Commercial Vessel Ballast Water Management

Report to Congress

September 30, 2022

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U. S. Coast Guard

Foreword

September 30, 2022

I am pleased to present the following report, "Commercial Vessel Ballast Water Management," as prepared by the U.S. Coast Guard in consultation and cooperation with the federal members of the Aquatic Nuisance Species Task Force and the Smithsonian Environmental Research Center.

Section 4712(f) of Title 16, United States Code, directs the submission of a report that synthesizes and analyzes the national data concerning ballasting practices of commercial vessels.

Pursuant to Congressional requirements, this report is being provided to the following:

The Honorable Maria Cantwell
Chair, Senate Committee on Commerce, Science, and Transportation

The Honorable Roger Wicker
Ranking Member, Senate Committee on Commerce, Science, and Transportation

The Honorable Peter DeFazio
Chairman, House Committee on Transportation and Infrastructure

The Honorable Sam Graves
Ranking Member, House Committee on Transportation and Infrastructure

Mr. David Miko
Co-Chair, Aquatic Nuisance Species Task Force
Assistant Director for Fish and Aquatic Conservation, U.S. Fish and Wildlife Service

Ms. Deborah Lee
Co-Chair, Aquatic Nuisance Species Task Force
Director and Great Lakes Regional Team Lead, Great Lakes Environmental Research Laboratory, National Oceanic and Atmospheric Administration

I am happy to answer any further questions you may have, or your staff may contact my Senate Liaison Office at (202) 224-2913 or House Liaison Office at (202) 225-4775.

Sincerely,

Linda L. Fagan
Admiral, U.S. Coast Guard
Commandant

Executive Summary

The Title 16 U.S. Code (U.S.C.) Section 4712(f)(4), as amended by the *Vessel Incidental Discharge Act of 2018* (VIDA), requires an annual report on the effectiveness of national ballast water (BW) management requirements. This first report has been delayed due to initial challenges in coordinating data management and analyses among various organizations including the Coast Guard and the National Ballast Information Clearinghouse (NBIC) under the oversight of the Smithsonian Environmental Research Center (SERC) as well as subsequent complications stemming from the response to the COVID-19 pandemic. This report includes separate sections that, together, cover the four years from January 1, 2017 through December 31, 2020, each of which focuses on three main elements to demonstrate the effectiveness of the Coast Guard's statutorily-directed ballast water management (BWM) regulatory program and validates that enforcement efforts continue to increase BWM and reduce the risk of introducing aquatic nuisance species (ANS) into U.S. waters. Additionally, this report provides a one-time initial retrospective overview of the national patterns of BWM and delivery over the years 1999-2018, the period prior to VIDA, during which the Coast Guard has been regulating and enforcing BW discharges by vessels nationally, and the patterns of biological invasions by marine and estuarine ANS in U.S. waters over time. Further, this report, as will future reports, provides analyses of the patterns of BW delivery and management; Coast Guard compliance and enforcement actions regarding BWM regulations; and patterns of biological invasions by marine and estuarine ANS.

Compliance trends show a significant increase in BW reporting from 33 percent in 1999-2004 to >94 percent in 2020. The analysis also shows that the volume of BW reported discharged has significantly increased in U.S. waters, from 41.9 million m^2 in 2005 to 184.2 million m^2 in 2020 for overseas BW and from 118.6 million m^2 in 2005 to 177.9 million m^2 for coastwise BW. However, the increase is not due to increasing ship arrivals, rather an increase of discharge per capita. Despite the increased volume, the percentage of overseas[1] BW discharge reported as unmanaged declined between 2005 (following establishment of mandatory BWM regulations nationally in 2004) and 2020, dropping from 25.3 percent of total discharge volume to 4.3 percent. The coastwise pattern has changed less over the same period, with approximately 90.8 percent and 46.4 percent of coastwise discharges reported as unmanaged in 2005 and 2020, respectively. Since 2015 (following the Coast Guard's establishment of a BW discharge standard in 2012), the percentage of BW discharged to the U.S. managed via an onboard ballast water management system (BWMS) increased from 1 percent to 55.7 percent for overseas BW and from 0.7 percent to 37.6 percent for coastwise BW by the end of 2020.

For the two-year reporting period covering 2017 and 2018, reporting compliance remained high; reported total volume of BW discharged in U.S. waters increased; the proportion of managed BW discharges reported was greater for overseas discharges when compared with coastwise discharges; and the proportion of discharges managed by a BWMS increased markedly.

[1] This report uses the term "Overseas BW" to refer to BW discharged to U.S. waters from ships that had transited outside of the U.S. and Canadian Exclusive Economic Zones (EEZs) (note this includes ships that transited between U.S. ports but which had to go outside the EEZ to do so, such as ships transiting between east coast and west coast ports), and the term "Coastwise BW" to refer to BW discharged from ships transiting between U.S. ports without leaving the EEZ.

For the two-year period covering 2019 and 2020, high compliance with the reporting requirement continued; BW delivery continued to increase (13 percent increase compared to the 2017-2018 period); the percent of BW discharged unmanaged continued to decline, dropping to 4.3 percent for overseas and 46.4 percent for coastwise in 2020, respectively; and the percent of BW managed by use of a BWMS continued to increase, reaching 55.7 percent and 37.6 percent for overseas and coastwise BW, respectively, in 2020.

Across 2017 and 2018, the Coast Guard conducted 16,369 BWM exams on foreign-flagged vessels. The most common deficiencies were wide-ranging, with the top-ranking deficiency in 2017 being missing or incorrect logs and records and in 2018 being inoperable BWMS. The Coast Guard imposed operational controls and marine enforcement actions on 34 commercial vessels with substandard BWM in 2017 and 2018, exercising authority to direct vessels beyond the Captain of the Port Zone (COTPZ) to perform BWM, and issue civil penalties.

For 2019, statistics on BW compliance and enforcement activities by the Coast Guard are not available due to an unintended consequence of a change to the database, which has since been resolved. For 2020 the Coast Guard conducted 7,383 port State control exams, a 9 percent decrease from 2018, reflecting the COVID-19 pandemic, and identified 108 BWM deficiencies on foreign vessels. In 2020, the Coast Guard imposed operational controls and enforcement actions on 34 commercial vessels for BWM infractions.

Given the lack of a national program to detect ANS across U.S. waters, the Coast Guard and the SERC developed an invasion-based performance measure for coastal marine waters. The National Exotic Marine and Estuarine Species Information System (NEMESIS) database identified 506 invertebrate and algal ANS that have established populations in coastal marine and estuarine waters of the continental U.S. from the early 1800s through 2020. Combined, commercial ship hull fouling (HF) and BW are a possible source for 79 percent of the coastal ANS in the continental U.S., however, most of the ANS could have been introduced by either BW or HF separately. For most species of ANS transported by commercial vessels, there is no way to distinguish between BW and HF as the principal method of transport.

During 2017 and 2018, the NEMESIS detected four novel ANS of marine and estuarine invertebrates and algae new to the continental U.S. Two out of the four ANS had BW as a possible vector and one out of the two ANS was associated with both BW and HF. The other two out of the four were associated with HF as a possible vector and not BW. During 2019 and 2020, the NEMESIS database did not discover any new ANS species with a first record of occurrence during the period. Continuing assessment of the published literature by NEMESIS discovered an additional 27 species of ANS with first records of occurrence prior to 2019, but which had not been previously recognized by NEMESIS.

In conclusion, while there are still areas for improvement in the BW program, overall the data from 1999 to present indicates significant strides over the past 30 years. There are notable changes in required reporting compliance and in the reported patterns of BWM and delivery. Between 1999 and 2018 there were significant increases in:

(1) compliance with the reporting requirement;
(2) the volume of BW discharged to the U.S.;
(3) the percent of overseas BW reported as managed; and
(4) the use of onboard BWMS to treat discharged BW.

The Coast Guard BWM program is predicted to reduce new ANS invasions by stopping the delivery of coastal organisms in BW. However, uncertainty remains about the residual risk of new invasions or secondary coastwise spread under different discharge standards (National Research Council 2011). The rate of each spread is expected to be ameliorated by BWM, but is also expected to correlate with the increases in the volume of BW discharge over time.

Ballast Water Management

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I. Legislative Language

This report responds to the language set forth in Title 16 U.S.C. Section 4712(f)(4), as amended by the *Vessel Incidental Discharge Act of 2018,* Pub. L. No. 115-282, 132 Stat. 4322 (VIDA), which reads:

16 U.S.C. § 4712. NATIONAL BALLAST WATER MANAGEMENT INFORMATION

(f) National ballast information clearinghouse

(1) In general
The Secretary shall develop and maintain, in consultation and cooperation with the Task Force and the Smithsonian Institution (acting through the Smithsonian Environmental Research Center), a clearinghouse of national data concerning-

(A) ballasting practices;

(B) compliance with the guidelines issued pursuant to section 4711(c) of this title (as in effect on the day before December 4, 2018); and

(C) any other information obtained by the Task Force under subsection (b).

(2) Ballast water reporting requirements

(A) In general
The owner or operator of a vessel subject to this chapter shall submit to the National Ballast Information Clearinghouse, by not later than 6 hours after the arrival of the vessel at a United States port or place of destination, the ballast water management report form approved by the Office of Management and Budget numbered OMB 1625–0069 (or a successor form), unless the vessel is operating exclusively on a voyage between ports or places within contiguous portions of a single Captain of the Port Zone.

(B) Multiple discharges
The owner or operator of a vessel subject to this chapter may submit a single report under subparagraph (A) for multiple ballast water discharges within a single port or place of destination during the same voyage.

(C) Advance report to States
A State may require the owner or operator of a vessel subject to this chapter to submit directly to the State, or to an appropriate regional forum, a ballast water management report form-

(i) not later than 24 hours prior to arrival at a United States port or place of destination in the State, if the voyage of the vessel is anticipated to exceed 24 hours; or

(ii) before departing the port or place of departure, if the voyage of the vessel to the United States port or place of destination is not anticipated to exceed 24 hours.

(3) Vessel reporting data

(A) Dissemination to States
On receipt of a ballast water management report under paragraph (2), the National Ballast Information Clearinghouse shall-

(i) in the case of a form submitted electronically, immediately disseminate the report to interested States; or

(ii) in the case of a form submitted by means other than electronically, disseminate the report to interested States as soon as practicable.

(B) Availability to public

Not later than 30 days after the date of receipt of a ballast water management report under paragraph (2), the National Ballast Information Clearinghouse shall make the data in the report fully and readily available to the public in a searchable and fully retrievable electronic format.

(4) Report

(A) In general

Not later than July 1, 2019, and annually thereafter, the Secretary shall prepare and submit a report in accordance with this paragraph.

(B) Contents

Each report under this paragraph shall synthesize and analyze the data described in paragraph (1) for the preceding 2-year period to evaluate nationwide status and trends relating to-

(i) ballast water delivery and management; and

(ii) invasions of aquatic nuisance species resulting from ballast water.

(C) Development

The Secretary shall prepare each report under this paragraph in consultation and cooperation with-

(i) the Task Force; and

(ii) the Smithsonian Institution (acting through the Smithsonian Environmental Research Center).

(D) Submission

The Secretary shall-

(i) submit each report under this paragraph to-

(I) the Task Force;

(II) the Committee on Commerce, Science, and Transportation of the Senate; and

(III) the Committee on Transportation and Infrastructure of the House of Representatives; and

(ii) make each report available to the public.

(5) Working group

Not later than 1 year after December 4, 2018, the Secretary shall establish a working group, including members from the National Ballast Information Clearinghouse and States with ballast water management programs, to establish a process for compiling and readily sharing Federal and State commercial vessel reporting and enforcement data regarding compliance with this chapter.

II. Background

Spurred by the negative environmental and societal impacts of the zebra mussel invasion of the Great Lakes, and evidence of an increasing number of biological invasions of other aquatic ecosystems by nonindigenous species, Congress enacted the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990[2] (NANPCA) and later the National Invasive Species Act of 1996[3] (NISA) which reauthorized and amended NANPCA. Together these statutes are referred to as NANPCA/NISA, and their purpose was to prevent and control infestations of the U.S. coastal and inland waters by nonindigenous ANS[4].

As directed by these two laws, the Secretary of Transportation, acting through the U.S. Coast Guard, established mandatory BWM regulations for the Great Lakes ecosystem, including the Hudson River north of the George Washington Bridge, and voluntary guidelines for the remainder of U.S. waters, which were later used as the basis for national mandatory BW reporting requirements[5] and BWM practices[6] established in 2004. Subsequently, the Coast Guard, under the Department of Homeland Security, published the Ballast Water Discharge Standard Final Rule (Final Rule) in March 2012.[7] The Final Rule includes requirements for BWM by ships (in Title 33 of the Code of Federal Regulations, or CFR) and requirements for type approval of BWM systems (BWMS) used to achieve the discharge standard (in Title 46 CFR). In brief, the new requirements in 33 CFR 151 subparts C and D establish BWM requirements for seagoing ships operating in U.S. waters, i.e. within 12 nautical miles (nm) of the baseline. The BWM requirements include using one or more of a suite of accepted options to manage BW:

- Use a Coast Guard approved BWMS to meet the BW discharge standard.
- Exclusively use water from a U.S. Public Water System (PWS) as BW.
- Discharge BW to a reception facility.
- Do not discharge BW inside 12 nm.
- Temporarily use a Coast Guard accepted Alternate Management System (AMS).

The requirement to use one of these options was predicated on implementation of a phased in compliance date as follows:

- New ships constructed after (keel-laying date) Dec. 1, 2013 - on delivery.
- Existing ships - first scheduled dry dock after:
  - Jan. 1, 2014 for ships with BW capacity 1500 - 5000 m3.
  - Jan. 1, 2016 for ships with BW capacity < 1500 or > 5000 m3.

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[2] Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (Pub. L. No. 101-646)
[3] National Invasive Species Act of 1996 (Pub. L. No. 104-332
[4] Aquatic Nuisance Species are defined in Pub. L. No. 104-332 as: "a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters".
[5] Final rule titled "Penalties for Non-submission of Ballast Water Management Reports". 69 FR 32864. June 14, 2004
[6] Final rule titled "Mandatory ballast water management program for U.S. Waters". 69 FR 44952. July 28, 2004
[7] Final rule titled "Standards for living organisms in ships' ballast water discharged in U.S. Waters". 77 FR 17253. March 23, 2012

Prior to its compliance date, an existing ship entering U.S. waters from outside the EEZ or the Canadian equivalent, is required to comply with requirements to conduct mid-ocean ballast water exchange (BWE), at least 200 nm from any shore. There are safety and route exemptions that result in some ships not being required to conduct BWE, due to stability concerns or coastal voyages that never exceed 200 nm from shore or do not do so for a sufficient time to conduct BWE. Section 1102(f)(1) of NANPCA/NISA directed the Secretary of Transportation to develop and maintain, in consultation and cooperation with the Aquatic Nuisance Species Task Force (Task Force)[8] and the SERC, a clearinghouse of data concerning:

- Ballasting practices;
- Compliance with the guidelines issued pursuant to section 1101(c); and
- Any other information obtained by the Task Force under subsection 1102(b).

Section 1101(c) of NANPCA/NISA contained the statutory directions to issue voluntary national guidelines on BWM practices by vessels. These guidelines and the regulations that followed included requirements for vessels to submit reports for each arrival to a U.S. port or place providing details about the ship, its BW, and its management of the BW to prevent the introduction and spread of ANS in U.S. waters. These BWM reports are required to be submitted to the NBIC.[9] Note that section 1101 of NANPCA/NISA was repealed by VIDA in 2018, but will continue in effect until such time as replacement regulations promulgated by the Secretary pursuant to VIDA enter into force.

VIDA, enacted on December 4, 2018, amended NANPCA/NISA section 1102(f) to add a subsection (4) requiring the Secretary of Transportation to submit a report to Congress annually, synthesizing and analyzing the data submitted to the NBIC for the preceding 2-year period to evaluate nationwide status and trends relating to a) BW delivery and management; and b) invasions of ANS resulting from BW. VIDA further directed the Secretary of Transportation to prepare each report in consultation and cooperation with the Task Force and SERC. This report is submitted in response to that requirement in VIDA mandating an annual report, however this first report also covers the period 2019-2020. This period of reporting was included because of delays due to challenges in coordinating data management and analyses among various organizations including the Coast Guard and the NBIC under the oversight of the SERC. Additionally, there were subsequent complications stemming from the response to the COVID-19 pandemic. The Coast Guard felt it was more expedient to include the various annual reporting periods in one report versus two separate reports.

The data used in this report regarding status and trends in BWM are from the database of BWM reports submitted to the NBIC. The NBIC was collaboratively established by the Coast Guard and SERC to collect, analyze, and synthesize information and data regarding compliance with BW reporting requirements, and patterns of BW delivery and management throughout the country. The NBIC prepares and submits to the Coast Guard an annual report on the status and trends of BWM by commercial vessels in the U.S. To determine rates of compliance with the reporting requirement, the NBIC uses "qualifying" arrivals as indicated by the Coast Guard's database of Advance Notice of

[8] Under NISA (Section 1201), the Task Force is comprised of the Director of the U.S. Fish & Wildlife Service; the Under Secretary of Commerce for Oceans and Atmosphere; the Administrator of the Environmental Protection Agency (EPA); the Commandant of the U.S. Coast Guard; the Assistant Secretary of the Army (Civil Works); the Secretary of Agriculture; and the head of any other Federal agency that the Chairpersons deem appropriate. The Director and Undersecretary serve as co-chairpersons

[9] The SERC manages the NBIC database of information regarding BWM and discharge by vessels in the U.S. Webpage: https://nbic.si.edu/

Arrival (ANOA), information collected and maintained by the Coast Guard's National Vessel Movement Center (NVMC). These arrival reports are compared with BWM reports to determine the proportion of arriving vessels that submit the BWM reports.

