Commercial Vessel Ballast Water Management (2020-2021)

Report to Congress

July 7, 2023

https://doi.org/10.5479/10088/117294

U.S. Coast Guard

Foreword

July 7, 2023

I am pleased to present the following report, "Commercial Vessel Ballast Water Management (2020-2021)," as prepared by the U.S. Coast Guard and Smithsonian Institution, in consultation and cooperation with the federal members of the Aquatic Nuisance Species Task Force.

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 provided to the following:

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

The Honorable Ted Cruz
Ranking Member, Senate Committee on Commerce, Science, and Transportation

The Honorable Sam Graves
Chairman, House Committee on Transportation and Infrastructure

The Honorable Rick Larsen
Ranking Member, House Committee on Transportation and Infrastructure

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

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

I am pleased to answer any 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,

L L Fagan

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

Executive Summary

The 2018 Vessel Incidental Discharge Act (VIDA)[1] requires an annual report on the effectiveness of national ballast water management (BWM) requirements. This report provides analyses of (1) the patterns of ballast water (BW) delivery and management; (2) Coast Guard's compliance and enforcement actions regarding BWM regulations; and (3) patterns of biological invasions by marine and estuarine aquatic nuisance species (ANS). It covers the two-year period from January 2020 through December 2021 to demonstrate the effectiveness of the Coast Guard's statutorily mandated BWM regulatory program and validates that enforcement efforts continue to increase BWM and reduce the risk of introducing ANS into U.S. waters.

Although slowed by the COVID-19 pandemic, BW delivery continued to increase, growing 1.4 percent over the prior 2018-2019 reporting period. The percent of BW discharged that was managed also continued to increase, reaching 97.5 percent for overseas[2] and 67.8 percent for coastwise in this reporting period. Likewise, the percent of BW managed via use of a Ballast Water Management System (BWMS) continued to increase, reaching 74.2 percent and 55.7 percent by volume for overseas and coastwise BW discharge, respectively. For the 2020-2021 period, high compliance with BWM reporting requirements continued.

In 2020, the Coast Guard conducted 7,383 Port State Control (PSC) exams, a 15 percent decrease from 8,622 exams in 2019, reflecting the COVID-19 pandemic, and identified 108 BWM deficiencies on foreign vessels. The majority of BWM deficiencies were issued to vessels with inoperable systems or deficient BWM plans, and to vessels that failed to report mandatory BW practices to the National Ballast Information Clearinghouse (NBIC) within specified timeframes.

In 2021, the Coast Guard conducted 8,663 PSC exams, a 17 percent increase from 2020 and exceeding the pre-pandemic 2019 total of 8,622, and identified 204 BWM deficiencies on foreign vessels. During a three-month period focused on enhanced BWM exams, the Coast Guard identified 41 of those deficiencies, and found that 56 percent of vessels surveyed used a Coast Guard type-approved (CGTA) BWMS, while 22 percent of vessels had been granted short term extensions to compliance dates.[3] The majority of BWM deficiencies were issued to vessels with inoperable systems, deficient BWM plans, and those that failed to report mandatory BW practices to the NBIC within specified timeframes. The Coast Guard noted a trend of vessels reporting their inoperable systems prior to arrival, and a 60 percent reduction in the number of discharges of non-compliant BW into waters of the U.S.[4]

Given the lack of a national program to detect ANS in U.S. waters, the Coast Guard and the Smithsonian Environmental Research Center (SERC) developed an invasion-based performance measure for coastal marine waters. The National Exotic Marine and Estuarine Species Information System (NEMESIS) database, which synthesizes available records on ANS detection and

---

[1] Title IX of the Frank LoBiondo Coast Guard Authorization Act of 2018 (Pub. L. No. 115-281)

[2] This report uses the term "Overseas BW" to refer to BW discharged into waters of the U.S. from ships that transited outside of the U.S. and Canadian Exclusive Economic Zones (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.

[3] "Port State Control in the U.S.," 2021 annual report (CG-CVC), page 3.

[4] "Port State Control in the U.S.," 2021 annual report (CG-CVC), page 24.

distribution in U. S. waters, has identified 507 invertebrate and algal ANS that have established populations in coastal marine and estuarine waters of the continental U.S. from the early 1800s through 2021. Analyses of NEMESIS data determined that commercial ship hull fouling (HF) and BW are the sources of 80 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 ability to distinguish between BW and HF as the principal method of transport.

Analysis of the NEMESIS database revealed no records of new ANS invasions for the U.S. Atlantic, Pacific, or Gulf Coasts in the 2020-2021 period. However, the data collected on biological invasions by ANS from searching published records alone is insufficient to draw any short-term or robust conclusions about invasion rates. Often, 10-15 years can elapse between the time of successful invasion and when an ANS is first detected and reported. Therefore, the available record is incomplete and may underestimate the true extent of invasion. This lag time in detection and reporting is well recognized and greatly limits insights on less than decadal time scales. For this reason, the Coast Guard and SERC established a network of sentinel sites[5] at selected U. S. ports to conduct extensive and standardized measurements at frequent intervals to provide the data quantity, quality, and frequency that improve ANS detection.

Evaluating the effects of the national BWM program requires a multi-faceted approach, including (1) changes in treatment of BW by vessels and its immediate effects on the within-tank organisms being discharged, (2) Coast Guard compliance and enforcement actions, and (3) associated changes in invasion rates in U. S. waters. To measure these cause-effect relationships, the Coast Guard measures performance in each of these three areas.

In this report, Section III *Status and Trends in Ballast Water Delivery* focuses on changes in the magnitude and management of BW. Section IV *Status and Trends in Invasions of Aquatic Nuisance Species from Ballast Water* focuses on the observed rate of invasion. In future reports, results from ongoing sampling of BW tanks on commercial ships will be included to present the realized changes in the concentration of organisms in BW.

In conclusion, before 1990, there were no requirements for BWM or reporting, and vessels discharged primarily unmanaged BW. Over the past thirty years, since Congress passed initial BW legislation on commercial vessels, U.S. regulations and management have shifted dramatically.

Although BWM has advanced significantly in recent years, it is 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 in many cases is currently not feasible. 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. Currently, the Coast Guard lacks a comprehensive national program to manage or regulate the transfer and introduction of marine ANS by HF. However, the Coast Guard anticipates addressing this under VIDA. 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.

---

[5] SERC projects under Coast Guard contract.

Commercial Vessel Ballast Water Management (2020-2021)

Table of Contents

I. Legislative Language

This report responds to the language set forth in Title 16 U.S. Code (U.S.C.) Section 4712(f)(4), 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.

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 (NANPCA) (Pub. L. No. 101-646) and later the National Invasive Species Act of 1996 (NISA) (Pub. L. No. 104-332), which reauthorized and amended NANPCA. Together, these statutes are referred to as NANPCA/NISA, and their purpose is to prevent and control infestations of the U.S. coastal and inland waters by ANS.[6]

As directed by these two laws, the Secretary of Transportation (Secretary), acting through the 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[7] and BWM practices[8] established in 2004. Subsequently, the Coast Guard, under the Department of Homeland Security (DHS), published the Ballast Water Discharge Standard Final Rule (Final Rule) in March 2012.[9] The Final Rule includes requirements for BWM by ships (in Title 33 of the Code of Federal Regulations (CFR)) and requirements for type approval of BWMSs used to achieve the discharge standard (in Title 46 CFR). In brief, the new requirements in 33 CFR Part 151 subparts C and D establish BWM requirements for seagoing vessels operating in U.S. waters, i.e., within 12 nautical miles (nm) of the baseline.

As per 33 CFR §151.2025, 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.
- Perform complete BW exchange at least 200 nm from shore in accordance with 33 CFR §151.2025(a)(3).

The requirement to use one of these options was predicated on implementation of a phased-in compliance date as follows (33 CFR §151.2035):

- New ships constructed after (keel-laying date) Dec. 31, 2013 — on delivery.
- Existing ships — first scheduled dry dock after:
    - Jan. 1, 2014 for ships with BW capacity 1500 - 5000 m^3
    - Jan. 1, 2016 for ships with BW capacity < 1500 or > 5000 m^3.

---

6 ANS 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."

7 Final rule titled "Penalties for Non-submission of Ballast Water Management Reports." 69 FR 32864. June 14, 2004

8 Final rule titled "Mandatory ballast water management program for U.S. Waters." 69 FR 44952. July 28, 2004

9 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 Exclusive Economic Zone (EEZ) or the Canadian equivalent, is required to comply with requirements to conduct mid-ocean BW 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, such as 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 Coast Guard to develop and maintain, in consultation and cooperation with the Aquatic Nuisance Species Task Force (Task Force)[10] 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 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, in accordance with 33 CFR §151.2060.[11] Section 1101 of NANPCA/NISA was repealed by VIDA in 2018 but will continue to be in effect until such time as replacement Coast Guard regulations are promulgated as mandated by VIDA.

VIDA, enacted on December 4, 2018, amended NANPCA/NISA section 1102(f) to add a subsection (4) requiring the Coast Guard to submit a report to Congress annually, synthesizing and analyzing the data submitted to the NBIC for the preceding two-year period to evaluate nationwide status and trends relating to BW delivery and management, as well as invasions of ANS resulting from BW. VIDA further directed the Coast Guard 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, covering the 2020-2021 period.

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 both 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 United States. To determine rates of compliance with the reporting requirement, the NBIC uses "qualifying" arrivals as indicated by the Coast Guard's database of

---

[10] 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; the Commandant of the 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.

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

Advance Notices of 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 discharge are drawn from the NEMESIS database created and maintained by SERC. NEMESIS provides extensive information on the distribution of approximately 500 invertebrates,[12] protists,[13] and algae[14] 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 different 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 different databases focusing on different groups of biota. Despite SERC diligently reviewing the scientific literature for new reports for marine and estuarine waters, the current NEMESIS database should not be considered comprehensive or definitive.

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

III. Status and Trends in BW Delivery and Management

This section of the report provides a nationwide summary of the patterns of BWM and discharge in the U.S.

