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# Ballasted: Stabilizing Ships and Destabilizing Seas

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# Ballasted: Stabilizing Ships and Destabilizing Seas

**Cover Page Footnote**
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## Abstract

This article critically assesses the history of ballast water as a vector for invasive species, management, current regulations and technological advancements in water treatment. The transport of invasive species is a global threat to ecosystems as well as economies. Ballast water, used to stabilize ships has been implicated in the spread of invasive species, including zebra mussels and harmful algal species. In 2017, the International Convention for the Control of and Management of Ship's Ballast water and Sediments, in an effort to mitigate the spread of invasive species was entered into force. However, at the same time legislation was presented in the United States which would decrease ballast water regulation. The Clean Water Act exemption for ballast water discharge, as well as the multitude of regulatory bodies responsible for ballast water management, is counterproductive to combating the spread of invasive species. The author concludes that without a no viable organism policy will fail to halt the spread of ballast water transported invasive species. The US should adopt a robust ballast water management strategy as well as take on a leadership role in an effort to mitigate ballast water related threats to native species and global economies.

*Keywords:* ballast, invasive species, ship, shipping, ballast water regulations

## Introduction

It is estimated that San Francisco Bay, a shining port and pinnacle of global progress, has been invaded every two weeks since 1961.[1] Yet, this invasion does not represent a localized problem. Invasive species, those species which are introduced to new ecosystems and disrupt or irreparably damage, are one of the largest threats to San Franciso Bay and other marine ecosystems.[2] Port cities across the globe have found alien species arriving at their doorsteps.[3] Yet too often, these species are only recognized once they have made the leap to invasive[4] and little can be done to restore the damage.[5] While there are many mechanisms by which species may enter unprepared eco-systems, ballast water has been implicated in many cross-global invasions.[6]

In September of 2018, The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWMC) was ratified.[7] The goal of the BWMC is to reduce the transport of “harmful aquatic organisms and pathogens . . . which may create hazards to the environment, human health, [or] impair biological diversity.”[8] Ballast water, used to stabilize ships during transit, has been recognized by

[1] Brautigam, “Control of Aquatic Nuisance Species Introductions via Ballast Water in the United States,” 37.
[2] Endresen et al., “Challenges in Global Ballast Water Management.”
[3] Brautigam, “Control of Aquatic Nuisance Species Introductions via Ballast Water in the United States”; Hallegraeff, “Transport of Toxic Dinoflagellates via Ships’ Ballast Water”; Bax et al., “Marine Invasive Alien Species.”
[4] Bax et al., “Marine Invasive Alien Species.”
[5] Lodge et al., “Biological Invasions.”
[6] Cohen and Foster, “The Regulation of Biological Pollution”; Kumar et al., “First Record of Marine Phytoplankton, Picochlorum Maculatum in the Southeastern Coast of India”; “International Convention for the Control and Management of Ships’ Ballast Water and Sediments (BWM).”
[7] “International Convention for the Control and Management of Ships’ Ballast Water and Sediments (BWM),” 4.
[8] International Maritime Organization, “International Convention for the Control and Management of Ships’ Ballast Water and Sediments.”

the International Maritime Organization as a major vector for invasive species since 1991[9] and has been regulated as such in the United States since the introduction of the zebra mussel.[10] The legal basis for the regulation of ballast water-introduced invasive species is derived from a broad body of competing regulations, and multiple overlapping agencies are responsible for their management.[11] After decades of discussion and innovation regarding ballast water management, technology has failed to create a "no viable organism" treatment system.[12] As such, some states find themselves in a "race to the bottom," repealing ballast regulations in an effort to harmonize with their neighbors.[13] If ballast water is to be removed as a vector for invasive species, a zero-transfer regulation must be adopted unilaterally. This strategy would protect the coasts and waterways of all nations from invasion and extend the ideals of the Clean Water Act to the world.

In this paper, after a brief introduction to ballast water, I will examine examples of ballast transported invasive species and their detrimental impacts. Next, a history of applicable United States regulations is examined as they pertain to ballast water management. Individual state ballast water management regulation strategies are discussed, as well as the legal precedents they were built upon. A selected international regulation framework is summarized, followed by an overview of the BWMC. Finally, I summarize the limitations of current strategies.

[9] David, Gollasch, and Hewitt, *Global Maritime Transport and Ballast Water Management*.
[10] O'Neill Jr and Dextrase, "The Introduction and Spread of the Zebra Mussel in North America."
[11] Peters and Lodge, "Invasive Species Policy at the Regional Level."
[12] Werschkun et al., "Emerging Risks from Ballast Water Treatment."
[13] Williams, "Political Roundup."

