Disclaimer

The Draft Report to Congress: Study of Discharges Incidental to Normal Operation of Commercial Fishing Vessels and Other Non-Recreational Vessels less than 79 feet has been signed by EPA. EPA is announcing this report in the Federal Register. While we've taken steps to ensure the accuracy of this Internet version of the report, it's not the official version. Upon publication you will be able to obtain the official copy of this notice at www.epa.gov/npdes/vessels/reportcongress.cfm or at the Federal Register Web site.

CHAPTER 1
INTRODUCTION TO THE REPORT

1.1. CONGRESSIONAL STUDY CHARGE

On July 31, 2008, Public Law (P.L.) 110-299[1] was signed into law. It provides a two-year moratorium for nonrecreational vessels less than 79 feet in length and all commercial fishing vessels regardless of length, from the requirements of the National Pollutant Discharge Elimination System (NPDES)[2] program to obtain a permit for discharges incidental to the normal operation of those vessels.[3] Additionally, P.L. 110-299 directs the United States Environmental Protection Agency (EPA) to study the environmental impacts of discharges incidental to the normal operation of those vessels. Specifically, the law directs the agency to study and evaluate the impacts of:

(1) Any discharge of effluent from properly functioning marine engines
(2) Any discharge of laundry, shower, and galley sink wastes
(3) Any other discharge incidental to the normal operation of a vessel

Congress mandated that EPA include the following elements in the study:

(1) Characterizations of the nature, type, and composition of the discharges for:
    a. Representative single vessels
    b. Each class of vessels
(2) Determinations of the volume (including average volumes) of those discharges for:
    a. Representative single vessels
    b. Each class of vessels
(3) A description of the locations (including the more common locations) of the discharges.
(4) Analyses and findings as to the nature and extent of the potential effects of the discharges, including determinations of whether the discharges pose a risk to human health, welfare, or the environment, and the nature of those risks.
(5) Determinations of the benefits to human health, welfare, and the environment from reducing, eliminating, controlling, or mitigating the discharges.
(6) Analyses of the extent to which the discharges are currently subject to regulation under federal law or a binding international obligation of the United States.

---

[1] P.L. 110-299, along with its companion law for recreational vessels, P.L. 110-288 (“The Clean Boating Act”) are presented in Appendix C of this report.

[2] The NPDES program requires a permit when a point source discharges a pollutant to waters of the US. A NPDES permit contains conditions and limitations on the rates, concentrations, and mass of a pollutant that can be discharged to a water body. The limitations are based on available pollution control technologies and water quality standards that are established to protect the designated uses of a water body, such as fishing or swimming.

[3] Although this report focuses on the discharges from vessels subject to the moratorium, the Agency became aware during interaction with congressional staff, that some members may be interested in additional information on discharges incidental to the normal operation of a larger universe of vessels—in particular, vessels currently subject to the NPDES General Permit for Discharges Incidental to the Normal Operation of a Vessel (“Vessel General Permit”). Therefore, EPA has included some additional information and analysis regarding those vessels where possible.

The law expressly excludes certain discharges from the scope of the study: discharges from vessels owned and operated by the Armed Forces;[4] discharges of sewage[5] from vessels, other than the discharge of graywater from vessels operating on the Great Lakes; and discharges of ballast water.

EPA conducted the study required by P.L. 110-299 and is publishing this report to present its findings. Due to the accelerated timeframe required to complete the study, EPA designed this analysis to be accomplished quickly with existing resources. Limitations in the study design are discussed in Chapter 2 of this report. Due to these factors, EPA focused its sampling efforts on the vessels that P.L. 110-299 specifically exempted. EPA henceforth refers to these vessels and vessel types as study vessels. EPA sampled discharges from a few other vessel types, including commercial vessels that were manufactured primarily for pleasure, where resources and logistics allowed.

1.2. ORGANIZATION OF THIS REPORT

The report is organized into seven chapters. In Chapter 1, EPA describes the universe of vessels with discharges subject to the study, the types of discharges generally thought to originate from those vessels, and the types of pollutants or other constituents generally found in those vessel discharges. In Chapter 2, EPA discusses the methods for sampling, the types of vessels sampled, the Quality Assurance and Quality Control (QA/QC) measures taken in the course of sampling, and the limitations of this study. Chapter 3 is the most technical portion of the report, presenting the results from EPA's sampling and other information gathered from literature reviews about the vessel discharges. Chapter 4 presents the results of EPA's screening-level model, which was designed to look at the large-scale, cumulative impacts of these vessel discharges on large harbor or estuarine systems in order to provide an initial evaluation of the threat the discharges pose to these ecosystems. Chapter 5 discusses the results and identifies those key areas where EPA found discharges most likely to be a concern to human health, welfare, or the environment. Chapter 6 provides a summary of federal law and binding international obligations to which discharges within the scope of the study are potentially subject. To a certain extent, Chapter 6 also discusses discharges described in the study that might be beyond the scope of the permitting moratorium in some circumstances. Chapter 7 lists report references.

1.3. CLASSES OR TYPES OF VESSELS

The study required by P.L. 110-299 could potentially include numerous classes or types of vessels that vary greatly in size. The smallest vessels include recreational boats used for commercial purposes, which can be less than 20 feet in length. The largest vessels, such as super oil tankers, can be more than 1,200 feet in length. Characteristics of these vessels, including construction material, designed purpose, onboard activities, crewing requirements, engine type and power, and days in

[4] The Clean Water Act defines "vessel of the Armed Forces" as any vessel owned or operated by the Department of Defense, other than a time or voyage chartered vessel; and any vessel owned or operated by the Department of Transportation that is equivalent to one owned by the Department of Defense. 33 U.S.C. § 1322(a)(14).
[5] "Sewage" is defined as "human body wastes and the wastes from toilets and other receptacles intended to receive or retain body wastes except that, with respect to commercial vessels on the Great Lakes, such term shall include graywater." 33 U.S.C. § 1322(a) (6).

operation vary widely. Consequently, the types and volumes of discharges generated by these different classes or types of vessels also vary to a great extent.

EPA identified many classes or types of nonrecreational vessels in the development of the 2008 Vessel General Permit (VGP). Examples include tank ships that transport large volumes of bulk liquids, container ships that transport containerized cargo, barges that transport bulk goods, and large cruise vessels that transport hundreds or thousands of passengers. In the VGP, EPA defines a “Cruise Ship” as a passenger ship that is used commercially for pleasure cruises and provides overnight accommodations to passengers. In a separate study, EPA prepared an extensive cruise ship discharge assessment report characterizing five different discharge types from these vessels.[6]

The moratorium of P.L. 110-299 applies to discharges from nonrecreational vessels less than 79 feet in length and all commercial fishing vessels. For some vessel classes or types, such as barges or cruise ships, the majority of that class or type are vessels longer than 79 feet. For other classes or types, such as container ships or oil tankers, all the vessels would be expected to be longer than 79 feet. EPA did not include such vessel classes in this study, as resources did not allow for representative sampling of the larger vessels to provide an assessment of the discharges from those classes and still adequately sample and assess the vessels specifically exempted by P.L. 110-299. In this study, EPA focused on sampling discharges from the most prevalent classes or types of vessels defined by the moratorium parameters, but sampled other vessels if the opportunity presented itself. The following subsections briefly describe key characteristics of some of the vessels considered for sampling in the study, but this list is not intended to be comprehensive.

1.3.1. Commercial Fishing Vessels

As defined in P.L. 110-299, commercial fishing vessels are vessels that commercially engage in the catching, taking, or harvesting of fish or an activity that can reasonably be expected to result in the catching, taking, or harvesting of fish. Commercial fishing vessels include any vessels harvesting fish, crab, lobster, shrimp, or other aquatic organisms for commercial sale. Commercial fishing vessels may employ various methods of collection including nets, trawls, traps, or hook-and-line to capture the target species. Types of fishing vessels include:

Purse Seiner: Purse seiners catch fish that school close to the surface, such as salmon, herring, and sardines, by encircling them with a long net and drawing (pursing) the bottom closed to capture the fish.

[6] This report is available at: www.epa.gov/owow/oceans/cruise_ships/pdf/0812cruiseshipdischargeassess.pdf.

Purse Seiner Fishing Vessel.

Troller: Troll vessels catch fish such as salmon and tuna by “trolling” bait or lures on lines through feeding concentrations of fish. Trolling vessels come in a variety of sizes and configurations, ranging from small, hand-trolling skiffs to large, ocean-going power trolling vessels of 50 feet or more in length.

Troller Fishing Vessel.

Crabber/Lobster: Crabbers and lobster boats target crabs (Dungeness, King, Tanner, and Blue) and lobsters using twine or wire-meshed steel pots (traps). Baited pots are left to "soak" for up to several days before retrieval. Crab and lobster boats come in a variety of shapes and sizes, from aluminum skiffs with outboard motors that fish the inside waters, to seagoing vessels 100 or more feet in length that fish the Bering Sea and the Gulf of Alaska for King Crab.

Gillnetter: Gillnetters catch a variety of fish, such as salmon, herring, and chum, by setting curtain-like nets perpendicular to the direction in which the fish are traveling as they migrate along the coast toward their natal streams. Nets can be set in place, such as at or near the mouths of rivers, or allowed to drift freely in deep water. Gillnet vessels are usually 30 to 40 feet long and are easily recognized by the drum on either the bow or the stern on which the net is rolled.

Gillnetter Fishing Vessel.

Trawler: Trawlers, also occasionally called draggers, typically catch large quantities of mid-water species, such as pollock or pink shrimp, and bottom-fish, such as flounder, by towing a large, cone-shaped net. Trawlers range in size from small shrimp trawlers to large, 600-foot ocean pollock trawlers that possess onboard processing facilities.

Trawler Fishing Vessel.

Longliner: Longliners catch fish (primarily halibut, black cod, swordfish, and tuna) via a longline that is either laid on the bottom or suspended in the water column. Each longline can be up to a mile in length and have thousands of baited hooks. A longline vessel typically sets several lines for a 24-hour “soak.” Longliners are typically 50 to 100 feet in length.

Longliner Fishing Vessel.

Fishing Dredge: A fishing dredge, also known as a scallop dredge or oyster dredge, is a device that is towed along the bottom of the sea by a fishing vessel to collect scallops, oysters, clams, crabs, and even in some cases, sea cucumbers. Dredge boats used to collect clams, oysters, and crabs in near-shore estuarine waters range from 24 to 50 feet long. Large off-shore dredges used to collect sea scallops can be as long as 190 feet

Fish Tender: A fish tender vessel supports fishing vessels by providing supplies and storing, refrigerating, or transporting fish, fish products, or other materials.

Tender Vessel.