The data used in this report, regarding Coast Guard compliance and enforcement efforts, come from the Coast Guard's Office of Commercial Vessel Compliance and Office of Investigations and Casualty Analysis. The data reflect compliance and enforcement activities conducted by Marine Inspectors and Vessel Examiners in Coast Guard Sectors throughout the U.S.

The data used in this report regarding status and trends of invasions of ANS in marine and estuarine habitats of the U.S. resulting from BW are drawn from the NEMESIS database, created and maintained by SERC. NEMESIS provides comprehensive information on the distribution of approximately 500 invertebrates[10], protists[11] and algae[12] that have established populations in the marine and estuarine waters of North America. The database includes information on when, where, and how species were introduced, as well as their global (native and non-native) distributions. The database also summarizes key information on the biology, ecology, and known impacts of each species. The information in the NEMESIS database comes from ongoing reviews of the scientific literature, and thus reflects the reports of invasions that result from independent research. There is currently no systematic nationwide effort at the federal level to survey and assess patterns and trends in biological invasions of aquatic ecosystems in the U.S. While many different federal agencies conduct surveys of aquatic organisms for many specific purposes, including detection of new invasions and monitoring established populations of ANS, these efforts are not coordinated or standardized and are not sufficient to contribute to a comprehensive assessment of invasion rates in U.S. ecosystems. There are several databases focusing on different groups of biota. SERC makes a diligent effort to review the scientific literature for new reports on marine and estuarine waters, but the current NEMESIS database should not be considered comprehensive or definitive.

[10] Animals without vertebrae; e.g., crabs, worms, snails, corals, etc.
[11] Organisms that are single-celled and not bacteria, animals, plants or fungi; e.g., amoebae, ciliates.
[12] Non-flowering photosynthetic multicellular aquatic organisms; e.g., seaweeds.

III. Status and Trends in Ballast Water (BW) Delivery and Management

A. Overview (1999 – 2018)

This analysis of status and trends of BW delivery and management covers the coastal and inland regions of the U.S., including the Great Lakes. This report uses the term "Overseas BW" to refer to BW discharged to U.S. waters from ships that had transited outside of the U.S. and Canadian EEZ (note, this includes ships that transited between U.S. ports but which had to go outside the EEZ to do so, such as ships transiting between east coast and west coast ports), and the term "Coastwise BW" to refer to BW discharged from ships transiting between U.S. ports without leaving the EEZ. Thus, "overseas" and "coastwise" are not synonymous with "foreign" and "domestic", respectively (see Box 1).

Box 1. Definitions/Descriptions of Vessels, Arrivals, and BW Delivery Types

Vessels refer to unique vessels with unique identification numbers (e.g., IMO, U.S. Coast Guard Number).

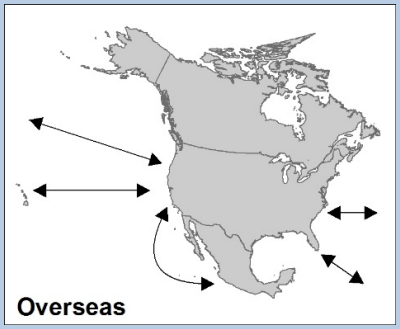
Arrivals refer to ports or places of call that a vessel makes. As such, a single vessel may report multiple arrivals during a year.

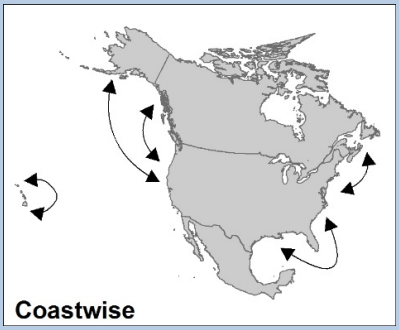
Overseas Arrivals are defined as arrivals directly after operating anywhere beyond the combined U.S./Canadian EEZs. An Overseas Arrival designation is not related to the country where a ship is registered or owned (e.g., not related to U.S. or foreign flag designation).

Coastwise Arrivals are defined as arrivals directly from last ports or places of call inside the combined U.S./Canadian EEZs. Importantly, a vessel must also remain within the combined U.S./Canadian EEZs prior to arrival to be considered a coastwise arrival. A Coastwise Arrival designation is not related to the country where a ship is registered or owned (e.g., not related to U.S. or foreign flag designation).

Overseas BW Discharge is defined as ballast water that originates anywhere beyond the combined U.S./Canadian EEZs, which is then discharged into waters of the U.S. Note: because this designation is defined by the BW's place of origin, Overseas BW can be present in BW tanks on both Overseas and Coastwise arrivals.

Coastwise BW Discharge is defined as ballast water that originates inside the combined U.S./Canadian EEZs which is then discharged into waters of the U.S. Note: because this designation is defined by the BW's place of origin, Coastwise BW can be present in BW tanks on both Overseas and Coastwise arrivals.





The Coast Guard's regulatory program stipulates compliance with mandatory BW reporting requirements. Reporting compliance rates were estimated by comparing the number of *bona fide* ballast water management reports (BWMR) received by the NBIC with the number of "qualifying" arrivals as indicated by the Coast Guard's database of ANOA, information collected and maintained by the Coast Guard's NVMC. The ANOA data track arrivals of ships calling on ports and places in the U.S., and the NVMC was established by the Department of Transportation in connection with the Coast Guard (later in the Department of Homeland Security) to track most commercial seagoing vessel movements in the country.

Because the NBIC and the NVMC were created to serve different purposes, they have separate reporting requirements. The resulting data sets share many vessels in common, but NVMC also includes reports on additional types of vessels. Thus, to establish appropriate comparisons, the NBIC applied a variety of quality control and assurance protocols to standardize vessel and arrival location information in both data sets, to identify vessels required to report to both entities, and to assign only one BWMR or ANOA of record for each arrival.

Prior to 2004, when NVMC data were first made available to the NBIC, the number of "qualifying" overseas arrivals was determined using the U.S. Foreign Waterborne Transportation Statistics maintained by the Department of Transportation's Maritime Administration (MARAD). The MARAD database is composed of overseas and coastwise arrivals to U.S. ports. The NBIC used the overseas arrivals data from MARAD and applied a series of standardized queries to characterize the population of qualifying overseas arrivals and estimate compliance rates through comparisons with BWMRs received by the NBIC (see Section VI for details on reporting compliance estimation).

Accurate estimates of BW delivery and management are not possible for coastwise BW discharged to the inland waters of the U.S. by non-seagoing vessels, because at present there are no comprehensive data sources describing coastwise inland vessel movements and arrivals within the inland waterways of the U.S. Although vessels arriving to coastal ports are required to submit an ANOA to the Coast Guard, no such report or similar notification is required of many vessels transiting exclusively between ports of the U.S. inland waterway system.

Since establishing the BWM initial reporting requirement for the Great Lakes in 1993, the Coast Guard has made several changes to the required information to be included in a BWMR. These changes reflect increased understanding over time of the information necessary to best track reporting compliance and patterns of BWM and delivery.

During the period of record (1999 – present) for the NBIC following establishment under NISA, which was enacted in 1996, there have been notable changes in compliance with reporting requirements and in the reported patterns of BWM and delivery. Between 1999 and 2018 there were significant increases in:

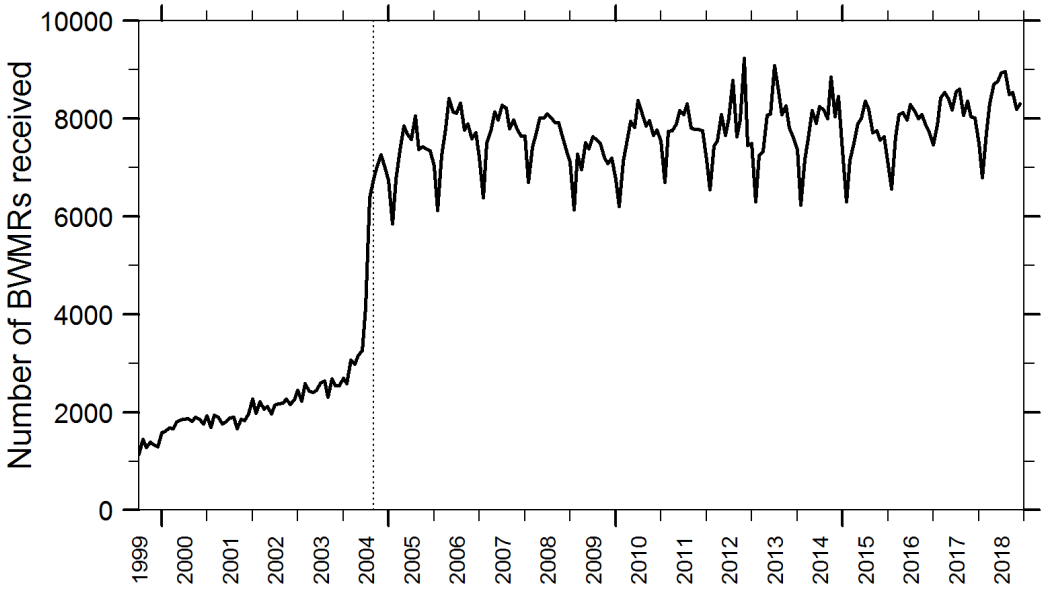
- Compliance with the reporting requirement;
- The volume of BW discharged to the U.S.;
- The percent of overseas BW reported as managed; and
- The use of onboard BWMS to treat discharged BW.

Additional details regarding each of these findings, and discussion of the implications for reducing the risks of introducing aquatic invasive species in BW are provided below.

1. There has been a significant increase in compliance with the BWM reporting requirement.

Numbers of BWMRs submitted were initially low following the establishment of the reporting requirement in 1999; approximately 1,318 reports per month were filed during the period July-December 1999. In 2004, the Coast Guard established penalties for non-submission of mandatory BWMRs. In 2005, the number of qualifying report[13] submissions increased greatly, to 87,348 per year, and rose steadily to 98,500 in 2018 (Figure 1).

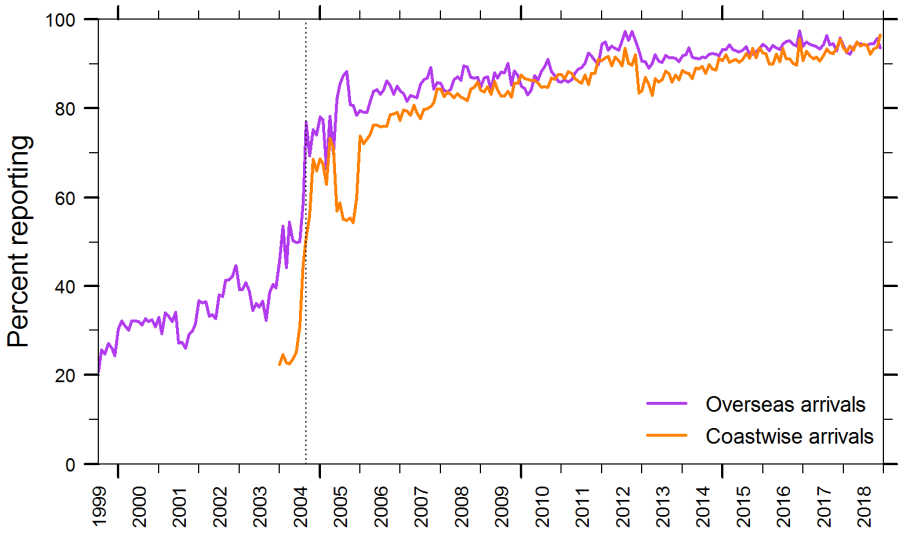
Figure 1. Number of BWMRs received monthly by the NBIC (July 1999 – December 2018). The dotted vertical line indicates when the BWM regulations imposed penalties for non-reporting and the expansion of mandatory reporting to include vessels making coastwise arrivals.



This increase in reporting is reflected in the percent compliance with the reporting requirement, which increased from approximately 33 percent in the period 1999 – 2004 to 79 percent in 2005, and to approximately 94 percent in 2018 (Figure 2). The approximately 6 percent noncompliance is not attributable to any one issue, but instead reflects a number of factors, including uncertainties on the part of vessel owner/operators in determining which vessels are required to submit reports. Increased reporting compliance has improved the comprehensiveness of the NBIC database. With greater than 90 percent of vessel arrivals reporting details for BWM practices and discharges, the NBIC is much better able to characterize nationwide patterns in management and discharge.

[13] Excluding duplicate, amended, and spurious submissions

Figure 2. Percent reporting by overseas and coastwise arrivals when compared to the corresponding number of qualifying arrivals of the respective arrival types (see Box 1). Percent reporting determined per month by comparison of NBIC reports to early notices of arrival received by the NVMC. The dotted vertical line indicates when BWM regulations imposed penalties for non-reporting and the expansion of mandatory reporting to include vessels making coastwise arrivals.



2. There has been a significant increase in the volume of BW discharged to the U.S.

From 1999 to 2018, there was a substantial increase in the volume of BW discharge reported to the U.S. This reflects both the observed increase in reporting compliance discussed above, and an additional genuine increase in the volume of BW transported to U.S. ports and places. Increased BW discharges are likely due to multiple factors, including escalating ship sizes and changes in global maritime trade patterns (e.g., increased grain and fossil fuel exports with corresponding increases in BW discharged by these exporting ships). Importantly, this increase in the volume of discharged BW was not due to an increase in the number of ship arrivals (Figure 2), but was instead produced by an increase in the per capita discharge of ships (Figure 3). The total reported overseas BW discharge increased[14] >290 percent from 41.9 million m3 (2005) to 164.3 million m3 (2018) (Figure 4).

[14] Throughout this report all measures of percent change compared to estimates from earlier time points are the relative percent change, i.e., $\% \, Change = \frac{Final - Initial}{Initial} \times 100\%$.

Figure 3. The per capita discharge volume of discharging arrivals from 2005 – 2018. The monthly mean discharge volume (shaded area is the 95 percent Confidence Interval) by vessels discharging A. overseas and B. coastwise ballast water.

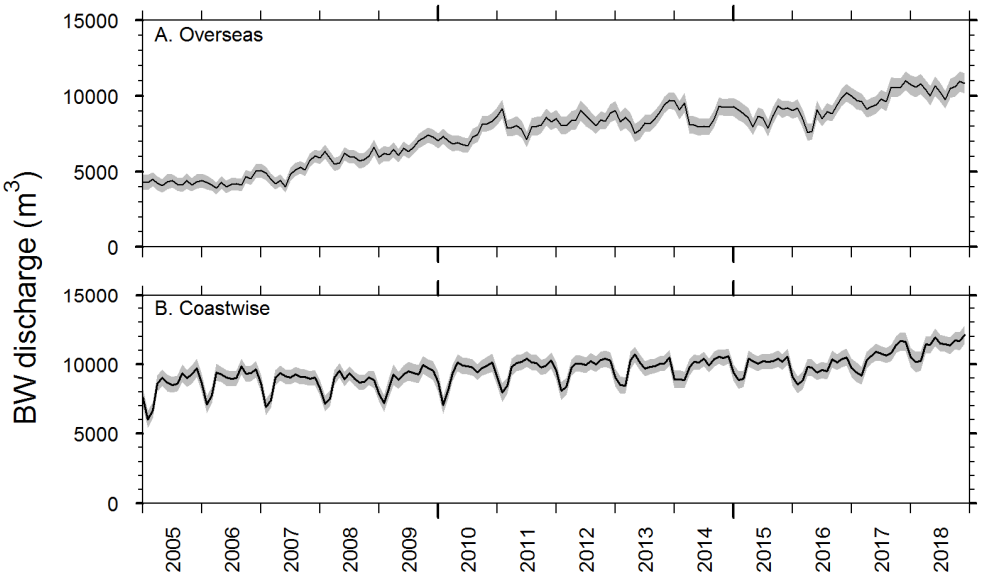
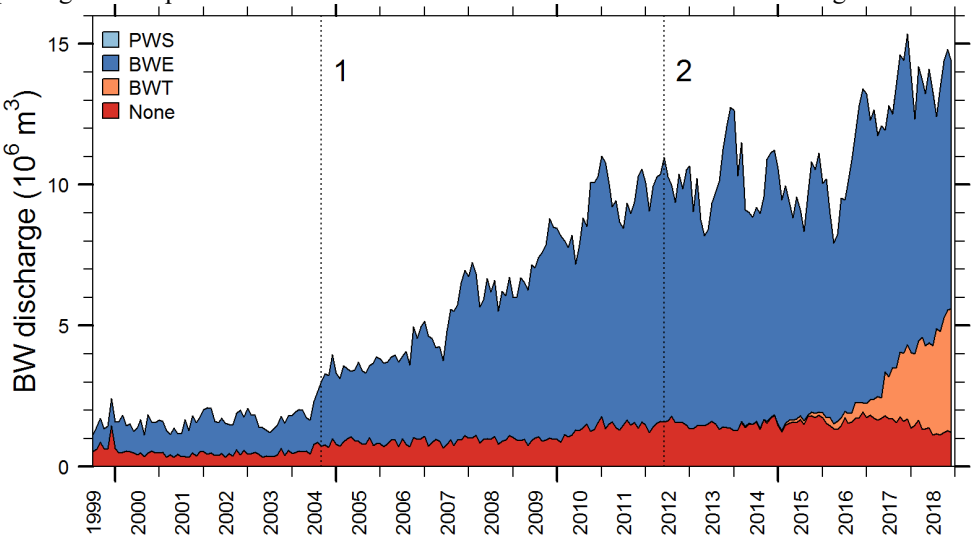
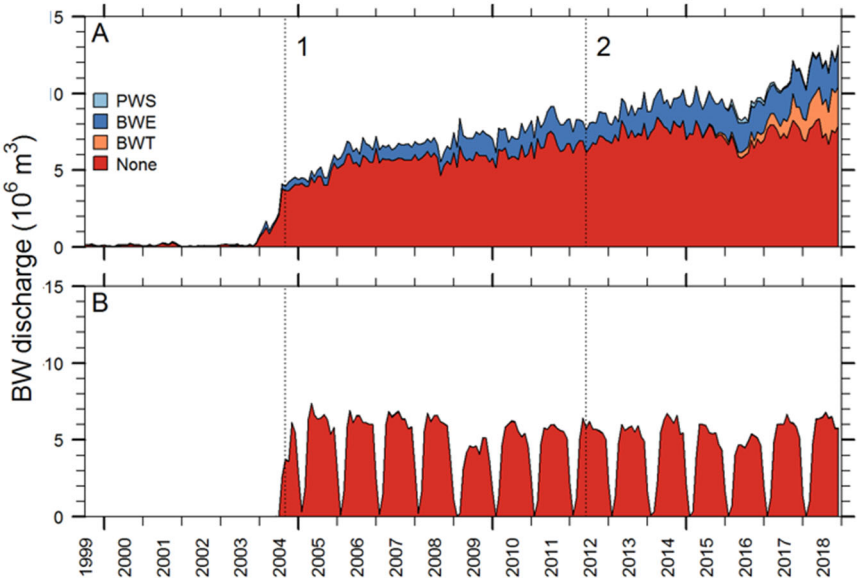


Figure 4. Monthly reported discharge of BW that originated from overseas (1999 – 2018), by type of BWM (i.e., PWS: BW from a U.S. PWS, Ballast Water Treatment (BWT): BW Treatment, BWE: BW Exchange, None: no BWM was reported) (see Table A-1 for reporting details). 1: Penalties for non-reporting were imposed. 2: Coast Guard established concentration-based discharge standards.



