2025 BIENNIAL REPORT

ON THE

CALIFORNIA MARINE INVASIVE SPECIES PROGRAM

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EXECUTIVE SUMMARY

The California State Lands Commission (Commission) prepared this report for the California Legislature pursuant to Public Resources Code sections 71210 and 71212. This is the twelfth biennial report to the California Legislature, and it summarizes California Marine Invasive Species Program (MISP) activities from January 1, 2022, through December 31, 2023. This report includes:

- A summary and analysis of vessel arrival patterns at California ports
- A summary of the information provided by vessels in the Ballast Water Management Report and Annual Vessel Reporting Form
- An analysis of the ballast water and biofouling management practices used by vessels that arrive at California ports
- An update on the implementation of ballast water discharge performance standards
- A summary of recent research related to nonindigenous species (NIS) and their pathways of spread
- A summary of MISP accomplishments, actions Commission staff can take to improve the program, and recommendations to the California Legislature

Nonindigenous Species: Impacts and Vectors

Nonindigenous species (NIS) are transported to new environments, both intentionally and unintentionally, through human activities. Once established, NIS pose significant threats to human health, the economy, and the environment. Attempts to eradicate NIS after they become established are often unsuccessful and costly. Hence, prevention of species introductions through vector management is the most effective way to protect California waters.

Shipping is the major pathway by which aquatic NIS are transported around the globe and is responsible for up to 79.5 percent of established aquatic NIS introductions in North America (Fofonoff et al. 2003). Commercial ships transport organisms through ballast water and vessel biofouling. Ballast water is used by ships to maintain stability at sea. When ballast water is loaded in one port and discharged in another, the entrained organisms are introduced to new regions. Vessel biofouling refers to the attachment or association of an organism or group of organisms to a vessel's submerged and wetted surfaces. Biofouling organisms are introduced to a new environment when they fall off their "host" structure or release larvae in the water as they reproduce.

What is the Marine Invasive Species Program?

The MISP was established in 1999 in response to threats to human health, the economy, and the environment posed by vessel-mediated aquatic NIS introductions. The MISP is a statewide, multiagency program that monitors new aquatic NIS introductions and prevents NIS introductions from vessels that are 300 gross registered tons and above (i.e., large commercial vessels), capable of carrying ballast water, and arriving at California ports.

The four MISP agencies are:

- **California State Lands Commission:** Administers the MISP and develops and implements vessel vector management regulations.
- **California Department of Fish and Wildlife:** Monitors and gathers data on NIS in California's coastal waters.
- **State Water Resources Control Board:** Consults with MISP partner agencies on topics related to water quality and toxicity.
- **California Department of Tax and Fee Administration: Collects** a fee (currently $1,000) from the owner or operator of each vessel that arrives at a California port from a port outside of California. (Pub. Resources Code, § 71215, subd. (c).) The collected fees are used to fund MISP activities.

Marine Invasive Species Program Updates

Vessel Arrival Patterns during 2022 and 2023

- California ports received 10,495 vessel arrivals in 2022 and 10,614 arrivals in 2023, consistent with the average observed in the past ten years.
- Southern California ports received 55 percent of all California arrivals from 2022 through 2023, while northern California ports received 45 percent.
- 25 percent of the vessel arrivals came from a port within the west coast of North America (excluding California but including Hawaii).
- Between January 1, 2022 and December 31, 2023, an average of 450 vessel arrivals per month were billed by the California Department of Tax and Fee Administration, with a fee collection rate of 101.4 percent (including late payment fees). Vessels moving from one California port to another are not assessed a fee for subsequent arrivals within California.

Vessel Reporting Compliance in 2022 and 2023

- 91 percent of vessels arriving at a California port submitted the required Ballast Water Management Report (BWMR), compared to 89 percent from 2020 and 2021.
- 90 percent of vessels complied with the Annual Vessel Reporting Form reporting requirement, slightly lower than the 94 percent in 2020 and 2021.

Vessel Inspections

The Marine Invasive Species Act (MISA) mandates that the Commission inspect at least 25 percent of the vessels arriving at California ports to assess compliance with the MISA and associated ballast water and biofouling regulations.

Commission staff inspected 28 percent of arrivals that were practical for inspection (i.e., the vessel was accessible for boarding). Additionally, Commission staff inspected 67 percent of vessel arrivals that were practical for inspection and designated as a high priority for inspection. Some vessel arrivals were impractical for inspection because the Commission's field operations staff do not have access to a boat or other means to conduct inspections at Catalina Island and San Francisco Bay anchorages. If accounting for all vessel arrivals (practical and impractical for inspection), Commission staff inspected 20 percent of all vessel arrivals at California ports in 2022 and 2023.

Ballast Water Discharge and Management

During 2022 and 2023, 89 percent of vessel arrivals that submitted reporting forms to the Commission did not discharge ballast water, presenting zero risk of ballast water-mediated species introductions. The remaining 11 percent of vessel arrivals that reported to the Commission cumulatively discharged 20 million metric tons of ballast water into California waters.

The primary ballast water management method for discharging vessels (86 percent) is ballast water treatment. Vessels are using ballast water treatment systems to comply with California's ballast water discharge standards that are identical to the U.S. federal standards. The Commission began implementing ballast water discharge performance standards on January 1, 2022 (see section 5.2).

Ballast water treatment system use has been steadily increasing since 2018. The Commission collects ballast water treatment information on the Annual Vessel Reporting Form to understand the types and frequency of ballast water treatment system issues or malfunctions. From 2018 to 2023, 23 percent of vessels

reported a ballast water treatment system malfunction. These data enable Commission staff to better identify the types of systems malfunctioning and aid in inspection prioritization.

Biofouling Maintenance and Vessel Operational Practices

During the reporting period, 279 million square meters of cumulative total wetted surface area arrived at California ports. Total wetted surface area is the area of the vessel susceptible to organism accumulation (i.e., biofouling) because it is permanently or temporarily submerged in water. Total wetted surface area can be used to estimate the likelihood of biofouling leading to a species introduction.

Antifouling coatings are applied to prevent biofouling from developing on the wetted surfaces of a vessel. These coatings are typically effective for three to five years. During 2022 and 2023, 82 percent of vessels reported coatings that were applied within the prior three years, which suggests that the coatings were still likely effective.

Extended idle periods, when vessels sit in one location for 10 days or longer, increase the risk of biofouling-mediated introductions because biofouling accumulates on wetted surfaces when vessels are not in motion. During 2022 and 2023, 55 percent of vessels reported at least 1 idle period of 10 days or longer since their last dry dock. 80 percent of these idle periods were between 10 and 20 days in length, 17 percent were between 21 and 45 days, and 3 percent were longer than 45 days.

Compliance with Ballast Water and Biofouling Requirements

Onboard vessel inspections by Commission field operations staff are a critical part of the compliance assessment process. During 2022 and 2023, field operations staff issued 378 administrative violations (e.g., late and missing reporting forms or recordkeeping). Vessels that were found in violation during an inspection received a letter of noncompliance sent to the vessel and owner.

Vessels discharging ballast water are also assessed for compliance with operational requirements (i.e., ballast water management). Commission staff found no operational violations in 2023 and four in 2022. Enforcement actions were initiated for all four violations, and, after negotiations, settled them for a total combined amount of $202,800. Penalties from enforcement actions are deposited into the Marine Invasive Species Control Fund.

During 2022 and 2023, a total of 2,194 vessels were inspected to assess compliance with the California biofouling management and recordkeeping regulations and 348 of the inspected vessels were noncompliant. Vessels that are noncompliant with the biofouling regulations receive a 60-day grace period

to address deficiencies. Vessels with an expired grace period are a high priority for inspection. Eighteen vessels were found to still be noncompliant after expiration of the grace period. These vessels received a notice of violation requiring them to correct deficiencies.

Improving the Implementation of California's Ballast Water Discharge Performance Standards Regulations

In 2020, California's ballast water regulations were amended to adopt ballast water discharge performance standards and related recordkeeping provisions; those regulations were implemented on January 1, 2022. During 2022 and 2023, Commission staff collected ballast water discharge samples from 12 vessels to assess compliance with California's ballast water discharge performance standards and refine standard operating procedures for sample collection and analysis. This process is another example that highlights MISP's role in providing global leadership, as no other regulatory authority is currently collecting and analyzing ballast water discharge samples for compliance assessment and enforcement purposes. The results of the Commission's sampling and the finalization of the standard operating procedures will be useful tools for the Commission and partner agencies across the globe in the years to come.

California Department of Fish and Wildlife Survey Results

Since 2000, California Department of Fish and Wildlife (CDFW) staff has managed surveys of California estuaries and marine waters for the presence of aquatic NIS. CDFW contracted with the Smithsonian Environmental Research Center to complete eight surveys between 2020 and 2023 at seven locations. Across all surveys, no new NIS to California were detected. However, 13 NIS were observed for the first time in a new location within California (mostly Santa Catalina Island), but all had previously been found in other parts of California.

Improving the Commission's Marine Invasive Species Act Enforcement Process

Commission staff is preparing to amend the Commission's enforcement regulations to incorporate a process for enforcing violations of the biofouling and ballast water discharge performance standards regulations, which will likely further deter violations. Additionally, Commission staff is working to automate methods to track and streamline enforcement of violations.

Vessel Incidental Discharge Act

In late 2018, the U.S. Congress passed the Vessel Incidental Discharge Act (VIDA). On December 4, 2018, the President signed VIDA into law. This law:

- Designates the U.S. Environmental Protection Agency (U.S. EPA) as the lead authority to establish national water quality standards for vessel discharges, including ballast water
- Designates the USCG as the lead authority to implement and enforce the national standards set by the U.S. EPA
- Will preempt state authority, once fully implemented, to adopt or implement state-specific management recommendations or standards for vessel discharges, including ballast water, that are stricter than the federal standards

Certain provisions were included in VIDA that protect states from some of the impacts to their authority, including:

- Individual states retain authority to inspect vessels and enforce the federal ballast water management requirements.
- Individual states retain authority to collect fees (with a cap) and Ballast Water Management Reports from vessels arriving at state ports.
- Individual states may, through their Governors, petition the U.S. EPA for stricter discharge standards.

State law is not preempted until the U.S. EPA and the USCG adopt regulations to establish discharge standards and implement enforcement procedures. The U.S. EPA published their final rule in October 2024, but the USCG rulemaking process could take several more years. During this time, states retain authority to continue implementing existing management programs.

For more details on VIDA's impacts upon state authority, fiscal impacts and implementation status, see Section 8.1.

Accomplishments

25th Anniversary of the MISP

The MISP celebrates its 25th anniversary on January 1, 2025. During the 25 years since inception, the MISP has developed into a world-renowned program focused on improving the management of vessels' ballast water and biofouling

through science-based regulations development and implementation and species monitoring to assess the effectiveness of those regulations.

During the 25 years of its existence, the MISP has adopted, revised, implemented, and enforced ballast water and biofouling management regulations to align with its statutory purpose of "mov[ing] the state expeditiously toward elimination of the discharge of nonindigenous species into the waters of the state... ." (Pub. Resources Code, § 71201, subd. (d)(1).) The MISP continuously evolved and improved during these 25 years, with 12 statutory actions adopted by the State Legislature and 13 regulatory actions adopted by the Commission (see section 3.2).

During the 25 years of MISP's existence:

- Approximately 228,000 vessels have arrived at California ports.
- 2.79 billion square meters of total wetted surface area (approximately 2.3 times the size of the city of Los Angeles) arrived at California ports, that could be colonized by biofouling communities.
- Approximately 14 percent of vessel arrivals discharged 233 million metric tons of ballast water (equivalent to the volume of 93,083 Olympic swimming pools).
- Commission staff inspected 47,611 vessel arrivals.
- Commission staff issued 4,808 administrative violations (e.g., late or missing reporting forms) and 479 management violations (e.g., incorrect ballast water exchange locations).
- The Commission initiated 24 enforcement actions. All were settled after negotiation totaling $1,022,590 in penalties that was deposited into the Marine Invasive Species Control Fund.

For more detail on data collected and analyzed by MISP for these 25 years, see section 9.1.

Improving Data Sharing

In October 2022, Commission staff launched a public facing interactive dashboard on the Commission's website. The dashboard includes current and historical data on vessel arrivals and ballast water discharge volumes. Both datasets are organized by quarter, vessel type, and location.

Global Leadership

The MISP is a global leader on advancing and implementing innovative science-based regulations and delivering effective outreach to the maritime shipping industry and regulatory partners. Because of MISP expertise and experience, Commission staff continues to be invited to participate in international policy discussions and training operations. During 2022 and 2023, staff was invited (with all costs covered) to deliver in-person biofouling management training on behalf of the International Maritime Organization in Mexico, Brazil, and Peru, with an additional virtual training in Ecuador.

Peer-Reviewed Scientific Journal Publications

Staff co-authored four peer-reviewed journal articles during 2022 and 2023 (see section 9.2 for a list of publications). Publication of journal articles allows MISP to continue its global leadership on the advancement of science and policy related to shipping and nonindigenous species.

Golden Mussels Introductions

As Commission staff was finalizing this report, the golden mussel (*Limnoperna fortunei*), a non-native, freshwater/brackish mussel, was discovered near the Port of Stockton in October 2024. Golden mussels were subsequently discovered in the southern portion of the San Joaquin – Sacramento Delta and the O'Neill Forebay. This is the first known discovery of golden mussels in North America. These mussels were likely introduced to California in discharged ballast water by a ship traveling from an international port.

For more details on golden mussels, see Section 9.4. The extent of the introduced golden mussel population is not yet known, and the response to the introduction is being led by the CDFW.

Recommendations

The Commission makes the following recommendations to the Legislature based on data presented in this report:

Funding

Support Commission efforts to secure ongoing funding for the Marine Invasive Species Program. The Commission's ability to collect fees will be limited by the federal (U.S. EPA and the USCG) implementation of VIDA. Once in effect, these

restrictions are projected to cause the MISCF to lose between $400,000 and $600,000 annually. This loss of revenue will move the MISCF towards insolvency (see section 8.1.2).

Biennial Report Frequency

Support an amendment of the Marine Invasive Species Act to require the report to the California Legislature mandated by Public Resources Code section 71212 (i.e., this report) to be updated triennially instead of biennially. Expanding responsibilities (see section 3.2), impending revenue losses (see prior "Funding" recommendation and section 8.1.2), current statewide spending reductions and elimination of vacancies, and future restrictions on raising the amount of the vessel arrival fee that supports the program will require adjustments to workloads and priorities. The production of this Legislative report is labor-intensive and time consuming, limiting staff's ability to maintain a high level of performance with an increasing workload. To ensure no lapse in vessel data availability with the recommended change, Commission staff has initiated quarterly vessel data updates posted on the Commission's website to provide most of the types of data presented in this report for continued access for interested users (see section 9.2).

Legislative Amendments to MISA

Support future Commission recommendations for amendments to the Marine Invasive Species Act to align with VIDA. Staff continues to review the U.S. EPA's final VIDA rule and is involved in the USCG's process for developing their proposed rule. California will likely need to amend the Marine Invasive Species Act to ensure that the Commission's enforcement of ballast water and biofouling management requirements remains consistent with federal preemption principles.

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ABBREVIATIONS AND ACRONYMS

µm	micrometers
AMS	Alternate Management System
ATB	Articulated Tug and Barge Combination Vessel
AVRF	Marine Invasive Species Program Annual Vessel Reporting Form
BWMR	Ballast Water Management Report
BWTS	Ballast Water Treatment System
Cal-NEMO	California Non-native Estuarine Marine Organisms Database
CDFW	California Department of Fish and Wildlife
CDTFA	California Department of Tax and Fee Administration
CFR	Code of Federal Regulations
CFU	colony-forming unit
Commission	California State Lands Commission
COVID-19	2019 corona virus disease
GIS	Geographic Information Systems
IMO	International Maritime Organization
IWC	In water cleaning
ISS	Internal seawater system
LPOC	Last Port of Call
m	meter
MISA	Marine Invasive Species Act
MISCF	Marine Invasive Species Control Fund
MISP	Marine Invasive Species Program
MT	metric tons
MMT	million metric tons
NIS	Nonindigenous Species
NM	nautical miles
PacDash	Pacific States Data Sharing Dashboard
PCR	Pacific Coast Region
SERC	Smithsonian Environmental Research Center

ULCV	Ultra Large Container Vessel
U.S.	United States
USCG	United States Coast Guard
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet Irradiation
VIDA	Vessel Incidental Discharge Act
TWSA	Total wetted surface area

DEFINITIONS AND VOCABULARY

Agent
A vessel's agent acts on behalf of the ship owner and provides information to the vessel crew about local requirements at each port

Antifouling coating
Specialized paint used to prevent biofouling growth on the vessel

Anchorage
Areas suitable for vessels to anchor away from shore while they wait for authorization to berth

Articulated tug and barge
An articulated tug and barge combination is a vessel that consists of a barge and a large powerful tug that is positioned in a notch in the stern (rear) of the barge which enables the tug to propel and maneuver the barge

Auto
Vessels designed to carry wheeled cargo such as cars, trucks, semi-trailer trucks, trailers, and railroad cars, that are driven on and off the ship on their own wheels or using a platform vehicle

Ballast water
Water used by vessels to improve and maintain stability, balance, and trim during cargo operations

Ballast water discharge performance standards
The legal restrictions setting the maximum allowable concentration of living organisms of various types and sizes (i.e., classes) in discharged ballast water

Ballast water exchange
Replacing the water in a ballast water tank with new water

Barge+Tug
Unmanned flat bottom vessel (barge) that must be tugged or towed by another vessel (tug). In this report, a Barge+Tug is counted as a single unit

Biocides
Toxic substances that have the potential to kill organisms

Biocidal coating
Antifouling coating containing biocides to prevent the attachment and accumulation of biofouling organisms

Biofouling
Attachment or association of an organism or group of organisms (community) to wetted surfaces (e.g., vessels and docks)

Bulk
Vessels designed to carry large quantities of dry cargo such as grain, coal, and ore

Container
Cargo vessels that carry all their load in truck-size intermodal containers in a technique called "containerization"

Dry dock
Removal of a vessel from the water for maintenance

Expected antifouling coating lifespan
Length of time that an antifouling coating is expected to be effective based on the specific application thickness and design of the coating

General
Vessels designed to carry a wide variety of cargo. Cranes and other heavy equipment needed to move, load, and unload cargo are usually on board

Idle period
Period of time where a vessel remains in one place and is not actively moving (also referred to as an "extended residency period")

In-water cleaning
Processes used to remove biofouling from the vessel's wetted surfaces while the vessel is in water (versus out-of-water or "dry dock")

Mid-ocean waters
Ocean water at least 200 nautical miles from any land and having a depth of least 2,000 meters

Nonindigenous species
Any species (or biological material capable of reproducing) that has been transferred from its location of origin or historical range into a new location

Offshore Supply Ships
Offshore Supply Ships are a vessel category specially designed to supply offshore oil and gas platforms

Other vessel
Broad group including fishing, research, and cable laying vessels

Out-of-water support strips
Areas on the vessel's hull where the support blocks are placed during dry dock (i.e., out-of-water maintenance) and remain unpainted and unprotected

Passenger vessel
A vessel whose primary function is to carry passengers on the sea; includes cruise vessels and large yachts

Phytoplankton
Marine and freshwater microscopic photosynthetic (contain chlorophyll and require sunlight to live) organisms that drift in the water. Also known as microalgae.

Tank
Vessels designed to transport or store liquids or gases in bulk. Major types of tankships include oil tankers, chemical tankers, and gas carriers

Vector
Specific mechanisms that facilitate the movement of nonindigenous species

Wetted Surface Area
Measurement of all vessel surface area that is temporarily or continuously submerged in water and is susceptible to biofouling accumulation

Zooplankton
Marine or freshwater animals (including immature stages of some animals), often microscopic, that drift with the water current

1 PURPOSE

The California State Lands Commission (Commission) prepared this report for the California Legislature pursuant to Public Resources Code sections 71210 and 71212. This 12th biennial report summarizes the California Marine Invasive Species Program (MISP) activities from January 1, 2022, through December 31, 2023.

Per statutory requirements, this report includes:

- A summary and analysis of vessel arrival patterns at California ports
- A summary of vessel arrival compliance rates by geographic area and vessel type
- A summary of the information provided in the Ballast Water Management Reports submitted by vessels to the Commission. This summary includes ballast water management method(s), volume of ballast water discharged into State waters, and locations where ballast water was sourced and discharged.
- An analysis of ballast water management practices
- An update on the implementation of ballast water discharge performance standards
- A summary of Commission-sponsored research and programs to evaluate alternatives for ballast water and biofouling management
- A summary and analysis of vessel biofouling management practices reported by vessels arriving at California ports
- A summary of recent research about nonindigenous species (NIS) introductions by vessels and other relevant vessel and NIS topics
- An evaluation of MISP effectiveness including measures taken to reduce or eliminate NIS introductions by vessels and recommendations for actions that should be taken to improve MISP effectiveness.

2 INTRODUCTION TO AQUATIC NONINDIGENOUS SPECIES

2.1 What are Aquatic Nonindigenous Species?

Nonindigenous species (NIS) are organisms that are intentionally or unintentionally transported through human activities to new habitats, such as California's marine, estuarine, and freshwater environments. NIS can pose significant risks to human health, the economy, and the environment. Nonindigenous species that are introduced into aquatic habitats (e.g., ocean, estuaries, rivers) are called aquatic NIS. Once an NIS is established in a new geographic location and causes impacts, it is considered an invasive species.

2.2 How are Aquatic Nonindigenous Species moved?

Although aquatic species can be dispersed naturally over short distances, human activities are responsible for moving aquatic NIS around the globe (Figure 2-1). The most effective way to prevent NIS introductions is by managing the ways they are moved.

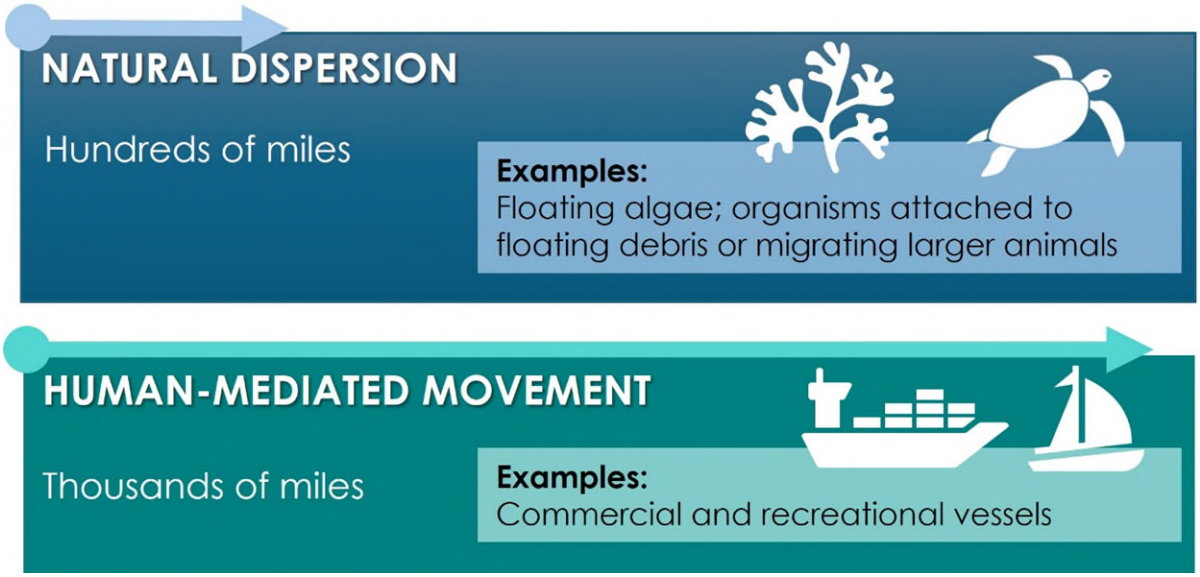


Figure 2-1. Natural dispersion vs. human-mediated movement of organisms

Some human-mediated activities (i.e., pathways) for aquatic NIS include:

- Aquaculture (Grosholz et al., 2012)
- Aquarium trade (Williams et al., 2012)
- Commercial shipping (Fofonoff et al., 2003)
- Live bait trade (Fowler et al., 2015)
- Live seafood trade (Chapman et al., 2003)
- Recreational watercraft (Ashton et al., 2012)

Each of these pathways contributes to aquatic NIS movement. However, commercial shipping has been recognized as the major contributor to the transport of these organisms worldwide (Ruiz et al., 1997, Hewitt and Campbell 2010).

Ballast water and vessel biofouling are vectors, or specific mechanisms, within the shipping pathway that transport aquatic NIS. Ballast water and vessel biofouling have contributed a large percentage of the established coastal aquatic NIS introductions in California (Ruiz et al., 2011) and in North America (Ruiz et al., 2015).

2.2.1 Ballast Water as a Vector

Vessels use ballast water for stability, balance, and trim. Vessels take on, discharge, or redistribute ballast water during cargo loading and unloading operations, as they encounter rough seas, or as they transit through shallow

coastal waterways. When vessels load ballast water, they take on organisms that are drawn in with the water. As vessels move around the world, they can pick up species in the water from one port and discharge them in different ports. This transfer of ballast water results in the worldwide movement of organisms (Figure 2-2).

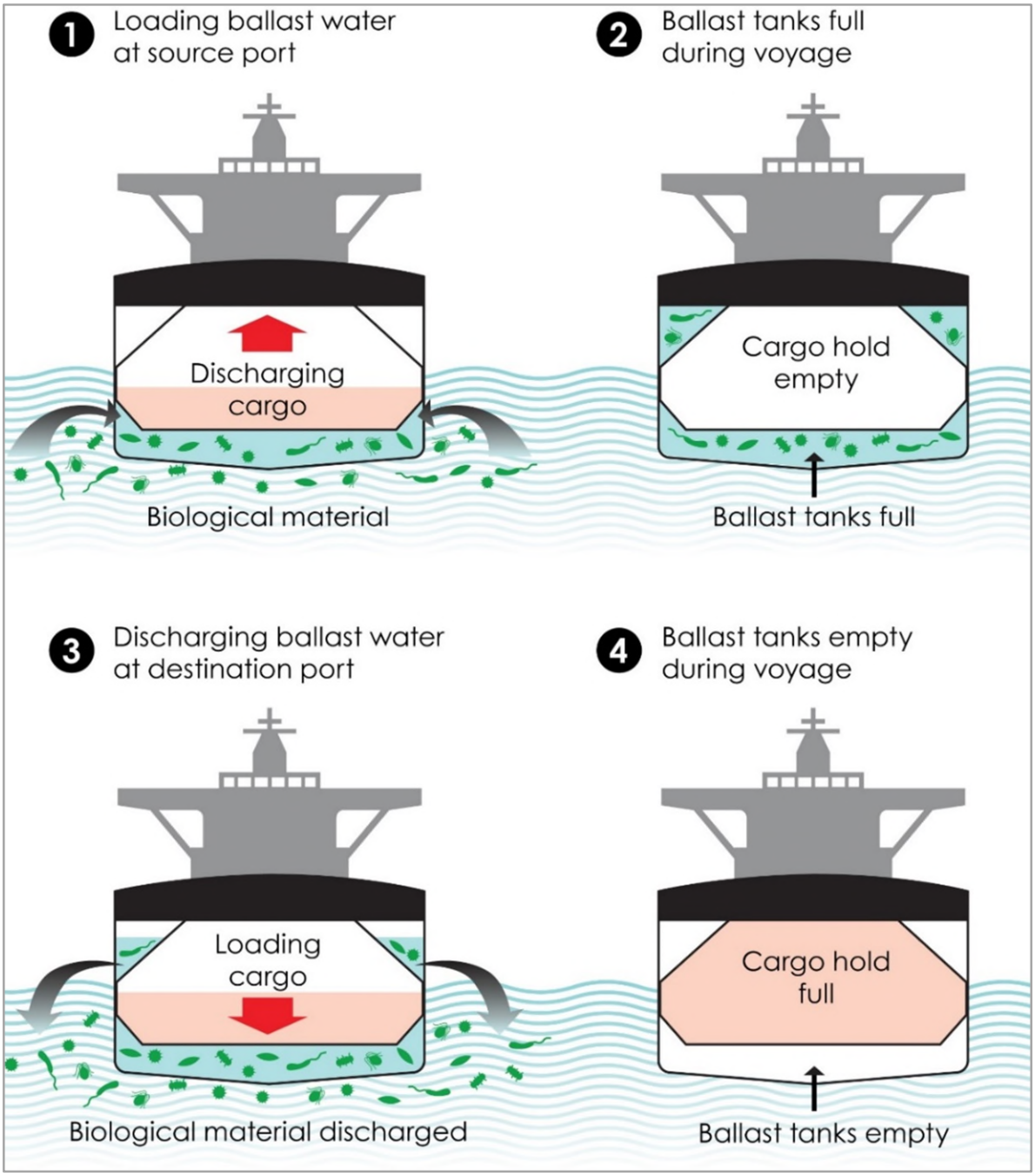


Figure 2-2. Ballast water loading and discharge in relation to vessel cargo operations.

