



An Overview of Ballast Water Transport and Treatment of Aquatic Invasive Species

Natural Resource Report NPS/NRSS/WRD/NRR—2022/2482





ON THIS PAGE

Zebra mussels growing on a larger bivalve.
USGS / RANDY WESTBROOKS

ON THE COVER

The *Ranger III* docked at Mott Island in Isle Royale National Park.
NPS

An Overview of Ballast Water Transport and Treatment of Aquatic Invasive Species

Natural Resource Report NPS/NRSS/WRD/NRR—2022/2482

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Abstract

Modern vessels rely on ballast water for proper buoyancy on voyages and while loading and unloading people or cargo. Because ballast water is usually taken on at one location and discharged at another, it has transported many marine organisms across the globe, some of which have become invasive. For example, ballast water introduced zebra mussels to the Great Lakes, and they have since caused extensive economic and environmental harm within the United States.

Growing international concern over ballast water transport of invasive species has led to the introduction of many different policies and regulations since the 1980s. Ballast water exchange—trading port water for open ocean water before docking again—represents the bare minimum standard for reducing invasive species transport. To meet the latest regulatory requirements, many commercial ballast water treatment systems have been developed, ranging from filtration to biocides.

The goal of this document is to provide a brief overview of ballast water transport of invasive species, historical and current regulations/policies, management strategies, and outreach suggestions to allow park managers to make informed decisions about ballast water within their parks.

Acknowledgments

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List of Acronyms

AIS: Aquatic Invasive Species

BW: Ballast water

BWM: Ballast water management

EPA: Environmental Protection Agency

GRT: Gross Register Tonnage

IMO: International Maritime Organization

NISA: National Invasive Species Act

NOBOB: No Ballast On Board

NPS: National Park Service

NRC: National Research Council

USCG: United States Coast Guard

UV: Ultraviolet

Introduction

Keeping a vessel balanced during its voyages requires the use of ballast. Wooden ships carried solid ballast, such as soil or rocks. The invention of the steel-hulled ship in the mid-1800s allowed the use of more versatile liquid ballast: water taken up at port, or during a voyage, to control the ship's buoyancy under different weather and cargo conditions. Ballast water is typically carried in tanks along the hull (National Research Council, 1996).

Ballast water plays a role in stabilizing vessels during cargo loading/unloading and en route. For example, more ballast water may be taken on to keep the ship submerged to the appropriate level on rough seas. Ships typically take on ballast water during cargo offloading, and release ballast water when loading cargo (Figure 1). This keeps the ship's center of balance and buoyancy constant and is a crucial element of safe vessel operation. Consequently, ships transfer water from port to port around the world. In the absence of any ballast water management, the organisms present in the local water are then transported across the globe and released into new waters, where they have potential to become nuisance or invasive species (National Research Council, 1996).

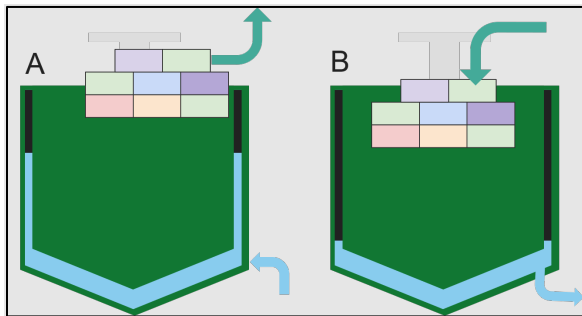


Figure 1. Ballast water is typically taken on during cargo offloading (A) and released during cargo loading (B).

Ballast water represents one of multiple ways ships transport organisms, and due to the large volumes of water at play, it is an especially concerning vector. As early as 1903, the discovery of an Asian diatom (*Biddulpha sinensis*) in European waters (Elton, 1958) prompted speculation that ballast water might transport organisms from one port to another. By the time observers found zebra mussels (*Dreissena polymorpha*) in the Great Lakes 85 years later (McMahon, 1996), ballast water had been confirmed as a very prolific transport vector. These incidents and others prompted international concern. The United Nation's maritime policy body, the International Maritime Organization (IMO), adopted the Ballast Water Management convention in 2004 with enforcement beginning in 2017. Meanwhile, multiple other nations put in place their own regulations to protect their economic and ecological resources. These national and international policies and regulations are still evolving today. Since 2015, an increasing number of ballast water management systems have become available for use on vessels operating in U.S. waters and subject to U.S. management requirements.

National Park waters have already been affected by ballast water transport of organisms such as the zebra mussel; parks have also previously taken action to mitigate the risks of ballast water release during vessel emergencies. This document provides an overview of current technology and regulations to help park managers decide how to handle ballast water within their parks.

