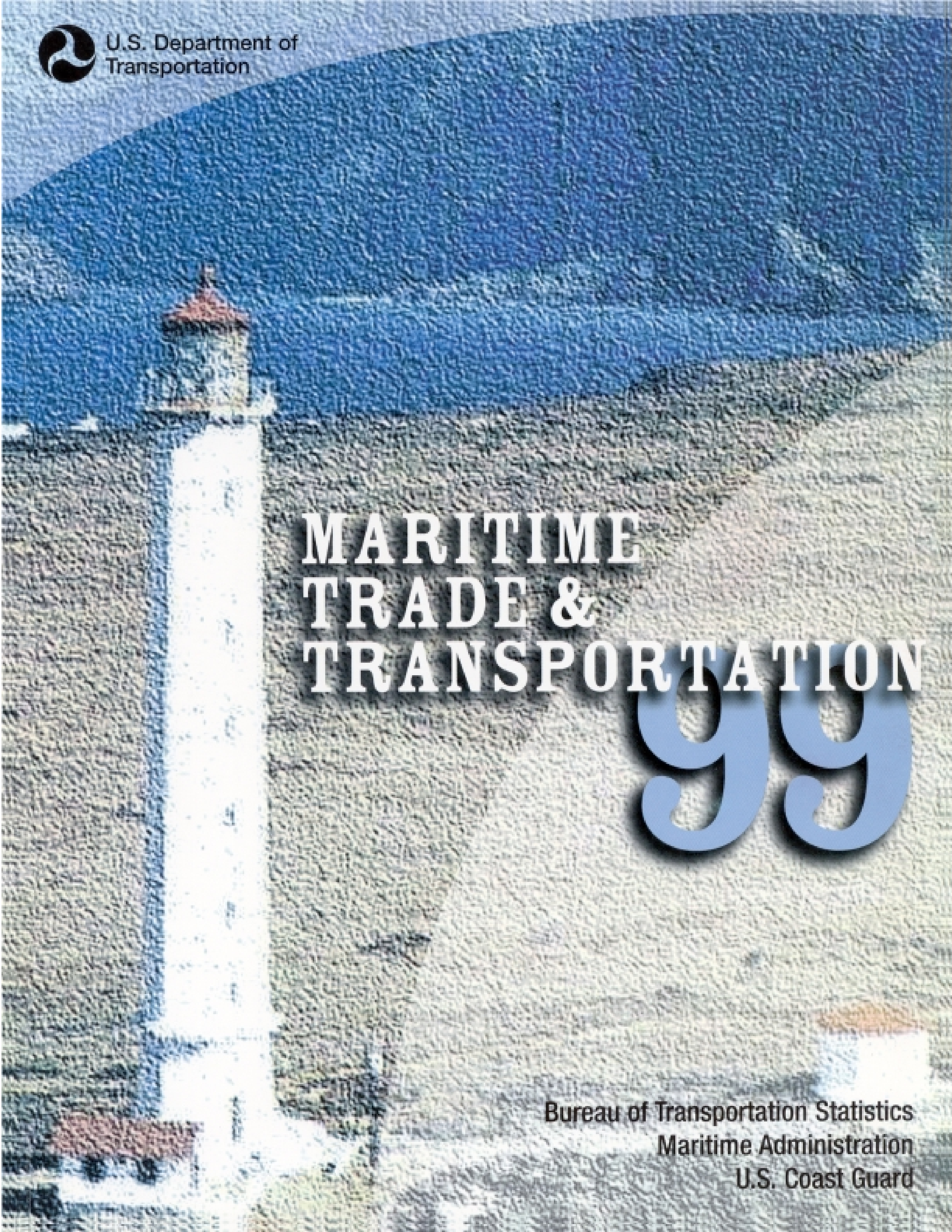

U.S. Department of Transportation

MARITIME TRADE & TRANSPORTATION 99

Bureau of Transportation Statistics
Maritime Administration
U.S. Coast Guard

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Recommended citation

U.S. Department of Transportation
Bureau of Transportation Statistics
Maritime Administration
U.S. Coast Guard
Maritime Trade and Transportation 1999
BTS99-02
Washington, DC: 1999

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Maritime Trade and Transportation was jointly developed by the U.S. Department of Transportation's Bureau of Transportation Statistics, Maritime Administration, and U.S. Coast Guard.

Foreword

The marine transportation system contributes to U.S. economic growth, enhances global competitiveness, and supports national security objectives. The marine transportation industry, with its extensive network of waterways, terminals, and ports, plays a critical role in both domestic and international trade, provides enormous travel and recreational opportunities, and employs hundreds of thousands of people in transportation services and related industries, such as shipbuilding and repair. Throughout our nation's history, the maritime industry has also played an important role in supporting national security objectives by maintaining an active core of U.S. flagged and crewed vessels for defense-related operations throughout the world.

This report is a cooperative effort of the Bureau of Transportation Statistics (BTS), the Maritime Administration (MARAD), and the U.S. Coast Guard (USCG) in the U.S. Department of Transportation (USDOT), with contributions from the U.S. Army Corps of Engineers. It is the result of an ongoing effort by BTS, MARAD, and USCG to provide comprehensive and relevant maritime-related statistics and information to decisionmakers at all levels of government and in private industry.

This report addresses USDOT's five strategic goals: to promote safety, improve mobility, advance economic growth, protect human and natural environments, and strengthen national security. The report covers major trends in maritime trade, transportation, and shipbuilding, and reviews the marine transportation industry's contribution to the U.S. economy, its safety record, and environmental impacts. It also discusses national security, advances in navigation technologies, and key information and data gaps.

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MARAD

The U.S. water transportation industry serves the needs of both international and domestic commerce. It comprises companies that carry freight or passengers on the open seas or inland waterways as well as companies that offer lighterage and towing services, operate canals and terminals, charter vessels, handle cargo, and build and repair ships. A variety of public agencies at all levels of government affect the water transportation industry, including port authorities, state departments of transportation, and national and international regulatory bodies.

This report describes major trends in the 1990s that affect the commercial water transportation industry, which provides vital freight and passenger travel services in international and domestic markets and port and cargo-handling services. It also describes the role and performance of the U.S. shipbuilding and repair industry and discusses the water transportation industry's contribution to the U.S. economy.

Considerable attention is devoted to maritime safety and environmental goals of the U.S. Department of Transportation (DOT) and its lead agency in these areas, the U.S. Coast Guard (USCG). In addition, the critical roles of the U.S. maritime industry and certain DOT programs, particularly those of the Maritime Administration (MARAD) in meeting our national security requirements, are explored in chapter 5.

Advances in navigation technology and relevant cooperative research programs are described in chapter 6. Reflecting the axiom that good analysis requires good data, the final chapter highlights relevant data issues.

WATERBORNE TRADE AND TRANSPORTATION SERVICES

Overall, world waterborne trade increased by 3.8 percent annually (on a tonnage basis) during the 1993-97 period to a total of 5.3 billion metric tons in 1997. Tankers, dry-bulk, and general cargo ships, such as containerships, are the three principal vessel types operating in deep-sea trades.

The steady growth in world waterborne trade contributed to increased earnings for merchant vessels in the mid-1990s, although recently earnings for container and dry-bulk vessels have fallen because of a sharp increase in fleet capacities.


USACE

Stacked high with containers, a containership is pushed through Charleston Harbor, Charleston, South Carolina. Containers are measured in twenty-foot equivalent units (TEUs)—the total length of the container divided by 20. A 48-foot container equals 2.4 TEUs.

At the end of 1997, the world merchant fleet amounted to 656 million deadweight tons (dwt). The largest growth in fleet capacity occurred in the containership fleet, due largely to the deployment of large (4,000+TEUs (twenty-foot equivalent units)) containerships in mainstream trades, which are dominated by global shipping alliances.

Many major containership operators offer shippers global service packages, with operations on all major routes (U.S.-Far East, U.S.-Europe, and Europe-Far East), supplemented by operations or operating agreements covering north-south and intra-regional trades. Containership capacity (measured in TEUs) deployed in round-the-world and tricontinental services increased by 103 percent from 1993 to 1997, while containership capacity involved in vessel-sharing agreements grew by 108 percent during the same period. By year-end 1997, vessel-sharing agreements covered 73 percent of world containership capacity.

The dry-bulk segment of the fleet increased over the 1993-97 period. The most pronounced increase occurred in 1996 and 1997 in response to a temporary 1995 surge in U.S. grain exports and freight rates. The tanker segment experienced only modest growth. Much of the new tanker construction that did occur was to replace old single-hull vessels with double-hull tankers to comply with oil spill prevention regulations promulgated by the United States and the International Maritime Organization (IMO).

In terms of vessel registrations, 57 percent of the world merchant fleet in 1997 were registered under open registries (vessel owners are not citizens of the flag state), up from 50 percent in 1993. Four of the top five national flag states (based on deadweight tons) are open registries: Bahamas, Liberia, Panama, and Malta. The United States ranks 11th. The picture shifts dramatically in terms of fleet ownership where the top five countries are Japan, Greece, the United States, Norway, and the United Kingdom. Citizens or firms from these five countries own 26 percent of the world merchant fleet.

Global Outlook

World deep-sea trade growth, projected at 3 to 4 percent per year over the 1998-02 period, will generally exceed fleet growth (1 to 2 percent per year) and improve earnings for water carriers.

Tanker fleet growth is expected to be limited as an aging fleet continues to be phased out by regulatory requirements for double-hull vessels. (At year-end 1997, only 21 percent of the world's tankers were equipped with double hulls.) With the expansion of global refinery capacity in crude oil producing areas (Middle East and Asia), it is expected that the product tanker fleet will grow more rapidly than the crude oil tanker fleet, and that the average size of product tankers will grow in response to long-haul shipping requirements.

