

REVISED DRAFT REPORT

**Technical Support for EPA Development of a Permitting Framework to
Address the Vacatur of the NPDES Vessel Exclusion**

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ATTACHMENT A: Table 1–State-by-state Recreational Vessel Registration Information

ACRONYMS AND ABBREVIATIONS

AFFF	aqueous film-forming foam
ANPRM	advanced notice of proposed rulemaking
APPS	Act to Prevent Pollution from Ships
AWO	American Waterways Operators
BMP	best management practice
CBP	U.S. Customs and Border Protection
CERCLA	Comprehensive Environmental Response and Community Right-to-Know Act
CFR	Code of Federal Regulations
CLIA	Cruise Lines International Association
CMC	Crowley Maritime Corporation
CPO	chlorine-produced oxidant
CPP	controllable pitch propeller
CSLC	California State Lands Commission
CWA	Clean Water Act
DA	Discharge Assessment
DB	deck barge
DCB	dry cargo barge
DDT	dichloro-diphenyl-trichloroethane
DEC	Department of Environmental Conservation (Alaska)
DHTB	double-hull tanker barge
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DO	dissolved oxygen
DOB	dry open barge
DoD	Department of Defense
EEZ	exclusive economic zone
EPA	United States Environmental Protection Agency
gph	gallons per hour
gpm	gallons per minute
HEM	hexane extractable material
HEP	Harbor Estuary Program (New York/New Jersey)
IMO	International Maritime Organization
LMC	Liberty Maritime Corporation
LSB	lash/seabee barge
MARAD	Maritime Administration
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto

MOGAS	motor gasoline
MPCD	marine pollution control device
NAISA	National Aquatic Invasive Species Act
NAS	National Academy of Sciences
NBIC	National Ballast Information Clearinghouse
NDC	Navigation Data Center
NEA	Northwest Environmental Advocates
NEP	National Estuary Program
NISA	National Invasive Species Act
nmi	nautical mile
NMMA	National Marine Manufacturers Association
NOD	Nature of Discharge
NPDES	National Pollutant Discharge Elimination System
NVDC	National Vessel Documentation Center
OPA	Oil Pollution Act
OTB	other tank barge
OWS	oil/water separator
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCT	pollution control technology
PSPA	Pacific Seafood Processors Association
RO	reverse osmosis
SBT	segregated ballast tanks
SERC	Smithsonian Environmental Research Center
TBT	tributyltins
TMDL	total maximum daily load
TMP	topside management plan
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSO	Transportation Series Operator
UNDS	Uniform National Discharge Standards
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USHMP	underwater ship husbandry management plan
UV	ultraviolet
VESDOC	Merchant Vessels of the United States
WCSC	Waterborne Commerce Statistics Center
WSC	World Shipping Council
WTLUS	Waterborne Transportation Lines of the United States

1.0 INTRODUCTION

1.1 The Clean Water Act

Originally enacted in 1972, the Clean Water Act (CWA) is the primary federal law governing water pollution in the United States (U.S.). Among other authorities, it allows the U.S. Environmental Protection Agency (EPA) to regulate discharges to the nation's waterways through the National Pollutant Discharge Elimination System (NPDES). The NPDES program "requires permits for the discharge of pollutants from any point source into the waters of the United States" (40 CFR 122.1(b)), with the definition of *point source* including, among other things, "vessel or other floating craft" (40 CFR 122.2). The term *pollutant* includes the following list of potential contaminants:

dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials..., heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste. (40 CFR 122.2)

However, section 122.3(a) of the CWA regulations (40 CFR 122.3(a)) exempts some vessel discharges from requiring a NPDES permit, stating:

The following discharges do not require NPDES permits:

(a) Any discharge of sewage from vessels, effluent from properly functioning marine engines, laundry, shower, and galley sink wastes, or any other discharge incidental to the normal operation of a vessel. (40 CFR 122.3(a))

Although the CWA regulations do not specifically define "discharges incidental to the normal operation of a vessel", this term is broadly described in "Phase I: Uniform National Discharge Standards (UNDS) for Vessels of the Armed Forces", a 1999 technical document developed by the EPA and the Department of Defense (DoD) under Section 312 of the CWA. This UNDS document further breaks down incidental discharges of Armed Forces vessels to include "discharges from the operation, maintenance, repair, or testing of vessel propulsion systems, maneuvering systems, habitability systems, or installed major systems such as elevators or catapults, and discharges from protective, preservative, or adsorptive hull coatings" (EPA, 1999a). During the development of the UNDS document, the authors consulted with Armed Forces technical experts and developed a list of 39 different discharges considered to be incidental to the normal operation of an Armed Forces vessel. While some of these 39 incidental discharges would not apply to civilian vessels (*e.g.*, catapult wet accumulator discharge, which can be found on aircraft carriers), and some of the standards set for others would not apply to civilian vessels, some of the studies developed for the UNDS rule may be instructive for this effort. Discharge reports were also developed for each of the discharges, with some of the more critical ones receiving a more in-depth examination (Section 2.5.1).

1.2 Northwest Environmental Advocates, et al. v. EPA

In January 1999, several environmental groups, including Northwest Environmental Advocates (NEA) (hereafter referred to as NEA *et al.*), collectively petitioned the EPA to repeal 40 CFR 122.3(a) (hereafter referred to as the 'vessel exclusion clause'). As explained in their petition, the primary concern of NEA *et al.* was for the discharge of ballast water and any potentially invasive or harmful organisms contained therein from vessels into United States waters. Referring to the CWA definition of *pollutant* (40 CFR 122.2) and the inclusion of 'biological materials' in that definition, NEA *et al.* stated that the vessel exclusion clause was illegal because it ran counter to the CWA and case law (*e.g.*, Natural Resources

Defense Council v. Costle (1977)). The petition asked that the EPA repeal this exclusion “to help prevent the further degradation of aquatic resources from” invasive species (Johnston, 1999).

EPA denied the petition in September 2003, stating that other federal statutes (e.g., the Act to Prevent Pollution from Ships [APPS], the National Invasive Species Act [NISA]) and federal-sponsored activities (e.g., workshops, research and development funding, and participation in the International Maritime Organization’s (IMO) invasive species control efforts) are sufficient to address the invasive species issue in U.S. waters.

In response to the petition denial, NEA *et al.* filed a lawsuit (C 03-05760 SI) in the U.S. District Court for the Northern District of California in December 2003 seeking to compel the EPA to repeal the vessel exclusion clause. While the court found for the plaintiffs (NEA *et al.*) in March 2005 and ordered the EPA to repeal 40 CFR 122.3(a), the EPA returned to the court to request that the repeal apply solely to ballast water and not to all “discharges incidental to the normal operation of a vessel”. This request was denied in a September 2006 injunction in which the court directed the EPA to vacate “the blanket exemption for discharges incidental to the normal operation of a vessel, contained in 40 CFR 122.3(a)” by September 30, 2008 (NEA *et al.* v. EPA, 2006). Hereafter, the vacating of the vessel exclusion clause shall be referred to as the ‘vessel vacatur’.

1.3 Scope of the Vessel Vacatur

As a result of the court-ordered vessel vacatur, the EPA must develop a feasible permitting system that will cover millions of formerly-exempt vessel discharges under the NPDES program. This permitting system must be conceived, developed, and implemented by September 30, 2008 or the EPA risks legal challenges. Prior to determining the type and manner of permitting system to implement, EPA must fully understand the scope of the issue, including the number and types of vessels that must be covered and the nature and type of discharges incidental to their normal operation. In addition, the EPA will need information on U.S. ports and waterways, current national and international regulations that apply to vessel discharges, and the current state of shipboard and land-based pollution control technologies (PCTs) and best management practices (BMPs).

1.3.1 Exemptions to the Vessel Vacatur

Under the pending NPDES permitting framework for the vessel vacatur, some discharges incidental to the normal operation of a vessel will not be affected due to their coverage or exemption under other federal regulations. As stated in the court’s injunction (NEA *et al.* v. EPA, 2006), NEA *et al.* sought to only vacate the first sentence of 40 CFR 122.3(a). The manner in which the following discharge types are regulated will not be affected by the vessel vacatur.

- In CWA §312(a)(12)(B)(i), the discharge of rubbish, trash, and garbage is specifically excluded as being ‘incidental to the normal operation of a vessel’. Rubbish, trash, and garbage discharge is regulated under APPS, which is the U.S. implementation of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).
- Discharges originating from a vessel when it is operating in a capacity other than a means of transportation, as specifically exempted in the second sentence of 40 CFR 122.3(a), which is not being vacated.
- Discharges from a vessel or other floating craft outside the U.S. three mile territorial sea limit do not constitute “the discharge of a pollutant” under CWA §502(12)(A) and thus are not subject to NPDES permitting.

- Sewage discharge from a vessel is specifically excluded from CWA's definition of *pollutant* (CWA §502(6)(A)) and thus is not subject to NPDES permitting.
- Discharges incidental to the normal operation of a vessel of the U.S. Armed Forces are excluded from NPDES permitting requirements under the CWA's definition of *pollutant* (CWA §502(6)(A)) and thus are not subject to NPDES permitting.

This report summarizes the findings of a search of available literature and databases and aims to provide EPA with the scope of existing conditions (as available) in four major categories: vessels, ports, discharges, and PCTs/BMPs. Because the field of information is constantly developing, particularly with regards to treatment technologies, and data on vessels and ports are updated at least annually, this report will be a living document to be added to and amended based on the state of the most current knowledge.

2.0 DATA GATHERING AND ANALYSIS

2.1 Recreational Vessel Data

2.1.1 National Marine Manufacturers Association (NMMA) 2006 Boating Statistics Report

Data on recreational vessels operating in U.S. waters were obtained primarily from the 2006 National Marine Manufacturers Association's (NMMA) Recreational Boat Registration Statistics report (NMMA, 2007) which compiles data from the registration agencies in each state and territory, among other sources. At the time of publication of this document, the 2006 version of the NMMA report was the latest available. However, the overall state-by-state vessel registration numbers had not been re-compiled for the 2006 version of the report; therefore, while the report contains some data that are updated for 2006, much of the data with which this report is concerned were from 2005.

2.2 Commercial Vessel Data

2.2.1 Merchant Vessels of the United States (VESDOC)

Vessel data were obtained from the United States Coast Guard (USCG) in the form of the Merchant Vessels of the United States (VESDOC) data file, which contained updated data through May 5, 2007 (USCG, 2007a). These data were sent from the USCG's National Vessel Documentation Center (NVDC) on CD-ROM to Battelle on May 14, 2007. The CD-ROM contained data in both tab-delimited and fixed-length formats as well as a metadata document. There were a total of 328,234 records in the file. These data were loaded into a table within the Battelle database on May 23, 2007.

VESDOC contains information on domestic merchant and recreational vessels with a valid Certificate of Documentation, which is a form of registration used to track U.S.-owned vessels involved in certain trade activities. Any vessel involved in fishing activities, passenger/merchandise transportation, towing, or dredging within U.S. navigable waters or the Exclusive Economic Zone (EEZ) and that measures five net tons or greater must be documented. A Certificate of Documentation can allow a vessel to be 'endorsed' for a specific trade, such as fishing or recreation, although a vessel that is only documented for recreation cannot be used for any other purpose. Some states do not require a documented recreational vessel to also register with the relevant state agency, a fact that has implications for the statistics gathered from the NMMA report (Section 2.1.1)

VESDOC data presented some difficulties when database queries were developed. For example, the VESDOC field 'hailing port' provides the state and/or city displayed on the vessel stern and is a good indicator of the vessel's geographic area of operation. However, the data entered for this field varied from city only to state only to a city/state combination and the syntax used was inconsistent (e.g., commas

were not always used to separate city from state, some state abbreviations had periods, etc.). These variations in data entry style made some of the VESDOC querying difficult because the field could not efficiently be parsed out.

2.2.2 Waterborne Transportation Lines of the United States (WTLUS)

The Waterborne Transportation Lines of the United States (WTLUS) is an annual three-volume product provided by the U.S. Army Corps of Engineers' (USACE) Navigation Data Center's (NDC) Waterborne Commerce Statistics Center (WCSC) (USACE 2005a, 2005b, 2005c). At the time of publication, the 2005 version of WTLUS was the latest available. Battelle downloaded 2005 WTLUS data in Microsoft Excel format directly from the NDC website¹ on April 25, 2007. These data were loaded into a table in the Battelle database.

WTLUS contains summary information on vessel companies and their U.S.-flagged vessels available for operation as of December 31, 2005 (for vessels capable of carrying passengers or freight, the information is updated through August 1, 2006). The three volumes contain summary statistics, characteristics of the vessels available (*e.g.*, net tonnage, length, type, year built, etc.), and information on the companies that own the vessels (*e.g.*, contact information, number of vessels owned by the company, etc.).

2.3 Foreign Vessel Data

2.3.1 U.S. Customs Entrances/Clearances Records

Data on the comings and goings (entrances and clearances) of vessels at U.S. ports were collected by U.S. Customs and Border Protection (CBP). The CBP gathers these data during the normal processing of imports and exports. Available information included the vessel name, the U.S. port that it was entering/clearing, the type of vessel, the vessel's flag of registry, and the last port (domestic or foreign) that the vessel had visited. The CBP entrances and clearances data were used as an indicator of the numbers and types of non-U.S. flag vessels coming to U.S. ports. Therefore, only the data on entrances have been described in this report. Battelle downloaded the most recently available (2005) entrances data from USACE's NDC website on May 10, 2007.

2.4 Port Data

2.4.1 MARAD Vessel Calls

The U.S. Maritime Administration (MARAD) collects annual data on calls by oceangoing vessels of 10,000 deadweight tons or greater at U.S. coastal ports. These data are published in a report entitled *Vessel Calls at U.S. Ports* (the most recently available report contained 2005 data [MARAD, 2006a]) as well as in Excel spreadsheets. Battelle downloaded the most recently available (2005) data from the MARAD website² as an Excel spreadsheet on April 18, 2007. The MARAD data downloaded by Battelle contained information on the number of vessel calls at U.S. coastal ports, separated by vessel type.

2.4.2 U.S. Customs Entrances/Clearances Records

See Section 2.3.1.

2.4.3 National Ballast Information Clearinghouse

The Smithsonian Environmental Research Center (SERC) and the USCG maintain the National Ballast Information Clearinghouse (NBIC), which maintains a database of the ballast water management

¹ <http://www.ndc.iwr.usace.army.mil/data/datavess.htm>

² http://www.marad.dot.gov/MARAD_statistics/index.html

practices and activities of commercial ships operating in U.S. waters and seeks to keep track of the amount and origins of discharged ballast water. This database (NBIC, 2004) stores information from ballast water reports, which must be submitted to the USCG by all ballast tank-equipped vessels entering U.S. waters, as required under the National Aquatic Invasive Species Act (NAISA) (33 CFR 151.2045). The information provided by the NBIC database includes state, port, vessel name, arrival date, the last port/country the vessel called at, vessel type, and data on the ballast water management (*e.g.*, volume discharged [if any] and treatment method). The NBIC currently has data available from 1999 through 2004, although in this report, only the most recent year of data were provided.

Similar to the problems encountered with the VESDOC data, the NBIC database proved to be difficult to work with. The NBIC website allows users to download data by text file, which can then be exported into Excel. However, when the data were imported into Excel, the fields were not consistent and the rows did not necessarily line up with the correct column headers. For example, a column that was supposed to contain locations may have contained some dates because the rows had been shifted or were misaligned. These errors were inherent in the text files and were not caused by incorrect importing. Additional problems were encountered when the data were downloaded in XML format: the arrival dates for the vessels were not included in the output and, therefore, could not be imported into Excel (despite the fact that the arrival dates *were* included in the text file and HTML output types, which were unusable in their own right). Some of the states with the busiest ports (*i.e.*, the most amount of available data) contained unallowable characters somewhere embedded in their files, preventing the files from being imported into Excel at all. After several attempts were made to correct the data output through NBIC, Battelle determined that, given these errors in the data and the inability to correct them in a timely manner, the data available through NBIC were unusable for the stated purposes.

2.4.4 EPA National Total Maximum Daily Load (TMDL) Database

To describe the current conditions of the major U.S. ports, information on pollutants that exceed water quality standards was gathered from EPA's collection of water bodies listed under §303(d) of the CWA (EPA, 2007a)³. Based on sampling activities, water bodies that do not meet state water quality standards for particular pollutants are placed on a list mandated by CWA §303(d). The water bodies placed on this list must have an evaluative report created for them, in which the pollutant sources are assessed and future loading rates for the listed pollutant(s) are set. Current CWA §303(d) lists were available from the EPA National TMDL database, which contains information on what pollutants were exceeding state water quality standards in each port, at the time of the most recent assessment (typically 2002 or 2004).

2.4.5 National Estuary Program 2007 Coastal Condition Report

The National Estuary Program's (NEP) Coastal Condition report (EPA, 2007b)⁴ evaluates the 28 NEPs based on water quality, sediment quality, benthic condition, and fish tissue contamination. Five parameters are measured as indicators of overall water quality of an NEP: dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), chlorophyll *a*, water clarity, and dissolved oxygen (DO). For each water quality indicator, EPA has assigned a range of values that, depending on the sampling data, allows the water quality station in question to be rated as 'good', 'fair', or 'poor'. For example, if DO concentrations are measured as >5 mg/L, then the station is rated as having 'good' DO levels. If the measured concentrations are 2-5 mg/L or <2 mg/L, the station DO level is rated as 'fair' or 'poor', respectively. Once a station's condition has been assessed for each of the five indicators, the station's health as a whole can be rated as 'good', 'fair', or 'poor', depending on the combination of indicator ratings. Finally, once several stations in an estuary have been evaluated in this manner, the estuary itself can be rated for overall water quality using the same scale. Because the NEP water bodies listed below

³ <http://www.epa.gov/owow/tmdl/index.html>

⁴ <http://www.epa.gov/owow/oceans/nepccr/index.html>

are described based on their overall estuarine rating, the following guide can help put the estuarine conditions in context.

Good: Less than 10% of the NEP estuarine area is in poor condition, and more than 50% of the NEP estuarine area is in good condition.

Fair: 10% to 20% of the NEP estuarine area is in poor condition, or more than 50% of the NEP estuarine area is in combined poor and fair condition.

Poor: More than 20% of the NEP estuarine area is in poor condition.

The same fundamental rating methodologies apply to the sediment quality, benthic condition, and fish tissue contamination indices.

2.5 Discharge Data

2.5.1 Uniform National Discharge Standards Reports

The vast majority of information on discharges originating from vessels came from the UNDS reports. A few other sources were helpful, but the UNDS reports are the greatest single source of information on vessel discharges. Although these reports focus on Armed Forces vessels, some of the discharge studies may be instructive for the evaluation of discharges from civilian vessels.

The team of federal agencies that is tasked with setting UNDS includes EPA and the DoD. Their activities are grouped into phases, with Phase I consisting of “determining for which Armed Forces vessel discharges it is reasonable and practicable to require control with a marine pollution control device (MPCD)” (EPA, 1999a). Phase II includes setting performance standards for any MPCD that would be required based on Phase I determinations. Finally, Phase III consists of setting requirements for the designing, constructing, installing, and operating the MPCDs identified in Phase II.

One of the results of Phase I was a technical development document entitled “Phase I Uniform National Discharge Standards for Vessels of the Armed Forces” (EPA, 1999a) which included as appendices separate “Nature of Discharge” (NOD) reports for each of the 39 discharges incidental to the normal operation of an Armed Forces vessel identified during Phase I. Each NOD report included a description of the discharge and discussion on the discharge characteristics (*e.g.*, constituents, rates, concentrations, etc.), as applicable to vessels of the Armed Forces. Some of the information presented in the NOD reports was gathered from primary research, while some of it was taken from existing literature, expert opinion, and expert workshop results. During Phase I, EPA and DoD determined that 14 of the 39 discharges would not require a MPCD when discharged from an Armed Forces vessel and, therefore, would not be examined in more detail beyond the NOD report. Therefore, only 25 discharges were chosen to undergo more extensive assessment for UNDS purposes.

For Phase II, EPA and DoD split up the 25 remaining discharges into batches and developed “Discharge Assessment” (DA) reports for the first batch of seven. For four of the seven discharges, EPA and DoD also developed reports on the environmental effects, feasibility impact analysis, and a characterization analysis. Therefore, each of the 39 discharges has a NOD report, seven of them have a DA report, and four of them currently have more in-depth analytical studies. Phase II is currently ongoing and more reports from EPA and DoD are expected in the future.

2.6 Pollution Control Technologies/Best Management Practices Data

2.6.1 Uniform National Discharge Standards Reports

While the UNDS NOD reports primarily cover the discharge characteristics and constituents, the DA reports focus partially on some of the PCTs or BMPs that were investigated by EPA and DoD for their feasibility in treating discharges from Armed Forces vessels. Although the DA reports are slightly dated (which matters more for technological advances than it does for the discharge characteristics discussed in the NOD reports), many of the fundamental technologies and management practices are still applicable today. The DA reports were primarily used for PCT and BMP information on chain locker effluent, deck runoff, elevator pit effluent, firemain systems, and small boat engine wet exhaust. In addition, the Phase I report (EPA, 1999a) included short separate MPCD reports for four of the discharges: distillation and reverse osmosis brine, hull coating leachate, small boat engine wet exhaust, and underwater ship husbandry. These four MPCD reports contained more detailed cost-benefit/feasibility analyses than the DA reports and the results are described in the appropriate sections of this report.

2.6.2 Lloyd's Register Ballast Water Treatment Technology Report

In June 2007, a report was published by Lloyd's Register that summarized the current status of ballast water treatment technology. This document was very useful for identifying the technologies that are currently available or soon to be approved as well as the costs of the technologies.

2.6.3 Miscellaneous Literature, Reports, and Phone Conversations

Much of what was learned about current PCTs and BMPs for operational vessel discharges was gained through contacting equipment manufacturers, conducting literature searches, and searching the endless available information found on the internet. For example, California Sea Grant and California State Lands Commission had a wealth of information on vessel hulls as vectors for invasive species introductions that helped to inform the sections on hull coating leachate and underwater ship husbandry. Contacts were made with numerous representatives of various PCTs, especially bilge water and grey water, which helped to establish the estimated costs for some technologies. Finally, state government websites provided information on BMPs for some of the more common discharges that may be found in a marina.

3.0 VESSEL POPULATION STATISTICS

To help EPA fully comprehend the universe of vessels that may need to be covered by the NPDES permitting program (Section 1.3), Battelle has compiled the most recently available data on the vessel population that operates in U.S. waters. The following sections present current data on recreational vessels (Section 3.1) and commercial vessels (Section 3.2), and includes (to the extent that the information was available) data on numbers and types of vessels. Section 2.0 describes the data sources consulted for this section.

3.1 Recreational Vessels

Battelle assumed that the vast majority of recreational vessels using U.S. waters are registered in one of the fifty United States or in one of the U.S. territories. Some recreational traffic may come to U.S. waters from Mexico or Canada, but, of the total population, these numbers are expected to be minimal.

Each of the states has different registration requirements for recreational vessels (see Table A-1 in the attachments), so the numbers provided in the NMMA report may not accurately represent the entire picture of recreational vessels in any given state. NMMA's report (NMMA, 2007) provides total and state-by-state numbers, in addition to information on vessel type and size. However, as indicated in Section 2.2.1, in some states recreational vessels that are documented in VESDOC are not required to

register with the relevant state agency. The NMMA report (NMMA, 2007) identifies those states that do not require the registration of documented vessels and provides the numbers of documented vessels in those states at the time of publication. Those states are noted with an asterisk in Tables 3-1 and A-1 and the state totals in Table 3-1 include both registered *and* documented recreational vessels.

Specific ownership information for recreational vessels as well as data on the port or harbor in which a recreational vessel is primarily used are not available through NMMA. However, Table A-1 includes the most current contact information for the registration agency in each state. These states can be contacted individually for answers to specific questions.

3.1.1 Recreational Vessel Numbers

According to NMMA's 2006 data (NMMA, 2007), the U.S. population of registered recreational vessels numbers 12,942,414. Figure 3-1 illustrates the NMMA's 2006 data on recreational vessel registration separated by U.S. region. Although it only encompasses five states, the Great Lakes region boasts the greatest number of registered recreational vessels, almost 44% more vessels than the next highest region, Inland.

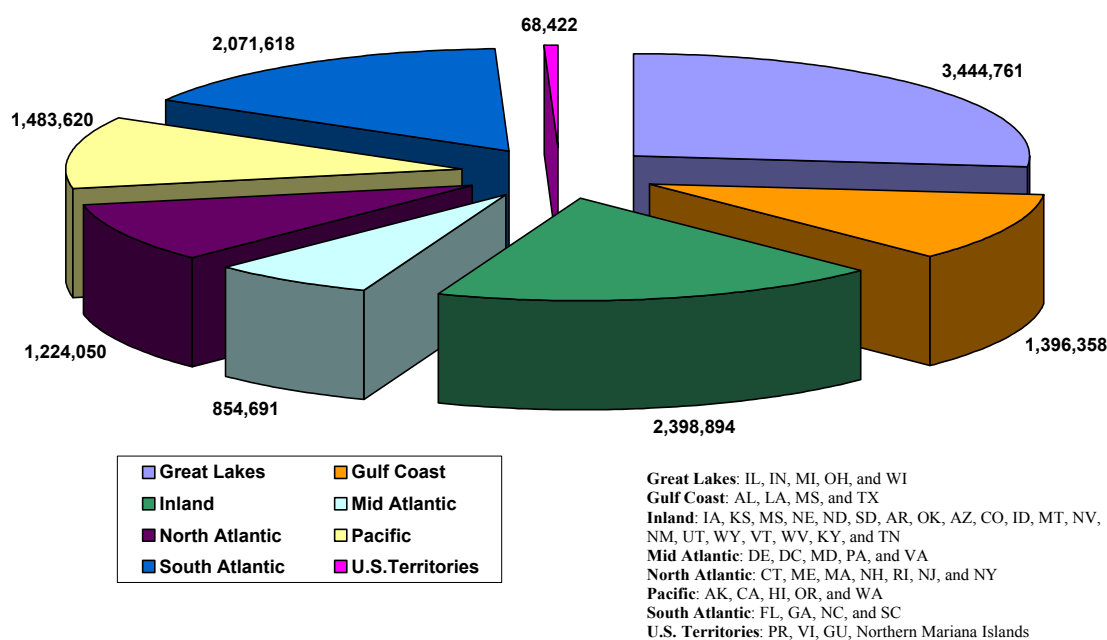


Figure 3-1. 2006 U.S. Regional Recreational Vessel Registration.

Source: NMMA, 2007.

On a state-by-state basis, California had the greatest number of registered recreational vessels in 2005, with Florida and Michigan rounding out the top three. Table 3-1 lists the top twenty states for numbers of registered recreational vessels and also indicates that the vast majority of registered vessels in the top twenty states were mechanically-propelled. However, as shown in Table A-1, not all states require non-mechanically propelled vessels to be registered, and in those states that do require such registration, some vessel owners either may not be aware of the requirement or may ignore it. Because the registration of mechanically-propelled vessels is likely

Table 3-1. Top 20 U.S. States for Total Registered Recreational Vessels, with General Type of Vessel Indicated.

State	Total Registered Recreational Vessels	Mechanically-Propelled ^a	Non-Mechanically-Propelled ^b
California*	989,021	892,722	71,036
Florida	973,859	932,673	41,186
Michigan	944,138	891,937	52,201
Minnesota*	856,411	640,862	212,627
Wisconsin	639,198	635,862	3,336
Texas*	623,868	604,929	9,687
New York	508,536	499,136	9,400
South Carolina*	419,841	393,341	23,422
Ohio	412,375	325,632	86,743
Illinois	380,865	308,875	71,990
North Carolina	362,784	357,253	5,531
Pennsylvania*	355,300	308,851	40,308
Missouri	326,749	277,433	49,316
Georgia	318,212	317,315	897
Louisiana*	310,772	308,104	0
Washington	267,793	267,793	0
Tennessee	267,567	265,966	1,601
Alabama	265,172	262,295	2,877
Virginia*	255,948	240,097	4,976
Iowa	243,924	115,044	128,880
Total	9,722,333	8,846,120	816,014

Source: NMMA, 2007.

* Indicates those states that do not require a documented recreational vessel to be registered with the state. Totals for these states include both registered and documented recreational vessel numbers. Information on propulsion type is for registered vessels only; no data on propulsion type for recreational documented vessels were available.

^a Mechanically-propelled includes power inboard, power outboard, power sterndrive (or inboard/outboard), personal watercraft (PWC), auxiliary sail inboard, and auxiliary sail outboard.

^b Non-mechanically propelled includes rowboats, sailboats, kayaks/canoes, and other.

to be more strictly enforced and monitored (by the state agencies and entities charged with enforcing vessel registration) than the registration of non-mechanically-propelled vessels, it is assumed that the NMMA numbers fully or nearly fully capture the national population of recreational mechanically-propelled vessels.

3.1.2 Recreational Vessel Propulsion and Size Data

The particular type of engine used on a mechanically-propelled vessel may have implications for the types of discharges it emits (Section 5.0). For example, some engine types take up ambient water to act as a cooling mechanism before discharging it back into receiving waters. As shown in Table 3-2, NMMA's data indicates that almost 66% of all registered mechanically-propelled recreational vessels are powered by outboard engines.

