STAFF REPORT
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CONSIDER APPROVAL OF THE LEGISLATIVE REPORT TITLED "2019 BIENNIAL REPORT ON THE CALIFORNIA MARINE INVASIVE SPECIES PROGRAM"

PARTY:
California State Lands Commission

BACKGROUND:

Nonindigenous Species and Vectors of Introduction

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 species 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. 2003a). 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 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.

California's Marine Invasive Species Program

The California Marine Invasive Species Program (MISP) is a multi-agency program designed to reduce the risk of introducing nonindigenous species into State waters from vessels 300 gross registered tons and above that are capable of carrying ballast water. The MISP was established by the Ballast Water Management for Control of Nonindigenous Species Act of 1999 and reauthorized and expanded by the Marine Invasive Species Act of 2003. The purpose of the MISP is to move the state expeditiously toward elimination of the discharge of nonindigenous species into the waters of the state (Pub. Resources Code, § 71201, subd. (d)).

Staff, charged with MISP oversight and administration, takes a multi-faceted approach to advancing program goals, including:

- Developing sound, science-based policies in consultation with technical experts and stakeholders
- Tracking and analyzing ballast water and vessel biofouling management practices of the California commercial vessel fleet
- Enforcing laws and regulations to prevent introductions of nonindigenous species
- Conducting and facilitating outreach to promote information exchange among scientists, regulators, the shipping industry, and other stakeholders

This report to the California Legislature on MISP activities between July 1, 2016, and June 30, 2018, fulfills the reporting mandates set forth in Public Resources Code sections 71210 and 71212.

SUMMARY OF REPORT FINDINGS:

Vessel Traffic and Vector Management Patterns

California ports received 21,150 vessel arrivals between July 1, 2016, and June 30, 2018. Container and tank vessels accounted for 63 percent of these statewide arrivals. Regional vessel traffic differed between northern and southern California ports. Northern California ports had 9,424 arrivals, with 82 percent of the arrivals coming from ports within the Pacific Coast Region (i.e., the majority of northern California traffic was regional and coastwise). Southern California ports had 11,726 arrivals, with 58 percent of the arrivals coming from outside the Pacific Coast Region (i.e., the majority of southern California traffic arrived from outside of the region).

Most vessels arriving at California ports do not discharge ballast water. Approximately 15 percent of all California arrivals reported ballast water discharges totaling 21.6 million metric tons (MMT). Most of this ballast water was discharged by bulk (10.6 MMT) and tank (7.6 MMT) vessels. Nearly all (98 percent) ballast water discharged in California waters, including 2.0 MMT of ballast water treated with ballast water management systems, was compliant with the Marine Invasive Species Act. The volume of noncompliant ballast water was relatively small, and the largest share (44 percent) of noncompliant water was sourced from Mexican ports. All the noncompliant ballast water sourced in Mexico was exchanged but not at the correct distance from land. This noncompliance was primarily due to vessel crews' failure to consider islands when calculating proper exchange distances from land.

A vessel's cumulative risk of introducing NIS is a function of both ballast water discharge volume (as a proxy for ballast water-mediated risk) and wetted surface area (as a proxy for biofouling-induced risk). During the last two years, 212 million square meters (Mm^2) of vessel wetted surface arrived at California ports, primarily associated with container (110 Mm^2) and tank (52 Mm^2) vessels. When considering the cumulative NIS introduction risk from both biofouling and ballast water at each of the California ports, the Ports of Los Angeles and Long Beach have the greatest relative risk, followed by Carquinez, Richmond, and Oakland.

MISP Partner Agency Updates
The California Department of Tax and Fee Administration issues invoices for, collects, and deposits a vessel arrival fee into the Marine Invasive Species Control Fund to fund all MISP activities. An average of 477 vessel arrivals were billed per month during this reporting period. The average collection rate was 96.3 percent.

The California Department of Fish and Wildlife's Office of Spill Prevention and Response conducts species monitoring in California coastal waters to assess the effectiveness of vessel vector management. A total of 11 NIS were newly detected in sampled bays and estuaries during 2014-2016. However, only one of those NIS was completely new to California, the bryozoan (a small invertebrate typically living in colonies) *Cradoscrupocellaria bertholletii* (the remaining ten were previously detected in other California bays or estuaries).

MISP Accomplishments
New or Amended Regulations
The Commission adopted or amended three regulations during the reporting period, including:

- California Biofouling Management Regulations: California became the world's first government entity to implement comprehensive vessel biofouling management regulations on October 1, 2017. Building on the momentum of voluntary international biofouling management guidelines, the Commission is helping to lead a new regulatory regime to reduce the risk of biofouling-mediated NIS introduction across the globe.
- Marine Invasive Species Act Enforcement Regulations: The maritime shipping industry continues to have a high compliance rate with the Marine Invasive Species Act, but there are still occurrences where outreach and education are not sufficient to prevent violations. The implementation of the Marine Invasive Species Act Enforcement Regulations on July 1, 2017, provides the Commission with tools to take additional steps as necessary to increase compliance with the Marine Invasive Species Act. During the first 18 months of implementation, the Commission pursued 12 enforcement actions and resolved five through

settlement agreements. Staff is in settlement discussions for the remaining seven.

- Fee Change Regulations: The MISP is funded exclusively through fees assessed on vessels arriving at California ports; the MISP uses no general fund dollars. Staff closely tracks the budget within the Marine Invasive Species Control Fund to ensure sufficient funding for all programmatic activities. In coordination with a stakeholder advisory group, the Commission amended the fee amount on October 1, 2017, from $850 to $1,000 per qualifying voyage arrival.

Pre-arrival Risk Assessment

Beginning in 2016, the submission requirement for Ballast Water Management Reports was changed from "upon departure" to "24 hours prior to arrival at a California port." This change enabled staff to review ballast water management activities prior to each vessel's arrival to assess NIS introduction risk and prioritize inspections to focus on the vessels representing the greatest risk. This change also allows staff to inform a vessel's crew of possible noncompliance prior to arrival, allowing the vessel crew to alter ballast water management or discharge activities to achieve compliance.

Public Facing Web-based Vessel Reporting Application: MISP.IO

The Commission unveiled a web-based user interface in July 2017 to allow online completion, submission, and tracking of required reporting forms. The web application is accessed at http://misp.io and has improved transparency and customer service while allowing the MISP to function more efficiently and effectively.

Peer-Reviewed Journal Publications

Staff uses data collected through many sources, including field or lab-based research and vessel-submitted reporting forms. These data are critical to developing and evaluating the effectiveness of policies and regulations to reduce NIS introduction risk. Staff is committed to publishing these data in peer-reviewed scientific journals to:

- Validate data collection and analysis methods through peer review
- Share data with the larger scientific and regulatory communities to allow partner agencies to benefit from Commission data
- Increase awareness of MISP research to attract collaborators for future work
- Further enable the Commission to base decisions on peer-reviewed science, including data collected by the MISP

Staff has co-authored four peer-reviewed journal articles during the last two years and now requires all funded research contracts to include submission of a manuscript to a peer-reviewed journal as one of the deliverables.

Challenges

The federal Vessel Incidental Discharge Act (VIDA), included as part of the Frank Lobiando Coast Guard Reauthorization Act of 2018 (Senate Bill 140), was signed into law by the President on December 4, 2018. The VIDA will preempt states from establishing and implementing ballast water management requirements, including the implementation of ballast water discharge standards. Although the bill was signed in December 2018, preemption of state authority will not occur until after adoption and implementation of regulations by the U.S. Environmental Protection Agency (setting national discharge standards) and U.S. Coast Guard (implementation and enforcement). These regulatory actions may take four years or more to accomplish.

During the estimated four-year period between when the bill was signed and full implementation, staff will work with the Attorney General's office and the Governor's office to closely review the law and determine next steps. These next steps may include amending the Marine Invasive Species Act to ensure California retains as much authority as possible to address NIS introduction risk from vessel vectors. As part of this effort, staff is recommending the Commission sponsor legislation as described in a separate staff report (Regular Item No. 82) also on the February 2019 meeting agenda.

Next Steps

Over the next two years, staff will work on high priority actions to improve the MISP, including:

- Expanding the Marine Invasive Species Act Enforcement Regulations to categorize and identify penalties associated with violations of the California Biofouling Management Regulations.
- Further developing and implementing a combined ballast water and vessel biofouling weighted risk assessment using vessel-submitted forms. This combined risk assessment will better capture the nuances of NIS introduction risk and will be more effective and efficient in prioritizing vessel inspections and targeted outreach.
- Proposing bill language to amend the definition of "Pacific Coast Region" to align with the functional definition of "Pacific Region" in the VIDA, reduce misinterpretation, and better reflect the NIS introduction risk from ballast water sourced from ports within the Gulf of California.
- Adopting the recommendations from the Commission-approved report titled "2018 Assessment of the Efficacy, Availability, and Environmental

Impacts of Ballast Water Treatment Technologies for use in California Waters," including:

- Funding research to evaluate the effectiveness of ballast water exchange plus ballast water treatment as a combined management approach
- Working with the Legislature to amend the interim California ballast water discharge performance standards to align with the U.S. Coast Guard ballast water discharge standards
- Working with the Legislature to amend Public Resources Code section 71206(a) to enable Commission staff to sample ballast water and biofouling for research purposes

REFERENCES CITED:

- Fofonoff, P.W., G.M. Ruiz, B. Steves, and J.T. Carlton. 2003a. "In ships or on ships? Mechanisms of transfer and invasion for nonnative species to the coasts of North America." Pp. 152-181. In *Invasive species, vectors and management strategies*. G.M. Ruiz and J.T. Carlton eds. Island Press, Washington D.C.

STAFF ANALYSIS AND RECOMMENDATION:

Authority:

Public Resources Code sections 71210 and 71212.

Public Trust and the State's Best Interests Analysis:

Approval of the proposed report will further the interests of the Public Trust by providing greater protection to Public Trust resources. The introduction of nonindigenous species to California's waters threatens Public Trust resources and values, including ecosystem preservation and the promotion and protection of fishing, water-related recreation, maritime commerce, and water-dependent tourism. The proposed report provides an update to the Legislature with information about the Commission's oversight of the Marine Invasive Species Program, including an analysis of vessel management data and program accomplishments.

The proposed report satisfies the purpose of the Marine Invasive Species Act (Pub. Resources Code, § 71201, subd. (d)) "to move the State expeditiously toward elimination of the discharge of nonindigenous species into the waters of the State." Thus, staff believes that approval of the proposed report would further enhance and protect Public Trust resources and is in the State's best interests.

OTHER PERTINENT INFORMATION:

1. This action helps fulfill Strategic Goal 1.1, Key Action 1.1.3 of the Commission's Strategic Plan. This Key Action calls for staff to implement ballast water discharge performance standards and biofouling management strategies that prevent the introduction of nonindigenous species into State marine waters.

2. The approval of the proposed report to the Legislature is not a project as defined by the California Environmental Quality Act because it is an administrative action that will not result in direct or indirect physical changes in the environment.

   Authority: Public Resources Code section 21065 and California Code of Regulations, title 14, section 15378, subdivision (b)(5).

EXHIBIT:

A. "2019 Biennial Report on the California Marine Invasive Species Program"

RECOMMENDED ACTION:

It is recommended that the Commission:

AUTHORIZATION:

1. Approve the proposed report to the Legislature titled "2019 Biennial Report on the California Marine Invasive Species Program," substantially in the form attached as Exhibit A.

2. Authorize staff to make non-substantive modifications to the report as are necessary to correct typographical errors or clarify the information presented prior to submission to the Legislature.

3. Direct staff to submit the report, substantially in the form attached as Exhibit A, to the Legislature in compliance with Public Resources Code section 71212.

EXHIBIT A

2019 BIENNIAL REPORT

ON THE

CALIFORNIA
MARINE INVASIVE SPECIES PROGRAM

PRODUCED FOR THE
CALIFORNIA STATE LEGISLATURE

By
C. Scianni, L. Ceballos Osuna, N. Dobroski,
M. Falkner, J. Thompson, and R. Nedelcheva

California State Lands Commission
Marine Environmental Protection Division
February 2019

EXECUTIVE SUMMARY

The California Marine Invasive Species Program (MISP) is a multi-agency program designed to reduce the risk of introducing nonindigenous species into State waters from vessels 300 gross registered tons and above that are capable of carrying ballast water. The MISP was established by the Ballast Water Management for Control of Nonindigenous Species Act of 1999 and reauthorized and expanded by the Marine Invasive Species Act (MISA) of 2003. The purpose of the MISP is to move the state expeditiously toward elimination of the discharge of nonindigenous species into the waters of the state (Public Resources Code section 71201(d)).

The California State Lands Commission (Commission), charged with MISP oversight and administration, takes a multi-faceted approach to advancing program goals, including:

- Developing sound, science-based policies in consultation with technical experts and stakeholders
- Tracking and analyzing ballast water and vessel biofouling management practices of commercial vessels that arrive at California ports
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Shipping is the major pathway by which aquatic NIS are transported around the globe and is responsible for up to 79.5% of established aquatic NIS introductions in North America (Fofonoff et al. 2003a). 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 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.

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A vessel's cumulative risk of introducing NIS is a function of both ballast water discharge volume (as a proxy for ballast water-mediated risk) and wetted surface area (as a proxy for biofouling-induced risk). During the last two years, 212 million square meters (Mm^2) of vessel wetted surface arrived at California ports, primarily associated with container (110 Mm^2) and tank (52 Mm^2) vessels. When considering the cumulative NIS introduction risk of both biofouling and ballast water at each of the California ports, the Ports of Los Angeles and Long Beach have the greatest relative risk, followed by Carquinez, Richmond, and Oakland.

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MISP Accomplishments

New or Amended Regulations

The Commission adopted or amended three regulations during the reporting period, including:

- California Biofouling Management Regulations: California became the world's first government entity to implement comprehensive vessel biofouling management regulations on October 1, 2017. Building on the momentum of voluntary international biofouling management guidelines, the Commission is helping to lead a new regulatory regime to reduce the risk of biofouling-mediated NIS introduction across the globe.

- Marine Invasive Species Act Enforcement Regulations: The maritime shipping industry continues to have a high compliance rate with the Marine Invasive Species Act (MISA), but there are still occurrences where outreach and education are not sufficient to prevent violations. The implementation of the MISA Enforcement Regulations on July 1, 2017 provides the Commission with tools to take additional steps as necessary to increase compliance with the MISA. During the first 18 months of implementation, the Commission pursued 12 enforcement actions and resolved five through settlement agreements. Staff is in settlement discussions for the remaining seven.

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- Validate data collection and analysis methods through peer review
- Share data with the larger scientific and regulatory communities to allow partner agencies to benefit from Commission data
- Increase awareness of MISP research to attract collaborators for future work
- Further enable the Commission to base decisions on peer-reviewed science, including data collected by the MISP

Commission staff has co-authored four peer-reviewed journal articles during the last two years and now requires all funded research contracts to include submission of a manuscript to a peer-reviewed journal as one of the deliverables.

Challenges

The federal Vessel Incidental Discharge Act (VIDA), included as part of the Frank Lobiando Coast Guard Reauthorization Act of 2018 (Senate bill 140), was signed into law by the President on December 4, 2018. The VIDA will preempt states from establishing and implementing ballast water management requirements, including the implementation of ballast water discharge standards. Although the bill was signed in December 2018, preemption of state authority will not occur until after adoption and implementation of regulations by the U.S. Environmental Protection Agency (U.S. EPA) (setting national discharge standards) and U.S. Coast Guard (USCG) (implementation and enforcement). These regulatory actions may take four years or more to accomplish.

During the estimated four-year period between when the bill was signed and full implementation, Commission staff will work with the Attorney General's office and the Governor's office to closely review the bill and determine next steps. These next steps may include amending the MISA to ensure California retains as much authority as possible to address NIS introduction risk from vessel vectors. In the staff report accompanying this biennial report to be voted on by the Commission, staff recommended the Commission sponsor legislation to amend the MISA. Such legislation could provide a mechanism for VIDA-induced statutory changes.

Next Steps

Over the next two years, the Commission will be working on several high priority actions to improve the effectiveness and efficiency of the MISP, including:

- Expanding the Marine Invasive Species Act Enforcement Regulations to categorize and identify penalties associated with violations of the California Biofouling Management Regulations.
- Further developing and implementing a combined ballast water and vessel biofouling weighted risk assessment using vessel-submitted forms. This combined risk assessment will better capture the nuances of NIS introduction risk and will be more effective and efficient in prioritizing vessel inspections and targeted outreach.

- Proposing bill language to amend the definition of Pacific Coast Region to align with the functional definition of Pacific Region in the VIDA, reduce misinterpretation, and better reflect the NIS introduction risk from ballast water sourced from ports within the Gulf of California.

- Adopting the recommendations from the Commission-approved report titled "2018 Assessment of the Efficacy, Availability, and Environmental Impacts of Ballast Water Treatment Technologies for use in California Waters," including:

    - Funding research to evaluate the effectiveness of ballast water exchange plus ballast water treatment as a combined management approach

    - Working with the Legislature to amend the interim California ballast water discharge performance standards to align with the U.S. Coast Guard ballast water discharge standards

    - Working with the Legislature to amend Public Resources Code section 71206(a) to enable Commission staff to sample ballast water and biofouling for research purposes

As part of these efforts, Commission staff will continue to use all available resources to work proactively to move the state expeditiously toward elimination of the discharge of nonindigenous species into California waters.

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ABBREVIATIONS AND ACRONYMS

AB	Assembly Bill
AMS	Alternative Management System
AVRF	Annual Vessel Reporting Form
BFMP	Biofouling Management Plan
BFRB	Biofouling Record Book
BLAST	Basic Local Alignment Search Tool
BW	Ballast Water
BWD	Ballast Water Discharge
BWE	Ballast Water Exchange
BWMR	Ballast Water Management Report
BWMS	Ballast Water Management Systems
BWT	Ballast Water Treatment
BWTTARF	Ballast Water Treatment Technology Annual Reporting Form
CCR	California Code of Regulations
Cal-NEMO	California Non-Native Estuarine and Marine Organism Database
CDFW	California Department of Fish and Wildlife
CDFW-OSPR	California Department of Fish and Wildlife’s Office of Spill Response and Prevention
CDTFA	California Department of Tax and Fee Administration
cfu	colony-forming unit
Commission	California State Lands Commission
CRMS	New Zealand’s Craft Risk Management Standard
eDNA	Environmental DNA
EBP	Experience-Building Phase
GIS	Geographic Information Systems
GloFouling	GloFouling Partnerships Project
HHRF	Hull Husbandry Reporting Form
IMO	International Maritime Organization
IWCC	In-Water Cleaning and Capture
Knots	Nautical Miles per Hour
LPOC	Last Port of Call
m	meter
MEPC	Marine Environment Protection Committee
MISA	Marine Invasive Species Act
MISP	Marine Invasive Species Program
ml	milliliter
MLML	Moss Landing Marine Laboratories
Mm^2	million square meters
MMT	million metric tons

MT	metric tons
NEMESIS	National Exotic Marine and Estuarine Species Information System
NIS	nonindigenous species
NM	nautical miles
NPDES	National Pollutant Discharge Elimination System
OTU	Operational Taxonomic Units
PCR	Pacific Coast Region
PVC	Polyvinyl Chloride
ROV	Remotely Operated Vehicles
SAB	EPA Science Advisory Board
SERC	Smithsonian Environmental Research Center
STEP	Shipboard Technology Evaluation Program
TAG	technology advisory group
TAP	technology advisory panel
µm	micrometer
U.S.	United States
USCG	United States Coast Guard
U.S. EPA	U.S. Environmental Protection Agency
UV	Ultraviolet Radiation
VIDA	Vessel Incidental Discharge Act
Water Board	State Water Resources Control Board (California)
WSA	Wetted Surface Area

1. PURPOSE

The California State Lands Commission (Commission) prepared this report for the California Legislature pursuant to Public Resources Code sections 71210 and 71212. According to statute, the report must be updated biennially and, at a minimum, include:

- A summary and analysis of ballast water management practices reported by the shipping industry
- A summary and analysis of vessel monitoring and inspection information, including compliance rates
- A summary of recent research addressing the release of nonindigenous species (NIS) by vessels
- A summary of Commission-sponsored research and programs to evaluate alternatives for treating or otherwise managing ballast water
- An evaluation of the effectiveness of the California Marine Invasive Species Program (MISP)
- Recommendations to improve upon the effectiveness of the program

Since the inception of the MISP in 2000, the California Legislature has expanded the purview of the program to include, among other responsibilities, ballast water discharge performance standards and the regulation of vessel biofouling. The Commission has expanded the biennial report accordingly to include:

- An update on the implementation of the ballast water discharge performance standards
- A summary and analysis of biofouling management practices reported by vessels arriving at California ports
- A summary of Commission-sponsored research to address biofouling science, management, and treatment

This ninth biennial report to the California Legislature summarizes MISP activities from July 1, 2016 through June 30, 2018.

2. INTRODUCTION

2.1 Nonindigenous Species

Nonindigenous species (NIS) are organisms that pose significant threats to human health, the economy, and the environment. Nonindigenous species are intentionally and unintentionally transported through human activities to new habitats, such as California's marine, estuarine, and freshwater environments. Once a NIS is moved, becomes established in a new geographic location, and causes impacts, it is considered an invasive species.

Because attempts to eradicate invasive species are mostly unsuccessful and costly, prevention of species introductions through management of their transport pathways is the most effective way to address NIS.

2.2 How are Nonindigenous Species Moved?

Nonindigenous species are introduced into aquatic habitats through multiple pathways, including:

- Aquaculture (Grosholz et al. 2012)
- Aquarium trade (Williams et al. 2012)
- Commercial shipping (Fofonoff et al. 2003a)
- Live bait trade (Fowler et al. 2015)
- Live seafood trade (Chapman et al. 2003)
- Marine debris (Barnes 2002)
- Recreational watercraft (Ashton et al. 2012)

Each of these pathways contributes to aquatic NIS introductions, but shipping is the primary pathway transporting aquatic species around the globe.

Ballast water and vessel biofouling are “vectors,” or specific mechanisms within the shipping pathway, that transport aquatic NIS. Ballast water and vessel biofouling are responsible for or have contributed to 79.5% of established aquatic NIS introductions in North America (Fofonoff et al. 2003a) and 81% in California (Ruiz et al. 2011).

2.2.1 Ballast Water

Vessels take on, redistribute, or discharge ballast water to improve and maintain stability, balance, and trim during cargo loading and unloading, in rough seas, or through transits of shallow coastal waterways. As vessels take on ballast water, they also take on organisms that are present in that water. Conversely, when ballast water is discharged, organisms in that water are also discharged into the surrounding environment. The transfer of ballast water from source ports to destination ports results in the worldwide movement of organisms.

Prior to the implementation of ballast water management practices in the early 2000s, it was estimated that more than 7,000 species were moved around the world daily in ballast water (Carlton 1999). The discharge of ballast water from a single vessel has the potential to release over 21.2 million individual organisms (Minton et al. 2005).

2.2.2 Vessel Biofouling

Vessel biofouling refers to the attachment or association of an organism or group of organisms (community) to a vessel's wetted surfaces. The vessel biofouling community consists of both sessile (directly attached to the vessel) and mobile organisms and can include barnacles, algae, mussels, worms, crabs, and other invertebrates.

As vessels transit from port to port, biofouling organisms can drop off or spawn (i.e., reproduce), resulting in the introduction of NIS. Vessel biofouling is considered a significant vector for aquatic NIS introductions in several regions, including Australia, the North Sea, Hawaii, and California (Ruiz et al. 2000a, 2011; Eldredge and Carlton 2002; Gollasch 2002).

2.3 Nonindigenous Species Impacts

2.3.1 Economic Impacts

In aquatic environments, NIS 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 2015, California’s ocean-based economy employed roughly 542,000 people and accounted for almost $44 billion of California’s total gross domestic product (NOEP 2018).

For example, the zebra mussel (*Dreissena polymorpha*) has caused significant economic impacts in much of its introduced range. Zebra mussels were introduced to the Great Lakes from the Black Sea in the mid-1980s via ballast water discharge from commercial ships (Carlton 1993). The mussels attach to hard surfaces and can form dense populations (as many as 700,000 per square meter) that clog municipal water systems and electric generating plants. Zebra mussels are also responsible for reducing sportfishing revenues by as much as $800 million annually in the states surrounding the Great Lakes (Rothlisberger et al. 2012).

In California, zebra mussels are now established in San Justo Reservoir in San Benito County. The closely related, invasive quagga mussel (*Dreissena bugensis*), has been found in multiple locations in southern California, including the Colorado River Aqueduct System (USGS 2018). Thus far, over $26 million has been spent by the California Department of Fish and Wildlife to control the spread of quagga and zebra mussels in California (Volkoff, M., pers. comm. 2018).

Water hyacinth (*Eichhornia crassipes*), a nonindigenous aquatic plant, has caused significant impacts to the Port of Stockton and several San Francisco Bay-Delta marinas. In 2014, shipping traffic to the Port of Stockton was restricted to daylight hours due to high densities of the plant in waterways. The Port spent $200,000 to mechanically remove the plant, and the shipping industry lost an estimated $300,000 due to delays in cargo operations (Wingfield, J., pers. comm. 2015). That same year, the City of Stockton cancelled its annual holiday boat parade, resulting in an estimated loss of $40,000 - $50,000 in tourism trade (KCRA 2014).

Additional examples of control or eradication costs include:

- Over $7 million between 2000 and 2006 to eradicate the Mediterranean green seaweed (*Caulerpa taxifolia*) from two small embayments (Agua Hedionda Lagoon and Huntington Harbor) in southern California (Woodfield 2006)
- $34 million since 2000 to manage the Atlantic cordgrass (*Spartina alterniflora*) in the San Francisco Bay-Delta (Olofson, S., pers. comm. 2018)

In total, NIS are believed to account for up to $120 billion per year in losses across the United States (Pimentel et al. 2005).

2.3.2 Environmental Impacts

Nonindigenous species significantly impact the environment of invaded areas. Worldwide, 42% of threatened or endangered species are listed because of impacts from NIS (Pimentel et al. 2005). Zebra mussels have caused localized extinction of species (Martel et al. 2001) and declines in recreationally valuable fishes (Cohen and Weinstein 1998). Nonindigenous species, like zebra and quagga mussels, may compete with native organisms for habitat and food. Invasive quagga and zebra mussels filter vast amounts of water and dramatically reduce plankton (tiny floating plants and animals that form the foundation of aquatic food webs) concentrations (Higgins and Vander Zanden 2010, Vanderploeg et al. 2010).

The overbite clam (*Potamocorbula amurensis*) spread throughout the San Francisco Bay within two years following its detection in 1986. The clam consumes 80 to 90 percent of zooplankton from the water column in the shallow portions of the San Francisco Bay (Greene et al. 2011), playing a significant role in phytoplankton (Kimmerer and Thompson 2014) and zooplankton (Kimmerer and Lougee 2015) reduction in the San Francisco Bay-Delta. The dramatic decline in phytoplankton caused by *P. amurensis* is believed to be associated with the decline of several pelagic fishes in the Sacramento-San Joaquin River Delta, including the threatened delta smelt (Feyrer et al. 2003, Sommer et al. 2007, Mac Nally et al. 2010)

2.3.3 Human Health Impacts

In addition to economic and ecological impacts, NIS impact human health. For example, vessels and port areas are connected to the spread of epidemic human cholera (Ruiz et al. 2000b, Takahashi et al. 2008). Ships are thought to have transported the seventh pandemic strain of Vibrio cholerae (serotype O1) from Asia to Latin America (where over 1 million people became ill and over 10,000 died) and then from Latin America to Mobile Bay, Alabama, in 1991 (Anderson 1991, McCarthy and Khambaty 1994, Tauxe et al. 1995). Due to the potential health impacts of that introduction, nearly all Mobile Bay oyster beds closed during the summer and fall of 1991 (CDC 1993).

In 2016, the Iranian Ports and Maritime Organization issued emergency procedures for vessels arriving to Iran from Iraq because of the spread of cholera in Iraqi waters (Gard 2016). The emergency measures included mandatory offshore ballast water exchange and quarantine of all vessels from Iraq until cleared of cholera.

Like cholera, other micro-organisms harmful to humans are introduced via discharged ballast water including:

- Human intestinal parasites (*Giardia lamblia*, *Cryptosporidium parvum*, *Enterocytozoon bieneusi*) (Johengen et al. 2005, Reid et al. 2007)
- Microorganisms that cause paralytic shellfish poisoning (Hallegraeff, 1998)
- Microbial indicators for fecal contamination (*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*), a host for cercarial dermatitis (i.e., swimmer's itch), was first detected in San Francisco Bay, California in 1999. Since 2005, cases of swimmer's itch at Robert Crown Memorial Beach in Alameda occur regularly and are associated with high densities of the Japanese sea slug (Brant et al. 2010). In 2013, the Alameda Department of Environmental Health issued a "Swimmer's Itch Advisory" due to the high number of cases (ACEH 2014). Since 2013, few cases have been reported; however, the potential for another outbreak remains.

3. CALIFORNIA'S MARINE INVASIVE SPECIES PROGRAM

The California MISP is a multi-agency program that strives to prevent the introduction of nonindigenous species from vessels that arrive at California ports. The MISP's statutory 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 section 71201(d)).

The MISP is made up of the Commission, the California Department of Fish and Wildlife, the State Water Resources Control Board, and the Department of Tax and Fee Administration (formerly known as the Board of Equalization).

- The Commission is the administrator of the MISP and is tasked with developing and implementing vessel vector management policies.

- The California Department of Fish and Wildlife's Office of Spill Prevention and Response (CDFW-OSPR) monitors and gathers data on species to maintain an inventory of NIS populations in the coastal and estuarine waters of the state. These data are used in conjunction with information on vessel arrivals and NIS management practices to assess the effectiveness of the MISP.

- The State Water Resources Control Board (Water Board) consults with MISP partner agencies on topics related to water quality and toxicity. More recently, the Commission has worked with the Water Board on the implementation of the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (EPA Vessel General Permit) and on policies related to in-water cleaning of vessels in California.

- The Department of Tax and Fee Administration (CDTFA) collects a fee from qualifying voyages to support all MISP activities (see Public Resources Code sections 71215(b)(2) and 71215(c)). All fees are deposited into the Marine Invasive Species Control Fund. The MISP does not receive any General Fund dollars.

For a discussion of MISP partner agency activities, see section 7 (Marine Invasive Species Program Partner Agency Updates).