Over the 1998-02 period, it is anticipated that growth for the dry-bulk segment of the fleet will be limited by the recent surge in dry-bulk fleet capacity and limited growth in world primary product trades. The containership fleet is expected to continue to grow at a significantly higher rate than other vessel types as still larger containerships are introduced into mainstream east-west trades and continue to replace traditional breakbulk ships in world liner trades. The containerization of fleets will be most rapid in intra-regional trades.

U.S. Foreign Waterborne Trade

In 1997, U.S. foreign waterborne trade amounted to 1,071 million metric tons, accounting for about 21 percent of global waterborne trade. Between 1993 and 1997, U.S. foreign waterborne trade grew 4.6 percent per year on average. However, growth-rate averages can hide considerable fluctuation between years. For example, U.S. dry-bulk trade achieved a 6.2 percent annual growth rate between 1993 and 1997 because of a recovery in U.S. grain exports late in the review period. However, U.S. tanker trades increased by only 2.9 percent per year during the same period. U.S. tanker imports declined in the mid 1990s, due primarily to an increase in world petroleum prices and draw-downs in domestic stocks, but recovered with the 1996-97 decline in crude oil prices.

Overall, U.S. foreign waterborne trade, measured in metric tons, is expected to grow at 3 to 4 percent per year for the period 1998-02, down from 4.6 percent per year for the 1993-97 period, reflecting the impact of the Asian crisis and the maturing of U.S. container trades.

U.S. waterborne trade accounted for 29 percent of global trade in 1997 in terms of ton-miles (demand for vessel services), significantly higher than the U.S. share of global trade in terms of metric tons.

U.S. Domestic Freight Trends

From 1993 to 1997, U.S. domestic waterborne trade increased by only 1.0 percent a year to a total of 1,010 million metric tons. In 1997, carriers serving this market segment moved 244 million tons of freight between U.S. ports on the deep seas, 655 million tons on the inland waterways, and 111 million tons on the Great Lakes.

Of the 244 million metric tons moved in domestic deep-sea trade in 1997, petroleum products and crude petroleum accounted for 41 and 31 percent, respectively. Container cargoes move primarily in noncontiguous trades (U.S. mainland to Alaska, Hawaii, Puerto Rico, and Guam) on both self-propelled and barge vessels.

Total cargo moving in domestic deep-sea trades has been declining steadily in the 1990s, reflecting a drop in Alaska North Slope crude oil shipments. The decline is expected to continue over the 1998-02 period.

The fleet serving U.S. domestic deep-sea trades in 1997 included 39 dry-cargo vessels (800,000 dwt), 122 tankers (8.2 million dwt), 3,393 dry-cargo barges (4.8 million dwt) and 669 tank barges (3.4 million dwt). Barges carried 86 percent of deep-sea cargoes moved less than 500 miles, while self-propelled vessels carried 91 percent of the metric tons moved in trades greater than 1,500 miles.

In 1997, barges transported 96 percent of the tonnage that moved on inland waterways. The primary commodities were coal, petroleum, crude materials, and farm products. The projected growth rate for inland waterways trades (2 percent per year) is higher than actual performance for the 1993-97 period (1.5 percent per year), largely because of an expected increase in domestic consumption of eastern coal.

As of year-end 1997, the inland-barge fleet consisted of 26,008 dry-cargo barges (35 million dwt) and 3,400 tank barges (6.9 million dwt). Total inland-barge capacity increased by 6.2 percent from 1995 to 1996, the largest annual increase in capacity since 1980-81. The 1996 increase was largely a function of the 1995 surge in barge freight rates that limited dry-cargo barge scrapping and led to a sharp increase in orders of new dry-cargo barges for delivery in 1996 and 1997.

In 1997, 111 million metric tons of domestic cargo moved on the Great Lakes. The major commodities moved were crude materials, coal and coke. More than 90 percent of the overall trade is moved in dry-bulk ships, and this dry-bulk traffic is expected to remain in the 104 to 105 million-ton range annually over the next five years.

As of year-end 1997, the U.S. Great Lakes fleet consisted of 129 dry-cargo vessels (1.9 million dwt), 5 tankers (20,000 dwt), 258 dry-cargo barges (400,000 dwt) and 41 tank barges (100,000 dwt). From 1993 to 1997, U.S. Great Lakes fleet capacity declined by about 2 percent per year. The decline of the fleet coupled with non-declining traffic levels suggests increased fleet utilization and/or productivity in the 1990s, and these trends are expected to continue over the next five years.

In terms of passenger travel, there are two principal types of passenger vessels serving U.S. markets—cruise ships and ferries. In the 1993 through 1997 period, the number of cruise passengers fluctuated from 4.5 million in 1993, reaching a low of 4.3 million in 1995, and then growing to 5 million in 1997. One projection anticipates growth over the 1998-02 period, reflecting the continued introduction of new ships and industry consolidation.

Within the ferry segment, fast ferries (vessels capable of speeds of at least 25 knots) accounted for only 7.4 percent of total ferry traffic. However, the fast-ferry market represents a growth area in the future as fast ferries continue to replace conventional ferries on existing routes and new longer haul routes are established.

Port and Cargo-Handling Services

Port activity is widely dispersed throughout the world, with the top 25 ports accounting for only 22 percent of vessel port calls. Of the top 25 ports, in terms of port calls, only 3 are in the United States: Houston (17), New Orleans (18), and Los Angeles (25).

Within the United States, there is considerable concentration among its ports, where there are more than 1,900 terminals (on- and off-loading facilities) comprising more than 3,100 berths. In 1997, the top 25 U.S. ports accounted for 81 percent of large-vessel calls.

Concentration is even more evident in international container trade through U.S. ports. The 25 leading container ports accounted for 98 percent of U.S. container traffic in 1997. Three of the top five container ports are on the West Coast, although South Atlantic ports have achieved the highest growth rates in recent years.

Challenges affecting U.S. public ports include the construction of megaships, landside access issues, and global shipping alliances. Most U.S. ports are currently unable to handle the largest new containerships, which have carrying capacities ranging from 4,500 to over 8,500 TEUs with fully loaded design drafts of 40 to 46 feet. Thus, dredging becomes the paramount issue confronting U.S. ports ability to handle these large ships.

The economics of these new vessels will mean fewer port calls for many ports and in some cases the elimination of port calls altogether. Additionally, these ships will impact terminal facilities because they will require larger cranes, berths, storage yards, and improved information systems. Landside access will have to be improved to handle the higher peak volumes of rail and truck traffic.

Global shipping alliances pose another challenge for U.S. ports in that they are likely to have greater leverage with ports in negotiating favorable tariffs, fees, financing, and services. For some ports, it will mean the loss of alliance business as a direct port call or, at a minimum, a reduction in cargo and vessel calls. For other ports, alliance business may reduce operating costs, expand trade route coverage, and improve overall transit times.

U.S. SHIPBUILDING

As of December 31, 1997, the world orderbook for large merchant vessels was 2,604 vessels, totaling 57 million gross tons. Japan and South Korea account for 68 percent of the market, while the United States ranked 14th with a 1-percent market share.

Despite the largest naval construction program in peacetime history, the commercial segment of the U.S. shipbuilding industry reached a low point in the 1980s when commercial orders dwindled. Since then, however, orders for U.S.-built ships have increased somewhat as U.S. shipyards, faced with declining naval orders, have sought out commercial work to survive. Even though naval orders are down, the U.S. Navy is expected to continue to be the principal customer of the U.S. shipbuilding industry.

The U.S. Major Shipbuilding Base (MSB) comprises 19 private shipbuilding and repair shipyards, only 2 of which are involved in constructing large oceangoing commercial vessels. More than 200 privately owned firms are involved in repairing ships in the United States, competing aggressively in both the domestic and foreign markets. Of this total, only 73 yards have the capacity to handle large vessels, and only 33 of these have drydocking capabilities. During 1998, U.S. shipyards delivered six commercial oceangoing ships and two nonoceangoing ferries.

USCG

Patrol boats, barges, tugs, and ferries are just some of the vessel types that comprise substantial orderbooks for small and medium-sized shipyards.

Small and medium-size yards are primarily engaged in construction for inland waterway and coastal operators. They build and repair small vessels such as barges, tug and towboats, offshore crew and supply boats, ferries, casino boats, fishing boats, military and nonmilitary patrol boats, fire and rescue vessels, and oil rigs. They have substantial orderbooks, and several Gulf Coast yards have been expanding their facilities to take full advantage of the thriving Gulf Coast oil and gas markets.

As of December 31, 1998, the U.S. shipbuilding and repair industry employed 100,300 people, a slight increase from revised 1997 figures. The 19 MSB shipyards employ about two-thirds of the total shipbuilding and repair industry workforce.

For more than 40 years, MARAD has been involved in promoting the growth and modernization of the merchant fleet and U.S. shipyards. Financial assistance to U.S. shipowners and shipyards is offered principally through the Title XI Federal Ship Financing program and the Capital Construction Fund program.

WATER TRANSPORTATION AND THE U.S. ECONOMY

In the 1990s, growth of real gross domestic product (GDP) from water transportation has been below that of other for-hire transportation services, except for the for-hire trucking industry. This is a reflection of the heavy involvement of water carriers in primary product trades (e.g., grains, crude oil, coal, and ores), which tend to grow at lower rates than manufactures trades.

In the mid-1990s, real GDP from water transportation accounted for only about 5 percent of real GDP from all transportation services. This low percentage can be attributed partly to the fact that the United States has a persistent balance of payments deficit in the ocean freight account, and that freight rates per ton-mile for waterborne shipments tend to be substantially lower than those for shipments by other modes. In 1997, the water transportation industry had a $2 billion deficit in its balance of payments.

