the risk of invasion.

1. Operational Changes

Description: Many ships carry cargo in one direction and carry ballast water on the return trip. Money dedicated to ballast water could be used to economically entice companies to carry cargo in both directions, which would reduce the amount of ballast water transported.

Advantages

Costs: Ships that carry cargo in both directions would not have to invest money for ballast water treatment systems. There have not been studies on this management method, so the estimated costs are unknown.

Safety: This management option would obviously not pose any safety hazards for the ship or its crew.

Disadvantages

Variability: The world trade market is always changing, so the plan for every ship would have to be evaluated by a business manager on a regular basis. Although some ships would be able to do this, the imbalance in the world trade market would not allow for every ship to take a full load on each segment of the shipping route.

Outlook: This is a viable option, but would only provide a partial answer to the problem. There is also a question of where the money would come from, and how this would be regulated.

2. Risk Analysis

Description: This process involves identifying and treating the ballast water from the ships that present the greatest risk of invasion. This method is under strong consideration in Australia.

Advantages

Costs: It would cost less for companies to only treat the ships and the ballast tanks that carry water from high risk ports.

Safety: The ships that didn't have to undergo exchange or treatment would not have any safety hazards.

Disadvantages

Effectiveness: It is very difficult to determine which organisms are potential invaders for any given environment. It is also difficult, if not impossible, to determine how many organisms it takes to generate a successful invasion. Although "low risk water" would be much less likely to lead to successful invasion than "high risk water," "low risk water" would still have a significant potential for invasion.

Outlook: Using this option could be a potential "stop-gap" measure, but the risk of invasion with this method is too high to be considered for a long-term solution.

3. Changes in Ship Design

Description: Ships can be redesigned to greatly reduce the amount of ballast water needed for operation. Also, many container ships can be reconfigured so that they could retain a major portion of their ballast on the ship, redistributing the ballast water from one tank to another to allow for proper trim of the ship.

Advantages

Costs: It will cost less to treat a smaller amount of ballast water.

Safety: This management option would not pose any safety hazards for the ship or its crew.

Disadvantages

Time: Most ships have a 20 to 30 year life-span, which would mean that it would take at least that long to replace all the ships with the new redesigned ships. Although some container ships could be retrofitted to allow for transfer of ballast water between tanks.

Outlook: This is a very practical management option. As in the case of economic incentive, this would only provide a partial answer to the problem. With the technology available today, most ship types will still require some ballast water to maintain proper trip and ship stability.

Summary of Current Research Projects

The inserted table list the projects that are being conducted on ballast water management and treatment technologies.

(To be included)

Monitoring

Monitoring is necessary to define the risk of ballast water introductions of ANS as well as the effectiveness of ballast water management activities. A well-designed monitoring program is needed to define the magnitude of the problem on a port-specific basis and to better understand the coastwide dynamics of invasions. Regular characterization of the organisms transported in ballast water as well as port environments are both important elements of a coastwide ballast water management program.

Ballast Water Monitoring

Cohen (1998) described five published investigations of the organisms present in ballast water sampled at West Coast ports dating back to 1986. Most sampling in these studies was conducted on ships transporting ballast water from Japanese ports. Domestic, or coastal, shipping dominated the sampling effort in one study (Ruiz and Hines 1997). Cumulatively, sampling of ballast water from ships traveling between ports on the West Coast accounted for only nine percent of the ships sampled in these studies. Slightly more than half of the ships arriving at Oregon and Washington ports (56 and 57 percent, respectively) are from domestic, West Coast ports, 65 percent of the ships arriving at LA/Long Beach are from domestic ports (Pruett, unpublished data). Thus, existing ballast water characterization on the West Coast does not appear to be representative of the types of voyages that are most common and likely to introduce non-indigenous organisms.

The potential diversity of organisms in ballast water is high. Virtually all organisms less than 1 cm in size that are adjacent to a vessel–naturally swimming in the water, stirred up from the bottom sediment, or rubbed off harbor pilings–could be ballasted into a vessel (National Research Council 1996). Large declines in abundance of organisms in ballast water occur during a voyage. Declines may occur as a result of adverse physical and chemical conditions or resource depletion. Differential survival may be a function of life-history traits of organisms. Species that can form resistant, resting stages or are benthic species that can survive in sediments in ballast tanks may survive longer in ballast tanks (Cohen 1998).

The limited sampling of ballast water from ships at West Coast ports that has occurred suggests that diatoms, arthropods, and annelids are the most common taxa (Figure x). Survival of organisms discharged from ships in de-ballasting operations is dependent, in part, upon the environmental similarity of source and receiver regions. Many organisms from tropical waters will not survive or reproduce in cooler, temperate or boreal ports, and vice-versa (National Research Council 1996, Chapman 1998).

The ideal ballast water treatment program would prevent the discharge of any organisms into receiving waters. No existing technology, other than on-shore treatment, is capable of reaching the ideal. Reliable sampling protocols are therefore necessary for characterization of organisms in ballast water. Although techniques for sampling ballast water are rather routine, type,

abundance, and variability in the ballast tank biota attributable to differences within and between tanks, ships, source-water, and voyage length must be better defined to evaluate risk and treatment efficacy. Better information on the biology of ballast water would permit characterization of the ballast water as high or low risk and permit appropriate management decisions, such a procedure was recommended in Australia (PPK Environment and Infrastructure and Thompson Clarke Shipping 1999).

(To be included)
Figure x. Relative abundance of taxa in ballast water collected at three West Coast ports (data from Table 5 of Cohen 1998).

Sampling protocols for the ballast water studies on the West Coast vary. For example, the Tacoma/Port Angeles study included sampling of ballast tank sediments whereas studies conducted in Coos Bay and Valdez included only water column sampling for planktonic organisms. Variations in net mesh, tow length and speed, and taxonomic expertise may also contribute to differences between studies. Studies that include bacteria and virus sampling have not been conducted on the West Coast.