3.1 The Commission's Marine Invasive Species Program

The structure and function of the Commission's MISP is discussed in detail in Appendix A, including program management, data administration, and field operations. Within the Commission, the MISP plays an important role, along with the Commission's oil spill prevention program, in marine pollution prevention and the protection and preservation of state resources for the benefit of the people of the State of California.

The following section includes a brief discussion of the accomplishments of the MISP in relation to the Commission's Strategic Plan during the two-year focus of this report.

3.2 The MISP's Role in the Implementation of the Commission's Strategic Plan

In 2015, the Commission adopted a strategic plan to guide its course through 2020 (see Commission 2015). The plan directs the Commission's stewardship of the public lands and resources entrusted to its care.

The Strategic Plan has four Strategic Goals, including:

1. Lead innovative and responsible land and resource management
2. Meet the challenges of our future
3. Engage Californians to help safeguard their trust lands and resources
4. Cultivate operational excellence by integrating technology

Within each Strategic Goal, the Commission identifies strategies and key actions to guide implementation and establish accountability. While Commission MISP staff strives to support all the Commission's goals, the MISP's key areas of responsibility fall under Goal One (Lead innovative and responsible land and resource management), Goal Three (Engage Californians to help safeguard their trust lands and resources), and Goal Four (Cultivate operational excellence by integrating technology).

The Key Actions specific to the Commission's MISP are discussed below and are linked to specific accomplishments during the period covered by this report.

Strategic Goal 1: Lead innovative and responsible land and resource management

Key Action 1.1.2: *Review existing safety standards and regulations for continued relevance and use the public rulemaking processes to amend or adopt new regulations* *to enforce lease compliance and promote environmental protection and public health and safety while reducing unnecessary bureaucracy*.

MISP staff works closely with the Commission's Legal Division to amend or adopt regulations to implement the Marine Invasive Species Act (MISA; Public Resources Code section 71200 et seq.) and promote environmental protection of State waters. The MISP was successful in adopting/amending three regulations over the past two years:

Vessel Biofouling Management Regulations

After approximately seven years of consultation and development, the Commission approved biofouling management regulations in April 2017 (*Article 4.8. Biofouling Management to Minimize the Transfer of Nonindigenous Species from Vessels Arriving at California Ports* (2 California Code of Regulations (CCR), section 2298 *et seq*.)). These biofouling management regulations are the first of their kind in the U.S. and became the first globally to be implemented in October 2017. The regulations focus on preventive planning and are aligned with voluntary and mandatory international efforts. See section 4.2 (Vessel Biofouling Management) for more information.

Enforcement Regulations

The Commission approved Marine Invasive Species Act enforcement regulations in August 2016 (*Article 4.9. Marine Invasive Species Act Enforcement and Hearing Process* (2 CCR, section 2299.01 *et seq*.)). These regulations went into effect in July 2017 and provide a transparent process for enforcing violations of the Marine Invasive Species Act and assessing administrative penalties. The enforcement regulations establish a classification system that bases penalties for specific violations on the risk of introducing NIS into California's waters. See section 4.3 (Marine Invasive Species Act Compliance and Enforcement) for more information.

Fee Change Regulations

As mentioned previously, the MISP is funded through fees assessed on vessels arriving at California ports. The fees collected are deposited into the Marine Invasive Species Control Fund, to fund all aspects of the State's program. The fee amount is set in regulation, and therefore is adjustable to account for inflation and changes to vessel arrival statistics. The amount of the fee has been raised and reduced several times since implementation, each time in consultation with a stakeholder advisory group. In December 2016, the Commission approved amendments to *Article 4.5. Marine Invasive Species Control Fund Fee* (2 CCR, section 2270 *et seq*.). These regulations became effective in April 2017 and increased the fee charged to vessels with a qualifying voyage arrival at a California port from $850 to $1,000 to ensure adequate funding for all MISP agencies and programmatic activities. See section 7.1 (California Department of Tax and Fee Administration) for more information.

Key Action 1.1.3 *Implement Ballast Water Discharge Performance Standards and biofouling management strategies that prevent the introduction of nonindigenous species into State waters.*

The Commission's adoption of the biofouling management regulations (2 CCR, section 2298.1 et seq.) was a major accomplishment toward implementing a comprehensive management program addressing vessels as vectors of NIS in California waters. The Commission's efforts to implement the new biofouling management regulations are discussed in section 4.3.3: Next Steps – Assessing Compliance with Biofouling Management Requirements.

Ballast Water Treatment Technology Assessment Report

The next step in the evolution of ballast water management includes the implementation of ballast water discharge performance standards. Discharge standards were established in statute in 2006 and later adopted via regulation (see 2 CCR, section 2291 *et seq.*), but implementation still requires available and effective ballast water treatment technologies and methods to assess vessel discharge compliance.

The Commission recently completed a report assessing the availability of ballast water treatment technologies to enable vessels to meet California's ballast water discharge performance standards (see Commission 2018). The Commission approved the *2018 Assessment of the Efficacy, Availability, and Environmental Impacts of Ballast Water Treatment Technologies for use in California Waters* (see Commission 2018) in December 2018. The report includes a third-party review on the feasibility of implementing a shore-based option for ballast water reception and treatment. See section 4.1.4 (California's Ballast Water Discharge Performance Standards) for more information.

Pre-Arrival Risk Assessments

The California State Legislature amended the Marine Invasive Species Act in 2015 via Assembly Bill (AB) 1312 (Chapter 644, Statutes of 2015), changing the requirement to submit a Ballast Water Management Report from "upon [vessel] departure" to 24 hours prior to arrival at a California port. Receiving the reports prior to arrival has enabled Commission staff to review submitted information and prioritize vessel boarding and inspections with an improved risk-based approach. Commission staff revised an inspection prioritization matrix to incorporate this pre-arrival information and included automatic risk categorization measures into the MISP internal database to allow Marine Safety Specialists to quickly identify priority vessels for inspection. See section 4.3 (Marine Invasive Species Act Compliance and Enforcement) for more information on the use of pre-arrival risk assessments within the MISP.

Strategic Goal 3: Engage Californians to help safeguard their trust lands and resources

Key Action 3.1.3 *Prioritize and effectively use targeted outreach and strategic partnerships to develop and enrich the lines of communication with the Commission's stakeholders.*

Marine Invasive Species Program staff works proactively to engage stakeholders in the development and implementation of major program initiatives. Staff relies heavily on input from Technical Advisory Groups (TAGs) that bring together interested parties involved in scientific research, the shipping industry, environmental organizations, and state, federal, and international agencies (see Appendix A for further discussion of TAGs).

In addition to TAGs, MISP staff educates and facilitates engagement with the regulated community at many conferences and meetings each year, including Commission-sponsored events such as the biennial Prevention First Symposium and Marine Environmental Protection Division Customer Service Meetings. In the last two years, MISP staff has also published multiple articles in peer-review scientific journals.

Peer-Reviewed Scientific Journal Articles

- *Dry and wet periods drive rapid shifts in community assembly in an estuarine ecosystem* (Chang et al. 2017). The authors used observations and experiments to show how changes in winter salinity in the San Francisco Bay resulting from wet and dry years influences estuarine organism communities. The results provide a window into potential shifts in estuarine organism communities that depend on precipitation levels and freshwater flows into the estuary.

- *Settlement plates as monitoring devices for non-indigenous species in marine fouling communities* (Marraffini et al. 2017). The authors evaluated how well the community of organisms colonizing small polyvinyl chloride (PVC) plates represent an established fouling community of a marina, and whether these PVC plates can be used as an effective proxy for the organisms inhabiting an area.

Results indicate that PVC “settlement” plates can provide a sensitive and standardized measure of NIS in marinas.

- *Non-native species colonization of highly diverse, wave swept outer coast habitats in Central California* (Zabin et al. 2018). The authors surveyed outer coast habitats in central California for the presence of NIS. Results suggest that open-coast environments are potentially vulnerable to NIS introductions and that marine protected areas were just as likely as sites outside of marine protected areas to have NIS present.

- *A history of ship specialization and consequences for marine invasions, management and policy* (Davidson et al. 2018). The authors reviewed operational (e.g., vessel speed, port residency time) and structural (e.g., ballast water capacity, wetted surface area, number and types of recesses or appendages) specialization among different vessel types and the implications of this specialization on marine invasions and NIS management. Policy implications include a recommendation to consider variation among commercial ship types and operational conditions during risk analyses to identify vessels that are more likely to introduce NIS.

Strategic Goal 4.0: Cultivate Operational Excellence by integrating technology

Key Action 4.1.6 Automate manual business processes for interactive public interfaces based on public stakeholder and constituent demand

Public Facing Web-based Vessel Reporting Application: MISP.IO

Commission staff released a public facing web-based application in July 2017 for the submission and tracking of mandatory MISP reporting forms. The application is accessed at http://misp.io and provides users the ability to:

- Complete and submit required reporting forms online
- Access, track, and review previously submitted reporting forms
- Receive immediate confirmation of form submittal
- Receive near-immediate feedback from Commission staff on missing or incomplete information
- Track reporting compliance for all vessels under their control

The MISP.IO web-based application will:

- Increase transparency by providing users greater access to available data

- Improve efficiency by reducing data entry time
- Improve data quality through better standardization of responses

See section 4 (Management of Vessel Vectors in California) for more information on mandatory reporting form submission.

4. MANAGEMENT OF VESSEL VECTORS IN CALIFORNIA

The following section highlights the MISP's statutory and regulatory tools used to reduce the risk of NIS introductions from vessels arriving at California ports.

4.1 Ballast Water Management

To prevent the introduction of NIS from discharged ballast water, the Commission implements a comprehensive ballast water management program. The program includes:

- Ballast water best management practices
- Ballast water management requirements
- Recordkeeping and recording procedures
- Assessing compliance with ballast water requirements in the MISA (see section 4.3 Marine Invasive Species Act Compliance and Enforcement for more information)

4.1.1 Ballast Water Best Management Practices

All vessel owners, masters, operators, and persons in charge must follow best management practices to minimize the release of NIS into California waters (see Public Resources Code section 71204). Vessels must:

- Discharge only the minimum amount of ballast water essential for operations
- Clean ballast tanks in accordance with applicable laws
- Rinse anchors and anchor chains when they are retrieved

Vessels must minimize the discharge of ballast water in:

- Marine sanctuaries
- Marine preserves
- Marine parks
- Coral reefs

Vessels must minimize 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)

4.1.2 Ballast Water Management Requirements

Retention of all ballast water onboard a vessel is the most protective ballast water management strategy for NIS prevention. Because no ballast water is discharged, no organisms are released into the environment. Vessels that intend to discharge ballast water in California waters must do at least one of the following (Public Resources Code section 71204.3 and Title 2 California Code of Regulations section 2284) prior to discharge:

- Take on and discharge ballast water at the same location
- Exchange ballast water at a minimum specified distance from any land prior to discharge (see description of Ballast Water Exchange within this section for more information)
- Discharge to a Commission-approved shore-based facility (see section 8.1 Ballast Water Research for more information on a study of the feasibility of shore-based treatment)
- Use a Commission-approved alternative management method (see description of Approved Alternative Ballast Water Management Methods within this section for more information)
- Under extraordinary circumstances, exchange ballast water within an area agreed to in advance by the Commission in consultation with the USCG

Ballast Water Exchange

Ballast water exchange (BWE) is the primary ballast water management method used by vessels discharging in California waters. The requirements for ballast water exchange vary depending on where a vessel arrives from and the source of the ballast water. Before discharging ballast water, vessels arriving at a California port from a port:

- Outside of the Pacific Coast Region (PCR; Figure 4-1), or carrying ballast water sourced from outside the PCR, are required to complete a mid-ocean ballast water exchange at least 200 nautical miles (NM) from any land, including islands, in water at least 2,000 meters (m) deep (Public Resources Code sections 71200(i) and 71204.3(c)).

- Within the PCR and with ballast water sourced within the PCR are required to complete a ballast water exchange in near-coastal waters at least 50 NM from any land, including islands, in water more than 200 m deep (Title 2 California Code of Regulations section 2284).

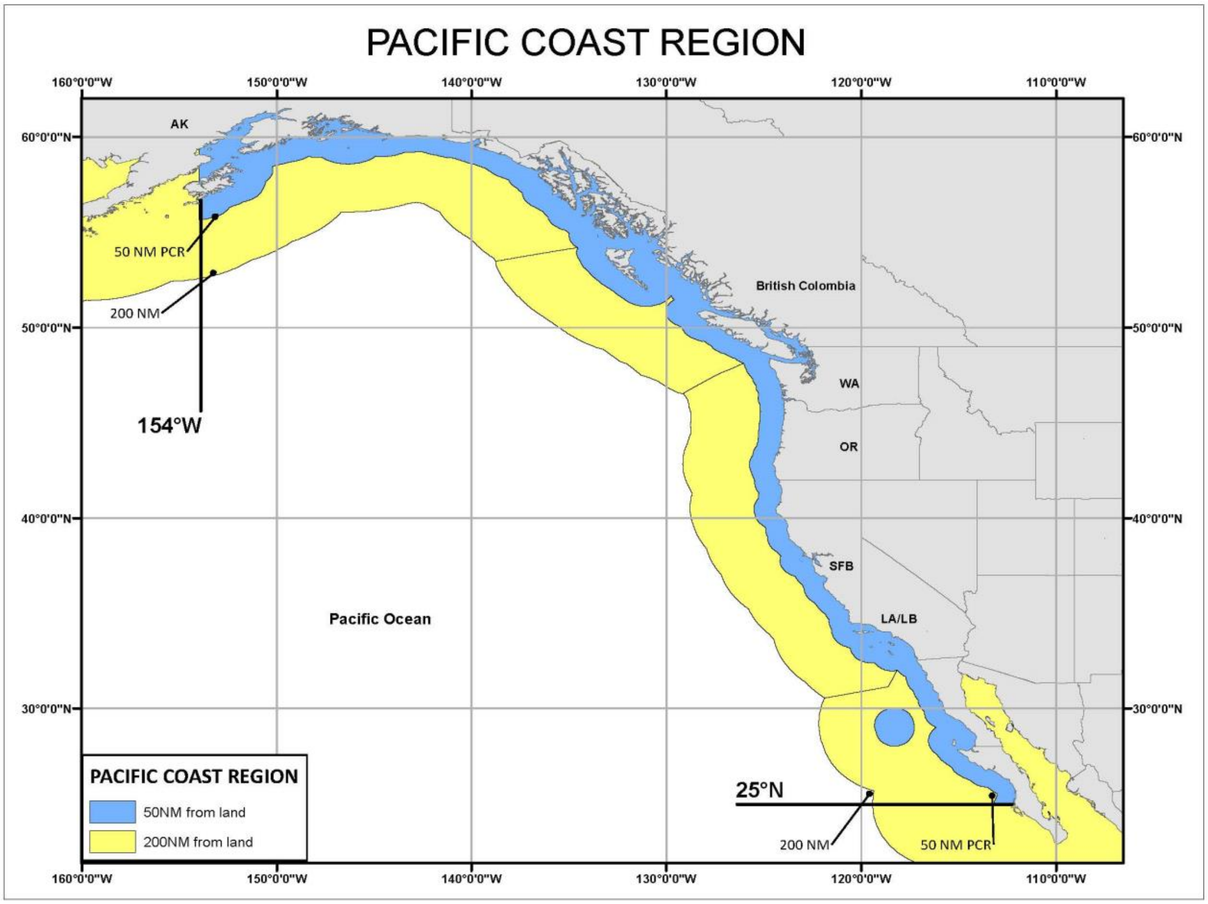

Figure 4-1. Map of the Pacific Coast Region (PCR). The PCR extends from 25° N latitude to 154° W longitude, exclusive of the Gulf of California.

During ballast water exchange, the biologically-rich water that is loaded while a vessel is in port, or near the coast, is exchanged with the comparatively biologically-poor waters of the open ocean. Coastal organisms adapted to the environmental conditions of bays, estuaries, and shallow coasts are not expected to survive or reproduce in the open ocean due to differences in biology and oceanography. Open ocean organisms are likewise not expected to survive in coastal waters (Cohen 1998).

Although ballast water exchange is intended to reduce the risk of introducing NIS into California waters, the efficacy of the practice is variable. Ballast water exchange eliminates between 70-99% of the organisms taken into a ballast tank (Parsons 1998, Zhang and Dickman 1999, USCG 2001, Wonham et al. 2001, MacIsaac et al. 2002). Therefore, even if a vessel reports exchanging 100% of its ballast water, living coastal NIS may remain in the tank after exchange.

Most vessels are capable of exchanging ballast water, and this management practice typically does not require any special structural modification. However, exchange may pose challenges. A proper exchange can take many hours to complete due to ballast pump and piping capacities. In some circumstances, exchange may not be possible without compromising vessel safety due to adverse sea conditions or vessel design. Some vessels may be routed on short voyages, or voyages that remain within 50 NM of shore. In such cases, the exchange process may create a delay or require a vessel to deviate substantially from its route. This would cause additional fuel usage and increased air emissions. For example, there are many small islands off the west coast of Mexico that require vessels to travel even farther offshore to conduct proper ballast water exchanges at the required distance from land (Figure 4-2).

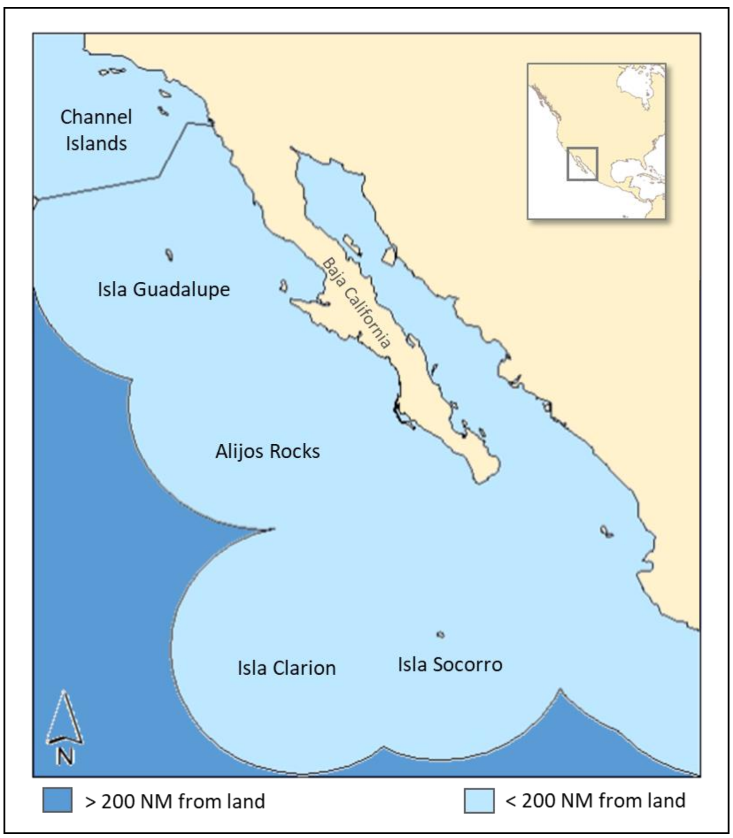

Figure 4-2. Islands offshore of the Mexican and U.S. Pacific coast that are often not considered by vessel crews when calculating distance from “land.”

Approved Alternative Ballast Water Management Methods

The Commission allows vessels to use ballast water management systems (BWMS) in lieu of ballast water exchange if the BWMS is:

- Accepted by the USCG as an Alternate Management System (AMS)
    - Alternate Management Systems are BWMS that have been type-approved by foreign countries in accordance with the International Maritime Organization's (IMO) G8 "Guidelines for Approval of Ballast Water Management Systems" and accepted by the USCG as being at least as effective as ballast water exchange
- Type-approved by the USCG for use in U.S. waters
- Being evaluated through the USCG Shipboard Technology Evaluation Program (STEP) to provide:
    - Vessels with incentives to install experimental BWMS to comply with USCG ballast water management requirements
    - USCG with the ability to collect data on the performance of treatment technologies
    - Treatment technology manufacturers with vessels to use for the USCG type approval testing process

4.1.3 Ballast Water Recordkeeping and Reporting

Ballast water management planning and recordkeeping are important components of the MISA. All vessels must maintain a vessel-specific ballast water management plan that describes the management strategy employed by the vessel. A vessel's crew must be trained on the application of the management plan and proof of that training must be kept onboard. Vessels must also maintain a separate ballast water log that outlines the ballast water management activities for each ballast water tank onboard the vessel and verifies that the vessel crew has followed the management plan.

Vessels must also report their ballast water management practices to the Commission for compliance assessment via the Ballast Water Management Report (BWMR; OMB number 1625-0069; Appendix B). The BWMR must be submitted to the Commission at least 24 hours prior to arrival at a California port (Public Resources Code section 71205(a)). The BWMR details ballast water management information for each voyage. BWMR data are compiled and analyzed by Commission staff to assess vessel compliance with ballast water management requirements, to gather data on vessel traffic arriving at California ports, and to help assess the risk of NIS introductions from vessel vectors.

Prior to October 1, 2017, vessels that used a BWMS to manage ballast water discharged into California waters were required to submit:

- The Ballast Water Treatment Technology Annual Reporting Form (Appendix B) once annually, within 60 days of receiving a written or electronic request from Commission staff
- The Ballast Water Treatment Supplemental Reporting Form (Appendix B) every time a vessel uses its ballast water management system to treat ballast water discharged in California

Those forms were repealed on October 1, 2017, and are no longer required to be submitted. Vessels must now submit the Annual Vessel Reporting Form (AVRF) to report on BWMS use (see section 4.2.1 Biofouling Recordkeeping and Reporting for more information).

4.1.4 California's Ballast Water Discharge Performance Standards

In 2006, California's ballast water discharge performance standards (California Performance Standards) were codified based on recommendations from the majority of a technical advisory panel that was convened by the Commission in 2005. The advisory panel consisted of scientists, regulators, representatives from the shipping industry, and environmental organizations. The standards were to be phased in over time to allow for the development of technologies that would enable vessels to meet the standards.

California has "interim" and "final" performance standards. The interim standards are composed of numeric concentrations of living organisms of various size classes in discharged ballast water and vary from the federal discharge standards (Table 4-1). The final performance standard requires that any ballast water discharged has zero detectable living organisms for all organism size classes (Public Resources Code section 71205.3).

Prior to implementing the performance standards, the Commission is required to report to the Legislature on the efficacy, availability, and environmental impacts of currently available ballast water management technologies (Public Resources Code section 71205.3). Reports are due 18 months prior to each performance standard implementation date. As of January 2019, seven reports have been prepared and submitted to the Legislature (see Dobroski et al. 2007, 2009; and Commission 2010, 2013, 2014, 2018). The 2018 report was approved by the Commission in December 2018.

Table 4-1. Ballast Water Discharge Performance Standards. Italics in the middle column represent parts of the standards that differ between U.S. Federal and IMO.

Organism Size Class	U.S. Federal (USCG, EPA)/*IMO D-2*	Interim California
Organisms greater than 50 µm[1] in minimum dimension	< 10 living/*viable* organisms per cubic meter	No detectable living organisms
Organisms 10 – 50 µm in minimum dimension	< 10 living/*viable* organisms per ml[2]	< 0.01 living organisms per ml
Living organisms less than 10 µm in minimum dimension		< 10^3 bacteria/100 ml < 10^4 viruses/100 ml
Escherichia coli	< 250 cfu[3]/100 ml	< 126 cfu/100 ml
Intestinal enterococci	< 100 cfu/100 ml	< 33 cfu/100 ml
Toxicogenic *Vibrio cholerae* (O1 & O139)	< 1 cfu/100 ml or < 1 cfu/gram wet weight zooplankton samples	< 1 cfu/100 ml or < 1 cfu/gram wet weight zoological samples

[1] µm = Micrometer; one-millionth of a meter
[2] ml = Milliliter; one-thousandth of a liter
[3] cfu = Colony-forming unit; a measure of viable bacterial numbers

In the 2018 report, the Commission concluded that no shipboard or shore-based ballast water treatment technologies are available to enable vessels to comply with the interim California Performance Standards set for implementation on January 1, 2020.

Commission staff also analyzed the utility of ballast water exchange (BWE) plus ballast water treatment (BWT) to determine if the combined approach could enable vessels to meet the interim California Performance Standards. The State of Oregon and the U.S. Environmental Protection Agency (for vessel arrivals in the Great Lakes) currently require BWE plus BWT because it is more effective at protecting freshwater ports than BWT alone (Oregon DEQ 2017, EPA VGP 2013).

Staff concluded that the available research on the efficacy of BWE plus BWT is limited and does not address whether it could be used by vessels to meet the interim California Performance Standards. However, the potential for BWE plus BWT to improve the performance of BWMS and enable vessels to meet a standard lower than the federal ballast water discharge standards needs further investigation. Staff is finalizing the details of a study that examines the efficacy of exchange plus treatment to meet the California Performance Standards and the environmental effects of BWE plus BWT.

As a result of the lack of technologies available to enable vessels to meet the interim California Performance Standards, the Commission made several recommendations to the California Legislature, including:

- Adopt the federal ballast water discharge performance standards set forth in Title 33 Code of Federal Regulations section 151.2030 with the associated implementation schedule (see Table 4-1 for comparison of California and federal ballast water discharge standards)
- Establish a requirement for vessels to conduct ballast water exchange in addition to treatment prior to discharge in California waters
- Convene a technical advisory group and re-evaluate if California can move to stricter discharge standards in the future (after implementation of the federal standards).

4.2 Vessel Biofouling Management

The Commission adopted vessel biofouling management regulations in April 2017 (*Article 4.8. Biofouling Management to Minimize the Transfer of Nonindigenous Species from Vessels Arriving at California Ports* (2 CCR § 2298 et seq.)), hereafter referred to as the California Biofouling Management Regulations. These regulations became effective in October 2017 and include requirements pertaining to:

- Biofouling Management Plans and Biofouling Record Books
- Strategies to manage biofouling on vessel’s wetted surfaces
- Extended residency periods (i.e., long durations within one geographic area)

4.2.1 Biofouling Recordkeeping and Reporting

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, are required to maintain a Biofouling Management Plan (BFMP) and make it available to Commission staff to review upon inspection.

A California-compliant BFMP is a vessel-specific planning document that must:

- Describe the vessel's operational profile (e.g., typical speed, activity level)
- Describe the vessel's maintenance practices for prevention and removal of biofouling organisms on a vessel's hull and a variety of underwater recesses and appendages collectively referred to as "niche areas"
- Indicate the effective coating lifespan for each antifouling (biocidal) or foul-release (biocide-free) coating used on the vessel (i.e., time length the coating is expected to be effective, based on coating formulation and applied thickness)
- Maintain consistency with the BFMP 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)

A California-compliant Biofouling Record Book (BFRB) is a vessel-specific document that must maintain consistency with the BFRB described in the IMO Biofouling Guidelines and must be used to record all completed biofouling inspections and management practices.

Collectively, the BFMP and BFRB should document each vessel's biofouling management strategy and show that the strategy is being implemented. A vessel's strategy can include measures to prevent biofouling accumulation, including the use of antifouling or foul-release coatings that create surfaces that are inhospitable or that prevent strong biofouling attachment. A biofouling management strategy can also include reactively cleaning biofouling off vessel surfaces when necessary. These strategies should change from vessel to vessel, based on the vessel's design and operational profile.

Beginning on October 1, 2017, vessels are required to report their biofouling maintenance and operational practices to the Commission via the Annual Vessel Reporting Form (AVFR; Appendix B). The AVRF must be submitted to the Commission annually, at least 24 hours prior to a vessel's first arrival at a California port of each calendar year. The AVRF is used by Commission staff to assess compliance with biofouling management requirements and to conduct pre-arrival weighted risk assessments to prioritize boarding and inspection. The AVRF is also used by vessels to document use of a BWMS (see 4.1.3 Ballast Water Recordkeeping and Reporting).

4.2.2 Biofouling Management of the Vessel's Wetted Surfaces

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, are required to manage biofouling on their wetted surfaces (i.e., vessel surfaces that are temporarily or continuously submerged in water) as described in this subsection.

Management of a Vessel's Hull

Biofouling on vessel hulls must be managed in a manner chosen by a vessel's master, owner, operator, or person in charge, and as indicated in the BFMP. Acceptable biofouling management options for vessel's hulls include:

- Using an antifouling or foul-release coating that is not aged beyond its expected coating lifespan
- Any other management action selected by the vessel master, owner, operator, or person in charge, if the BFMP describes how biofouling on the hull will be managed:
    - After the expected coating lifespan of an antifouling or foul-release is exceeded
    - In the absence of an antifouling or foul-release coating

Management of a Vessel's Niche Areas

Niche areas include recesses, appendages, and other wetted vessel surfaces that are more susceptible to biofouling due to variable hydrodynamic forces or inadequate protection by antifouling or foul-release coatings and other antifouling systems. Biofouling on eight specific niche areas must be managed in a manner chosen by a vessel's master, owner, operator, or person in charge, and as indicated in the BFMP. Specific niche areas that require management are:

- Sea chests
- Sea chest gratings
- Bow and stern thrusters
- Bow and stern thruster gratings
- Fin stabilizers and recesses
- Out-of-water support strips
- Propellers and propeller shafts
- Rudders

4.2.3 Requirements for Vessels with Extended Residency Periods

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, that remain in one port consecutively for 45 days or longer must manage niche area biofouling in a manner consistent with its BFMP prior to arrival at a California port. In most cases, biofouling that accumulates because of an extended residency period of 45 days or longer should be managed in the same location where the long residency period occurred to prevent the movement of the biofouling community to a new location.

4.3 Marine Invasive Species Act Compliance and Enforcement

The Commission utilizes a variety of processes to assess compliance with the MISA and associated regulations to prevent the introduction of NIS into California waters. Commission staff works continuously to improve and identify key actions necessary to reduce the risk of NIS introductions, by conducting vessels inspections and enforcing against violations.