Ballast Water Management Systems

Treatment and management of ballast water can be broadly divided into two categories: (A) those requiring a dedicated onboard system for purification of ballast water, and (B) those not requiring such additional equipment. Some methods in the latter category are ballast water exchange or using potable water. Dedicated onboard systems usually use a filtration step to remove sediment and larger particles, followed by a disinfection step to reduce the concentration of any remaining regulated organisms in the ballast water.

Considerations for equipping a vessel with an onboard system include available space, cargo volatility, route conditions, and cost. The sheer volume of ballast water released at once (upwards of 100,000 m³—over 50 Olympic swimming pools—for some cargo ships) poses additional challenges, as management systems must be able to handle large flow rates. The Coast Guard has approved several dozen commercially available ballast water management systems. Installation costs vary per vessel circumstances and may exceed hundreds of thousands of dollars.

Many pitfalls exist when determining and comparing the efficacies of treatment methodologies, such as:

- 1) Not all organisms respond the same way to a given treatment (Gregg et al., 2009),
- 2) Chemical concentrations and incubation times differ (see Gregg et al., 2009 Table 8),
- 3) Systems tested on land do not necessarily perform the same way once installed on a vessel (Gregg et al., 2009),
- 4) Testing protocols for organism viability are not yet standardized (EPA, 2020), and
- 5) Consistent efficacy testing is still under development (Drake et al., 2021).

The most common methods of ballast water management are summarized in Table 1 and briefly summarized below. For a comprehensive meta-analysis of treatment options, see Gregg et al. (2009).

Table 1. Some common types of ballast water treatment and management. See Gregg et al., 2009 for a thorough meta-analysis.

Treatment Type	Benefits	Drawbacks
Filtration	Removes sediment and larger organisms; works well as a first step before a physical or chemical disinfectant step	Easily clogged by filamentous algae; cannot block very small organisms without slowing water flow rate
UV Light	Relatively inexpensive; does not require transport or discharge of chemical biocides	Requires relatively clear water; not effective against some organisms such as dinoflagellate cysts
Biocides (bleach, peroxides, etc.)	Up to 100% biological inactivation is possible, even for resistant organisms like dinoflagellate cysts	May require transportation and deactivation of chemical agents; environmental fate of biocides must be considered; can corrode ship components

Table 1 (continued). Some common types of ballast water treatment and management. See Gregg et al., 2009 for a thorough meta-analysis.

Treatment Type	Benefits	Drawbacks
Mid-ocean ballast water exchange	Accessible: does not require additional equipment installation	Highly variable efficacy; depending on vessel design and/or voyage conditions, may not be possible to carry out

Ballast Water Exchange

Replacing fresh or brackish port water with open-ocean water (Figure 2) reduces organism load in ballast water while also decreasing the risk of releasing potentially invasive species. For example, an organism that typically lives in warm, shallow, coastal water will most likely not survive in the cold, deep, open ocean, and any organisms taken up in the open-ocean ballast water will most likely not thrive in the coastal waters of the ship's destination. Effectiveness strongly depends on the salinity mismatch between the port water and ocean water (Drake et al., 2020).

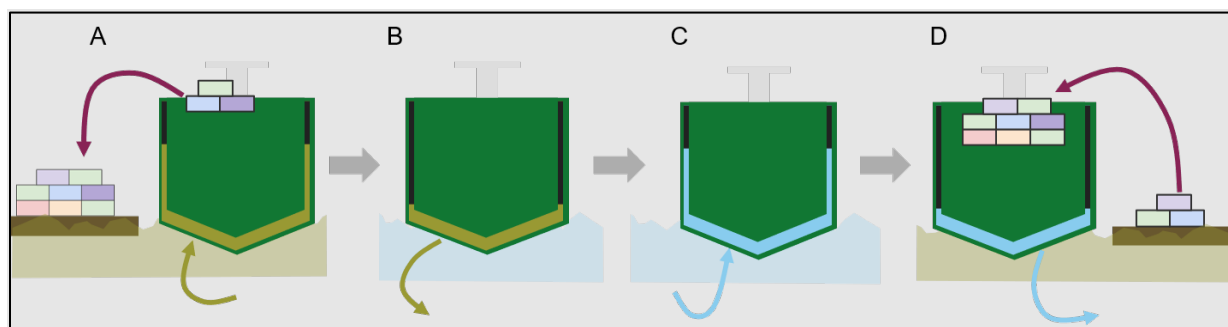


Figure 2. An example of mid-ocean ballast water exchange (empty-refill method). (A) As cargo is unloaded from a vessel, port water is taken on for balance. (B) After the ship leaves port and is on the open ocean, sediment-heavy, brackish port water is released. (C) Cold, saline ocean water is taken up to refill the ballast tanks. (D) As the vessel takes on new cargo at a different port, only open ocean water is released.