A. Overview

This analysis of the status and trends of BW delivery and management covers the coastal and inland regions of the U.S., including the Great Lakes. Arrivals were classified based on their arrival port and last port of call, while BW discharges were independently classified based on the BW source and discharge locations (see Box 1). Throughout this report, the term "Overseas Arrivals" refers to arrivals directly after operating anywhere beyond the combined U.S./Canadian EEZs, while "Coastwise Arrivals" refers to arrivals directly from last ports or places of call inside the combined U.S./Canadian EEZs. Similarly, "Coastwise BW" refers to BW discharge which was transported between U.S. ports or places without leaving the EEZ. "Overseas BW" is BW discharged to U.S. waters that was transported across the U.S. and Canadian 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). Thus, "overseas" and "coastwise" are not synonymous with "foreign" and "domestic," respectively.

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* BWM reports (BWMRs) received by the NBIC with the number of "qualifying" arrivals as indicated by the Coast Guard's database of ANOA, information that is 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 (DOT), in connection with the Coast Guard, to track most commercial seagoing vessel movements in the country.

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

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

Vessels refer to unique vessels with unique identification numbers (e.g., the International Maritime Organization (IMO), Coast Guard Number). Throughout this report vessels and ships are used interchangeably.

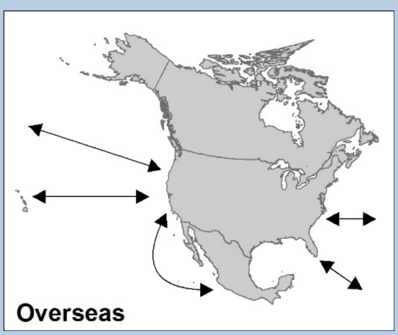
Arrivals refer to ports or places of call that a vessel makes. As such, a single vessel may report multiple arrivals during a year.

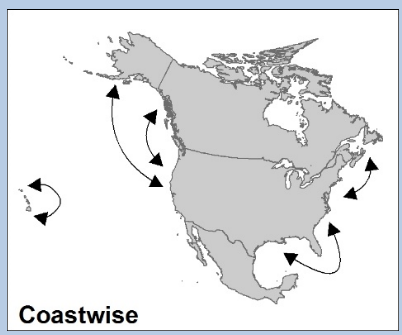
Overseas Arrivals are defined as arrivals directly after operating anywhere beyond the combined U.S./Canadian EEZs. An overseas arrival designation is not related to the country where a ship is registered or owned (e.g., not related to U.S. or foreign flag designation).

Coastwise Arrivals are defined as arrivals directly from last ports or places of call inside the combined U.S./Canadian EEZs. Note, 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 or is transported 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 and stays inside the combined U.S./Canadian EEZs which is then discharged into waters of the United States. 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.





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. Currently, 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 most 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 information required in a BWMR. These changes reflect a progressively better understanding of the information necessary to best track reporting compliance and patterns of BWM and delivery.

B. Period of Record 2020 and 2021

This section provides a summary of the status and trends for BWM covering the 2020 and 2021 period, although data are also shown for preceding years for context. During the period covering 2020 and 2021:

- Compliance by vessels with the BW reporting requirement remained consistently high;
- The total volume of discharged BW continued to increase, following a reduction in discharge due to the COVID-19 pandemic in early 2020;
- The percent of discharged overseas BW and coastwise BW that were managed continued to increase;
- The use of onboard BWMSs continued to increase rapidly; and
- The Coast Guard continued to conduct BWM compliance assessments on a significant number of vessels and to 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 2020 and 2021

The NBIC received 84,347 and 86,939 BWM reports of record[15] in 2020 and 2021, respectively, for a national two-year average of 85,643 reports per year (Fig. 1). The decline in 2020 coincided with the COVID-19 pandemic. Overseas Arrivals accounted for approximately 42 to 43 percent of arrivals in both years. The Gulf and East Coasts received the most reported Overseas Arrivals over the two-year period (13,410/year and 12,786/year), followed in order by the West Coast (5,827/year), Caribbean territories (3,166/year), Pacific Islands (1,044/year), and Alaska (191/year) (Fig. 2A). Reductions in arrivals coinciding with COVID-19 resulted in a decrease in the two-year averages for all regions compared with 2018-2019. When aligned with corresponding NVMC arrivals, these overseas BWM reports suggest a greater than 95 percent compliance with the BW reporting requirement nationally during 2020-2021 (Fig. 3). The Gulf Coast (98.9 percent) and the West Coast (98.0 percent) had the highest two-year averages for compliance with reporting requirements, followed by the East Coast (95.5 percent), Alaska (89.7 percent), Hawaii (89.3 percent), Guam (82.4 percent), Caribbean territories (81.6 percent), and the Great Lakes (69.7 percent) (Fig. 4A).

The comparison of 2020-2021 coastwise BWM reports with corresponding coastwise arrivals reported by NVMC for applicable locations and vessel traffic (see Table A1 for details) indicates greater than 95 percent compliance with the BWM reporting requirement, nationally (Fig. 3). The East, Gulf, and West Coasts received the most coastwise arrivals, with respective two-year averages of 17,264/year, 14,147/year, and 8,074/year (Fig. 2B). Compliance with the reporting requirements during the 2020-2021 period was highest on the West Coast, (98.5 percent) followed by the Gulf (97.5 percent) and East (93.9 percent) coasts, and Alaska (87.4 percent) (Fig. 4B).

---

[15] Excluding duplicate, amended, and spurious submissions.

Figure 1. Number of BWMRs received monthly by the NBIC (July 1999 – December 2021). The dotted vertical line indicates when the Coast Guard promulgated BWM regulations that included penalties for non-reporting, and the expansion of mandatory reporting to include vessels making coastwise arrivals. The 2020-2021 report period is highlighted by the shaded area on the right side.

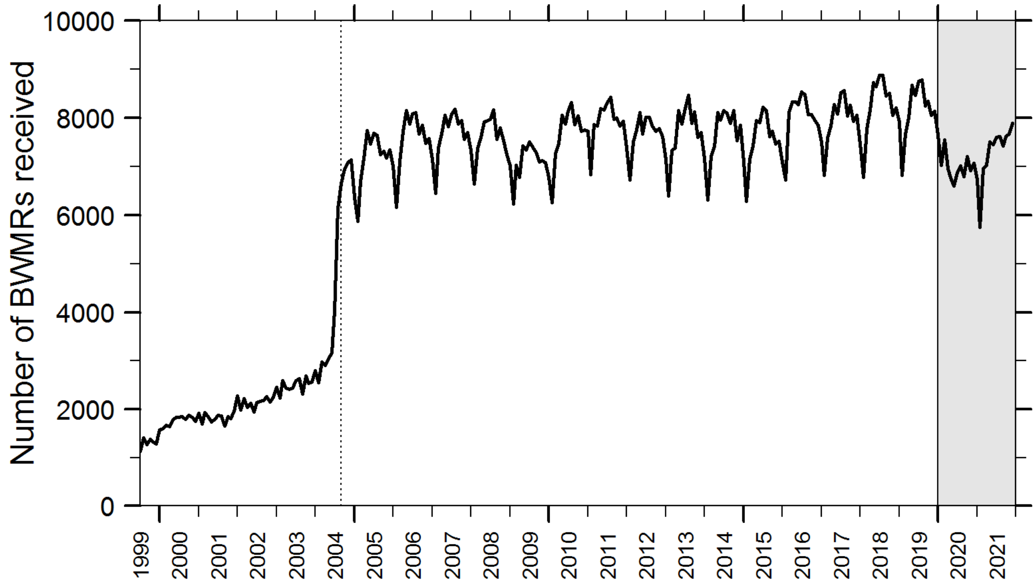


Figure 2. Discharge and management status of U.S. arrivals by coastal region (2018 – 2021). Discharge and management status of overseas arrivals (A) and coastwise arrivals (B; see Box 1) designated according to number of BWMRs received by NBIC for each coastal region. For the purposes of this report, 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.

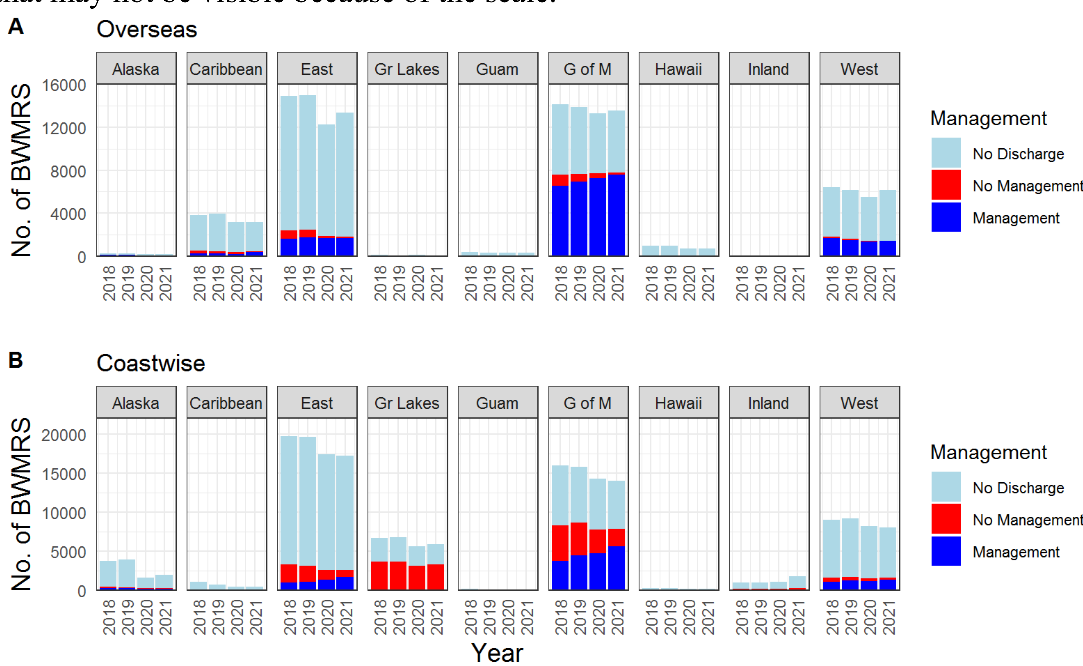


Figure 3. Percent reporting by overseas and coastwise arrivals when compared to the corresponding number of qualifying arrivals of the respective arrival types (see Box 1). Percent reporting determined per month by comparison of NBIC reports to notices of arrival received by the NVMC (see Table A1 for reporting details). The dotted vertical line indicates when the Coast Guard promulgated BWM regulations, including penalties for non-reporting, and the expansion of mandatory reporting to include vessels making coastwise arrivals. The 2020-2021 report period is highlighted by the shaded area on the right side.