4.3.1 Ballast Water Compliance Assessment Process

Vessel activity is monitored and entered into the MISP database daily using information received from local Marine Exchange offices. A priority risk category of High, Medium, or Low is assigned to each vessel arrival based on vessel characteristics, including:

- California arrival and inspection history
- Ballast water management and discharge activity
- Previous violation history

Ballast Water Management Reports that are submitted at least 24 hours prior to arrival are immediately reviewed by Commission staff to identify vessels that intend to discharge upon arrival. For each BWMR that indicates an intended ballast water discharge, staff plots the reported ballast water exchange coordinates using Google Earth Pro to assess compliance with MISA requirements (see section 4.1.2. Ballast Water Management Requirements for more information). When a ballast water exchange that was not conducted at an appropriate distance from land is identified, staff immediately notifies the vessel's agent and master to inform them of the potential violation if the water is discharged in California. The process of informing the vessel agent and master of possible noncompliance provides the vessel master with an opportunity to either conduct a proper exchange while the vessel is still or if possible, change operations so the ballast water can be retained onboard upon arrival in California.

Vessel Inspections

Commission staff assesses compliance with the Marine Invasive Species Act and associated regulations through a vessel inspection program (Public Resources Code section 71216). Inspections are conducted by the Commission's field operations staff based in northern (Hercules) and southern (Long Beach) California. This geographic spread enables the Commission to inspect at least 25% of vessels arriving at California ports, as mandated by the MISA.

During inspections, field operations staff interviews the person in charge of the vessel following a step-by-step process to review all the documents required by the MISA. These documents include the ballast water management plan, ballast water log, and required reporting forms. The field operations staff reviews ballast water exchange coordinates with the vessel's crew and takes a sample of ballast water from a ballast tank intended for discharge to measure the salinity of the water. Low salinity is indicative of water that may not have been properly exchanged in the open ocean.

A report is written at the conclusion of the inspection to inform the vessel about the findings of the inspection, including noncompliance if determined. If violations are detected, a report is issued to the vessel crew and an enforcement letter is sent to the vessel owner.

Vessel inspections are also an important opportunity for field operations staff to provide outreach to the maritime industry. Direct outreach to vessel personnel responsible for ballast water management is key to maintaining a high rate of compliance with California's management, reporting, and recordkeeping requirements.

Geographic Information Systems (GIS) Evaluations

In addition to onboard inspections, Commission staff uses Geographic Information Systems (GIS) software ArcMap (ESRI 2017) to assess ballast water management compliance of all vessels arriving at California ports. Staff reviews vessel-submitted BWMRs for the ballast water source and management location coordinates (latitude and longitude). The GIS analysis accurately maps reported ballast water source and management locations, allowing staff to identify patterns of noncompliance. ArcMap is capable of handling very large datasets, allowing staff to evaluate the ballast water management practices of all vessel arrivals statewide, even those that were not inspected by field operations staff. Commission staff conducts GIS compliance analyses on a quarterly basis.

4.3.2 Ballast Water Management Enforcement

In August 2016, the Commission adopted regulations to codify the Marine Invasive Species Act Enforcement and Hearing Process (Title 2, CCR section 2299.01 et seq.), hereafter referred to as the MISA Enforcement Regulations. The regulations became effective on July 1, 2017, and established an administrative enforcement process for violations of the MISA and associated regulations. These enforcement regulations lay out clear and transparent procedures outlining the severity of specific violations and provide an easy to follow penalty matrix to establish maximum penalties associated with different classes of violations.

The regulations separate violations into operational and administrative categories to differentiate between the level of NIS introduction risk presented through each violation. Violations are further separated into three classes:

- **Class 1** violations are operational and pertain to ballast water discharges of noncompliant ballast water. Violations are categorized as Minor, Moderate, Major I, or Major II, with each category dependent on the distance from land at which ballast water exchange was conducted, or if no exchange was conducted at all (Major II) (see 2 CCR section 2299.03 for more information). The maximum monetary value of each violation category (Table 4-2) was set to represent the relative level of NIS introduction risk associated with each type of violation. Violations are assigned per ballast tank.

Table 4-2. Categories and maximum penalties associated with violations of the Marine Invasive Species Act and associated regulations.

Violation Category	Maximum Penalty
Minor	Not to exceed $5,000 per violation
Moderate	Not to exceed $10,000 per violation
Major (I)	Not to exceed $20,000 per violation
Major (II)	Not to exceed $27,500 per violation

- **Class 2** violations are administrative and are issued to vessels that fail to properly maintain required documentation on board (e.g., Ballast Water Management Plan). A Letter of Noncompliance is issued by the Commission upon the first occurrence of a Class 2 violation. Upon the second occurrence of a Class 2 violation, the vessel is subject to a maximum penalty of $10,000 per violation.

- **Class 3** violations are also administrative and are issued to vessels that fail to submit required reporting information to the Commission (e.g., Ballast Water Management Report). A Letter of Noncompliance is issued by the Commission upon the first occurrence of a Class 3 violation. Upon the second occurrence of a Class 3 violation, the vessel is subject to a maximum penalty of $1,000 per violation.

4.3.3 Next steps – Assessing Compliance with Biofouling Management Requirements

The number of vessels that are subject to the California Biofouling Management Regulations has steadily risen since phased implementation began on January 1, 2018. In preparation for conducting biofouling management inspections, Commission staff has developed inspection procedures and checklists to ensure that all inspections are consistent and thorough. Field operations staff has been trained on these new procedures and began conducting biofouling management inspections in August 2018.

To maximize the effectiveness of inspection efforts, staff in 2019 will begin prioritizing vessels for boarding and inspection based on a weighted risk assessment procedure using the information reported on each vessel's AVRF (see section 4.2.1 Biofouling Recordkeeping and Reporting for more information). This biofouling risk assessment will tie into a ballast water risk assessment to enable more effective inspection prioritization for vessels that are assumed to carry the greatest risk of NIS introduction.

Commission staff is also preparing to propose amendments to the MISA Enforcement Regulations (see section 4.2.3 Ballast Water Management Enforcement for more information) to establish risk-based classification and maximum penalties associated with violations of the California Biofouling Management Regulations.

5. EMERGING ISSUES

5.1 Vessel Vector Management

5.1.1 Federal Preemption of State Authority

Federal regulation of ballast water discharges in the U.S. has been under the jurisdiction of both the USCG operating under the authority of the National Invasive Species Act and the U.S. EPA operating under the authority of the Clean Water Act. The dual federal agency regulation of vessel discharges led to confusing, and at times conflicting, requirements for vessel NIS management activities.

Over the past six years, numerous versions of the "Vessel Incidental Discharge Act" (VIDA) have been proposed to "fix" the problem of dual federal regulation of vessel discharges. In late 2018, after months of negotiations, Congress approved the Vessel Incidental Discharge Act, 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. The bill:

- Designates U.S. EPA as the lead authority to establish national water quality standards for vessel discharges, including ballast water
- Designates USCG as the lead authority to implement and enforce the national standards set by U.S. EPA
- Preempts state authority to adopt or implement state-specific management requirements or standards for vessel discharges, including ballast water
- Retains state authority to conduct vessel inspections and enforce the federal ballast water management requirements
- Retains state authority to collect fees and ballast water management reporting forms from vessels arriving at state ports

VIDA could take four years to preempt state law because the U.S. EPA and the USCG must sequentially adopt regulations to implement. During that time, states retain authority to continue implementing existing management programs. Commission staff is working with Congressional staff, the Governor's Office, and the Attorney General's office to closely review the bill language and determine next steps. The Commission may propose changes to the MISA as necessary to retain as much state authority as possible to protect California waters from the risk of species introductions from vessels arriving at California ports.

5.2 Ballast Water Management

5.2.1 IMO Ballast Water Convention

In 2004, the IMO adopted the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (see IMO 2005), hereafter referred to as the IMO Ballast Water Convention. To enter into force, the IMO Ballast Water Convention required ratification by at least 30 countries representing at least 35% of world merchant shipping tonnage. The ratification threshold was achieved on September 8, 2016, and the Convention entered into force on September 8, 2017. As of October 2018, a total of 77 countries representing 77.17% of the world's tonnage have signed onto the convention (IMO 2018). The U.S. is not a signatory.

The IMO Ballast Water Convention contains standards (known as the "D-2" standards) that specify the maximum concentration of viable organisms allowed in ballast water discharged by vessels (see Table 4-1). The timeline for implementation of the D-2 standards is presented in Table 5-1. Global implementation is expected by September 8,2024 (MEPC 2017).

Table 5-1. IMO Ballast Water Convention Implementation Timeline for D-2 Standards

Vessel Age	Implementation Date
New Builds – Constructed after September 8, 2017	Upon delivery into service
Existing Vessels – Constructed prior to September 8, 2017	By the vessel's first International Oil Pollution Prevention Certificate renewal survey after September 8, 2019

Recognizing the challenges associated with implementing a global approach to managing ballast water, the IMO initiated "the experience-building phase (EBP) associated with the [IMO Ballast Water] Convention" (MEPC 2017). The purpose of the EBP is to allow the IMO's Marine Environment Protection Committee (MEPC) to monitor the implementation of the IMO Ballast Water Convention. The EBP includes data gathering and analysis to allow the MEPC to identify aspects of the Convention's implementation that are working well and issues that require further attention (see MEPC 2017 for the data gathering and analysis plan and timeline). The EBP includes a systematic and evidence-based process for reviewing and improving the Convention.

As part of the EBP, the MEPC has adopted certain non-penalization measures. These measures are intended to recognize and address the challenges associated with penalizing ship owners and operators that are not compliant with the D-2 standards but used an approved BWMS. These measures, however, do not prevent Port States from taking preventive actions to protect their environment, human health, property, and resources from the discharge of non-compliant ballast water.

Commission staff is closely following the reports that come from the EBP data gathering process to help inform California's approach to assessing compliance with ballast water discharge standards.

5.2.2 Ballast Water Management Systems Not Functioning as Intended

The IMO EBP is all-the-more important because of recent information indicating that BWMS are not operating as expected when installed on board vessels. In a 2017 report, the American Bureau of Shipping found that 43% of the BWMS installed on 220 vessels are either inoperable or considered problematic (ABS 2017). In a recent conversation with an independent tanker company that operates throughout the U.S., Commission staff learned that of their 103 vessels with installed shipboard BWMS, over 50% are currently not functional, and the shipping company is not having success in getting system manufacturers to fix the malfunctions (Schroder, O., pers. comm. 2018).

Commission staff has attempted to take samples and assess the performance of BWMS on vessels arriving at California ports, but Public Resources Code section 71206 subdivision (a) states that the Commission may take samples of ballast water and sediments only to assess compliance with the Marine Invasive Species Act. The Commission is not authorized to take ballast water samples for research purposes, limiting the ability of staff to collect valuable information about BWMS performance.

In the recent ballast water treatment technology assessment report (see Commission 2018), the Commission recommended that the Legislature grant the Commission authority to sample ballast water for research purposes during the period between statutory adoption of the federal ballast water discharge performance standards and the date that vessels are required to comply with those standards. Staff could then begin sampling ballast water for research purposes to assess the concentration of living organisms in discharged ballast water. These data are critical to assess the real-world operational capabilities of BWMS.

5.3 Biofouling Management

5.3.1 New Regulatory Landscape

A new international vessel biofouling management regulatory environment has emerged in recent years. After adoption of the IMO Biofouling Guidelines (see IMO 2011), several jurisdictions began developing biofouling management regulations designed to reduce the risk of introducing NIS into their waters. These efforts have resulted in the adoption and implementation of new biofouling management regulations in California (see Section 4.2 (Biofouling Management)) and New Zealand.

New Zealand's Craft Risk Management Standard (CRMS) for Biofouling on Vessels Arriving to New Zealand (see NZ MPI 2014) became effective on May 15, 2018, after a four-year voluntary lead-in period. The CRMS is also consistent with the IMO Biofouling Guidelines, promotes preventive biofouling management, and offers three options for compliance to vessels that arrive at a New Zealand port:

- Clean the hull within 30 days prior to arriving in New Zealand
- Conduct continual hull maintenance using best practices (e.g., IMO Biofouling Guidelines)
- Conduct hull treatment using an approved provider within 24 hours off arriving in New Zealand

More information about New Zealand's CRMS is available at:
https://www.mpi.govt.nz/importing/border-clearance/vessels/arrival-process-steps/biofouling/biofouling-management/

5.3.2 IMO GloFouling

Through a partnership with the Global Environment Facility and the United Nations Development Program, the IMO has initiated a GloFouling Partnerships Project (GloFouling) to assist with the implementation of the IMO Biofouling Guidelines. The GloFouling project will focus on building capacity in developing countries to reduce biofouling-mediated NIS introductions. The project was approved in May 2017 with nearly $7 million of funding and is undergoing a preparation phase prior to full commencement. More information on GloFouling can be found at:
http://www.imo.org/en/mediacentre/pressbriefings/pages/20-biofouling.aspx

5.3.3 In-Water Grooming

Vessel biofouling management is most effective when applied in a proactive or preventive manner (e.g., the appropriate use of effective antifouling coatings). When proactive management fails, and biofouling accumulates to unacceptable levels, reactive management (e.g., physical removal) is typically employed. While in-water cleaning is almost always a reactive management approach, there has been recent interest in regular proactive in-water cleaning, or "grooming," of vessel surfaces as a proactive measure to limit biofouling to a biofilm or slime layer (i.e., no macroscopic animals) (Scianni and Georgiades, submitted).

Regular in-water grooming has been experimentally shown to be effective at minimizing biofouling accumulation on a variety of antifouling or foul-release coatings (Tribou and Swain 2015). In-water grooming also requires less abrasive cleaning methods than traditional in-water cleaning, thereby minimizing the amount in biocides that is removed from the coatings and preventing damage or accelerated deterioration of the coatings (Tribou and Swain 2017).

In-water grooming is likely to become more prevalent as a proactive biofouling management tool in future years. Although the practice is expected to reduce the amount in biocides that is removed from the vessel's coatings, water quality regulators are likely to require testing data to verify that the release of copper and other biocides is within existing regulatory thresholds.

5.3.4 In-Water Cleaning and Capture (IWCC) Evaluations

The practice of in-water cleaning of vessel wetted surfaces has come under increased regulatory scrutiny during the past decade. The in-water cleaning process often results in the release of the removed biofouling organisms and a large pulse of biocides that are removed from the vessel's antifouling coatings, resulting in NIS introduction and water quality risks.

New in-water cleaning and capture (IWCC) technologies have been developed and introduced to minimize NIS introduction and water quality risks by capturing the removed debris and treating the wastewater stream prior to discharge. Technologies achieve these goals through various capture and treatment methods, and each technology is likely to differ slightly in how well it can minimize risks. Efforts are underway in the U.S. (ACT 2018) and New Zealand (Growcott et al. 2018) to independently evaluate how well NIS introduction and water quality risks are reduced by emerging IWCC technologies. The U.S.-led effort will produce public reports for each of the technologies involved in that evaluation.

6 DATA COLLECTION AND ANALYSIS

As required by Public Resources Code section 71212, the Commission must provide the Legislature with a summary of vessel vector management patterns and MISA compliance. Vessel arrival patterns, ballast water discharge patterns, reporting compliance rates, and potential species introduction risks are analyzed by Commission staff using data from the following sources:

- Mandatory vessel-submitted reporting forms:
    - Ballast Water Management Report
    - Ballast Water Treatment Technology Annual Reporting Form (BWTTARF, until October 2017)
    - Hull Husbandry Reporting Form (until October 2017)
    - Annual Vessel Reporting Form (starting October 2017)
- Vessel inspection reports produced by Commission Field Operations staff
- Vessel arrival statistics received from the Marine Exchanges of Southern California and the San Francisco Bay Region
- Information provided by ports and shipping agents as needed

The data presented in this report correspond to the period between July 1, 2016 and June 30, 2018. For data analysis purposes, pattern visualization, and consistency with previous reports, some of the data will be grouped by six-month periods (see Table 6-1).

Table 6-1. Current reporting period presented by six-month period.

Six-Month Period	Date Range
2016b	July 1, 2016 to December 31, 2016
2017a	January 1, 2017 to June 30, 2017
2017b	July 1, 2017 to December 31, 2017
2018a	January 1, 2018 to June 30, 2018

6.1 Reporting Compliance

Data Synopsis

- 86.1% of vessel arrivals submitted a Ballast Water Management Report
- 18% of the submitted forms were not received 24 hours in advance of the vessel arrival as required.

6.1.1 Ballast Water Management Report

Ballast Water Management Reports must be submitted prior to each vessel arrival at a California port, including anchorages (designated areas away from a port terminal where a vessel can anchor for refueling or to wait for a terminal to become available) (see section 4.1.3 Ballast Water Recordkeeping and Reporting for more information).

During the two-year reporting period, BWMRs were submitted for 86.1% of the 21,150 vessel arrivals at California ports (Figure 6-1). Approximately 18% of these submitted BWMRs were not received 24 hours in advance of the arrival, as required. The BWMR submission compliance rate was lower than previous reporting periods (see Dobroski et al. 2015, Brown et al. 2017). This reduction in compliance can be partially attributed to shipping industry confusion about changes requiring BWMR submission prior to arrival beginning in January 2016. Commission staff is focusing outreach to increase awareness of recent changes and increase submission rates. The Commission may also pursue enforcement on violators of reporting requirements.

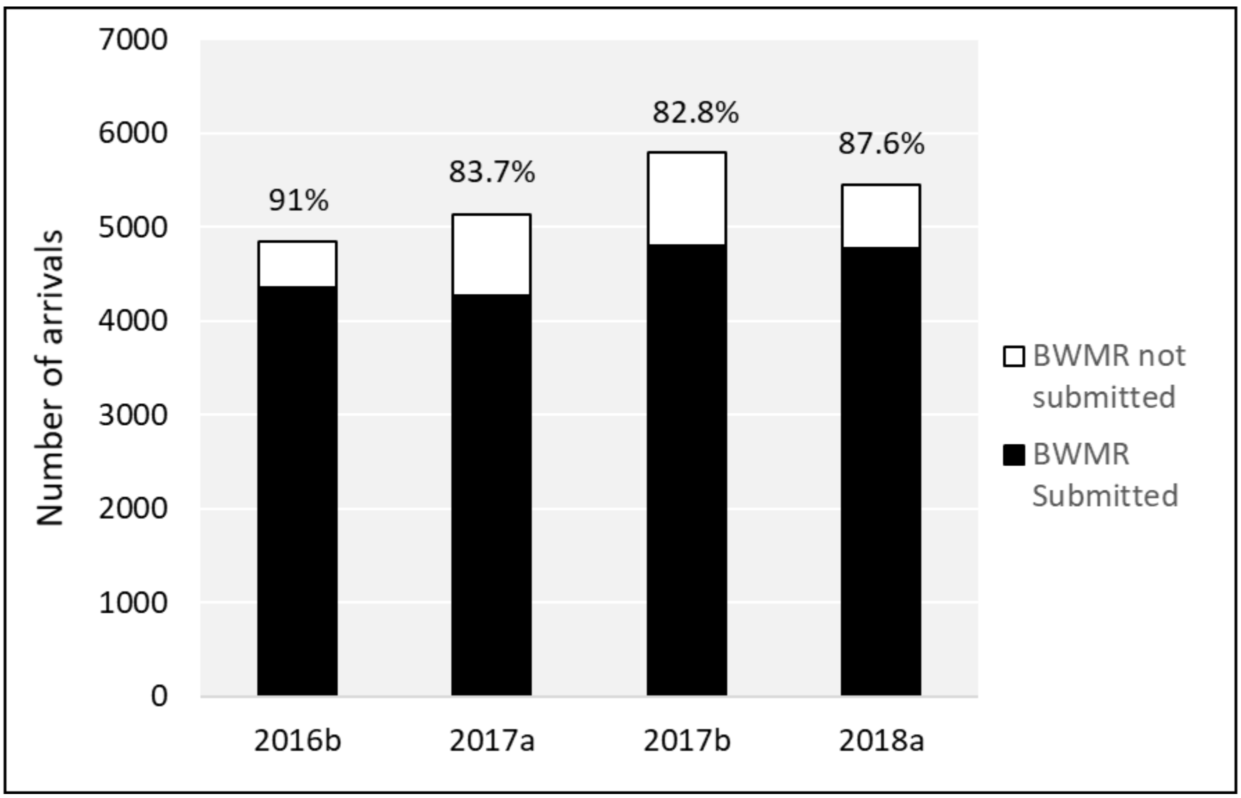

Figure 6-1. Ballast Water Management Report submission compliance.

6.1.2 Hull Husbandry Reporting Form and Annual Vessel Reporting Form

Vessels arriving at California ports have been required to submit the HHRF annually since 2008. Reporting compliance for the HHRF was consistent between 2009 and 2016, varying between 89 to 94%. On October 1, 2017, the HHRF form was repealed and replaced by the AVRF (see section 4.2.1 Biofouling Recordkeeping and Reporting). Reporting compliance during this transition decreased to 87%. Commission staff will continue focused outreach to increase awareness of the new AVRF requirement to increase overall submission compliance.

6.2 Vessel Travel and Arrival Patterns

Data Synopsis

- Collectively, California ports averaged 872 vessel arrivals per month between July 2016 and June 2018
- The Los Angeles/Long Beach port complex consistently received the greatest percentage of vessel arrivals in the State (48%)
- 41% of all California port arrivals came from outside the Pacific Coast Region (PCR)
- 58% of the arrivals at southern California ports are from outside the PCR, while only 18% of arrivals in northern California arrived from outside the PCR

6.2.1 Vessel Arrivals and Last Port of Call

Commission staff tracks vessel arrivals at all California ports using data from the Marine Exchanges of Southern California and the San Francisco Bay Region and mandatory vessel-submitted reporting forms. During the period of this report (Table 6-1), California ports received a total of 21,150 vessels arrivals, an average of 872.4 ± 9 (standard deviation) per month. The number of arrivals during this two-year reporting period increased by about 14% (Figure 6-2) when compared to the previous two-year reporting period (July 1, 2014 through June 30, 2016).

The increase in arrivals is partially a result of a change in reporting requirements. Since April 2017, vessel arrivals at anchorages have been required to comply with reporting requirements. This change was made because vessels may discharge ballast while at an anchorage, and these activities must be recorded to assess compliance with MISA and associated regulations.

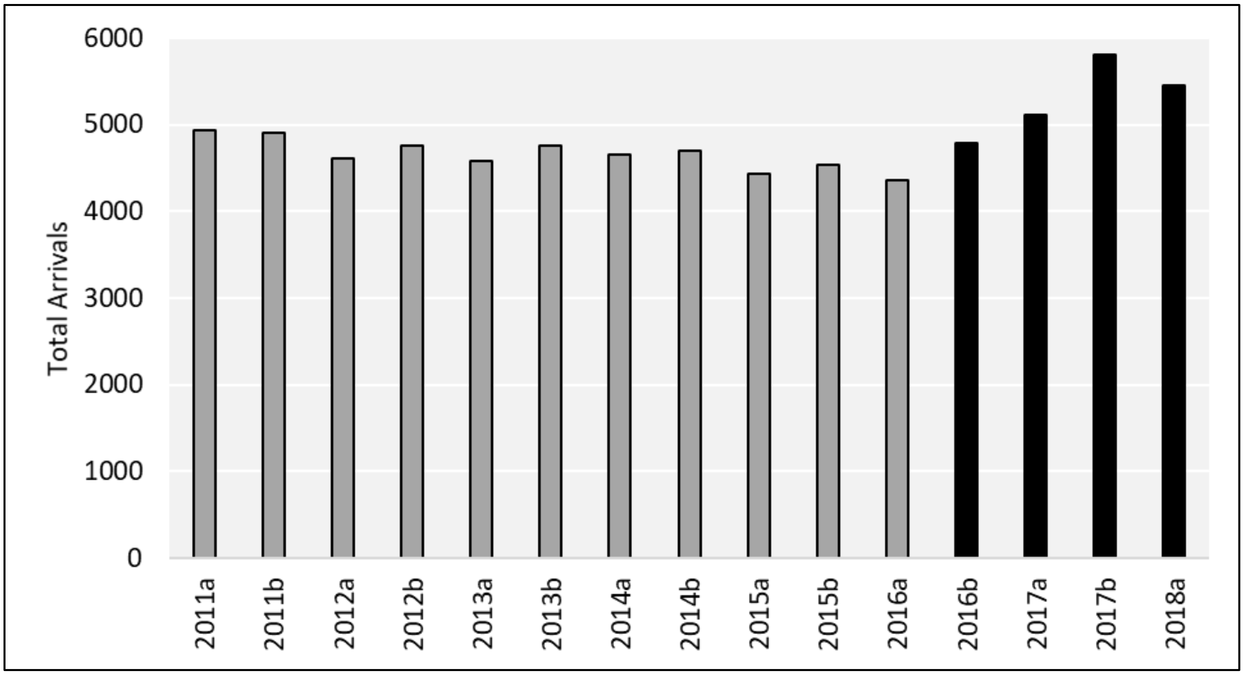

Figure 6-2. Total number of arrivals at all California ports from January 1, 2011 to June 30, 2018, reported by 6-month periods (a = January through June; b = July through December). Black bars represent the current reporting period.

Commission staff tracks the last port of call (LPOC) for each arrival to identify the appropriate ballast water management requirement. This requirement depends on whether the origin of the ballast water or the LPOC was inside or outside the PCR (See section 4.1.2 Ballast Water Management Requirements for more information).

Overall, 41% of all 21,150 California arrivals during this two-year reporting period reported a LPOC from outside of the PCR. Regional patterns varied considerably. The majority (58%) of the 11,726 arrivals at southern California ports reported a LPOC outside the PCR, whereas only 18% of the 9,424 arrivals at northern California ports had a LPOC from ports outside the PCR (Figure 6-3). This percentage is consistent with patterns observed in recent years (see Dobroski et al. 2015, Brown et al. 2017).

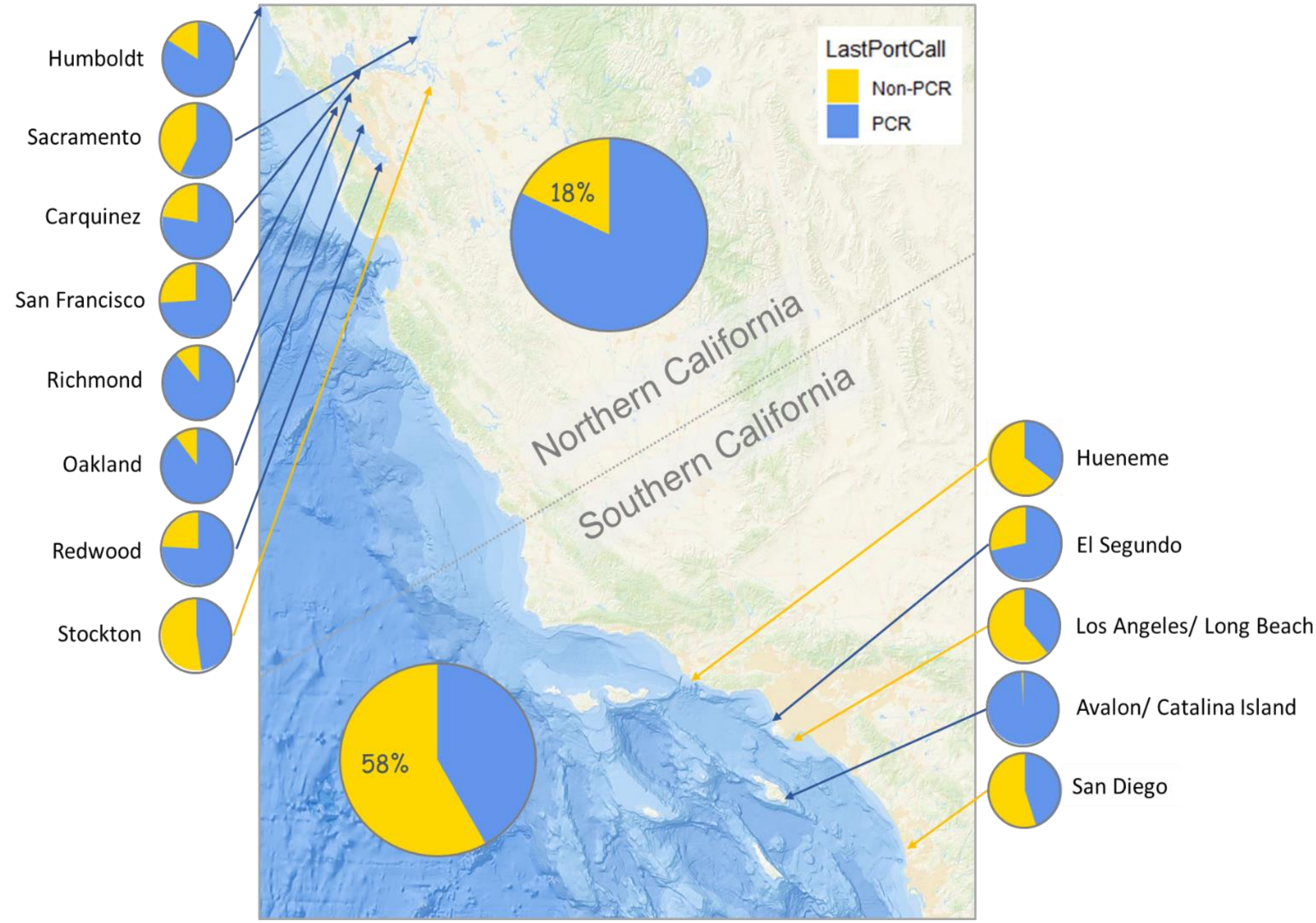

Figure 6-3. Arrivals at Northern and Southern California ports based on reported last port of call (LPOC). Yellow represents LPOC from outside the Pacific Coast Region (PCR); blue represents LPOC from within the PCR.

6.2.2 Arrival Patterns at California Ports by Vessel Type

Multiple factors (e.g., local industry, demand, port infrastructure, economy) contribute to differences in the types of vessels arriving at California ports. Among the different vessel types that arrived at California ports during the reporting period (2016b-2018a), container ships were the most common with 38% of all arrivals, followed by tank vessels with 25% of arrivals (Figure 6-4). These two vessel types contributed more than half of the total arrivals across the state.