## A Free Ride

Through rapid transport of goods via well-established routes,[14] shipping unites the world.[15] Yet, the world is united by more than just shipping routes; it is also connected by the water that fills ballast tanks within those ships. Unloaded ships use the exchange of ballast water to provide stability and maneuverability. By adjusting buoyancy, ballast water allows ships to operate optimally, increasing safety as well as efficiency. When a ship arrives in a receiving port, it is deballasted, a process in which water taken from some part of the world is exchanged in another. A typical 200,000-ton ship carries 60,000 tons of ballast water,[16] and it is estimated that over three billion tons of this water is discharged annually.[17]

This bulk water transport allows for alien species, including bacteria and pathogens, to not only travel between continents but regionally, as well.[18] Regional exchanges, those between ports along the same coastline or within the same river system, may be particularly problematic as species may be exchanged into similar waters.[19] Discharging waters in areas with similar salinities, temperatures, nutrients, or within regions, increases the probability that organisms will be introduced to suitable habitat, thus surviving and potentially becoming invasive.[20] The variety of organisms which may be transported in ballast water is broad,[21] and as global shipping speed and volume increase, so does the potential for harm.[22] Pathogens and algae, as well as

[14] Endresen et al., “Challenges in Global Ballast Water Management,” 616.
[15] Abrahamsson, “The Marine Environment and Ocean Shipping,” 292.
[16] Patrick, “Ballast Water Law,” 3.
[17] Werschkun et al., “Emerging Risks from Ballast Water Treatment,” 257.
[18] Ibid.
[19] Ibid.
[20] Ibid, 256.
[21] Endresen et al., “Challenges in Global Ballast Water Management,” 1.
[22] Bax et al., “Marine Invasive Alien Species,” 313

viruses and macroscopic species, have been shown to survive long voyages, remaining viable and increasing the potential of invasion.[23]

Perhaps the most famous example of ballast water transported species is the zebra mussel.[24] Discovered in 1986 in Lake St. Clair along the U.S. and Canada border, this European stowaway spread rapidly along both the Erie Canal and St. Lawrence Seaway into the rest of the Great Lakes.[25] The mussels have found a niche in the entire Northeast, the Pacific Northwest, and have the potential to invade the rest of the continent.[26] Clogging and fouling water intakes of power plants, water treatment plants, and causing damage to docks and boats, zebra mussel mitigation costs and economic losses are estimated at US $1 billion annually.[27] Asian clams, green and Chinese mitten crabs, and comb jellies[28] have also affected ecosystems around the world. Among other issues, the destruction caused by invasive species includes altered food webs which may lead to loss of species and erosion, impacting tourism and devastating fisheries.[29] Every harmful algal species known today has been shown to survive in ballast water.[30] *Alexandrium* species have been introduced into Australia and Tasmania, and are suspected to have been introduced by way of ballast to New Zealand and Chile.[31] These microscopic algae release neurotoxins, commonly known as paralytic shellfish

[23] David, Gollasch, and Leppäkoski, "Risk Assessment for Exemptions from Ballast Water Management–the Baltic Sea Case Study,", 1.
[24] Brautigam, "Control of Aquatic Nuisance Species Introductions via Ballast Water in the United States," 36.
[25] O'Neill Jr and Dextrase, "The Introduction and Spread of the Zebra Mussel in North America," 433.
[26] Ibid.
[27] Corn and Johnson, *Invasive Species*, 7.
[28] Werschkun et al., "Emerging Risks from Ballast Water Treatment," 257.
[29] Brautigam, "Control of Aquatic Nuisance Species Introductions via Ballast Water in the United States," 37.
[30] Hallegraeff, "Transport of Toxic Dinoflagellates via Ships' Ballast Water."
[31] Cohen and Foster, "The Regulation of Biological Pollution," 798.

toxins, forcing shellfish closures due to human health impacts, as well as causing mortality or distress for mammals and birds.[32]

On a global scale, 10,000 marine species are transported daily in ships' ballast water.[33] Estimates of bacterial cells in ballast water delivered to the United States range from $10^7$ to $10^9$ cells/L.[34] In 1991, a ballast-carried Asian strain of cholera was found in the Gulf of Mexico and an epidemic outbreak occurred in South America.[35] Once a species arrives, it may lay dormant for years; however, once the invasion occurs it is likely irreversible.[36] Thus, vector control, or mitigation of transport mechanisms, may be the best method to minimize the transport of alien and potentially invasive species.