1.3.2. Tugs/Towing Vessels

Tugboats and towboats serve many functions and include vessels that operate solely in river systems to ocean-going vessels. Tugboats can be utilized to push or tow barges and rafts. Tugboats often assist larger vessels in docking maneuvers in harbors and are generally powerful relative to their size. Although tugboats and towboats can be over 200 feet in length, many are in the 40- to 100-foot range.

Tugboat/Push Boat.

1.3.3. Water Taxis/Small Ferries

Water taxis and small ferries (or water busses) are vessels employed to provide public transport of people from one location to another. Small ferries are vessels for hire that are designed to carry passengers and/or vehicles between two ports, usually in inland, coastal, or near-shore waters. Many of these vessels can be found in the coastal harbors of New York, Baltimore, Boston, San Diego, Seattle, and others. The sizes of the vessels in this class vary and can surpass 100 feet in length.

1.3.4. Tour Boats

This vessel class encompasses a variety of vessels used for activities such as dinner cruises, ecotourism, whale watching excursions, and sightseeing trips. Vessels in this class can range from small private vessels with just a few passengers to large vessels carrying 50 or more passengers. Large tour boats designed for extended excursions can include galley facilities, overnight accommodations, and laundry.

A Tour Boat (left) and a Water Taxi (right).

1.3.5. <u>Recreational Vessels Used for Non-Recreational Purposes</u>

This class includes vessels manufactured as recreational vessels that are used for nonrecreational purposes, such as law enforcement vessels, fire/rescue vessels, towing and salvage vessels (not to be confused with towboats above), and research vessels. This vessel class encompasses a broad range of vessel types and sizes. Under the Clean Boating Act of 2008 (P.L. 110-288), vessels that are manufactured or used primarily for pleasure are “recreational vessels” subject to regulation under that Act.

Recreational Vessel Modified for Towing/ Salvage.

1.4. VESSEL POPULATION

As discussed in Section 1.1, P.L. 110-299 requires EPA to characterize discharges for representative single vessels and for each class of vessel in terms of its nature; type and composition; average volume; location; nature and extent of the potential effects; and benefits of reducing, eliminating, controlling, or mitigating the discharges. EPA focused its attention on the commercial fishing vessels and other nonrecreational vessels less than 79 feet in length covered by the moratorium. Understanding the characteristics of discharges from all commercial fishing vessels and nonrecreational vessels less than 79 feet in length requires considering these vessels in term of their number, vessel type, onboard equipment, type of service, and area of operation. A brief overview of the analysis on vessel type and size is presented in this section. A more complete analysis, including a discussion regarding vessel location (which impacts the location of vessel discharges) and other vessel characteristics, is presented in Appendix B of this report.

1.4.1. Vessel Characteristics Data

In evaluating and describing the vessel population, EPA primarily relied on data gathered by the U.S. Coast Guard. The primary data source used in the vessel population analysis is the U.S. Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) database (USCG, 2009). MISLE provides a wide range of information regarding vessel and facility characteristics, accidents, marine pollution incidents, and other pertinent information tracked by the U.S. Coast Guard. Where possible, EPA complemented the data available in MISLE with information obtained from published sources or from consultations with U.S. Coast Guard personnel or port authorities.

MISLE includes data for nearly 1 million vessels that operate in U.S. waters. The database covers a wide ensemble of vessels (e.g., recreational vessels, commercial fishing vessels, freight barges, tank barges, tank ships, passenger vessels, utility vessels), and provides data on various characteristics for each individual vessel. These data include:

- Identification number(s)
- Vessel category (e.g., class, type, subtype, service)
- Size (e.g., tonnage, length, breadth, depth)
- Area of operation (e.g., hailing port, route type)
- Passenger and crew capacity
- Propulsion (i.e., method, engine type, and horsepower)
- Construction material and design (e.g., hull material, design type, hull configuration/shape)
- Year built or age

In compiling MISLE data, the U.S. Coast Guard largely relies on documents submitted by vessel owners or operators in accordance with vessel documentation requirements (e.g., certificate of documentation) or on information gathered by U.S. Coast Guard staff directly (e.g., during inspections, vessel boardings, or accident investigations). While the database scope is not limited to a certain size or class of vessel, the scope of the data included in MISLE is driven in part by the regulatory requirements to which different types of vessels are subject or by activities conducted by Coast Guard offices. MISLE therefore, is generally most comprehensive for those vessels that are documented, state registered, and/or subject to inspection requirements.

While MISLE represents the most comprehensive national dataset currently available, it does not capture the entire universe of vessels operated on U.S. waters. As discussed at greater length in Appendix B, only limited information is available for certain classes of vessels, such as smaller recreational vessels, due to the way in which vessel data are gathered. Most recreational vessels are not subject to documentation or regular inspection requirements and thus are not captured in MISLE.[7] The MISLE data set currently contains approximately 700,000 recreational vessels, approximately 36 percent of which are documented vessels; the other recreational vessels are present in MISLE because of other U.S. Coast Guard activities, such as boardings, nonmandatory inspections (e.g., voluntary inspection program), or incident investigations.[8] Shortcomings of the database mostly regard small recreational vessels. Since recreational vessels are covered separately under the Clean Boating Act of 2008 (P.L. 110-288) and are therefore not the primary focus of this report, EPA believes that data limitations do not preclude the use of the MISLE data for the current analysis to generally describe the characteristics of study vessels.

1.4.2. <u>Overview of Vessel Universe</u>

Information is provided in MISLE for a total of 993,863 vessels. Based on information recorded in the database, 976,649 of these vessels are presumed currently operational, of which 918,469 vessels are identified as U.S.-flagged vessels (referred to as "domestic" vessels in the remainder of the section).[9,10] Nearly 80 percent of the 918,469 operational domestic vessels recorded in MISLE are recreational vessels (722,522 vessels), while 7.6 percent are identified as commercial fishing vessels. The remainder of the MISLE universe is composed of other types of nonrecreational vessels (10.5 percent) such as freight and tank barges and ships, passenger vessels, and utility vessels, and vessels of unspecified service (3 percent). Figure 1.1 presents the MISLE population of operational, domestic vessels for all vessel service categories, excluding recreational vessels. While the P.L. 110-299 moratorium will generally apply to discharges from the vessel service categories shown in the figure, many of the vessels presented in Figure 1.1 are not subject to the P.L. 110-299 permitting moratorium since the law is limited to commercial fishing vessels (regardless of size) and other nonrecreational vessels 79 feet or less. Approximately one-third of the operational, domestic, nonrecreational vessels are commercial fishing vessels. The next largest vessel service category is freight barges, with

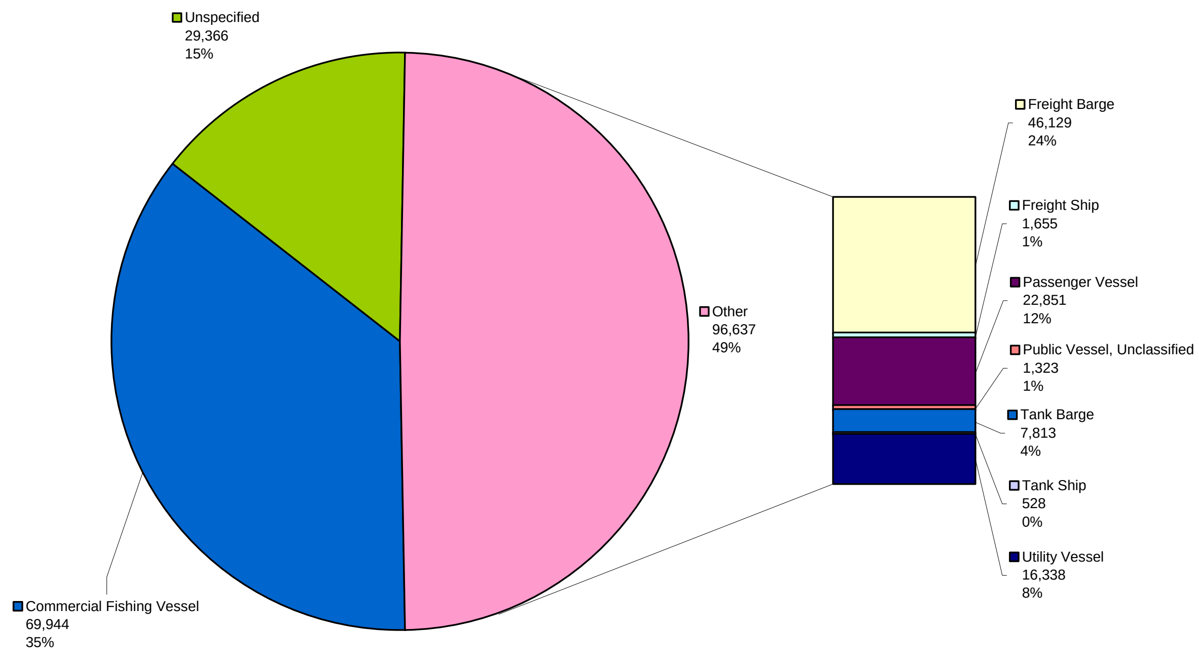
[7] While the number of recreational vessels recorded in MISLE is high (over 700,000), the database accounts for only a small fraction of the 16.9 million recreational vessels estimated to operate in U.S. waters, according to EPA's Economic Impact Analysis of the Recreational Vessel Permit (USEPA, 2008a) and to the National Marine Manufacturers Association's (NMMA's) 2007 U.S. Recreational Boat Registration Statistics (NMMA, 2009).

[8] Personal communication with U.S. Coast Guard Representative, LCDR Scott Muller, on May 15, 2009.

[9] Approximately 355,000 vessels do not provide a vessel status and 5,000 have an "unknown" status. Following guidance from a Coast Guard representative (*Source:* Personal email communication with Harold Krevait of the U.S. Coast Guard. March 13, 2009), EPA assumed that these vessels are currently operational.

[10] This count is based on the flag of the vessel. However, the MISLE database records a U.S. hailing port for some vessels that are foreign flagged. Additionally, approximately 57,000 vessel records do not identify the vessel flag. EPA assumed that these are domestic vessels.

approximately 24 percent of vessels; however, many of these barges may exceed the 79-foot length restriction.



Source: U. S. Coast Guard, MISLE database, 2009.

Note; The chart includes all commercial fishing vessels recorded in MISLE (69,944) and all 96,637 other non-recreational vessels, regardless of length.