Table 3-2. Type of Propulsion for All Registered Mechanically-Propelled Recreational Vessels.

Propulsion Type	Number of Boats
Outboard	7,911,509
Inboard/PWC	2,269,542
Sterndrive	1,680,045
Auxiliary Sail Inboard	67,742
Auxiliary Sail Outboard	69,890
TOTAL	11,998,728

Source: NMMA, 2007.

Along with the propulsion type of a recreational vessel, the size is also important when considering potential discharges. Smaller vessels are more likely than larger vessels to be removed from the water for repairs and maintenance. Larger vessels are more likely to have greater deck surface area, may generate grey water from an onboard galley or bathroom, and have bilge water tanks with greater capacities.

The NMMA data indicate that over 95% of all registered mechanically-propelled recreational vessels in the U.S. are less than 26 feet in length (NMMA, 2007). No data are available for sizes of non-mechanically-propelled vessels. Table 3-3 presents the number of vessels less than 26 feet in length and the number of vessels 26 feet and over in length for each state, organized by the percent of the total registered mechanically-propelled recreational vessels that are less than 26 feet in length.

Table 3-3. Lengths of All Registered Mechanically-Propelled Recreational Vessels.

State	Number of Recreational Mechanically-Propelled Vessels		Percent of total less than 26 feet
	Less than 26 feet in length	26 feet and over in length	
Nebraska*	78,499	483	99.39%
North Dakota*	43,431	297	99.32%
South Dakota*	48,013	514	98.94%
Kansas*	92,385	1019	98.91%
Arkansas*	185,139	2,162	98.85%
Montana*	69,020	911	98.70%
Minnesota*	631,838	9,024	98.59%
West Virginia*	43,674	630	98.58%
Wyoming*	25,110	400	98.43%
Georgia	312,222	5,093	98.39%
Louisiana*	302,857	5,247	98.30%
Wisconsin	623,542	12,320	98.06%
New Mexico	36,430	766	97.94%
Pennsylvania*	302,432	6,419	97.92%
Colorado*	92,248	1,958	97.92%
Iowa	112,651	2,393	97.92%
Mississippi*	198,807	4,413	97.83%
South Carolina*	383,366	9,975	97.46%
Maine*	108,402	2,911	97.38%
Oklahoma	211,034	5,879	97.29%
Idaho*	79,756	2,279	97.22%
Alabama	254,566	7,729	97.05%

Table 3–3. Lengths of All Registered Mechanically-Propelled Recreational Vessels, continued.

State	Number of Recreational Mechanically-Propelled Vessels		Percent of total less than 26 feet
	Less than 26 feet in length	26 feet and over in length	
Missouri	268,975	8,458	96.95%
North Carolina	345,986	11,267	96.85%
Texas*	585,715	19,214	96.82%
Indiana	197,760	6,765	96.69%
Kentucky*	157,855	5,579	96.59%
Oregon	178,295	6,348	96.56%
Virginia*	231,629	8,468	96.47%
Vermont	31,120	1,266	96.09%
Utah	71,423	3,001	95.97%
Tennessee	254,708	11,258	95.77%
Michigan	850,848	41,089	95.39%
Illinois	294,328	14,547	95.29%
New Hampshire	93,501	4,669	95.24%
Massachusetts*	134,498	6,892	95.13%
California*	848,098	44,624	95.00%
Nevada*	53,436	3,150	94.43%
Arizona*	133,708	8,019	94.34%
Ohio	305,363	20,269	93.78%
Alaska*	40,379	3,027	93.03%
Connecticut	98,378	9,625	91.09%
Florida	847,626	85,047	90.88%
Washington	242,777	25,016	90.66%
New York	451,654	47,482	90.49%
New Jersey	171,450	20,463	89.34%
Hawaii*	12,461	1,851	87.07%
Delaware*	44,218	7,111	86.15%
Maryland	165,018	31,677	83.90%
Rhode Island	35,930	7,726	82.30%
District of Columbia	1228	784	61.03%
TOTAL	11,383,787	547,514	95.41%

Source: NMMA, 2007.

* Documented recreational vessel numbers are not included in this table for those states that do not require a documented vessel to also be registered with the state.

3.2 Commercial Vessels

As described in Section 2.0, data on commercial vessels operating in U.S. waters were obtained primarily from the USCG (VESDOC) and USACE (WTLUS).

3.2.1 Domestic Commercial Vessel Numbers and Types

USACE’s most recent WTLUS volumes (USACE, 2005a, 2005b, 2005c) contain substantial and well-organized data on U.S.-flagged passenger and cargo vessels operating in U.S. waters. Table 3-4 presents

the summary findings by propulsion type (self-propelled or non-self-propelled); the subtypes contained within these general categories are provided in the table footnote. Figure 3-2 illustrates that the vast majority (78%) of cargo and passenger vessels operating in U.S. waters can be found in the Mississippi River System or the Gulf Intracoastal Waterway.

Table 3-4. Summary of the U.S.-Flag Cargo or Passenger Vessels Operating in U.S. Waters by Region.

Type of Vessel	Total Number of Vessels	Atlantic, Gulf, and Pacific Coasts	Mississippi River System and the Gulf Intracoastal Waterway	Great Lakes System
SELF-PROPELLED				
Dry Cargo and/or Passenger, Offshore Support	2,967	1,638	1,162	167
Vehicular Ferries and Railroad Cars	619	472	82	65
Tankers	100	90	6	4
Towboats	5,290	1,864	3,303	123
TOTAL SELF-PROPELLED	8,976	4,064	4,553	359
TOTAL CARGO CAPACITY^a (short tons)	12,342,485	9,175,249	894,749	2,272,487
TOTAL PASSENGER CAPACITY^b (persons)	451,723	330,271	85,072	36,380
NON-SELF-PROPELLED				
Barges, Dry Cargo	27,876	3,961	23,739	176
Barges, Tanker	4,151	618	3,525	8
Railroad Car Barge	25	24	1	0
TOTAL NON-SELF-PROPELLED	32,052	4,603	27,265	184
TOTAL CARGO CAPACITY^c (short tons)	57,035,748	11,398,711	45,259,164	377,873
TOTAL PASSENGER CAPACITY^d (persons)	553	167	386	0
GRAND TOTAL SELF- AND NON-SELF-PROPELLED	41,028	8,667	31,818	543

Source: USACE, 2005a.

^a Includes cargo capacity of dry cargo vessels and tankers.

^b Includes passenger capacity of passenger vessels and vehicular ferries

^c Includes cargo capacity of dry cargo barges, tanker barges, and railroad car floats

^d Includes passenger capacity of dry cargo barges

Self-Propelled, Dry Cargo: Crewboat / Supply / Utility Vessel; Vehicle Carrier; General Cargo Freighter; Passenger Carrier; Break Bulk / RO-RO Carrier; Combination Passenger and Cargo; RO-RO Vessel; Ferry; Bulk Carrier; Railroad Car Ferry; Containership; Lash Vessel; Partial Containership; Excursion / Sightseeing Vessel; Container / Vehicle / Trailer (RO-RO) Carrier

Self-Propelled, Tanker: Petroleum / Chemical Carrier; Liquid Gas Carrier; Chemical Carrier; Other Tanker; Liquid Bulk Tanker

Towboat: Pushboat; Tugboat

Non-Self-Propelled, Tanker: Liquid Cargo Barge (Single Hull); Liquid Cargo Barge (Double Bottom Only); Liquid Cargo Barge (Double Hull); Other Liquid Cargo Barge, Not; Liquid Cargo Barge (Double Sided Only) Elsewhere Included

Non-Self-Propelled, Dry Cargo: Open Hopper Barge; Covered Dry Cargo Barge; Covered Hopper Barge; RO-RO Barge; Carfloat (Railroad Car Barge); Container Barge; Flat / Deck Barge; Lash / Seabee Barge; Pontoon Barge; Convertible Barge; Open Dry Cargo Barge; Other

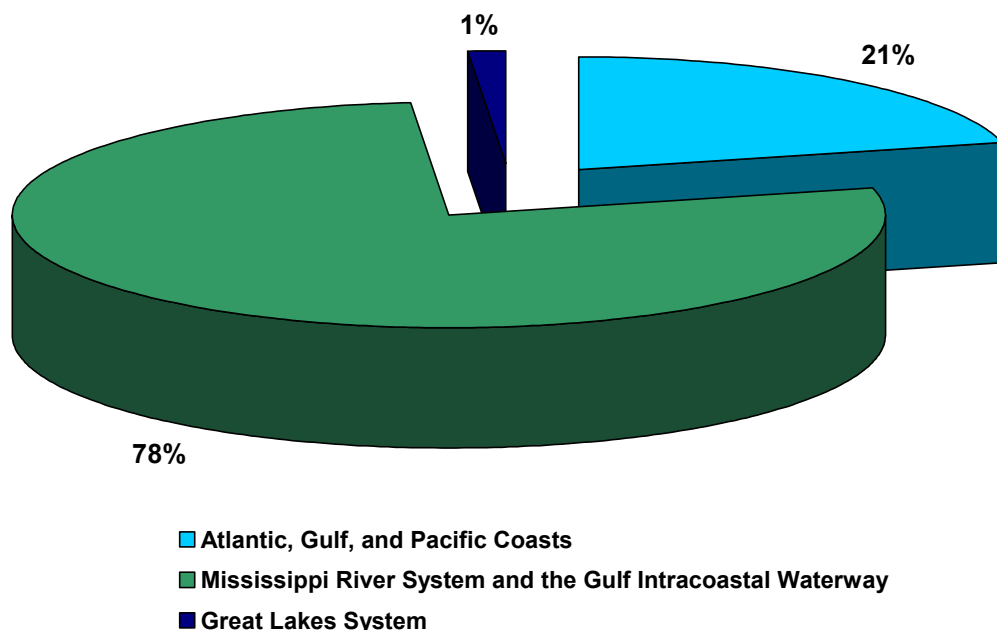


Figure 3-2. Summary of U.S. Flag Cargo and Passenger Vessels Operating in U.S. Waters by Region.

Source: USACE, 2005a

As described in Section 2.2.3, WTLUS also provides information on the Transportation Series Operator (TSO) company that operates these 41,028 passenger or cargo vessels (Volume 2) as well as the relevant characteristics of the vessels themselves (Volume 3). There are 2,732 TSO companies that own the 41,028 vessels (USACE, 2005b). Table 3-5 lists the top twenty U.S. TSO companies according to the number of vessels operated and includes the principal types of vessels operated as well as a list of the major commodities carried. More detailed information on all 2,732 TSO companies with specific contact information can be found in USACE (2005b). USACE (2005c) also provides more detail on each vessel, including in which specific subtype (in list above) the vessel is categorized, the vessel’s registered length/depth/breadth, and horsepower.

As described in Section 2.2.1, VESDOC is another source for data on commercial vessels operating in U.S. waters. All U.S.-owned commercial vessels involved in passenger or merchandise transportation as well as towing or dredging must be documented with the USCG. One of the ways VESDOC data are organized is by “Vessel Service Type”, which indicates the primary service for which the vessel was documented. The VESDOC metadata (USCG, 2007b), however, caution that the vessel service type may not be the most reliable indicator of the specific use of a vessel. Rather, USCG (2007b) recommends using the vessel numbers provided in the ‘trade indicator’ fields, as described in Section 2.2.1, for a more complete picture. However, the vessel service type field is broken into more categories than the trade indicator field; in addition, the trade indicator field appeared to be focused more on where the vessel could be operated and less on the general use of the vessel. Table 3-6 provides the VESDOC statistics for the various vessel service types.

Table 3-5. Top Twenty U.S. TSO Companies Operating Cargo or Passenger Vessels in U.S. Waters by Number of Vessels Operated.

TSO Name	City/State Location of the TSO	Total Number of Vessels Operated by TSO	Principal Types of Vessels Operated by TSO ^a	List of Principal Commodities Carried by TSO's Vessels
Ingram Barge Co.	Nashville, TN	4,256	DCB, DOB, DHTB	Towing, petroleum products, bulk freight, coal, coke, grain and aggregates
American Commercial Lines, LLC	Jeffersonville, IN	3,249	DCB, DOB, DHTB	Towing, steel, petroleum products, coal, coke, sulphur, sugar, creosote, grain, scrap iron, chemicals, salt and general commodities
American River Transportation Co.	Ama, LA	2,221	DCB, DHTB, DB	Grain and grain products, coal, fertilizer, salt and scrap
AEP Memco, LLC	Chesterfield, MO	1,620	DOB, DCB, PUSH	Towing, coal, grain, grain products, cement, chemicals, salt, steel, lime, coke, slag, and aggregates
Kirby Inland Marine, LP	Houston, TX	1,013	DHTB, PUSH, OTB	Chemical and petroleum products
Crouse Corporation	Paducah, KY	939	DOB, PUSH	Towing, bulk freight and coal
Cargill Marine and Terminal, Inc.	Minneapolis, MN	673	DCB	Coal, grain, vegetable oil, salt and miscellaneous commodities
McDonough Marine Service (Div. of Marmac Corporation)	Metarie, LA	672	DB, DOB, DHTB	Miscellaneous freight
Teco Barge Line	Metropolis, IL	612	DOB, DCB	Coal, phosphate sulphur and bulk commodities
Canal Barge Company, Inc.	New Orleans, LA	608	DOB, DHTB, DB	Towing, bulk petroleum, molten sulphur, chemicals, coal, grain, fertilizer and general cargo
SCF Marine, Inc.	St. Louis, MO	581	DCB, DOB, DB	Grain, industrial commodities, rice, meals, salt, coal and dry bulk commodities
Campbell Transportation Co.	Charleroi, PA	404	DOB	Coal, sand & gravel
American Commercial Barge Line, LLC	Jeffersonville, IN	383	DCB	Towing, liquid chemicals, petroleum, crude oil and refined oil products
Central Gulf Lines, Inc.	New Orleans, LA	378	LSB	Steel, paper products and miscellaneous cargo - rubber, timber, flour and rice
Forest Lines, LLC	New Orleans, LA	332	LSB	Paper products

Table 3-5. Top Twenty U.S. TSO Companies Operating Cargo or Passenger Vessels in U.S. Waters by Number of Vessels Operated, continued.

TSO Name	City/State Location of the TSO	Total Number of Vessels Operated by TSO	Principal Types of Vessels Operated by TSO ^a	List of Principal Commodities Carried by TSO's Vessels
Alter Barge Line, Inc.	Bettendorf, IA	327	DCB, DB	Coal, steel, scrap, grain, containers and general commodities; bulk products - regulated and exempt
Consolidation Coal Company (River Division)	Elizabeth, PA	297	DOB	Coal
Marquette Transportation Company	Paducah, KY	285	DCB, DB, PUSH	Grain, coal, salt, fertilizer and rock
Pine Bluff Sand and Gravel Company	Pine Bluff, AR	253	DB, DOB, PUSH	Construction equipment and materials, sand and gravel
Luhr Bros., Inc.	Columbia, IL	245	DB, DOB, PUSH	Crushed limestone products, rip-rap and heavy construction equipment

Source: USACE, 2005b.

^a Vessel type abbreviations: DCB = dry covered barge; DOB = dry open barge; DB = deck barge; DHTB = double hull tank barge; PUSH = pushboat; LSB = lash/seabee barge; OTB = other tank barge

Table 3-6. Total Number of U.S. Documented Vessels by Service Type.

VESDOC Vessel Service Type	Total Number of Vessels Documented
Commercial Fishing Vessel	28,972
Fish Processing Vessel	35
Freight Barge	23,153
Freight Ship	651
Industrial Vessel (e.g., cable layer, dredge, crane barge)	823
Mobile Offshore Drilling Unit	118
Offshore Supply Vessel	1,114
Oil Recovery	372
Passenger (Inspected)	9,539
Passenger (Uninspected)	2,311
Passenger Barge (Inspected)	109
Passenger Barge (Uninspected)	127
Public Freight	6
Public Tankship/Barge	2
Public Vessel, Unclassified	24
Research Vessel	234
School Ship	38
Tank Barge	4,134
Tank Ship	129
Towing Vessel	6,898
Unclassified/Unknown/Unspecified	5,357

Source: VESDOC, 2007

3.2.2 Domestic Commercial Fishing Vessel Numbers

Because the USCG differentiates between commercial vessels and commercial fishing vessels (see Section 3.2), these two categories of vessels are dealt with separately in this report. As described in Section 2.2.1, VESDOC categorizes documented vessels based on the trade for which the vessel is licensed. One of the trade categories is ‘fishery’, which applies to vessels “licensed to engage in the fisheries trade in the navigable waters of the U.S. and on the Exclusive Economic Zone” (USCG, 2007b). Another trade category is ‘limited fishery only’, but the VESDOC metadata (USCG, 2007b) does not define this category further. Battelle has included this latter category in the commercial fishing vessel totals in the next paragraph. Any vessel owned by a U.S. citizen that commercially fishes in U.S. waters must be documented and, therefore, is included in the most recent VESDOC data.

The May 2007 VESDOC data indicate that there are 33,550 commercial fishing vessels licensed to fish in U.S. navigable waters and the EEZ⁵. Due to the data problems associated with VESDOC (as described in Section 2.2.1), Battelle was unable to query the database by ‘hailing port’ which would have been a good indicator of the vessel’s geographic area of operation (USCG, 2007b). The contact state and/or city of a given vessel’s managing owner was available and, although the owner’s state may not in all cases be equivalent to the ‘hailing port’ state, it may also be a reasonable indicator of where the fishing vessel typically operates. Figure 3-3 illustrates the number of documented commercial fishing vessels by owner’s contact state.

⁵ There is about a 4,500 vessel difference between vessels with a vessel service type of ‘commercial fishing vessel’ (Table 3-6) and vessels with a trade indicator of ‘fishery’. This may be explained by the vessel owner’s opinion of what his vessel’s use was. For example, ‘fisheries trade’ may have meant, to some vessel owners, charter fishing or other fishing-for-hire activities, not solely commercial fishing. Therefore, the true number of commercial fishing vessels operating in U.S. waters is likely somewhere between 28,972 and 33,550.

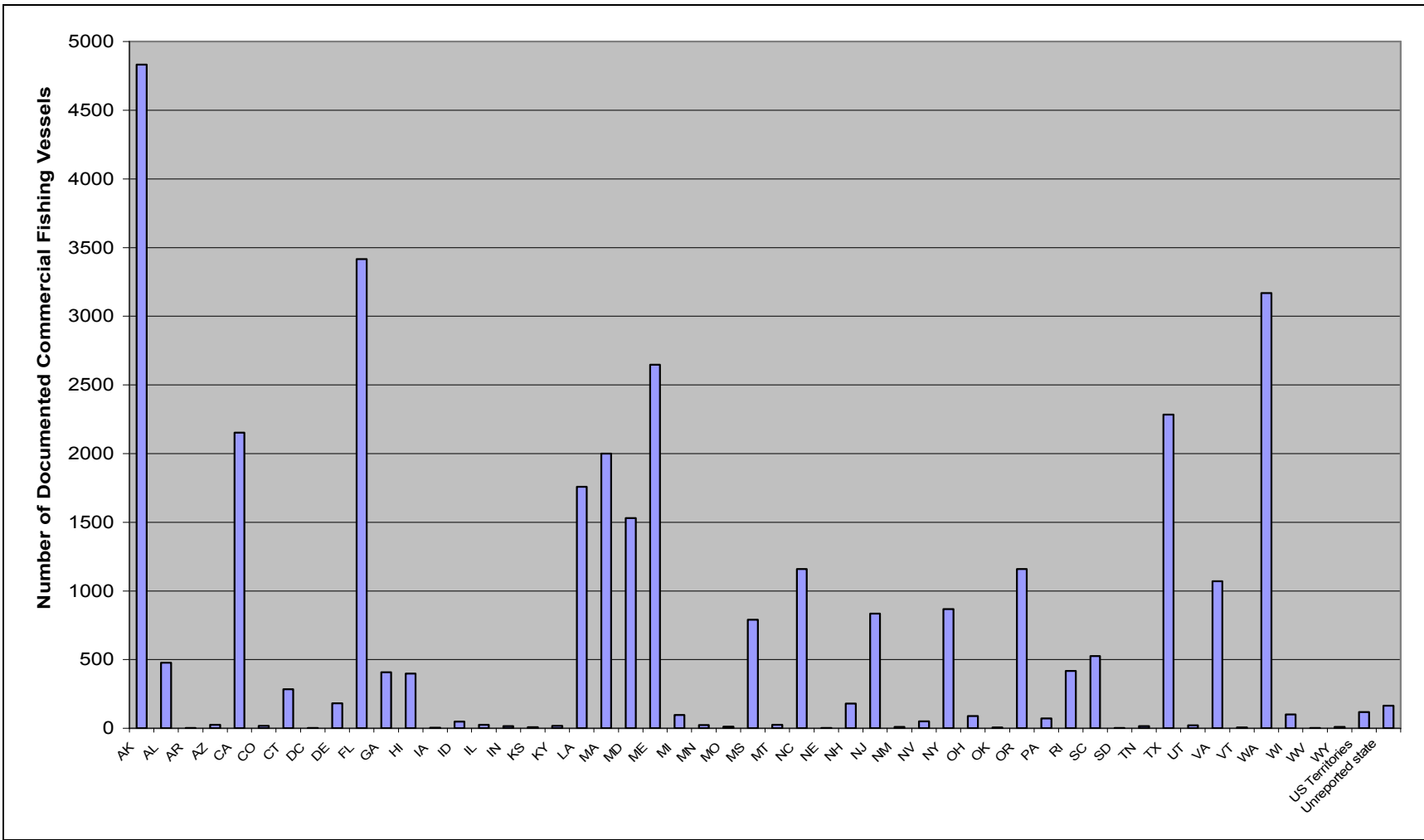


Figure 3-3. Documented Commercial Fishing Vessels by Owner's Contact State.

Source: USCG, 2007a

3.2.3 Foreign Commercial Vessel Numbers

Information on foreign commercial vessels operating in U.S. waters was more difficult to obtain. MARAD provides general world fleet statistics, but does not have data on which waterways world fleet vessels typically operate.

One source for the number of foreign commercial vessels visiting U.S. waters is the U.S. Customs Entrances/Clearances records (U.S. CBP, 2007). These data are also discussed in Section 4.0, although in terms of what type of port (domestic or foreign) a vessel had visited immediately prior to entering the U.S. port at which it was recorded. As described in Section 2.3, the 2005 Entrances/Clearances records were the most recent available from the NDC. According to these data, there were a total of 90,328 vessel entrances to a major U.S. port or waterway in 2005 and 7,726 different vessels made these entrances (U.S. CBP, 2007). Of the 7,726 unique vessels making entrance, 6,982 flew one of 83 different foreign flags (the remaining 744 flew U.S. flags). In the CBP (2007) data, a foreign vessel may have been recorded under more than one flag; this was due to some vessels changing their flag of registry during the year and, therefore, being recorded under more than one flag. Table 3-7 presents the top twenty most frequently recorded flags of vessels entering a major U.S. port or waterway in 2005.

Table 3-7. Top 20 Most Frequently Recorded Flags Entering U.S. Ports or Waterways in 2005

COUNTRY	TOTAL ENTRANCES
Panama	13,670
United States and territories	11,216
Bahamas	9,682
Liberia	8,569
Canada	4,662
Antigua and Barbuda	4,578
Marshall Islands	3,227
Singapore	3,169
Cyprus	2,745
Norway	2,600
Greece	2,216
Netherlands	2,123
St. Vincent and the Grenadines	1,963
Hong Kong	1,946
Malta	1,839
Bermuda	1,743
Germany	1,641
United Kingdom	1,525
Danish International Register	868
Italy	692

Source: U.S. CBP, 2007.

4.0 PORT FINDINGS

Information on the busiest ports in the U.S. is useful for understanding the characteristics of national waterway traffic, of both domestic and foreign arrivals. The following sections describe the various available information on U.S. port traffic, including number of vessel calls, flag registration of arriving vessels, and the last port of call of arriving vessels.

4.1 Calls to U.S. Ports

Figure 4-1 illustrates the number of vessel calls to U.S. coastal ports in 2005 by geographic region as provided by MARAD (2006). MARAD only recorded self-propelled vessels of greater than 10,000 tons deadweight⁶.

The U.S. Gulf region received nearly 31% of all coastal vessel calls in 2005, followed by the South Atlantic region with approximately 19%. Table 4-1 lists the total number of calls made by vessels to all coastal U.S. ports in 2005 (MARAD, 2006) along with the most frequent type of vessel calling there. Table 4-2 shows the top 20 coastal U.S. ports for 2005 vessel calls; these 20 ports will hereafter be referred to as the ‘major ports’.

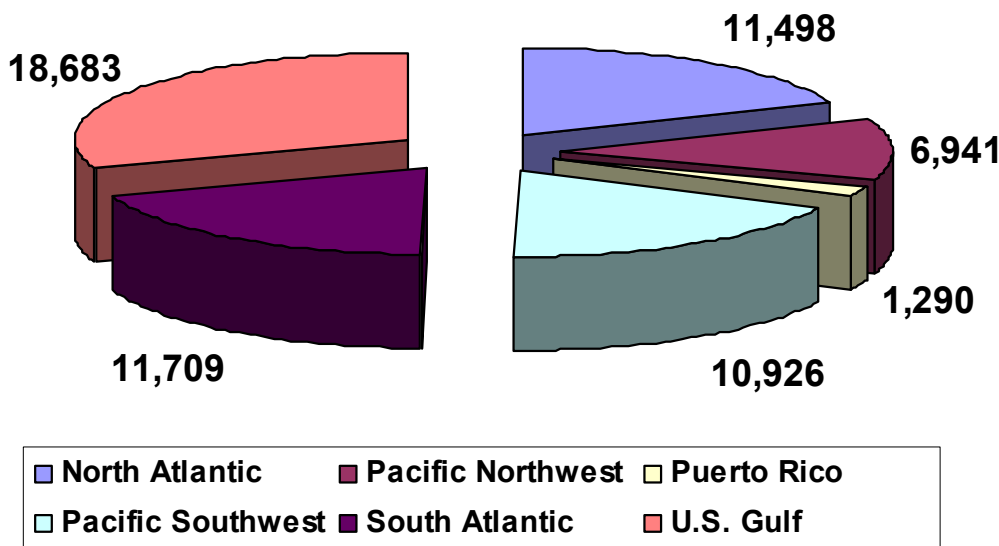


Figure 4-1. 2005 Vessel Calls to U.S. Coastal Ports by Geographic Region.

Source: MARAD, 2006

- North Atlantic: Ports from Eastport, ME to Baltimore, MD
- South Atlantic: Ports from Alexandria, VA to Miami, FL
- U.S. Gulf: Ports from Key West, FL to Brownsville, TX
- Pacific Southwest: Ports from Crockett, CA to San Diego, CA and all Hawaiian ports
- Pacific Northwest: Ports from Barrow, AK to Coos Bay, OR
- Puerto Rico: Ports in Puerto Rico

⁶ Deadweight is defined as the total weight in metric tons of cargo, fuel, fresh water, stores and crew which a ship can carry when immersed to its load line (MARAD, 2006).