Standardization of sampling protocols (type, number, and frequency of samples, quality assurance, taxonomic authorities) for ballast water would aid in developing a dataset that would enable better characterization of ballast water. Given the relatively limited sampling that has occurred to date, concern over development of sampling protocols has been subordinate to collecting any information on ballast water biota. With the beginning of a coastwide effort to reduce ballast water introduction of aquatic non-indigenous species, standardized protocols would facilitate comparisons between and among studies. Quality assurance through use of taxonomic authorities for identification of species present in ballast water is perhaps the most critical element of ballast water characterization.

Although ballast water characterization at West Coast ports has been minimal, it is clear that ballast water in coastal, domestic shipping is least well characterized. Implementation of voluntary ballast water exchange under the new Coast Guard rule may reduce the threat of introductions via transoceanic shipping, however, coastal shipping remains uncontrolled. The short voyages and presence of highly invaded estuaries on the West Coast suggest that coastal shipping poses a serious risk for spread of non-indigenous species. Better characterization of ballast water biota coastwide is necessary to understand the dynamics of species introductions and to document the efficacy of current programs. Characterization of ballast water biota in domestic, coastal shipping should be a priority, although further characterization of ballast water biota in transoceanic shipping is also necessary to document the efficacy of ballast water exchange.

Environmental Monitoring

Ultimately, reducing establishment of non-indigenous species is the goal of ballast water management efforts. Monitoring of receiving water is necessary to document establishment of

introduced species. While biological characterization of ballast water is necessary to assess risk of introduction and to evaluate efficacy of ballast water management techniques, monitoring of receiving waters is necessary to evaluate overall effectiveness of the program.

As with ballast water sampling, biological surveys of West Coast estuaries and port facilities are limited. Pioneering work on marine invasions was done by Carlton (1997) on Coos Bay. San Francisco Bay (SFB), where at least 230 introduced species account for up to 99 percent of the biomass in some communities, is perhaps the most studied West Coast estuary (Cohen and Carlton 1998). Limited sampling has been conducted on invasive species in Prince William Sound (PWS) (Ruiz and Hines 1997). Fewer invasive species were identified in PWS than in SFB; possibly because PWS has had a shorter history of ballast water, high latitude communities are more resistant to invasion, or because sampling has been less intensive in PWS than in SFB (Ruiz and Hines 1997).

A rapid assessment survey was conducted in Puget Sound .....more here

Effects of introduced species on estuarine systems can be dramatic. Invasion of Willapa Bay, in Southwestern Washington, by *Spartina alterniflora* Loisel. (Smooth cordgrass) has altered hydrology and function of the Bay. Sediment deposition in Spartina has lead to development of Spartina meadows and loss of mudflat habitat necessary for many invertebrate and vertebrate species (Landin 1990, OTHERS).. Introduction of the Asian clam (*Portamocorbula amurensis*) has altered trophic dynamics in SFB through filtering of the water column (ref). Mitten crab (*Eriocheir sinensis*) populations in the SFB system have exploded in recent years, and have interfered with efforts to maintain populations of endangered fish species (Webb 1999).

Other introductions have less dramatic, but possibly just as serious, ecological effects. At least six species of Asian copepods have been recently introduced to the west coast of North America. *Pseudodiaptomus inopinus*, has become abundant in the Columbia River and at least eight other estuaries in the region (Cordell and Morrison 1996). It is sometimes the dominant zooplankton species and has undoubtedly altered food web dynamics in invaded systems with unknown ecological consequences and impacts on threatened and endangered fish species. Similarly, various other fish, clam, and crab species have been introduced to estuarine systems on the West Coast with unknown effects. It seems clear, however, that since these introduced species have been introduced into the food web they are having some effect on interactions between native species. Cumulative effects of multiple introductions are even less well understood. Given the emphasis and investment in restoration of endangered salmon populations on the West Coast, introduction of any species that can impact recovery must be deemed serious.

Surveys of biological communities of West Coast estuaries and freshwater systems has been inadequate to characterize the extent and severity of non-indigenous species invasion. Detailed baseline information on the biological composition of coastal estuaries subject to ballast water introduction is not available. Those organized, systematic surveys that have occurred have been conducted with limited funding and sampling and provide only a cursory view. Inadequate baseline information exists to effectively evaluate trends in the rate of introductions and efficacy

of ballast water management activities. Even West Coast surveys that have been identified as priorities in the National Invasive Species Act (NISA), such as an ecological survey of the Columbia River, have not been funded. Clearly, well-funded, regular surveys of West Coast estuaries are required to document the efficacy of ballast water management programs.

Development of survey protocols for biological characterization of West Coast estuaries would facilitate collection of data that could be used to examine latitudinal gradients in invasive species abundance and aid in understanding the biology of invasions. Adherence to such coastwide protocols, however, may limit resources available to study unique characteristics of individual estuaries. A meeting at the Smithsonian Environmental Research Center (SERC) in the spring of 1998 was convened to discuss development of national protocols for ecological surveys. A draft protocol is expected by September 1999 (Greg Ruiz, personal communication with Mark Sytsma).

Details of sampling protocols are determined by the purpose of the sampling. A sampling protocol developed to characterize latitudinal differences in susceptibility to invasion, for example, may focus on specific taxa or habitats identified *a priori*. Alternatively, if full characterization of the biology of an estuary is the goal of the sampling program, a stratified random sampling program may be developed, with sampling intensity dependent upon habitat area and/or seasons. A sampling program that focuses on index sites, taxa, and/or habitats may be the most cost-effective method of characterizing estuaries for both regional and estuary-specific purposes.

Development of a national protocol for ecological surveys of estuaries is necessary for a better understanding of regional and coastwide processes important in invasion biology. Such a national protocol, however, must be flexible enough to permit adequate characterization of individual estuaries for purposes of evaluating trends in rate of invasion. Both approaches must include provisions for quality control in sampling and identification of taxa. Development of sampling protocols without adequate funding for field collection and identification is not productive. Funding for ecological surveys, especially the Columbia River survey identified in NISA, should be a priority to allow evaluation of the effectiveness of changes in ballast water management practices.

