2009 BIENNIAL REPORT ON THE CALIFORNIA MARINE INVASIVE SPECIES PROGRAM

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EXECUTIVE SUMMARY

The Marine Invasive Species Act of 2003 revised and expanded the Ballast Water Management for Control of Nonindigenous Species Act of 1999 to more effectively address the threat of nonindigenous species (NIS) introductions. The law charged the California State Lands Commission (Commission) with oversight of the state's program to prevent or minimize the introduction of NIS from commercial vessels. To advance this goal, the Commission utilizes a comprehensive, multi-pronged approach that includes: ballast water and vessel fouling management tracking, compliance, and enforcement; sound policy development in consultation with a wide array of experts and stakeholders; applied research that advances the strategies for NIS prevention; and outreach and education to coordinate information exchange among scientists, legislators, and stakeholders. This report summarizes the activities and accomplishments in each of these areas from July 2006 through June 2008.

Upon departure from each port or place of call in California, vessels are required to submit a Ballast Water Reporting Form which details their ballast management practices. Since July 2006, over 22,000 reporting forms have been submitted to the Commission. In order to verify that vessels have submitted reporting forms, received forms are matched with arrival data from the State's Marine Exchanges. Compliance with the requirement to submit this form consistently exceeds 95%.

Compliance rates with ballast water management requirements in California remain extremely high. During the period covered by this report, more than 135 million metric tons of vessel-reported ballast water was carried into State waters, and 98% was managed in compliance with California law. Over 85% of the vessels operating in California achieve compliance with California's requirements by retaining their ballast water onboard. Of the nearly 19 million metric tons of ballast water discharged into California between July 2006 and June 2008, 84.5% was appropriately managed through legal ballast water exchange and was compliant with California law.

The total volume of ballast water discharged into California has been increasing since the last half of 2006, however, the volume of noncompliant ballast water has decreased 45% over the past two years. Furthermore, the vast majority of the noncompliant ballast water discharged in State waters underwent some type of exchange, likely reducing the risk of NIS introductions.

Commission Marine Safety personnel verify vessel-reported ballast water management practices through onboard inspections of vessel logbooks and sampling of ballast water to be discharged. Between July 2006 and June 2008, 3792 ballast water inspections were conducted by Commission staff. Of those inspections, approximately two percent of the vessels were in violation of the operational aspects of the law, which includes improper ballast water management.

In September 2006, the Legislature passed the Coastal Ecosystems Protection Act of 2006, directing the Commission to adopt performance standards for the discharge of ballast water by January 1, 2008, and prepare a report assessing the availability of treatment technologies to meet those standards. The Commission completed the rulemaking process and adopted the standards in October 2007; the technology assessment report was completed in December 2007. The effective implementation of these standards requires Marine Invasive Species Program staff to move forward on several new projects and rulemaking actions including: 1) ballast water treatment technology testing guidelines, 2) regulations to inform the selection of sampling points (i.e. location) and sampling facilities (i.e. equipment) on vessels, and 3) procedures and protocols for use by Commission Marine Safety personnel to verify vessel compliance with the performance standards.

Commission staff has also been working to address the threat of NIS introductions via vectors other than ballast water. In January 2008, Commission staff began collecting data, using a Hull Husbandry Reporting Form, on the fouling-related husbandry practices of the commercial vessel fleet visiting California waters. These data will be used in conjunction with information gathered through fouling-related research currently funded by the Commission's Marine Invasive Species Program (MISP) to better understand how husbandry practices and voyage characteristics affect the quantity and quality of fouling biota associated with vessels operating in California. The Commission is mandated to adopt regulations governing the management of vessel fouling by January 1, 2012. Both sets of information will guide and inform the development of these regulations.

The Commission continues to fund and facilitate numerous research projects that address high priority management challenges including: a variety of inter-related vessel fouling research projects; research examining tools to verify ballast water exchange; the assessment of ballast water treatment technologies on operational vessels; and the establishment of a ballast water testing platform in California to facilitate the development of treatment systems and their evaluation.

Commission staff have also maintained an advisory role and/or are an active participants in several organizations that address ship-born NIS issues. Staff participates in activities with the California Agencies Aquatic Invasive Species Team, part of the California Invasive Species Management Plan; West Coast Ballast Outreach Project Advisory Committee; Oregon's Ballast Water Management Task Force; and the Pacific Ballast Water Group. Additionally, staff has convened or received invitation to participate in several workshops and has given presentations at numerous national and international meetings to build dialogues with professionals across a wide range of disciplines.

In the coming years the Commission will be: (1) developing protocols and regulations to effectively implement California's performance standards for the discharge of ballast water; (2) compiling and analyzing data related to vessel fouling to guide and inform the development of regulations on fouling management for vessels operating in California; (3) supporting research on ballast water treatment and hull cleaning technology development; and (4) seeking legislative authority to amend the ballast water reporting requirements via regulations. The focus of the Commission will continue to be on protection, prevention, outreach and education, and solution-based actions. The Commission will concentrate available resources on working proactively with the regulated industry to achieve a high rate of compliance with required management practices, to minimize discharges of unmanaged water, and to reduce the risks of biological invasions.

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ABBREVIATIONS AND ACRONYMS

AB	Assembly Bill
ABRPI	Aquatic Bioinvasions Research and Policy Institute
Act	Marine Invasive Species Act (AB 433)
APL	American Presidential Line
BEAM	Ballast Exchange Assurance Meter
BOE	Board of Equalization
BWE	Ballast Water Exchange
BWEv	Ballast Water Exchange verification
CA	California
CANOD	California Aquatic Non-Native Organism Database
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDOM	Chromophoric Dissolved Organic Matter
CFR	Code of Federal Regulations
CFU	Colony-Forming Unit
COI	Cytochrome Oxidase subunit I
Commission	California State Lands Commission
CWA	Clean Water Act
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ETV	Environmental Technology Verification
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
HHRF	Hull Husbandry Reporting Form
IMO	International Maritime Organization
LA-LB	Los Angeles-Long Beach port complex
LPOC	Last Port-Of-Call
m	Meters
ml	Milliliter

MARAD	Maritime Administration
MISP	Marine Invasive Species Program
MLML	Moss Landing Marine Laboratories
MMT	Million Metric Tons
MPCA	Minnesota Pollution Control Agency
MT	Metric Tons
NIS	Nonindigenous Species
nm	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
NOBOB	No Ballast On Board
NPDES	National Pollution Discharge Elimination System
ODEQ	Oregon Department of Environmental Quality
OR	Oregon
OSPR	Office of Spill Prevention and Response
PCR	Pacific Coast Region
PPT	Parts Per Thousand
PRC	Public Resources Code
QV	Qualifying Voyage
ROV	Remotely Operated Vehicle
SD	Standard Deviation
SERC	Smithsonian Environmental Research Center
STEP	Shipboard Technology Evaluation Program
TAG	Technical Advisory Group
TBT	Tributyltin
µm	Micrometer
U.S.	United States
USCG	United States Coast Guard
WA	Washington
Water Board	State Water Resources Control Board
WDFW	Washington Department of Fish and Wildlife
WSA	Wetted Surface Area

I. PURPOSE

This report was prepared for the California State Legislature pursuant to Public Resources Code (PRC) Section 71212. According to statute, the California State Lands Commission (Commission) shall prepare, and update biennially, a report that includes an analysis of ballast and vessel fouling management practices reported by the industry, summarizes recent research addressing the release of nonindigenous species (NIS) by vessels, evaluates the effectiveness of California's Marine Invasive Species Program (MISP), and puts forth recommendations to improve the effectiveness of the program.

The activities from the first two and one half years of the program (January 2000 – June 2002) are detailed in the first biennial report to the Legislature (Falkner 2003). MISP activities from January 2003 through December 2004 are covered in Falkner et al. (2005), and Falkner et al. (2007) describes MISP progress between January 1, 2004 and June 30, 2006. This report summarizes MISP activities, research and analyses between July 1, 2006 and June 30, 2008.

II. INTRODUCTION

Nonindigenous Species and Vehicles of Introduction – "Shipping Vectors"

Also known as "introduced," "invasive," "exotic," "alien," or "aquatic nuisance species," nonindigenous species in marine, estuarine and freshwater environments may be transported to new regions through numerous human activities. Intentional and unintentional introductions of fish and shellfish, aquaculture, illegal releases from the aquarium and pet industries, floating marine debris, bait shipments, and accidental release from research institutions are just a few of the mechanisms, or vectors, by which organisms are introduced into United State (U.S.) waters (U.S. Commission on Ocean Policy 2004). In coastal environments, commercial shipping is the most important vector for invasion, accounting for or contributing to 79.5% of introductions to North America (Fofonoff et al. 2003).

Commercial ships transport organisms through two primary mechanisms - ballast water and vessel fouling. Ballast water is necessary for many functions related to the trim, stability, maneuverability, and propulsion of large seagoing vessels (National Research Council 1996). Vessels may take on, discharge, or redistribute water during cargo loading and unloading, as they encounter rough seas, or as they transit through shallow coastal waterways. Typically, a vessel takes on ballast water after cargo is unloaded in one port to compensate for the weight imbalance, and will later discharge water when cargo is loaded in another. This transfer of ballast water from "source" to "destination" ports results in the movement of many organisms from one region to the next. In this fashion, it is estimated that more than 7000 species are moved around the world on a daily basis (Carlton 1999). Moreover, each ballast water discharge event has the potential to release over 21.2 million individual planktonic animals (Minton et al. 2005).

Fouling organisms are aquatic species attached to or associated with submerged hard surfaces. These include organisms such as barnacles, algae, and mussels that physically attach to vessel surfaces, and mobile organisms such as worms, juvenile crabs, and amphipods (small shrimp-like animals) that associate with the attached fouling community. When vessels move from port to port, fouling communities are transported along with their "host" structure. Fouling organisms are introduced to new environments when they spawn (reproduce) or drop off their transport vector (i.e. vessels). Thus vessel fouling has been identified as one of the most important mechanism for marine NIS introductions in several regions, including North America, Hawaii and the North Sea (Ruiz et al. 2000a, Eldredge and Carlton 2002, Gollasch 2002).

NIS Impacts

The rate, and thus the risk, of species invasions has increased significantly during recent decades. In North America, the rate of reported invasions in marine and estuarine waters has increased exponentially over the last 200 years (Ruiz et al. 2000a). In the San Francisco Bay Estuary alone, a new species is believed to become established every 14 weeks (Cohen and Carlton 1998). One of the primary factors leading to this increase has been the vast expansion of global trade during the past 50 years, which in turn has lead to significantly more ballast water, fouled hulls, and associated organisms moving around the world. The increased speed of global trade has allowed many more potentially invasive organisms entrained in ballast tanks to survive under decreased transit times (Ruiz and Carlton 2003). Organisms that arrive "healthy" in recipient regions are more likely to thrive and reproduce in their new habitats.

Once established, NIS can have severe ecological, economic, and human health impacts in the receiving environment. One of the most infamous examples is the zebra mussel (*Dreissena polymorpha*) which was introduced to the Great Lakes from the Black Sea in the mid-1980s. Zebra mussels attach to hard surfaces in dense populations (as many as 700,000 per square meter) that clog municipal water systems and electric generating plants, resulting in costs of approximately a billion dollars a year (Pimentel et al. 2005). In such high densities, zebra mussels filter vast amounts of tiny floating plants and animals (plankton) from the water. Plankton support the foundations of aquatic food webs, and disruptions to this base appear to reverberate throughout the ecosystem. By dramatically reducing plankton concentrations and crowding out other species, zebra mussels have altered ecological communities, causing localized extirpation of native species (Martel et al. 2001) and declines in recreationally valuable fish species (Cohen and Weinstein 1998). In 2007, a cousin of the zebra mussel, the quagga mussel (*Dreissena rostriformis bugensis*), was discovered in the Colorado River Aqueduct System that serves southern California, and in 2008 the zebra mussel was discovered in San Justo Reservoir (California Department of Fish and Game 2008). Impacts to California's waterways and conveyance structures are only beginning to be calculated.

In San Francisco Bay, the overbite clam (*Corbula amurensis*) spread throughout the region's waterways within two years of being detected in 1986. The clam accounts for up to 95% of the living biomass in some shallow portions of the bay floor (Nichols et al. 1990). It has contributed to a persistent decline in the availability of plankton in the

Sacramento-San Joaquin River Delta (Jassby et al. 2002) which, in turn, may be a cause of declines in local fish populations (Feyrer et al. 2003).

In addition to impacting ecosystems and native species, NIS may also pose a risk to human health. The microorganisms that cause human cholera (Ruiz et al. 2000b) and paralytic shellfish poisoning (Hallegraeff 1998) have been found in the water and sediments in ballast tanks. The Chinese mitten crab (*Eriocheir sinensis*), first sighted in San Francisco Bay in 1992 (Rudnick et al. 2000, Rudnick et al. 2005), is a secondary host for the Asian lung fluke (*Paragonimus westermanii),* which is a known parasite of humans. Though as of 2008 no infected crabs have been found in California, there is significant risk of outbreak should the fluke, or an infected crab, arrive from overseas (California Sea Grant 2003, G. Ruiz pers. comm. 2008).

Prevention through Vector Management

Attempts to eradicate NIS after they have become widely distributed are often unsuccessful and costly (Carlton 2001). Between 2000 and 2006, over $7 million was spent to eradicate the Mediterranean green seaweed (*Caulerpa taxifolia)* from two small embayments (Agua Hedionda Lagoon and Huntington Harbour) in southern California (Woodfield 2006). Control is likewise extremely expensive. By 2010, over $12 million will have been spent in San Francisco Bay to control the Atlantic cordgrass (*Spartina alterniflora*) (M. Spellman, pers. comm. 2008). Prevention of species introductions through vector management is therefore considered the most desirable way to address the NIS issue.

Ballast Water Management

The vast majority of commercial vessels use ballast exchange as the primary method of ballast water management. Exchange has been the best compromise of efficacy, environmental safety, and economic practicality. Most vessels are capable of conducting exchange, and the management practice does not require any special structural modification to most vessels in operation.

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

Ballast water exchange (BWE) is an interim ballast water management tool, however, because of its variable efficiency and due to several operational limitations. Scientific research indicates that ballast water exchange typically eliminates between 70% and 99% of the organisms originally taken into a tank while at or near port (MacIsaac et al. 2002, Wonham et al. 2001, USCG 2001, Zhang and Dickman 1999, Parsons 1998, Cohen 1998), however the percentage of ballast water exchanged does not necessarily correlate with a proportional decrease in organism abundance (Choi et al. 2005, Ruiz and Reid 2007). A proper exchange can take many hours to complete, and in some circumstances, may not be possible without compromising safety due to adverse sea conditions or antiquated vessel design. Some vessels are regularly routed on short voyages, or voyages that remain within 50 nautical miles (nm) of shore. In such cases, the exchange process may create a delay or require a vessel to deviate from the most direct route.

Because of the aforementioned limitations on exchange, regulatory agencies and the commercial shipping industry have looked toward the development of effective ballast water treatment technologies as a promising management option. For regulators, ballast water treatment will provide NIS prevention including in situations where exchange may be unsafe or impossible. Technologies that eliminate organisms more effectively than exchange will provide a consistently higher level of protection to coastal ecosystems from NIS. For the shipping industry, the use of effective ballast water treatment systems will allow voyages to proceed along the shortest routes, in all operational scenarios, thereby saving time and money, and avoiding the safety issues related to BWE.

Until recently, financial investment in the research and development of ballast water treatment systems was limited and the advancement of ballast water treatment technologies slow. Many barriers have hindered the development of technologies including equipment design limitations, the cost of technology development, and the lack of guidelines for testing and evaluating performance. However, some shipping industry representatives, technology developers and investors considered the absence of a specific set of ballast water performance standards as a primary deterrent to progress. Performance standards would set benchmark levels for organism discharge that a technology would be required to achieve for it to be deemed acceptable for use in California. Developers requested these targets so they could design technologies to meet these standards (MEPC 2003). Without standards, investors were reluctant to devote financial resources towards conceptual or prototype systems because they had no indication that their investments might ultimately meet future regulations. For the same reason, vessel owners were hesitant to allow installation and testing of prototype systems onboard operational vessels. It was argued that the adoption of performance standards would address these fears, and accelerate the advancement of ballast treatment technologies. Thus in response to the slow progress of ballast water treatment technology development and the need for effective ballast water treatment options, state, federal and international regulatory agencies have adopted or are in the process of developing performance standards for ballast water discharge (See Section IV for more details).

Vessel Fouling Management

Mariners have long been aware of fouling as a nuisance to vessel operations as it relates to vessel performance and fuel efficiency. Fouling on the hull can create drag, increasing fuel consumption and potentially causing engine strain. In pipes, fouling can block inflowing seawater meant to cool machinery. To prevent such problems, common industry fouling management strategies include cleaning of underwater vessel surfaces and the use of antifouling coatings and systems.

The frequency with which most vessels clean their hull is usually based on the maintenance rules of their classification society (i.e. organization that establishes and applies technical standards for ship design, construction and survey). Vessel-specific programs may include a five-year cycle of annual in-water surveys and special out-of-water (dry dock) surveys. Most vessel owners commonly take advantage of required dry dockings to clean vessel hulls of fouling organisms and apply antifouling coatings. Because fouling continues to accumulate between required dry dockings, vessel owners also conduct interim in-water cleanings of the vessel hull. Out-of-water cleanings during dry dock allow for the containment of materials, including fouling organisms that are removed from the vessel hull. In-water cleanings, however, may allow organisms and paint debris to enter the water column. In-water cleaning, therefore, has increasingly come under scrutiny due to concerns about water quality and NIS introductions.

The application of antifouling coatings, either biocide-containing or biocide-free, is another strategy to combat fouling organisms. Biocidal antifouling coatings are applied during dry dock and are used to deter the attachment of fouling organisms by leaching toxic compounds, such as tributyltin (TBT), copper, and zinc. However, these compounds are also detrimental to non-target organisms in the surrounding environment, and thus many regions have adopted or are considering restrictions on their use. TBT is a highly effective antifouling agent that has been restricted by many nations in line with the 2001 International Maritime Organization (IMO) Convention on the Control of Antifouling Systems on Ships (IMO 2001), which bans the use of all organotin compounds in antifouling coatings as of September 17, 2008. Most non-TBT coatings available utilize copper compounds as biocides, though they are generally less effective and their longevity is shorter than TBT (Lewis 2002). In addition, bans and restrictions on copper-based paints are being considered in a number of places. Biocide-free silicon-based coatings are available, but are more costly to apply and are currently only practically effective for active, swift vessels (those that cruise over 15 knots) (Lewis 2002, International Marine Coatings 2006). As new coatings are developed and vessels shift to different antifouling coatings with potentially lower efficacies, there are concerns that the risk posed by fouling as a transport mechanism for NIS may increase (Nehring 2001).

Despite the efforts of the maritime industry to minimize vessel fouling by employing hull cleaning and antifouling coatings, recent studies indicate that fouling is still an important mechanism by which nonindigenous organisms can be transported to new regions (see Takata et al. 2006). Vessels that move at slow speeds, spend long periods in port, or are repainted infrequently, tend to accumulate more organisms (Coutts 1999). Though much of the outer surface of vessel hulls are treated with antifouling paints, certain locations, particularly those that are not exposed to shear forces, have been found to be more prone to fouling, including dry docking support strips, waterlines, propellers, rudders, sea chests, and worn or unpainted areas (Coutts et al. 2003, Minchin and Gollasch 2003, Coutts and Taylor 2004, Ruiz et al. 2005). These “niche” areas have the potential to harbor diverse assemblages of NIS. Although this vector can have a high level of NIS introduction risk associated with it, managers and policy makers have only recently been focusing resources toward it (See Section IV for more details).

III. REGULATORY OVERVIEW

International, U.S. federal and state regulations governing the management of ballast water share several similar components. All allow ballast water exchange as an acceptable method of ballast water management, and many programs provide some type of exemption should a vessel or its crew become endangered by the exchange process. All accept approved alternative ballast water treatments in anticipation of the development of effective technologies. All but the IMO require the completion and submission of forms detailing ballast management and discharge practices. While ballast water management has seen substantial progress over the past decade, until recently little attention has been directed at managing NIS introductions via vessel fouling. Currently, no country has adopted national regulations that specifically address NIS introductions from commercial vessel fouling. The only states that have statutes addressing commercial vessel fouling concerns are California and Hawaii.

International Programs

International Maritime Organization (IMO)

The IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) in February of 2004, which becomes effective one year after ratification by 30 countries representing 35% of the world shipping tonnage (IMO 2005). As of September 30, 2008, 16 countries representing 14,24% of the world shipping tonnage, had signed the BWM Convention (IMO 2008). The BWM Convention requires vessels to conduct exchange at least 50 nm from shore in waters at least 200 meters (m) deep, though it is preferred that exchange be conducted 200 nm offshore (IMO 2005). The BWM Convention also imposes performance standards for the discharge of ballast water (Regulation D-2) with an associated implementation schedule based on vessel ballast water capacity and status as a new or existing vessel (Tables III-1 and III-2).

Table III-1. Ballast Water Treatment Performance Standards

Organism Size Class	IMO Regulation D-2[1]	California[1,2]
Organisms greater than 50 µm[3] in minimum dimension	< 10 viable organisms per cubic meter	No detectable living organisms
Organisms 10 – 50 µm in minimum dimension	< 10 viable organisms per ml[4]	< 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[5]/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] See Implementation Schedule (Table III-2) for dates by which vessels must meet California Interim Performance Standards and IMO Ballast Water Performance Standards.
[2] Final discharge standard for California, beginning January 1, 2020, is zero detectable living organisms for all organism size classes.
[3] Micrometer – one-millionth of a meter
[4] Milliliter – one-thousandth of a liter
[5] Colony-forming unit – a measure of viable bacterial numbers

Table III-2. Implementation Schedule for Performance Standards

Ballast Water Capacity of Vessel	Standards apply to new vessels in this size class constructed on or after	Standards apply to all other vessels in this size class beginning in[1]
< 1500 metric tons	2009 (IMO)[2] /2010 (CA)[3]	2016
1500 – 5000 metric tons	2009 (IMO) /2010 (CA)	2014
> 5000 metric tons	2012	2016

[1] In California the standard applies to vessels in this size class as of January 1 of the year of compliance. The IMO Convention applies to vessels in this size class not later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of delivery of the ship in the year of compliance (IMO 2005)
[2] IMO has pushed back the initial implementation of the performance standards for vessels constructed in 2009 in this size class until the vessel's second annual survey, but no later than December 31, 2011 (IMO 2007).
[3] California Senate Bill 1781 (Chapter 696, Statutes of 2008) delayed the initial implementation of performance standards for vessels in this size class from January 1, 2009 to January 1, 2010.

Until the BWM Convention is ratified, it cannot be enforced upon any ships (IMO 2007). Because insufficient time remains to ratify the BWM Convention and have it enter into force before the first date of performance standards implementation in 2009, the IMO General Assembly adopted Resolution A.1005(25), on November 29, 2007. The Resolution delays the date by which vessels with keels laid in 2009, and with a ballast water capacity of less than 5000 MT must comply with Regulation D-2, from 2009 until the vessel's second annual survey, but no later than December 31, 2011 (IMO 2007). For now, the implementation dates for all other vessel size classes remain the same as originally proposed (Table III-2).

The IMO has also adopted the International Convention on the Control of Harmful Antifouling Systems on Ships in October 2001 (AFS Convention) (IMO 2001). The AFS Convention has been ratified by 35 member states representing 62.7% of world shipping tonnage and entered into force on September 17, 2008. The AFS Convention prevents the use of harmful organotins (including TBT) in antifouling paints used on ships and establishes a mechanism to prevent the potential future use of other harmful substances in antifouling systems.

Australia and New Zealand

Australia requires ballast water exchange outside of the 12 nm Australian limit, in waters greater than 200 m deep, and ballast water from "high risk" areas is prohibited

(Australian Quarantine and Inspection Service 2005). Australia is currently implementing a new National System for the Prevention and Management of Marine Pest Incursions. This National System will work to create domestic ballast water regulations as well as some form of biofouling regulations or guidelines (Australia Department of Agriculture, Fisheries, and Forestry 2006).

In New Zealand, vessels must conduct mid-ocean exchange in waters at least 200 nm offshore and must obtain permission before discharging, even if ballast water has been exchanged. No discharge is allowed if vessels contain water from the "high risk" Australian ports of Tazmania and Port Philip Bay (New Zealand Ministry of Fisheries 2005).

North America - Canada and Mexico

Canada adopted mandatory ballast water management regulations in 2006. Vessels arriving to Canadian ports with ballast originating from outside of Canadian waters must conduct exchange more than 200 nm from shore in at least 2000 m of water. Additionally, vessels transiting solely within 200 nm of land must conduct exchange at least 50 nm from shore at a minimum depth of 500 m. Alternative ballast water exchange zones may be established within 200 nm for vessels that are unable to conduct mid-ocean exchange for safety reasons. These requirements do not apply to vessels transiting exclusively within Canadian waters or the waters of the Great Lakes (Transport Canada 2006).

Mexico currently has no legislation governing the management of ballast water or vessel fouling.

Federal Regulations

The authority to regulate ballast water discharges in the United States has recently shifted to include the U.S. Environmental Protection Agency (EPA) in addition to the U.S. Coast Guard (USCG). As of February 6, 2009, the EPA must regulate ballast water, and other discharges incidental to normal vessel operations, under the Clean

Water Act (CWA). This requirement stems from the 2003 lawsuit filed by Northwest Environmental Advocates et al. against the U.S. EPA in U.S. District Court, Northern District of California (Nw. Envtl. Advocates v. U.S. EPA, No. C 03-05760 SI, 2006 U.S. Dist. LEXIS 69476 (N.D. Cal. Sept. 18, 2006)), challenging a regulation originally promulgated under the CWA. The regulation at issue, 40 Code of Federal Regulations (CFR) Section 122.3(a), exempted effluent discharges "incidental to the normal operations of a vessel" from regulation under the National Pollution Discharge Elimination System (NPDES). The plaintiffs sought to have the regulation declared *ultra vires,* or beyond the authority of the EPA under the CWA. On March 31, 2005, the district court concluded that the EPA had exceeded its authority under the CWA in exempting these discharges from permitting requirements. The district court vacated Section 122.3(a), effective September 30, 2008. EPA filed an appeal with the Ninth Circuit U.S. Court of Appeals. On July 23, 2008, the appellate court affirmed the decision of the district court. On August 27, 2008, EPA filed a motion with the U.S. District Court, Northern District of California for an extension of the CWA exemption vacature until December 19, 2008. The motion had the consent of the plaintiffs and was granted in September, 2008. An additional extension until February 6, 2009 was granted in December, 2008.