Real GDP from water transportation is expected to increase at an average rate of about 2 percent per year over the 1998-03 period, according to the Bureau of Economic Analysis. This growth rate is less than the projected growth in international waterborne trades but above the projected growth in domestic trades.

For water transportation, employment growth historically has not kept pace with real GDP growth, an indication of increasing productivity. Consequently, employment is expected to increase by only about 1 percent per year from 1998 to 2003. In 1997, employment in the for-hire water transportation industry was 187,000.

SAFETY AND THE ENVIRONMENT

Water transportation provides great economic benefits, mobility, and recreational opportunities, but it also creates unintended consequences, such as fatalities and injuries due to accidents, and environmental damage. Hence, promoting safety and protecting the environment are key goals in DOT's strategic plan.

Safety

Marine transportation accidents can result not only in loss of life, but also costly damage to ships, cargo, surrounding infrastructure, shoreline property, and the environment. The principal causes of waterborne accidents are human factors, equipment failure, adverse weather, and hazardous situations. The USCG collects extensive data on accidents, fatalities, injuries, property damage, and pollution. As part of DOT's efforts to reduce or prevent such occurrences, the USCG is looking at risk exposure measures to develop profiles of situations or locations where incidents are likely to occur.

In commercial shipping, one of the major problems in selecting an exposure measure is that the nature of the risk varies according to the type of water the vessel is navigating, such as coastal, deep sea, or inland waterways. For recreational boating, risk exposure is difficult to quantify because it is a discretionary activity, the primary goal of which is to spend time on the water rather than travel from one point to another. Most fatalities, injuries, and accidents on the water involve recreational boating, which has increased over the past several years. Despite significant recreational boating safety efforts, 8,047 recreational boating accidents, involving 11,396 boats, were reported in 1997, with 821 fatalities. For three out of five recreational boats involved in accidents between 1985 and 1994, human factors were considered the cause. Alcohol is a major factor and is generally underreported in statistics.

One-third of new recreational boat sales in the United States are for personal watercraft (PWC). PWC are the only type of recreational watercraft for which the leading cause of fatalities is not drowning. On an exposure-adjusted basis, injury risk is considered higher for PWCs than for open motorboats, canoes, and kayaks.

USCG and MARAD Safety-Related Operations and Programs

The USCG is the lead DOT agency responsible for maritime safety. Between 1993 and 1997, the USCG was involved in more than 47,000 search and rescue cases, on average, each year. The USCG estimates that these operations saved about 5,000 lives annually.

Since 1913, the year after the RMS Titanic disaster, the USCG has participated in the International Ice Patrol (IIP) to detect icebergs and warn ships of their location in North Atlantic shipping lanes. Since establishment of the IIP, no vessels have been lost to icebergs within the IIP patrol area. The 17 signatory nations fund the IIP in proportion to their share of total tonnage transiting the North Atlantic area during the ice season.

The USCG, in cooperation with the maritime industry, has also developed the Prevention Through People program to promote maritime safety and environmental protection. As part of this program, the USCG devotes more than 40,000 operational hours each year on boating safety activities.

Another safety-related initiative, called the International Maritime Information Safety System, is a joint USCG/MARAD effort designed to capture causal information and lessons learned about near collision situations, near pollution events, and other unsafe occurrences; and related precursor events (hazardous situations) such as crew fatigue, equipment maintenance/failure, communication failure, and policy and procedural issues. The goal is to identify system vulnerabilities and weaknesses before failures or accidents occur.

The popularity of personal watercraft has grown in recent years, prompting safety concerns.

Environment

A key challenge for the U.S. maritime industry is to meet the growing demands and diverse needs of waterborne transportation while protecting environmentally sensitive harbors, coastal areas, and marine resources. Among the principal environmental concerns are the dredging of navigation channels and managing the disposal or beneficial use of dredged material, oil spills, air pollution from ships, and antifouling paints.

Most ports and harbors are not deep enough for the newest vessels, and they require periodic dredging to maintain depths. As world trade increases and shipping practices and technology evolve, many ports may need deeper and broader channels and harbors.

The U.S. Army Corps of Engineers (USACE) and U.S. port authorities are responsible for dredging. U.S. Ports spent $129.4 million on new construction and modernization/rehabilitation dredging in 1997. From 1992-97, the USACE dredged an annual average of 273 million cubic yards of sediments in ports and harbors at a cost of $542 million per year.

Oil spills can have major impacts on nearby ecosystems, aquatic species, wildlife, and birds, but the extent and severity of environmental contamination vary greatly with the location and size of the spill. The total number of reported spills from self-propelled vessels and barges in U.S. waters increased from 1986 to 1995, while the volume and number of large spills declined. This is attributable to a stricter regulatory environment, definitions regarding spills, and increased awareness by customers and vessel facility operators.

In recent years, new technologies have improved the USCG's ability to detect oil spills, especially at night. These technologies enhance the efficiency of environmental protection efforts in two ways. They allow oil-spill cleanup activities to take place during nighttime hours, and they also enable USCG units to actively survey areas for illegal oil dumping at night, a time when the risk of illegal oil discharge is greatest.

The prevention of air pollution from ships and recreational watercraft has also become the focus of treaty, legislative, and regulatory activities at both the national and international levels. Recreational gasoline-powered marine engines are a major source of nonroad hydrocarbon and nitrogen oxide emissions.

In 1990, the International Maritime Organization (IMO) Marine Environment Protection Committee recommended that governments adopt measures to eliminate the use of antifouling paint containing tributyltin (tbt), a harmful compound of tin (organotin) that acts as a biocide. Several countries, including Japan, have already banned its use for most ships. A draft resolution is to be submitted to the IMO Assembly by November 1999 that would ensure a global prohibition on the application of tbt and other organotins by January 1, 2008.

Environment-Related Programs

Several federal programs and activities address environmental concerns. They include the Port State Control (PSC) program, fisheries enforcement in conjunction with the National Marine Fisheries Service in the U.S. Department of Commerce, aquatic nuisance species control, and the artificial fish reef program.

The United States uses the PSC program to ensure that non-U.S.-flag vessels calling at U.S. ports adhere to U.S. safety and environmental standards. The U.S. system, which is copied by many nations around the world, uses a risk-based targeting methodology to select vessels for boarding as a means of eliminating substandard vessels from the nation's waters. According to the USCG, other countries flagged 95 percent of all passenger ships and 75 percent of all cargo ships entering the United States.

Seventeen European nations and Canada have signed a Memorandum of Understanding (MOU) on Port State Control, covering the coastal waters of the North Atlantic and Mediterranean Sea. PSC inspections are conducted to ensure that ships are seaworthy, do not pose a pollution risk, provide a healthy and safe working environment, and comply with relevant international conventions. Under PSC, substandard vessels can be detained while they are within the waters of the PSC nation. The United States is not a member of any PSC MOU.

In addition to ensuring that vessels do not pose a safety and/or environmental risk, the USCG works closely with National Marine Fisheries Service in the Department of Commerce in enforcing fisheries law. The USCG is the only agency with the maritime authority and infrastructure to project its federal law enforcement presence in the Exclusive Economic Zone, which consists of 3.3 million square miles of ocean and 90,000 miles of coastline. It is estimated that commercial and recreational fisheries annually contribute an estimated $30 billion to the U.S. economy.

The USCG also enforces marine sanctuary regulations to protect designated areas and is taking steps to slow the spread of aquatic nuisance species via ships' ballast water. Invading nuisance species, such as the Zebra Mussel, European Ruffle, and Spiny Water Flea, cause economic and environmental impacts. Recently, the USCG published regulations and guidelines on the exchange of ballast water with open seawater that covers all U.S. waters.

NATIONAL SECURITY

The United States has a strong interest in maintaining a U.S.-flag merchant fleet that can support economic and national security needs in times of political or economic turmoil. Throughout this nation's history, many programs have been instituted to meet these needs, ranging from the Ocean Mail Contracts of the middle and late 19th century to the direct subsidy programs of recent decades, such as the Maritime Security Program (MSP) administered by MARAD, and military deployment support provided by the USCG.

The MSP is designed to maintain an active core of privately owned, U.S.-flagged, and U.S.-crewed dry-cargo vessels that meet national security requirements while maintaining a competitive U.S.-flag presence in international commerce. Created in 1996, the program helps preserve a skilled American seafaring labor base to crew both the government-owned strategic sealift fleet and the U.S. commercial fleet in peace and war.

MARAD has awarded MSP operating agreements to 10 U.S.-flag operators, covering 47 commercial vessels. The 10-year program (through FY 2005) provides for the payment to participants of up to $100 million annually ($2.1 million per ship) for operations in the U.S. foreign trade.

Like the MSP, the Voluntary Intermodal Sealift Agreement (VISA) provides the U.S. Department of Defense (DOD) with access to U.S. commercial intermodal capacity to move ammunition and other cargo during contingencies while minimizing disruptions to commercial operations. By partnering with the U.S. commercial maritime industry, the U.S. government also ensures access to the global intermodal network, which includes management services, terminals and equipment, and communications and logistics systems as well as a cadre of well-trained, professional seafarers and shore-side employees.

VISA was authorized in 1997 and jointly developed by MARAD and the Transportation Command (USTRANSCOM) in DOD. The FY 1999 VISA fleet comprising 35 U.S.-flag commercial vessel-operating companies and 109 oceangoing commercial dry-cargo liner vessels, which represents 80 percent of the total

U.S.-flag commercial dry-cargo fleet; 22 VISA/DOD chartered ships; 141 oceangoing tugs; 100 oceangoing barges; and 52 offshore supply vessels.