## Regulation and Litigation

### Waterways

Ballast, in the form of sand, rock, and other debris, has been regulated in the United States since the 1800s.[37] The Rivers and Harbors Act of 1899 specifically addressed ballast; however, it was never applied to the water form of ballast although its language, "refuse of any kind or description whatsoever," certainly seems to apply to water containing exotic species.[38] The Ocean Dumping Act (ODA) expanded ballast regulation to coastal and offshore waters.[39] The ODA broadly defined what cannot be dumped as "matter of any kind or description, of which sediments and polluted waters

[32] Ibid.
[33] Buck, "Ballast Water Management to Combat Invasive Species," 1.
[34] Lymperopoulou and Dobbs, "Bacterial Diversity in Ships' Ballast Water, Ballast-Water Exchange, and Implications for Ship-Mediated Dispersal of Microorganisms," 1962.
[35] Cohen and Foster, "The Regulation of Biological Pollution," 799.
[36] Werschkun et al., "Emerging Risks from Ballast Water Treatment," 257.
[37] Cohen and Foster, "The Regulation of Biological Pollution," 788.
[38] Ibid, 848.
[39] Ibid, 846.

could be regulated under."[40] As the threat of invasive species began to be recognized, the 1900 Lacey Act allowed for some modicum of control.[41] Lacey was intended to regulate the import of "any wild animal or bird,"[42] creating a black list.[43] This list now contains 621 species, including the most famous ballast-introduced invasive species, the zebra mussel.[44] The Plant Protection Act and its amended form, the Noxious Weed Control and Eradication Act of 2004, also present opportunities for ballast water control measures, via the Commerce Clause of the US Constitution.[45] By regulating foreign and interstate agricultural commerce, modes of transportation which may transfer invasive species can now be inspected.[46]

**Pollution**

In 1948, due to growing apprehensions about water pollution, Congress enacted the Federal Water Pollution Control Act (FWPCA).[47] Under the FWPCA, states and local governments were provided assistance to address water quality issues, based on the assumption that such problems were localized.[48] Environmental protection became increasingly important in the US during the 1960s.[49] Along with public frustration regarding slow cleanup, the perception of inadequate technology use and difficulties in linking pollution to polluters, this concern gave rise to the amended FWPCA of today.[50] Initially, the 1972 amendments were focused on traditional definitions of pollutants and

[40] Ibid.
[41] Ibid, 861.
[42] Alexander, "Injurious Species Listings Under the Lacey Act: A Legal Briefing," 7.
[43] Summary of Species Listed as Injurious Wildlife under the Lacey Act. Accessed November 8, 2017.
[44] Ibid.
[45] Corn and Johnson, *Invasive Species*, 16-18.
[46] Ibid, 17.
[47] Copeland, "Clean Water Act," 5
[48] Ibid.
[49] Ibid.
[50] Ibid.

wastewater treatment, with the hope that "fishable" and "swimmable" waters would be attained by 1983. However, the EPA had excluded certain source categories from the FWPCA permit requirements.[51] Because of these exclusions, environmental groups sued in 1976, and the court held that such exemptions diminished the FWPCA, thus expanding regulations to include pollution point sources, or single identifiable pollution sources such as discharge pipes.[52] The Clean Water Act (CWA) was born of the aforementioned amendments and the National Resources Defense Council suit in 1977, and it is particularly well suited as a starting point for ballast water regulation.[53] The intent of the CWA was to "restore and maintain the chemical, physical, and biological integrity of the nation's waters."[54]

States were also granted the authority to manage ballast water discharges under the CWA.[55] The EPA, however, had exempted ballast water as incidental to normal vessel operation.[56] This exemption was determined to be arbitrary, though, as Congress amended the CWA to exempt Armed Forces vessels' ballast water exchanges.[57] In 2003, environmental groups sued the EPA over this exemption.[58] The plaintiffs claimed that ballasted ships were point sources, or localized and easily identifiable pollution sources, and as such should be required to acquire a National Pollution Discharge Elimination System (NPDES) permit.[59] The groups had previously petitioned to remove

[51] "NRDC v. Train, 396 F. Supp. 1393," accessed November 18, 2017.
[52] Ibid.
[53] Patrick, "Ballast Water Law," 83.
[54] Ibid.
[55] Ibid.
[56] Ibid.
[57] Cohen and Foster, "The Regulation of Biological Pollution," 838.
[58] "Northwest Env't Advocates v. United States EPA, 340 F.3d 853," accessed November 9, 2017.
[59] Ibid.

the NPDES permit exemption, but the EPA failed to act.[60] Following mediation, the EPA determined that Congress had not intended ballast water to be covered by the CWA, and that the US Coast Guard (USCG) had jurisdiction.[61] Northwest Environmental Advocates sued again in 2005, and this time the US Court of Appeals for the Ninth Circuit Court ruled that the exemption was outside of the EPA's interpretative power, remanding the case to the EPA with instructions to vacate the exemption.[62] In determining that injunction, relief was warranted. The court stated, "The broad and significant effects that invasive species have on their new environment, combined with the generally impossible task of removal once those species become established, easily satisfies the threshold requirement of irreparable injury."[63] Citing High Sierra Hikers, the court emphasized that

> the environmental injury… introduction of invasive species-- is more certainly irreparable than most. There is no dispute that invasive species have been, and continue to be, introduced into the marine ecosystems of this country through ballast water discharges. There is also no dispute over the consequences that their introduction can have on the environment. Once introduced, invasive species can spread rapidly, threaten native species with extinction, and become almost impossible to eradicate.[64]

[60] Patrick, "Ballast Water Law," 83.
[61] Ibid.
[62] Northwest Envtl. Advocates v. EPA, No, 537 F.3d 1006, 2005, accessed November 9, 2017.
[63] Northwest Envtl. Advocates v. United States EPA, 2006 U.S. Dist. LEXIS 69476, accessed November 9, 2017.
[64] Ibid.