2.2.2 Vessel Biofouling as a Vector

Vessel biofouling refers to the attachment or association of an organism or group of organisms (community) to a vessel's wetted surfaces (i.e., the areas of the vessel that are permanently or temporarily in contact with water). Vessel biofouling communities consist of both sessile (directly attached to the vessel, e.g., barnacles) and mobile (associated with the sessile organisms but not directly attached, e.g., crabs) organisms that can survive long voyages and a wide range of environmental conditions. Biofouling communities can include barnacles, mussels, worms, crabs, other invertebrates, algae, and fishes.

As vessels transit from port to port, biofouling organisms can drop off or spawn (i.e., reproduce), resulting in aquatic NIS introductions (Figure 2-3). Vessel biofouling is considered a major vector for aquatic NIS introductions globally (Ruiz et al., 2000a, 2011, Eldredge and Carlton 2002, Gollasch 2002).

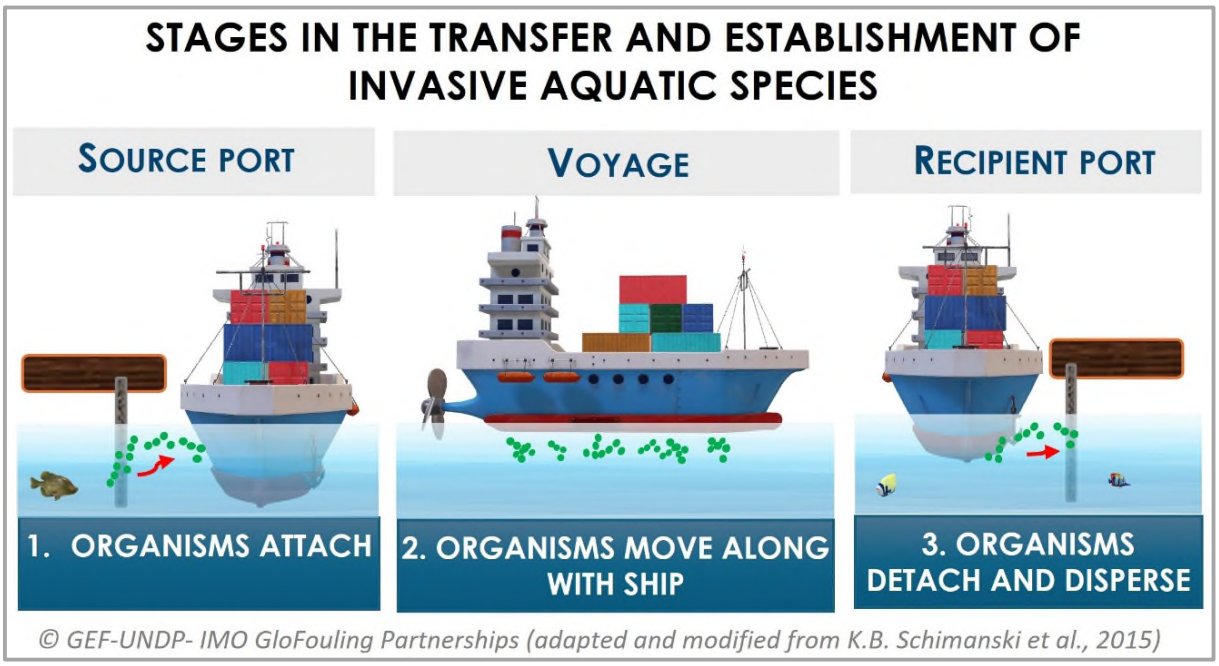
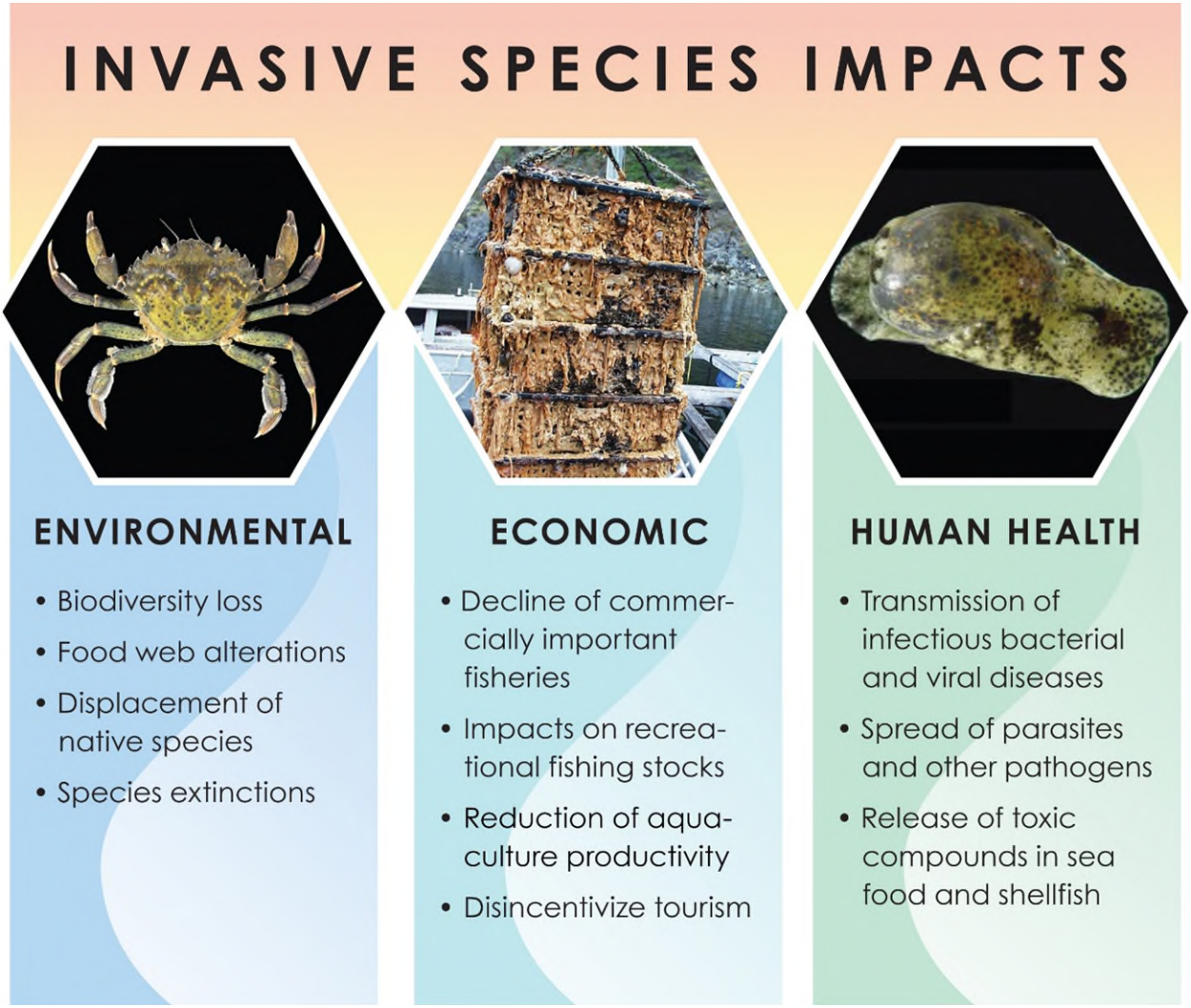


Figure 2-3. The stages of biofouling transport via commercial vessels.

2.3 Invasive Species Impacts



Environmental Impacts

NIS significantly impact the ecology of invaded habitats by affecting community structure, food web interactions, resources availability, and biodiversity (Carlton 2001, Grosholz 2012). Worldwide, 42 percent of threatened or endangered species are listed because of NIS impacts (Pimentel et al., 2005). Aquatic NIS are commonly found in bays and estuaries (Ruiz et al., 2000b, Ruiz et al., 2009) due to the influence of human-mediated pathways (e.g., shipping and recreational boating) in these areas (Miller et al., 2011).

Some examples of aquatic NIS that have had significant environmental impacts are:

- Green crab (Carcinus maenas)

- Overbite clam (Potamocorbula amurensis)
- Quagga mussels (Dreissena bugensis)
- Zebra mussels (Dreissena polymorpha)

Economic Impacts

Aquatic invasive species threaten aquaculture operations, recreational boating, agriculture, water conveyance, commercial and recreational fishing, marine transportation, and tourism, among other industries - all of which are essential to California's economy. In 2019, California's ocean-based economy employed an estimated 598,327 people and accounted for almost $52 billion of California's total gross domestic product (NOEP 2024a).

The invasive green crab is threatening California's fishing economy by competing for resources with the commercially important Dungeness crab *(Metacarcinus magister*) and other native species. Dungeness crab is one of the most important commercial fisheries in California, accounting for approximately $47 million in revenue in 2017 (NOEP 2024b).

Tens of millions of dollars have been spent on managing and reducing the impact of aquatic NIS introductions in California, including the following examples:

- Since 2008, the California Department of Fish and Wildlife (CDFW) has spent over $43.9 million to control the spread of quagga and zebra mussels, as eradication is not feasible (Volkoff, M., CDFW, *pers. comm*. 2024).
- Between 2000 and 2006, more than $7 million was spent to eradicate the Mediterranean green seaweed (*Caulerpa taxifolia*) from two small embayments (Agua Hedionda Lagoon and Huntington Harbor) in southern California (Woodfield 2006).
- A related species of *Caulerpa* (*Caulerpa prolifera*) was detected in Newport Beach in 2021 and in San Diego Bay in 2023. To date, eradication efforts have cost $2.3 million with another $1.7 million pending approval (SCCAT unpublished data).
- Since 2000, approximately $51 million was spent to manage the Atlantic cordgrass (*Spartina alterniflora*) in the San Francisco Bay-Delta (Latta, M., State Coastal Conservancy, *pers. comm*. 2024).

These costs represent only a fraction of the cumulative expenses related to NIS management because eradication is rarely successful, and control is an unending process. The environmental damages and losses associated with NIS

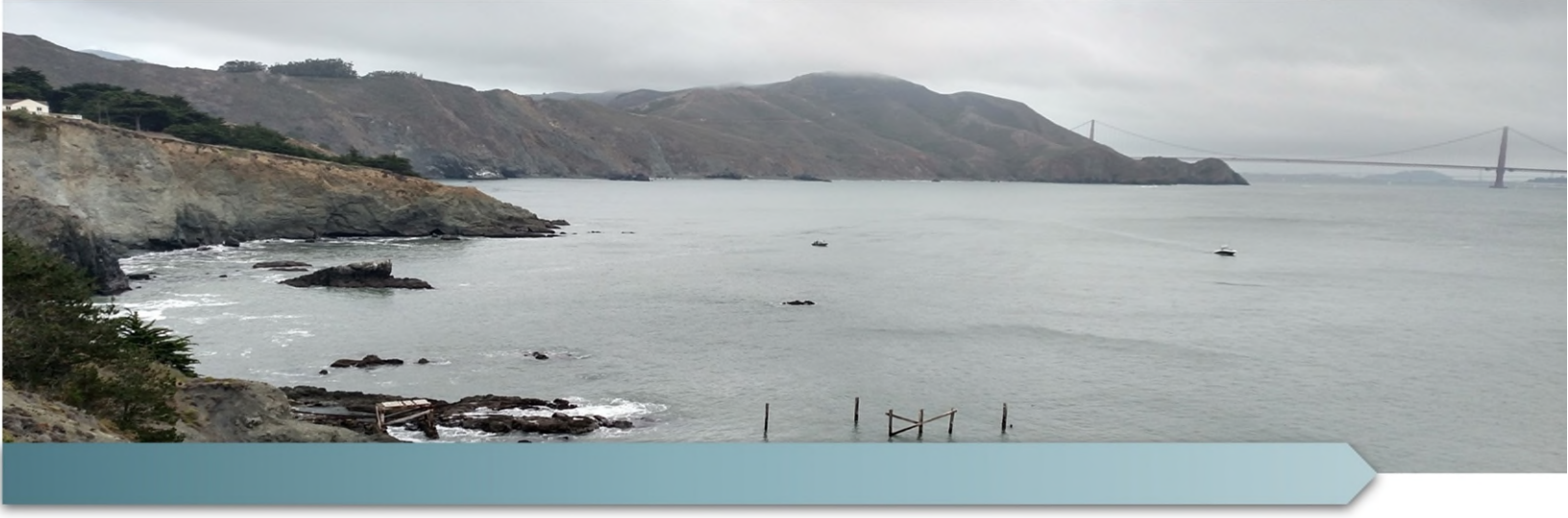
(aquatic and terrestrial) in the United States have been estimated between $120 to $137 billion per year in 2005-dollar value (Pimentel et al., 2005, Neill 2011), and these post-invasion costs are estimated to be almost 25 times more than costs associated with NIS prevention (Cuthbert et al., 2022).

Human Health Impacts

In addition to economic and environmental impacts, invasive species impact human health by acting as a vector for many human pathogens or by being the pathogens themselves. Some of the best studied epidemics can be traced to biological invasions, including the bubonic plague, which was caused by a bacterium in a flea that infested an invasive rat (Bramanti et al., 2016). Also, a cholera outbreak in South America during the 1990s was likely introduced into port areas through ballast water discharge (Ruiz et al., 2000b, Takahashi et al., 2008, Neill 2011).

Other examples of organisms that are harmful to humans and were introduced by vessel vectors include:

- Human intestinal parasites (e.g., *Giardia lamblia, Cryptosporidium parvum, Enterocytozoon bieneusi*) (Johengen et al., 2005, Reid et al., 2007)
- Microorganisms that cause paralytic shellfish poisoning (e.g., *Alexandrium fundyense*) (Hallegraeff 1998)
- Microbial indicators for fecal contamination (e.g., *Escherichia coli* and intestinal enterococci) (Reid et al., 2007)
- *Vibrio parahaemolyticus*, which infects shellfish and causes gastrointestinal illness in humans when ingested (Revilla-Castellanos et al., 2015)
- The Japanese sea slug (*Haminoea japonica*), which serves as a host of the parasitic flatworm that causes cercarial dermatitis (i.e., swimmer's itch) (Brant et al., 2010).



3 CALIFORNIA'S MARINE INVASIVE SPECIES PROGRAM

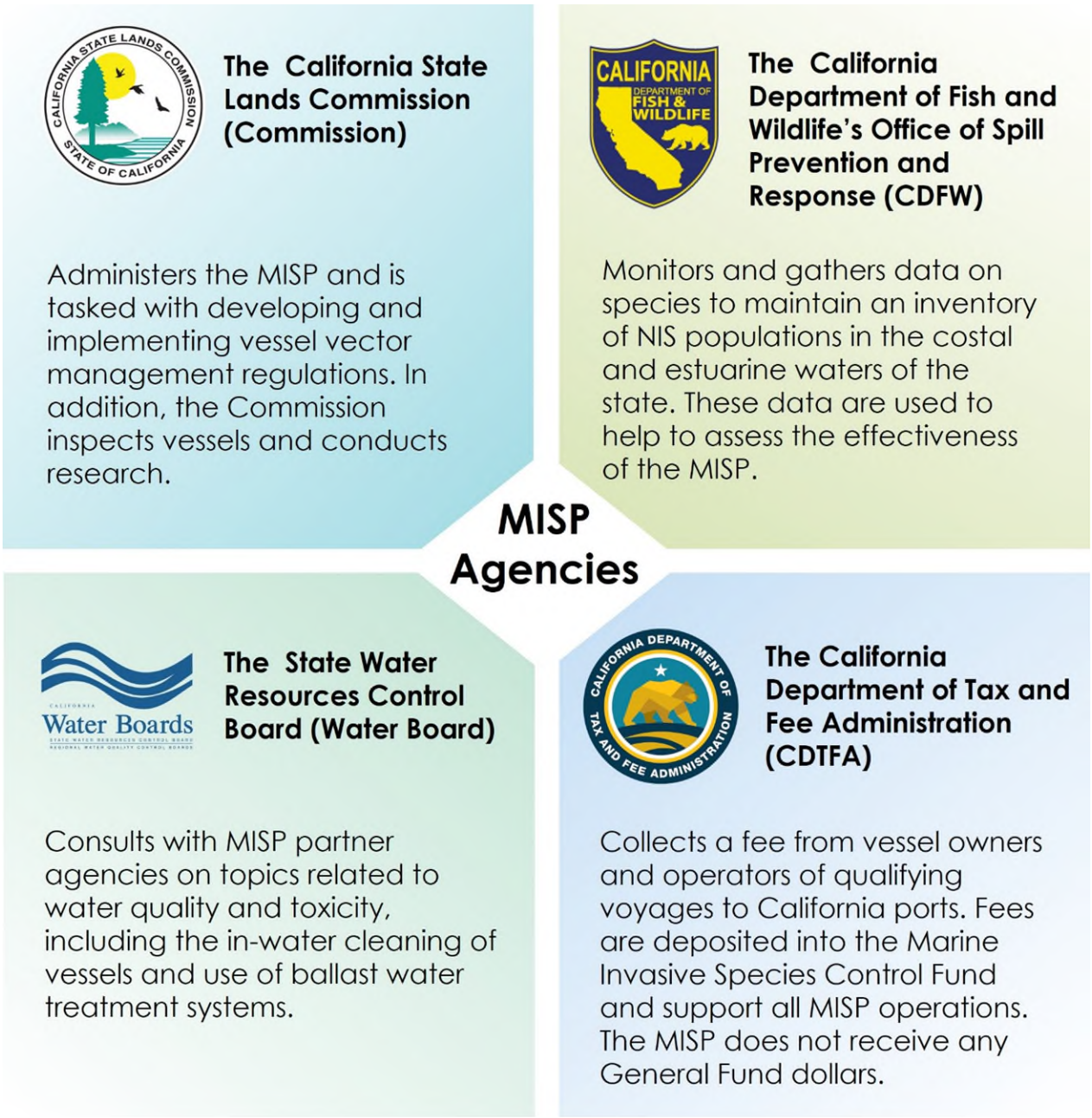
Attempts to eradicate invasive species are costly and often unsuccessful. California has worked to prevent vessel-mediated introductions of aquatic NIS by managing the ways they are moved. In 1999, the California Legislature established what later became the Marine Invasive Species Program. The MISP is a statewide, multiagency program designed to prevent the introduction of NIS from large vessels arriving at California ports. The MISP mandate is to:

> ***"Move the State expeditiously toward elimination of the discharge of nonindigenous species into the waters of the State or into waters that may impact the waters of the State, based on the best available technology economically achievable." (Public Resources Code, § 71201, subd. (d)(1).)***

3.1 MISP's Statutory Authority

The Marine Invasive Species Act (MISA; Public Resources Code section 71200 et seq.) grants authority to four MISP agencies (California State Lands Commission, California Department of Fish and Wildlife, State Water Resources Control Board, and California Department of Tax and Fee Administration) to work collaboratively to address the risk of species introductions from vessel biofouling and ballast water discharge. Vessels subject to the MISA are 300 gross registered tons or more and carrying, or capable of carrying, ballast water.

The MISP consists of four agencies:



For more details on MISP partner agency activities, see section 4.2.3 (Quantifying Arrivals and Fee Collection) and section 7.2 (Marine Invasive Species Program: Species Monitoring Update).

The Commission administers the MISP, including policy development, data administration, field operations (i.e., inspections), and outreach. The Commission is also the fund administrator for the Marine Invasive Species Control Fund.

The Commission's MISP Functions are:

Program Management and Science-based Policy Development

- Recommend policy proposals to the legislature
- Develop and implement regulations
- Review best available science to inform policy decisions
- Oversee and perform research
- Analyze data to assess vessel compliance
- Prepare reports for the Legislature
- Pursue enforcement actions for violations of the Marine Invasive Species Act (MISA)

Data Administration

- Input data from ballast water and biofouling reporting forms
- Track form submission and compliance
- Assess quality and accuracy of data entry
- Maintain contact with stakeholders to relay information about MISP requirements

Field Operations

- Vessel inspections
- Disseminate, clarify, and answer questions about MISA requirements during inspections
- Compliance assessment of report submission, recordkeeping, and management requirements. Violations are written on-site when vessels are found noncompliant.

THE SHARED ROLE OF OUTREACH

A key success of the MISP is the focus on outreach that fosters collaboration and communication with the maritime industry, state, federal and international partners to:

- Establish and maintain partnerships with stakeholders
- Improve compliance
- Develop well-informed policy decisions
- Implement strategies based on the best available science

The MISP staff work closely with state, federal, and foreign regulatory authorities, technical advisory groups, non-governmental organizations, researchers, and the shipping industry. By consulting with other regulatory jurisdictions, the MISP effectively develops policies that are consistent regionally and internationally.

MISP staff participates on numerous working groups, advisory panels, and committees including (but not limited to):

- California Agencies Aquatic Invasive Species Team
- California Marinas Interagency Coordinating Committee
- Delta Interagency Invasive Species Coordination Team
- Pacific Ballast Water and Biofouling Group
- Southern California Caulerpa Action Team
- State of Washington's Ballast Water Working Group
- State of Oregon's Shipping Transport of Aquatic Invasive Species Task Force
- State of Hawaii's Alien Aquatic Organism Taskforce
- Western Regional Panel on Aquatic Nuisance Species (part of the federal Aquatic Nuisance Species Task Force)
- United States Coast Guard (USCG) Vessel Incidental Discharge Act Ballast Water Reporting and Enforcement Data Work Group
- International Maritime Organization (IMO): GloFouling Partnership and TEST Biofouling Project collaborations

3.2 Legislative and Regulatory Evolution of the MISP

Since the initial authorizing legislation in 1999 (AB 703, Lempert), the California Legislature has reauthorized and expanded the MISP to better protect California waters from NIS introduced through ballast water discharge and vessel biofouling. During these 25 years, the Commission has adopted and amended multiple regulations to implement the MISA. The legislative and regulatory changes to the MISP from the start of the program are:

LEGISLATIVE EVENTS

1999 Ballast Water Management for Control of Nonindigenous Species Act: **Established the state program.**

2003 Marine Invasive Species Act: Reauthorized the program, and directed the Commission to **adopt ballast water management regulations**

2006 Coastal Ecosystems Protection Act: Directed the Commission to **implement ballast water discharge performance standards**

2007 Directed the Commission to **develop and adopt biofouling management regulations.**

2008 **Delayed the implementation** of California's **ballast water discharge performance standards**.

2009 Granted authority to the Commission to **collect ballast water treatment system data** from vessels.

2013 **Delayed the implementation** of California's **ballast water discharge performance standards**.

2015 **Delayed the implementation** of California's **ballast water discharge performance standards.**

2018 **Removed statutory requirements for biofouling removal** that were superseded by the 2017 regulatory amendments.

2019 Directed the Commission to **adopt federal ballast water discharge performance standards.**

2021

- Authorized CDTFA to invoice and collect the vessel arrival fee through an agent acting on behalf of the owner or operator.
- Requires vessel owners or operators to **report inoperable ballast water treatment system** to the Commission as soon as practicable.

REGULATORY EVENTS

2000 Established the vessel **arrival fee**.

2004 Amended amount of the vessel **arrival fee.**

2005 Established **ballast water management requirements** for vessels arriving at a California port from a port within the Pacific Coast Region.

2007 **Adopted ballast water discharge performance standards**.

2008 Established **Hull Husbandry Reporting Form** submission requirement.

2009 Amended **ballast water standards implementation date** and amount of vessel **arrival fee.**

2010 Adopted ballast water treatment system annual and per-arrival reporting.

2017
- Amended amount of vessel **arrival fee.**
- Established **enforcement procedures**
- Established **biofouling management, record keeping, and reporting requirements**

2020 Required online submission of Annual Vessel Reporting Form.

2021 Amended **ballast water discharge performance standards** to match federal standards.

4 VESSEL ARRIVALS IN CALIFORNIA

4.1 Reporting Requirements and Compliance

MISP staff monitors vessel arrivals at California's ports (Figure 4-1) to analyze ballast water and biofouling management patterns to evaluate the risk of NIS introduction and prioritize vessels for inspection. Staff obtains daily arrival information from the Marine Exchanges of Southern California and the San Francisco Bay Region. Ballast water and biofouling management information is obtained from required vessel-submitted reporting forms. The reporting forms are:

Ballast Water Management Report (BWMR): The BWMR is a USCG form that vessels must submit to the Commission at least 24 hours prior to each arrival at a California port. The BWMR includes the vessel's voyage information and ballast water activities (source, management, discharge). This report can be submitted either as a PDF via email or directly into the Commission's web-based reporting portal at https://MISP.io (MISP.io). MISP staff assesses BWMR reporting compliance by tracking vessel arrivals and determining if a report was submitted for each arrival. MISP staff notifies vessel owners, operators, and agents via email if a BWMR is not received. Overall, 91 percent of vessel arrivals in 2022 and 2023 submitted a BWMR, an increase when compared to 89 percent during 2020 and 2021, and 83 percent from 2018 and 2019.

Marine Invasive Species Program Annual Vessel Reporting Form (AVRF): The AVRF is a Commission-adopted form that vessels must submit at least 24 hours prior to their first arrival at a California port each calendar year. The AVRF includes details of the vessel's operational practices, biofouling maintenance practices, and onboard ballast water treatment systems (BWTS). Vessels must submit the AVRF directly into MISO.io. MISP staff assesses AVRF reporting compliance by determining if an AVRF was submitted for each vessel that arrives at a California port at least once

per calendar year. The compliance submission rate in 2022 and 2023 was 90 percent, slightly lower than the 94 percent observed in 2020 and 2021.

All data analyses and data patterns presented in this report are based on data collected from the BWMR and AVRF. Receiving reporting forms prior to an arrival is crucial for prioritizing vessels for inspection and identifying potentially noncompliant vessels before they arrive.