The total reported coastwise discharge volume increased from 118.6 million m3 (2005) to 200.9 million m3 (2018). The proportion of reported coastwise discharge that required BWM rose from 48.8 percent (57.9 million m3) in 2005 to 71.8 percent (144.2 million m3) in 2018, a 149 percent volumetric expansion (Figure 5A). At the same time, the volume of coastwise discharge that is exempt from management by regulation has remained relatively stable, averaging 53.9 ± 1.34 million m3 per year (mean ± standard error of the mean) (Figure 5B). This discharge is dominated by vessels operating on the Great Lakes and oscillates seasonally as shipping on the Great Lakes declines greatly during the winter.

Figure 5. Monthly reported coastwise discharge from vessels (July 1999 – December 2018) by type of BWM (i.e., PWS: BW from a U.S. PWS, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported) (see Table A-1 for reporting details). A. Coastwise discharge to Coastal regions. B. Coastwise discharge to inland regions (i.e., the Great Lakes and rivers), most of which is by non-seagoing vessels, which are currently exempt from BWM requirements. 1: Coastwise Arrivals required to report to the NBIC and penalties for non-reporting were imposed. 2: Coast Guard established concentration-based discharge standards.



3. There has been a significant increase in the percent of overseas BW discharge that is managed.

Despite an increased discharge volume, the percentage of overseas BW discharge reported as unmanaged declined between 2005 and 2018, dropping from 25.3 percent of total discharge volume (10.6 million m^3) to 9.6 percent (15.8 million m^3) (Figure 4). For coastwise discharges not exempted from BWM requirements, the pattern has changed less between 2005 and 2018, with approximately 90.8 percent and 62.7 percent of coastwise discharges reported as unmanaged in 2005 and 2018, respectively (Figure 5A). This difference between management of overseas and coastwise BW is largely explained by the fact that the only management option practicably available to ships was BWE during most of this time period[15]. However, because coastwise BW is not carried outside of the U.S. EEZ, there is no opportunity for BWE beyond 200 nm, as required by federal regulation. Following the 2012 Final Rule, the suite of practical BWM practices expanded beyond BWE, to include the use of BWMS, and to a lesser degree, the use of potable water from U.S. PWS. Vessels operating solely within Inland Waters, including the Great Lakes, are not required to manage their BW, and thus remain a possible vector for secondary spread. Over the period 2009 – 2018, the proportion of coastwise BW subject to BWM requirements reported as discharged without management has averaged 77.5 percent. Recent short-term changes in this pattern are discussed in section 4, below.

These upward trends in BWM suggest increased protection from new ANS introductions, but increases to overall discharge volumes must be also considered. Specifically, even when discharge standard concentrations are achieved, the overall discharge of living organisms scales with the

[15] The first Independent Laboratory for testing BWMS was accepted by the Coast Guard on July 3, 2012, four months after the 2012 BW Discharge Standard Final Rule was published. The first type approval of a BWMS was issued by the Coast Guard on December 2, 2016, after publication of the Final Rule.

magnitude of BW volume discharged. Thus, although the risk of invasion is lessened with BWM, the residual risk of ANS introduction is not zero and is offset, to some degree, by increased BW discharge.

4. There has been a significant increase in the use of BWMS to manage discharged BW.

Between 2015 and 2018, the percentage of overseas BW discharged to the U.S. managed via an onboard BWMS increased from 1 percent to 24.6 percent (Figure 4) and the percentage of discharged coastwise BW requiring management that was managed with a BWMS increased from 0.7 percent to 17.1 percent (Figure 5A). This increase in the use of a BWMS to manage BW is due to the increased availability of both Coast Guard type approved (CGTA) BWMS and temporarily accepted AMS (AMS; BWMS approved under the International Convention for the control and management of ships' ballast water and sediment (BWM Convention; International Maritime Organization, 2004), but not by the Coast Guard) over the period 2012 – 2018. In part, this reflects the passage of sufficient time for a substantial number of vessel owners to complete the technically complicated installation of BWMS on new and existing vessels. As of December 31, 2018, 3,324 vessels reported the installation of onboard BWMS, of which 454 were Coast Guard Approved and 2,870 were AMS.

B. Period of Record 2017 and 2018.

The statutory period of record directed in VIDA for this report is a two-year period; this first report covers January 1, 2017 to December 31, 2018. This report summarizes these two years and also provides summaries, but not discussion, of data from 2015 and 2016 for immediate temporal context. The patterns of BW reporting and management for the two-year period generally reflect the patterns described in prior sections. Over the period 2017 – 2018:

- Reporting compliance by vessels remained high;
- The total volume of BW discharged increased compared with previous years;
- The percent of BW discharges reported as managed was greater for overseas discharges than for coastwise discharges;
- The proportion of discharges managed by the use of a BWMS increased rapidly; and
- The Coast Guard conducted a significant number of BW compliance and enforcement actions on commercial vessels.

These findings are discussed in greater detail below.

1. Compliance by vessels with the BW reporting requirement remained high in 2017 and 2018.

The NBIC received 95,437 and 98,500 BWM reports of record in 2017 and 2018, respectively, for a national two-year average of 96,969 reports per year. Overseas arrivals accounted for approximately 42 percent of arrivals in both years. The East and Gulf coasts received the most reported overseas arrivals, with two-year averages of 14,622 per year and 14,089 per year, followed in order by the West coast (6,413 per year), Caribbean territories (3,714 per year), Pacific Islands (1,372 per year), and Alaska (213.5 per year) (Figure 6A). For the East and Gulf coasts, these numbers document a slight increase in arrivals from the prior two years. When compared to NVMC arrivals, these overseas reports reflect greater than 94 percent compliance with the BW reporting requirement, nationally, over the two-year period 2017-2018 (Figure 2). The West coast (99.4 percent) and Alaska (96.5 percent) have the highest two-year averages for compliance with reporting requirements followed by

the Gulf (95.7 percent) and East (93.5 percent) coasts, Hawaii (88.9 percent), Guam (87.3 percent), Caribbean territories (86.8 percent) and the Great Lakes (74.8 percent) (Figure 7A).

The comparison of 2017 – 2018 coastwise BWM reports to NVMC coastwise arrivals for applicable locations and vessel traffic reflect greater than 93 percent compliance with the reporting requirement, nationally (Figure 2). The East, Gulf, and West coasts received the most coastwise arrivals, with respective two-year averages of 19,438 per year, 15,438 per year, and 8,973 per year (Figure 6B). Compliance with the reporting requirements during the 2017 – 2018 period was highest on the West coast (95.7 percent) followed by the East (93.4 percent), the Gulf (91.8 percent), and Alaska (91.6 percent) (Figure 7B).

Figure 6. Discharge and management status of U.S. arrivals by coastal region (2015 – 2018). Discharge and management status of A. Overseas and B. Coastwise arrivals designated according to number of BWMRs received by NBIC for each coastal region. For the purposes of this report, the Great Lakes and Inland Waterways are exempt from BWM for coastwise movement of BW. Note: Other than the Inland region for overseas arrivals, all other categories have values that may not be visible because of the scale.

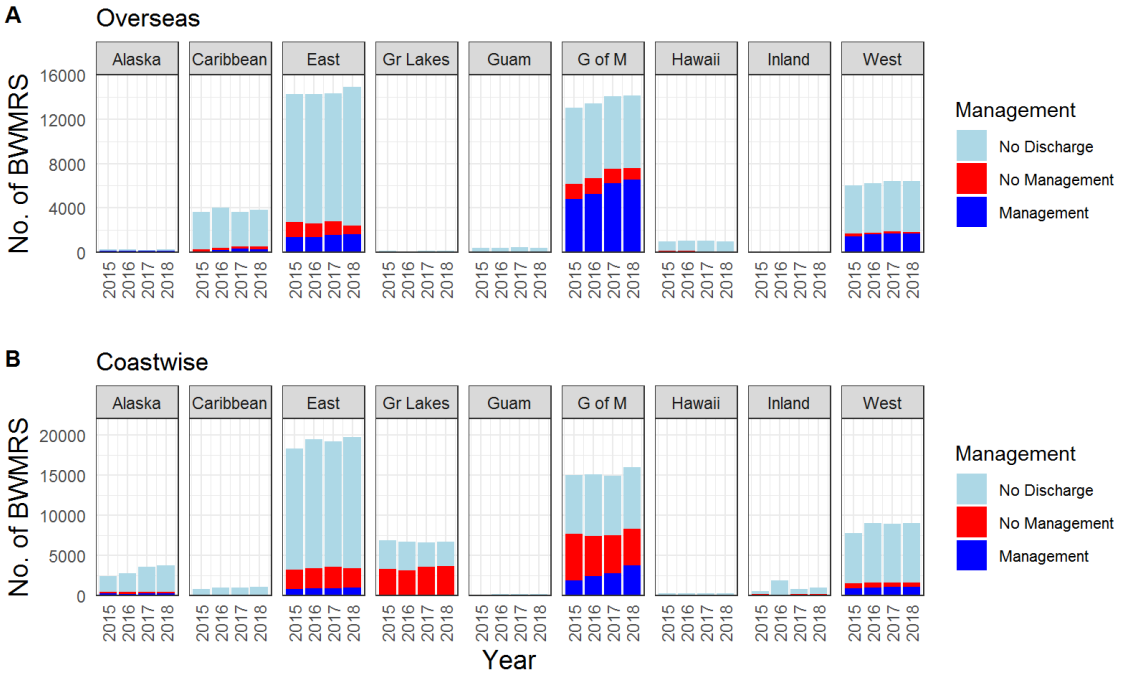
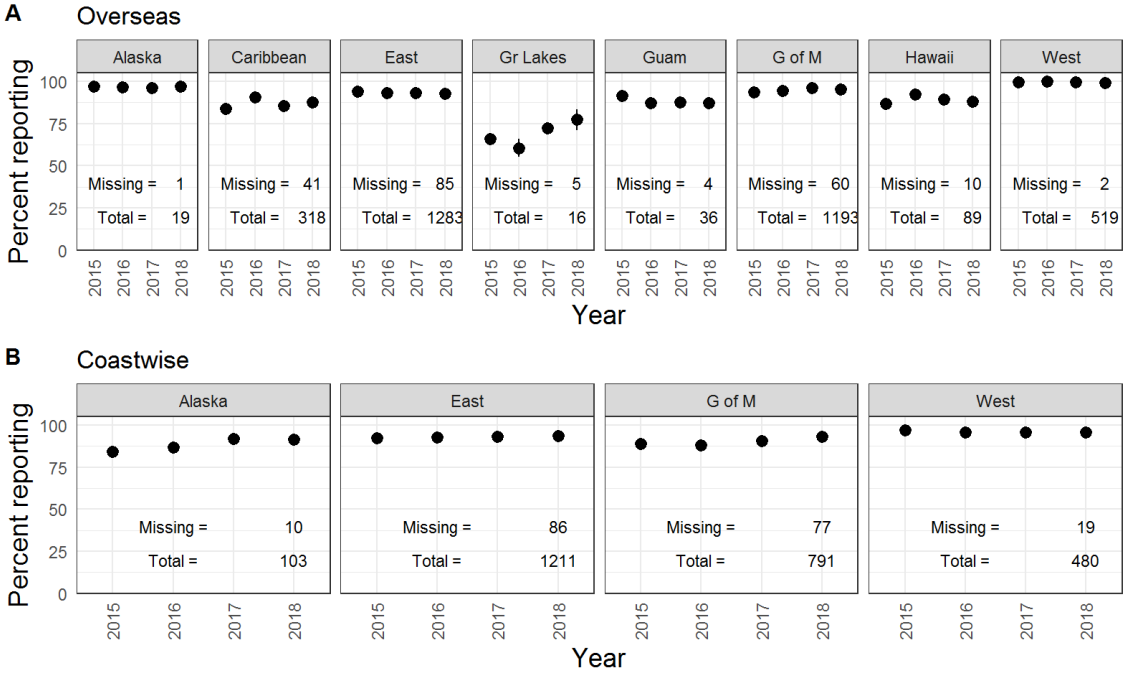


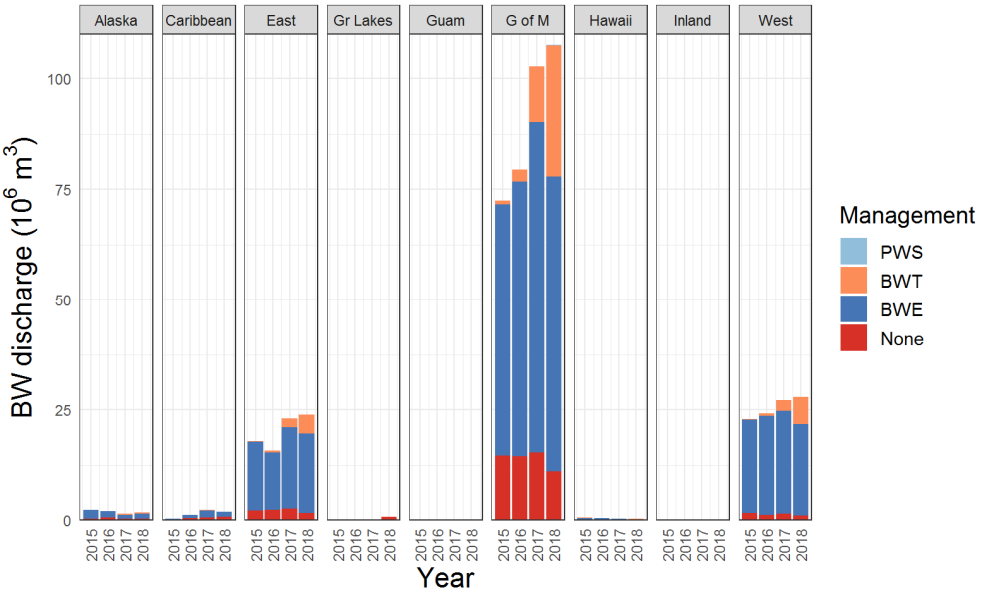
Figure 7. Compliance with reporting requirements of arrivals by coastal region (2015 – 2018). The percent reporting (± 1 standard error of the mean) by year and coastal region of A) overseas and B) coastwise arrivals as compared to ANOA submitted to NVMC. The mean monthly number of BWMRs that were missing and the mean monthly number of ANOAs are presented for each region. Note: Percent reporting for coastwise traffic is not estimated for all coastal regions because they are largely comprised of vessels operating within a single COTPZ or are populations that do not have an appropriate standard to compare against.



2. Reported total discharge volume is increasing.

Cumulatively, vessels arriving to U.S. ports and places reported discharging 157.2 and 164.3 million m^3 of overseas BW in 2017 and 2018, respectively (Figures 4 & 8), and 184.3 and 200.9 million m^3 of coastwise BW in 2017 and 2018, respectively (Figures 5 & 9). This reflects an increase in average yearly discharge of 33.7 percent for overseas discharges and 21.2 percent for coastwise discharges, as compared to the prior two-year period (2015 and 2016).