Table 4-1. 2005 Vessel Calls at All U.S. Coastal Ports Organized by Geographic Region

State	Port ^a	Number of Calls	Most Frequently Calling Vessels
NORTH ATLANTIC			
CT	Bridgeport	87	General cargo vessels
CT	Groton	4	Tanker
CT	New Haven	185	Tanker, General cargo vessels
CT	New London	32	General cargo vessels
MA	Boston	332	General cargo vessels, Tanker
MA	Fall River	1	General cargo vessels
MA	Salem	2	General cargo vessels
MA	Sandwich	2	Tanker
MD	Annapolis	134	General cargo vessels
MD	Baltimore	1,825	General cargo vessels, Roll on-Roll Off cargo vessels
MD	Cove Point	74	Tanker
MD	Piney Point	50	Tanker
ME	Bucksport	2	Tanker
ME	Camden	1	General cargo vessels
ME	Eastport	13	General cargo vessels
ME	Portland	364	Tanker
ME	Sandy Point	1	Tanker
ME	Searsport	19	Tanker
NH	Portsmouth	129	General cargo vessels, Tanker
NY	Albany	1	General cargo vessels
NY	Kingston	2	General cargo vessels
NY	New York	4,902	General cargo vessels, Tanker
NY	Northport	9	Tanker
NY	Northville	47	Tanker
NY	Riverhead	2	Tanker
NY	Stony Point	2	General cargo vessels
PA	Philadelphia	2,998	Tanker, General cargo vessels
RI	Brayton Point	5	General cargo vessels
RI	Davisville	78	Roll on-Roll Off Cargo Vessels
RI	Jamestown	1	General cargo vessels
RI	Newport	1	General cargo vessels
RI	Providence	193	Tanker, General cargo vessels
PACIFIC NORTHWEST			
AK	Afognak	95	Roll on-Roll Off Cargo Vessels
AK	Anchorage	150	General cargo vessels
AK	Drift River Term.	1	Tanker
AK	Dutch Hbr.	157	General cargo vessels
AK	Hawk Inlet	2	General cargo vessels
AK	Homer	79	Tanker
AK	Hoonah	5	General cargo vessels
AK	Hydaburg	15	General cargo vessels
AK	Juneau	1	Tanker
AK	Kake	5	General cargo vessels

Table 4-1. 2005 Vessel Calls at All U.S. Coastal Ports Organized by Geographic Region, continued

State	Port ^a	Number of Calls	Most Frequently Calling Vessels
AK	Kenai	11	General cargo vessels
AK	Ketchikan	4	General cargo vessels
AK	Klawock	12	General cargo vessels
AK	Kodiak	97	General cargo vessels
AK	Nikiski	143	Tanker
AK	Red Dog	9	General cargo vessels
AK	Seward	7	General cargo vessels
AK	Tolstoi Bay	5	General cargo vessels
AK	Valdez	399	Tanker
OR	Columbia River	2,189	General cargo vessels
OR	Coos Bay	43	General cargo vessels
WA	Anacortes	8	General cargo vessels
WA	Bellingham	2	General cargo vessels
WA	Bremerton	2	General cargo vessels
WA	Cherry Point	209	Tanker
WA	Everett	33	General cargo vessels, Roll on-Roll Off cargo vessels
WA	Ferndale	123	Tanker
WA	Manchester	11	Tanker
WA	March Point	342	Tanker
WA	Olympia	20	General cargo vessels, Roll on-Roll Off cargo vessels
WA	Point Wells	19	Tanker
WA	Port Angeles	277	Tanker
WA	Port Townsend	3	General cargo vessels
WA	Seattle	1,186	General cargo vessels
WA	Tacoma	1,270	General cargo vessels
WA	Westport	7	General cargo vessels
PUERTO RICO			
PR	Guanica	1	General cargo vessels
PR	Guayanilla	125	Tanker
PR	Las Mareas	7	General cargo vessels
PR	Mayaguez	1	General cargo vessels
PR	Ponce	19	General cargo vessels
PR	Puerto Rico	9	Tanker
PR	San Juan	1,086	General cargo vessels
PR	Yabucoa	42	Tanker
PACIFIC SOUTHWEST			
CA	El Segundo	245	Tanker
CA	LA/Long Beach	5,178	General cargo vessels
CA	Port Hueneme	397	Roll on-Roll Off cargo vessels
CA	S. California light. area	24	Tanker
CA	San Diego	319	Roll on-Roll Off cargo vessels, General cargo vessels
CA	San Francisco	3,871	General cargo vessels
HI	Barbers Point	162	Tanker
HI	Hilo	54	Roll on-Roll Off cargo vessels
HI	Honolulu	586	General cargo vessels

Table 4-1. 2005 Vessel Calls at All U.S. Coastal Ports Organized by Geographic Region, continued

State	Port ^a	Number of Calls	Most Frequently Calling Vessels
HI	Kahului	77	Roll on-Roll Off cargo vessels
HI	Kawaihae	1	General cargo vessels
HI	Nawiliwili	11	Roll on-Roll Off cargo vessels
HI	Port Allen	1	Roll on-Roll Off cargo vessels
SOUTH ATLANTIC			
FL	Cape Canaveral	2	General cargo vessels, Roll on-Roll Off cargo vessels
FL	Fernandina	6	General cargo vessels
FL	Jacksonville	1,237	General cargo vessels, Roll on-Roll Off cargo vessels
FL	Miami	1,299	General cargo vessels
FL	Palm Beach	116	General cargo vessels
FL	Port Canaveral	55	General cargo vessels, Roll on-Roll Off cargo vessels
FL	Port Everglades	1,182	General cargo vessels, Tanker
GA	Brunswick	243	Roll on-Roll Off cargo vessels
GA	Savannah	2,333	General cargo vessels
NC	Morehead City	36	General cargo vessels
NC	Southport	1	Tanker
NC	Wilmington	600	General cargo vessels, Tanker
SC	Charleston	2,046	General cargo vessels
SC	Georgetown	6	General cargo vessels
VA	Virginia Ports	2,547	General cargo vessels
U.S. GULF			
AL	Mobile	811	General cargo vessels
FL	Key West	2	Tanker
FL	Panama City	6	General cargo vessels
FL	Pensacola	19	General cargo vessels
FL	Port Manatee	159	General cargo vessels
FL	Tampa	1,003	Tanker, General cargo vessels
LA	Gulf Gateway Term.	2	Tanker
LA	Lake Charles	701	Tanker
LA	LOOP Term.	401	Tanker
LA	New Orleans	3,749	General cargo vessels, Tanker
LA	Port Fourchon	1	Tanker
LA	Southwest Pass light. area	3	Tanker
MS	Gulfport	39	General cargo vessels
MS	Pascagoula	233	Tanker
MS	Pascagoula light. area	5	Tanker
TX	Beaumont	72	General cargo vessels
TX	Brownsville	158	General cargo vessels
TX	Corpus Christi	989	Tanker
TX	Freeport	759	Tanker
TX	Freeport light. area	2	Tanker, Roll on-Roll Off cargo vessels
TX	Galveston	429	General cargo vessels, Tanker
TX	Galveston light. area	98	Tanker

Table 4–1. 2005 Vessel Calls at All U.S. Coastal Ports Organized by Geographic Region, continued

State	Port ^a	Number of Calls	Most Frequently Calling Vessels
TX	Houston	5,891	Tanker, General cargo vessels
TX	Ingleside	107	General cargo vessels, Tanker
TX	Point Comfort	321	Tanker
TX	Port Arthur	1,563	Tanker
TX	S. Sabine Point light. Area	17	Tanker
TX	Smith's Bluff	1	Tanker
TX	Texas City	1,142	Tanker

Source: MARAD, 2006.

^a Some of the port names in this table refer to groupings of geographically-similar ports. This was done to decrease the unwieldiness of the table and had been done by MARAD in previous years (MARAD, 2006). The groupings are described below.

Columbia River

- Includes the ports of Astoria, Kalama, Longview, Portland, Rainier, Vancouver, and Willbridge.

L.A./Long Beach

- Includes the ports of Los Angeles and Long Beach.

New Orleans

- Includes the ports of Ama, Arabi, Avondale, Baton Rouge, Belle Chasse, Boothville, Braithwaite, Burnside, Chalmette, Convent, Darrow, Davant, Destrechan, Donaldsonville, Empire, Garyville, Geismar, Good Hope, Gramercy, Gretna, Harvey, La Place, Magnolia, Marrero, Meraux, Michoud, Myrtle Grove, New Orleans, Norco, Ostrica, Paulina, Pilottown, Plaquemine, Port Allen, Port Sulfur, Reserve, St. Bernard, St. James, St. Rose, Taft, Violet, Waggaman, and Westwego.

Philadelphia

- Includes the ports of Burlington, NJ, Camden NJ, Claymont, DE, Chester, PA, Delair, NJ, Delaware City, DE, Eddystone, PA, Fairless Hills, Gloucester, NJ, Marcus Hook, PA, Paulsboro, NJ, Philadelphia, PA, Reedy Point, DE, Salem, NJ, Tullytown, PA, Westville, NJ, and Wilmington, DE.

San Francisco Bay

- Includes the ports of Alameda, Antioch, Bencia, Concord, Crockett, Martinez, Oakland, Pittsburg, Redwood City, Richmond, Rodeo, Sacramento, San Francisco, Selby, and Stockton.

Virginia

- Includes the ports of Chesapeake, Hampton Roads, Hopewell, Lynnhaven Roads, Newport News, Norfolk, Portsmouth, Richmond, and Yorktown

Table 4-2. Top 20 U.S. Ports by Number of Vessel Calls in 2005.

Coastal Region	Port	State	Number of Calls
U.S. Gulf	Houston	TX	5,891
Pacific Southwest	LA/Long Beach	CA	5,178
North Atlantic	New York	NY	4,902
Pacific Southwest	San Francisco	CA	3,871
U.S. Gulf	New Orleans	LA	3,749
North Atlantic	Philadelphia	PA	2,998
South Atlantic	Virginia Ports	VA	2,547
South Atlantic	Savannah	GA	2,333
Pacific Northwest	Columbia River	OR	2,189
South Atlantic	Charleston	SC	2,046
North Atlantic	Baltimore	MD	1,825
U.S. Gulf	Port Arthur	TX	1,563
South Atlantic	Miami	FL	1,299
Pacific Northwest	Tacoma	WA	1,270

Table 4–2. Top 20 U.S. Ports by Number of Vessel Calls in 2005, continued.

Coastal Region	Port	State	Number of Calls
South Atlantic	Jacksonville	FL	1,237
Pacific Northwest	Seattle	WA	1,186
South Atlantic	Port Everglades	FL	1,182
U.S. Gulf	Texas City	TX	1,142
Puerto Rico	San Juan	PR	1,086
U.S. Gulf	Tampa	FL	1,003

Source: MARAD, 2006.

Table 4-2 shows that Houston, TX had more vessel calls than any other coastal U.S. port in 2005.

The U.S. CBP data on vessel entrances and clearances (CBP, 2007) provide information on all U.S. ports (coastal and inland), including the date a vessel entered a given port (*i.e.*, filed an entrance record), the vessel’s flag, and the previous port the vessel had called at. Having information on the previous port visited by a vessel can help evaluate the threat of invasive species introductions. Table 4-3 presents the number of calls that the previous port was foreign (‘foreign calls’) and the number of calls that the previous port was domestic (‘domestic calls’) for the 20 U.S ports with the most total calls in 2005, according to the CBP data. The top 20 ports with the most calls in 2005 according to CBP may differ slightly from the MARAD data; MARAD recorded data only at coastal ports, while CBP recorded data at all U.S. ports. In addition, MARAD grouped some of the geographically similar coastal ports (see Table 4-1) and CBP did not.

Table 4-3 shows that a number of the top 20 U.S. ports primarily receive foreign calls: Port Everglades, FL; Long Beach, CA; San Juan, PR; and Seattle, WA. Elizabeth River, VA was the U.S. port with the highest percentage of domestic calls, followed by Oakland, CA. One caveat presents itself with these data: a domestic call does not necessarily mean that there is less of an invasive species introduction threat than a foreign call.

Table 4-3. 2005 Domestic and Foreign Vessel Calls at Top 20 U.S. Ports.

U.S Port	Number of Domestic Calls	Number of Foreign Calls	Percent Domestic Calls	Most Frequently Cited Last Port*
Houston, TX	2,032	3,585	36.2%	Mexico
New York, NY	1,565	3,218	32.7%	Canada
Port Everglades, FL	642	3,665	14.9%	Bahamas
Miami, FL	788	2,937	21.2%	Bahamas
Long Beach, CA	469	2,159	17.8%	Mexico
San Juan, PR	333	2,186	13.2%	U.S. Virgin Islands
Savannah, GA	1,671	725	69.7%	Elizabeth River, VA
St. Thomas, VI	1,235	1,128	52.3%	San Juan, PR
Seattle, WA	142	2,197	6.1%	Canada
New Orleans, LA	1,067	1,222	46.6%	Houston, TX (D); Mexico (F)
Charleston, SC	1,565	709	68.8%	Elizabeth River, VA
Los Angeles, CA	368	1,856	16.5%	Mexico
Baltimore, MD	1,175	812	59.1%	New York, NY
Elizabeth River, VA	1,689	134	92.6%	New York, NY

Table 4-3. 2005 Domestic and Foreign Vessel Calls at Top 20 U.S. Ports, continued.

U.S Port	Number of Domestic Calls	Number of Foreign Calls	Percent Domestic Calls	Most Frequently Cited Last Port*
Oakland, CA	1,248	471	72.6%	Los Angeles, CA
Bayou Lafourche, LA	14	1,679	0.8%	Unknown*
Galveston, TX	75	1,520	4.7%	Unknown*
Tacoma, WA	188	1,406	11.8%	Canada
Jacksonville, FL	662	880	42.9%	Bahamas
South Louisiana, LA	332	1,141	22.5%	Mexico

Source: CBP, 2007

* According to CBP (2007), a port cited as 'Unknown' reported its last port as "high seas"

4.2 Receiving Water Characteristics

For each of the top 20 U.S. ports (as determined by total number of vessel calls and listed in Table 4-3), several sources were consulted to assess the current water quality conditions. In the following sections, each of the top 20 ports are briefly described in terms of their water quality and general condition. As described in Sections 2.4.4 and 2.4.5, the sources consulted for the following descriptions included EPA's National TMDL database (EPA, 2007a), the 2007 NEP Coastal Condition Report (EPA, 2007b), and a collection of other sources that are cited below in the relevant sections. The water quality characteristics of the top 20 ports are described below from most vessel calls to fewest (based on CBP, 2007).

4.2.1 Houston, Texas

EPA's National TMDL database lists chlordane (in tissue), dieldrin (in tissue), dioxin, heptachlor epoxide, polychlorinated biphenyls (PCBs) (in tissue), and sediment toxicity as the pollutants in exceedance of water quality standards in Port of Houston waters (as of 2004, the most recently-available year). According to the mapping feature of the National TMDL database, the water body segments that comprise the Houston Ship Channel and the Port of Houston include: Barbour's Cut, Houston Ship Channel/San Jacinto River Tidal, Black Duck Bay, Tabbs Bay, Scott Bay, and Houston Ship Channel/Bufalo Bayou Tidal. All of these segments are impaired for one or more of the pollutants listed above. In addition, vessels traveling to and from the Port of Houston must traverse Upper Galveston Bay, which is impaired for bacteria, dioxins, and PCBs, prior to entering the Houston Ship Channel (EPA, 2007a).

Galveston Bay is designated as an NEP estuary⁷, with the 2007 Coastal Condition Report describing Galveston Bay as well-mixed and shallow and strewn with extensive oyster beds. The water quality in Galveston Bay is classified as 'fair-to-poor', with high DIN and DIP concentrations being the main causes of excessive chlorophyll *a* levels and poor water clarity. DO concentrations, however, were rated as 'good'. Total organic carbon (TOC) concentrations and sediment toxicity was both rated 'good', although sediment toxicity data were not available for 31% of the estuary. Finally, sediment contaminant levels were classified as 'fair' (EPA, 2007b).

According to the Galveston Bay Estuary Program's water quality monitoring program, nutrient (*e.g.*, total nitrogen, ammonia, and total phosphorus) and chlorophyll *a* concentrations in Galveston Bay, its sub-bays, and tributaries have been generally declining since monitoring began in the 1970s, with many areas

⁷ The Coastal Condition Report discussion of the waters surrounding the port of Houston is also relevant to Galveston Bay (Section 4.2.16).

achieving a ‘good’ or ‘very good’ rating. Other areas, however, especially those areas surrounding the shipping route through the Bay (e.g., Upper and Lower Galveston Bay, Houston Ship Channel, Buffalo Bayou) exhibit a ‘fair’ or ‘poor’ rating for nutrients and chlorophyll *a*. Enterococcus, *Escherichia coli*, and fecal coliform were also found in high concentrations in many tributaries surrounding Galveston Bay and the Port of Houston; for many of these tributaries, the bacterial levels have been consistently high since the 1970s (EPA, 2007b)

4.2.2 New York City, NY

The Port of New York City is comprised of facilities located in both New York and New Jersey. EPA’s National TMDL database lists PCBs, nitrogen, mercury, cadmium, oxygen demand, floatables, and dioxins as the pollutants in exceedance of water quality standards in Port of New York and New Jersey waters (as of 2004, the most recently-available year). According to the mapping feature of the National TMDL database, the water body segments that comprise the Port of New York include: Lower East River, Upper New York/New Jersey Harbor, Kill Van Kull, Newark Bay, and Arthur Kill and tidal tributaries. All of these segments are impaired for one or more of the pollutants listed above (EPA, 2007a).

The water quality of the New York-New Jersey Harbor Estuary Program (HEP) is discussed in EPA’s 2007 Coastal Condition Report and is rated as ‘poor’; however, there are no data available for approximately 62% of the estuarine area. According to available data, DIN and DIP levels were elevated over a wide area of the estuary and rated as ‘fair’ and ‘poor’, respectively. The estuary was rated ‘good’ for chlorophyll *a*, DO levels, and water clarity. Sediment quality, however, was generally considered ‘poor’, with both sediment toxicity and sediment contaminants being elevated. TOC in sediment was rated ‘good’ for a majority of the estuarine area. On a positive note, none of the water quality indicators monitored by the HEP (i.e., fish tissue contamination, coliform bacteria levels, dissolved oxygen, harmful algal blooms, etc.) has exhibited downhill trends since monitoring began. Despite these positive trends, the overall health of the estuary is rated as ‘poor’ primarily because of the deteriorating trends in some wading bird and fish populations and ongoing fish consumption advisories (EPA, 2007b).

4.2.3 Port Everglades, Florida

EPA’s National TMDL database lists coliforms, DO, and nutrients as the pollutants in exceedance of water quality standards in Port Everglades waters (as of 2002, the most recently-available year). According to the mapping feature of the National TMDL database, the water body segment that comprises the Port of Port Everglades includes the Intracoastal Waterway in Dade County (EPA, 2007a). Water quality sampling programs managed by the Broward County Department of Natural Resources and the South Florida Water Management District did not have stations located in or around the Port of Port Everglades.

4.2.4 Miami, Florida

EPA’s National TMDL database does not list any water quality exceedances in and around the Port of Miami. Water quality sampling programs managed by the Miami-Dade County Department of Environmental Resource Management and the South Florida Water Management District did not have stations located in or around the Port of Miami (EPA, 2007a).

4.2.5 Los Angeles/Long Beach, CA

EPA’s National TMDL database lists pesticides (dichloro-diphenyl-trichloroethane [DDT], toxaphene, chlordane, and dieldrin), polycyclic aromatic hydrocarbons (PAHs), PCBs, zinc, copper, chromium, lead, mercury, cadmium, nickel, and sediment toxicity as the pollutants in exceedance of water quality standards in the waters in and around the ports of Los Angeles/Long Beach (as of 2002, the most recently-available year). According to the mapping feature of the National TMDL database, the water body segments that comprise the Port of Los Angeles/Long Beach include: Los Angeles Harbor Main

Channel, Los Angeles Harbor Southwest Slip, Los Angeles Fish Harbor, Los Angeles Harbor Consolidated Slip, Long Beach Harbor Main Channel, and San Pedro Bay Near/Offshore Zones (EPA, 2007a).

Although the Port of Los Angeles/Long Beach is located adjacent to Santa Monica Bay, one of the 28 NEPs, the geographic scope of the monitoring described in the 2007 Coastal Condition Report does not cover the port.

4.2.6 San Juan, Puerto Rico

EPA's National TMDL database lists ammonia, fecal coliform, and DO as the pollutants in exceedance of water quality standards in the waters in and around the port of San Juan (as of 2004, the most recently-available year) (EPA, 2007a).

San Juan Bay is one of the NEPs described in the Coastal Condition Report (EPA, 2007b). The overall condition of the Bay was rated as 'poor', based on the water quality, sediment, benthic, and fish tissue indices. Water column DIN and DIP concentrations were rated as 'fair', although data for DIP were unavailable for 78% of the estuarine area. 73% of the estuarine area was rated as 'good' for chlorophyll a levels and water clarity measurements were found to be 'fair' overall. DO concentrations were listed as 'fair' for 57% of the estuary and 'good' for 36%. Sediment toxicity was 'poor' (with PCBs, DDT, 2-ethylhexyl phthalate, lead, and mercury among the most abundant sediment contaminants) and sediment TOC levels were rated 'good'. Low benthic species diversity has resulted in a 'poor' rating for benthic conditions and, with 40% of fish tissue samples collected in the estuary exceeding EPA's advisory levels, the fish tissue contaminants index was rated 'poor' (EPA, 2007b).

4.2.7 Savannah, GA

EPA's National TMDL database lists DO and mercury as the pollutants in exceedance of water quality standards in the waters in and around the Port of Savannah (as of 2002, the most recently-available year) (EPA, 2007a). According to the mapping feature of the National TMDL database, the water body segments that comprise the Port of Savannah include: Savannah River and Savannah Harbor (EPA, 2007a).

4.2.8 St. Thomas, Virgin Islands

EPA's National TMDL database lists DO, fecal coliform, oil and grease, and pH as the pollutants in exceedance of water quality standards in the waters in and around the Port of St. Thomas, U.S. Virgin Islands (as of 2004, the most recently-available year) (EPA, 2007a). According to the mapping feature of the National TMDL database, the water body segments that comprise the Port of St. Thomas include: Hassel Island at Haulover Cut to Regis Point and Sprat Bay (EPA, 2007a)

4.2.9 Seattle, WA

EPA's National TMDL database lists total PAHs, pH, total PCBs, and fecal coliform as the pollutants in exceedance of water quality standards in the waters in and around the Port of Seattle (as of 2002, the most recently-available year) (EPA, 2007a).

In the Coastal Condition Report, the Puget Sound NEP is given an overall 'fair' rating⁸. The water quality index is 'fair', with DIN and DO concentrations rated 'good', chlorophyll a and DIP levels rated 'fair', and water clarity classified as 'poor'. 'Poor' sediment toxicity measurements have resulted in a 'poor' overall sediment quality rating, despite a 'good' rating for TOC levels. Benthic health was given a

⁸ Both Seattle, WA and Tacoma, WA are located on Puget Sound. Therefore, the estuarine conditions (based on the Coastal Condition report data) described for Seattle also apply to Tacoma (Section 4.2.17).

‘good’ rating and fish tissue contamination was rated as ‘fair’, with 14% of the fish having contaminant levels greater than EPA advisory levels (and the most frequently detected contaminant being PCBs) (EPA, 2007b).

4.2.10 New Orleans, LA

EPA’s National TMDL database lists fecal coliform as the pollutant in exceedance of water quality standards in the waters in and around the Port of New Orleans (as of 2002, the most recently-available year) (EPA, 2007a).

4.2.11 Charleston, SC

EPA’s National TMDL database does not list any water quality exceedances in and around the Port of Charleston (EPA, 2007a).

4.2.12 Baltimore, MD

EPA’s National TMDL database lists PCBs, zinc, and chromium as the pollutants in exceedance of water quality standards in and around the Port of Baltimore (as of 2004, the most recently-available year)(EPA, 2007a). In addition, Middle Chesapeake Bay (through which vessels must pass en route to the Port of Baltimore) has water quality exceedances for nutrients. According to the mapping feature of the National TMDL database, the water body segments that comprise the Port of Baltimore include: Curtis Bay, Bear Creek, Southern Branch Elizabeth River, Eastern Branch Elizabeth River, and Indian River (EPA, 2007a)

4.2.13 Elizabeth River, VA

EPA’s National TMDL database lists phosphorus, fecal coliforms, PCBs, and benthic (unknown) as the pollutants in exceedance of water quality standards in the waters in and around the Port of Elizabeth River (as of 2004, the most recently-available year) (EPA, 2007a). According to the mapping feature of the National TMDL database, the water body segments that comprise the Port of Elizabeth River include: Western Branch Elizabeth River, Southern Branch Elizabeth River, Eastern Branch Elizabeth River, and Indian River (EPA, 2007a)

Dedicated to restoring the health of the river, the Elizabeth River Project⁹ has been studying its condition for several years, focusing on the benthic communities and toxic characteristics. Several of their reports have been posted on their website. The most recent benthic monitoring report (2005) indicates that, in general, benthic species diversity and biomass in the Elizabeth River watershed are below reference condition levels while abundance was often above reference condition levels and considered excessive. The reports characterizes the water quality of the Elizabeth River as follows: (1) nutrients have a poor status indicating high concentration levels, (2) there were improvements in long-term trends in total nitrogen levels and inorganic nitrogen levels, and (3) there were widespread improvements in long-term trends in total phosphorus levels. Nitrogen levels are highest in the Southern Branch with smaller differences between the branches of the river for phosphorus levels. Chlorophyll levels are good in both the Eastern Branch and Southern Branch in spite of high nutrient levels and good water clarity. Chlorophyll levels are fair in the Western Branch with an improving long-term trend. Bottom dissolved oxygen levels are fair to good in all branches (Dauer, 2006).

4.2.14 Oakland, CA

EPA’s National TMDL database lists chlordane, DDT, diazinon, dieldrin, dioxins, exotic species, mercury, PCBs, and selenium as the pollutants in exceedance of water quality standards in the waters in and around the Port of Oakland (as of 2002, the most recently-available year) (EPA, 2007a).

⁹ www.elizabethriver.org

The Port of Oakland is located within the San Francisco Bay NEP and, therefore, is included in the 2007 Coastal Condition report (EPA, 2007b). The overall condition of the NEP is rated as 'fair', with water quality in general classified as 'fair' to 'poor', with approximately 73% of the estuary rated 'fair' and 20% rated 'poor'. Chlorophyll a and DO concentrations were 'good' in 90% and 99% of the estuary, respectively. DIN levels were 'fair', while both DIP and water clarity were rated 'poor'. The sediment in the estuary is in very good condition, with 100% of the estuary rated 'good' for sediment toxicity and 96% rated 'good' for TOC levels. Benthic invertebrate communities are in 'good' condition, while fish tissue contaminants are rated 'poor', with 58% of fish caught exceeding EPA's guidance values.

4.2.15 Bayou Lafourche, LA

EPA's National TMDL database lists DO, nutrients, total coliform, and fecal coliform as the pollutants in exceedance of water quality standards in the waters in and around Bayou LaFourche (as of 2004, the most recently-available year) (EPA, 2007a).

Currently, the state of Louisiana and the Louisiana Department of Natural Resources is studying a potential reintroduction of Mississippi River water into Bayou Lafourche. A water quality monitoring report was developed in February 2006 in which data collected in support of a hydrodynamic model were published. Data were collected via 18 permanent platforms installed along the bayou which were in data collection mode from February 2004 until January 2005. Parameters that were collected included temperature, specific conductance, water surface elevation (depth), salinity, and stream velocity, direction, and speed. Data from this project are available online.¹⁰

4.2.16 Galveston, TX

EPA's National TMDL database lists bacteria as the pollutant in exceedance of water quality standards in the waters in and around the Port of Galveston (as of 2004, the most recently-available year) (EPA, 2007a).

The general condition of the waters surrounding the port of Galveston is described in the Section 4.2.1 discussion of Houston. However, the Galveston NEP published a State of the Bay report in 2002¹¹ that described the water quality data and trends in the estuary. Generally speaking, concentrations of ammonia-nitrogen and total phosphorus have been occurring over the past three decades. Nitrate-nitrite data for the 1990s did not exhibit an upward or downward trend, but did indicate seasonal peaks in concentrations. Chlorophyll a levels have been declining over the past two decades and have reached 25% of their 1975 values. Dissolved metals have declined in the Houston Ship Channel over the last ten years, although organic contamination in the Channel from spillage of petroleum products is substantial (Galveston Bay Estuary Program, 2002).

4.2.17 Tacoma, WA

EPA's National TMDL database lists total PCBs, bis(2-ethylhexyl) phthalate, DDT, PAHs, and pesticides as the pollutants in exceedance of water quality standards in the waters in and around the Port of Tacoma (as of 2002, the most recently-available year) (EPA, 2007a).

The Port of Tacoma is located on Puget Sound. Refer to the Section 4.2.9 discussion on Seattle for more information on the overall ecosystem health of the waters surrounding this port, according to EPA's 2007 Coastal Condition Report.

¹⁰ <http://www.bayoulafourche.org/default.asp?id=64>

¹¹ <http://gbic.tamug.edu/sobdoc/sob2/sob2page.html>

4.2.18 Jacksonville, FL

EPA's National TMDL database lists coliforms, nutrients, total suspended solids, and turbidity as the pollutants in exceedance of water quality standards in the waters in and around the Port of Jacksonville (as of 2002, the most recently-available year) (EPA, 2007a).

4.2.19 South Louisiana, LA

The Port of South Louisiana is comprised of facilities along 54 miles of the Mississippi River in St. James, St. Charles, and St. John parishes. EPA's National TMDL database lists fecal coliform as the pollutant in exceedance of water quality standards in the waters in and around the Port of South Louisiana (as of 2002, the most recently-available year) (EPA, 2007a).

5.0 DISCHARGE FINDINGS

5.1 Discharges Incidental to the Normal Operation of a Vessel

As described in Section 2.5, the vast majority of information on discharges originating from vessels came from the UNDS reports on discharges from Armed Forces vessels. One of the products from Phase I was a list of the 25 Armed Forces vessel discharges that should require a MPCD. EPA and DoD also identified 14 additional discharges that they determined would not require an MPCD when discharged from an Armed Forces vessel, based on the nature of the discharge, the environmental effects, and the economic costs and practicability of a MPCD for an Armed Forces vessel. In the following sections, Battelle has included information on the group of 25 Phase I discharges that should require an MPCD, except for one: Catapult Water Brake Tank and Post-Launch Retraction Exhaust. A catapult is the mechanism used to help launch aircraft from a carrier and aircraft carriers are exclusively used by the military. The 24 UNDS Phase I discharges that should require an MPCD are listed in Table 5-1, along with a brief description.

On June 21, 2007, the EPA published an Advanced Notice of Proposed Rulemaking (ANPRM) in the Federal Register (Vol. 72, No. 119, p. 34241) providing background information on the pending NPDES permitting program. The ANPRM requested that commentors provide information or data sources that might help the EPA better comprehend the universe of vessels and discharges that will be affected by the new permitting scheme. Six commentors provided specific lists and/or descriptions of discharges that were relevant to certain types of vessels:

- Liberty Maritime Corporation (LMC): a civilian company that transports military and food aid cargo for the U.S. government
- Crowley Maritime Corporation (CMC): operates a fleet of vessels, including roll on-roll off, lift on-lift off, tankers, tugs, and barges.
- World Shipping Council (WSC): a trade association that represents all types of ocean carriers.
- Cruise Lines International Association (CLIA): represents the interests of 24 cruise line companies.
- Pacific Seafood Processors Association (PSPA): represents floating seafood processing vessels.
- American Waterways Operators (AWO): a national trade association for the inland and coastal tugboat, towboat, and barge industry.