Figure 1.1: MISLE Population of Operational, Domestic Non-Recreational Vessels by Vessel Service[11].[12]

Table 1.1 further characterizes the vessel population in terms of length greater than or equal to or less than 79 feet within each vessel service category. As shown in both Table 1.1 and Figure 1.1, the vast majority of vessels documented in MISLE are less than 79 feet in length. For example, nearly 77 percent of commercial fishing vessels (54,176 vessels out of 69,944) recorded in MISLE have a length less than 79 feet.[13] Vessels less than 79 feet also are a vast majority (94 percent) of the recreational

[11] This figure does not include the 722,522 recreational vessels included in the MISLE population of operational, domestic vessels.
[12] Approximately 74,000 vessels have a vessel service indicated as "unclassified", "unknown", or "unspecified" in MISLE. In approximately 44,000 of those instances, EPA was able to assign a vessel service for the purpose of this analysis based on information provided in other data fields (i.e., using vessel class, vessel type, or vessel subtype information).
[13] According to a U.S. Coast Guard representative, the overall fraction of commercial fishing vessels that are less than 79 feet in length is estimated to be approximately 95 percent (Personal communication with Jack Kemerer, Fishing Vessel Safety Program, May 26, 2009).

vessels. Only the other nonrecreational vessel service category counts a majority of vessels 79 feet or longer.

Table 1.1: Population of Operational, Domestic MISLE Vessels by Vessel Length

	Recreational	Commercial Fishing	Other Non-Recreational	Unspecified
Greater than or Equal to 79 ft	2,256	2,231[(2) (3)]	54,142	1,991
Less than 79 ft	676,915	54,176	32,799	15,011
Zero or Null[1]	43,351	13,537	9,696	12,364
Total	722,522	69,944	96,637	29,366

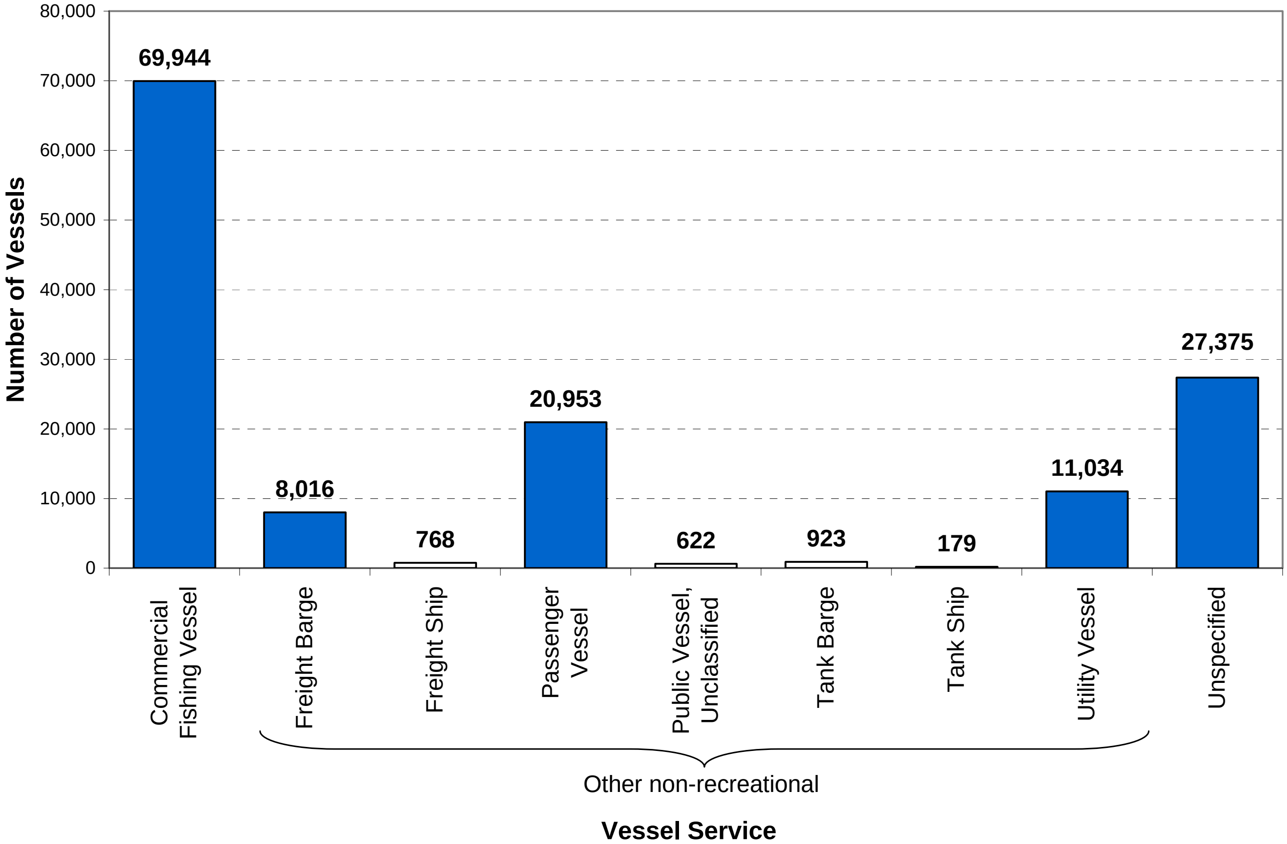
Source: U. S. Coast Guard, MISLE database, 2009
[(1)] MISLE indicates a length of zero or the vessel length field is blank.
[(2)] A separate estimate provided by U.S. Coast Guard personnel suggests that commercial fishing vessels 79 feet long or greater number approximately 1,800 to 1,900 vessels.[14]
(3) Columns with yellow background represent study vessels

Recreational vessels are generally excluded from many parts of our analysis because a separate act (the Clean Boating Act of 2008 (P.L. 110-288)) exempts discharges incidental to the normal operation of these vessels from NPDES permitting requirements. The Clean Boating Act defines recreational vessels as those that are either 1) manufactured or used primarily for pleasure, or 2) leased, rented, or chartered to a person for the pleasure of that person. Furthermore, vessels that are subject to U.S. Coast Guard inspection and that are either engaged in commercial use or that carry paying passengers are not considered recreational vessels under the Clean Boating Act. This definition does not necessarily correspond to the service categories used in MISLE to identify recreational versus nonrecreational vessels because MISLE categories are based on the type of service the vessel is used for rather than original manufacture purpose.

1.4.2.1. Study Vessel Type

Once commercial, non-fishing vessels longer than 79 feet are removed from the analysis, the relative makeup of the study vessels changes. EPA estimates there are nearly 140,000 vessels in the United States subject to the permitting moratorium established by P.L. 110-299. Figure 1.2 presents the estimated distribution of vessels within the study vessel population by vessel service (type). Approximately one-half of these vessels are commercial fishing vessels involved in such activities as fish catching (e.g., longliner, shrimper, and trawler), fish processing, fishing tenders, and charter fishing. The other one-half are distributed among a variety of vessel classes, including passenger vessels (e.g., water taxis, tour boats, harbor cruise ships, dive boats), utility vessels (e.g., tug/tow boats, research vessels, offshore supply boats), and freight barges.

[14] Personal communication with Jack Kemerer, Fishing Vessel Safety Program, May 26, 2009.



Note: The figure is based on operational, U.S.-flagged commercial fishing vessels (regardless of length) and other nonrecreational vessels less than 79 feet in length.
Commercial fishing vessels also include *fish processing vessels* and *fishing vessels*. Passenger vessels include *passenger (inspected*), *passenger (uninspected), passenger barge (inspected), passenger barge (uninspected),* and *passenger ships*. Public vessel, unclassified includes military and other public service vessels. EPA notes that military vessels are specifically excluded in P.L. 110-299. Utility vessels include *towing vessels (i.e., tugs), school ships, research vessels/ships, mobile offshore drilling units, offshore vessels, offshore supply vessels, oil recovery vessels,* and *industrial vessels.* Some vessel service categories did not fall into one of the listed categories. Therefore, based on the other classification fields (class, type, subtype), EPA determined an appropriate service category.
Source: U. S. Coast Guard, MISLE database, 2009

Figure 1.2. Number of Study Vessels Recorded in MISLE, by Vessel Service (Type)

<u>Commercial Fishing Vessels</u>

As shown in Figure 1.2, approximately 70,000 commercial fishing vessels represent the largest category of study vessels. Based on this information, EPA sampled more commercial fishing vessels than other nonrecreational vessels less than 79 feet in length (see discussion in Section 2.2.1). According to the vessel service categories used by the U.S. Coast Guard in MISLE, "commercial fishing vessels" are vessels involved in such activities as fish catching (e.g., longliner, shrimper, trawler), fish processing, and charter fishing.[15]

[15] Several charter fishing vessels are categorized as "commercial fishing vessels" in MISLE even though they are generally not considered commercial fishing vessels by the U.S. Coast Guard Fishing Vessel Safety Program. That program considers

The U.S. Coast Guard generally describes commercial fishing vessels as including fishing vessels, fish tender vessels, and fish processing vessels as follows:

- Fish processing vessel[16] means a vessel that commercially prepares fish or fish products other than by gutting, decapitating, gilling, skinning, shucking, icing, freezing, or brine chilling.
- Fish tender vessel means a vessel that commercially supplies, stores, refrigerates, or transports fish, fish products, or materials directly related to fishing or the preparation of fish to and from a fishing, fish processing, or fish tender vessel or a fish processing facility.
- Fishing vessel means a vessel that commercially engages in the catching, taking, or harvesting of fish or an activity that can reasonably be expected to result in the catching, taking, or harvesting of fish.

While there is some overlap in service use for commercial fishing vessels and other vessel categories, such as passenger vessels (e.g., charter fishing), EPA assumed that the categorization used in MISLE generally follows the U.S. Coast Guard definition of commercial fishing vessels.[17]

Other Nonrecreational Vessels

Excluding the approximately 27,000 "unspecified" vessels shown in Figure 1.2, "passenger vessels" have the second highest number of study vessels with approximately 21,000 vessels. These vessels are further divided into subtypes according to the types of activities in which they are involved (e.g., diving vessels, charter fishing vessels, ferry, harbor cruise vessels, sailing vessels). The service category labeled "public vessel, unclassified" accounts for nearly 700 study vessels (e.g., lighthouse tender vessels, hospital ships, law enforcement vessels, ice breakers). The "utility vessels" category covers remaining types of vessels, including tug/tow boats, school ships, research vessels/ships, mobile offshore drilling units, offshore vessels, offshore supply vessels, oil recovery vessels, and industrial vessels. More than 11,000 vessels are classified as utility vessels in MISLE.[18] Freight barges (8,016 vessels), freight ships (768 vessels), tank barges (622 vessels), and tank ships (179 vessels) account for the remaining nonrecreational study vessels.

---

these vessels to be passenger vessels (Source: Personal communication with Jack Kemerer, Fishing Vessel Safety Program, May 26, 2009). According to the Coast Guard definition, the key difference between vessels formally classified as commercial fishing vessels and recreational vessels or passenger vessels that may be used in fishing activities is whether the catch is sold.