Summary of Current Legislation and Regulations

International Law

United Nations Convention on Law Of the Sea (UNCLOS)

Article 196 - "States shall take all measures necessary to prevent, reduce and control pollution. . .or accidental introduction of species, alien or new, to any particular part of the marine environment, which may cause significant or harmful changes thereto." International law scholars have interpreted this language to require the U.S. to utilize due diligence to prevent the introduction of ANS.

Convention on Biological Diversity 3Article 8(h)1 I.L.M. 818 (1992) Requires its parties, as far as possible and appropriate, "to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species." (US is not a party).

General Agreement on Tariffs and Trade Article XX (b) Acknowledges need of parties to protect themselves from harmful exotic species, legitimizes trade restraints, such as quarantine regulations, that are necessary to protect the life or health of humans, animals, and plants.

International Maritime Organization (IMO) IMO Resolution A. 868 (20) The IMO has adopted "soft law" in the form of voluntary ballast water exchange guidelines, preventing the introduction of ANS through ships ballast water. In their development of the U.S. ballast water legal regime, the United States Congress and the Coast Guard utilized these guidelines as a framework.

Possible introduction of Annex VII to MARPOL. The IMO's ballast water working group is developing mandatory ballast water exchange regulations that will likely be introduced as Annex VII to MARPOL.

Laws in Other Countries of Note

Australian Ballast Water Guidelines

Similar to the U.S. and IMO voluntary guidelines. One section of particular note is § 6.1. § 6.1 arrangements allow vessels to enter Australian waters without being subject to the Australian Quarantine and Inspection Service (AQIS) at sea exchange requirements. Specifically, these arrangements require vessels to properly document operational procedures that ensure ballast water is loaded in areas of low risk and that the ballast water is subsequently monitored to ensure that low risk. These arrangements are monitored by AQIS at least twice per year.

Federal Law

National Invasive Species Act of 1996

16 U.S.C. § 4701	Findings and purposes
Id. § 4702	Defines "aquatic nuisance species"
Id. § 4711	Guidelines for Great Lakes for discharges of ballast water; voluntary guidelines for discharges to other waters of the U.S.
Id. § 4712	Task Force shall conduct a study on the effects of ballast water exchange.
Id. § 4713	Secretary of Defense, Secretary of Commerce, Task Force, and IMO shall implement a ballast water management program for Dept. of Defense seagoing vessels to minimize the risk of introduction of non-indigenous ANS.
Id. § 4714	Secretary shall conduct ballast water demonstration program to demonstrate technologies and practices to prevent ANS from introduction from ballast water discharges.
Id. § 4721	Establishment of Task Force.
Id. § 4722	Task Force shall develop and implement program to prevent introduction and dispersal of ANS; monitor, control and study species and disseminate related information.
Id. § 4723	Task Force shall request Great Lakes commissioner to convene panel of Great Lakes regional representatives.
Id. § 4724	Governor of each state shall prepare and submit a comprehensive management plan for managing ANS to the Task Force.
Id. § 4725	All Federal agency actions taken in implementing provisions of § 4722 shall be consistent with all applicable federal, state, and local environmental laws.
Id. § 4726	Secretary of State, in consultation with Task Force, is encouraged to negotiate with foreign governments regarding prevention, monitoring, research, education and control of ANS.
Id. § 4741	Authorizations of Appropriations.
Id. § 4751	Secretary of State encouraged to negotiate with Canada and Mexico to provide for reciprocal analysis of trans-boundary effects of ANS.

Coast Guard Regulations- implementation of NISA

33 CFR § 151.1500	Definitions ("environmentally sound methods" includes methods to control ANS).
Id. § 152.1502	(1) Vessels with ballast tanks which enter the Great Lakes or Hudson River are subject to mandatory ballast water management requirements in § 151.1508 and reporting requirements in § 151.1514. (2) Vessels that enter other waters of the U.S. after operating beyond the EEZ during part of a voyage are requested to comply with the voluntary ballast water management guidelines in §151.1516 and are still required to comply with the mandatory reporting requirements in § 151.1514, whether or not they comply with the voluntary management guidelines. Vessels exempt from

	this subpart: (1) Crude oil tankers engaged in coastwise trade, (2) Passenger vessels equipped with treatment systems designed to kill ANS in their ballast water approved by the Coast Guard.
Id. § 151.1508	The master of each vessel subject to this subpart must employ one of the following ballast water management practices: (1) Carry out a reasonably complete ballast water exchange in the open ocean. A level of salinity below 32.4 parts per thousand is a basis for presuming that a reasonably complete exchange has not occurred. However, a salinity level below 32.4 is not a basis for presuming a reasonably complete exchange. A reasonably complete exchange may be evidenced by any logical combination of salinity, other chemical or biological indicators, the voyage and ballasting history of the vessel, and shipboard records. (2) Retain the ballast water on board the vessel- seal any tank or hold for the duration of the voyage. (3) Use a reasonably effective ballast water management system, which is consistent with an environmentally sound method, and has been approved by the Commandant of the Coast Guard.
Id. § 151.10	Nothing in this subpart relieves the master of the responsibility for ensuring the safety and stability of the vessel, its crew and passengers.
Id. § 151.1512	The master of any vessel subject to this subpart, who due to weather, vessel architectural design, equipment failure or other extraordinary conditions, is unable to effect a ballast water exchange before entering the EEZ, must (a) employ another method of ballast water management listed in § 151.1508 or (b) request permission of the COTP to exchange the vessels ballast within an area agreed to by the COTP.
Id. § 151.1514	Mandatory reporting and record-keeping.
Id. § 151.1516	Voluntary ballast water guidelines.
Id. § 151.1518	The COTP may take samples of ballast water and sediment, examine documents, and make other appropriate inquires to assess the compliance with and the effectiveness of this subpart.

Federal Water Pollution Control Act: 33 U.S.C. §§ 1251 et seq. (Clean Water Act)

Section 402: Permit Program: Section 301 (a) of the Clean Water Act prohibits the discharge of "any pollutant by any person" into waters of the United States, unless done in compliance with specified sections of the Act, including the permit requirements in Section 402.