In December, 2008, EPA issued the NPDES Vessel General Permit for discharges incidental to the normal operation of vessels. In large part, the NPDES Vessel General Permit defers the management of ballast water discharges to existing USCG regulations found in 33 CFR Part 151. The USCG regulations, developed under authority of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, revised and reauthorized as the National Invasive Species Act of 1996, require ballast water management (i.e. ballast water exchange) for vessels entering U.S. waters from outside of the 200 nm Exclusive Economic Zone (EEZ) of the U.S. Vessels that experience undue delay, however, are exempted from the ballast water management requirements. The NPDES Vessel General Permit includes provisions for ballast water management of vessels transiting between Captain of the Port Zones along the Pacific Coast of the U.S. (i.e. Pacific Nearshore Voyages). These vessels are required to conduct ballast water exchange 50 nm from shore in waters at least 200 m deep. There is no management requirement, however, for vessels traveling “coastally” or wholly within the 200 nm EEZ bound for U.S. ports on the Gulf or Atlantic coasts.

Vessels may use onboard treatment systems to meet the current ballast water management requirements if that system is approved by the Commandant of the USCG. However, as of December, 2008 no approval process has been implemented. The NPDES Vessel General Permit does not include performance standards for the discharge of ballast water, though standards may be included in the next iteration of the permit (in 2013) based on the outcome of the anticipated USCG rulemaking on ballast water treatment standards, and if treatment technologies are determined to be commercially available and economically achievable to meet those standards.

The NPDES Vessel General Permit also limits other discharges incidental to the normal operation of vessels, including discharges originating from antifouling hull coatings, underwater ship husbandry, and seawater piping biofouling protection. Antifouling hull coatings and chemicals used for seawater piping biofouling protection must be either registered according to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) or must not contain biocides or toxic materials banned for use in the U.S (e.g. TBT). Under the permit, underwater ship husbandry must be conducted in a manner that minimizes the discharge of fouling organisms and antifouling hull coatings and the cleaning of copper-based antifouling coatings must not produce a visible plume of paint.

State Programs

Great Lakes Region - In 2008, regulations were established requiring all ‘NOBOB’ vessels (vessels declaring No Ballast On Board) to conduct a salt-water flush of their ballast tanks prior to entering the St. Lawrence Seaway. This regulation closed a loophole in prior regulations and addresses the residual ballast water and sediments in otherwise empty ballast tanks.

In January 2007, Michigan implemented a general permit program to cover maritime operations and the discharge of ballast water into state waters. The general permit requires ballast treatment systems for all ocean-going vessels intending to discharge in Michigan waters. The state has approved four treatments for use under the general permit including sodium hypochlorite, chlorine dioxide, ultraviolet light, and de-oxygenation. Vessel operators may propose alternative ballast treatment options that may be covered under an individual permit. There is broad support for this program amongst other states of the Great Lakes region.

Effective July 1, 2008 Minnesota state law requires vessels operating in state water to have both a ballast water record book and a ballast water management plan approved by the Minnesota Pollution Control Agency (MPCA). Additionally, the MPCA has issued a State Disposal System general permit for ballast water discharges into Lake Superior and associated waterways. Under the permit, vessels are required to comply immediately with approved best management practices. No later than January 1, 2012 for new vessels and January 1, 2016 for existing vessels, all discharges must comply with the IMO D-2 performance standards.

Hawaii – In October 2007, the Department of Land and Natural Resources adopted new rules to manage ballast discharge from vessels operating in Hawaiian waters. The regulations require a vessel specific management plan, advance reporting to the state, and mid-ocean (greater than 200 nm from any coast) BWE for any ballast originating from outside state waters.

Washington - Washington implemented ballast water management requirements in 2000. Vessels arriving from outside of the U.S. EEZ are required to conduct exchange at least 200 nm offshore. Coastally transiting vessels are required to conduct exchange at least 50 nm offshore, with the exception that exchange is not required if the ballast water is common to the state and has not been mixed with waters outside of the Columbia River system (Washington Department of Fish and Wildlife 2003). In 2001, the Washington Department of Fish and Wildlife (WDFW) established interim ballast water discharge standards to provide a target for technology developers (WAC 220-77-095). The standard requires the inactivation or removal of 95 percent of zooplankton and 99 percent of phytoplankton and bacteria in ballast water. The Washington Ballast Water Work Group is currently in the process of revising Washington's performance standards from a percent reduction-based standard to a concentration-based one (number of organisms per unit volume). Additional revisions are also being made to the treatment technology approval process. WDFW staff expects the new regulations to be adopted in early 2009 (A. Pleus, pers. comm. 2008)

Oregon - Oregon began requiring ballast water management in 2002. Vessels arriving from outside the EEZ are required to conduct exchange at least 200 nm offshore. Oregon's legislation also established the first regulations designed to reduce the risk of intra-coastal transport of NIS. Vessels traveling within 200 nm of shore and entering Oregon from areas north of 50 degrees North latitude or south of 40 degrees North latitude must conduct exchange at least 50 nm from shore in at least 200 m of water (Simkanin and Sytsma 2006). In 2007, Oregon's Legislature adopted a number of recommendations put forth by the Oregon Ballast Water Task Force. The Legislature made funding available to Oregon's Department of Environmental Quality (ODEQ) to support ballast water data collection, compliance monitoring and enforcement efforts and staff support for additional Task Force activities. The ODEQ recently completed a legislative report (Hooff 2008) that identified several needs and actions, including additional funding and staff to effectively implement existing program, legislative authority for ODEQ to board and inspect regulated vessels and authority to develop rules defining ballast water treatment technology standards.

IV. CALIFORNIA'S MARINE INVASIVE SPECIES PROGRAM

Legislation

California's initial NIS-related legislation, Assembly Bill (AB) 703 (Chapter 849, Statutes of 1999), addressed the ballast water invasion threat at a time when national regulations were not mandatory. The Ballast Water Management for Control of Nonindigenous Species Act established a statewide multi-agency program to prevent and control NIS in state waters. In addition to the Commission, the California Department of Fish and Game (CDFG), the State Water Resources Control Board (Water Board) and the Board of Equalization (BOE) were charged to direct research, monitor vessel arrivals and species introductions, develop policy and regulations, and to cooperatively consult with one another to address the NIS problem (Falkner 2003). AB 703 required that vessels entering California from outside the EEZ manage ballast before discharging into state waters. Vessels were required to exchange ballast water 200 nm offshore or treat ballast water with an approved shipboard or shore-based treatment system. There was, however, no management requirement for vessels transiting between ports wholly within the EEZ, despite evidence that "intra-coastal" transfer may facilitate the spread of NIS from one port to the next (Lavoie et al. 1999, Cohen and Carlton 1995). The Legislature, sensitive to the uncertainties surrounding the development of an effective ballast water management program for the State, included a sunset date of January 1, 2004 in AB 703.

In 2003 AB 433 (Chapter 491, Statutes of 2003) was passed, reauthorizing and enhancing the 1999 legislation to include many of the recommendations of the program's first biennial report (Falkner 2003). The bill, referred to as the Marine Invasive Species Act (Act), reauthorized, enhanced, and renamed the State's ballast water management program, creating the Marine Invasive Species Program. The Act applies to all U.S. and foreign vessels over 300 gross registered tons that arrive at a California port or place. The Act requires all vessels to have a ballast water management plan and ballast tank logbook specific to the vessel. A ballast water reporting form detailing the ballast water management practices must be submitted by each vessel upon departure from each port call in California.

The Act also directed the Commission to adopt regulations for vessels transiting within the Pacific Coast Region (PCR). The PCR is defined as coastal waters of the Pacific Coast of North America east of 154 degrees West longitude and north of 25 degrees North latitude, exclusive of the Gulf of California (Figure IV.1). The coastal regulations, which were finalized in March 2006, require vessels arriving to California (CA) ports after operating within the PCR to conduct ballast water exchange 50 nm from shore in waters at least 200 m deep prior to discharging into California waters.

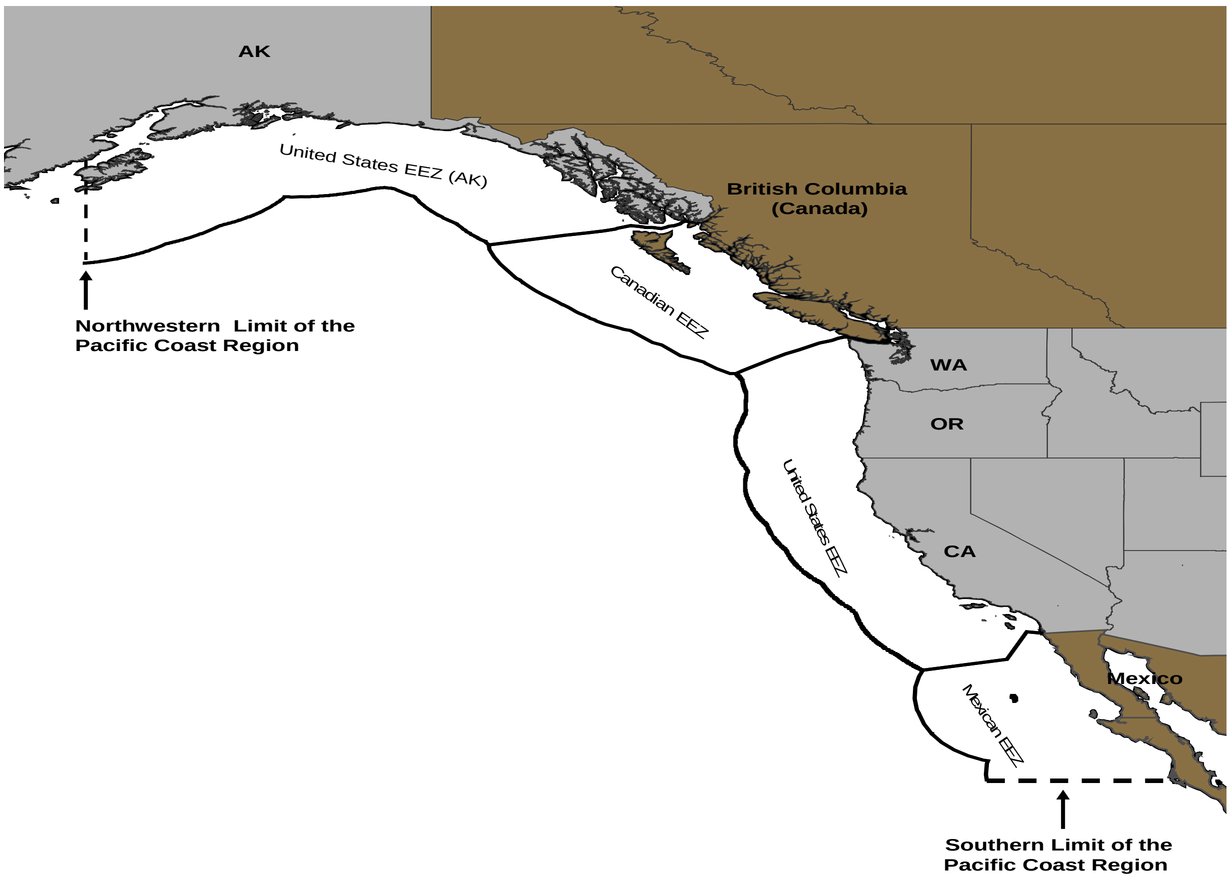

Figure IV.1. Exclusive Economic Zones of Pacific North America (200 nm), and the Pacific Coast Region (PCR). The PCR extends from approximately Cooks Inlet, AK (154° west longitude) to ¾ down the Baja Peninsula (25° north latitude) and 200 nm offshore.

Performance Standards

The Act further directed the Commission to recommend performance standards for the discharge of ballast water to the State Legislature in consultation with the Water Board, the USCG and a technical advisory panel (PRC Section 71204.9). The Commission submitted the recommended standards and information on the rationale behind its selection in a report to the State Legislature in January of 2006 (Falkner et al. 2006). By the fall of that same year, the Legislature passed the Coastal Ecosystems Protection Act of 2006, directing the Commission to adopt the recommended standards and implementation schedule through the California rulemaking process by January 1, 2008. The Commission completed that rulemaking process in October, 2007 (2 California Code of Regulations (CCR) (see Tables III-1 and III-2).

The law also required the Commission to prepare a report for the Legislature assessing the efficacy, availability and environmental impacts, including the effect on water quality, of currently available technologies for ballast water treatment. The final report, approved by the Commission in December 2007, evaluated 28 ballast water treatment systems for potential compliance with California's performance standards and water quality objectives (see Dobroski et al. 2007).

Of the 28 systems reviewed, only 20 had results of biological efficacy testing publicly available. For those 20, the methods used to evaluate efficacy were variable, and the results were frequently presented in metrics that were not comparable to California's standards. Thus, it was often impossible to compare the available data for a single system against all of the organism size classes specified by California's performance standards. On a system-by-system basis and across all testing platforms and scales (laboratory, dockside, shipboard), no single technology demonstrated the capability to meet all of California's performance standards.

Based on the conclusions drawn in the report, and in an effort to strengthen the Marine Invasive Species Program's management of NIS, staff recommended that the California Legislature: 1) Change the implementation date for new vessels with ballast water capacity less than 5000 metric tons from 2009 to 2010, and require the Commission to prepare an update of the technology assessment report on or before January 1, 2009; 2) Authorize the Commission to amend the ballast water reporting requirements via regulation; and 3) Support continued research promoting technology development.

In response to the recommendations in the technology assessment report (Dobroski et al. 2007), the Legislature passed new legislation in 2008. Senate Bill 1781 amended PRC Section 71205.3(a)(2) and delayed the initial implementation of the interim performance standards from January 1, 2009 to January 1, 2010. The bill also requires that an update of the technology assessment report be provided to the Legislature on or before January 1, 2009 (see Dobroski et al. 2009).

Additionally, Assembly Bill 169 was proposed to provide the Commission with authority to modify the existing ballast water reporting form to capture additional information regarding shipboard treatment technologies. Although this bill had broad bipartisan support, and was passed by both California houses during the 2008 session, it, along with hundreds of other bills, was vetoed by the Governor due to the late passage of the budget. The Commission intends to sponsor similar bill language during the 2009 legislative session.

The implementation of California's performance standards require MISP staff to move forward on several new projects and rulemaking actions. First and foremost has been the development of ballast water treatment technology testing guidelines to provide technology vendors with a standardized approach to evaluating treatment system performance relative to California's discharge standards and water quality objectives. Verification testing according to the guidelines will not required by the Commission, nor will the Commission be approving ballast water treatment systems for use in California waters. Staff developed these protocols to help ensure a uniform, cost-effective, scientifically-rigorous, independent assessment of system performance and environmental safety. These testing guidelines were developed in consultation with the Water Board, USCG, the EPA's Environmental Technology Verification program staff, and an expert panel of scientists. The guidelines and an associated information sheet were completed and distributed in October, 2008. Initial response from industry has been positive.

Commission staff is also in the process of developing regulations to inform the selection of sampling points (i.e. location) and sampling facilities (i.e. equipment) on vessels to facilitate the collection of ballast water samples to assess compliance with the performance standards. PRC Section 71206 requires the Commission to "take samples of ballast water and sediment from at least 25 percent of the arriving vessels…and make other appropriate inquiries to assess the compliance of any vessel subject to this division." The new regulation will clarify the necessity of taking samples during or at the point of ballast water discharge (per 2 CCR § 2291 *et seq*., "Performance Standards for the Discharge of Ballast Water for Vessels Operating in California Water"). Additionally, the regulations will offer guidance on the selection of sampling facilities so as to reduce or eliminate the possibility of artificially induced organism mortality associated with passage through the sampling apparatus.

Finally, Commission staff is developing procedures and protocols for use by Commission Marine Safety Inspectors to verify vessel compliance with the performance standards. These enforcement protocols will be drafted in association with the same panel of experts involved in the writing of the technology testing guidelines. The protocols should be ready for preliminary field testing in mid-2009 in anticipation of the initial implementation and enforcement of the performance standards on January 1, 2010.

Vessel Fouling

The Marine Invasive Species Act directed the Commission to analyze and evaluate the risk of NIS release from commercial vessel vectors other than ballast water (essentially vessel fouling) in a report to the Legislature, developed in consultation with a technical advisory group. The report (see Takata et al. 2006) was approved by the Commission and submitted to the Legislature in April 2006. It summarized the analysis, evaluation, and consultations conducted by the Commission in accordance with the Act, and offered recommendations to reduce the discharge of NIS from vessel fouling.

In October 2007, the Governor signed AB 740 (Chapter 370, Statutes of 2007) which incorporated the recommendations in Takata et al. (2006), and further amended the Marine Invasive Species Act to include provisions requiring the removal of fouling organisms from vessel hulls, piping, propellers, sea chests and other submerged portions of vessels on a regular basis. AB 740 also required vessel owners/operators to provide information to the Commission annually on vessel hull maintenance practices including drydocking, in-water cleaning of the submerged surfaces of the vessel, and the application of antifouling paint to the vessel. A draft Hull Husbandry Reporting Form was developed in consultation with the maritime industry in late-2007 and implemented January 1, 2008. The rulemaking package to formally adopt the final Hull Husbandry Reporting Form via regulations was approved in December 2008.

The Commission's Marine Invasive Species Program

The Marine Facilities Division of the California State Lands Commission administers the Marine Invasive Species Program. To carry out the requirements of the law and to ensure effective management, the MISP is separated into three key components: 1) Data Management, 2) Field Operations, and 3) Program Administration (Figure IV.2). All program components contribute to outreach activities in the form of technical advisory groups, dispersal of educational materials, and public outreach at state, national and international events.

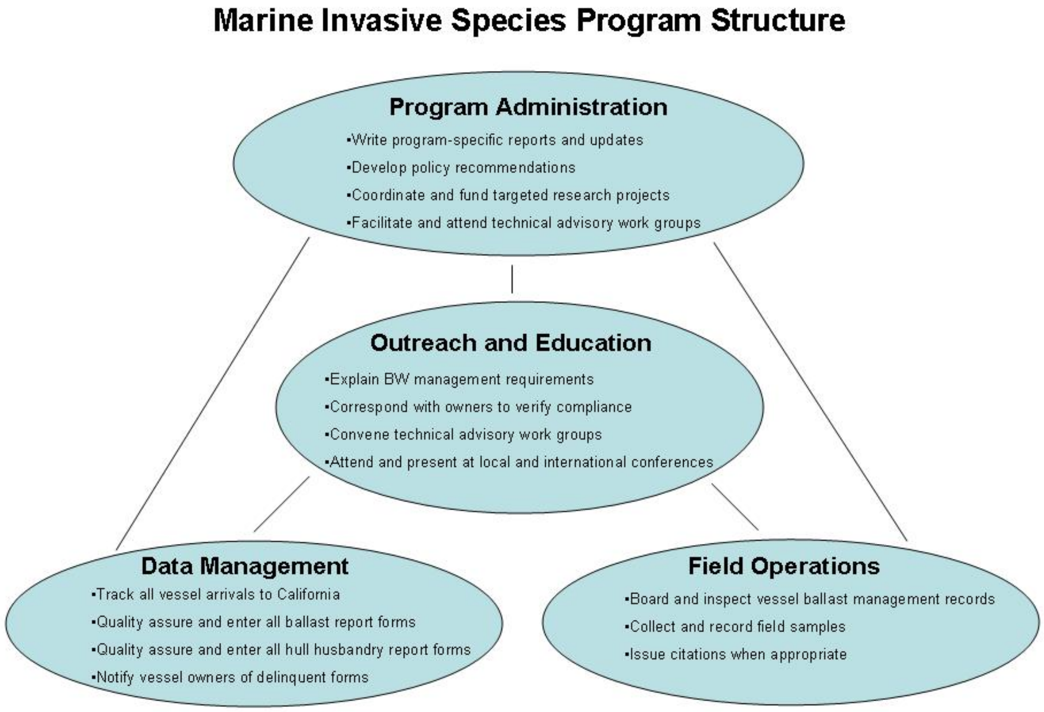

Figure IV.2. Schematic Model Showing MISP Components and Associated Functions

MISP data management staff track ballast water management, compliance and enforcement of more than 900 vessel arrivals every month. This involves the standardized, step-wise tracking of all vessel arrivals, reviewing ballast water management reports to identify and clarify inconsistencies, and issuing delinquency notices. In order to verify that vessels on qualifying voyages submit Ballast Water Reporting Forms, received forms are matched with arrival data from the Northern and Southern California Marine Exchanges. Late and missing form notifications are sent to agents representing vessels that neglect to submit forms. Between July 2006 and June 2008, over 22,000 ballast water reporting forms were received, reviewed, entered into a database, and reconciled with actual port arrival data. MISP data management staff also track Hull Husbandry Reporting Form submission and compliance. Submitted forms are reviewed for inconsistencies before being entered into the MISP database.

MISP field operations are based out of offices located in Northern and Southern California. Commission Marine Safety personnel at these field offices implement an extensive vessel monitoring program to ensure compliance with the law. Marine Safety personnel serve as an important, direct conduit of information to vessel crews, particularly in an industry where vessels frequently change ownership, routes, and crew composition. All vessels are required to submit to compliance inspections, which include sample collection of ballast water, examination of ballast water logbooks, engine books, report forms, and any additional inquiries as needed. The Marine Invasive Species Act specifies that at least 25% of arriving vessels are to be inspected, with enforcement administered through the imposition of administrative civil and criminal penalties.

During vessel visits, Marine Safety personnel verbally explain paperwork, reporting, and ballast management obligations, and point out where a vessel may be falling short of compliance. Staff also sample ballast tanks when discharge is intended. The samples are analyzed for salinity (a measure of the salt concentration in water), which is currently the best available method to indicate if ballast water has been exchanged. Salinity levels are expected to indicate whether ballast water originated from coastal or mid-ocean areas because coastal regions tend to have more freshwater runoff. Coastal regions often exhibit lower salinities than open ocean water, which maintains an approximate reading of 35 PPT (parts per thousand). When a violation is found, a citation is given to the vessel crew and a hard copy is retained in Commission files. A copy of the violation and enforcement letter is also sent to the vessel owner. The vessel is then targeted for re-inspection upon its next visit to California waters. The Commission finds that working with vessel owners in this way creates a positive working relationship with the industry that results in higher compliance rates.

In addition to verifying compliance with the management requirements of the Act, the inspection program plays a key role in MISP activities by providing vessel access for research projects, and outreach and education for the maritime industry. Beginning in 2008, Commission Marine Safety personnel began assisting the Smithsonian

Environmental Research Center (SERC) on a project designed to compare key chemical tracers found in ballast water measured from a hand-held device - the Ballast Exchange Assurance Meter (BEAM) - with SERC's lab-based fluorometer. Commission Marine Safety personnel board vessels and collect water samples for this project (see Research, Ballast Water Exchange Verification for more details). Ballast water (both exchanged and un-exchanged) will be sampled from approximately 40 vessels of various types carrying foreign and/or domestic ballast water.

MISP administrative staff works closely with data management and field staff in order to assess vessel compliance with the requirements of the Act, develop policy recommendations to the Legislature, and coordinate research to reduce the spread of NIS from vessel vectors. Administrative staff regularly consults with a wide array of scientists, state and federal regulators, non-government organizations and the maritime industry to evaluate current knowledge and guide policy recommendations. The administrative component of the MISP also coordinates and funds targeted, applied research that advances the development of strategies for NIS prevention from the commercial ballast water and vessel fouling vectors. Other functions of the administrative staff include the development and review of NIS-related environmental documents.

One of the key components for the success of the MISP continues to be the close communication, coordination, and outreach that occurs between the Commission, the maritime industry, and other state agencies. In general, outreach activities are designed to coordinate information exchange among scientists, legislators, the regulated industry, non-governmental organizations and regulating agencies. Data management staff regularly corresponds with vessel owners to verify compliance with ballast water reporting requirements. Field operations staff interfaces with the industry on a regular basis to verify and educate crewmembers on ballast water and vessel fouling management and reporting requirements. Program administrative staff are active members in several ballast water-related work groups including: the West Coast Ballast Outreach Project; Oregon's Ballast Water Management Task Force; the

Washington Ballast Water Work Group, the Aquatic Nuisance Species Task Force; and the Pacific Ballast Water Group. Wherever possible, Staff works with the scientific community, other West Coast state representatives, Federal agencies, and the international maritime community to standardize vessel management programs. This coordination and standardization has improved support and compliance by the maritime industry, and has encouraged knowledgeable cross-disciplinary input as policies are crafted.

In addition to the regulatory directives, the Act included mandates to address gaps identified during the beginning years of the MISP that would improve the Commission's ability to prevent NIS introductions from commercial vessel vectors. The MISP has formed several Technical Advisory Groups (TAGs) that discuss policy and regulatory matters related to general NIS management and the implementation of legislative mandates. TAGs include representatives from the maritime industry, ports, state and federal agencies, environmental organizations, and research institutions, and serve several critical outreach functions. They serve as a forum through which information and ideas can be exchanged, and ensure that rulemaking decisions consider the best available science as well as the concerns of affected stakeholders. TAG members also relay information to their respective constituencies, keeping them abreast of Commission actions and activities.

V. DATA ANALYSIS

Trends in Statewide Vessel Traffic

Ballast Water Reporting Requirements

Under the Marine Invasive Species Act, the master, owner, operator, agent, or person in charge of a vessel is required to submit the Ballast Water Reporting Form upon departure from each port or place of call in California. A qualifying voyage (QV) for the purpose of reporting and Fee submittal includes all vessels greater than 300 gross registered tons operating in California waters. The Commission is required to compile the information obtained from submitted reports to assess shipping patterns and

compliance with the requirements of the Act. Utilizing a state database created under AB 703, and modified pursuant to AB 433, the Commission can assess: (1) QV traffic patterns (see *Vessel Traffic Patterns*, Section V); (2) rates of compliance with mandatory reporting requirements (see *Ballast Water Reporting Compliance*, Section V); (3) patterns of ballast water discharge and management according to vessel class and geographic area (see *Ballast Water Discharge Patterns*, Section V); and (4) rates of compliance with mandatory ballast water management (see *Ballast Water Management Compliance*, Section V). This information is assessed for both coastal (within the Pacific Coast Region (PCR)) and foreign (arriving from outside of the PCR) vessel traffic to California ports. The PCR extends from approximately Cooks Inlet, AK (154° west longitude) to ¾ down the Baja Peninsula (25° north latitude) and 200 nm offshore.
The Commission relies on three primary sources of data for assessment of ballast water management practices. These include: (1) ballast water information reported directly to the Commission via the Ballast Water Reporting Form by vessels operating in California waters; (2) transportation statistics collected from the two California Marine Exchanges, individual ports, and shipping agents; and (3) verification inspections of vessels operating in California waters conducted statewide by Commission Marine Safety personnel.