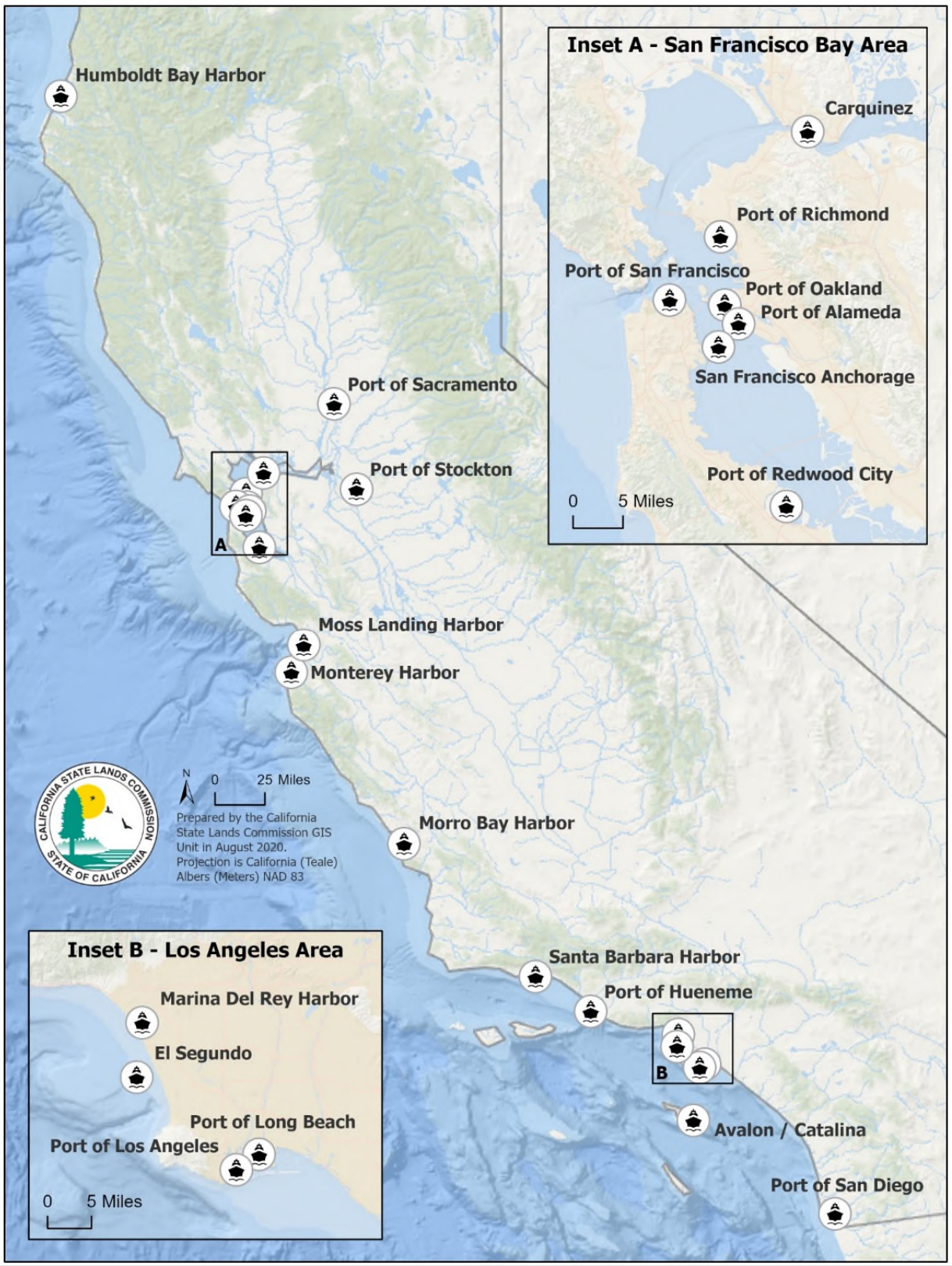


Figure 4-1. Map of California ports recognized by the Marine Invasive Species Program. Insert A: San Francisco Bay Area, Insert B: Los Angeles Area.

4.2 Vessel Arrival Patterns

2022 and 2023 Vessel Arrival Highlights:

- Southern California ports received 55 percent of all California arrivals during 2022 and 2023.
- Only 2 percent of the arrivals in northern California were at a port outside the Golden Gate.
- 25 percent of the vessel arrivals came from a port within the west coast of North America.

California received 10,495 vessel arrivals in 2022 and 10,614 in 2023, consistent with the average observed in the past ten years (excluding the period affected by the COVID-19 pandemic where the number of arrivals was significantly lower than the average; see Thompson et al., 2023).

For analysis purposes and to identify vessel arrival patterns within California, "northern California" is defined as all ports from California's northern border with Oregon, south to Morro Bay, and "southern California" is defined as all ports from Santa Barbara south to California's border with Mexico.

Southern California ports received 55 percent of all California arrivals during 2022 and 2023. The Los Angeles/Long Beach port complex received 42.8 percent of all arrivals in California and 77.8 percent of all southern California arrivals (Figure 4-2). In northern California, the San Francisco Bay area (i.e., all ports east of the Golden Gate), including the ports of Sacramento and Stockton, received 45 percent of all arrivals in California. Only 2 percent of the northern California arrivals occurred at a port outside the Golden Gate (i.e., Humboldt, Moss Landing, and Morro Bay).

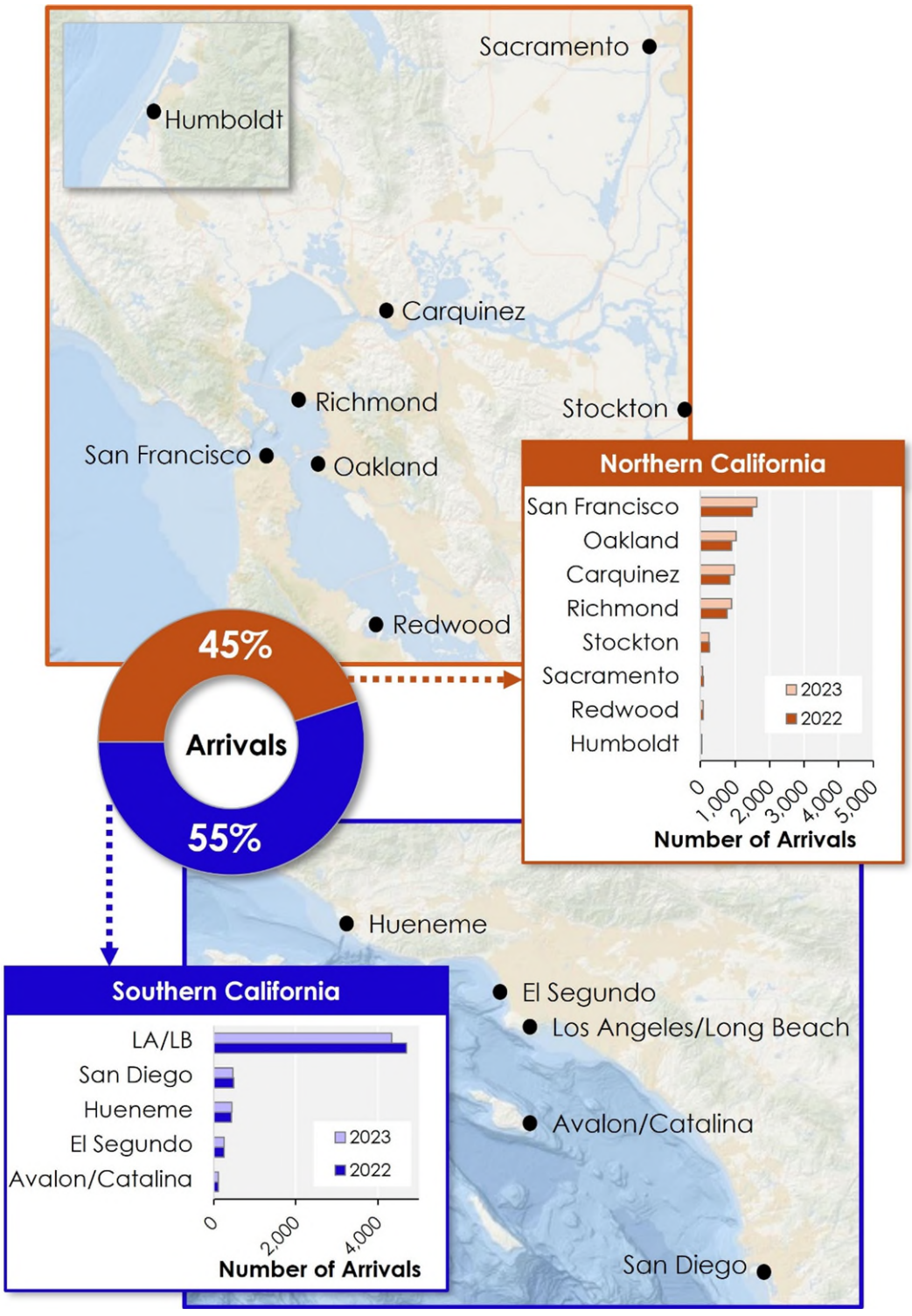


Figure 4-2. Number of vessel arrivals at northern and southern California ports during 2022 and 2023. Ports with less than 100 arrivals during this period (i.e., Alameda, Moss Landing, Morro Bay, and Santa Barbara) were removed from the figure. LA/LB: Los Angeles and Long Beach Port Complex.

4.2.1 Where are the Vessels Coming from?

To understand the connectivity between California ports and ports in other states or regions, Commission staff analyzes the reported last port of call (LPOC). During 2022 and 2023, 43 percent of the vessel arrivals came directly from a different California port and 25 percent arrived from a port outside of California but on the west coast of North America (i.e., Alaska, British Columbia (Canada), Washington, Oregon, Mexico) or Hawaii (Figure 4-3A). Of the arrivals from the North American west coast (excluding California but including Hawaii), nearly half of them (48 percent) came from ports in Mexico (Figure 4-3B and 4-4).

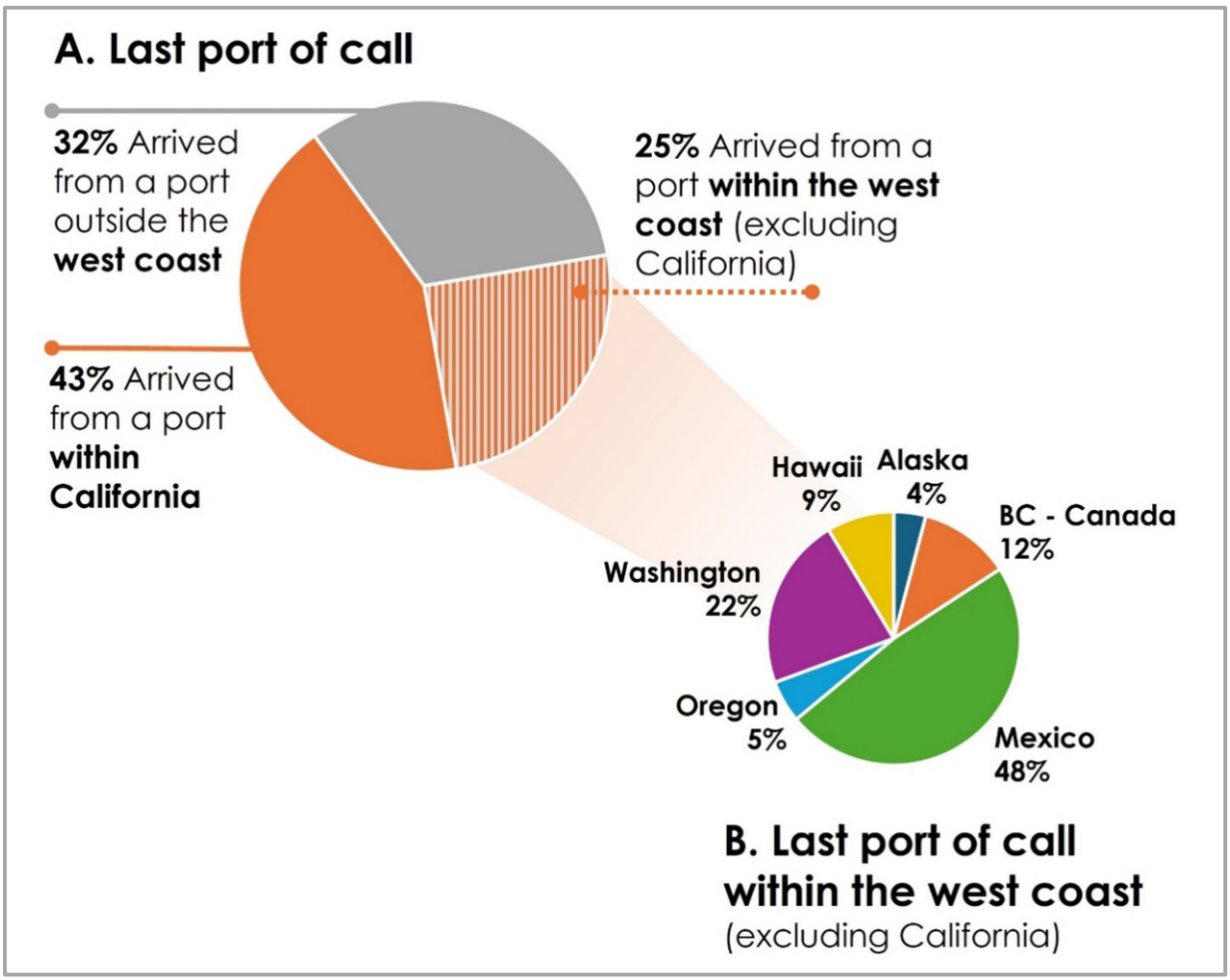


Figure 4-3. Total arrivals at California ports during 2022 and 2023 based on the reported last port of call (LPOC). **A.** Percentage of reported LPOC grouped by arrivals from ports within California, ports within North America's west coast (excluding California, but including Hawaii), and ports outside North America's west coast. **B.** Percentage of reported LPOC from jurisdictions within the North America west coast (excluding California but including Hawaii). BC: British Columbia.

Figure 4-4. Connectivity between California and the North America west coast (including Hawaii) based on the reported last port of call. The total number of arrivals during 2022 and 2023 is represented by the size of the bubbles.

Consistent with previous years (see Thompson et al., 2023), 75 percent of the arrivals at southern California ports and 34 percent of northern California arrivals originated from outside of California (Figure 4-5).

Connectivity patterns within northern and southern California show that more vessels are moving from southern California to northern California (31 percent of all northern California arrivals reported a LPOC in southern California), compared to 12 percent of the southern California arrivals that reported a LPOC in northern California.

Additionally, the LPOC data show more movement within northern California ports, where 36 percent of northern California arrivals reported a LPOC within the same region, compared to only 13 percent of southern California arrivals that moved within the southern ports (Figure 4-5). The movements within northern California are almost exclusively (98 percent) between ports east of the Golden Gate (i.e., in the greater San Francisco Bay Area).

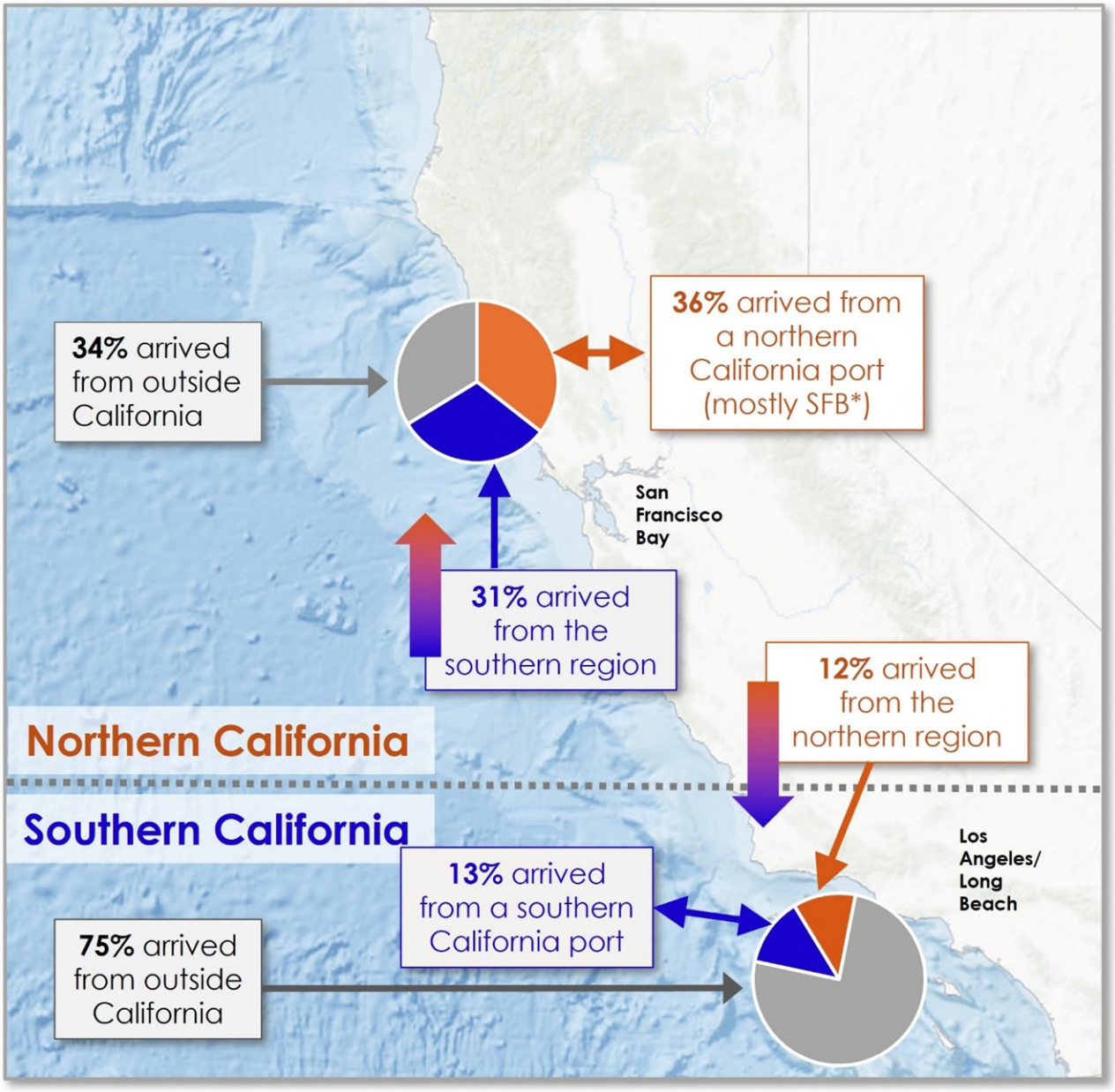


Figure 4-5. Connectivity between southern and northern California vessel arrivals based on the reported last port of call during 2022 and 2023. *SFB= San Francisco Bay area (including Sacramento and Stockton ports).

4.2.2 Vessel Arrival Patterns by Vessel Type

Local and regional industries, product demand, and other economic factors influence the types of vessels that arrive at California ports (see vessel type categories in the Definitions). Consistent with the patterns observed in previous years (Ceballos-Osuna et al., 2021, Thompson et al., 2023), container and tank vessels accounted for 56 percent of all vessel arrivals at California ports during 2022 and 2023.

During this reporting period, the number of arrivals for some vessel types differed from the observed historical average (from 2012 through 2021). Container vessel arrivals decreased by 25 percent from the historical average in both years, while tank vessels increased by 28 percent in 2023. Tank vessel arrivals surpassed container arrivals in 2023 (Figure 4-6) for the first time since at least 2000 when the MISP began tracking vessel arrivals. Passenger vessels also exceeded the historical average by 43 percent in 2022 and by 35 percent in 2023. Bulk vessel and articulated tug and barge combination vessel (ATB) arrivals also exceeded the historical average (Figure 4-6).

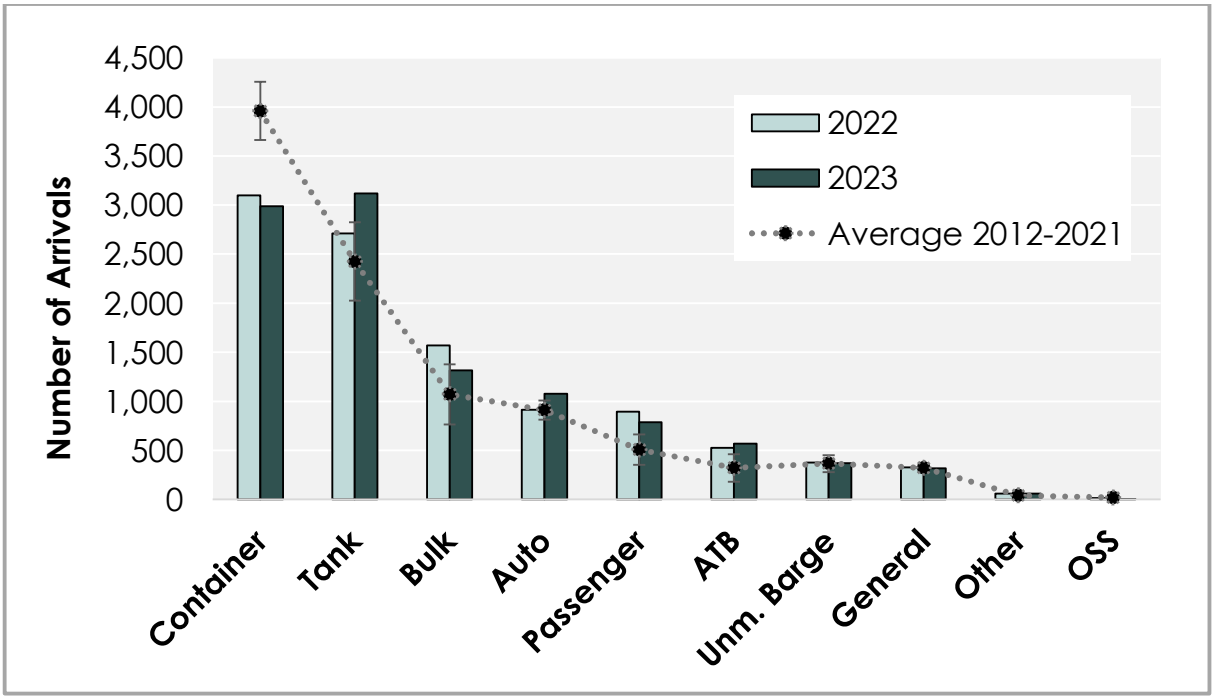


Figure 4-6. Number of arrivals per vessel type during 2022 and 2023 compared to the historical average (± standard deviation) from 2012-2021. Vessel type categories are described in the Definitions.

4.2.3 Fee Collection for Qualifying Arrivals

The Commission contracts with the California Department of Tax and Fee Administration (CDTFA) to collect a $1,000 fee from the owner or operator of a vessel for each qualifying arrival. A qualifying arrival is a vessel arriving at a California port from a port outside of California. (Pub. Resources Code, § 71215.) Vessels moving from one port in California to another are not assessed a fee for subsequent arrivals within California.

The CDTFA, like the Commission, uses regional marine exchange reports to identify qualifying arrivals at California ports and sends invoices to collect the fee. Between January 1, 2022, and December 31, 2023, approximately 450 vessels were billed per month, totaling $11,053,754, with a fee collection rate of 101.4 percent (including late payment fees).

All received fees are deposited into the Marine Invasive Species Control Fund that supports all California MISP operations and personnel. The MISP receives no funding from the California General Fund.

4.3 Vessel Inspections

2022 and 2023 Inspection Highlights:

Commission Field Operations Staff inspected:

- 20 percent of the 21,109 vessel arrivals at California ports
- 28 percent of arrivals that were practical for inspection
  - 5,971 arrivals were impractical for inspection because field operations staff do not have access to a boat or other means to inspect vessel arrivals at Avalon (Catalina Island), San Francisco Bay anchorages, and Los Angeles and Long Beach port complex anchorages.
- 67 percent of high priority arrivals that were practical for inspection.

The Commission's field operations staff monitors and inspects vessel arrivals at California ports to assess compliance with the MISA and associated ballast water and biofouling management and reporting regulations. The Commission has two field offices, the Northern California Field Office in Hercules and the Southern California Field Office in Long Beach. All vessels that are subject to the MISA are required to allow Commission staff on board for inspections. The Commission is mandated to inspect at least 25 percent of all vessel arrivals. Vessel inspections include, as applicable:

- Examining ballast water and biofouling management documents and reporting forms
- Assessing the compliance of ballast water and biofouling management activities
- Collecting ballast water samples, if necessary
- Examining vessel hulls at the waterline for signs of biofouling
- Providing outreach on MISP requirements and invasive species (https://www.slc.ca.gov/marine-invasive-species-program/information-for-vessels-arriving-at-california-ports/)
- Answering vessel crews' questions about California's biofouling and ballast water requirements

Vessels that are identified as noncompliant with management, recordkeeping, or reporting requirements receive a written violation and either a letter of noncompliance or notice of violation. Some violations may result in an

enforcement action including monetary penalties (see table of Violation Classes and Penalties in Appendix A).

4.3.1 Prioritizing Arrivals for Inspection

MISP staff uses vessel arrival data from the regional marine exchanges to populate a vessel schedule within a MISP database. Vessel arrivals entered into the vessel schedule are assigned an inspection priority level (High, Medium, Low, or not a priority for inspection) using the following criteria:

HIGH PRIORITY

- Vessels that have not been inspected in the past five years or vessels new to California
- Vessels discharging ballast water
- First arrival after becoming subject to the biofouling regulations
- Vessels with an unresolved previous violation
- Vessels that have changed their name
- Vessels with errors in their submitted ballast water and biofouling reporting forms
- Suspicion of improper ballast water or biofouling management

MEDIUM PRIORITY

- Vessels that have not been inspected in the past 12 months
- Vessels with resolved previous violations

LOW PRIORITY

- Vessels that have not been inspected in the past three months
- Vessels with an installed ballast water treatment system that are not discharging ballast water

These prioritization criteria are designed to reduce the risk of vessel-mediated species introductions by targeting vessels based on their interactions with the natural environment (e.g., vessels discharging ballast water), if a vessel is likely to

have a new crew (e.g., vessel name change, first California arrival), or any other reason requiring intervention (e.g., reporting form errors).

4.3.2 Inspection Data

During 2022 and 2023, California received a total of 21,109 vessel arrivals, corresponding to approximately 27 arrivals per day.

During this two-year period, Commission staff inspected 20 percent of all vessel arrivals at California ports (Table 4-1). However, 5,971 of the arrivals could not practicably be inspected because field operations staff do not have access to a boat or other means to inspect vessel arrivals at Avalon (Catalina Island), San Francisco Bay anchorages, and Los Angeles and Long Beach Port Complex anchorages. When removing vessel arrivals that are not practicable to inspect, Commission staff inspected 28 percent of arrivals.

Table 4-1. Vessel inspections during 2022 and 2023 at California ports.

Year	Region	Inspected Arrivals	Total Arrivals	Percent Inspected (from total arrivals)	Percent Inspected (from inspectable arrivals*)
2022	**Northern California**	967	4,494	22%	31%
2022	**Southern California**	1,264	6,001	21%	30%
2023	**Northern California**	904	4,999	18%	26%
2023	**Southern California**	1,096	5,615	20%	26%
2022-2023	**Entire State**	**4,231**	**21,109**	**20%**	**28%**

* Inspectable arrivals are those that can be accessed by the Commission field operations staff (excludes vessel arrivals at Avalon (Catalina Island), San Francisco Bay anchorages, and Los Angeles and Long Beach Port Complex anchorages).

