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Coastal and Port Environments: International Legal and Policy Responses to Reduce Ballast Water Introductions of Potentially Invasive Species

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Marine transportation moves the vast majority of cargo volume in international trade. Ballast water loaded in one port to stabilize ships for a safe voyage contains local aquatic species that are later discharged into other ports, where they are potentially invasive and can cause ecological, socioeconomic, and human health consequences. This article discusses the new Global Ballast Water Convention, what the Convention suggests about the International Maritime Organization (IMO), and its relationship to the United Nations Convention on the Law of the Sea. The article also considers implementation of the Ballast Water Convention by presenting a decision support model that allows regulators to explore tradeoffs between costs and benefits of new technologies and derive optimal reductions of ballast-water-borne biological pollutants.

Keywords Ballast Water Convention, IMO, invasive species, marine environment, UNCLOS

Introduction

Ships take on water by gravity or through pumping and store that water in onboard tanks to control trim and draft, provide stability, and enhance voyage safety, an action known as ballasting. Although any heavy solid or liquid can serve as ballasting material, ships almost exclusively employ ballast water for operational convenience. Ships often store so-called ballast water as compensation for those times in which they are less than fully loaded. The term ballast water is a bit of a misnomer, however, as the "water"

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contains organisms and pathogens that were present in the aquatic environment from which the ballast originated; while other organisms and pathogens that have been entrained in ballast water tanks are found in a sediment layer, which separates out from the liquid phase in the tanks.[1] When ships reach destination ports, they discharge ballast (both water and the surviving organisms and pathogens) into those new port environments. Ballast is discharged to lighten loads in aid of navigation, because ships intend to take on additional cargo, and for other reasons. In new aquatic environments, some introduced organisms reproduce, live more than one life cycle, and become established. These organisms—referred to sometimes as exotic, nonnative, nonindigenous, alien, nuisance, marine pests, or invasive—may, for example, out-compete native aquatic species, transmit diseases to native species, or contaminate the genome of native species through interbreeding. Pathogens such as E. Coli also may be present in ballast water (for example, where local discharge of untreated sewage to coastal waters occurs), thus providing a vector for disease transmission to human populations from one port to the next.

Although the use of ballast to stabilize ships has been employed since the Phoenicians began to trade by sea, two changes during the industrial era have greatly increased the rate of species transfer from one aquatic environment to another: first, a technological shift from solid to liquid ballast; and second, globalization of trade and the concomitant increase in the number, size, and speed of ships engaged in waterborne commerce. Because the marine transportation system presently moves the vast majority of international trade,[2] vessels have become the primary vector for the introduction of nonindigenous species.[3] Indeed, each day some 3000 species are transported in ship ballast or on ships' hulls.[4]

The effects of species introduction on ecosystems and biodiversity are increasingly a cause of domestic and international concern.[5] For example, although it was not the central focus at the time of the negotiations of the 1992 Convention on Biological Diversity (CBD), the issue of marine biodiversity has now taken a prominent place in that regime.[6] This development is not surprising when one considers that of the thirty-five phyla found in nature, all but one is found in the marine environment, sixteen phyla are found exclusively in the marine environment and another five comprise species that are almost entirely marine.[7] Given this wealth of fauna and flora in the marine environment, parties to the CBD adopted the Jakarta Mandate on Marine and Coastal Biological Diversity in 1995.[8] As a result, the CBD is now focused on integrated marine and coastal area management, the sustainable use of living resources, establishment of marine protected areas, management of mariculture, and, most importantly for present purposes, the control of aquatic invasive species.

Although the impact of species introduction is in one sense ecological, those ecological impacts have potentially grave socioeconomic consequences,[9] as witnessed by the infestation of zebra mussels in the North American Great Lakes. In response, there have been efforts at local, national, and global levels to control species introductions from ships' ballast.

A number of countries have adopted rules and regulations related to the handling of ballast water, including Argentina, Australia, Canada, Chile, Israel, United Kingdom, New Zealand, and the United States.[10] Since September 1999, New Zealand, for example, has required ballast water reporting and prohibited the disposal of ballast water sediment at sea and the discharge of ballast water within twelve nautical miles of its shore unless such discharge has been approved.[11] To be approved, the liquid ballast must be treated, exchanged at sea, or discharged into an approved area or onshore treatment facility, or be from a fresh water source.[12] In 2001, Australia prohibited discharge

of ballast water posing a "high risk" of introducing exotic marine pests, that is, any ballast water taken up in salt water from ports or coastal waters outside of its territorial sea.[13] Finally, turning to the United States, the U.S. Coast Guard adopted a rule in June 2004 that requires most ships when undertaking ballast water discharges to file reports and provides for substantial penalties for a failure to file timely reports.[14] While the U.S. Environmental Protection Agency has so far avoided regulating the discharge of ballast water and the organisms it contains,[15] having rejected a citizen petition making such a request,[16] the U.S Coast Guard has begun to explore the creation of a ballast water discharge standard.[17]

Significant achievements have been realized at the global scale, the arena that is the focus of this paper. Of particular relevance is a recently adopted convention by the International Maritime Organization (IMO) regarding ballast water, the International Convention for the Control and Management of Ships' Ballast Water and Sediments (hereinafter, the Ballast Water Convention, Convention, or BWC),[18] which is detailed in the second section. The Ballast Water Convention is important in its own right and because it may presage broader institutional change at the IMO, which increasingly is being called on to balance biodiversity and health concerns with its more traditional emphasis on ship and crew safety and maritime economics.

The Convention's relationship to, and implications for, the United Nations Convention on the Law of the Sea (UNCLOS)[19] for ballast water management are considered in the third section. Given the central role that the Ballast Water Convention is expected to play in reducing the introduction of pathogens and non-native species into port ecosystems, the focus of the analysis in this contribution is on the Ballst Water Convention and UNCLOS, leaving for future analysis other international hard and soft laws, such as the General Agreement of Tariffs and Trade (GATT)[20] and related instruments, and the FAO Code of Conduct for Responsible Fisheries[21] that may bear on this question.[22] In the fourth section, a decision support model is presented that could be used by policymakers to implement the Ballast Water Convention; by the IMO as a basis for modification of the standards established under the Ballast Water Convention; by individual port and coastal states to facilitate the adoption of more stringent national standards; by shipcarriers to determine least-cost solutions for their vessel fleets; and by port operators to determine relative risks that individual vessels pose to particular port environments. The model has wide applicability and could be applied to any port in the world.

Ballast Water Convention

On 13 February 2004, the IMO adopted the Ballast Water Convention. The Convention, as detailed below, requires ships to develop ballast water management plans, maintain a ballast water record book, undertake certain ballast water management measures, and eventually comply with concentration-based discharge limits. The Convention also establishes an "enlightened" inspection and enforcement regime. First, to be considered briefly are the developments over the past decade leading up to the Convention as well as more general issues such as the form of the Convention, entry into force, amendments, and jurisdiction.

The Long March Toward a Global Convention

The international community has long recognized that the introduction of nonindigenous species could cause significant damage to native environments.[23] Indeed, as early as 1933,

in the Convention Relative to the Preservation of Fauna and Flora in their Natural State,[24] the colonial powers in Article 2.2 agreed that within certain natural reserves, primarily in Africa, "the introduction of any species of fauna or flora, whether indigenous or imported, wild or domesticated, shall be strictly forbidden." This concern for the integrity of essentially unspoiled ecosystems is also embodied in Article IX.1 of the 1964 Agreed Measures for the Conservation of Antarctica Fauna and Flora,[25] where the contracting parties agreed to prohibit the importation of nonindigenous animal and plant species except in conformance with a permit.[26] The problem had gained sufficient international attention that a provision based on a 1974 Norwegian proposal was included in the UNCLOS,[27] a provision whose implications are discussed in more detail below.

Ten years later, in 1992, at the United Nations Conference on the Environment (UNCED) held in Rio de Janerio, the nations of the world adopted Agenda 21,[28] the blueprint and action program for sustainable development for the 21st century. Agenda 21 contained a number of "calls to arms," including calling upon states, acting through the IMO and other mechanisms, to adopt "appropriate rules on ballast water discharge to prevent the spread of non-Indigenous organisms."[29] The 2002 World Summit on Sustainable Development renewed the international call for action by the IMO.[30]

In 1992, the CBD was adopted and has been almost universally accepted, with the exception of the United States and several other states. Article 8(h) of the CBD directs the parties, "as far as possible and as appropriate," to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species." In 1995, the CBD Conference of the Parties (COP) adopted the Jakarta Mandate on Marine and Coastal Biological Diversity,[31] which was followed up by a detailed program of work in 1998 that identified alien species as one of five thematic areas.[32] In 2002, the CBD COP established guiding principles to prevent and mitigate the impacts of alien species and urged the IMO to complete preparation of an international instrument to address ballast water and called on governments to ensure its full implementation.[33]

While it is true that the IMO did not adopt the Ballast Water Convention until 2004, it first considered the implications of the introduction of aquatic organisms from ballast water some three decades earlier.[34] More formally, in 1991, the IMO's Marine Environmental Protection Committee (MEPC) adopted guidelines calling for the prevention of the introduction of unwanted organisms, pathogens, and sediment from ballast water which, with slight modification, were adopted by the IMO in November 1993.[35] The IMO agreed to more comprehensive guidelines to control ballast water in 1997[36] and began to emphasize principles of risk minimization.[37] The guidelines were an important development because they set forth internationally agreed management practices and called for uniform action by states. Yet the guidelines have a number of deficiencies: they are nonbinding; rely heavily on the mid-ocean exchange of waters (and associated organisms) taken up from coastal waters in the vicinity of the port of origin for oceanic waters (so-called ballast water exchange or BWE);[38] and provide little incentive for treatment innovation. In the 1997 resolution adopting the 1997 guidelines, the IMO acknowledged the need to complete a legally binding ballast water instrument.[39]

Preliminary Matters

Early on in the development of the Ballast Water Convention, the IMO contemplated appending the ballast water regime as an annex to the principal vessel-source marine pollution convention, MARPOL 73/78,[40] rather than adopting a freestanding convention. That approach was ultimately rejected, it is suggested, because of MARPOL's entry and

amendment conditions and the emphasis MARPOL places on flag state obligations as compared to port state control, and perhaps due to a recognition of the need to transcend the narrower vision embodied in the concept of pollution prevention toward a more expansive and affirmative vision of biodiversity conservation.