Reporting and ballast water management requirements are assessed at two different geographic scales: statewide and local port system. Through the original legislation (AB 703) and as modified by regulations, the Commission has identified 19 port zones, including Humboldt Bay, Sacramento, Stockton, Carquinez, Richmond, San Francisco, Oakland, Redwood, Moss Landing, Monterey, Morro Bay, Santa Barbara, Carpinteria, Port Hueneme, El Segundo, Los Angeles-Long Beach (LA-LB), Avalon/Catalina, Camp Pendleton, and San Diego (Figure V.1).

Figure V.1. California Port Zones

Ballast Water Reporting Compliance

In late 2000, the Commission initiated an electronic procedure to notify ship agents and owners of missing Ballast Water Reporting Forms. This electronic notification process, coupled with education and outreach to the shipping industry, has resulted in high compliance with ballast water reporting requirements. For purposes of data analysis and reporting, the six-month period from January through June will be indicated as “a” and the period from July through December will be indicated as “b”. Between 2006b-2008a, 99% of QVs to California ports or places were compliant with reporting requirements, and 83% of QVs were both compliant and submitted forms on time (Figure V.2).

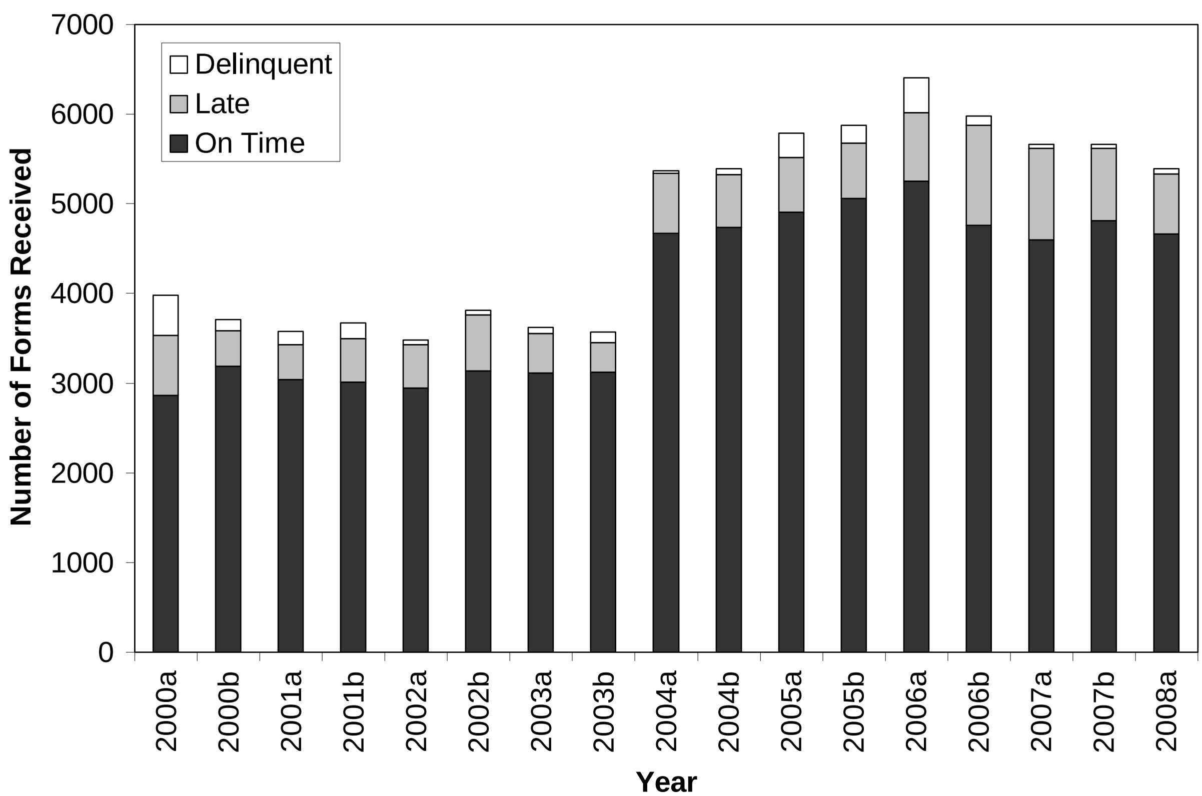

Figure V.2. Ballast Water Reporting Form Compliance
(a = January to June, b = July to December)

Vessel Traffic Patterns

Based upon the information provided by vessels on the ballast water reporting forms, the Commission assesses patterns of vessel traffic and ballast water management. Vessel traffic to California ports increased steadily through 2006 to a high of 5645 QV arrivals per six month period in 2006b (Figure V.3). Since that time, arrivals have leveled off; 5382 QVs arrived to California ports in 2008a.

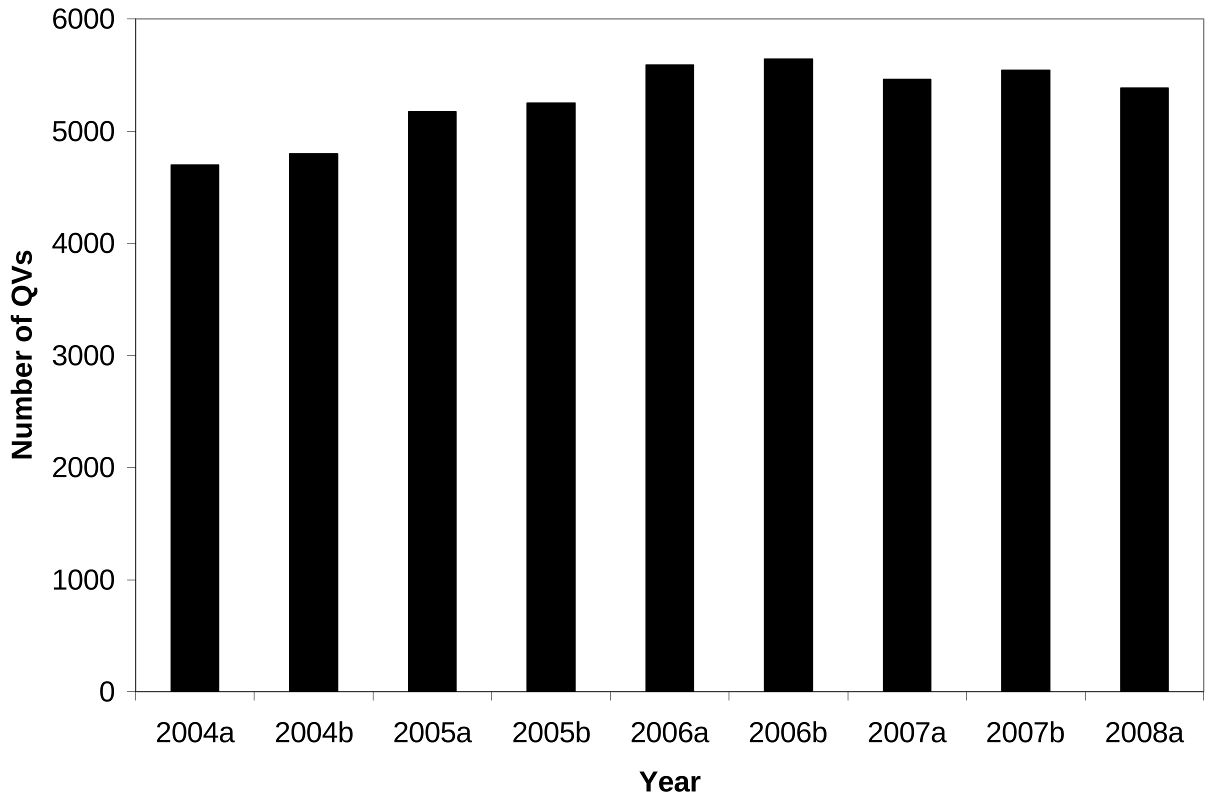

Figure V.3. Number of Qualifying Voyage (QV) Arrivals to California Ports (a = January to June, b = July to December)

On a port-by-port basis, the pattern of QV arrivals has remained generally consistent over the past two years (Figure V.4). The LA-LB Port Complex received 50% of all arrivals to California ports between 2006b and 2008a. During this time, LA-LB also led the state in both foreign and coastal arrivals, although foreign arrivals accounted for almost two-thirds (64%) of traffic to LA-LB (Figure V.4). The Port of Oakland received comparable numbers of coastal arrivals annually as LA-LB, but less than one-tenth as many foreign arrivals (Figure V.4). Arrivals from foreign ports accounted for 15% of QV arrivals to the Port of Oakland between 2006b and 2008a. The Port of San Diego saw a 20% increase (= 37 QVs) in foreign vessel arrivals between 2006b and 2008a, and now receives more foreign arrivals per six-month period than Oakland.

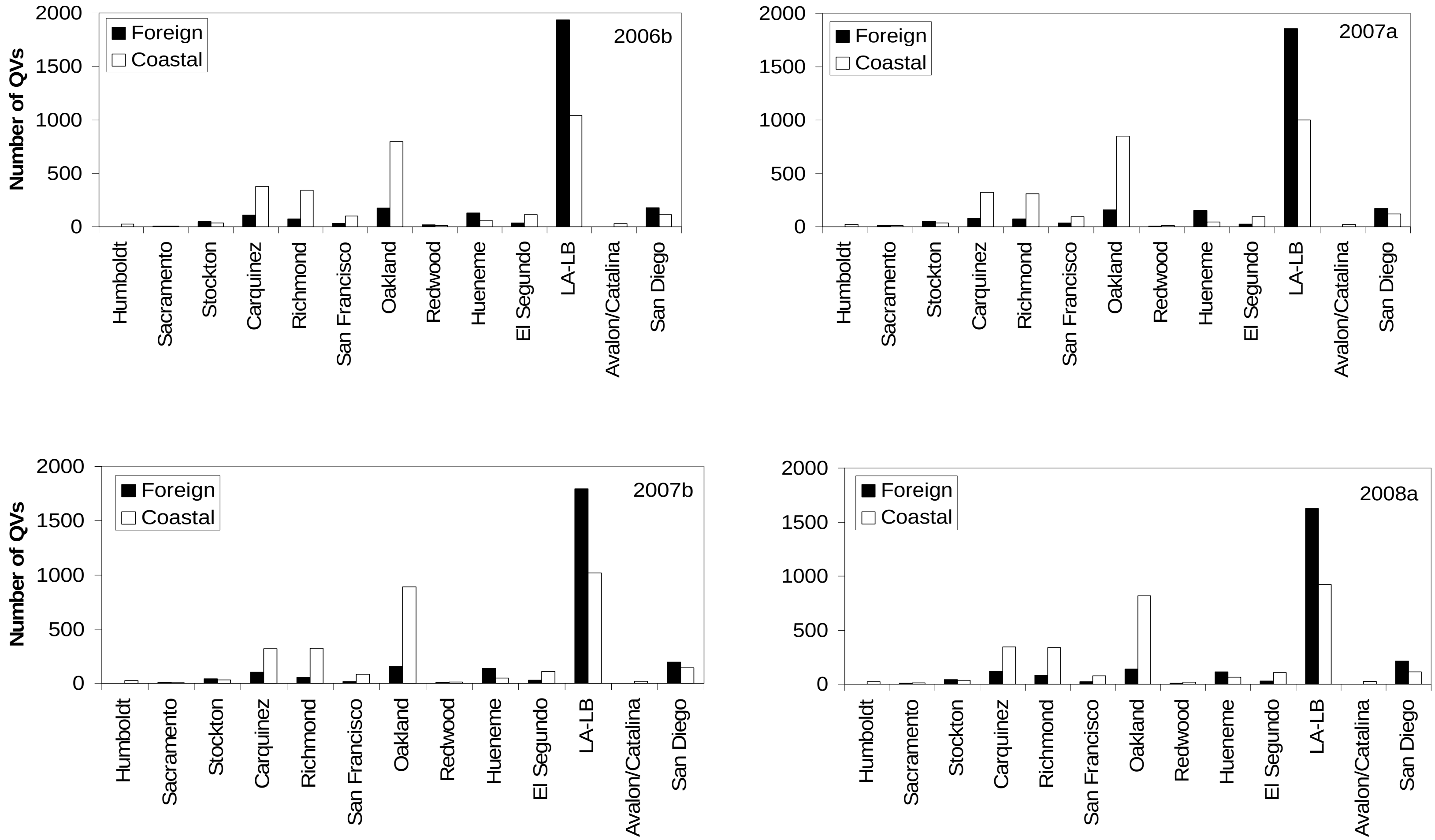

Figure V.4. Distribution of Qualifying Voyage (QV) Arrivals by Port. Coastal voyages originate from PCR ports, foreign voyages originate from non-PCR ports. Three QV arrivals are not presented for 2007a: two coastal QV arrivals in Monterey and one coastal QV arrival in Morro Bay (there were no other QV arrivals for these ports between 2006b and 2008a).

The distribution of vessel types calling on California ports has held steady since the last biennial report (see Falkner et al. 2007). Statewide, container vessels continue to dominate vessel calls (43% of arrivals between 2006b and 2008a), followed by tank vessels (19%), and auto carriers (10%) (Figure V.5). Bulk carriers, passenger vessels and unmanned barges each account for roughly 7% of vessel traffic to California ports between 2006b and 2008a.

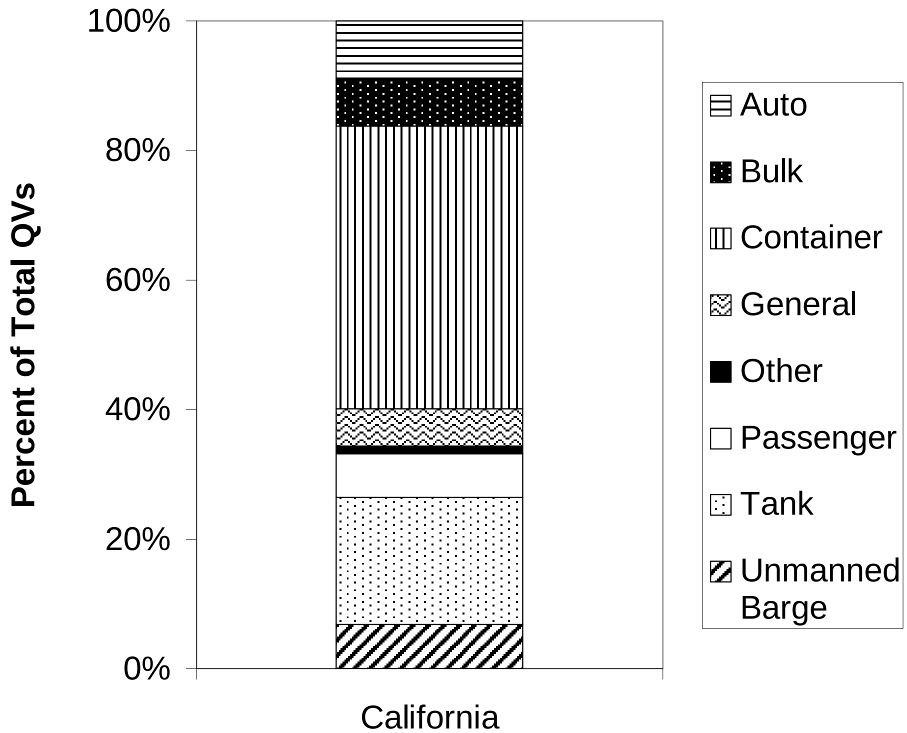

Figure V.5. Percent of QV Arrivals by Vessel Type (2006b – 2008a)

The Ports of LA-LB and Oakland combined receive 99% of all container vessel traffic to California ports. LA-LB also receives the majority of passenger (55%) and bulk (53%) vessel arrivals to California (Figure V.6A). Forty-five percent of all tank vessels, on average, arrive to LA-LB with the remainder largely divided between the Ports of Carquinez (20%), Richmond (19%) and El Segundo (11%) (Figure V.6B). Auto carriers primarily arrive to LA-LB (35% on average), San Diego (23%), Hueneme (20%), and Carquinez (19%).

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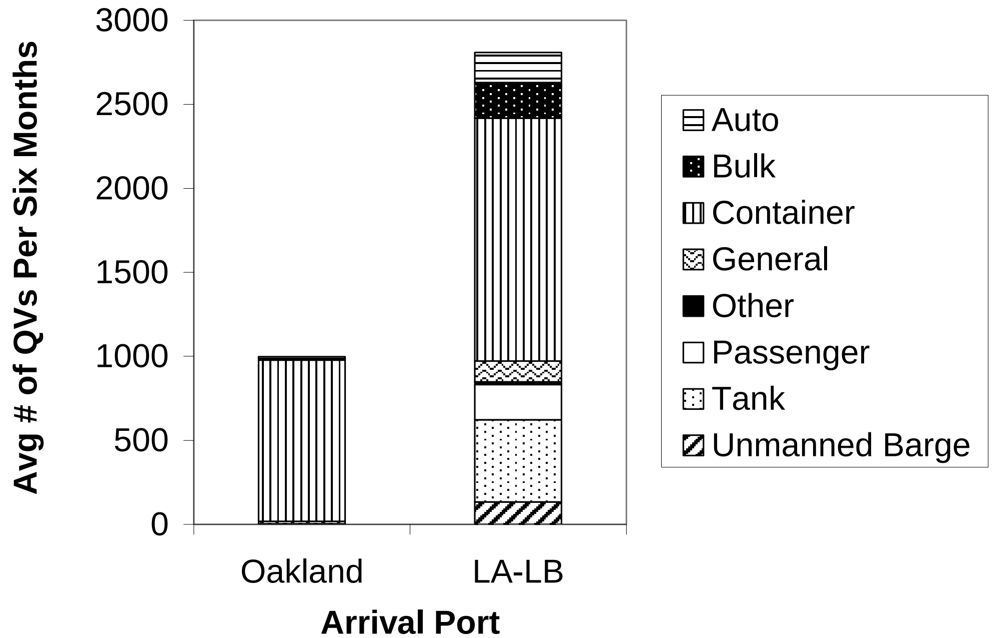
A



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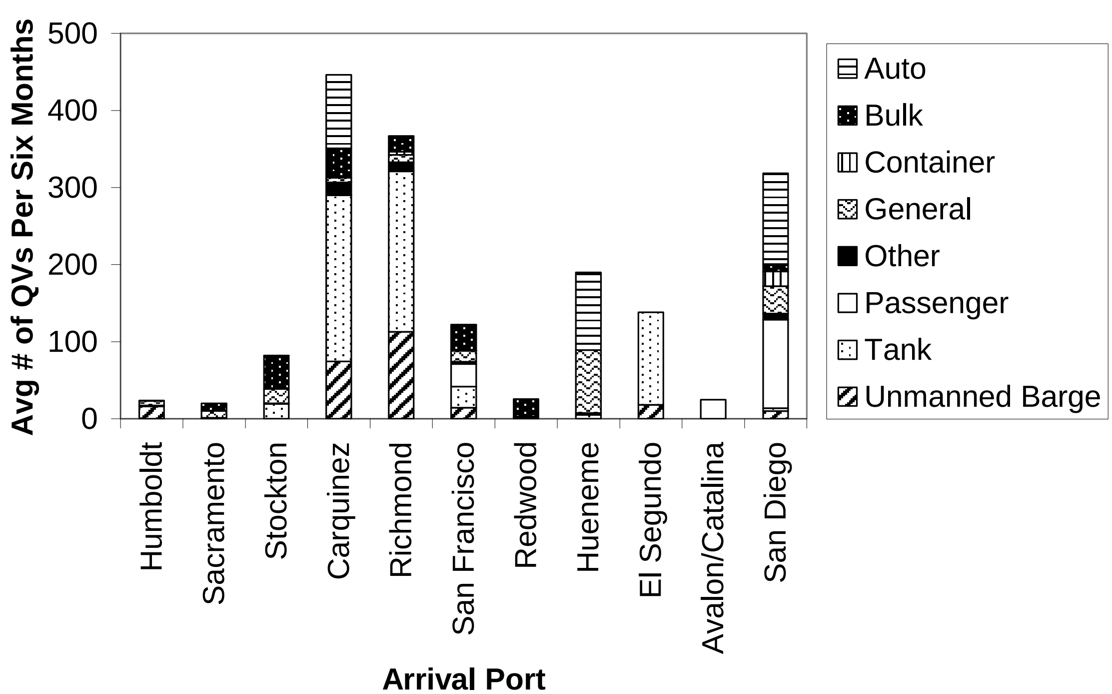

Figure V.6. Average Number of Arrivals per Six-Month Period by Vessel Type and Port (2006b –2008a) for Oakland and LA-LB (A) and the Remaining California Ports (B). Note that the scales are not the same across panels.

Since July 2006, almost 50% of all arrivals to California originated from within the Pacific Coast Region (Figure V.7, see Figure IV.1 for map of PCR). Thirty-six percent of vessel calls to California ports came from other California ports, 5% originated in Washington State, 3% in coastal (i.e. within the PCR) Mexican ports, 3% in Oregon, 3% in coastal Canadian ports, and less than 1% from Alaska. The majority of foreign (non-PCR) arrivals to California came from Asian ports (China, Japan, Korea, and all other Asian countries ("Other Asia") account for 23% of all QVs) followed by approximately 6% from foreign (non-PCR) Mexican ports (Figure V.7).

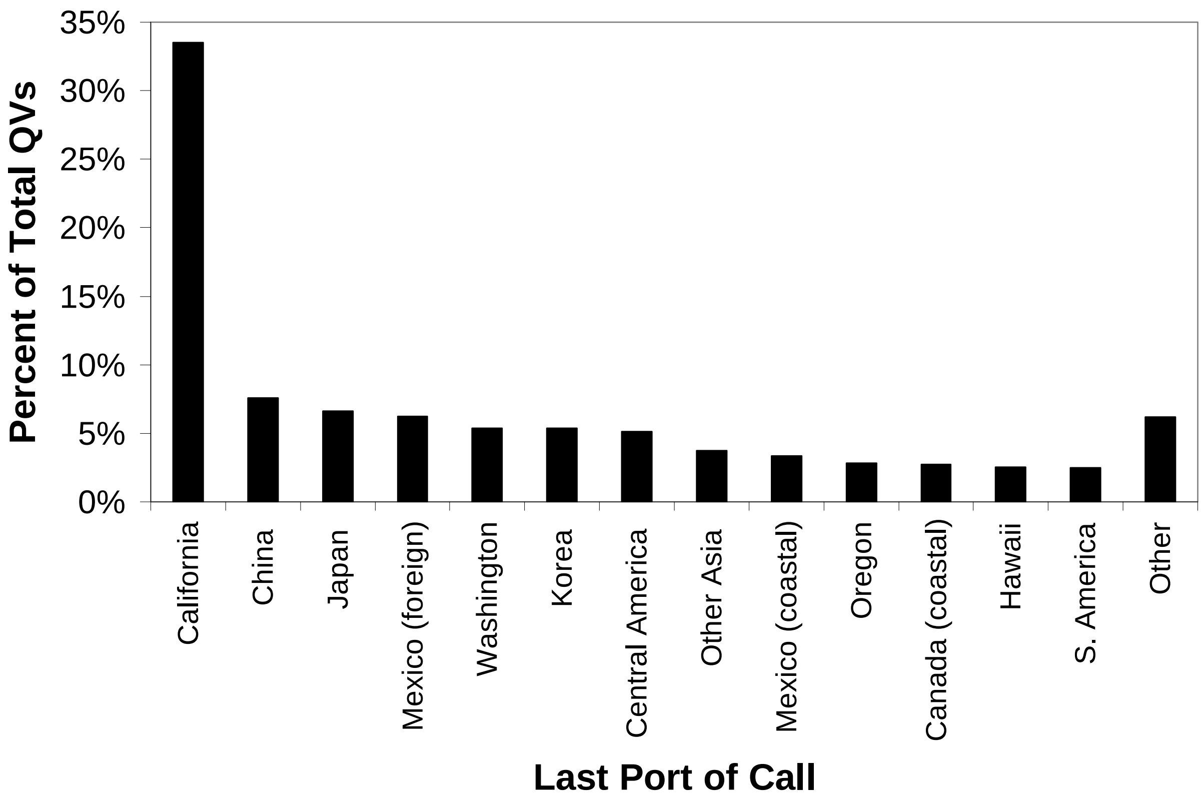

Figure V.7. Last Port of Call for Qualifying Voyages (QVs) to California Ports (2006b – 2008a)

A closer examination of last port of call data reveals patterns for each vessel type visiting California ports (Figure V.8). Unmanned barges that arrive to California operate almost exclusively along the U.S. West Coast. Tankers and auto carriers also arrive to

California ports predominantly after a visit to another U.S. West Coast port. Bulk carriers and container vessels frequently arrive to California from Asia ports. As may be expected, passenger vessels visit California ports after travel in Mexico. These vessel traffic patterns provide valuable information about potential source locations for NIS both in ballast water and attached to the hull and other submerged vessel surfaces.