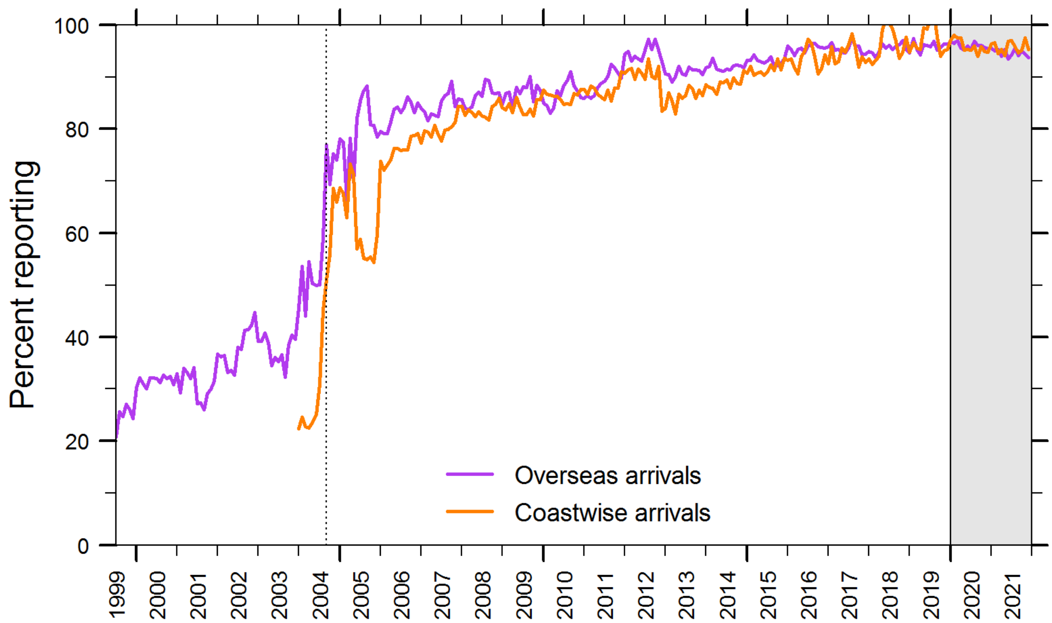
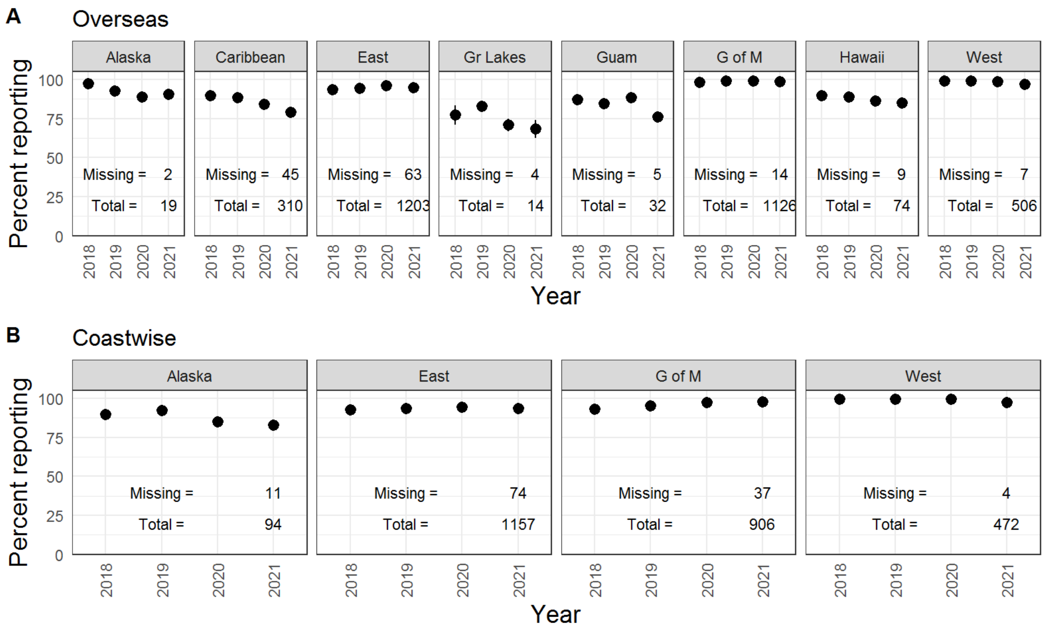


Figure 4. Compliance with reporting requirements by arrivals according to coastal region (2018 – 2021). Percent reporting (± 1 standard error of the mean [SEM]) by year and coastal region. BWM reports from overseas arrivals (A) and coastwise arrivals (B), compared with ANOA submitted to NVMC. To illustrate differences in traffic to each region, the mean monthly number of BWMRs that were missing and the mean monthly number of ANOAs are indicated 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 Captain of the Port Zone (COTPZ) or are populations that do not have an appropriate standard to compare against.

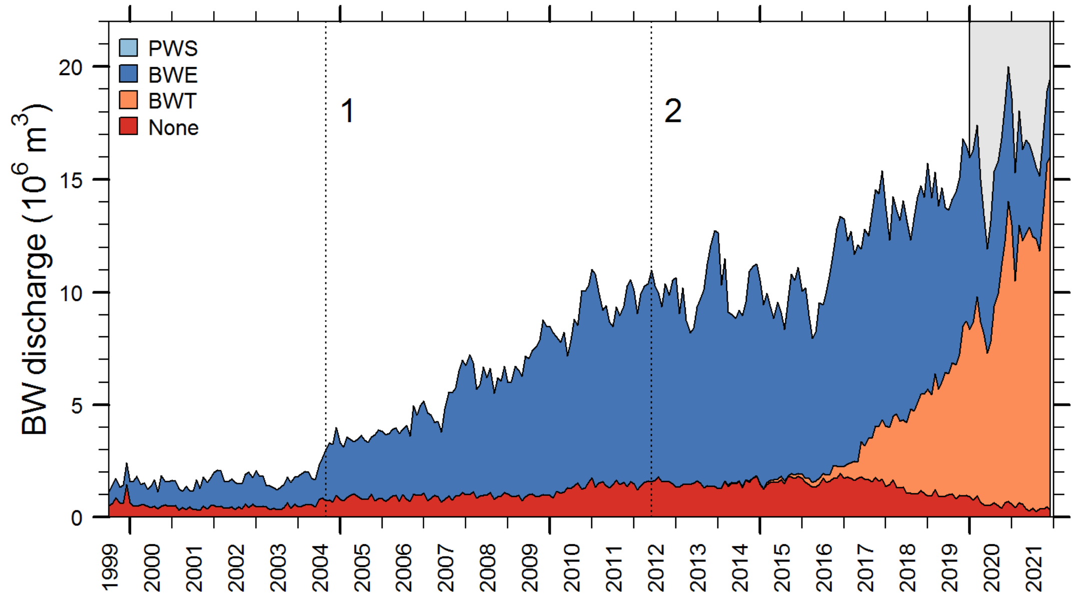


<u>2. The total volume of BW discharged to the U.S. continued to increase, following a reduction in discharge due to the COVID-19 pandemic in early 2020.</u>

Cumulatively, vessels arriving to U.S. ports and places reported discharging 189.5 and 204.0 million m^3 of overseas BW in 2020 and 2021 (Fig. 5) and 178.9 and 188.7 million m^3 of coastwise BW in 2020 and 2021 (Fig. 6). This change reflects an increase[16] in average yearly discharge of 15.2 percent for overseas discharges compared with the prior two-year period (2018 and 2019), and a 10.7 percent decrease in coastwise discharge, coinciding with COVID-19 shipping slowdowns. Although increases in coastwise reporting compliance (Fig. 3) account for a small part of this increase, the majority represents an 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 arrivals that discharge BW (Fig. 7). This change was particularly noticeable in 2020-2021 when the per capita discharge volume increased while overseas arrivals decreased due to the COVID-19-related economic slowdown (Fig. 1) during this time, resulting in a peak in overseas discharge (Fig. 7A).

[16] Throughout this report all measures of "percent change" compare current to former time points are the relative percent change, i.e., $\%\ Change = \frac{Current - Former}{Former} \times 100\%$.

Figure 5. Monthly reported discharge of BW that originated from overseas (1999 – 2021), by type of BWM (i.e., PWS: BW from a U.S. Public Water System, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported). 1: Penalties for non-reporting were promulgated. 2: Coast Guard established concentration-based discharge standards.



Of total coastwise discharge, the percentage discharged to coastal regions (Fig. 6A) increased from 48.1 percent in 2005 to 73.1 percent in 2020 and 71.0 percent in 2021. At the same time, the volume of coastwise discharge to the Great Lakes and Inland waterways remained relatively stable, averaging 54.2 ± 1.4 million m^3 per year (mean ± SEM; 16 years) (Fig. 6B). 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 6. Monthly reported coastwise discharge from vessels (July 1999 – December 2021) by type of BWM (i.e., BW from a U.S. Public Water System (PWS), BW Treatment (BWT), BW Exchange (BWE), None: no BWM was reported). Coastwise discharge to coastal regions (A). Coastwise discharge to inland regions (i.e., the Great Lakes and rivers; B), 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 promulgated. 2: Coast Guard established concentration-based discharge standards.