Taking the latter point first, in its preamble, the Ballast Water Convention acknowledges the threat that ballast water poses to the conservation and sustainable use of biological diversity. More importantly, the Convention explicitly regulates the discharge of those organisms and pathogens that "may . . . impair biological diversity."[41] The decision to employ a free-standing Convention to regulate ballast water thus suggests an expanded regulatory horizon for the IMO to engage in biodiversity protection in addition to pollution prevention.

Turning next to entry into force requirements, IMO conventions generally require a specified number of ratifying states and that these ratifying states have flagged vessels that represent a certain percentage of the gross tonnage of the world merchant fleet in order to enter into force. For example, MARPOL required a minimum of fifteen ratifying states representing fifty percent of world gross tonnage for entry into force.[42] However, this approach does not appropriately balance the interest of the maritime states (states with ships) with the interest of coastal or port states (states with major coastlines or ports) that are the prime consumers of goods shipped in international maritime commerce. Indeed, with a world fleet now dominated by developing states, such as Panama and Liberia,[43] a fifty percent requirement gives those states undo influence over whether and when a MARPOL Annex comes into force. Amendments to MARPOL Annexes also are linked to the fifty percent requirement, although in most circumstances, such amendments come into force absent an objection from at least one-third of the states parties or from states parties representing not less than fifty percent of the gross tonnage.[44] Moreover, the minimum number of states required to ratify MARPOL, fifteen, is out-of-step with the growth in the number of U.N. member nations—135 in 1973, 191 today.

In contrast to MARPOL, the Ballast Water Convention provides that it will enter into force twelve months after the date on which thirty states, with combined merchant fleets constituting thirty-five percent of world gross tonnage, have ratified or otherwise agreed to be bound by the Convention.[45] Thus, the Ballast Water Convention requires twice the number of agreeing nations (thirty instead of fifteen), and reduces the tonnage dominance of open-registry states such as Panama and Liberia. While this rebalancing of states' power at IMO is significant, even more striking is how the Ballast Water Convention addresses amendments: it has no gross tonnage requirement.[46]

The Convention follows the IMO's tradition of separating the basic State obligations (in the body of the treaty) from the technical requirements of managing ballast water, which are found in regulations attached to the Convention as an Annex. Article 2.2, however, makes it clear that the Annex "forms an integral part of this Convention." Moreover, "unless expressly provided otherwise, a reference to this Convention constitutes at the same time a reference to the Annex."[47] A similar formulation dates back to at least the 1946 International Convention for the Regulation of Whaling.[48] In addition, the Convention envisions a substantial "administrative" role for the IMO. In ten instances, an Article or an Annex Regulation of the Convention makes reference to guidelines to be developed by the IMO. Given the unusually heavy burden placed on the IMO to provide more detailed guidance for the full development and implementation of the Convention, the Conference at which the Convention was adopted, approved a resolution which calls on the IMO to develop the guidelines as a "matter of urgency . . . as soon as possible."[49]

The Ballast Water Convention, like other IMO conventions, also adopts a tacit amendment procedure for regulations contained within the Annex.[50] Article 19.2(e)(ii) provides that amendments to the Annex adopted by the MEPC are considered "accepted" by the parties twelve months after their adoption unless more than one-third of the parties to the Convention object. Under Article 19.2(f)(ii), six months later, the amendment enters into force for all parties except any individual state that opts out during this time period, in which case the amendment will not be binding on that state unless it subsequently accepts the amendment to the Annex. Amendments also can be adopted by the Conference of the Parties in accordance with Article 19.2(g).

Each party to the Convention is required, "with due regard to its particular conditions and capabilities," to develop national ballast water management policies and promote attainment of the Convention objectives.[51] Each party also "shall require" ships flying its flag to comply with the Convention, including taking "effective measures" to ensure such compliance.[52] The Convention applies to all ships with a few practical exceptions: certain vessels that operate in no more than one state's jurisdictional waters unless doing so would "impair or damage" the "environment, human health, property or resources"; warships and state-owned ships, which are required to act consistently with the Convention "so far as reasonable and practicable"; ships not designed to carry ballast water; and ships carrying ballast water in sealed tanks not subject to discharge.[53] Indeed, pleasure craft and craft "used primarily for search and rescue" that carry ballast water are required to comply with the Convention as well, although, if those craft are less than 50 meters in length and have a maximum of eight cubic meters of ballast water capacity, they are allowed to attain "equivalent compliance."[54] As discussed in more detail below, states may exempt certain vessels from the ballast water discharge standards that follow specified routes based on a risk assessment undertaken in accordance with guidelines to be developed by the IMO. Like MARPOL,[55] the Ballast Water Convention is to be applied by parties as a condition for port entry for nonparties; thus ships of nonparties receive "no more favorable treatment."[56]

The parties to the Convention have a number of obligations, including: to provide technical assistance "as appropriate"; to "cooperate actively" in technology transfer "subject to their national laws"; and to enhance regional cooperation, particularly in enclosed and semi-enclosed seas.[57] The central role that technical assistance is envisioned to play in the achievement of the goals of the Ballast Water Convention is underscored by the adoption of a specific resolution, Resolution 3, on that subject in the Conference Final Act.[58] The parties also have obligations regarding monitoring, data gathering and sharing, inspection, and enforcement and are required to inform the IMO and other parties of domestic ballast water management requirements and procedures and reception facilities for ballast water and related sediments. The Ballast Water Convention seeks to facilitate the undertaking and sharing of the results of scientific and technical research and monitoring, including "observation, measurement, sampling, evaluation and analysis" of treatment technologies and of any adverse impacts caused by the discharge of organisms or pathogens.[59]

Article 9 provides that when a ship that flies the flag of one party to the Convention is in a "port or offshore terminal" of another party, it is subject to inspection for the "purpose of determining whether the ship is in compliance with this Convention."[60] A port state also may inspect a ship if a request is received from another party, "together with sufficient evidence that a ship is operating or has operated in violation of a provision" of the Convention.[61] In general, inspections are limited to verifying that the ship has a valid International Ballast Water Management Certificate, inspecting the Ballast

Water record book, and sampling the ballast water in accordance with guidelines to be developed by IMO.[62] By authorizing port states to sample ballast water to determine compliance with ballast water discharge standards in the absence of "clear grounds" for believing that the ship does not conform substantially to the Certificate, the Ballast Water Convention, like the 2001 International Convention on the Control of Harmful Anti-Fouling Systems on Ships ("Anti-Fouling Convention"),[63] represents a significant departure from MARPOL.[64] Authorizing compliance sampling rather than merely a paper examination is a major step that should enhance compliance with the Ballast Water Convention.

In addition, if a ship lacks a valid certificate or there are "clear grounds" for believing that either the ship does not conform substantially to the Certificate or the master or crew are not familiar with essential ballast water management procedures or have failed to implement those procedures, a port state may undertake a more detailed inspection.[65] When these clear grounds exist, the port state is required to take steps to prevent the discharge of ballast water until such time as the ship can do so without "presenting a threat of harm to the environment, human health, property or resources."[66] Likewise, when sampling indicates that a ship poses such a threat of harm, the party in whose waters the ship is operating is required to prohibit the discharge of ballast water until such time as the threat is removed.[67] When an inspection indicates a violation, the inspecting party is required to notify the ship and the "Administration" (the flag state).[68]

The Convention requires flag, coastal and port states to establish sanctions for violations.[69] Port and coastal states sanctions are meant to address violations of the Convention within their jurisdiction, presumably in internal waters, territorial seas, archipelagic waters, continental shelves, and exclusive economic zones (EEZs).[70] Importantly, port and coastal states have authority under the Convention to not only furnish the flag state with information regarding a violation, but, in the alternative, to institute enforcement proceedings.[71] This grant of authority to port and coastal states, while not unusual on its face,[72] takes on added significance given the ability of port states to engage in compliance sampling. In contrast, the two most prominent examples of international instruments providing for enhanced port and coastal state control and/or jurisdiction, UNCLOS[73] and the United Nations Fish Stocks Agreement,[74] are structured in such a manner that enforcement under those regimes ultimately can devolve to the flag state if the flag state so wishes.[75]

The Ballast Water Convention thus encompasses an expanded vision of port state control. This is most apparent in its authorizing port states to engage in compliance sampling without regard to cause, that is, in the absence of "clear grounds," and to institute enforcement proceedings without regard to normal flag state prerogative. Beyond this expanded role in ballast water enforcement for port states, this development may have broader implications for port state control and regional arrangements on port state control,[76] such as the 1982 Paris Memorandum of Understanding on Port State Control (Paris MOU).[77]

In those instances when a port or coastal state chooses to inform the flag state of a violation, the flag state is required to investigate the matter and undertake enforcement proceedings as soon as possible.[78] The flag state also is required to promptly inform the state reporting the violation and the IMO of action taken.[79] Article 8, while not requiring a specific sanction, does require that parties adopt sanctions that "shall be adequate in severity to discourage violations of this Convention wherever they occur."[80] This suggests that the drafters of the Ballast Water Convention were concerned with general, as opposed to specific, deterrence.[81] In addition to the sanctions specified in Article 8, the