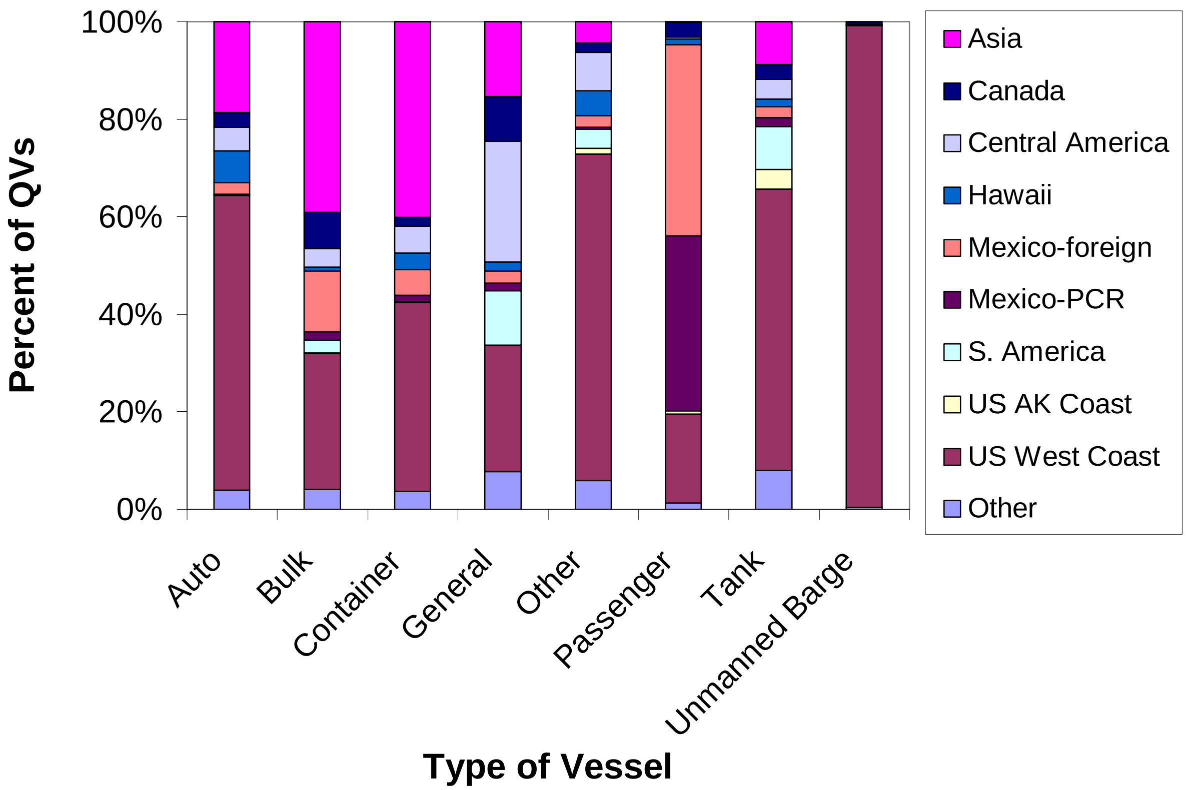

Figure V.8. Last Region of Call for Qualifying Voyages (QV) by Vessel Type (2006b – 2008a)

Ballast Water Management and Compliance

Ballast Water Discharge Patterns

The risk for NIS introductions through ballast water is based on many factors, including (but not limited to) the source, age, and volume of ballast water discharged, environmental similarities between the source and recipient port waters, and time of year (i.e. season). Therefore, an examination of geographic and volumetric patterns of ballast water retention and discharge provides valuable background that may be used to frame relative trends and risk of species introductions in the State.

Vessels that do not discharge any ballast water within the state pose no risk for NIS introductions through the vector, and retention is currently the most protective management strategy available. Since reporting requirements were implemented in 2000, the percent of vessels discharging ballast water has steadily decreased to a low of 14% in 2007 and 15% in 2008a (Figure V.9).

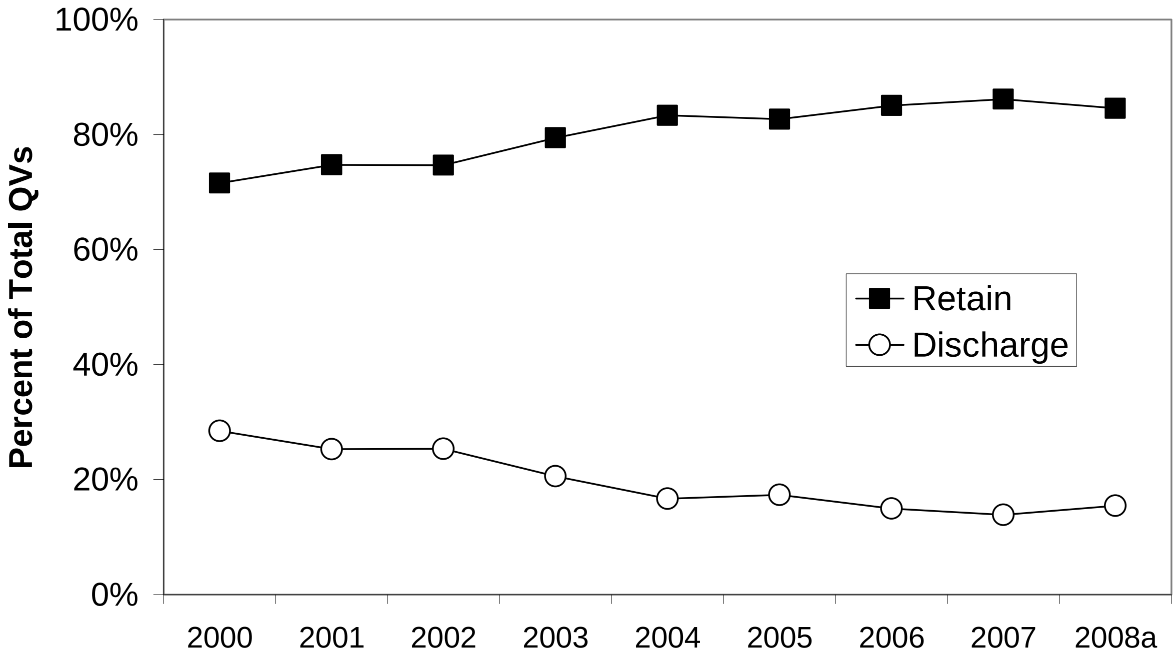

Figure V.9. Reported Ballast Water Management (a = January to June)

While the percent of vessels discharging ballast in California water continues to decrease (Figure V.9), the volume of ballast water discharged over that same time period appears to be on the rise. More ballast water was discharged into California waters during the first six months of 2008 (5.23 million metric tons, MMT) than in any similar time period since the inception of the Marine Invasive Species Program (Figure V.10).

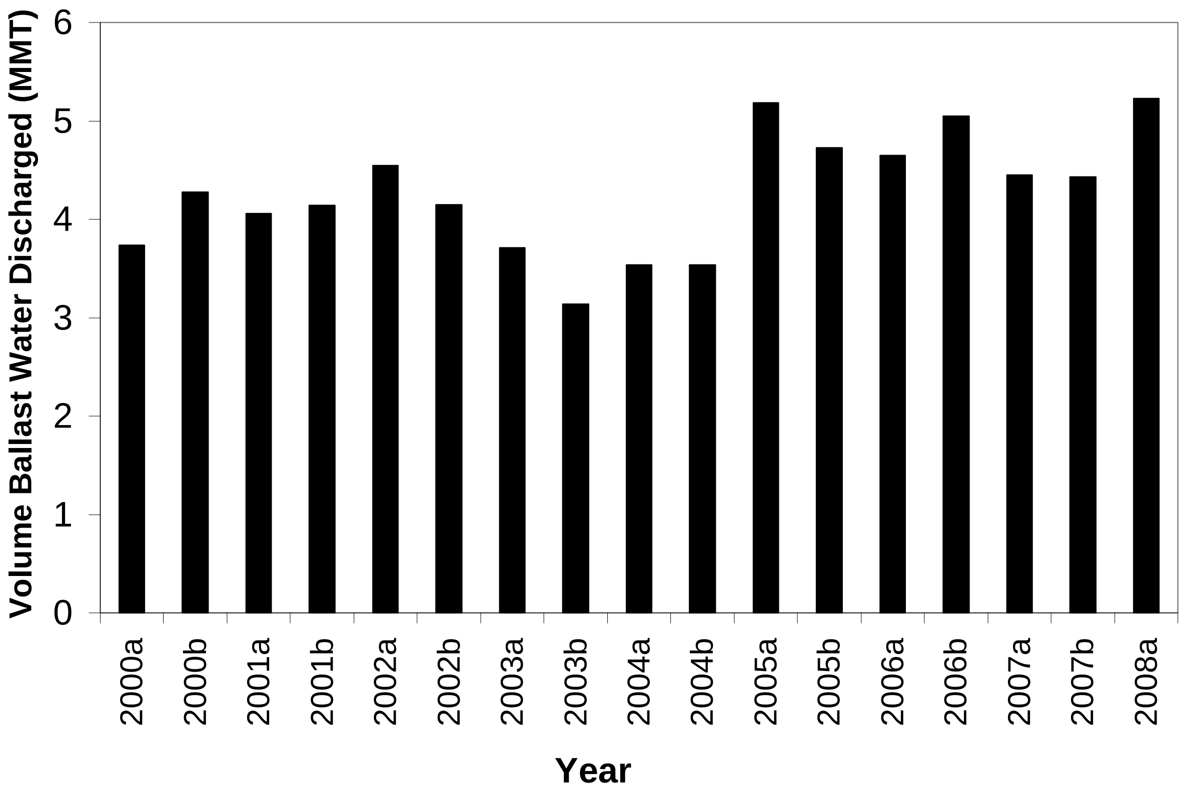

Figure V.10. Total Volume Ballast Water Discharge (million metric tons; MMT) (a = January to June, b = July to December)

This increase in the total volume of ballast water discharged in the State has been driven, in large part, by tank vessels (Figure V.11). Tank vessels carry more ballast water, on average, than any other ship type. The average ballast water capacity of a tank vessel operating in California waters is 30,100 metric tons (MT) of ballast water. By comparison, container vessels operating in California have the capacity to carry, on average, only 13,995 MT of ballast water - less than half the capacity of tank vessels. The total volume of ballast water discharged by tank vessels per six-month period increased 16% between 2006b (2,075,285 MT) and 2008a (2,404,468 MT). Between 2006b and 2008a, tank vessels made up only 19% of the total number of vessel arrivals to California ports, but they were responsible for 43% of the total volume of discharged ballast (Figure V.11).

In addition to tank vessels, unmanned barges are the other vessel type that has added to the recent increase in the total volume of discharged ballast in the state. The volume of ballast discharged from unmanned barges per six-month period rose from 324,798 MT in 2006b to 399,845 MT in 2008a – a 23% increase (Figure V.11).

Like tank vessels, bulk vessels also contribute disproportionately to the total volume of ballast discharged in the state. Between 2006b and 2008a, bulk vessels accounted for only 7% of the total number of arrivals, but discharged 31% of the total volume of ballast into California waters. Unlike tank vessels, however, the volume of bulk vessel discharges per six month period decreased almost 16% during the last two years from 1,698,454 MT in 2006b to 1,465,701 MT in 2008a (Figure V.11).

Following the trend seen in the last biennial report (Falkner et al. 2007), the volume of ballast water discharged from container vessels has continued to decrease – from 726,026 MT in 2006b to 547,213 MT in 2008a. Between 2006b and 2008a container vessels discharged only 12.5% of the total volume of ballast water even though they made up 43% of the total number of arrivals.

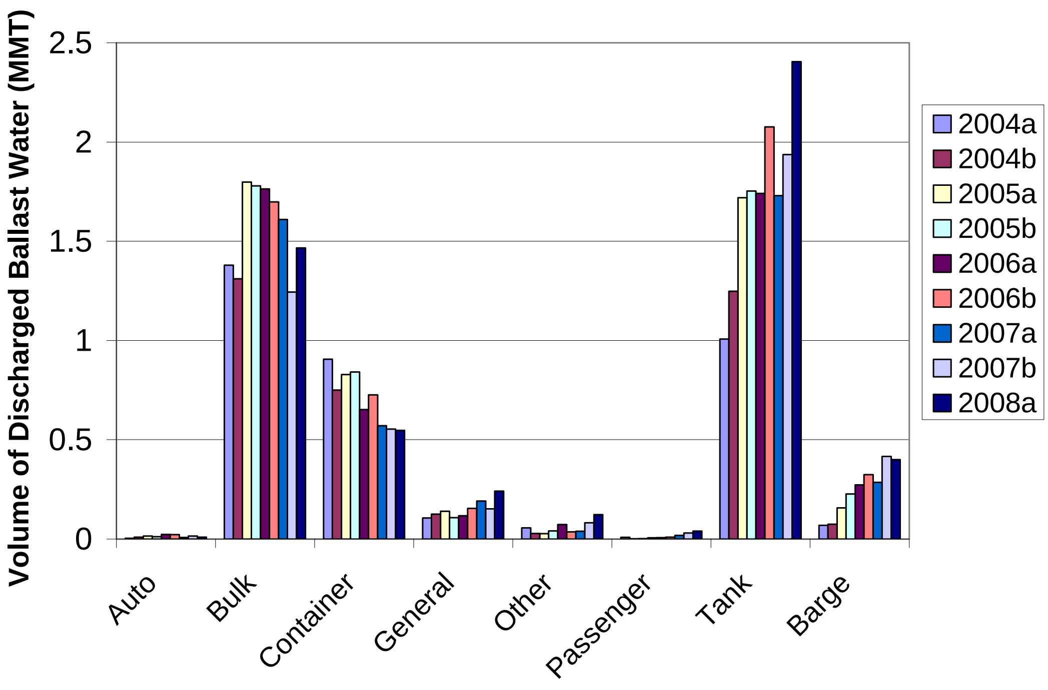

Figure V.11. Volume of Ballast Water (million metric tons; MMT) Discharged per Six-Month Period as a Function of Vessel Type. (a = January to June, b = July to December)

A close examination of the number of vessels discharging by arrival port highlights the regional nature of vessel discharge patterns (Table V.1). The majority of vessels discharging in LA-LB are of foreign origin, while the majority of vessels discharging in the San Francisco Bay ports of Oakland, Carquinez, Richmond, San Francisco, and Redwood City are of coastal origin. Furthermore, 100% of vessels discharging in Humboldt are of coastal origin.

Table V.1. Number of Qualifying Voyages that Discharged Ballast by Port, Six-Month Period, and Origin of Voyage (2006b-2008a; a = January to June, b = July to December)

Discharge Port	2006b		2007a		2007b		2008a	
	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign
Humboldt	2	0	6	0	5	0	6	0
Sacramento	2	4	6	6	1	3	5	5
Stockton	1	7	6	12	2	9	7	14
Carquinez	99	23	66	13	76	19	104	35
Richmond	90	9	65	7	84	8	82	14
San Francisco	23	6	24	7	26	7	10	2
Oakland	76	10	75	22	69	17	54	14
Redwood	6	4	6	3	4	5	2	7
Hueneme	1	2	0	0	2	0	0	1
El Segundo	20	5	15	7	23	4	28	5
LA-LB	166	268	156	232	175	203	190	206
San Diego	15	20	16	18	26	26	17	21
TOTAL	**501**	**358**	**441**	**327**	**493**	**301**	**505**	**324**

While the number of vessels discharging at each port (Table V.1) is an indicator of potential risk of introduction, the volume of ballast water released at these ports is perhaps a better gauge of invasion pressure (Table V.2). The Ports of Richmond and

Carquinez received fewer QVs, on average, than Oakland (see Figure V.4), but these ports received, on average, 3 and 5 times more ballast water, respectively, than Oakland per six-month period (Table V.2). The average volume of ballast water discharged from coastal voyages per six-month period was roughly equal for LA-LB and Carquinez, even though LA-LB had over twice as many coastal vessels discharging, on average, than Carquinez. This pattern can be explained by the high volume of tank vessel traffic to Carquinez.

Overall, 60% of the volume of ballast water discharged in California between 2006b and 2008a came from vessels whose last port of call was within the PCR (Table V.2). The combination of the quantity of arriving coastal vessels and large volumes of ballast water discharged by such transits (Tables V.1 and V.2) demonstrates the high potential for intraregional transport of introduced species across several recipient ports. In examining these statistics, it is important to note that several factors influence invasion risk in addition to the volume of ballast water released. This includes the age of the ballast water discharged (species often survive better when held for a short period of time), the degree of repeated inoculation (frequency with which ballast is discharged in a given area), and similarity between donor and recipient regions (biological, chemical, and physical characteristics at each port) (Carlton 1996, Ruiz and Carlton 2003). The coastal regulations implemented in early 2006 require vessels to manage their ballast water when moving between ports in the PCR. The regulations are proving to be an effective tool to help reduce the risk of new species introductions into ports or places that receive mostly coastal ballast water such as San Francisco Bay and Humboldt Bay.

Table V.2. Discharge Volume (metric tons = MT) by Port, Six-Month Period, and Source of Voyage. (2006b-2008a; a = January to June, b = July to December)

Discharge port	2006b			2007a			2007b			2008a		
	Percent foreign discharges	Percent coastal discharges	Total volume discharged (MT)	Percent foreign discharges	Percent coastal discharges	Total volume discharged (MT)	Percent foreign discharges	Percent coastal discharges	Total volume discharged (MT)	Percent foreign discharges	Percent coastal discharges	Total volume discharged (MT)
Humboldt	0%	100%	1,690	0%	100%	24,821	0%	100%	19,485	0%	100%	15,386
Sacramento	92%	8%	19,600	59%	41%	71,158	91%	9%	18,331	57%	43%	80,116
Stockton	90%	10%	79,575	78%	22%	169,095	61%	39%	121,485	81%	19%	182,911
Carquinez	19%	81%	1,037,646	15%	85%	773,189	22%	78%	900,932	29%	71%	1,387,587
Richmond	20%	80%	905,819	8%	92%	648,848	7%	93%	717,476	12%	88%	884,156
San Francisco	10%	90%	194,360	24%	76%	174,171	19%	81%	292,746	11%	89%	102,467
Oakland	20%	80%	225,062	39%	61%	275,799	41%	59%	267,618	41%	59%	210,501
Redwood	43%	57%	72,433	24%	76%	70,261	55%	45%	81,037	54%	46%	119,193
Hueneme	90%	10%	2,607	0%	0%	0	0%	100%	1,496	100%	0%	65
El Segundo	4%	96%	131,215	16%	84%	134,571	14%	86%	279,597	8%	92%	233,918
LA-LB	67%	33%	2,296,233	57%	43%	2,075,217	59%	41%	1,683,378	65%	35%	1,986,692
San Diego	60%	40%	43,034	51%	49%	29,704	52%	48%	46,509	61%	39%	28,357
TOTAL			**5,009,274**			**4,446,833**			**4,430,088**			**5,231,349**

Ballast Water Management Compliance

California PRC Section 71204.3 requires that the master, operator, or person in charge of a vessel arriving to a California port or place from a port or place outside of the Pacific Coast Region shall manage ballast water in at least one of the five following ways:

- Exchange ballast water in areas at least 200 nm from any shore and in waters at least 2000 m deep (mid-ocean waters) before discharging in California waters
- Retain all ballast water on board the vessel.
- Discharge ballast water at the same location where it was taken on, provided that the ballast water has not been mixed with water taken on in an area other than mid-ocean waters.
- Use an alternative, environmentally sound, Commission or USCG-approved method of treatment.
- Discharge the ballast water to an approved reception facility (although currently there are no such facilities in California).

The master, operator, or person in charge of a vessel arriving to a California port or place from another port or place within the PCR, shall manage ballast water in at least one of the following ways:

- Exchange the vessel's ballast water in near-coastal waters (more than 50 nm from land and at least 200 m deep) before entering the waters of the State, if that ballast water has been taken on in a port or place within the PCR.
- Retain all ballast water on board the vessel.
- Use an alternative, environmentally sound, Commission or USCG-approved method of treatment
- Discharge the ballast water to an approved reception facility (although currently there are no such facilities in California).

Of the more than 135 MMT of vessel-reported ballast water carried into State waters between July 2006 and June 2008, 98% or 133 MMT was managed in compliance with

California law. The majority of vessels operating in California achieve compliance with California's requirements by retaining their ballast water onboard. Between July 1, 2006 and June 30, 2008, over 85% of the QVs arriving to the State, an average of 4768 $\pm$ 202 (Standard Deviation; SD) arrivals each six-month period, did not discharge ballast water (Figure V.9), and were therefore compliant with California law.

Of the nearly 19 MMT of ballast water discharged into California between July 2006 and June 2008, 84.5% was appropriately managed through legal ballast water exchange and was compliant with California law (Figure V.12). When examined over smaller temporal scales, an interesting trend emerges. Although the total volume of ballast water discharged into California has been increasing since the last half of 2006, the volume of noncompliant ballast water has been decreasing (Figure V.12). As a percentage of the total amount of discharged ballast water, the volume of noncompliant ballast water has decreased forty-five percent over the past two years.

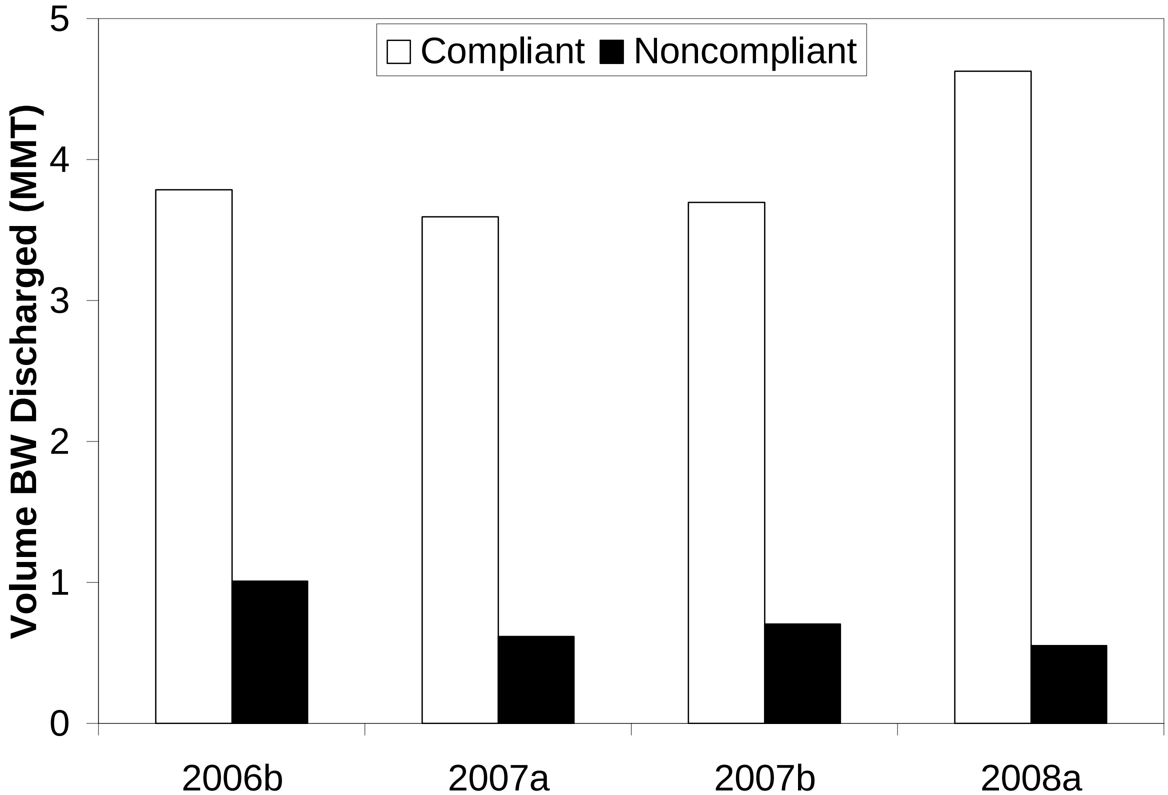

Figure V.12. Volume (million metric tons, MMT) of Compliant and Noncompliant Ballast Water (BW) Discharged by Six-Month Period. This includes only compliance of discharging vessels and does not include data for vessels that comply by retaining ballast water (a = January to June, b = July to December).

Nearly 3 MMT of noncompliant ballast water has been discharged in to California waters between July 2006 and June 2008. This noncompliant ballast water generally fell into one of three categories:

- Ballast water exchange was attempted, but the location of exchange was not in mid-ocean or in near-coastal waters as required by PRC Section 71204.3 or by 2 CCR § 2280 *et seq*.
- Ballast water was not exchanged.
- Vessel reported exchanging ballast water, but the location of exchange was unknown or unspecified.

While ballast water exchange at legal distances offshore is clearly most protective, some attempt at ballast water exchange is, in most cases, more beneficial than no exchange at all. Most vessels in violation of management requirements attempted to exchange before discharging in California, but did so in a location not acceptable by California law. This category was relatively stable and accounted for 72% of noncompliant ballast water by volume in 2006b (146 qualifying voyages), 69% in 2007a (101 QVs), 69% in 2007b (99 QVs) and 69% in 2008a (108 QVs) (Figure V.13). Of the noncompliant ballast water exchanged in the wrong location between 2006b and 2008a, 5.1% (0.102 MMT from 60 QVs) was exchanged within five percent of the required offshore distance (e.g. within 10 nm of the 200 nm boundary for mid-ocean waters or within 2.5 nm of the 50 nm boundary for near coastal waters). This subgroup serves as an example of vessels that are attempting to comply with California law but in this case failed to extend fully to the required distance offshore.