Several of these commentors stated that some UNDS vessel discharges that had not been included in the first draft of this report (*i.e.*, that did not require an MPCD when discharged from an Armed Forces vessel) were relevant to specific types of civilian vessels. In light of this new information, these additional discharges are listed in Table 5-2 and more detailed descriptions are included in the sections below.

Table 5-1. Phase I UNDS Armed Forces Vessel Discharges Requiring an MPCD.

Armed Forces Vessel Discharge	Description
Aqueous Film-Forming Foam	Fire-fighting agent used for flammable liquid fires on vessels. A concentrated liquid mixed with ambient water to form a solution which is discharged during planned maintenance and inspections.
Chain Locker Effluent	Ambient water and debris that collects in the anchor chain storage locker as a result of anchor chain washdowns, retrievals, and heavy weather. The liquid collects in a sump and is removed by a drainage eductor powered by the shipboard firemain.
Clean Ballast	Ambient water that is transferred into and out of dedicated tanks to adjust a surface ship's draft and to improve stability under various operating conditions. The discharge is generated when the ballast is no longer required and the tanks are partially or completely emptied.
Compensated Fuel Ballast	Ambient water that is introduced into fuel tanks to maintain the stability of a vessel by compensating for the weight of the expended fuel that is consumed. During refueling, this ambient water is displaced overboard.
Controllable Pitch Propeller Hydraulic Fluid	Hydraulic oil that is released from controllable pitch propeller (CPP) systems under three conditions: leakage through CPP seals, releases during underwater CPP repair and maintenance, or releases from equipment used for CPP blade replacement.
Deck Runoff	Water runoff from precipitation, freshwater washdowns, and ambient water that falls on the exposed decks of a vessel such as a weather deck or flight deck. This water washes off residues from the deck and topside equipment, can be contaminated with materials from other deck activities, and is discharged overboard to receiving waters.
Dirty Ballast	Ambient water that is occasionally pumped into empty fuel tanks for the specific purpose of improving ship stability. Before taking on ambient water, fuel in the tank to be ballasted is transferred to another fuel tank or holding tank. Dirty ballast is comprised of residual fuel mixed with ambient water. The discharge is generated when the ballast is no longer required and the tanks are partially or completely emptied.
Distillation and Reverse Osmosis Brine	Seawater concentrate or "brine" that is left over by water purification systems that generate freshwater from seawater for a variety of shipboard applications including potable water for drinking. This "brine" is discharged overboard.
Elevator Pit Effluent	Liquid from deck runoff and elevator equipment maintenance activities that collects in the bottom of elevator shafts. The liquid waste is either directed overboard, collected for shore-side disposal, or processed along with bilge water.
Firemain Systems	Ambient water distributed for fire fighting and other services aboard ships. Discharges of firemain water from normal operations occur during firemain testing, maintenance and training activities, anchor chain washdown, and cooling of auxiliary machinery.
Gas Turbine Water Wash	Wash water discharge from cleaning internal and external propulsion and auxiliary gas turbine components.
Grey Water	Wastewater from showers, galleys, laundries, deck drains, lavatories, interior deck drains, water fountains, miscellaneous shop sinks, and similar sources.
Hull Coating Leachate	Antifouling agents that leach into surrounding waters from hull coatings designed to prevent corrosion and to inhibit biological growth on the hull surface.
Motor Gasoline Compensating Discharge	Ambient water used to compensate for expended motor gasoline (MOGAS) used to operate equipment stored on some vessels. MOGAS is stored in a compensating tank system to which ambient water is added to fuel tanks as fuel is consumed. The discharge occurs as a result of refueling when the displaced water is discharged overboard.

Table 5-1. Phase I UNDS Armed Forces Vessel Discharges Requiring an MPCD, continued.

Armed Forces Vessel Discharge	Description
Non-Oily Machinery Wastewater	Generated from the operation of distilling plants, water chillers, low- and high-pressure air compressors, and propulsion engine jacket coolers. The discharge is captured in a dedicated system of drip pans, funnels, and deck drains to segregate the water from bilge water, and is either drained directly overboard or into dedicated collection tanks before being discharged overboard.
Photographic Laboratory Drains	Shipboard photographic lab wastes from processing color and black-and-white film. Typical wastes include spent film processing chemical developers, fixer-bath solutions, and film rinse water
Seawater Cooling Overboard Discharge	Seawater used to cool heat exchangers, propulsion plants, and mechanical auxiliary systems.
Seawater Piping Biofouling Prevention	Anti-fouling compounds such as sodium hypochlorite introduced in seawater cooling systems to inhibit the growth of fouling organisms on interior piping and component surfaces.
Small Boat Engine Wet Exhaust	Ambient water injected into the exhaust of small boat engines for cooling and to quiet operation. Exhaust gas constituents are entrained in the injected ambient water and discharged overboard as wet exhaust.
Sonar Dome Discharge	Some domes that house detection, navigation, and ranging equipment are filled with ambient water to maintain their shape and pressure. The discharge occurs when water from inside the dome is pumped overboard before performing maintenance or repair on the dome and when materials leach from the dome exterior.
Submarine Bilge water	Sources of bilge water include seawater accumulation, normal leakage from machinery, and fresh water washdowns that collect in the bilge. On some submarines, oily wastewater is separated from non-oily wastewater. The oily wastewater is held for shore-side disposal and the non-oily wastewater is discharged overboard.
Surface Vessel Bilge water/Oil-Water Separator Discharge	Sources include condensate from steam systems, boiler blowdowns, water fountains, and machinery space sinks that drain to the bilge. Bilge water is either held for shore-side disposal or treated in an oil-water separator before being discharged overboard.
Underwater Ship Husbandry	Discharge from the grooming, maintenance, and repair of hulls and hull appendages performed while a vessel is waterborne. Underwater ship husbandry includes hull cleaning, fiberglass repair, welding, sonar dome repair, non-destructive testing, masker belt repairs, and painting operations.
Welldeck Discharges	Water and residuals from precipitation, equipment and vehicle washdowns, washing gas turbine engines, grey water from stored landing craft, and general washdowns of welldecks and vehicle storage areas.

Source: EPA, 1999a.

Table 5-2. Phase I UNDS Armed Forces Vessel Discharges Not Requiring an MPCD.

Armed Forces Vessel Discharge	Description
Boiler Blowdown	Water removed from the boiler system to prevent particulates, sludge, and treatment chemical concentrations from accumulating.
Cathodic Protection	Zinc, aluminum, and chlorine-produced oxidants released during the consumption of sacrificial anodes and the operation of impressed current cathodic protection systems. The purpose of cathodic protection is to prevent hull corrosion.
Freshwater Lay-up	Freshwater used to fill condensers when submarine seawater cooling systems are placed in stand-by mode, or "lay-up." While the condenser is in lay-up mode, the water is discharged and refilled approximately every 30 days.

Table 5–2. Phase I UNDS Armed Forces Vessel Discharges Not Requiring an MPCD, continued.

Armed Forces Vessel Discharge	Description
Refrigeration /Air Conditioning Condensate	Condensate from air conditioning, refrigerated spaces, and stand-alone refrigeration units. The condensate is collected in drains and is either discharged directly overboard or held in dedicated tanks before discharge.
Rudder Bearing Lubrication	Grease and oil used to lubricate rudder bearings. The grease and oil can be released while the vessel is moving, when the rudder is used, or when pierside because the oil lubricant is slightly pressurized.
Steam Condensate	Condensate from steam used to operate auxiliary systems, such as laundry facilities, heating systems, and other shipboard systems, that drains into collection tanks and is discharged overboard.
Stern Tube Seals and Underwater Bearing Lubrication	Lubricants used in propeller support struts and bearings that can be released to the environment.

Source: EPA, 1999a

Some of these discharges listed in Tables 5-1 and 5-2 are more likely than others to be found on civilian commercial and recreational vessels. Given the range of sizes and types of vessels that will potentially be affected by the pending vessel vacatur, the entire scope of discharges incidental to the normal operation of a vessel that could potentially be discharged by a vessel to U.S. navigable waters were included here.

As stated in Section 2.5.1, some of the UNDS-identified discharges had detailed reports available that included extensive information on the discharge characteristics, while others had only summary reports with less detailed information. Each of the discharges is described briefly below. A caveat to this information that bears repeating is that the discharge information provided by EPA and DoD relates to Armed Forces vessels. If data on discharge rates or concentrations were available and are included in this section, they apply specifically to the type(s) of Armed Forces vessel(s) discussed in the UNDS reports.

In a similar vein, Battelle’s ability to associate discharges to particular civilian vessel types was limited, given the specific applicability of the UNDS reports to Armed Forces vessels. Some discharges can be easily connected to certain types of vessels while other discharges may or may not apply to any number of vessels. Deck runoff, for instance, will be a factor for virtually all commercial and recreational vessels, whereas elevator pit effluent will not be a discharge for vessels without elevators (*i.e.*, smaller recreational vessels). With these caveats in place, the following sections describe each of the discharges.

5.1.1 Aqueous Film Forming Foam (AFFF)

The information on aqueous film forming foam (AFFF) was obtained from EPA (1999b) and five comments¹² on EPA’s ANPRM.

Discharge Summary

AFFF is a synthetic firefighting agent used aboard USCG and Navy vessels and possibly civilian vessels. Consisting of fluorosurfactants and/or fluoroproteins, AFFF can extinguish as well as prevent fires by forming an oxygen-excluding barrier over the area. AFFF concentrate is mixed with ambient water to form a 6% dilution and is never discharged from a vessel in its undiluted form. The discharge of AFFF, as discussed in this section, refers to the direct overboard discharging of the AFFF system. Some maintenance, inspection, and training activities may result in AFFF accumulating on the vessel deck; in these cases, the AFFF becomes a part of other discharges, such as deck runoff, chain locker effluent, elevator pit effluent, or bilge water.

¹² These comments included EPA-HQ-OW-2007-0483-0619 (AWO), EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), EPA-HQ-OW-2007-0483-1498 (WSC).

AWO, CMC, WSC, and the CLIA all cited AFFF as a potential discharge from some of their vessels. AWO specifically stated that some of their towing vessels are equipped with AFFF systems, especially those transporting flammable liquid cargo. They also stated that maintenance, testing, and training activities lead to AFFF being either discharged directly overboard or discharged onto the deck and then subsequently washed overboard. CMC stated that commercial vessels are required by international and U.S. law to test AFFF systems periodically, although no specific law was cited. They also stated that AFFF is discharged from all commercial vessel types, including unmanned barges. A comment by LMC stated that they do not conduct firefighting training using foam in U.S. waters.

When and Where Discharge Occurs

Discharge of AFFF can occur during planned maintenance and inspection activities that, on Armed Forces vessels, take place on an annual or semi-annual basis. On Armed Forces vessels, these maintenance and inspection activities occur by discharging the AFFF hose over the vessel's side. Following these maintenance and inspection activities, any AFFF on the vessel deck is washed down with the firemain and becomes a part of other vessel discharges. Maintenance discharges can only occur when the Armed Forces vessel is outside territorial waters (*i.e.*, 12 nautical miles [nmi]). Discharges due to inspections and certifications can occur anywhere, unless the AFFF has been washed into the vessel's bilge tank, which cannot be discharged within 12 nm. Civilian vessels may have different self-imposed restrictions for direct AFFF discharge.

Unless equipped with a fixed extinguishing system that must be tested, recreational vessels will not have this discharge. When used to fight fires on either commercial or recreational vessels, fire-fighting foam is not considered a discharge incidental to the normal operation of a vessel.

In their comments to the EPA's ANPRM, CLIA stated that AFFF discharge occurs whenever testing and maintenance activities are scheduled, which happen as often as needed to maintain fire fighting systems, and to ensure crew proficiency and vessel safety. However, they also state that these discharges typically occur outside of 12 nmi from land.

Discharge Rates, Concentrations, and Constituents

Along with the ingredients in the AFFF itself, the discharge will contain the constituents of the firemain water and the AFFF piping. The specific ingredients of the AFFF concentrate will vary by manufacturer. EPA (1999b) lists constituents, although they are specific to the brand of concentrate used by the Armed Forces and are not necessarily relevant to civilian vessels. These constituents include: water (which makes up 80% of the ingredients by weight), 2-(2-butoxyethoxy)-ethanol, urea, alkyl sulfate salts (2 in number), amphoteric fluoroalkylamide derivative, perfluoroalkyl sulfonate salts (5), triethanolamine, and methyl-1H-benzotriazole. As discussed in Section 5.1.10, constituents of the firemain water in Armed Forces vessels may include residue from the copper-nickel alloy pipes. AFFF piping in Armed Forces vessels is also constructed of copper-nickel alloy; therefore, perfluoroalkyl sulfonate salts, total nitrogen, bis(2-ethylhexyl) phthalate, copper, nickel, sulfides, and iron may be discharge constituents. The results of sampling by EPA and DoD indicated that each of these pollutants exceeded the most stringent state water quality standards in the U.S.¹³ Ambient water from the firemain system has little potential for harboring invasive species.

5.1.2 Boiler Blowdown

The information on boiler blowdown was obtained from EPA (1999c) and from four comments on EPA's ANPRM¹⁴

¹³ EPA and DoD used state water quality standards to evaluate discharge constituents and compared the sampling results (when available) to the state with the most stringent standards for a given constituent.

¹⁴ These comments included EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

Discharge Summary

For steam-powered vessels, onboard boiler systems must be supplied with feedwater to maintain the water level. On some Armed Forces vessels, a treatment is added to the feedwater to prevent corrosion and minimize scale formation in the boiler system. As the feedwater is boiled to produce steam, the concentration of particulates and chemicals (from the added treatment) increases in the feedwater remaining to be boiled. Boiler systems must periodically undergo a ‘blowdown’ to control the treatment concentrations and to remove accumulated sludge. A blowdown involves releasing the water from the boiler and from the ship altogether, into the ambient water through hull fittings below the waterline. Different types of blowdowns release different percentages of boiler water, but, typically, blowdowns remove between 1% and 10% of the total volume of water in the boiler. The UNDS report indicates that the volume of this discharge from Armed Forces vessels is rarely greater than 310 gallons and that the discharge is ejected from the vessel at high pressures (up to 1200 psi) and high temperatures (above 325°F). Boiler blowdown discharge can originate from any vessel with steam propulsion or a steam generator.

Comments submitted in response to the ANPRM indicated that boiler blowdown is a discharge associated with some types of civilian vessels. LMC, a civilian company that transports military and food aid cargo for the U.S. government, cited boiler blowdown as one of the discharges incidental to the operation of its vessels. CMC operates a fleet of vessels, including roll on-roll off, lift on-lift off, tankers, tugs, and barges. Their comment indicated that boiler blowdown was a relevant discharge for their fleet, although they did not specify which types of vessels. The WSC is a trade association that represents all types of ocean carriers and boiler blowdown was included in a non-annotated list of discharges relevant to their industry. Finally, the CLIA, which represents the interests of 24 cruise line companies, cited “boiler/economizer washdown waste” as a discharge relevant to cruise ships. A definition provided with their comment indicates that this discharge is equivalent to boiler blowdown.

When and Where Discharge Occurs

The UNDS report states that the frequency of boiler blowdown is dependent on the needs of the particular boiler system. Therefore, this discharge can occur whenever and wherever necessary to maintain the boiler system. In their comment, CLIA stated that, on cruise ships, boiler blowdowns occur as needed to maintain performance, which is typically on a weekly or monthly basis. However, they indicated that this discharge is nearly always done while underway and as far from land as practicable.

Discharge Rates, Concentrations, and Constituents

The constituents of boiler blowdown discharge will be dependent on the type(s) of anti-scaling and anti-corrosion treatment originally added to the feedwater. Numerous constituents found in boiler blowdown discharges from Armed Forces vessels were defined as priority pollutants by the EPA: antimony, arsenic, cadmium, copper, chromium, lead, nickel, selenium, thallium, zinc, and bis(2-ethylhexyl) phthalate. Other detected constituents are listed in Table 3 of the UNDS report (EPA, 1999c).

Thermal modeling using Armed Forces vessel specifications and described in the UNDS report showed that the high temperatures of the boiler blowdown discharge did not exceed the thermal mixing zone criteria of Virginia and Washington State, the only two U.S. states with such standards.

5.1.3 Cathodic Protection

The information on cathodic protection was obtained from EPA (1999d) and from three comments on EPA’s ANPRM¹⁵.

¹⁵ These comments included EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

Discharge Summary

According to the UNDS report on this discharge, nearly all Armed Forces vessels use cathodic protection systems (usually in conjunction with corrosion-resistant coatings) to prevent steel hull or metal underwater structure corrosion. Vessels with hulls made of fiberglass, wood, aluminum, or other non-ferrous material do not require cathodic protection systems. Two types of cathodic protection are most common on Armed Forces vessels: sacrificial anodes and Impressed Current Cathodic Protection (ICCP)-based systems. Sacrificial anodes are physically connected to an underwater vessel structure or component (which acts as the cathode). The anode is preferentially corroded (or 'sacrificed') which, via the electrolytic properties of seawater, produces a flow of electrons to the cathode, thereby preventing the cathode from corroding. Sacrificial anodes are used on most Armed Forces vessels, particularly those with mandatory dry-dock inspection or overhaul intervals of less than three years. When immersed, the anodes continue to corrode and have to be maintained and routinely replaced; zinc anodes need to be replaced at least every six years. Anodes can also be constructed of aluminum. The ICCP-based mechanism of protection is identical to sacrificial anodes, except ICCP systems use direct current (DC) from a source within the vessel in lieu of current supplied from anodes.

According to comments submitted in response to EPA's ANPRM, cathodic protection system discharge can originate from civilian vessels. CLIA, the WSC, and CMC all cited cathode protection discharge as relevant to the types of vessels they represent in their ANPRM comments.

When and Where Discharge Occurs

For vessels equipped with sacrificial anodes, the discharge occurs continuously whenever the vessel's hull is submerged. The comment submitted by CLIA also stated that this discharge occurs continuously

Discharge Rates, Concentrations, and Constituents

Ionized zinc or aluminum can be released into the surrounding water column as sacrificial anodes are consumed by corrosion. At the cathode, the water is reduced, forming hydroxyl ions which can form zinc or aluminum hydroxide if enough oxygen is present in the water. ICCP systems can generate chlorine-produced oxidants (CPOs), but the specific types will vary according to the specific chemistry or the surrounding water. These oxidants can include hypochlorous and hypobromous acids, hypochlorite and hypobromite, chloro- and bromo-organics, chloride, bromide, chloramines, and bromamines. Utilizing a tidal prism modeling approach, the receiving water concentrations of zinc and CPOs were estimated and none of the concentrations were found to exceed the most stringent state water quality standards.

5.1.4 Chain Locker Effluent

The information on chain locker effluent was obtained from EPA (1999e) and from four comments¹⁶ on EPA's ANPRM.

Discharge Summary

Armed Forces vessels, along with other civilian vessels, store their anchor chain(s) in a below deck compartment (chain locker) when not in use. In the locker, the chain rests on a grate below which is a sump that collects liquids and materials that enter the chain locker via rain and green water¹⁷. Most large surface vessels have at least one chain locker (EPA, 2003a). Chain locker effluent is generated during anchor retrieval (which, according to CLIA's comment, occurs weekly) or during storm events, when water may wash over the deck of a vessel. The sump in the chain locker is emptied either directly overboard (with assistance from firemain water) or is drained into the bilge tank for later disposal.

¹⁶ These comments included EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

¹⁷ Green water refers to fresh or salt water that washes over the deck of a vessel from wave action.

LMC, CMC, WSC, and CLIA all cited chain locker effluent as a discharge relevant to their types of vessels. CLIA further states that this is a discharge on all the vessels they represent.

When and Where Discharge Occurs

Navy vessels do not directly discharge chain locker effluent within 12 nmi of shore. Civilian vessels may have different self-imposed restrictions for direct chain locker effluent discharge.

Discharge Rates, Concentrations, and Constituents

Chain locker effluent has the potential to contain marine organisms, which may have been introduced into the sump from the anchor and chain, through the firemain system, or via green water. However, the Navy practice of washing down the anchor and chain as they are retrieved and the 12 nmi discharge limit makes the introduction of invasive species from chain locker effluent unlikely. Similar practices by civilian vessels will help prevent species introduction. Other constituents can include residue from materials used in the chain locker, such as rust, paint chips, grease, and zinc, as well as residue from copper-nickel alloy firemain pipes. The actual materials used in the construction of the chain locker or firemain pipes will vary for civilian vessels.

Discharge concentrations and annual mass loadings for chain locker effluent were not calculated for the UNDS report due to the expected minimal amount of discharge and the 12 nmi discharge limit followed by Armed Forces vessels.

5.1.5 Clean Ballast

The information on clean ballast was obtained from EPA (1999f) and from six comments¹⁸ on EPA's ANPRM.

Discharge Summary

Clean ballast is water that is taken onboard to assist with vessel draft, buoyancy, and stability and stored in dedicated ballast tanks that have never contained anything but ballast water (as opposed to Compensated Fuel Ballast and Dirty Ballast). Clean ballast tanks (sometimes called segregated ballast tanks [SBT]) can be filled from the firemain or by ballast pumps that take in ambient water. Large commercial vessels (*e.g.*, cargo, tankers, ro-ro, passenger) typically have ballast tanks, although they may not have clean ballast tanks. Under recent amendments to MARPOL 73/78 (Regulation 13G), all tankers must now have SBT configurations or be double-hulled. SBT arrangements are associated with smaller volume oil spills because the oil is carried in multiple tanks. According to the National Academy of Sciences (NAS) (2003), approximately two-thirds of the worldwide tanker fleet (crude and product) uses SBT, although this number has likely increased since that source's publication.

Recreational boats typically do not have ballast water tanks. However, boats used for wakeboarding are now being marketed with ballast tanks (*e.g.*, Centurion Boats, Correct Craft) or existing boats can be retrofitted with expandable, portable ballast tanks (*e.g.*, BoardStop). Normally, these tanks are filled and emptied with the same source water.

Comments submitted in response to EPA's ANPRM indicate that clean ballast discharge is relevant to several different types of vessels. LMC, WSC, and CMC all specifically cited clean ballast as their discharge. In their comment, American Waterway Operators stated that their towing vessels are ballasted for stability and trim and that a large number of their towing vessels are only ballasted with water from municipal or commercial sources, except in emergencies. They also stated that tank barges are purposely ballasted for a variety of reasons, including to maintain proper trim during loading and unloading

¹⁸ These comments included EPA-HQ-OW-2007-0483-0619 (AWO), EPA-HQ-OW-2007-0483-1168 (PSPA), EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

operations, to improve tow configurations, and to permit passage underneath obstructions such as bridges. However, tank barges taking up ballast while at sea for trim purposes is very rare and, when this must occur, the ballast taken onboard is kept to a minimum. Because the crew of a tank barge must transit from the tugboat to the barge to perform ballasting or deballasting operations, operators will retain ballast onboard whenever feasible. If there is an emergency, the operator will only release enough ballast to continue with safe operations.

PSPA cited ballast water as a relevant discharge for the vessels they represent, but it was not specified that clean ballast tanks were used.

When and Where Discharge Occurs

Armed Forces vessels cannot discharge ballast water within 12 nmi of shore and must perform at least two exchanges prior to entering the 12 nmi zone.

AWO commented that ballasting and deballasting operations on their towing vessels are conducted during major shipyard maintenance and to replace spent fuel (which is stored in separate tanks) to retain vessel stability. They also stated that coastal tugboats discharge their ballast water outside the demarcation line¹⁹ whenever possible or retained it onboard for disposal at a shore-side facility. For their tank vessels, AWO stated that ballast is frequently taken on and discharged in the same location.

CLIA also cited ballast water as a relevant discharge for the vessels they represent, although they do not specify whether the ballast tanks are ‘clean’. They stated that ballast water is discharged as needed to ensure the safety of the ship, which, typically, is several times per week.

Discharge Rates, Concentrations, and Constituents

Ballast water discharged from clean ballast tanks may contain marine organisms as well as material from inside the tank, piping, or other machinery. Ballast tanks filled via the firemain may contain residue from the firemain pipes. The actual materials and contents used in civilian ballast tanks will vary. Some possible constituents may include rust inhibitors, flocculant compounds, epoxy coating materials, zinc or aluminum (from anodes), iron, nickel, copper, bronze, and silver. Accumulated sediments from the bottom of the tank may also be discharged.

The discharge rate and constituent concentrations of clean ballast water from civilian vessels will vary by vessel type, ballast tank capacity, and type of deballasting equipment. According to a study published by the Bluewater Network (Maddison, 2006), typical cruise ships have a ballast capacity of approximately 1,000 metric tons and have a ballast discharge rate of between 250-300 metric tons per hour. The Prince William Sound Regional Citizens’ Advisory Council estimates that oil tankers can carry between

5.1.6 Compensated Fuel Ballast

The information on compensated fuel ballast was obtained from EPA (1999g).

Discharge Summary

Some vessels have a series of connected ballast tanks that store fuel and, as the fuel is consumed, water is introduced to the same tanks via the firemain to ‘compensate’ for the lost weight of the spent fuel. The water fills in the spaces vacated by the fuel. Then, as the vessel is refueled, the fuel, being denser, ‘pushes’ the ambient water back through the tanks. At the end is an overflow/ expansion tank with an overboard discharge pipe; this expansion tank always contains ambient water and prevents fuel from being accidentally discharged into open waters if the fuel tanks are overfilled. Compensated fuel ballast tanks are only completely emptied during maintenance activities.

¹⁹ This ‘demarcation line’ is not further defined in the comment.

It is notable that none of the commentors that listed the relevant discharges for their vessel types cited compensated fuel ballast.

When and Where Discharge Occurs

Discharge of compensated fuel ballast water may occur through the overflow/expansion tank during refueling, which can occur while the vessel is at port or at sea. For Armed Forces vessels, at sea refueling occurs only outside the 12 nmi limit. Civilian vessels may have different refueling policies.

Discharge Rates, Concentrations, and Constituents

Studies on Armed Forces vessels have detected oil in compensated fuel ballast discharge in concentrations ranging from below detection level to 370 milligrams per liter (mg/L). Other research has tested discharges for a suite of parameters and discovered copper, nickel, silver, thallium, zinc, benzene, phenol, and toluene were present in measurable amounts. Mercury, total petroleum hydrocarbons (TPH), and hexane extractable material (HEM) (which corresponds to the amount of oil and grease present) were also detected. Research conducted by EPA and DoD determined that several constituents detected in compensated fuel ballast exceeded the most stringent state water quality standards: ammonia, nitrate/nitrite, HEM, total phosphorus, mercury, copper, nickel, silver, thallium, zinc, 2-propenal, and benzene. According to EPA (1999g), invasive species are not likely to be introduced during refueling operations.

For Armed Forces vessels, compensated fuel ballast is discharged at a rate of up to 400 gallons per minute (gpm) per ballast tank group (maximum of 2,400 gpm per vessel) during at port refueling operations, which take place approximately twice a year. Civilian vessels with compensated ballast tanks will have a variety of discharge rates, dependant on vessel size and type.

5.1.7 Controllable Pitch Propeller Hydraulic Fluid

The information on controllable pitch propeller hydraulic fluid was obtained from EPA (1999h) and two comments²⁰ on EPA's ANPRM.

Discharge Summary

Controllable pitch propellers (CPPs) are variably-pitched propeller blades that can change the speed or direction of a vessel without requiring the vessel's main propulsion system to change speed or direction. Hydraulic control oil is provided to each CPP hub, which is surrounded by seals meant to keep the oil from coming into contact with the surrounding water. Many civilian ocean-going vessels may use CPP technology.

Two commenter's on EPA's ANPRM cited controllable pitch propeller hydraulic fluid as a relevant discharge for the vessels they represent.

When and Where Discharge Occurs

Hydraulic oil can leak past the CPP's protective seals (if they are worn or defective). These leaks can occur at any time, while the vessel is at port or underway in open water, although they are more likely while the vessel is underway since the seals are under higher pressure. Regular maintenance activities on the CPP system, which can occur portside, can also cause oil discharge.

In their comment, CMC stated that controllable pitch propeller maintenance activities on the vessels they represent is typically done while the vessel is in dry-dock. When dry-docking is not an option, then maintenance will occur pierside.

²⁰ These comments included: EPA-HQ-OW-2007-0483-1248 (CMC) and EPA-HQ-OW-2007-0483-1498 (WSC).

Discharge Rates, Concentrations, and Constituents

Constituents of the hydraulic oil will vary by manufacturer. Other potential discharge constituents include copper, tin, aluminum, nickel, and lead from the piping, hub, and propeller.

Oil leaks from around defective or worn seals are believed to be negligible. During maintenance activities, small amounts of oil may be discharged. EPA (1999h) estimates that approximately 20 ounces of oil may be released for every CPP blade that is replaced (the Armed Forces estimates there are about 30 blade replacements annually). When the blade replacement includes removal of the blade port cover (during about seven of the 30 instances), a worst case scenario of five gallons of oil may be discharged.

5.1.8 Deck Runoff

The information on deck runoff was obtained from EPA (1999i) and six comments²¹ on EPA's ANPRM.

Discharge Summary

The majority of vessel deck runoff is attributable to precipitation, although deck washdowns and green water washover can also contribute. All vessels, regardless of size or type, discharge some amount of deck runoff.