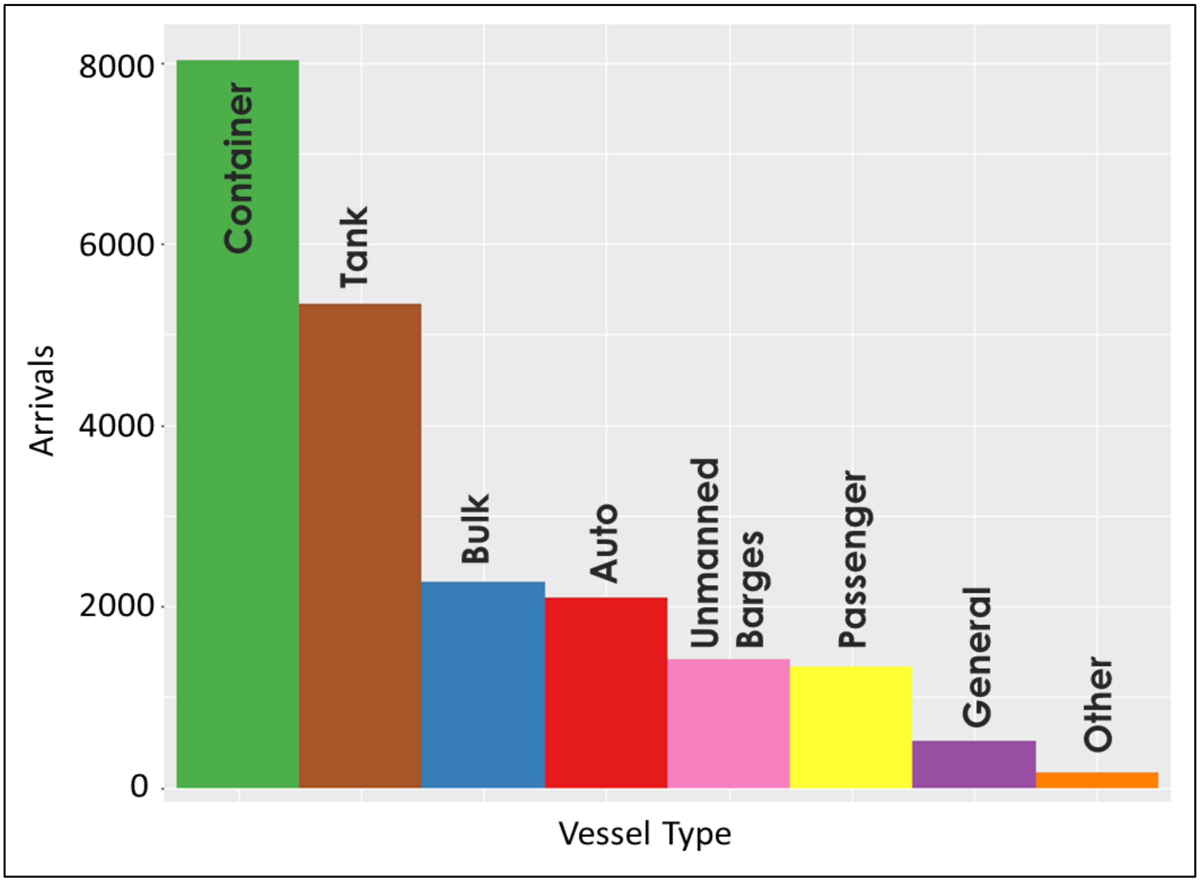

Figure 6-4. Total number of arrivals by vessel type at all California ports between July 2016 and June 2018.

Regionally, the Port of Oakland received 35% of all northern California arrivals, with container ships accounting for more than 98% of those Oakland arrivals (Figure 6-5; additional data are presented in Appendix C). Bulk vessels accounted for the majority of arrivals in Sacramento, Stockton, and Redwood City, while tank vessels accounted for the majority of arrivals at Carquinez, Richmond, and San Francisco (tank vessel arrivals at San Francisco were exclusively from anchorage arrivals (Anchorage 9) (Figure 6-5).

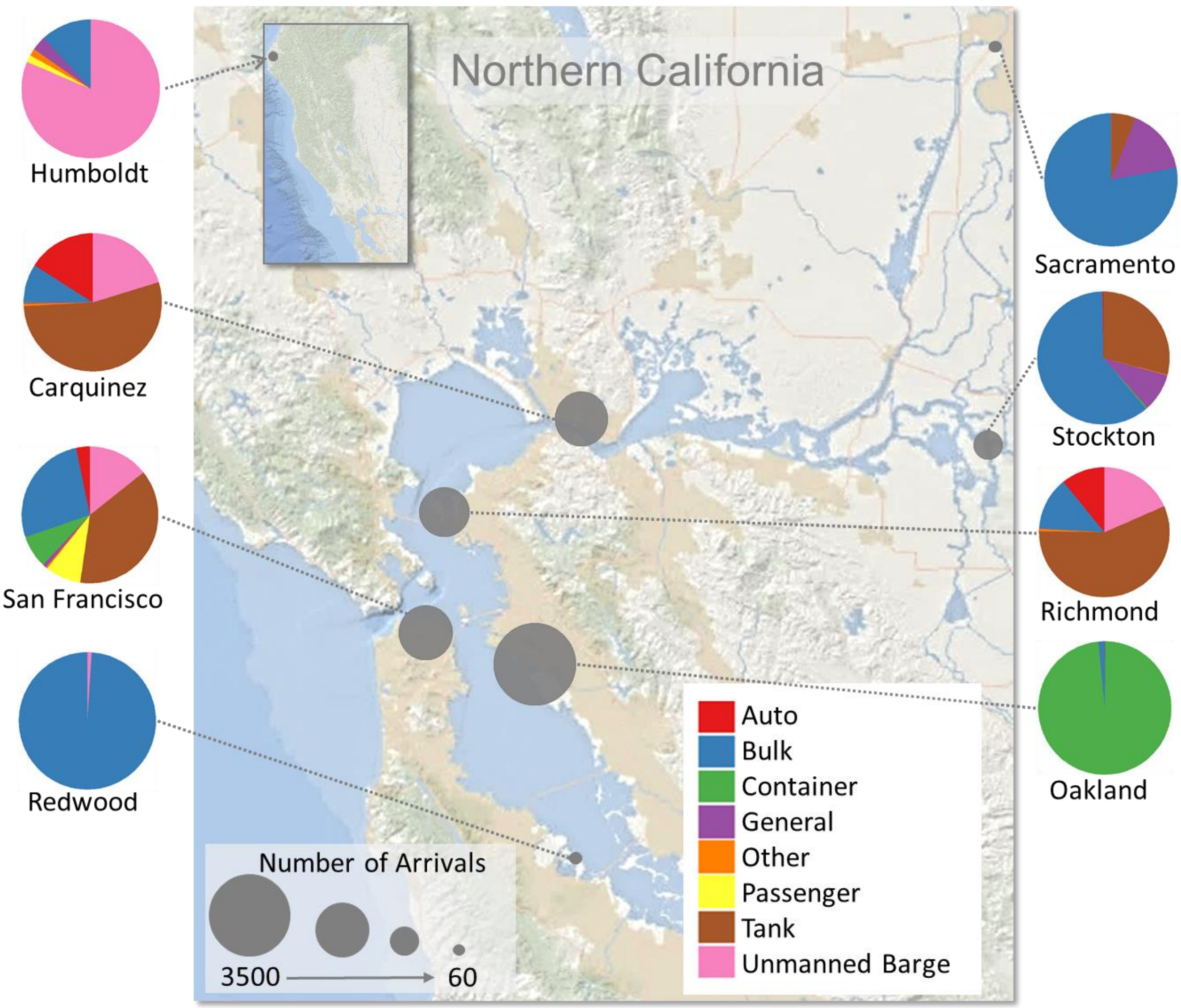

Figure 6-5. Total number of arrivals at northern California ports by vessel type between July 2016 and June 2018. The size of the bubbles on the map represents the number of arrivals. Ports with fewer than 50 arrivals, including Morro Bay (1), Alameda (3), Moss Landing (21), and Monterey (8) have been removed in this visual representation.

With more than 9,000 arrivals in the past two years, the Los Angeles/Long Beach port complex received 79% of the southern California arrivals and 44% of arrivals statewide (Figure 6-6). The most populous vessel types arriving at the Los Angeles/Long Beach port complex were container (46%), tank (22%), bulk (9%) and passenger (8%) vessels. Auto carriers accounted for the majority of arrivals at the Port of San Diego (57%) and Port Hueneme (56%), while arrivals at the El Segundo offshore marine oil terminal were primarily tank vessels (93%). Avalon on Catalina Island almost exclusively received passenger vessels which accounted for 98% of the arrivals between July 1, 2016 and June 30, 2018 (Figure 6-6).

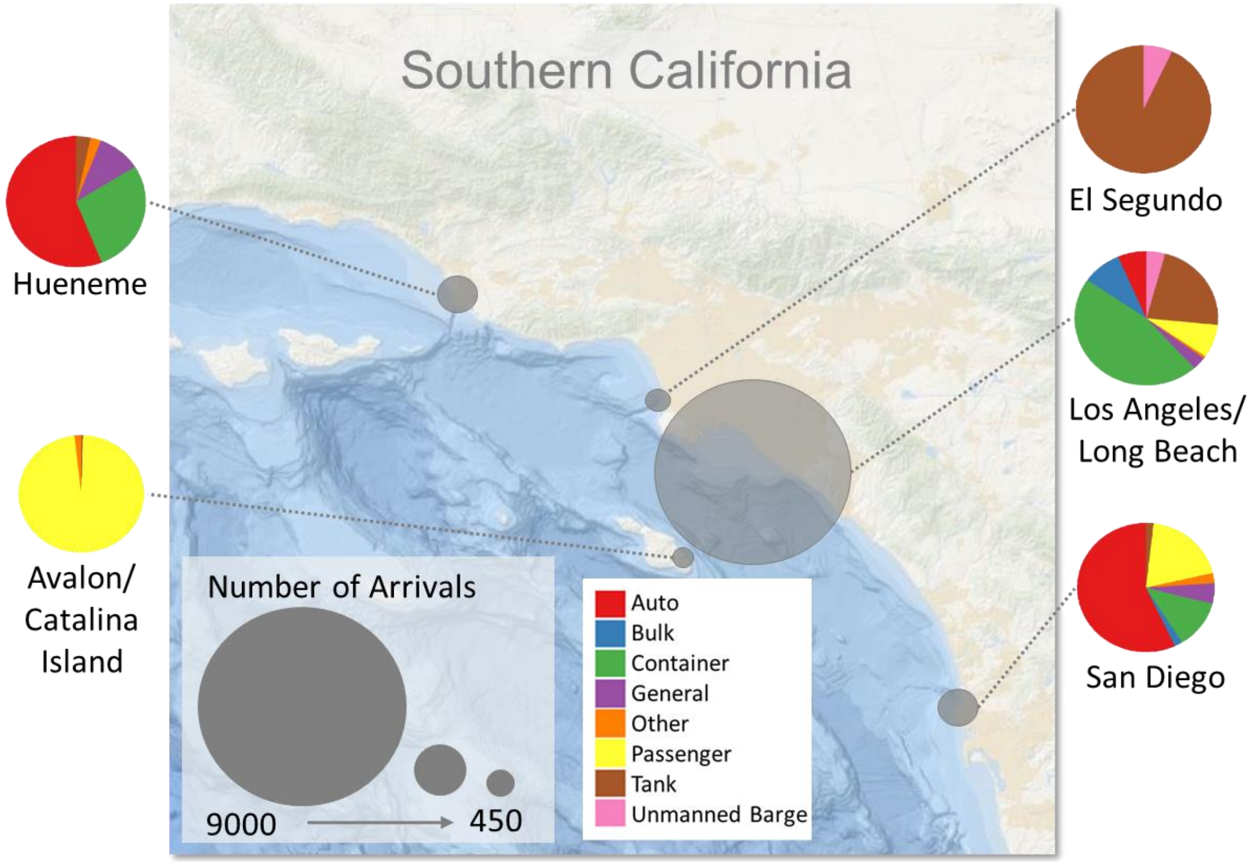

Figure 6-6. Total number of arrivals at southern California ports by vessel type between July 2016 and June 2018. The size of the bubbles on the map represents the number of arrivals. Ports with fewer than 50 arrivals, including Santa Barbara (37), Marina del Rey (3), and Newport Beach (1) have been removed in this visual representation.

6.2.3 Vessel Profile Patterns: Vessel Speed

All vessels that arrive at California ports must submit a reporting form (HHRF or AVRF) once per calendar year that includes information about vessel operating profiles (e.g., speed, freshwater port visits) and hull husbandry practices (see section 4.2.1 Biofouling Recordkeeping and Reporting for more information). These data allow Commission staff to identify operating profile patterns by vessel type that can be used to conduct risk assessments, a practice suggested by Davidson et al. (2018). The data presented in this subsection represent the 2016 and 2017 reporting years.

Vessel speed is an important operating profile attribute that can influence the performance of anti-fouling or foul-release coatings and the amount of biofouling that accumulates on vessel hulls (Coutts et al. 2010a, 2010b; Floerl and Coutts 2009). During 2016 and 2017, container vessels, auto carriers, and passenger vessels reported traveling at an average speed greater than 15 knots (i.e., nautical miles per hour), representing the fastest speeds in the fleet of vessels that arrived at California ports. The remaining vessel types each reported average speeds ranging from 9.1 (unmanned barges) to 13.6 (general vessels) knots (Figure 6-7).

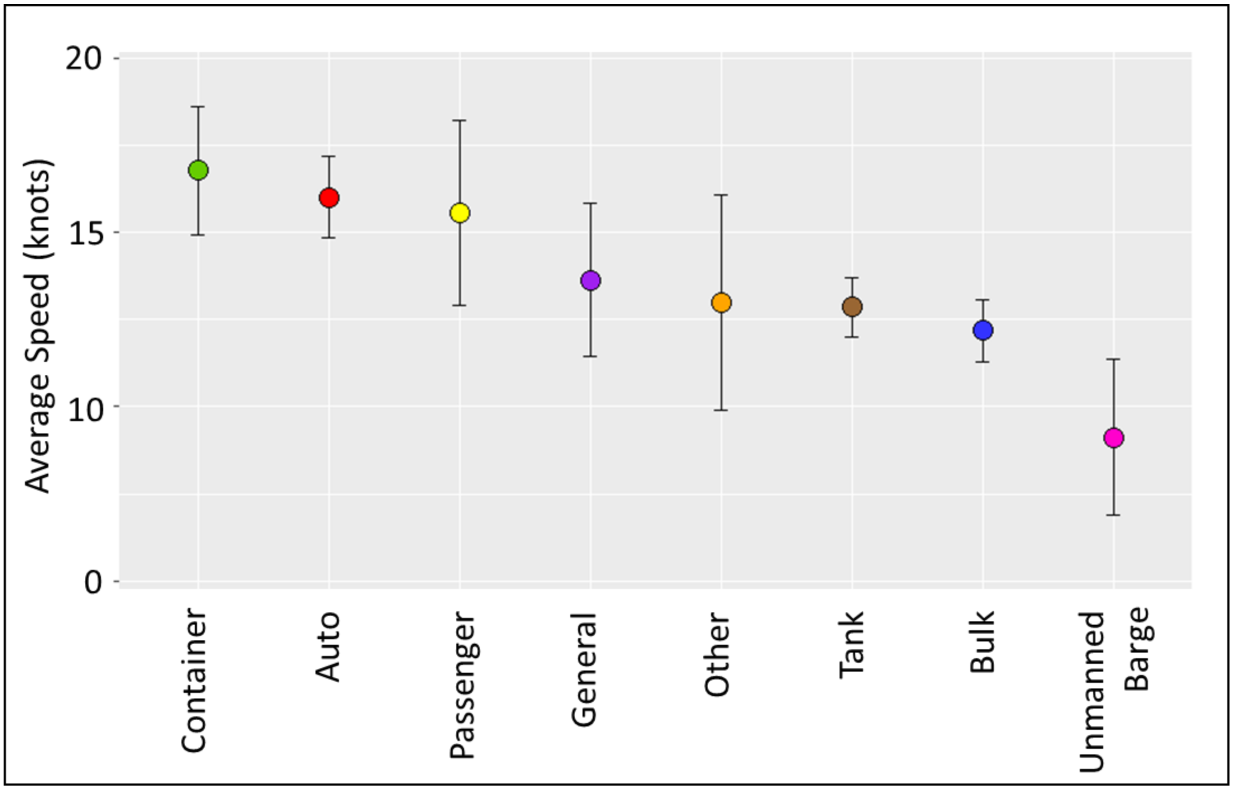

Figure 6-7. Average reported vessel speed by vessel type from HHRFs and AVRFs submitted during 2016 and 2017. Error bars represent standard deviation.

6.3 Ballast Water Discharge Patterns

Data Synopsis

- An average of 11.1 million metric tons of BW is discharged in California per year
- 85% of the vessels arriving at California ports do not discharge ballast water
- Bulk and tank vessels discharge more ballast water than all other vessel types combined
- 98% of the ballast water discharged in state waters is compliant with the MISA and associated regulations
- The volume of treated ballast water discharged during 2017 was more than double the volume from 2016, and the volume of treated water discharged during the first half of 2018 is already greater than all of 2017
- Most of the noncompliant ballast water was discharged by bulk and tank vessels and most noncompliant bulk and tank vessel discharges were exchanged in the wrong location
- 45% of all noncompliant ballast water discharged in California was sourced in Mexico and was not exchanged at the required distance from land
    - This noncompliance is likely due to the presence of small islands off of Baja California that are not considered by vessel crews when calculating distance from "land."

Analyzing ballast water discharge patterns enables the Commission to assess the risk of NIS introductions to California and help frame future policy and management recommendations.

6.3.1 Total Volume of Ballast Water Discharged

The volume of BW discharged in California has varied between 9.6 and 12.6 million metric tons (MMT) per year since 2011. On average, 11.1 ± 1.1 (standard deviation) MMT of ballast water is discharged in California waters every year beginning in 2011 (Figure 6-8). During this two-year reporting period, 21.6 MMT of ballast water was discharged in California waters.

6.3.2 Ballast Water Discharge by Vessel Type

Factors like vessel type, cargo operations, and local environmental conditions influence whether a vessel needs to discharge ballast water. Vessels that do not discharge BW pose no risk of NIS introductions through ballast water. Therefore, retaining ballast water is the most effective management strategy to reduce the risk of BW-mediated NIS introductions. Approximately 85.4% of vessel arrivals at California ports during the two-year reporting period did not discharge BW. The remaining 14.6% of arrivals discharged ballast water and represent some level of risk of BW-mediated NIS introductions.

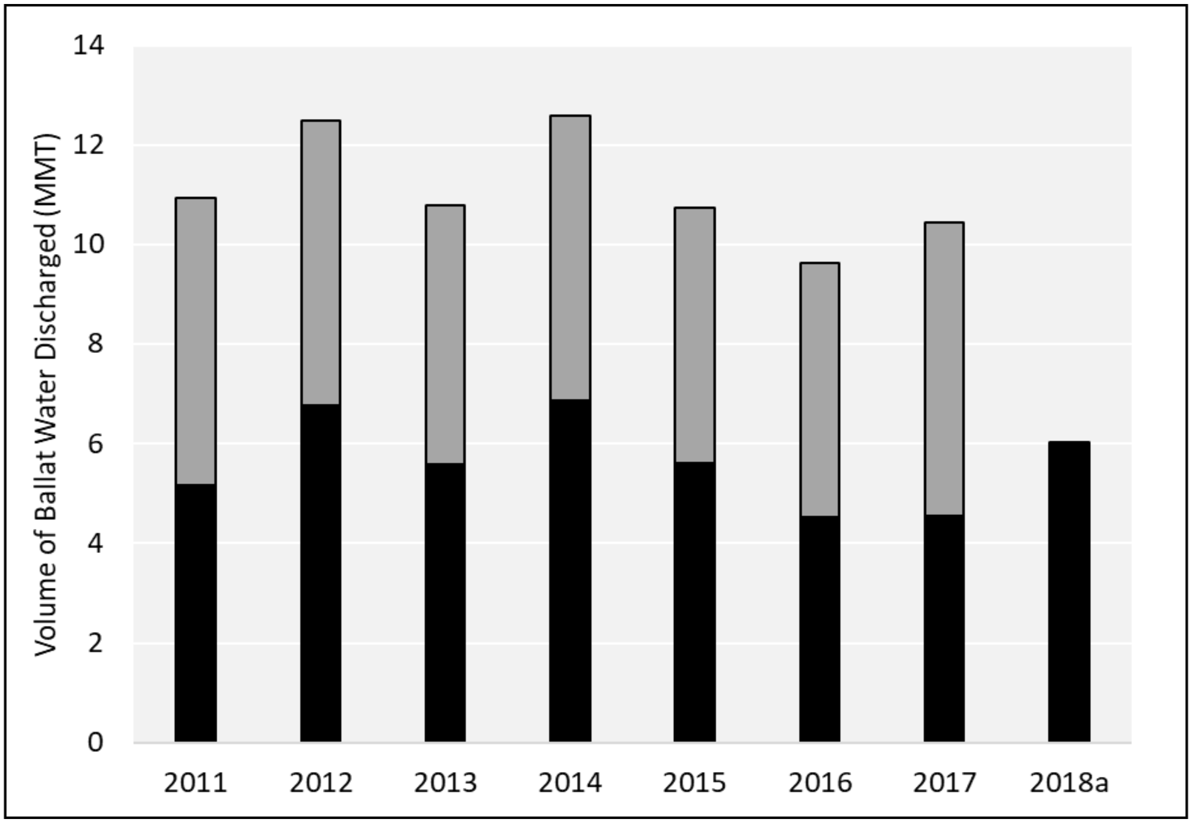

Figure 6-8. Annual volume (million metric tons; MMT) of ballast water discharged in California waters. Black bars represent January through June of each year; gray bars represent July through December of each year.

The ratio of discharging to non-discharging vessels has been consistent for at least 10 years (see Figure 10 in Brown et al. 2017) and is likely driven by consistency in the types of vessels visiting California ports and their cargo operations.

The highest risk vessel arrivals are those that frequently discharge BW and discharge large BW volumes. During this reporting period (2016b-2018a), bulk (10.6 MMT) and tank (7.6 MMT) vessels discharged more ballast water than all the other types of vessels combined (3.3 MMT) (Figure 6-9). Bulk and tank vessels typically have the greatest BW capacity of all vessel types, and their cargo operations often require all-or-nothing BW discharges (i.e., partial discharges are rare).

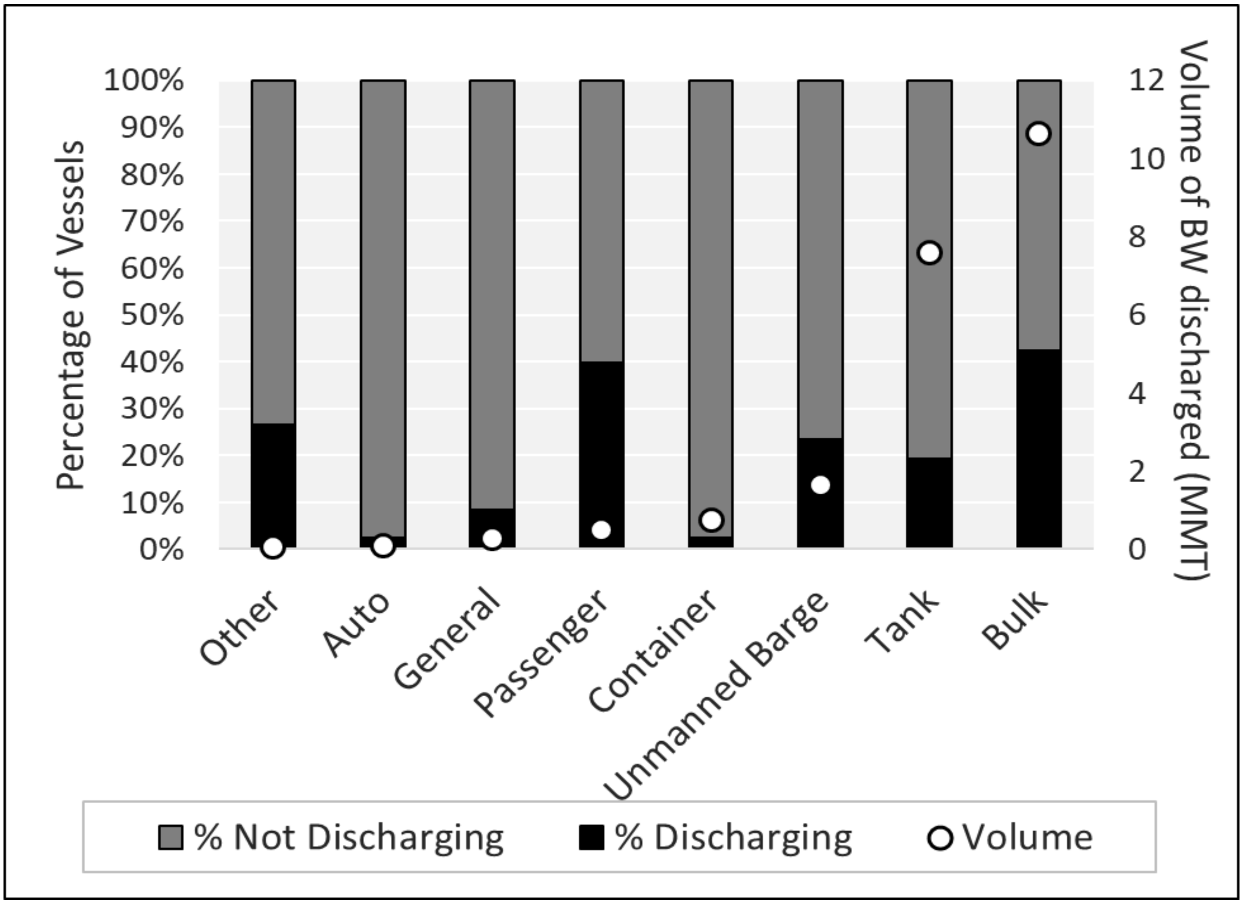

Figure 6-9. Ballast water discharge patterns by vessel type (percentage of arrivals and total volume of BW discharged) from July 2016 to June 2018.

6.3.3 Ballast Water Management and Compliance

Approximately 98% of discharging vessels were compliant with the MISA and associated regulations by using a compliant ballast water management practice to reduce the risk of species introductions (Figure 6-10). Noncompliant discharges occur after ballast water is either exchanged in the wrong location (determined by the source of the ballast water and the LPOC) or not managed at all.

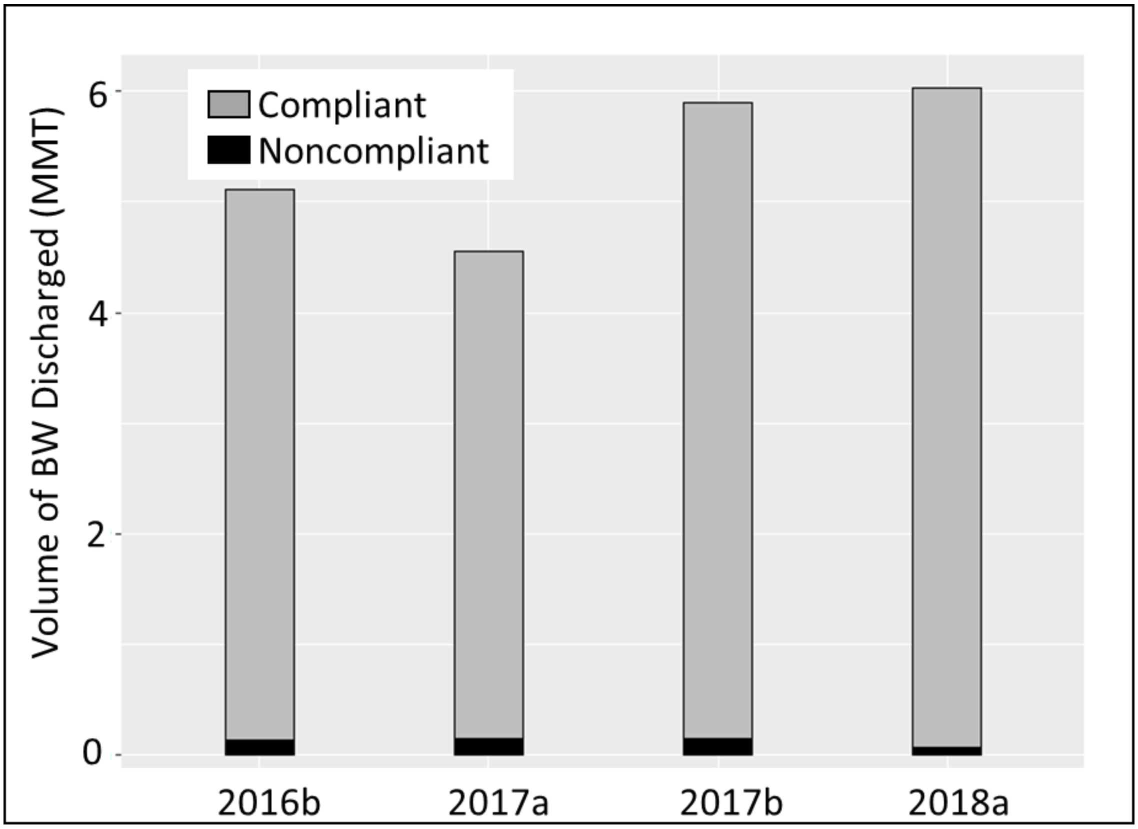

Figure 6-10. Compliance of reported ballast water discharges from July 2016 to June 2018.

Ballast water source is an important consideration when assessing the risk of noncompliant water discharged in California. Most of the noncompliant water discharged during the reporting period was sourced from North American ports (most commonly from Mexico and the U.S. Pacific coast) (Figure 6-11). This is likely due to confusion about the definition of “land” when determining the required ballast water exchange distance from land. Vessel crews may not realize that islands, especially small islands off the Pacific coast of Mexico (Figure 4-2), are considered land, and therefore, conduct exchanges that are not at the required distances.

The similarity of environmental parameters (e.g., salinity and temperature) between source and discharge locations, also known as “environmental match,” is a major driver for a successful NIS introduction and subsequent establishment. Consequently, environmental match is one of the most influential factors considered when assessing NIS introduction risk. Ballast water that is not managed prior to discharge represents the greatest potential NIS introduction risk because the organisms taken up at the source are directly discharged in the recipient port. This risk is even greater if the source and discharge ports have a strong environmental match.

During the reporting period, unexchanged ballast water was sourced primarily from coastal waters (i.e., sourced offshore, but not at an appropriate distance from land ("not a port" in Figure 6-11). Therefore, although the largest share of unexchanged ballast water that was discharged in California ports was noncompliant, the NIS introduction risk is likely less than if the water was sourced from a port.