Convention grants flag and port states the authority to "warn, detain, or exclude" an offending ship.[82] In the event a state takes action under Articles 9.3, 10.2, or 10.3, the officer of that state is required to notify the flag state of the circumstances leading to the action.[83] That state is also required to notify the offending vessel's next port of call for the offending vessel.[84]

Ballast Water Management

The Ballast Water Convention applies to discharges of "harmful aquatic organisms and pathogens" and to "sediments" that settle out of ballast water from ships that fly the flag of, or are otherwise under the administration of, a party to the Convention. As noted earlier, there is an expectation that the parties will apply the Convention to ships of nonparties as well. A ship is defined as a "vessel of any type whatsoever operating in the aquatic environment and includes submersibles, floating craft, floating platforms, FSUs [Floating Storage Units] and FPSOs [Floating Production Storage Offloading Units]."[85] The Convention defines the term "harmful aquatic organisms and pathogens" as organisms and pathogens "which, if introduced into the sea including estuaries, or into fresh water courses, may create hazards to the environment, human health, property or resources, impair biological diversity or interfere with other legitimate uses of such areas."[86] By reference to "biological diversity" and the use of the permissive "may," this definition is less anthropocentric than other definitions of "pollution" under international law, such as found in the UNCLOS or as crafted by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP).[87] Moreover, in the preamble of the Ballast Water Convention there is explicit acknowledgment of the threat that ballast water poses to the conservation and sustainable use of biological diversity and of the actions taken by the CBD COPs to protect marine biodiversity from invasive species.[88] These developments suggest an expanded regulatory horizon for the IMO, and the definition moves beyond pollution prevention to biodiversity protection.

While no mention of the precautionary approach is found in the substantive text of the Convention, the parties were at least "mindful" of it.[89] Rather than explicitly relying on the precautionary approach, the Convention establishes specific requirements in a number of areas, including ballast water management planning and reporting; ship surveying and certification; ballast water exchange; sediment management; ballast water treatment; and additional measures for certain areas in order to prevent, minimize, and ultimately eliminate the threat posed by aquatic organisms and pathogens contained in ballast water. These requirements are summarized below. Further guidance as well should be forthcoming from the IMO, as the Convention and its Regulations make repeated references to various guidelines to be developed by IMO.

When in force, the Ballast Water Convention will require each ship from a party to have an approved ship-specific Ballast Water Management Plan (BWMP). The plan, among other matters, will have to document the safety procedures to be followed, describe strategies to implement ballast water management and procedures for sediment disposal, designate an officer on board to be in charge of ballast water management, and specify reporting requirements.[90] A ship also must have on board a ballast water record book in which to enter and maintain a record of its ballast activities and explain the circumstances behind, and the reasons for, any nonstandard ballasting activities (e.g., due to an exemption, for safety, or as a result of an accident).[91]

Each ship (excluding FSUs and FPSOs) of 400 gross tonnage and greater will be required to undertake a series of surveys at specified intervals and after significant re-

pair to ensure that its BWMP and any associated "structure, equipment, systems, fitting, arrangements and material or processes" fully comply and "have been maintained in accordance with" the Convention and "remain satisfactory for the service for which the ship was intended."[92] The flag state is required to establish "appropriate measures" for ships that are not subject to that survey mandate.[93] After "successful completion of a survey," a ship is awarded a certificate by the flag state, or by another state if requested by the flag state.[94] A certificate is valid for a period of not greater than five years and ceases being valid if the ship is transferred to the flag of a different State.[95] If a ship is found not to conform to the certificate, the flag State is required to "ensure that corrective action is taken."[96]

Turning now to the substantive requirements, the Convention requires ships to engage in ballast water exchange (BWE) with at least ninety-five percent volumetric exchange or to pump through three times the volume of each ballast water tank.[97] "Whenever possible" a ship should conduct BWE "taking into account" the guidelines to be developed by the IMO in water at least 200 meters in depth and at least 200 nautical miles from the nearest land.[98] If a ship is "unable" to meet that last requirement, it must undertake BWE "as far from the nearest land as possible," and in any event, at least 50 nautical miles from shore.[99] When a sea area is such that the parameters specified cannot be met, a port state, "in consultation with adjacent or other States, as appropriate," and in light of the IMO guidelines, may designate areas for BWE.[100] These exchange requirements may be challenging to meet for vessels traveling on coastwise routes or on international routes that fall within national seas closer than 200 (and/or 50) nautical miles from shore. This may represent a substantial portion of vessel traffic, given that 70% of ship activity is within 400 km (~216 nautical miles) of shore.[101]

Each party to the Convention must ensure that "adequate" sediment reception facilities are provided "where cleaning or repair of ballast water tanks occurs."[102] Ships in turn are required to manage ballast water sediment in accordance with their BWMPs.[103] Moreover, newly constructed ships, including those undergoing a major conversion, should, "without compromising safety or operational efficiency," be designed and constructed "with a view to minimize the uptake and undesirable entrapment of Sediments, facilitate removal of Sediments, and provide safe access to allow for Sediment removal and sampling" taking into account IMO guidelines and Regulation B-5.1 of the Convention.[104] This is a fairly weak requirement in that the wording is: (a) ships "should" rather than "shall," be designed; (b) the goal is not to minimize, but merely with a "view" toward minimizing sediment effects; and (c) the construction goals are paramount only if both "safety" and "operational efficiency" are not compromised.

Perhaps the most important aspect of the Ballast Water Convention is its establishment of concentration-based ballast water performance standards, which ships that fly the flag of a state party must meet. Assuming timely entry into force of the Convention, these standards will come into effect between 2009 and 2016 depending on vessel class, size, and construction date.[105] Vessels can gain an additional five years by participating in a technology demonstration project.[106] Two performance standards (limits) are set for "viable organisms" and three performance standards are set for "indicator microbes" in order to protect human health from pathogens.[107] These standards must be achieved unless the vessel undertakes alternative methods that ensure an equivalent level of protection.[108] Interestingly, the Convention reserves an important role for the IMO, giving it authority to approve ballast water treatment systems to the extent that they employ "active substances."[109] In addition, as discussed in more detail below, parties may establish additional measures pursuant to Article 2.3 and Section C of the Regulations.

Regarding the concentration-based ballast water performance standards in the Convention Regulations, first, for those organisms greater than or equal to 50 micrometers, the discharge is required to have less than 10 viable organisms per cubic meter.[110] Second, for those organisms greater than or equal to 10 but less than 50 micrometers, the discharge is limited to less than 10 viable organisms per milliliter.[111] Unfortunately, the Convention does not define what is meant by the term *viable organisms*, which could lead to problems with enforcement. For example, is a living organism viable if the environment into which it is to be discharged is so incompatible with its native environment that it would ultimately die in the new environment? What period of survival would mark the threshold between a viable organism and one that could not possibly survive the new environment?[112]

The limits established for the indicators microbes are: Vibro cholerae (O1 and O139) [less than 1 colony forming unit (cfu) per 100 milliliters or less than 1 cfu per 1 gram (wet weight) zooplankton]; E. Coli [less than 250 cfu per 100 milliliters]; and intestinal Enterococci [less than 100 cfu per 100 milliliters].[113] This emphasis on reducing and eliminating pathogens in ballast water in addition to harmful aquatic organisms suggests an integral role for the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)[114] in the ballast water regime through the reduction of pathogens in the waters in which ballast water is taken up.[115] Indeed, GESAMP has identified the control of sewage to be among the most serious threats posed by land-based activities.[116]

The Ballast Water Convention also explicitly acknowledges the right of individual states to establish more "stringent measures . . . consistent with international law."[117] While states enjoy broad authority to condition entry into their ports on compliance with environmental and other mandates—in this regard, the U.S. Oil Pollution Act of 1990 requires oil tankers to be double hulled[118]—it is unusual, although not unprecedented, for an international treaty to explicitly acknowledge the right of states to establish more stringent standards.[119] In this regard, Convention Regulation C-1 is related to Article 2.3, although they appear to have developed separately and it is unclear whether the drafters intended the regulation to provide further direction to States on how the Article should be implemented or whether they intended it to provide an alternative mechanism. More specifically, the regulation provides that, if a party determines that additional measures are "necessary to prevent, reduce, or eliminate" the transfer of aquatic organism or pathogens from ballast water or sediment, that party, may, after consulting with affected States and consistent with international law, require ships to meet a specified standard.[120] The party must inform IMO of its intention at least 6 months prior to the proposed effective date (absent an emergency or epidemic), describe in detail the additional measure(s), take into account any guidelines issued by the IMO, and, "to the extent required by customary international law as reflected in the [UNCLOS], as appropriate, obtain IMO approval for the additional measure(s)."[121] While the regulation on its face does not prevent a state party from adopting a blanket measure that would apply in all of its jurisdictional waters, Section C is denominated "Special Requirements in *Certain Areas*" (emphasis added), suggesting a more targeted approach. Presumably, an additional measure could include a more stringent discharge standard or a no discharge zone. While the Convention does not explicitly authorize no discharge zones, it appears to invite the creation of no uptake zones, calling on parties to "endeavor to notify mariners" of areas where ballast water uptake should not occur due to "known conditions" (e.g., in areas of toxic algal blooms, near sewage outfalls, and where tidal flushing is inadequate).[122]

The Convention also provides several exceptions to the ballast water performance standards that also apply to the extent a state adopts more stringent measures under Article 2.3 and Regulation C. The exceptions include ship safety under "emergency conditions or saving life at sea"; accidental discharge/ingress due to nonwillful and nonreckless ship or equipment damage provided reasonable precautions are taken; and avoidance or minimization of pollution incidents.[123] The Convention also permits parties in "waters under their jurisdiction" to exempt certain ships from Regulation B-3 performance standards and C-1 additional measures as well.[124] More specifically, a party may, based on risk assessment guidelines to be developed by the IMO, exempt a ship taking a voyage between specified locations that does not mix ballast water or sediments from other locations for a period of up to five years, with an intermediate review.[125]