All ballast water exchange comes with safety considerations, as the shifting of significant weight puts stress on the ship's structural elements, and in some cases the addition or discharge of water must match the rate of cargo unloading or loading. Additionally, the percent of water exchanged is not necessarily proportional to the percent of organisms removed, and truly 100% efficient ballast water exchange does not exist. There will always be some un-pumpable water and sediment remaining in the tank (Hallegraeff and Bolch, 1992). Vessels declaring “no ballast on board” (NOBOB) still transport a substantial quantity of water and sediment (National Research Council, 1996). Because of these drawbacks, ballast water exchange alone does not meet current regulatory standards, though it may be used as a stopgap measure until the installment of a dedicated treatment system (see the Regulations section for more information). However, since the era of mandatory saltwater flushing prior to ships entering the Great Lakes (2007–2019), the rate of known species introductions fell

from 2 species/year to 0.31 species/year, an 85 percent decline in 13 years (Ricciardi and MacIsaac, 2022).

Combining ballast water exchange with an additional treatment method can increase treatment efficacy (Bradie et al., 2021; Briski et al., 2015).

Filtration

Typically, filtration is the first step in a complete management system (Figure 3). A filter removes suspended material (sediment and organisms) from incoming ballast water. Backflow flushing keeps the filter clean while avoiding contamination of local water.

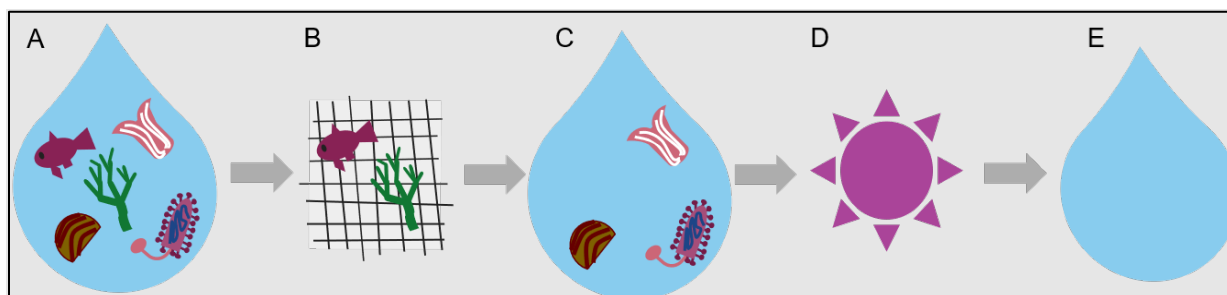


Figure 3. Schematic of a filtration and UV treatment system. (A) Ballast water initially contains many organisms as it is taken on. (B) Larger organisms and sediment are caught on a filter(s). (C) Small organisms remain in the ballast water. (D) As the ballast water enters the ballast tanks, it is permeated with UV radiation, decontaminating small organisms in the water, with efficiency varying depending on water conditions and types of organism present (E).

Filtering out small organisms (plankton) requires very fine filters that dramatically slow down the flow rate when taking on or discharging ballast water. This precludes the use of filtration alone for treating ballast water. Furthermore, filters may become clogged with filamentous algae (Cangelosi, 2011). However, filtration can be an effective first step in a treatment methodology. Other disinfection methods are more effective with sediment and larger organisms removed.

Ultraviolet light

Ultraviolet (UV) light disinfects by breaking down organisms' DNA and other biomolecules, thus rendering them nonviable. UV disinfection requires sufficiently clear water for the light to fully permeate (Cangelosi, 2011). It does not have the hazards associated with chemical treatment, and its performance is less sensitive to water pH, salinity, and temperature. However, UV light does not render some organisms nonviable, such as dinoflagellate cysts (National Research Council, 1996).

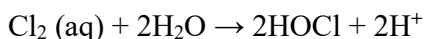
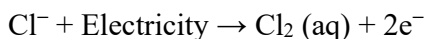
Biocides

Chemicals such as chlorine and hydrogen peroxide can be very effective ballast water sanitizers because they sterilize organisms, such as dinoflagellate cysts, that other methods do not. However, chemical methods can damage ship components, may require storage of harsh chemicals onboard, and may require neutralization before discharge (Gregg et al., 2009). In particular, chlorinating methods require an additional dechlorination/neutralization step before discharging water to avoid

harming the local environment (Matousek et al., 2006). Choosing the correct system for an individual vessel should account for the type of chemical, typical water conditions, and cargo space, among other considerations.