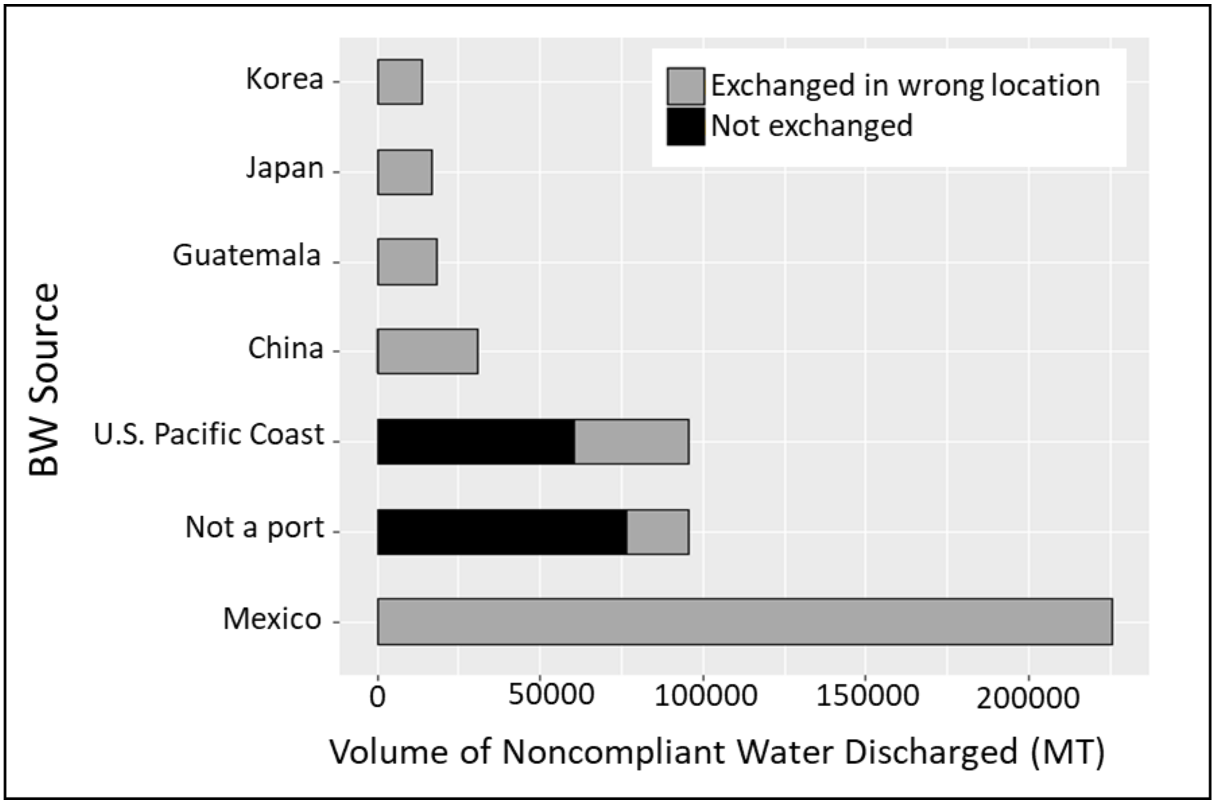

Figure 6-11. Source of noncompliant BW discharged in California waters between July 1, 2016 and June 30, 2018. "Not a port" represents discharges where the source was primarily from coastal waters but not at an appropriate distance from land. Sources of noncompliant ballast water with less than 10,000 metric tons (MT) discharged in California waters have been removed for visual purposes (American Samoa, Tahiti, New Zealand, Canada, Chile, El Salvador, and Panama). All data presented in Appendix C.

6.3.4 Ballast Water Treatment Technology Use in California

Vessel owners and operators are installing shipboard ballast water management systems (BWMS) in anticipation of the IMO, U.S. federal government, and state implementation of ballast water discharge performance standards.

The Commission gathers information on the installation and use of BWMS in California through:

- The BWTTAF, before October 2017 (see Appendix B)
- The AVRF, beginning October 2017 (see Appendix B)
- The BWMR (see Appendix B)
- Vessel inspections.
- U.S. EPA Vessel General Permit annual reporting

The Commission allows treated ballast water to be discharged in California waters under certain scenarios (see section 4.1.2 Ballast Water Management Requirements for more information). The treated ballast water presented in this section is therefore compliant with the MISA.

A total of 122 unique vessels reported using a BWMS to treat ballast water prior to discharge in California waters during the reporting period. Those 122 vessels discharged 273 times for a total volume of 2.0 MMT of treated ballast water (9.3% of the total volume discharged in California).

The number of vessels using a BWMS and the volume of treated ballast discharged are increasing from year to year (Figure 6-12). The volume of treated ballast water discharged during 2017 was more than double the volume from 2016, and the volume of treated water discharged during the first half of 2018 is already greater than all of 2017.

The volumes of treated ballast water discharged in California by bulk and tank vessels have increased 10-fold and 3-fold, respectively, during the last two years (Figure 6-12). Tank and bulk vessels were responsible for the largest volume of treated ballast water discharged during the two-year reporting period (Figure 6-13) because these two vessel types discharged treated water often and released large volumes per discharge, approximately 12,637 metric tons (MT) per bulk vessel discharge and 8,863 MT per tank vessel discharge. Passenger vessels also discharged treated ballast water often (77 times), but only averaged 604 MT per discharge (approximately 15-20 times less by volume per discharge than bulk and tank vessels) (Figure 6-13).

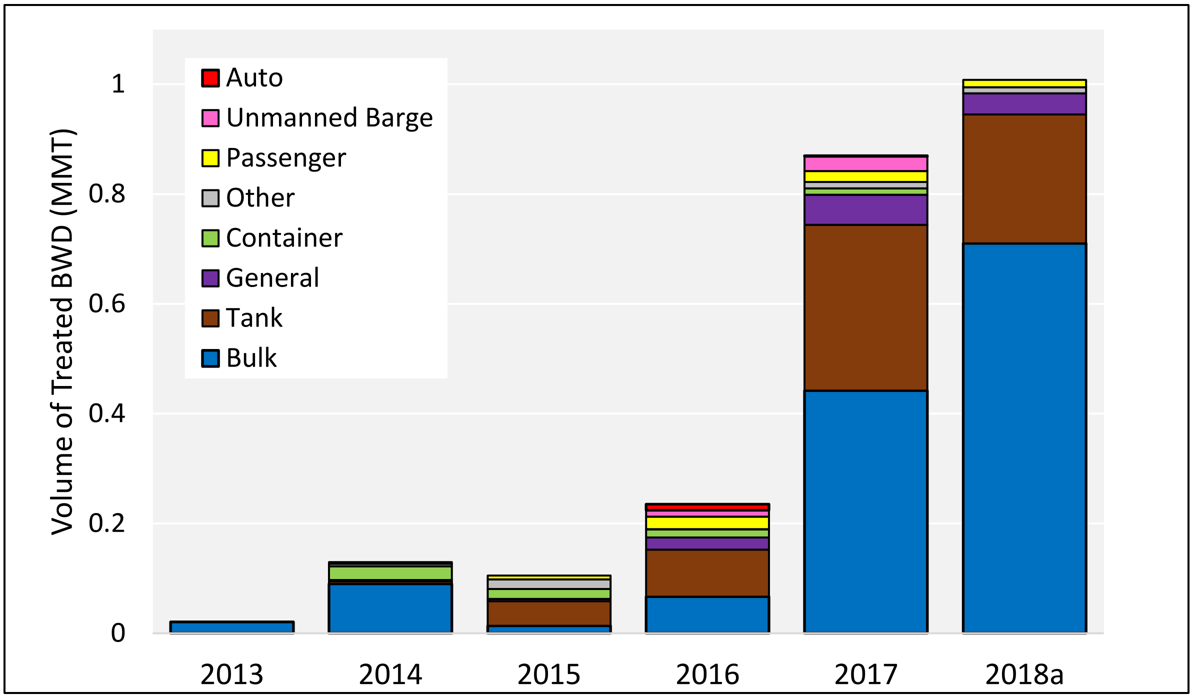

Figure 6-12. Volume of ballast water treated by a BWMS and discharged in California waters by vessel type. Note that 2018a represents January – June 2018. These data do not imply that similar numbers will be reported during 2018b (July – December 2018).

There are a variety of ballast water treatment methods used to kill organisms or render them not viable (e.g., UV, oxidation, chemical, electrochlorination). Almost all the available BWMS incorporate a multi-step process that includes mechanical filtration to remove large organisms prior to treatment by one of the aforementioned methods. During the reporting period, passenger vessels and unmanned barges exclusively used UV BWMS, while container and auto carriers used UV in 50-60% of the discharges. Electrochlorination was the primary treatment method used by tank (90% of the treated volume) and bulk (50%) vessels (Figure 6-14).

For further information regarding available types of BWMS and their methods of treatment, see the Commission's reports on the "Assessment of the Efficacy, Availability, and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters" (Commission 2013, 2014, 2018).

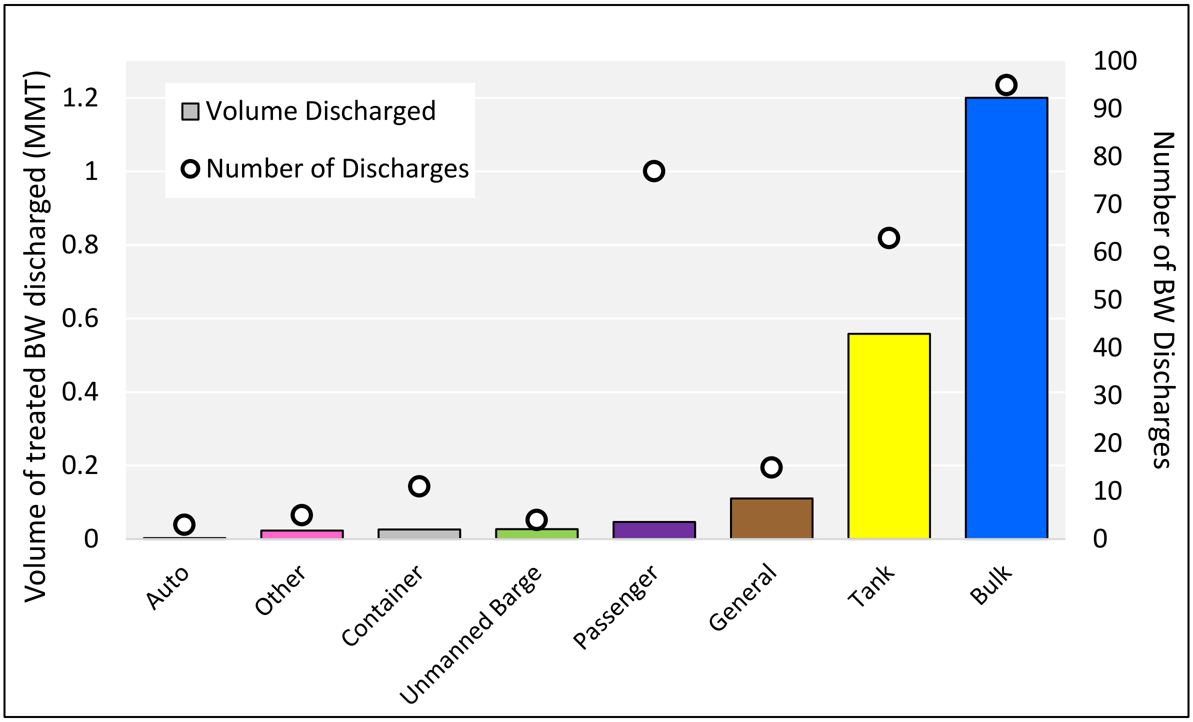

Figure 6-13. Volume of treated ballast water discharged and the corresponding number of discharges by vessel type during the reporting period (2016b-2018a). Bars represent volume of treated BW discharged, points are the number of discharging events.

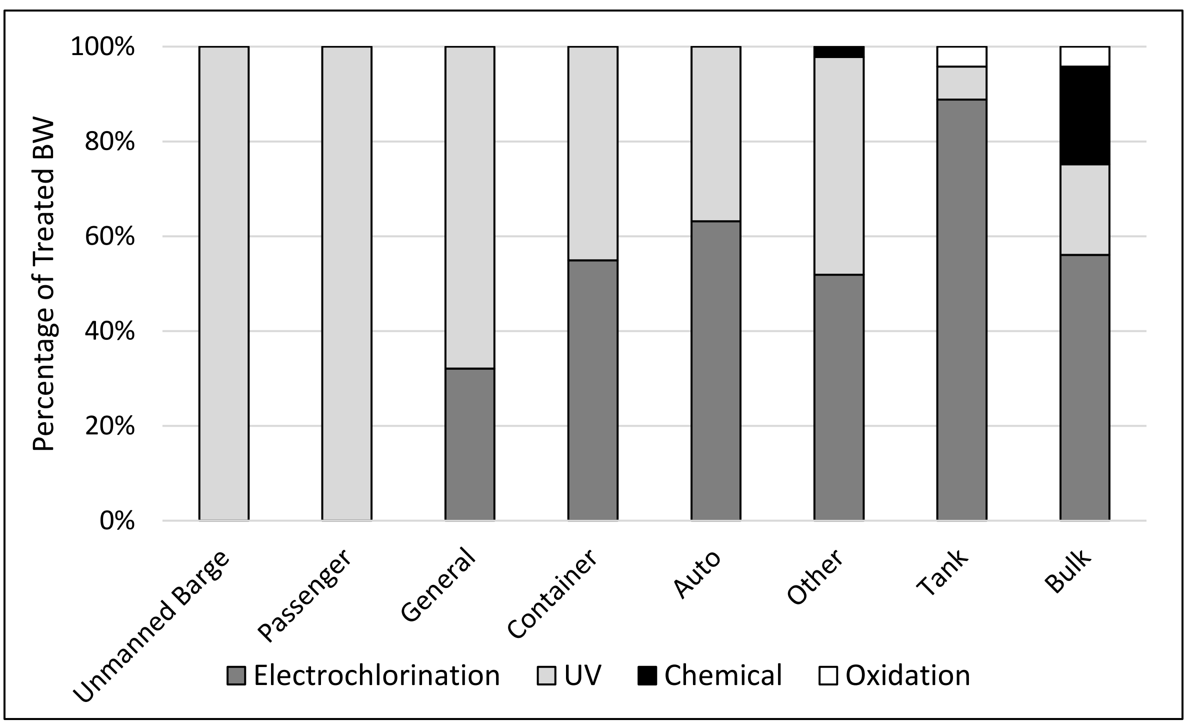

Figure 6-14. Percentage of treated ballast water discharged in California during the reporting period (2016a-2018b) by method of treatment.

6.3.5 Compliance Assessment and Enforcement

Vessel Inspections

Under Public Resources Code section 71206, the Commission must assess compliance of vessels subject to the MISA and associated regulations through vessel inspections. Vessel inspections are carried out by Field Operations staff within the Commission's Marine Environmental Protection Division field offices in northern and southern California. For a description of the inspection process and procedures see Dobroski et al. (2015).

During the two-year reporting period, Field Operations staff inspected 4,556 vessel arrivals, accounting for 22% of total California port arrivals. However, not all California arrivals are inspectable because of the danger associated with transferring Field Operations staff from a mobile boat to an anchored vessel away from a terminal.

After removing vessel arrivals that are not practically inspectable due to safety concerns and resource limitations, Field Operations staff inspected 26% of all accessible arrivals, above the 25% threshold mandated by the MISA.

An assessment of outreach opportunity and the potential risk of NIS introduction determines each vessel's priority for inspection. Based on this risk assessment and prioritization protocol (where vessels are categorized as High, Medium, Low, or no priority), 13.5% of the vessel arrivals at California ports between November 2017 and June 2018 (the period when the new priority ranking system was initiated), were categorized as "High Priority." Field Operations staff inspected 64.1% of all High Priority arrivals, and 78.8% of accessible High Priority arrivals. Addressing personnel shortages within Field Operations will likely result in a greater percentage of High Priority arrivals being inspected. However, accessing vessels at anchorage and at Avalon, Catalina will continue to be a challenge due to safety concerns and resource availability.

Violations of MISA and Enforcement

Vessels that are not compliant with the MISA requirements will be issued a Notice of Violation and are subject to enforcement action. During this reporting period, only 0.5% of vessel arrivals (96 total arrivals) violated the MISA or associated regulations. The number of violations is comparable with previous reporting periods (~50 violations/year) (Figure 6-15).

There are two types of violations of the MISA: Administrative and Operational. Administrative violations involve documentation submission and onboard recordkeeping. These violations are usually identified during vessel inspections when the Field Operations staff review the vessel's documentation. Operational violations (i.e., BW exchange in the wrong location), are determined by analyzing the vessel-submitted ballast water management information either during inspections or using GIS mapping software (see section 4.3 Marine Invasive Species Act Compliance and Enforcement for more information).

Tank and bulk vessels had the greatest number of violations, both operational and administrative, during the reporting period (Figure 6-15).

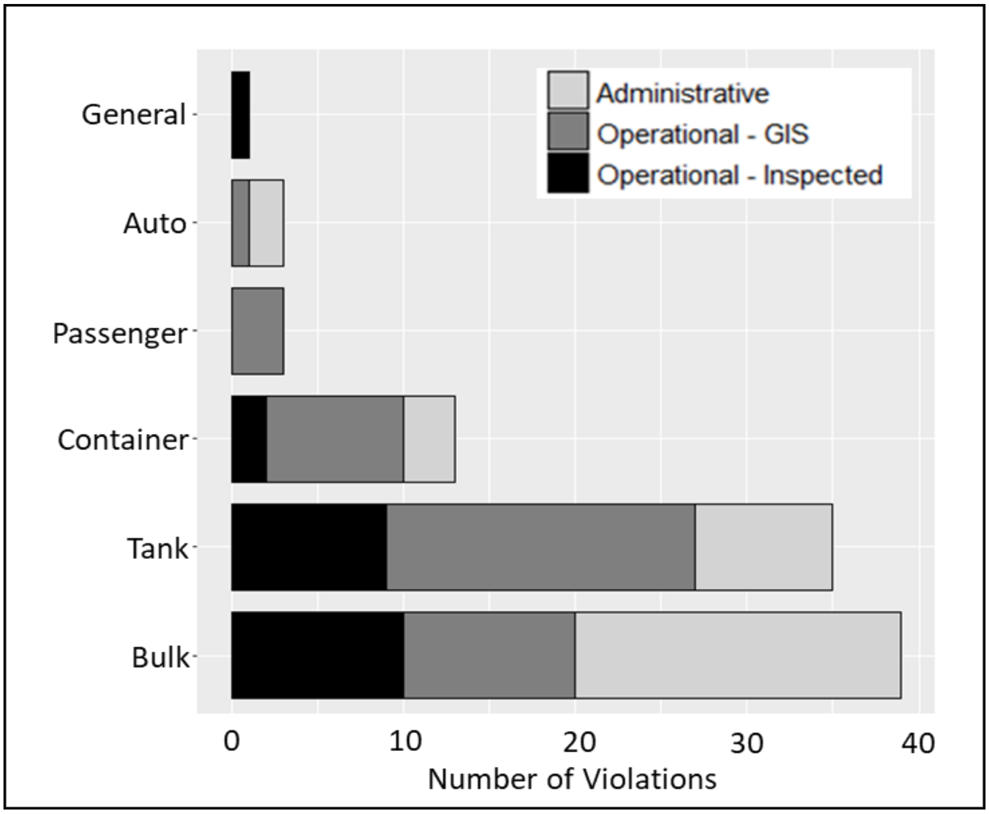

Figure 6-15. Number of violations per vessel type between July 1, 2016 and June 30, 2018. Operational-GIS and Operational-Inspected refer to the method by which the violation was detected.

Since the implementation of MISA Enforcement Regulations (see 2 CCR section 2299.01 et seq.) on July 1, 2017, the Commission has initiated 12 enforcement actions against violators of the MISA and 5 have been settled.

6.4 Comparative Risk Assessment: Ballast Water and Biofouling

Data Synopsis

- The Long Beach/Los Angeles port complex received more than 100 million square meters (Mm^2) of cumulative Wetted Surface Area (WSA), followed by the Port of Oakland with about 50 Mm^2 of WSA
- Passenger vessels have the highest percentage of niche WSA
- The Port of Oakland is more susceptible to biofouling-mediated NIS introductions than ballast water, while Carquinez and Richmond have a greater risk from ballast water discharges than biofouling

A major component of NIS introduction risk analysis is quantifying the number of organisms released during an introduction event (Lockwood et al. 2009). Measuring the number of organisms released during ballast water discharges would require time, personnel, and financial resources beyond those available to the Commission. Likewise, quantifying the number of biofouling organisms associated with a vessel is impractical for all vessels arriving at California ports.

Ballast water discharge volume has been used as a proxy for the potential number of organisms released (i.e., large discharge volumes are likely to release large quantities of organisms) (Verna et al. 2018). Similarly, the area of a vessel's wetted surfaces (i.e., the total area of the vessel that is susceptible to biofouling because it is temporarily or continuously submerged in water) can be used as a proxy for the area of a vessel that biofouling organisms can settle on and attach.

Some sections of a vessel's WSA are considered more prone to biofouling accumulation due to structural complexity or lack of effective biofouling management. These areas are called "niche areas" and represent greater risk of biofouling-mediated NIS introductions than the rest of the vessel's WSA because their biofouling communities are typically more abundant and diverse (Coutts et al. 2003). Using WSA equations reported by Miller et al. (2018) and Moser et al. (2017) for different vessel types, Commission staff analyzed hull WSA and niche area WSA for all the vessels that arrived at California ports during this reporting period.

Commission staff evaluated cumulative ballast water discharge volumes and cumulative WSA (hull WSA and niche WSA) by vessel type and by arrival port to assess the relative NIS introduction risk associated with both ballast water and biofouling (Figure 6-16 and 6-17).

When evaluating all vessels arriving at California ports, data from this two-year reporting period suggest different levels of ballast water and biofouling-mediated NIS introduction risks between vessel types. For example, the fleet of container vessels arriving at California ports during this two-year reporting period represent relatively low risk through ballast water discharges (i.e., cumulative discharge from container vessels is relatively low; Figure 6-16), but their cumulative WSA presents a potential high risk for biofouling-mediated NIS introductions. The fleet of tank vessels arriving at California ports discharge a relatively high volume of ballast water and account for a relatively large amount of WSA, representing both ballast water and biofouling-mediated NIS introduction risk (Figure 6-16).

These ballast water discharge (BWD) and WSA data can also be used to assess NIS introduction risk at specific ports. For example, the Port of Oakland is potentially more susceptible to biofouling introductions because container vessels (low ballast discharge, high WSA) are the primary vessel type arriving at the Port of Oakland. Conversely, Carquinez and Richmond have a greater risk of NIS introductions from ballast water discharges (Figure 6-17).

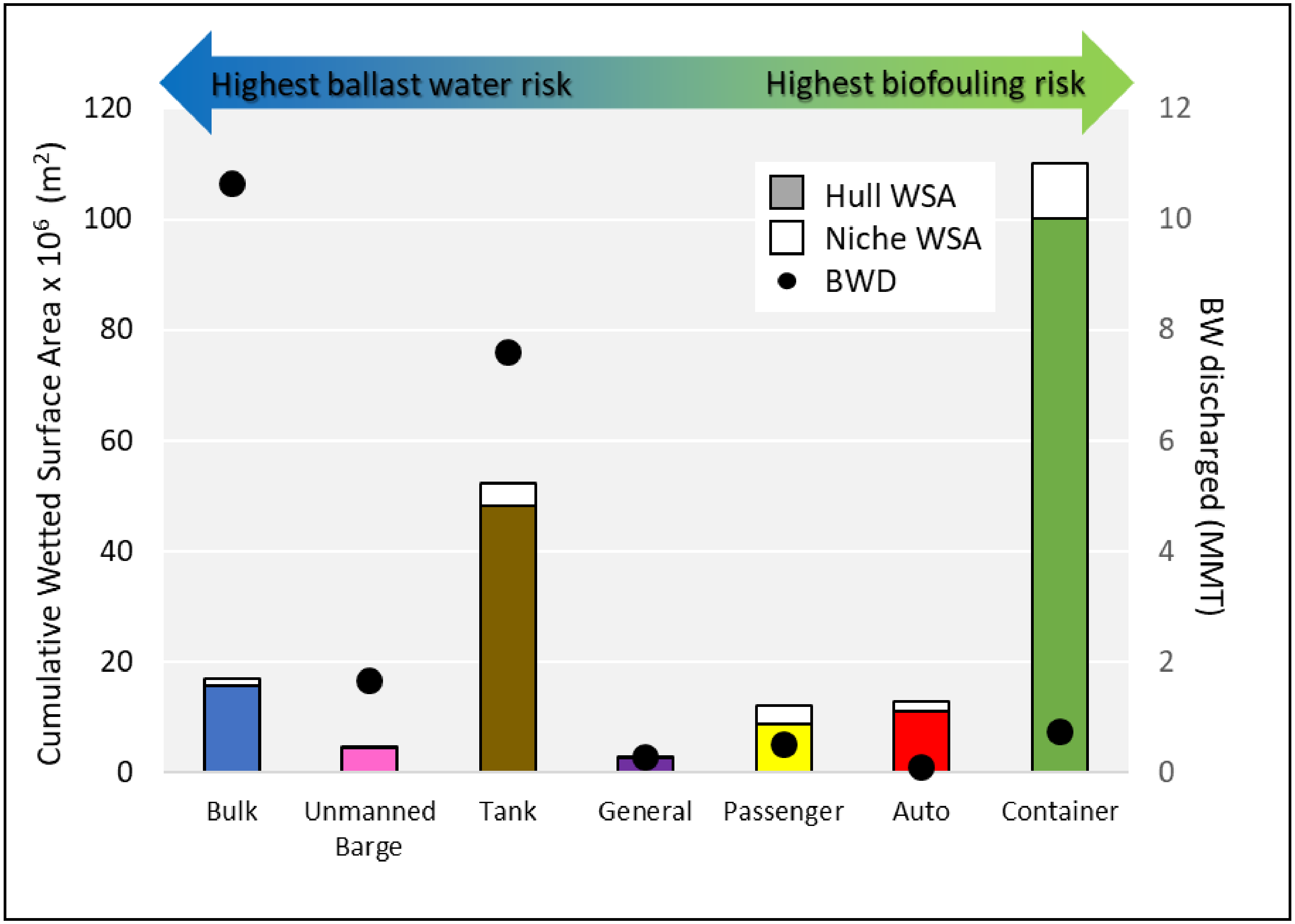

Figure 6-16. Cumulative wetted surface area (Hull WSA: shaded bars, Niche WSA: white bars) and ballast water discharge (BWD: black points) of vessel arrivals at California ports between July 1, 2016 and June 30, 2018, displayed by vessel type. Placement along the spectrum of ballast water risk to biofouling risk was determined by the ratio of total WSA (hull +niche) to total BWD (see Table C-4 in Appendix C for details).

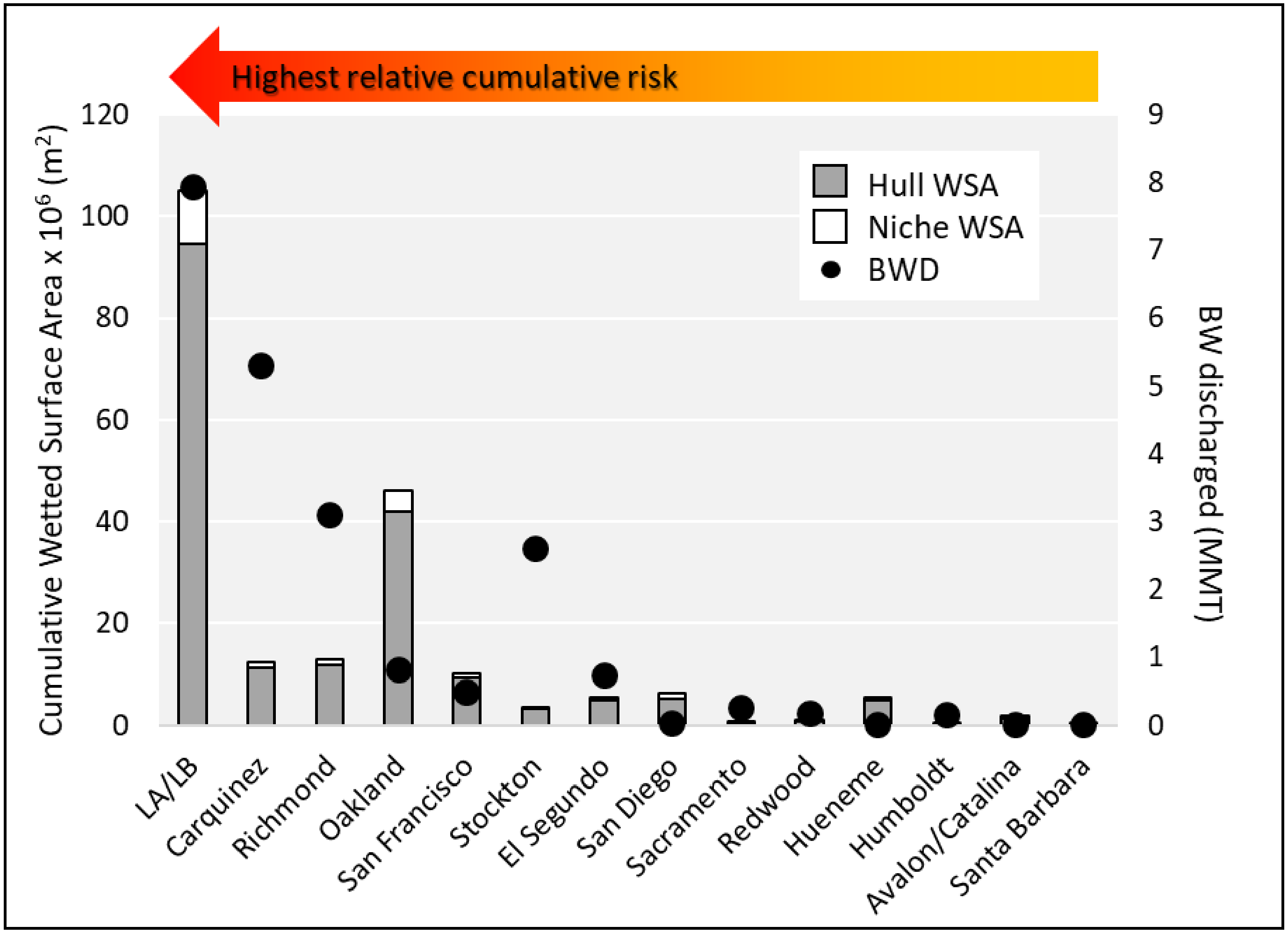

Figure 6-17. Cumulative wetted surface area (Hull WSA: shaded bars, Niche WSA: white bars) and ballast water discharge (BWD: black points) of vessel arrivals at California ports between July 1, 2016 and June 30, 2018, displayed by arrival port. Placement along the relative cumulative risk spectrum was determined by rank assignment (see Table C-5 in Appendix C for details).