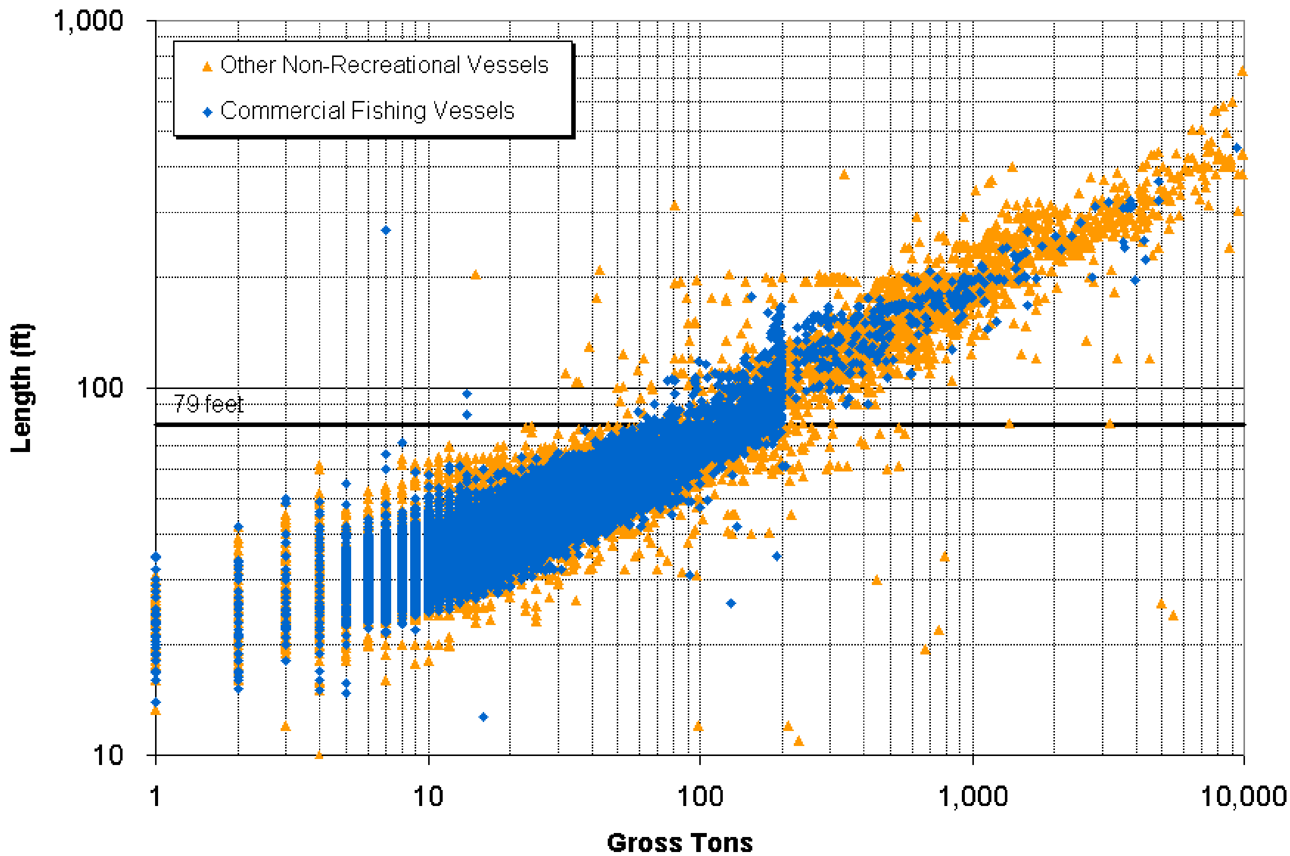
[16] The moratorium provided by P.L. 110-299 applies only to discharges incidental to the normal operation of a vessel when acting in the mode of transportation. EPA requires NPDES permits for seafood processing vessel discharges when they are created by the processing of seafood as an industrial activity.

[17] The MISLE classification also depends on the information provided directly by the vessel owner or operator on the application for documentation or renewal (*Source:* Personal communication with Jack Kemerer, Fishing Vessel Safety Program, May 26, 2009).

[18] Some vessel service categories did not fall into one of the listed categories. EPA determined an appropriate service category based on information provided in other vessel classification fields (class, type, subtype).

1.4.2.2. Vessel Size

Vessels can be characterized by size according to two metrics: length and gross tons. The two metrics are related to each other (gross tonnage is a function of the ship's enclosed spaces as measured to the outside of the hull framing), and Figure 1.3 presents a scatter plot of gross tons and lengths for commercial fishing vessels and other nonrecreational vessels obtained from MISLE. In general, most nonrecreational vessels in MISLE have a length ranging between 26 and 50 feet, which translates into a tonnage generally below 50 gross tons. The 79-foot length threshold for other nonrecreational vessels (the criterion for applicability of P.L. 110-299 moratorium) corresponds roughly to a tonnage of 150 gross tons. In Chapter 6 of this report, EPA uses this information in determining whether certain vessels may be subject to regulation under federal law or a binding international obligation of the United States.

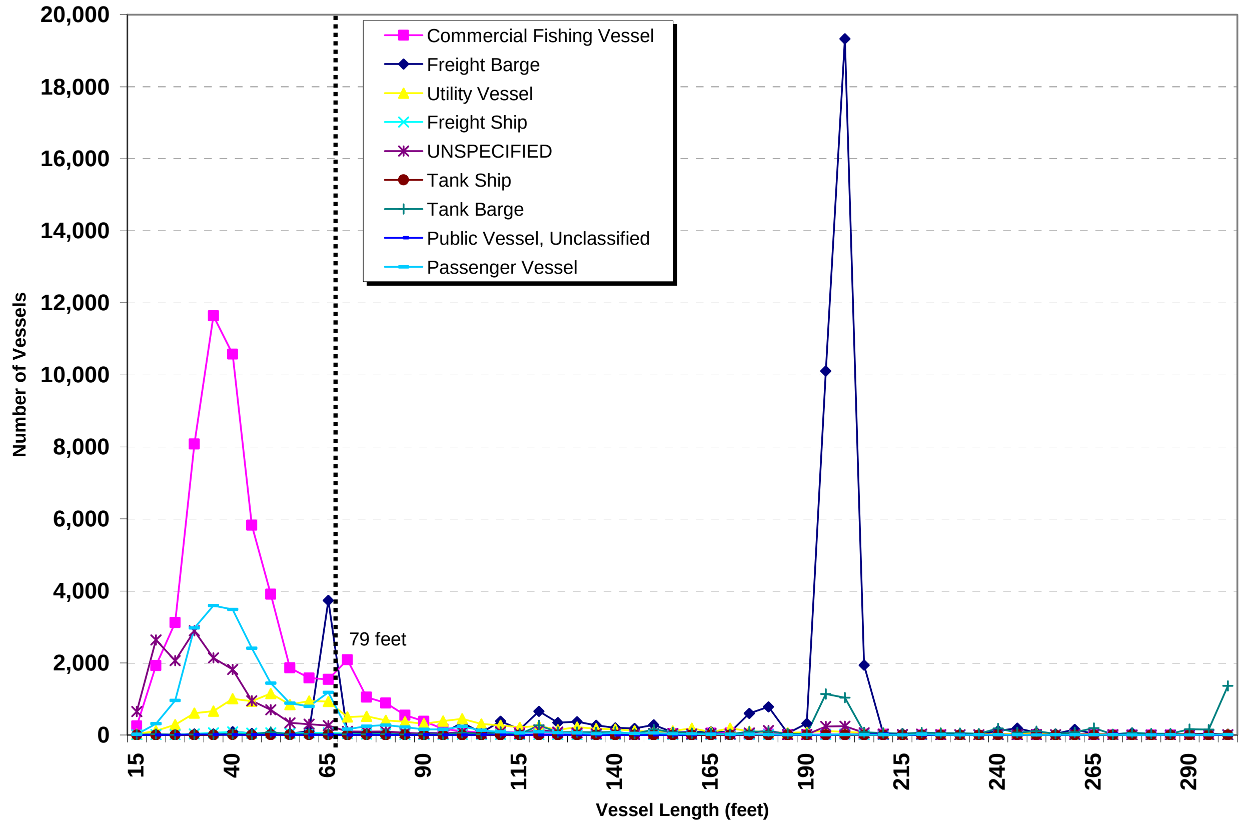


Note: This chart is based on all operational, U.S.-flagged commercial fishing vessels and other nonrecreational vessels, regardless of length.

Source: U. S. Coast Guard, MISLE database, 2009

Figure 1.3: Relationship Between Vessel Gross Tons and Length

Approximately half of vessels documented in MISLE fall within the 26- to 50-foot-length category, they have an average vessel length of 41 feet. Figure 1.4 and Figure 1.5 illustrate the distribution of vessel length for commercial fishing vessels and other nonrecreational vessels in terms of the vessel count (Figure 1.4) and cumulative distribution (Figure 1.5). In analyzing the cumulative distribution of vessels by length (Figure 1.5), tank ships are the only vessel service category with a large percentage of vessels longer than 300 feet.[19] For almost all vessel service categories, vessels less than 79 feet represent the majority of vessels within the overall population.

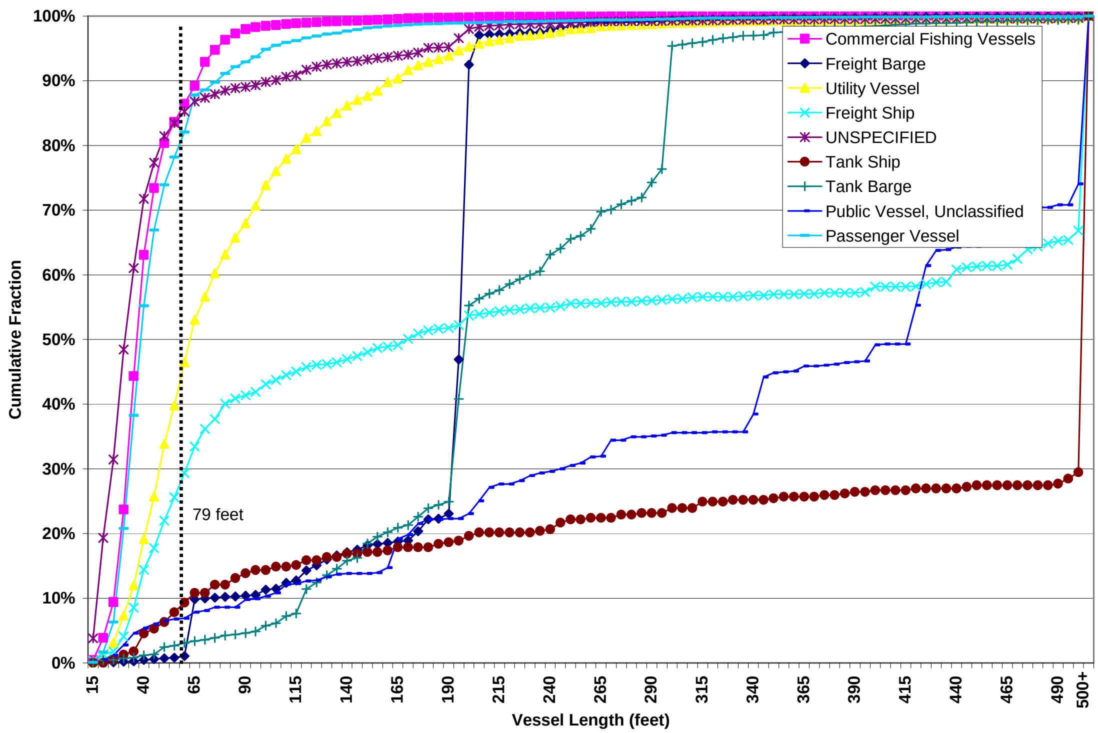


Note: This figure is based on operational, U.S.-flagged commercial fishing vessels and all other nonrecreational vessels (no size exclusion).