The MISP's goal is to inspect as many as feasible of inspectable high priority arrivals. During the years analyzed for this report, 5,096 arrivals (24 percent of all California port arrivals) were categorized as a high priority for inspection, but 1,392 of these arrivals were impractical for inspection. During 2022 and 2023, staff inspected 67 percent of high priority vessel arrivals that were practical for inspection, and the remaining high priority arrivals that were practical for inspection were not inspected due to personnel shortages.

5 BALLAST WATER

This section highlights the MISP's statutory and regulatory tools for reducing the risk of NIS introductions via ballast water discharge from vessels arriving at California ports. The section also presents ballast water data discharge and management patterns for vessels that arrived at California ports during 2022 and 2023.

5.1 Ballast Water Best Management Practices

Vessels that discharge ballast water in California must implement the following best management practices to reduce the likelihood of introducing NIS into California waters:

- Discharge only the minimum amount of ballast water essential for operations
- Clean ballast tanks in accordance with applicable laws
- Minimize the discharge of ballast water in:
  - Marine sanctuaries
  - Marine preserves
  - Marine parks
  - Coral reefs
- Minimize the uptake of ballast water in areas that are high risk due to the presence of NIS, such as:
  - Areas known to have infestations or populations of NIS and pathogens
  - Areas near a sewage outfall
  - Areas for which the master, owner, operator, or person in charge of a vessel has been informed of the presence of toxic algal blooms

- Turbid waters or areas where tidal flushing is known to be poor
- In darkness when bottom-dwelling organisms may rise in the water column
- Areas where sediments have been disturbed (e.g., near dredging operations or where propellers may have recently stirred up sediment)

5.2 California Ballast Water Discharge Performance Standards

Effective January 1, 2022, the Commission began implementing ballast water discharge performance standards (Performance Standards) for vessels arriving at California ports. California's Performance Standards are limits on the concentration of living organisms that may be discharged in ballast water and are identical to the U.S. federal standards (Table 5-1).

Table 5-1. Ballast Water Discharge Performance Standards

Organism Size Class	California/U.S. Federal Standard
Organisms greater than 50µm [1] in minimum dimension	< 10 organisms per cubic meter
Organisms 10-50µm in minimum dimension	< 10 organisms per ml [2]
Escherichia coli	< 250 cfu [3]/100 ml
Intestinal enterococci	< 100 cfu/100 ml
Toxicogenic *Vibrio cholerae* (O1 & O139)	< 1 cfu/100 ml or

[1] Micrometer = one-millionth of a meter
[2] Milliliter = one-thousandth of a liter
[3] Colony-forming unit (cfu) is a standard measure of culturable heterotrophic bacteria numbers

Although not required by the Commission, most vessels will use a ballast water treatment system (BWTS; sometimes referred to as a ballast water management system) to treat ballast water to reduce the number of living organisms. The USCG issues type approvals for BWTSs that have demonstrated the ability to consistently treat ballast water to meet federal performance standards.

Although implementation began on January 1, 2022, not all vessels were immediately subject to the Performance Standards. The Commission adopted the same implementation schedule as the USCG (Table 5-2).

Table 5-2. California's Performance Standards implementation schedule (identical to USCG Implementation Schedule for Approved Ballast Water Management Methods in 33 CFR § 151.2035)

New or Existing Vessels	Vessel Ballast Water Capacity (m^3)	Vessel construction date	Vessel compliance deadline
New vessels	All	On or after Dec. 1, 2013	On delivery
Existing vessels	Less than 1,500	Before Dec. 1, 2013	First scheduled dry docking after Jan. 1, 2016
Existing vessels	1,500 - 5,000	Before Dec. 1, 2013	First scheduled dry docking after Jan. 1, 2014
Existing vessels	Greater than 5,000	Before Dec. 1, 2013	First scheduled dry docking after Jan. 1, 2016

The implementation schedule is a phased-in approach based on a vessel's size and its last regularly scheduled out-of-water maintenance (i.e., dry docking). The USCG may grant extensions to the implementation schedule to individual vessels on a case-by-case basis (33 CFR 151.2036). Some vessels have been granted an extension by the USCG and now have an extended compliance date, which is typically five years after the original compliance date. These extended compliance dates also apply to California's Performance Standards. Vessels with an extension must have a letter on board from the USCG approving the extension.

Additionally, vessels may use an Alternative Management System (AMS) for five years after the end of their original or extended compliance date if the AMS was installed prior to the original or extended compliance date. AMSs are BWTSs that are accepted by the USCG and are:

- Type approved by another country according to IMO guidelines
- Not type approved by the USCG

As an alternative to meeting the Performance Standards, vessels can use water from a public water system as ballast water. If the ballast tanks previously had water from a source other than a public water system, the ballast tanks and supply lines must be cleaned before using this alternative method. In addition, vessels using water from a public water system must maintain a receipt, invoice, or other documentation recording which public water system was used.

California's previously adopted, but not yet implemented, Interim and Final Ballast Water Discharge Performance Standards are scheduled to take effect in 2030 and 2040, respectively. These implementation dates were delayed because technology was not available to meet these standards (see Commission 2018).

5.2.1 Requirements for Vessels Subject to the California Performance Standards

Vessels that are subject to the Performance Standards are required not only to comply with the organism concentration limits of the Performance Standards (Table 5-1), but also with additional maintenance and recordkeeping requirements. These requirements are intended to ensure that, if used, BWTSs are functioning properly and are operated in alignment with the BWTS manufacturer's maintenance and operational specifications.

These requirements include the following:

- Maintain records of all biological monitoring (Cal. Code Regs., tit. 2, §§ 2295, 2297.)
- Maintain records showing that the BWTS was operated within USCG Type Approval design limitations
- Maintain records showing that sensors and control equipment are calibrated consistent with manufacturer recommendations

Additionally, Commission staff are authorized to collect ballast water and sediment samples for research and compliance assessment purposes. (Cal. Code Regs., tit. 2, § 2294.)

5.3 Vessels not subject to the California Performance Standards

Vessels not yet subject to the Performance Standards are required to manage ballast water using one of the following management methods before discharging ballast water in California waters (see Public Resources Code section 71204.3 and California Code of Regulations, title 2, section 2284):

- Exchange ballast water at a minimum specified distance from land prior to discharge (see description in this section below)
- Use a Commission-approved alternative management method such as a BWTS (see section 5.6) or freshwater from a public water system
- Take on and discharge ballast water at the same location (within one nautical mile (NM))
- Discharge to a Commission-approved shore-based reception facility (none currently exist in California; for more information on a Commission funded study of the feasibility of shore-based treatment in California, see Commission 2018)
- Under extraordinary circumstances, exchange ballast water within an area agreed to in advance by the Commission in consultation with the USCG

Additionally, if a vessel's ballast water management threatens the safety of the vessel, its crew, or its passengers, then the vessel master, operator, or person in charge can decide if managing ballast water is unsafe and must do the following:

- Take all feasible measures, based on the best available technologies economically achievable, that do not compromise the safety of the vessel to minimize the discharge of ballast water containing nonindigenous species into the waters of the state, or waters that may impact waters of the state.
- Record a description of how a ballast water management practice was unsafe in the ballast water log.
- Notify the Commission of the determination at the earliest practicable time.

5.3.1 Ballast Water Exchange

The intent of ballast water exchange is to replace the typically biologically rich water that is loaded into a vessel's ballast tanks in a port, or near the coast, with open ocean water (typically biologically poor). Coastal organisms that are found in bays, estuaries, and shallow coasts are not expected to survive or reproduce in the open ocean due to chemical, physical, and biological differences between the habitat types. Open ocean organisms are likewise not expected to survive in coastal waters (Cohen 1998).

The location where ballast water is required to be exchanged depends on a vessel's LPOC and the ballast water source, based on the following:

- Vessels arriving from outside of the Pacific Coast Region (PCR) (Appendix B), or carrying ballast water sourced from outside the PCR, are required to complete a mid-ocean ballast water exchange at least 200 NM from any land, including islands, in water at least 2,000 meters (m) deep. (Pub. Resources Code, §§ 71200, subd. (i), 71204.3, subd. (c).)
- Vessels arriving from within the PCR, and with ballast water sourced within the PCR, are required to complete a near-coastal ballast water exchange in waters at least 50 NM from any land, including islands, in water more than 200 m deep. (Cal. Code Regs., tit. 2, § 2284.)

5.3.2 Alternative Ballast Water Management Methods

The Commission has the authority to approve ballast water management methods that are alternatives to ballast water exchange. The most common alternative requests are for the use of:

- freshwater from a public water system as ballast (reviewed and approved on a case-by-case basis)
- a BWTS accepted by the USCG as an AMS
- a BWTS installed on a vessel as part of a testing and approval process through the USCG Shipboard Technology Evaluation Program

5.4 Ballast Water Recordkeeping Requirements

5.4.1 Recordkeeping for All Vessels

In addition to the reporting requirements (Ballast Water Management Report; see section 4.1), all vessels that arrive at a California port must also comply with the MISA's ballast water-related recordkeeping requirements, including the following:

- Maintain a vessel-specific ballast water management plan that describes the ballast water management strategy employed by the vessel
- Train crew on the application of the management plan and keep proof of that training on board
- Maintain a separate ballast water log that outlines the ballast water management activities for each ballast water tank on board the vessel

5.4.2 Additional Recordkeeping for Vessels using a Ballast Water Treatment System

Some vessels use a BWTS to comply with California's ballast water management requirements and Performance Standards (see section 5.2). Any vessel that discharges ballast water using a BWTS for ballast water management must keep a variety of related records that demonstrate that the BWTS is operating properly. These records include the following:

- Type approval certificate issued by the USCG, if applicable
- Material safety data sheets for all chemicals used by the ballast water treatment system
- Two years of functionality monitoring records
- Two years of calibration records
- Relevant measures of performance according to the BWTS manufacturer (e.g., biological tests, chemical concentrations)
- BWTS malfunctions or unexpected situations, including problem resolution
- Procedures in case of equipment malfunction
- The date, time, and location of the starting and stopping of the system for the purpose of treating ballast water
- Scheduled and unscheduled BWTS maintenance

5.5 Ballast Water Data Patterns

2022 and 2023 Ballast Water Data Patterns:

- 11 percent of vessel arrivals reported discharging ballast water in California waters during the reporting period
- 20 million metric tons of ballast water was discharged in California ports during 2022 and 2023
- Ballast water treatment system use has been steadily increasing since 2018
- The most frequently reported ballast water treatment system type for vessels arriving at California ports was filtration combined with Ultraviolet (UV) irradiation

The likelihood of ballast water-mediated species introductions depends on several factors:

- The volume of ballast water discharge
- The frequency of ballast water discharge
- The number of organisms in the ballast water discharge
- Whether the organisms in the discharged ballast water will survive and reproduce in the location where they are introduced
- The management of ballast water

5.5.1 Ballast Water Discharge Patterns

Commission staff analyzes ballast water discharge patterns to increase knowledge and understanding of vessel discharge trends and ballast water management strategies. Commission staff use these results to better protect California waters from invasive species introductions by developing and implementing compliance assessment policies and recommending changes to the ballast water management requirements when necessary.

During 2022 and 2023, 89 percent of arriving vessels that reported to the Commission did not discharge ballast water in California waters. Some arriving vessels do not have ballast water on board and others retain their ballast water, depending on cargo operations (see Figure 2-2). Vessels that retain all ballast water on board present no risk for ballast-mediated NIS introductions because if

no ballast water is discharged, no organisms within the ballast water are released into the environment.

The remaining 11 percent of arriving vessels discharged ballast water in California (Figure 5-1). These vessels reported discharging 9.6 million metric tons (MMT) of ballast water into California waters in 2022 and 10.4 MMT in 2023. These volumes are consistent with the historical average of 10.8 MMT (±1.1 MMT standard deviation) discharged per year since 2012. The ballast water discharge operations of 9 percent of the vessel arrivals remains unknown because these vessels did not submit a BWMR (See section 4.1).

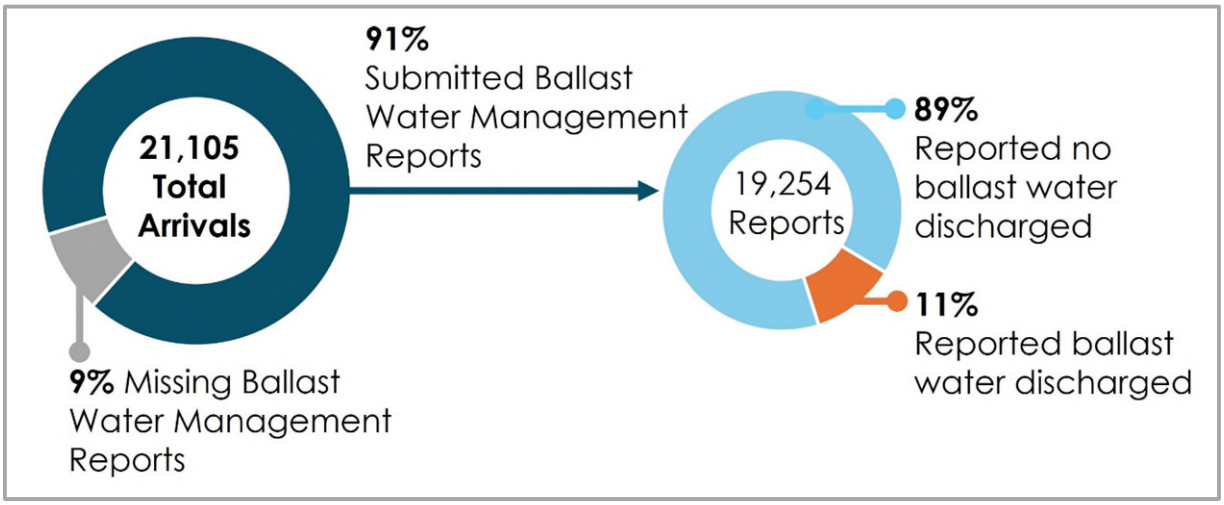


Figure 5-1. Percentage of ballast water management reports submitted and percentage of arrivals that reported ballast water discharges in California during 2022 and 2023.

Northern California ports received 54 percent of the discharged ballast water (10.7 MMT), and southern California ports received 46 percent (9.3 MMT) of the volume discharged into California during 2022 and 2023 (Figure 5-2).

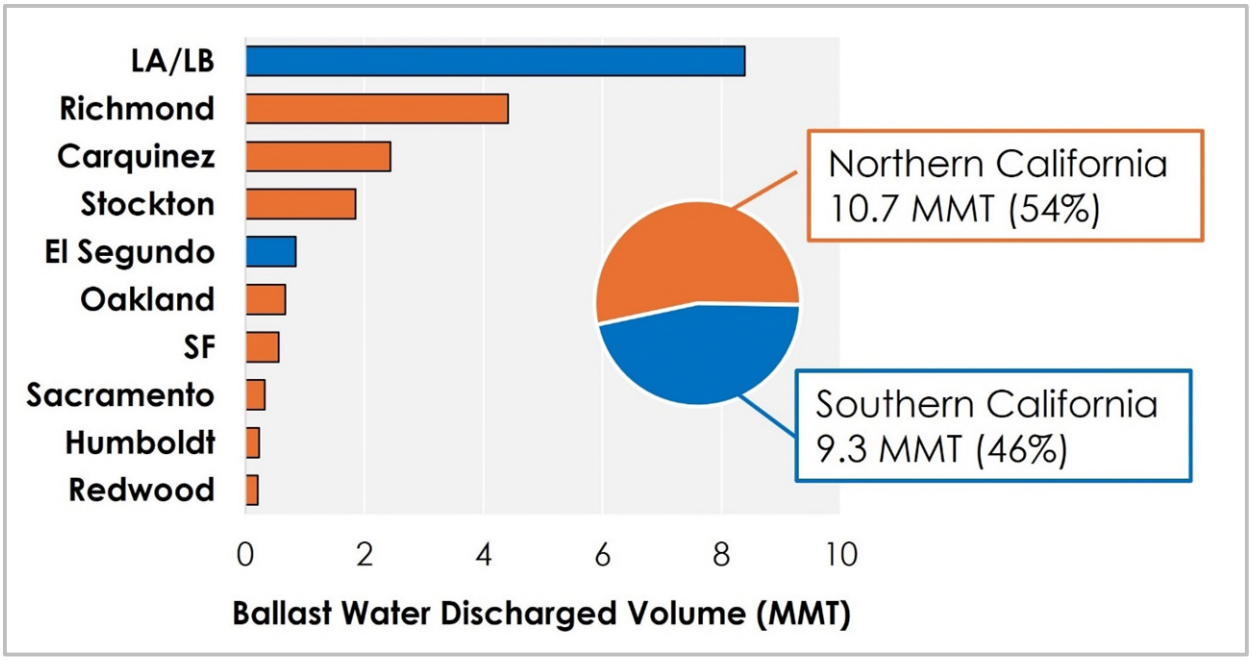


Figure 5-2. Volume and percentage of ballast water discharged in northern and southern California ports during 2022 and 2023. Ports with less than 0.1 MMT discharged volume were removed from the graph. LA/LB: Los Angeles/Long Beach; SF: San Francisco.

Consistent with historical trends in California, bulk (10.3 MMT) and tank (7.8 MMT) vessels discharged more ballast water than all other types of vessels combined (Figure 5-3). This pattern is likely because these vessels are loading heavy cargo and often require all-or-nothing ballast water discharges (i.e., partial discharges are rare). In contrast, container vessels and auto carriers discharge very little ballast water because they mostly unload cargo (which requires ballast water intake, not discharge) in California or do not need to discharge ballast water for their normal cargo operations (Figure 5-3).

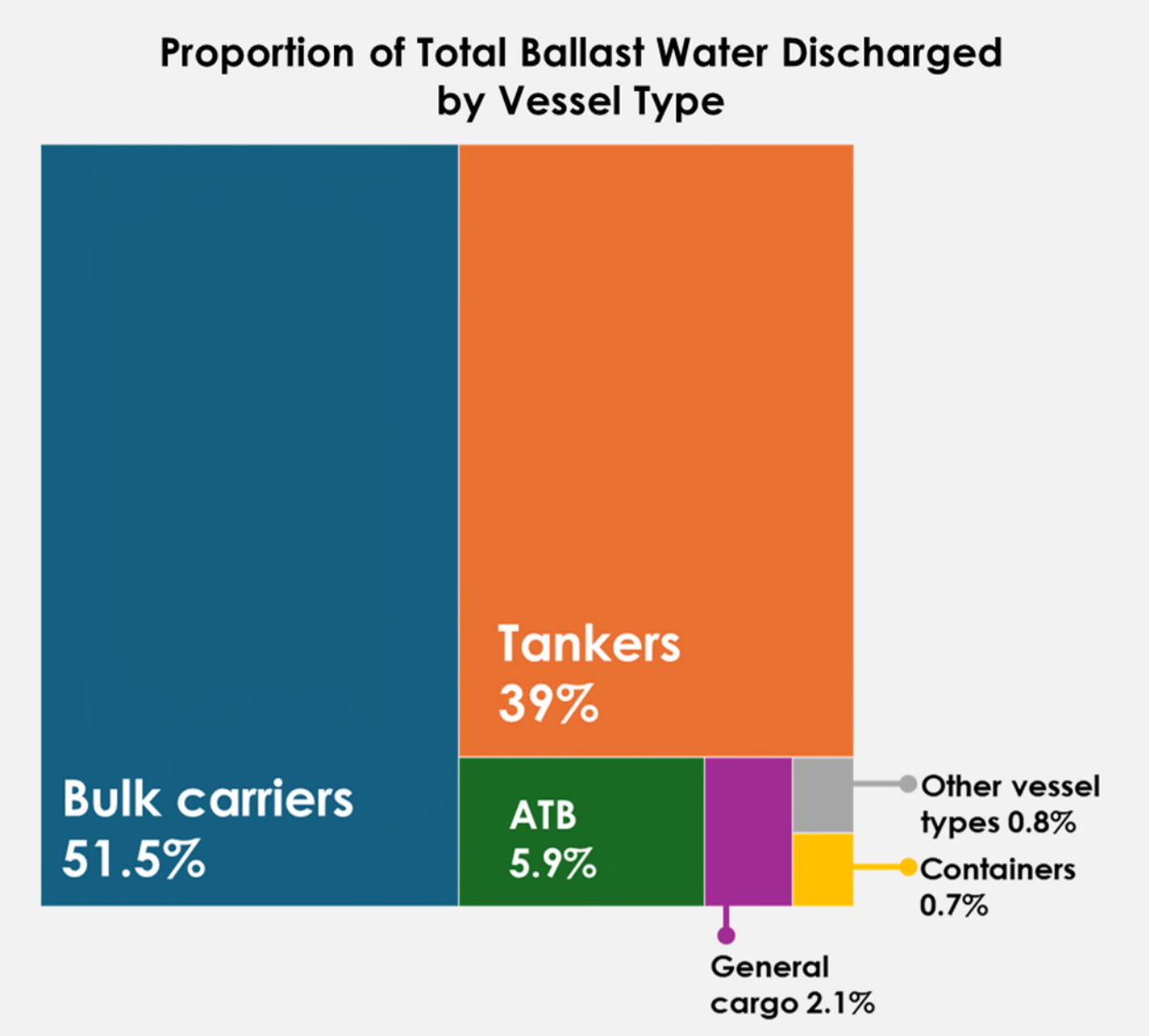


Figure 5-3. Ballast water discharge patterns by vessel type (proportion of ballast water discharged) during 2022 and 2023. The vessel type descriptions can be found in the definitions.

5.5.2 Ballast Water Management Strategies

As vessels are adapting to ballast water discharge performance standards in California and worldwide, the use of BWTSs has replaced ballast water exchange as the most prevalent ballast water management method. During 2023, 86 percent of discharging vessels (962 arrivals) used only a BWTS to manage their ballast water, while only 2 percent (25 arrivals) used only exchange. Some vessels used a combination of ballast water treatment and ballast water exchange (9

percent of arrivals), and others used a mix of management strategies (3 percent of arrivals). Mixed strategies refer to arrivals where not all the tanks were managed using the same strategy (e.g., mid-ocean source and ballast water exchange).

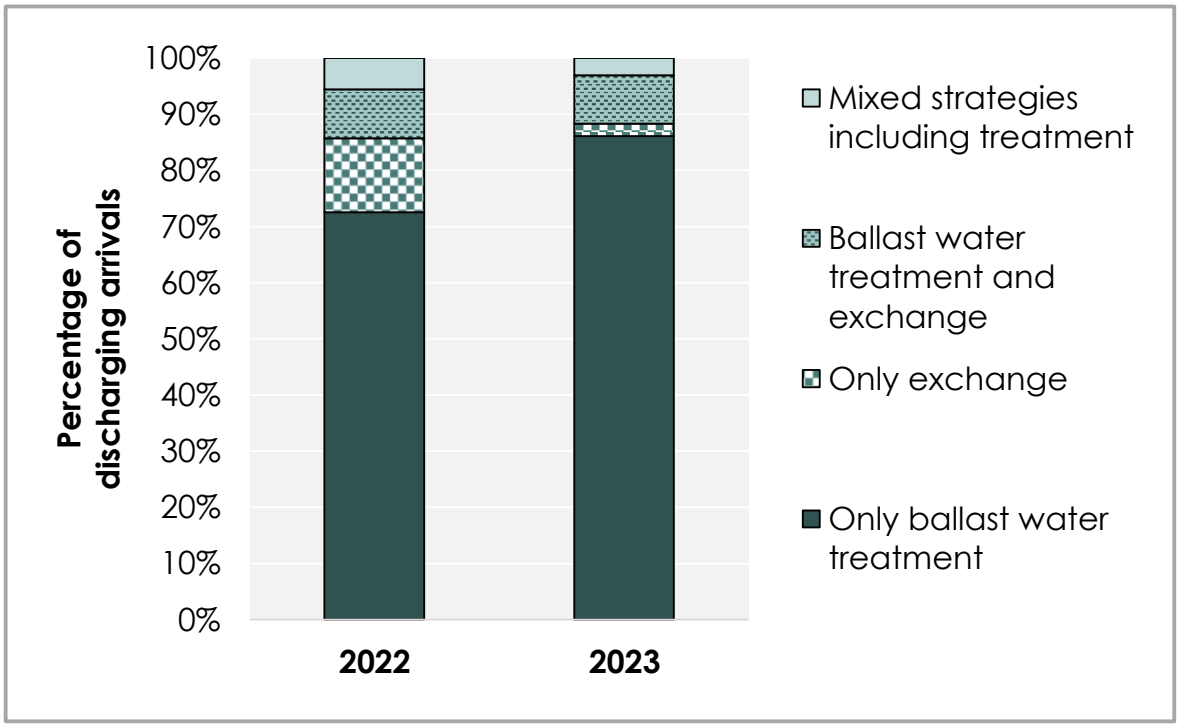


Figure 5-4. The percentages of discharging arrivals using each ballast water management strategy. Mixed strategies refer to arrivals where not all the tanks were managed using the same strategy (e.g., mid-ocean source and ballast water exchange).

5.6 Ballast Water Treatment System Use in California

Although vessels must comply with California's Performance Standards while discharging at California ports, vessels are also using BWTSs to meet U.S. federal and international ballast water discharge standards. In anticipation of this shift towards BWTS use, the Commission began collecting BWTS information on the AVRF in 2018. The number of vessels reporting an onboard BWTS has increased every year since 2018 (Figure 5-5).

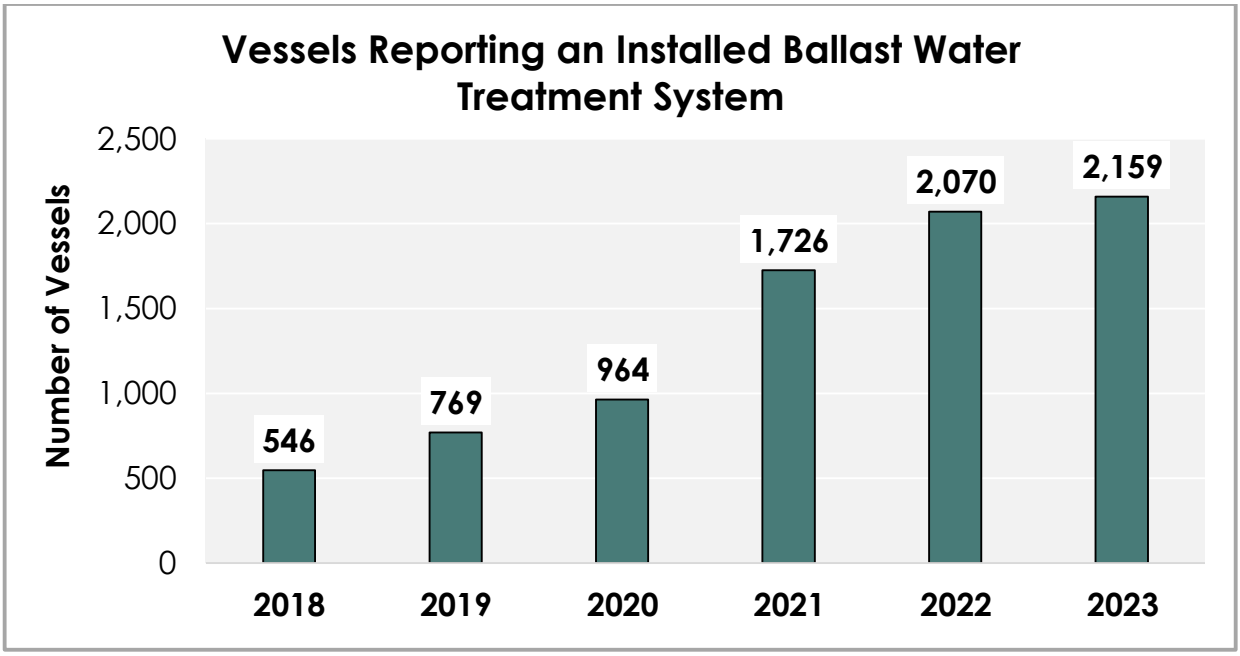


Figure 5-5. The number of vessels that reported having an installed ballast water treatment system by year.