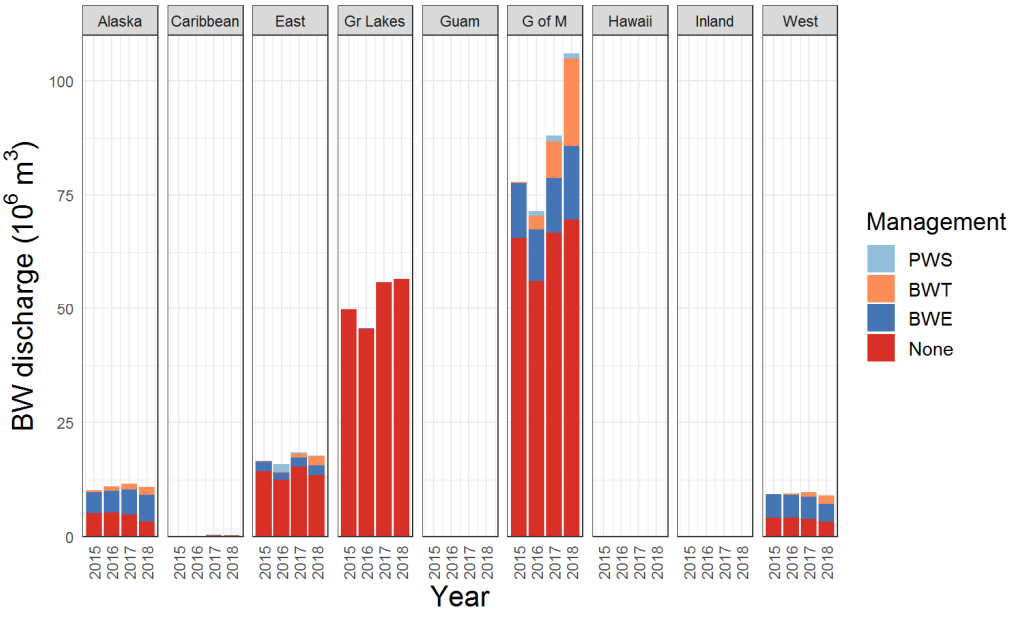
Figure 8. Total reported discharge of BW that originated overseas in 2015 – 2018 by type of BWM (i.e., PWS: BW from a U.S. PWS, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported) and coastal region.



3. The proportion of discharging arrivals that managed their BW is greater for overseas dischargers than for coastwise dischargers.

The proportion of discharging arrivals that managed their BW discharge by use of an approved method (BWE, BWMS, AMS, or PWS) was much greater for overseas arrivals in 2017 and 2018—76.1 percent and 81.4 percent, respectively (Figure 6A)—than for coastwise arrivals by seagoing vessels in those same years—38.5 percent and 44.3 percent, respectively (Figure 6B). Of the overseas BW that was reported as being managed prior to discharge, the greatest proportion was reported as having been exchanged in both 2017 (87.2 percent) and 2018 (72.7 percent) (Figure 8). Compared to overseas BW, exchanged water constituted a much smaller proportion of managed coastwise BW discharged by seagoing vessels in both years—65.4 percent and 51.7 percent, respectively (Figure 9). While BWE is not required for coastwise BW discharge under Coast Guard regulations, other regulatory authorities do require BWE (e.g., California regulations and the EPA Vessel General Permit (VGP) require BWE beyond 50 nm by certain vessels on coastwise transits), and the Coast Guard requires reporting of all uptake and discharge of BW. By definition, coastwise ship transits do not go beyond the EEZ, and so do not have the opportunity to conduct BWE beyond 200 nm, which is the requirement for BWE under the regulations in 33 CFR 151, subparts C and D.

Figure 9. Total reported discharge of coastwise BW 2015 – 2018 by type of BWM (i.e., PWS: BW from a U.S. PWS, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported) and coastal region.



The disparity between the proportions of regulated overseas and coastwise BW that are managed will remain significant until BWM methods other than conducting BWE beyond 200 nm become available for vessels carrying coastwise BW, as such, vessels do not transit beyond 200 nm. BW carried by non-seagoing vessels, and particularly those vessels that operate exclusively among the Great Lakes (Lakers), will continue to be unmanaged until practicable methods are available for such vessels to meet BWM requirements. Under the 2012 Final Rule,[16] non-seagoing vessels were exempted from the requirement to manage BW prior to discharge. The Coast Guard noted in the Final Rule its intent to expand the applicability of the regulation to non-seagoing vessels following additional analysis and research, particularly on the availability of technology that can be practicably installed, the cost of such technology, and the benefit of requiring such vessels to manage BW. Notably, VIDA includes a provision for the Great Lakes and Lake Champlain Invasive Species Program to investigate this issue.

4. The percent of overseas BW discharges managed by the use of a BWMS increased rapidly.

The volume and percentage of overseas discharge reported as undergoing management by use of an onboard BWMS increased from 1.2 million m^3 (1 percent) in 2015 to 17.4 million m^3 (11.1 percent) in 2017, and reached 40.5 million m^3 (24.6 percent) in 2018 (Figures 4 and 8). For coastwise discharge from seagoing vessels, the proportion also increased, from 11.2 million m^3 (8.7 percent) in 2017 to 24.6 million m^3 (17.1 percent) in 2018 (Figures 5A and 9).

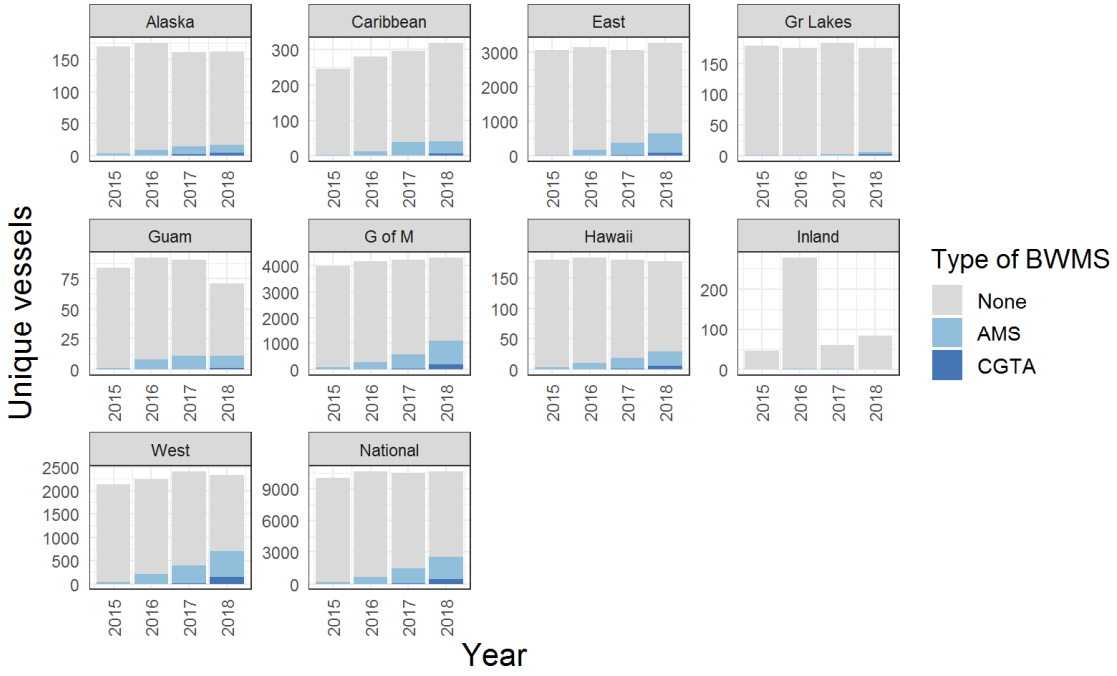
The number of unique vessels submitting BWM reports to the NBIC remained relatively stable in 2017 (10,490 vessels) and 2018 (10,621 vessels), yet the proportion of vessels with an onboard BWMS increased from 13.7 percent to 23.7 percent (Figure 10). The number of vessels with CGTA BWMSs installed increased from 44 to 440 between the beginning of 2017 and the end of 2018. The number of vessels with an AMS increased from 1,392 to 2,080 during this same two-year time period.

[16] Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters, 77 Fed. Reg. 17253 (Mar. 23, 2012).

Over the two-year period, AMS were installed at a higher rate than Coast Guard approved BWMS (63.5 percent and 36.5 percent, respectively), likely reflecting the circumstance that the relative number of Coast Guard approved systems was still quite low compared to BWMS approved under the convention.

PWS water was used infrequently as a method of BWM (454 BWM reports and 0.9 percent of total volume); vessels using this method were primarily in the Gulf of Mexico (78 percent) and on the East coast (18 percent) (Figures 8 and 9). No vessels reported discharge to a BW treatment facility during the two-year period.

Figure 10. Number of unique vessels in 2015 – 2018 with BWMSs. The unique vessels that reported having a CGTA BWMS, an AMS, or no BWMS (None), by year.



5. Coast Guard conducted a significant number of compliance and enforcement activities.

The 2012 Final Rule established a BW discharge standard, and became effective in June 2012. Beginning January 1, 2016, the implementation schedule for installing BWMS began, and both existing and new vessels were required to begin installing and using BWMS type-approved by the Coast Guard or adopt one of the other compliance options. This rule change initiated the phase-out of BWE as the primary method for BWM in the U.S. The following two sections summarize Coast Guard compliance and enforcement actions for foreign vessels operating in U.S. waters in 2017 and 2018. Future reports will include comparable statistics for domestic vessels subject to the BWM requirements.

a. 2017: The Coast Guard conducted 8,229 BWM exams on foreign flagged vessels in 2017, an increase of 1.9 percent compared to 2016, and deficiencies doubled from 110 to 219 over the period. The most common deficiencies were related to missing or incorrect logs/records (22 percent), unacceptable use of an AMS (18 percent), failure to conduct mandatory practices (18 percent), and the discharge of unmanaged BW into waters of the U.S. (17 percent). Consequently, the Coast Guard imposed operational control restrictions on 17 vessels due to the

severity of deficiencies and required some of these vessels to leave port in order to comply. These 17 vessels received sanctions ranging from warnings, Notices of Violation, and Administrative Civil Penalty (Class I) actions for failure to implement BWM requirements.

Common issues found in the deficiency cases were lack of familiarity and training on the use of a BWMS, on the use of a BWM plan specific for the vessel, and on implementation of a BWM strategy. In some cases, the Coast Guard found that the BWMS was only used during voyages to the U.S. and that crews received little or no training in operating and maintaining the system. For a BWMS to operate reliably, it must be used regularly and in accordance with the manufacturer's specifications. This improves crew operational knowledge of the BWMS, its reliability, and reduces the potential for ballast tanks to become contaminated with untreated BW. Furthermore, the BWM plan should include routine shipboard operations and contingencies for those situations when compliance with the BWM requirements using a preferred or primary method is not possible.

b. 2018: In March, 2018, the Coast Guard published Navigation and Vessel Inspection Circular (NVIC) 01-18 to provide additional guidance to the maritime industry and Coast Guard personnel on the Coast Guard's BW regulatory requirements. Additionally, the Coast Guard Office of Commercial Vessel Compliance released CG-CVC Policy Letter 18-02, which clarified actions to be taken in the event that a ship's BWMS becomes inoperable. Both documents are important for understanding the U.S. Coast Guard's BWM regulations. It is also important for owners and operators of foreign-flagged vessels to realize that the United States is not signatory to the BWM Convention, and has separate requirements and compliance schedules.

The Coast Guard conducted 8,140 BW exams on foreign flagged vessels in 2018, similar in scope to 8,229 conducted in 2017. In 2018, the Coast Guard identified 119 BWM deficiencies, a 54 percent reduction from 2017. The most common deficiencies were related to inoperable BWMS (34 percent), various issues related to conducting BWE as required (14 percent), the discharge of unmanaged BW into waters of the U.S. (14 percent); and failure to submit reports (11 percent). Consequently, the Coast Guard imposed operational control restrictions on 17 vessels due to the severity of deficiencies/noncompliance. The Coast Guard issued 2 Letters of Warning, 8 Notices of Violation, and 11 Administrative Civil Penalties (Class I) to non-compliant vessels for failure to implement BWM requirements in 2018.

The majority of operational controls issued to vessels were for inoperable BWMS or failure to employ one of the approved BWM methods as per 33 CFR 151.2025. These cases were handled on a case-by-case basis subject to the discretion of the Coast Guard Captain of the Port. In most cases, vessels were required to modify their cargo loading plan to facilitate safe and compliant BW discharges to be conducted offshore beyond the territorial sea (12 nm). As noted for 2017, many of the Coast Guard interventions associated with BWMS were attributed to vessel crews not actively using the system when trading outside U.S. waters. In the NVIC 01-18, the Coast Guard encourages vessel operators subject to the International Safety Management Code to include BWMS into their vessel's Safety Management System (SMS) and continue to use the SMS to maintain crewmembers' proficiency in using this equipment.

C. Period of Record 2019 and 2020.

This section provides a summary of the status and trends for BWM covering the two-year period 2019 and 2020. As for the preceding section covering 2017 and 2018, data are also shown for preceding years for context. During the period 2019 and 2020:

- Compliance by vessels with the BW reporting requirement continued to be high;
- The total volume of discharged BW continued to increase, before dropping due to the COVID-19 pandemic;
- The percent of discharged overseas BW that is managed remained high, and continued to increase; the percent of discharged coastwise BW that is managed continued to increase, but at a slower rate than overseas;
- The use of onboard BWMS continued to increase rapidly; and
- The Coast Guard continued to conduct BWM compliance assessments on a significant number of vessels, and take enforcement actions when warranted.

These trends are explained in greater detail below.

1. Compliance by vessels with the BW reporting requirement remained high in 2019 and 2020.

The NBIC received 97,841 and 84,632 BWM reports of record in 2019 and 2020, respectively, for a national two-year average of 91,237 reports per year (Figure 11). The decline in 2020 was associated with the COVID-19 pandemic. Overseas arrivals accounted for approximately 42 percent of arrivals in both years. The East and Gulf coasts received the most reported overseas arrivals, with two-year averages of 13,601/yr and 13,570/yr, followed in order by the West coast (5,836/yr), Caribbean territories (3,570/yr), Pacific Islands (1,153/yr), and Alaska (212/yr) (Figure 12A). The drop in arrivals related to COVID-19 resulted in a decrease in the two-year averages for all regions compared to 2017-2018. When compared to NVMC arrivals, these overseas reports reflect greater than 95 percent compliance with the BW reporting requirement, nationally, over the two-year period 2019-2020 (Figure 13). The West coast (98.9 percent) and the Gulf (96.4 percent) had the highest two-year averages for compliance with reporting requirements followed by and the East coast (95.3 percent), Alaska (90.9 percent), Hawaii (87.7 percent), Guam (86.7 percent), Caribbean territories (86.4 percent) and the Great Lakes (76.8 percent) (Figure 14A).

The comparison of 2019-2020 coastwise BWM reports to NVMC coastwise arrivals for applicable locations and vessel traffic reflect greater than 94 percent compliance with the reporting requirement, nationally (Figure 13). The East, Gulf, and West coasts received the most coastwise arrivals, with respective two-year averages of 18,482/yr, 15,034/yr, and 8655/yr (Figure 12B). Compliance with the reporting requirements during the 2019-2020 period was highest on the West coast (95.4 percent) followed by the Gulf (94.8 percent), the East (94.1 percent), and Alaska (90.3 percent) (Figure 14B).

Figure 11. Number of BWMRs received monthly by the NBIC (July 1999 – December 2020). The dotted vertical line indicates when the Coast Guard imposed BWM regulations that included penalties for non-reporting, and the expansion of mandatory reporting to include vessels making coastwise arrivals. The 2019-2020 report period is highlighted by the shaded area on the right side.

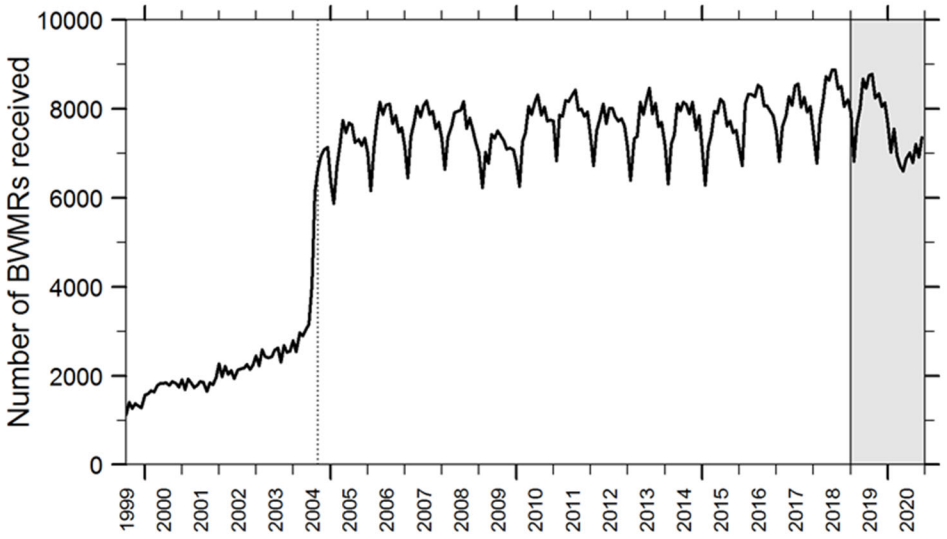


Figure 12. Discharge and management status of U.S. arrivals by coastal region (2017 – 2020). Discharge and management status of A) Overseas and B) Coastwise arrivals designated according to number of BWMRs received by NBIC for each coastal region. For the purposes of this report, the Great Lakes and Inland Waterways are exempt from BWM for coastwise movement of BW. Note: Other than the Inland region for Overseas arrivals, all other categories have values that may not be visible because of the scale.