In a retreat from this mentality, the Commercial Vessel Incidental Discharge Act was introduced in January 2017.[65] The bill offers an exemption to USCG ballast regulations, but only if "ballast water is discharged solely to ensure the safety of life at sea, accidentally . . . or for avoiding or minimizing a discharge . . . of a pollutant."[66] Clearly, safety should be of the highest priority, but this exemption may make regulation difficult as it leaves ship personnel to decide what constitutes acceptable emergency deballasting.

**Environmental Protection**

In 1970, the National Environmental Policy Act (NEPA) created a policy of environmental protection.[67] NEPA requires the consideration of environmental effects by federal agencies and ensures that environmental impact statements must be prepared for actions which may affect the quality of the human environment.[68] Further, NEPA stipulates that both intentional and incidental actions that may affect invasive species must be considered.[69] Congress, under the Marine Mammal Protection Act, determined that "species and populations of stocks of marine mammals [that] are, or may be, in danger of extinction" should have their habitats protected.[70] These habitats are directly affected by ballast water-transported alien species, including harmful algae that may release neurotoxins that affect marine mammals and birds. Though not directly focused on invasive species or ballast water, the 1973 Endangered Species Act (ESA) protects

[65] Williams, "Political Roundup."
[66] Wicker, "S.168 - 115th Congress (2017-2018): Commercial Vessel Incidental Discharge Act," accessed March 30, 2017.
[67] Corn and Johnson, *Invasive Species*, 15.
[68] Ibid.
[69] Ibid.
[70] NOAA Fisheries, "Text of the Marine Mammal Protection Act (MMPA)" accessed November 11, 2017.

and conserves the habitats of endangered species, which may be marine or aquatic.[71] The ESA prohibits the "taking" of endangered species, and the introduction of invasive species may be considered harm, constituting a taking under Section 9.[72]

Addressing this unintentional introduction of aquatic invasive species, Congress passed the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) in 1990.[73] NANPCA, in responding to the Great Lakes zebra mussel problem, mandated a ballast water management program and required that ships comply with US Coast Guard-approved ballast water treatments.[74] The NANPCA also addresses prevention, management, and research regarding the control invasions of waterways, through NOAA and Sea Grant.[75] The 1996 National Invasive Species Act (NISA) further expanded ballast regulation, requiring ships to file a ballast water management plan with the US Coast Guard (USCG), recognizing that invasive species are a threat to the nation.[76] NISA has suffered criticism, though, including delayed implementation and agency weakness.[77] Under NISA, coastwise ship traffic is exempted from ballast water regulation where shipments from a highly-invaded port like San Francisco to the relatively pristine Puget Sound, with similar oceanographic characteristics, may increase the likelihood species survival.[78] In 2008, a USCG bill sought to amend the NANPCA and create a national ballast water standard but failed to be implemented.[79]

[71] Corn and Johnson, *Invasive Species*, 15.
[72] Cohen and Foster, "The Regulation of Biological Pollution," 857.
[73] Corn and Johnson, *Invasive Species*, 18.
[74] Ibid.
[75] Ibid.
[76] Howe, "Fednav, Ltd. v. Chester," 384.
[77] Buck, "Ballast Water Management to Combat Invasive Species," 5.
[78] Ibid.
[79] Papavizas and Kiern, "2007-2008 U.S. Maritime Legislative Developments," 319.

**Invasive Species**

Attempting to harmonize ballast water management plans, President Clinton established the National Invasive Species Council (NISC) by executive order 13112 in 1999.[80] [81] Before he left office in 2017, President Obama directed the continued federal invasive species management efforts of the NISC and expanded the council.[82] This order further directed agencies to address and consider invasive species and to refrain from activities that may exacerbate problems related to them.[83] The NISC is primarily responsible for developing international cooperation regarding invasive species, including monitoring and information sharing.[84] In 2009, both the National Aquatic Invasive Species Act (NAISA)[85] and the Prevention of Aquatic Invasive Species Act (PAISA)[86] failed to be enacted by the 110th Congress. NAISA would have addressed all mechanisms of ship-related invasive species transport, while PAISA specifically addressed ballast water as a driver of invasive species transport.