Comments submitted in response to EPA's ANPRM by WSC, LMC, and CMC cited deck runoff as a relevant discharge from the vessels they represent. In their comment, CLIA stated that deck runoff from the vessels they represent may include detergent or soap residue left behind from deck or window cleaning. Deck runoff discharge will occur upon a rain event or during weekly (or more frequently, as needed) deck washdowns. AWO stated that, on their towing vessels, rain water is allowed to freely and quickly run off the decks. Accumulated water on decks can create problems for vessel stability and make deck surfaces slippery, compromising the safety of the crew. Tank barges also generate deck runoff, although AWO's comment states that an increasing number of tank barges are being fitted with perimeter spill rails and/or drip pans. These technologies are further described in Section 6.6. Finally, the same commentator stated that deck and hopper barges also generate deck runoff and rain water that collects in open, but contained areas²² is pumped periodically into waterways. AWO also listed wash water as a separate discharge on their towing vessels. According to the comment, towing vessels periodically have their topsides washed down with potable water (or clean ambient water) and biodegradable and phosphate-free detergent.

PSPA listed rain, snow, ice, waves, water from fishing gear brought onboard, and deck washdown water as the types of deck runoff that may be relevant to the vessels they represent.

When and Where Discharge Occurs

Precipitation can occur anywhere at anytime and will instigate deck runoff (unless it is otherwise contained). Green water washover can happen virtually anywhere to smaller vessels, whereas larger vessels may only experience deck washover while at sea or during extreme weather conditions. Deck washdowns are typically done while the vessel is at port or otherwise stationary.

According to their comment on EPA's ANPRM, the frequency of AWO water wash discharges vary greatly by vessel size and service.

²¹ These comments included EPA-HQ-OW-2007-0483-0619 (AWO), EPA-HQ-OW-2007-0483-1168 (PSPA), EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

²² The comment did not further specify what these 'open, but contained areas' were.

Discharge Rates, Concentrations, and Constituents

Vessel decks can accumulate a variety of residues originating from various on-deck activities. Topside machinery and refueling operations may contribute oil and grease to the deck, while general debris (*e.g.*, paper, wire, garbage) can also be washed overboard if left unsecured. Spilled oil cargo may be present on the decks of some oilers in the Armed Forces. Residue from cleaners and detergents used to wash the deck may be present in runoff, as can soot particles (from fuel burning) and AFFF remnants. The specific constituents will vary.

Discharge rates for deck runoff vary from vessel to vessel and will depend on the weather as well as the frequency of deck washdowns. EPA (1999i) developed a formula to estimate the amount of annual precipitation-caused deck runoff from Armed Forces vessels which takes into account the deck surface area, annual precipitation, and the number of days a vessel is within 12 nmi of shore. This formula may be useful for determining reliable deck runoff rates for vessel vacatur purposes; however, the wide variety of formula inputs that would be required may not make using the formula realistic.

5.1.9 Dirty Ballast

The information on dirty ballast was obtained from EPA (1999j).

Discharge Summary

Dirty ballast tanks are similar to compensated fuel ballast tanks in that the ballast water can come into contact with the vessel's fuel. Unlike compensated fuel ballast, however, dirty ballast is water that is pumped from outside the vessel directly into the same tank that once held fuel, once that fuel was spent and space is available. When discharged, the dirty ballast water may contain fuel residuals and similar constituents.

It is notable that none of the commentors that listed the relevant discharges for their vessel types cited dirty ballast.

When and Where Discharge Occurs

The policy of the few Armed Forces vessels that still maintain dirty ballast systems is to not discharge the dirty ballast water within 12 nmi of shore.

Discharge Rates, Concentrations, and Constituents

According to EPA (1999j), dirty ballast water constituents are similar to those found in compensated fuel ballast water.

5.1.10 Distillation and Reverse Osmosis Brine

The information on distillation and reverse osmosis brine was obtained from EPA (1999k) and four comments²³ on EPA's ANPRM.

Discharge Summary

Some vessels have onboard plants that distill seawater into fresh, potable water or high-purity feedwater. The remnants of the distillation process, which can include brine and any residue or constituents from the distillation plant itself is typically discharged overboard. Condensate is also produced during the distillation process, but this is usually either reused in the boiler system or is collected as non-oil machinery wastewater. Anti-scaling treatments as well as acidic cleaning compounds may also be injected into the distillation system. Plants that utilize reverse osmosis (RO) produce water of lesser purity than distillation, but generate discharges without anti-scaling or cleaning compounds.

²³ These comments included: EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HW-OW-2007-0438-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

CLIA, LMC, WSC, and CMC all cited distillation and RO brine as a relevant discharge from the vessels they represent. CMC also stated that distillation systems are installed on most commercial vessels.

When and Where Discharge Occurs

Distilling plants on steam-propelled vessels operate whenever the vessel's boilers are operating; therefore, distillation and RO brine discharge can occur at any time while the vessel is underway or at port. According to EPA (1999k), gas- or diesel-powered Armed Forces vessels rarely operate their distillation or RO plants within 12 nmi of shore. However, civilian vessels equipped with these systems have the potential to operate them anywhere.

Discharge Rates, Concentrations, and Constituents

Onboard distillation and RO systems discharge brine, which is essentially concentrated seawater and possessive of the same properties and constituents of seawater, including dissolved and suspended solids and metals. Distillation plants are manufactured of metal that can be corroded by seawater, particularly at the elevated temperatures at which these plants are operated; in Armed Forces vessels, this corrosion process could introduce such constituents as copper, chromium, nickel, and zinc to the brine. Plants found on civilian vessels may be constructed of various materials that may leach into brine prior to discharge. RO plants are not operated at high temperatures and are not expected to release corrosive materials to brine. Constituents of anti-scaling compounds utilized by civilian vessels will vary by manufacturer, although the Armed Forces compounds consist of such materials as polyacrylates and anti-foaming additives. EPA and DoD conducted effluent sampling on a collection of Armed Forces vessels and detected that the following constituents (along with copper, nickel, and zinc) exceeded the most stringent water quality standards: iron, lead, total nitrogen, and total phosphorus. These materials may or may not be present in the discharge from civilian vessels. The brine mixture will also be warmer than ambient temperatures, constituting a thermal discharge. Thermal plume modeling (EPA, 1999k) indicated that discharge temperatures may reach a maximum of 120°F and, in the two states used in the model (Washington and Virginia), the discharge did not exceed thermal mixing zone standards.

5.1.11 Elevator Pit Effluent

The information on elevator pit effluent was obtained from EPA (1999l) and one comment²⁴ on EPA's ANPRM.

Discharge Summary

Large vessels with multiple decks are equipped with elevators to facilitate the transportation of maintenance equipment, people, and cargo between decks. Some vessels may have multiple elevators utilized for various purposes. Only elevators that are operated within a shaft will have a pit at the bottom, along with a sump to collect materials and liquids that may find their way into the shaft. Much of what ends up in the elevator pit and sump is deck runoff along with residue and materials used in elevator maintenance and repair. On Armed Forces vessels, waste that accumulates in elevator pits is removed by gravity draining, by educting overboard using the firemain, by using a vacuum or sponges to transfer the waste for treatment as bilge water or graywater, or by containerizing it for shore disposal. On Armed Forces vessels, direct, untreated overboard discharge of elevator pit effluent is rare and, if necessary, typically occurs more than 50 nmi from shore and only if the effluent is non-oily.

The comment on EPA's ANPRM from WSC simply listed elevator pit effluent as a discharge relevant to the vessels they represent.

²⁴ This comment was EPA-HQ-OW-2007-0438-1498 (WSC).

When and Where Discharge Occurs

While the Armed Forces does not discharge elevator pit effluent within 12 nmi of shore, civilian vessels may empty their pits at anytime while underway or pier-side.

Discharge Rates, Concentrations, and Constituents

Elevator pit discharge will have constituents similar to those found in deck runoff and firemain water. On Armed Forces vessels, elevator maintenance and repair residues may include lubricants, cleaning solvents, soot, and paint chips. Tests conducted by EPA and DoD discovered that some detected constituents from elevator pit effluent exceeded the most stringent state water quality standards, including total nitrogen, bis(2-ethylhexyl) phthalate, copper, iron, and nickel, all of which are present in deck runoff and firemain water.

Determining the rates and concentrations of elevator pit effluent discharge is difficult given the variety of types and sizes of Armed Forces and civilian vessels as well as the differences in the elevator maintenance frequency.

5.1.12 Firemain Systems

The information on firemain systems was obtained from EPA (1999m) and four comments²⁵ on EPA's ANPRM.

Discharge Summary

Most vessels have some sort of fire fighting system, whether this consists of individual fire extinguishers, as may be found on smaller, recreational vessels, or built-in water- and foam-distribution systems, which are more practical on larger vessels. For this latter category, a firemain system uses a sea chest to pump ambient water into the vessel, which can then be distributed via fire hose stations, sprinkler systems, or AFFF distribution stations. Firemain systems can be 'wet' (*i.e.*, water is pressurized and is available on demand) or 'dry' (*i.e.*, water is unpressurized and not available on demand). Besides fire fighting activities, the firemain system can be used for what EPA (1999m) terms 'secondary services', which include deck and equipment washdowns, machinery cooling water, and ballast tank filling. Other activities may require firemain usage on civilian vessels. This section describes only firemain water that is discharged directly overboard during maintenance and inspection activities. Discharges that contain firemain water from secondary services are described in their respective sections.

Comments on EPA's ANPRM from LMC and WSC cited firemain discharges as a relevant discharge from the vessels they represent. In their comments, CLIA stated that firemain discharges take place during anchor chain washdowns, firemain testing, and various maintenance and training activities. CMC stated that all of the vessels they represent are equipped with firemain systems.

When and Where Discharge Occurs

On Armed Forces vessels, firemain water is discharged directly overboard during testing and maintenance, inspections, training activities, and anchor chain washdown. If water demand is low, the firemain system may also produce bypass discharges to prevent the pumps from overheating. Civilian vessels may have other activities that cause the firemain to discharge water directly overboard. Other vessel discharges may contain firemain water (*e.g.*, ballast discharges, AFFF, chain locker effluent, elevator pit effluent, deck runoff, etc.), but these are discussed in their respective sections.

For Armed Forces vessels, the discharge of water from the firemain system directly overboard typically occurs at any time and any place and whenever maintenance, repair, testing, inspection, or training

²⁵ These comments included: EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0438-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

activities are occurring. Civilian firemain discharge will occur at a variety of frequencies and locations, dependent on the demands of the particular vessel and crew.

CMC stated in their comments that while firemain system discharges may occur both within and beyond 12 nmi from land, typical operating policies mandate that testing of the system take place only beyond 12 nm.

Discharge Rates, Concentrations, and Constituents

Firemain water contains a variety of constituents. The firemain pipes found on most Armed Forces vessels are constructed of copper, zinc, and nickel, which can be eroded from the system due to high fluid velocity or abrasive materials being caught in the flow. Other constituents can include aluminum, tin, silver, iron, titanium, and chromium, which can erode from sections of the firemain pumps, valves, and sea chests. The firemain systems, and therefore the discharges, on civilian vessels may not contain these materials. EPA (1999m) found that (aside from copper, iron, and nickel) bis(2-ethylhexyl) phthalate, nitrate/nitrite, and total nitrogen were the constituents that exceeded the most stringent water quality standards. Thermal discharge is a risk with Armed Forces firemain systems used for cooling systems. Due to the short residence times of water in most firemain systems, NIS introductions are a minimum risk.

Firemain types, configurations, and sizes can vary from vessel to vessel, a fact that is true for Armed Forces as well as civilian vessels. The frequency of use also has bearing on the discharge rate. EPA (1999m) estimated that firemain systems on USCG vessels are operated an average of 5 minutes a week per pump (the USCG is obligated to have at least two pumps per vessel). However, the actual discharge rate varies by the flow rate of the pumps, the number of days the vessel is in use, etc. Civilian vessels will have an entirely different set of variables to consider when determining rate and concentration values. Additionally, the actual type of firemain system has bearing on discharge amounts because continuously discharging wet firemain systems will produce more discharge than dry firemain systems.

5.1.13 Freshwater Layup

The information on freshwater layup was obtained from EPA (1999n) and two comments²⁶ to EPA's ANPRM.

Discharge Summary

Seawater cooling systems serve to condense low pressure steam from propulsion plant or generator turbines on some vessels. When a vessel is at port or pierside for an extended period of time, the cooling systems are not circulated, risking the accumulation of biological growth and reduced system efficiency. The freshwater layup process includes removing all seawater from the condensers (using pressurized air) and filling the condensers with potable water, where it remains stagnant for two hours before being blown overboard, again using pressurized air. Following this flushing process, the condensers are again filled with potable water, which remains in the condensers for 21 days before being blown overboard. Following this step, the condensers are filled with potable water and emptied on a 30-day cycle until the vessel returns to normal operations.

Civilian vessels with a seawater cooling system will require freshwater layup cycles if they are not operated for an extended period. CMC stated in their comments that some of their vessels need to be periodically laid up. WSC included freshwater layup as one of the discharges relevant to the vessels they represent.

²⁶ These comments included EPA-HQ-OW-2007-0483-1248 (CMC) and EPA-HQ-OW-2007-0483-1498 (WSC).

When and Where Discharge Occurs

When a vessel is pierside or in port for more than three days, the main steam plant is shut down, the condensers are not circulating, and a freshwater layup cycle is required. This discharge will only occur while the vessel is in port.

Discharge Rates, Concentrations, and Constituents

Freshwater layup discharge will include the constituents of the potable water along with residual seawater and any residue that has leached from the condenser while the water is being held. Potable water may contain disinfectants like chlorine or chloramine.

5.1.14 Gas Turbine Water Wash

The information on gas turbine water wash was obtained from EPA (1999o) and one comment²⁷ on EPA's ANPRM.

Discharge Summary

On some vessels, gas turbines are used for propulsion and electricity generation. To maintain efficiency, the turbines must occasionally be washed down of the byproducts that can accumulate, including salt, lubricants, and combustion residuals. On Armed Forces vessels, a cleaning compound is added to the freshwater washdown, although civilian vessel water wash may contain different constituents. Water wash discharge may be channeled to a dedicated holding tank for onshore disposal (in which case no overboard discharge occurs), or the water may become a component of deck runoff, welldeck discharge, or bilge water.

CLIA was the only commentator that cited gas turbine water wash as a relevant discharge to the vessels they represent. However, they stated that not every one of their vessels was equipped to produce this discharge, and, of the ones that are so equipped, this discharge is a rare occurrence.

When and Where Discharge Occurs

The location and frequency of gas turbine water wash discharge will vary according to where the used water wash is channeled.

Discharge Rates, Concentrations, and Constituents

Gas turbine water wash discharge will contain constituents of the particular cleaning solvent added to the fresh water, which will vary according to manufacturer. The Navy utilizes gas path cleaner which may include naphthalene and other hydrocarbon compounds. EPA and DoD found that naphthalene exceeded the most stringent state water quality standards. The constituents of cleaners used by civilian vessels will vary by manufacturer.

Rates and concentrations of gas turbine water wash discharge vary according to the frequency of washdown. Most Armed Forces vessels have washdowns at least once every 48 hours of operation and EPA and DoD estimated that approximately 122 gallons of wash is generated for every turbine washed. The gas turbine wash practices for civilian vessels will likely differ.

5.1.15 Grey Water

The information on grey water was obtained from EPA (1999p) and six comments²⁸ on EPA's ANPRM.

²⁷ This comment was EPA-HQ-OW-2007-0483-1494 (CLIA).

²⁸ These comments included EPA-HQ-OW-2007-0483-0619 (AWO), EPA-HQ-OW-2007-0483-1168 (PSPA), EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

Discharge Summary

Grey water is non-sewage wastewater, including water from showers, baths, sinks, and laundry facilities. Vessels may collect and store grey water discharge for later disposal or may continuously discharge it. Grey water discharges occur in any vessel equipped with a kitchen or a bathroom, which can include a large scope of vessels from recreational boats to large cruise ships. Since grey water may contain fecal coliform, Armed Forces vessels frequently treat it as black water.

LMC, WSC, PSPA, and CMC all cited grey water (without further comment) as a relevant discharge from the vessels they represent. AWO stated that the amount of grey water generated and discharged from a towing vessel varies with respect to crew numbers and habits. They stated that grey water from the laundry, shower, and kitchen is released directly overboard from towing vessels on a daily basis, although the detergents and cleaners used onboard these vessels are biodegradable and phosphate-free.

When and Where Discharge Occurs

Most Armed Forces vessels without a holding tank discharge grey water outside of 3 nmi from shore. However, grey water can be discharged while pierside if the vessel is not equipped with an alternative collection system. Civilian grey water discharge practices will vary.

In their comment, CLIA stated that grey water was either discharged untreated from their vessels while underway or it was treated as part of an Advanced Wastewater Purification System. No further description of this system was provided.

Discharge Rates, Concentrations, and Constituents

Grey water discharges can contain a variety of constituents, including bacteria, pathogens, oil and grease, detergent and soap residue, metals (cadmium, chromium, lead, copper, zinc, silver, nickel, mercury), solids, and nutrients. Of these constituents, sampling conducted by EPA and DoD found that ammonia, copper, lead, mercury, nickel, silver, and zinc exceeded the most stringent state water quality standards. The constituents found in civilian vessel grey water is likely to be similar.

The volume of grey water generated by a vessel is dependent on the number of passengers and crew. It is estimated that 30 – 85 gallons of grey water is generated per person per day (Copeland, 2007). Vessels that carry a large number of passengers, such as cruise ships, generate a large volume of grey water, which can be 90-95% of all the liquid waste onboard. Large cruise ships can carry thousands of passengers. For example, Royal Caribbean's ship, Vision of the Seas, can carry 3,200 passengers and crew generating an estimated volume of 96,000 to 272,000 gallons of grey water per day (Alaska DEC, 2007).

According to EPA (1999p), Navy designers use a generation standard of 30 gallons per person per day when constructing grey water collection systems. A Bluewater Network report (Schmidt, 2000) stated that, on an average one-week journey, a typical cruise ship with 3,000 passengers and crew generates an estimated 1,000,000 gallons of grey water.

The Alaska Cruise Ship Initiative (ASCI) was a federal, state, and local collaborative effort to identify, characterize, and manage waste streams from cruise ships plying Alaskan waters. Sampling of large cruise ships indicated that the sanitation devices onboard these vessels did not operate effectively. While the USCG mandates that the type of sanitation devices installed on these cruise ships must discharge effluent of no more than 200 fecal coliforms per 100 mL, sampling results from 2000 showed that the effluent coming from grey water discharges had concentrations as high as 32 million fecal coliform per 100 mL. Surprisingly, the fecal coliform concentration in grey water was twice as high as that detected in sewage effluent (black water).

5.1.16 Hull Coating Leachate

The information on hull coating leachate was obtained from EPA (1999q) and four comments²⁹ on the EPA's ANPRM.

Discharge Summary

The hulls of some vessels may be covered with anticorrosive and antifouling coatings to prevent rust and marine growth, respectively. The antifouling coating is applied over the anticorrosive coating and the latter should not leach into the receiving water, provided the antifouling coating is intact. Only vessels that have had their hulls coated in antifouling material are included as contributors to this discharge.

Comments from WSC and LMC on EPA's ANPRM cited (without further comment) hull coating leachate as a relevant discharge from the vessels they represent. CLIA also cited hull coating leachate, although they stated that not every one of their vessels generated this discharge. CMC stated that all of the vessels they represent use antifouling compounds on their hulls.

When and Where Discharge Occurs

Hull antifouling coatings will continuously leach into receiving waters whenever the vessel is in water.

Discharge Rates, Concentrations, and Constituents

Armed Forces vessels use very specific types of antifouling coatings which may not have the same constituents as the coatings applied to civilian vessels. However, most vessels use copper- or zinc-based antifouling coatings and these metals may leach into receiving waters.

Although it is no longer found on Armed Forces vessels, some civilian vessels may have tributyltin (TBT)-based antifouling hull coatings. While an effective preventative of invasive species introductions, TBT is extremely toxic to marine life.

A Navy study (Navy Research and Development Division, 1997) cited in the UNDS report tested copper antifouling paint leaching rates for stationery and underway Naval vessels. The long-term average release rates for a vessel cruising at 17 knots were 17 micrograms per square centimeter per day ($\mu\text{g}/\text{cm}^2/\text{day}$) for copper and 6.7 $\mu\text{g}/\text{cm}^2/\text{day}$ for zinc. When the vessel was stationery, the leaching rates were 8.9 and 3.6, respectively. EPA (1999q) determined that copper leachate from antifouling hull coatings was a significant contributor to total copper levels in several specific Naval ports, with, for example, localized areas around vessels in San Diego Harbor exhibiting twice the average ambient copper concentration of 3.7 $\mu\text{g}/\text{L}$.

Recent civilian research (Schiff *et al.*, 2003) on fiberglass hulls with copper-based coating indicated that passive leaching rates (*i.e.*, when the vessel was stationary and had not been recently cleaned) of copper were between 3.7 to 4.3 $\mu\text{g}/\text{cm}^2/\text{day}$. If the hull had been cleaned within one day of sampling, the leaching rates were between 15 and 18 $\mu\text{g}/\text{cm}^2/\text{day}$, with these rates decreasing with each day removed from the cleaning activity. While the copper leaching rate was higher around cleaning activities, the researchers found that only 4-7% of monthly copper emissions were attributable to cleaning. The remaining 93-96% of monthly emissions were from passive leaching. These rates were extrapolated to typical recreational vessels: a 9.1m (~30 foot) motorboat that is cleaned once a month (using the best management practices described in Section 6.20) contributes from 22 to 26 grams of dissolved copper per month to the surrounding waters.

²⁹ These comments included EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

5.1.17 Motor Gasoline Compensating Discharge

The information on motor gasoline compensating discharge was obtained from EPA (1999r).

Discharge Summary

Motor gasoline (MOGAS) is gasoline used as fuel, identical to that which is put into automobiles. Some vessels may transport MOGAS-powered vehicles, equipment, or machinery which may be brought onboard fully loaded with MOGAS. MOGAS may also be transported in drums or other containers or stored in the vessel's permanent ambient water compensating tanks, if present. When a vessel with built-in MOGAS tanks gets overhauled, it must empty its tanks to pierside trucks, transit 50 nmi offshore and perform three tank exchanges of ambient water before filling up the tanks completely for the transit back to shore. When the MOGAS is reloaded to the vessel, the ambient water that was in the tanks is discharged.

It is notable that none of the commentors that listed the relevant discharges for their vessel types cited MOGAS.

When and Where Discharge Occurs

Armed Forces vessels with MOGAS tanks are overhauled prior to redeployment, which occurs about once annually. Civilian vessels with MOGAS tanks may have a different timetable. The compensating ambient water is discharged directly overboard as the vessel's tanks are refilled pierside.

Discharge Rates, Concentrations, and Constituents

The discharged ambient water may contain traces of gasoline constituents, which vary depending on the specific manufacturer. Generally, gasoline will contain alkanes, alkenes, aromatics, metals, and additives. A 1992 study cited in EPA (1999r) detected a variety of compounds in gasoline, including benzene, toluene, ethylbenzene, phenol, and naphthalene.

MOGAS compensating ambient water is discharged at the same rate at which the fuel trucks refill the tanks. EPA (1999r) estimated this rate at 50 gpm or less, although the actual rate for civilian vessels will vary according to vessel and fuel supplier.

The concentration of MOGAS constituents will also vary according to manufacturer, although EPA (1999r) estimated the concentrations of various constituents in MOGAS compensating discharge. Based on the most stringent state standards, benzene, toluene, ethylbenzene, phenol, and naphthalene exceeded water quality criteria.

5.1.18 Non-Oily Machinery Wastewater

The information on non-oily machinery wastewater was obtained from EPA (1999s) and four comments³⁰ on EPA's ANPRM.

Discharge Summary

Non-oily machinery wastewater systems are meant to separate machine-generated wastewater that must go to the bilge compartment (*i.e.*, that has an oil content) from the wastewater that can be collected in tanks before being discharged directly overboard (*i.e.*, that has no oil content). Vessels can have numerous sources of non-oily machinery wastewater, including (among others) distilling plants start-up discharge, chilled water condensate drains, fresh and saltwater pump drains, potable water tank overflows, and leaks from propulsion shaft seals. However, the major source is desalination distillation

³⁰ These comments included EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

plant discharge which occurs after the start-up of the distillation system and before the desired level of salinity has been achieved, when the discharge ends.

Comments from WSC, LMC, and CMC on EPA's ANPRM cited (without further comment) non-oily machinery wastewater as a relevant discharge from the vessels they represent. CLIA also cited scrubber wash water (*i.e.*, seawater used to rinse scrubbers) as a discharge which falls into the non-oily machinery wastewater category, but that only one of their vessels generated this discharge. They also stated that the scrubber wash water was discharged directly overboard after scrubbing operations.

When and Where Discharge Occurs

Non-oily machinery wastewater discharge can occur continuously for machinery located above deck. Wastewater from machinery located below deck must be held in tanks and is pumped overboard intermittently. Since there is no oil present, the wastewater may be discharged anywhere.

CLIA stated that their scrubber wash water was discharged within 12 nmi of land.

Discharge Rates, Concentrations, and Constituents

Constituents of non-oily machinery wastewater discharge include a suite of classical pollutants, metals, and organics. Many of the specific constituents examined in EPA (1999s) exceeded the water quality standards of the most stringent U.S. state, including copper, nickel, silver, zinc and a collection of nutrients. Mercury was also detected, but concentrations did not exceed the most stringent water quality standards.

Non-oily machinery wastewater discharge flow rates vary by vessel size and operation type. EPA (1999s) estimated discharge rates from distillation plant start-up to range from 100 gallons per hour (gph) to over 4,000 gph, depending on the size of the plant. These rates are not entirely applicable to the vessels that will be covered under the vacatur, but the rate variability is instructive. EPA (1999s) did not provide rates or concentrations for overall non-oily machinery wastewater discharge.

5.1.19 Photographic Laboratory Drains

The information on photographic laboratory drains was obtained from EPA (1999t).

Discharge Summary

When a vessel has the capability to develop photographs onboard, there is accumulated waste associated with the developing process. Given the recent move toward digital photography, however, it is expected that many civilian vessels that once had the ability to process photographs will now do so digitally and, therefore, without waste. In the case that a vessel will retain its ability to manually process photographs, the amount of accumulated waste is expected to be small enough to be held onboard for onshore disposal.

It is notable that none of the commentators that listed the relevant discharges for their vessel types cited photographic laboratory drain discharge.

When and Where Discharge Occurs

Navy guidance prohibits the discharge of photographic laboratory drains within 12 nmi from of shore and mandates the containerization of all discharge for onshore disposal. Despite the allowance of such disposal beyond the 12 nmi limit, most vessels containerize all photographic laboratory drain contents for onshore disposal. If the drains are discharged further than 12 nmi from land, additional treatments must be employed. Fixer solution must pass through a silver recovery unit prior to overboard discharge and black-and-white and x-ray effluent must pass through the ship's blackwater collection, holding, and transfer system. Civilian vessels may have different policies for this discharge.

Discharge Rates, Concentrations, and Constituents

Photographic laboratory drains may contain constituents found in developing solutions, fixers, and rinse water (e.g., silver). EPA (1999t) provides an extensive table listing some of the potential constituents of commonly used photographic laboratory solutions.

5.1.20 Refrigeration/Air Conditioning Condensate Discharge

The information on refrigeration/air conditioning condensate was obtained from EPA (1999u) and five comments³¹ on EPA's ANPRM.

Discharge Summary

Condensation forms when warm air comes into contact with the cold refrigeration or evaporator coils of an air conditioning system or refrigeration unit on a vessel. The condensation drips from the coils and collects in drip troughs which typically channel to a drainage system. On Armed Forces vessels, condensate that is collected above the vessel's waterline is immediately discharged overboard while condensate collected below the waterline is held onboard for a period of time before being discharged overboard. Some vessels may channel condensate in the drain to other areas, such as the bilge tank or the sewage system tanks, for temporary holding until those tanks can be disposed of onshore or discharged overboard according to the relevant regulations. Refrigeration and air conditioning systems on Armed Forces vessels typically have coils constructed of copper.

In the ANPRM comments, PSPA, CMC, WSC, CLIA, and AWO all cited refrigeration/air conditioning condensate as discharges that were relevant to their particular types of civilian vessels. AWO stated in their comments that all their towing vessels are equipped with continuously running refrigeration units and air conditioners which drain very small amounts of condensation directly overboard.

When and Where Discharge Occurs

Refrigeration/air conditioning condensate can be discharged wherever and whenever these systems are in operation.

Discharge Rates, Concentrations, and Constituents

This discharge may contain metals from the refrigeration/air conditioning coils and drainage systems, including aluminum, bronze, copper, iron, lead, nickel, silver, tin, and zinc. Traces of mild detergent may also be found in this discharge from the cleaning of refrigerated spaces, as can seawater (used to defrost some cargo spaces) and freshwater (used to flush residual seawater from these cargo spaces).

5.1.21 Rudder Bearing Lubrication Discharge

The information on rudder bearing lubrication was obtained from EPA (1999v) and three comments³² on EPA's ANPRM.