Electrochlorination

Biocides can also be generated on-board by running electric currents through the ballast water. This method can only be used in saltwater. When exposed to an electric current, the chlorine anions in seawater form chlorine gas; chlorine gas then reacts with water molecules to create bleach in the form of hypochlorite ions (Equation 1) (Matousek et al., 2006). While electrochlorination removes the need to transport concentrated bleach on the vessel, a neutralizing chemical must still be added to the ballast water before discharge.



These chemical equations represent only one of the reactive pathways possible in the ballast water. Seawater contains many different ions and organic compounds that may react with each other in the stimulating presence of an electric current.

Emergency and Manual Treatment Systems

Bleach, chlorine, or another oxidizer/biocide may be injected into the ballast water as concentrated solutions or as solids. In cases where an onboard treatment system is nonexistent or unfeasible, manual or semi-automated addition of biocides can be used to treat ballast water.

Manual addition of biocides was used as an emergency method to treat ballast water in a grounded vessel near Biscayne National Park in 1996 (Isle Royale National Park, 2014). The manual rapid-response system used on the *Ranger III* was pioneered by the National Park Service (NPS) on a grounded vessel near the Bay of Biscayne in 1996 (Isle Royale National Park, 2014; MIDSIS, 2021). Similar portable emergency systems that were tested in the Great Lakes have also been developed (Global Diving and Salvage, 2018).

In 2007, parks in the Great Lakes prohibited ballast water discharge within park boundaries to limit the spread of viral hemorrhagic septicemia (VHS) (NPS, 2008). VHS affects many fish species and leads to large die-offs (NPS, 2021b). Ballast water exchange may have introduced VHS to the Great Lakes, where it has been detected since 2003 (NPS, 2021). To prevent spreading VHS into Isle Royale National Park, the park began treating ballast water on the *Ranger III*, the vessel that carries visitors from Houghton, MI, to the park. Initially, the park used a manual emergency method. They added bleach (as NaOCl) to the ballast tanks to render stowaway organisms nonviable, then added a neutralizer (sodium thiosulfate) before discharging (NPS 2012). Several years later, they installed a commercial filtration and UV system (National Parks Traveler, 2012). This represented “the first permanent ballast treatment installation on a freshwater ship in the Great Lakes”, according to Isle Royale NP Superintendent, Phyllis Green.

Examples of Aquatic Invasive Species Transported by Ballast Water

This section summarizes the impact of several ballast water-transported AIS. Species listed in this section were chosen because clear verdicts on their ecosystem and economic impacts were evident in the literature. Ballast water is most likely to transport small creatures that live in the water column and associated sediments (phytoplankton and zooplankton). Larger organisms, such as mollusks, crustaceans, and fish may spend their larval stages as zooplankton, and these planktonic life stages can be transported in ballast water to a new location, where they morph into their adult forms. Ballast water can also transport pathogens. There is concern in the South Florida/Caribbean region that Stony Coral Tissue Loss Disease, which has devastated coral reefs, was transported by ballast water (Dahlgren et al., 2021), and concern about the fish disease viral hemorrhagic septicemia (VHSV) led to intensive ballast water discussions in the Great Lakes parks (NPS, 2008).

Zebra and Quagga Mussels (*Dreissena polymorpha* and *D. rostriformis bugensis*)

Perhaps the most notorious AIS, the zebra mussel (Figure 4A) first appeared in the Great Lakes in the 1980s. European ballast water likely introduced the larval mussels to North America (McMahon, 1996). Their invasion was followed closely by that of the quagga mussel, which has since supplanted zebra mussels in the Great Lakes (Nalepa, 2010). In the intervening decades, the mussels have spread to around 30 U.S. states and required significant management intervention. They are particularly detrimental to human structures, as they colonize water supply pipes and restrict water intake for power plants and other public facilities. An estimated \$750 million—\$1 billion has been spent on repairing mussel-related damage and attempting to control their populations (U.S. Geological Survey, 2021).