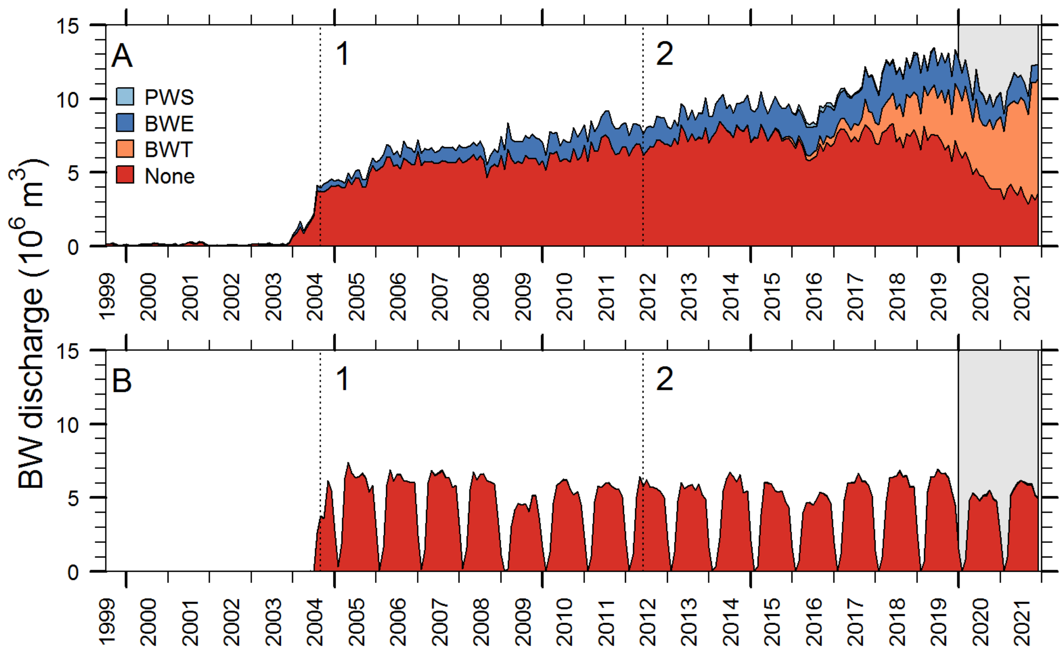
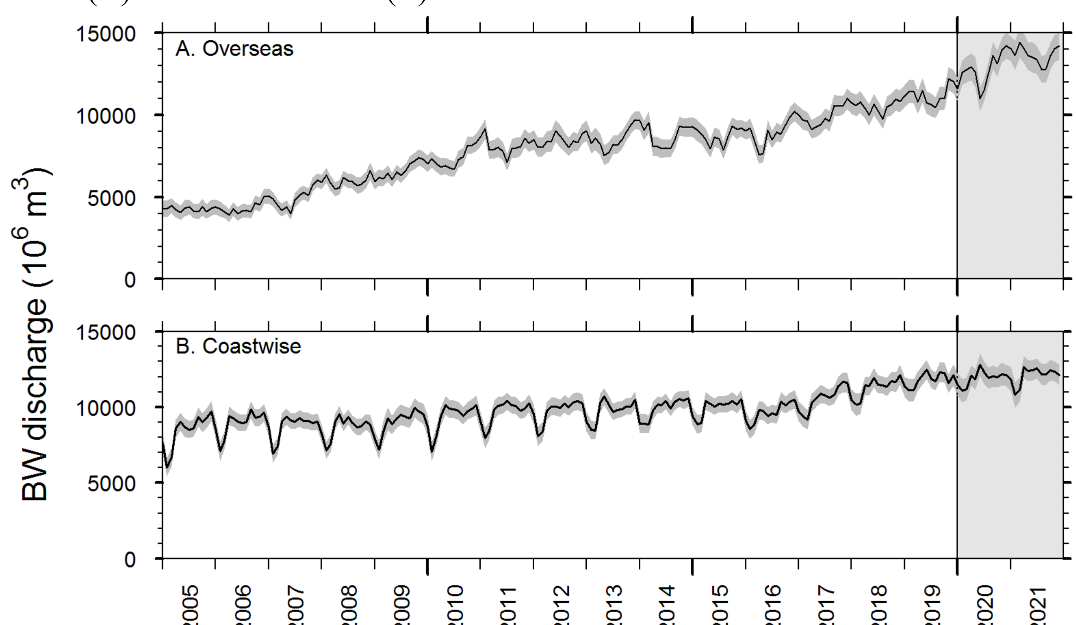
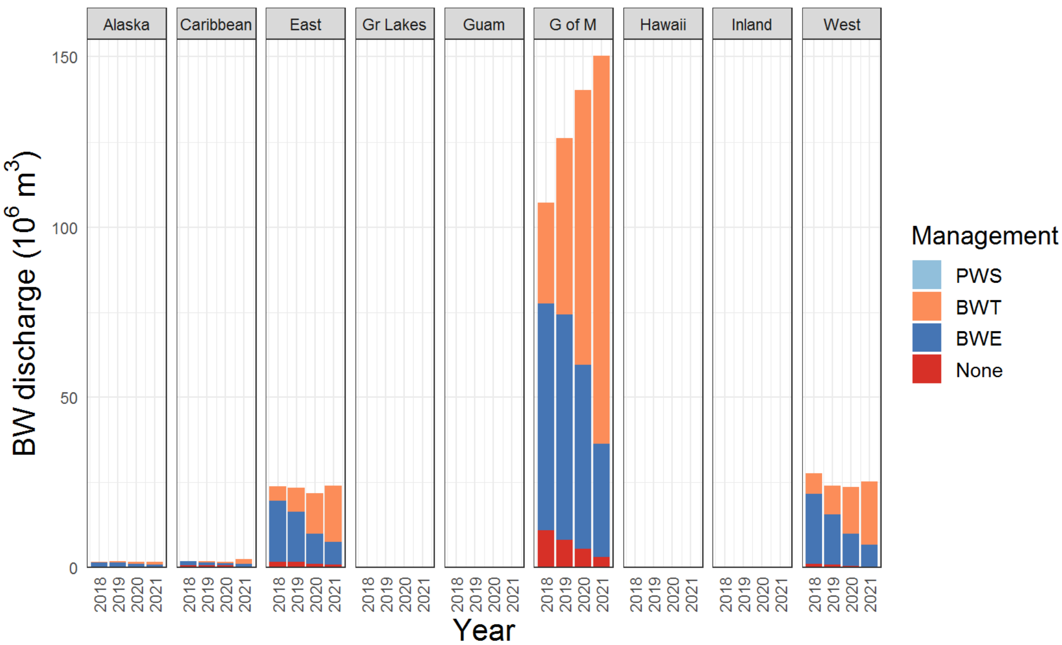


Figure 7. The per capita discharge volume of discharging arrivals from 2005 – 2021. The monthly mean discharge volume (shaded area is the 95 percent Confidence Interval) by vessels discharging overseas BW (A) and coastwise BW (B).



Increases in national BW discharge continue to be driven by increases in BW discharge on the Gulf Coast. The percentage of overseas BW discharge received by the Gulf Coast increased from 65.8 percent of reported overseas discharge in 2018, to approximately 74 percent by 2021 (Fig. 8). Coastwise BW discharge has remained more stable, increasing from 52.5 to 55.1 percent in 2020 before dropping to 53.0 percent of all coastwise discharges in 2021 (Fig. 9).

Figure 8. Total reported overseas BW discharge in 2018 - 2021 by type of BWM (i.e., PWS: BW from a U.S. Public Water System, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported) and coastal region.

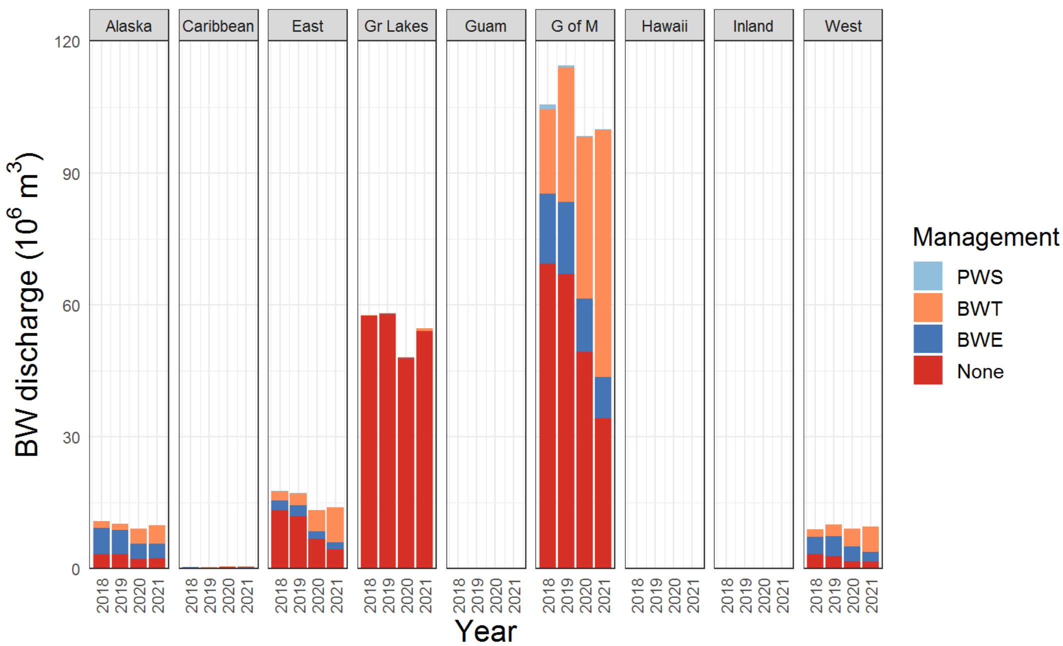


<u>3. The percentages of discharged overseas BW and coastwise BW that were managed continued to increase.</u>

Among seagoing vessels, the proportion of discharging arrivals that report managing their BW discharge by use of an approved method (BWE, BWMS, Alternate Management System (AMS), or PWS) was much greater for overseas arrivals in 2020 and 2021 (92 percent and 95.7 percent; Fig. 2A) than for coastwise arrivals (60.5 percent and 71.1 percent; Fig. 2B). The reduction of BWE as the dominant reported BWM type (dropping from 39.0 percent in 2020 to 23.3 percent in 2021) and rise of BWT (either CGTA, BWMS, or AMS) is of particular importance. Since 2018, the percentage (and overall volume) of overseas BW discharge reported as undergoing onboard BWT increased from 24.8 percent to 56.7 percent in 2020 and 74.2 percent in 2021 (Figs. 5 and 8). The long-term decrease in the percentage of coastwise BW discharge that was unmanaged continued (46.2 percent in 2020 and 32.2 percent in 2021; Figs. 6A & 9). The use of BWT by seagoing vessels to manage coastwise BW has also continued to increase, rising from 37.5 percent in 2020 to 55.7 percent in 2021 (Figs. 6A & 9). The adoption of BWT appears to be driving much of the increase in management of coastwise BW, as well as related reductions in BWE. Coastwise BW discharge by seagoing vessels using BWE decreased precipitously from 96.5 percent of managed discharge in 2015 to 29.7 percent in 2020 and 17.7 percent in 2021.