Under the National Pollutant Discharge Elimination System (NPDES) set up under Section 402, EPA assigns discharge conditions, including technology-based control requirements, to its permits to ensure that discharges meet all applicable standards set under the Clean Water Act.

U.S.C. § 1343 (a) In addition, NPDES permits issued to discharges into the territorial sea also must comply with "ocean discharge criteria" specifically designed to prevent the degradation of those waters, pursuant to Clean Water Act Section 403.

40 CFR § 122.3 (a) Currently, an EPA regulation specifically exempts ballast water from the NPDES permit program.

In January 1999, a petition was made to the EPA by the Pacific Environmental Advocacy Center, on behalf of conservation groups, commercial and recreational fishing interests, Native American tribes and California water agencies, to regulate ballast water discharges under the NPDES permit program Section 402.

> The petition argues that EPA's regulation exempting ballast water from the NPDES permit program is illegal and should be repealed, because:
>
> The Clean Water Act specifically defines "discharge of a pollutant" to include discharges of "biological materials from "vessels[20]," and
>
> EPA does not have the authority to create categorical exemptions from the Act or to establish regulations clearly contrary to express statutory requirements.[21]

In its response to the petition, EPA committed to issuing a draft report by September 1, 1999, outlining potential regulatory options under the Act.

Section 303 (d) Regulation of Discharges into impaired Waters: If a pollutant is threatening or impairing use of a water body, the water body violates water quality standards and must be listed under Section 303 (d) of the Clean Water Act as "water quality limited" for that pollutant.[22]

EPA or the state then must establish the "total maximum daily load" (TMDL) of the offending pollutant that can be released into the water body and still ensure that the water meets water quality standards, within a "margin of safety."[23]

A water body whose use is impaired by ANS could be "listed" under Section 303 (d); if so, EPA or the sate must identify the maximum load of problem aquatic NIS, it may be difficult for the applicable agency to set a TMDL for aquatic NIS other than zero and still meet Section 303(d)'s "margin of safety" requirement.

Section 303 (d)'s requirements are currently being implemented in the San Francisco Bay region, as discussed in section d below.

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[20] 33 U.S.C. § 1362(6), 1362(12), 1362(14).

[21] *Natural Resources Defense Council v. Costle*, 568 F.2d 1369, 1377 (1977); *Chevron v. Natural Resources Defense Council*, 467 U.S. 837 (1984); *City of Chicago v. EDF*, 114 S.Ct. 1588 (1994).

[22] 33 U.S.C. § 1313(d).

[23] 33 U.S.C. § 1313(d)(1)(c).

Marine Protection, Research, and Sanctuaries Act, 33 U.S.C. §§ 1401 et seq. (Ocean Dumping Act): The Ocean Dumping Act prohibits the unpermitted dumping of "any material transported from a location outside the United States" into the territorial sea of the United States (i.e. within three miles of shore), or into the zone contiguous to the territorial sea (i.e. within 12 miles of shore), to the extent discharge into the contiguous zone would affect the territorial sea or the territory of the United States.[24]

"Dumping" is defined broadly as " a disposition of material."[25]

The statute contains a very few specific exemptions from this term, including the "routine discharge of effluent incidental to the propulsion of, or operation of motor-driven equipment on, vessels." Arguments could be made that this exemption narrowly applies only to discharges related to engines, motors, etc., as opposed to ballast water.

The statute has not yet been applied to ballast water discharges, but if it were, it would provide an important extension to the Clean Water Act permitting requirements, which stop at the three-mile "territorial sea" limit.

National Environmental Policy Act, 42 U.S.C. §§ 4321 *et seq.* (NEPA): NEPA requires that federal agencies prepare an Environmental Impact Statement (EIS) for "major Federal actions significantly affecting the quality of the human environment."[26] NEPA thus may be used to require further examination of federal projects that may result in increased discharges of ballast water containing NIS.

The EIS must provide the public with a "full and fair discussion of significant environmental impacts" of the proposed project,[27] including an analysis of whether the project threatens a violation of federal law or adversely affects an endangered or threatened species or its habitat.[28]

The EIS also must "inform decision-makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts" and must analyze such project alternatives

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[24] 33 U.S.C § 1411(b).

[25] 33 U.S.C. § 1402(f).

[26] 42 U.S.C. § 433(2)©.

[27] 40 C.F.R § 1502.1.

[28] 40 C.F.R. § 1508.27(b)(9), (10).

comprehensively.[29] In addition, the EIS must discuss "appropriate mitigation measures not already included in the proposed action or alternatives."[30]

Finally, the lead agency must state at the time of its decision "whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and, if not, why not."[31]

At least one circuit court has recognized that NEPA requires federal agencies to evaluate a project's indirect impacts on the spread and introduction of aquatic NIS.[32]

At least two challenges have been made to federal projects under NEPA on the grounds that the responsible agencies have not properly analyzed the effects of proposed federal projects on the release of aquatic NIS in ballast water: San Francisco Bay (related to deepening activities at the Port of Oakland) and in the Columbia River (related to a channel deepening project).

Endangered Species Act (ESA), 16 U.S.C. §§ 1531 *et seq.* (ESA): The Endangered Species Act contains both consultation requirements and a substantive requirement prohibiting certain activities that threaten listed species.

Under § 7 of ESA, federal agencies must ensure that their actions are "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species . . . ."[33]

In addition, federal agencies must consult with the Secretary of the Interior and/or Commerce, as appropriate, "on any agency action which is likely to jeopardize the continued existence of any species proposed to be listed . . . or result in the destruction or adverse modification of critical habitat proposed to be designated for such species."[34] This consultation is designed to ensure that the federal agency's activities do not violate the Section 7 prohibition on actions that are likely to jeopardize listed species or their habitat.

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29 40 C.F.R. §§ 1502.1, 1502.14, 1502.16.

30 40 C.F.R. §§ 1502.14(f), 1502.16(h).

31 40 C.R.R. § 1505.2(c).

32 *Hughes River Watershed Conservancy v. Glickman*, 81 F.3d 437 (4th Cir, 1996)(court rejected the adequacy of an Army Corps of Engineers NEPA analysis on the grounds that it failed to consider the significance of how construction of a dam could affect the introduction of exotic zebra mussels into a watershed).