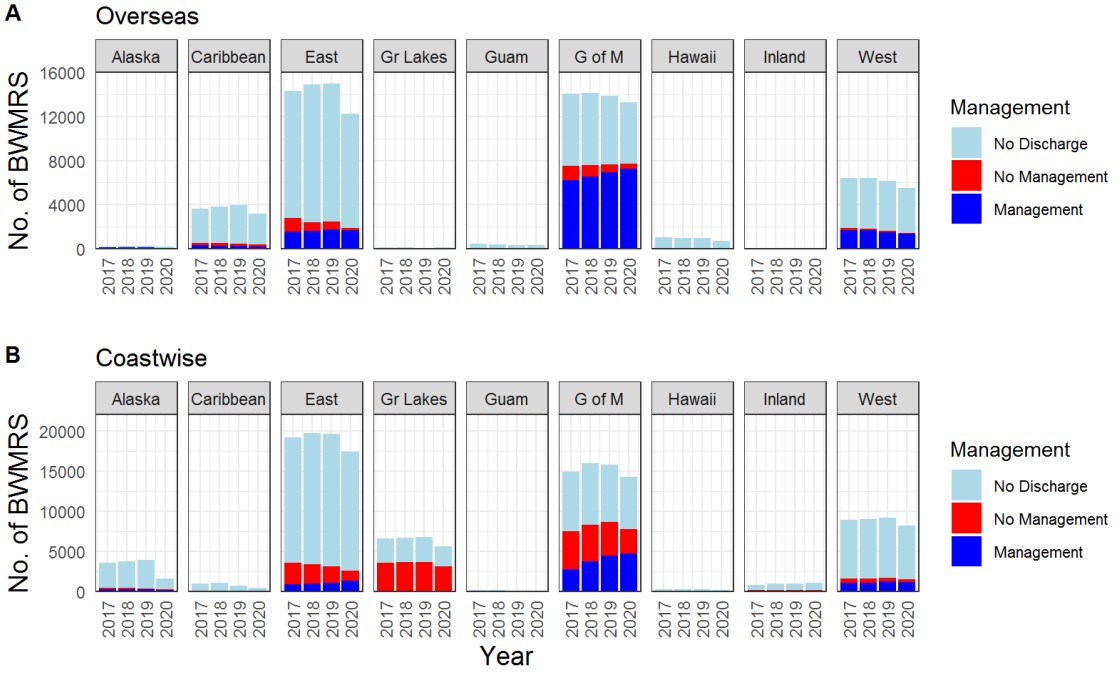


Figure 13. Percent reporting by Overseas and Coastwise arrivals when compared to the corresponding number of qualifying arrivals of the respective arrival types (see Box 1). Percent reporting determined per month by comparison of NBIC reports to notices of arrival received by the NVMC. The dotted vertical line indicates when the Coast Guard imposed BWM regulations, including penalties for non-reporting, and the expansion of mandatory reporting to include vessels making coastwise arrivals. The 2019-2020 report period is highlighted by the shaded area on the right side.

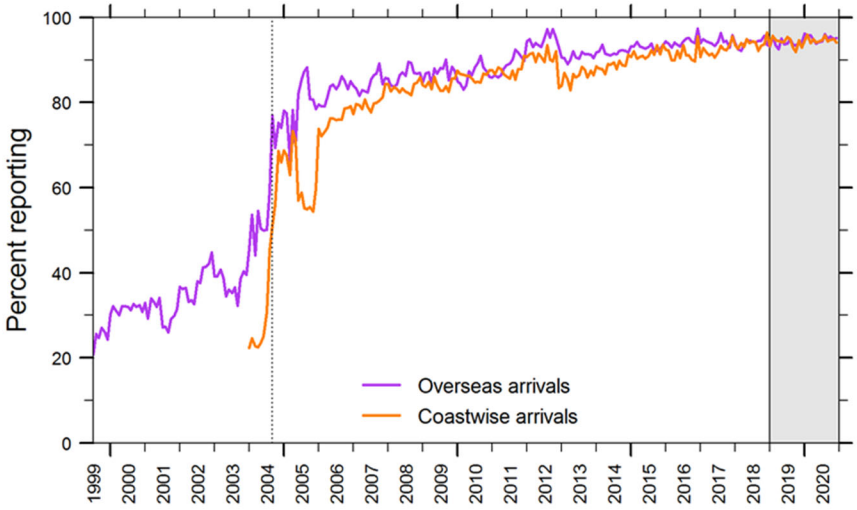
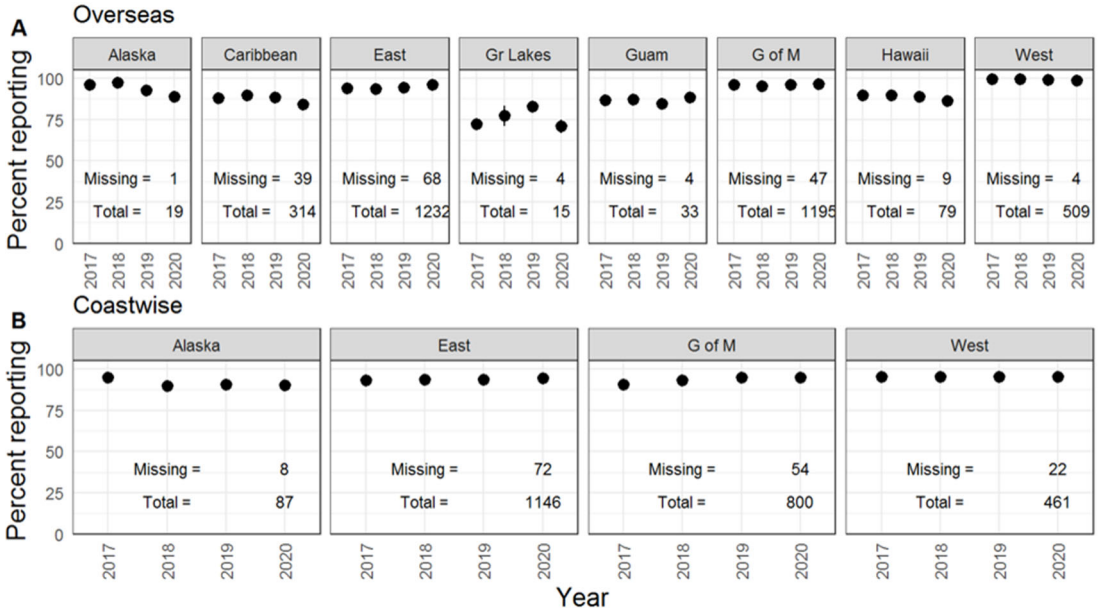


Figure 14. Compliance with reporting requirements of arrivals by coastal region (2017 – 2020). The percent reporting (± 1 standard error of the mean) by year and coastal region of A. Overseas and B. Coastwise arrivals as compared to ANOA submitted to NVMC. The mean monthly number of BWMRs that were missing and the mean monthly number of ANOAs are presented for each region. Note: Percent reporting for coastwise traffic is not estimated for all coastal regions because they are largely comprised of vessels operating within a single COTPZ or are populations that do not have an appropriate standard to compare against.

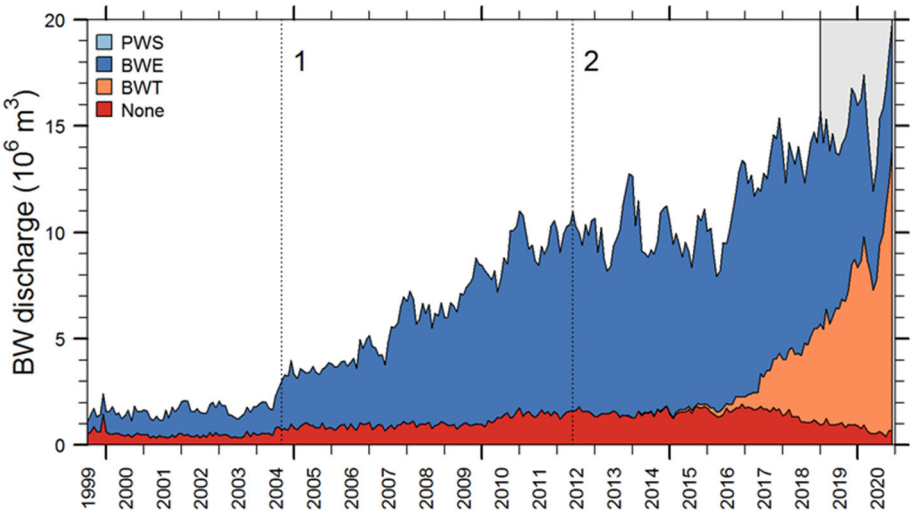


2. The total volume of discharged BW to the US continued to increase.

Cumulatively, vessels arriving to U.S. ports and places reported discharging 178.1 and 184.2 million m^3 of overseas BW in 2019 and 2020 respectively (Figure 15) and 210.3 and 177.9 million m^3 of coastwise BW in 2019 and 2020, respectively (Figure 16). This reflects an increase in average yearly discharge of 13 percent for overseas discharges as compared to the prior two-year period (2017 and

2018) and an 8.8 percent increase in coastwise discharge in 2019 before decreasing 15.3 percent in 2020, coincident with COVID-19 shipping slowdowns. Although a small part of this increase can be accounted for by increases in reporting compliance (Figure 13), the majority represents a significant increase in BW discharge arising from larger ships and changes in trade patterns (e.g., increases in bulk grain and petroleum exports) resulting in an increase in the per capita discharge volume of both overseas and coastwise discharging arrivals (Figure 17). This was particularly noticeable in 2020 when overseas arrivals decreased due to the COVID-19 related economic slowdown (Figure 11) while the per capita discharge volume increased during this time resulting in a peak in overseas discharge (Figure 17A).

Figure 15. Monthly reported discharge of BW that originated from overseas (1999-2020), by type of BWM (i.e., PWS: BW from a U.S. PWS, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported). 1: Penalties for non-reporting were imposed. 2: Coast Guard established concentration-based discharge standards.



Of total coastwise discharge, the percentage discharged to coastal regions (Figure 16A) has increased from 48.1 percent in 2005 to 72.4 percent in 2019 and 72.9 percent in 2020. At the same time, the volume of coastwise discharge to the Great Lakes and Inland waterways has remained relatively stable averaging 54.2 ± 1.5 million m3 per year (mean ± standard error of the mean) (Figure 16B). This discharge is dominated by vessels operating on the Great Lakes and oscillates seasonally as shipping on the Great Lakes declines greatly during the winter.

Figure 16. Monthly reported coastwise discharge from vessels (July 1999 – December 2020) by type of BWM (i.e., PWS: BW from a U.S. PWS, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported). A. Coastwise discharge to Coastal regions. B. Coastwise discharge to inland regions (i.e., the Great Lakes and rivers), most of which is by non-seagoing vessels which are currently exempt from BWM requirements. 1: Coastwise Arrivals required to report to the NBIC and penalties for non-reporting were imposed. 2: Coast Guard established concentration-based discharge standards.

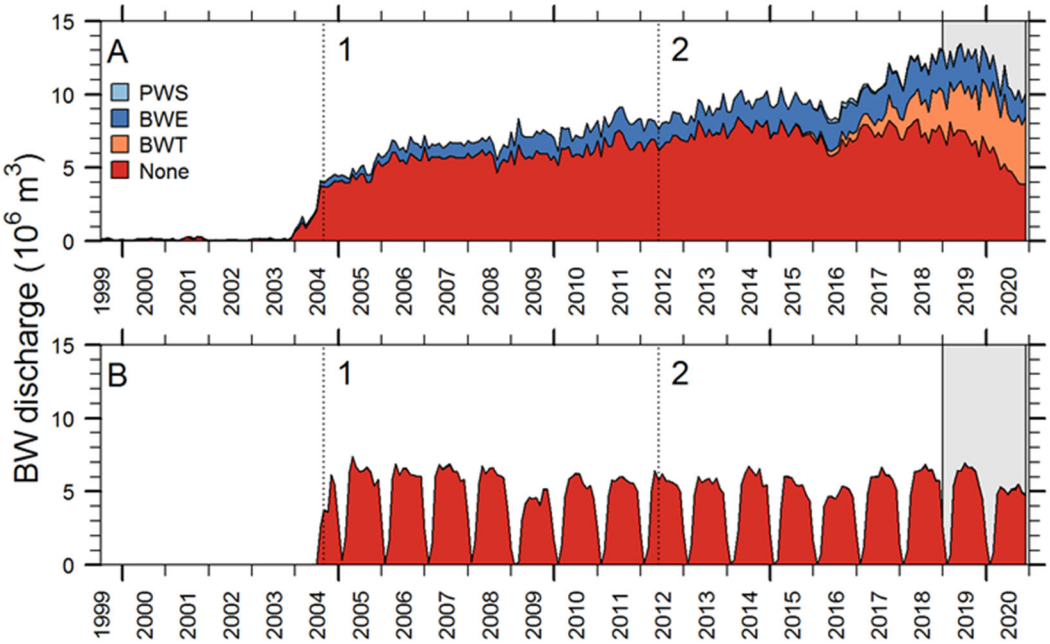
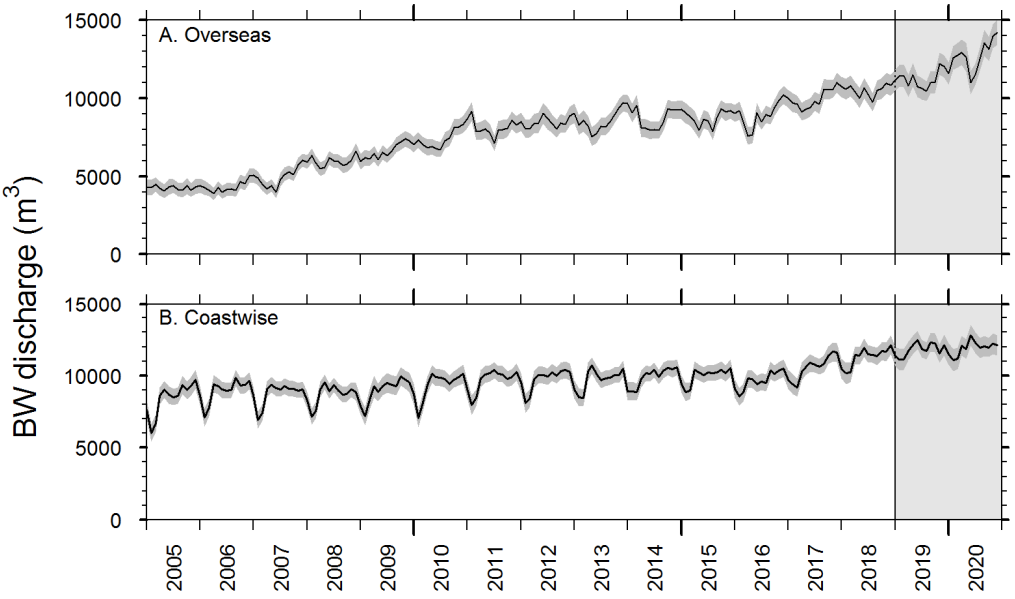
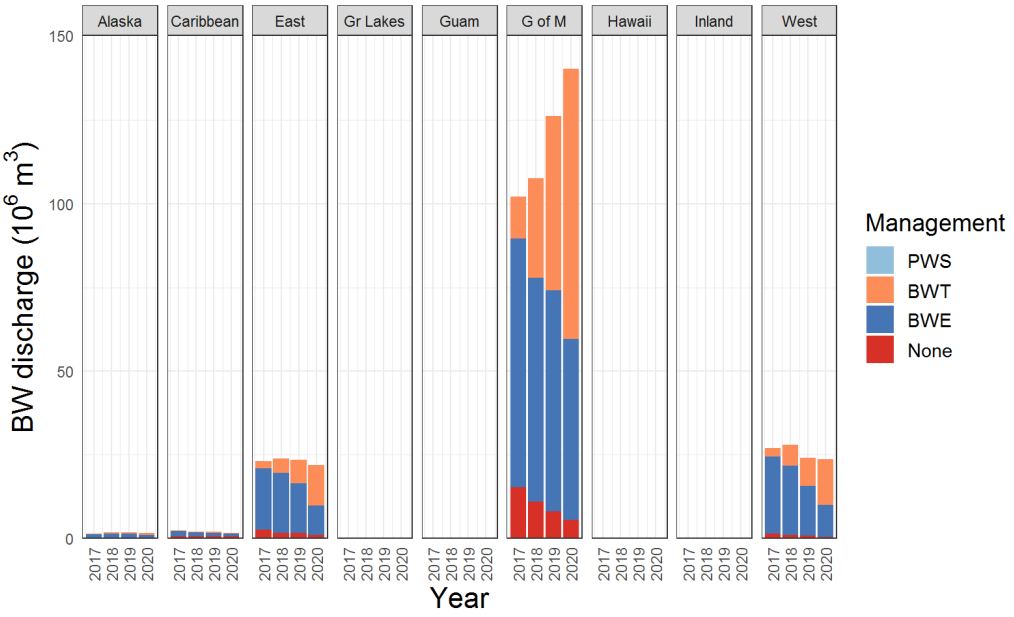


Figure 17. The per capita discharge volume of discharging arrivals from 2005 – 2020. The monthly mean discharge volume (shaded area is the 95 percent Confidence Interval) by vessels discharging A. overseas and B. coastwise ballast water.



Increases in national BW discharge continue to be driven by increases in BW discharge on the Gulf coast. The percentage of BW discharge received by the Gulf coast increased from 65 percent of reported overseas discharge in 2017, to over 74 percent by 2020 (Figure 18), while increasing from 50.9 percent to 57.9 percent of coastwise discharges during the same period (Figure 19).