Given the aquatic organism and pathogen performance standards and the lack of off-the-shelf technology to necessarily meet them, it is expected that substantial thought and effort will be directed in the near term toward developing treatment technologies that will reduce or eliminate the introduction of species from ballast water as cheaply as possible. However, as noted above, individual states may regulate ballast water discharges more stringently, and as next described, the global standards established by the Ballast Water Convention are not inviolate. Indeed, the Convention performance standards are subject to review by the MEPC "no later than three years before" their "earliest effective date."[126] Regulation B-3.3 provides that certain specified ships constructed "in or after 2009" must meet that ballast water standard. For a review to occur more than three years before 2009, as noted in Resolution 4 of the Final Act,[127] the review would have to commence by 2006, even before the Convention is likely to come into force! This very aggressive deadline for review of the standards suggests that the agreed-to standards (and the dates for their implementation) reflect a delicate compromise among the IMO delegates. In any event, the MEPC review is required to include a "determination of whether appropriate technologies are available to achieve" the performance standards; an assessment of the limits established for indicator microbes; and an "assessment of the socio-economic effect(s) specifically in relation to the developmental needs of developing countries, particularly small island developing States."[128] The MEPC review of appropriate technologies is also required to take into account their compatibility, cost-effectiveness, and biological effectiveness, safety of the crew and vessel, and environmental acceptability of the performance standards.[129] If as a result of the review, the parties wish to change the standards—for example, the parties could propose new limits that are stricter or more lenient or they could extend the time period for compliance—they would then follow the amendment procedures specified in Article 19 of the Convention discussed in the previous section.[130]

To assist the MEPC in its review of ballast water standards, Resolution 2 of the Conference Final Act,[131] calls for the application of "suitable" decision-making tools. Fundamental, interdisciplinary research is thus needed not only to facilitate implementation of the specified standards, but to design and develop these decision and risk assessment tools as well. In light of the existing performance standards, the mandated review of the standards, and the ability of states to implement more stringent measures on a state-by-state basis, what is needed is: (a) an enhanced understanding of which trade routes and vessel types present the greatest risk of introducing nonindigenous species; (b) information on which treatment technology or suite of technologies will need to be employed on a particular vessel that follows a specific route to reduce the concentration of viable organisms and pathogens prior to discharge to levels that are below the standards specified in the Convention; (c) exploration of the least-cost solution for that vessel

to come into compliance with the standards; and (d) an evaluation of the cost-effectiveness of meeting the present standards and/or alternative standards. Attention also may be directed toward whether an administratively feasible and enforceable alternative market-based standard that would allow for trading among vessels can provide equal protection at less cost.

The UN Convention on the Law of the Sea

This section considers the extent to which UNCLOS authorizes or restrains the ability of a state to regulate the introduction of aquatic organisms from ballast water as well as the extent to which UNCLOS may require a state to act.[132]

Obligations Imposed on States

Part XII of UNCLOS (Articles 192–237), which for the most part is focused on marine pollution, also imposes a broad, general obligation in Article 192 on states to "protect and preserve the marine environment."[133] While the general duty of Article 192 would appear to easily encompass a duty to protect the marine environment from ballast-borne organisms and pathogens, what ultimately may be inferred from that duty is uncertain and ultimately depends on the extent to which that duty is constrained by later provisions in Part XII.

Article 194(1) directs states to take measures "necessary to prevent, reduce and control *pollution of the marine environment* from any source," which would include pollution discharge from ship ballast tanks (emphasis added). This raises the question of whether or not introduced organisms from ballast water are "pollution" within the meaning of UNCLOS. The starting point for analysis is Article 1(4), which defines "pollution of the marine environment" as the introduction of "substances or energy" into the marine environment, "which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities." The question thus becomes whether introduced aquatic organisms and pathogens are "substances or energy."[134]

Assuming for the sake of argument that introduced aquatic organisms are "pollution" within the meaning of the UNCLOS, a number of other obligations become relevant. To begin with, Article 194(2) requires states "to take all measures necessary" to ensure that "activities under their jurisdiction or control" neither cause pollutant damage to other states and their environment nor result in the spread of pollution "beyond the areas where they exercise sovereign rights." Such measures include those actions designed to protect and preserve "rare and fragile ecosystems" and "habitat of depleted, threatened or endangered species and other forms of marine life."[135] Thus, flag states would be required to prevent the introduction of aquatic organisms from ballast water to the extent that their introduction into a given marine environment would cause "deleterious effects" to marine ecosystems or habitat.

Potentially even more significant is Article 211(2), which requires flag states to adopt laws and regulations to prevent, reduce, and control vessel-source marine pollution that have "at least . . . the same effect as that of generally accepted international rules and standards established through the competent international organization or general diplomatic conference." As an initial matter, the quoted language raises the question

of what threshold must be crossed in order for a rule or standard to be "generally accepted." Various interpretations of the phrase "generally accepted" have been advanced. A rule or standard attains general acceptance: (1) even before entry into force if an international agreement is widely signed; (2) at entry into force; (3) when some wider level of acceptance is reached, which could be signified by either ratification or implementation; (4) with participation that is widespread, representative, and includes states whose interests are particularly affected; or (5) only when it becomes a general rule of international law.[136] To the extent that the threshold required is something less than (4) above and if deleterious introduced aquatic organisms are "pollution," then at an early point in time, Article 211(2) would establish the Ballast Water Convention performance standards as the minimum required of all state parties to UNCLOS, which would greatly expand the Ballast Water Convention's global reach and facilitate its timely implementation. Indeed, included among the states parties to UNCLOS are five states that together regulate almost forty percent of the world fleet (Panama, the Bahamas, Malta, Greece, and Cyprus). It is because of this that a "pollution" determination could be of greatest significance.

UNCLOS also includes a specific provision that addresses both pollution of the marine environment and the introduction of aquatic organisms, but it is inconclusive on the relationship between the two. Article 196(1) requires states to:

> take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control, or the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto.

This provision thus speaks to two state obligations: controlling technology impacts and species introduction. As introduced by Norway in 1974, the provision focused solely on species introduction and made no reference to pollution. More importantly, Norway, at the time it introduced the provision, noted that its purpose was to draw attention to disturbances to the ecological balance of the marine environment that result from the introduction of aquatic organisms rather than pollution.[137] However, given the subsequent amendments to the Norwegian proposal, it is unclear whether this distinction remains. Moreover, as explained by Lindy Johnson,[138] the text can be read in one of two ways, one of which supports species introduction as falling within the pollution rubric (states shall "take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from . . . the intentional or accidental introduction of species, alien or new"), and of which does not (states shall "take all measures necessary to prevent, reduce and control . . . the intentional or accidental introduction of species, alien or new").

In contrast to UNCLOS, the Convention on the Law of Non-Navigational Uses of International Watercourses explicitly distinguishes between pollution and species introduction.[139] It requires states, on one hand, to take necessary measures to prevent species introductions that "may have effects detrimental to the ecosystem of the watercourse"[140] and, on the other, to prevent, reduce, and control "pollution"—that is, "any detrimental alteration in the composition or quality of the waters."[141] The former requirement was considered necessary because the definition of pollution in Article 21.1 of the Non-Navigational Uses Convention "does not include biological alterations."[142]

Coastal and Port State Regulation

In addition to imposing obligations on states to control the introduction of aquatic organisms into the marine environment, UNCLOS also provides coastal and port states with the means to impose obligations on ships flying the flag of other States when those ships are in coastal and port state jurisdictional waters.

To begin with, the right of navigation within a state's territorial sea (or archipelagic waters) is not unbounded. Rather, passage must be innocent, that is, not "prejudicial to the peace, good order or security of the coastal State."[143] In pertinent part, a foreign ship's passage is considered to be "prejudicial" if it engages in "willful and serious pollution" or "any other activity not having a direct bearing on passage."[144] As such, UNCLOS provides a coastal state with prescriptive jurisdiction to adopt laws and regulations with respect to innocent passage through its territorial sea related to the conservation of marine living resources provided such laws and regulations do not concern the "design, construction, manning or equipment" of a foreign vessel, unless they are implementing an international mandate.[145] Thus, while a state may be able, for example, to prohibit the discharge of ballast water when ships transit its territorial sea,[146] the prohibition on design and equipment mandates would appear to bar coastal states from requiring the installation of technology to limit or eliminate the introduction of aquatic organisms and pathogens absent a specific standard or rule adopted by the IMO. The Ballast Water Convention could, however, be seen as providing such a standard. In addition, Article 220(2–3) provides coastal states with inspection authority for violations of pollution laws and regulations.[147] This enforcement authority raises anew, however, the question of whether ballast water and its constituents constitute UNCLOS pollution under the UNCLOS definition.

A determination that such organisms are pollution also could have the effect of restricting states from adopting more stringent measures than those set forth in the Ballast Water Convention in their EEZs. Or, at the very least, it could require that such additional measures be well-tailored to a specific area and receive IMO approval.[148] Recall that Article 2.3 of the Ballast Water Convention allows for the establishment of more stringent measures without specifying any geographic boundary and without mention of IMO approval, but, in any event, only to the extent that such measures are "consistent with international law." As a result, some states may be of two minds on the question of whether ballast water is an UNCLOS "pollutant," desiring broader flag state applicability of the Ballast Water Convention standards, but fearing an intrusion into the potentially broad conferral of coastal state sovereignty by the Ballast Water Convention's Article 2.3.