33 16 U.S. C. § 1536(a)(2).

34 16 U.S.C. §1536(a)(4).

ESA Section 7 may be used to examine the impacts of a federal project that may result in increased discharges of ballast containing NIS. For example, a "sixty-day notice of intent to sue" has been filed in the San Francisco Bay area under ESA Section 7.[35] The notice states that the Army Corps of Engineers failed to consult with U.S. Fish and Wildlife Service and the National Marine Fisheries Service regarding how potential increases in ballast water discharges of NIS resulting from the Port of Oakland's deepening project will affect listed species.

Office of the Secretary of Transportation

49 C.F.R. § 1.46	Establish and enforce regulations to control the introduction and spread of ANS through ballast water discharges.

Magnuson/Stevens Act Regulations

50 C.F.R. § 600.815	FMPS must identify non-fishing related activities that may adversely affect EFH, including introduction of exotic species.

State Law

State Environmental Protection Acts: Like NEPA, state environmental protection acts call for the careful review of the environmental impacts of state "projects." These acts may be used to require further examination of the impacts of state projects that may result in increased discharges of ballast water containing NIS.

Unlike NEPA, some state statutes, such as the California Environmental Quality Act, California Public Resources Code, §§ 21000 *et seq.* (CEQA), also contain substantive provisions that require appropriate mitigation of projects that contain significant environmental impacts. CEQA requires that agencies adopt feasible mitigation measures in order to substantially lessen or avoid the otherwise significant environmental impacts of a proposed project.[36]

A "significant" impact is a "substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the Project including land, air, water, minerals, flora, [and] fauna. . . ."[37] The documented adverse impacts associated with NIS appear to fit this broad definition.

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[35] Letter from Deborah Sivas, Stanford Environmental Law Clinic, to Lt. Gen. Joe Ballard and Lt. Col. Peter Grass, U.S. ACOE (January 6, 1999) (letter filed on behalf of the Center for Marine Conservation and the San Francisco Bay Keeper).

[36] Public Resources Code §§ 21002, 21081(a); 14 C.C.R. §§ 15002(a)(3), 15021(a)(2), 15091(a)(1).

[37] 14 C.C.R. § 15382; *see also* Public Resources Code § 21068.

In addition to meeting the general definition of "significant effect," the impacts associated with increased discharges of NIS may require a mandatory finding of significance under CEQA, thus mandating feasible mitigation of those impacts.[38]

CEQA also mandates that the responsible agencies consider a reasonable range of project alternatives that offer substantial environmental advantages over the project proposal.[39]

The responsible agency must "deny approval of a project with significant adverse effects when feasible alternatives or feasible mitigation measures can substantially lessen such effects."[40]

State Water Quality Laws: Many states have their own water quality acts that could be used to address the discharge of NIS in ballast water.

a) For example, under California's Porter-Cologne Water Quality Control Act, California Water Code §§ 13000 *et seq.*, "any person discharging waste, or proposing to discharge waste, within any region that could affect the quality of the waters of the state" must file with the appropriate Regional Water Quality Control Board a report of the discharge.[41]
b) Pursuant to the Act, the Regional Board then prescribes "waste discharge requirements" related to control of the discharge.[42]
c) The Act defines "waste" broadly[43] and the term has been applied to a diverse array of materials.[44]
d) The San Francisco Bay Regional Quality Control Board has determined that "ballast water and hull fouling discharges cause pollution as defined under the Porter-Cologne Water

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[38] For example, projects must incorporate mitigation measures under CEQA if they have the "potential to substantially degrade the quality of the environment, substantially reduce the habitat of the fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, [or] reduce the number or restrict the range an endangered, rare or threatened species. . . ." (14 C.C.R. § 14065.)

[39] Public Resources Code § 21002; 14 C.C.R. §§ 15002(a)(3), 15021(a)(2), 15126(d); *Citizens of Goleta Valley v. Board of Supervisors ("Goleta II")*, 52 Cal.3d 553, 564, 566 (1990).

[40] Public Resources Code § 21002; 14 C.C.R. §§ 15002(a)(3), 15021(a)(2); *Sierra Club v. Gilroy City Council*, 222 Cal.App.3d 30, 41 (6th Dist. 1990).

[41] Water Code § 13260(a).

[42] Water Code § 13263(a).

[43] Water Code § 13050(e).

[44] For a more complete discussion of the applicability of Porter-Cologne to ballast water discharges, *see* "Petition of the San Francisco BayKeeper and DeltaKeeper to the Bay Area Regional Water Quality Control Board, Seeking Control of Ballast Water Discharges in the Bay-Delta Region," pp. 11-17 (May 21, 1997).

Quality Control Act,"[45] raising the possibility that the Act may be actively used to regulate such discharges.

State Fish and Wildlife Laws: State fish and wildlife laws also may contain provisions that relate to the control of aquatic NIS. State fish and wildlife laws may also control the discharge of ballast water containing NIS.

Some examples in the California Fish and Game Code include the following:

> "No live aquatic plant or animal may be imported into this state without the prior written approval of the department."[46]
>
> "All fish, amphibia, or aquatic plants which the department determines are merely deleterious to fish, amphibia, aquatic plants or aquatic animal life, shall be destroyed by the department, unless the owner or the person in charge . . . ships them out of the State . . ."[47]
>
> "It is unlawful to place, plant, or cause to be placed or planted, in any waters of this State, any live fish, any fresh or salt water animal, or any aquatic plant, whether taken without or within the State, without first submitting it for inspection to, and securing the written permission of, the department."[48]
>
> "The commission may regulate the placing of aquatic plants and animals in waters of the state."[49]

Revised Code of Washington

Title 35- RCW 35 A.88.010	
Optional Municipal Code	Code city may exercise the powers regulating discharge of ballast within or in front of such city.
Title 77 Game and Game Fish	
RCW 77.08.010	Defines "deleterious exotic wildlife."

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45 San Francisco Bay Regional Water Quality Control Board, "Draft Exotic Species TMDL Workplan Workload," pp. 2, 8-9 (May 7, 1999).