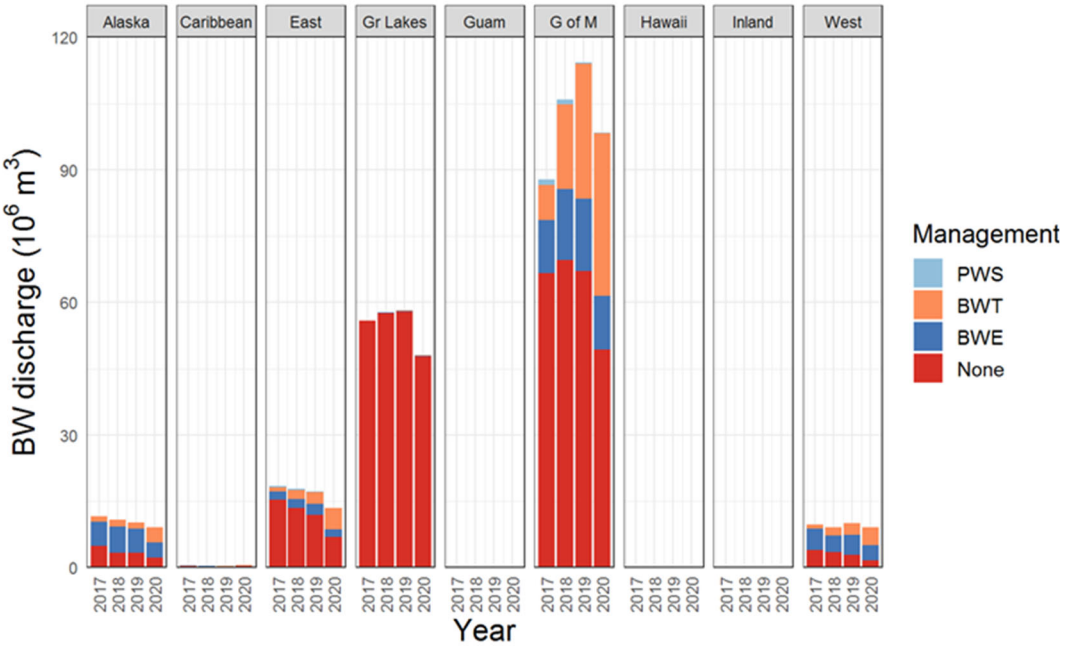
Figure 18. Total reported discharge of BW that originated overseas in 2017 – 2020 by type of BWM (i.e., PWS: BW from a U.S. PWS, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported) and coastal region.



3. The percent of discharged overseas BW that is managed remained high, and continued to increase; the percent of discharged coastwise BW that is managed continued to increase, but at a slower rate than overseas.

The proportion of arrivals that managed their BW discharge by use of an approved method (BWE, BWMS, AMS, or PWS) was much greater for overseas arrivals in 2019 and 2020--85 percent and 92 percent, respectively (Figure 12A)--than for coastwise arrivals by seagoing vessels in those same years--51.2 percent and 60.3 percent, respectively (Figure 12B). The transition from BWE as the dominant type of BWM (dropping from 58.9 percent of overseas BW discharge in 2019 to 48.1 percent in 2020) with increasing use of BWT (either BWMS or AMS) is of particular importance. Since 2018, the percentage (and volume) of overseas discharge reported as undergoing onboard BWT increased from 24.8 percent to 38.4 percent in 2019 and 55.7 percent in 2020 (Figures 15 and 18). The long-term decrease in the percentage of coastwise BW discharge that was unmanaged continued, dropping from 56.1 percent in 2019 to 46.4 percent in 2020 (Figures 16 & 19). The use of BWT by seagoing vessels to manage coastwise BW has continued to increase, rising from 24.6 percent in 2019 to 37.6 percent in 2020 (Figures 16A & 19). The adoption of BWT appears to be driving much of the increase in management of coastwise BW, as well as related reductions in BWE (i.e., coastwise BW discharge by seagoing vessels using BWE decreased from 96.5 percent of managed discharge in 2015 to 43.3 percent in 2019 and 29.6 percent in 2020). While BWE is not required for coastwise BW discharge under Coast Guard regulations, other regulatory authorities do require BWE (e.g., California regulations and the EPA VGP require BWE beyond 50 nm by certain vessels on coastwise transits), and the Coast Guard requires reporting of all uptake and discharge of BW. By definition, coastwise ship transits do not go beyond the EEZ, and so do not have the opportunity to conduct BWE beyond 200 nm, which is the requirement for BWE under the regulations in 33 CFR 151, subparts C and D.

Figure 19. Total reported discharge of coastwise BW 2017 – 2020 by type of BWM (i.e., PWS: BW from a U.S. PWS, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported) and coastal region.



The most common reason provided for discharge of unmanaged BW to the Gulf coast and the Caribbean was the route exemption (i.e., the vessel did not transit at least 200 nm from shore for long enough to conduct BWE); on the East and West coasts the most frequent reason claimed was a mid-ocean source; and in Alaska and Hawaii safety exemptions were significant responses (Figure 20). Non-management of coastwise BW discharge is also prevalent throughout the Nation, with regulatory, route, and safety exemptions as the primary reasons for not conducting BWM (Figure 21). The disparity between the proportions of regulated overseas and coastwise BW that are managed will remain significant until BWM methods other than conducting BWE beyond 200 nm become available for vessels carrying coastwise BW, as such vessels do not transit beyond 200 nm. BW carried by non-seagoing vessels (approximately 30 percent of all coastwise discharge), and particularly those vessels that operate exclusively among the Great Lakes (Lakers) (Figure 16B), will continue to be unmanaged until practicable methods are available for such vessels to meet BWM requirements. Under the 2012 Final Rule,[17] non-seagoing vessels were exempted from the requirement to manage BW prior to discharge. The Coast Guard noted in the Final Rule its intent to expand the applicability of the regulation to non-seagoing vessels following additional analysis and research, particularly on the availability of technology that can be practicably installed, the cost of such technology, and the benefit of requiring such vessels to manage BW. Notably, VIDA includes a provision for the Great Lakes and Lake Champlain Invasive Species Program to investigate this issue.

[17] Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters, 77 Fed. Reg. 17253 (Mar. 23, 2012).

Figure 20. Overseas unmanaged BW discharge by the reason reported for non-management of BW. The A. volume and B. proportion of unmanaged BW discharge per year by coastal region. The reported reasons are Equipment_Failure (equipment failure / malfunction), MidOcean (claiming that the source was beyond 200 nm of any shore so they were not required to conduct BWE and did not have a BWMS), None (no reason was provided), Regulation_Exempt (exempted from BWM requirements in 33 CFR 151.2025), Route_Exempt (their transit did not go at least 200 nm from shore for long enough to conduct BWE), Safety_Design (a vessel's Master/Operator determines that BWE is not safe to conduct due to vessel design), and Safety_Weather (A vessel's Master/Operator determines that BWE is not safe to conduct due to weather and/or sea conditions).

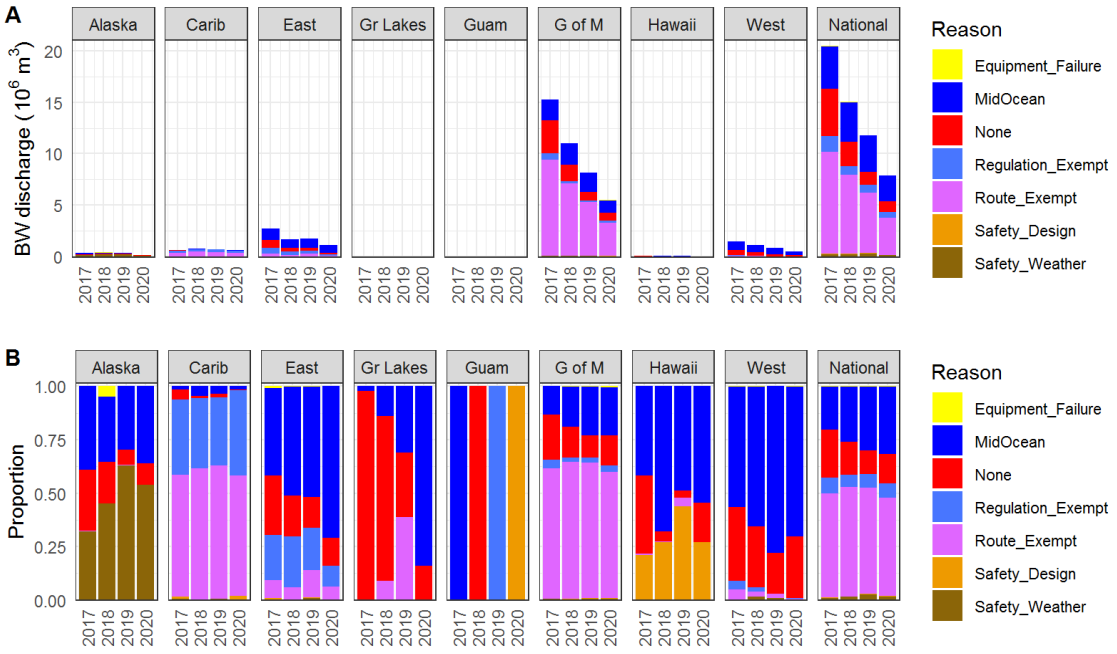
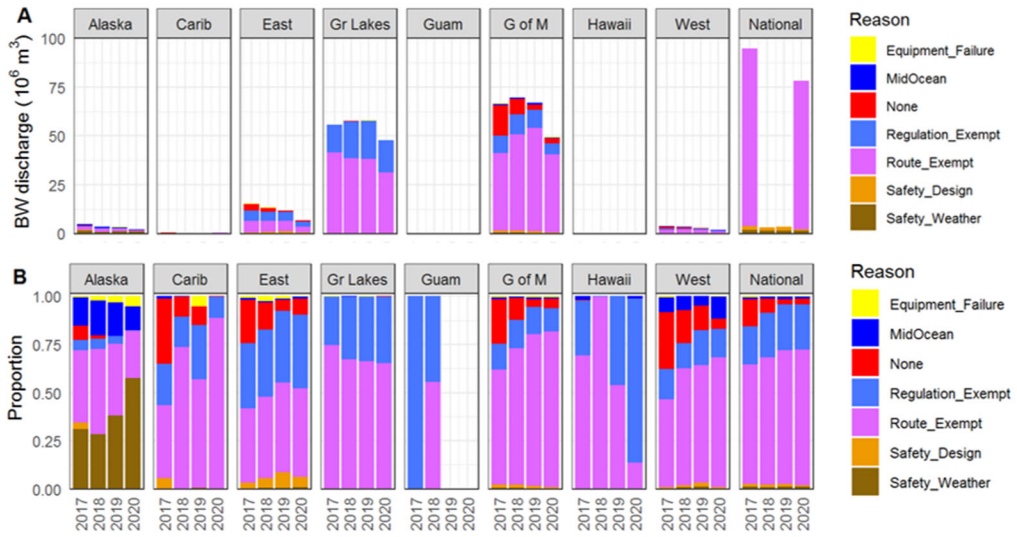


Figure 21. Coastwise unmanaged BW discharge by the reason report for non-management of BW. The A. volume and B. proportion of unmanaged coastwise BW discharge per year by coastal region. The reported reasons are Equipment_Failure (equipment failure / malfunction), MidOcean (claiming that the source was beyond 200 nm so they were not required to conduct BWE and did not have a BWMS), None (no reason was provided), Regulation_Exempt (exempted from BWM requirements in 33 CFR 151.2025), Route_Exempt (they were unable to go at least 200 nm for long enough to conduct BWE), Safety_Design (a vessel's Master/Operator determines that BWE is not safe to conduct due to vessel design), and Safety_Weather (A vessel's Master/Operator determines that BWE is not safe to conduct due to weather and/or sea conditions).



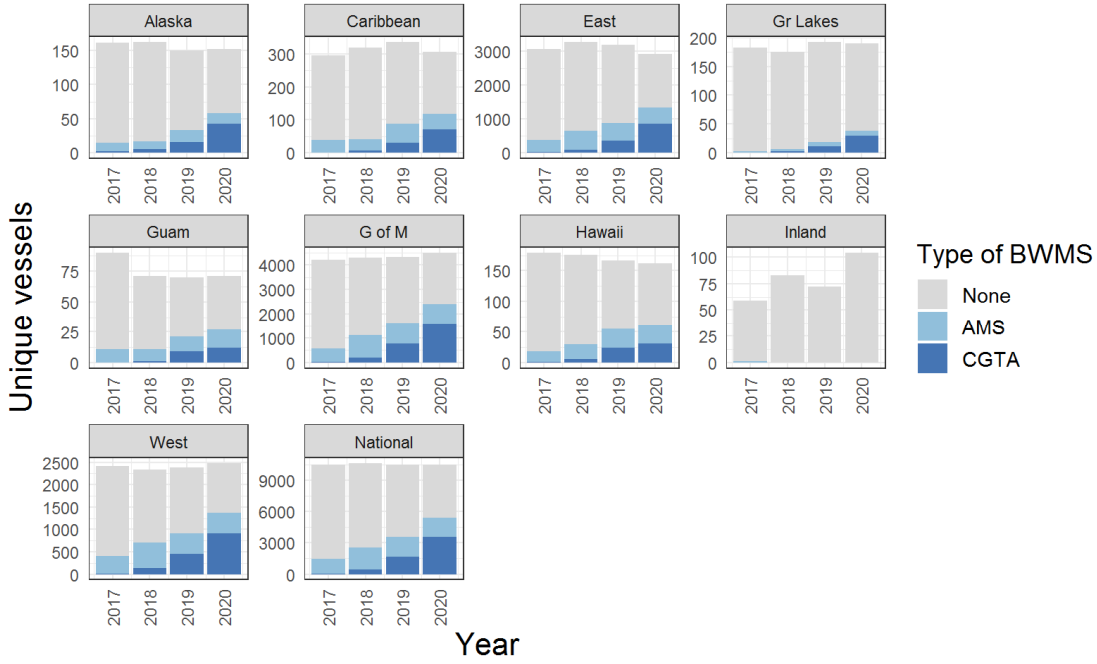
4. The use of onboard BWMS continued to increase rapidly.

The volume and percentage of overseas discharge reported as undergoing management by use of an onboard BWMS increased from 40.5 million m^3 (24.8 percent) in 2018 to 68.3 million m^3 (38.4 percent) in 2019 and reached 102.6 million m^3 (55.7 percent) in 2020 (Figures 15 and 18). Although at a slower pace, the use of onboard BWMS for coastwise discharge from seagoing vessels increased, from 24.6 million m^3 (17.1 percent) in 2018 to 37.5 million m^3 (24.6 percent) in 2019 and 48.4 million m^3 (37.3 percent) in 2020 (Figures 16A and 19).

The number of unique vessels submitting BWM reports to the NBIC remained relatively stable in 2019 (10,463 vessels) and 2020 (10,621 vessels), yet the proportion of vessels with an onboard BWMS increased from 33.9 percent to 51.2 percent (Figure 22). The number of vessels with CGTA BWMSs installed increased from 454 to 4,106 between the end of 2018 and the end of 2020. The number of vessels with an AMS increased from 2,870 to 3,813 during this same two-year time period. These increases demonstrate a significant shift towards installing Coast Guard approved BWMS (79.5 percent) rather than AMS (20.5 percent) during this period, compared to the prior two-year period. Given the substantial increases in overseas BW discharge, and therefore increased invasion opportunity, the increasing use of onboard BWMS is particularly noteworthy.

PWS water was used infrequently as a method of BWM (457 BWM reports and 0.2 percent of total volume); vessels using this method were primarily in the Gulf of Mexico and on the East coast for coastwise ballast water (Figures 18 and 19). No vessels reported discharge to a BW treatment facility during the two-year period.

Figure 22. Number of unique vessels in 2017 – 2020 with BWMSs. The unique vessels that reported having a CGTA BWMS, an AMS, or no BWMS (None), by year.



5. Coast Guard continued to conduct BWM compliance assessments on a significant number of vessels, and take enforcement actions when warranted.

a. 2019: Accurate and consistent data on BWM deficiencies for 2019 was unable to be determined due to a change to the coding system used by the Coast Guard's vessel inspection database. In 2019, an effort to harmonize the U.S. deficiency codes with those of the international community resulted in the inadvertent loss of the BW and VGP codes used by inspectors to document noncompliance with related regulations within the database. The deficiency codes have since been restored for data being entered into the database, and ballast water deficiency data will continue to be gathered and reported annually.

b. 2020: There was a noticeable decrease in vessel arrivals to the U.S., which correlated to an overall decrease in the number of exams compared to prior years. In 2020 the Coast Guard conducted 7,383 PSC exams, which include examination of vessel compliance with BWM requirements. The number of exams decreased by 9.3 percent from 2018 to 2020, reflecting the impacts of the COVID-19 pandemic on international shipping. In 2020, the Coast Guard identified 108 BWM deficiencies onboard foreign vessels visiting ports in the U.S., a 9 percent decrease from 2018, the most recent prior year for which data are available. The decrease in deficiencies was almost certainly due to the pandemic-caused decrease in inspections, as 1.46 percent percent of inspected vessels were found to have deficiencies in both 2018 and 2020. As in 2018, the majority of the deficiencies resulted from vessels arriving with inoperable BWMS (42 percent). Incomplete BWM plans (16 percent) and failures to report BWM practices to the National Ballast Water Clearinghouse (13 percent) also ranked high among deficiencies noted by Coast Guard Port State Control Examiners. In the majority of cases where the discharge of ballast water could pose a threat to the marine environment, vessels were required to modify their cargo plans to facilitate safe and compliant ballast water discharges, leading to costly unforeseen port scheduling conflicts. By incorporating BWMS into their company SMS, vessel operators can more effectively maintain their crewmembers' ballast water training and competencies to help ensure the vessel is in compliance when it arrives to port. Enforcement actions may be used by the Coast Guard to ensure compliance with the mandatory ballast water requirements in order to safeguard the waters of the United States. In 2020, the majority of enforcement actions were issued to vessel operators for the illegal discharge of untreated ballast water, failing to report inoperable systems to the nearest Captain of the Port or District Commander, and failing to make complete, accurate and timely ballast water reports to the NBIC. Letters of Violation (8), Notices of Warning (11) and Civil Penalty (4) actions were taken in 2020.