Coastwise ship transits do not travel beyond the EEZ (see Box 1), and therefore, have no opportunity to conduct proper BWE beyond 200 nm, as required under the federal regulations in 33 CFR Part 151, subparts C and D. Nevertheless, despite the absence of mandatory BWE for coastwise BW discharge under Coast Guard regulations, other regulatory authorities do require BWE in some instances. For example, California regulations and the U.S. Environmental Protection Agency (EPA) Vessel General Permit require BWE beyond 50 nm from shore along the North American West Coast by certain vessels. Furthermore, the Coast Guard requires vessels to report all uptake and discharge of BW, regardless of transit type or whether some sort of BWM has been undertaken.

Figure 9. Total reported coastwise BW discharge 2018 - 2021 by type of BWM (i.e., PWS: BW from a U.S. Public Water System, BWT: BW Treatment, BWE: BW Exchange, None: no BWM was reported) and coastal region. Coastwise discharge to inland regions (i.e., the Great Lakes and inland rivers), is mostly by non-seagoing vessels, which are currently exempt from BWM requirements.



The most common reason provided for the discharge of unmanaged BW to the Gulf Coast and the Caribbean was 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 exchange of BW; and in Alaska and Hawaii, safety exemptions were significant responses (Fig. 10). Non-management of coastwise BW discharge is also prevalent throughout the Nation, with regulatory, route, and safety exemptions provided as the primary reasons for not conducting BWM (Fig. 11). The disparity between the amounts of regulated overseas and coastwise BW being managed prior to discharge will remain significant until BWM methods, other than conducting BWE beyond 200 nm, become available for vessels carrying coastwise BW. BW carried by non-seagoing vessels (approximately 28 percent of all coastwise discharge), and particularly those vessels that operate exclusively among the Great Lakes (i.e., Lakers) (Fig. 6B), is likely to continue to go unmanaged until practicable methods become available for such vessels to meet BWM requirements. The 2012 Final Rule[17] exempted non-seagoing vessels from the requirement to manage BW prior to discharge. Information and evidence on the availability of technology that can be practicably installed, the cost of

---

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

such technology, and the benefit of requiring such vessels to manage BW may inform new regulations under VIDA. Notably, VIDA includes a provision for the Great Lakes and Lake Champlain Invasive Species Program to investigate this issue.

Figure 10. Unmanaged Overseas BW discharge according to the reason reported for non-management of BW. Unmanaged BW discharge by volume (A) and proportion (B) by year and coastal region. The reported reasons were: Equipment Failure (equipment failure/malfunction), MidOcean (claims that the BW source was beyond 200 nm of any shore, so were not required to conduct BWE, and that the vessel lacked an onboard 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 determined that BWE is not safe to conduct due to vessel design), and Safety Weather (a vessel's Master/Operator determined that BWE was not safe to conduct due to weather and/or sea conditions).

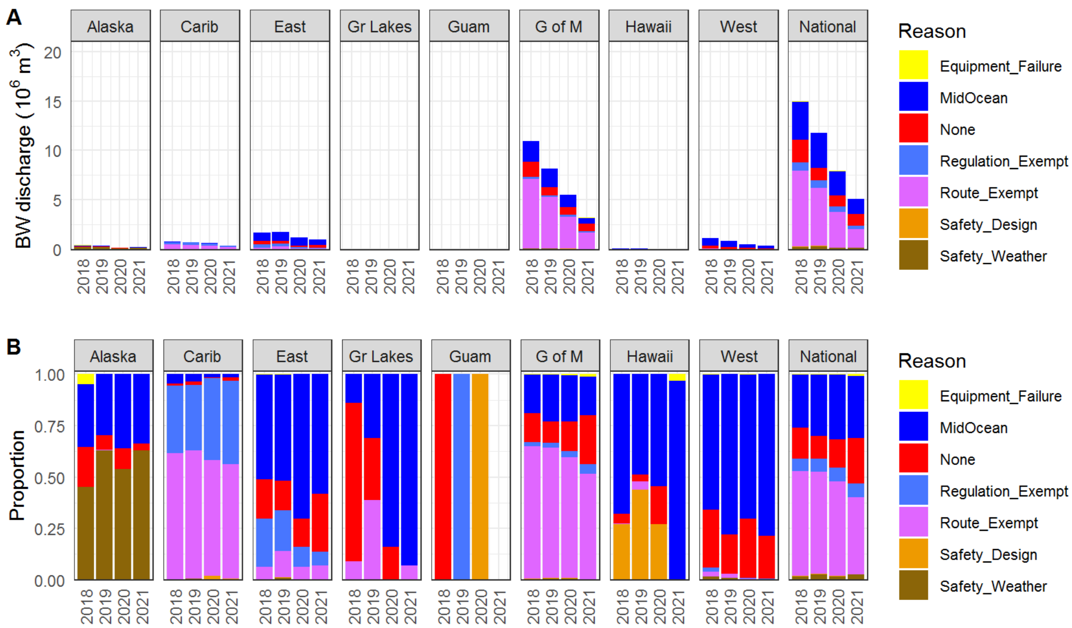
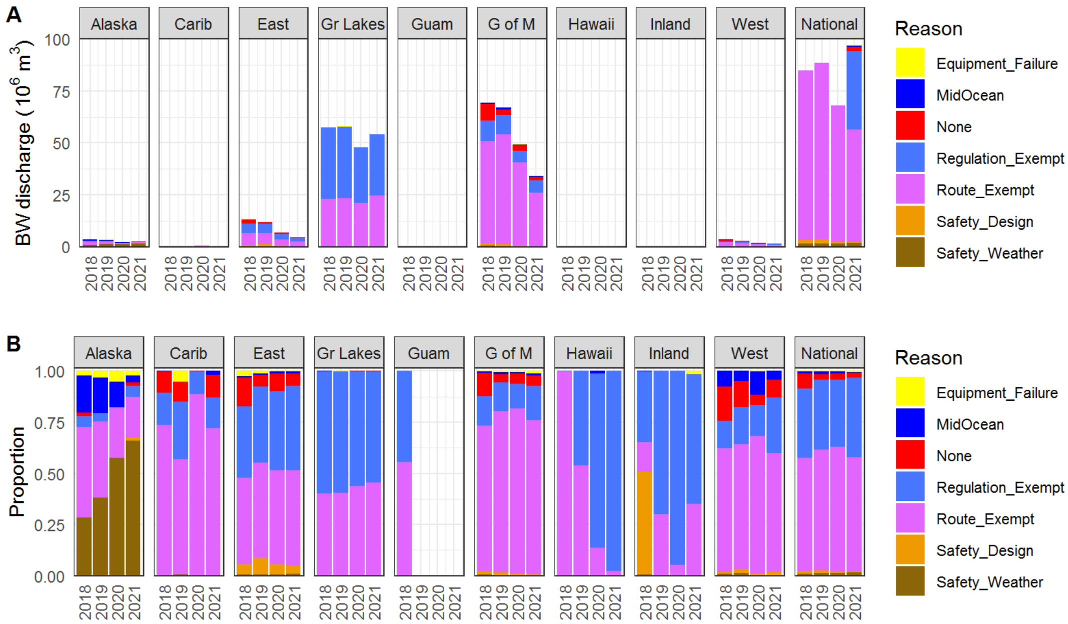


Figure 11. Unmanaged coastwise BW discharge by the reason report for non-management of BW. Unmanaged BW discharge by volume (A) and proportion (B) by year and coastal region. The reported reasons were: Equipment Failure (equipment failure/malfunction), MidOcean (claims that the BW source was beyond 200 nm of any shore so did not required to conduct BWE and that the vessel lacked an onboard 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 determined that BWE is not safe to conduct due to vessel design), and Safety Weather (A vessel's Master/Operator determined that BWE was not safe to conduct due to weather and/or sea conditions).



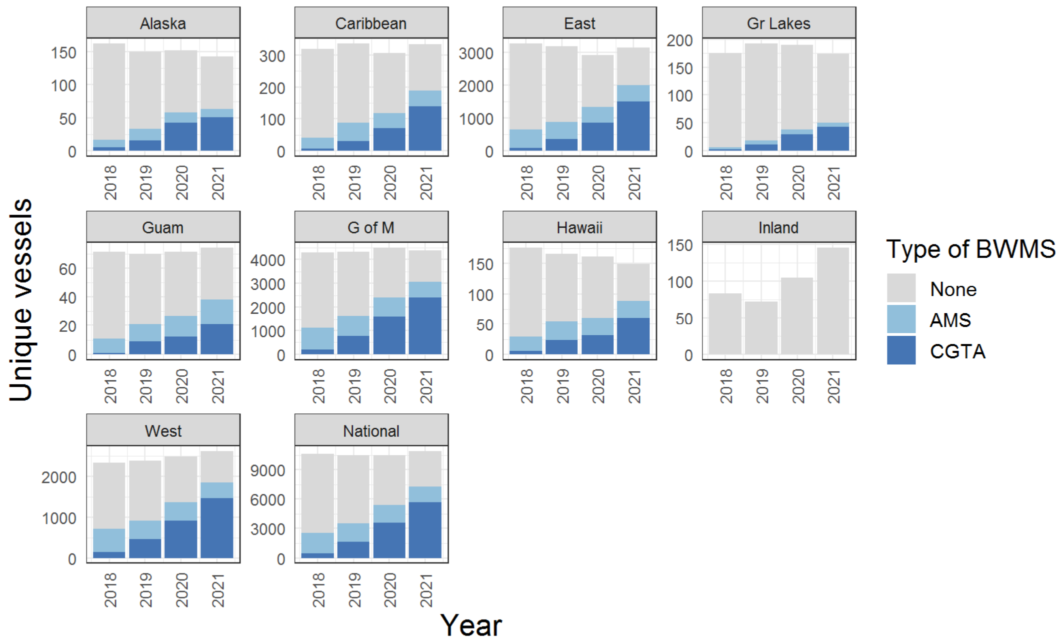
4. The use of onboard BWMS continued to increase rapidly.

The volume and percentage of overseas BW discharge reported as undergoing management by use of an onboard BWMS increased from 40.4 million m^3 (24.8 percent) in 2018 to 107.5 million m^3 (56.7 percent) in 2020, reaching 151.4 million m^3 (74.2 percent) in 2021 (Figs. 5 and 8). Although at a slower pace, the use of onboard BWMS for coastwise BW discharge from seagoing vessels increased, from 24.6 million m^3 (17.1 percent) in 2018 to 49.1 million m^3 (37.5 percent) in 2020, and 74.6 million m^3 (55.7 percent) in 2021 (Figs. 6A and 9).