46 California Fish and Game Code § 2271.

47 California Fish and Game Code § 6303.

48 California Fish and Game Code § 6400.

49 California Fish and Game Code § 15200.

RCW 77.12.020	Power of Fish and Wildlife to request designation of a species as deleterious exotic wildlife.
RCW 77.12.040	The commission shall regulate the takings, sale, possession and distribution of wildlife and deleterious exotic wildlife
77.44.40	Transplantation and introduction of exotic warm water fish shall be carefully reviewed to assure that adverse effects to native fish and wildlife populations do not occur.

Title 88 Navigation and Harbor Improvements

RCW 88.28.060	Prohibitions on discharge of ballast.

Title 90 Water Rights-Environmental (Water Pollution Control)

RCW 90.48	Point source discharges to surface waters of the state must have a discharge permit- Ecology considers a discharge pollutant to include aquatic nuisance species; therefore all regulations pertaining to regulation of point source discharges also apply to discharges of aquatic nuisance species.

Washington Administrative Code

WAC 232-12-01701	Designates zebra mussels as deleterious exotic wildlife and a public nuisance; prohibits importation and possession; inspection, reporting requirements; abatement measures.

Recent State Legislation: Concerned about the rising costs associated with aquatic NIS and the relatively slow pace of reform, a number of states nationwide are exploring or have passed legislation to address aquatic NIS within state waters.

Legislation in Washington State

SB 6114, 55th Leg., 1st Reg. Sess. (Wash 98)	Created the Zebra Mussel and European Green Crab Task Force which developed a plan with legislative recommendations including a coordinating committee chaired by a fully funded ANS coordinator. The ZMGCTG also called for the allocation of funds for education, enforcement, detection, monitoring and containment of ANS.
Senate Bill 5315	Did not pass.

In California, Assembly Member Ted Lempert introduced a bill, AB 703, in February 1999 to control ballast water discharges into state waters. The bill sets up a program under which the discharge of ballast water must meet certain treatment requirements. In the near term, the ballast water must be exchanged at sea or subjected to equivalent treatment. The waste discharge requirements would then be updated periodically as improved treatments become economically and technologically achievable.

In Oregon, state Senator Terry Thompson introduced, but recently pulled from consideration, a bill (HB 3071) that would have made it a crime to transport or introduce live NIS into the waters of the state.

Local (Includes port regulations)

Local Application of Federal and State Law: Place-based management of ballast water discharges can occur where agencies implement state and federal laws on a local level.

For example, in response to a petition from conservation groups,[50] the San Francisco Bay Regional Water Quality Control Board identified ANS as "pollutant stressors" subject to Clean Water Act Section 303(d) in Lower, South, and Central San Francisco Bay, Richardson Bay, Suisun Bay, San Pablo Bay, Carquinez Strait and the Delta.[51] The Regional Board ranked ANS as a "high" priority for action in all affected water bodies.[52]

The listing was approved by the State Water Resources Control Board and U.S. EPA, and the Regional Board then developed a draft plan[53] to implement Section 303(d).

Among other things, the Regional Board asserts in its draft "TMDL Workplan" that, in order to comply with the mandates of the federal Clean Water Act, "we intend to amend the Basin Plan establishing a TMDL of zero for exotic species, and a Discharge Prohibition for ballast water and perhaps hull fouling, allowing consideration of exceptions provided that discharges of exotic organisms to the estuary are minimized from these sources."[54]

Application of Clean Water Act Section 303 (d) will result in this in some type of ballast water management specific to the listed water bodies. The Regional Board will encourage extensive stakeholder input to ensure that the program implements "cost-effective control technology without compromising the competitiveness of ports in the San Francisco Bay Region."

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50 "Petition of the San Francisco BayKeeper and DeltaKeeper to the Bay Area Regional Water Quality Control Board and the Central Valley Regional Water Quality Control Board, Seeking Control of Ballast Water Discharges in the Bay-Delta Region," pp. 11-17 (May 21, 1997).

51 San Francisco Bay Regional Water Quality Control Board, "Section 303 (d) List of Impaired Water Bodies and Priorities for Development of Total Maximum Daily Loads for the San Francisco Bay Region: Final Staff Report," p.3 and Table A1 (March 9, 1998).

52 Id., Table A-1.

53 San Francisco Bay Regional Water Quality Control Board, "Draft Exotic Species TMDL Wrkplan Workload," (May 7, 1999) ("TMDL Workplan").

54 Id., p. 7.

Individual Port Regulations

The Port of Vancouver enacted a mandatory ballast water exchange regulation in April 1997, with a nine-month grace period to comply. Port executives reported being "pleased" with industry response to the regulation.[55]

The Port of Vancouver is "among the fastest-growing container ports on the West Coast, logging a 24 percent boost in business in 1996 and an expected 17 to 18 percent increase in 1997."[56]

Using Vancouver as a model, the Port of Oakland has proposed a similar mandatory ballast water exchange regulation as mitigation for expansion activities underway at the Port.[37]

Regulatory Gaps and Weaknesses

The significant and mounting damages and costs associated with aquatic nuisance species have prompted increasing activity at the international, national, regional, state and local levels to regulate ballast water. Current regimes, while an improvement from the relative lack of regulation only a decade ago, have not proven adequate to slow the increasing rate of invasions. Focused and effective action is needed to prevent further damage to coastal environments and economies.

International Regimes

The IMO, the federal government,[38] the shipping industry and the ports advocate that a consistent international or national approach is more preferable than local approaches, and will avoid the regulatory confusion and competition issues that may occur under a "patch work" regulatory approach.[39] However, it is generally recognized that international efforts are ponderously slow in development and, by the time they are ratified, are often toothless. The IMO's draft MARPOL Annex and its guidelines recognize that present ballast water exchange methods must be viewed

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55 "Vancouver Ballast Policy on Track," *Marine Digest and Transportation News*, p. 22 (Feb. 1998).

56 "Deltaport Partners Target a Bigger Share of North American Intermodal Cargo," Marine Digest and Transportation News, p. 22 (Feb. 1998).