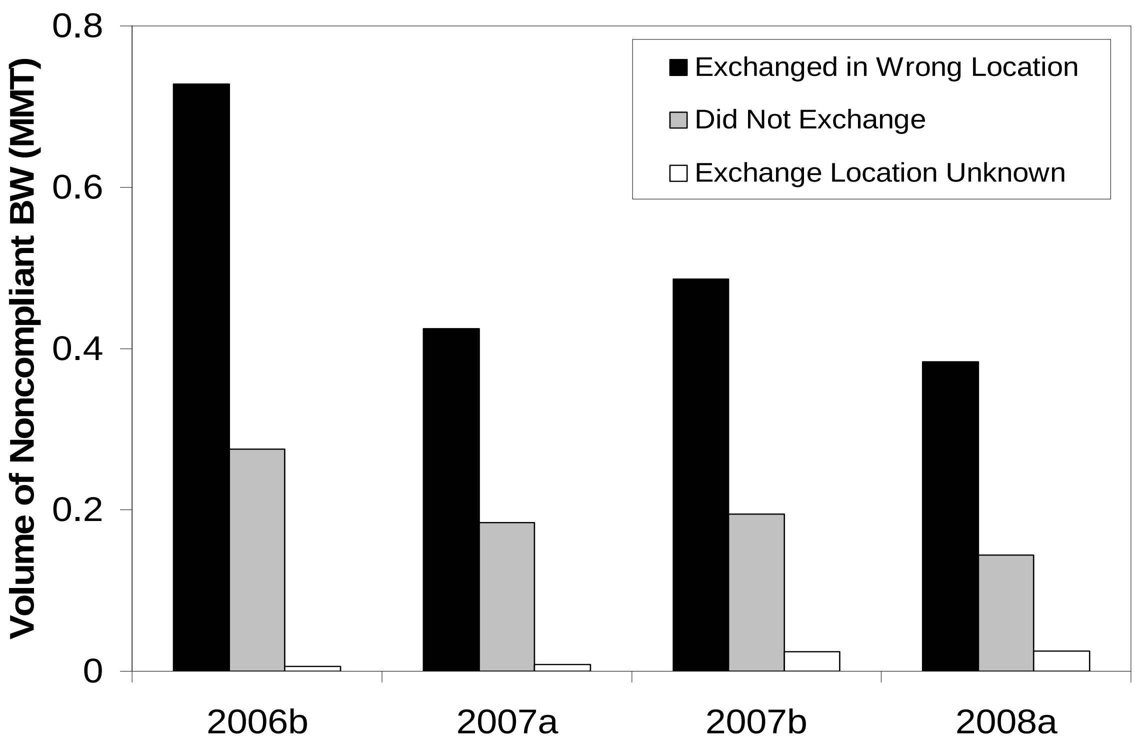

Figure V.13. Volume (million metric tons; MMT) of Noncompliant Ballast Water (BW) Discharged by Violation Type (a = January to June, b = July to December).

The largest proportions of noncompliant ballast water can be attributed to two vessel types: bulk and tank vessels. These two vessel types were responsible for 87.1% of all noncompliant ballast water discharged into California between July 2006 and June 2008. The relative contribution of both bulk and tank vessels were not consistent over this time span. During 2006b, bulk and tank vessels accounted for 55.6% and 33.3% of the total noncompliant ballast water, respectively. However, over the next year and a half, the proportion attributable to bulk vessels decreased to 28.7% (2008a) while the tank vessel contribution to total noncompliant ballast water increased to 56.9% (2008a) (Figure V.14).

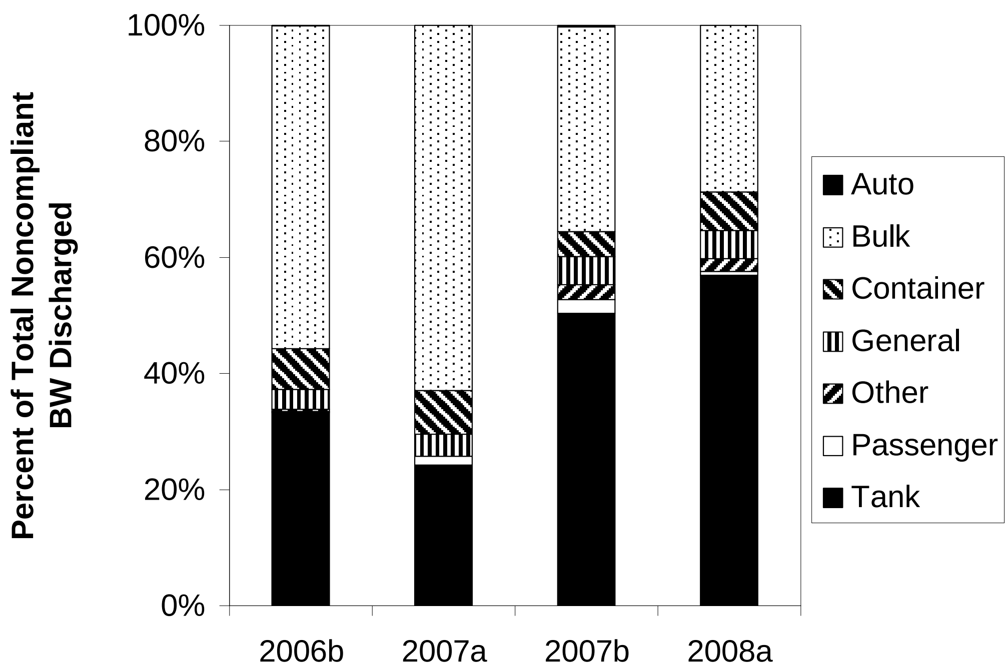

Figure V.14. Proportions of Noncompliant Ballast Water (BW) by Vessel Type (a = January to June, b = July to December)

The data presented in Figure V.14 suggest that illegal ballast water discharges from tank vessels have been increasing over the past two years; however, this is not the case. Instead, it is the decrease in illegal ballast water discharges from bulk vessels that is driving the proportional increase in illegal tank vessel discharges (Figure V.15).

Aside from 2007a, the volume of noncompliant ballast water discharged from tank vessels has been consistent while the volume of illegal ballast water attributed to bulk vessels has been rapidly decreasing, from 0.56 MMT in 2006b to 0.16 MMT in 2008a. This 71.4% reduction in noncompliant ballast water discharges attributable to bulk vessels has occurred when overall bulk vessel discharges have dropped by 12.4% (from 1.7 MMT (2006b) to 1.5MMT (2008a)) (Figure V.11). This implies that although bulk vessel operators are retaining more of their ballast water onboard, they are also reducing the proportion of discharged water that is out of compliance. As a result, bulk vessels as a whole are likely to pose a reduced risk of introducing NIS via ballast water than two years ago.

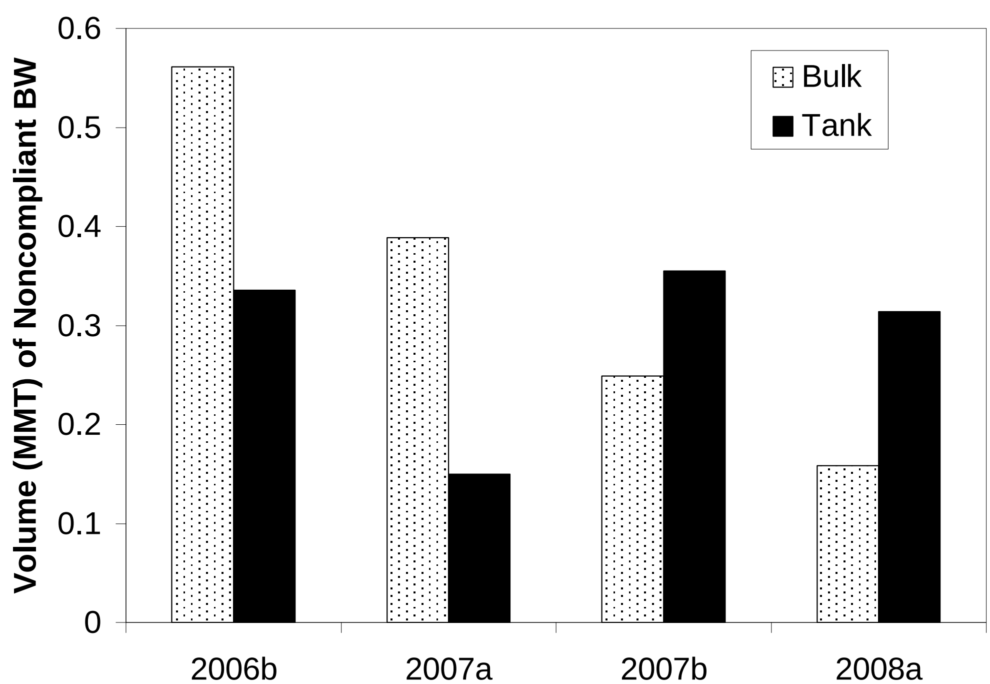

Figure V.15. Volume (million metric tons; MMT) of Noncompliant Ballast Water Discharges Attributable to Bulk and Tank Vessels. (a = January to June, b = July to December)

Over the past four and a half years, container vessels have accounted for the greatest proportion of QVs to California - 45% between January 2004 and June 2006 (Falkner et al. 2007) and 44% between July 2006 and June 2008 (Fig V.5). While the percentage of qualifying arrivals attributed to container vessels has been steady during this 4.5 year span, the total volume and proportion of noncompliant ballast water discharged from container vessels has been decreasing, from 31.7% of all noncompliant ballast water discharges in 2004a (Falkner et al. 2007) to 6.6% in 2008a (Figure V.14). This decrease in the discharge of illegal ballast water is likely reducing the risk of NIS introduction via ballast water from container vessels, the most common vessel type operating in California waters.

In addition to discharge volumes and vessel types, the source of the discharged water can also relay important information for assessing the risk of NIS introductions, particularly since risk may relate to chemical and physical similarities between source and receiving waters. The largest proportion of noncompliant ballast water discharged in California from July 2006 through June 2008 originated within the United States West Coast Exclusive Economic Zone (200 nm or closer to California, Oregon or Washington). This proportion was consistent throughout this two-year span, ranging from 39.5% to 42.4% of the total volume of noncompliant ballast water per six-month period (Figures V.16 – V.19). The majority of this noncompliant ballast water from the U.S. West Coast was discharged by tank and bulk vessels, which together accounted for 88.9% by volume between July 2006 and June 2008.

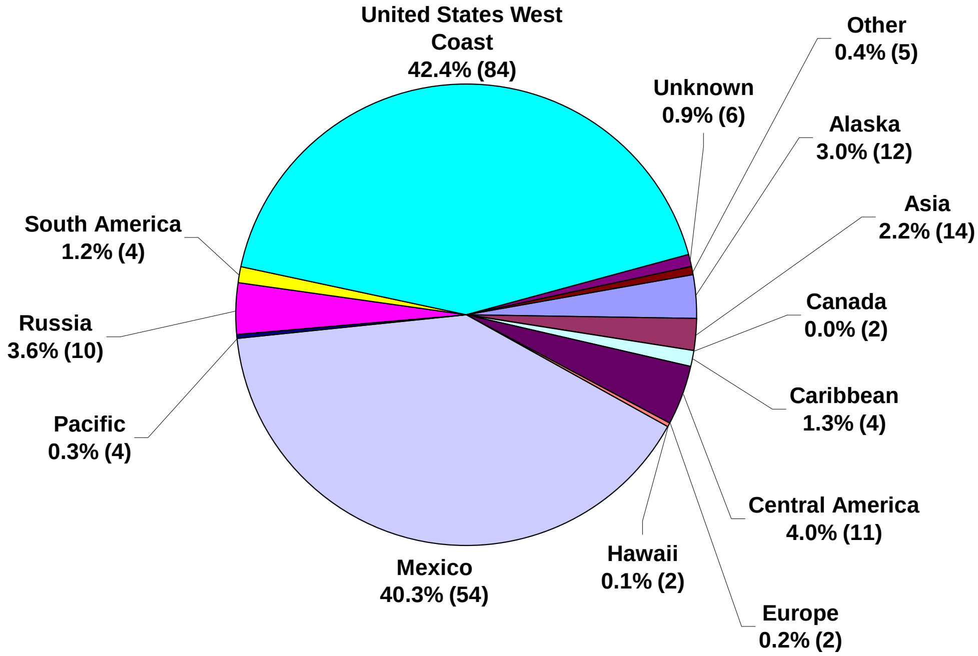

Figure V.16. Source of Noncompliant Ballast Water (July-December 2006). Numerals in parentheses denote number of vessels.

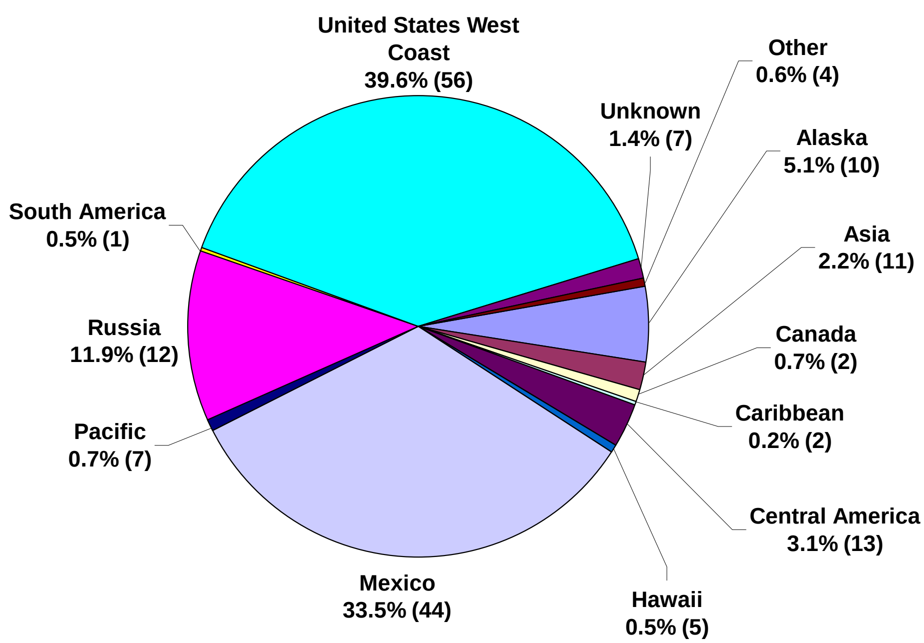

Figure V.17. Source of Noncompliant Ballast Water (January-June 2007). Numerals in parentheses denote number of vessels.

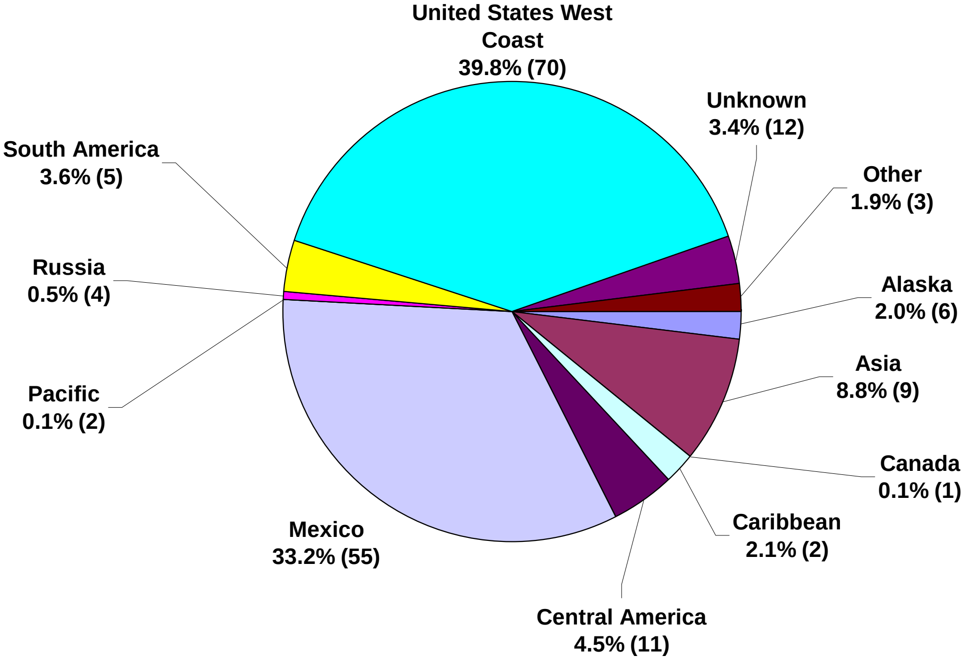

Figure V.18. Source of Noncompliant Ballast Water (July-December 2007). Numerals in parentheses denote number of vessels.

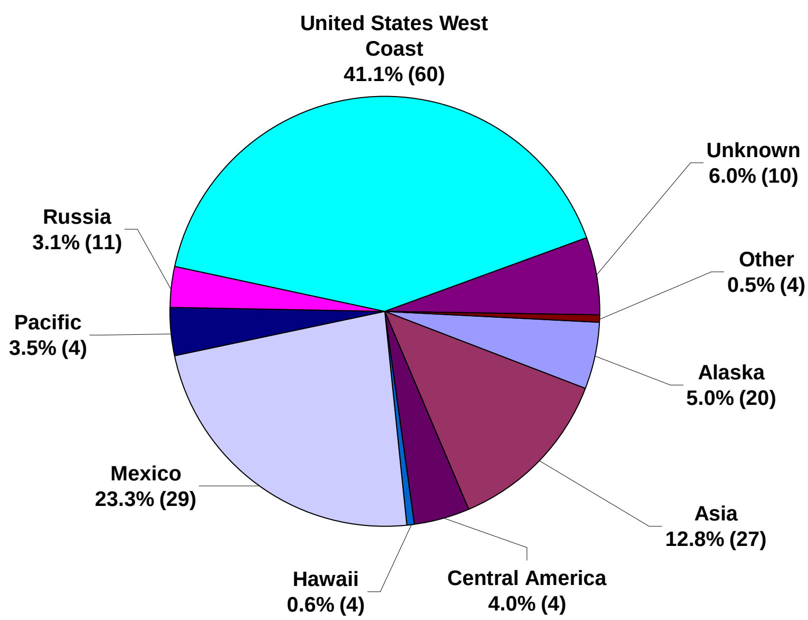

Figure V.19. Source of Noncompliant Ballast Water (January-June 2008). Numerals in parentheses denote number of vessels

The second largest proportion of noncompliant ballast water discharged in California originated in Mexican waters. However, the relative contribution of this noncompliant ballast water has steadily decreased over the past two years from 40.3% of the total in 2006b (406,419 MT, Figure V.16) to 23.3% in 2008a (128,500 MT, Figure V.19). This overall decrease has been driven by the decrease in the volume of noncompliant bulk vessel discharge, down from 369,532 MT (90.9% of all noncompliant discharges originating in Mexican waters) in 2006b (38 vessels) to 12,309 MT (9.6%) in 2008a (3 vessels). During this time however, the volume of noncompliant ballast water from Mexican waters discharged by tankers has increased from 20,447 MT (5.0% of all noncompliant discharges originating in Mexican waters) in 2006b (4 vessels) to 96,742 MT (75.3%) in 2008a (12 vessels).

The contribution of noncompliant ballast water originating in Asia to the total volume of illegal ballast water has been increasing over the past two years, from 2.7% in 2006b (Figure V.16) to 12.8% in 2008a (Figure V.19). This increase has been driven almost entirely by bulk vessel discharges, which accounted for 2,624 MT (12.2% of all noncompliant discharges originating in Asian waters) in 2006b (2 vessels) but increased to 53,491 MT (75.5%) in 2008a (12 vessels).

Prior to the implementation of California's coastal regulations requiring ballast water management of vessels transiting within the PCR (2 CCR § 2280 *et seq*., implemented March 22, 2006), vessels arriving from the west coast of Canada were required to exchange their ballast water at a distance greater than 200 nm from shore. During this time, noncompliant ballast water discharged from vessels arriving from Canada accounted for 2.6% (11 vessels) of the total volume of noncompliant ballast water in 2004 and 4.2 % (14 vessels) in 2005 (Falkner et al. 2007). However, during the first six months of 2006 (i.e. when coastal regulation was implemented), noncompliant ballast water arriving from Canada accounted for only 0.7% (1 vessel) of the total volume of noncompliant discharges. From July 2006 through June 2008, noncompliant ballast water originating in Canada continued to contribute less than 1% of the total volume of noncompliant discharges into California. Over this period, vessels arriving from Canada have accounted for less than 0.1% (2 vessels) in 2006b, 0.7% (2 vessels) in 2007a, 0.1% (1 vessel) in 2007b, and did not discharge any noncompliant ballast water into California during 2008a. This decrease in noncompliant discharge from vessels arriving from Canada may be attributable to the fact that vessels now only have to exchange their ballast water 50 nm from shore, rather than 200 nm, in order to be compliant with California law.

The ability to determine the origin of noncompliant ballast water and identify the types of vessels that frequently discharge illegal water is important in assessing the risk of NIS introductions into California. It is important to remember that the overall volume of noncompliant ballast water being discharged into California waters since July of 2006 has decreased 45% from 1,009,232 MT (2006b) to 552,062 MT (2008a). During this two-year span only 2% of the over 135 MMT of ballast water carried into California has been discharged without properly complying with the State's management requirements. Furthermore, the vast majority of the noncompliant ballast water discharged in State waters underwent some type of exchange, likely reducing the risk of NIS introductions.

Although the volume of noncompliant ballast water being discharged into California has decreased dramatically over the past two years, the number of vessel arrivals in violation of ballast water management requirements has remained small and has experienced a more modest decrease over this time, from 198 vessels (3.51% of all QVs) in 2006b to 149 vessels (2.77% of all QVs) in 2008a. Superficially, the large decrease (45%) in the volume of illegal ballast water discharged does not parallel the smaller decrease (25%) in the number of arriving vessels out of compliance with ballast water management requirements. However, this can be explained, at least partially, by the fact that bulk vessel arrivals in violation of ballast water management requirements have decreased by 53.6% from 2006b (69 vessels) to 2008a (32 vessels). This drastic decrease in noncompliant bulk vessels, which have high ballast water volume capacities, has contributed to the overall decrease in the volume of improperly managed ballast water discharged into California.

Compliance Through Field Inspections

Under PRC Section 71206, the Commission assesses compliance of any vessel subject to the Act through a vessel inspection program. The Commission has two field offices, one in Southern California and the other in Northern California. Marine Safety personnel boarded and inspected 17% (3792) of qualifying voyages between July 1, 2006 and June 30, 2008.

During the inspection process, Marine Safety personnel interview vessel crew and review paperwork, including but not limited to ballast water reporting forms, ballast water logbooks and engine logbooks. Staff also examine the latitude and longitude of ballast water exchange locations and take a salinity sample at the top, middle and bottom of a subset of tanks intended for discharge in California. Finally, Staff provide educational materials relevant to California's Marine Invasive Species Program.

The majority of vessels inspected are found to comply with the Act. Most noted violations are associated with administrative components of the law (e.g. incomplete ballast water management plan, inaccurate ballast report forms, incomplete ballast tank logs) versus operational violations (e.g. discharging unexchanged ballast water) (Table V.3). All inspected vessels found in violation of California law are cited. A copy of the citation is given to the vessel crew and a copy is retained by the Commission. In addition, a copy of the violation and an enforcement letter is sent to the vessel owner. The vessel is then targeted for re-inspection upon its next visit to California waters. Civil or criminal penalties may be assessed on non-compliant vessels.

Table V.3. Vessel Inspections and Violation Information

	2006b	2007a	2007b	2008a
No. Qualifying Voyages	5645	5463	5541	5382
No. Inspections Conducted	818	897	969	1108
Total No. Violations Cited	148	114	82	66
No. Administrative	123	86	59	53
No. Operational	25	28	23	13

Trends in Vessel Fouling-Related Practices and Patterns

Unlike the ballast water vector where over 85% of the qualifying voyages into California do not discharge and therefore pose ‘zero’ risk, through the fouling vector all vessels pose some level of risk because all vessels have submerged hard surfaces open to fouling accumulation. In an effort to evaluate the risk of NIS introduction through the vessel fouling vector, the Commission produced and presented a report assessing “Commercial Vessel Fouling in California” (see Takata et al. 2006) to the State Legislature in April of 2006. This report indicated that there was a lack of baseline information regarding the fouling vector and associated risks, especially across the types of vessels regularly operating in California waters. In response to the recommendations made in that report, the State Legislature passed Assembly Bill 740 (Chapter 370, Statutes of 2007) in October 2007 which amended PRC Section 71205, among others. Assembly Bill 740 requires the master, owner, operator, agent, or person in charge of a vessel arriving to a California port or place to submit, on an annual basis starting January 2008, fouling-related information via a reporting form to be developed by the Commission.

The Hull Husbandry Reporting Form (HHRF) was developed in consultation with a technical advisory group consisting of representatives from the shipping industry (including dry dock, in-water cleaning and antifouling coating representatives), scientific community, and local, state, federal, and international agencies. The form was distributed to the commercial fleet operating in California via shipping agents in January of 2008. The HHRF is divided into two sections: one dealing with husbandry practices relating to submerged vessel surfaces, and the other relates to voyage characteristics which are likely to influence fouling accumulation and complexity.

PRC Section 71205(e) requires annual submission of the HHRF. As of August 20, 2008, 47% of the 1472 individual vessels that have called to a California port or place have submitted the HHRF as required. While a compliance rate of nearly 50% is not as high as expected, this is the first year of a new submission requirement. Commission staff will be contacting vessel operators and reminding them of the reporting requirements and their delinquency before the end of 2008. The information collected and entered to date into the State's database does not yet represent a complete dataset, therefore only a preliminary look at the fouling-related practices of the commercial fleet operating in California will be presented in this report. As such, all fouling-related data will be presented as percentages rather than raw values.

Four hundred HHRFs have been entered into a database and evaluated as of August, 2008. The majority of the vessels for which fouling-related data has been collected and evaluated include container vessels (36% of the 400 total forms evaluated), tank vessels (25%), auto carriers (19%), and bulk vessels (9%, Figure V.20).

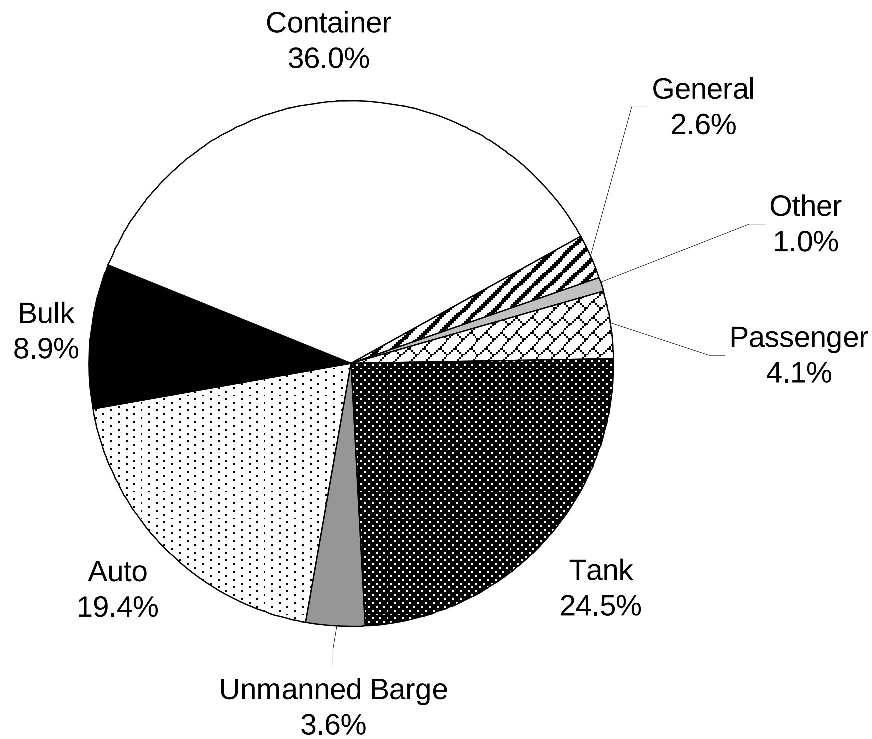

Figure V.20. Proportion of Vessel Types Evaluated for Fouling-Related Trends. 400 total vessels evaluated.