The number of unique vessels submitting BWM reports to the NBIC remained relatively stable in 2020 (10,469 vessels) and 2021 (10,916 vessels), yet the proportion of vessels reporting an onboard BWMS increased from 51.2 percent to 66.8 percent (Fig. 12). The number of vessels with (CGTA) BWMSs installed increased from 1,658 to 5,697 between the beginning of 2020 and the end of 2021. The number of vessels with an AMS decreased from 1,888 to 1,591 during this same two-year time period. These increases demonstrate a significant shift towards installing CGTA BWMS (78.2 percent) rather than AMS (21.8 percent) during this period, compared to the prior two-year period. Given the substantial increases in overseas BW discharge, and therefore increased potential for invasion, the expanding use of onboard BWMS is particularly noteworthy.

U.S. PWS water was used infrequently as a method of BWM (399 BWM reports and 0.002 percent of total volume) during the 2020-2021 period. Vessels using this method were primarily discharging coastwise BW to the U.S. Gulf Coast (Figs. 8 and 9). No vessels reported valid discharge to a BW treatment facility during the two-year period.

Figure 12. Number of unique vessels in 2018 – 2021 with BWMSs. The unique vessels that reported having a CGTA BWMS, an AMS, or no BWMS (None), by year.



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

<u>a. 2020</u>: There was a noticeable decrease in vessel arrivals to the U.S., which correlated to an overall decrease in the number of PSC 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 on board foreign vessels visiting ports in the U.S, a nine percent decrease from 2018, the most recent prior year for which data are available. As in 2018, the majority of the deficiencies resulted from vessels arriving with inoperable BWMSs (42 percent). Incomplete BWM plans (16 percent) and failures to report BWM practices to the NBIC (13 percent) also ranked high among deficiencies noted by Coast Guard PSC Examiners. In most cases where the discharge of BW could pose a threat to the marine environment, vessels were required to modify their cargo plans to facilitate safe and compliant BW discharges, leading to costly unforeseen port scheduling conflicts.

<u>b. 2021</u>: The Coast Guard conducted 8,663 PSC exams, an increase of 17 percent from 2020, which include examination of vessel compliance with BWM requirements. The Coast Guard identified 204 BWM deficiencies on board foreign vessels visiting ports in the U.S. As in 2020, the majority of the deficiencies (42 percent) resulted from vessels arriving with inoperable BWMSs. Incomplete BWM plans (22 percent) and failures to report BWM practices to the NBIC (13 percent) also ranked high among deficiencies noted by Coast Guard PSC Examiners. In most cases

where the discharge of BW could pose a threat to the marine environment, vessels were required to modify their cargo plans to facilitate safe and compliant BW discharges, leading to unforeseen port scheduling conflicts. By incorporating BWMS into their company Safety Management System (SMS), vessel operators can more effectively maintain their crewmembers' BW training and competencies to help ensure the vessel complies when it arrives to port.

C. Conclusions

Over the past 30 years, since Congress passed initial BW legislation on commercial vessels in 1990, U.S. regulations and management have shifted dramatically. Before 1990, 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 and coastwise arrivals exceeded 95 percent compliance with the reporting requirements during 2020 and 2021.
- Most vessel arrivals report BWM, including no discharge upon arrival, use of BWE, or use of BWT (AMS or CGTA BWMS).
- Of the total volume of overseas BW discharge reported in 2021, over 97 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 greater than 74 percent in the past seven years (2015-2021), underscoring the 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 still 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 and others per 33 CFR §151.2015). While BWE is an allowable BWM option (33 CFR §151.2025 and §151.2035), vessels will not be required to divert transit beyond 200 nm or delay voyages to conduct BWE, unless required by the Captain of the Port pursuant to 33 CFR §151.2040(b) or entering the Great Lakes (EPA 2013 VGP part 2.2.3.6.6 Exemptions). Additionally, under another current exemption, some vessels do not conduct BWE due to safety considerations, either in general (i.e., vessel is not designed to enable safe BWE) or due to voyage-specific circumstances (i.e., when 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 204.0 million m^3 in 2021 (a 387 percent increase). This increase is associated primarily with changes in traffic to the Gulf Coast, with shifts in commerce patterns, and the expansion of the Panama Canal to provide 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. In 2021, coastwise BW discharge volumes began to rebound to pre-COVID rates.

The current upward trajectories in the adoption and usage of BWT suggest that organism concentrations (numbers of living organisms per unit volume of BW at discharge) will continue to decrease in overseas BW discharge. Increasing implementation of BWT on more ships will address many of the BWM gaps that exist for coastwise BW discharges, further decreasing organism concentrations in discharges from these vessels. However, the increase in total BW discharge will have some compensatory effect in total propagules (i.e., eggs, larvae, juvenile/adult life stages of biota) delivered, since this discharge 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 continuing to reduce the 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 also expected to be related to increases in BW discharge volume over time.

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

A. Overview (1990-2021)

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; Bailey et al. 2020). Many of the organisms transported in BW are also transported as HF; however, it is not possible to completely separate the two transport mechanisms in an analysis such as this one. The detection rate of new aquatic invasions increased dramatically in recent decades. Since 1990, the total number of new ANS reported in U.S. coastal waters 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. A goal for BWM is preventing new invasions and, thus, a critical endpoint for performance analysis. Although we can measure direct reductions in organism concentrations in BW due to management, and this effort 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 effort 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 the Coast Guard 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, West, and Gulf Coasts); 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 ongoing 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. The NEMESIS date of publication is 2018, but the data are regularly updated and this report reflects data through 2021. It is important to note that the primary focus of NEMESIS is on invertebrates and algae, because most known 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 report focuses on ANS in marine and estuarine habitats, and on invertebrates and algae in particular. The Coast Guard and SERC are working 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, SERC and the Coast Guard 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 evaluate changes in detection rate with statistical confidence (National Research Council 2011). Measures at the sentinel sites serve this purpose. Currently, one sentinel site is 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). Two additional sentinel sites were initiated in 2021 to represent different regions and environmental conditions in U.S. waters, including (a) Ketchikan, AK (North Pacific), to represent high latitude and potential poleward spread of invasions and (b) Duluth/Superior Harbor, MN/WI (Great Lakes), funded through the EPA Great Lakes Restoration Initiative, to extend this program to U.S. Great Lakes. Future sites in the U.S. Pacific Islands (e.g., Hawaii) or Caribbean Islands (e.g., Puerto Rico) are under consideration, depending upon 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 the NANPCA that initiated the federal BWM program. Specifically, we evaluate the temporal changes in the number of newly detected ANS to each coast and the continental U.S. that are associated with BW and HF from 1990-2021, as well as the number of these detected in the most recent two-year period 2020-2021, as specified by VIDA. The longer-term analysis for 1990-2021 establishes a baseline to evaluate subsequent rates of change in response to BWM.

This 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 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 number of focused 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; Ruiz and Hewitt 2002; Bailey et al. 2020).

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, 507 ANS of invertebrates and algae are documented to have established populations in coastal marine and estuarine waters of the continental U.S. through 2021. The record of ANS detection began in the early 1800s and accelerated in modern time, and the quality of the record is uneven over time and among geographic regions (Ruiz et al. 2000, 2015). Analyses of NEMSIS data determined that commercial ships, including both BW and HF combined, are a vector (i.e., mechanism of introduction) for approximately 80 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 507 marine and estuarine ANS known for the continental U.S., 60 percent may have been introduced initially by BW as a possible vector, but may also have been introduced through HF, and 62 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 limited ability to distinguish between BW and HF as the principal mechanism of transport, because they are associated with both (See Box 2).

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.

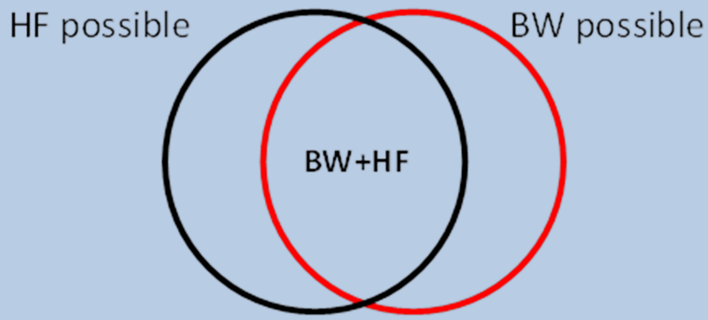


Table 1. Minimum Number of Marine and Estuarine ANS with Established Populations and Associated Vectors, through 2021. Shown are the numbers of ANS, including invertebrates and algae, documented for marine and estuarine waters of the continental U.S. and from each coast. Also shown are the numbers (and 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 the numbers in the various columns and rows do not add up to the listed total numbers, 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 BW and HF.

	Contin. U.S.	West Coast	East Coast	Gulf Coast
Total number of marine ANS (all vectors)	507	342	215	105
Number of Marine ANS with shipping as a possible vector	406 (80%)	275 (80%)	172 (80%)	84 (80%)
Number with BW as a possible vector	303 (60%)	196 (57%)	131 (61%)	62 (59%)
Number with HF as a possible vector	316 (62%)	214 (63%)	134 (62%)	69 (66%)