D. Conclusions

Over the past thirty years, since Congress passed initial legislation on ships' BW in 1990, regulations and management have shifted dramatically for commercial ships in the U.S. At the beginning of this time-period, there were no requirements for BWM or reporting, and vessels discharged primarily unmanaged BW (Smith et al. 1999, Carney et al. 2017). Today, the situation is very different, in response to Coast Guard and EPA regulations. Currently:

- The vast majority of arriving ships submit a BWMR to the NBIC, and overseas arrivals exceeded 95 percent while coastwise arrivals reached 94 percent compliance with the reporting requirements during 2019 and 2020.

- Most vessel arrivals report BWM, including no discharge upon arrival, use of BWE, or use of BWT (AMS or CGTA).
- Of the total volume of overseas BW discharge reported in 2020, over 95 percent was managed by either BWE or BWT.
- The total volume of overseas BW discharge reported as treated, using an onboard BWMS, increased from 1 percent to >55 percent in the past six years (2015-2020), showing rapid adoption and use of BW treatment technologies.

By virtue of its completeness (representing a near census of arriving vessels at the national level), the NBIC database of vessel BWM reports provides extensive power for tracking trends and detecting changes in BWM and delivery.

Despite the rapid expansion and use of BWM for overseas vessel arrivals, the majority of BW discharge by coastwise arrivals is reported as unmanaged, with the Great Lakes and the Gulf Coast regions receiving the majority of this unmanaged BW discharge. This pattern reflects the limited use of BWE by these vessels, which do not transit the open ocean (as required for BWE) or are exempt from BWM by regulation (i.e., non-seagoing vessels). Under the current BWM regulations, vessels are not required to divert or delay voyages to transit beyond 200 nm for a period of time long enough to conduct BWE. Additionally, under another current exemption, some vessels do not conduct BWE due to safety reasons, either in general (i.e., vessel is not designed to enable safe BWE) or due to voyage circumstances (i.e., safe BWE is not possible due to sea conditions). Fewer geographic and safety limitations are expected as BWMSs are adopted by vessels operating on these routes.
While BWM has increased, the volume of overseas and coastwise BW delivery to the U.S. has also increased, especially since 2005. In 2005 overseas BW delivery equaled 41.9 million m^3 compared with 184.2 million m^3 in 2020 (>339 percent increase). This increase is associated primarily with changes in traffic to the Gulf coast and with shifts in commerce patterns and the expansion of the Panama Canal, which provides greater capacity to handle more and larger ships. Likewise, volumes of coastwise BW discharge in the U.S. have also expanded, but to a lesser extent, from 120.3 million m^3 in 2005 to 210.3 million m^3 in 2019 (74.8 percent increase) before dropping in 2020 due to COVID-19 related shipping slowdowns.

The current upward trajectory in usage of BWT suggests that organism concentrations (numbers of living or viable organisms per unit volume of BW at discharge) will continue to decrease for overseas BW. It is also expected that increasing implementation of BWT will address many of the gaps that now exist for coastwise BW, further decreasing organism concentrations in discharges from these vessels. However, the increase in total BW discharge has some compensatory effect in total propagules delivered, since this is the product of the two (Total BW Volume x Organisms Concentration).

Overall, the Coast Guard BWM program is predicted to reduce new ANS invasions by reducing delivery of coastal organisms in BW. However, uncertainty remains about the residual risk (likelihood) of new invasions or secondary coastwise spread under different discharge standards (National Research Council 2011). The rate of each is expected to be ameliorated by BWM, but is also expected to be related to the increases in volume of BW discharge over time.

IV. Status and Trends in Invasions of Aquatic Nuisance Species Resulting from Ballast Water

A. Overview (1990-2018)

1. Detecting New Invasions: A Key Performance Measure for the BWM Program

Based on extensive research to date, it is evident that waters of the U.S. are being colonized by ANS, and commercial vessels are a dominant source of these biological invasions, resulting from the unintentional delivery of aquatic organisms associated with both BW and the biofouling of submerged surfaces (HF) of vessels (National Research Council 1996, 2011; Ruiz et al. 2011, 2015). Because many of the organisms transported in BW are also transported as HF, it is not possible to completely separate the two transport mechanisms in an analysis such as this. Importantly, the detection rate of new aquatic invasions has increased dramatically in recent decades. Since 1990 the total number of new ANS reported in U.S. coastal waters has increased over 50 percent, when considering only marine invertebrates and algae (Ruiz et al. 2015) and some of these ANS have severe negative effects on economies (e.g., fisheries and industry), environmental quality, ecological function, or human health.

Statutory requirements under NANPCA, NISA, and VIDA to reduce the threat of new aquatic invasions associated with commercial vessels have led to federal requirements by the Coast Guard and the EPA for ships to manage their BW prior to discharge in U.S. waters, to prevent new invasions and their impacts by reducing the number (concentration) of ANS delivered in BW.

These laws (starting with NISA) also directed the Coast Guard to establish the NBIC to collect and analyze data for the Nation on (a) BW delivery and management and (b) invasions by aquatic species resulting from BW. Under NISA, the NBIC is intended to evaluate status and trends of the national BWM program, including performance measures, which will be included in reports to Congress. Section A of this Report covered patterns of BWM and discharge. Another key performance measure is whether there is a reduction in new ballast-mediated invasions, especially for locations with significant shipping activity, which is the focus of Section B of this report. Preventing new invasions is, in fact, the ultimate goal for BWM and thus a critical endpoint for performance analysis. Whereas direct reductions in organism concentrations in BW due to management can be measured, and this is expected to reduce new invasions, there remains considerable uncertainty about how many ANS can still colonize at the organism concentration limits specified in regulations (Ruiz and Carlton 2003; National Research Council 2011). In short, measuring ship BWM behavior is a necessary short-term measure of BWM program performance, but this is not sufficient to evaluate its efficacy in reducing aquatic invasions.

2. Approach to Measuring ANS Detection Rate

To develop this invasion-based performance measure of the BWM Program, SERC and Coast Guard have advanced a multi-tiered approach for coastal marine waters in the continental U.S. This approach includes (1) a cumulative synthesis (or summary) of available literature, reports, museum records, and observations of ANS detected in marine and estuarine habitats by U.S. coastal region (e.g., East Coast, West Coast, Gulf Coast); and 2) standardized field surveys at selected sentinel sites that are repeated through time. These two approaches are described below in detail.

a. Synthesis of ANS detected and reported in U.S. coastal waters.

To provide a comprehensive summary of all ANS detected in coastal marine waters of the U.S., SERC conducts an on-going synthesis of available information, using these data to evaluate status and trends of invasions. This process has multiple steps. First, records of species occurrences are collected from available resources (e.g., scientific publications, technical reports, and museum collections). Second, analysis of these records is used to identify those that are ANS, based on the current state of knowledge about taxonomy and biogeography of the species. Third, this information is used to evaluate and quantify the number of new ANS discoveries by geographic location (coast or bay) and year. Fourth, those ANS attributed to either vessel BW and/or HF are identified according to the organisms' known life-history and habitat characteristics (e.g., whether they occur in the water column or on surfaces, including vessel hulls, and thus could be transported by BW or HF, respectively, and if they could be transported by both BW and HF). With this approach, changes in detection rate of new ANS are estimated over time to test the extent to which new ANS invasions may be occurring.

This information is maintained in the NEMESIS (Fofonoff et al. 2018), which is a database operated by SERC and available to the public. It is important to note that the primary focus of NEMESIS is on invertebrates and algae, because most invasions to coastal marine waters--and especially those from BW, and ships more broadly--are in these groups; currently, this synthesis does not include a complete analysis for fishes and other vertebrates, or vascular plants. The SERC NEMESIS database also does not cover inland freshwater ecosystems. Thus, this initial report focuses on ANS in marine and estuarine habitats, and on invertebrates and algae in particular. The Coast Guard and the SERC will work with other partner agencies in the Task Force to identify potential sources of information for freshwater habitats where commercial vessels operate, and to incorporate such information, as available, in future versions of the report.

b. Standardized field surveys for ANS at selected sentinel sites that are repeated through time.

To provide a standardized measure of invasion rates, the SERC and the Coast Guard have established sentinel sites, where regular quantitative surveys are conducted for ANS. While NEMESIS data and analysis (above) allows detection of some ANS, the source of such data are highly variable in time and space, and only standardized and repeated field measures can provide the data required to measure changes in detection rate with statistical confidence (National Research Council 2011). Measures at the sentinel sites serve this purpose. Currently, one sentinel site is now established on each coast: San Francisco Bay, CA (West Coast), Chesapeake Bay, MD/VA (East Coast), and Tampa Bay, FL (Gulf Coast). These specific sentinel sites were selected for long term detection and enumeration of ANS invasions, because they represent major port systems that occur on different coasts (i.e., with different environmental conditions and vessel trade patterns, each of which may affect invasion). An additional sentinel site in the U.S. Great Lakes, funded through the EPA Great Lakes Restoration Initiative, is under development, and further sites in Alaska and the Pacific Islands are under consideration, including the availability of funding.

3. Scope of ANS Analysis in this Report

This report documents the cumulative number of new ANS detected for coastal marine and estuarine species of the continental U.S., West Coast, East Coast, and Gulf Coast, considering explicitly the invasions since 1990. This information is provided separately for ANS associated with BW as a possible vector or HF as a possible vector. An additional section reports the number of ANS that

have spread geographically to new bays or states along each of the three coasts since 1990. Understanding the coastwise spread of ANS is also a critical aspect of marine invasion dynamics, since ANS often spread beyond the initial site of colonization, establishing new populations along a coast that can have impacts and serve as the sources for transport due to other vectors.

In this report, 1990 was selected as a reference point, corresponding to legislation[18] that initiated the federal BWM program. Specifically, the changes in the number of newly detected ANS to each coast and the continental U.S. that are associated with BW and HF from 1990-2018 were evaluated, as well as the number of these detected in the successive two-year periods 2017- 2018 and 2019-2020, as specified by VIDA. The longer term analysis for 1990-2018 establishes a baseline to evaluate subsequent rates of change in response to BWM.

This initial report relies entirely on data from NEMESIS, focusing on ANS invasions of coastal marine waters of the continental U.S. by invertebrates and algae. Subsequent reports will also include information from standardized contemporary surveys at sentinel sites, providing a repeated measure across years to test for temporal changes (declines) in new ANS detections in response to management of BW. The sentinel site data will both complement the national data in NEMESIS and provide a more robust statistical framework to measure change at selected indicator sites. More specifically, sentinel site surveys provide a mechanism to validate broad national patterns and establish a detailed understanding of invasion dynamics on each coast. These recent and limited SERC/Coast Guard sentinel site measures aim to address, in part, a key gap in data on invasions of U.S. waters. There is no prior or current long-term national program to detect ANS across all U.S. waters, using a standardized method needed for statistical analysis to quantify invasion rates over time (Ruiz et al. 2000).

Throughout, it is important to recognize that the numbers of ANS in this report represent minimum estimates, including only those that have been detected to date. There is little doubt that additional invasions have occurred and have gone undetected, because many types of organisms have not been evaluated in various regions of the country or in recent time.

4. ANS Invasions Attributed to Vessels (All Years)

Based on the NEMESIS database, 479 ANS of invertebrates and algae are documented to have established populations in coastal marine and estuarine waters of the continental U.S. through 2018. The record of ANS detection began in the early 1800s and has accelerated in modern time, and the quality of the record is very uneven over time and among geographic regions (Ruiz et al. 2000, 2015). Commercial ships, including both BW and HF combined, are a possible vector (i.e., mechanism of introduction) for 79 percent of the coastal ANS in the continental U.S. recorded in NEMESIS (Table 1). Most of these ANS could have been introduced to U.S. waters by either BW or HF, based on their biology and invasion history (see discussion below). Of the 479 marine and estuarine ANS known for the continental U.S., 59 percent may have been introduced initially by BW as a possible vector, but may also have been introduced through HF, and 61 percent are associated with HF as a possible vector, but may also have been introduced via BW (Table 1). For most species transported by commercial ships, there is no way to distinguish between BW and HF as the principal mechanism of transport, because they are associated with both (See Box 2).

[18] NANPCA

Box 2. Overlap of BW AND HF as a Vector

Shipping (including both BW and HF) is the dominant vector of established ANS in coastal marine waters of the U.S. When considering only the 479 invertebrates and algae ANS in the continental U.S., 379 of them may have been transported by commercial vessels by either BW or HF or both, whereas only 100 of the 479 are not likely to have been transported by commercial vessels.

While BW and HF are possible vectors for a large number of ANS, both vectors are possible for the majority of these species. This is indicated conceptually below, where the number of species for each BW and HF is shown by the size of the circle, and overlap between circles shows the proportion for which either vector is possible. Note that the sizes of the circles and the degree of overlap shown are approximate.

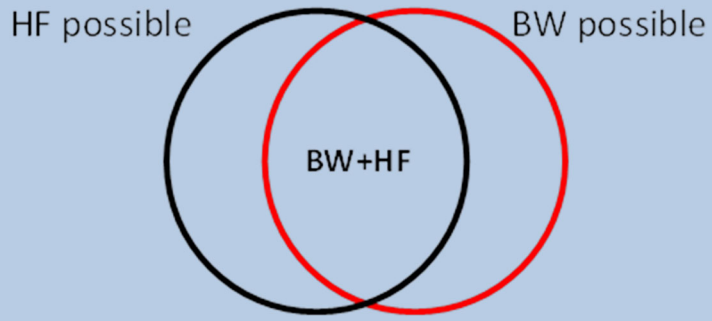


Table 1. Minimum Number of Marine and Estuarine ANS with Established Populations and Associated Vectors, through 2018. Shown are the numbers of ANS, including invertebrates and algae, documented for marine and estuarine waters of the continental U.S. and from each coast. Also shown are the numbers (and percent total) of these ANS associated with commercial shipping (BW + HF), BW (but not HF) and HF (but not BW) as possible vector for the initial introduction to each region. Note that columns and rows do not total, due to overlaps in distribution of ANS. Note also that other non-shipping vectors may also be possible for ANS in each category. Data are from NEMESIS (Fofonoff et al. 2018). See Box 2 regarding ballast water HF.

	Continental U.S.	West Coast	East Coast	Gulf Coast
Total number of marine ANS (all vectors)	479	325	203	101
Number of Marine ANS with shipping as a possible vector	379 (79.1%)	256 (78.7%)	163 (80.3%)	80 (79.2%)
Number with BW as a possible vector	283 (59.1%)	181 (55.7%)	123 (60.6%)	57 (56.4 %)
Number with HF as a possible vector	293 (61.2%)	198 (60.9%)	128 (63.1%)	66 (65.3%)

For individual coasts, the documented number of ANS (for invertebrates and algae) range from 101 to 325 when all vectors are considered (Table 1). Similar to the continental scale, BW and HF contribute strongly to ANS at the coast level: (a) 79-80 percent of all ANS are associated with ships (BW + HF) as the possible vector, (b) 56-61 percent are associated with BW, and (c) 61-65 percent are associated with HF (Table 1). Vectors other than BW and HF of commercial ships also have contributed to the total ANS on each coast documented (included in Table 1, line 1), these are not considered further in this report and include aquarium and pet trades, fisheries and mariculture activities, nursery trades in wetland species, and recreational vessels.

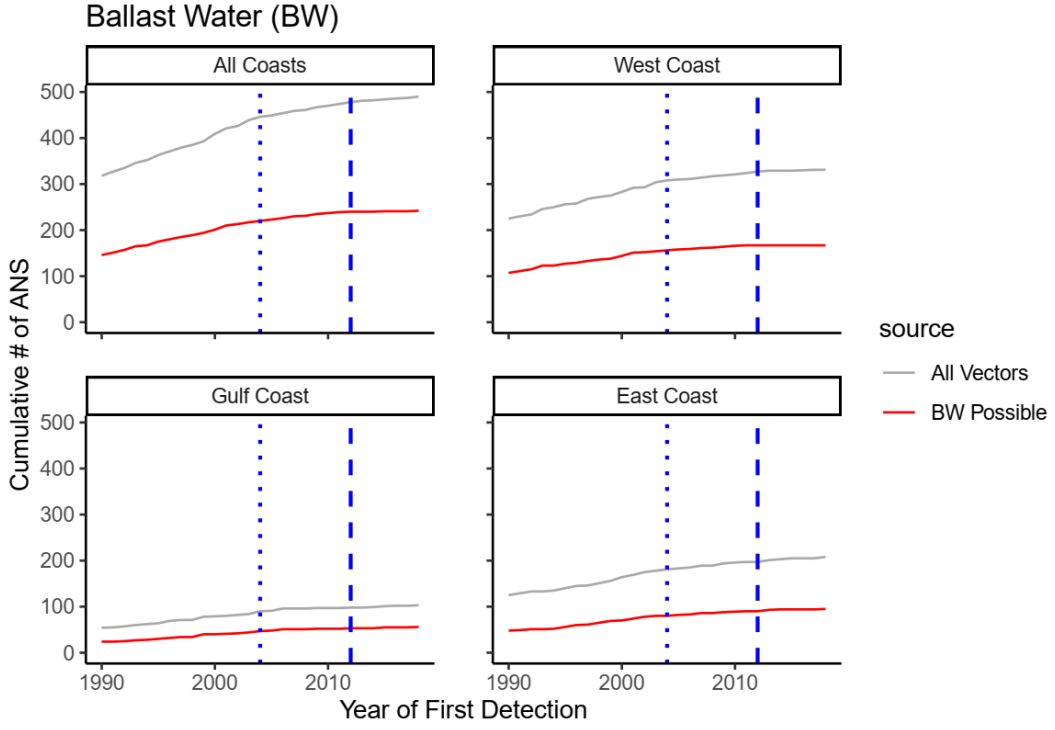
These results highlight three key points about invasions in coastal marine and estuarine waters of the U.S., both at the continental scale and for individual coasts. First, shipping is a possible vector, via either BW or HF, for the initial invasion of ~80 percent of all marine and estuarine invertebrate and algae ANS. Second, both BW and HF are considered a possible vector for over 50 percent of ANS detected to date. Third, there is uncertainty about the actual vector responsible for many individual invasions, since ANS could have arrived in several different ways. For example, many species (e.g.,

barnacles and mussels) have adult life stages that can cling to the outer hulls of vessels as well as larval stages that exist in the water column and can be taken up in BW, such that both HF and BW are possible vectors. Moreover, other vectors beyond shipping, such as mariculture and live trade (e.g., seafood and bait), are also possible for some of the ANS transported by BW and HF (Fofonoff et al. 2003, Ruiz et al. 2015). Thus, the percentages reported above indicate the potential contribution of BW and HF separately for the documented ANS to date.