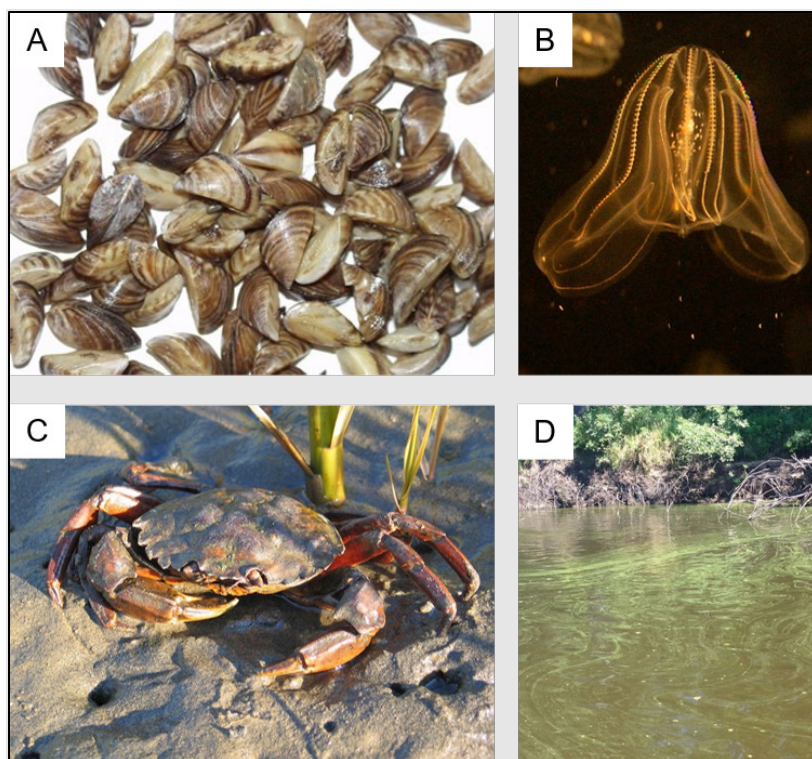


Figure 4. Examples of aquatic invasive species. (A) Zebra mussel (NPS photo). (B) North American comb jelly (Steven G. Johnson). (C) European green crab (P. Sean McDonald). (D) Blue-green algae surface bloom (Chauncey Anderson).

North American Comb Jelly (*Mnemiopsis leidyi*)

This small comb jelly (Figure 4B) traveled from the Atlantic Ocean to the Black Sea in ballast water, where it has no predators. *M. leidyi* was first identified in the Black Sea in 1982, and by 1989 the anchovy fishery industry had been significantly reduced. Unchecked, it proceeded to consume zooplankton until the entire region's aquatic food chain collapsed, depressing the seal population and destroying the fishing economy (Global Invasive Species Database, 2022). Circa 1997, ballast water imported another non-native comb jelly (*Beroe ovata*). A voracious consumer of *M. leidyi*, *B. ovata* significantly reduced the *M. leidyi* population and allowed the indigenous ecosystem to begin rebounding (Shiganova et al., 2001).

European Green Crab (*Carcinus maenas*)

Carcinus maenas (Figure 4C) eats shellfish, and its introduction to the East Coast prompted \$22 million annual losses for commercial shellfisheries. It has recently been found along the West coast, where it competes with Dungeness crabs, and is projected to cause \$0.84 million annual damages to commercial fisheries (Lovell et al., 2007).

Ballast water is one of several potential human-mediated spread vectors for the crab (Carlton and Cohen, 2003). Green crab populations can also expand rapidly when currents carry planktonic larvae to new areas (Alaska Dept. of Fish and Game, 2013; U.S. Geological Survey, 2011).

Toxic Algae (a.k.a., Harmful Algal Blooms, various species)

Dinoflagellates may go through a dormant phase of life called a ‘cyst.’ In the cyst form, dinoflagellates are difficult to render nonviable, and are easily transported from one locale to another in ballast water and associated sediments. Such transportation has led to the spread of toxic algae (Figure 4D) from Japan to Australia, including algae that causes human health problems (Hallegraeef and Bolch, 1992).

Existing Ballast Water/Aquatic Invasive Species Regulations

The United Nations International Maritime Organization (IMO) regulates ballast water on the global scale. In the United States, the USCG has established ballast water management regulations and the EPA has established the Vessel General Permit which covers multiple vessel discharges, including ballast water. These programs include prohibitions on uptake or discharge of ballast water within NPS jurisdictions. Individual states may also regulate ballast water. Regulations typically require the concentration of organisms in discharged ballast water to be below a threshold level. Vessels achieve this threshold by using a dedicated onboard treatment system, or, until the installation of such a system, vessels may use BWE to achieve a theoretical 95% reduction in transported organisms. Thresholds are summarized in Table 2.

Table 2. Numerical standards for discharged ballast water.