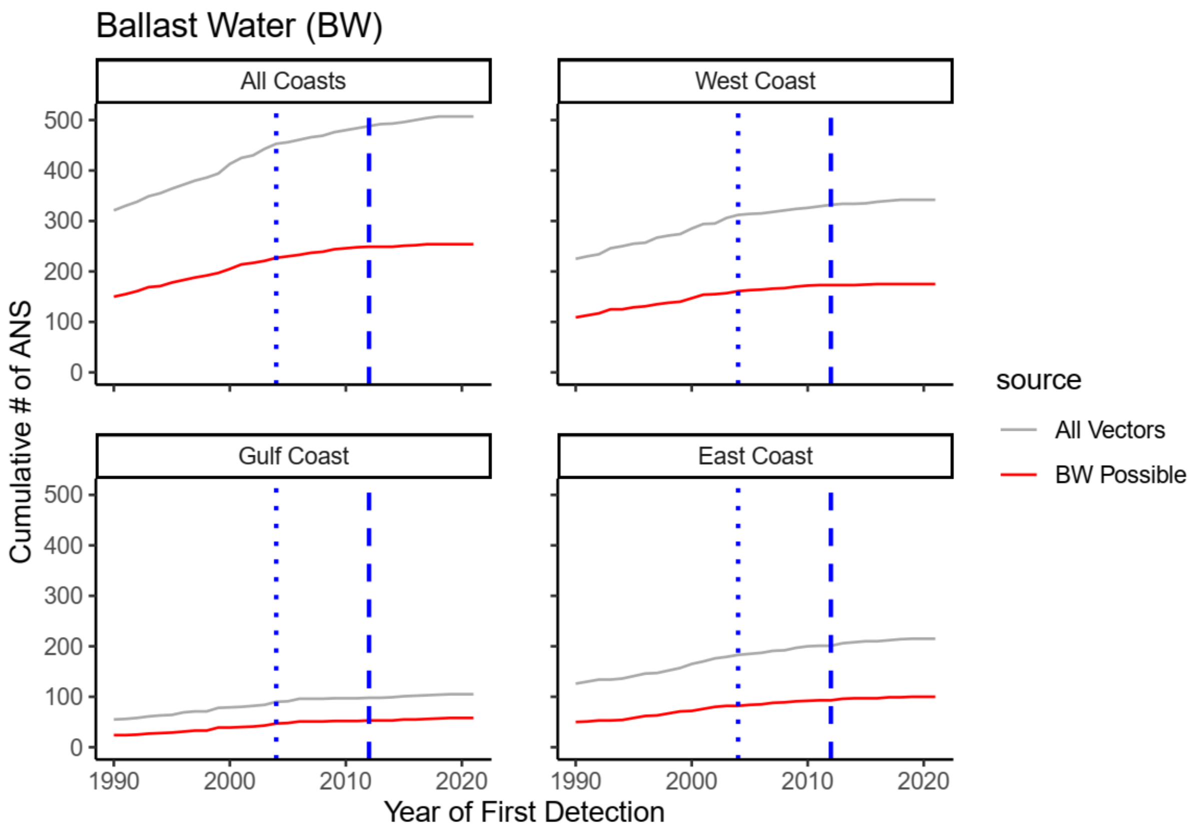
Analyses of NEMSIS data determined that for individual coasts, the documented numbers of ANS (for invertebrates and algae) range from 105 to 342 when all vectors are considered (Table 1). Similar to the continental scale, BW and HF contribute strongly to ANS at the coast level. Approximately 80 percent of all ANS are associated consistently among the three coasts with ships (BW + HF) as the possible vector, with approximately 57-61 percent associated with BW, and approximately 62-66 percent 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 approximately 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 here indicate the potential contribution of each BW and HF alone for the documented ANS to date.

5. ANS Invasions Attributed to BW (1990-2021)

Of the 507 marine ANS documented above, 220 (43 percent) of these species were first detected in U.S. coastal waters from 1990-2021, including 102 on the West Coast, 91 on the East Coast, and 52 on the Gulf Coast (with some ANS occurring on multiple coasts). For these new ANS detected since 1990, 62 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 Fig. 13. Since 1990, the cumulative total number of new ANS associated with BW as a possible vector has increased for the West Coast (62 percent), East Coast (65 percent), and Gulf Coast (66 percent).

Figure 13. Cumulative number of new ANS per year associated with BW as a possible vector (red line), compared to all introductions by any vector (gray line), since 1990. Shown are numbers for invertebrates and algae. Data are from NEMESIS (Fofonoff et al. 2018). Vertical lines correspond to the year of implementation for two key BW regulations by the 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) and (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).



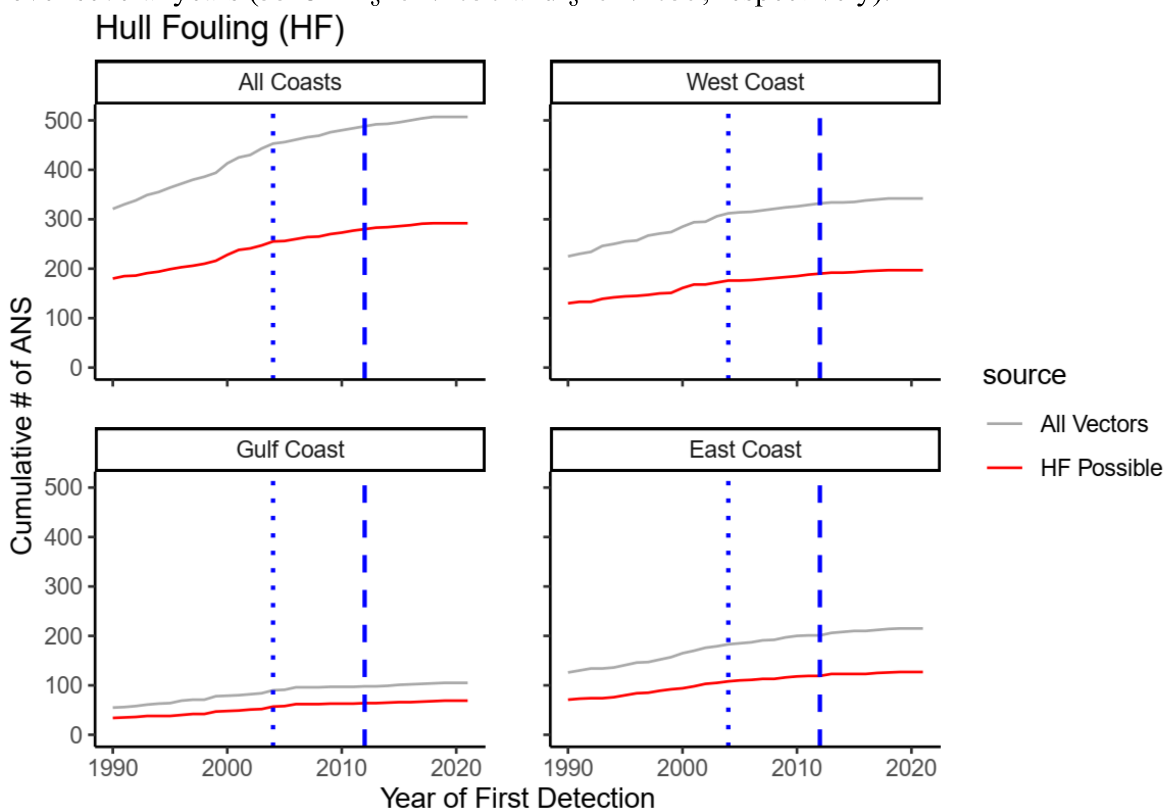
Of critical importance, many of these documented species could have arrived by one of multiple vectors, including but not limited to BW or HF, and uncertainty exists about the relative contribution of each. In many instances, multiple vectors can transfer a particular species; however, the exact vector that produced an observed invasion is often unknown. Thus, Fig. 13 depicts the potential contribution of the BW vector to the new ANS detected per year relative to the total number (red and gray lines, respectively) for each geographic region. The shapes of the ANS curves in Fig. 13 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 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 the rapid implementation demonstrated by NBIC in this report (see Section A) is expected to further decrease the likelihood of new ANS invasions from BW.

While these results are encouraging, it is still premature to draw conclusions about any changes in detection rates for multiple reasons. First, there is a lag time in that 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; Bailey et al. 2020). As a result, we should expect ANS detection rate 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 the 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 test for and evaluate change in a way that adequately controls for detection lag time and improves temporal and geographic resolution.

6. ANS Invasions Attributed to HF (1990-2021).

When observed detection rates since 1990 are plotted (Fig. 14), 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 period, 61 percent were associated with HF as a possible vector at a continental scale. For individual coasts, these percentages ranged from 59 percent (West Coast) to 69 percent (Gulf Coast) and 64 percent (East Coast) 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.

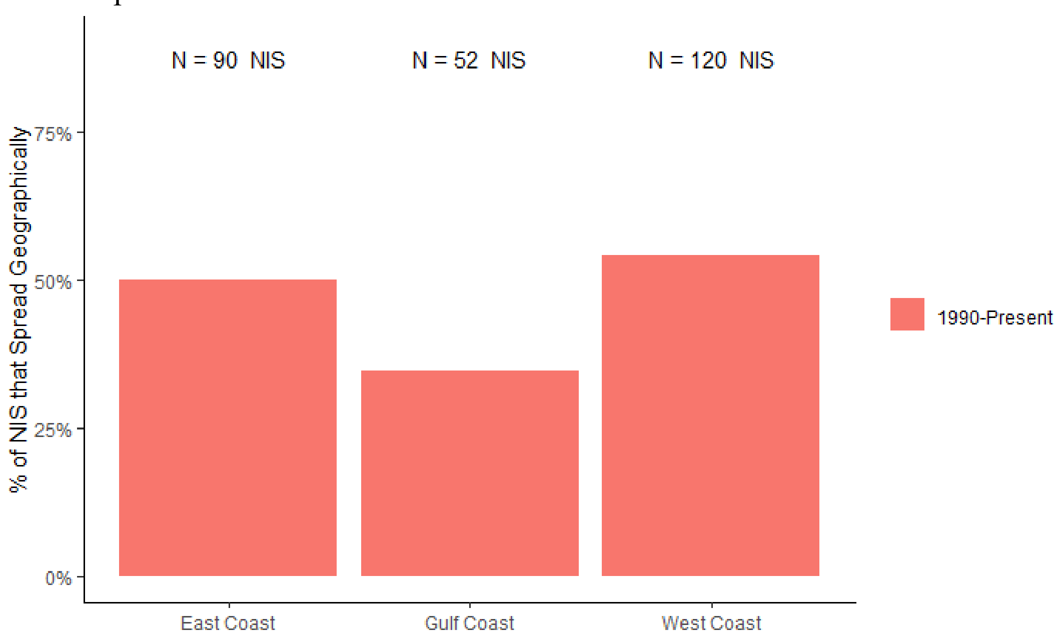
Figure 14. Cumulative number of new ANS per year associated with HF as a possible vector (red line), compared to all introductions (gray line), since 1990. Shown are numbers for invertebrates and algae. Data are from NEMESIS (Fofonoff et al. 2022). Vertical lines correspond to the year of implementation for two key BW regulations by the 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) and (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 (1990-2021)

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 Coasts. Although some ANS can spread by larval dispersal, many species cannot, 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. Fig. 15 shows the percentage of species that spread, expanding their geographic ranges from 1990-2021. This percentage includes only those ANS that were new invasions (i.e., not previously recorded on the U.S. coast) during this 31-year period, to evaluate spread of these recent ANS invasions. For all three coasts combined, over 50 percent of ANS are known to have expanded their ranges during this time. For the three individual coasts, geographic spread beyond the initial bay of introduction has been documented for 35-54 percent of the recent ANS invasions. 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 15. Percent of ANS (invertebrates and algae) introduced to each coast that have spread geographically to new bays along each coast from 1990-2021, beyond their initial site of invasion. Data are from NEMESIS (Fofonoff et al. 2022). In the figure, N represents the number of species in each sample.



a

B. New ANS Invasions for the Period 2020-21

The NEMESIS database detected no new ANS invasions (established, reproducing populations) at the coast or national level within the continental U.S. since 2018. While this result may suggest a slowdown of new ANS in recent years, as suggested in Fig. 13 and Fig. 14, possibly due in part to BWM, additional measures are required to evaluate whether this is a robust and sustained pattern. There are previous years with no reported invasions, and there can be significant lag times in detection even when invasions continue to occur.