7. MARINE INVASIVE SPECIES PROGRAM PARTNER AGENCY UPDATES

7.1 California Department of Tax and Fee Administration

The California Department of Tax and Fee Administration (CDTFA; formerly known as the Board of Equalization) collects a fee from the owner or operator of each vessel that arrives at a California port from a port outside of California (Table 7-1, Public Resources Code section 71215). On April 1, 2017, the fee was raised from $850 to $1,000 per qualifying voyage. All fees are deposited into the Marine Invasive Species Control Fund. Vessels moving from one port in California to another are not assessed a fee for the additional arrivals within the State. Once a vessel leaves state waters, it will be assessed the fee upon the next arrival at a California port. The Marine Invasive Species Control Fund supports all Marine Invasive Species Program operations and personnel. The MISP receives no General Fund dollars.

Table 7-1. Annual Summary of Collected Marine Invasive Species Program Fees

Year	Voyages Billed	Voyages Reported [a]	Total Voyages	Fees Billed ($)	Fees Reported ($)	Total Fees ($)	Payments Recd. for Period [b] ($)
2000	5,870		5,870	2,735,134		2,735,134	2,724,072
2001	5,263	510	5,773	2,105,200	204,000	2,309,200	2,307,593
2002	4,599	921	5,520	1,376,600	277,200	1,653,800	1,645,350
2003	4,668	1,013	5,681	933,600	202,600	1,136,200	1,134,962
2004	5,858	1,123	6,981	2,788,000	535,100	3,323,100	3,296,523
2005	6,161	1,157	7,318	2,873,800	535,200	3,409,000	3,374,372
2006	6,247	1,161	7,408	2,498,800	464,400	2,963,200	2,956,348
2007	5,997	1,199	7,196	2,398,800	479,600	2,878,400	2,863,459
2008	5,578	1,133	6,711	2,753,750	557,825	3,311,575	3,273,822
2009	5,023	866	5,889	3,324,325	574,100	3,898,425	3,856,119
2010	5,067	899	5,966	4,306,950	764,150	5,017,100	5,009,473
2011	5,174	930	6,104	4,397,900	790,500	5,188,400	5,143,239
2012	4,479	767	5,246	3,807,150	651,950	4,459,100	4,356,722
2013	4,753	819	5,572	4,070,050	696,150	4,766,200	4,662,171
2014	4,864	768	5,632	4,134,400	652,800	4,787,200	4,697,234
2015	4,764	753	5,517	4,049,400	633,250	4,682,650	4,517,499
2016	4,817	859	5,676	4,085,950	730,150	4,816,100	4,706,981
2017	5,047	813	5,860	4,865,200	781,950	5,647,150	5,516,217
2018 [c]	3,756	486	4,242	3,756,000	486,000	4,242,000	4,103,570
TOTAL	**97,130**	**16,163**	**113,293**	**60,341,809**	**9,993,925**	**70,335,734**	**68,992,344**

[a] "Voyages Reported" are vessel operators/owners that self-report to CDTFA once a month
[b] Actual amounts received may exceed amount billed because of penalties and interest charges
[c] Amounts may be understated until return processing is complete, data provided through September 2018.

The CDTFA receives daily reports from the Marine Exchanges of Southern California and the San Francisco Bay Region. The reports provide a list of all arrivals at California ports. These reports are reviewed by CDFTA to identify arrivals that are subject to the fee. Vessel accounts are billed based on the arrival information.

Between July 1, 2016, and June 30, 2018, an average of 477 vessel arrivals were billed per month. The average collection rate was 96.3% (Table 7-1).

7.2 California Department of Fish and Wildlife

7.2.1 Species Monitoring

The California Department of Fish and Wildlife Office of Spill Prevention and Response (CDFW-OSPR) began conducting field-based surveys in 2000 to assess the distribution and diversity of NIS in the State's marine and estuarine waters under mandate by the Ballast Water Management for Control of Nonindigenous Species Act of 1999. The goals of the long-term monitoring program are to:

- Measure the status and trends of biological invasions in California's coastal marine ecosystems
- Understand the distribution and patterns of spread of NIS among waterbodies and habitats
- Assess the vectors of NIS introduction and spread
- Detect changes in the patterns (rate, spread, prevalence) of nonindigenous marine and estuarine species in response to management strategies and shifts in vector dynamics.

The CDFW-OSPR revised their comprehensive monitoring plan in 2012 to focus on NIS diversity and dynamics between five estuaries that support commercial shipping (i.e., "Ports" in Figure 7-1) and five that do not (i.e., "Non-Ports" in Figure 7-1). Each focal estuary is sampled once over an approximately four-year period and additional continuous sampling is conducted in two sentinel sites: San Francisco Bay and (beginning in 2017) Los Angeles/Long Beach Harbor. A complete report of all monitoring completed between 2012 and 2014 is available online: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=91995&inline.

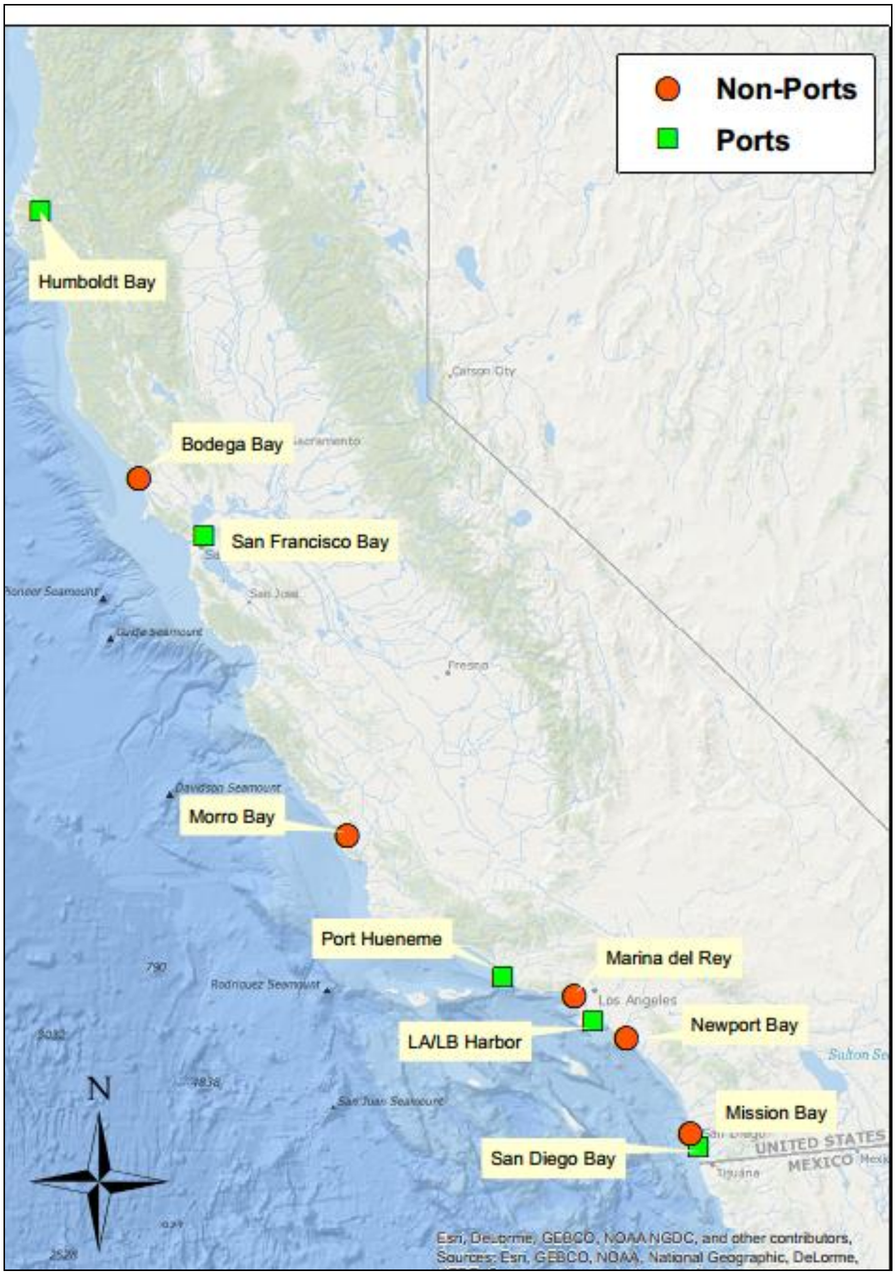

Figure 7-1. Focal estuaries for NIS monitoring, 2012-2018. “Ports” indicates locations where commercial shipping activities occur, “Non-Ports” indicate locations without commercial shipping activities.

<u>Analyses of Field Collections, 2014-2016</u>

Sampled organisms are identified through both traditional morphological (i.e., based on visible physical characteristics) and DNA-assisted identification protocols to analyze species composition for each habitat and bay. DNA-based genetic analyses are compared to results from morphological analyses to confirm species identification and detect species of unknown origin. The effectiveness of an integrated morphology-based and genetic identification system for NIS was established during a two-year pilot study in 2011 (CDFW 2014).

Sample collection and morphological taxonomy was conducted by the Smithsonian Environmental Research Center (SERC). SERC sampled hard-substrate invertebrate communities, soft sediment communities, and plankton communities in multiple estuaries between 2014 and 2016 (Table 7-2 and Figure 7-1).

Table 7-2. Habitats sampled per bay, 2014-2016.

BAYS & ESTUARIES	Hard Substrate			Plankton			Soft-Sediment		
YEAR	14	15	16	14	15	16	14	15	16
Humboldt Bay		x			x			x	
Port Hueneme		x			x				
Marina del Rey Harbor		x			x				
San Francisco Bay	x	x	x	x	x	x	x	x	x

A total of 11 new NIS were detected across all sampled bays between 2014 and 2016. Eight new NIS were detected in San Francisco Bay, including three solitary ascidians (sea squirts): *Microcosmus squamiger, Styela canopus,* and *Perophora japonica.* These occurrences represent coastwise spread from other parts of the state. Five polychaetes were also detected for the first time in San Francisco Bay. These marine worms could be either recent arrivals or previously overlooked because polychaetes have received little attention relative to other taxonomic groups. Humboldt Bay had three new NIS detected, including two Asian gastropods (snails) (*Philine auriformis* and *P. orientalis*) and one bryozoan (*Cradoscrupocellaria bertholletii*). The gastropods were previously known from the U.S. Pacific coast, and it is likely that neither record represents a significant range expansion along the coast.

During the current phase of the monitoring plan (2017-2019), SERC will sample the sentinel sites in San Francisco Bay and Los Angeles/Long Beach annually. All the other focal estuary sites throughout the state will be reassessed once more to develop a time-series of repeated measures.

Outer coast sites that were surveyed over a decade ago (see Maloney et al. 2008) will also be re-surveyed to test whether “spillover” from nearby bays or estuaries are a source of NIS introductions on the open coast. Annual “BioBlitz” surveys (i.e., intense biological surveying over a short time period to record all species within a designated area) will be conducted in San Francisco Bay to collect rare or underrepresented NIS reference specimens to continue the development of a DNA barcode reference library (i.e., a comprehensive library of DNA sequences that correspond to individual species).

Genetic Analyses and NIS Detection

CDFW-OSPR staff continued to support projects to advance the implementation of genetic tools to streamline NIS detection in future monitoring surveys. Three genetic contracts were in progress during this reporting period. All genetic work was performed by the Molecular Ecology Laboratory at Moss Landing Marine Laboratories (MLML) under the direction of Dr. Jonathan Geller.

The first contract (concluded in June 2017) continued the genetic analyses for three focal estuaries (Humboldt Bay, Port Hueneme, and Marina del Rey Harbor) and annual sampling in San Francisco Bay. The following tasks were included therein:

Sequence Detection: A total of 4,680 reference specimens received from SERC were assigned a genetic identification. Exact matches between the genetic and morphological species names occurred 82% of the time overall. Discordance between genetic and morphological names were most commonly attributed to:

- Morphological misidentification
- Presence of sequences of one or more non-target organisms associated with the reference organism (including bacteria)
- Contamination by external or non-target DNA during field sample processing or laboratory workflow
- Contamination by environmental DNA (eDNA), free-floating DNA molecules, present in surrounding seawater

In general, concordance levels tended to vary by taxonomic group. Genetic and morphological identifications tended to agree more frequently at the genus level, which may not provide adequate resolution for NIS detection because many genera include both native and introduced species. Moreover, many taxonomic groups (e.g., sponges, hydroids, nemerteans, platyhelminths, and many microorganisms) remain difficult to identify with confidence. Workflows have been changed to address some of these issues (e.g., contamination during sample handling). However, given current limitations of both morphological and genetic methods, both approaches should be continued to supply complementary data.

DNA Barcode Database: DNA of unique or underrepresented taxa were also analyzed via the Sanger (conventional) method to produce high-quality, longer-length sequences for the existing barcode reference database. To date, a total of 374 unique barcodes of distinct, known-origin species have been curated by MLML.

Plankton Community Analysis: Metagenetic (whole-community) analysis was conducted on approximately 150 randomly-selected plankton samples collected by SERC from three focal estuaries and San Francisco Bay. Bulk DNA was extracted, amplified, and labelled to identify each sample prior to metagenetic analysis. A computer program called Basic Local Alignment Search Tool (BLAST) was used to search both GenBank and MLML reference barcode databases, which assigned 666 species names to the samples. Seventy-one NIS (69 invertebrate and two algal species) were detected from plankton samples. Many of the NIS were found in only a few bays and occurred in relatively low numbers. In addition, sequences of 21 potential new NIS were detected, including seven cosmopolitan species. However, some of the latter results may be false-positives because results are reported as operational taxonomic units (OTUs), and OTUs are merely rough approximations of biological species. Significant differences in NIS species composition and abundance were observed among plankton samples. Temperature and salinity were strong influences on community composition.

Two other three-year genetic contracts commenced during Fiscal Year 2017/2018. A relatively small contract was executed to complete DNA analyses (same components as above) for the remaining two focal estuaries (Newport Bay and the Los Angeles/Long Beach Harbor). This contract also included two side projects:

Environmental DNA Evaluation: Free DNA molecules (environmental DNA or eDNA) exist naturally suspended in water samples, having been released as truly naked DNA, or from sloughed cells, waste products, and fragmented organisms. Metagenetic eDNA analysis may be an easier, more efficient, and economical means of detecting NIS in aquatic habitats than more traditional DNA analysis methods (Ficetola et al. 2008, Goldberg et al. 2015). The use of waterborne eDNA in lieu of bulk samples (e.g., square PVC panels used to allow organisms to colonize, also known as settlement plates) reduces the costs and effort of DNA extractions, as well as the risk of cross-sample contamination. MLML will conduct a pilot project to test whether NIS associated with fouling communities may be detected from waterborne eDNA as effectively as from bulk DNA. A total of 70 randomly-selected eDNA samples will be analyzed, including:

- Ambient seawater adjacent to where settlement plates are deployed

- Water in which retrieved settlement plates were stored prior to morphological analysis (1-, 4-, and 24-hour soak times)

Metagenetic Analyses: Approximately 116 settlement plates and 114 plankton samples remained unprocessed after randomly-selected quotas were met for morphological analyses under previous focal estuary survey phases. These and an additional 20 settlement plates and 20 plankton tows (from Newport Bay and the Los Angeles/Long Beach Harbor) will be analyzed to provide additional species richness data. Thus far, DNA extractions, amplification, and other pre-sequencing preparations have been completed for these samples. Sequencing and bioinformatic analyses will be completed by late May 2019.

An additional three-year contract with MLML was executed in July 2018 to provide sequence detection, DNA barcode library augmentation, and plankton community analyses for an additional round of sampling in the focal estuaries. This contract also includes provisions for sequence detection and barcode library augmentation from targeted reference specimen collections from two side projects (outer coast surveys and annual BioBlitz excursions).

7.2.2 Results from Recently Published Literature Based on Ongoing CDFW-OSPR-Funded Monitoring

<u>Settlement plates as monitoring devices for NIS</u>

By examining sessile invertebrates on both marina structures and settlement plates from three marinas in San Francisco Bay, SERC analyzed whether settlement plates accurately represent the established nonindigenous fouling community of a marina. There was great similarity between organisms on plates and existing marina floating docks indicating that settlement plates can provide a sensitive and standardized measure of NIS richness (i.e., number of species present) and composition in fouling communities (Marraffini et al. 2017).

<u>Contribution of NIS to the soft-sediment community of San Francisco Bay</u>

NIS numerically dominate San Francisco Bay soft-sediment communities (e.g., mudflats, sand flats), accounting for 76% of all organisms detected during sampling that occurred during the summer of 2012. NIS average abundance was three-and-a-half times higher than for native species. Overall, NIS contributed to 36% of observed taxa and 24-29% of total estimated regional diversity. The percent contribution of NIS to species richness was at least twice as high when compared to data reported two decades ago (Jimenez and Ruiz 2016).

San Francisco Bay comparison of hard-bottom and soft-bottom habitats

NIS made up an average of 79% of total species richness (i.e., the number of species present) per sample from hard-bottom communities (e.g., rocky intertidal shores or rocky subtidal reefs) in San Francisco Bay. NIS as a percentage of total species richness for soft bottom samples was much lower: 46% for high salinity (i.e., sites in central and southern San Francisco Bay) and 60% for low salinity (i.e., sites in San Pablo Bay and eastward) (Jimenez et al. 2017). A greater percent of samples contained NIS than native species for hard-bottom habitats in both high-salinity and low-salinity habitats, but this was not true for soft-bottom habitats. Average NIS richness was greatest in hard-bottom habitat at high salinity. NIS contributed substantially to the existing community structure across habitat types and salinities (Jimenez et al. 2017).

NIS colonization of outer-coast habitats

Outer-coast habitat was surveyed at 12 rocky intertidal and eight subtidal sites. At least one NIS was detected at half of the sites surveyed, although most NIS were not widespread or abundant. A bryozoan in the *Watersipora* spp. complex, however, was found at multiple sites, and was abundant at several. A nonindigenous seaweed, *Caulacanthus ustulatus*, was abundant at one site. For subtidal sites, proximity to a harbor was correlated with the abundance of NIS, providing evidence for a spillover effect from estuaries. Findings suggest that these parts of the outer coast are still relatively uninvaded, but the success of *Watersipora* within some of these highly diverse rocky habitats shows the potential vulnerability of the outer coast to invasions (Zabin et al. 2018).

Community assembly shifts in San Francisco Bay during dry and wet periods

Surveys show that invertebrate communities from hard substrates in the San Francisco Estuary are dominated by NIS and indicate that these communities are extremely sensitive to interannual climatic fluctuations. Large shifts in community composition were seen in response to environmental extremes (Chang, et al. 2017). Nonindigenous solitary tunicates were especially dominant in dry years with stable, low volume freshwater flow. These changes illustrate how alterations to the water cycle can enhance the success of NIS in the downstream, high-salinity portion of the estuary (Chang et al. 2017). Greater interannual variability in species composition and more frequent and severe extremes in freshwater flow is predicted for the future.

Northward range expansion of three non-native tunicates

Three solitary ascidians (sea squirts) were detected in San Francisco Bay, representing probable coastwise spread from other parts of the state. They were previously known to be from California but have moved beyond their previously known introduced range, indicating possible range expansions northward. All three species spread north from the natural biogeographic barrier of Point Conception, implicating both human vectors and ocean warming. These records add to an increasing number of NIS expanding their range northwards on the Pacific coast of North America (Tracy et al. 2017).

7.2.3 CDFW-OSPR Conclusions

Monitoring surveys detected a high percentage (> 90%) of the total pool of NIS estimated to be present (based on historical cumulative species lists) in each bay per year. Repeated surveys for San Francisco Bay were conducted across multiple years with different environmental conditions and provided geographically extensive surveys. These data provide a measure of temporal change in NIS composition and a robust baseline to detect new invasions. Thus, it is notable that although there were 11 newly detected NIS within focal estuaries in the current study using morphological analyses, only one was completely new to California.

The relative lack of new records is surprising given the spatial and temporal scale of the sampling efforts and detailed morphological analyses. One explanation for the recent paucity of detections of new introductions is that a shift in invasion rates has occurred in recent years, compared to the rate reported in previous decades (Ruiz et al. 2011). Repeated sampling over time in each bay will help determine whether the slowing rate of new invasions is real, and if so, identify patterns of correlation between this change and ballast water and biofouling management requirements or other factors such as shipping patterns or environmental changes.

7.2.4 Future Direction

CDFW-OSPR will continue both morphological and genetic analysis of field samples, using paired samples to continue building a comprehensive NIS DNA barcode library, confirm morphological identifications, and advance metagenetic approaches to detect species. Morphological analyses provide novel information on NIS species abundance and effects on community structure which complement genetic data on species detection and occurrence.

7.2.5 California Database

The CDFW-OSPR database of California non-native marine organisms, Cal-NEMO (California Non-native Estuarine and Marine Organism) is a web-based portal. SERC maintains the database, which utilizes SERC's National Exotic Marine and Estuarine Species Information System (NEMESIS) framework. Data are available to the public, including individual species profiles enhanced by images, world invasion history (distribution and occurrences), ecology, impacts, and interactive maps for over 200 species introduced into the coastal waters of the State. The database continues to be updated as new species are discovered and new research becomes available, including data from the CDFW statewide survey program to monitor for newly arriving species. The Cal-NEMO database can be found at: http://invasions.si.edu/nemesis/calnemo/intro.html

8. COLLABORATIVE AND FUNDED RESEARCH

The Marine Invasive Species Program is mandated to "move the state expeditiously toward elimination of the discharge of nonindigenous species into the waters of the state" (Public Resources Code section 71201). The MISP implements this directive through funding, conducting, and collaborating on research that advances the development of strategies to prevent the introduction of NIS from ballast water and vessel biofouling. Specifically, Public Resources Code section 71213 requires the Commission to:

> *". . . identify and conduct any other research determined necessary to carry out the requirements of this division. The research may relate to the transport and release of nonindigenous species by vessels, the methods of sampling and monitoring of the nonindigenous species transported or released by vessels, the rate or risk of release or establishment of nonindigenous species in the waters of the state and resulting impacts, and the means by which to reduce or eliminate a release or establishment . . . "*

The Commission has funded research addressing several NIS-related issues to reduce or prevent the occurrence of NIS introductions into California waters. This section summarizes the Commission's research efforts between July 1, 2016, and June 30, 2018.

8.1 Ballast Water Research

The implementation of ballast water discharge performance standards at the state, federal, and international levels is rapidly approaching, underscoring the need to investigate the suitability of compliance assessment technologies and ballast water treatment methods. To address this need, the Commission has investigated new technologies and approaches to implementation and compliance assessment through funding, conducting, and collaborating on targeted research. The four projects described in this section, funded by the Commission over the past two years, are either in progress or were recently completed by:

- The Delta Stewardship Council
- Michigan State University and The Royal Netherlands Institute for Sea Research
- Washington State University
- Smithsonian Environmental Research Center

A brief discussion of each of these studies is presented below.

8.1.1 Shore-Based Ballast Water Treatment Feasibility Study

Per Public Resources Code section 71204.3, vessels may comply with California's pending ballast water performance standards by discharging ballast to a shore-based reception facility. However, there are currently no shore-based facilities in California or the United States that are designed to treat nonindigenous species in ballast water. Previous research on the feasibility of shore-based ballast water treatment has found encouraging potential for such facilities to manage ballast water. Unfortunately, these studies have been limited in scope, generally focusing on only one port or place, or covering only a coarse level of analysis.

In June 2013, the Commission provided funding for a feasibility study to investigate the use of shore-based treatment and reception facilities as an option for vessels to comply with the interim California Performance Standards (see section 4.1.4 California's Ballast Water Discharge Standards for more information on performance standards). The contract was managed by the Delta Stewardship Council who selected the Glosten Associates as the lead contractor.

A final report was presented to Commission staff in April 2018. The final report is available on the Delta Stewardship Council's website: http://deltacouncil.ca.gov/feasibility-study-shore-based-ballast-water-reception-and-treatment-facilities-california-0

The authors concluded that a network of treatment barges would be the best shore-based approach to enable vessels to meet the interim California Performance Standards. According to the Study, such an approach would not come without impacts or costs. A barge-based network could lead to increased air emissions and congestion at California's ports. In the case of the South Coast Air Basin, these shore-based ballast water treatment activities could increase overall harbor craft air emissions by 2.5% to 5% (Glosten 2018). The 30-year lifecycle cost of building and operating a network of treatment barges is estimated at $1.45 billion. Marine vessel operators will bear an additional $2.17 billion in costs to retrofit vessels to support transfer of ballast to barges. The authors estimated that it will take a minimum of nine years to implement such a treatment network once the funding is secured. Possible next steps may include pilot-scale testing of the ballast water treatment methods and scale-up to a treatment barge to assess system performance over various rates of ballast water transfer.

The findings and conclusions from the shore-based ballast water treatment feasibility study were incorporated into the Commission's ballast water treatment technology assessment report (see Commission 2018), which was approved by the Commission in December 2018.

8.1.2 Enumerating Viruses in Ballast Water

In 2014, the Commission found that no ballast water treatment technologies were available to meet the California Performance Standards (see Commission 2014). One reason for this finding was that available methods to detect and count all living viruses in ballast water do not exist. The absence of these methods makes it impossible to determine the availability of BWMS to meet the interim California Performance Standard for viruses and to assess vessel discharges for compliance with this standard.

As a result, the Commission funded the Michigan State University and The Royal Netherlands Institute for Sea Research to identify the availability and feasibility of methods to enumerate viruses in ballast water.

The four-phase study consisted of:

- Phase 1: A review of natural aquatic viral abundances in different water types and their relation to the California Performance Standards
- Phase 2: An evaluation of the detection limits for viruses in ballast water using current counting techniques
- Phase 3: A laboratory-based evaluation of the ability of ultraviolet radiation (UV) to reduce virus concentrations
- Phase 4: Submission of a manuscript for publication in a peer-reviewed scientific journal

Based on a literature review, between 99.99999% and 99.999999% of all viruses present in ballast water would need to be removed for vessels to meet the interim California Performance Standard for living viruses. The investigators identified a technique known as a “plaque assay” as the best method for detecting and counting viruses in ballast water samples. A limitation noted by the investigators is that the plaque assay method requires knowledge of the hosts, or bacteria or other organism that viruses infect. Because each individual virus requires a host, each plaque assay requires knowledge of each individual virus host.

The investigators used plaque assay techniques to detect and count viruses in ballast water samples that were treated using UV technology. The investigators stated that a UV dose of 60 mJ/cm^2 would be required to meet a 99.999% reduction in the viruses that could be detected and counted using plaque assays. Although less than the percent reduction that was suggested by the investigators based on the literature review, a 99.999% reduction is equivalent to what is required in many drinking water standards.

Finally, the investigators suggested that specific viruses could be used as an indication that ballast water treatment is effective at removing or inactivating viruses. However, an indicator virus would not help determine if a BWMS could meet the interim California Performance Standard for all living viruses.

A draft publication of the study's findings was submitted to the journal *Marine Pollution Bulletin*.

8.1.3 Nonindigenous Zooplankton Monitoring

In October 2016, the Commission provided funding to Dr. Stephen Bollens at Washington State University to document the spread of the introduced Asian copepod, *Pseudodiaptomus inopinus*, and other nonindigenous zooplankton species in California waters. Zooplankton species were monitored in Autumn 2016 in eight California river estuaries: Klamath, Eureka Slough (Humboldt), Elk River (Humboldt), Noyo, Russian, Elkhorn Slough, Morro Bay, and Tijuana.

The results of the California surveys were combined with similar surveys of zooplankton in the Pacific Northwest estuaries to create a comprehensive listing of invasive zooplankton species on the west coast of the United States. During the 2016 sampling, the study authors found one new nonindigenous Asian copepod species (*Paracyclopina nana*) in Eureka Slough that had not been previously recorded in the Northeast Pacific Ocean. The results of the sampling are being further analyzed and interpreted, along with data from the Pacific Northwest sampling, as part of a dissertation at Washington State University.

8.1.4 Historical Shipping Patterns

In August 2017, the Commission approved funding to the Smithsonian Environmental Research Center to support an examination of historical shipping patterns in the San Francisco Bay region to identify links to the transport of nonindigenous species.

The study consists of two components:

1. An analysis of archived (1965-1986) and contemporary (1987-2003) records from the Marine Exchange of the San Francisco Bay Region to identify trends in vessel arrivals, including by ship type, to estimate temporal changes in ballast

water discharge volume within San Francisco Bay. This vessel and ballast water information will be compared with notable zooplankton species introductions in San Francisco Bay to examine potential cause and effect.

2. A detailed examination of trade routes between Asia and San Francisco Bay, including magnitude and direction of trade, using additional data compiled from regional ports and trade and cargo statistics. This information will allow for a focused analysis by source and arrival ports.

The shipping data will be used in concert with data from biological survey and analyses (gathered through the CDFW-OSPR) to test key hypotheses about the relationship between ballast water delivery, management, and invasion dynamics. The goal is to establish a historical baseline to adequately evaluate the efficacy of existing ballast water management requirements.

The project is currently in progress. A final report is expected in late 2020.

8.2 Vessel Biofouling Research

The Commission also investigates the risk of vessel biofouling-mediated NIS introductions into California. Three projects are in progress or were recently completed, and involve researchers from:

- San Jose State University
- Smithsonian Environmental Research Center
- University of Maryland Center for Environmental Science
- Naval Research Lab

A brief discussion of each of these studies is presented below.

8.2.1 Experimental Assessment of the Link Between Copper Tolerance and Invasion in Fouling Species

The Commission provided funds to San Jose State University in 2015 to investigate the prevalence of copper tolerance in biofouling organisms and the role that copper tolerance may play in NIS introduction risk.