**Authority**

Multiple regulatory agencies are granted overlapping authority to regulate ballast water under federal statutes, causing some jurisdictional confusion.[87] The US Army Corps of Engineers, the US Fish and Wildlife Service, the National Oceanographic and Atmospheric Agency, and the National Marine Fisheries Service, as well as the FDA and the Departments of Transportation, Interior, and Homeland Security, all have

[80] World Shipping Council, "Ballast Water," accessed November 5, 2017.
[81] US EPA, “Invasive Species: Laws and Regulations - Executive Order 13112.”
[82] “Safeguarding the Nation From the Impacts of Invasive Species,” Federal Register, accessed December 8, 2016.
[83] Corn and Johnson, *Invasive Species*, 19.
[84] Ibid, 22.
[85] National Aquatic Invasive Species Act of 2007, S. 725, 110th Cong. (2007).
[86] Prevention of Aquatic Invasive Species Act of 2007, H.R. 889, 110th Cong. (2007).
[87] Buck, “Ballast Water Management to Combat Invasive Species,” 3.

jurisdiction over invasive species and ballast water.[88] However, the USCG and EPA, under the NANPCA, hold the position of regulatory authority.[89] As previously mentioned, the EPA had forfeited its jurisdiction to the USCG but was forced to regulate ballast water under the CWA by the decision in *Northwest Environmental Advocates v. EPA*.[90] This joint enforcement allows ballast water to be regulated as a safety and security concern by the USCG, with science and research-based mechanisms guided by the EPA.[91] Further, post September 11th, 2001, the USCG has focused on national security and counterterrorism while facing budgetary constraints, which may be somewhat alleviated by this joint venture.[92]

For nearly two centuries, ballast has been recognized to physically and biologically alter waterways. As public awareness of the effects of pollution and invasive species grew, a vast array of regulations was created to protect waterways. Ultimately, enforcement of ballast water exchange regulations falls under the jurisdiction of the USCG; however, with changing priorities, the agency is unlikely to have either the tools or efficient communication with the EPA to ensure adequate monitoring.

## The States and Legal Precedent

Many US states have taken ballast water regulation into their own hands, including those on the west coast.[93] California enacted the Marine Invasive Species Act in 2003, which required mid-ocean ballast exchanges, where water held in tanks is emptied and refilled in open waters, to combat the transport of coastal or estuarine

[88] Corn and Johnson, *Invasive Species*, 2.
[89] Buck, "Ballast Water Management to Combat Invasive Species," 5.
[90] "Northwest Envtl. Advocates v. EPA, No. 537 F.3d 1006, 2005, accessed November 9, 2017.
[91] Mah, "Sailing by Looking in the Rearview Mirror," 668.
[92] Ibid, 673.
[93] Remsberg, "Too many Cooks in the Galley," 1422.

species, which are less likely to survive offshore.[94] California also enforces a ballast water treatment standard, where onboarded water is subjected to some type of chemical or mechanical decontamination that is over 1,000 times what required by the EPA and USCG.[95] Under the NANPCA, any ship entering the Great Lakes, or the upper Hudson River, must use some ballast treatment, or exchange, which meets Federal Water Pollution Control requirements.[96] Though the EPA determined that ballast water exchanges were not required on the Gulf and Atlantic coasts, both New York and Massachusetts enacted regulations requiring near-shore ballast water exchange management.[97] Numeric organismal discharge limits are enforced by both Wisconsin and Minnesota.[98] Salt water flushing 200 nautical miles from shore is required of all ships entering the St. Lawrence Seaway for passage into the Great Lakes, with the assumption that freshwater transported organisms will not remain viable in highly saline ballast.[99] Michigan enacted strict controls in 2005, leading an effort to protect the Great Lakes.[100] A state permit has been required since 2007 in which vessel operators agree to follow invasive species regulations and/or to certify that no discharges will occur, or employ an approved ballast water treatment method.[101] Michigan expected other regional and state ports to adopt stringent management requirements, but to date, none have. This has left the state's ports struggling to remain economically competitive because shippers may bypass Michigan's ports in favor of those that do not require

[94] Ndlovu, "The Marine Environment and Ballast Water Management Law," 972.
[95] World Shipping Council, "Ballast Water."
[96] Ndlovu, "The Marine Environment and Ballast Water Management Law," 972.
[97] Papavizas and Kiern, "2007-2008 U.S. Maritime Legislative Developments," 322.
[98] David, Gollasch, and Hewitt, *Global Maritime Transport and Ballast Water Management*,70.
[99] Ibid, 72.
[100] Williams, "Political Roundup."
[101] Howe, "Fednav, Ltd. v. Chester," 386.

certification, avoiding the monetary cost of treatment.[102] In November 2017, HB 5095 passed in the Michigan House, which would reduce ballast water management requirements to "harmonize" with those of the USCG.[103] In 2011, a routine reauthorization of the USCG, H.R. 2584, included an amendment, Sec. 459, which would have prohibited