Discharge Summary

Rudder bearings allow a vessel's rudder to turn freely and, on Armed Forces vessels, rudder bearings can be either grease-, oil-, or water-lubricated. Grease-lubricated rudder bearings on Armed Forces vessels discharge grease directly to the bilge tank while oil-lubricated bearings are kept at a slightly positive pressure in relation to the outside ambient water pressure and will only discharge into the surrounding water if a leak occurs around the rudder mechanism. Many vessels install hull seals where the rudder penetrated the hull to prevent the type of leaks that could lead to oil discharges.

³¹ These comments included EPA-HQ-OW-2007-0483-619 (AWO), EPA-HQ-OW-2007-0483-1168 (PSPA), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), EPA-HQ-OW-2007-0483-1498 (WSC).

³² These comments included EPA-HQ-OW-2007-0483-619 (AWO), EPA-HQ-OW-2007-0483-1248 (CMC), and EPA-HQ-OW-2007-0483-1498 (WSC).

Three commentors to the EPA's ANPRM cited rudder bearing lubrication discharge as relevant to their types of civilian vessels: CMC, WSC, and AWO.

When and Where Discharge Occurs

This discharge occurs primarily when the vessel is underway and the rudder is in use; turning the rudder can cause gaps in the hull seal. These gaps can become larger if the rudder is turned sharply or the vessel is moving at a high rate of speed. If oil-lubricated rudder bearings are present, leakage may occur at any time (even when the vessel is stationary) because the lubricant is slightly pressurized.

Discharge Rates, Concentrations, and Constituents

Depending on the type of rudder bearings in use, this discharge can cause oil or grease to be released into the water column. With a malfunctioning or failing seal, Armed Forces vessels can leak one gallon of oil per day while at sea or one pint per day while in port. This amount of oil does not exceed federal oil sheen standards or the most stringent state water quality criteria.

5.1.22 Seawater Cooling Overboard Discharge

The information on seawater cooling overboard discharge was obtained from EPA (1999w) and six comments³³ on EPA's ANPRM.

Discharge Summary

Seawater cooling systems onboard vessels use ambient water pumped in directly or through the firemain to absorb the heat from the propulsion system and auxiliary heat exchangers. This water is then discharged back overboard. Cooling water demand is continuous, particularly for larger vessels, and seawater spends approximately one minute in the cooling system before being discharged. Some vessels add seawater piping biofouling prevention chemicals to the cooling water to keep marine organisms from becoming established and clogging the system. Strainer plates are used to prevent clogging from larger material; the strainer plates must occasionally be cleared using low-pressure air or steam. Anything that had been caught on these plates would also be considered a discharge.

In their comments on EPA's ANPRM, LMC, WSC and CMC all cited seawater cooling overboard discharge as relevant discharges from the vessels they represent. PSPA's comments also listed cooling activities as producing discharge, but, along with engine cooling water, they also listed (without further comment) hydraulic system cooling water, refrigeration cooling water, and processing factory cooling water as relevant discharges. CLIA also cited engine cooling water as a relevant discharge that originates from all the vessels they represent and that this discharge occurs continuously. AWO stated that their towing vessels produced this discharge on a continuous basis.

When and Where Discharge Occurs

Seawater cooling systems are used both while vessels are pierside and while they are underway.

Discharge Rates, Concentrations, and Constituents

The potential constituents of seawater cooling overboard discharge include entrained or dissolved materials from the system itself. Although the specific constituents will vary depending on the vessel and the type of cooling system, EPA (1999w) identified copper, iron, aluminum, zinc, nickel, tin, titanium, arsenic, manganese, chromium, lead, and oil and grease as possible contents of the discharge. Mud, biota, and other debris that were stuck to the strainer plates may also be discharged. The seawater is also being discharged at a higher temperature than when it was taken up and constitutes a thermal discharge into the

³³ These comments included EPA-HQ-OW-2007-0483-619 (AWO), EPA-HQ-OW-2007-0483-1168 (PSPA), EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

receiving water. EPA (1999w) estimates that the thermal difference between seawater intake and discharge can range from 5 to 25°C, with a maximum discharge temperature of 140°C.

Seawater cooling discharge flow rates vary by vessel size and operation type. EPA (1999w) estimated rates ranging from 1,500 gpm for a pierside destroyer to over 170,000 gpm for an in-transit aircraft carrier. These rates are not entirely applicable to the vessels that will be covered under the vacatur, but the rate variability is instructive. Constituent concentrations will also be variable, depending on the residence time, the quality of the intake water, and the erosion and corrosion of cooling system components. However, EPA studies indicated that copper, nickel, and silver concentrations exceeded the most stringent state water quality standards.

5.1.23 Seawater Piping Biofouling Prevention

The information on seawater piping biofouling prevention was obtained from EPA (1999x) and three comments³⁴ on EPA's ANPRM.

Discharge Summary

Seawater cooling systems onboard vessels use ambient water pumped in directly or through the firemain to absorb the heat from the propulsion system and auxiliary heat exchangers. This water is then discharged back overboard. To prevent biofouling of the cooling system, low amounts of chlorinating substances are sometimes injected near the seawater intakes to kill any organisms that may have been sucked in.

In their comments on EPA's ANPRM, WSC cited (without further comment) seawater piping biofouling discharge as relevant to the vessels they represent. CLIA also cites this type of discharge, although they stated that only 13 of the vessels they represent are so equipped. Finally, CMC stated that most commercial vessels are equipped with seawater piping biofouling systems.

When and Where Discharge Occurs

Discharge will occur wherever and whenever a vessel equipped with biofouling prevention equipment is underway.

Discharge Rates, Concentrations, and Constituents

Seawater that has been discharged after being treated with chlorinating substances will contain free chlorine and reaction products (collectively called 'chlorine-produced oxidants'). These reaction products include chloride ions, chloramines, free bromine, and chloroorganics. EPA (1999x) provided estimates of discharge rates and concentrations for specific classes of Armed Forces vessels, but these estimates are not reproduced here.

5.1.24 Small Boat Engine Wet Exhaust

The information on small boat engine wet exhaust was obtained from EPA (1999y) and five comments³⁵ on EPA's ANPRM.

Discharge Summary

Smaller vessels take in ambient water to cool their engines and then discharge it back into the receiving waters. The water passes through the engine and some components of the exhaust transfer to the water before it is discharged as 'wet exhaust'. Both inboard and outboard engines have this type of cooling

³⁴ These comments included EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

³⁵ These comments included EPA-HQ-OW-2007-0483-619 (AWO), EPA-HQ-OW-2007-0483-1177 (LMC), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

system, although inboard engines discharge their wet exhaust above the water line while outboard engines discharge underwater. Inboard engines are usually powered by diesel while outboard engines run on gasoline.

In their comments on EPA's ANPRM, WSC, LMC, and AWO listed (without further comment) small engine wet exhaust as a relevant discharge from the vessels they represent. CLIA stated that the boat tenders that accompany their cruise ships generate this discharge, although only when in port which can be three to five days a week.

When and Where Discharge Occurs

This discharge can occur anywhere and will occur anytime an inboard or outboard engine is operating.

Discharge Rates, Concentrations, and Constituents

Research by EPA and DoD found that the constituents discharged by outboard engines differ from those discharged by inboard engines, due to the different fuel types. For outboard engines, a handful of constituents were estimated to exceed the most stringent state water quality standards: benzene, toluene, ethylbenzene, and naphthalene. Inboard engines are expected to exceed standards for polycyclic aromatic hydrocarbons (PAHs), including acenaphthylene, phenanthrene, chrysene, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and others. Additionally, wet exhaust can contain nitrogen oxides, hydrocarbons and other organic compounds, carbon monoxide, and particulates.

EPA (1999y) estimates that outboard engines discharge wet exhaust at a rate of 20 gpm while inboard diesel engines have an estimated discharge rate of 150 gpm

5.1.25 Sonar Dome Discharge

The information on sonar dome discharge was obtained from EPA (1999z).

Discharge Summary

Sonar domes are attached to a vessel's hull and protect the equipment used for navigation and detection. To equalize pressure within the sonar dome, freshwater is added to the inside and any water that is lost is replenished using ambient water from the firemain system. Maintenance on the sonar dome, while typically (but not always) done while a vessel is in dry dock, can involve the release of the inner sonar dome water. In addition, the components of the outside of the sonar dome can leach into the surrounding waters.

It is notable that none of the commentors that listed the relevant discharges for their vessel types cited sonar dome discharge.

When and Where Discharge Occurs

Discharges from the exterior of the sonar dome occur continuously as long as the vessel is in water. Repairs and maintenance to the interior of the sonar dome (which necessitates the release of the water on the inside) only occurs (if at all) while the vessel is pierside.

Discharge Rates, Concentrations, and Constituents

On Armed Forces vessels, the components that make up the outside of sonar domes can include TBT, plastic, steel, rubber, and antifouling coatings. Along with these materials, tin, zinc, copper, nickel, and epoxy paints may be found on the inside of sonar domes. Studies conducted by EPA and DoD indicated that, of these constituents, TBT, copper, nickel, and zinc exceeded the most stringent state water quality standards. Although the firemain system was occasionally used to replenish lost water from inside the sonar dome, EPA and DoD found that the constituents found in firemain water negligibly contributed to the discharge.

The rates of discharge will depend on the size of the sonar dome as well as the frequency of which repair or maintenance is required. For Armed Forces vessels, EPA and DoD estimated that as little as 300 gallons and as much as 74,000 gallons would be discharged from inside the sonar dome with every repair event. This amount will vary for civilian vessels.

5.1.26 Steam Condensate

The information on steam condensate discharge was obtained from EPA (1999aa) and from one comment³⁶ on EPA's ANPRM.

Discharge Summary

When in port, some Armed Forces vessels utilize shore-based steam resources to power auxiliary systems (such as laundry or heat). As the steam is pumped from boilers on land through the vessels' steam lines and to the equipment that requires it, it cools and condenses into water. This condensed water collects in insulated tanks before being pumped overboard. This discharge only occurs when Armed Forces vessels are using shore-based steam; condensed water from steam created on ship is recycled as boiler feedwater. The UNDS reports refer to the shore steam capabilities of naval facilities, but it is unclear following a brief internet search whether shore steam systems are widely available at civilian ports.

In response to EPA's ANPRM, WSC cited (without further comment) steam condensate as a relevant discharge to the vessels they represent.

When and Where Discharge Occurs

Steam condensate is only discharged when an Armed Forces vessel is in port and using shore steam resources. If steam condensate is a relevant discharge for civilian vessels, the same would be true.

Discharge Rates, Concentrations, and Constituents

Steam condensate is primarily water that contains material from the piping and heat exchangers. Depending on the construction of the vessel, these materials may include metals, organics (*e.g.*, 4-chloro-3-methylphenol, benzidine, bis(2-ethylhexyl)phthalate), oil and grease, and volatile residue, among other classical pollutants. The steam condensate may also be discharged at a higher temperature than the surrounding water column. Based on modeling activities, EPA and DoD determined that steam condensate may exceed Washington State's thermal water quality criteria, but the exceedance would be brief. When discharged, the thermal plume would be narrow and shallow and any disturbance of the water would cause enough mixing to dissipate the plume.

Based on steam condensate discharge sampling, a handful of constituents exceeded the most stringent state or federal water quality standards. Copper exceeded both state and federal standards, while nickel, ammonia, benzidine, and bis(2-ethylhexyl)phthalate exceeded the most stringent state standards.

5.1.27 Stern Tube Seals and Underwater Bearing Lubrication

The information on stern tube seals and underwater bearing lubrication was obtained from EPA (1999bb) and from three comments³⁷ on EPA's ANPRM.

Discharge Summary

On Armed Forces vessels, stern tube seals and bearings are associated with the propeller shaft; the former prevents water from entering the vessel and the latter support the weight of the propeller shaft. Depending on the type of vessel, seawater, freshwater, or oil provides the lubrication for the bearings and seals.

³⁶ This comment was EPA-HQ-OW-2007-0483-1498 (WSC).

³⁷ These comments included EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

Seawater lubrication is delivered via the firemain or the auxiliary seawater cooling main while freshwater comes from the port water supply, although only rarely is freshwater used as a bearing and seal lubricant.

In response to EPA's ANPRM, WSC, CMC, and CLIA all cited stern tube seals and underwater bearing lubrication as a relevant discharge for the vessels they represent. CMC stated that almost all vessels have stern tube seals and bearings that require lubrication.

When and Where Discharge Occurs

This discharge is continuous because the stern tube seals and bearings require constant lubrication.

Discharge Rates, Concentrations, and Constituents

Given that the seawater from the firemain is only very briefly in contact with the bearings and seals, the majority of the constituents will be those contained in the firemain or auxiliary seawater cooling main water and piping systems. Seawater used for lubrication may contain bis(2-ethylhexyl) phthalate, copper, nickel, and iron. If the shaft is turning, rubber may be contained in the discharge. Discharge from freshwater lubrication may contain chlorine as a disinfectant for the port facility water system.

Discharge sampling indicated that bis(2-ethylhexyl) phthalate, copper, nickel, and iron exceeded the most stringent state water quality criteria.

5.1.28 Submarine Bilge Water

The information on submarine bilgewater was obtained from EPA (1999cc).

Discharge Summary

Similar to the bilge water that collects in surface vessels, submarine bilge water is a combination of water, effluent, and other materials that drain from various areas of the vessel to the lowest compartment. In Armed Forces submarines, the bilge area consists of a non-oily collection tank, an oily bilge tank, and a waste oil collection area. Non-oily waste is sent via a segregated piping system to the non-oily bilge tank, where it is discharged directly overboard. In some Armed Forces submarine, bilge water that has oil or potentially has oil in it is sent through a gravity separation system, where the water is settled out of the oily mixture and discharged overboard. The remaining oily substance is sent to the waste oil collection area where it is held for onshore disposal.

When and Where Discharge Occurs

The times and places submarine bilge water is discharged depends on vessel operations, distance from shore, and depth. Generally, most Armed Forces submarines discharge all non-oily bilge water outside of 12 nmi of land or hold all bilge water (oily and non-oily) for onshore disposal.

Discharge Rates, Concentrations, and Constituents

Pearl Harbor Naval Station estimates that 2,000-3,000 gallons of bilge water are generated per day while an Armed Forces submarine is pierside. One class of submarine is estimated to dispose of 31,500 gallons on shore, zero gallons within 12 nmi of land, and 300,000 gallons outside of 12 nm, while another class disposes of 54,000 gallons onshore, 80,540 gallons within 12 nmi of land, and 400,200 gallons outside of 12 nm.

Submarine bilge water effluent sampling has detected oil and grease, copper, cadmium, lead, nickel, iron, zinc, mercury, lithium bromide, citric acid, chlorine, phenol, cyanide, sodium bisulfite, and the pesticides heptachlor and heptachlor epoxide. High total suspended solids (TSS) and chemical oxygen demand (COD) may also be present. The measured levels of oil and grease, copper, nickel, silver, and zinc exceeded both the federal and state water quality standards, while mercury, heptachlor, heptachlor epoxide, chlorine, and cadmium exceeded the most stringent state standards, but not the federal.

5.1.29 Surface Vessel Bilge Water/Oil-Water Separator (OWS) Discharge

The information on surface vessel bilge water/oil-water separator discharge was obtained from EPA (1999dd) and from four comments³⁸ on EPA's ANPRM.

Discharge Summary

The bilge is a compartment in a vessel's hull where water and other residue originating from the decks and interior of the vessel accumulate. According to EPA (1999dd), most of the bilge contents (or bilge water) in Armed Forces vessels come from vessel machinery and engine room drainage.

Comments on EPA's ANPRM from WSC cited (without further comment) discharge from the onboard oily water separator as relevant to the vessels they represent. CLIA stated that their bilge water is discharged (after being treated by an OWS) typically several times per week and that all their vessels have this discharge. AWO stated that their towing vessels are equipped with a segregated bilge system, which keeps oily bilge liquids (*e.g.*, from the vessels' machinery spaces) separate from any oil-free water that may accumulate in the bilge areas surrounding the propeller shafts. Their oily bilge liquids are stored and disposed of onshore at the appropriate facility.

When and Where Discharge Occurs

Armed Forces vessels are not permitted to discharge bilge water unless it has been treated with an OWS and only then if the oil content of the bilge water is less than 15 mg/l prior to discharge. If an OWS is used and the oil content is below the limit, than bilge water may be discharged anywhere and anytime.

Discharge Rates, Concentrations, and Constituents

Several studies on the bilge water content have been conducted on Armed Forces vessels. The constituents that were detected included oil, grease, volatile and semi-volatile organic compounds, inorganic salts, and metals. Additionally, on some vessels, effluent from the chain locker drains into the bilge as do elevator pit effluent and discharge from the gas turbine water wash. Schmidt (2000) stated that, on a one week journey, an average cruise ship with 3,000 passengers and crew can generate 25,000 gallons of oily bilge water.

5.1.30 Underwater Ship Husbandry

The information on underwater ship husbandry was obtained from EPA (1999ee) and from three comments³⁹ on EPA's ANPRM.

Discharge Summary

Many vessels are too large to be regularly removed from the water and any repair or maintenance required on the hull or hull appendages must occur while the vessel is pierside. Specifically, EPA (1999ee) defines underwater ship husbandry to include hull cleaning, fiberglass repair, welding, sonar dome repair, tests/inspections, masker belt repairs, and paint operations, as well as other activities that are specific to Armed Forces vessels only. All of these husbandry activities are also conducted on civilian vessels, although the size and type of vessel will dictate the extent of the maintenance. In addition, most recreational and other smaller vessels are removed from the water during husbandry operations; therefore, underwater ship husbandry discharges may not be applicable to them.

³⁸ These comments included EPA-HQ-OW-2007-0483-619 (AWO), EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

³⁹ These comments included EPA-HQ-OW-2007-0483-1248 (CMC), EPA-HQ-OW-2007-0483-1494 (CLIA), and EPA-HQ-OW-2007-0483-1498 (WSC).

In their comments on EPA's ANPRM, the WSC and CMC both cited (without further comment) underwater ship husbandry as a relevant discharge from the vessels they represent. CLIA stated that hull and propeller cleaning on all their vessels is conducted annually via remote operated vehicles or by divers using scrubbers or pressure washers. They also state that this cleaning is only done while in port or at anchor.

When and Where Discharge Occurs

Most underwater husbandry is done while the vessel is at port. The frequency with which the maintenance and repair activities occur is dependent on the type of vessel and the nature of the maintenance. EPA (1999ee) estimates that Armed Forces vessels receive about one full hull cleaning annually, with more frequent cleanings of hull appendages (*e.g.*, propellers). Fiberglass repair and welding operations on Navy vessels each occur about twelve times per year fleetwide.

The frequency with which a vessel's hull needs to be cleaned depends on a variety of factors, including water temperature, water chemistry characteristics (*i.e.*, nutrient concentrations), and frequency of use. A demonstration project by California Sea Grant (Johnson and Gonzalez, 2006) in San Diego Bay tested the efficacy and other characteristics of three different types of anti-fouling hull coatings (epoxy, ceramic-epoxy, and silicone-rubber), including during hull cleaning activities. Boats participating in this project included three powerboats between 28 and 42 feet and three sailboats between 21 and 46 feet in length, representing a range of typical recreational vessels. The researchers stated that recreational boats are typically cleaned on a schedule set by the owners with input from their hull cleaning companies. The project boats with epoxy or ceramic-epoxy coatings were cleaned approximately every 15-18 days, while the vessels with silicone-rubber coatings were cleaned more frequently: every 7-12 days.

Another study commissioned by California Sea Grant along with the California Department of Boating and Waterways (Carson *et al.*, 2002) evaluated the possible policy options for reducing the use of copper-based hull anti-fouling paint on recreational boats in San Diego Bay. One of the factors they examined was hull cleaning frequency. Generally, they found that recreational vessel hulls that were treated with coatings that were not copper-based ('alternative paints') required more frequent cleaning: from once a week to once every three weeks.

Discharge Rates, Concentrations, and Constituents

The constituents discharged due to underwater ship husbandry differ depending on the specific activity. For example, hull cleaning may discharge copper and zinc from the antifouling paint. Fiberglass, resins, and hardeners may enter the water during fiberglass repair, although the specific ingredients in the resins and hardeners will vary by manufacturer. Welding activity may introduce metals, including chromium, iron, nickel, manganese, and beryllium while the repair of the sonar dome and masker belts may discharge rubber and sealant (the contents of which will vary by manufacturer). The constituents of the particular paint used may also enter the water column.

Additionally, invasive species that have attached to the vessel's hull may be a constituent of the discharge. Some states have begun to document the transport mechanisms of the marine invasive species found in their waters. Hawaii, for example, recently estimated that about 73% of the marine invasive species observed in Hawaiian waters were transported via vessel hulls and 90% of those have become established. A recent study also found that 72% of organisms that have been cleaned off a vessel hull remain viable.

The variability of maintenance and repair activities, as well as the variety of vessel sizes and types, makes estimating discharge rates and concentrations difficult. During each fiberglass repair, approximately one quart of resin is discharged. Welding operations each emit approximately five pounds of metal slag. Discharges from the other activities will vary.

5.1.31 Welldeck Discharges

The information on welldeck discharges was obtained from EPA (1999ff).

Discharge Summary

A welldeck is typically located at the stern of a large vessel and is a floodable platform used for launching or loading smaller, satellite vessels or vehicles as well as to facilitate cargo loading operations. The floors of an Armed Forces welldeck are lined with pressure-treated lumber. Residues and materials that accumulate on the welldeck can be discharged via green water washover or the intentional washdown of vessels or vehicles stored on the welldeck. The U.S. Department of Agriculture (USDA) requires that any vessel or vehicle that comes into contact with foreign soil must be washed down to remove any invasive species. These washdowns typically occur on the welldeck while still in the foreign port, once the vessel has been brought on board the ship or the vehicle has been loaded.

It is notable that none of the commentors that listed the relevant discharges for their vessel types cited sonar dome discharge.

When and Where Discharge Occurs

Welldeck discharges can occur at anytime or anyplace.

Discharge Rates, Concentrations, and Constituents

On Armed Forces vessels, the potential constituents of welldeck discharges include fresh water, distilled water, firemain water, grey water, air-conditioning condensate, sea-salt residues, paint chips, wood splinters, dirt, sand, organic debris and marine organisms, oil, grease, fuel, detergents, combustion by-products, and lumber treatment chemicals. Discharges from civilian vessels will vary depending on the vessel type and the activity in which the vessel is engaged.

6.0 Pollution Control Technologies and Best Management Practices

The following sections describe PCTs or BMPs available to either lessen the volume or environmental impact of vessel discharges. Many of the discharges do not have PCTs because they have never been regulated; therefore, for some of the discharges listed below, information is limited. A handful of the discharges did not have either PCTs or BMPs and these will not be discussed further in this section: boiler blowdown, cathodic protection, non-oily machinery wastewater, refrigeration/air conditioning condensate, rudder bearing lubrication, steam condensate, stern tube seals and underwater bearing lubrication, submarine bilgewater, and welldeck discharges. Focus is put on the discharges with the most available information.

6.1 Aqueous Film Forming Foam

Battelle did not identify any specific PCTs or BMPs for AFFF discharge. However, a variety of manufacturers exist (*e.g.*, Kidde, OmniQual, Amerex) and some foam formulas may have fewer pollutants than others.

As stated in Section 5.1.1, one Armed Forces BMP for AFFF discharge is that maintenance discharges may only occur farther than 12 nmi from shore. However, inspection and certification discharges have no distance limit for Armed Forces vessels.

6.2 Chain Locker Effluent

Battelle did not identify any specific PCTs for chain locker effluent discharge.

One Navy BMP for chain locker effluent discharge is that chain lockers may only be washed down beyond 12 nmi from shore. Civilian vessels may have different self-imposed restrictions for chain locker

effluent discharge. A comment in response to EPA's ANPRM from CLIA⁴⁰ provides two additional BMPs for this discharge. The anchor chain should be carefully and thoroughly washed down (*i.e.*, more than a cursory rinse) as it is being hauled out of the water to remove sediment and marine organisms. In addition, chain lockers should be cleaned thoroughly during dry docks to eliminate accumulated sediments and any potential accompanying pollutants (EPA, 2003a).

Australia's Department of Agriculture, Fisheries, and Forestry commissioned a research study (Taylor and Rigby, 2002) to study vessel invasive species prevention management practices and some of the suggested methods pertained to chain lockers (as described in Section 5.1.4, the chain locker has the potential to harbor invasive species). The suggestions provided in this report included the following:

- Chain lockers should include a grate at the bottom, raised about 0.5 meters above the bottom of the locker, with manhole access for cleaning the space.
- Extra washing nozzles should be installed to more efficiently and completely clean the space.
- Prior to entering nearshore waters (preferably in deep ocean), the space beneath the chain locker should be inspected, cleaned, and pumped out.
- Prior to entering nearshore waters, anchor cables should be reinspected and, upon any sign of sediment or organisms, they should be rewashed.
- Chain lockers should be regularly maintained, and painted to prevent corrosion and rust formation which can trap sediment and organisms.

6.3 Clean Ballast

Ballast water PCTs generally fall under one of two main types of process technologies: solid-liquid separation and disinfection (Lloyds Register, 2007). Figure 6-1 illustrates these processes.

Solid-liquid separation involves the separation of suspended solid material, including larger suspended micro-organisms, from the ballast water either by sedimentation (allowing the solids to settle out by weight), or by surface filtration (the pores in the filtering material being smaller than the size of the particle or organism).

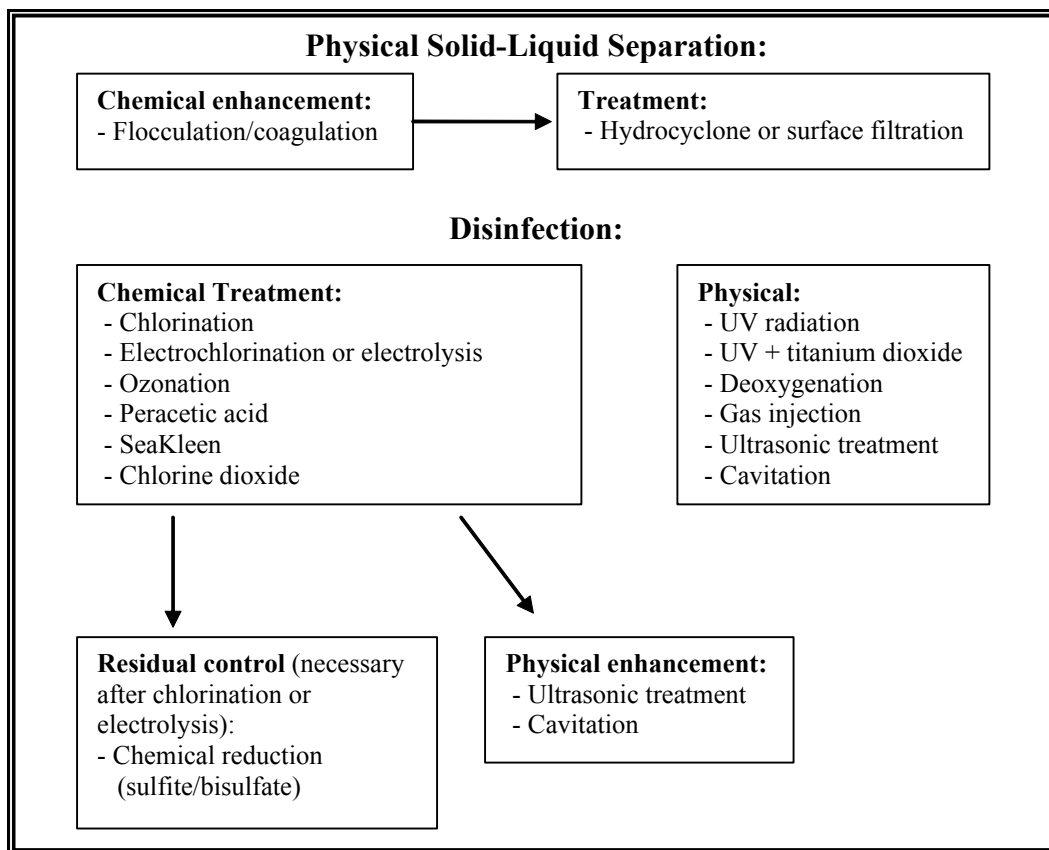
Disinfection removes and/or inactivates organisms using one or more of the following methods:

- Chemical inactivation of the organism
- Physicochemical inactivation by irradiation with ultraviolet light (UV), which prevents an organism from reproducing. Ultrasound or cavitation (or "microagitation") are also physicochemical disinfection methods.
- Deoxygenation either by displacement of the DO with an inert gas injection or stripping it by means of a vacuum, asphyxiating organisms.

Most commercial systems comprise two stages of treatment with a solid-liquid separation stage being followed by disinfection, though some disinfection technologies are used in isolation. One ballast water treatment technology also employs chemical enhancement (*i.e.*, coagulation/flocculation) prior to solid-liquid separation; another uses titanium dioxide to intensify UV irradiation. Some of the manufacturers of ballast water treatment technologies as well as the corresponding technologies utilized, capital costs, and operational costs are listed below (Table 6-1).

⁴⁰ Comment No. EPA-HQ-OW-2007-0483-1494

Figure 6-1. Types of Processes Utilized by Ballast Water Treatment Technologies.