The National Defense Reserve Fleet (NDRF) is another program that supports DOD during national emergencies. The NDRF has been activated several times since the 1950s. MARAD is responsible for maintaining vessels in the NDRF so they can be activated quickly and at minimum cost. Currently, the NDRF consists of 258 vessels, primarily dry-cargo ships, with some tankers and other types of vessels.

As of March 1999, 91 ships of the NDRF have been designated to form a special fleet known as the Ready Reserve Force (RRF). The RRF was created in 1976 to support the rapid worldwide deployment of U.S. military forces. It is structured to maintain surge shipping and resupply capability available on short notice to support military deployment before commercial ships can be marshaled. RRF ships are maintained in a specified 4- to 30-day readiness status at a reserve fleet site or designated outport. The National Port Readiness Network was formed in 1994 to encourage the exchange of deployment information between military personnel responsible for the logistics of moving a unit and the unit itself. This information is vital to identify lift requirements, port capabilities, cargo staging areas, and potential commercial disruption impacts.

DOD evaluates its requirements and selects the participating ports. Eighteen ports have thus far been selected for use during a deployment, and each has received a nonbinding planning order. MARAD is the lead agency for ensuring port readiness.

A major component of the USCG mission is national defense. The USCG performs a wide range of defense-related duties for the U.S. Navy, such as convoy escorts, search and rescue and salvage operations, surveillance and interdiction, boardings, and aids to navigation. Other defense-related activities include maritime interception operations, port security and defense, and Maritime Defense Zone operations. In 1997, the USCG devoted more than 3,000 resource (vessel or helicopter) hours to military operations and port security in the Coastal Zone.

NAVIGATION TECHNOLOGY

Major technological advances in navigation have occurred in recent decades, contributing to vessel safety and environmental protection through avoidance of vessel collisions and groundings. Charting advances include the use of aerial photography, electronic devices, and computer software to replace paper charts. Another technological advance is the use of electronic navigation aids, which use satellites to provide real-time position information to mariners. The Electronic Chart Display and Information System (ECDIS) uses the differential Global Positioning System to provide mariners with real-time position fixing displayed on an electronic chart. ECDIS and other electronic chart systems have the potential to help navigators avoid collisions and groundings.

Ten regional ship pilot's organizations are evaluating the utility of a new electronic piloting technology, called the Portable Pilot Unit (PPU). The PPU combines three systems—the satellite-based Differential Global Positioning System, an electronic chart system, and automated surveillance—to enable more precise own-ship navigation.

Although buoys, lighthouses, and paper charts are still an integral part of maritime navigation, major technological advances in electronic charting, radionavigation, and global positioning systems have greatly improved traffic management and open-sea navigation.

In the United States, thousands of electronic devices assist mariners in navigating waterways. These navigation aids are classified as either radionavigation or short-range aids.

The Radionavigation Aids Program provides continuous, all-weather capability through the use of radio beacons, LORAN, and the Global Positioning System. Short-range aids physically mark waterways with sound and visual signals to warn of danger and mark safe waters. The USCG maintains about 50,000 short-range aids to navigation, and private interests maintain a similar number.

New technological advances in traffic management systems have promoted the safe and orderly flow of traffic in and out of a port or waterway. The USCG operates the Vessel Traffic Service (VTS) in nine major U.S. ports and shares responsibilities with the state of California at the Port of Los Angeles/Long Beach. Worldwide, there are more than 130 VTS's now in operation, with many more in the planning stages. The VTS provides information on the location of vessels, navigation discrepancies, hazards to navigation, weather reports, and other vital information to participating vessels.

Other traffic management technologies include the Automated Identification System (AIS) and the Physical Oceanographic Real-time Systems (PORTS). AIS is a shipboard broadcast transponder system that is capable of sending information on a ship's identification, position, heading, ship length, beam, type, draft, and hazardous cargo to ships and to shore. The USCG is supporting international efforts to complete Universal AIS standards and institute carriage requirements for ships nationally and internationally as early as July 2002. PORTS provides information on currents and water levels and help safe transits.

DATA ISSUES

Consistent and detailed data on trade volume, cargo flows, and vessels are basic to measuring demand for maritime transportation facilities and services. Although several sources of world seaborne trade data are available, they can vary by as much as 20 percent because of differences in coverage.

Ton-miles, which are widely used as a measure of demand for freight transportation services, are not yet available in official U.S. foreign waterborne transportation statistics. U.S. foreign cargo movement data have traditionally been presented in terms of liner, tanker, and tramp services. However, this categorization does not adequately reflect movement of various commodity groups, and there is a growing demand to publish trade flows by vessel types.

Moreover, there is a need to harmonize coding and standardize definitions for geographic representation of places. Currently, multiple coding schemes are used to represent ports and countries in transportation data.

Several of the weaknesses in current official transportation data can be traced to the fact that trade documents do not contain accurate transportation details. A major data gap remains regarding accurate inland U.S. origin/destination data which are critical for intermodal analysis.

With respect to vessel inventory data, there is a need to precisely define size and type categories, and to achieve consistency among databases. There is also a need to deal with issues related to fundamental data concepts such as supply surplus, vessel ownership, and transport operator nationality. The International Maritime Statistics Forum has provided a common comparison framework for vessel types with its International Classification of Ships by Type, and has undertaken similar work with respect to ownership and nationality issues. Cooperative efforts also have been undertaken by the USACE and MARAD to improve data on vessels under construction, while the USACE and USCG are working to reconcile their fleet databases. To more accurately portray the true size and complexity of the U.S. fleet, a new framework for presentation of MARAD's U.S. fleet statistics has been developed.

With respect to USCG information, several data issues have been identified. These include the overstatement of lives and property saved in its Search and Rescue data, estimation errors in maritime worker fatality data, and biases in oil spill removal data. Current data used to measure reliability of equipment and personnel performance tend to overstate the impact of a failed navigational aid because complete system outages are rare and a single aid outage does not usually degrade a waterway's entire aid system.

Denominators of exposure need to be developed so that the level of risk can be compared from year to year with the increase or decrease in the number of incidents reported. Solely enumerating outputs can be misleading.

Currently, maritime data that might be used for evaluation of risk are not readily available and are most often drawn from information collected from disparate sources and for reasons unrelated to statistical applications. The results of calculations that combine data from different sources are themselves questionable and often unreliable. To resolve these issues, the USCG has undertaken development of new information systems to meet operational needs for more accurate and reliable statistics.

Waterborne Trade and Transportation Services

MARAD

The U.S. water transportation services industry comprises companies that carry freight or passengers on the open seas, the Great Lakes, or inland waterways as well as companies that offer lighterage and towing services, operate canals and terminals, charter vessels, and handle cargo. The major segments of the industry are domestic and international freight transportation, passenger transportation, and port and cargo-handling services. This chapter describes global trends in vessel types, average length of haul, earnings, and the world fleet. It also discusses U.S. water-industry trends in freight transportation and passenger travel in the 1990s. Finally, it discusses issues facing the public port industry.

GLOBAL TRENDS

Vessel Types

Three types of vessels operate in deep-sea trades:

1. general cargo, including containerships, which carry primarily semimanufactured and manufactured products;
2. dry-bulk carriers, which carry homogeneous dry cargoes such as grains, coal, steel, and iron ore; and
3. tankers, which carry liquid-bulk cargoes, primarily petroleum and petroleum products.

Average Length of Haul

The average length of haul for world waterborne trade was 4,220 miles in 1997, a slight decline from 1993 (Fearnley 1999). This decline reflects a 7-percent fall in average length of haul for crude-oil tanker trades. Average length of haul for other commodities remained steady over the same period.

Earnings

In the mid 1990s, steady growth in world waterborne trade contributed to increased earnings for merchant vessels (table 1-1). Figure 1-1 displays time-charter equivalent rates for major vessel types in the 1990s.[1] Despite continued trade growth, earnings for container and dry-bulk vessels fell in recent years as fleet capacities increased sharply (table 1-1).

Fleet

From 1993 to 1997, the capacity of the world's dry-bulk fleet increased by 4.2 percent per year as owners geared up to meet what would ultimately prove to be a temporary mid-decade increase in U.S. grain exports (Tyler 1998). For the same period, the large (35,000 deadweight tons (dwt) or greater) bulk-carrier fleet increased by 6.5 percent annually, while capacity for the smaller (less than 35,000 dwt) fleet remained at about the 1993 level. As of year-end 1997, small bulk carriers accounted for 24 percent of total dry-bulk fleet capacity, down from 30 percent in the early 1990s. Growth of the less than 35,000 dwt bulk fleet was limited by increasing competition from general cargo ships in steel trades, a primary source of demand for small bulk-carrier services (Tyler 1998).

As of year-end 1997, the average age of small bulk carriers was 20 years, compared to 13 years for the rest of the world fleet. Approximately 55 percent of small bulk carriers are 20 years or older, and may be removed from service over the next 5 years (Clarkson Research Studies 1998).

Overall, world tanker capacity grew by 0.8 percent per year from 1993 to 1997. However, large (≥ 200,000 dwt) crude-carrier world fleet capacity declined by 0.4 percent per year, while other tanker capacity increased by 1.1 percent annually. The decline in large crude carriers, which are used primarily in long-haul Middle East export trades, was due in part to increases in crude-oil production in Latin America, Europe, Mexico, and Canada (Tyler 1998).

Moreover, the existing tanker world fleet is aging. As a result, rather than adding to the total tanker fleet capacity, new vessels are being built to replace old ones and to comply with double-hull regulations (mandatory phase-outs of single-hull tankers) imposed by the United States and the International Maritime Organization (IMO) (McGraw-Hill and USDOC 1999).