Regulatory Agency	Acceptable number of organisms >50 µm	Acceptable number of organisms 10–50 µm	Area of Regulatory Effect
International Maritime Organization (IMO)	<10 viable organisms/m ³	<10 viable organisms/mL	Vessels transiting international economic zones
U.S. Coast Guard regulations and EPA Vessel General Permit (VGP 2013)	<10 living organisms/m ³	<10 living organisms/mL	U.S. marine and internal waters
U.S. Vessel Incidental Discharge Act (VIDA 2018); not yet in effect	<10 viable organisms/m ³	<10 viable organisms/mL	U.S. marine and internal waters

International Regulations

The International Convention for the Control and Management of Ships' Ballast Water and Sediments, or BWM Convention, was adopted by the IMO in 2004. Under the convention, vessels are required to keep records of all ballast water taken up or released, and must adhere to two standards, D-1 and D-2. Ballast water exchange is regulated under standard D-1, and the performance of ballast water management is judged under standard D-2.

Standard D-1 requires all water exchange to be done with an efficiency of 95% by volume or pumping through three times the water tank volume. Under a different regulation (B-4), ballast water exchange must be done more than 200 nautical miles from shore, in water at least 200 meters deep. The regulations allow discharge at as low as 50 nautical miles from land in the event 200 miles is not feasible. Ballast water exchange is considered an intermediate solution, with the installation of ballast water treatment systems on most ships as the ultimate goal.

Standard D-2 requires the number of viable organisms in ballast water to be under certain limits. Ballast water released must contain less than ten viable organisms larger than 50 microns per cubic meter, and less than ten viable organisms between 10 and 50 microns per milliliter. Human pathogen “indicator organisms”, such as cholera, must also be under certain limits.

The BWM Convention entered into force in 2017. Vessels must switch from ballast water exchange to an onboard treatment system on a schedule depending on the vessel’s size and manufacture date, with new constructions required to include a treatment system immediately, and older vessels phased in at their next dry-dock appointment.

The responsibility for enforcing IMO standards rests with port officials, who may review ballast water records, take ballast water samples, and/or disallow ballast water discharge in their port.

The U.S. is not a signatory of the IMO requirements. As of 2017, signatory countries accounted for approximately 70% of global merchant tonnage (International Maritime Organization, 2017).

United States Regulations

Vessels operating in U.S. waters are subject to requirements established by the USCG and the EPA. Under the National Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990, as revised and reauthorized by the National Invasive Species Act (NISA) of 1996, the Coast Guard has established ballast water management requirements for vessels arriving to U.S. ports or places. Coast Guard ballast water requirements can be found in 33 CFR 151 Subparts C and D. Under the Clean Water Act, the EPA has established the Vessel General Permit (VGP, 2013), which includes requirements for numerous discharges, including ballast water. States may also impose their own regulations.

In 2018, Congress enacted the Vessel Incidental Discharge Act (VIDA, 2018). VIDA directs the EPA to set discharge limits for multiple vessel discharges, including ballast water, and directs the Coast Guard to establish implementing regulations to enforce those discharge limits. VIDA regulations will supersede existing state-level regulations. While VIDA directed EPA to establish the discharge standards within two years, and the Coast Guard to establish the implementing regulations within two years after the EPA regulations, the actual time frame will be longer; as of March 2022, final EPA regulations have not been issued. Until both the EPA and USCG regulations under VIDA are in place, the existing Coast Guard and EPA VGP requirements remain in effect.

Vessel General Permit (VGP, 2013)

Currently, U.S. ballast water standards are similar to international ones and apply to U.S. coastal and interior waters. They require discharged ballast water to contain less than 10 living organisms greater than 50 microns per cubic meter, and less than 10 organisms between 10 and 50 microns in size per milliliter. The specification of *living*, rather than *viable*, organisms is the key difference between the IMO and VGP standards.

Most vessels are required to meet this standard, unless the vessel’s voyage is less than 10 nautical miles in length and does not cross any physical barriers, such as a lock, or stays within one USCG

Captain of the Port zone; the vessel is an unmanned, unpowered barge; the vessel operates solely on the Great Lakes and was built before 2009; or the vessel is less than 1600 GRT (EPA, 2013).

For vessels that must adhere to VGP rules, ballast water uptake and discharge is prohibited in federally protected waters, including National Parks.

Vessel Incidental Discharge Act (VIDA, 2018)

This section summarizes the language of the Act as approved by Congress, and the EPA proposed rule made available for comment in November 2020. Please note that the final rule may differ when it is published.