Some states may find a way out of this box through the imposition of port entry conditions. Port entry conditions can be controversial, for they may touch on ship construction, design, equipment, and manning. Examples include the U.S. requirement under the Oil Pollution Act that oil tankers have double hulls[149] and requirement that cruise ships accommodate persons with disabilities at least to the extent to which the duties imposed do not interfere with the ship's internal affairs.[150] Yet, it cannot be forgotten that foreign vessel operators can exercise the option of not trading with a port state.

UNCLOS specifically contemplates port states setting conditions for entry into their ports.[151] Article 25(2) permits a port State to take "necessary steps" to prevent a breach of port entry conditions, while Article 211(3) declares that any port entry condition that is imposed for the purpose of preventing, reducing and controlling marine environmental pollution be publicized and the "competent international organization" (the IMO) notified.[152] Neither Article 25(2) nor 211(3) imposes "substantive restrictions on port State

prescriptive jurisdiction."[153] Nor do they address where those restrictions may be imposed (e.g., in the territorial sea or EEZ).[154] Thus, a port state could condition entry into its ports on a requirement that a ship have an onboard ballast water treatment system that is capable of complying with national ballast water discharge requirements while that ship is in its territorial sea and EEZ. Alternatively, a port State could craft it laws and regulations so that the violation is either the actual discharge of ballast water in its territorial sea or EEZ or the entry into its ports after a ship has illegally discharged ballast water in its EEZ or territorial sea.[155]

Summary

In sum, the possibility that UNCLOS could render the Ballast Water Convention applicable to all its states parties and affect the ability of states to impose obligations on foreign vessels underscores the necessity of developing decision models to assist with implementation of the Ballast Water Convention.

A Ballast Water Discharge Compliance and Policy Support Model

Decisions can be difficult for several reasons.[156] To begin with, a decision may simply be complicated, with a number of factors to consider. In addition, some considerations that bear on a decision may be uncertain. For example, in the present context, ecosystem risk factors, vector characteristics, and treatment technology efficacy and costs are all uncertain to at least a limited degree. Frequently, a decision also poses tradeoffs among desirable attributes or objectives. Moreover, because differently situated actors often approach a question from their own unique perspectives, they in turn weigh decision criteria differently. While port states may place a priority on protecting sensitive ecosystems from species introductions, the major maritime nations may be more interested in meeting the economic goals of shippers that fly their flags.

With the above discussion as a backdrop, what is proposed is a Ballast Water Discharge Compliance and Policy Support Model (BWDCPSM)[157] that is premised on five primary objectives:

- Minimizing the number of viable organisms discharged (or alternatively achieving a specified standard);
- Reducing the time needed to achieve reductions;
- Minimizing total cost (public and private);
- Protecting particularly sensitive ecosystems; and
- Maximizing technology adoption by vessels according to their relative risk of introducing organisms.

By evaluating how alternative policy scenarios fare under these five objectives, such a model could shed light on points of agreement, identify other considerations in need of more scientific research or policy development, and generally assist policymakers in the implementation of the Ballast Water Convention and other applicable policies.

The BWDCPSM extends a recent model that Winebrake, Corbett, and others developed to generate optimal passenger ferry air pollution reductions.[158] The model is of a class of mathematical models known as "mixed integer, nonlinear programming models." In laymen's terms, the BWDCPSM is an optimization model that allows determination of the minimum cost required for a given ship(s) that takes a particular voyage to meet a

specified ballast water discharge performance standard given the cost and efficacy of the suite of available treatment technologies.

The BWDCPSM builds on efforts of others to develop ballast water evaluation systems that have been devised to assist port state decision-making, including GEF/UNDP/IMO's Global Ballast Water Management Programme (GloBallast);[159] the Australian Quarantine & Inspection Service's Decision Support System (DSS);[160] Det Norske Veritas's EMBLA program in Norway;[161] and the New Zealand-based Cawthorn Institute's Shipping Explorer.[162] In contrast to the BWDCPSM, which as noted above is an optimization model, these evaluation systems are premised on a risk assessment framework. They attempt to minimize the risk posed to a given port environment by identifying either high-risk vessels or donor ports. For example, the GloBallast program, which recently completed risk assessments at six ports in developing countries (Brazil, South Africa, China, India, Ukraine, and Iran),[163] employs an approach premised on a port applying a management regime uniformly to all vessels that discharge ballast water. Although data is input into the model at the level of an individual vessel trip, results are reported in the aggregate. That is, the GloBallast risk assessments consider the relative risk posed by ports that are the source of ballast water uptake to a given destination port (e.g., Odessa, Ukraine). In addition, unlike the BWDCPSM, those earlier evaluation systems typically rely in part on a target list of species.

The BWDCPSM, while simpler in some respects than other models (e.g., in contrast to the GloBallast model, the BWDCPSM simplifies for environmental compatibility, focusing on temperature and salinity), moves ballast water decision support forward in both legal and policy respects and is responsive to the IMO's call for the use of "suitable decision-making tools" to analyze ballast water management protocols.[164] Indeed, the BWDCPSM can generate results in a disaggregated fashion that will permit analysis of the relative risk posed by a given vessel (e.g., by type, tonnage, ballast tank capacity) undertaking a particular voyage;[165] support implementation of the Ballast Water Convention; and assist policy-makers in their consideration of the relative merits of alternative policy goals.

The model requires data in five variable categories:

- Vessel attributes (e.g., ballast water tank size);
- Voyage attributes (e.g., duration, quantity of BWE and ballast water discharge);
- Port ecosystem attributes (e.g., temperature and salinity of donor/recipient ports);
- Treatment cost and efficacy (e.g., Filtration, UV, De-oxygenation, Biocides, Chlorine); and
- Policy options (e.g., no action, BWE, concentration standards, volume standards).

The BWDCPSM also requires a user to obtain vessel data for a given port (e.g., the Port of New York/New Jersey, USA, the Port of Odessa, Ukraine, or the Port of Antwerp, Belgium). For each vessel trip to the given port, ecosystem attributes of the port of interest and the port of origin, and vessel and voyage attributes must be obtained. Costs to employ potential treatment technologies and the performance measures of those technologies also must be entered into the model.

The model can be run under various policy scenarios, including the Ballast Water Convention's concentration-based standards. Alternatively, the BWDCPSM permits a user to model either more stringent or more lenient concentration-based standards to facilitate the Convention-mandated review of standards established therein or, as to the former, to assist states that may wish to set more stringent standards. Indeed, in the U.S. Senate

there is a legislative proposal that, if adopted, would set ballast water organism discharge standards for U.S. waters at 1/100 of those established by the Ballast Water Convention.[166] Moreover, recent testimony before the U.S. Congress recommended establishing a standard of zero live organisms above 50 microns to simplify enforcement.[167]

The BWDCPSM can facilitate the analysis of other policy scenarios as well. For example, concentration-based standards could vary by port (e.g., some ports may have sensitive ecosystems, while others may have ecosystems that have only a slight chance of being invaded) or be even more finely tuned to vary by source-destination port pair. Furthermore, the model is flexible enough that at a given port, a concentration-based standard could be set at the average concentration of viable organisms in the ballast water across all discharges. Finally, in addition to or in place of a concentration-based standard, other constraints could be specified such as one on the total number of organisms that could be discharged into a port ecosystem over a given period of time. In sum, inclusion of policy variables in the BWDCPSM permits decision-makers to model the technical feasibility of achieving various policy objectives, alternative means of achieving those objectives, and the comparative compliance costs associated with those means. And for any given policy scenario, the model will generate the least-cost solution. More specifically, the objective function for the model, assuming a policy that places limits on both the concentration and the total number of viable organisms that may be discharged, is:

$$\min \left(\sum_{v}^{V} \sum_{k}^{K} BINK_{v,k} \cdot KTE_{v,k} \right) \text{ subject to:} \tag{1}$$

$$C_v < P_v, \tag{1a}$$

$$\sum_{v}^{V} C_v * V_v \leq \sum_{v}^{V} Q_v. \tag{1b}$$

The binary variable $BINK_{v,k}$ takes on a value of "1" if a given treatment technology (k) (e.g., filtration) is incorporated on a specific vessel (v) and a value of "0" otherwise. The variable $KTE_{v,k}$ is the total annual expense (the capital cost annualized over its lifetime at a given discount rate plus operation and maintenance costs) of incorporating technology k on vessel v. Those two variables are multiplied together in equation (1) and the resulting product is summed over all vessels and treatment technologies, with the objective of minimizing total costs. C_v is the concentration of viable organisms (e.g., the number per cubic meter) in the ballast water discharge of vessel v; it is a function of the initial organism/pathogen concentration by size and a number of factors that affect survivability, including: donor and recipient port environmental attributes such as water temperature and salinity; voyage duration; ballast water tank size; volume exchanged at sea; and treatment efficacy. P_v is the maximum concentration of viable organisms permitted by regulatory authorities to be discharged by vessel v. Under equation (1a), the concentration discharged must be less than that permitted. Finally, V_v is the volume of ballast water discharged by vessel v and Q_v is the maximum quantity of organisms permitted by regulatory authorities to be discharged by vessel v.[168]

The use of limits on the concentration and quantity of organisms discharged (the risk of introduction) in the model rather than the risk of harm/invasion[169] has parallels in the surface water quality discharge regulatory context where regulators can choose to focus on end of pipe discharge limits rather than water quality parameters. The choice

of risk of introduction also is sensible given a similar focus in the Ballast Water Convention. Moreover, at this point in time, we believe it prudent to avoid modeling individual species or quantifying species invasive potential given the fact that the majority of species that move in international waterborne commerce have yet to be identified, let alone analyzed for their invasive potential, and, in any event, predicting invasiveness continues to confound experts.[170]

Conclusion

The Ballast Water Convention has ushered in a new era in several respects. First, it suggests a continuing move by IMO away from the MARPOL approach and toward stand-alone environmental conventions with different entry-into-force and amendment requirements than contained in MARPOL.[171] Second, it suggests that the international community has come to recognize that near-exclusive flag state control is outmoded and that flag state prerogatives must be complemented by, and in some circumstances give way to, coastal and port state jurisdiction in an era where crew safety, while still paramount and reasonably a flag state interest, has been joined by biodiversity protection, primarily a port or coastal state interest. Third, it provides evidence that the international community has begun to take seriously the threat posed by organisms and pathogens contained in ballast water.