BWTS technology includes various methods that kill or remove organisms in ballast water to meet performance standards. A list of the different types of ballast water treatment systems is presented below (see Commission 2013 for a comprehensive description of each method of treatment).

Different types of Ballast Water Treatment Systems are:

- Chemical Injection
- Electrochlorination
- Electrolysis
- Electrolysis/Chemical Injection
- Filtration/Chemical Injection
- Filtration/Electrochlorination
- Filtration/Ultraviolet light (UV)
- Ozone
- Separation/UV
- Other (AMS, STEP)

The most frequently reported BWTS type installed on vessels arriving at California ports between 2018 and 2023 was filtration/ultraviolet light (UV; 54 percent), followed by filtration/electrochlorination (34 percent) (Figure 5-6).

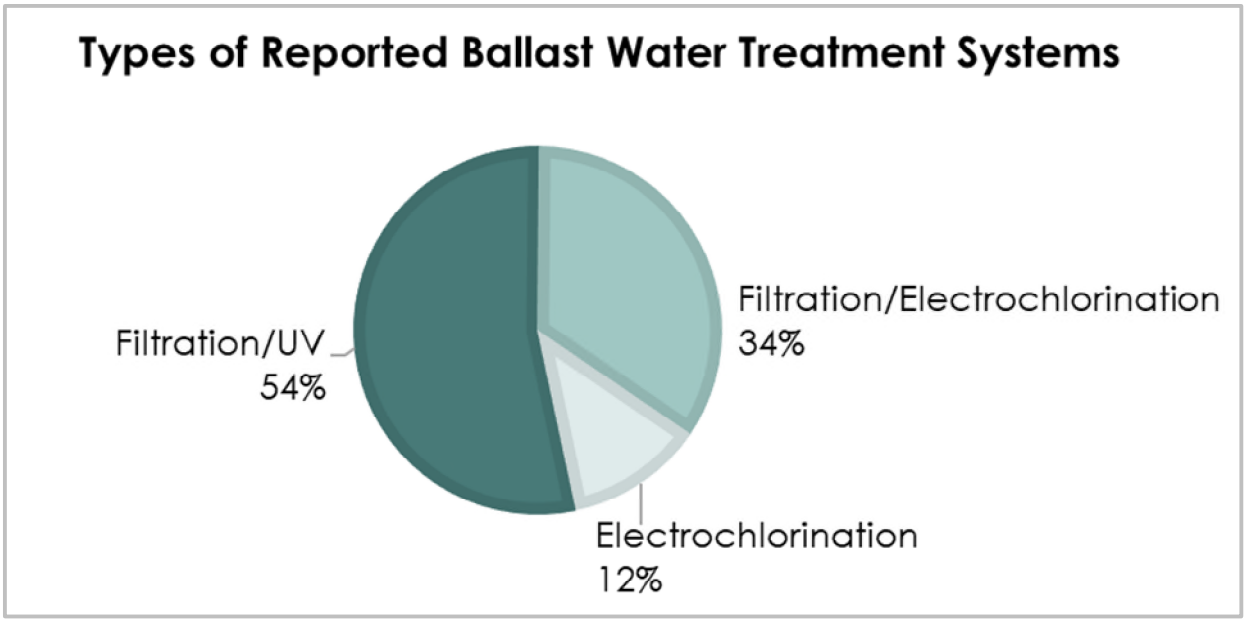


Figure 5-6. Reported Ballast Water Treatment System types on board vessels arriving at California ports (2018-2023). Less than 1 percent of these BWTS types were, ozone and separation/UV and are therefore not shown in this figure.

As BWTS use increases to meet the California, U.S., and international ballast water requirements, understanding the types of BWTSs used to manage ballast water discharged in California can inform the Commission's ability to assess compliance with California's requirements. During the reporting period (2022 to 2023), BWTSs using filtration/UV treatment were the most frequently used to manage ballast water prior to discharge (Figure 5-7A), whereas BWTSs using filtration/electrochlorination accounted for the largest volume of discharged ballast water (Figure 5-7B). The remainder of the BWTS types used during the reporting period rely on the use of active substances (mainly chlorine) to kill organisms in ballast water, either as a standalone method or in combination with a filtration step. Fewer than 1 percent of vessels reported using BWTS types relying on chemical injection, electrolysis, electrolysis/chemical injection, filtration/electrodialysis, ozone, and separation/UV.

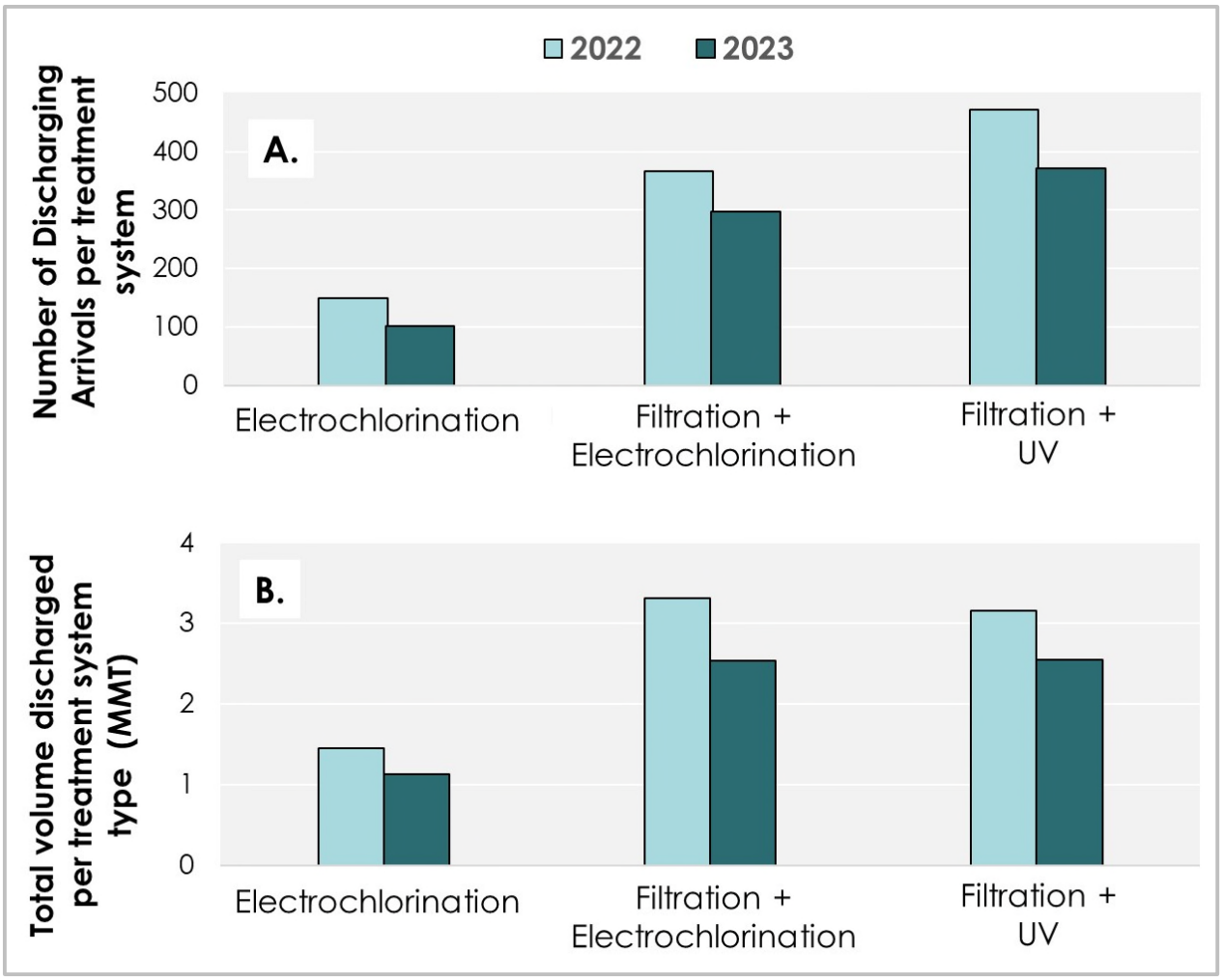


Figure 5-7. A. The number of vessel arrivals that discharged ballast water using various types of ballast water treatment systems (BWTS) in California during 2022 and 2023. **B.** The ballast water volume discharged into California waters by vessels in 2022 and 2023 using the various types of BWTSs. MMT: million metric tons. BWTS types with values lower than 1 percent are not shown (i.e., chemical injection, electrolysis, electrolysis/chemical injection, filtration/electrodialysis, ozone, and separation/UV).

5.6.1 Ballast Water Treatment System Malfunctions

With BWTS use increasing annually, it is important to understand the types and frequency of BWTS issues or malfunctions. The Commission collects these key data via the AVRF.

From 2018 through 2023, 7,458 vessels reported having a USCG Type Approved BWTS on board. Of these vessels, 23 percent reported a BWTS malfunction on the AVRF (Table 5-3).

Table 5-3. Vessels with a USCG type approved ballast water treatment system (BWTS) that reported at least one BWTS malfunction and the total number of malfunctions per year.

Year	Vessels With a USCG Type Approved System	Percent of Vessels with a BWTS Reporting a Malfunction	Number of Reported Malfunctions
2018	558	24%	135
2019	769	25%	190
2020	962	23%	226
2021	1,637	23%	380
2022	1,929	20%	385
2023	1,603	24%	380

In addition to the percentage of vessels reporting malfunctions, the total number of malfunctions reported over time shows how often these malfunctions occur. Commission staff will continue to monitor these data in the future.

In addition to the total number of malfunctions reported by vessels, the types of BWTSs that are malfunctioning is an important factor to understand to prioritize inspections. One way of determining which types of BWTSs are malfunctioning more often is to count the total malfunctions reported per BWTS type and create a ratio of that to the number of vessels with that specific type of BWTS. The higher the ratio, the more often vessels with those types of BWTSs experience malfunctions. BWTSs that use filtration followed by electrochlorination to produce chlorine had the most malfunctions per AVRF received (Table 5-4).

Table 5-4. Reported malfunctions by ballast water treatment system type from 2018 to 2023 Data obtained from the submitted annual vessel reporting forms (AVRF).

Ballast Water Treatment System Type	Forms With at Least 1 Malfunction Reported	Total Forms Received	Ratio of Malfunctions per Form
Filtration/Electrochlorination	550	947	**0.7**
Ozone	11	23	**0.5**
Filtration/UV	774	1,930	**0.4**
Electrochlorination	162	550	**0.3**
Separation/UV	0	20	**0.0**

The types of malfunctions occurring are also important factors to consider when determining the effectiveness of BWTSs. In 2022 and 2023, the most frequently reported malfunctions were associated with sensors, UV lamp equipment, filters, and plumbing (Figure 5-8).

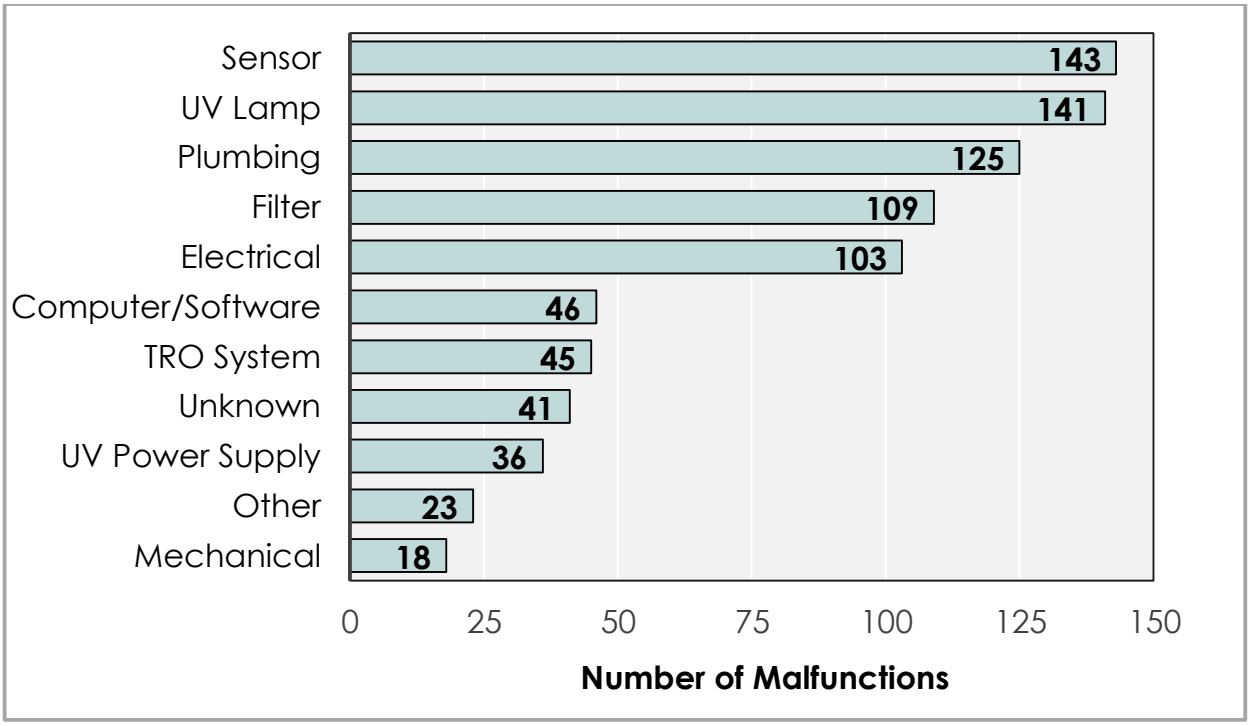


Figure 5-8. The number of malfunctions by type in 2022 and 2023. Other: cold weather (2), installation (2), water quality (4), low chemical (5), and non-filter cleaning (10). TRO System: Total Residual Oxidants system.

5.7 Ballast Water Compliance Assessment and Enforcement

Because of the phased implementation schedule for California's Performance Standards, vessel arrivals during 2022 and 2023 were either subject to the CA Performance Standards or the California ballast water management requirements (e.g., ballast water exchange).

5.7.1 Ballast Water Compliance Assessment and Enforcement for All Vessels

Regardless of whether vessels are subject to the Performance Standards, all vessels must comply with California's best management practices (see section 5.1).

Onboard Inspection

Onboard vessel inspections by field operations staff (see section 4.3) are a critical part of the compliance assessment process. During an inspection, staff:

- Reviews all required documentation kept onboard the vessel (e.g., ballast water management plan and log books)
- Verifies that ballast water management activities are recorded in the ballast water log book
- Documents violations if needed (documented violations are later analyzed by administrative staff to determine enforcement options)
- Provides outreach to the vessel's crew to increase awareness and understanding of the ballast water requirements

Through these onboard inspections, 378 administrative violations (e.g., late and missing reporting forms or recordkeeping) were issued during 2022 and 2023. Vessels that were found in violation during an inspection received a letter of noncompliance sent to the vessel and owner.

5.7.2 Compliance Assessment for Vessels Subject to the Performance Standards

As vessels transition towards complying with performance standards throughout the world, BWTS use is increasing (see section 5.6) and so are BWTS malfunctions. To ensure that BWTSs are operating properly when used in California, vessels subject to the Performance Standards (see section 5.2) are required to report to the Commission, as soon as is practical, if an installed BWTS is inoperable during a California arrival. In 2022 and 2023, 44 (2022 = 25, 2023 = 19) vessels reported to the Commission that their system was inoperable. In these cases, Commission staff consulted with the USCG on possible alternative management options, when applicable.

Performance Standards – Discharging Vessels

All vessels subject to the Performance Standards that discharge ballast water are a high priority for inspection. Generally, this inspection involves reviewing documents and data from an onboard BWTS. On January 1, 2022, the Commission began inspecting vessels to assess compliance with, and enforce, the Performance Standards.

Assessment of compliance with the Performance Standards includes the following elements:

- Pre-arrival review: Review the BWMR discharge information in advance of a vessel arrival to determine the type of management used and identify potential noncompliant discharges
- Onboard inspections:
    - Functionality Monitoring – Ensuring vessels have records showing that the BWTS is being operated as intended and within the limitations set by the USCG Type Approval
    - BWTS Maintenance – Ensuring vessels are properly following BWTS maintenance and calibration schedules.

During 2022 and 2023, 759 vessels were inspected for compliance with California's Performance Standards. Of those vessels, 4 were found to be noncompliant with the functionality monitoring and BWTS maintenance requirements.

Sampling and Analysis of Vessels for Compliance Assessment with the California Performance Standards

Commission staff, in collaboration with other ballast water regulators and researchers, are developing a sampling and analysis process to determine vessel compliance with the California Performance Standards.

In February 2023, Commission staff started collecting ballast water samples to assess compliance with the Performance Standards and contracted with an independent lab to test the protocols and analyze the collected samples. In 2023, 12 vessels were sampled using these protocols. Of these 12 vessels, 1 had concentrations of organisms greater than 50 microns (generally zooplankton) and organisms equal to or less than 50 microns and greater than 10 microns (generally phytoplankton) that were at least ten times greater than the limits set in the Performance Standards (Table 5-5 and Figure 5-9).

Table 5-5. Sampling results from ballast water sampled and analyzed from 12 vessels in 2023.

Organism size class greater than 50 µm	Organism size class 10-50µm
9 Compliant	8 Compliant
2 exceeded the standard but were within expected margin of error	3 exceeded the standard but were within expected margin of error
1 exceeded the standard by more than 10 times*	1 exceeded the standard by more than 10 times*

*same vessel failed both size classes

Commission staff will continue to review and revise the compliance assessment protocols to improve our ability to detect noncompliant discharges and protect California waters from vessel-mediated NIS introductions.

Figure 5-9. Commission Field Operations Staff assisting with ballast water sampling.

5.7.3 Compliance Assessment and Enforcement for Vessels Not Subject to the California Performance Standards

As described in section 5.3, vessels not subject to the Performance Standards during 2022 and 2023 were required to comply with California's ballast water management requirements (e.g., ballast water exchange). Commission staff assessed vessel compliance by analyzing ballast water management and discharge information reported on the BWMR. The analysis had 3 phases:

Pre-arrival assessment: Review the BWMR discharge information in advance of a vessel arrival to determine the type of management used and identify potential noncompliant discharges

Onboard inspections: Validate the submitted information upon arrival and assess recordkeeping requirements

Post-arrival assessment: Analyze ballast water management and discharge data for all arrivals within a given period (e.g., monthly, quarterly)

Pre-arrival Assessment

The requirement to submit a BWMR at least 24 hours in advance of arrival provides Commission staff with the opportunity to identify vessels that intend to discharge ballast water. When possible, staff reviews the reported ballast water management information and plots the ballast water exchange locations (latitude and longitude) using Google Earth Pro to identify potential noncompliant discharges. When staff identifies a vessel that is planning to discharge undermanaged ballast water in California (e.g., the vessel did not exchange ballast water at an appropriate distance from land), staff immediately notifies the vessel and the vessel's agent about the potential noncompliance.

This pre-arrival assessment and notification process provides the vessel master with an opportunity to either properly manage ballast water prior to discharge or, if possible, change operations so the ballast water can be retained onboard upon arrival in California. This process allows staff to prevent the discharge of undermanaged ballast water, reducing the likelihood of introducing NIS.

Onboard Inspection

For vessels not subject to the California Performance Standards, onboard inspections of ballast water management reports and vessel ballast water logs are reviewed to determine if the vessel is compliant with ballast water management requirements (e.g., correct exchange location depending on the origin of the voyage and source of the ballast water).

Post-arrival Assessment of Ballast Water Management Data

For vessels not subject to the California Performance Standards, staff assesses ballast water management compliance for all discharging vessels using the Geographic Information Systems (GIS) software ArcMap. The GIS analysis accurately maps reported ballast water source and management locations (latitude and longitude), which helps staff identify noncompliant activities. ArcMap is capable of handling very large datasets, allowing staff to evaluate the ballast water management practices of all vessel arrivals statewide on a quarterly basis.

Enforcement

Vessels that are not subject to the California Performance Standards and are not compliant with ballast water management requirements under the MISA (i.e., operational violations) are issued a notice of violation and may be subject to enforcement actions (see Appendix A; Thompson et al., 2023).

Commission staff found no operational violations in 2023 and four in 2022. The potential penalties for these violations ranged from $20,000 to $220,000 and are based on the violation class (number of tank violations and the type of noncompliant ballast water management). The Commission initiated enforcement actions for all four violations and, after negotiations, settled them for a total combined amount of $202,800. Penalties from enforcement actions are deposited into the Marine Invasive Species Control Fund.

Commission staff does not currently have the authority to issue penalties for violations of the ballast water performance standards but is preparing to amend the enforcement regulations (see California Code of Regulations, title 2, section 2299.01 et seq.) to create a more comprehensive enforcement process.

6 BIOFOULING

This section highlights the MISP's statutory and regulatory tools for reducing the risk of NIS introductions via biofouling from vessels arriving at California ports. The section also presents biofouling data patterns for vessels that arrived at California ports during 2022 and 2023.

6.1 Biofouling Management Requirements

The California biofouling management regulations (California Code of Regulations, title 2, section 2298 et seq.), implemented in 2017, were the first set of regulations worldwide to require vessels to have a biofouling management plan and biofouling record book. Collectively, these documents describe a vessel's biofouling management strategy and document that the strategy is being implemented. The strategy should include proactive measures (e.g., coatings, maintenance) to prevent biofouling accumulation and reactive measures (e.g., cleaning) to remove biofouling from vessel surfaces when necessary (see Scianni and Georgiades 2019), for descriptions of reactive measures). These strategies should be developed specifically for each vessel, based on the vessel's design and operational profile.

The California biofouling management regulations apply to new vessels delivered into service on or after January 1, 2018, and existing vessels that complete a regularly scheduled out-of-water maintenance (i.e., dry docking) on or after January 1, 2018. The rest of this section applies to vessels that are subject to California's Biofouling Management Regulations.

The main requirements of the California biofouling management regulations are:

- Maintain a biofouling management plan
- Maintain a biofouling record book

- Manage biofouling on a vessel's wetted surfaces
- Manage biofouling after extended idle periods (an idle period is a period where a vessel remains in one place and is not actively moving, also referred to as an "extended residency period")
- Submit the MISP Annual Vessel Reporting Form once annually 24 hours in advance of the first arrival of each calendar year

6.2 Biofouling Recordkeeping

The Biofouling Management Plan Must:

- Describe the vessel's operational profile (e.g., typical speed, activity level)
- Describe the vessel's maintenance practices for preventing and removing biofouling organisms on a vessel's hull and niche areas (i.e., underwater recesses and appendages; see Figure 6-1)
- Indicate the expected lifespan of the vessel's antifouling coating (i.e., length of time the coating is expected to be effective, based on coating formulation and applied thickness)
- Be consistent with components of the biofouling management plan described in the IMO's voluntary "Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species," hereafter referred to as "IMO Biofouling Guidelines" (IMO 2011). The IMO's Biofouling Guidelines were updated in 2023.

The Biofouling Record Book Must:

- Be consistent with components of the biofouling record book described in the IMO Biofouling Guidelines
- Record all completed biofouling inspections and management practices

What are Niche Areas?

Niche areas include recesses, appendages, and other wetted vessel surfaces that are more susceptible to biofouling due to structural complexity and inadequate protection by specialized coatings and other antifouling systems.

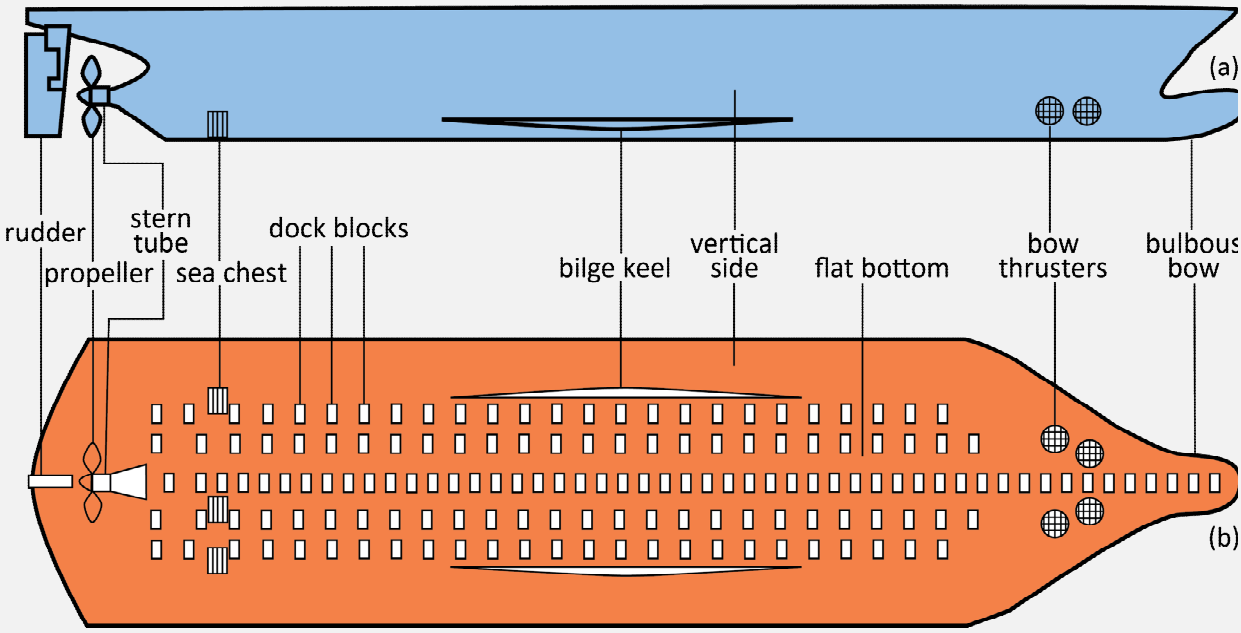


Figure 6-1. Niche areas susceptible to biofouling accumulation. a) Side view of a vessel. b) Bottom view of a vessel. Figure originally from Davidson et al. 2016.

6.2.1 Managing a Vessel's Hull

The biofouling management plan must describe the strategies used to manage biofouling on the vessel's hull. Vessels can use an antifouling coating to minimize the accumulation of biofouling. If a coating's expected lifespan is exceeded, the biofouling management plan must describe the strategies used to manage biofouling on the vessel's hull. The expected coating lifespan is the length of time that an antifouling coating is expected to be effective, based on the specific application thickness and coating design.

Antifouling coatings

An antifouling coating is a specialized paint that is applied to the wetted surfaces of a vessel (e.g., the hull) to prevent the accumulation of biofouling organisms. There are two main types of antifouling coatings.

- **Biocidal coatings:** rely on toxic substances (e.g., copper, zinc) to prevent organisms from attaching to, or growing on, the coated surface.
- **Foul-release coatings:** rely on slippery surfaces, made from biocide-free materials like silicone, to prevent organisms from staying attached once the vessel starts to move.

Vessel owners/operators determine the type of coating to be used based on the vessel's operational profile (e.g., how fast it moves, the locations through which it transits, the frequency and duration of its idle periods).