The proposed rule is generally similar to the VGP and retains language prohibiting ballast water uptake and release in federally protected waters. Numerical thresholds for ballast water discharge still require there to be less than 10 living organisms per cubic meter for organisms greater than 50 microns in diameter, and less than 10 living organisms per milliliter for organisms 10–50 microns in diameter. However, the definition of “living” now excludes any organism rendered unable to reproduce (nonviable), bringing U.S. requirements in line with international ones. The EPA notes that they do not yet have a testing protocol for organism viability (EPA, 2020). VIDA also includes region-specific requirements for ballast water discharge. Regions that requested different requirements include the Great Lakes, the Pacific Coast, and Hawai’i.

Exceptions to ballast water requirements include all the exceptions listed in the VGP. Additionally, due to unique water conditions, all vessels that operate solely on the Great Lakes regardless of manufacture date are not subject to VIDA. For complete details on exceptions to numeric organism limits, please visit the Federal Register (EPA, 2020).

Current NPS Ballast Water Requirements

Under the current federal rules, vessels must avoid ballast water uptake and discharge in federally protected waters, including National Parks, except for sanctuaries focused on maritime heritage (EPA, 2020). Vessels to which the federal rules do not apply can be subjected to NPS rules. For example, vessels operating solely on the Great Lakes do not need to follow VGP rules, but parks can create and enforce ballast water rules applying to these vessels in park waters.

Parks have several options for decreasing the risk of ballast water species introductions. In addition to installing treatment systems on park vessels, parks can make use of the Superintendent’s Compendium authority to control ballast water activity within NPS waters for vessels that are not subject to federal rules. For example, the Isle Royale National Park’s Superintendent’s Compendium forbids any discharge of untreated ballast water within the park (NPS, 2021a). NPS has successfully used emergency biocide treatment systems in the past and can continue to do so (see “Emergency and Manual Treatment Systems” section of this paper). In such emergencies where a large quantity of ballast water may be released, parks can request that the incident command require treatment prior to discharge.

NPS-approved boilerplate language for Concession contracts regarding ballast water treatment is available from the NPS Concessions Division and is included in the Additional Resources section

(page 17). Parks can use this language to require concessionaire vessels to treat ballast water, and adapt it for contractor, research, and other vessels. Most recreational boating does not involve ballast water; for recreational boats that use ballast water, Superintendent's Compendium authority applies, and park law enforcement can handle violations. Though outside of NPS jurisdiction, park managers can discuss best ballast water management practices with cruise lines that pass near park waters.

Ballast water discharge is typically visible as a strong stream of water exiting a vessel's hull above the water line. Upon witnessing a ballast water infraction for vessels subject to federal regulations, NPS staff can report the violation to their park law enforcement and should call their local USCG Captain of the Port office. USCG personnel can handle vessel inspections and connect parks to the appropriate resources. Depending on which state(s) the park is in, state law may also apply, and park staff should find a state-level point of contact as well.

Suggestions for Outreach Messaging

General notes on language

“Invasive species” is defined as “an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Executive Order 13112). When discussing invasive species, especially when interfacing with the public, the use of more aggressive language may be tempting. For example, news outlets often frame invasive species as a willfully destructive enemy. However, an unemotional scientific tone and less aggressive language still engages the public (Shaw et al, 2020). Rather than using sensationalism or demonizing the organisms themselves, public engagement can be maintained by focusing on actionable items (Clarke et al., 2020) and emphasizing the role human-mediated transport plays in spreading invasive species (Shaw et al., 2020).

Calling a species “alien”, “foreign”, “native”, etc., can draw unwanted parallels to xenophobia among humans (Johnston and Shimada, 2004). The Black Environmental Network (United Kingdom) suggests the use of “indigenous” and “introduced” rather than “native” and “non-native” to reduce inflammatory connections with anti-immigration sentiment (Wong, no date). Making vocabulary changes at an institutional level requires considering how to maintain effective communication across interagency partnerships due to how these terms are defined in policy/regulation. NPS Management Policies 2006 uses “native” and “non-native”, terms used by many other organizations that do invasive species work. In the Great Lakes region, the term “non-local beings” is gaining traction (Lower and Sturtevant, 2021). Vocabulary choice is essential to reach a wide variety of individuals in an outreach audience.

Suggested talking points for interactive outreach

Essential theme questions are open-ended and serve as platforms for discussion (NPS 2018). One potential essential theme question for ballast water is, “Do humans have an obligation to consider how our activities move organisms around the world?” When discussing this question, avoid portraying a species as the villain of the story, even if discussing impacts and invasive species management. Since audience members may not remember specific facts, maintaining an overall theme of “humans move organisms around the world” without attaching negative feelings to a particular geographic location is essential.