In regard to the last point, the Ballast Water Discharge Compliance and Policy Support Model (BWDCPSM) can help decision-makers evaluate regulatory standards and market-based policies that can enable innovation of environmental technologies to meet performance-based targets. Policy-makers could construct a ballast water management regime that applied selectively to those vessel voyages posing the greatest risk or, alternatively, could apply more stringent measures to those vessels that pose the greatest risk. The model also will assist ship operators in compling with the Ballast Water Convention's concentration-based standards and at the same time minimize costs. Third, interested ports could gather and input the necessary data to determine costs associated with protecting individual port ecosystems. And finally, because the model includes treatment technologies and policy options, policy-makers can use the model to assist them in their consideration of the relative merits of differing policy and treatment combinations.

Notes

1. See, for example, Gregory M. Ruiz and James T. Carlton, "Invasion Vectors: A Conceptual Framework for Management," pp. 459–504, 468 in G.M. Ruiz and J.T. Carlton, eds., INVASIVE SPECIES: VECTORS AND MANAGEMENT STRATEGIES (2003).

The International Convention for the Control and Management of Ships' Ballast Water and Sediments, concluded 13 February 2004, not in force, IMO Doc. BWM/Conf/36, 16 February 2004 (see generally that the IMO website at <www.imo.org>) defines "ballast water" in Article 1.2 as "water with its suspended matter taken on board a ship to control trim, list, draught, stability or stress of the ship" and "sediments" in Article 1.11 as "matter settled out of Ballast Water within a ship."

2. R. Slater and MTS Task Force, "An Assessment of the U.S. Marine Transportation System: A Report to Congress," Washington, DC, U.S. Department of Transportation (1999) and MARAD, Maritime Transportation System Brochure, Maritime Administration, U.S. Department of Transportation (1999).

3. Z. Yang and A. N. Perakis, "Multiattribute decision analysis of mandatory ballast water treatment measures in the US Great Lakes," 9 *Transportation Research* Part D 81–86 (2004);

A.N. Cohen and J.T. Carlton, "Accelerating Invasion Rate in a Highly Invaded Estuary," 279 *Science* 555–558 (1998); National Research Council, Committee on Ships' Ballast Operations, STEMMING THE TIDE: CONTROLLING INTRODUCTIONS OF NONINDIGENOUS SPECIES BY SHIPS' BALLAST WATER (1996).

4. Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), "A Sea of Troubles," Rep. Stud. GESAMP No. 70. (2001).

5. David Pimentel, Rodolfo Zuniga, and Doug Morrison, "Update on the Environmental and Economic Costs Associated with Alien-Invasive Species in the United States," 52 *Ecological Economics* 273–288 (2005); Jeremy Firestone and Robert Barber, "Fish as Pollutants: Limitations of and Crosscurrents in Law, Science, Management, and Policy," 78(3) *Washington Law Review* 693–756 (2003); and O.E. Sala, F.S. Chapin, et al., "Global Biodiversity Scenarios for the Year 2100," 287 *Science* 1770–1774 (2000).

6. Convention on Biological Diversity, concluded June 5, 1992, 1760 *United Nations Treaty Series* 79, entered into force December 29, 1993.

7. E.A. Norse, "Unchartered Waters: Conserving Marine Biological Diversity," pp. 94–97, 95 in G.K. Meffe and C.R. Carroll (eds.), PRINCIPLES OF CONSERVATION BIOLOGY (2nd Ed. 1997).

8. Jakarta Mandate on Marine and Coastal Biological Diversity, Decision II/10 adopted in 1995 by the Second Ordinary Meeting Conference of the Parties (COP) to the Convention on Biological Diversity (CBD), available at <www.biodiv.org/programmes/areas/marine/>.

9. European Commission, Life III Programme, et al., "Alien Species and Nature Conservation in the EU: The role of the LIFE Program," Office for Official Publications of the European Communities (2004); M. Doelle, "The Quiet Invasion: Legal and Policy Responses to Aquatic Invasive Species in North America," 18(2) *International Journal of Marine and Coastal Law* 261–294 (2003); C. Perrings, M. Williamson, et al., eds., *The Economics of Biological Invasions* (2000); and D. Pimentel, supra note 5.

10. See Intertanko, BALLAST WATER REQUIREMENTS (2004); Mark L. Miller and R. M. Fabian, eds., HARMFUL INVASIVE SPEICES: LEGAL RESPONSES (2004); Moira McConnell, "Globallast Legislative Review, Final Report," Globallast Monograph Series No. 1 (2002), available at globallast.imo.org/monograph1%20legislative%20review.pdf; and David McKie, "Ballast Water 'Minefield' Could Explode on Owners," *Lloyd's List*, 28 March 2001 available at http://www.elbornes.com/articles/shipping/shi_0006.htm. For the most part these state laws implement the Guidelines adopted by the International Maritime Organization (IMO) that emphasized ballast water exchange outside of coastal waters. *See infra* text at notes 35–36.

11. Maritime Safety Authority of New Zealand, Guidance on New Zealand's Ballast Water Controls, Ship Notice 07/1999 September, available at <www.msa.govt.nz/publications/shipnotices/snot0799.htm>.

12. Id.

13. Australian Quarantine and Inspection Service, Australia Ballast Water Management Requirements (2001), available at <www.affa.gov.au/corporate_docs/publications/html/quarantine/ballast_water/Australian_BW_Requirements.pdf>.

14. United States Coast Guard, Department of Homeland Security, Penalites for Non-Submission of Ballast Water Reports, 69 *Fed. Reg.* 32864-32871 (June 14, 2004). See also United States Coast Guard, Department of Homeland Security, Mandatory Ballast Water Program for U.S. Waters, 69 *Fed. Reg.* 44592–44961 (July 28, 2004).

15. Lisa A. Brautigam, "Control of Aquatic Nuisance Species Introductions Via Ballast Water in the United States: Is the Exemption of Ballast Water Discharges from Clean Water Act Regulation a Valid Exercise of Authority by the Environmental Protection Agency?," 6 *Ocean & Coastal Law Journal* 33 (2001) and Sandra B. Zellmer, "The Virtues of 'Command and Control' Regulation: Barring Exotic Species From Aquatic Ecosystems," *University of Illinois Law Review* 1233, 1285 (2000).

16. Environmental Protection Agency, Decision on Petition for Rulemaking to Repeal 40 *C.F.R.* §122.3(a) (2003), available at <www.epa.gov/owow/invasive_species/ballast_report_9_2_03.pdf>. In Northwest Environmental Advocates v. US EPA, 205 U.S. Dist. Lexis 5373 (March 31, 2005),

found the EPA acted unlawfully in categorically excluding ballast water discharges from regulation. See <www.earthjustice.org/news/display. html?ID=786> (December 22, 2003).

17. United States Coast Guard, ballast water discharge standard; preventing introductions and spread of nonindigenous species; environmental protection requirement, Washington, DC, United States Coast Guard, 68 *Fed. Reg.* 55559–55563 (2003).

18. BWC, supra note 1.

19. United Nations Convention on the Law of the Sea, U.N.Doc A/Conf 62/122, concluded 10 December 1982, 1833 *United Nations Treaty Series* 397, entered into force 16 November 1994, available at <www.un.org/Depts/UNCLOS/convention_agreements/texts/uncUNCLOS/cUNCLOSindx.htm>.

20. General Agreement on Tariffs and Trade 1994, 15 April 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1A, 1867 *United Nations Treaty Series* 187.

21. FAO Code of Conduct for Responsible Fishing is available at <www.fao.org/fi/agreem/codecond/ficonde.asp>.

22. See McConnell, supra note 10; C. Shine and N. Williams, et al., "A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species," Environmental Policy and Law Paper No. 40, IUCN Environmental Law Centre (2000).

23. D.J. Bederman, "International Control of Marine 'Pollution' by Exotic Species," 18 *Ecology Law Quarterly* 677–717 (1991).

24. Convention Relative to the Preservation of Fauna and Flora in Their Natural State, 8 November 1933, 17 *League of Nations Treaty Series* 241, entry into force, 4 January 1936.

25. Agreed Measures for the Conservation of Antarctica Flora and Fauna, June 1964, 17 *U.S.T.* 991, *T.I.A.S.* 6058.

26. See also Article III.4.c. of the 1979 Bonn Convention on the Conservation of Migratory Species, of Wild Animals, 19 *International Legal Materials* 15 (1980).

27. S. Rosenne and A. Yankov, United Nations Convention on the Law of the Sea 1982: A Commentary, Vol. IV (1991). See also UNCLOS, Article 196(1).

28. Agenda 21 is available at <www.un.org/esa/sustdev/documents/agenda21/>.

29. Agenda 21, Section 17.30(a)(vi).

30. Johannesburg Plan of Implementation, paragraph 34(b), available at <www.un.org/esa/sustdev/wssd_poi_pd>.

31. Supra note 8.

32. See decision IV/5 of the Fourth Ordinary Meeting of the CBD COP (1998), available on the CBD website at <www.biodiv.org>.

33. Decision VI/23 of the Sixth Ordinary Meeting of the CBD COP (2002), available on the CBD website at <www.biodiv.org>.

34. McConnell, supra note 10.

35. IMO, Guidelines for Preventing the Introduction of Unwanted Organisms and Pathogens from Ships' Ballast Water and Sediment Discharges, Resolution A.774(18) (1993).