37 "An Ordinance Amending Port Ordinance No. 2833 Relating to Ballast Water- Draft" 12/7/98," *Berths 55-58 Project Draft Environmental Impact Report*, App. F-2 (Dec. 11 1998).

38 64 Fed. Reg. 26672, 26674 (May 17, 1999) ("consistent standards of universal application, coupled with Federal initiatives to address unique regional concerns, are the best means of meeting local and national environmental goals with the least disruption to international maritime commerce").

39 Port of Oakland, Berths 55-58 Project Draft Environmental Impact Report, App. F: "Technical Memorandum: Ballast Water Management," p. 10 (December 11, 1998) ("Berths 55-58 Memorandum"); see also California Association of Port Authorities *et al.*, *Ballast Water Exchange and Treatment*, Executive Summary (June 1999).

only as a "stop-gap" measure,[40] but fail to provide a system for ensuring that improved methods will be integrated as developed.

Moreover, there is real concern that the IMO will be able to move forward effectively to promulgate the anticipated MARPOL Annex. Most nations other than the United States, Canada and Australia have evidenced no noticeable enthusiasm for a ballast water convention.[41] IMO's budget has been frozen for five years, in part due to concerns over its growing role in responding to environmental concerns and the funding of those operations.[42] If IMO continues to be "increasingly hamstrung by financial constraints,"[43] its work on the proposed Annex may be delayed sufficiently that member states such as the United States and Australia may feel compelled to take stronger measures on a unilateral basis, rather than wait for the IMO.

National Regimes

Moving to the next level, federal rules provide the most consistent regulatory approach. Competition issues are usually offset by the sheer economic weight of the U.S. trade and market and, for all practical purposed, a U.S. rule becomes a world rule.[44] The recent enactment of new legislative authority to regulate ballast water in Canada[45] further reduces concerns about competitive issues arising from national, rather than international, regulation.

NISA, the existing U.S. regime that specifically addresses ballast water, contains a number of significant limitations that inhibit its ability to address the influx of aquatic nuisance species effectively. The most significant limitation is that the program relies on ballast water exchange, a "stop-gap" measure that cannot achieve the 100 percent effectiveness needed to ensure a stop to aquatic nuisance species invasions from ballast. Another major limitation is that, with the exception of vessels entering the Great Lakes, the program is completely voluntary, and will remain so unless affirmative action is taken. Moreover, NISA will not permit a decision to be made on whether, if at all, to make the program mandatory before January 1, 2002—and that is assuming no further delays in a program that is already 1½ years behind schedule. Two other significant concerns are that NISA addresses only vessels entering the U.S. from outside the

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40 *Id.*

41 Reeves, Cdr. Eric, U.S. Coast Guard (ret.), *Analysis of Laws and Policies Concerning Exotic Invasions of the Great Lakes*, p. 44 (March 15, 1999), citing Personal Discussion with Mr. Thomas Morris, Transport Canada, Ottawa, the Canadian representative to the IMO's Ballast Water Working Group.

42 "IMO Faces Fundamental Issues of Funding," *Singapore Shipping Times* (July 14, 1999).

43 *Id.*

44 Statement of Kenneth Levin, Vice-President, Pacific Merchant Shipping Association.

45 Canadian Shipping Act, Revised Statutes of Canada, RS-9, Sec. 657.1, as added October 31, 1998 (reading in full: "The Governor in Council may make regulations respecting the control and management of ballast water").

EEZ, and so ignores coastwise traffic from infested areas (such as San Francisco Bay); and that the Coast Guard has not enforced NISA against NOBOBs,[46] which make up the vast majority of vessels entering the Great Lakes from outside the EEZ.[47]

Impatience with the pace and limitations inherent in NISA led a group of conservation, utility, fishing and other organizations from around the country to petition the Environmental Protection Agency to regulate ballast water discharges under the Clean Water Act.[48] EPA will issue a draft report on regulatory options under the Clean Water Act on September 1, 1999, and expects to complete a final report in spring or summer of 2000.

Regional/State/Local Regimes

As noted above, the Coast Guard, the shipping industry and the ports strongly prefer national or international regulatory regimes over regional, state or local efforts in order to ensure regulatory clarity and a "level playing field." Moreover, the current "lack of interjurisdictional consistency in laws, regulations and policies directed at aquatic nuisance species control efforts" inhibits effective action to control what is an ecosystem-based problem that does not respect jurisdictional boundaries.[49]

However, the slow implementation of the existing national regime and concerns over its voluntary nature has prompted a flurry of local activity by conservationists and impacted industries such as fishing and water purveyors. For example, in California a coalition of conservation and fishing groups, including the Center for Marine Conservation and the San Francisco BayKeeper, have raised concerns under NEPA, CEQA and ESA regarding the adequacy of the federal and state environmental analyses of the impacts of deepening and expansion projects at the Port of Oakland. In response, the Port of Oakland has established a mandatory ballast water exchange program. Also in California, a group of conservation organizations petitioned the state and U.S. EPA to regulate aquatic nuisance species under Section 303(d) of the Clean Water Act. This petition was granted, and the state has begun the process of regulating ANS within San Francisco Bay.

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[46] Reeves, *supra* note __, at 45-46, 136. "NOBOBs" are vessels with essentially "no ballast on board." These vessels often take on ballast water in the Great Lakes after offloading cargo; this water can mix with NIS-contaminated sediments in the ballast tanks and transport those NIS upon discharge at another Great Lakes port.

[47] Reeves, *supra* note __, at 15. For a more comprehensive review of the effectiveness of NISA, *see id.* at 45-67; *see also* Cohen, Dr. Andrew, San Francisco Estuary Institute, *Ships' Ballast Water and the Introduction of Exotic Organisms into the San Francisco Estuary*, pp. 29-30 (October 1998).

[48] Petition by the Pacific Environmental Advocacy Center, *et al.* to Carol Browner, U.S. Environmental Protection Agency (Jan. 13, 1999).