Husbandry Practices of the Commercial Fleet in California

One of the most common ways of reducing the amount of fouling organisms on the submerged surfaces of a vessel is to physically remove them. This usually occurs during a vessel's out-of-water dry dock, which most classification societies require at least every five years. Thus far, the fleet operating in California has followed this pattern, as over 86% have been delivered as new or dry docked within the past three years, and 99% within the past five years (Figure V.21). Newly built vessels (which represent 27.5% of the total number of vessels evaluated) and recently dry docked vessels, because of insufficient time for heavy colonization and succession, generally have underwater surfaces with low levels of fouling biota and therefore may pose a lower risk for NIS introduction.

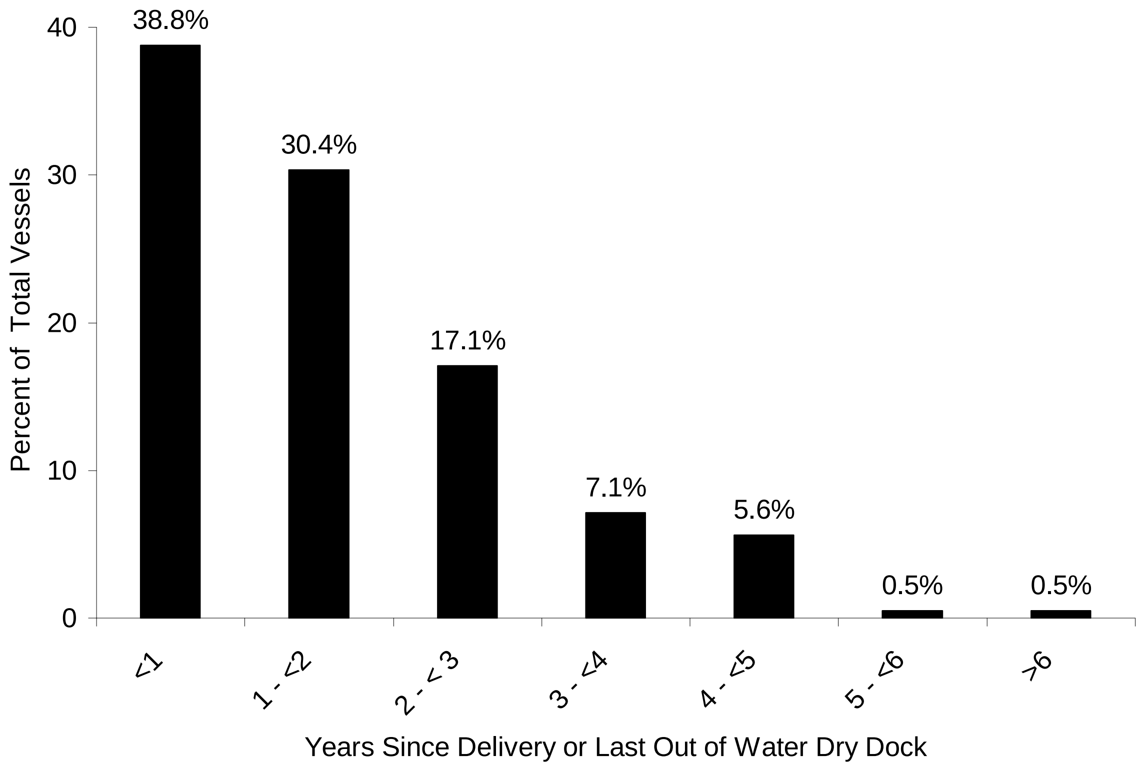

Figure V.21. The Percentage of Total Vessels Either Delivered as New or Cleaned During Dry Dock within each of the Past Six-Years.

While nearly all of the vessels evaluated have been newly delivered or dry docked within the past five years, evaluating the average ($\pm$ Standard Deviation; SD) time since each type of vessel has been out of water (either during ship building or dry docking) will allow for an assessment of risk according to vessel type. Three vessel types (general cargo carriers, unmanned barges, and auto carriers) averaged less than 1.5 years since their underwater surfaces were last completely clean of fouling organisms, and none of the vessel types evaluated averaged more than 2.3 years since the last out of water cleaning (Figure V.22).

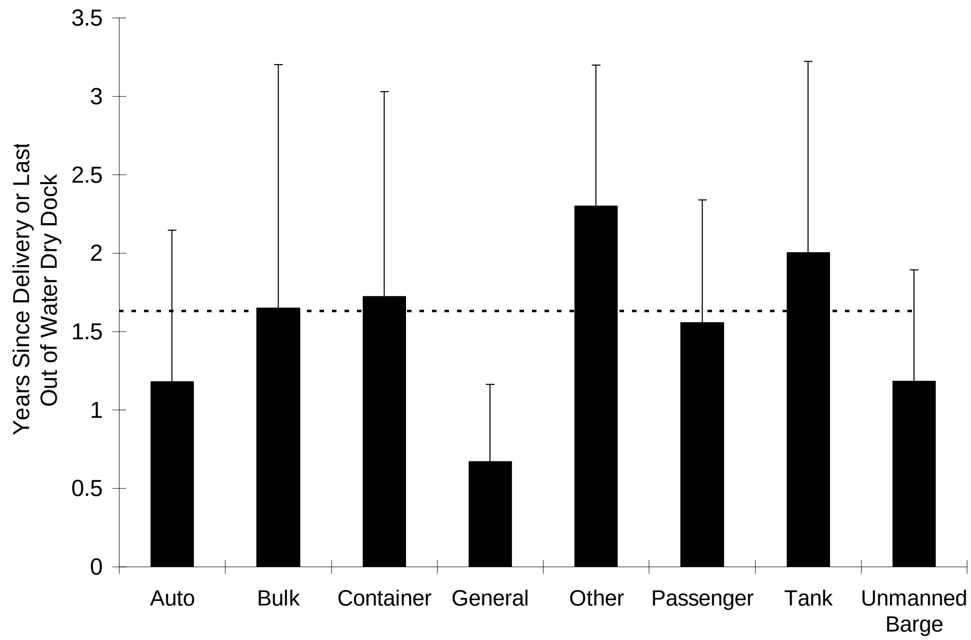

Figure V.22. Average (± standard deviation) Number of yYears Since Vessels (grouped by type) have been Delivered as New or Cleaned During Dry Dock. Dotted line represents overall average.

Physical removal of fouling organisms from submerged vessel surfaces can also take place while the vessel is in the water. In-water cleaning is an option many vessel owners and operators utilize to remove fouling organisms during the time between dry dock cleanings (i.e. inter-dry dock period) if fouling levels become elevated. In-water cleaning can include cleaning of many underwater areas on a vessel, or it can simply involve the cleaning of the propeller (i.e. propeller polishing), which is typically done as a first step when an increase in fuel consumption is detected. Overall, 33% of vessels have conducted some sort of in-water cleaning since delivery or dry dock, and of these, two-thirds have performed propeller polishing only. The vessels that have had multiple submerged areas cleaned in-water (white bars depicted in Figure V.23) include passenger, tank, container, bulk and other vessels - the five vessel types with the longest average amount of time since delivery or last dry dock (Figure V.22). Therefore, all eight vessel types appear to be actively involved in keeping fouling biota at relatively low levels through physical removal, either during out of water dry dock or through in-water cleaning in the interim period between dry docking.

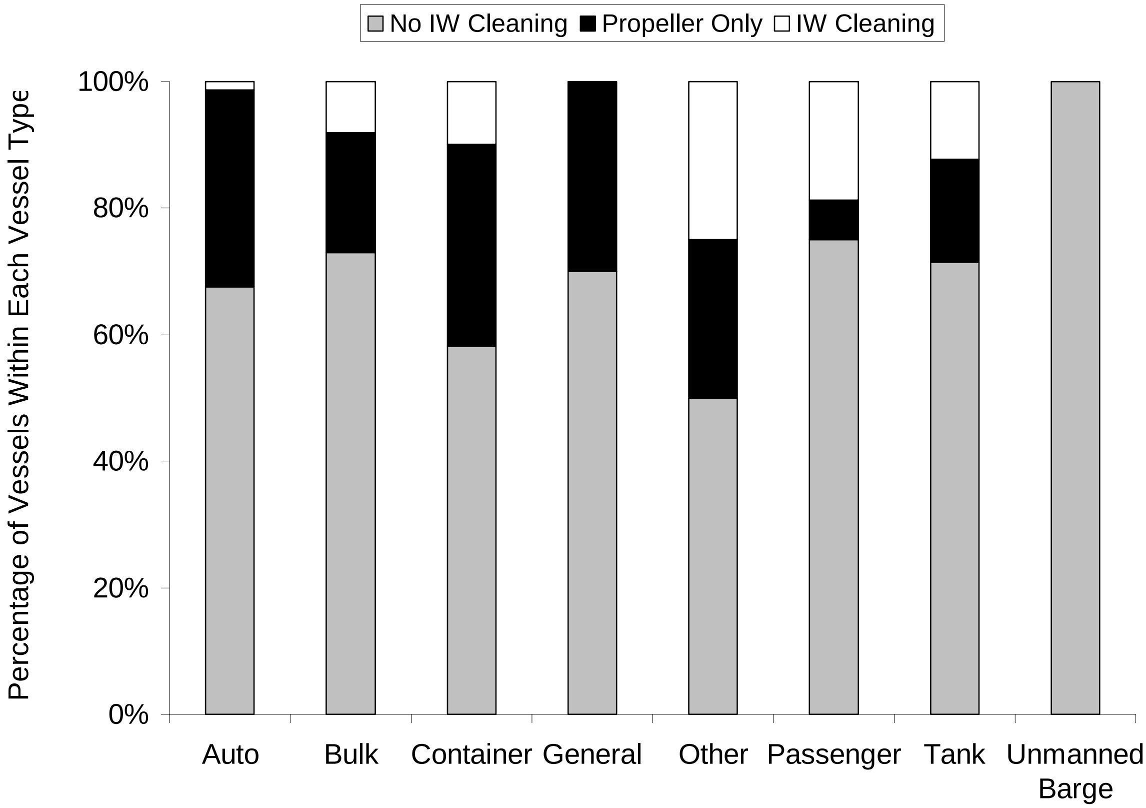

Figure V.23. Percentage of Vessel Types Conducting In-Water (IW) Cleaning and Propeller Polishing.

The majority of the vessels undergoing in-water cleaning are doing so within the United States (46.7% of total; Figure V.24), a trend not seen for out of water dry docking (7.8% conducted within the United States). Of those vessels undergoing in-water cleaning within the United States, over 85% have been cleaned in California, nearly all within the Los Angeles and Long Beach harbors.

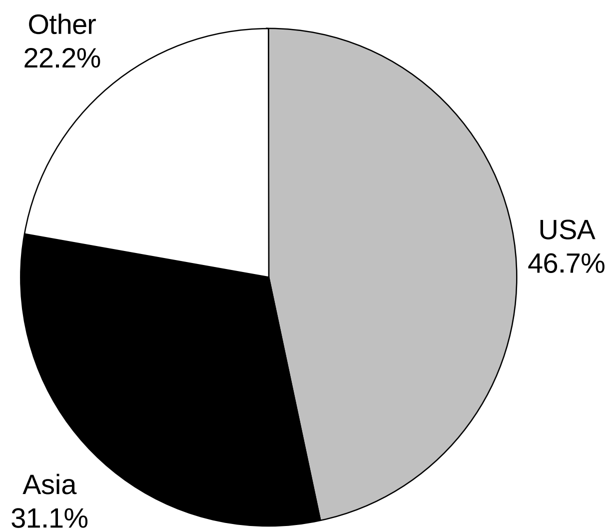

Figure V.24. Proportions of Vessels Undergoing In-Water Cleaning by Region.

In-water cleaning is typically conducted by divers or a remotely operated vehicle (ROV) and includes physical scrubbing or brushing of the vessel's submerged surfaces with a variety of bristle types designed for specific surfaces or coating types. Many different submerged areas are susceptible to fouling and may be cleaned during this in-water process. The most common areas cleaned are the sides and bottom of the hull, the propeller, sea chests, and the rudder (Figure V.25).

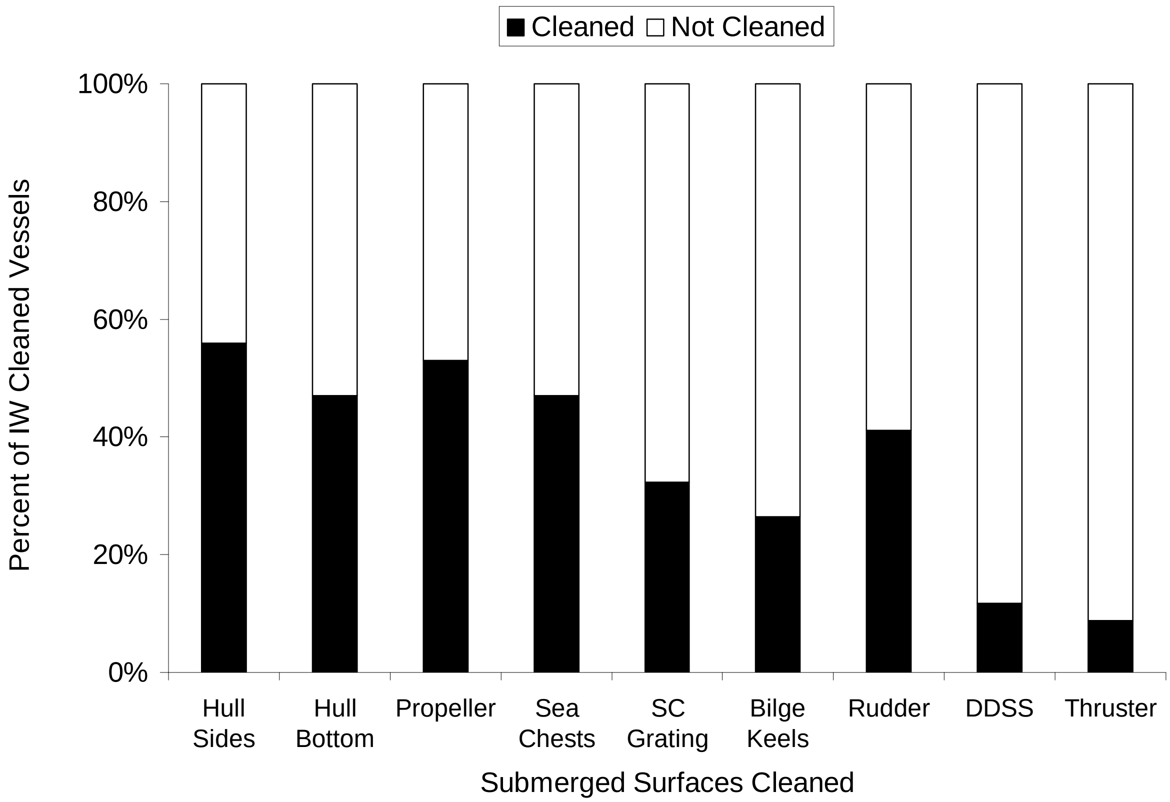

Figure V.25. Proportion of In-Water (IW) Cleaned Vessels Indicating Cleaning of Submerged Vessel Areas. SC represents Sea Chest. DDSS represents dry dock support strips (areas on the hull where the vessel rests during a dry docking event and therefore are not coated with antifouling treatments).

Aside from physical removal of fouling organisms from vessels, the shipping industry also utilizes preventative measures to keep levels of fouling to a minimum between required dry docking. One of these preventative measures is the use of antifouling coatings. Except in the rare case of dry docking for emergency repair, antifouling coatings are typically applied during each dry dock or during the shipbuilding process. Therefore, the ages of these antifouling coatings applied to the commercial fleet in California mirror the amount of time since these vessels were last out of water. Eighty-four and one tenth percent (84.1%) % of vessels were coated with antifouling treatments within the past three years, and 98.7% within the past five years.

Many submerged areas other than the hull are susceptible to fouling, including sea chests, rudders and thrusters, among others. These 'niche' areas are frequently located out of the direct effects of high flow as the vessels are traveling and may provide a shelter for organisms to escape from external pressures. To combat the accumulation of fouling organisms on submerged surfaces, antifouling coatings are typically applied to the hull and many of these niche areas. The following locations have been coated with antifouling treatments on over 75% of the vessels reporting: hull sides (96%), hull bottom (97%), sea chests (86%), sea chest gratings (83%), rudder (78%), and the bilge keels (75%) (Figure V.26).

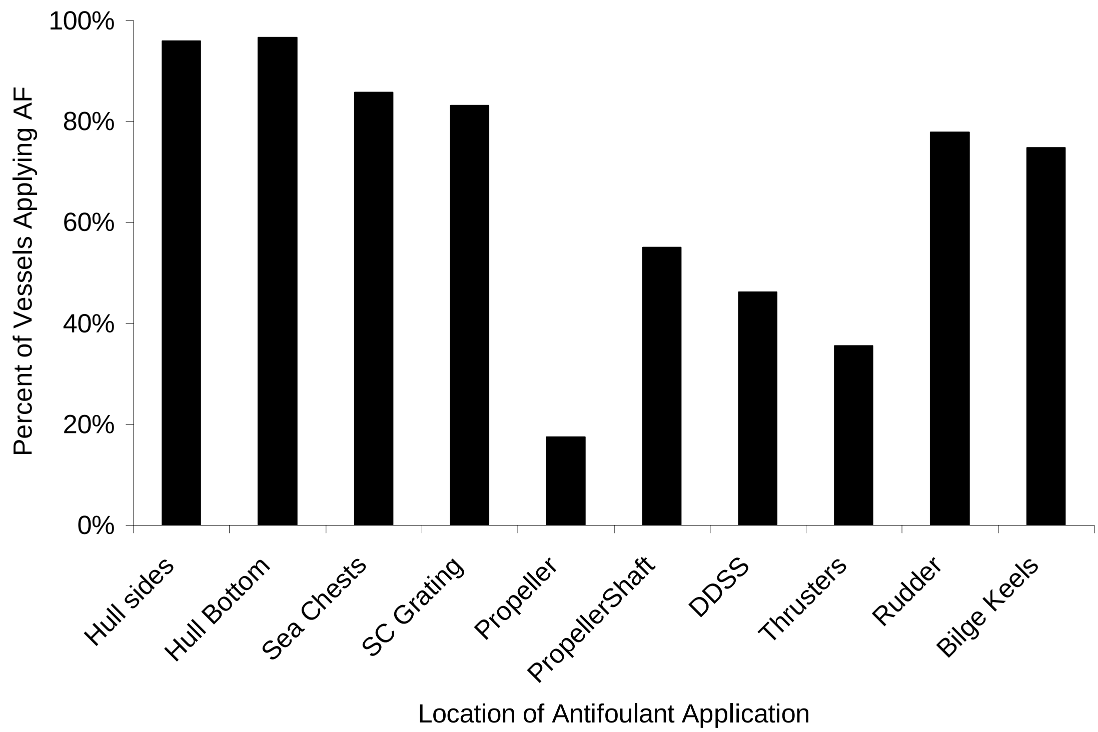

Figure V.26. Percentage of Vessels Applying Antifouling (AF) Coatings to Submerged Vessel Surfaces.

Antifouling coatings generally fall into one of two categories - those containing biocides and those that are biocide-free. Biocide-based coatings usually contain toxic metals and are most frequently copper-based (over 90% of all biocide-based coatings). Biocide-free coatings generally contain silicon and rely on a fouling-release mechanism. Organisms are not expected to adhere tightly to these surfaces and therefore ‘release’ or fall off as the vessel is in transit. These fouling-release coatings are designed to be used with vessels that travel at speeds of 15 knots and above. By far, the most commonly used antifouling coatings are biocide-based, as 85.3% of vessels have used at least one biocide-containing coating (Figure V.27). In comparison, biocide-free coatings have been used on only 10.7% of vessels. According to the data collected through the HHRF, only three vessel types have applied biocide-free coatings: container (22% of all container vessels used this type of coating), passenger (28%), and tank vessels (8%). Some vessels (5.6%) have applied a combination of both biocide and biocide-free coatings, generally covering the sides of the hull (where high flow velocities are more likely) with biocide-free treatments and using biocide-containing coatings along the bottom of the hull and other niche areas (where flow velocities are likely to be reduced) (Figure V.27).

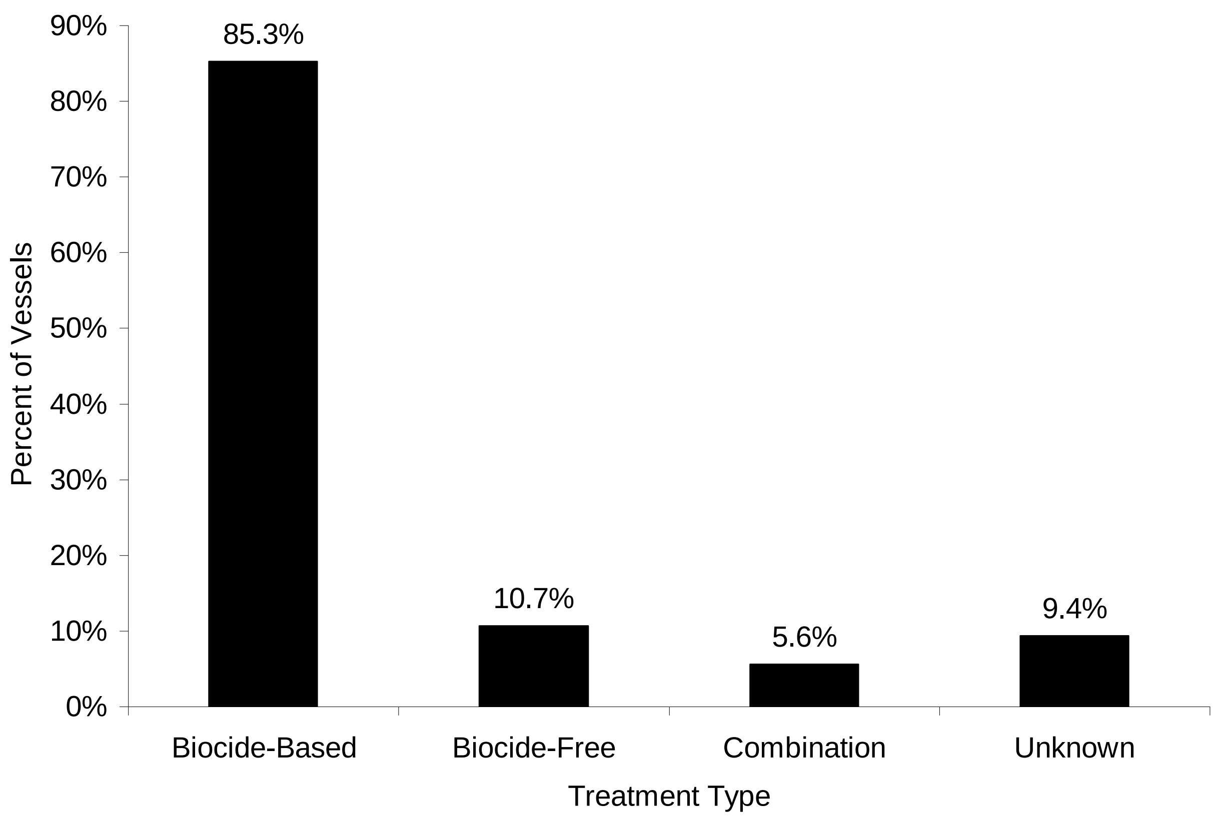

Figure V.27. Proportion of Vessels Applying Antifouling Treatments. Combination refers to application of both biocide-based and biocide-free coatings to different areas on the same vessel.

Fouling-Related Voyage Characteristics of the Commercial Fleet in California

Certain voyage characteristics and patterns are believed to influence the extent and complexity of vessel fouling. One of these characteristics is the amount of time that a vessel spends in a given port, as vessels that remain in port for extended periods of time may have more of an opportunity to accumulate fouling organisms. As a whole, vessels averaged 1.7 ± 1.6 (SD) days in port within the four months prior to submission of the HHRF (Figure V.28). However, when evaluated according to vessel type, the overall average is misleading. Three vessel classes average less than a day in port: auto carriers (0.87 ± 0.71 days), container vessels (0.87 ± 0.38 days), and passenger vessels (0.46 ± 0.09 days). All other vessel types average over two days in port, and three vessel types have average port residency times greater than 3.3 days: unmanned barges (3.37 ± 1.16 days), bulk vessels (3.93 ± 2.08 days), and other vessels (3.50 ± 2.12 days).