36. IMO, Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens, Resolution A.868(20) (1997), available at <globallast.imo.org/index.asp?page=resolution.htm&menu=true>.

37. Id. and see McConnell, supra note 10.

38. Oceanic waters are thought to contain fewer organisms than coastal waters and organisms that are less likely to survive in the donor port coastal environment when deballasted. Alan Taylor, et. al., "Preventative Treatment and Control Techniques for Ballast Water," 484–507, 487–88 in Erkki Leppäkoski, Stephan Gollasch, and Sergej Olenin, (eds.), Invasive Aquatic Species of Europe, Distribution, Impacts and Management (2002).

39. IMO, 1997 Guidelines, supra note 36.

40. International Convention for the Prevention of Pollution from Ships, 2 November 1973, 12 *International Legal Materials* 1319 (1973) and the 1978 Amendments, 17 *International Legal Materials* 246 (1978).

41. BWC, Article 1.8.

42. MARPOL, supra note 40, Article 15.1.

43. Lloyds Maritime Information System (LMIS), The Lloyds Maritime Database, Lloyd's Register (2002) and C.S. Brookman, "IMO Environmental Regulations—Is There a Case for Change to the Standard Entry-into-Force Requirements?," 39(4) *Marine Technology* 232–238 (2002).

44. MARPOL, supra note 40, Article 16(2)(f)(ii–iii).

45. BWC, Article 18.1.

46. BWC, Article 19.

47. BWC, Article 2.2.

48. International Convention for the Regulation of Whaling, 161 *United Nations Treaty Series* 72 and 1956 amendments 338 *United Nations Treaty Series* 336, Article 1.1 detailing the relationship between the Convention and the Schedule.

49. IMO, "Final Act of the International Conference on Ballast Water Management for Ships" (2004). At its 51st Session, 29 March to 2 April 2004, IMO MEPC adopted a plan of action to promulgate guidelines while at its 52nd Session, 11–15 October 2004, progress was noted on guidelines for approval of ballast water management systems and for such systems that use active substances. See the IMO website, supra note 1.

50. Robin R. Churchill and Geir Ulfstein, "Autonomous Institutional Arrangements in Multilateral Environmental Agreements: A Little-Noticed Phenomenon in International Law," 94 *American Journal International Law*, 623–659 (1999).

51. BWC, Article 4.2.

52. BWC, Article 4.1.

53. BWC, Article 3.2.

54. BWC, Regulation A-5.

55. MARPOL, supra note 40, Article 5.4.

56. BWC, Article 3.3.

57. BWC, Articles 13–14.

58. IMO, Final Act, supra note 49.

59. BWC, Article 6.

60. BWC, Article 9.1.

61. BWC, Article 10.4

62. BWC, Article 9.1 and Regulation B-2.6.

63. Anti-Fouling Convention, IMO Doc.AFS/CONF/26, 18 October 2001, see generally the IMO website, supra note 1.

64. Compare BWC, Art 9.1(c) and the Anti-Fouling Convention, supra note 63, Article 11(1)(b) to MARPOL, supra note 40, Article V.2. In a nod toward flag state prerogatives, the BWC does, however, provide that "the time required to analyze the samples shall not be used as a basis for unduly delaying the operation, movement or departure of the ship." BWC, Article 9.1(c).

65. BWC, Article 9.2.

66. BWC, Article 9.3.

67. BWC, Article 10.3.

68. BWC, Articles 1.1 and 11.1.

69. BWC, Article 8.

70. BWC, Article 8.1.

71. BWC, Article 8.2.

72. See, MARPOL, supra note 40, Article 4.2.

73. UNCLOS, Articles 218, 220, 226.

74. The United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (in force as from 11 December 2001) ("Fish Stocks Agreement" or "FSA"), Articles 21–23, 34 *International Legal Materials* 1542 (1995).

75. Jeremy Firestone and James Corbett, "Maritime Transportation: A Third Way for Port

and Environmental Security," 9 *Widener Law Symposium Journal* 419–437 (2003). In any event, port states may in practice have other enforcement tools at their disposal. For example, in 1999, the Royal Caribbean Cruises, Ltd. agreed to plead guilty to twenty-one felonies and pay an $18 million fine. See www.usdoj.gov/opa/pr/1999/July/316enr.htm.

76. IMO, Regional Cooperation in the Control of Ships and Discharges, Resolution A.682(17) (1991).

77. The 1982 Paris Memorandum of Understanding on Port State Control, reprinted in 21 *International Legal Materials* 1 (1982). See Erik Jaap Molenaar, COASTAL STATE JURISDICTION OVER VESSEL-SOURCE POLLUTION, pp. 121–129 (1998) and see Z.O. Ozcayir, PORT STATE CONTROL, chapter (2001).

78. BWC, Article 8.1.

79. BWC, Article 8.1

80. BWC, Article 8.3.

81. Jeremy Firestone, "Enforcement of Pollution Laws and Regulations: An Analysis of Forum Choice," 27 *Harvard Environmental Law Review* 105–176, 128 (2003) and Jeremy Firestone, "Agency Governance and Enforcement: The Influence of Mission on Environmental Decisionmaking," 21 *Journal of Policy Analysis and Management* 409–426, 412 (2002).

82. BWC, Article 10.2.

83. BWC, Article 11.2.

84. BWC, Article 11.3.

85. BWC, Article 1.12. Compare the BWC with the UNCLOS, where no definition is provided. See George K. Walker and John E. Noyes, "General Introduction: Definitions for the 1982 Law of the Sea Convention—Part II," 33 *California Western International Law Journal* 191, 217–18, 316–22 (2003).

86. BWC, Article 1.8.

87. M. Tomczak, Jr., "Defining Marine Pollution: A Comparison of Definitions used by International Conventions," 8 *Marine Policy* 311–322 (1984).

88. BWC, Preamble.

89. BWC, Preamble.

90. BWC, Regulation B-1.

91. BWC, Regulation B-2 and Appendix II.

92. BWC, Regulation E-1.1 and Article 7.

93. BWC, Regulation E-2.

94. BWC, Regulations E-2 and E-3 and Appendix I.

95. BWC, Regulations E-4 and E-5 and Article 9.2.

96. BWC, Regulation E-1.6.

97. BWC, Regulation D-1.

98. BWC, Regulation B-4.1.

99. BWC, Regulation B-4.1.

100. BWC, Regulation B-4.2.

101. James J. Corbett, J.J and P.S. Fischbeck, "Emissions from Ships" 278 *Science* 823–824 (1997); K.O. Skjølsvik, A.B. Andersen, J.J. Corbett, and J.M. Skjelvik, "Study of Greenhouse Gas Emissions from Ships," MEPC 45/8 Report to International Maritime Organization on the outcome of the IMO Study on Greenhouse Gas Emissions from Ships, MARINTEK Sintef Group, Carnegie Mellon University, Center for Economic Analysis, and Det Norske Veritas, Trondheim, Norway (2000).

102. BWC, Article 5.

103. BWC, Regulation B-5.1.

104. BWC, Regulation B–51. See also BWC, Regulation A-1, 4–5.

105. BWC, Regulations A-5 and B-3.

106. BWC, Regulation D-4.

107. BWC, Regulation D-2.

108. BWC, Regulation B-3.7

109. BWC, Regulations A-1.7 and D-3.2.

110. BWC, Regulation D-2.1.

111. BWC, Regulation D-21.

112. Similarly for cysts and other "nonliving" spores, are these organisms considered viable in the dormant state even if later stages of life for these organisms may not survive in the environment where they are discharged? This also raises a stepping-stone problem for the definition, where an organism temporarily discharged into waters in which it cannot long survive may be re-ballasted into another vessel visiting the same port, but destined elsewhere.

113. BWC, Regulation D-2.2.

114. Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA), see the GPA website at <www.gpa.unep.org>.

115. McConnell, supra note 10.

116. GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) and Advisory Committee on Protection of the Sea, A Sea of Troubles, Rep. Stud. GESAMP No. 70, pp. 2–3 (2001).

117. BWC, Article 2.3.

118. 46 U.S.C. §3703a.

119. See, e.g., 1996 Protocol to the London Dumping Convention of 1972, 36 *International Legal Materials* 1 (1997); Article 3.4 and UNCLOS, Article 210(6).

120. BWC, Regulation C-1.1-2.

121. BWC, Regulation C-1.3.

122. BWC, Regulation C-2.

123. BWC, Regulation A-3.

124. BWC, Regulation A-4.

125. BWC, Regulation A-4.1.

126. BWC, Regulation D-5.1.

127. IMO, Final Act, supra note 49.

128. BWC, Regulation D-5.1.

129. BWC, Regulation D-5.2.

130. BWC, Regulation D-5.3-4.

131. IMO, Final Act, supra note 49.

132. It is to be noted at the outset that the Ballast Water Convention is not intended to prejudice either a State's rights or obligations as they exist under customary international law as reflected in the UNCLOS. BWC, Article 16.