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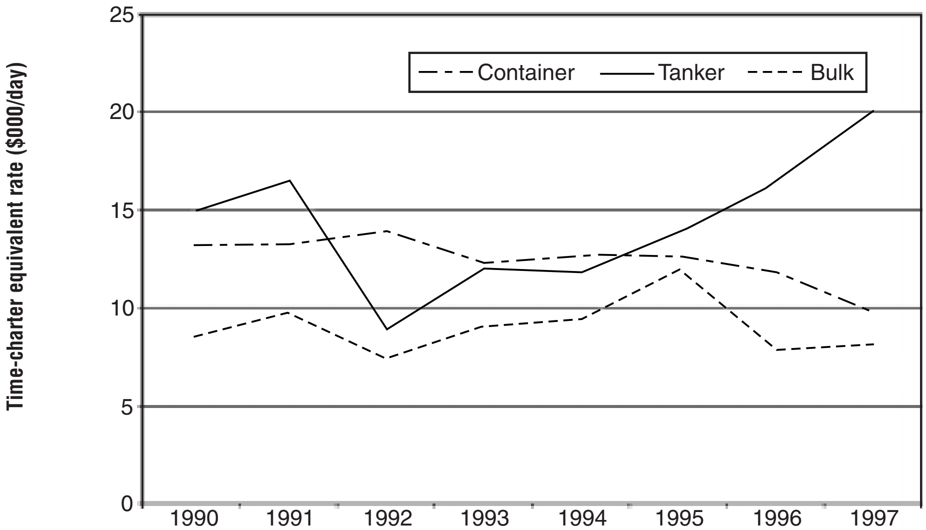
[1] Time charter equivalent rate = ((voyage freight rate x load) - voyage fuel cost - voyage port costs)/voyage days.

Figure 1-1
Average Earnings Per Day by Vessel Type



SOURCE: Clarkson Research Studies, C. Tyler, ed., *Shipping Review and Outlook* (London: fall, 1998).

Table 1-1
Global Trade Growth v. Fleet Growth

	1993	1994	1995	1996	1997	Compound annual growth 1993-97
Trade (million metric tons)						
Dry bulk	1,619	1,701	1,819	1,808	1,871	3.7
Tanker	1,939	1,978	2,016	2,124	2,210	3.3
General cargo	1,009	1,046	1,087	1,144	1,219	4.8
Container	461	514	549	589	634	8.3
Other general cargo	548	532	538	555	585	1.6
Total	**4,567**	**4,726**	**4,922**	**5,076**	**5,300**	**3.8**
Fleet (million deadweight tons[a])						
Dry bulk	215	219	227	243	253	4.2
Tanker	285	290	286	286	292	0.6
General cargo	101	103	105	107	110	2.2
Container	35	38	41	45	50	9.6
Other general cargo	66	65	64	62	60	-2.4
Total	**600**	**610**	**619**	**637**	**656**	**2.2**

[a] Vessel deadweight capacity, the total cargo, bunkers and stores that a ship can carry up to its water marks, measured in metric tons.

SOURCE: Clarkson Research Studies, C. Tyler, ed., adapted from *Shipping Review and Outlook* (London: May 1998).

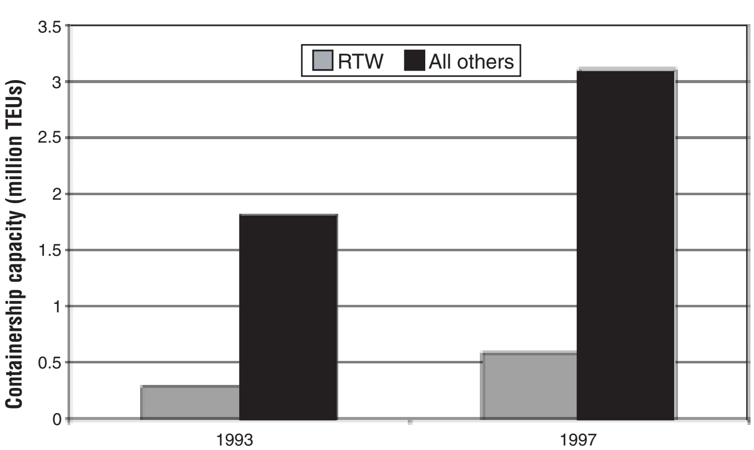
In the "other general cargo fleet" category, which includes partial containerships, breakbulk ships, roll-on/roll-off ships, and car carriers, capacity declined between 1993 and 1997 as a result of the containerization of intraregional breakbulk trades. Breakbulk ships, which carry a variety of high-value manufactured and semimanufactured products, are slower and spend more time in port than newer containerships. Another advantage of containerships is that their refrigerated container capacity can also be used for nonrefrigerated cargoes. Thus, containerships generally have more opportunities for backhaul cargoes than refrigerated breakbulk (reefer) ships. During the 1993 to 1997 period, containership capacity, in dwt, increased by 9.6 percent per year while breakbulk world fleet capacity fell by 6.6 percent per year (McGraw-Hill and USDOC 1999).

Containerships

Containerships allow a variety of commodities to be consolidated in large, standard units or containers, thereby facilitating cargo transfers. As a result of containerization, highly specialized line-haul/feeder services that connect carrier services, vessel-sharing agreements, and intermodal transportation services have evolved, which in turn have increased carrier productivity in general cargo trades.

From 1993 to 1997, overall world containership fleet capacity,[2] as measured in 20-foot equivalent units (TEUs), increased 15 percent per year. During that same period, containership capacity deployed in round-the-world (RTW) and tricontinental services (North America, Europe, and the Far East) increased by 103 percent. As of year-end 1997, approximately 16 percent of total containership capacity was deployed in RTW/tricontinental services, up from 14 percent four years earlier (figure 1-2). The average age of the containership world fleet deployed in these services is 7 years, compared with 10 years for containerships deployed in other services. The growth in RTW/tricontinental services reflects the fact that major shippers prefer container shipping lines that operate on a worldwide scale on all

Figure 1-2
World Containership Fleet, RTW/Tricontinental v. Other



KEY: RTW = Round the world; TEU = Twenty-foot equivalent unit.

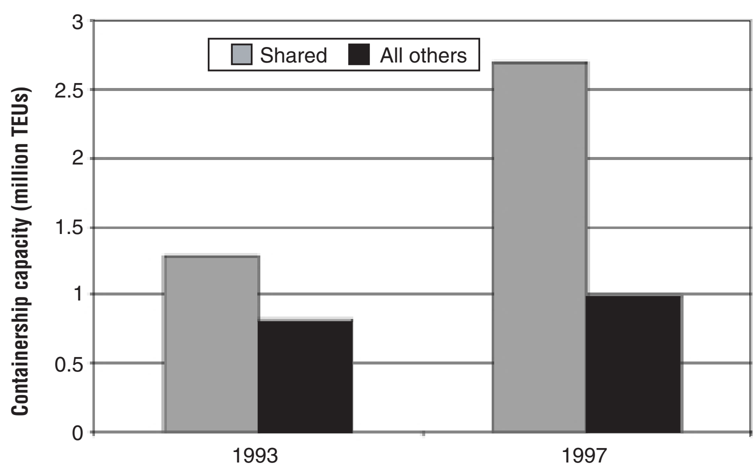
SOURCE: MDS Transmodal, *Containership Databank* (Chester, England: February issues 1994, 1998).

[2] Containership fleet capacity is generally measured in 20-foot equivalent units (TEUs), which is the total length of containers in feet divided by 20. For example, a 48-foot trailer equals 2.4 TEUs; a 53-foot container equals 2.65 TEUs.

major routes (USDOT MARAD OSEA 1999).

A major trend for containership operators has been the increasing use of vessel-sharing agreements (figure 1-3). These agreements (alliances) expand an operator's geographic coverage, enhance vessel utilization, and reduce average shipment costs. Containership capacity involved in vessel-sharing agreements has grown from 1.3 million TEUs at the end of 1993 to 2.7 million TEUs at the end of 1997, a 108-percent increase (figure 1-3). At the end of 1993, vessels involved in vessel-sharing agreements accounted for 61 percent of world containership capacity. By year-end 1997, that percentage increased to 73 percent (MDS Transmodal 1994, 1998).

Figure 1-3
World Containership Capacity, Shared and Other



KEY: TEU = Twenty-foot equivalent unit.

SOURCE: MDS Transmodal, *Containership Databank* (Chester, England: February issues 1993, 1998).

As of year-end 1997, approximately 36 percent of the world containership capacity was involved in the top five vessel-sharing agreements (table 1-2). Each agreement offers multiple services covering mainstream east-west trades (Europe-Far East, U.S.-Europe, and U.S.-Far East). Four of the agreements are global alliances; that is, they offer services in each of the mainstream east-west trades. The Grand, Maersk/Sea-Land, and Hanjin/Tricon alliances offer RTW/tricontinental services. The New World Alliance offers end-to-end services in each of the mainstream trades. The Maersk/Sea-Land Alliance is the only global alliance that offers services in north-south and intraregional trades. The K-line/Yangming Alliance offers end-to-end service on two of the three mainstream routes (Europe-Far East and U.S.-Far East) (MDS Transmodal 1994, 1998).

Table 1-2
Top Five Vessel Sharing Agreements, Dec. 31, 1997

	Carriers[a]	Vessels	TEUs
Grand Alliance	6	90	340,063
Maersk/Sea-Land	5	111	334,420
New World Alliance	6	80	308,070
Hanjin/Tricon	9	66	223,924
K-Line/Yangming	4	38	111,665
Total of top five	30	385	1,318,142
Total sharing agreements		2,229	3,694,840
Percent of total sharing agreements		17.3	35.7

[a] Includes regional partners.