5. ANS Invasions Attributed to BW (1990-2018)

Of the 479 marine ANS documented above, 169 (35 percent) of these species were first detected in U.S. coastal waters from 1990-2018, including 106 on the West Coast, 80 on the East Coast, and 47 on the Gulf Coast (with some ANS occurring on multiple coasts). For these new ANS detected since 1990, 70 percent of the total at the continental scale (U.S. coastal waters across all three coasts) were associated with BW as a possible vector. The pattern of increase per year in ANS associated with BW as a possible vector is shown in Figure 23. Since 1990, the cumulative total number of new ANS associated with BW as a possible vector has increased for the West Coast (53 percent), East Coast (69 percent), Gulf Coast (104 percent), and all coasts combined (73 percent).

Figure 23. Cumulative number of new ANS per year associated with BW as a possible vector (red line), compared to all introductions by any vector (grey line), since 1990. Shown are numbers for invertebrates and algae. Data are from NEMESIS (Fofonoff et al. 2018). Vertical lines correspond to year of implementation for two key BW regulations by Coast Guard: (a) 2004 (dotted line) -- mandatory BW reporting and BWM (primarily retention and BWE) for overseas arrivals and expanded BW reporting to coastwise arrivals (33 CFR §151.2060 and §151.2025); (b) 2012 (dashed line) -- mandatory BW discharge standards (effectively requiring BWMS to replace BWE) initiated, to phase in over several years (33 CFR §151.2030 and §151.2035, respectively).



Of critical importance, many of these documented species could have arrived by one of multiple vectors, including but not limited to BW or HF, and uncertainty exists about the relative contribution of each. In many instances, multiple vectors can transfer a particular species; however, the exact vector that produced an observed invasion is often unknown. Thus, Figure 23 depicts the potential

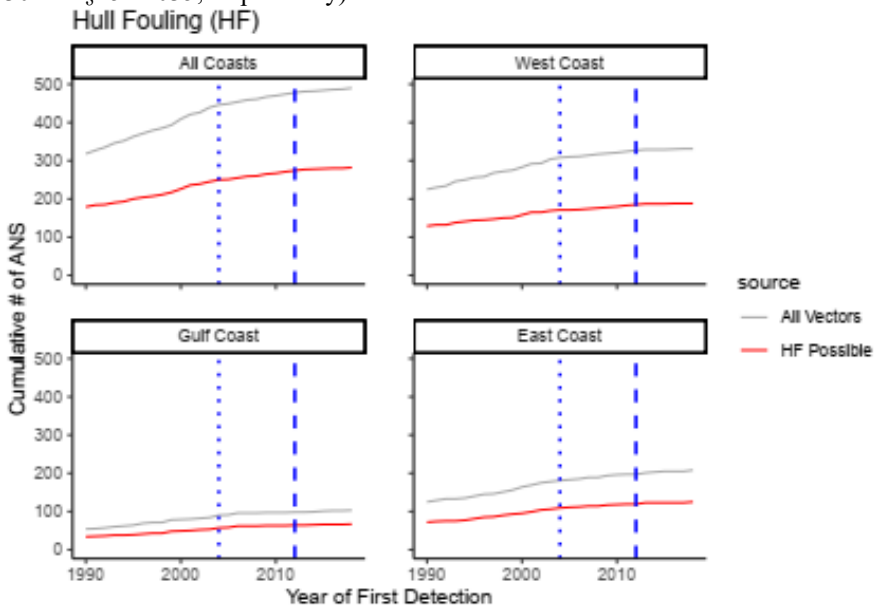
contribution of the BW vector to the new ANS detected per year relative to total number (red and grey lines, respectively), for each geographic region. The shapes of the ANS curves in Figure 23 are also of great interest. In particular, the rate of increase appears to be slowing in recent years, as is most evident for the West Coast and the continental scale. Specifically, it may appear that the slopes of the lines are lower (flatter) in recent years, and this slowdown corresponds roughly with the 2004 Coast Guard regulation (dotted line), implementing mandatory BWM for overseas vessels. The subsequent BW regulation in 2012 initiated discharge standards, to be phased in over subsequent years, and is expected to further decrease the likelihood of new ANS invasions from BW.

While these results are encouraging, it is premature to draw conclusions about any changes in detection rates for multiple reasons. First, there is a lag-time in detecting new invasions, since it can take several years to detect and report new ANS following a successful invasion. Past studies of invasions suggest that such lag-times may be 10-15 years (Ruiz et al. 2015, Seebens et al. 2017). As a result, ANS detection rate is expected to be suppressed in the most recent 15-year period, independent of any BW regulation, simply due to the lag-time in detection and reporting that is commonly seen in studies of invasion dynamics. Second, as discussed earlier, synthesis data are especially challenging to interpret in this regard, because search effort may be low and/or uneven within and across regions and time periods. The use of sentinel sites with relatively frequent standardized measures is designed explicitly to evaluate (test for) change in a way that adequately controls for detection lag-time and improves temporal and geographic resolution.

6. ANS Invasions Attributed to Hull Fouling (HF) (1990-2018)

When observed detection rates since 1990 are plotted (Figure 24), patterns similar to BW exist for ANS invasions associated with HF as a possible vector. Of all new ANS detected by the NEMESIS database over this time period, 66 percent were associated with HF as a possible vector at a continental scale. For individual coasts, these percentages ranged from 54 percent (West Coast) to 64 percent (Gulf Coast) with the East Coast (61 percent) close to the higher end of this range. The rate of increase follows a similar pattern as BW, and the same interpretation applies for HF. Specifically, many ANS associated with HF as a possible vector may have arrived by BW (instead of HF), or may have been introduced via both BW and HF, and the lag-time in detection creates uncertainty about estimates for the past 10-15 years. Nonetheless, these data suggest that HF is a potent vector, contributing significantly to ANS invasions in the past several decades.

Figure 24. Cumulative number of new ANS per year associated with HF as a possible vector (red line), compared to all introductions (dashed line), since 1990. Shown are numbers for invertebrates and algae. Data are from NEMESIS (Fofonoff et al. 2018). Vertical lines correspond to year of implementation for two key BW regulations by Coast Guard: (a) 2004 (dotted line) -- mandatory BW reporting and BWM (primarily retention and BWE) for overseas arrivals and expanded BW reporting to coastwise arrivals (33 CFR §151.2060 and §151.2025); (b) 2012 (dashed line) -- mandatory BW discharge standards (effectively requiring BWMS to replace BWE) initiated, to phase in over several years (33 CFR §151.2030 and §151.2035, respectively).



7. Secondary Coastwise Spread of ANS in U.S. Waters (1990-2018)

While previous sections have focused on the numbers of new ANS to each coast and the Nation, another important measure is the extent to which ANS spread coastwise to new bays, states, and regions beyond their initial introduction or arrival to a single site on the East, Gulf, or West Coast. Although some ANS are able to spread by larval dispersal, many species are not and require human transport to spread from one bay or port to another. Analysis of spread patterns through time indicates that most ANS spread coastwise (among bays) beyond their initial site of introduction. Figure 25 shows the percentage of species that spread, expanding their geographic ranges, from 1990-2018. For all three coasts, over 50 percent of ANS are known to have expanded their ranges in this time period. Thus, while prevention of new ANS introductions is a major focus of the BWM program, coastwise spread adds another dimension to this issue. Current assessments suggest that vessels play a significant role in this secondary spread, including HF of commercial, recreational, and fishing vessels (Ashton et al. 2014; Zabin et al. 2014). However, the relative contribution of HF versus BW and various vessel types to this spread is still the focus of analyses.

Figure 25. Percent of ANS (invertebrates and algae) introduced to each coast that have spread geographically to new bays along each coast from 1990-2018, beyond their initial site of invasion. Data are from NEMESIS (Fofonoff et al. 2018).

B. New ANS Invasions for the period 2017 and 2018

The NEMESIS database detected few new ANS invasions to coastal marine waters of the continental U.S. during the two year period of 2017-2018. Only four novel ANS records of marine invertebrates and algae to the continental U.S. were documented, contributing to the observed slower rate in new ANS detections shown in Figs 23 and 24. Of these 4 ANS, two were associated with BW as a possible vector, including one species for which both BW and HF were possible vectors. Two additional ANS were associated with HF as a possible vector but not BW.

On a coastal level, three of these ANS were detected on the East Coast, including one of these also detected on the Gulf Coast. Two of these East Coast ANS had BW as a possible vector and two had HF as a possible vector (with one of these including both BW and HF). Only one new ANS was documented by NEMESIS on the West Coast during this period, and it was not associated with either BW or HF as a vector.

This result is consistent with a reduced number of new ANS associated with BWM, compared to previous years. However, it is important to recognize that the historical record of ANS detection is highly variable from year-to-year. For example, prior to any BWM program, there have been many other past two-year periods with five or less new ANS detected in U.S. coastal waters at the continental scale, followed by a surge in new detections. Thus, while the result is consistent with a slowdown of new ANS in recent years, additional measures are required to distinguish a short-term (temporary) dip from a sustained and robust pattern across several years.

C. New ANS invasions for the period 2019 – 2020

1. Updated Analyses Through 2020

Ongoing analysis of the literature by NEMESIS through the period 2020 resulted in an increase in the database of the number of documented ANS in coastal waters of the continental US from 479 to 506 species of invertebrates and algae, representing a 5.6 percent increase. This was a net change of 27 total species, most of which included BW and HF as a possible vector, representing a 7-8 percent increase in the number of ANS in the database associated with these two vectors in the last two years. Reflecting the combined effects of lag-times in analytical results, publication, and data access, while most "new" species in the NEMESIS database have first records of occurrence as an ANS in U.S. waters in the last decade, some extend much further back in time.

A similar pattern was observed when considering coasts individually. The total number of coastal and algal ANS documented in NEMESIS increased over the past two years on the West Coast (5.2 percent), East Coast (5.4 percent), and Gulf Coast (4.0 percent). Nearly all of these species were associated with BW and HF as possible vectors for introduction to the respective coasts.

2. New ANS Invasions for the period 2019 – 2020

The NEMESIS database detected no new ANS invasions with records of first occurrence in 2019 or 2020. Importantly, as discussed above, this record is liable to change due to lag-times, and will be updated as necessary in subsequent reports.

D. Conclusions

The available data indicate that new ANS invasions associated with BW as a possible vector continue to be detected in recent years, on all coasts of the U.S., but very few new ANS have been detected in 2017-2020 based on NEMESIS data. While encouraging, considerable caution should be used in interpreting the number of new records and any changes in detection rate in response to BWM. There is often a significant lag-time of several years to detect new invasions, and search effort and ANS detection rate is still highly variable (uneven) in space and time, making reliable estimates of invasion rates especially problematic (National Research Council 2011; Ruiz et al. 2015, Seebens et al. 2017). Standardized measures at sentinel sites, repeated over time, can serve to reduce this lag-time to improve and validate current estimates of detection rate, and these are currently underway, although at only a single location on each coast.

Although BWM has advanced significantly in recent years, it is also important to recognize the challenge in clearly measuring its effects on reducing ANS invasions, because many species can be transferred by either BW or HF. As a result, disentangling whether BW or HF is responsible for new invasions is currently not feasible in many cases. The record of coastal marine invasions in the U.S. indicates that HF of ships is also a potent vector for invasions (and secondary spread) of ANS. Ships have extensive and complex submerged surface areas that are colonized often by marine and estuarine organisms (Moser et al. 2017, Miller et al. 2018), resulting in species transfers and invasions. Currently, the U.S. lacks a comprehensive national program to manage or regulate the transfer and introduction of marine ANS by HF. While the International Maritime Organization

(2011) has set forth voluntary guidelines for minimizing the transfer of HF organisms, approaches to manage this vector are only just beginning at both national and international scales. Thus, independent of the success of BWM, some level of ANS invasions can be expected to continue in U.S. coastal ecosystems without increased HF management.

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VI. Comparison of Data from the NBIC and the NVMC

An important aspect of compliance estimation concerns the overlap of the NBIC and NVMC data sets that, as mentioned above, is not complete because of differences in the populations of reporting vessels. For this reason, estimates of reporting compliance rates are constrained to those subpopulations that are shared between the two data sets. For example, offshore supply vessels are included in the NBIC reporting requirements but exempted from reporting to the NVMC. Table A1 summarizes the geographic regions and vessel types that are either exempted or known to be incomplete in one or both of the databases and indicates which data sets were used to generate each of the figures and tables in this report.

To avoid spurious results when estimating reporting compliance rates (i.e., the number of BWMRs received vs. qualified arrivals as reported to the NVMC), the exemptions in Table A1 are always taken into consideration. Note: overlap between the NBIC and the NVMC reporting requirements is significantly less for coastwise than overseas arrivals, so estimates for the NBIC coastwise reporting compliance rates are based on a smaller proportion of overall forms than are those for overseas compliance. Nevertheless, since 2010 the combined subset of BWMR forms used to estimate compliance rates was ~72 percent of the overall number of retained forms. At present there are no comprehensive data sources describing coastwise vessel movements and arrivals within the inland waterways of the US. For this reason, BW reporting compliance rates cannot be reliably estimated for coastwise arrivals to the inland waterways or the Great Lakes at this time.

Table A1. Regions and vessel classes exempted (**E**) from reporting to the NBIC or NVMC or with incomplete reporting (**I**) to NVMC or NBIC. Exemptions factored into analyses of reporting compliance (no. BWMRs) and BWM activities (volumes). Regions or vessel classes excluded from analyses for a table or figure are designated by **X**. Vessel classes marked "**not evident**" are not required to report to NVMC, but were not evident in either database and were not explicitly excluded. **Cells that are shaded dark gray** indicate categories that are not applicable * Submission of BWMRs directly to the NBIC is not required under current regulations.

Region and Vessel Classes	NBIC – Reporting Exemptions	NVMC – Reporting Exemptions	NBIC – BW Analysis		Reporting Compliance Analysis			
			Overseas (Figures 3,5,7)	Coastwise (Figures 4,6,8)	Overseas (Figure 1)		Coastwise (Figure 1)	
					NBIC	NVMC	NBIC	NVMC
REGIONS								
Alaska	-	-	-	-	-	-	-	-
Caribbean	-	-	-	-	-	-	NA	NA
East Coast	-	-	-	-	-	-	-	-
Great Lakes (Coastwise)	-	I	-	-	NA	NA	X	X
Great Lakes (Overseas)	*	-	-	-	-	-	NA	NA
Guam and Am. Samoa	-	I	-	-	-	-	NA	NA
Gulf of Mexico	-	-	-	-	-	-	-	-
Hawaii	-	-	-	-	-	-	NA	NA
Inland Rivers and Waterways	I	I	-	-	X	X	X	X
West Coast	-	-	-	-	-	-	-	-
VESSEL CLASSES - OPERATIONS								
Crude oil tankers engaged in coastwise trade	E	-	-	-	NA	NA	X	X
Offshore supply vessels	-	E	-	-	X	X	X	X
Oil spill recovery vessels	-	E	-	-	X	X	X	X
Recreational vessels	E	I	-	-	X	X	X	X
Tugs and barges operating exclusively in continental US	-	E	-	-	NA	NA	X	X
Vessels ≤300 GRT	-	E	-	-	X	X	X	X
Vessels operating exclusively in a single COTPZ or between MORMS and NEWMS	E	E	-	-	NA	NA	X	X
Dept. of Defense and Coast Guard Vessels	E	E	-	-	X	X	X	X
Public vessels	-	E	-	-	X	X	X	X
Vessels arriving under force majeure	-	E	-	-	Not Evident	Not Evident	Not Evident	Not Evident

Appendix: Abbreviations

Abbreviation	Meaning
AMS	Alternate Management System
ANOA	Advanced Notice of Arrival
ANS	Aquatic Nuisance Species
BW	Ballast Water
BWE	Ballast Water Exchange
BWM	Ballast Water Management
BWMS	Ballast Water Management System
BWMR	Ballast Water Management Report
BWT	Ballast Water Treatment
CFR	Code of Federal Regulations
CGTA	Coast Guard Type Approved
COTPZ	Captain of the Port Zone
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
Final Rule	Ballast Water Discharge Standard Final Rule
HF	Hull Fouling
MARAD	Maritime Administration
NANPCA	Nonindigenous Aquatic Nuisance Prevention and Control Act
NBIC	National Ballast Information Clearinghouse
NISA	National Invasive Species Act
NEMESIS	National Exotic Marine and Estuarine Species Information System
nm	Nautical Mile
NVMC	National Vessel Movement Center
PWS	U. S. Public Water System
SERC	Smithsonian Environmental Research Center
SMS	Safety Management System
U.S.C.	U. S. Code
VGP	Vessel General Permit
VIDA	Vessel Incidental Discharge Act of 2018