133. UNCLOS, Article 192.

134. The UNCLOS definition has its roots in a definition crafted by GESAMP. Tomczak, supra note 87. Although not stated in the GESAMP definition, under the GESAMP rubric that existed at that time, GESAMP considered only eight narrowly drawn pollutant categories, none of which is broad enough to include aquatic organisms or pathogens. Lindy S. Johnson, COASTAL STATE REGULATION OF INTERNATIONAL SHIPPING (2004), note 390, pp. 111–112. Thus, a historical perspective suggests a narrow interpretation, excluding ballast water from coverage. This narrow interpretation is supported by the Ballast Water Convention regulations, wherein a distinction is drawn between the "uptake and discharge of Ballast Water and Sediments" and "pollution incidents from the ship" (Regulation A-3.3). On the other hand, the delegates may have been merely juxtaposing the BWC and MARPOL rather than making a statement on whether ballast water is "pollution." Indeed, it appears that the IMO delegates viewed ballast water as a form of pollution since they were considering appending the ballast water regime as an Annex to MARPOL. In that vein, at least one scholar has referred to deballasting as an "operational discharge." Molenaar, supra 77, at 20. Further, and perhaps most persuasively, the plain meaning of the word "substance" can comfortably include ballast water and its constituents. As stated in Article 31(1) of the Vienna Convention on the Law of Treaties, a treaty "shall be interpreted in good faith in accordance with the ordinary meaning to be given to terms of the treaty in their context and in the light of its object and purpose." The word "substance" is defined to include "a being that

subsists by itself; a separate or distinct thing; hence *gen.*, a thing, being," OXFORD ENGLISH DICTIONARY (2nd Ed. 1989) and "that which has mass and occupies space" AMERICAN HERITAGE COLLEGE DICTIONARY (1993). Yet, under this broad formulation, almost anything that humans introduce into the marine environment would fall within the term "pollution" provided that it also is likely to generate the requisite deleterious effects. A similar argument has been made by one of the authors in regard to the escape of nonnative fish reared in aquaculture cages under the U.S. Clean Water Act (33 U.S.C. §1362(6)), which defines *pollutant* to include "biological materials." See Firestone and Barber, supra note 5, at 746–749. Given the stated provisio, however, perhaps such a formulation is not too broad. In addition, given that sewage is considered a pollutant in part because it is a conduit for pathogens, it can be argued that ballast water should be treated similarly, particularly in light of the fact that ballast water borne pathogens may have originated in sewage disposed of in a donor port's marine environment.

135. UNCLOS, Article 194(5).

136. See, for example, Molenaar, supra note 77, at 151–157; Bernard H. Oxman, "The Duty to Respect Generally Accepted International Standards," 24 *New York University Journal of International Law and Politics* 109–159 (1991); American Law Institute (ALI), RESTATEMENT OF THE LAW THIRD, THE FOREIGN RELATIONS LAW OF THE UNITED STATES, §502, comment c (1987); and Alan E. Boyle, "Marine Pollution under the Law of the Sea Convention," 79 *American Journal of International Law* 347–372 (1985).

137. Rosenne and Yankov, supra note 27, at 76.

138. Johnson, supra note 134, at 126.

139. Convention on the Law of Non-Navigational Uses of International Watercourses, 36 *International Legal Materials* 700 (1997).

140. Ibid., Article 22.

141. Ibid., Article 21.1.

142. A. Tanzi and M. Arcari, THE UNITED NATIONS CONVENTION ON THE LAW OF INTERNATIONAL WATERCOURSES (2001) and International Law Commission (ILC), Report of the International Law Commission on the Work of its Forty-Sixth Session, U.S. GAOR 49th Sess., Suppl. No. 10 (1994).

143. UNCLOS, Articles 19(1) and 52.

144. UNCLOS, Article 19(2).

145. UNCLOS, Article 21(1–2).

As part of the U.S. Senate's consideration of accession by the United States to UNCLOS during the 108th Congress, a number of "understandings" were formulated regarding certain UNCLOS provisions. The one regarding Article 21(2) is as follows:

> The United States understands, with respect to article 21(2), that measures applying to the "design, construction, equipment or manning" do not include, *inter alia*, measures such as traffic separation schemes, ship routing measures, speed limits, quantitative restrictions on discharge of substances, restrictions on the discharge and/or uptake of ballast water, reporting requirements, and record-keeping requirements.

Senate Foreign Relations Committee Report on the United Nations Convention on the Law of the Sea, Senate Resolution of Advice and Consent to Ratification, § 3(14) (March 11, 2004) (hereinafter U.S. Understandings and Declarations), available at <lugar.senate.gov/sfrc/seareport.pdf>. See also U.S. Understandings and Declarations § 3(19) regarding contiguous zone authority: "The United States understands that, with respect to article 33, the term 'sanitary laws and regulations' includes laws and regulations to protect human health from, *inter alia*, pathogens being introduced into the territorial sea."

146. The ability of a state to engage in even this degree of regulation is further constrained in international straits and in archipelagic sea lanes. UNCLOS, Articles 42(1)(b) and 54.

147. Firestone and Corbett, supra note 75.

148. UNCLOS, Article 211 (5–6) and see Johnson, supra note 134, at 108–111. One of the U.S. "understandings" states: "The United States understands that the Convention supports a coastal State's exercise of its domestic authority to regulate the introduction into the marine

environment of alien or new species." U.S. Understandings and Declarations, supra note 145, at 3(16).

149. See supra note 118. See also U.S. Understandings and Declarations, supra note 145, at 3(13). "The United States understands that the Convention recognizes and does not constrain the long-standing sovereign right of a State to impose and enforce conditions for the entry of foreign vessels into its ports, rivers, harbor, or offshore terminals, such as a requirement that ships exchange ballast water beyond 200 nautical miles from shore or a requirement that tank vessels carrying oil be constructed with double hulls."

150. Spector v. Norwegian Cruise Line Ltd., 545 U.S. (June 6, 2005) (plurality opinion by Justice Kennedy).

151. Support for the imposition of port entry conditions also can be found in customary international law. For example, as noted by R.R. Churchill and A.V. Lowe, THE LAW OF THE SEA (1999), at 63, the "existence of sovereignty over internal waters and the absence of any general right of innocent passage through them logically implies the absence of any right in customary international law for foreign ships to enter a State's ports or other internal waters." Indeed, by "virtue of its sovereignty," a coastal State may "regulate . . . access to its ports." *Military and Paramilitary Activities in and against Nicaragua, Nicaragua v. United States*, [1986] *I.C.J. Reports* 14, 111. As explained by the U.S. Supreme Court a century ago, if the implied consent to enter a state's ports "may be wholly withdrawn, it may be extended upon such term and conditions as the government sees fit to impose." *Patterson v. Bark Eudora*, 190 U.S. 169, 178 (1903). Dictum in *Saudi Arabia v. Arabian American Oil Co.*, 27 *International Law Reports* 117, at 212: "according to a great principle of public international law, the ports of every state must be open to foreign merchant vessels and can only be closed when the vital interests of the state so require," however, suggests otherwise.

152. UNCLOS, Article 255 likewise indicates that a state has the ability to condition the access of marine science research vessels to its ports based on its own laws and regulations.

153. Molenaar, supra note 77, at 103.

154. Johnson, supra note 134, at 41–43.

155. Ibid., at 42-43.

156. R.T. Clemen and T. Reilly, "Making Hard Decisions with Decision Tools" (2001).

157. This model is presently being tested by the authors at two U.S. ports. The model is elaborated in full in J. Firestone, J.J. Corbett, J.J. Winebrake, and N.D. Cass, "Evaluating alternative technology-policy scenarios to reduce ballast water species introductions in port ecosystems" (working paper 2005) (on file with authors).

158. James J. Winebrake, James J. Corbett, et al., "Optimizing Emissions Reductions for Passenger Ferries in the New York-New Jersey Harbor: A MINLP Approach," 1st National Transportation EMS Conference, New York, Transportation Research Board (2004).

159. C. Clarke and K. R. Hayes, et al., "Ballast Water Risk Assessment, Port of Khark Island, Islamic Republic of Iran, Final Report," GloBallast Monograph Series No. 8 (2003).

160. Id.; International Council for the Exploration of the Sea (ICES) Advisory Committee on the Marine Environment (ACME), Report of the ICES/IOC/IMO Study Group on Ballast Water and Other Ship Vectors (SGBOSV) (2003); Chad L. Hewitt and Keith R. Hayes, "Risk Assessment of Marine Biological Invasions," pp. 456–66 in E. Leppäkoski, supra note 38 and Australian Quarantine Inspection Service (AQIS), Australian Government Department of Agriculture, Fisheries and Forestry, Ballast Water Decision Support System (DSS) (2001).

161. Det Norske Veritas (DNV), The Concept of Environmental Management of Ballast Water Transfer using the Risk Based Approach of EMBLA (2001) and see G.P Haugom, H. L. Behrens, et al., "Risk based methodology to assess invasive aquatic species in ballast water," pp. 467–76 in Leppäkoski, supra note 38.

162. Mike Taylor, D. Mountfort, et al., "Shipping Explorer: A New Tool for Managing Marine Biosecurity Risks, Cawthorn Institute: PowerPoint Presentation" (2002) (on file with authors).

163. IMO Globallast Programme, available at <globallast.imo.org>.

164. IMO, Final Act, supra note 49.

165. D. Oemcke, "The Treatment of Ship's Ballast Water," EcoPorts Monograph Series 18, Brisbane, Australia, Ports Corporation of Queensland: 102 (1999).

166. S.363, 109th Congress 10 February 2005).

167. Allegra Cangelosi, Ballast Water Management Hearing: Testimony of Allegra Cangelosi, Senior Policy Analyst, Northeast-Midwest Institute before the United States House of Representatives Committee on Transportation and Infrastructure Subcommittee on Coast Guard and Maritime Transportation Subcommittee on Water Resources and Environment (2004).

168. A more thorough and technical description of the model can be found in Firestone, supra note 157.

169. Stephen Gollasch, "Hazard Analysis of Aquatic Species Invasions," pp. 447–455 in Leppäkoski, supra note 38.

170. Anne M. Perrault and William Carroll Muffett, "Turning off the Tap: A Strategy to Address International Aspects of Invasive Alien Species," 11(2) Review of European Community & International Environmental Law 211-224 (2002).

171. The IMO recently took a different approach when it adopted security regulations post 9–11 at a December 2002 diplomatic conference on maritime security. See generally the IMO website, supra note 1. There it took advantage of the existing 1974 International Convention for the Safety of Life at Sea (SOLAS) to facilitate rapid implementation of the regulations through SOLAS's tacit amendment procedures.