KEY: TEU = Twenty-foot equivalent unit.

SOURCE: MDS Transmodal, *Containership Databank* (Chester, England: February 1998).

Ownership v. Registry

To reduce costs, owners have been shifting national flag registrations of ships to open

Table 1-3
Top 20 Ranking of World Merchant Fleet by Registry, January 1, 1998

	Tanker		Dry Bulk		Container		Other[a]		Total	
	No.	Dwt(000)	No.	Dwt(000)	No.	Dwt(000)	No.	Dwt(000)	No.	Dwt(000)
Panama[b]	937	43,940	1,258	67,943	417	11,317	1,686	13,336	4,298	136,536
Liberia[b]	658	55,861	479	31,870	160	4,535	312	4,361	1,609	96,627
Greece	261	23,714	338	16,964	41	1,086	141	1,302	781	43,066
Bahamas[b]	239	22,232	149	7,854	47	954	562	7,450	997	38,490
Malta[b]	314	17,063	366	14,627	39	726	535	4,783	1,254	37,199
Cyprus[b]	167	7,031	523	20,503	108	2,227	655	6,611	1,453	36,372
Norway (NIS)[b,c]	293	20,316	103	6,802	5	89	247	3,357	648	30,564
Singapore[b]	373	15,330	131	8,097	145	3,243	207	2,552	856	29,222
China	237	3,294	328	10,558	99	1,712	807	6,722	1,471	22,286
Japan	288	10,591	177	8,029	34	991	224	1,136	723	20,747
U.S.	161	9,696	14	538	85	2,743	217	3,851	477	16,828
Philippines	69	282	223	10,553	13	261	238	1,920	543	13,016
Saint Vincent[b]	108	2,298	152	5,968	24	150	511	3,971	795	12,387
India	94	5,011	134	5,118	6	111	64	688	298	10,928
Marshall Islands[b]	38	6,432	44	3,047	24	1,176	21	137	127	10,792
Republic of Korea	107	928	122	6,715	70	1,901	169	910	468	10,454
Turkey	74	1,041	187	7,789	8	91	262	1,475	531	10,396
Russia	248	2,398	123	2,386	23	271	1,144	4,516	1,538	9,571
Hong Kong[b]	6	93	103	7,773	43	1,067	31	624	183	9,557
Taiwan	18	1,653	53	4,356	85	2,646	40	212	196	8,867
Top 20	4,690	249,204	5,007	247,490	1,476	37,297	8,073	69,914	19,246	603,905
All Flags	6,573	308,071	5,839	281,179	2,178	55,287	12,967	99,747	27,557	744,284

[a] Breakbulk ships, partial containerships, refrigerated cargo ships, barge carriers, cruise/passenger, and specialized cargo ships.

[b] Open registries.

[c] NIS=Norweigan International Shipping Registry.

SOURCE: Lloyd's Maritime Information Services, *Ship Particulars,* computer file extract (London: Lloyd's Register, January 1998).

registries (flagging out).[3] For vessels that are flagged-out, owners are not citizens of the flag state. By flagging out, operators typically avoid the higher labor costs of national crews, pay less in taxes, and are subject to less restrictive manning regulations. Flagging out expanded significantly on a worldwide basis in the 1990s. In 1997, for example, 57 percent of the world merchant fleet was registered under open registries, up from 50 percent in 1993 (LMIS 1994, 1998a).

Table 1-3 shows the top 20 registries based on fleet deadweight tons (dwt). Four of the top five are open registries. The United States is the 11th largest registry.

In terms of fleet owner nationality, the picture shifts dramatically. The top five countries are Japan, Greece, the United States, Norway, and the United Kingdom (table 1-4). German owners account for the largest national share of the world container-

[3] Cyprus, Danish International Shipping Registry, Gibraltar, Honduras, Hong Kong, Isle of Man, Kerguelen Islands, Liberia, Luxembourg, Madeira, Malta, Marshall Islands, Mauritius, Netherlands Antilles, Norwegian International Shipping Registry, Palau, Panama, Sao Tome and Principe, Singapore, Sri Lanka, St. Vincent, Turks and Caicos Islands, and Vanuatu.

Table 1-4
Top 20 Ranking of World Merchant Fleet by Country of Owner, January 1, 1998[a]

	Tanker		Dry Bulk		Container		Other[b]		Total	
	No.	Dwt (000)	No.	Dwt (000)	No.	Dwt (000)	No.	Dwt (000)	No.	Dwt (000)
Japan	685	34,091	751	42,809	190	5,205	923	7,222	2,549	89,327
Greece	404	25,556	723	30,423	47	832	565	5,995	1,739	62,806
United States	379	29,872	185	8,184	113	3,830	351	5,108	1,028	46,994
Norway	399	27,051	148	8,449	9	209	431	5,970	987	41,679
United Kingdom	259	21,084	193	12,987	83	2,731	264	2,272	799	39,074
China	235	4,015	468	19,337	148	2,996	835	7,084	1,686	33,432
Singapore	423	23,047	109	4,817	92	2,101	205	2,321	829	32,286
Republic of Korea	158	5,439	214	14,646	117	3,369	267	1,519	756	24,973
Hong Kong	62	4,633	224	14,159	83	1,818	177	2,124	546	22,734
Panama	113	5,837	239	11,031	54	1,375	208	2,303	614	20,546
Germany	116	1,470	80	3,639	425	10,353	634	4,152	1,255	19,614
Taiwan	28	2,175	118	6,409	158	5,022	109	826	413	14,432
Russia	277	4,367	153	4,276	33	735	1,184	4,823	1,647	14,201
Liberia	53	6,663	130	5,632	4	80	40	537	227	12,912
Sweden	108	9,909	18	956	-	-	169	1,734	295	12,599
India	104	5,316	144	5,833	4	93	73	740	325	11,982
Denmark	133	4,988	39	2,757	74	2,836	235	1,206	481	11,787
Saudi Arabia	74	10,656	3	37	2	46	26	479	105	11,218
Italy	220	4,794	57	4,564	17	421	139	1,245	433	11,024
Brazil	85	4,515	60	4,533	11	237	38	343	194	9,628
Top 20	4,315	235,478	4,056	205,478	1,664	44,289	6,873	58,003	16,908	543,248
All Flags	6,573	308,071	5,839	281,179	2,178	55,287	12,967	99,747	27,557	744,284

[a] Based on parent company nationality.

[b] Breakbulk ships, partial containerships, refrigerated cargo ships, barge carriers, cruise/passenger, and specialized cargo ships.

SOURCE: Lloyd's Maritime Information Services, *Ship Particulars,* computer file extract (London: Lloyd's Register, January 1998).

ship fleet, reflecting heavy German involvement in the containership charter market, while Japanese and Greek tonnage is heavily concentrated in the tanker and dry-bulk segments. U.S. interests owned 47 million dwt (compared to a U.S. registry of 16.8 million dwt). Approximately 67 percent of U.S. ownership interest is in the tanker segment. U.S.-owned tankers account for nearly 10 percent of the world total.

GLOBAL OUTLOOK

World deep-sea trade has been projected to grow more rapidly than fleet capacity during the 1998 to 2002 period, which could improve earnings for water carriers (table 1-5) (McGraw-Hill and USDOC 1999).

In the coming years, world tanker fleet growth will be affected as vessels built during the boom years–1974 to 1978–reach 25-plus years in service and are scrapped

Table 1-5
Forecast, World Trade Growth v. Fleet Growth, 1998 to 2002 (Compound annual growth rates)

Trade Fleet	Percent	
Dry bulk	3-4	1-2
Tanker	2-3	1-2
Product	4-5	3-4
Crude	1-2	0-1
General cargo	6-7	2-3
Container	8-10	8-10
Other general cargo	0-1	-1-0
Total	**3-4**	**1-2**

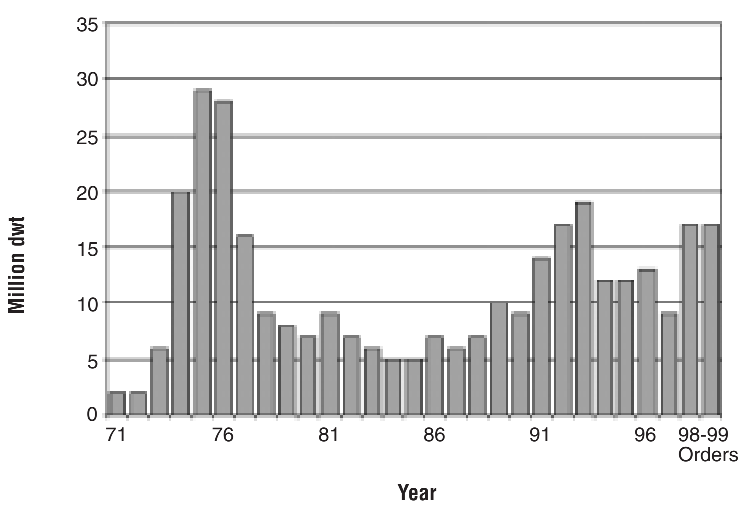
SOURCE: **Trade:** adapted from DRI/McGraw-Hill, World Sea Trade Service, 3rd quarter computer file (Lexington, MA: November 1998). **Fleet:** McGraw-Hill Companies and U.S. Department of Commerce, Transportation, S. Barry, ed., *U.S. Industry & Trade Outlook 1999* (New York: February 1999).