Adapted from: Lloyd's Register, 2007

Table 6-1. Characteristics of Example Ballast Water Treatment Systems

Manufacturer	Technology	Capacity (GPM)	Capital Cost (\$',000)		O&M Cost (\$/264,172 gal)
			880 GPM	8,806 GPM	
Ecochlor, Inc.	Chlorine dioxide	>44,029	260	400	60
Electrichlor, Inc.	Filtration + electrolysis/ electrochlorination	>44,029	350	NA	NA
Environmental Technologies, Inc.	Filtration + ultrasound	>44,029	NA	500	5
Greenship	Hydrocyclone + electrolysis/ electrochlorination	>44,029	300	2300	NA
Marenco Technology Group	Filtration + UV	4,403	135	NA	100
MH Systems, Inc.	Deoxygenation	>44,029	650	950	55
NEI Treatment Systems, Inc.	Deoxygenation + cavitation	>44,029	150	250	50
Nutech 03	Ozonation	>44,029	350	800	320

Table 6–1. Characteristics of Example Ballast Water Treatment Systems, continued

Manufacturer	Technology	Capacity (GPM)	Capital Cost (\$',000)		O&M Cost (\$/264,172 gal)
			880 GPM	8,806 GPM	
Optimarin AS	Filtration + UV	>44,029	500	NA	NA
Resource Ballast Technology	Filtration + electrolysis/ Electrochlorination + cavitation	>44,029	150	250	NA
Severn Trent De Nora	Filtration + electrolysis/ Electrochlorination + reduction	>44,029	350	500	20
Techcross	Electrolysis/ Electrochlorination	>44,029	150	NA	10

Adapted from: Lloyd's Register, 2007

In the United States, the USCG has requirements for the treatment and management of ballast water. First, any vessel, including tugs and barges, equipped with ballast water tanks must file a report with the USCG 24 hours prior to arrival at a United States port (including inland ports) (33 CFR. §151.2041). Second, all vessels equipped with ballast water tanks must have a vessel-specific ballast water management (BWM) plan (33 CFR. §151.2305(7)). Lastly, all vessels equipped with ballast water tanks entering U.S. waters after operating beyond the EEZ must perform one of the following BMPs (33 CFR 151.2035(b)):

- **Open Ocean Exchange:** a vessel empties all of its ballast water in the open ocean. The vessel then refills its tanks (and often empties and refills multiple times as a precaution) and proceeds to its destination ports. Although organisms may be present in the ballast water, the vast majority of them will be pelagic and unlikely to survive or thrive in nearshore environments.
- **Retain ballast water on board while the vessel is in U.S. waters:** this virtually eliminates the chance for introduction of invasive species via ballast water. All vessels operating in U.S. waters with ballast water that was taken up within 200 nmi of any coast after operating beyond the U.S. EEZ must perform either one of the above BMPs, or
- **Use an alternative environmentally sound method of ballast water management that has been approved by the Coast Guard.**

Other BWM practices are mandated under 33 CFR 151.2035(a) and apply to all vessels with ballast tanks operating on U.S. waters regardless of whether the vessel left the U.S. EEZ. These mandatory BMPs include:

- Avoiding ballast operations in or near marine sanctuaries, preserves, parks, or coral reefs
- Avoiding ballast water intake:
 - Where infestation, harmful organisms, and pathogens are located
 - Near sewage outfalls
 - Near dredging operations
 - Where tidal flushing is poor or where a tidal stream is known to be turbid
 - In darkness when organisms may rise up in the water column
 - In shallow water or where propellers may stir up the sediment
 - In areas with whale pods, convergence zones, and boundaries of major currents
- Cleaning ballast tanks regularly to remove sediment
- Only discharging minimal amounts of ballast water in coastal and internal waters

- Rinsing anchors and anchor chains during retrieval to remove organisms and sediments at their place of origin
- Removing fouling organisms from piping, hull, and tanks on a regular basis and disposing of any removed substances in accordance with regulations
- Maintaining a vessel-specific ballast water management plan
- Training crew in ballast water and sediment management and treatment procedures.

In addition, USCG has accelerated its efforts to evaluate and approve prototype and experimental shipboard installations of ballast water management equipment on vessels, implementing the Shipboard Technology Evaluation Program in 2004. USCG is also collaborating closely with EPA in the quantitative evaluation of specific ballast water treatment systems. The Environmental Technology Verification Program seeks to accelerate the development of environmental technologies based on rigorous and credible performance tests conducted according to standardized protocols. These policy and regulatory efforts continue⁴¹.

In the international arena, the International Maritime Organization (IMO) developed the International Convention for the Control and Management of Ships' Ballast Water and Sediments which regulates discharges of ballast water with the goal of reducing the risk of introducing invasive species. Regulation D-2 of the Convention sets the treatment standards that systems must meet (Table 6-2).

Table 6-2. Ballast Water Treatment System Standards.

Organism category	Standard
Organisms, > 50 µm in minimum dimension	<10 cells/m ³
Organisms, 10 – 50 µm	<10 cells/ml
Organisms, < 10 µm	No standard
Toxicogenic <i>Vibrio cholerae</i>	<1 cfu/100 ml
<i>Escherichia coli</i>	< 250 cfu/100 ml
Intestinal <i>Enterococci</i>	< 100 cfu/100ml

6.4 Compensated Fuel Ballast

PCTs and BMPs for compensated fuel ballast discharge are similar to those described for clean ballast discharge. Other BMPs are utilized by the Navy and include filling fuel storage tanks to no greater than 85% of capacity while in port to prevent overflow through the expansion tank, limiting the in-port refueling rate to 400 gpm, and positioning personnel to watch for overflows or monitor fuel levels during refueling.

6.5 Controllable Pitch Propeller Hydraulic Fluid

Battelle did not identify any specific PCTs for CPP hydraulic fluid discharge.

EPA (1999h) identified a handful of BMPs employed by Armed Forces vessels to control and reduce this discharge. An oil boom is typically used during underwater CPP activities to contain hydraulic oil leakage. The aft third of a vessel (plus an additional 20 feet beyond the stern) is enclosed within the boom during these procedures. Additionally, oil spill response personnel and equipment (*e.g.*, absorbent pads) must be present while underwater CPP work is underway and, in the event of any spillage, the oil will be removed from within the boom using vacuum trucks and other technology.

⁴¹ EPA-HQ-OW-2007-1093 (FedNav, Ltd.)

6.6 Deck Runoff

An internet and literature search performed by Battelle indicated that there are no deck runoff treatment technologies currently on the market or in development. The UNDS Discharge Assessment report on deck runoff (EPA, 2003b) provided some information on PCTs and BMPs that had been evaluated for use on Armed Forces vessels. Several technologies were assessed, including capture and containment systems, flocculation, water oxidation, and filter media. However, for the purposes of the Armed Forces, none of the PCTs that were evaluated were appropriate at the time for use aboard military vessels, primarily because none of the technologies had been developed for use on waterborne vessels. However, EPA (2003b) determined that developing and utilizing a topside management plan (TMP) describing deck runoff pollution reduction methods and practices was the best strategy for controlling deck runoff at the time.

Some Armed Forces fleets have instituted their own BMPs for deck runoff. A few Naval ports require the containment of deck runoff that contains cleaning agents while pierside. The USCG manually clears its vessels' decks of debris and garbage prior to conducting deck washdowns. Armed Forces oilers must plug up deck openings during the loading and unloading of fuel cargo and any spillage is directed to the oily waste treatment system. Oil spill cleanup kits are also present on these types of vessels.

In comments on EPA's ANPRM, AWO⁴² stated that an increasing number of tank barges are being fit with perimeter spill rails fitted with scuppers (pluggable holes) that permit the runoff of rain water. During cargo transfer operations, the scuppers are plugged up, thereby containing any spilled cargo on deck and preventing it from being discharged into the water. After cargo loading is complete, the scuppers are not unplugged until the accumulated water on deck is examined for signs of oil contamination (*e.g.*, sheen) or spills of other materials. If contamination is detected, the accumulated water is removed and held for disposal at an onshore facility. Drip pans are also found on tank barges underneath the end of the cargo pipeline. As cargo is being loaded onto the vessel, small amounts of cargo can be spilled in the course of connecting and disconnecting transfer hoses. The drip pan catches this spillage and the contents are held for shore-side disposal.

AWO also stated that deck and hopper barges can collect rain water in open, but contained spaces. Clean rain water is routinely pumped overboard from these spaces, but accumulated water that may be contaminated is left where it is and the space is covered or contained to prevent discharge over the side. The contents are then properly disposed of onshore.

6.7 Dirty Ballast

PCTs and BMPs for dirty ballast discharge are similar to those described for clean ballast discharge and compensated fuel ballast. On Armed Forces vessels, dirty ballast must be screened prior to discharge by an oil content monitor (OCM) that measures the amount of oil in the water. If the oil content exceeds 15 parts per million (ppm), an alarm sounds and deballasting operations must cease until an OWS can be employed to reduce the water's oil concentration.

6.8 Distillation and Reverse Osmosis Brine

During the UNDS Phase I process, EPA and DoD investigated different pollution control options for distillation and RO brine discharge from Armed Forces vessels (EPA, 1999gg). They evaluated five options for reducing or eliminating the concentrated brine discharge:

⁴² Comment No. EPA-HQ-OW-2007-0483-619

1. Restrict the operation of water purification plants while a vessel is in port.
2. Layup non-essential water purification plants with freshwater when in port.
3. Require RO technology on new vessels.
4. Substitute freshwater for seawater in distilling plants on stem-powered vessels while in port.
5. Change distillation and RO plant construction materials.

The EPA and DoD concluded that Option 3 was the most desirable option because RO systems have lower life cycle costs than distillation plants and do not require chemical feed and cleaning agents. With no other source of feedwater, Option 1 may have resulted in compromised vessel operations or high monetary costs for providing an alternative feedwater source. Options 2 and 4, while cost effective and benign to vessel operations, may not provide the reduced metals concentrations in discharges needed to meet water quality standards. The dearth of available purification equipment constructed from alternative materials made Option 5 not attractive at the time of the report.

6.9 Elevator Pit Effluent

Battelle did not identify any specific PCTs for elevator pit effluent discharge, although many Armed Forces vessels will transfer elevator pit effluent to the bilge tank (if oily), the gray water treatment system (if non-oily) or contain the effluent for onshore disposal. In these cases, the elevator pit effluent will be treated by a bilge treatment system, a grey water treatment system, or an onshore treatment system. Elevator pit effluent is very rarely discharged directly overboard of Armed Forces vessels without treatment.

6.10 Firemain Systems

Battelle did not identify any specific PCTs for firemain system discharge. However, utilizing a ‘dry’ firemain system, rather than a ‘wet’ one, will minimize the amount of discharge from this source because ‘dry’ systems are not continuously pressurized and do not provide water on demand. Therefore, ‘dry’ systems cannot provide water for the various other shipboard activities that may need it, such as engine cooling or anchor chain washdown. According to EPA (1999m), ‘dry’ firemain systems produce 0.1% of the discharge produced by a ‘wet’, continuously pressurized system.

6.11 Freshwater Layup

Battelle did not identify any specific PCTs for freshwater layup discharge.

According to EPA (1999n), rather than discharging directly overboard, some vessels of the Armed Forces route the used freshwater effluent from the condensers to the bilge tank, where it can be treated with an OWS.

6.12 Gas Turbine Water Wash

Battelle did not identify specific PCTs for gas turbine water wash discharge.

As a BMP, Navy vessels collect gas turbine water wash effluent in a dedicated tank for onshore disposal.

6.13 Grey Water

Since 2000, the Alaska Department of Environmental Conservation (DEC) has been closely monitoring the treatment systems of cruise ships in Alaskan waters. The most recent data supplied by Alaska DEC

(as of August 2007) indicate that 29 ‘large’ and 17 ‘small’⁴³ cruise ships have been in Alaskan waters so far in 2007. Very few of the large ships had separate grey water treatment systems onboard, with about 65% of them combining grey water with black water prior to treatment. The currently available treatment technologies for combined grey water/black water wastestream consist of methods also utilized by onshore municipal treatment plants, the most common being biological degradation and membrane separation. Other technologies employed by vessels with a large passenger capacity include vibrating membrane filtration, physical/chemical treatment, and effluent disinfection via electrolytic oxidation. An example of a treatment system developed by Hydroxyl Systems, Inc. for cruise ships is found in Figure 6-2. Examples of grey water treatment technologies and corresponding costs are presented in Table 6-3.

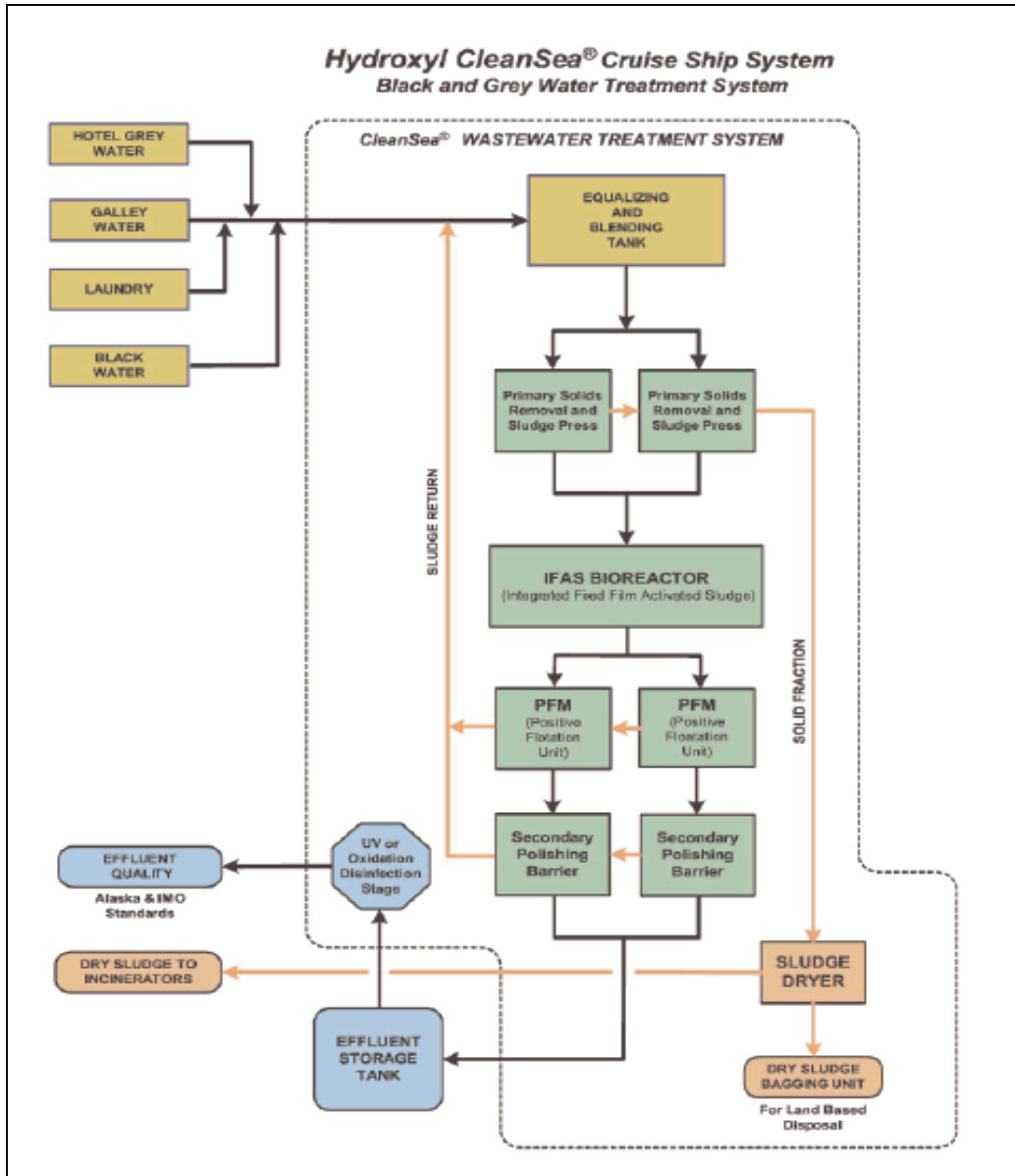


Figure 6-2. Grey Water Treatment System

⁴³ ‘Large’ cruise ships have overnight accommodations for over 250 or more passengers.

Table 6-3. Grey Water Treatment Technology Costs

Technology	Manufacturers	Capacity (gal/day)	Cost (\$',000US)	Sources
Physical/chemical treatment	Zodiac	21,240	58.3	Shirley Frederick, Zodiac
Membrane bioreactor	Zodiac	14,998	506	Shirley Frederick, Zodiac
Biological treatment	Zodiac	3,460	35	Shirley Frederick, Zodiac
Electrochemical cell/NaOCl disinfection	Severn Trent De Nora	14,794	120	George Starolis, Severn Trent de Nora
Biofilm carrier/dissolved air flotation/filtration	Hydroxyl Systems, Inc.	264,172	2,200 - 2,400	Dan Turner, Hydroxyl
		528,344	2,600 - 2,800	
		792,516	3,100 - 3,300	
		1,056,688	3,600 - 3,800	

Other vessels are allowed to discharge grey water outside of no discharge zones. However, the USCG and various state agencies are promoting BMPs for grey water to minimize the volume of wastewater discharged. For example, Alaska has established grey water BMPs:

- Limiting wastewater discharges while the vessel is stationary or in port (*i.e.*, holding water in port)
- Discharge only while vessel is greater than one nautical mile from shore and traveling at a speed >6 knots.
- Vessels that cannot hold water (*i.e.*, do not have any or sufficient holding tank space):
 - Can minimize grey water production by limiting usage of washers, dishwashers, etc. while in port and
 - Train crew to limit their usage of water while in port.

Several states have developed grey water discharge BMPs for recreational boats. Washington State Department of Ecology (1998) recommends, for example, using biodegradable and low nitrogen, phosphate-free detergents, providing adequate garbage receptacles to prevent the overboard disposal of food waste, and avoiding using dish soaps onboard. Massachusetts Office of Coastal Zone Management (2001) cites boater education as a key to preventing grey water discharge pollution, along with encouraging the use of shore-based dishwashing stations and shower facilities.

6.14 Hull Coating Leachate

During the UNDS Phase I process, EPA and DoD evaluated a handful of potential pollution control methods for reducing the discharges associated with hull coatings from Armed Forces vessels (EPA, 2003c; EPA, 1999hh). Three potential options were assessed for feasibility:

1. Use Less Toxic Fouling Release Coatings.
2. Control the Maximum Allowable Anti-Fouling Release Rate.
3. Limit or Eliminate Use of TBT Paints.

EPA and DoD determined that Options 2 and 3 were the most feasible, with establishing a maximum copper release rate (Option 2) having estimated costs of \$300,000 to \$500,000, as long as the coatings with the reduced release rate were still effective at preventing hull fouling. Option 3, which would involve replacing TBT coatings with copper- or silicone-based coatings, was less desirable because copper coatings may accelerate the corrosion of aluminum-hulled vessels and silicone coatings are effective only once a vessel attains a minimum speed. However, at the time of the report, silicone-based

coatings were not yet proven effective on Armed Forces vessels, which was the problem EPA and DoD had with Option 1.

Today, Option 1 may indeed be a feasible option for many types of vessels, including civilian. Silicone-based hull coatings are non-leaching and the slippery surface they provide cause marine organisms to slide off when the vessel achieves a minimum speed. International Marine Coatings⁴⁴ (IMC) currently manufactures Intersleek[®]900, a fluoropolymer low-friction coating that prevents most organisms from latching on to a hull. Those that do succeed in attaching are easily removed when the vessel reaches a minimum speed of 10 knots. IMC estimates that vessels using Intersleek[®]900 can achieve approximately 6% in fuel savings (hull fouling can increase drag on a vessel and decrease efficiency), resulting in reduced air emissions. Intersleek[®]900 is specifically appropriate for large and active scheduled vessels, such as dry cargo vessels (*e.g.*, container ships, refrigerated cargo vessels, roll on-roll off ships, vehicle carriers), tankers, and cruise ships. Costs for Intersleek[®]900 are approximately \$100/liter, with a typical liquefied natural gas carrier requiring 13,000 liters, for example (Alperowicz, 2007). Other manufacturers of silicone-based hull coatings include PPG Protective and Marine Coatings, Hempel, Jotun, Wearlon, and SeaCoat Technology, LLC.

Other antifouling coatings are available that slowly release a rapidly biodegradable biocide into the water surrounding the hull. Many of these biocides use non-metallic compounds, including SeaNine[™] 211N, manufactured by Rohm and Haas⁴⁵. SeaNine[™] 211N is specifically recommended for large vessels operating in shipping lanes or harbors and in marine or brackish environments. Large recreational yachts may also benefit from application.

Finally, a collection of non-coating methodologies are available to prevent hull fouling, including sonic technology. Barnaclean[™] (manufactured by SeaCure) uses sonic resonance transmitted through the vessels hull to cause fouling organisms like barnacles to detach and the rapidly-moving water that surrounds the hull as a result makes it difficult for algae and other organisms to attach. According to the company's website⁴⁶, to outfit an average-sized boat (34 feet) would cost less than \$2,000. However, because it is designed to complement other preventative activities, the company recommends utilizing Barnaclean in conjunction with some sort of anti-fouling paint.

BMPs for reducing hull coating leachate discharge during cleaning are provided in Section 6.26 on underwater ship husbandry PCTs and BMPs. However, as described in Section 5.1.16 on hull coating leachate discharges, passive leaching from vessel hulls coated with copper-based paints can contribute a significant amount of copper to the water column. The researchers for this same study (Schiff *et al.*, 2003) stress that, due to the heavy contribution of passive leaching to dissolved copper concentrations, BMPs should focus on changing the type of hull protection, rather than on hull cleaning activities.

6.15 Motor Gasoline Compensating Discharge

Battelle did not identify any PCTs specific to motor gasoline compensating discharge.

Similar to compensated fuel ballast, several BMPs are in place on relevant Armed Forces vessels to prevent or reduce the likelihood of MOGAS discharge. First, the MOGAS tanks are only filled to 80% capacity and the truck supplying the MOGAS is only loaded with the amount of fuel needed to achieve this capacity. Fuel loading rates cannot exceed 50 gpm. Individuals are assigned to visually watch for problems during refueling. Containment systems are also deployed around all locations (*e.g.*, hose

⁴⁴ www.international-marine.com

⁴⁵ www.rohmhaas.com

⁴⁶ www.barnaclean.com

connections) where leakages could conceivably occur. Civilian measures for preventing MOGAS discharges may vary.

6.16 Photographic Laboratory Drains

Battelle did not identify any PCTs that reduce or eliminate discharge from photographic laboratory drains.

Currently, the Armed Forces may discharge all photographic laboratory drains outside of 12 nmi from shore; however, the most common procedure involves collecting such waste for onshore disposal (EPA, 2003d). The UNDS team did not identify other PCTs or BMPs for this discharge given the high unlikelihood of discharge within 12 nm.

6.17 Small Boat Engine Wet Exhaust

During the development of the UNDS Phase I reports, EPA and DoD researched potential PCTs and BMPs to control small boat engine wet exhaust on Armed Forces vessels and published a brief report (EPA, 1999ii). Specifically, EPA and DoD were investigating methods, practices, or technologies that would reduce or eliminate the discharge of combustion by-products, including hydrocarbons, VOCs, and oil and grease, into the water. After screening several options (all of which were not described), EPA and DoD determined that wet exhaust discharge from Armed Forces small boat engines could best be reduced by:

1. Mandating all new Armed Forces boats with inboard engines be fitted with a dry exhaust system.
2. Converting inboard engines on existing Armed Forces boats to dry exhaust.
3. Replacing existing outboard engines on Armed Forces boats with low-emission models.

Option 1 was determined to be a feasible option for vessels with inboard engines. There may be some additional costs associated with design, but additional installation costs would be limited to materials, since the labor needed to install dry exhaust engines is no different than that needed to install wet exhaust engines. The report went on to conclude that Option 2 was cost prohibitive. Retrofitting Armed Forces vessels with dry exhaust systems would require numerous modifications and a detailed feasibility study. EPA and DoD estimated that just to retrofit Navy inboard engines with dry exhaust systems would cost \$36 million in study, design, and installation costs. This does not include the small vessels in other branches of the Armed Forces. Option 3 was estimated to cost approximately \$9 million for Navy boats, with the only negative determination being that the cost of the conversion may exceed the cost of the vessel itself. However, if this option were implemented through attrition, the annual costs were estimated to be about \$34,000.

6.18 Sonar Dome Discharge

Battelle did not identify any PCTs for reducing or eliminating sonar dome discharge.

The UNDS report (EPA, 1999z) states that most sonar dome repair is done while the vessel is in dry-dock. If the repair involves releasing the inner sonar dome water, this water should be containerized and disposed of at the appropriate facility.

6.19 Surface Vessel Bilge Water/Oil-Water Separator Discharge

According to EPA (1999cc), Armed Forces vessels are equipped with an oily waste holding tank where bilge water is retained until it can either be disposed of onshore or treated with an oil-water separator discharged overboard. Oil content monitors evaluate the bilge water as it passes through the OWS and will sound an alarm if the allowable concentration of oil is exceeded.

IMO regulations (MEPC 107(49)) specify that the total oil concentration (free and emulsified oil) of bilge water cannot exceed 15 ppm if it is to be discharged overboard. Most shipboard bilge water treatment systems involve an oil-water separator (OWS), which separates the oil and water using mechanical means (e.g., centrifugation, filtration) and/or employ bacteria to digest the organic material. Because of the new regulations, manufacturers are frequently combining several technologies in order to break up oil emulsions as well as to separate and remove the oil. The following list includes technologies used in bilge water separation equipment (EPA, 2003e):

- **Centrifuge and Hydrocyclone:** uses high-speed rotation to separate the heavier liquids and solids from the lighter oils.
- **Dissolved Air Flotation:** uses high-pressure air to separate suspended solids and insoluble liquids from water.
- **Evaporation:** uses heat to evaporate the water, leaving only oil, sludge, and other solids.
- **Biological Treatment:** uses microorganisms to digest organic material from bilge.
- **Flocculation (Coalescence):** using electrical current or separating agents to cause smaller particles to coagulate and precipitate out of the solution for later disposal.
- **Gravity Coalescence:** allows oil and water to form separate layers.
- **Oil-Absorbing Socks:** designed to absorb oil and repel water when placed in bilge water.
- **Filtration:** separates high molecular weight constituents from fluids using filter media.

For recreational vessels, discharge of bilge water is allowed outside of marinas, provided the discharge does not contain oil or oily waste. A comment⁴⁷ on EPA's ANPRM cited a bilge treatment system that has been specifically developed for recreational and other small vessels. A pollution control device designed for use in any vessel with a bilge tank and bilge pump, HarborGardTM⁴⁸ prevents petroleum waste that ends up in the bilge tank from being discharged overboard and potentially violating federal and state water pollution laws. According to the commentor, Paul Clukies of HarborGard, LLC, units can be purchased and installed on an average-sized recreational vessel for less than \$50.

Other bilge tank technology available for recreational vessels is produced by Mycelx Technologies Corporation⁴⁹. Their BilgeKleenTM filtering system comes in three different sizes and is installed on the bilge pump discharge line. The filter within the system removes 100% of hydrocarbons from bilge water before it is pumped overboard and includes a SmartPadTM that can be placed at the bottom of the bilge tank to absorb any other contaminants. RGF Environmental Group, Inc. manufactures an inline bilge filtering system designed for small- to medium-sized recreational vessels. Table 6-4 presents the examples of commercial and recreational bilge water separator technologies and the corresponding capacities and costs (if available).

⁴⁷ This comment was EPA-HQ-OW-2007-0483-0254 (Paul Clukies, HarborGard)

⁴⁸ www.harborgard.com

⁴⁹ www.mycelx.com

Table 6-4. Bilge Water Treatment Technology Costs

Technology	Type of Vessels	Examples of Manufacturers	Capacity (GPM)	Capital Cost (\$',000)	Sources
OWS with coalescence and filtering	Facet: Large commercial RGF: recreational and commercial Ecologix: commercial	Facet International, RGF Environmental, Ecologix Env. Systems	0.694	5	Mike Wood, Facet; Bill Speck, RGF;
			2	10 -23	
			5	12 -30	
			8.8 -10	16 -40	
			44 - 45	27 -55	
OWS with microbial action	Commercial	EnSolve Biosystems	1.04 – 3.75	39 - 99	Jason Caplan, EnSolve
High speed centrifugal separator	Commercial	Alfa Laval EcoStream	8.8	100	Larry Bozha, Alfa Laval
Filter system	Recreational power or sail boats	Mycelx	20 - 66	.14 -.4	www.mycelx.com
Not available	Recreational power or sail boats	HarborGard	Not available	.05	Comment EPA-HQ-OW-2007-0483-0254

The Massachusetts Office of Coastal Zone Management (2001) provided suggested BMPs for bilge water handling for recreational vessels and marinas, including making oil-absorbent pads available dockside, providing bilge vacuum systems for boaters, encouraging the installation of bilge oil filters, promoting the use of onboard OWSs or providing portable OWSs, and educating and informing boaters. Guidance provided by the Oregon Department of Environmental Quality (2002) adds to these suggestions by recommending that soap and emulsifiers not be used to clean a bilge tank; rather, oil-absorbent pads should be used if discharge directly to a sanitary sewer is not feasible. They also suggest that drip pans be kept under the engine compartment to prevent oil from entering the bilge and that all oil used during repairs should be contained and disposed of properly onshore. Numerous other states provide BMPs for marinas, including Georgia, Washington, and California,

6.20 Underwater Ship Husbandry

In the UNDS MPCD report (EPA, 1999jj), EPA and DoD identified four potential pollution control options for Armed Vessel discharges associated with underwater ship husbandry:

1. Underwater Ship Husbandry Management Plan (USHMP)
2. Variable Cleaning Pressure Equipment
3. Improved Brushes
4. Underwater Ship Husbandry Discharge Collection Equipment

Options 1 and 2 were determined to be the most feasible for Armed Forces vessels. A USHMP, while useful for the Armed Forces (an organized group with a clear line of command), may not be as useful for recreational vessels. However, companies that own and operate large numbers of vessels may benefit from defining ship husbandry requirements and establishing a routine, if such a plan is not already in place. Option 2 involves using lighter cleaning pressure when removing soft fouling organisms (e.g., algae, grass) that detach fairly easily. This would not only decrease the discharge associated with the cleaning, but potentially extend the life of the hull coating. However, this option only addresses discharges that originate from the hull coating and does not address other husbandry-related discharges (e.g., fiberglass from repair work or metals from welding).