Source: U.S. Coast Guard, MISLE database, 2009

Figure 1.4. Distribution of MISLE Vessels by Length and Vessel Service (Type)

[19] Although a large *percentage* of tank ships are listed as greater than 300 feet long, this accounts for a very small *number* of vessels when compared to the overall universe of vessels in the selected service categories; approximately 300 of the 391 tank ships that list a vessel length are longer than 300 feet.

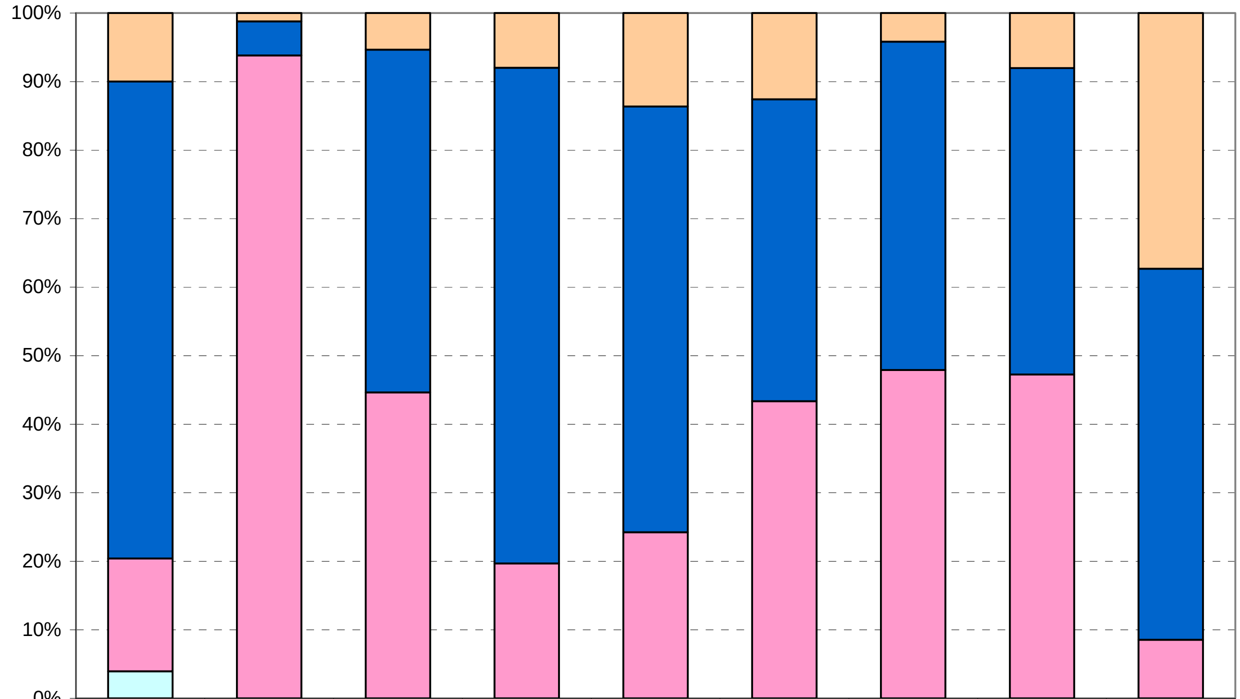


Note: This figure is based on operational, U.S.-flagged commercial fishing vessels and all other nonrecreational vessels (no size exclusion).

Source: U. S. Coast Guard, MISLE database, 2009

Figure 1.5. Cumulative Distribution of MISLE Vessels by Length and Vessel Service (Type)

As shown in the two previous figures, there is significant variability in vessel length across categories of nonrecreational vessels. Most freight barges reported in MISLE are about 200 feet in length and relatively few (10 percent) are under 79 feet in length. Hence, most freight barges are not subject to the moratorium in P.L. 110-299 and are currently eligible for coverage under the VGP. In contrast, the majority of utility vessels (e.g., towing vessels), passenger vessels, and commercial fishing vessels overall are less than 79 feet in length. Figure 1.6 shows the distribution of all commercial fishing vessels and only nonrecreational vessels less than 79 feet in length by length and vessel service (focusing on the study vessels). The majority of commercial fishing vessels are relatively small compared to other nonrecreational vessels such as barges or utility vessels, with 56 percent of commercial fishing vessels in the 26- to 50-foot range. The length of other nonrecreational vessels varies among the subcategories, with as many as 64 percent of passenger vessels in the 26- to 50-foot range, compared to less than 3 percent of freight barges within that same range.



	Commercial Fishing Vessel	Freight Barge	Freight Ship	Passenger Vessel	Public Vessel, Unclassified	Tank Barge	Tank Ship	Utility Vessel	Unspecified
Less than 26	5,631	52	31	1,489	9	36	2	713	5,598
26-50	39,262	214	289	13,496	41	126	23	3,966	8,129
50-79	9,283	4,021	258	3,674	16	124	23	4,196	1,284
79 or more	2,231	NOT INCLUDED IN SELECTED POPULATION							

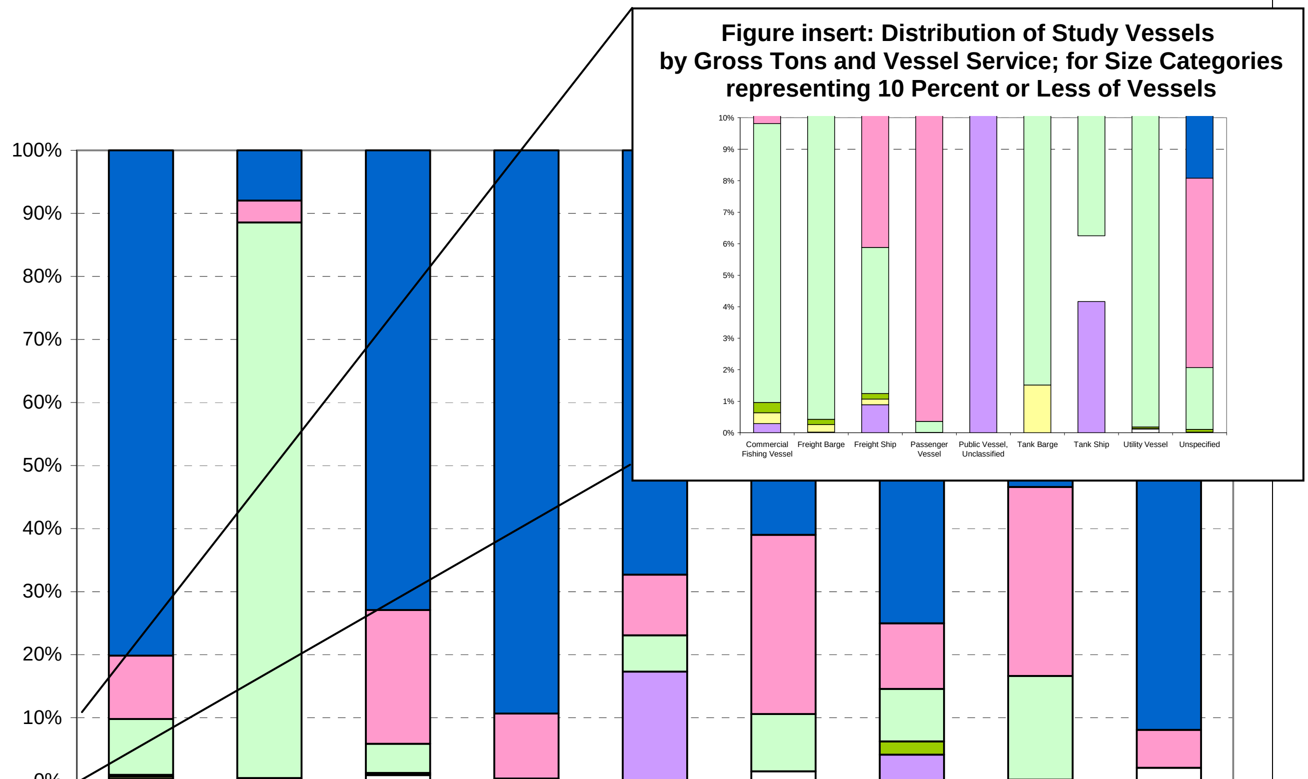
Note: This figure is based on operational, U.S.-flagged commercial fishing vessels and other nonrecreational vessels less than 79 feet in length.

The length field is not reported or provides a value of zero for approximately 36,000 vessels.

Source: U. S. Coast Guard, MISLE database, 2009

Figure 1.6. Distribution of Study Vessels by Length (in Feet) and Vessel Service (Type)

Figure 1.7 presents the distribution of study vessels by gross tons and vessel service. Overall, nearly 77 percent of study vessels are less than 50 gross tons, while the remaining vessels generally fall within the 50- to 300-gross-tons range. Very few vessels (less than 1 percent) within the selected vessel population are greater than 300 gross tons. Note that some vessel service categories appear underrepresented because the gross tons field is blank or is listed as zero in MISLE for approximately 56,000 vessels.



	Commercial Fishing Vessel	Freight Barge	Freight Ship	Passenger Vessel	Public Vessel, Unclassified	Tank Barge	Tank Ship	Utility Vessel	Unspecified
Less than 50	36,650	337	409	15,190	35	161	36	4,398	7,474
50-100	4,599	148	119	1,751	5	75	5	2,469	489
100-300	4,048	3,734	26	59	3	24	4	1,356	159
300-500	148	7	1	2			1	4	7
500-1000	158	10	1			4		1	2
1,000 or more	133	1	5		9		2	10	

Note: This chart is based on operational, U.S.-flagged commercial fishing vessels and other nonrecreational vessels less than 79 feet in length.

The gross tons field is not reported or provides a value of zero for approximately 56,000 vessels.