(figure 1-4). The age of the fleet, however, is only one factor affecting tanker scrapping. U.S. and IMO safety and environmental regulations also influence fleet replacement. The Oil Pollution Act of 1990 (OPA-90)[4] mandates that single-hull tankers serving U.S. ports be phased out in stages (based on age and size) beginning in 1995. IMO regulations for tankers serving foreign ports require that new tankers delivered after July 6, 1996 have double hulls and that 25-year-old single-hull tankers be retrofitted with double hulls beginning in 1995. This latter requirement will likely result in operators opting to acquire new ships rather than retrofit older vessels. As of year-end 1997, Clarkson's Tanker Register (a comprehensive registry of seagoing tankers) reported that 21 percent of the world's tankers were equipped with double hulls, up from 12 percent at the beginning of 1995 (Tyler 1998).

In terms of safety, the International Maritime Organization (IMO) Safety of Life at Sea (SOLAS) convention requires that all ships of at least 500 gross registered tons meet International Safety Management (ISM) mandated safe-management standards. Passenger ships, tankers, bulk carriers, and high-speed cargo ships had to be ISM-certified by July 1, 1998. Other cargo ships must be ISM-certified by July 1, 2002. Vessels that do not have ISM certification will be denied access to U.S. ports. So far, ISM certification has not restricted the available shipping capacity for deep-sea trades (IMO 1994).

For passenger vessels, SOLAS requires significant changes to shipboard infrastructure. By 1997, ships were required to have low-level lighting, smoke detection, alarm, and sprinkler systems. By 2000, ships must

Figure 1-4
World Merchant Fleet by Year Built, Tanker



KEY: dwt = deadweight ton.

SOURCE: Lloyd's Maritime Information Services, *Ship Particulars*, computer file extract (London: Lloyd's Register, January 1998).

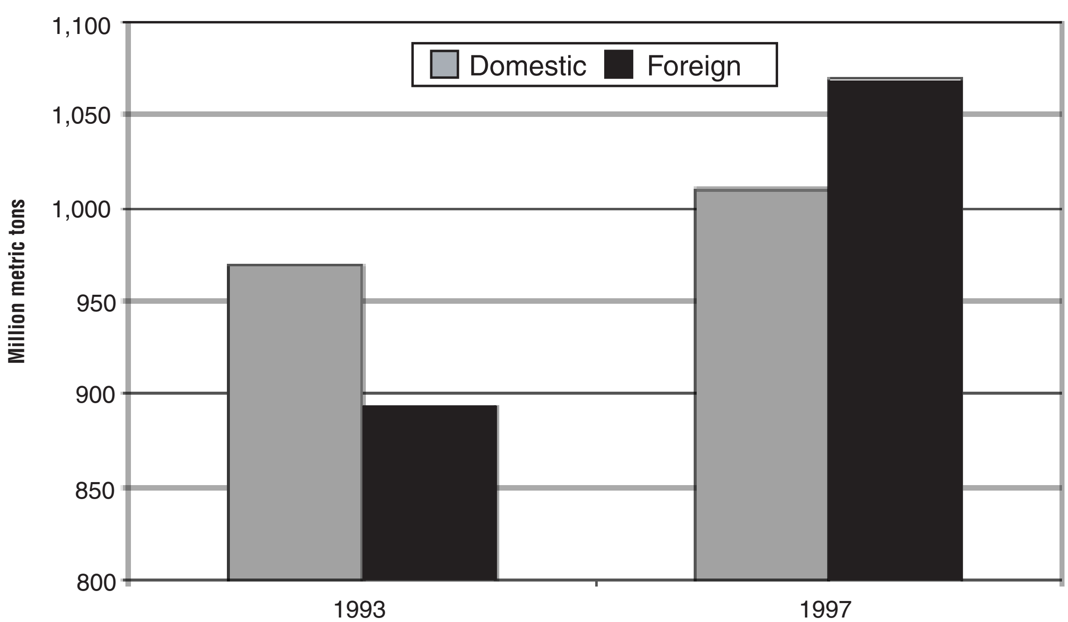
[4] Public Law 101-380, 104 Stat. 517-522 (1990).

have steel frames in stairways, ventilation ducts equipped with fire dampers, and fire-extinguishing systems for certain machinery. For many ship owners, the steel-frame stairway requirement in year 2000 represents a significant expense and will likely accelerate removal of older vessels from service (IMO 1994).

With the expansion of global refinery capacity in crude-oil producing areas, such as the Middle East and Asia, it is expected that the product tanker fleet will grow more rapidly than the crude-oil tanker fleet, and that the average size of product tankers will increase in response to long-haul shipping requirements (USDOT MARAD OSEA 1999).

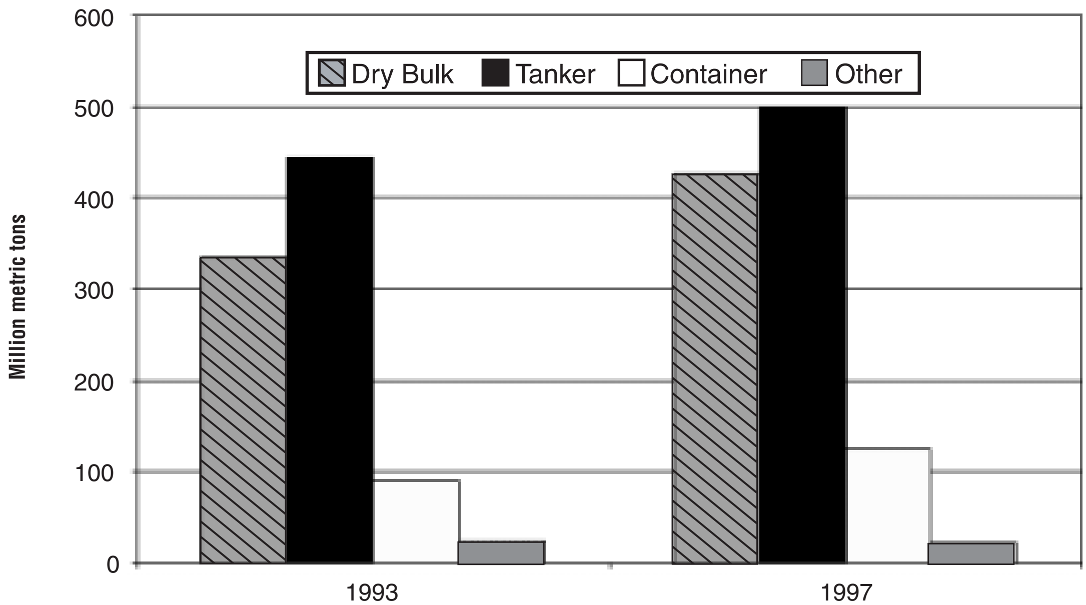
The containership fleet is expected to grow at a higher rate than other vessel types as larger containerships are introduced into mainstream east-west trades and as containerships continue to replace traditional breakbulk ships in world liner trades. The containerization of fleets will be most rapid in intraregional trades (USDOT MARAD OSEA 1999).

Figure 1-5
U.S. Foreign and Domestic Waterborne Trades, 1993 and 1997



SOURCES: **Domestic trade:** U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, *Waterborne Commerce of the United States, Part 5, National Summaries, 1997* (Fort Belvoir, VA, February 1998). **Foreign trade:** World Sea Trade Service, 3rd quarter computer file (New York: DRI/McGraw-Hill, November 1998).

Figure 1-6
U.S. Foreign Waterborne Trade, 1993, 1997



SOURCE: World Sea Trade Service, 3rd quarter computer file (New York: DRI/McGraw-Hill, November 1998).

U.S. INDUSTRY TRENDS

Freight Transportation

U.S. waterborne trade, both foreign and domestic, drives U.S. water transportation industry growth.[5] From 1993 to 1997, U.S. foreign waterborne trade grew by 4.6 percent per year, surpassing in total volume domestic waterborne trade, which increased by only 1.0 percent (figure 1-5).

Table 1-6
U.S. Foreign Waterborne Trade Growth[a]
(Compound annual growth rates)

Vessel type	Percent growth 1993-97	Percent growth 1998-02 (projected)
Container	8.6	6–8
Dry bulk	6.2	2–3
Tanker	2.9	2–3
Other general cargo	(3.1)	(2–3)
Total	**4.6**	**3–4**

[a]Growth rates based on metric tons.

SOURCE: Adapted from DRI/McGraw-Hill Companies and Mercer Management Consulting, Inc., World Sea Trade Service, 3rd quarter computer file (Lexington, MA: November 1998).

U.S.-Foreign Waterborne Transportation

This segment of the water transportation industry carries imports and exports between the United States and foreign ports. From 1993 to 1997, U.S. waterborne exports and imports accounted for about 21 percent of global waterborne trade (DRI/McGraw Hill 1998).

[5] The Jones Act (section 27 of the Merchant Marine Act of 1920) precludes foreign-owned or foreign-flagged vessels from participating in U.S. domestic trade.

U.S. dry-bulk trade increased by 6.2 percent per year between 1993 and 1997, in part because of the recovery of U.S. grain exports after major Midwestern floods in 1993 (figure 1-6 and table 1-6). Dry-bulk trades are also affected by general economic conditions and other factors, such as labor strikes in commodity producing industries (United Mine Workers strike in 1994) and trade policies.

U.S. tanker trades increased by 2.9 percent per year between 1993 and 1997. However, there was considerable fluctuation in imports over this period. U.S. tanker imports declined by 7 percent in the mid 1990s, due primarily to higher world petroleum prices and drawdowns in domestic stocks. Lower crude-oil prices in 1996 and 1997 contributed to a recovery in U.S. crude-oil imports (USDOT MARAD OSEA 1999).