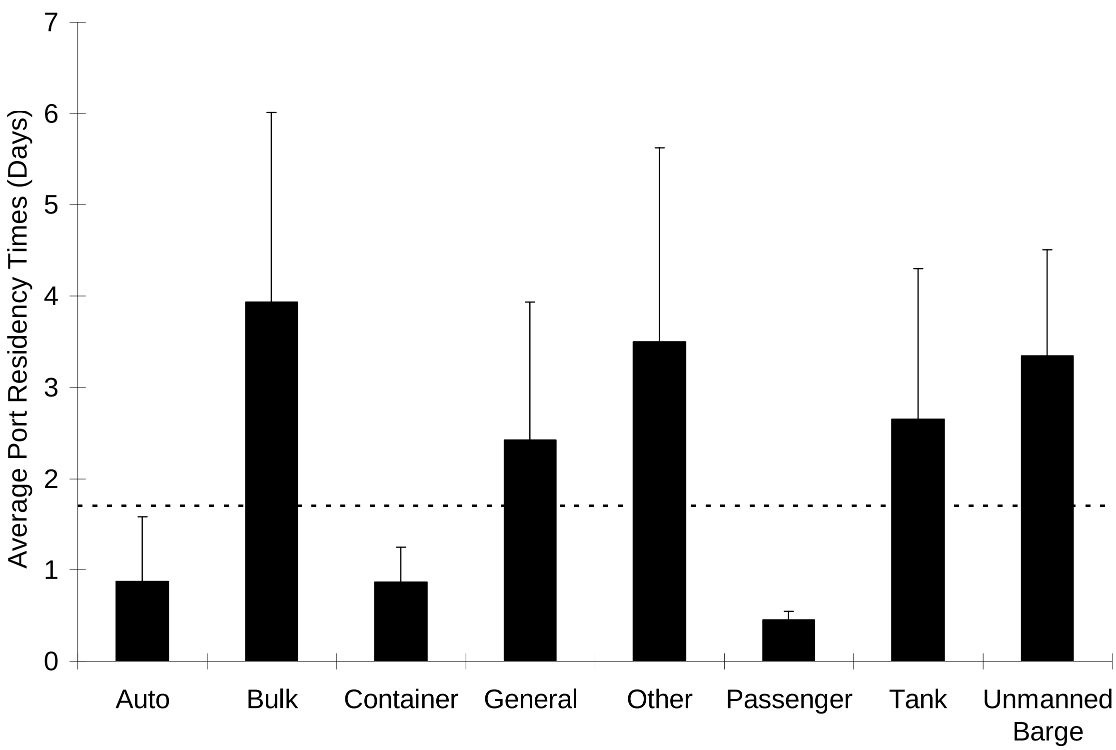

Figure V.28. Average (± standard deviation) Port Residency Times of Each Vessel Class. Data was reported for four-month period prior to submittal of the Hull Husbandry Reporting Form. Dotted line represents overall average.

Although auto carriers, containerships, and passenger vessels average less than a day in port, and all eight vessel types average less than four days in port, there may be infrequent occurrences when vessels remain in port for extended periods of time. Thirty point six percent (30.6%) of all vessels have reported at least one instance of remaining in a single port for more than 10 days since their last out of water or in-water cleaning. With the exception of three vessel types (auto carriers, passenger vessels, and container vessels), more than 50% of the vessels within each vessel class have remained in at least one port for longer than 10 days (Figure V.29).

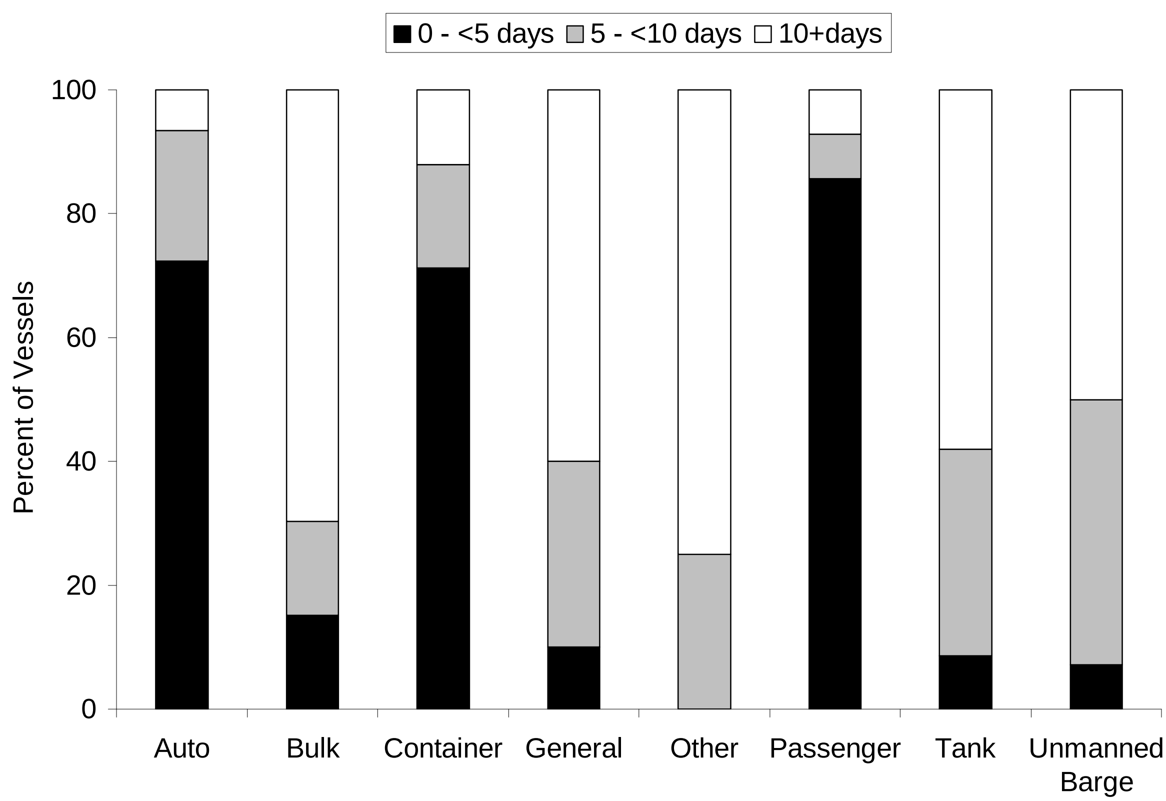

Figure V.29. Proportions of Each Vessel Type Reporting Port Stays of a Given Duration.

The speed at which vessels travel is another characteristic that is believed to influence fouling accumulation. Slower vessels are thought to be more susceptible to accumulating fouling organisms because the force and stress placed on these organisms is reduced in comparison to forces experienced at elevated speeds. Overall, the average (± SD) traveling speed of the commercial fleet operating in California is 17.1 ± 4.0 knots (Figure V.30). However, only three vessel types travel at speeds greater than 15 knots, on average: container vessels (21.0 ± 1.7 knots), auto carriers (17.4 ± 2.4) and passenger vessels (17.3 ± 3.2 knots). The slowest traveling vessel type operating in California are the unmanned barges, with an average traveling speed of 8.1 ± 2.0 knots. Recall that 22% of all container vessels, 28% of all passenger vessels, and 8% of all tank vessels have applied biocide-free antifouling coatings, which are designed for vessels traveling at 15 knots and above. This is appropriate for container and passenger vessels, as they average over 17 knots but may not be appropriate for tank vessels, which average 14.2 ± 0.9 knots.

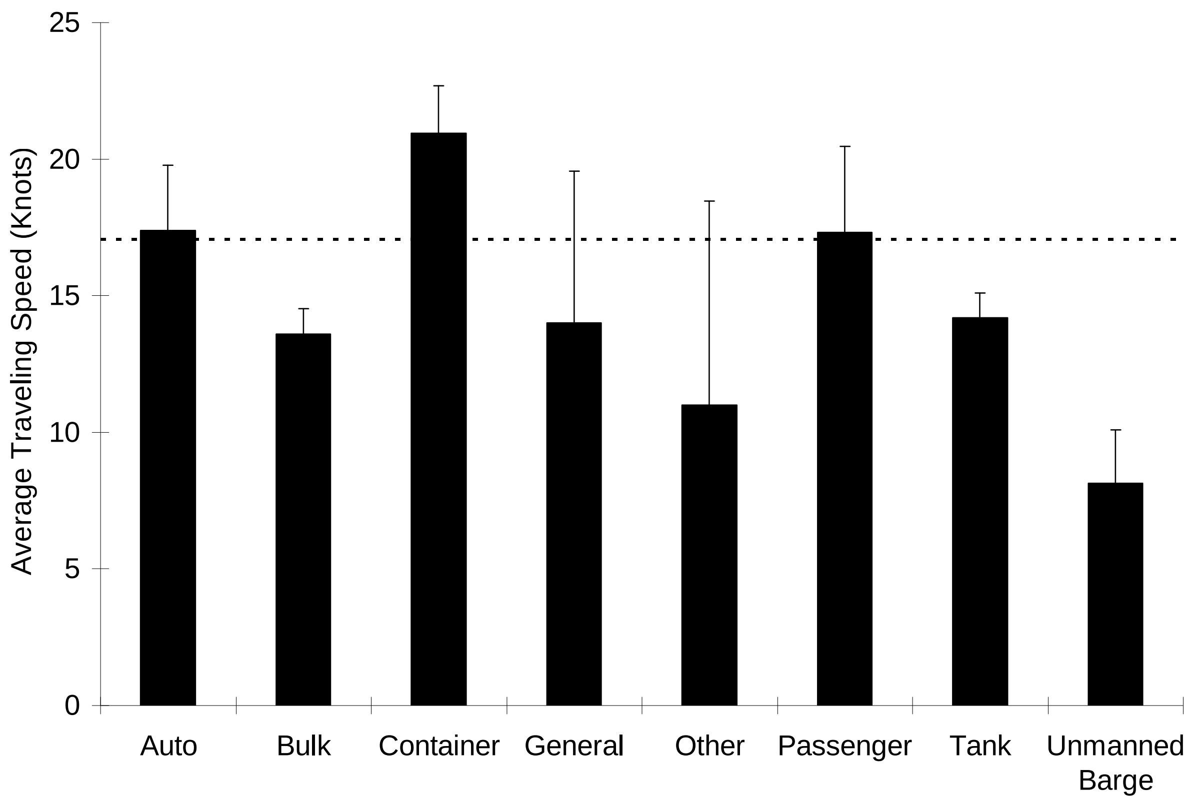

Figure V.30. Average (± standard deviation) Traveling Speed (knots) for each of the Vessel Types Operating in California. Dotted line represents the average speed of the California fleet as a whole.

The geographic locations where vessels travel may also influence fouling accumulation. The salinity extremes experienced when traveling from freshwater ports to the open ocean and back are thought to impact the viability of fouling organisms and reduce the risk of NIS introductions. Overall, 67.4% of all vessels operating in California waters have visited a freshwater port (or traversed the freshwater Panama Canal) since their last cleaning (Figure V.31). When evaluated by vessel type, at least half of the vessels within each vessel class have reported visiting a freshwater port during this time.

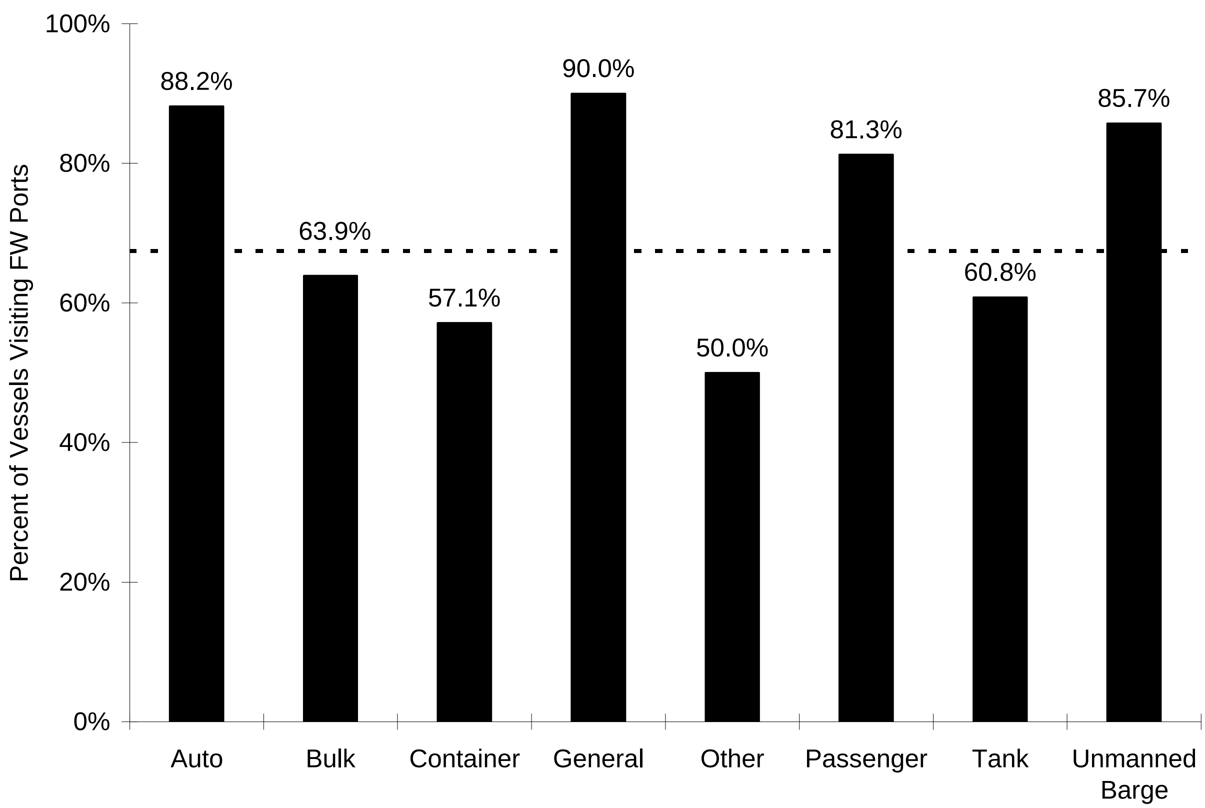

Figure V.31. Proportion of Vessels within Each Vessel Class that have Called to a Freshwater (FW) Port (including the Panama Canal) since Delivery or Their Last Cleaning. Dotted line represents the overall percentage (67.4%) of vessels operating in California that have visited a FW port.

The hull husbandry practices employed by the fleet of commercial vessels operating in California suggests that vessels are complying with California law and are attempting to limit the amount of fouling organisms that can accumulate. The data presented suggest that the fleet is relatively young. Over one-quarter of the vessels evaluated thus far are newly built and delivered within the past five years and therefore have had comparatively less time to accumulate fouling organisms. The remainder of the vessels, those older than five years (72.5% of all vessels evaluated), appear to be physically removing fouling organisms regularly. Overall, over 85% of all vessels have been out of water (either newly built or dry docked) within the past three years (99% within the past five years). The physical removal of organisms while the vessels remain in water does not appear to be a major tool used fleet-wide, as less than 10% of all vessels conduct in-water cleaning of the hull and other submerged surfaces. However, the five vessel types that conduct the majority of the in-water cleaning (bulk, container, other, passenger, and tank vessels) have had the longest amount of time elapse since delivery or out-of-water cleaning (i.e. there is a positive relationship between time since delivery/dry dock and the occurrence of in-water cleaning). The application of antifouling treatments as a preventative measure is being conducted on a regular basis, typically during either the shipbuilding process or the last out-of-water dry dock. Because of this, the age of these coatings mirrors the amount of time since the vessel was last out of water, with the application of 84.1% of all coatings occurring within the past three years.

Unlike the ballast water vector, all vessels pose some level of risk through the fouling vector. However, because fouling organisms are external, they are exposed to many more varying environmental conditions than sheltered ballast water organisms. These environmental conditions and voyage patterns are likely to influence the amount, complexity, and viability of fouling biota on the submerged surfaces of the commercial fleet. The voyage characteristics evaluated in this section suggest a gradient of risk associated with the different vessel types, with auto, container, and passenger vessels posing the lowest amount of risk and barges, bulk, and tank vessels posing the greatest amount of risk.

The lower risk vessel classes (auto, container, and passenger vessels) all share short average port residency times (less than one day), elevated traveling speeds (greater than 17 knots), and freshwater port calls (greater than 55% of the vessels within each class). These vessels also tended to avoid extended port durations, as over 70% of the vessels within each of these groups have not remained in a single port for more than four days. All of these characteristics are believed to limit the amount of viable fouling organisms that can accumulate on vessels and therefore are likely to limit the amount of risk associated with these vessels.

The higher risk vessel types (unmanned barge, bulk, and tank vessels) all share voyage characteristics which are believed to increase the risk of NIS introduction. These vessel types have longer average port residency times (greater than three days) and generally travel at slower speeds (14.2 knots and below), especially unmanned barges (8.1 knots). These vessel types also tend to experience extended port stays, as over 50% of the vessels in each of these classes report at least one stay of 10 days or more since the vessel had been delivered or dry docked. Not all of the voyage characteristics associated with these vessel classes indicate higher risk; at least 60% of the vessels within each of these classes have visited a freshwater port (or the Panama Canal) since delivery or last dry dock.

The information presented in this section along with the rest of the data that will be collected via the HHRF over the next few years will provide the Commission with valuable insight into the fouling-related practices of the fleet as a whole. These data will be used in conjunction with the information learned through fouling-related research currently funded through the MISP (see Section VII) to get a better idea of how the husbandry practices and voyage characteristics described in this section affect the quantity and quality of fouling biota associating with vessels operating in California. Both sets of information will guide and inform the development of regulations on the management of fouling for vessels operating in California, mandated by January 1, 2012.

Fee Submission

Under PRC Section 71215, the Board of Equalization (BOE) collects a fee from the owner or operator of each vessel that arrives at a California port or place from a port of place outside of California. The Fees collected are deposited in the Marine Invasive Species Control Fund to support the State's Marine Invasive Species Program.

BOE receives daily reports from the Los Angeles/Long Beach Marine Exchange and San Francisco Marine Exchange listing all arrivals to California ports. An electronic record of this information is maintained for reference and use by the BOE staff. The reports are reviewed to determine which arrivals are qualifying voyages and subject to the Fee. Vessel accounts are billed based on arrival information. Additional analysis is necessary to assign the correct account numbers to these arrivals.

There are currently 3,131 ballast accounts representing 8,561 vessels registered with the BOE. On average, 65 new vessel accounts are added per month. In addition, an average of 150 account maintenance items (address changes, adding vessels to existing accounts, etc.) are processed per month. Approximately six vessel accounts are closed out each month, and an average of 500 vessel billings are mailed per month. Compliance rate for fee submission exceeds 98%.

Table V.4. Summary of Marine Invasive Species Fee Program.

Period of Activity	Voyages Billed	Voyages Reported (Note 1)	Total Voyages	Fees Billed	Fees Reported (1)	Total Fees	Payments Received for Period (2)
2000	5871		5871	2735534		2735534	2723981
2001	5263	510	5773	2105200	204000	2309200	2306992
2002	4608	921	5529	1378400	277200	1655600	1639458
2003	4668	1013	5681	933600	202600	1136200	1133732
2004	5699	1123	6822	2752200	535100	3287300	3248625
2005	6070	1156	7226	2830700	534700	3365400	3326187
2006	6196	1161	7357	2478400	464400	2942800	2938686
2007	5959	1199	7157	2383600	479600	2863200	2835401
Through June 2008 **(3)**	2781	517	3298	1112400	206800	1319200	1259540
TOTAL	**47115**	**7600**	**54714**	**18710034**	**2904400**	**21614434**	**21412602**

NOTES: Note 1: Returns are due at the end of the month following the period of activity.

Note 2: As a result of penalties and accrued interest for any one period, actual cash received may exceed amount originally billed.

Note 3: Amounts may be understated until completion of return and payment reconcillation process.

VI. RESEARCH

Funded and Collaborative Research

PRC Section 71201 declares that the purpose of the Marine Invasive Species Program is, "to move the state expeditiously toward elimination of the discharge of nonindigenous species into the waters of the state." The MISP advances this goal through a comprehensive multi-pronged approach to vessel vector management including funding and coordination of targeted, applied research that advances the development of strategies to prevent the introduction of NIS from ballast water and vessel fouling. Specifically, PRC Section 71213 mandates 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 . . .."*

In an effort to advance the goals of the MISP, the Commission has funded specific research addressing many of the NIS-related issues for which information has been limited or lacking, including research related to emerging technologies which may strengthen the Commission's ability to reduce or prevent the occurrence of NIS introductions into California waters. This section summarizes the research that the Commission has funded and collaborated on during the previous two years.

Vessel Fouling Research

The Commission has been actively evaluating the risk of NIS introductions into California through both the ballast water (see Section V. Data Analysis – *Ballast Water Management and Compliance*) and vessel fouling (see Section V. Data Analysis – *Trends in Vessel Fouling-Related Practices and Patterns*) vectors over the past two years. As part of the evaluation of vessel fouling (i.e. the attachment of aquatic organisms to the underwater areas of vessels), the MISP has funded research aimed at evaluating and understanding this vector more completely. This research is being conducted by the Aquatic Bioinvasions Research and Policy Institute (ABRPI), a joint collaboration between SERC and Portland State University. This research includes a variety of inter-related projects, some of which have been completed and some of which are currently being investigated. A brief discussion of each of these studies is presented below.

Recently Completed Fouling-Related Research

The Implications of Maritime Vessel Traffic, Wetted Surface Area and Port Connectivity for Hull-Mediated Marine Bioinvasions on the U.S. West Coast (Davidson et al. 2006a)

The ABPRI has conducted an analysis of shipping patterns of vessels arriving to U.S. West Coast ports in California (CA), Oregon (OR), and Washington (WA) over a two-year period (July 2003 through June 2005). Included in this study was an evaluation of the total amount of underwater vessel surface area, referred to as wetted surface area (WSA), arriving to the U.S. West Coast. The WSA serves as an estimate of the total potential colonizable area on a vessel, and therefore is analogous to ballast water discharge volume as a risk factor analysis tool. Overall, 29,282 vessels arrived to U.S. West Coast ports during the study period, representing 265.6 million square meters of WSA.

A number of interesting patterns have emerged from this analysis. Overall, roughly two-thirds of arrivals had a last port of call (LPOC) that was from ‘overseas’ (defined in this study as outside of CA, OR or WA), largely driven by container vessels, which made up nearly 48% of all WSA arrival to the U.S. West Coast. Bulk vessel WSA arrival was also dominated by overseas transits, with 4.6 times more overseas than coastal voyages. Tank vessel WSA arrived from both coastal and overseas ports at roughly the same rate. The only vessel type whose WSA arrivals were predominantly coastal were barges (coastal arrivals were 7.8 times more frequent than overseas).

Protocol for Sampling Commercial Vessel Biofouling Using a Remotely Operated Vehicle (ROV) (Davidson et al. 2006b)
Little data exist from surveys of hulls and other underwater areas on vessels, particularly from the contemporary commercial fleet. One of the contributing factors to this lack of data is the difficulty associated with surveying the underwater surfaces of vessels. This study describes a protocol for sampling the underwater surfaces of vessels using a remotely operated vehicle (ROV), and focuses on six specific underwater areas that are considered fouling hotspots: rudder, stern tube and propeller, stern-end vertical (belly-line), horizontal hull transects along the dry dock support strips, bow thruster, and the bow and bulbous bow.

Comparing Methodologies for Assessing Vessel Biofouling: Dry Dock, Diver and ROV Sampling (Davidson et al. 2007a)
Assessments of commercial vessel fouling have traditionally been conducted either in-water by diver sampling or out-of-water by dry dock sampling. More recently, archival video footage from underwater vessel inspections has been utilized as a vessel fouling evaluation tool. This current study compares each of these three methods with ROV surveys (see description above: Davidson et al. 2006b), across ten different criteria to assess the merits and constraints of each of these four methods. Overall, underwater sampling by divers is the most effective method for assessing commercial vessel fouling because it provides data representative of the commercial fleet, and because it provides researchers with the ability to combine photographic sampling with biological sample collection.

Commercial Vessel Biofouling Extent and Composition: Containerships Sampled by Diver and ROV Survey (Davidson et al. 2007b)
The ABRPI conducted underwater surveys of 22 vessels, all container vessels, using either divers or ROV. In addition to determining fouling extent through underwater surveys, this study also includes an evaluation of vessel characteristics such as duration since last dry docking and recent operational history (e.g., voyage routes) and

how they correlate with fouling extent and composition, as well as a comparison to other surveys of vessel fouling conducted worldwide.

Overall, this report suggests that both voyage range and duration since last dry dock may be more important in fouling accumulation than ship type. However, it is clear that a greater intensity of hull sampling, across a variety of different vessel types, is required to obtain a better view of the extent and composition of fouling on the contemporary commercial fleet. Doing so will facilitate thorough assessments of all of the factors influencing fouling accumulation and survivorship and subsequent risk of NIS introduction.

Current Fouling-Related Research

The Commission is currently funding three fouling-related studies through the ABRPI to build upon the results of the research described above. The first study involves a critical appraisal and re-analysis of data from the hull fouling literature. It is broadly agreed that there is both a lack of information related to the vessel fouling vector and a lack of review and synthesis of the data that is available. This work involves a re-analysis of existing data to provide a solid foundation of fouling-related knowledge and will enable much needed assessments of the spatial and temporal variability of fouling transfers. One of the goals of this project is to determine how well findings from modern studies of vessel fouling in different regions of the world can be applied to California in order to influence possible management options in the future.

The ABRPI is also building upon the results of their analysis of fouling extent on container vessels (see Davidson et al. 2007b) by performing a similar study on a different class of vessels operating in California - barges. Barges were selected for this study because they lie on the opposite end of the spectrum from container vessels in terms of potential fouling-related practices. Barges tend to travel at much slower speeds, typically spend longer durations of time in port, and operate more regionally than container vessels. All of these characteristics of barges make them an appropriate next step in the goal to steadily increase the study of vessel hulls to all vessel types in order to provide essential data on the transfer of fouling organisms across the contemporary commercial fleet operating within California waters. This study also includes an assessment of fouling organism survivorship, which is being assessed by sampling the same locations on the same barges after random interim periods and also includes dockside viability tests involving biological samples removed from the hull. The results of this study will complement the data generated from previous work on container vessels (Davidson et al. 2007b) and will allow for assessments of fouling extent and composition within and between vessel types.

The third currently funded study is an evaluation of fouling organism viability, an important factor to bridge the gap between the vessel fouling vector and potential introduction into a recipient region. There is a considerable amount of information known about ballast water organism survival but data relating to survival of fouling organisms are lacking. In contrast to ballast water organisms, which are effectively sheltered from environmental conditions occurring along a voyage route, fouling organisms are constantly exposed to a myriad of different environmental conditions (e.g., salinity, temperature, and flow characteristics) and are more susceptible to the potentially lethal effects associated with these types of variables. This study focuses on the effects of salinity on fouling organism viability and is designed to test salinities that mimic ship movements within the Panama Canal and into California's marine, brackish and freshwater ports. The test organisms will be collected on settling plates from the area surrounding the Panama Canal, to serve as NIS posing an incursion threat to California. This study will also likely include an evaluation of temperature and flow tolerance as well. These experimental trials will provide valuable insight into the influence of natural levels of environmental variability encountered in California's port systems on potential inoculation by fouling species. The results may also shed light on how certain vessel traffic patterns (e.g., passage through Panama Canal and freshwater port calls) may influence the risk of NIS introduction into California.