For example, ongoing analysis of the literature by NEMESIS through the period from 2018 to 2021 resulted in an increase in the database of the number of documented ANS in coastal waters of the continental U.S. from 479 to 507 species of invertebrates and algae, representing a 5.6 percent increase. This increase was a net change of 28 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 three years. All but four of these new ANS records were dated prior to 2018 but had not been resolved previously. This issue was due to the common lag time in reporting, resulting from the time it takes for researchers to complete, report, and publish analyses, after which new records become accessible. When added to the NEMESIS database, most "new" ANS records in U.S. waters were actually detected in the last decade, and some first records extend much further back in time, but these were not available earlier due to this reporting lag time. Thus, as indicated earlier, it often takes 10-15 years for many new ANS to be reported and evaluated as new invasions for previous time periods.

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

C. Conclusions

The available data indicate that very few new ANS have been detected in the last several years (especially since 2018) based on NEMESIS data. While encouraging, we urge considerable caution 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 10-15 years to detect new invasions, and the search effort and ANS detection rate are 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 and also improve and validate current estimates of detection rates. Such standardized measures are currently underway, although at only a single location in each of five separate U.S. regions.

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 in many cases is currently not feasible. 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 Coast Guard lacks a comprehensive national program to manage or regulate the transfer and introduction of marine ANS by HF. While the IMO (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 (i.e. under VIDA) 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.

V. References

Ashton, G., I. Davidson, & G.M. Ruiz (2014) Transient small boats as a long-distance coastal vector for dispersal of biofouling organisms. *Estuaries Coast* 37:1572-1581 DOI: **http://doi.org/10.1007/s12237-014-9782-9**.

Bailey S.A., L. Brown, M.L. Campbell, J.T. Carlton, J. Canning-Clode, N. Castro, P. Chainho, F.T. Chan, J. Creed, A.Curd, J. Darling, P. Fofonoff, B.S. Galil, C.L. Hewitt, G.J. Inglis, I. Keith, N.E. Mandrak, A. Marchini, C.H. McKenzie, A. Occhipinti, H. Ojaveer, L. Pires-Teixeira, T. Robinson, G.M. Ruiz, K. Seaward, E. Schwindt, M. Son, T.W. Therriault, A. Zhan (2020) Trends in the detection of aquatic non-indigenous species across global marine, estuarine, and freshwater ecosystems: a 50-year perspective. *Diversity and Distribution* 26:1780-1797.

Carney K.J., M.S. Minton, K.K. Holzer, A.W. Miller, L.D. McCann, G.M. Ruiz (2017) Evaluating the combined effects of ballast water management and trade dynamics on transfers of marine organisms by ships. *PLOS ONE* 12:e0172468 DOI: http://doi.org/10.1371/journal.pone.0172468.

Fofonoff, P.W., G.M. Ruiz, B. Steves, & J.T. Carlton (2003) In Ships or On Ships? Mechanisms of transfer and invasion for non-native species to the coasts of North America. In: Invasive Species: Vectors and Management Strategies, G. M. Ruiz and J.T. Carlton (editors), pp. 152-182. Island Press, Washington.

Fofonoff, P. W., G.M. Ruiz, B. Steves, C. Simkanin, & J.T. Carlton (2018) National Exotic Marine and Estuarine Species Information System. http://invasions.si.edu/nemesis/. Access Date: 4 April 2022.

International Maritime Organization (IMO) (2004) International Convention for the control and management of ships' ballast water and sediments. International Maritime Organization, London, U.K.

International Maritime Organization (IMO) (2011) Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species. Marine Environment Protection Committee, Annex 26, Resolution MEPC.207 (62). International Maritime Organization, London, U.K.

Miller, A.W., I.C. Davidson, M.S. Minton, B. Steves, C.S. Moser, L.A. Drake, & G.M. Ruiz (2018) Evaluation of wetted surface area of commercial ships as biofouling habitat flux to the United States. *Biol. Invasions* DOI: http://doi.org/10.1007/s10530-018-1672-9.

Moser, C.S., T.P. Wier, M.R. First, J.F. Grant, S.C. Riley, S.H. Robbins-Wamsley, M.N. Tamburri, G.M. Ruiz, A.W. Miller, & L.A. Drake (2017) Quantifying the extent of niche areas in the global fleet of commercial ships: the potential for "super-hot spots" of biofouling. *Biol. Invasions* 19:1745-1759 DOI: http://doi.org/10.1007/s10530-017-1386-4.

National Research Council (NRC) (1996) Stemming the tide: Controlling introductions of nonindigenous species by ship's ballast. National Academy Press, Washington, D.C.

National Research Council (NRC) (2011) Assessing the relationship between propagule pressure and invasion risk in ballast water. National Academy Press, Washington, D.C.

Ruiz, G.M., & J.T. Carlton (2003) Invasion vectors: a conceptual framework for management. In: Ruiz, G.M. and Carlton, J.T. (eds) Invasive Species: Vectors and management strategies. Island Press, Washington, D.C., pp. 459-504.

Ruiz, G.M., P.W. Fofonoff, J.T. Carlton, M.J. Wonham, & A.H. Hines (2000) Invasion of coastal marine communities in North America: apparent patterns, processes, and biases. *Annu. Rev. Ecol. Syst.* 31:481-531 DOI: http://doi.org/10.1146/annurev.ecolsys.31.1.481.

Ruiz, G.M., P.W. Fofonoff, B. Steves, S.F. Foss, & S.N. Shiba (2011) Marine invasion history and vector analysis of California: A hotspot for western North America. *Diversity and Distributions* 17:362-373.

Ruiz G.M., P.W. Fofonoff, B.P. Steves, & J.T. Carlton (2015) Invasion history and vector dynamics in coastal marine ecosystems: A North American perspective. *Aquat. Ecosyst. Health Manage.* 18:299-311 DOI: http://doi.org/10.1080/14634988.2015.1027534.

Ruiz G.M. & C.L. Hewitt (2002) Toward understanding patters of coastal marine invasions: A prospectus. In: *Invasive aquatic species of Europe*, E. Leppakoski, S. Olenin, & S. Gollasch (editors), p. 529-547. Kluwer Academic Publishers, Dordrect.

Seebens, H., T.M. Blackburn, E.E. Dyer, P. Genovesi, P.E. Hulme, J.M. Jeschke, S. Pagad, P. Pyšek, M. Winter, M. Arianoutsou, S. Bacher, B. Blasius, G. Brundu, C. Capinha, L. Celesti-Grapow, W. Dawson, S. Dullinger, N. Fuentes, H. Jäger, J. Kartesz, M. Kenis, H. Kreft, I. Kühn, B. Lenzner, A. Liebhold, A. Mosena, D. Moser, M. Nishino, D. Pearman, J. Pergl, W. Rabitsch, J. Rojas-Sandoval, A. Roques, S. Rorke, S. Rossinelli, H.E. Roy, R. Scalera, S. Schindler, K. Štajerová, B. Tokarska-Guzik, M. van Kleunen, K. Walker, P. Weigelt, T. Yamanaka, & F. Essl (2017) No saturation in the accumulation of alien species worldwide. *Nat. Commun.* 8:14435 DOI: http://doi.org/10.1038/ncomms14435.

Smith L.D., M.J. Wonham, L.D. McCann, G.M. Ruiz, A.H. Hines, J.T. Carlton (1999) Invasion pressure to a ballast-flooded estuary and an assessment of inoculant survival. *Biol. Invasions* 1:67-87.

Zabin, C.J., C.V. Ashton, C.W. Brown, I.C. Davidson, M.D. Sytsma, & G.M. Ruiz (2014) Small boats provide connectivity for non-native marine species between a highly invaded international port and nearby coastal harbors. *Management of Biol. Invasions* 5: 97–112.

VI. Comparison of Data from the NBIC and the NVMC

An important aspect of compliance estimation concerns the degree of overlap between the NBIC and NVMC data sets. Because ships are required to report to each entity for different purposes and under different circumstances, some arrivals that qualify for NVMC reporting are not required to submit a BWM report to NBIC. 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 are exempted from reporting to the NVMC. Two geographic areas suffer from different reporting behaviors to the NBIC and the NVMC, which causes spurious results and are excluded from estimates of reporting compliance (i.e., movements between locations within the San Francisco Bay and passenger vessel movements between locations within Sector Juneau). 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. 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 approximately 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 U.S. 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.

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 DOT’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.

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 the 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 (Figs. 1,2,5,7,8,10,12)	Coastwise (Figs. 1,2, 6,7,9,11,12)	Overseas (Figs. 3,4)		Coastwise (Figs. 3,4)	
					NBIC	NVMC	NBIC	NVMC
REGIONS								
Alaska								
Caribbean								
East Coast								
Great Lakes (Coastwise)		**I**					**X**	**X**
Great Lakes (Overseas)								
Guam and Am. Samoa		**I**						
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**						**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 U.S.		**E**					**X**	**X**
Vessels ≤300 GRT		**E**			**X**	**X**	**X**	**X**
Vessels operating exclusively in a single COTPZ or between MORMS and NEWMS	**E**	**E**					**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)**
Intra-SFB and intra-JUNMS passenger vessel movements	**I**	**I**					**X**	**X**

Appendix: Abbreviations

Abbreviation	Meaning
AMS	Alternate Management System
ANOA	Advanced Notices 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
DHS	Department of Homeland Security
DOT	Department of Transportation
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
HF	Hull Fouling
IMO	International Maritime Organization
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
PSC	Port State Control
PWS	U. S. Public Water System
SEM	Standard error of the mean
SERC	Smithsonian Environmental Research Center
SMS	Safety Management System
U.S.C.	U. S. Code
VIDA	Vessel Incidental Discharge Act