[49] Great Lakes Panel on Aquatic Nuisance Species, *Legislation, Regulation and Policy for the Prevention and Control Nonindigenous Aquatic Nuisance Species: Model Guidance for the Great Lakes Jurisdictions*, p. 1 (June 1999) ("Great Lakes Panel Report").

In Oregon, interest groups are calling for greater consideration of NIS species impacts stemming from a proposed dredging plan for the Columbia River. These groups argue that continued large-hull ship activity throughout the Columbia and lower Willamette Rivers, as contemplated in the proposed 20-year dredging plan, will increase discharges of ANS and so will significantly impact the health of the local environment and economy. A strong national or international program that adequately addresses environmental and economic impacts from ANS could result in reductions in such local activities, and at the same time address concerns raised about regulatory clarity and industry competition.

New Regulatory Activities Needed

Effective regulations at the international level do not appear to be forthcoming in the near, or even distant, future. The escalating costs associated with ballast-introduced invasions, and the permanence of those costs, demand prompt action. While efforts to regulate the introduction of aquatic nuisance species at the international level should be continued, activities at the national and other levels must continue to prevent further invasions and to ensure that control efforts underway are not taken in vain.

An effective program to regulate the discharge of aquatic nuisance species will balance the benefits of the commercial activity against the externalized costs associated with the activity and internalize those costs to the maximum extent feasible. Those members of the public presented with the bulk of the externalized costs will work to change the status quo to a "polluter pays" model at the level most applicable to their situation (i.e., local, state, regional or national). Members of the regulated industry that find proposed controls unreasonable or unsafe will in turn resist such controls. A protracted process can be avoided by swift and strong, but balanced, action on a widespread basis.

Several, not necessarily mutually exclusive, steps can be taken to improve regulation of the ballast water discharge of aquatic nuisance species. Options include the following:

- Use a stakeholder process to develop and publicize model regional/state legislation, that could be used as a template for future federal action.[50]
- Revise NISA to strengthen protections and close identified gaps.[51]
- Develop funding, through legislation or other means, to identify technologically and economically feasible ballast water treatment solutions for both on-board and on-shore installations.
- Examine the applicability of existing federal and state laws to ballast water and enforce them as appropriate.[52]

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[50] See Great Lakes Panel Report, *supra* note ___.

[51] *See, e.g.*, Reeves, *supra* note ___, at 7.

[52] For a review of laws that relate to, and may relate to, ballast water discharge of aquatic nuisance species, *see* Cohen, *supra* note __, at Appendix C and D; *see also* Reeves, *supra* note __, at 91-118.

- Set national standards for new vessels, which would incorporate improvements at a point in the ship's life when it is most cost-effective to do so.
- Devise new federal incentive programs, such as grant or loan programs for ship retrofits, as well as financial disincentive programs, such as a tax on the discharge of "dirty" ballast.[53]
- Support regulatory activities in neighboring Canada and Mexico, particularly the development of new regulations under the revised Canadian Shipping Act.
- Establish innovative state/regional initiatives that could be used as models for other states and regions, and eventually for federal action.[54]

One cross-cutting area that needs particular focus is verification of compliance with chosen regimes and enforcement of those regimes. Experience with records required under Annex I of MARPOL indicates that there will be some attempts to falsify ballast water management activities.[55] One verification trial conducted in Australia, referred to as the "Newcastle Method," found that, of those vessel operators who stated that they had complied fully with ballast water exchange requirements, 27 percent of ships provided evidence of partial exchange of more than 50 percent, 18 percent of ships provided evidence of partial exchange of less than 50 percent, and 24 percent of ships could show no evidence of any exchange having taken place at any time during the voyage.[56] The chosen regulatory regime(s) should have a clear monitoring and enforcement strategy to ensure maximum compliance.

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[53] *See* Reeves, *supra* note __, at 140-41.

[54] *See id.* at 137-40 (suggesting models based on the Alaska ballast water law applied to tank ships and a 1999 State of California bill, AB 703).

[55] Berths 55-58 Memorandum, p. 9.

[56] Presentation by Penny Lockwood, former Director of Australia Ballast Water Program, to the Pacific Ballast Water Working Group, Oakland, California (June 17, 1999).

Points to Consider for the Summary of Recommendations

The following points have not been approved by the PBWG and are included for discussion only.

Goal: Eliminate, or minimize as much as possible, the discharge of viable exotic species from vessels.

Adopt a precautionary principle: We should not introduce an exotic organism unless we have documented evidence that it is benign in the new environment.

- Formalize the PBWG with a board of officers/directors and some charter from government(s). Do not let it be absorbed by an existing group.
- Author an agreement between the governments of California, Alaska, Washington, Oregon, BC, and the Mexican border state with California that promotes consistent ballast water regulation within the Pacific region.
- Adopt the Vancouver/Oakland protocols for the Pacific region.
- Pursue federal funds for R&D to determine a standard measure to evaluate the effectiveness of ballast water purification methods.
- Conduct baseline inventories of nonindigenous species for all major Pacific Coast ports.
- Expand the scope of the PBWG from ballast water issues to the transport of non-indigenous species on the hull, shaft, propeller, anchor and chain of ships.
- Pursue federal funds to conduct R&D on ballast water management technologies.
- Expand the membership in the PBWG to insure that all stakeholders are involved in the decision making process.
- Support the development, adoption and implementation of a ballast water management program under the water quality permit system of the Clean Water Act.
    - The Coast Guard program is a good start, but has critical gaps.
        - Covers only ballast water exchange, which is currently imperfect.
        - Does not cover the coastal shipment of Ballast water.
        - Salinity measurements are not a reliable method to determine if ballast water is benign.

- The shipping industry needs a nationally consistent regulatory system, and state agencies should have some involvement since the impacts of improperly treated or exchanged ballast water fall on the local and state level.
- The Clean Water Act offers state agency involvement that is coordinated on a national basis.
  - Water Quality agencies exist throughout the country and are coordinated nationally by EPA.
  - Such a program is moving forward through the 303 (d) activities in the San Francisco Bay area and a petition to regulate discharges under the permit requirements for the Clean Water Act.

References

(To be included)

Appendix A: Pacific Ballast Water Group Participants

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