Ballast Water Exchange Verification

Salinity measurements are currently the only available assessment tool for rapid verification of BWE. Unfortunately, it is extremely limited in value (Murphy et al. 2007). Ballast water taken up at one of many high salinity ports would register salinity readings comparable to those of the open ocean. Thus salinity measurement may not indicate whether an exchange had been conducted and will not always indicate whether compliance with California law is being met.

The Commission entered into an agreement with the SERC to test the application of ballast water exchange verification (BWEv) methodologies in 2005. The goal of the project was to identify chemical components of sea water that have unique concentration ranges between open-ocean and coastal waters. Based upon this information, SERC developed a new method to identify whether ballast water has been properly exchanged. The results of this study suggest that several chemical components in ballast water (e.g. barium, manganese, phosphorous, and chromophoric dissolved organic matter (CDOM)) may be useful for this purpose.

The Commission recently entered into a new contract with SERC to evaluate the efficacy of using these chemical components as indicators of ballast water exchange for vessels arriving to California and the West Coast of the United States. Ballast water samples will be collected by Commission Marine Safety personnel during routine ballast water inspections and later analyzed by SERC. Staff will also measure the concentrations of CDOM aboard the vessel using a hand-held instrument (Ballast Exchange Assurance Meter (BEAM)) developed by Dakota Technologies. SERC will evaluate the accuracy of the BEAM by comparing the concentrations of CDOM measured in the field to those measured in the laboratory using the samples collected by Commission Inspectors. Additionally, SERC will analyze samples for concentrations of selected metals likely found in ships' ballast water that may be of concern from a water quality perspective (e.g. zinc, nickel, copper). This study will help the Commission determine the appropriate next steps for BWEv of vessel discharging in California ports. The project should be completed in 2009.

Alternative Treatment Technology Pilot Projects

In addition to the mandate in PRC Section 71213 to conduct research necessary to carry out the requirements of the division, PRC Section 71210 specifically addresses the management of ballast water using alternative treatment technologies and requires the Commission to:

> *"…sponsor pilot programs for the purpose of evaluating alternatives for treating and otherwise managing ballast water. The goal of this effort shall be the reduction or elimination of the discharge of nonindigenous species into the coastal waters of the state…Priority shall be given to projects to test and evaluate treatment technologies that can be used to prevent the introduction and spread of nonindigenous aquatic species into coastal waters of the state by ship-mediated vectors."*

To fulfill this mandate, Commission staff has worked with the maritime industry and technology vendors over the last several years to help identify vessels and test platforms for the purpose of treatment system development and evaluation. It is a challenge to find companies willing to commit to costly vessel retrofits in support of shipboard experimental testing of ballast water treatment systems. Identifying appropriate shipboard platforms for treatment system evaluations requires a unique combination of owner willingness, available funding, and engineering compatibilities.

The Commission has funded the following projects in recent years in order to gather much needed information about the design, development, installation and evaluation of ballast water treatment technologies.

<u>Matson - Ecochlor</u>

In 2005, a portion of MISP funds was allocated to support the shipboard installation and evaluation of an experimental ballast water treatment technology onboard the Integrated Tug/Barge *Moku Pahu,* operated by Matson Navigation Inc. The funds were provided to assist in the installation and evaluation of a chlorine dioxide treatment system designed by Ecochlor Inc. Initial studies have shown this technology to effectively treat zooplankton, phytoplankton, and some microorganisms (Oviatt et al. 2002). The Commission finalized a funding contract and project timeline with Matson Navigation Inc. which required system evaluation according to the USCG's Shipboard Technology Evaluation Program (STEP). During the summer of 2006, Matson Navigation Inc. submitted an application to the STEP for the *Moku Pahu*.

USCG's delay in processing the STEP application has deferred the biological analysis of treatment system performance on the *Moku Pahu*. During 2006 and 2007, the Ecochlor system on the *Moku Pahu* was adjusted and modified to optimize performance, and sampling ports were installed to facilitate ballast water sampling at inlet and discharge. In 2008, the USCG released the draft Environmental Assessment (EA) - necessary to evaluate the applicant for enrollment into STEP - for the *Moku Pahu*. Matson and Ecochlor worked with USCG to address the comments received in response to the draft EA, and the vessel was accepted into STEP in November, 2008. Biological efficacy testing should begin shortly.

APL - NEI

The Commission has also allocated funds for a ballast water treatment technology installation and evaluation onboard an American Presidential Line (APL) vessel. This technology, developed by NEI Treatment Systems, treats ballast water through de-oxygenation using a low-sulfur inert gas to displace the oxygen, thereby creating a hypoxic (low oxygen concentration) environment that significantly decreases the survival of NIS. This system also claims an added benefit of reducing corrosion within ballast water tanks under certain operating conditions (Tamburri et al. 2005). The project was initially approved for funding from the Commission in 2006, however, the project was delayed while additional funds and agreements were obtained from other sources. All funding is now in place, and Commission staff and APL finalized the contract in October, 2008. Work began in the fall of 2008.

Glosten – T/S *Golden Bear*

In 2008, the Commission approved funding to support the development of a ballast water treatment technology testing and evaluation facility onboard the California Maritime Academy's Training Ship *Golden Bear.* The Commission funding will augment federal funds from the National Oceanic and Atmospheric Administration (NOAA) Sea Grant Ballast Water Management Demonstration Program and from the Maritime Administration (MARAD). The project will establish the first ballast water treatment technology testing and evaluation facility in California, and the only dock-side shipboard facility on the West Coast. This work will provide valuable real-time information about shipboard operation of ballast water treatment systems. This information is critical for the continued development of effective means to control NIS introductions through ballast water discharges. The project is expected to commence in late 2008.

CDFG Marine Invasive Species Program

Pursuant to the Marine Invasive Species Act of 2003, the California Department of Fish and Game (CDFG) continues to monitor the location and geographic ranges of introduced species populations in the State's coastal and estuarine waters to supplement the existing baseline inventory of resident nonindigenous species. The baseline inventory development began under mandate by the Ballast Water Management for Control of Nonindigenous Species Act of 1999. The ongoing monitoring is intended as a means of detecting new introductions. The 2003 statute (the Marine Invasive Species Act) expanded the ongoing monitoring program to include intertidal and nearshore subtidal habitats along the open coast. The overall program is intended to assess the effectiveness of ballast water controls implemented under current laws and regulations. These findings will be made available in CDFG's Report to the Legislature due January 1, 2009.

CDFG's Office of Spill Prevention and Response (OSPR) continues to collaborate with other agencies and organizations conducting similar surveys for NIS in coastal waters, and to share data generated by these studies so that financial and personnel resources are maximized. As in previous years, OSPR has continued to retain Moss Landing

Marine Laboratories (MLML) as the primary contractor to conduct the on-going monitoring effort.

Activities for the current reporting period are summarized below. Readers wishing further details may view the CDFG Report to the Legislature, which shall be available concurrently with this report through the following website: www.dfg.ca.gov/ospr/about/science/misp.html.

Species Inventories and Ongoing Monitoring

First Outer Coast Survey, 2004

During the previous reporting period, MLML had completed most of the work for the initial Outer Coast Study, and their preliminary results were included in the Commission's 2007 Biennial Report to the Legislature (Falkner et al. 2007). CDFG received MLML's final report in December 2006. Due to ongoing taxonomic revisions, the introduction status of many species have been subsequently reclassified. Of the 26 species previously designated as introduced, 20 species have been reassigned to other categories, thereby reducing the total number of 2004 introduced species to six. Thus, except for Diablo Canyon and Arroyo Hondo, no introduced species were detected at stations north of Point Dume during 2004.

San Francisco Bay and Delta Survey, 2005

One additional survey of the San Francisco Bay and Delta was in progress during the previous reporting period. Samples collected from subtidal fouling, subtidal infauna, rocky intertidal and sandy intertidal habitats were analyzed in early 2007, and a draft report was completed in November 2007. The samples yielded an overall total of 513 resolved species. Many of the species historically found in the San Francisco Bay (e.g., pelagic organisms and mobile species such as the mitten crab, *Eriocheir sinensis*) were not found because sampling was limited to intertidal and subtidal habitats and sampling methods were habitat-specific. Furthermore, 44 species that were not previously included in the California Aquatic Non-Native Organism Database (CANOD) database were found, but subsequent literature and data reviews confirmed that none of these species were new to San Francisco Bay. In general, the number of introduced species was much greater in the central and south bays than in San Pablo and Suisun Bays. Lower salinities, scarcity of natural rocky intertidal habitats, and the small number of sampling sites may account for overall lower species diversity in the latter two bays.

Second Bay and Estuary Survey, 2006

Bay and Estuary sites were re-sampled by MLML during 2006, and the report was completed in February 2008. A total of 775 species were identified to species level (Table VII.1), and another 402 were taxonomically unresolved. No new introduced species were discovered during this survey.

Overall species diversity in freshwater ports was about one order of magnitude less than that of marine bays and harbors, consequently the number of introduced species differed between freshwater and marine sites in about the same proportions. However, comparison of numbers of species between sites is difficult, due to a lower level of sampling effort in freshwater ports. Among the marine ports, overall species diversity varied widely, although Southern California sites tended to have higher proportions of introduced species.

Table VII.1. Number of species found during the 2006 Bay and Estuary Survey by introduction status.

Introduction Status	**Number of Species**
Native	567
Introduced	82
Cryptogenic*	126
Unresolved	402

*Cryptogenic = species of unknown origin

Second Outer Coast Survey, 2007

Outer Coast sites were resampled by MLML during 2007. The same 22 coastal headland sites were targeted, but subtidal sampling was omitted for three of the northernmost sites due to logistical constraints. Sample analysis was completed in early 2008, and MLML submitted a final report in September 2008. Overall, fewer kinds of organisms were found in 2007 than in the previous survey, even after taxonomic and introduction status revisions had been accounted for (Table VII.2). Introduced species comprised approximately 0% to 1.2% of the total resolved species collected from each site. Cryptogenic species ranged from 11 to 56 species per site, representing 9.7% to 15.1% of total taxa, while native species ranged from 40 to 201 per site, representing 46.6% to 59.9% of total taxa collected.

Of the six introduced species found during 2004, three species of algae and one polychaete species were observed again in 2007. Five other introduced species were also found, but none are new to California waters.

The California coastline is divided into two distinct physiographic zones, separated by Point Conception. The two zones differ biogeographically, which may also account for the dissimilarities in the distribution pattern of nonindigenous species. In the northern zone, one introduced species was found at Shelter Cove (*Monocorophium insidiosum*, an amphipod) and at Diablo Canyon (*Sargassum muticum*, a brown seaweed). Although no introduced species were found at Point Conception, one or more were found at all other sites within the southern zone. *Sargassum muticum* and *Caulacanthus ustulatus* (a red seaweed) have persisted within the Southern California Bight since the previous survey. All other introduced species occurrences showed no temporal or spatial trends.

Given the three-year interval between surveys and the quantitative approach of the surveys thus far, the increase in the number of introduced species does not in any way refute the efficacy of California's Ballast Water Management Program. First, it must be stressed that none of the additional species detected in 2007 are new arrivals in California waters. The species may have been present but may have been missed due to chance alone because marine organisms tend to be distributed in patches. Secondly, many introduced species are polyvectic (i.e. having many possible vectors of introduction). Despite efforts to curb introduced species transported by the commercial sector, fouling from both commercial and recreational watercraft remains the primary source of introduced species to California's coastal waters.

Table VII.2. Number of Species Found During Outer Coast Surveys by Introduction Status, 2004 and 2007.

Introduction Status/Year	Number of Species	
	2004	**2007**
Native	1,069	802
Introduced	6	9
Cryptogenic*	147	144
Unresolved	618	474
Unresolved Complex	8	5

*Cryptogenic = species of unknown origin

Survey Report Updates

Due to the constantly changing state of taxonomy and introduction designations, the reader is advised that the numbers reported herein and post-survey reports submitted by MLML may be superseded at any time. Consequently, those wishing the most current version of list of introduced species from survey reports and other documents should consult CANOD. A description of CANOD is provided below.

California Aquatic Non-native Organism Database (CANOD)

PRC Section 71211 (a)(1) requires the CDFG to collect data necessary to establish and maintain an inventory of the location and geographic range of nonindigenous species populations in the coastal and estuarine waters of the state. Furthermore, Subsection (a)(2) requires that said existing data and accompanying analysis shall be made available to the public through the Internet on or before January 1, 2007, and provide an update for said inventory no later than July 1, 2008. To this end, CDFG, in collaboration with MLML, created the California Aquatic Non-native Organism Database (CANOD), a relational database of all organisms collected during California Marine Invasive Species Program surveys to date, as well as all data generated from collaborations with other agencies and organizations. In addition, literature-based information about introduced species have been incorporated into CANOD. Updates to CANOD are ongoing, as necessary to accommodate new records as well as taxonomic or introduction status revisions. CANOD may be accessed through the following website: www.dfg.ca.gov/ospr/about/science/misp.html.

Future Activities

The Marine Invasive Species Act of 2003 had previously extended the sunset date of the CDFG monitoring program to January 1, 2010. Meanwhile, the Coastal Ecosystems Protection Act of 2006 deleted the repeal of the monitoring program. In addition, the new legislation set a triennial cycle for future Reports to the Legislature regarding the CDFG monitoring program after January 1, 2009.

Plans for future sampling include:

- a third round of sampling for Bay and Estuaries sites, including San Francisco Bay, planned for 2009-2010
- a third visit to Outer Coast sites, planned for 2011-2012

Review of current vessel vector research

Nonindigenous Species

A large amount of NIS-related research has been published over the past few years, including a number of studies evaluating ballast tank sediments and vessel fouling as sources for NIS introductions. Drake et al. (2007) compiled ballast tank sediment data from various studies and determined that a high concentration of microbes is found in ballast tank sediments. While ballast water introduces more microbes than ballast tank sediments due to the large volume discharged, the authors state that ballast tank sediments should be addressed by best management practices.

Ballast tank sediments have also played a role in harboring active and resting stages of invertebrates (Bailey et al. 2007). This study contends that sediments can play an influential role in the success of invasions by providing habitat for invertebrates with tolerant resting stages, bypassing the harsh conditions associated with ballast tanks. Dormant invertebrates collected for this study were viable when placed into nutrient-rich conditions.

Another area of NIS-related research has focused on the transport of macroalgae via ballast water and ballast tank sediments. Flagella et al. (2007) recently discussed their finding of various life stages (such as spores and propagules) of 13 species of macroalgae in ballast water that were viable and culturable, suggesting that ballast water may be an important vector for transporting not only microalgae but also microscopic life stages of macroalgal species.

Vessel fouling has become another area that has received much attention in recent years. In a quantification and identification effort, Drake and Lodge (2007) identified 944 fouling individuals on a single vessel, more than an order of magnitude greater than previous efforts. While the authors acknowledge that this vessel may exceed “average” fouling, they emphasize that vessels which are heavily fouled pose the greatest threat for NIS introductions. Anti-fouling treatments applied to submerged surfaces of a vessel are intended to prevent and minimize fouling. However, recent research suggests that copper-based antifoulants may increase larval recruitment of NIS compared to control or TBT-treated conditions, and may inadvertently increase the risk of introducing NIS to new environments (Dafforn et al. 2008). The authors suggest that this observation may be due to resistance of heavy metal exposure in certain species, a theory that is supported by previous studies.

In addition to the fouling of vessel hulls, vessel sea chests can also harbor a variety of NIS (Coutts and Dodgshun 2007). The authors of this study surveyed the sea chests of 42 vessels and found that 42% of the identified organisms were mobile. These mobile NIS species may be more of a risk for successful introductions because of their ability to rapidly disperse while the vessel is in port.

Recent vessel fouling research has also indicated that in-water cleaning methods may increase NIS introduction risk. The brushes used during in-water cleaning have the potential to disperse viable fragments of certain species (e.g. macroalgae, bryozoans) into bays and harbors (Hopkins and Forrest 2008). The authors showed that live barnacles and hydroids were dislodged during in-water cleaning. Furthermore, cleaning without reapplication of antifouling paint may increase the susceptibility to increased levels of fouling as six-times more individuals were found on surfaces that were manually cleaned, compared to surfaces that were not (Floerl et al. 2005).

Silicone-based anti-fouling paints, which are designed to reduce the ability for fouling organisms to adhere to a vessel's surface, are not generally considered to be toxic. However, these silicone-based paints have the potential to cause adverse water quality conditions in ports. A recent study (Nendza 2007) states that the silicone oils in antifouling paints (known as polydimethylsiloxanes, or PDMS) may leach out from the coatings and are highly persistent and have low solubility in water. These oils may clog surface sediments and cause anoxic (i.e. no oxygen) conditions.

Another important direction for invasive species research has been the effect of climate change. In a recent review, Rahel and Olden (2008) discuss how climate change may influence the geographical range of established NIS through factors such as altered thermal regimes, reduced ice cover in lakes, and increased salinity. For example, freshwater and estuarine ecosystems may become more saline in a warming climate because of reduced precipitation. This could allow brackish water species, such as the Chinese mitten crab (*Eriocheir sinensis*), to survive in these environments or expand their range into nearby ecosystems that were historically freshwater. The authors also discuss how climate change may affect how we identify invasive species, as native species may also expand their distribution to populate new environments and cause adverse effects on other native species. The authors also reference the need for managers to have an integrated monitoring system for invasive aquatic species.

Management and Policy

Since the number of discovered NIS in the Great Lakes has increased since 1993, (when regulations were first implemented in the Great Lakes), regulatory agencies and researchers have wondered if ballast water exchange requirements have been adequate in the prevention of NIS introductions. Using a theoretical model, Costello et al. (2007) found that too few data exist to make a defensible conclusion about the efficacy of BWE. The authors also attribute the continuing discovery of new NIS in the Great Lakes to lag time between the time of introduction and detection. In a correspondence in Letters to the Editor, Drake et al. (2008) clarified issues discussed by Ricciardi and MacIsaac (2008) and summarized the main finding of Costello et al. (2007), stating, “there is insufficient data to precisely estimate the effectiveness of the BWE policy. However, empirical evidence suggests that this policy has not been 100% effective in preventing all ship-vectored transfers of NIS to the Great Lakes.”

VII. NEEDED RESEARCH

In addition to the research that has been funded by the Commission and research ongoing through independent parties, Commission staff believes the following research is necessary in order to advance the Marine Invasive Species Program and prevent the introduction of species from commercial vessel vectors into California waters.

Support research to develop methods to verify compliance with performance standards.

The field of treatment performance assessment, like that of treatment technology development, is emerging. Scientists are striving to find rapid, innovative techniques that can be used by both scientists and regulatory agencies to assess vessel discharge compliance with the relevant performance standards. Most notable for California, the performance standards for organisms less than 10 micrometers in size (bacteria and viruses) have not been adopted by any other regulatory entity in the world. Consequently, there is little ongoing effort to develop assessment techniques for these size classes of organisms. Currently, there are no available techniques to both quantify and assess the viability of all bacteria and viruses in a sample of ballast water (see discussion in Dobroski et al. 2009). The Commission should continue to support research addressing the development of new techniques and technologies to assess vessel compliance with California’s performance standards.

Support research promoting in-water cleaning technology development. Vessel owners and operators strive to maintain clean hulls in order to minimize fuel costs, maximize vessel speed, meet classification society requirements, and to help ensure the structural integrity of their vessels. While complete cleaning and re-coating of vessel hulls with antifouling paint may provide better long-term antifouling protection than in-water cleaning, the dry dock facilities necessary to apply those paints are limited and expensive. Most owners and operators therefore conduct in-water cleaning between required dry dockings. In-water cleaning is one of several ways through which fouling NIS can be transferred from a vessel to a recipient port, and the activity poses some NIS introduction risk. A technology that can collect and contain in-water cleaning debris would be a desirable tool to prevent NIS release during in-water cleaning, while also providing commercial operators an avenue to clean hulls without placing a vessel in dry dock. The Commission should support the development of new technologies to address this issue.

VIII. CONCLUSIONS AND LOOKING FORWARD

Through a variety of forward-looking and innovative management strategies, the Commission has continued to improve California's Marine Invasive Species Program over the past two years. Staff has not only worked to address gaps in compliance monitoring and enforcement actions, but Commission legislative reports completed since 2006 (Falkner et al. 2007, Dobroski et al. 2007) have been instrumental in the development of regulations to stem the transport of NIS in California. Specifically, the reports have lead to the development of regulations that: 1) implement performance standards for ballast water discharges, 2) reset the Fee amount collected that supports the various program components 3) adopt the Hull Husbandry Reporting Form, and 4) contribute to legislation delaying the initial implementation of the performance standards from 2009 to 2010. Furthermore, MISP continues to play a role in collaboration with other agencies and organizations to better address ship-born NIS issues.

The focus of the Commission's Program continues to be on protection, prevention, outreach and education, and solution-based actions. The Commission will concentrate available resources on working proactively with the regulated industry to achieve a high rate of compliance with required management practices, to minimize discharges of unmanaged water, and to reduce the risks of biological invasions.

Looking Forward

The legislatively-mandated reports and projects completed by the Commission since 2006 have strengthened the knowledge and ability of the Commission to prevent NIS introductions, led to new legislation, and have increased agency responsibilities. They have also identified challenges that will need to be addressed over the next two years in order for the Commission to fulfill new legislative directives and to continue to “move the state expeditiously toward the elimination of the discharge of nonindigenous species into the waters of the State”. To address these challenges, Commission staff is currently engaged in the following activities:

Protocols and regulations to implement California’s performance standards

The effective implementation of California’s performance standards requires Commission staff to move forward on several new projects and rulemaking actions. First and foremost has been the development of ballast water treatment technology testing guidelines to provide technology vendors with a standardized approach to evaluating treatment system performance relative to California’s discharge standards and water quality objectives. The guidelines were completed and distributed in October, 2008. The testing guidelines draw heavily on the EPA’s draft Environmental Technology Verification (ETV) protocols for ballast water performance verification. EPA is currently in the process of revising the draft ETV protocols and expects to release the next version in late-2009 or 2010. As the ETV protocols are updated, Commission staff will revise the testing guidelines in order to eliminate variability between the proposed federal technology evaluation program and California’s recommended guidelines.

Commission staff must make several amendments to the performance standards regulations (2 CCR § 2291 *et seq*.) during the next year to ensure effective implementation. The passage of SB 1781 (Chapter 696, Statutes of 2008) delayed the initial implementation of those standards from 2009 to 2010. The regulations must now be amended to maintain consistency with the statute.

Commission staff is also in the process of developing regulations to guide the selection of sampling points (i.e. location) and sampling facilities (i.e. equipment) on vessels to facilitate the collection of ballast water samples to assess compliance with the performance standards. Additionally, the regulations will offer guidance on the selection of sampling facilities so as to reduce or eliminate the possibility of artificially induced organism mortality associated with passing through the sampling apparatus.

Finally, Commission staff is developing procedures and protocols for use by Commission Marine Safety personnel to verify vessel compliance with the performance standards. These enforcement protocols will be drafted in association with the same panel of experts involved in the writing of the technology testing guidelines.

Continue to work in consultation with the Water Board to identify applicable water quality requirements for ballast water treatment technologies and provide technology developers with guidance documents to ensure system compliance with applicable California laws.

As specified in the California Coastal Ecosystems Protection Act of 2006, ballast water treatment systems must be reviewed for environmental impacts, including effects on water quality. As the state agency with the authority and expertise to evaluate and enforce water quality requirements under the Clean Water Act, the State Water Resources Control Board plays an integral role in this regard. The Water Board and the Commission staff will continue to work to identify the California water quality requirements that are applicable to ballast water treatment systems. Commission staff is also working with Water Board staff to stay informed about the provisions in the State's Clean Water Act Section 401 certification of the NPDES Vessel General Permit and any changes to the California Ocean Plan or relevant monitoring programs associated with vessel discharges. This information will be incorporated into a guidance document and passed on to treatment developers so that they may ensure that their systems will be in compliance with California's water quality requirements.

Compiling and analyzing data related to vessel hull husbandry

Unlike the ballast water vector, all vessels pose some level of risk through the fouling vector. However, because fouling organisms are external, they are exposed to many more varying environmental conditions than sheltered ballast water organisms. These environmental conditions and voyage patterns are likely to influence the amount, complexity, and viability of fouling biota on the submerged surfaces of the commercial fleet. In January 2008, Commission staff began collecting data, using a Hull Husbandry Reporting Form (HHRF), on the fouling-related husbandry practices of the commercial vessel fleet visiting California waters. The data collected via the HHRF over the next few years will provide the Commission with valuable insight into the fouling-related practices of the fleet as a whole. These data will be used in conjunction with the information learned through fouling-related research currently funded through the Commission to get a better idea of how husbandry practices and voyage characteristics affect the quantity and quality of fouling biota associating with vessels operating in California. Both sets of information will guide and inform the development of regulations on the management of fouling for vessels operating in California which the Commission is mandated to adopt by January 1, 2012.

Improving Compliance

As a result of extensive outreach by Commission staff, the utilization of technical advisory groups, the implementation of a monthly electronic notification system and the potential for civil and criminal penalty action, compliance with ballast water reporting form submission continues to exceed 95 percent. Conversely, compliance with the reporting requirements for hull husbandry practices needs significant improvement. This is the first year of this new reporting requirement and as such, misunderstanding exists about when vessels should report. Commission staff believes that these misunderstandings have been corrected via the rulemaking process and the associated public commenting period. Staff will continue in its outreach efforts in order to ensure that the HHRF compliance rate increases to levels comparable to that of the ballast management reporting.

In addition to outreach efforts to increase reporting compliance, Commission staff continues to address compliance with ballast water management requirements. The total volume of ballast water discharged into California has been increasing over the last two years, though the volume of noncompliant ballast water has decreased approximately 45 percent during this time. Furthermore, only two percent of all ballast water carried into the waters of the State did not meet the management requirements as prescribed in the law. The vast majority of these noncompliant ballast water discharges underwent some type of exchange, reducing the risk of NIS introductions. As vessel owners/operators transition from ballast water exchange to effective treatment technologies in response to the implementation of performance standards, the risk of NIS introductions posed by ballast water will decrease. During this transition period and beyond, the Commission will continue to address noncompliant vessels through outreach and education and the pursuit of enforcement action as necessary.

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