Source: U. S. Coast Guard, MISLE database, 2009

Figure 1.7. Distribution of Study Vessels by Gross Tons and Vessel Service (for which gross ton data are given in MSLE)

To select specific vessel classes for sampling, EPA first developed a list of commercial vessel classes based on published information and industry experience. Next, EPA eliminated those vessel classes believed to consist of vessels greater than 79 feet in length, with the exception of commercial fishing vessels. Examples of vessel classes eliminated because of their size include cable laying ships, cruise ships, large ferries, and oil and petroleum tankers. Next, EPA eliminated vessel classes not subject to VGP permitting, including stationary seafood processing vessels and vessels that can be secured to the ocean floor for mineral or oil exploration (the CWA regulations separately require NPDES permits for industrial operations onboard vessels). After screening out these vessel classes, EPA selected a subset of priority vessel classes to study, including commercial fishing boats, tug and tow boats, water taxis, tour boats, recreational vessels used for nonrecreational purposes, and industrial support boats less than 79 feet in length. EPA selected these vessel classes because they provide a cross section of discharges and a broad range of potential pollutants.

1.4.2.3. Additional Vessel Characteristic Information

Other vessel characteristics such as vessel age and engine power (horsepower ahead) likely influence the characteristics and the volume of many vessel discharges. Intuitively, where a vessel is located and operated can determine the impacts. Additionally, where there are more vessels, there is a greater likelihood of cumulative impacts (e.g., where there are more vessels, there will be a greater impact from vessel discharges).

Appendix B presents additional vessel characteristic information, including summaries of vessel subtypes, the hailing port of domestically flagged vessels, and information on construction and propulsion of these vessels, including the vessel age and horsepower ahead. Appendix B also discusses limitations in using the MISLE data. Appendix B lists the most common subtypes of vessel within each vessel type. For example, towing vessels are the most common type of utility vessel. Appendix B also shows where concentrations of vessel activities occur and what vessels are most predominant in those assemblages. For example, the hailing port of New Orleans has the most registered vessels, including significant numbers of commercial fishing vessels and other nonrecreational vessels. Finally, Appendix B shows that most study vessels are relatively old, with the majority of them being more than 25 years old. These analyses helped EPA qualitatively and quantitatively analyze the cumulative impact of many vessels' discharges (see Chapter 4 of this report), and to put the numbers and locations of study vessels into perspective relative to other vessels, such as recreational vessels and other non-study vessels (e.g., nonrecreational, noncommercial vessels greater than 79 feet in length).

1.5. DISCHARGES FROM VESSELS

EPA developed a substantial list of discharges from vessels, and pollutants of concern in each of those discharges, during the development and issuance process of the VGP in 2008. Starting with this list, EPA developed a subset of discharges prevalent on fishing vessels and nonrecreational vessels less than 79 feet in length that are expected to have pollutants of concern. The subset of discharges that EPA selected included: bilgewater, deck washdown and runoff, propulsion engine effluent, generator engine effluent, firemain systems, fish hold effluent, fish hold cleaning effluent, graywater, and shaft packing gland effluent. While EPA did not sample antifouling hull-coating leachate, this discharge is discussed as well because this is a significant discharge from many vessels and has been documented to cause water quality impacts (see Section 3.2.8).

EPA recognizes that there are additional discharges[20] that also sometimes are present on study vessels. Some of these were not conducive to sampling, such as cathodic protection, underwater ship husbandry, and oil-to-sea interfaces. Some discharges are generally combined with other discharges and

[20] EPA lists many discharges and descriptions of those discharges in the VGP and the accompanying fact sheet. Due to the timeframe and resource limitations of this study, EPA chose to focus on the nine discharges that were a) conducive to sampling and b) most likely to cause or contribute to impacts to human health, welfare, or the environment.

are not typically available for independent sampling. An example of this is refrigeration system condensate that is drained to the bilge. Other discharges are not expected to be commonly generated on commercial fishing vessels or nonrecreational vessels less than 79 feet in length. These discharges are typically associated with larger vessels, such as those covered by the VGP, and were not sampled for in this study due to resource limitations. Some examples include aqueous film-forming foam, distillation and reverse osmosis brine, exhaust gas scrubber effluent, elevator pit effluent, and boiler/economizer blowdown. A detailed discussion on the discharges EPA decided not to sample is provided in Chapter 2.

1.5.1.1. Bilgewater

Bilgewater is defined as the water that collects in the bottom of a vessel’s hull. This includes water from rough seas, rain, minor leaks (designed or accidental) in the hull or stuffing box, condensate from various types of equipment, spills onboard the vessel, and leaks from pumps and seals. Bilgewater can be found on almost every vessel; if too much water accumulates, it could threaten the safety and stability of the vessel. For example, the U.S. Coast Guard requires that certain commercial fishing vessels and fish-processing vessels have automated bilge pumping systems as part of their basic safety features (46 CFR Part 28.255).

A number of oily and non-oily wastewater sources sometimes drain intentionally or unintentionally into the bilge. Oily wastewater sources include oil, fuel, and antifreeze leaks from engine and machinery operation and maintenance. To prevent floating oils typically found in bilgewater from being discharged overboard, vessels can either use oil-adsorbent pads in the bilge compartment or pump the bilgewater through a properly operating oil-water separation system or oil absorbent filter prior to overboard discharge.

Non-oily wastewater sources include non-oily leaks from engine and machinery operation and maintenance and various condensates. Vessels can have numerous sources of non-oily machinery wastewater, including chilled water condensate drains, fresh- and saltwater pump drains, potable water tank overflows, and leaks from propulsion shaft seals. Large vessels typically have separate systems to collect non-oily machinery wastewater in dedicated drip pans, funnels, and deck drains for subsequent direct discharge. Small vessels can also generate non-oily machinery wastewater; however, these wastewaters likely drain into the bilge.

1.5.1.2. Deck Washdown and Deck Runoff

Deck washdowns are typically performed to prevent slip and fall hazards; to prevent dirt, grit, or other materials from harming the integrity of the deck surface; or to clean the deck after pulling in a catch or unloading cargo. Deck washdown is typically performed using hoses and mops that move the deck washdown water and cleaning agents (if any) to the scuppers through which the water is discharged overboard. Deck cleaning often occurs while the vessel is underway but is also performed pierside, generally after loading or unloading catch or cargo.

Deck runoff is typically related to either precipitation or surface water spray that lands on the deck and flows to the scuppers where it is discharged overboard. Operators of the vessel do not have control over the volume of discharge related to precipitation events or sea sprays, but they can minimize the pollutants carried by the runoff by utilizing appropriate maintenance practices.

Deck washdown and deck runoff have the potential to contain a variety of pollutants, including oil and grease, nutrients, solids, metals, detergents, and solvents. Some or all of these pollutants could be introduced to the deck from shipboard activities, storage of material on the deck, maintenance activities, and the decking material itself.

Deck Washdown Activity of a Water Taxi (left) and a Towing and Salvage Vessel (right).

1.5.1.3. Engine Effluent

Engines found on commercial vessels are typically used for two purposes: propulsion and electricity generation. Engines used for vessel propulsion can be either outboard or inboard engines. Outboard engines are self-contained units designed to be mounted outside the vessel hull at the stern (rear) of the vessel. Inboard engines are enclosed within the hull of the vessel, usually connected to a propulsion screw by a drive shaft. Outboard engines are typically fueled by gasoline, while inboard motors can use either gasoline or diesel fuel. Gasoline or diesel engines can be either two stroke, which require small amounts of oil to be mixed with the fuel to create a mixture that both lubricates and provides combustion, or four stroke, which have separate lubrication systems.

All combustion engines require cooling systems to remove excess heat. Direct-cooled marine engines draw raw water (either fresh water or seawater in which the vessel is floating) into the engine and rely on the raw water to absorb the heat directly from the engine. Biocides sometimes are added to the raw water to prevent biofouling of the heat exchange system (biofouling prevention). Indirect-cooled marine engines use an enclosed cooling system that requires circulation of a freshwater-coolant solution through the engine to absorb heat. The coolant solution passes through a closed heat exchanger where the raw water absorbs the heat from the coolant solution and is then discharged.

Vessels also use keel-cooling systems for indirectly cooling marine engines. A keel cooler is essentially a heat exchanger mounted outside the vessel's hull beneath the waterline. Hot water from the marine engines is pumped through the keel cooler, which is in constant contact with the seawater. This closed-circuit cooling system eliminates the need for an inboard heat exchanger, raw water pumps, and strainers and does not result in a discharge.

Some engines also use water to cool and quiet their exhaust, referred to as boat engine wet exhaust. These engines inject spent cooling water from the engine into the exhaust stream, which results in some of the gaseous and solid components of the exhaust being entrained into the cooling water discharge.

Vessels that require significant lighting or have electrical equipment, such as appliances and/or electric motors, are likely equipped with engines used for electricity generation. Electrical generators on these vessels are typically powered by diesel engines. The size of the electrical generators depends on the electrical load requirements for the vessel, but could range from small generators used to power navigation equipment and galley appliances to large generators used to power electric motors on deck winches and cranes. Similar to vessel engines, electrical generators will require direct or indirect cooling.

Collecting a Sample of Engine Effluent at Full Speed.

Inboard Engine (left) and Outboard Engine (right)

1.5.1.4. Firemain Systems

Some vessels are equipped with firemain systems to supply water for firefighting, and to supply water to other vessel systems. Vessels use either "wet type" or "dry type" firemain systems. The wet type firemain piping is normally filled with water. Wet type systems are particularly used on vessels where the firemain water is used frequently, typically for maintenance activities such as deck washdown. In a dry type system, the piping is normally empty. Water is only introduced to the pipes when actual firefighting takes place, or for testing or training.

Aqueous film-forming foam (AFFF) can also be used on vessels as a fire suppression agent. AFFFs are a combination of fluorochemical surfactants, hydrocarbon surfactants, and solvents (Koetter, 2008) that are injected into the water stream of a fire hose. These film-forming agents are capable of forming water solution films on the surface of flammable liquids, separating the fuel from the air (oxygen). Systems that use AFFFs do not appear to be common on smaller vessels.

Firemain System on a Fire Boat.

Fire Boat.