> funds made available by this Act for the EPA from being provided to any state that: (1) is adjacent to one or more of the Great Lakes; and (2) has in effect a certification under the CWA or a state permit requirement that imposes on vessels that discharge ballast water into, take in ballast water from, or transit such state's waters, a performance standard for ballast water management systems, or a ballast water exchange standard, which the Commandant of the Coast Guard determines is more stringent than specified standards.[104]

Also included in H.R. 2584 was an amendment that would have prohibited the EPA from requiring a permit under the CWA for point source discharges of pesticides, or a vessel's incidental discharges or effluents from biofouling prevention.[105] The bill was not passed; however, it displayed a disregard for state mandated regulations in favor of interstate regulation standardization and a lack of understanding regarding the differing sensitivities of regions to invasive species.[106] In May 2017, H.R. 953, the Reducing Regulatory Burdens Act (RRBA), passed through the House. The RRBA mirrors H.R.

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[102] Williams, "Political Roundup."
[103] Ibid.
[104] "H.R.2584 - 112th Congress (2011-2012): Department of the Interior, Environment, and Related Agencies Appropriations Act, 2012 | Congress.Gov | Library of Congress," accessed November 13, 2017.
[105] Ibid.
[106] Ibid.

2584 and would remove state authority to require NPDES permits.[107] The Sensible Environmental Protection Act (SEPA) was also introduced in the Senate in February, 2017.[108] S. 340 of the SEPA would amend the CWA to prohibit the EPA from requiring an NPDES permit for discharges approved under the Federal Insecticide, Fungicide, and Rodenticide Act, which would exempt all typical ballast water discharges.[109] It is likely due to the number of bills removing permit requirements for ballast water discharge that they will no longer be required in the near future and states will be allowed to self-regulate, jeopardizing the health of shared aquatic areas.[110]

The right of states to self-regulate ballast water was not without contention. Alaska prohibited the discharge of oily ballast water and in 1982 was challenged by Chevron.[111] Citing Chevron as the basis for removing the ballast water exemption, the court—in *Northwest Environmental* Advocates v. EPA—upheld Alaska's authority to prohibit the discharge of oily ballast water and required ships to deballast into onshore facilities.[112] Further, based on *Amoco Prod. Co.* v*. Village of Gambell*,[113] the court determined that monetary damages were insufficient to remedy the injury caused by the introduction of invasive species. After Michigan enacted controls greater than those of the USCG, shippers brought suit to force the state to adopt the lower standards. The court found in *Fednav* v*. Chester* that the state had authority under the NISA to prevent

[107] "H.R.953 - 115th Congress (2017-2018): Reducing Regulatory Burdens Act of 2017. Congress.Gov. Library of Congress," accessed November 13, 2017.
[108] "S.340 - 115th Congress (2017-2018): Sensible Environmental Protection Act of 2017. Congress.Gov. Library of Congress," accessed November 13, 2017.
[109] Ibid.
[110] "Legislative Search Results | Congress.Gov | Library of Congress," accessed November 13, 2017.
[111] Chevron USA, Inc. v. Hammond, 726 F. 2d, 1984.
[112] "Northwest Envtl. Advocates v. EPA, 537 F.3d 1006, 2005.
[113] Amoco Prod. Co. v. Village of Gambell, 480 U.S. 531, 545, 107 S. Ct. 1396,

the spread of invasive species.[114] These hard-fought cases created a strong precedent for future state environmental control but also grant states the right to give up ground. The west coast of the US represents policies working together to decrease the risk of invasion, while the Great Lakes exemplifies the "tragedy of the commons" scenario where relenting states may necessitate that those neighboring them do the same.

## Global Regulation

Numerous countries have attempted to regulate ballast water, recognizing the imminent threat of invasive species transport.[115] The 1969 international health regulations proposed by the World Health Organization put forth public health measures to combat cholera outbreaks, in which ballast water has been implicated.[116] In 1971, the Ramsar Convention specifically addressed the adoption of regulations to prevent and restrict the movement of marine and aquatic invasive species.[117] Ballast water organism transport was at the forefront during the 1973 International Maritime Organization's (IMO) Marine Pollution Conference, leading to the resolution on "Research into the Effect of Discharge of Ballast Water Containing Bacteria of Epidemic Diseases."[118] This resolution resulted in the recognition that ballast water had led to introducing numerous unwanted species, and that member states should "seek international co-operative measures to resolve" such introductions.[119]

Defining global marine environment obligations, the 1982 UN Convention on the Law of the Sea yielded an international framework for marine protection.[120] In 1991, the

[114] Fednav, Ltd. v. Chester, 505 F. Supp. 2d.
[115] Scriven et al., "Ballast Water Management in Canada," 125
[116] David, Gollasch, and Hewitt, *Global Maritime Transport and Ballast Water Management*, 60.
[117] Ibid, 61.
[118] Ibid, 64.
[119] Ibid.
[120] Ibid, 62.