6.2.2 Managing Niche Areas

A vessel's biofouling management plan must include a management action (e.g., use of antifouling coating, marine growth preventions system, regular cleaning) for eight niche areas, if they are present. These eight niche areas include:

- Sea chests
- Sea chest gratings
- Bow and stern thrusters
- Bow and stern thruster gratings
- Fin stabilizers and recesses
- Out-of-water support strips (also referred to as dock blocks)
- Propellers and propeller shafts (stern tube)
- Rudders

6.2.3 Managing Biofouling After Extended Idle Periods

Before arriving at a California port, any vessel that has experienced an extended idle period of 45 days or more must manage biofouling consistent with

the management actions described in its biofouling management plan. In most cases, biofouling that accumulates because of an extended idle period should be managed in the same location where the idle period occurred to prevent moving the biofouling organisms to new locations.

6.3 Biofouling Data Patterns

2022 and 2023 Biofouling Data Patterns:

- 279 million square meters of cumulative wetted surface area on vessels arrived at California ports
- 81.6 percent of the vessels had antifouling coatings that were applied within the prior three years, which indicates that the coatings were still likely to be effective
- 55 percent of the vessels reported at least one idle period of 10 days or longer before arriving to California
- 60 percent of the vessels reported visiting at least one freshwater port before arriving to California
- 36.1 percent of the vessels reported at least one in-water cleaning event before arriving to California

6.3.1 Total Wetted Surface Area

Total wetted surface area (TWSA) is an estimate of a vessel's total surface area, including niche areas, that is temporarily or continuously submerged in water.

TWSA is used to evaluate the potential for biofouling accumulation based on the area that is available for biofouling organisms to colonize and grow. TWSA varies by vessel because it depends on the size (gross tonnage) and the number and types of niche areas (Ceballos et al., 2021). Passenger and container vessels have the largest average TWSA, followed by tank vessels (Figure 6-2).

During 2022 and 2023, California received more than 279 million square meters of cumulative wetted surface area. This number is 7.3 percent larger than the cumulative wetted surface area reported for 2020 and 2021(Thompson et al., 2023).

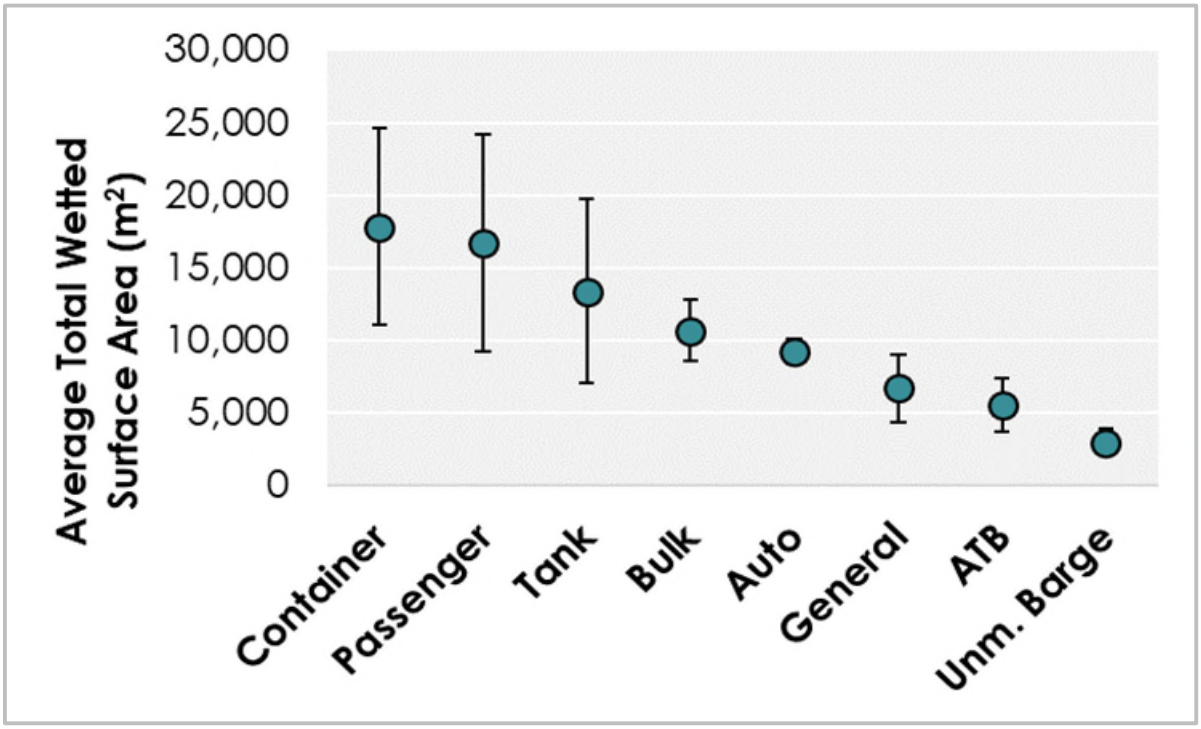


Figure 6-2. Average total wetted surface area of vessels arriving at California ports during 2022 and 2023. Vessel types are described in the definitions section. Error bars represent standard deviation (values used to describe the variability of the observations from the average of a defined population).

6.3.2 Vessel Operational Practices that Influence Biofouling

Vessel maintenance and operational practices affect biofouling accumulation and organism survival during vessel voyages. Commission staff analyzes the following practices using AVRF data to assess the likelihood of biofouling accumulation on vessels arriving at California ports:

1) Type and age of antifouling coatings
2) Frequency and length of idle periods
3) Average vessel speed
4) Freshwater transits
5) In-water cleaning events

Type and Age of Antifouling Coatings

During 2022 and 2023, 86 percent of the vessels that arrived at California ports relied solely on biocidal antifouling coatings, nearly all copper based, to prevent the attachment and accumulation of biofouling organisms. Only 1 percent of vessels relied solely on biocide-free foul-release coatings. An additional 1 percent of vessels used a mixed strategy applying biocide-containing coatings on some surfaces (e.g., niche areas) and biocide-free foul-release coatings on other surfaces (e.g., hull). Twelve percent of vessels reported a coating type that was classified as unknown due to lack of coating specifications.

Most antifouling coatings are designed and applied to be effective for three to five years. During 2022 and 2023, 82 percent of vessels reported coatings that were applied within the prior three years, which indicates that the coatings were still likely effective. Coatings aged beyond three years are in the latter stages of their service life and are likely to be less effective because of wear and damage. Only four percent of vessels reported relying on a coating aged beyond five years.

Frequency and Duration of Idle Periods

The frequency and duration of idle periods affect biofouling accumulation because most coatings require movement above a certain speed to be effective. The longer the idle period, the more likely the vessel is to accumulate biofouling and have many different species present (Davidson et al., 2020). As more biofouling accumulates, there is an increased likelihood of transporting and introducing those organisms as the vessel travels to new locations.

During 2022 and 2023, 55 percent of the vessels reported at least 1 idle period of 10 days or longer since their last dry dock. 80 percent of these idle periods were between 10 and 20 days, 17 percent were between 21 and 45 days, and 3 percent were longer than 45 days (Figure 6-3A and B).

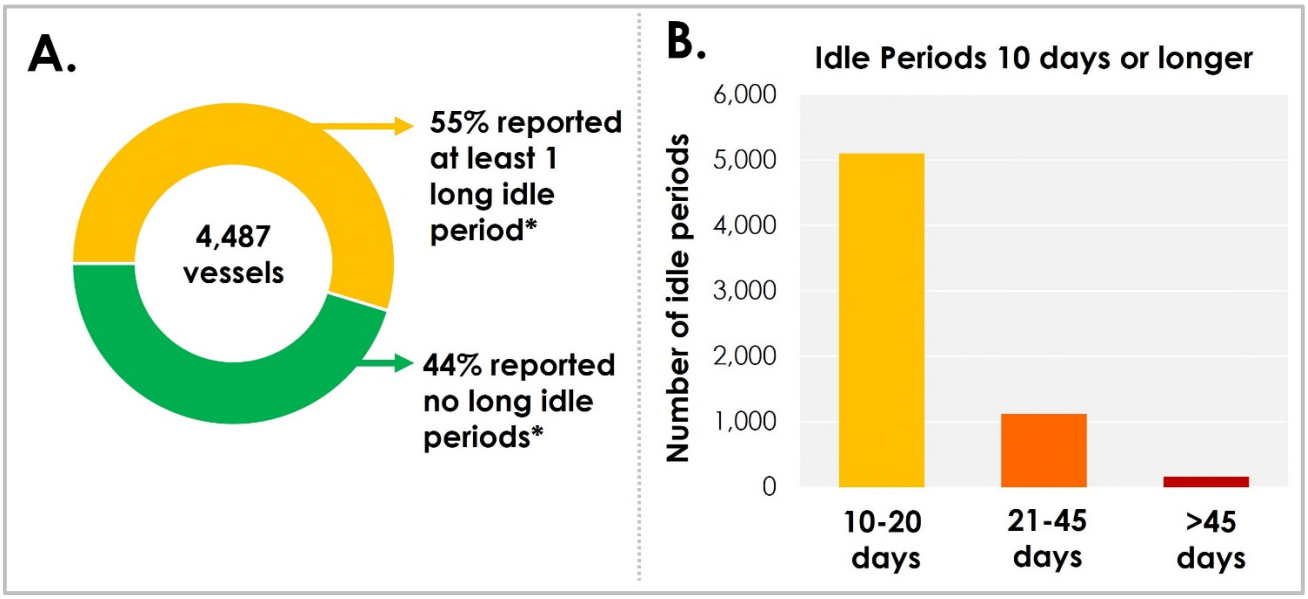


Figure 6-3. A. Percentage of vessels that reported at least one long idle period during 2022 and 2023. **B.** Frequency of idle period 10 days or longer. *A "long idle period" refers to an idle period that is 10 days or longer.

The frequency of these long (10 days or longer) idle periods varied by vessel type. Bulk and tank vessels accounted for 70 percent of all long idle periods reported.

Vessel Average Speed

Vessel traveling speed influences biofouling accumulation because organisms are more likely to remain attached and survive at slower speeds, leading to an increase in the likelihood of NIS introductions (Coutts et al., 2010, Davidson et al., 2020). The speeds reported during 2022 and 2023 by the different vessel types are consistent with the average observed in previous years (Figure 6-4).

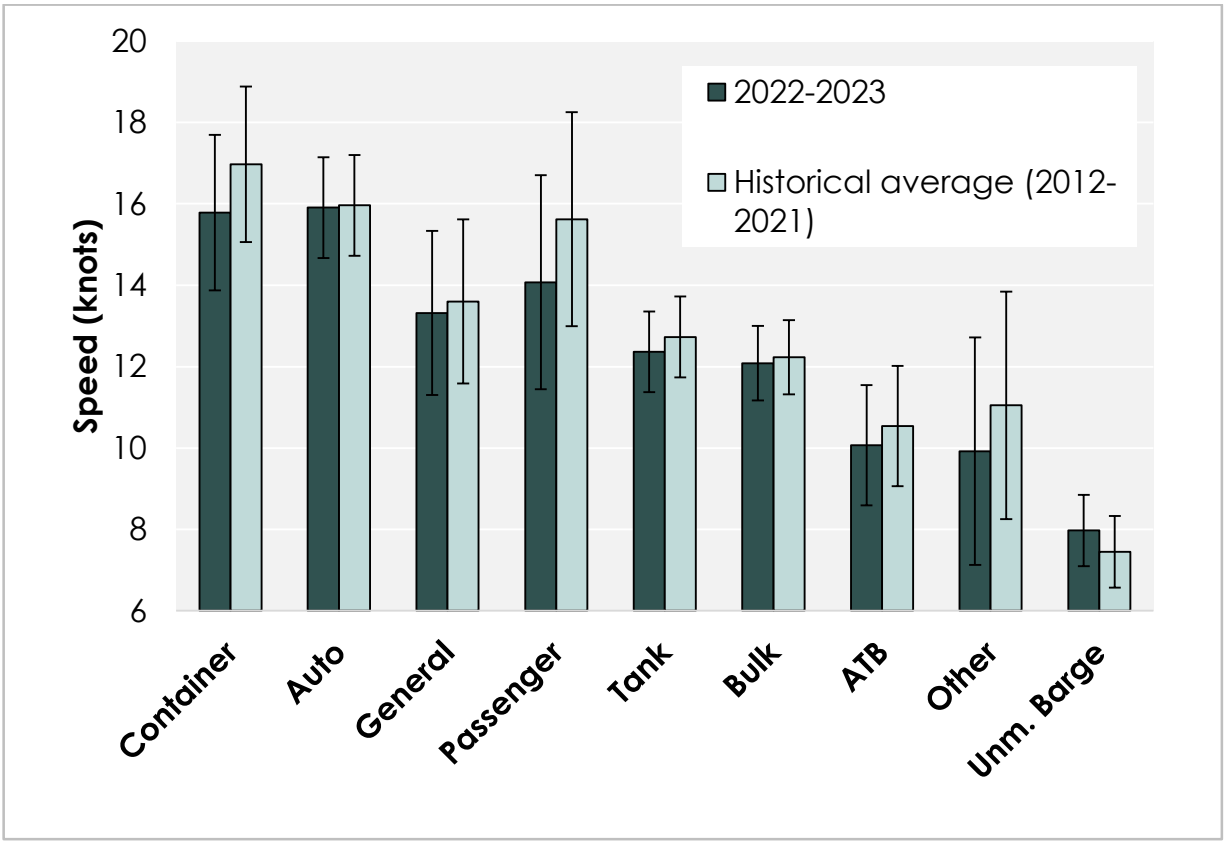


Figure 6-4. Historical average speed per vessel type compared to the average speeds reported during 2022 and 2023. Error bars represent the standard deviation (values used to describe the variability of the observations from the average).

Freshwater Transits

Vessels that travel through freshwater are less likely to spread marine biofouling organisms because freshwater is a natural biocide for most marine organisms. During 2022 and 2023, 67 percent of vessels reported visiting a freshwater port at least once before arriving at a California port (Figure 6-5A). The vessel types that more frequently reported at least one freshwater transit during this period were ATBs and barges, followed by auto carriers and general cargo vessels (Figure 6-5B).

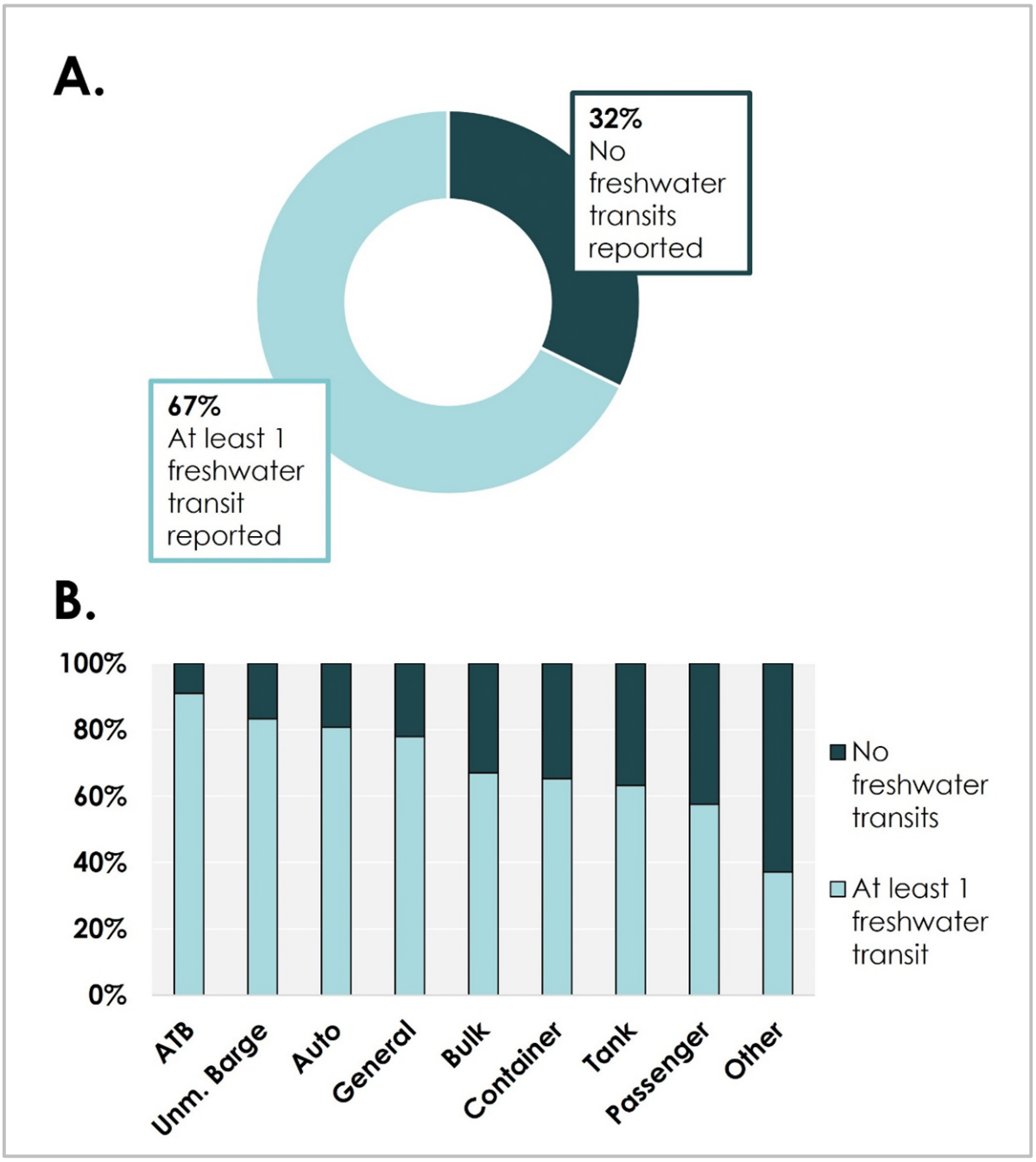


Figure 6-5. A. Percentage of vessels that reported at least 1 freshwater transit during 2022-2023 before arriving to California. **B.** Percentage of vessels in each vessel type category that reported at least 1 freshwater transit during 2022-2023 before arriving to California. The vessel types are described in the definitions section.

In-Water Cleaning

In-water cleaning (IWC) of vessels can prevent or remove biofouling (Scianni and Georgiades 2019). As a result, vessels that reported at least one IWC event before coming to California are less likely to introduce species into California waters.

During the reporting period, 36 percent of vessels reported at least one IWC event before arriving to California (Figure 6-6A and B). The IWC events include full cleanings, partial cleanings (only some parts of the vessels), and events where only the propeller is cleaned.

Consistent with patterns observed in previous years, passenger vessels reported more IWC events proportionally than any other vessel type (Figure 6-6C).

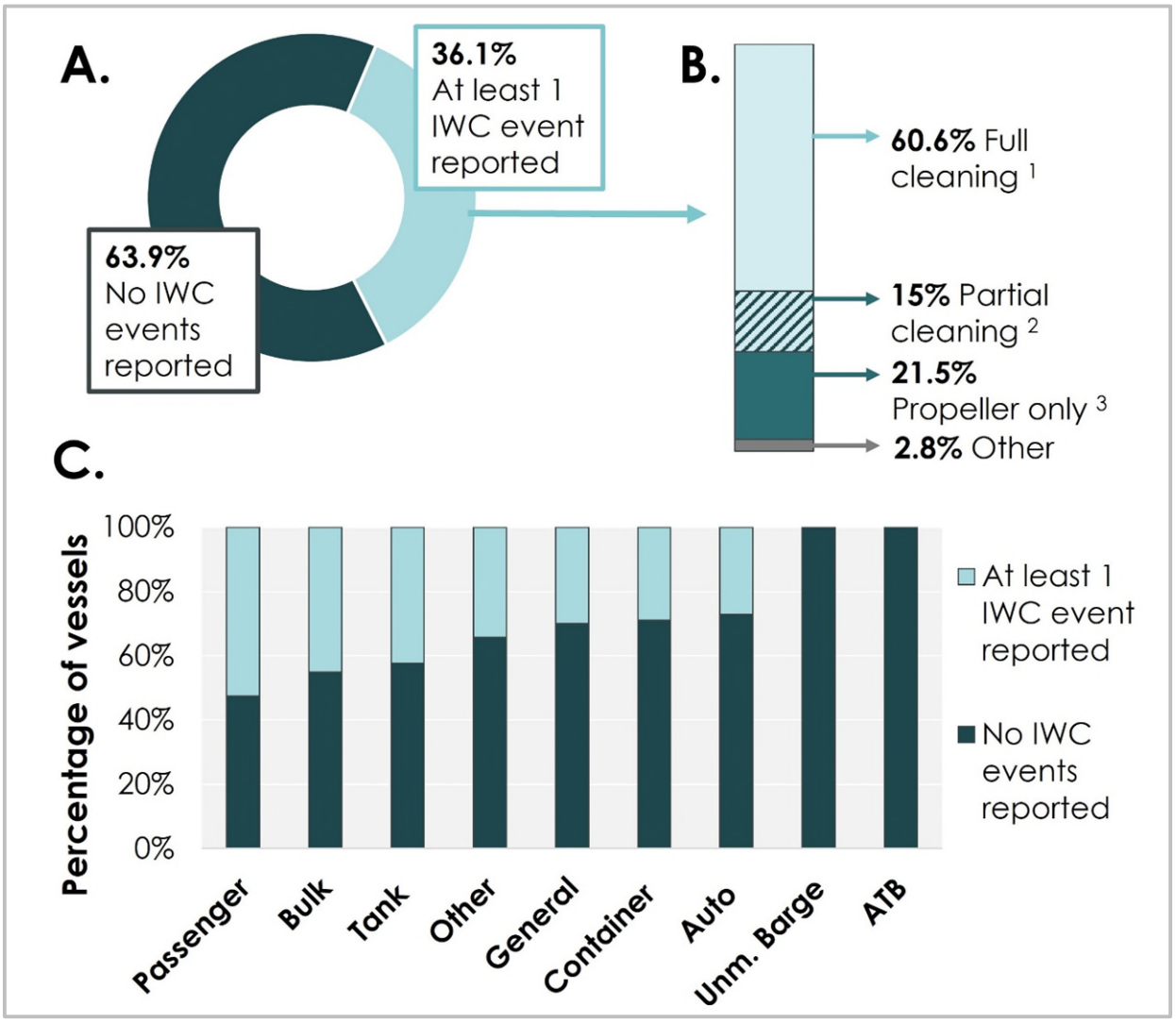


Figure 6-6. A. Percentage of vessels that reported in-water cleaning (IWC) events during 2022 and 2023. **B.** Percentage of reported types of cleanings. [1] Full cleaning: all hull was cleaned including sides and bottom; [2] Partial cleaning: only parts of the hull and/or the propeller were cleaned; [3] Propeller only: only the propeller is cleaned, not the hull. **C.** Percentage of vessels within each vessel type that reported at least one in-water cleaning event before arriving in California. Descriptions of the different vessel types can be found in the definitions section.

6.4 Biofouling Compliance

2022 and 2023 Biofouling Compliance Highlights:

- Commission staff inspected 45 percent of the 4,827 vessel arrivals that were required to comply with the California Biofouling Management Regulations
- 348 vessels had at least one biofouling deficiency that resulted in a 60-day grace period
- 18 vessels were issued violations because they were found to be noncompliant during follow-up inspections after the expiration of a 60-day grace period

The Commission assesses compliance with, and enforces, biofouling management requirements through vessel inspections and notifications of violations. During 2022 and 2023, a total of 2,194 vessels were inspected for biofouling (Figure 6-7).

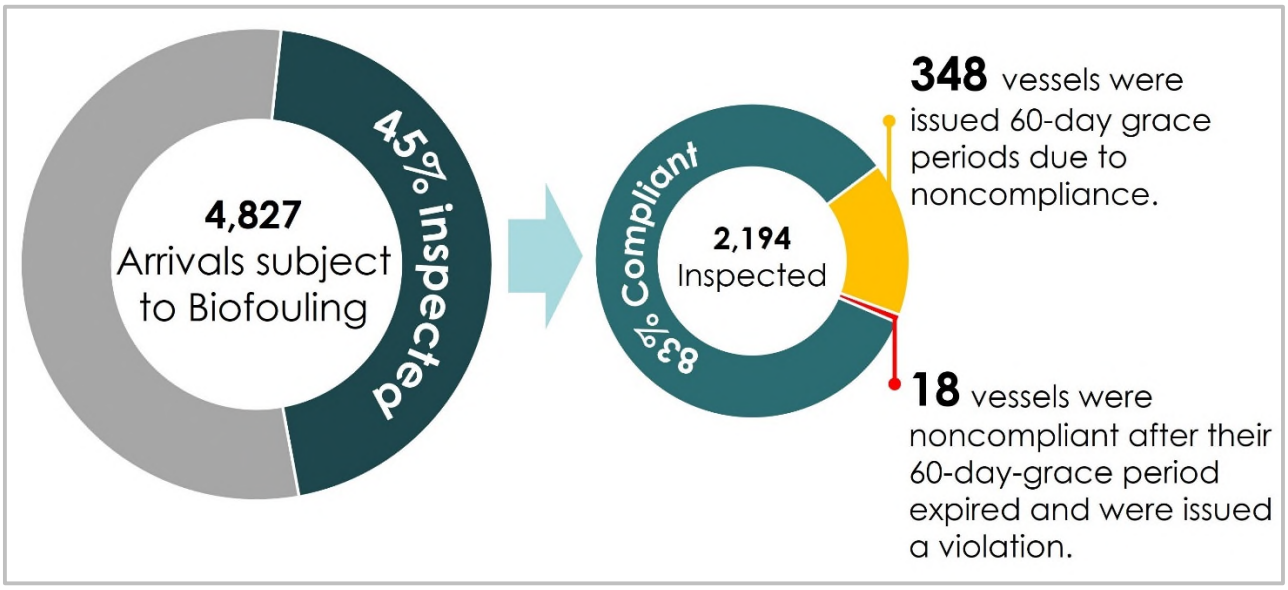


Figure 6-7. Biofouling inspections and compliance trends during 2022 and 2023.

As mentioned in section 4 (Vessel Arrivals in California), vessels are prioritized for inspection based on several factors. Vessels are designated as a high priority for inspection during their first arrival after becoming subject to California's Biofouling Management Regulations (see section 6.1) or for the first arrival after an expired 60-day grace period (Grace Period).

Grace periods to assist with the new biofouling management understanding and implementation

To assist and educate new vessels or new crews with the biofouling requirements in California, the regulations include a grace period for noncompliant vessels.

A vessel with incomplete or missing management plans or record books are given 60 days to correct their deficiencies. Following the 60-day grace period, the vessel would be a high priority for inspection to determine if the deficiencies were corrected.

During the reporting period, 348 vessels were issued a Grace Period (Figure 6-7) because they were found to be noncompliant with the Biofouling Regulations. Most noncompliance was due to lack of information about the coating's expected lifespan, lack of a management description for out-of-water-support strips, or deficient or missing biofouling record books, or a combination of these (Figure 6-8).