1.5.1.5. Fish Hold and Fish Hold Cleaning Effluent (Refrigerated Seawater Discharge or Fish Ice Slurry Discharge)

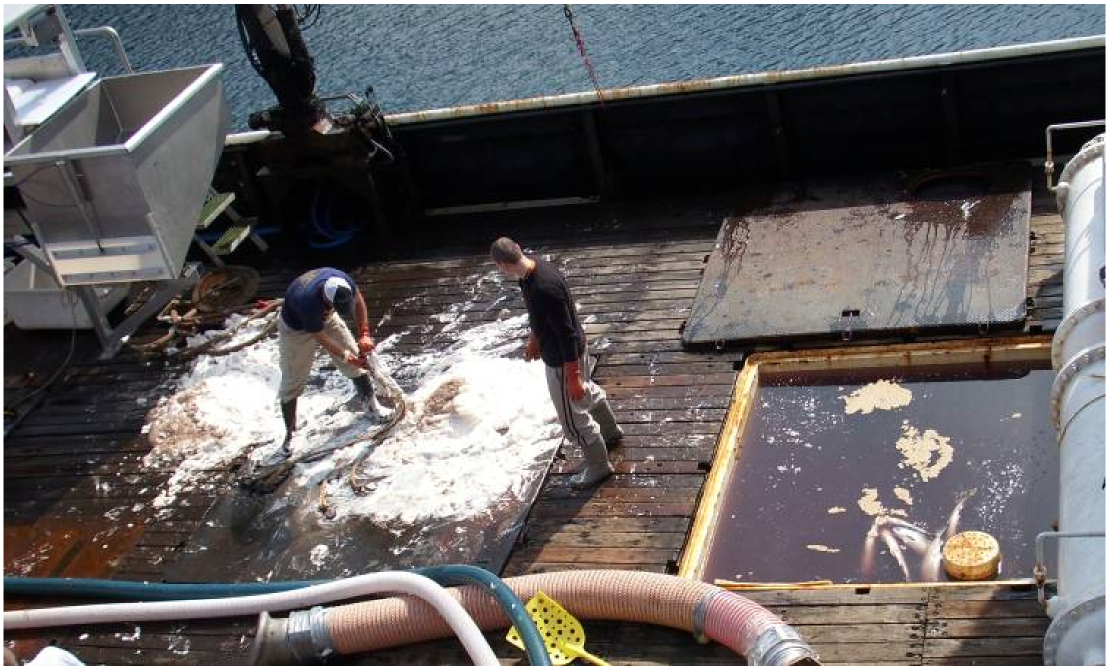
Commercial fishing vessels utilize different methods to keep seafood fresh after it is caught. Most seafood is either dead when brought onboard or is killed shortly thereafter, before being stored in a refrigerated seawater holding tank, with the exception of certain shellfish (e.g., crab, lobster), which must be kept alive. The two most common methods of cooling seawater are by mechanical refrigeration or by adding ice. Mechanical refrigeration is common on tenders, purse seiners, and trawlers, while chipped and slurry ice tanks are more common on trollers, longliners, gillnetters, and some trawlers.

For vessels with refrigerated seawater tanks, fish are typically extracted using a vacuum system that removes both the fish and refrigerated seawater simultaneously. Any excess refrigerated seawater that is not required to assist in fish extraction is pumped overboard pierside. Vessels that use chipped or slurry ice generally remove the seafood and then discharge the spent ice overboard pier side. Occasionally, vessels that store their catch in ice slurry also use vacuum filtration systems (e.g., some shrimping boats in the Gulf of Mexico). These discharges often contain pollutants generated by the catch, such as biological wastes.

Tanks used to keep lobster and crab catch alive pump surrounding water into the tank constantly to maintain the highest water quality possible. The flow rate through these systems results in a nearly continuous discharge of fish hold effluent. Because the majority of the seafood product remains alive, however, there is little biological decay or degradation in the tank. Furthermore, because these tanks have reasonably rapid flushing times and a continuous discharge, there is a little accumulation of pollutants.

Fish holds are also often cleaned or disinfected by vessel crews between catches. To rinse the tank, vessel crews use either municipal water from the pier or dock or they pump water from the surrounding ambient water. Cleaning may simply involve rinsing the tanks with this water, or crews sometimes add detergents or disinfectants. Crews also often use scrub brushes to clean the walls and floor of the fish hold to maximize the removal of organic material. Fish hold cleaning effluent is a combination of residual fish hold water and ambient or municipal water and often contains soaps or detergents.

Shoveling Fish Hold Ice Overboard From Ice Tank.



View of a Full Refrigerated Seawater Tank.

1.5.1.6. Graywater

Graywater is generated onboard vessels from domestic activities such as dish washing, food preparation, laundry, and bathing. Graywater is discharged through either a single discharge port from a collection system or through multiple, separate discharge ports for each graywater source (e.g., sink, shower, washing machine). Graywater discharge is intermittent and occurs only when the specific activity is performed. Most graywater processes use onboard potable water (service water).

Smaller vessels can sometimes not generate any graywater. Many of these vessels are for day use and do not provide any overnight quarters or heads (toilets). Smaller vessels that do generate graywater (e.g., those that have accommodations, sinks, or showers) generally discharge graywater directly overboard via ports typically located above the waterline. Most larger vessels used for overnight or multiday travel have numerous graywater sources, including showers, bathroom and kitchen sinks, and laundry. On these vessels, graywater discharges overboard by draining through gravity to either a discharge port above the water line or to a small collection tank located in the vessel hull, where it is immediately pumped to a discharge port above the waterline. Other vessels can collect their graywater and treat it along with sewage in Marine Sanitation Devices (MSDs).

Typical pollutants found in graywater often include metals, pathogens, total suspended solids, biochemical oxygen demand, chemical oxygen demand, oil, grease, ammonia, nitrogen, and phosphates. Graywater does not include sewage, or “blackwater”, which is exclusively human waste from toilets and urinals. Sewage is regulated under Section 312 of the Clean Water Act and 40 CFR Part 140 (see Chapter 6 of this report for further discussion).

Collecting Graywater (Shower) Effluent.

1.5.1.7. Shaft Packing Gland Effluent

For vessels with propeller shafts, a packing gland, or stuffing box, is used to provide a seal around a propeller shaft at the point where it exits a boat's hull underwater. This is a common method for preventing water from entering the hull while still allowing the propeller shaft to turn. In a conventional packing gland, the seal itself is provided by packing rings made of greased flax that is packed or wound tightly around the propeller shaft and compressed in place with a threaded nut and spacer. The gland can also be fitted with an opening for periodic insertion of grease between the rings, and sometimes includes a small grease reservoir.

A packing gland packed with flax rings is designed to leak a small amount of water—a few drops per minute—to provide lubrication when the shaft is turning. Water that leaks through the seal sometimes drips into a non segregated bilge or collects in a segregated area to avoid contact with oily wastewaters. In the case of a segregated area, the water that collects (referred to as shaft packing gland effluent) is automatically pumped overboard when levels reach a preset depth to prevent overflow.

1.5.1.8. Antifouling Hull Coatings[21]

Vessel hulls are often coated with antifouling compounds to prohibit the attachment and growth of aquatic life. Coatings are formulated for different conditions and purposes, and many contain biocides. Those that contain biocides prevent the attachment of aquatic organisms to the hull by continuously leaching substances into the surrounding water that are toxic to aquatic life. While a variety of different biocides are used, the most commonly used is copper. Hull cleaning activities often can cause additional releases of biocides, particularly if hulls are cleaned within the first 90 days following application of the antifouling coating.

A second metal-based biocide is organotin-based, typically tributyltin (TBT), which was historically applied to vessel hulls. TBT and other organotins cause deformities in aquatic life, including defects that disrupt or prevent reproduction. TBT and other organotins are also stable and persistent, resisting natural degradation in water bodies. As discussed in Chapter 6 of this report, the use of TBTs and other organotins as biocides has been phased out on all vessels by domestic law and international treaty.

1.6. POLLUTANTS POTENTIALLY FOUND IN VESSEL DISCHARGES

EPA developed groupings of pollutants of concern in the issuance process of the VGP in 2008. EPA recognizes that while some discharges from all sizes of vessels are essentially the same, many will vary due to the specific machinery and activities conducted on these vessels. EPA used slightly different groupings of the pollutants from the discharges sampled for this report to address differences from the discharges covered by the VGP. The pollutants and constituents of concern are broken down into the following groups: classical pollutants, nutrients, pathogen indicators, metals, volatile organic chemicals (VOCs), semivolatile organic chemicals (SVOCs), and nonylphenols. Not all pollutants are expected to be found in each discharge. For each discharge, EPA attempted to identify which pollutant groups are of concern.

[21] Though antifoulant hull coatings are present on some study vessels, particularly those operating in areas where there is a significant potential for fouling, it was not feasible to sample discharges from these coatings for this study (see Chapter 2 for further discussion).

1.6.1. Classical Pollutants

For purposes of this report, EPA uses the term "classical pollutants" for the following 14 pollutants: temperature; conductivity; salinity; turbidity; dissolved oxygen; Total Suspended Solids (TSS); Biochemical Oxygen Demand (BOD); chemical oxygen demand (COD); total organic carbon (TOC); oil and grease; pH; sulfide; and total residual chlorine (TRC). These include the CWA conventional pollutants, plus other common pollutants that are of general concern in a wide variety of contexts.

Temperature changes can directly affect aquatic organisms by altering their metabolism, ability to survive, and ability to reproduce effectively. Increases in temperature are frequently linked to acceleration in the biodegradation of organic material in a water body, which increases the demand for dissolved oxygen and can stress local aquatic communities. Thermal impacts from vessel discharges are generally much smaller than those from traditional point sources, and the vessel discharge with the greatest potential to alter receiving water temperature is engine cooling water.

Conductivity and salinity measurements are related to ionic strength and can indicate what specific ions are present in water or wastewater. Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids (or ions). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore, have a low conductivity when in water. Conductivity is also affected by temperature; the warmer the water, the higher the conductivity. Salinity is a measure of the mass of dissolved salts (ions) in solution. Ions commonly found in water include calcium, magnesium, potassium, and sodium cations and bicarbonate, carbonate, chloride, nitrate, and sulfate anions. The average ocean salinity is approximately 35 parts per thousand (ppt), while freshwater salinity is generally less than 0.5 ppt. The salinity of brackish water, such as estuaries, is between 0.5 ppt and 17 ppt. Conductivity is a good measure of salinity in water and vice versa.

Both turbidity and TSS are assessments of the amount of suspended solids present in the water column. Turbidity is an indicator of water clarity, measuring how much the material suspended in water decreases the passage of light through the water. Higher turbidity increases water temperatures because suspended particles absorb more heat. Suspended materials, also measured as the mass of TSS, can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can smother fish eggs and benthic macroinvertebrates on the bottom substrate. Vessel discharges with relatively high turbidity and TSS concentrations include fish hold effluent, bilgewater, graywater, and deck washdown.

The oxygen content of water or wastewater is measured in its dissolved form as dissolved oxygen (DO). Low DO levels (hypoxia) can impair animal growth or reproduction, and the complete lack of oxygen (anoxia) will kill aquatic organisms. Organic material found in vessel discharges (e.g., fish waste, bilgewater, graywater) that are easily biodegraded will result in depressed DO concentrations in ambient receiving waters. The ability of the organic material in vessel discharges to biodegrade and depress oxygen levels is measured as either BOD_5 or COD. BOD measures the amount of oxygen used by naturally occurring microorganisms to metabolize the organic material in the vessel discharge, while

COD measures the oxygen needed to chemically oxidize the organic material in the vessel discharge. If there is a large quantity of organic waste in water, there will also be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria), so the BOD level will be high. COD levels can often be correlated with BOD levels, though they are generally higher because the measurement examines chemicals that are both biologically and chemically oxidized. As the waste is consumed or dispersed through the water, BOD levels will begin to decline.