IMO began providing ballast guidance, which was later adopted by the IMO assembly.[121] Recognizing the socio-economic and environmental costs of invasive species, the UN 1992 "Convention on Biological Diversity" specifically provided for states to develop ballast water regulations to prevent the transport of invasive species.[122] Canada has also worked cooperatively to regulate invasive species in the Great Lakes for decades and in 2012 established ballast water discharge limits.[123] Many other international treaties have focused on protecting rare or endangered species and ecosystems, and on managing threats to either.[124]

**Harmonization**

In 2004, the IMO proposed the Convention for the Control and Management of Ships' Ballast Water and Sediments (BWMC), the first global attempt to provide comprehensive protection from invasive species.[125] The BWMC was implemented after Finland ratified it in 2016.[126] As of November 2017, 64 countries have accepted the BWMC.[127] Under the BWMC, ships under the flags of ratified countries are required to use open water ballast exchange and phase in ballast water treatment systems, to be installed by 2024.[128] Ships adhering to the BWMC must also record ballast water management, submit to inspection and enforcement, and meet minimum viable organism concentration limits as per Regulation D-2.[129] Perhaps the simplest and most

[121] Corn and Johnson, *Invasive Species*, 44.
[122] David, Gollasch, and Hewitt, *Global Maritime Transport and Ballast Water Management*, 63.
[123] Scriven et al., "Ballast Water Management in Canada," 124.
[124] Corn and Johnson, *Invasive Species*, 44.
[125] International Maritime Organization, "International Convention for the Control and Management of Ships' Ballast Water and Sediments."
[126] Ibid.
[127] Ibid.
[128] Ibid.
[129] Ibid.

efficient management strategy of the BWMC is Regulation C-2, which requires that signatories "shall endeavor to notify mariners of areas under their jurisdiction where ships should not uptake Ballast Water due to known conditions," such as harmful algal events, which would enable vessels to avoid taking ballast from affected areas.[130] The US has not ratified the BWMC, but the USCG employs similar ballast water exchange controls.[131]

## Limitations

Open water exchange is currently the most widely used ballast treatment method employed. This treatment method requires that ships exchange water 200 nautical miles from shore and at a minimum depth of 200 m.[132] However, studies have found that this method has limited efficacy.[133] The presumption is that fewer organisms inhabit offshore waters, and organisms released there are less likely to remain viable. Yet, these standard exchange parameters do not consider the productivity differences in regional waters. For example, in Washington State, the approved area includes the "prairie," an area of high productivity that may be ripe for invasion.[134] These parameters do offer some protection, but in closed waters, this type of strategy is not possible.[135] Additionally, ships are exempt if exchange may affect the safety of the ship and its crew, and under the BWMC "a ship shall not be required to deviate from its intended voyage,

[130] Ibid.
[131] The Maritime Executive "U.S. Clarifies Ballast Water Convention Stance," accessed November 10, 2017.
[132] Ibid.
[133] Carney et al., "Evaluating the Combined Effects of Ballast Water Management and Trade Dynamics on Transfers of Marine Organisms by Ships."
[134] Davis et al., "Estuary-Enhanced Upwelling of Marine Nutrients Fuels Coastal Productivity in the U.S. Pacific Northwest."
[135] Endresen et al., "Challenges in Global Ballast Water Management," 620.

nor delay the voyage, in order to comply."[136] Thus ballast water treatment offers the only 100% effective management strategy.

In the run up to international BWMC ratification, numerous onboard ballast water treatment methods were developed.[137] Any type of treatment costs, on average, $300,000 to install, and this cost will most likely be passed on to consumers of ship-transported products.[138] Chemical and UV treatments are more likely to achieve "no viable organism" decontamination but may have deleterious effects on crew members or contaminate deballasted water.[139] Many schemes also use combined treatments to achieve accepted levels of decontamination.[140] Mechanical methods sidestep these potentially harmful effects but are costly and less efficient.[141] No ballast on board (NOBOB) ships, or those with no water currently within their ballast tanks, are exempted from discharge regulations, but large numbers of organisms often remain viable in sediments retained in ballast systems.[142] NOBOB ships pose a unique issue, as accepted ballast treatments are typically ineffective when turbidity is high or they do not penetrate sediments, which may accumulate as up to five hundred gallons per ship.[143]

Monitoring the efficacy of ballast treatments is also of concern. In addition to the cost of installing and maintaining a system, crew members must have thorough knowledge of testing and sampling techniques.[144] Different taxa require different