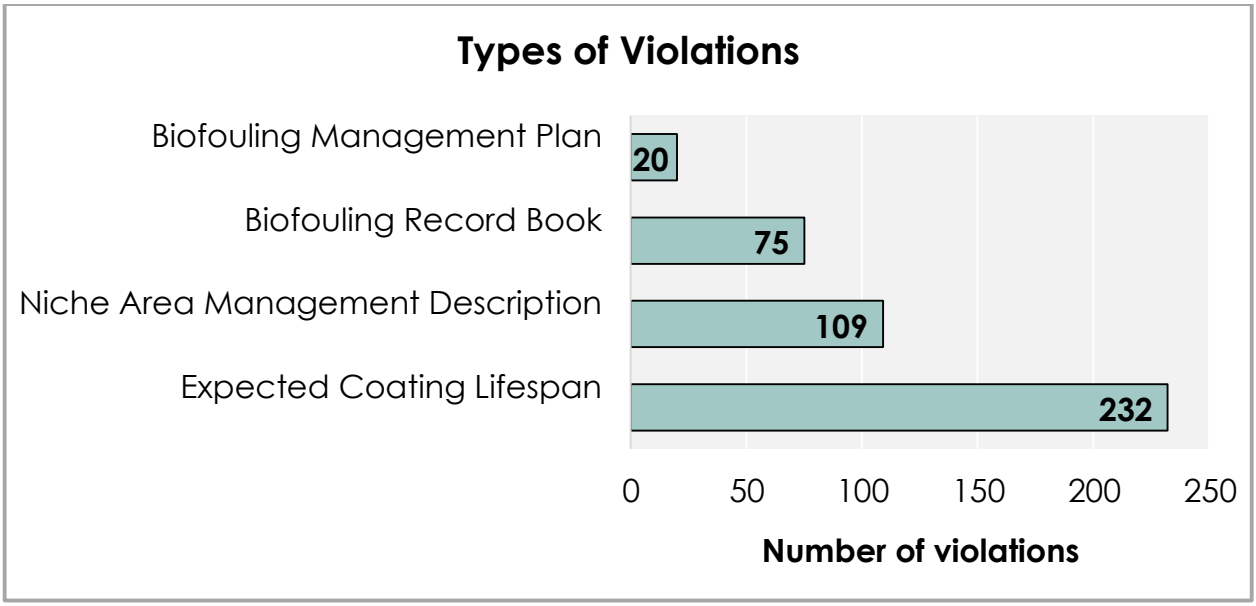


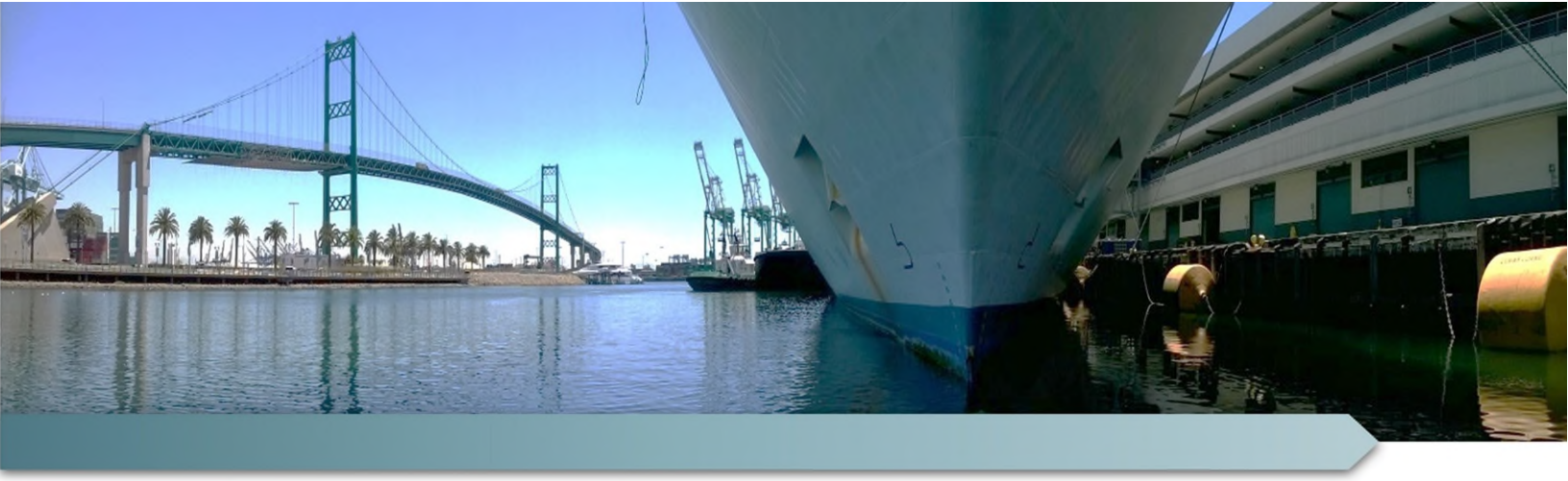
Figure 6-8. Number of biofouling violations by type during 2022 and 2023. Biofouling Management Plan: the plan was incomplete, not specific to the vessel, or not on board. Biofouling Record Book: The vessel did not have a biofouling record book, or it was not vessel specific. Niche Area Management Description: The vessel's biofouling management plan lacked a description for managing niche areas. Expected Coating Lifespan: No documentation of the expected effective lifespan of antifouling coatings on board.

Vessels with an expired grace period are a high priority for inspection. Eighteen vessels were found to still be noncompliant after expiration of the Grace Period (Figure 6-8). These vessels received a notice of violation requiring them to correct deficiencies. Most of these violations were due to biofouling management plan deficiencies (Table 6-1). These vessels will continue to be high priority for inspections until the deficiencies have been corrected.

Table 6-1. Vessels that received a notice of violation due to noncompliance after the expiration of their 60-day grace period in 2022 and 2023.

Year	Total Notices of Violation	Management Plan Violations	Record Book Violations	Management Plan and Record Book Violations
2022	14	11	1	2
2023	4	1	2	1

Commission staff does not currently have the authority to issue penalties for violation of biofouling management requirements. However, staff is preparing to amend the Commission's enforcement regulations (codified under California Code of Regulations, title 2, section 2299.01 et seq.) to create a more comprehensive enforcement process that includes a transparent biofouling management violation penalty structure.



7 NONINDIGENOUS SPECIES RESEARCH AND MONITORING

In addition to evaluating ballast water and biofouling as discrete vectors of species introductions, the MISP also takes a wholistic approach to evaluating the role of vessels as a pathway for species introductions. This section is a summary of the following:

- Recent research relating to ballast water, biofouling, and vessels as vectors of NIS introductions
- Marine Invasive Species Program: Species Monitoring Update

7.1 Vessel Vector Research Review

As required by Public Resources Code 71212, subdivision (e), this Biennial Report includes summaries of recent research on vessel vectors and NIS introductions. This section summarizes peer-reviewed articles published in 2022 and 2023.

As mentioned in the introduction of this report (see section 2), aquatic NIS introductions can harm coastal environments. While most shipping and invasive species research and regulations focus on larger plants and animals, microscopic organisms like bacteria, viruses, and parasites can also be transported through ballast water. **Pagenkopp Lohan et al. (2022)** found that ballast water discharges are effective at spreading marine parasites. These organisms infect a wide range of hosts and only require a single host for reproduction, which increases the likelihood of establishing in coastal ecosystems. **Guo et al. (2022)** found that ballast water can also spread bacteria with antibiotic resistance and suggested that research on ballast water treatment systems should include evaluating their effectiveness at limiting the spread of these bacteria. This is important because **Kuchi et al. (2022)** found that

ecosystems can change due to the introduction of antibiotic-resistant genes into a system. Also important is the findings of **Studivan et al. (2022),** who found that the pathogen that causes Stony Coral Tissue Loss Disease (a disease that is all but a death sentence for infected corals) is transported in ballast water and can survive ultraviolet ballast water treatment.

Yuan et al. (2023) found that proper techniques should be used to assess ballast water discharge compliance as BWTS use increases. The authors recommend specific sampling flow rates (based on organism size), a minimum sample volume, and multiple samples per test to accurately assess ballast water compliance. **Casas-Monroy et al. (2022)** tested rapid assessment tools that indirectly evaluate organism concentrations in ballast water discharges. The authors found that most of these devices have higher uncertainty when the abundance of organisms is low (as expected in treated ballast water). In addition, **First et al. (2022)** suggested that more samples and greater analysis volumes could increase BWTS testing accuracy because larger analysis volumes will increase the ability to detect small concentrations of living organisms.

Although BWTSs can decrease the likelihood of transporting NIS by shipping, they still can malfunction and must be operated properly to be effective. **Drillet et al. (2023)** stated that BWTS failures have been decreasing over the last several years, with declines in commissioning test (a process that verifies the proper installation and operation of a BWTS) failures from 2019 to 2022. The authors also had some recommendations for compliance testing, such as focusing on the largest size class of organisms (greater than 50µm). Some studies have analyzed the effectiveness of BWTS compared to ballast water exchange commonly used before the implementation of performance standards**. Chen et al. (2023)** showed that the abundance and diversity of some algae in ballast water was lower when the water was treated with a BWTS than using ballast water exchange as a management strategy.

Contingencies to reduce invasion risk associated with malfunctioning systems were evaluated by **Bradie et al. (2022)**, who found that ballast water exchange was more effective at reducing the likelihood of NIS introduction than non-treatment when a BWTS was not functioning properly. The risk was reduced even more when partially functioning systems were combined with ballast water exchange. **Rolla et al. (2023)** came to a similar conclusion, finding that fully functional ballast water systems reduced NIS establishment risk by 38-66 percent compared to untreated water, but even partially functioning systems reduced NIS risk substantially. **Bailey et al. (2022)**, who examined whether BWTSs were meeting required standards, found that 10 percent of the sampled vessels experienced system malfunctions. Although these malfunctions happened for a variety of reasons, the researchers said these issues might be avoided in the future if the crew was given more comprehensive training and if the systems had more frequent maintenance checks. **Yilmaz et al. (2023)** surveyed seafarers about these systems to learn about on board experiences with operating BWTSs

and to help make better decisions about selecting appropriate systems for future installations. One key finding was that 76 percent of the surveyed seafarers agreed that ultraviolet BWTS were less likely to malfunction than their electrochemical counterparts.

Understanding the potential for vessels to spread NIS is vital to prioritizing efforts to conserve and protect aquatic habitats and maintain the health of the shipping and coastal economies. To that end, vessel biofouling is a major research topic for identifying risks and possible mitigation measures. **Brinklow et al. (2022)** found that biofouling is a "dominant, active vector for the transport of NIS into Canadian waters." Modeling the probability of biofouling-mediated introduction and establishment of NIS, the authors found that there was a considerable likelihood of NIS establishment in all regions of Canada. **Tempesti et al. (2022)** reported similar results in the Mediterranean Sea, finding that recreational harbors are very susceptible to invasions because of the activities of recreational and fishing vessels.

Hadžić et al. (2022) studied biofouling effects on ship performance and added the fouling community's reproductive potential to existing models of vessel biofouling to estimate NIS introductions. **Donelan et al. (2022)** found that vessel routes and residence times influence the potential for organisms to reproduce. **Castro et al. (2022)** found that ships coming from environments more like their current port had a higher chance of successfully introducing NIS than those coming from different environments. **Riley et al. (2022)** also looked at port similarity as a factor for zebra and blue mussels' survival, finding that blue mussels could survive up to 14 days in vastly different conditions and zebra mussels up to eight.

Understanding biofouling community structure over time and space is another important consideration. **Wassick et al. (2023)** found that stationary vessel biofouling is influenced by the dominant biofouling organisms present and local environmental factors. These factors can be used to estimate the likelihood of extensive biofouling and can help to prioritize vessel inspections and vessel biofouling removal either prior to leaving the stationary location or when they move to a new port. **Martinez-Laiz et al. (2022)** found that vessel biofouling accumulation can create habitat for mobile species that can then be spread as the vessel moves throughout the world.

Biofouling accumulation is also affected by a vessel's speed, route, and length of time in port. **Costello et al. (2022)** emphasized that understanding vessel movements and routes could be key to improving antifouling management practices. In addition to supporting the finding that commercial ships act as active pathways for introducing NIS, **Chan et al. (2022)** found that the number of NIS that make up a fouling community and the total area of a vessel that is covered with biofouling varies based on time spent in port and the number of ports a vessel visits. The authors also found that, regardless of ship speed or

length of time in port, ships that have older antifouling coatings are more likely to spread NIS.

Biofouling also influences vessel efficiency. **Davidson et al. (2023)** found that biofouling on internal vessel surfaces (e.g., internal seawater systems) and other niche areas increases potential for NIS introduction, and that biofouling build-up can negatively affect performance and efficiency of these vessel systems. **Hadžić et al. (2022)** described how increased vessel biofouling can increase fuel consumption, increasing vessel operating costs. The authors created a model to determine the best time to dry dock a vessel based on vessel schedules, ship maintenance costs, biofouling growth rate, and hull roughness. The model can vary by ship type and should decrease operational expenses.

In-water cleaning (IWC) is a tool to decrease vessel biofouling build-up. New techniques and technologies were studied by **Wu et al. (2022)**. The authors tested a technique that cleans by blasting biofouling with high-pressure water jets while vessels are traveling. This can decrease cleaning costs by nearly seven percent when used in addition to other methods (e.g., dry-docking). **Ralston et al. (2022)** found that surfaces covered in antifouling paints and regularly groomed (i.e., proactively cleaned to prevent buildup) were free of macrofouling and were kept free of macrofouling for up to two years, depending on the coating used. Similarly, **Ralston and Swain (2023)** groomed panels (as proxies for vessel hulls) in two Florida bays and found that they had less macrofouling accumulation than both uncleaned panels and panels cleaned less frequently, regardless of antifouling coating type. A study by **Swain et al. (2022)** on U.S. Navy ships had similar results. Although an initial layer of microscopic organisms (i.e., biofilm) was present on all coatings tested, no macrofouling was found on surfaces subjected to grooming. The authors also found that grooming, when applied properly, did not damage antifouling ship coatings.

Aside from the benefits of IWC, it may also have negative effects. **Soon et al. (2023)** examined IWC effluent and its effects on aquatic environments. They analyzed the amount and rate of particles released during IWC. The authors found that the toxic substance concentrations would be hazardous to the environment, especially without further protection. There are some current treatment systems that can capture and decrease these toxic substance concentrations before they enter the environment. **Scianni et al. (2023)** came to similar conclusions, recommending regulatory authorities be aware of all the pollutants that can be released during IWC. Additionally, the authors suggested to avoid narrowly focusing on one pollutant type at the expense of others.

New antifouling techniques are being developed that may offer more ecologically sound (i.e., non-toxic) protection against fouling organisms. **Ali et al. (2024)** discussed new antifouling coating technologies based on a wide range

of different, natural processes. They range from slippery lubricant surfaces to natural hydrogel surfaces that can absorb and retain water. All the surfaces investigated in this study are inspired by a variety of plants and animals (e.g., pitcher plants, frog skin, seaweed, and carp). These technologies are not yet fully developed and will require additional research.

In addition to coatings and IWC, vessels are now being designed to decrease biofouling. **Piola et al. (2022)** examined altering the design of sea chests to decrease biofouling accumulation. They found that the new design reduced the overall surface area within the sea chests and, therefore, reduced the amount of biofouling. **Hopkins et al. (2023)** evaluated a unique idea using air bubbles to decrease biofouling settlement. Though this was tested on stationary structures, and not vessels, the approach was effective at preventing biofouling until the air bubble machines themselves became fouled.

Vessel characteristics and movements are important when considering how to prioritize vessels for inspection or better understand the likelihood of NIS introductions. One factor is the vessel's operational profile, which includes different shipping routes and ports visited. For example, **Bereza et al. (2023)** found that ultra large container vessels (ULCV) may be exposed to fewer types of NIS than smaller vessels because they tend to visit a small number of ports in the same geographical area. However, ULCVs average longer port calls which likely increases the likelihood of biofouling accumulation regardless of the areas they travel. Long port stays were also the focus of work by **Ruiz et al. (2022)**, who evaluated how the COVID-19 pandemic affected vessel biofouling. The authors described examples of pandemic-related increases in vessel port residency times because of reduced commerce and reduced biofouling management (i.e., in-water cleaning) due to an urgency to return to business once pandemic restrictions were eased. These actions increased the potential for excessive vessel biofouling that increases likelihood of species spread. A model created by **Lenzen et al. (2022)** assessed the likelihood of NIS spread using the ports that vessels visit and economic modelling of the types of cargo they carry. The authors suggest that the likelihood of NIS introductions can be assessed using economic models without the need for detailed vessel itineraries.

7.2 Marine Invasive Species Program: Species Monitoring Update

Since 2000, the MISP at the California Department of Fish and Wildlife (CDFW-MISP) staff has managed surveys of California estuaries and marine waters for aquatic NIS. Results of these surveys are used to understand aquatic NIS distribution in California waters. The results are also used to evaluate the

effectiveness of California's ballast water and biofouling management requirements at reducing the rate of aquatic NIS introductions.

CDFW-MISP contracted with the Smithsonian Environmental Research Center (SERC) to complete eight surveys between 2020 and 2023 at seven locations:

- San Francisco Bay
- Los Angeles/ Long Beach Harbor
- Santa Catalina Island
- Mission Bay
- San Diego Bay
- Humboldt Bay
- Bodega Harbor and Tomales Bay

These surveys are designed to detect the presence of both sessile (i.e., attached to hard surfaces like port and marina structures) and planktonic (i.e., floating in the water column) non-native invertebrate organisms and algae. Standardized protocols are used to monitor the presence of organisms at each location. Species identification is done through taxonomical and genetic analyses (details of the methodology can be found in Ruiz et al., 2023, Figure 7-1). Once the organisms have been identified, statistical models are used to estimate the number of NIS per location (Colwell et al. 2012; Chao et al. 2020).

Figure 7-1. Example of plate used by the Smithsonian Environmental Research Center to monitor the presence of organisms in hard surfaces at each location surveyed after 3 months submerged in the water.

In 2021, hard surfaces surveys observed 39 NIS in the Los Angeles / Long Beach port complex and 44 NIS in San Francisco Bay. In 2022, 52 NIS were detected in San Francisco Bay and 21 NIS at Santa Catalina Island. No new NIS were found in the soft sediment or plankton surveys.

Across all surveys, no new NIS to California were detected. However, 13 NIS were observed for the first time in a new location within California (mostly Santa Catalina Island), but all had previously been found in other parts of California. This may suggest expanded ranges, but it is more likely that most of these species have been present in these locations but were not found/detected until now because these areas have not been extensively surveyed previously (Ruiz et al., 2023).

Additional efforts to enhance the taxonomic and genetic library in California were done through BioBlitzes (targeted sampling efforts focused on specific

organism groups) in three additional locations. During these surveys, 55 species were observed and added to the reference libraries.

California Non-native Estuarine and Marine Organisms Database (Cal-NEMO), a state-specific portal to an online database of marine and estuarine NIS in California has been updated with the new NIS observations from the surveys.

8 FEDERAL VESSEL VECTOR MANAGEMENT

8.1 Vessel Incidental Discharge Act

In late 2018, after months of negotiations, the U.S. Congress passed the Vessel Incidental Discharge Act (VIDA), included as Title IX within S.140, the Frank Lobiando Coast Guard Reauthorization Act of 2018. On December 4, 2018, the President signed VIDA into law. This law:

- Designates the U.S. Environmental Protection Agency (U.S. EPA) as the lead authority to establish national water quality standards for vessel discharges, including ballast water
- Designates the USCG as the lead authority to implement and enforce the national standards set by the U.S. EPA
- Once fully implemented, will preempt state authority to adopt or enforce state-specific management recommendations or standards for vessel discharges, including ballast water, that are stricter than the federal standards

Certain provisions were included in VIDA that protect states from some of the impacts to their authority, including:

- Individual states retain authority to inspect vessels and enforce the federal ballast water management requirements.
- Individual states retain authority to collect fees (with a cap) and Ballast Water Management Reports from vessels arriving at state ports.

- Individual states may, through their Governors, petition the U.S. EPA for stricter discharge standards.

State law is not preempted until the U.S. EPA and the USCG adopt regulations to establish discharge standards and implement enforcement procedures. The U.S. EPA published their final rule in October 2024, but the USCG rulemaking process could take several more years. During this time, states retain authority to continue implementing existing management programs.

8.1.1 Impacts Upon State Authority

Once VIDA is fully implemented, California will lose the authority to establish or implement any standards for discharges incidental to the normal operation of a vessel (including ballast water and biofouling) that are stricter than the federal standards. This means that unless changes are made to the federal law, California would be preempted from moving forward with the State's interim and final ballast discharge performance standards in 2030 and 2040, respectively (See Cal. Code Regs., tit. 2, § 2293.). While the Governor can petition the U.S. EPA to set stricter standards, the process is, and will likely remain, complicated. It requires not only an estimate of cost impacts on affected vessels, but also evidence showing that a stricter standard is achievable.

8.1.2 Fiscal Impacts

The implementation of VIDA will also initiate a cap on state fees at $1,000 for each qualifying vessel arrival to support ballast water management programs. California's fee is set at $1,000, so the Commission will be restricted from raising the fee, although the cap may be adjusted for inflation once every five years. Additionally, VIDA sets an annual $5,000 cap on fees that states can collect from U.S. flagged vessels. This cap is projected to cause the MISCF to lose between $400,000 and $600,000 in revenue each year. This loss of revenue will move the Marine Invasive Species Control Fund towards insolvency.

8.1.3 Implementation Status

In October 2020, the U.S. EPA proposed regulations in the Federal Register to establish national standards of performance for discharges incidental to the normal operation of a vessel. The public comment period was open for 30 days.

Commission staff submitted comments and worked with partner agencies in Pacific coast states to submit a regional response. The Governor also submitted a Letter of Objection in accordance with the provisions of Clean Water Act section 312(p)(4)(A)(iii)(III).

In response to the state comment letters and Governors' objection letters, the U.S. EPA reengaged with the states in 2021. The U.S. EPA held nine meetings with states between June and November 2021. Topics of discussion included:

- Ballast water best management practices
- Ballast water numeric discharge standards
- Best available technology determination
- Vessel biofouling
- Hull cleaning
- Exhaust gas cleaning systems
- Great Lakes ballast water management requirements
- State petitions to U.S. EPA for more stringent standards

U.S. EPA staff members were active listeners during the state re-engagement meetings but did not participate in a dialogue with states and did not offer additional information that would help the states understand the U.S. EPA's plans for addressing state concerns with the proposed regulations. At the close of the State re-engagement meetings, U.S. EPA staff indicated that states may submit additional comment letters if they had new information or comments to share that were not previously submitted to the U.S. EPA. Commission staff submitted a comment letter in January 2022 in response.

In October 2023, the U.S. EPA released a supplemental notice of proposed rulemaking in the Federal Register to propose several revisions to the originally proposed performance standards. The public comment period was open for 61 days. Commission staff worked closely with partner agencies in Pacific coast states to submit a regional response to the U.S. EPA.

The U.S. EPA published the final rule in the Federal Register on October 9, 2024. Commission staff is reviewing the contents of the final rule and will determine if regulation adjustments or legislative changes are necessary.

8.2 Federal Comparison

Although federal VIDA regulations are still under development and will not be in force until the U.S. EPA and USCG each complete their regulations development process, both federal agencies have current programs in place to manage NIS introduction risk from vessels operating in U.S. waters. The Commission works

cooperatively with both federal programs to fill management gaps and coordinate inspections and enforcement actions. While the Commission identified and discussed many of these complementary characteristics in a 2013 report (Commission 2013), several of the most prominent differences between the state and federal programs are highlighted in this section.

8.2.1 Differences in Reporting Requirements

Both the USCG and the Commission require vessels to submit the Ballast Water Management Report (see section 4.1 Reporting Requirements and Compliance). However, submission timing requirements vary considerably between the two programs. The Commission requires the BWMR to be submitted at least 24 hours prior to each arrival at a California port, whereas federal law requires the BWMR to be submitted no later than six hours after arrival. (33 C.F.R. § 151.2060, subd. (b)(3).) Receiving the BWMR prior to arrival allows the Commission to prioritize inspections for vessels that report an intent to discharge ballast water, ensuring a more efficient use of field operations staff. Pre-arrival submission also provides opportunities for Commission staff to assess compliance with ballast water management requirements and identify cases of potential noncompliance before the vessel arrives at a California port.

8.2.2 Differences in Biofouling Management Requirements

California's Biofouling Management Regulations were the first set of comprehensive regulations to be implemented in the U.S. and globally that provides a framework for managing biofouling to minimize the likelihood of NIS introductions (see section 7.1 Biofouling Management Requirements for more details). These requirements were modeled after the IMO Biofouling Guidelines to consistently improve biofouling management for all vessel wetted surfaces, including niche areas.

California's Biofouling Management Regulations fill important gaps in the federal biofouling management regulations by providing more specific actions for vessels to take to minimize the likelihood of NIS introduction. For example, the USCG requires vessels to "remove fouling organisms from the vessel's hull, piping, and tanks on a regular basis" (33 C.F.R. § 151.2050), but the term "regular basis" is not defined and, therefore, is ambiguous in its meaning. The USCG also requires vessels to include fouling maintenance procedures as part of their ballast water management plan (33 C.F.R. § 151.2050) and allows for a biofouling management plan to serve this purpose.

Similarly, the U.S. EPA's 2013 Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (Vessel General Permit) requires vessels to remove fouling organisms from seawater piping "on a regular basis," but this term is also undefined. The Vessel General Permit also requires vessels to minimize the transport of attached living organisms when traveling into U.S. waters or between Captain of the Port Zones but does not describe how biofouling can or should be minimized.

8.2.3 Differences in Inspection Requirements

California's MISP and the two federal programs (U.S. EPA and USCG) all include vessel inspections to assess compliance with management requirements, but the reach and scope of the inspections differ considerably between programs. The Commission's compliance assessment inspections are more thorough and targeted than ballast water inspections at the federal level (see sections 5.5.2 Compliance Assessment for Vessels Subject to the performance standards, 5.5.3 Compliance Assessment and Enforcement for Vessels not Subject to the Performance Standards, and 6.4 Biofouling Compliance for more information about Commission inspections and enforcement).

The USCG inspects vessels during their domestic vessel surveys and Port State Control examinations for foreign vessels. The USCG ballast water compliance assessment is only a small part of a larger USCG inspection and does not include sampling to directly assess compliance with performance standards. For example, Port State Control examinations include an evaluation of all engineering systems, pollution prevention systems, marine facilities and structures, proper carriage of hazardous materials, checking licenses and certificates, and emergency drills, among others. Typically, USCG inspectors will spend 10-15 minutes of a multi-hour inspection on ballast water compliance assessment, given the large number of other duties required of them (Commission 2013).

U.S. EPA inspects vessels for compliance with the Vessel General Permit through onsite inspections and offsite evaluations, although this is very limited with only a few inspectors dedicated to VGP inspections. U.S. EPA inspections focus on ballast water and all the other incidental discharges covered under the Vessel General Permit.

8.2.4 Intergovernmental Coordination

Coordination between the Commission and the federal programs is key to the success of all three programs. In many cases, a violation at the state level is likely

also a federal violation, and vice versa. Open communication between Commission staff and USCG Captains of the Port allows for rapid notification between programs of possible violations that might be of interest to the other party. In cases where the vessel is using a BWTS and that system malfunctions prior to arrival at a California port, the vessel is required to notify both the USCG and the Commission. If the vessel also intends to discharge, Commission staff coordinate with the USCG to identify an alternate method for managing ballast water, if warranted, and provide the same direction to the vessel. This open coordination ensures consistency and improves compliance.

9 ACCOMPLISHMENTS, LOOKING FORWARD, RECOMMENDATIONS

9.1 25th Anniversary of the MISP

The MISP celebrates its 25th anniversary on January 1, 2025. During the 25 years since inception, the MISP has developed into a world-renowned program focused on improving the management of vessels' ballast water and biofouling through science-based regulations development and implementation and species monitoring to assess the effectiveness of those regulations.