Copper is toxic at certain concentrations, and its presence can make an underwater surface inhospitable to most biofouling organisms. Copper-based antifouling coatings are used by vessel owners and operators to prevent vessel biofouling. Although the presence of effective copper-based antifouling coatings will prevent most biofouling organisms from accumulating on a vessel's underwater surfaces, some organisms have proven to be more tolerant of copper than others and are not as affected by copper-based antifouling coatings. These copper-tolerant species may have a competitive advantage over other species at colonizing copper-coated vessels, resulting in a prevention strategy that inadvertently facilitates species introductions.

The San Jose State University researchers relied on the use of artificial underwater surfaces with varying levels of copper (including controls with no copper) to evaluate copper tolerance across a variety of native and nonindigenous species. These experiments were conducted at sites across a gradient of ambient copper pollution (from remote coastal sites to highly polluted marinas) and a gradient of vessel activity (from remote sites to heavily trafficked ports).

The copper tolerance project was completed in 2018. Key findings from this research include:

- The average level of copper tolerance was greater in NIS than in native species
- The amount of nearby artificial structure (e.g., marina docks) was more of a factor than background copper pollution at explaining the number of species present
- The most common species found in commercial shipping ports were not copper tolerant

A draft publication of the study's findings was submitted to the journal *Biological Invasions.*

8.2.2 Vessel Biofouling and Invasions: Evaluating Biofouling Introduction Risks Under Lay-Up Conditions in Marine Systems

The Commission provided funds to SERC in 2017 to investigate the impact of vessel stationary periods on the development of biofouling communities. This research involves two years of field experiments, one set of experiments on the U.S. east coast (Cape Charles, VA) during the summer of 2017 and another set on the U.S. west coast (San Francisco Bay, CA) during the summer of 2018.

Most antifouling or foul-release coatings that are used on vessels rely on vessel movement to function properly (e.g., to promote self-polishing of biocidal coatings or to provide physical force to remove organisms from foul-release coatings). These coatings are likely to be less effective when a vessel is stationary, especially for long layup periods.

The SERC researchers deployed artificial underwater surfaces (i.e., settlement plates) coated with either antifouling or foul-release coatings. Sets of settlement plates were removed from the water at six time periods across a gradient of three to sixty days. These incubation periods allowed the researchers to track the fine-scale development of biofouling communities on the different surfaces to provide guidance on what levels of biofouling can be expected to accumulate on a stationary vessel.

A second component of this research is focused on identifying the effects of vessel movement (i.e., transit effects) on the biofouling community that develops on the panels, to provide guidance on what portion of the biofouling that accumulates after a stationary period will survive a transit at typical vessel speeds. The researchers used a purpose-built flume designed to control a steady flow of water to test this component by exposing each panel (after the stationary periods described earlier) to 14 knot waterflow during a simulated voyage.

Preliminary results indicate that the antifouling coating had less than 1% biofouling cover for stationary periods of 3, 6, 10, and 28 days, whereas the foul-release coating had less than 1% cover for only the 3, 6, and 10-day panels. Overall, foul-release coatings (approximately 10% cover) accumulated more biofouling than antifouling coatings after a 28-day stationary period. However, the biofouling accumulation on the two coating types evened out after 45 days. The simulated transit had no effect on the foul-release coating for the 28-day stationary panels, but there was a significant reduction in the amount of biofouling on both coating types for the 45 and 60-day stationary period panels.

The project is expected to be completed during the first half of 2019, and a draft publication of the study’s findings will be submitted to a peer-reviewed journal.

9. REVIEW OF CURRENT VESSEL VECTOR RESEARCH

As required by Public Resources Code section 71212(e), this Biennial Report includes a summary of recent research relating to vessel vectors and NIS introductions. This section summarizes selected peer-reviewed articles published between July 2016 and June 2018.

9.1 Propagule Pressure

Propagule pressure is a measure of the number of organisms introduced and their frequency of arrival at a certain location. **Davidson et al. (2018)** evaluated the influence of variability in design and operational behaviors among ship types on propagule pressure, creating an uneven transfer of species through both BW and biofouling. Stationary periods (also referred as residence times) and voyage speeds, factors that influence biofouling accumulation and survival, varied substantially among different ship types. Ballast water discharge volume also varied, by an order of magnitude, between ship types. The authors suggested the integration of “ship type” into analyses of propagule pressure and risk assessment to enable the development of more targeted management strategies.

Vessel profiles can also affect species-specific propagule pressure, as discussed in a study using the bryozoan *Bugula neritina* as a model organism. **Schimanski et al. (2017)** showed the impacts of different voyage scenarios (travel times, speeds, and exposure to nutrient-enriched waters) on the propagule pressure for this species. Shorter voyages did not affect the reproductive success of this bryozoan, while longer and more infrequent voyages reduced their reproductive output. Furthermore, colony age influenced larval delivery, demonstrating that older colonies are less likely to release larvae than younger colonies.

Carney et al. (2017) studied the combined effects of BW management and trade dynamics before (1993-2000) and during (2012-2013) the ballast water management era. Even though ballast water exchange has been shown in multiple studies to reduce the abundance of organisms in ballast tanks, the authors of this study found an increase in coastal zooplankton after using this management method.

Pagenkopp-Lohan et al. (2017) evaluated the propagule pressure of single-celled organisms (protists) entering U.S. coastal waters. The authors identified high protist diversity, with more than 8,000 taxonomic units (potential different species) and high relative abundance of some taxa, emphasizing the potential impacts of BW on microbial invasions. Many of these protists are less than 10 µm and are not accounted for in state, federal, and international ballast water discharge performance standards. This research suggests that there is likely an underestimate of propagule pressure of protists entering U.S. ports through BW and a management gap in current discharge standards.

9.2 Ballast Water Exchange

Molina and Drake (2016) conducted a literature review on the efficacy of BWE as a method to prevent BW introductions. They concluded that both empty-refill and flow-through methods exchanged between 66 to 99 percent of the BW in tanks with a low consistency (high variability) of removing organisms from the tanks. Nearly all data showed decreased concentrations of overall zooplankton abundance in exchanged tanks, but with high variability in species-specific responses. However, similar to other studies on single-celled organisms, the results were highly variable, in some cases showing an increase in bacterial concentration following exchange.

Paolucci et al. (2017) supported the idea that a hybrid approach to ballast water management, combining ballast water treatment and ballast water exchange achieves a stronger reduction of plankton abundance. Although the authors observed a significant reduction in abundance across all taxonomic groups when either ballast water exchange or ballast water treatment were tested on their own, their data showed that treated water would be compliant with IMO discharge performance standards but still had a diverse phytoplankton community.

Recent research has shown species-specific responses to different BW management methods. **Lymperopoulou and Dobbs (2017)** found that open-ocean exchange does not fully flush coastal bacteria from ballast water tanks. Additionally, they found bacterial composition to be more affected by salinity than by temperature or water age.

9.3 Ballast Water Treatment

Davidson et al. (2017) reviewed the increasing use of BWMS onboard vessels arriving at U.S. waters. Twenty-eight months of data showed that the most common treatment technology type used across different vessel types is filtration combined with UV radiation. BWMS were installed most often on passenger vessels, tankers, and bulkers. The increasing use of BWMS over time suggests that if the systems can meet the required standards, a significant decrease in the discharge of organisms to U.S. waters is expected.

Batista et al. (2017) reviewed the two most common technologies used in BWMS (electro-chlorination and UV radiation) and assessed the current obstacles and challenges to the use of these technologies. The authors suggest that despite the challenges associated with each of the technologies analyzed, BWMS continue to be widely accepted and established solutions for reducing BW-mediated NIS introduction risk. The authors also discussed the use of green biocides (i.e., chemical products or organisms (live or active) that inhibit the success or proliferation of other organisms) to minimize environmental damage. Green biocides are widely used in agriculture to manage plagues or diseases, and according to the authors, have been ignored because of regulatory impediments. The authors suggest that green biocides have potential to be an effective technology at a low cost, with easier maintenance and less environmental impact.

Casas-Monory et al. (2018) assessed the efficiency of filtration and UV radiation at low water temperatures as encountered in polar regions or during the winter season. These combined methods effectively eliminate both phytoplankton and zooplankton regardless of the temperature.

Cohen et al. (2017) re-analyzed the BWMS test data used by the EPA Science Advisory Board (SAB) in 2011 (see SAB 2011) to recommend the BW discharge standards included in the EPA's Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels. The result of this new analysis was inconsistent with previous SAB conclusions. The authors suggest that the original SAB study was flawed and made conclusions without strong evidence. The authors also suggest that the EPA standards should be re-evaluated because some existing treatment systems could meet standards more stringent than the existing ones.

Wang et al. (2018) demonstrated that heating was the only method that successfully inactivated cysts of the microalgae *Scripssiella trochoidea.* **Fokanova et al. (2017)** observed that UV radiation was the most effective method to reduce concentrations of two species of microalgae and one species of bacteria. However, the effect of UV exposure on the inactivation of *Vibrio cholerae* was variable and depended on salinity **(Chen et al. 2018),** suggesting that salinity and site-specific conditions need to be considered when developing treatment systems and compliance testing tools.

Lenz et al. (2018) explored the concept of "enhanced invasiveness" using mussels that survived vessel transport where they were subjected to an initial heat exposure to understand the response to a subsequent heat stress. Some of the organisms studied showed enhanced thermal tolerance when compared to organisms from their same population that did not receive an initial heat exposure. The results suggest an acquired robustness due to stress exposure, which can be experienced both during ship voyages through regions with higher water temperatures or in BW tanks where the temperature can increase significantly.

9.4 Ballast Water Compliance Assessment

Most of the BW research in the past was focused on the composition of species being transported and discharged at different locations. More recently, there has been a focus on compliance assessment due to the implementation of the IMO and U.S federal ballast water discharge standards.

Different BW sample collection methods for compliance testing are expected to influence the results of the test. **Bradie et al. (2018)** compared different BW sampling techniques and found significant differences in organism concentrations depending on the method used to collect BW from tanks**.** These results highlight the need to collect representative samples for compliance testing and monitoring purposes. **Gollasch and David (2017)** found that water volume, sampling duration, timing, and number of samples are the main factors influencing the concentrations of viable organisms. This publication includes detailed protocol recommendations to reduce common sampling effects that may alter compliance assessment results.

Compliance testing continues to be a challenge because it depends on accurate quantification of either viable or living organisms. According to **King (2017),** achieving compliance with the IMO Ballast Water Convention D-2 discharge standards has significant challenges because of vague testing and approval guidelines. These challenges have led to shipping industry skepticism about BWMS performance, resulting in industry's unwillingness to invest in BWMS without "absolute confidence" that it ensures compliance. The author suggested that regulators face the biggest challenge because uncertainty will slow or prevent the development of new technologies and may force adjustments to implementation timelines.

Although methods for compliance assessment are developing at a fast pace, multiple challenges remain because of insufficiently standardized assessment methodologies and their uncertain capacity to accurately quantify organisms to assess against rigorous standards. New methods relying on a genetic approach may be able to solve the challenge of detecting organism viability. However, quantification of such organisms remains a challenge **(Darling and Frederick 2018).**

Vanden Byllaardt et al. (2018) discuss the importance of considering multiple factors when assessing the utility of compliance tools. After attempting to ground truth a handheld indicative compliance assessment tool using microscope counts, the authors found inconsistent results because both methods were looking at different aspects of the organism's biology. Organisms that spend long periods of time in BW tanks will appear dead for one of the compliance assessment methods (handheld indicative tool) but appear alive during microscopic counts.

Flow cytometry is another powerful method that measures abundance, relative size, and vitality of organisms. **Hoell et al. (2017)** suggests that flow cytometry could be used for both compliance assessment and analyses of BW community dynamics. **Bradie et al. (2018)** compared several rapid analysis tools to more detailed, time and labor-intensive methods of BW compliance assessment (e.g., microscopy and flow cytometry). The authors showed that multiple tools enable faster processing and require less expert knowledge than the detailed, time-intensive methods, while still providing similar results. However, some of these rapid analysis methods may provide inaccuracies when used for compliance assessment because of differences in minimum detectable levels and abundance measures.

Measuring the concentration of chlorophyll *a* (a pigment found in plants and phytoplankton) as a proxy for cell abundance is a common method for organism abundance and BW compliance assessment. However, **Trindade de Castro and Veldhuis (2018)** suggest that filtration processes used to separate the organisms in different size classes may lead to an overestimation of the numbers of organisms present in BW because even within a size class (e.g., 10-50 µm), the amount of chlorophyll *a* per cell varies widely. The authors argue that measuring chlorophyll *a* within an organism size class may be biased and urged caution when used for compliance purposes.

9.5 Risk Assessment

Miller et al. 2018 calculated the wetted surface area flux into U.S. waters (approximately 510 million square meters per year) from global bioregions to demonstrate the importance of global management approaches to reduce NIS introduction risks associated with biofouling. The proportion of niche area WSA to total vessel WSA was explored by **Moser et al. (2017)**. The study concluded that passenger vessels have a higher proportion of niche areas (27% of total WSA) than other vessel types. They also found that thruster tunnels represent a “super-hot spot” for biofouling with large proportional areas subject to biofouling. These results have important implications for management strategies targeting higher risk vessel types.

Bouda et al. (2018) also demonstrated the importance of WSA as a proxy to assess biofouling risk by estimating the vessel’s total WSA accumulated in one year of arrivals at the Port of Arzew, Algeria (~9 million m^2). This study underscores why biofouling should not be underestimated in propagule pressure studies.

9.6 Management Considerations and Implications

Ricciardi and Ryan (2017) analyzed the increasing worldwide denialism about invasive species impacts (77 articles published from 1994 to 2016 denying the potential impacts of invasive species) and the consequences for the development and implementation of policies. The authors concluded that effective management of invasive species requires that biologists communicate findings more persuasively using all media tools available to generate a community consensus.

Magaletti et al. (2018) presents a methodological approach to develop an Early Warning System for the detection of NIS. The goal of this method is to warn vessels and ports to not conduct BW activities when the surrounding water exhibits sub-optimal conditions (i.e., toxic algal blooms or excessive levels of harmful bacteria).

McElroy et al. (2017) show some evidence that copper-based antifouling coatings may be favoring copper-tolerant invertebrate species either by direct or indirect interactions with biofilms attached to vessel surfaces. These results suggest that the primary management tool (i.e., copper-based antifouling coatings) may facilitate NIS transfer and increase NIS introduction risk in some cases.

Zabin et al. (2018) summarize the status of biofouling management guidelines and regulations, including compliance assessment methods, around the world. The study evaluated the benefits and difficulties associated with using divers and remotely operated vehicles (ROVs) to conduct biosecurity inspections. The authors concluded that ROV surveys are safer and logistically advantageous, while the use of divers provides higher detection capacity and more precise data collection.

10. CONCLUSIONS AND NEXT STEPS

The Commission's Marine Invasive Species Program continues to be globally recognized as an active, cutting-edge program at the forefront of marine invasive species research and policy development. The MISP has achieved accomplishments and experienced challenges over the last two years, all summarized in this section.

10.1 Data Summary

California ports received 21,150 vessel arrivals between July 1, 2016 and June 30, 2018. Container and tank vessels accounted for 63% of these statewide arrivals. Regional vessel traffic differed between northern and southern California ports. Northern California ports had 9,424 arrivals, with 82% of the northern California arrivals coming from ports within the PCR (i.e., the majority of northern California traffic was regional and coastwise). Southern California ports had 11,726 arrivals, with 42% of the southern California arrivals coming from PCR ports (i.e., the majority of southern California traffic arrived from outside of the region).

Most vessels arriving at California ports do not discharge ballast water. Approximately 15% of all California arrivals reported ballast water discharges totaling 21.6 million metric tons. Most of this ballast water was discharged by bulk (10.6 MMT) and tank (7.6 MMT) vessels. Nearly all (98%) ballast water discharged in California waters, including 2.0 MMT of ballast water treated with ballast water management systems, was compliant with the Marine Invasive Species Act. The volume of noncompliant ballast water was relatively small, and the largest share (44%) of noncompliant water was sourced from Mexican ports. All the noncompliant ballast water sourced in Mexico was exchanged but not at the correct distance from "land." This noncompliance was primarily due to vessel crews failing to consider islands when calculating proper exchange distances from land.

A vessel's cumulative risk of introducing NIS is a function of both ballast water discharge volume (as a proxy for ballast water-mediated risk) and wetted surface area (as a proxy for biofouling-induced risk). During the past two years, 212 million square meters of vessel wetted surface arrived at California ports, primarily associated with container (110 Mm^2) and tank (52 Mm^2) vessels. When considering the cumulative NIS introduction risk of both biofouling and ballast water at each of the California ports, the Ports of Los Angeles and Long Beach have the greatest relative risk, followed by Carquinez, Richmond, and Oakland.

10.2 Major MISP Accomplishments

10.2.1 New and Amended Regulations

California Biofouling Management Regulations

California became the world's first government entity to implement comprehensive vessel biofouling management regulations on October 1, 2017. Building on the momentum of the voluntary IMO Biofouling Guidelines, the Commission helped lead a new regulatory regime to reduce the risk of biofouling-mediated NIS introductions across the globe. Commission staff will continue to lend experience, insight, and data with international groups, including the IMO Pollution Prevention and Response subcommittee and GloFouling to ensure regulatory consistency and increasing awareness of, and compliance with, the California Biofouling Management Regulations.

MISA Enforcement Regulations

The maritime shipping industry continues to have a high compliance rate with the Marine Invasive Species Act, but there are still occurrences where outreach and education are not sufficient to prevent violations. The implementation of the MISA Enforcement Regulations on July 1, 2017, provides the Commission with tools to take additional steps as necessary to increase compliance with the MISA. During the first 18 months of implementation, the Commission pursued 12 enforcement actions and settled five.

Fee Change Regulations

The MISP is funded exclusively through fees assessed on vessels arriving at California ports; the MISP uses no general fund dollars. Commission staff tracks the budget within the Marine Invasive Species Control Fund closely to ensure sufficient funding for all programmatic activities. In coordination with a stakeholder advisory group, the Commission amended the fee amount on October 1, 2017, from $850 to $1,000 per qualifying voyage arrival.

10.2.2 MISP Updates and Improvements

Ballast Water Treatment Technology Assessment Report

The Commission approved a ballast water treatment technology assessment report to the Legislature in December 2018 (see Commission 2018). The report is a comprehensive review of available ballast water treatment technologies, including commercially available shipboard technologies and the feasibility of shore-based ballast water reception and treatment. The report found that no shipboard or shore-based technologies are available to enable implementation of the California Performance Standards on January 1, 2020. The report includes a discussion on the implications for the implementation of California's ballast water discharge standards and provides a series of recommended actions to the Legislature, including amendments to the MISA.

Pre-Arrival Risk Assessment

Beginning in 2016, the Ballast Water Management Report submission requirement was changed from "upon departure" to "24 hours prior to arrival at a California port." This change enabled Commission staff to review ballast water management activities prior to each vessel's arrival to assess NIS introduction risk and prioritize inspections to focus on the vessels representing the greatest risk. This new procedure allows staff to:

- Map the location of ballast water exchange activities to identify possible noncompliant ballast water prior to discharge in California waters
- Contact the vessel crew and agent to inform them of possible noncompliance and to give the vessel an opportunity to conduct an appropriate exchange or other form of management (e.g., treatment) prior to arrival or to change ballasting operations
- Follow-up with an inspection when the vessel arrives to either issue a violation or confirm that an appropriate action was taken

MISP.IO

Commission staff unveiled a web-based user interface in July 2017 to allow online completion, submission, and tracking of required reporting forms. The web application is accessed at http://misp.io and will improve transparency and customer service while allowing the MISP to function more efficiently and effectively.

Effective Outreach

Commission staff continuously reviews and updates MISP outreach materials to reflect new regulatory changes. The information packets that are distributed during vessel inspections have been updated to include guidance materials for the California Biofouling Management Regulations, and the packets themselves are now available to vessel crews as a flash drive or as a traditional hard copy. Vessel inspections are the Commission's primary tools to provide focused outreach to the vessel crews that are responsible for vessel operations.

Peer-Reviewed Journal Publications

Commission staff use data collected through many sources, including field or lab-based research and vessel-submitted reporting forms. These data are critical to developing and evaluating the effectiveness of policies and regulations to reduce NIS introduction risk. Staff is committed to publishing these data in peer-reviewed scientific journals to:

- Validate data collection and analysis methods through peer-review
- Share data with the larger scientific and regulatory communities to allow partner agencies to benefit from Commission data
- Increase awareness of MISP research to attract collaborators for future work
- Further enable the Commission to base decisions on peer-reviewed science, including data collected by the MISP

Commission staff members have co-authored four peer-reviewed journal articles during the last two years and now require all funded research contracts to include submission of a manuscript to a peer-reviewed journal as one of the deliverables.

10.3 Challenges

10.3.1 Vessel Incidental Discharge Act

The Vessel Incidental Discharge Act, included as part of the Frank Lobiando Coast Guard Reauthorization Act of 2018 (S. 140), was signed into law by the President on December 4, 2018. The VIDA will preempt states from establishing and implementing ballast water management requirements, including the implementation of ballast water discharge standards. Although the bill was signed in December 2018, preemption of state authority will not occur until after adoption and implementation of regulations by the U.S. EPA (setting national discharge standards) and USCG (implementation and enforcement). These regulatory actions may take four years or more to accomplish.

During the estimated four-year period between when the bill was signed and full implementation, Commission staff will work with the Attorney General’s office, and the Governor’s office to closely review the bill and determine next steps. These next steps may include amending the MISA to ensure California retains as much authority as possible to address NIS introduction risk from vessel vectors. In the staff report accompanying this biennial report to be voted on by the Commission, staff recommended the Commission sponsor legislation to amend the MISA. Such legislation could provide a mechanism for VIDA-induced statutory changes.

10.3.2 In-Water Cleaning Jurisdiction Issues

In-water cleaning activities to remove organisms from a vessel's wetted surfaces typically results in elevated NIS introduction risk (e.g., removed organisms may be introduced into the local environment) and water quality risk (e.g., copper or other biocides from the antifouling coating is removed and may be released into the environment). In-water cleaning activities are regulated by the U.S. Clean Water Act, through the Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (for in-water cleaning systems that do not collect and filter or treat the removed debris) or a separate individual permit through the National Pollution Discharge Elimination System (NPDES; for systems that collect and filter or treat the removed debris). Commission staff work with Water Board staff to ensure that all in-water cleaning activities in California waters meet water quality standards and address NIS introduction risk (see Scianni and Georgiades, submitted, for more information).

Once the VIDA is fully implemented, in-water cleaning activities will be regulated by the U.S. EPA and USCG. Presumably, in-water cleaning systems that collect and filter out or treat the removed debris will continue to be covered by individual NPDES permits, not through VIDA, as these discharges are not currently considered incidental to the normal operation of vessels. Commission staff will continue to track the development of regulations associated with the VIDA to identify any management gaps that may result.

10.4 Next Steps

10.4.1 Expand MISA Enforcement Regulations to Include California Biofouling Management Regulations

The MISA Enforcement Regulations were adopted and implemented prior to the California Biofouling Management Regulations and therefore provide a mechanism to enforce only ballast water management requirements. Commission staff has begun drafting rulemaking documents to incorporate biofouling management requirements into the enforcement regulations. Staff will initiate this rulemaking action in 2019.

10.4.2 Implement Combined Weighted Risk Assessment

As of October 1, 2017, the Annual Vessel Reporting Form is required to be submitted 24 hours prior to a vessel's first arrival of each calendar year at a California port. Staff has developed a biofouling weighted risk assessment using the data submitted via the AVRF to prioritize inspections in a risk-based manner. This biofouling risk assessment is currently independent of the ballast water risk assessment and may leave gaps in identifying high priority vessels for inspection. Staff plans to develop a combined ballast water and biofouling weighted risk assessment using vessel-submitted forms to better capture the nuances of NIS introduction risk and to be more effective and efficient in prioritizing vessel inspections.

10.4.3 Amend Pacific Coast Region Definition

The Pacific Coast Region is defined in the MISA (Public Resources Code section 71200(k)) as “all coastal waters on the Pacific Coast of North America east of 154 degrees W longitude and north of 25 degrees N latitude, exclusive of the Gulf of California.” The definition also provides a mechanism for changing this definition via regulations if the proposed modification is “equally or more effective at preventing the introduction of nonindigenous species…”

The VIDA defines the Pacific Region as “north of parallel 20 degrees north latitude, inclusive of the Gulf of California,” expanding on the MISA definition to include more of Baja California and ports within the Gulf of California.

Most noncompliant ballast water discharged in California waters is sourced in Mexico (often within the Gulf of California) and exchanged but not at the required distance from land. Based on inspection reports and exchange coordinates that are mapped for verification by Commission staff, most of this noncompliant water is exchanged at distances greater than 200 NM from mainland Mexico but not from Mexican islands. Vessel crews often fail to consider these islands when calculating distance from “land.”

Commission staff will work with the Legislature to propose bill language to amend the definition of the Pacific Coast Region to align with the functional definition of Pacific Region in the VIDA, reduce misinterpretations, and better reflect the NIS introduction risk from ballast water sourced from ports within the Gulf of California.

10.4.4 Adopt the Recommendations from the Commission Report Titled “2018 Assessment of the Efficacy, Availability, and Environmental Impacts of Ballast Water Treatment Technologies for use in California Waters”

The Commission approved the report titled “2018 Assessment of the Efficacy, Availability, and Environmental Impacts of Ballast Water Treatment Technologies for use in California Waters” in December 2018. Staff will work to adopt the recommendations presented in the report, including:

- Funding research to evaluate the effectiveness of ballast water exchange plus ballast water treatment as a combined management approach

- Working with the Legislature to amend the interim California ballast water discharge performance standards to align with the U.S. Coast Guard ballast water discharge standards
- Working with the Legislature to amend Public Resources Code section 71206(a) to enable Commission staff to sample ballast water and biofouling for research purposes

APPENDIX A: STRUCTURE AND FUNCTION OF THE MARINE INVASIVE SPECIES PROGRAM

A.1 The Commission’s MISP

To effectively carry out the administrative and operational requirements of the Marine Invasive Species Act (Public Resources Code section 71200 et seq.), the Commission’s MISP is separated into three primary functional components: program management and policy development, data administration, and field operations (Figure A-1).

A.1.1 Program Management and Policy Development

The MISP program management and scientific staff develops NIS prevention policies for vessel ballast water and biofouling vectors, and:

- Recommend policy proposals to the Legislature
- Propose and implement regulations
- Coordinate and fund research
- Analyze data to assess vessel compliance
- Prepare and update reports for the Legislature
- Pursue enforcement actions, in coordination with the Commission’s Legal Division and Executive staff, for violations of the Marine Invasive Species Act

The MISP management and scientific staff work closely with sister MISP agencies; state, federal, and international regulatory agencies/authorities; technical advisory groups; non-governmental organizations; researchers; and the shipping industry. By consulting with other regulatory jurisdictions (states, federal, international), the MISP increases efficiency, regional and international consistency, and effectiveness by sharing successes and failures. MISP staff members participate on numerous working groups, advisory panels, and committees including (but not limited to):

- California Agencies Aquatic Invasive Species Team
- Delta Interagency Invasive Species Coordination Team
- Pacific Ballast Water Group
- 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
- Great Lakes Ballast Water Collaborative

The MISP management and scientific staff assembles Technical Advisory Groups and Panels (TAGs or TAPs) to exchange information and ideas for the implementation of legislative mandates. TAGs are an effective outreach tool to keep stakeholders abreast of Commission actions and activities. These groups review the best available science and provide a forum for affected stakeholders to voice support and concerns in the development of rulemakings and policy recommendations. TAGs include representatives from the maritime industry, ports, state, federal, and international agencies, environmental organizations, and research institutions. Throughout the history of the MISP, staff has assembled TAGs for the development and review of:

- Regulations to establish ballast water management requirements within the Pacific Coast Region
- Performance standards for ballast water discharge
- Regulations for ballast water discharge compliance assessment
- Regulations for biofouling management
- Changes to the MISP fee
- Forms to collect vessel biofouling and ballast water treatment technology data
- Reports assessing the ability of ballast water treatment systems to meet the California performance standards

A.1.2 Data Administration

The MISP data administration staff inputs data from ballast water and biofouling management reporting forms. More than 800 forms are submitted every month. Data from Ballast Water Management Reports are matched with arrival data from the Marine Exchanges of the San Francisco Bay Region and Southern California. Between July 1, 2016 and June 30, 2018, over 18,160 Ballast Water Management Reports were received, reviewed, entered into the program database, and reconciled with actual port arrival data.

Staff also tracks submission and compliance for ballast water treatment technology reporting forms (repealed as of October 1, 2017), the Hull Husbandry Reporting Form (repealed as of October 1, 2017), and the Annual Vessel Reporting Form (adopted as of October 1, 2017). Submitted forms are reviewed for inconsistencies and are then entered into the MISP database. Quality control procedures are followed to ensure accuracy of data entry.

For forms received through the MISP's online reporting system (http://misp.io), data administration staff performs a quality assessment of the data prior to releasing the information into the database.

MISP staff reconciles the data received against vessel arrival data to determine if reporting requirements have been met. Notices are sent to owners, operators and agents when vessels fail to submit required forms or submit inconsistent, incorrect, or questionable data. These vessels are also flagged for follow-up by Field Operations staff.

The data administration staff also maintains contact with ship owners, officers, and agents to relay information about MISP requirements. They coordinate with the Commission's Field Operations personnel to request data from or distribute information to vessels.

A.1.3 Field Operations

Commission Field Operations staff is the primary means of assessing vessel compliance and distributing information to vessel personnel. They implement an extensive inspection program, including vessel boarding, monitoring, and outreach to enforce MISP laws and regulations. MISP Field Operations personnel are based out of offices located in northern and southern California (Hercules and Long Beach, respectively).

Education and outreach during vessel inspections is key to maintaining the high rate of compliance with California's management, reporting, and recordkeeping requirements (see section 6.3 Ballast Water Discharge Patterns for compliance data). During inspections, staff examines the vessel's ballast water and biofouling management plans, logbooks, and required MISP reporting forms. Vessel reporting and recordkeeping errors are identified and crew are instructed in proper recordkeeping, as needed. Commission staff members is also available to respond to questions from vessel crew members.

Additionally, ballast water samples are collected from select ballast tanks intended for discharge. The samples are analyzed for salinity (a measure of the salt concentration in water) as an indicator for compliant ballast water exchange. The hull of the vessel is checked for the presence of biofouling and recorded as "clean" of all growth, "green" (i.e., only algae growing), "animals" (i.e., attachment of barnacles, mussels, or other macrofouling organisms), or both "green" and "animals."