Oil and grease are other known components of vessel discharge, with potentially harmful impacts to humans and to aquatic life. Oil and grease are measured using hexane extractable material (HEM) and silica gel treated (SGT)-HEM. Vessels sometimes discharge oil, including lubricating oils, hydraulic oils, and vegetable or organic oils, in everyday operation. Oils produce a visible slick or sheen[22] on the water surface, which decreases natural oxygen transfer, resulting in depressed DO concentrations. Also, oils might contain heavy metals and SVOCs, which can bioaccumulate in fish, birds, marine mammals, and ultimately humans. Bilgewater, fish hold effluent (fish oils), and graywater (galley wastewater) are the vessel discharges most likely to contain oil and grease.

The term pH is used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. Substances with lower pH (i.e., less than 7) are acidic, while substances with higher pH (i.e., greater than 7) are basic. pH affects many chemical and biological processes in the water. The largest variety of aquatic animals prefers a range of 6.5 to 8.0. pH outside this range can reduce diversity because it stresses the physiological systems of most organisms. Low pH can allow toxic elements and compounds to become mobile and "available" for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life, particularly sensitive species. Many vessel-cleaning wastewaters can be either acidic (e.g., metal cleaners and tub, toilet, and sink cleaners) or basic (e.g., degreasers).

Sulfide is a strong reducing agent typically generated during anaerobic decomposition of organic materials. Sulfides are naturally present in ground water as a result of leaching from sulfur-containing mineral deposits. Surface water does not usually contain high sulfide concentrations. Sulfide is a pollutant that is commonly elevated in water distribution systems as well as sewers. Sulfur-reducing bacteria, which use sulfur as an energy source, are believed to be the primary producers of large quantities of hydrogen sulfide. Ecologically, these bacteria are common in anaerobic environments (e.g., plumbing systems). For vessels, possible sources of sulfide include trace constituents in the fuel, products of incomplete combustion, or formations in anaerobic systems onboard the vessel. Sulfide generated from anaerobic decomposition is suspected in graywater, bilgewater, and fish holds. Sulfide may also be formed during fuel combustion in a vessel's engine. Sulfide, typically found as hydrogen sulfide, poses a potential long-term hazard to aquatic life (USEPA, 1986b) at low concentrations.

Chlorine is commonly used as a disinfectant in wastewater and drinking water. Chlorine, measured as TRC, though toxic to humans at high concentrations, is of much greater concern to aquatic species, which can experience respiratory problems, hemorrhaging, and acute mortality. TRC is present

---

[22] Visible slick or sheen means a "silvery" or "metallic" sheen, gloss, or increased reflectivity; visual color; iridescence, or oil slick on the surface (58 FR 12507).

in potable water supplies, and consequently, any vessel systems that use potable water could potentially discharge TRC while conducting graywater activities and deck washing. Chlorine bleach can also used as a disinfectant in cleaning activities, such as cleaning the fish hold, general vessel cleaning, and laundry.

Measuring Total Residual Chlorine Immediately After Sample is Taken.

1.6.2. Nutrients

Nutrients, including nitrogen, phosphorus, and numerous micronutrients, are constituents of vessel discharges. Though traditionally associated with discharges from sewage treatment facilities and runoff from agricultural and urban stormwater sources, small quantities of nutrients from vessels are discharged from deck runoff, graywater, bilgewater, and fish hold tanks, among other sources. Although outside the scope of this report, sewage discharge (blackwater) is likely one of the primary sources of nutrients from vessels.

When excessive amounts of phosphorus and nitrogen are added to the water, algae and aquatic plants can be produced in large quantities and cause eutrophication of lakes or ponds. Eutrophication is a natural process whereby primary producers (algae and aquatic plants) exhibit extreme growth due to increased nutrient loading. Eutrophication can be greatly accelerated by human activities that increase the rate at which nutrients enter the water. Increased nutrient discharges from human sources are a major source of water quality degradation throughout the United States.

Total nitrogen is a measure of all the various forms of nitrogen (nitrate, nitrite, and ammonia) that are found in a water sample. Nitrification is the biological oxidation of nitrogen compounds in both water and soil: ammonia is oxidized to nitrite (via Nitrosomas bacteria) and further oxidized to nitrate via Nitrobacter bacteria. Nitrite and ammonia are relatively toxic forms of nitrogen, while nitrate is relatively nontoxic. Nitrogen in natural waters is usually found in the form of nitrate.

Phosphorus can be measured in either the particulate phase or the dissolved phase. Particulate matter includes living and dead plankton, precipitates of phosphorus, phosphorus adsorbed to particulates, and amorphous phosphorus. The dissolved phase includes inorganic phosphorus and organic phosphorus. Phosphorus in natural waters is usually found in the form of phosphates. Phosphates can be in inorganic form (including orthophosphates and polyphosphates) or organic form (organically bound phosphates).

1.6.3. Pathogen Indicators

Pathogens are microbes that cause disease. They include a few types of bacteria, viruses, protozoa, and other organisms. Bacteria associated with human and animal waste (e.g., total and fecal coliforms, *E. coli,* enterococci) are often monitored in water and wastewater, and the detection of these organisms can be a reliable indicator that other dangerous pathogens might be present. Pathogens are often found in discharges from vessels, particularly in vessel sewage and graywater.

1.6.4. Metals

Metals are a diverse group of pollutants, many of which are toxic to aquatic life and humans. While some metals, including copper, nickel, and zinc, are known to be essential to organism function, many others, including thallium and arsenic, are nonessential and/or are known to have only adverse impacts. Even essential metals can do serious damage to organism function in sufficiently elevated concentrations. Adverse impacts can include impaired organ function, impaired reproduction, birth defects, and at extreme concentrations, acute mortality. For example, copper can inhibit photosynthesis in plants and interfere with enzyme function in both plants and animals in concentrations as low as 4 µg/l. Additionally, through a process known as bioaccumulation, metals can accumulate in predator organisms further up the food chain, including commercially harvested fish species.

The toxic potential of a metal depends on its bioavailability in a given aquatic environment. A metal's bioavailability is determined by the characteristics of the surrounding environment (e.g., temperature, pH, salinity, TOC) and the species of the affected organism. The environmental conditions determine a metal's tendency to either adsorb to suspended organic matter and clay minerals or to precipitate out of solution and settle to the sediments. Benthic organisms can bioaccumulate metals by consuming metal-enriched sediments and suspended particles or by uptaking ambient water containing the dissolved form of the metal.

Vessel discharges can contain a variety of metal constituents, which can come from a variety of onboard sources. Graywater, bilgewater, and firemain systems have been shown to contain numerous metals, the exact constituents of which vary depending on onboard activities and the materials used in the construction of the vessel. Other metals, such as copper, are known to leach from the antifoulant coatings on vessel hulls and can cause exceedances of water quality standards.

1.6.5. Volatile and Semivolatile Organic Compounds

A variety of organic compounds have been found in vessel discharges, many of which are known to have a broad array of adverse impacts on aquatic species and human health. For this study, EPA measured VOCs and SVOCs, which can dissolve other substances and evaporate readily at room temperature and atmospheric pressure. These carbon-containing compounds include a wide range of chemicals, such as aldehydes, ketones, and hydrocarbons, and are present in oily materials such as gasoline, motor oil, engine coolants, and lubricants used on vessels. VOCs such as benzene, which is found in fuel, has acute hematological toxicity (ATSDR, 2007), and many SVOCs such as benzo(a)pyrene are persistent, bioaccumulative, and toxic compounds.

EPA measured VOCs and SVOCs in vessel discharges from engines, bilges, and firemains for this study. The most significant rates and levels of detection were phthalates (plasticizers added to plastics to make them flexible) and components of or products of incomplete combustion of oil and fuel. For example, VOCs and SVOCs detected in engine effluent included multiple polycyclic aromatic hydrocarbons (PAHs), straight-chain hydrocarbons, phenol and methyl phenols, trimethylbenzene, phthalates, and the volatile constituents of fuel, commonly referred to as "BTEX" (benzene, toluene, ethylbenzene, xylene). Many of these compounds are known to cause adverse impacts on aquatic species and human health.

1.6.6. Nonylphenols

Long- and short-chain nonylphenols are a component of many liquid detergents and soaps and are often toxic to aquatic life. These compounds (all non-ionic surfactants) belong to the larger group of compounds called alkylphenol ethoxylates. There are different types of alkylphenol ethoxylates, such as nonylphenol polyethoxylates (NPEOs) and octylphenol polyethoxylates (OPEOs). Because NPEOs and OPEOs are in the same family, they have similar chemical properties. Longer chain NPEOs degrade in the environment to NPEOs with shorter chained ethoxylate groups, or to nonylphenoxy carboxylates (NPECs) with a carboxylated ethoxylate under aerobic conditions. In general, the shorter the ethoxylate chain becomes, the more hydrophobic, persistent, and toxic the substance becomes. Once nonylphenol is buried in the sediment, it may persist for a long time. Many fish are bottom feeders and can be significantly exposed to nonylphenols. Long- and short-chain nonylphenols are expected to be found in several vessel discharges, including graywater, deck washing wastewater, and bilgewater.

1.6.7. Chapter Conclusions

The information summarized and referenced in this chapter provides an introduction to the study vessel universe. It describes the universe of study vessels, the types of discharges generally thought to originate from those vessels, and the types of pollutants or other constituents generally found in those vessel discharges. It also references information contained in Appendix B of this report, which provides more detailed information on the study vessel universe, such as vessel locations and characteristics. EPA estimates that there are approximately 140,000 vessels in the United States subject to the NPDES permitting moratorium established by P.L. 110-299. This chapter concludes that commercial fishing vessels are the most common type of study vessels, although there are significant numbers of other commercial study vessels.

The information contained in this chapter helped inform EPA's decisions of which discharges to sample and the relative importance of each discharge (see Chapters 3, 4, and 5 for additional discussion). Based on EPA's experience gained during the VGP process, the Agency believes bilgewater, graywater, deck washdown, fish hold, engine effluent, and antifouling hull coating leachate are the primary vessel discharges that could impact surface water quality. Pollutants in these discharges might include metals, organics, nonylphenols, nutrients, oxygen depleting compounds, and pathogens. The following chapters of this report present the methodology EPA used to characterize discharges from vessels subject to the NPDES permitting moratorium, the results of that characterization, and the potential environmental impacts to ambient waters that could be caused by these discharges.