Prior to the MISP, there were no requirements in California, or anywhere in the U.S., for vessels to manage their ballast water to decrease the risk of moving species around the world. However, concern about ballast water soared after zebra mussels (*Dreissena polymorpha*) were discovered in the Great Lakes in 1989 (Hebert et al., 1989, Griffiths et al., 1991) and mitten crabs (*Eriocheir sinensis*) were discovered in the San Francisco Bay in 1994 (Cohen and Carlton 1997, Rudnick et al., 2003, ANSTF 2003).

During the 25 years of its existence, the MISP has adopted, revised, implemented, and enforced ballast water and biofouling management regulations to align with its statutory purpose of "*mov[ing] the state expeditiously toward elimination of the discharge of nonindigenous species into the waters of the state*... ." (Pub. Resources Code, § 71201, subd. (d)(1).) The MISP continually improved during these 25 years, with 12 statutory actions adopted by the State Legislature and 13 regulatory actions adopted by the Commission (see section 3.2).

Approximately 228,000 vessels have arrived at California ports over the life of the program (2024 data were not completed at the time of writing and were excluded)(Figure 9-1), accounting for 2.79 billion square meters of total wetted surface area (approximately 2.3 times the size of the city of Los Angeles) that could be colonized by biofouling communities (see section 6.3.1 for description

of total wetted surface area). Approximately 14 percent of these arrivals (32,086) discharged 233 million metric tons of ballast water (equivalent to the volume of 93,083 Olympic swimming pools). To assess if vessels were compliant with California requirements, Commission staff inspected 47,611 vessel arrivals during these 24 years (data from 2024 were not completed at the time of writing and were excluded), resulting in 4,808 administrative violations (e.g., late or missing reporting forms) and 479 management violations (e.g., incorrect ballast water exchange locations). Notably, management violations dropped from an average of 21.5 violations per year for the six years prior to adoption of enforcement regulations (i.e., ability to apply penalties) in 2017 to 3.7 violations per year for the six years after adoption.

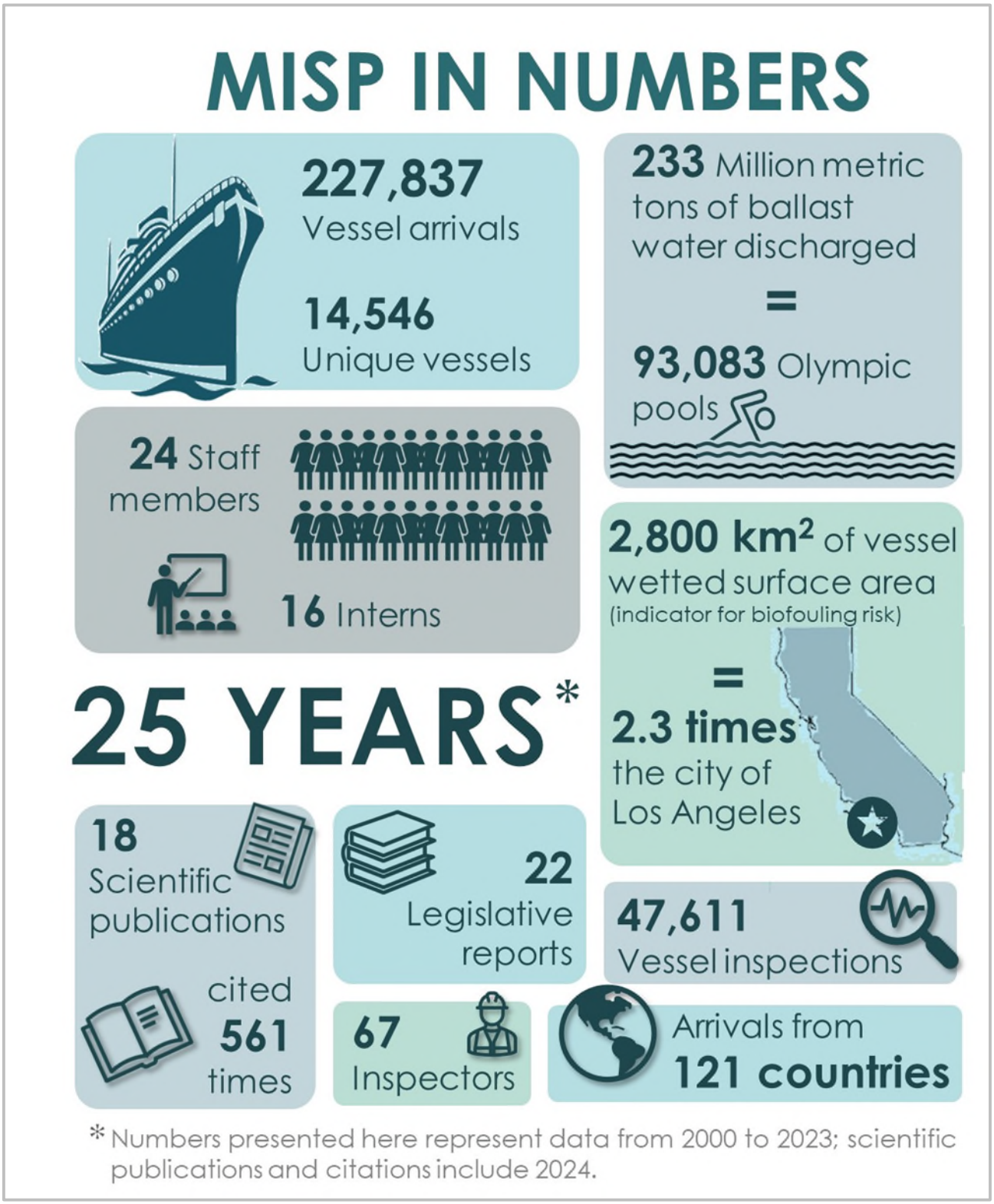


Figure 9-1. Marine Invasive Species Program statistics and accomplishments in the 25 years* of the program's existence.

Since the creation of the MISP in 2000, the number of newly detected NIS likely introduced through ballast water or biofouling in state waters has sharply declined (Figure 9-2).

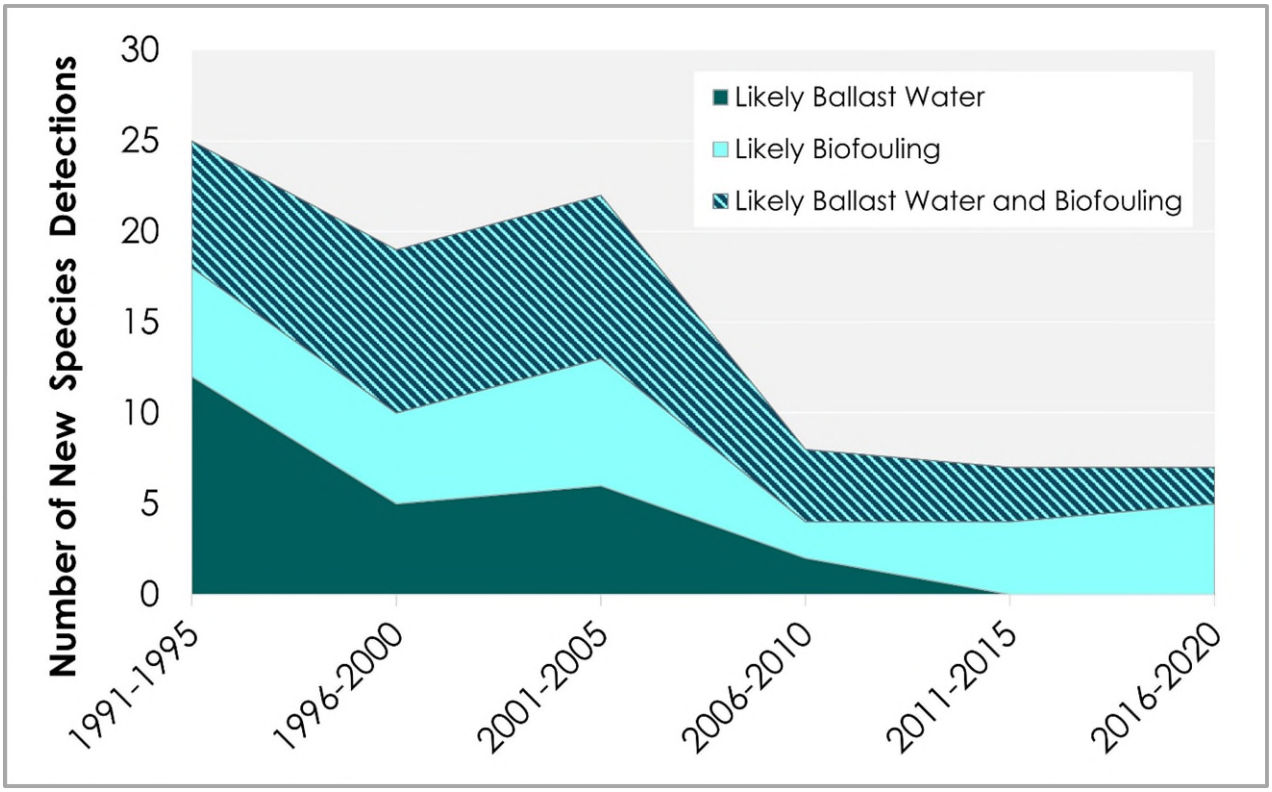


Figure 9-2. Number of new nonindigenous species detections per five-year period, shown by likely vector (ballast water, biofouling or both). Data were obtained from the CDFW-MISP California Non-native Estuarine Marine Organisms (Cal-NEMO) database.

An additional program success is that MISP staff have contributed to the global pool of scientific knowledge about invasive species and commercial shipping, serving as lead or co-author for 18 peer-reviewed scientific journal articles during the 25-year period.

Through these actions, and many others, the MISP has worked to protect California's coastal and estuarine habitats and reduce the likelihood of invasive species introductions since 2000. The MISP has also continued to be a global leader on the development and implementation of science-based regulations to reduce the likelihood of species introductions, and the impacts that invasive species can have on coastal environments.

9.2 MISP Accomplishments 2022-2023

The MISP continues to be globally recognized as an active, cutting-edge program at the forefront of marine invasive species research and policy development. This section summarizes the major accomplishments achieved during 2022 and 2023.

Quarterly Posting of Interactive Data Dashboards on MISP Website

The Commission launched a public facing interactive data dashboard on the Commission's website (https://misp-cslc.hub.arcgis.com/) in December 2023. This dashboard (Figure 9-3A), updated quarterly, makes vessel arrival and ballast water management data available to the public to view and download, with filters to sort by location, time, and vessel type.

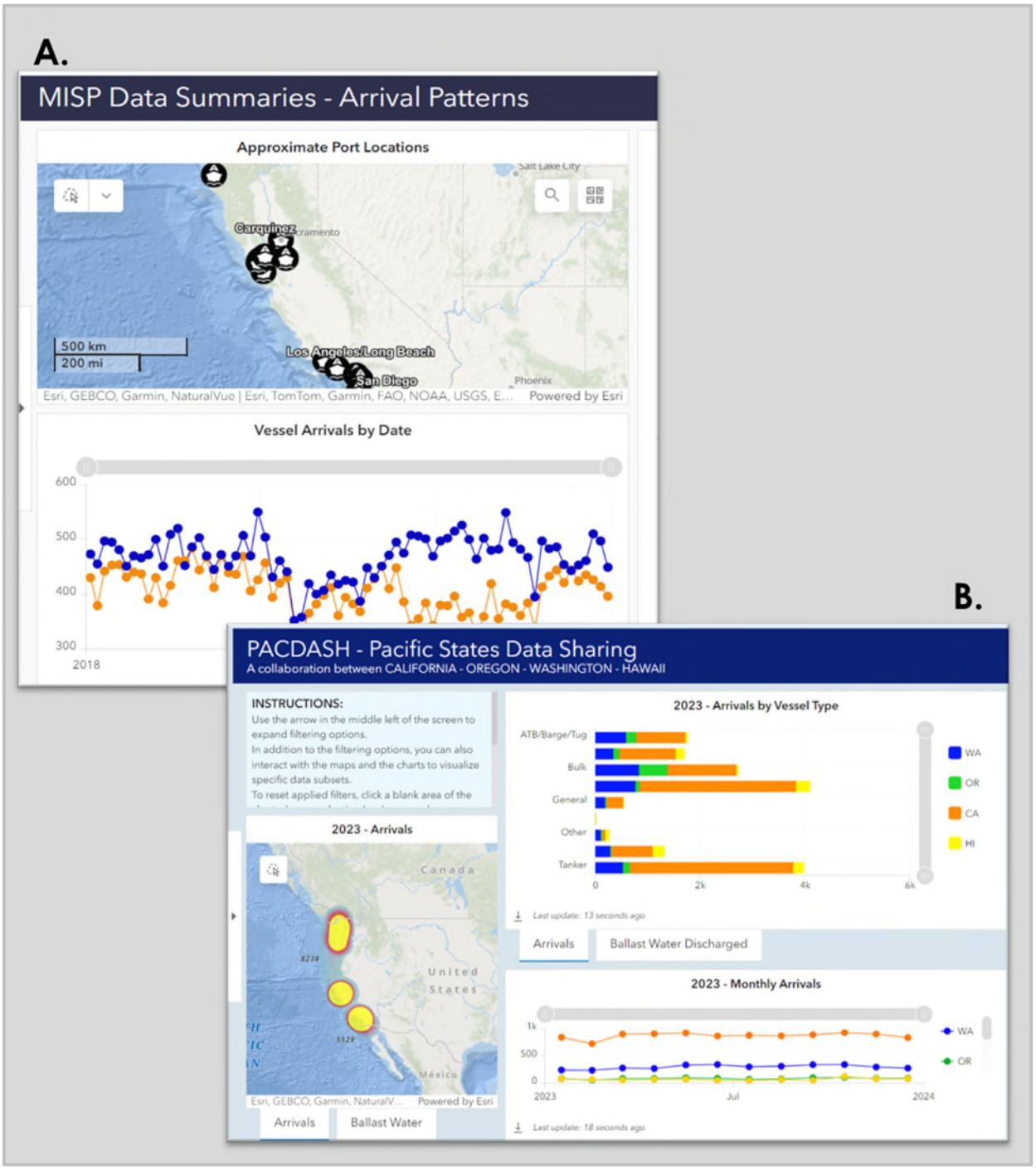


Figure 9-3. A. A screenshot of the Marine Invasive Species Program public facing interactive. **B.** A screenshot of the Pacific states data sharing dashboard (PacDaSh).

In addition to the Commission's dashboard, Commission staff led the development of a Pacific states data sharing effort (PacDaSh) (Figure 9-3B) to make available data from programs in California, Oregon, Washington, and Hawaii. PacDaSh is also updated quarterly and is available on the Commission's

website and the Pacific Ballast Water and Biofouling Group website (PBWBG 2024).

Global Leadership

The MISP is a global leader on advancing and implementing innovative science-based regulations and delivering effective outreach to the maritime shipping industry and regulatory partners. Because of MISP expertise and experience, Commission staff continues to be invited to participate in international policy discussions and training operations. During 2022 and 2023, staff was invited (with all costs covered) to delivered in-person biofouling management training on behalf of the International Maritime Organization in Mexico, Brazil, and Peru, with an additional virtual training in Ecuador.

Peer-Reviewed Scientific Journal Publications

Commission staff co-authored four peer-reviewed journal articles during 2022 and 2023. Publication of journal articles allows MISP to continue its global leadership on the advancement of science and policy related to shipping and nonindigenous species. Additionally, MISP-funded research contracts require contractors to submit a manuscript to a peer-reviewed journal as one of the deliverables. Staff was lead author or co-author on the following publications during 2022 and 2023:

- Understanding the potential release of microplastics from coatings used on commercial ships (Tamburri et al., 2022)
- Biofilms associated with ship submerged surfaces: implications for ship biofouling management and the environment (Georgiades et al., 2023)
- Biofouling occlusion of ships' internal seawater systems: operational, economic, and biosecurity consequences (Davidson et al., 2023)
- Balancing the consequences of in-water cleaning of biofouling to improve ship efficiency and reduce biosecurity risk (Scianni et al., 2023)

Compliance Sampling for Ballast Water Discharges

Commission staff collected ballast water discharge samples for compliance analysis from 12 vessels during 2022 and 2023 to develop standard operating procedures for assessing compliance with, and enforcing, California's ballast water discharge performance standards. This process is another example that highlights MISP's role in providing global leadership, as no other regulatory authority is currently collecting and analyzing ballast water discharge samples for compliance assessment and enforcement purposes. The results of the Commission's sampling and the finalization of the standard operating

procedures will be useful tools for the Commission and partner agencies across the globe in the years to come.

9.3 Next Steps

Over the next two years, Commission staff will work on high priority actions to better protect California waters from nonindigenous species introductions, including:

Update the Marine Invasive Species Act Enforcement Process

Commission staff is preparing to amend the MISP enforcement regulations (Marine Invasive Species Act Enforcement and Hearing Process, California Code of Regulations, title 2, section 2299.01 et seq.) to incorporate a processes for enforcing violations of the biofouling management requirements (see section 6.1) and ballast water discharge performance standards (see section 5.2).

Staff is also developing a process to automate methods to track reporting compliance and streamline enforcement of violations (see section 4.1 and Class 3 violations in Appendix A).

Improve the Implementation of Ballast Water Discharge Performance Standards and Associated Requirements

As discussed in section 5.2, the Commission implemented ballast water discharge performance standards on January 1, 2022. Commission staff is refining inspection protocols to improve compliance assessments and is continuing to develop sampling and analysis standard operating procedures (see section 9.2). Staff is also improving outreach materials to help the regulated industry understand the new requirements.

Update California's Biofouling Management Regulations

Commission staff is preparing to amend California's Biofouling Management Regulations to change several references from the 2011 IMO Biofouling Guidelines to the revised 2023 IMO Biofouling Guidelines.

Track and Participate in the Development of federal Vessel Incidental Discharge Act Regulations by the U.S. EPA and USCG

The U.S. EPA's recently finalized VIDA regulations will impact the Commission's authorities. Staff is evaluating the extent of those impacts and is working to harmonize processes, where appropriate, and recommend actions if necessary to ensure that the Commission can continue to fulfill the Legislative mandate of the MISA to "move the state expeditiously toward elimination of the discharge of nonindigenous species into the waters of the state."

Commission staff is working with the USCG and other participating states to provide input on the development of VIDA implementation regulations, specifically to help create standardized VIDA inspection procedures. USCG expects to adopt these regulations by the end of 2026. Commission staff continues to provide input so that these federal regulations will adequately protect California's waters from ballast water and biofouling mediated species introductions.

9.4 Golden Mussel Introduction

As Commission staff was finalizing this report, the golden mussel (*Limnoperna fortunei*), a non-native, freshwater/brackish mussel, was discovered near the Port of Stockton in October 2024. Golden mussels were subsequently discovered in the southern portion of the San Joaquin – Sacramento Delta and the O'Neill Forebay. This is the first known discovery of golden mussels in North America. These mussels were likely introduced to California in discharged ballast water by a ship traveling from an international port.

Golden mussels pose a significant and immediate threat to the natural ecosystems, water conveyance systems, infrastructure and water quality in California and across the U.S. Golden mussels are similar in appearance, biology, and impacts to the invasive quagga and zebra mussels, but can establish in waters with considerably lower calcium levels and higher salinity than required by quagga and zebra mussels.

Golden mussels are filter feeders that can consume large quantities of the microscopic plants and animals that other species depend on. As a result, the ecological balance of an entire waterbody can be disturbed, displacing native species and sport fish. Additionally, golden mussels pose an economic threat to

California's infrastructure and recreation industries. Mussels may clog water intakes and fish screens, impacting power plant operations and impeding distribution of municipal water supplies and agricultural irrigation. Golden mussels can also impact recreation by limiting recreational opportunities, encrusting docks and beaches, colonizing recreational equipment including watercraft hulls, engines, and steering components.

The extent of the introduced golden mussel population is not yet known, and the response to the introduction is being led by the CDFW.

9.5 Recommendations to the Legislature

The Commission makes the following recommendations to the Legislature based on data presented in this report:

Funding

Support Commission efforts to secure ongoing funding for the Marine Invasive Species Program. The Commission's ability to collect fees will be limited by the federal (U.S. EPA and the USCG) implementation of VIDA. Once in effect, these restrictions are projected to cause the MISCF to lose between $400,000 and $600,000 annually. This loss of revenue will move the MISCF towards insolvency (see section 8.1.2).

Biennial Report Frequency

Support an amendment of the Marine Invasive Species Act to require the report to the California Legislature mandated by Public Resources Code section 71212 (i.e., this report) to be updated triennially instead of biennially. Expanding responsibilities (see section 3.2), impending revenue losses (see prior "Funding" recommendation and section 8.1.2), current statewide spending reductions and elimination of vacancies, and future restrictions on raising the amount of the vessel arrival fee that supports the program will require adjustments to workloads and priorities. The production of this Legislative report is labor-intensive and time consuming, limiting staff's ability to maintain a high level of performance with an increasing workload. To ensure no lapse in vessel data availability with the recommended change, Commission staff has initiated quarterly vessel data updates posted on the Commission's website to provide most of the types of data presented in this report for continued access for interested users (see section 9.2).

Legislative Amendments to MISA

Support future Commission recommendations for amendments to the Marine Invasive Species Act to align with VIDA. Staff continues to review the U.S. EPA's final VIDA rule and is involved in the USCG's process for developing their proposed rule. California will likely need to amend the Marine Invasive Species Act to ensure that the Commission's enforcement of ballast water and biofouling management requirements remains consistent with federal preemption principles.

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APPENDIX A

In August 2016, the Commission adopted regulations to codify the Marine Invasive Species Act Enforcement and Hearing Process (California Code of Regulations, title 2, section 2299.01 et seq.). The regulations established an administrative enforcement process for violations of the MISA and associated regulations. The violations and associated penalties are classified as follows:

Class 1: Noncompliant ballast water discharges classified based on the distance from land at which ballast water exchange was conducted (operational violation). **Note:** Violations are assessed on per tank basis.

Violation Level	Type of Violation	Maximum Penalty
Minor	• Arrival from outside of the Pacific Coast Region (PCR) and carrying ballast water from outside the PCR: Ballast water exchanged less than 200 NM and equal to or greater than 180 NM from land • Arrival from inside the PCR and carrying ballast water from inside the PCR: Ballast water exchanged less than 50 NM and equal to or greater than 45 NM from land	$5,000
Moderate:	• Arrival from outside of the PCR and carrying ballast water from outside the PCR: Ballast water exchanged less than 180 NM and equal to or greater than 100 NM from land • Arrival from inside the PCR and carrying ballast water from inside the PCR: Ballast water exchanged less than 45 NM and equal to or greater than 25 NM from land	$10,000
Major I:	• Arrival from outside of the PCR and carrying ballast water from outside the PCR: Ballast water exchanged less than 100 NM from land • Arrival from inside the PCR and carrying ballast water from inside the PCR: Ballast water exchanged less than 25 NM from land	$20,000
Major II:	No ballast water exchange	$27,500

Class 2: Failure to properly maintain required documentation on board (administrative violation)

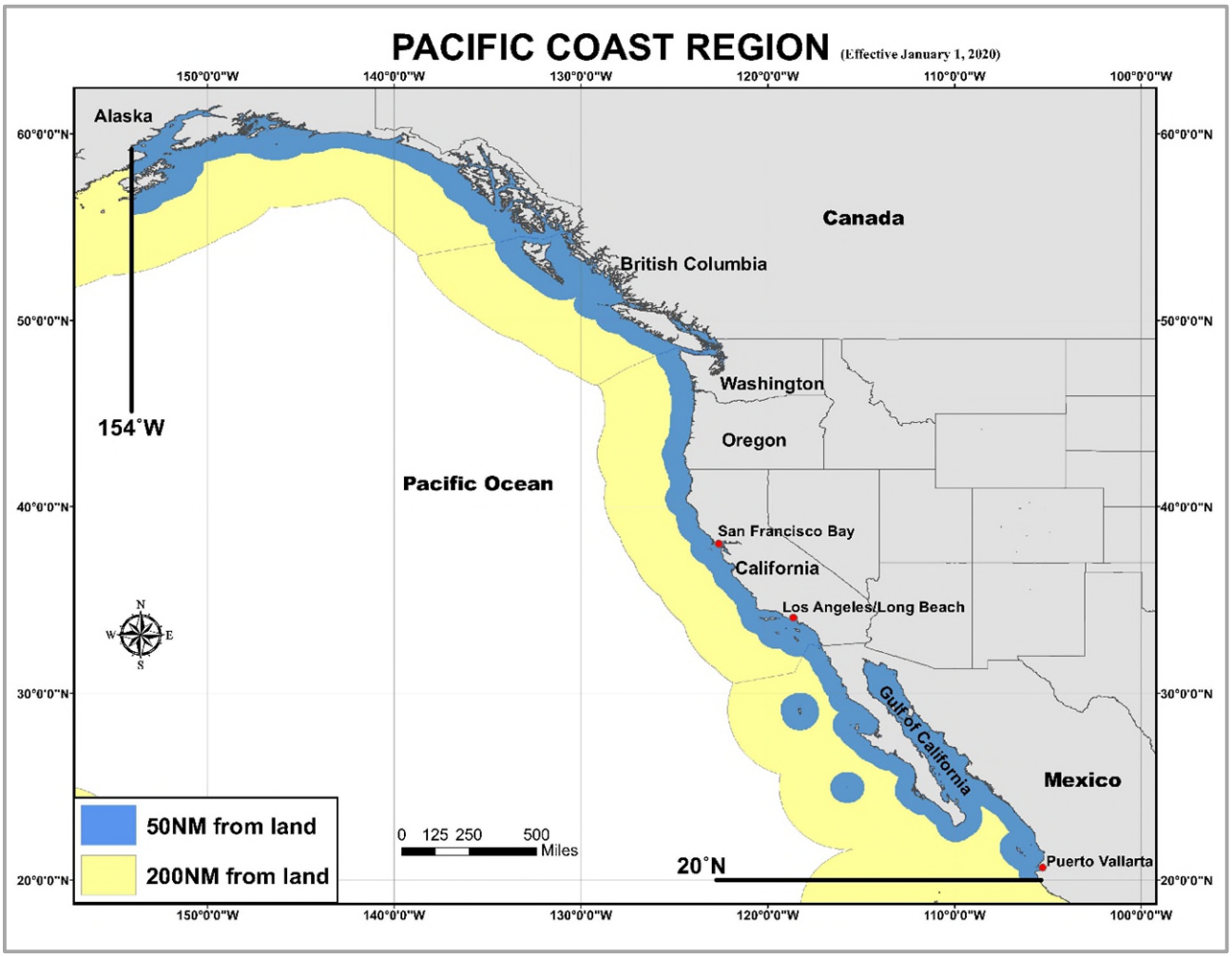
Occurrence	Penalty
First occurrence	A Letter of Noncompliance is issued with no monetary penalty
Second occurrence	Maximum penalty of $10,000 per violation

Class 3: Failure to submit required reporting information to the Commission (administrative violation)

Occurrence	Penalty
First occurrence	A Letter of Noncompliance is issued with no monetary penalty
Second occurrence	Maximum penalty of $1,000 per violation

APPENDIX B

Map of the Pacific Coast Region (PCR) recognized by the Marine Invasive Species Program.



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