Underwater ship husbandry activities can also cause invasive species to be detached from a vessel’s hull and introduced to the water column. Research in New Zealand (Floerl et al., 2004) has indicated that approximately 72% of organisms that were removed from the hull of a small vessel (< 49 meters in length) during cleaning activities remained viable. Scott Godwin of the Hawaii Coral Reef Assessment and Monitoring Program is one of the few experts on hull fouling as an invasive species vector. In a recent report (Godwin et al., 2006), he offers numerous suggestions for reducing or eliminating the discharge of invasive species during underwater ship husbandry activities. One of the most obvious approaches is to maintain protective anti-fouling coatings or technologies in top working order, which can be done by increasing the frequency of shipyard service; however, this can be costly to the owner is not likely a viable option. Another management practice he suggests is to teach port authority personnel how to identify vessels with high potential for hull fouling invasive species introductions. These ‘high-risk’ vessels include barges, floating dry-docks, and vessels from military decommission yards (purchased as scrap metal or for the fleets of developing nations). Barges, for example, move slowly and spend considerable time in port, creating a situation conducive to the settlement and establishment of fouling organisms. Vessel decommission yards house vessels that have been idle for years and poorly maintained. Port authorities should require hull maintenance records for high-risk vessels and deny port entry based on these records. For those vessels unable to produce such documents, a quarantine area could be set up in deep water greater with remote video or commercial diver inspection capabilities.

The California State Lands Commission (CSLC) published a report (CSLC, 2006) in which they compiled the current mandatory or voluntary management practices in use around the world to prevent invasive species from being introduced via the hulls of commercial vessels. Table 6-5 is reproduced from their report.

Table 6-5. Global BMPs for Preventing Vessel Hulls from being Invasive Species Vectors.

Country/State	Management Strategy	Details
U.S. Federal	Embedded in ballast water regulation	Rinse anchor chains and anchors at place of origin
California	Embedded in ballast water statute	Remove fouling from hull, piping and tanks on a regular basis. Dispose wastes in accordance with local, state, and federal law.
Hawaii	Information Framework Targeting High Risk Vessels (Proposed)	Pro-active measures: Education/outreach, vessel arrival monitoring, evaluation for high-risk arrivals Re-active measures: Rapid response/investigation of high risk event Post-event measures: Long term regulations for high-risk events <ul style="list-style-type: none"> • Limit time in port • Vessel quarantine • Out of water cleaning
New Zealand	Survey (On Ballast Water Declaration Form)	1. When and where was the vessel last dry-docked and cleaned? 2. Has the vessel been laid-up for 3 months or more since it was last dry-docked and cleaned? If YES, state when and where. (Also requests start and end date laid up) 3. Do you intend to clean the hull of the vessel in New Zealand? If YES, state when and where
	Voluntary Codes of Practice (Fishing Industry)	Chartered foreign owned or sourced fishing vessels must be substantially free from plant or animal growth prior to entering New Zealand’s EEZ. If no assurance, vessel inspected and cleaned before departure. Otherwise inspected in NZ and if necessary, fouling removed so no foreign organisms enter the marine environment

Table 6–5. Global BMPs for Preventing Vessel Hulls from being Invasive Species Vectors, continued.

Country/State	Management Strategy	Details
Australia	Prohibition (States/Territories/Ports)	States and territories prohibit in-water cleaning. Many require containment and disposal regulations of fouling debris removed during out-of-water cleaning.
	Regulation (Vessels less than 25 m)	Keep ancillary gear and internal seawater systems clean of marine pests and growths Before departing your last port for Australia... <ul style="list-style-type: none"> o Clean hull within one month before arrival OR o Apply antifouling paint within one year before arrival OR o Book vessel for slipping and cleaning within one week of arrival (cleaning should be in a shipway where material removed can be collected and disposed of away from the sea)
Australia and New Zealand Environmental Conservation Council (ANZECC)	Codes of Practice	In-water hull cleaning prohibited, except under extraordinary circumstances. Sea-chests, sea suction grids, other hull apertures may be allowed under permit, if debris not allowed to pass to water column or sea bed. Polishing propellers may be allowed under permit.
Merchant Classification Societies	Requirements (Applies to majority of merchant fleet)	Dry dock requirements vary somewhat depending on classification society. Generally: <ul style="list-style-type: none"> o Dry dock every 5 years. Cleaning and painting is usually conducted, but is at the discretion of the company. o Interim in-water cleanings: Periodicity at the discretion of the company. Typically dependent on results of fuel consumption tests.

California Sea Grant (2003) offers the following BMPs to mariners who must clean their vessel’s hull while it is still submerged:

- Wait 90 days to clean the vessel’s hull after applying new paint. Paints release more toxicant when new.
- Soft sloughing or ablative paints release toxicant and paint to water when cleaned. On these boats, clean only running gear and zinc anodes.
- Use only soft materials (*e.g.*, piece of carpet, sponge) to clean the hull.
- Use soft nylon or similar material on rotary brush machines.
- Use stainless steel brushes and pads on non-painted, metal areas *only*.
- Use more rigorous cleaning pads *only* as needed to remove hard marine growth.
- Do not sand or strip hull paint underwater.
- Bring zinc anodes back to shore; recycle or dispose of properly.
- Clean gently to avoid creating a plume or cloud of paint in the water.

EPA (2001) adds to these suggestions:

- Wash boat hulls above the waterline by hand. Where feasible, remove boats from the water and clean them where debris can be captured and properly disposed of.
- Attempt to wash boats frequently enough that the use of cleansers will not be necessary.
- If using cleansers, buy and use ones that will have minimal impact on the aquatic environment.

- Switch to long-lasting and low-toxicity or nontoxic antifouling paints.
- Avoid in-the-water hull scraping or any abrasive process done underwater that could remove paint from the boat hull.
- Ensure that adequate precautions have been taken to minimize the spread of exotic and invasive species when boats are transferred from one water body to another.

7.0 Laws, Regulations, and Conventions

A number of international standards, federal laws, and state permitting schemes exist or are pending that concern some of the discharges covered in this report. This section provides information for EPA to consider during the nationwide permitting framework development, including whether existing standards, laws, or state programs may become redundant or ineffectual upon the institution of the new NPDES program.

7.1 International and National Laws and Regulations

Several international treaties and national laws apply to discharges incidental to the normal operation of a vessel. While all of the regulations listed in this section do not necessarily apply to every one of the discharges described in Section 5.0, depending on the constituents of the discharge, one or more of the regulations discussed below may be applicable. Even if a constituent or discharge is not directly regulated by any national or international law, a close examination of the potentially *relevant* legislation may be informative and prevent legal repercussions.

7.1.1 International Standards

Annexes I, II, and V of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) may be relevant. In the U.S., these annexes are implemented through APPS, which applies to all U.S.-flag vessels operating anywhere in the world and to all foreign-flag vessels operating or at port within U.S. navigable waters. In its implementation of MARPOL Annex I, APPS regulates oil discharges from U.S.- and foreign-flagged seagoing vessels (33 CFR, parts 151, 155, 156, 157). MARPOL's Annexes II and V are also implemented by APPS. Annex II regulates pollution from noxious liquid substances in bulk (33 CFR 151). Annex V regulates garbage pollution of the ocean by ships from operational or accidental causes and restricts the discharge of maintenance waste, which includes paint chips (33 CFR 151).

With regard to hull coating leachate, international standards governing the discharge of copper or zinc antifouling coatings do not exist. The International Convention on the Control of Harmful Antifouling Systems on Ships (AFS Convention) was adopted by the IMO in 2001, although it is not yet in force. Once in force, no vessels from signatory nations to the AFS Convention may bear TBT-based antifouling coatings, unless covered by an approved sealant (Showalter and Savarese, 2005).

7.1.2 National Law

As described in EPA (2000), the Oil Pollution Act (OPA) (33 U.S.C. §§ 2701 et seq.) is a comprehensive statute designed to expand oil spill prevention, preparedness, and response capabilities of the Federal government and industry. It amends §311 of the CWA to clarify federal response authority, increase penalties for spills, establish USCG response organizations, require tank vessel and facility response plans, and provide for contingency planning in designated areas. OPA prohibits the discharge of oil or hazardous substances, in such quantities as may be harmful, into or upon: U.S. navigable waters, adjoining shorelines, waters of the contiguous zone, or waters which may affect natural resources in the Exclusive Economic Zone (extending some 200 miles offshore). Within twelve miles of shore, OPA's regulations prohibit the discharge of oil unless it is passed through an oil-water separator, and does not

cause a visible sheen or exceed 15 ppm (33 CFR §151.10). Beyond twelve miles, oil or an oily mixture may be discharged while proceeding en route if the oil content of the effluent without dilution is less than 100 ppm. Vessels are required to maintain an Oil Record Book, which records, among other things, the disposal of oily residues and the discharge or disposal of bilge water (33 CFR §151.25). CWA §311(b)(5) mandates that any person in charge of a vessel which discharges or spills oil into the navigable waters of the U.S. must notify the appropriate federal agency, who will then notify the state(s) that potentially could be affected.

Individual U.S. states have the authority (under CWA §303(c)) to set their own water quality standards applicable within state waters and vessels in state waters must abide by these standards.

The Comprehensive Environmental Response and Community Right-to-Know Act (CERCLA) may be relevant to some vessel discharges. CERCLA establishes notification requirements upon the environmental release of specific hazardous substances, listed in 40 CFR 302.4. Petroleum and any refinery-added substances (*e.g.*, xylene, benzene, toluene) are specifically excluded from CERCLA due to their coverage under other regulations. However, if the vessel vacatur leads to discharges (and their constituents) being permitted via the NPDES system, CERCLA liability and reporting provisions will no longer apply to those permitted discharges.

Under the Organotin Antifouling Paint Control Act (33 USC 2041), TBT-based antifouling coatings are partially banned in the U.S., with vessels less than 25 meters (82 feet) in length no longer permitted to apply it (unless the vessel has an aluminum hull or the TBT is applied only to the outboard motor or lower drive unit of such a vessel) and the sale and delivery of organotins-based paints with a release rate of 4.0 µg/cm²/day or more prohibited. In 2004, EPA released ambient water quality criteria for TBT that, while not legally enforceable, can help states establish their own water quality standards (Showalter and Savarese, 2005).

Under the requirements of NISA, the USCG enforces mandatory ballast water BMPs for all vessels with ballast tanks operating in U.S. waters, as described in 33 CFR 151.2035(a) and (b). The specific mandatory activities are described in the Clean Ballast discharge description. Other provisions of NISA include mandatory ballast water reporting requirements and the funding of treatment technology research. NISA technically expired in 2002 (although the specific regulations promulgated under it remain binding; 33 CFR 151) and, for several years, bills have been introduced in the U.S. House of Representatives and the U.S. Senate seeking to reauthorize it as the National Aquatic Invasive Species Act. The most recent bill was introduced in the winter of 2007, but whether the bill will make it out of committee during this congressional session remains to be seen.

7.1.3 State Law

Some states have developed their own permitting mechanisms, mostly pertaining to ballast water discharge, or have permitting plans in the works.

Table 7-1. Current or Pending State Permitting Systems Pertaining to Vessel Discharges Covered in this Report.

State	Permitting Systems Pertaining to Vessel Discharges Covered in this Report
Alaska	AS 46.03.100: permit is required for the discharge of graywater Pending: Large Commercial Passenger Vessel Wastewater Discharge General Permit (2007DB0002)
Indiana	Pending: Senate Bill 219 of 2006-- would allow vessels to operate in the waters of IN only if ballast water and sediment in the vessel have been sterilized. Ballast discharge would be allowed only with a permit.

Table 7-1. Current or Pending State Permitting Systems Pertaining to Vessel Discharges Covered in this Report, continued.

State	Permitting Systems Pertaining to Vessel Discharges Covered in this Report
Maine	General Permit for the Discharge of Graywater or a Mixture of Graywater and Blackwater from Large Commercial Passenger Vessels to Coastal Waters (Permit no. W008222-5Y-A-N)
Michigan	Ballast Water Control General Permit No. MIG140000: ballast water discharges only permitted if in compliance with treatment requirements and other methods described in the general permit. Ships may apply for an individual permit if they prefer to use an alternate treatment method but they must demonstrate that the method is both environmentally sound and its treatment effectiveness is equal to or better than the treatment methods included in the general permit.
Minnesota	Pending: H.F. No. 3705 (2006), Reintroduced S.F. No. 53 (January 2007)—oceangoing vessels with ballast tanks would need a permit and the vessel is equipped to discharge ballast in compliance with set rules.
Ohio	Pending: House Bill 298 (2007-2008)-- oceangoing vessels capable of discharging ballast will not be permitted to operate without a permit, which will be issued only if it can be demonstrated either that discharge will not happen or that approved treatment methods will be used.
Pennsylvania	Pending: House Bill 1736, Session of 2007-- would require vessels using PA ports to obtain a permit proving that the vessel cannot take on ballast water or that it is outfitted with approved treatment technology.
Wisconsin	Pending: 2005 Assembly Bill 919 (Introduced January 17, 2006)—would require vessels using WI ports to obtain a permit proving that the vessel cannot take on ballast water or that it is outfitted with approved treatment technology.

8.0 CONCLUSIONS

With the scheduled date for implementation of the vessel vacatur on the horizon, EPA must fully comprehend the scope of the NPDES permitting changes that must be instituted. This report provides an overview of available information on vessel populations and characteristics, as well as port statistics and existing information on the various types of discharges incidental to the normal operation of a vessel. Table 8-1 summarizes the statistical findings for vessel and port information.

Table 8-1. Summary of Statistical Findings for Vessels and Ports.

VESSELS	
Recreational	
Total Registered Recreational Vessel Population in 2005	12, 942,414
Top 3 U.S. Regions with Largest Recreational Registration in 2005	Great Lakes Inland waterways South Atlantic
Top 3 U.S. States with Largest Recreational Registration in 2005	California Florida Michigan
Percent of All Recreational Vessels Mechanically Propelled in 2005	93%
Percent of Mechanically Propelled Vessels Equipped with Outboard Engine (s) in 2005	70%
Percent of Mechanically Propelled Recreational Vessels < 26 Feet in Length in 2005	95%
Commercial	
Total Cargo/Passenger Vessel Population in 2005	41,028
Percent of Cargo/Passenger Vessels Operating Chiefly on the MS River System of the Gulf Intracoastal Waterway in 2005	78%
Number of Industrial Vessels (e.g., cable layers, dredges) in 2007	823

Table 8-2. Summary of Statistical Findings for Vessels and Ports.

VESSELS	
Number of Towing Vessels in 2007	6,898
Number of Offshore Supply Vessels in 2007	1,114
Number of Commercial Fishing Vessels in 2007	33,550
Top 3 U.S. States with Most Documented Commercial Fishing Vessels in 2007	Alaska Florida Washington
Top 3 Most Frequently Recorded Foreign Flags Entering U.S. Ports in 2005	Panama Bahamas Liberia
PORTS	
Top U.S. Region for Vessel Port Calls in 2005	Gulf of Mexico
Percent of All 2005 Port Calls Received in the Gulf of Mexico	31%
Top 3 U.S. Ports for 2005 Vessel Calls	Houston, TX Los Angeles/Long Beach, CA New York, NY

For discharges incidental to the normal operation of a vessel, the discharges that will be relevant for the greatest number of vessels include clean ballast, deck runoff, grey water, bilge water, hull coating leachate, small boat engine wet exhaust, and underwater ship husbandry. The other discharges may be applicable to a collection of commercial vessels; however, these seven discharges will likely be of the highest concern to EPA in light of the vessel vacatur.

9.0 REFERENCES

- Alaska Department of Environmental Conservation (DEC). 2007. 2007 Large Ship Treatment and Discharge Status. Last accessed September 15, 2007.
http://www.dec.state.ak.us/water/cruise_ships/pdfs/Large%20ship%20Wastewater%20Table%202007%201.xls
- Alperowicz, N. 2007. Akzo Nobel Reinforces Leadership in Marine Coatings. eChemicalWeekChina. June 20, 2007. Last accessed September 15, 2007.
<http://www.echemicalweekchina.com/articles/2007/06/20/034.html>.
- California Sea Grant. 2003. Underwater Hull Cleaner's Best Management Practices. Last accessed September 15, 2007. <http://commserv.ucdavis.edu/CESanDiego/seagrant/hullclean.htm>
- California State Lands Commission. 2006. Commercial Vessel Fouling in California: Analysis, Evaluation, and Recommendations to Reduce Nonindigenous Species Release from the Non-Ballast Water Vector. CSLC, Marine Facilities Division.
- Carson, R., M. Damon, L. Johnson, and J. Miller. 2002. Transitioning to Non-Metal Antifouling Paints On Marine Recreational Boats in San Diego Bay. University of California and California Department of Boating and Waterways.
- Copeland, C. 2007. Cruise Ship Pollution: Background, Laws and Regulations, and Key Issues. Congressional Research Service. Last accessed September 15, 2007.
<http://www.bluewaternet.org/CRS%20CruisePollution.pdf>

Dauer, D.M. 2006. Benthic Biological Monitoring Program of the Elizabeth River Watershed (2005). Last accessed September 15, 2007. <http://www.elizabethriver.org/Publications/Pub-Detail.asp?ID=22>

EPA. 1999a. Phase I: Uniform National Discharge Standards for Vessels of the Armed Forces. U.S. Environmental Protection Agency, Office of Water. EPA-821-R-99-001.

EPA. 1999b. Nature of Discharge Report: Aqueous Film-Forming Foam. Uniform National Discharge Standards Program.

EPA. 1999c. Nature of Discharge Report: Boiler Blowdown. Uniform National Discharge Standards Program.

EPA. 1999d. Nature of Discharge Report: Cathodic Protection. Uniform National Discharge Standards Program.

EPA. 1999e. Nature of Discharge Report: Chain Locker Effluent. Uniform National Discharge Standards Program.

EPA. 1999f. Nature of Discharge Report: Clean Ballast. Uniform National Discharge Standards Program.

EPA. 1999g. Nature of Discharge Report: Compensated Fuel Ballast. Uniform National Discharge Standards Program.

EPA. 1999h. Nature of Discharge Report: Controllable Pitch Propeller Hydraulic Fluid. Uniform National Discharge Standards Program.

EPA. 1999i. Nature of Discharge Report: Deck Runoff. Uniform National Discharge Standards Program.

EPA. 1999j. Nature of Discharge Report: Dirty Ballast. Uniform National Discharge Standards Program.

EPA. 1999k. Nature of Discharge Report: Distillation and Reverse Osmosis Brine. Uniform National Discharge Standards Program.

EPA. 1999l. Nature of Discharge Report: Elevator Pit Effluent. Uniform National Discharge Standards Program.

EPA. 1999m. Nature of Discharge Report: Firemain Systems. Uniform National Discharge Standards Program.

EPA. 1999n. Nature of Discharge Report: Freshwater Layup. Uniform National Discharge Standards Program.

EPA. 1999o. Nature of Discharge Report: Gas Turbine Water Wash. Uniform National Discharge Standards Program.

EPA. 1999p. Nature of Discharge Report: Grey Water. Uniform National Discharge Standards Program.

EPA. 1999q. Nature of Discharge Report: Hull Coating Leachate. Uniform National Discharge Standards Program.

EPA. 1999r. Nature of Discharge Report: Motor Gasoline Compensating Discharge. Uniform National Discharge Standards Program.

EPA. 1999s. Nature of Discharge Report: Non-Oily Machinery Wastewater. Uniform National Discharge Standards Program.

EPA. 1999t. Nature of Discharge Report: Photographic Laboratory Drains. Uniform National Discharge Standards Program.

EPA. 1999u. Nature of Discharge Report: Refrigeration/Air Conditioning Condensate Discharge. Uniform National Discharge Standards Program.

EPA. 1999v. Nature of Discharge Report: Rudder Bearing Lubrication. Uniform National Discharge Standards Program.

EPA. 1999w. Nature of Discharge Report: Seawater Cooling Overboard Discharge. Uniform National Discharge Standards Program.

EPA. 1999x. Nature of Discharge Report: Seawater Piping Biofouling Prevention. Uniform National Discharge Standards Program.

EPA. 1999y. Nature of Discharge Report: Small Boat Wet Engine Exhaust. Uniform National Discharge Standards Program.

EPA. 1999z. Nature of Discharge Report: Sonar Dome Discharge. Uniform National Discharge Standards Program.

EPA. 1999aa. Nature of Discharge Report: Steam Condensate Discharge. Uniform National Discharge Standards Program.

EPA. 1999bb. Nature of Discharge Report: Stern Tube Seals and Underwater Bearing Lubrication. Uniform National Discharge Standards Program.

EPA. 1999cc. Nature of Discharge Report: Submarine Bilge Water. Uniform National Discharge Standards Program.

EPA. 1999dd. Nature of Discharge Report: Surface Vessel Bilge water/Oil-Water Separator Discharge. Uniform National Discharge Standards Program.

EPA. 1999ee. Nature of Discharge Report: Underwater Ship Husbandry. Uniform National Discharge Standards Program.

EPA. 1999ff. Nature of Discharge Report: Welldeck Discharges. Uniform National Discharge Standards Program.

EPA. 1999gg. Distillation and Reverse Osmosis Brine: Marine Pollution Control Device. Uniform National Discharge Standards Program.

EPA. 1999hh. Hull Coating Leachate: Marine Pollution Control Device. Uniform National Discharge Standards Program.

EPA. 1999ii. Small Boat Engine Wet Exhaust: Marine Pollution Control Device. Uniform National Discharge Standards Program.

EPA. 1999ii. Underwater Ship Husbandry: Marine Pollution Control Device. Uniform National Discharge Standards Program.

EPA. 2000. Cruise Ship White Paper. Last accessed September 15, 2007.
http://www.epa.gov/owow/oceans/cruise_ships/white_paper.pdf

EPA. 2001. National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating. U.S. Environmental Protection Agency, Office of Water. EPA-841-B-01-005. Last accessed September 15, 2007. <http://www.epa.gov/owow/nps/mmsp/index.html>

EPA. 2003a. Discharge Assessment Report: Chain Locker Effluent. Uniform National Discharge Standards Program.

EPA. 2003b. Discharge Assessment Report: Deck Runoff. Uniform National Discharge Standards Program.

EPA. 2003c. Discharge Assessment Report: Hull Coating Leachate. Uniform National Discharge Standards Program.

EPA. 2003d. Discharge Assessment Report: Photographic Laboratory Drains. Uniform National Discharge Standards Program.

EPA. 2003e. Discharge Assessment Report: Surface Vessel Bilge water/Oil-Water Separator. Uniform National Discharge Standards Program.

EPA. 2007a. TMDL National Database. <http://www.epa.gov/OWOW/tmdl/index.html>

EPA. 2007b. National Estuary Program Coastal Condition Report. EPA-842/B-06/001.

Floerl, O., N. Norton, G. Inglis, B. Hayden, C. Middleton, M. Smith, N. Alcock, I. Fitridge. 2004. An investigation of hull cleaning and associated waste treatment options for preventing the spread of non-indigenous marine species. Final research report for Ministry of Fisheries Project ZBS2002-04. 40 pgs.

Galveston Bay Estuary Program. 2002. The State of the Bay: A Characterization of the Galveston Bay Ecosystem, 2nd Edition. GBEP T-7. Last accessed September 15, 2007.
<http://gbic.tamug.edu/sobdoc/sob2/sob2page.html>

Godwin, S., K. Rodgers, and P. Jokiel. 2006. Reducing Potential Impact of Invasive Marine Species in the Northwestern Hawaiian Islands Marine National Monument. Hawaii Coral Reef Assessment and Monitoring Program. Last accessed September 15, 2007.
http://www.hawaii.edu/HIMB/nwhi_crrp/documents/Godwin_et_al_Invasives_2006.pdf

Johnson, L. and J. Gonzalez. 2006. Nontoxic Hull Coating Field Demonstration: Long-Term Performance. UCSGEP-SD Fact Sheet 06-3. Last accessed September 15, 2007.
<http://seagrant.ucdavis.edu/watershed/CoatingPerformanceUpdate2006.pdf>

Johnston, C. N. 1999. Re: Petition for repeal of 40 C.F.R. § 122.3(a). Letter to Carol Browner, EPA Administrator. January 13, 1999.

Lloyd's Register. 2007. Ballast Water Treatment Technology, Current Status.

Maddison, B. 2006. Treating Ballast Water from Cruise Ships at the Port of San Francisco: Options and Feasibility. Bluewater Network. Last accessed September 15, 2007.
<http://www.bluewaternet.org/ballastwaterstudy.pdf>

MARAD. 2006. 2005 Vessel Calls at U.S. and World Ports. United States Department of Transportation, Maritime Administration, Office of Statistical and Economic Analysis. April 2006.

Massachusetts Office of Coastal Zone Management. 2001. Massachusetts Clean Marine Guide; Strategies to Reduce Environmental Impacts. Last accessed September 15, 2007.
www.mass.gov/czm/marinas/guide/

Navy Research and Development Division. 1997. UNDS Hull Coating Evaluation. Marine Environmental Support Office, Naval Command, Control & Ocean Surveillance Center, RDT&E Division (NRaD), 28 February 1997.

NAS. 2003. Oil in the Sea III: Inputs, Fates, and Effects. National Academy of Sciences. National Academy Press.

NBIC. 2004. *NBIC Online Database*. Electronic publication, Smithsonian Environmental Research Center & United States Coast Guard. <http://invasions.si.edu/nbic/search.html>

NEA et al., v. EPA. 2006. Order Granting Plaintiffs' Motion for Permanent Injunctive Relief. Case No. 03-05760SI. Sept. 18, 2006

NMMA. 2007. 2006 U.S. Recreational Boat Registration Statistics. National Marine Manufacturers Association.

Oregon Department of Environmental Quality. 2002. Best Management Practices for Oregon Marinas. ODEQ Marina Outreach Team. May 2002. Last accessed September 15, 2007.
<http://www.devilslakeor.us/text/MarinaBMPs-1.pdf>

Schiff, K., D. Diehl, and A. Valkirs. 2003. Copper Emissions from Antifouling Paint on Recreational Vessels. Southern California Coastal Water Research Project. Tech. Rpt. 405. Last Accessed September 15, 2007. <http://www.waterboards.ca.gov/sandiego/programs/baycleanup/DiverBMPSCCWRP.pdf>

Schmidt, K. 2000. Cruising for Trouble: Stemming the Tide of Cruise Ship Pollution. Bluewater Network. Last accessed September 15, 2007.
http://www.bluewaternet.org/reports/rep_ss_cruise_trouble.pdf

Showalter, S. and J.Savarese. 2005. Restrictions on the Use of Marine Antifouling Paints Containing Tributyltin and Copper. Sea Grant Law Center. MASGP 04-052

Taylor, A.H. and G. Rigby. 2002. The Identification and Management of Vessel Biofouling Areas as Pathways for the Introduction of Unwanted Aquatic Organisms. Australia, Dept. of Agriculture, Fisheries, and Forestry, Ballast Water Research Programme. Last accessed September 15, 2007.
http://www.daff.gov.au/_data/assets/pdf_file/0019/9082/ballast_report16.pdf

USACE. 2005a. Waterborne Transportation Lines of the United States. Volume 1: National Summaries. United States Army Corps of Engineers, Institute for Water Resources. Alexandria, Virginia.

USACE. 2005b. Waterborne Transportation Lines of the United States. Volume 2: Vessel Company Summary. United States Army Corps of Engineers, Institute for Water Resources. Alexandria, Virginia.

USACE. 2005c. Waterborne Transportation Lines of the United States. Volume 3: Vessel Characteristics. United States Army Corps of Engineers, Institute for Water Resources. Alexandria, Virginia.

USCG. 2007a. Merchant Vessels of the United States (VESDOC). National Vessel Documentation Center. Revised May 5, 2007.

USCG 2007b. Metadata for Merchant Vessels of the United States (VESDOC). National Vessel Documentation Center. Revised May 8, 2007.

U.S. CBP. 2007. 2005 U.S. Customs Vessels Entrances and Clearances. USACE, Navigation Data Center. <http://www.ndc.iwr.usace.army.mil/data/dataclen.htm>

Washington State Department of Ecology. 1998. Resource Manual for Pollution Prevention in Marinas. Publication # 9811.

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ATTACHMENT A

State-by-state Recreational Vessel Registration Information

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