Vessels that violate the reporting, recordkeeping, or management requirements are cited and targeted for re-inspection, as necessary. Citations are given (on-site) to the vessel crew and a Notice of Violation or letter of noncompliance is mailed to the vessel owner and the representative shipping agent.

In addition to assessing compliance with the requirements of the MISP, Field Operations staff plays a key role in MISP activities by facilitating access to vessels, with the cooperation of vessel operators, for researchers engaged in data collection for NIS research. This assistance is important due to heightened security levels at ports.

A.1.4 The Shared Role of Outreach

One of the key components of the success of the MISP is the close communication, coordination, and outreach between Commission staff, the maritime industry, and other state, federal, and international agencies. Outreach is a role shared by everyone in the MISP (Figure A-1). By establishing and maintaining relationships with the diverse groups that play a role in preventing new introductions of NIS, MISP staff helps work towards improved compliance within the regulated community, development of well-informed policy decisions, and the utilization of management tools and strategies based on the best available science.

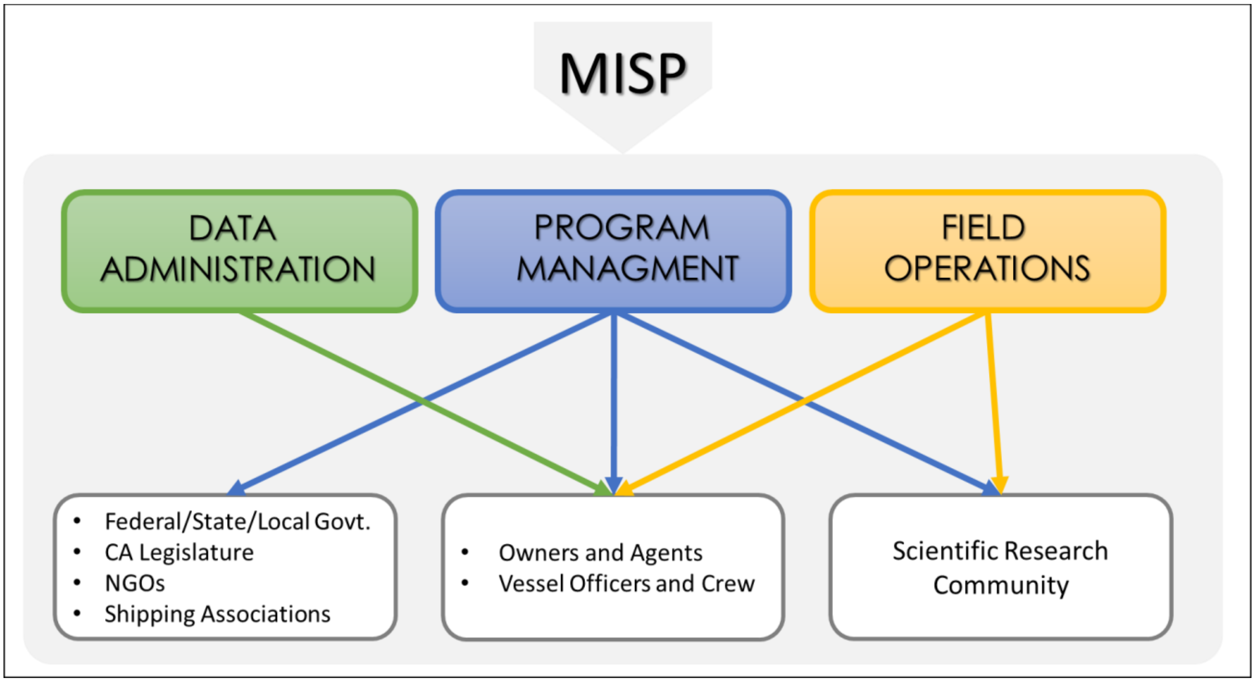

Figure A-1. Marine Invasive Species Program Information Exchange with Stakeholders

MISP staff makes presentations at conferences and for workgroups involved with invasive species science and management. Such participation is particularly important given the global nature of shipping and the methods of transporting NIS. In many cases, MISP staff members are invited to participate due to their extensive knowledge and experience with vessel vector management. Since July 2016, presentations have been given at numerous local, state, national, and international meetings, including:

- ICES/IMO Ballast Water Workgroup
- International Congress on Marine Corrosion and Fouling
- Oceanology International Americas
- California Marinas and Antifouling Strategies Interagency Coordinating Committee
- Green Shipping USA Summit
- Western Regional Panel on Aquatic Nuisance Species Annual Meeting
- National Estuarine Research Reserve Hazard Assessment Critical Control Point Workshop
- Long Beach Ballast Water Summit
- Commission Marine Environmental Protection Division Customer Service Meetings
- California State Lands Commission’s Prevention First Symposium

APPENDIX B: REQUIRED MISP REPORTING FORMS

B.1 Ballast Water Management Report

OMB number 1625-0069
Exp. date: 31-Dec-2018

Ballast Water Management Report

Vessel Information

Vessel name

ID number — IMO number

Country of Registry — Select country

Owner/operator

Type — Select vessel type — Gross Tonnage

Ballast water volume units — Select units

Total ballast water capacity — Number of tanks on ship

Onboard BW Management System

Voyage Information

Arrival port (port and state) — Select state

Arrival date

Last port (port and country) — Select country

Next port (port and country) — Select country

Total ballast water on board — Number of tanks in ballast

Number of tanks discharged

Alternative BW management conducted, per instructions from COTP

Certificate of accurate information

By checking this box, I attest to the accuracy of the information provided and that ballast water management activities were in accordance with the ballast water management plan required by CFR 151.2050(g).

Responsible Officer's name and title

Report type — Select report type

Submitted by — Contact information

Ballast Water History

On the following page(s), provide the ballast water history for each tank discharged into the waters of the United States or to a reception facility, en route to or at the arrival port. Vessels entering the Great Lakes or Hudson River (north of George Washington Bridge) from beyond the US EEZ must also provide the history for empty tanks that underwent alternative management.

Submit report via e-mail | Submit report on-line

Ballast Water History

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons **Select reason**

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons **Select reason**

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons **Select reason**

Tank name/number Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons **Select reason**

B.2 Marine Invasive Species Program Annual Vessel Reporting Form

STATE OF CALIFORNIA – STATE LANDS COMMISSION
MARINE INVASIVE SPECIES PROGRAM ANNUAL VESSEL REPORTING FORM
SLC 600.12 (Revised 08/17)
Public Resources Code Sections 71201.7, 71205

Vessel Name:
Official / IMO Number:
Responsible Officer's Name and Title:
Date Submitted (Day/Month/Year):

1. Does the vessel have a ballast water treatment system installed?

Yes	☐	IF "YES" Complete sections 1 and 2
No	☐	IF "NO" Complete section 1 only

Section 1: Hull Husbandry Maintenance and Operational Information

2. Since delivery, has this vessel ever been removed from the water for maintenance?

Yes	☐	No	☐	

a. If Yes, enter the date and location of the most recent out-of-water maintenance.

Last date out of water (**Day/Month/Year**):	
Port or Position:	Country:

b. If No, enter the delivery date and location where the vessel was built:

Delivery Date (**Day/Month/Year**):	
Port or Position:	Country:

3. Were the submerged portions of the vessel coated with an anti-fouling treatment or coating during the **out-of-water** maintenance or shipbuilding process listed above?

Yes, full coat applied	☐	
Yes, partial coat	☐	Date last full coat applied (**Day/Month/Year**)
No coat applied	☐	Date last full coat applied (**Day/Month/Year**)

Official / IMO Number________________

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STATE OF CALIFORNIA – STATE LANDS COMMISSION
MARINE INVASIVE SPECIES PROGRAM ANNUAL VESSEL REPORTING FORM
SLC 600.12 (Revised 08/17)
Public Resources Code Sections 71201.7, 71205

4. For the most recent full coat application of anti-fouling treatment, what type of anti-fouling treatment was applied and to which specific sections of the submerged portion of the vessel was it applied?

Manufacturer/Company:
Product Name:
Applied on **(Check all that apply)**: Hull Sides ☐ Hull Bottom ☐ Sea Chests ☐ Sea Chest Gratings ☐ Propeller ☐ Rope Guard/Propeller Shaft ☐ Previous Docking Blocks ☐ Thrusters ☐ Rudder ☐ Bilge Keels ☐

Manufacturer/Company:
Product Name:
Applied on **(Check all that apply)**: Hull Sides ☐ Hull Bottom ☐ Sea Chests ☐ Sea Chest Gratings ☐ Propeller ☐ Rope Guard/Propeller Shaft ☐ Previous Docking Blocks ☐ Thrusters ☐ Rudder ☐ Bilge Keels ☐

Manufacturer/Company:
Product Name:
Applied on **(Check all that apply)**: Hull Sides ☐ Hull Bottom ☐ Sea Chests ☐ Sea Chest Gratings ☐ Propeller ☐ Rope Guard/Propeller Shaft ☐ Previous Docking Blocks ☐ Thrusters ☐ Rudder ☐ Bilge Keels ☐

5. Were the sea chests inspected and/or cleaned during the out-of-water maintenance listed above? If no out-of-water maintenance was performed since delivery, select Not Applicable.

(Check all that apply) Yes, sea chests inspected ☐	Yes, sea chests cleaned ☐
No, sea chests not inspected or cleaned ☐	Not Applicable ☐

6. Are Marine Growth Prevention Systems (MGPS) installed in the sea chest(s) or sea strainer(s)?

Yes ☐	Manufacturer:	Model:
If Yes, MGPS installed in (**check all that apply**): Sea Chest(s) ☐ Sea strainer(s) ☐		
No ☐		

Official / IMO Number________________

7. Has the vessel undergone in-water cleaning to the submerged portions of the vessel since the last out-of-water maintenance period? Yes ☐ No ☐

a. If Yes, when and where did the vessel most recently undergo **in-water** cleaning?
(Do not include cleaning performed during out-of-water maintenance period)

Date (**Day/Month/Year**):	
Port or Position:	Country:
Vendor providing cleaning service:	
Section(s) cleaned (**Check all that apply**): Hull Sides ☐ Hull Bottom ☐ Propeller ☐ Sea Chest Grating ☐ Sea Chest ☐ Bilge Keels ☐ Rudder ☐ Docking Blocks ☐ Thrusters ☐ Unknown ☐	
Cleaning method: Divers ☐ Robotic ☐ Both ☐	

8. Has the propeller been polished since the last **out-of-water** maintenance (including shipbuilding process) or **in-water** cleaning?

Yes	☐	Date of propeller polishing (**Day/Month/Year**):
No	☐	

9. Are the anchor and anchor chains rinsed during retrieval? Yes ☐ No ☐

10. List the following information for this vessel averaged over the last four months:

a. **Average** Voyage Speed (knots):
b. **Average** Port Residency Time (hours or days): **Hours** or **Days**

11. Since the hull was last cleaned (out-of-water or in-water), has the vessel visited:

a. Fresh water ports (Specific gravity of less than 1.005)?

Yes	☐	How many times?
No	☐	

b. Tropical ports (between 23.5° S and 23.5° N latitude)?

Yes	☐	How many times?
No	☐	

c. Panama Canal?

Yes	☐	How many times?
No	☐	

Official / IMO Number_______________

STATE OF CALIFORNIA – STATE LANDS COMMISSION
MARINE INVASIVE SPECIES PROGRAM ANNUAL VESSEL REPORTING FORM
SLC 600.12 (Revised 08/17)
Public Resources Code Sections 71201.7, 71205

12. List the previous 10 ports visited by this vessel in the order they were visited (start with most recent). You do not have to use all 10 spaces if the vessel has a regular route that involves less than 10 ports.

Check here ☐ if the vessel visits the same ports on a regular route.

List dates as (**Day/Month/Year**).

Port or Position:	Country:
Arrival date:	Departure date:

Port or Position:	Country:
Arrival date:	Departure date:

Port or Position:	Country:
Arrival date:	Departure date:

Port or Position:	Country:
Arrival date:	Departure date:

Port or Position:	Country:
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Arrival date:	Departure date:

Port or Position:	Country:
Arrival date:	Departure date:

Port or Position:	Country:
Arrival date:	Departure date:

Official / IMO Number________________

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MARINE INVASIVE SPECIES PROGRAM ANNUAL VESSEL REPORTING FORM
SLC 600.12 (Revised 08/17)
Public Resources Code Sections 71201.7, 71205

13. Since the most recent hull cleaning (out-of-water or in-water) or delivery, has the vessel spent 10 or more consecutive days in any single location? (Do not include time out-of-water or during in-water cleaning.)

No ☐ Indicate the longest amount of time spent in a single location since the last hull cleaning

Number of Days:	Date of Arrival:
Port or Position:	Country:

Yes ☐ List all of the occurrences where the vessel spent 10 or more consecutive days in any single location since the last hull cleaning. List dates as (**Day/Month/Year**):

Number of Days:	Date of Arrival:
Port or Position:	Country:
Number of Days:	Date of Arrival:
Port or Position:	Country:
Number of Days:	Date of Arrival:
Port or Position:	Country:
Number of Days:	Date of Arrival:
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Number of Days:	Date of Arrival:
Port or Position:	Country:

Official / IMO Number_______________

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MARINE INVASIVE SPECIES PROGRAM ANNUAL VESSEL REPORTING FORM
SLC 600.12 (Revised 08/17)
Public Resources Code Sections 71201.7, 71205

Section 2: Ballast Water Treatment System Information

COMPLETE ONLY IF VESSEL HAS A BALLAST WATER TREATMENT SYSTEM INSTALLED

Note: Complete a separate Section 2 for each installed ballast water treatment system.

14. Provide the following information about the vessel's installed ballast water treatment system:

Manufacturer/Company:
Product Name:
Model Number:
Date System Commissioned (**Day/Month/Year**):

15. Has the installed ballast water treatment system been used to treat ballast water in the last 12 months?

Yes	☐	
Number of times the system was used in the last 12 months:		
No	☐	

16. Has the installed ballast water treatment system malfunctioned in the last 12 months?

Yes	☐	Date of Most Recent Malfunction (**Day/Month/Year**)
Describe all malfunctions during the previous 12 months:		
Describe all repairs for all malfunctions during the previous 12 months :		
No	☐	

17. Has an onboard test for biological performance of the vessel's installed ballast water treatment system been completed since the system was commissioned?

Yes	☐	If "YES", List the dates of the tests (**Day/Month/Year**):
No	☐	

Official / IMO Number_______________

B.3 Hull Husbandry Reporting Form

*****REPEALED 10/01/2017*****

California State Lands Commission
Marine Invasive Species Program
Hull Husbandry Reporting Form
Public Resources Code – 71205(e) and 71205(f)
June 6, 2008
Part I: Reporting Form

Vessel Name:
Official / IMO Number:
Responsible Officer's Name and Title:
Date Submitted (**Day/Month/Year**):

Hull Husbandry Information

1. Since delivery, has this vessel ever been removed from the water for maintenance?
   Yes ☐ No ☐

   a. If Yes, enter the date and location of the most recent out-of-water maintenance:

Last date out of water (**Day/Month/Year**):	
Port or Position:	Country:

   b. If No, enter the delivery date and location where the vessel was built:

Delivery date (**Day/Month/Year**):	
Port or Position:	Country:

2. Were the submerged portions of the vessel coated with an anti-fouling treatment or coating during the **out-of-water** maintenance or shipbuilding process listed above?

Yes, full coat applied ☐		
Yes, partial coat ☐	Date last full coat applied (**Day/Month/Year**)	
No coat applied ☐	Date last full coat applied (**Day/Month/Year**)	

3. For the most recent **full coat** application of anti-fouling treatment, what type of anti-fouling treatment was applied and to which specific **sections** of the submerged portion of the vessel was it applied?

Manufacturer/Company:
Product Name:

   Applied on (**Check all that apply**): Hull Sides☐ Hull Bottom☐ Sea Chests☐
   Sea Chest Gratings☐ Propeller☐ Rope Guard/Propeller Shaft☐
   Previous Docking Blocks☐ Thrusters☐ Rudder☐ Bilge Keels☐

Manufacturer/Company:
Product Name:

   Applied on (**Check all that apply**): Hull Sides☐ Hull Bottom☐ Sea Chests☐
   Sea Chest Gratings☐ Propeller☐ Rope Guard/Propeller Shaft☐
   Previous Docking Blocks☐ Thrusters☐ Rudder☐ Bilge Keels☐

1

Official / IMO Number: ____

Manufacturer/Company:	
Product Name:	

Applied on (**Check all that apply**): Hull Sides☐ Hull Bottom☐ Sea Chests☐
Sea Chest Gratings☐ Propeller☐ Rope Guard/Propeller Shaft☐
Previous Docking Blocks☐ Thrusters☐ Rudder☐ Bilge Keels☐

4. Were the sea chests inspected and/or cleaned during the **out-of-water** maintenance listed above? If no out-of-water maintenance since delivery, select Not Applicable. **Check all that apply**.
Yes, sea chests inspected☐ Yes, sea chests cleaned☐
No, sea chests not inspected or cleaned☐ Not Applicable☐

5. Are Marine Growth Protection Systems (MGPS) installed in the sea chests?

Yes☐	Manufacturer:	Model:
No ☐		

6. Has the vessel undergone **in-water** cleaning to the submerged portions of the vessel since the last out-of-water maintenance period? Yes☐ No☐

a. If Yes, when and where did the vessel most recently undergo **in-water** cleaning (Do not include cleaning performed during out-of-water maintenance period)?

Date (**Day/Month/Year**):	
Port or Position:	Country:
Vendor providing cleaning service:	

Section(s) cleaned (**Check all that apply**):
Hull Sides ☐ Hull Bottom ☐ Propeller☐ Sea Chest Grating☐
Sea Chest☐ Bilge Keels ☐ Rudder☐ Docking Blocks☐
Thrusters ☐ Unknown ☐

Cleaning method: Divers ☐ Robotic ☐ Both ☐

7. Has the propeller been polished since the last **out-of-water** maintenance (including shipbuilding process) or **in-water** cleaning?

Yes ☐	Date of propeller polishing (**Day/Month/Year**):	
No ☐		

8. Are the anchor and anchor chains rinsed during retrieval? Yes ☐ No ☐

Voyage Information

9. List the following information for this vessel averaged over the last four months:

a. **Average** Voyage Speed (knots):				
b. **Average** Port Residency Time (hours or days):		**Hours** or		**Days**

2

Official / IMO Number: ____

10. Since the hull was last cleaned (**out-of-water** or **in-water**), has the vessel visited:

a. Fresh water ports (Specific gravity of less than 1.005)?

Yes ☐	How many times?
No ☐	

b. Tropical ports (between 23.5° S and 23.5° N latitude)?

Yes ☐	How many times?
No ☐	

c. Panama Canal?

Yes ☐	How many times?
No ☐	

d. List the previous 10 ports visited by this vessel in the order they were visited (start with most recent). Note: If the vessel visits the same ports on a regular route, check here ☐ and list the route once (you do not have to use all 10 spaces if the route involves less than 10 ports; add more lines if regular route involves more than 10 ports). **List dates as (Day/Month/Year)**.

Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	
Port or Position:		Country:	
Arrival date:		Departure date:	

Official / IMO Number: _____

11. Since the **most recent** hull cleaning (out-of-water or in-water) or delivery, has the vessel spent 10 or more consecutive days in any single location (Do not include time out-of-water or during in-water cleaning).

No ☐ List the longest amount of time spent in a single location since the last hull cleaning:

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Yes ☐ List all of the occurrences where the vessel spent 10 or more consecutive days in any single location since the last hull cleaning.

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

Number of Days: ______ Date of Arrival (Day/Month/Year): ______
Port or Position: ______ Country: ______

B.4 Ballast Water Treatment Technology Annual Reporting Form

*****REPEALED 10/01/2017*****

California State Lands Commission
Marine Invasive Species Program
Ballast Water Treatment Technology Annual Reporting Form
Public Resources Code Section 71205(g)
July 1, 2010

Vessel Name:	
Official / IMO Number:	
Responsible Person's Name and Title:	
Date Submitted (DD/MM/YYYY):	

Treatment System Information

1. List the treatment system installed on board the vessel:

   Manufacturer/Company: ______

   Product Name: ______

   Model Number: ______

   1a. Mode(s) of Action (check all that apply):

Filtration ☐	Cavitation ☐	Hydrocyclone ☐	Deoxygenation ☐
Active Substance/Biocide ☐	Ultra Violet Irradiation ☐	Heat ☐	
Other ☐, please describe:			

   1b. List all substances (i.e. chemicals, biocides, flocculants, neutralization agents) created or used by the treatment system (if any), and indicate whether or not the Material Safety Data Sheet is kept on board for each substance.

Substance	MSDS on Board?
	Yes ☐ No ☐ N/A ☐
	Yes ☐ No ☐ N/A ☐
	Yes ☐ No ☐ N/A ☐
	Yes ☐ No ☐ N/A ☐
	Yes ☐ No ☐ N/A ☐
	Yes ☐ No ☐ N/A ☐
N/A ☐, No substances used by system.	

1

Official/IMO Number:________________________

1c. Are manufacturer's technical guides, publications and/or manuals for the treatment system kept on board? Yes ☐ No ☐

2. When did the system installation receive classification society approval?

   Date (DD/MM/YYYY): ____________________________________

3. Did the system installation occur (check all that apply):

As part of a scheduled out of water dry docking?	Yes ☐ No ☐
During a special/non-routine out of water dry docking?	Yes ☐ No ☐
Without the need for out of water dry docking?	Yes ☐ No ☐

4. Has there been any significant upgrade/modification to the system since classification society approval? (Do not include repairs. See instructions for more information and definition of significant.)

Yes ☐	Date of Upgrade (DD/MM/YYYY):
Describe upgrade:	
No ☐	

5. Has any unscheduled or emergency maintenance been performed on the system since classification society approval (or since the previously submitted Ballast Water Treatment Technology Annual Reporting Form)?

Yes ☐	Date of Most Recent Event (DD/MM/YYYY):
Describe most recent maintenance event:	
No ☐	

6. Is the vessel in compliance with the requirement to maintain a ballast water treatment performance log on board? (This log may be incorporated into the existing ballast water management log. See form instructions for minimum requirements). Yes ☐ No ☐

7. Is system performance (i.e. biological efficacy) verified on a regular basis? Verification is not a requirement by the State of California, however, regular performance testing will allow the vessel to ensure the system is working properly.

Yes ☐				
How often:	Weekly ☐	Monthly ☐	Yearly ☐	Every 2 years ☐
	Other ☐, describe:			
No ☐				

2

B.5 Ballast Water Treatment Supplemental Reporting Form

*****REPEALED 10/01/2017*****

California State Lands Commission
Ballast Water Treatment Supplemental Reporting Form
Public Resources Code Section 71205(g)
July 1, 2010
ALL VESSELS MUST ALSO SUBMIT BALLAST WATER REPORTING FORM

IS THIS AN AMENDED REPORTING FORM? Yes ☐ No ☐

Vessel Information	**Voyage Information**
Vessel Name:	Arrival Port:
Official/IMO Number:	Arrival Date (DD/MM/YYYY):

Ballast Water Treatment

1. Did the treatment system experience any malfunction that affected the treatment of ballast water to be discharged at this arrival port?

   Yes ☐ , please provide the following information:

   Date of malfunction (DD/MM/YYYY):

   Explain the malfunction:

   If applicable, how was the situation resolved?

   No ☐

2. Ballast Water Treatment History. Provide information for all ballast tanks that will be discharged at arrival port. Enter additional tanks on page 2. One tank per line. If none, go to Question #3.

Tanks/ Holds	**BW Source**			**BW Discharge**			**BW Treatment**		
	Date (DD/MM/YY)	Port or Lat-Long	Volume (Units)	Date (DD/MM/YY)	Port or Lat-Long	Volume (Units)	Date of 1st treatment (DD/MM/YY)	Date 2nd treatment (if applicable) (DD/MM/YY)	Volume Ballast Treated (Units)
			m3			m3			m3
			m3			m3			m3
			m3			m3			m3
			m3			m3			m3

Ballast Water Tank Codes: Forepeak = FP, Aftpeak = AP, Double Bottom = DB, Wing = WT, Topside = TS, Cargo Hold = CH, Other = O

3. Responsible Officer's Name and Title:

1

APPENDIX C: SUPPLEMENTARY DATA TABLES

Table C-1. Total vessel arrivals between July 1, 2016 and June 30, 2018.

	Auto	Bulk	Container	General	Other	Passenger	Tank	Unmanned Barge	Total
Northern California									
Alameda					3				**3**
Carquinez	286	160	2	6	10		964	363	**1,791**
Humboldt		7		2	1	1		48	**59**
Monterey						8			**8**
Morro Bay					1				**1**
Moss Landing					21				**21**
Oakland		51	3,245	1			3	2	**3,302**
Redwood		101						1	**102**
Richmond	183	224		2	11		962	312	**1,694**
Sacramento		78		16			6		**100**
San Francisco	60	496	141	17	7	155	697	263	**1,836**
Stockton	1	309	2	47	1		147		**507**
Southern California									
Avalon/Catalina					4	221	1		**226**
El Segundo							443	33	**476**
Hueneme	461		230	84	20		28		**823**
Los Angeles/Long Beach	597	826	4,292	287	55	743	2,068	393	**9,261**
Marina Del Rey					3				**3**
Newport Beach					1				**1**
San Diego	512	17	109	46	23	176	16		**899**
Santa Barbara	2					35			**37**
Total	**2,102**	**2,269**	**8,021**	**508**	**161**	**1,339**	**5,335**	**1,415**	**21,150**

Table C-2. Source and volume (MT) of noncompliant ballast water discharges between July 1, 2016 and June 30, 2018. Locations in the first column represent ballast water source. "Not a port" represents discharges where the source was primarily from coastal waters but not at an appropriate distance from land.

	Auto	Bulk	Container	General	Passenger	Tank	Unmanned Barge	Total
Exchanged in wrong location								
American Samoa			1,675					**1,675**
Canada		1,912						**1,912**
China		27,917	2,804			32		**30,753**
El Salvador		3,732						**3,732**
Guatemala		13,724				4,670		**18,393**
Japan		16,892						**16,892**
Korea		13,750						**13,750**
Mexico		96,238		2,429	77	127,073		**225,816**
New Zealand				1,676				**1,676**
Not a port		4,726	710	185	2,202	10,594		**18,416**
Panama		1,931						**1,931**
Tahiti			575					**575**
US Pacific Coast			2,034			31,215	1,795	**35,044**
Not exchanged								
Chile						1,996		**1,996**
Not a port		51,896	8,829		5,088	11,302	66	**77,180**
US Pacific Coast	2,276	21,145	3,006			34,371		**60,798**
Total	**2,276**	**253,863**	**19,633**	**4,290**	**7,367**	**221,252**	**1,860**	**510,540**

Table C-3. Shipboard ballast water treatment methods used, and volume of ballast water discharged (BWD) from 2013 to June 2018 (2018a). "n" represents number of discharging events. BWD is presented in metric tons.

		2013		2014		2015		2016		2017		2018a	
Vessel Type	**Treatment Method**	**BWD**	**n**	**BWD**	**n**	**BWD**	**n**	**BWD**	**n**	**BWD**	**n**	**BWD**	**n**
Auto	Electrochlorination							1,664	2				
	Oxidation							9,546	1				
	UV									970	1		
Bulk	Chemical									41,262	2	205,732	13
	Electrochlorination			73,719	3	13,923	1	45,044	6	249,905	21	392,814	29
	Oxidation							3,575	1	18,456	2	32,135	2
	UV	20,547	3	16,185	2			17,940	3	132,460	12	79,507	8
Container	Electrochlorination			24,716	3			14463	4				
	Oxidation												
	UV					18,001	8			11,441	5		
General	Electrochlorination							8,401	2	11,385	1	15,643	1
	Oxidation												
	UV			2,378	1	4,071	1	13,998	4	43,806	6	22,604	4
Other	Chemical			4,928	2	13,312	2	506	1				
	Electrochlorination									953	2	11,073	1
	UV					4485	1			10,638	1		
Passenger	Oxidation			2,322	1	991	1						
	UV	366	1	392	1	5,439	14	22,809	41	19,825	36	13,540	18
Tank	Electrochlorination			4,858	1	41,408	5	85,596	7	299,241	29	175,650	20
	UV									2,369	1	35,679	7
	Oxidation					3,232	1					23,652	2
Unmanned Barge	UV									27,006	4		
	Oxidation							11,500	1				
TOTAL		20,913	4	129,498	14	104,862	34	118,957	32	117,287	45	235,042	73

Table C-4. Risk assessment by vessel type based on the ratio of total WSA to total BWD. Low ratio values represent greater relative ballast water risk (blue), greater ratio values represent greater relative biofouling risk (green).

Vessel type	Total WSA (m^2)	BWD (MT)	Relative risk (Ratio WSA / BWD)
Bulk	16,917,699	10,643,387	1.6
Unmanned Barge	4,578,065	1,659,426	2.8
Tank	52,244,732	7,597,864	6.9
General	2,907,664	280,553	10.4
Passenger	12,041,559	501,375	24
Auto	12,955,207	95,036	136.3
Container	110,029,969	748,276	147.1

Table C-5. Cumulative risk assessment by arrival port based on relative rank assignment. Arrival ports were assigned a rank number from 1-14 where 14 represents the largest WSA or BWD received in the reporting period (red) and 1 the lowest (yellow). The addition of these two rank numbers (Relative WSA rank + Relative BWD rank) was used as a cumulative relative risk score.

Port	WSA (m^2)	BWD (MT)	Relative WSA rank	Relative BWD rank	Relative risk score (Rank WSA + Rank BWD)
Santa Barbara	412,270	5,784	2	3	5
Humboldt	195,954	144,815	1	5	6
Avalon/Catalina	1,919,563	0	5	1	6
Sacramento	639,257	256,132	3	7	10
Redwood	825,631	175,464	4	6	10
Hueneme	5,595,847	2,871	8	2	10
San Diego	6,173,761	22,479	9	4	13
El Segundo	5,454,528	739,196	7	9	16
Stockton	3,560,536	2,594,912	6	11	17
San Francisco	10,313,229	491,913	10	8	18
Oakland	46,262,140	818,197	13	10	23
Carquinez	12,409,217	5,295,268	11	13	24
Richmond	12,891,201	3,104,690	12	12	24
LA/LB	104,949,337	7,932,273	14	14	28

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