Facilitate discussion to build the audience members’ personal connections to the topic. Because the global supply chain is largely responsible for ballast water spread of AIS, ask audience members to think about where their possessions were manufactured. Ask them follow up questions, such as “how do you think your shirt traveled from [manufacture location] to you?” Discuss how cargo ships move most of the world’s goods around, and how their ballast water can move organisms around too. Discuss invasive species, such as the sea walnut, that originated in North America and are invasive in other parts of the world, not just species from elsewhere that are invasive in North America. This will reduce xenophobic connotations to the discussion, and the “species trade” of the sea walnut to Europe and the zebra mussel to the U.S. makes for a cohesive story narrative.

For those wanting more context for what ballast water is and why it matters, discuss the Ever Given. The Ever Given is a 1300-foot-long cargo vessel that blocked the Suez Canal for a week in 2021 after foul weather and pilot errors wedged it diagonally across the canal, blocking a prolific trade route and becoming the source of countless memes and news stories (Chellel et al., 2021).

Contextualize the Ever Given in the global trade network by discussing its planned route from East Asia to Western Europe, and make it relatable by discussing its cargo, which included everyday items like shoes and laptops (Chellel et al., 2021). Ballast water plays into the Ever Given's story in several ways. Thousands of tons of ballast water were released into the Suez Canal to help re-float the Ever Given by decreasing its weight (Chellel et al., 2021; Mirza et al., 2021). Based on the Ever Given's manufacture date and information from its parent company, the Ever Given was most likely equipped with a filtration and UV ballast water treatment system (Evergreen Marine Corp, 2015). These factors can contextualize a discussion of how we prevent AIS transport without hindering global trade.

In outreach discussions, it is preferable to provide "action items" (Clarke et al., 2020); for example, discuss how the audience may avoid transporting organisms around by using boot brushes and applying Clean, Drain, Dry to their personal watercraft. Though the average park visitor has little control over ballast water in most cases, these examples will help cement personal connections between the audience and the topic.

Additional Resources

Other Agency Contacts

USCG Captain of the Port directory: <https://homeport.uscg.mil/Pages/sector-directory.aspx>

US EPA Violation Reporting: <https://www.epa.gov/report-violation>

General Information

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NPS-approved Boilerplate Language for Concession Contracts

Vessel Ballast Water Treatment Requirements for Concession Contracts:

Existing policy¹ requires measures to prevent the spread of Aquatic Invasive Species that cause economic and natural resource damage where they establish. Consistent with NPS policy, Executive Orders², and law³, NPS requires that vessels that exchange ballast water within or outside park boundaries shall be equipped with a ballast water treatment system. The treatment system shall be capable of sterilizing the water and shall be maintained in operable condition in both marine and freshwater environments. The crew shall be trained on how to use the system properly and shall utilize the system where and when appropriate. Records of all ballast water taken on, exchanged, treated, or released shall be maintained for seven (7) years, and made available for inspection as needed.

Treatment

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Ultraviolet radiation as a ballast water treatment strategy: Inactivation of phytoplankton measured with flow cytometry. Marine Pollution Bulletin 103 (1), 270–275.

Stehouwer, P. P.; Buma, A.; Peperzak, L. 2015. A comparison of six different ballast water treatment systems based on UV radiation, electrochlorination and chlorine dioxide. Environmental Technology 36 (16), 2094–2104.

Regulations

International Maritime Organization:

<https://www.imo.org/en/OurWork/Environment/Pages/BallastWaterManagement.aspx>

IMO-Approved systems: [Microsoft Word - Table of BA FA TA updated December 2019 \(imo.org\)](#)
Accessed 19 January 2022

EPA VGP and VIDA: <https://www.epa.gov/vessels-marinas-and-ports/vessel-incident-discharge-act-vida>

¹ NPS Management Policies 2006 (nps.gov)

² Executive Orders for Invasive Species | National Invasive Species Information Center

³ Vessel Discharge Permit (VGP 2013) and Vessel Incidental Discharge Act (VIDA 2018), and 36 CFR 2.1 (a)(2), which prohibits “introducing wildlife, fish or plants, including their reproductive bodies, into a park area ecosystem”

U.S. Coast Guard Ballast Water Management Type Approval Information:

<https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Commercial-Regulations-standards-CG-5PS/Marine-Safety-Center-MSC/Ballast-Water/>

Outreach

Aquatic Nuisance Task Force: “Stop Aquatic Hitchhikers.” <https://stopaquatichitchhikers.org/>.
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Photo credits

Zebra mussel: <https://www.nps.gov/mnrr/learn/nature/images/Harpers-Ferry-Zebra-Mussel-Image.jpg?maxwidth=650&autorotate=false> “HAFE NPS Photo”

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