[136] International Maritime Organization, "International Convention for the Control and Management of Ships' Ballast Water and Sediments."
[137] Scriven et al., "Ballast Water Management in Canada," 5.
[138] Buck, "Ballast Water Management to Combat Invasive Species," 3.
[139] Werschkun et al., "Emerging Risks from Ballast Water Treatment," 260.
[140] Buck, "Ballast Water Management to Combat Invasive Species," 2.
[141] Werschkun et al., "Emerging Risks from Ballast Water Treatment," 259.
[142] Buck, "Ballast Water Management to Combat Invasive Species," 2.
[143] Cohen and Foster, "The Regulation of Biological Pollution," 792.
[144] David, Gollasch, and Leppäkoski, "Risk Assessment for Exemptions from Ballast Water Management–the Baltic Sea Case Study," 1967.

monitoring protocols and some expertise in analysis.[145] Continuous monitoring during discharge must also occur, as organismal concentrations in water can vary greatly.[146] This strategy also requires self-reporting, which is often unreliable.[147] Port and flag states both have enforcement authority under the BWMC.[148] This may be complicated, as certification, surveying, and penalizing may vary in scope and interpretation.[149] If a vessel is found to be violating the BWMC, the port state may impose sanctions, but there is no guidance as to who is responsible for the manner in which further actions should be taken.[150] This uncertainty may also cause ship operators to ensure that they are in compliance with higher standards than those of the BWMC; if penalties are strictly enforced, this may further motivate them to do so. Contrarily, operators may ignore regulations, as this same regulatory uncertainty yields plausible deniability.

## Conclusion

The ratification of the BWMC demonstrates that ballast water-transported organisms are internationally recognized as a significant potential threat to the environment.[151] This also affords a mode of global harmonization and protection for countries with less economic clout on the world stage.[152] However, this minimum standard fails to eliminate ballast water as a vector. As a leader in protecting the

[145] Bradie et al., "A Shipboard Comparison of Analytic Methods for Ballast Water Compliance Monitoring," p 2
[146] David, Gollasch, and Leppäkoski, "Risk Assessment for Exemptions from Ballast Water Management–the Baltic Sea Case Study," 2.
[147] Ibid.
[148] Tsimplis, "Alien Species Stay Home," 420.
[149] David, Gollasch, and Leppäkoski, "Risk Assessment for Exemptions from Ballast Water Management–the Baltic Sea Case Study."
[150] Tsimplis, "Alien Species Stay Home," 421.
[151] International Maritime Organization, "International Convention for the Control and Management of Ships' Ballast Water and Sediments."
[152] David, Gollasch, and Leppäkoski, "Risk Assessment for Exemptions from Ballast Water Management–the Baltic Sea Case Study," 1971.

environment from invasive species, the US has set a high standard for ballast water management. The US has also had a strong record of ecocentrism. However, the principles that guide the country change with the political tide.[153] Currently, proposed HB 5095 in Michigan elucidates a "race to the bottom" scenario.[154] This is likely to be the case at global scales as neighboring countries with lax policies, or those that relax regulations attempting to promote their own port development, put adjacent countries at risk.[155] Economically, the cost of combatting one invasive species, as the zebra mussel situation illustrates, outweighs the burden to shippers of ballast water treatment.

An internationally accepted "no viable organisms" policy would hold all nations accountable, creating an incentive to develop and install a universal method of ballast water treatment. The accepted treatments must ensure that viruses, and any possible chemicals used to eliminate them, are also removed as a potential source of water pollution. Onboard chemical recycling methods may alleviate some treatment costs, as well as reducing pollution caused by disposal of chemical treatments. Automated real-time water monitoring and annual equipment inspections, reported to whichever country a ship is operating in the waters of, should provide a means to effectively manage ballast treatment. Automated monitoring may also reduce the need for expert monitoring and analysis as well as overcoming the inherent uncertainty and unreliability of self-reporting and compliance. As a major economic power, the US should not only implement but lead the charge on developing such a technology. The current US

[153] Brautigam, "Control of Aquatic Nuisance Species Introductions via Ballast Water in the United States."
[154] Williams, "Political Roundup."
[155] David, Gollasch, and Leppäkoski, "Risk Assessment for Exemptions from Ballast Water Management–the Baltic Sea Case Study," 1967.

strategy, where the burden is placed on the USCG whose priority is human safety, fails to recognize the chemical and biological knowledge required to monitor ballast water, yet neither is the agency equipped to include it. Thus, dedicated agencies or branches of agencies should be responsible for ballast water regulation enforcement. Enforcement of ballast water policies must be strict, with noncompliance fines high enough to deter violations. Not only do existing regulations allow for such a standard to be made, but case law puts forth a framework to enforce it. There are multiple vectors by which invasive species may be transported, but by limiting ballast water introductions, a giant step may be taken toward stabilizing the seas.

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