Table 1-7
U.S. Waterborne Foreign Trade Growth by Major World Regions[a] 1993-1997 (Compound annual growth)

	Percent growth		
	Tanker	Other	Total
Far East	-11.9	3.3	0.9
Europe/Mediterranean	-4.4	8.1	3.6
Latin America	10.8	10.1	10.6
Middle East	-6.7	2.3	-4.2
Australasia	-4.1	6.8	4.1
Canada	-0.8	7.7	6.1
Africa	4.7	-1.7	3.7
Total	**2.8**	**6.2**	**4.6**

[a]Growth rates based on metric tons.

SOURCE: Adapted from DRI/McGraw-Hill Companies and Mercer Management Consulting, Inc., World Sea Trade Service, 3rd quarter computer file (Lexington, MA: November 1998).

U.S. container trades increased by 8.6 percent per year from 1993 to 1997 (metric tons), reflecting the containerization of U.S. breakbulk trades (USDOT MARAD OSEA 1999). Furthermore, the immediate effects of reductions in trade barriers in the 1990s have been more conspicuous in manufactured products trades, which are shipped in containers, than on the demand for primary commodities. These trends are expected to continue over the 1998 to 2002 period.

As shown in table 1-6, overall U.S. foreign waterborne trade is expected to grow at 3 to 4 percent per year from 1998 through 2002, down from 4.6 percent per year for the 1993 to 1997 period. As noted earlier, the 1993 to 1997 growth rates were high due to recoveries in U.S. tanker and dry-bulk trades (DRI/McGraw-Hill and Mercer Management Consulting, Inc. 1998).

Regional Trade Patterns. Table 1-7 shows annual growth rates for U.S.-foreign waterborne trade by regions. For the 1993 to 1997 period, U.S.-Latin American trade increased by 10.6 percent per year, partly due to privatization and relaxation of trade restrictions in Latin American countries. For the same period, tanker shipments from Latin America (Mexico and Venezuela) and Canada increased significantly at the expense of shipments from the Far East and Middle East, contributing to a decline in ton-miles for U.S. tanker

Table 1-8
U.S. Waterborne Foreign Trade Growth, Ton-Mile Estimates, 1993 and 1997 (Billion ton-miles)

	1993	1997	Compound annual growth, 1993-97 in percent
Tanker	2,884	2,712	-1.5
Bulk	1,920	2,649	8.4
Container	575	679	4.2
Other	248	240	-0.8
Total	**5,687**	**6,280**	**2.5**

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Statistical and Economic Analysis, estimates developed from World Sea Trade Service (metric tons) computer file (New York: DRI/McGraw-Hill, November 1998) and Fairplay International, Fairplay Desktop Encyclopaedia (mileage tables) computer file (London: November 1998).

Table 1-9
U.S. Waterborne Foreign Trade 1997 (Thousand metric tons)

U.S. Coast	Far East	Europe, Mediterranean	Latin America	Middle East	Canada	Australia, New Zealand	Africa	Total
				Container Ships				
Alaska	139	1	0	0	0	0	0	140
California	36,367	2,498	2,194	48	263	1,606	1	42,977
Great Lakes	0	0	0	0	0	0	0	0
Gulf	90	4,878	5,035	107	0	167	168	10,444
Hawaii	265	0	2	0	0	42	0	308
North Atlantic	6,166	14,455	5,522	881	113	584	644	28,365
North Pacific	14,014	359	181	19	42	150	0	14,765
Puerto Rico/Virgin Islands	74	425	1,070	0	81	0	0	1,651
South Atlantic	6,367	7,719	10,771	523	24	263	352	26,019
Total	**63,482**	**30,334**	**24,775**	**1,578**	**523**	**2,812**	**1,164**	**124,668**
				Tanker ships				
Alaska	1,698	57	0	0	8	0	0	1,763
California	5,606	324	9,521	4,219	551	243	0	20,464
Great Lakes	0	0	0	0	259	0	0	259
Gulf	3,816	21,892	164,623	97,530	1,774	777	6,998	297,410
Hawaii	4,563	0	387	240	85	1,349	0	6,624
North Atlantic	6,639	27,389	38,344	6,661	12,190	124	27,973	119,320
North Pacific	558	0	1,004	8	892	62	0	2,524
Puerto Rico/Virgin Islands	2,176	1,148	6,498	85	250	0	784	10,942
South Atlantic	1,920	818	5,806	0	82	0	0	8,626
Total	**26,977**	**51,628**	**226,183**	**108,742**	**16,092**	**2,555**	**35,755**	**467,932**
				Dry bulk ship				
Alaska	2,474	39	229	28	85	44	0	2,898
California	9,789	3,948	3,987	1,175	1,096	569	327	20,890
Great Lakes	38	2,446	180	0	21,363	0	0	24,027
Gulf	48,348	66,354	55,612	6,194	4,917	2,940	12,034	196,399
Hawaii	703	0	180	0	41	115	0	1,039
North Atlantic	10,882	39,077	21,044	399	8,597	1,242	1,676	82,916
North Pacific	28,657	489	2,184	3,666	2,912	3,822	35	41,765
Puerto Rico/Virgin Islands	184	469	1,296	0	183	24	129	2,286
South Atlantic	2,476	5,277	6,888	81	3,175	434	456	18,787
Total	**103,550**	**118,100**	**91,600**	**11,542**	**42,368**	**9,190**	**14,657**	**391,006**
				Other general cargo				
Alaska	793	112	0	0	119	0	0	1,024
California	4,358	888	955	590	200	369	0	7,359
Great Lakes	79	1,296	136	0	215	41	0	1,767
Gulf	9,348	7,571	12,913	1,414	504	474	835	33,060
Hawaii	19	0	0	0	0	18	0	37
North Atlantic	2,016	4,717	2,676	515	3,331	245	199	13,699
North Pacific	5,569	357	213	246	3,539	735	18	10,677
Puerto Rico/Virgin Islands	159	157	157	0	70	0	0	542
South Atlantic	1,945	3,276	3,029	478	699	261	144	9,832
Total	**24,286**	**18,375**	**20,079**	**3,242**	**8,676**	**2,144**	**1,196**	**77,998**

SOURCE: *Journal of Commerce,* Port Import/Export Reporting Service, computer file (New York: February 1998).

trades (table 1-8). These trends are expected to continue over the 1998 to 2002 period. It should be noted that in 1997, U.S.-foreign waterborne trade accounted for 29 percent of global trade in terms of ton-miles (demand for vessel services), significantly higher than the U.S. share of global trade in terms of metric tons. A significant amount of U.S. bulk trade moves on long-haul routes, such as the U.S. Gulf-Middle East (9,600 miles) and U.S. Gulf-Far East trades (10,500 miles). In 1997, the average length of haul for U.S.-foreign waterborne trade was 5,900 miles, compared to 4,220 miles for world trades.

As shown in table 1-9, the U.S. Atlantic and Pacific coasts are heavily involved in U.S. container trades, while the U.S. Gulf coast is involved primarily in dry-bulk and tanker trades. Great Lakes trades are primarily dry-bulk commodities.

U.S. Domestic Waterborne Trades

This market segment includes carriers that transport freight between U.S. ports on the deep seas, inland waterways, and Great Lakes. In 1997, 244 million metric tons moved on the deep seas, 655 million metric tons moved on the inland waterways, and 111 million metric tons moved on the Great Lakes (table 1-10).

Domestic Deep Sea. The top domestic deep-sea cargoes in 1997 (ranked by tonnage) were petroleum products (41 percent), crude petroleum (31 percent), crude

Table 1-10
U.S. Domestic Waterborne Trade by Major Segment, Metric Tons, Ton-Miles, and Average Haul (Miles)

	1993	1994	1995	1996	1997	Compound annual growth, 1993-97 percent
Ocean						
Million metric tons	251	257	248	249	244	-0.70
Billion ton-miles	449	458	441	409	316	-8.41
Miles	1,790	1,785	1,778	1,641	1,294	-7.79
Inland						
Million metric tons	618	636	638	645	655	1.46
Billion ton-miles	258	271	279	271	268	0.96
Miles	418	427	437	419	410	-0.48
Lakes						
Million metric tons	97	104	105	104	111	3.43
Billion ton-miles	56	58	60	58	56	0.00
Miles	514	508	514	508	509	-0.24
Total						
Million metric tons	964	997	991	998	1,010	1.17
Billion ton-miles	763	787	780	738	640	-4.30
Miles	791	783	792	744	634	-5.38

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, *Waterborne Commerce of the United States,* Calendar Year 1997, Part 5, National Summaries (Fort Belvoir, VA: February 1997).

Table 1-11
Major Commodities Shipped in the U.S. Domestic Ocean Trades, 1997

	Billion ton-miles	Million metric tons	Average miles
Coal and coke	9.4	14	672
Petroleum	235.2	177.8	1,322
Crude	140	70	1,829
Products	94.4	102.6	936
Chemicals	33.3	15.5	2,145
Crude materials	10.1	16.4	622
Primary manufactured goods	4.9	6.8	719
Farm products	12.6	6.9	1,818
Manufactured goods	10.5	6.8	1,542
Other	0.1	0.1	995
Total	**316.1**	**244.3**	**1,294**

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, *Waterborne Commerce of the United States,* Calendar Year 1997, Part 5, National Summaries (Fort Belvoir, VA: February 1997).

materials (7 percent), chemicals (6 percent), and coal (6 percent) (table 1-11). Container cargoes move primarily in noncontiguous trades (U.S. mainland to Alaska, Hawaii, Puerto Rico, and Guam) on both self-propelled and barge vessels.

Total cargo moving in domestic deep-sea trades has declined steadily in the 1990s, reflecting a decrease in Alaska North Slope crude-oil shipments (USACE, Part 5, 1995–1999). Domestic deep-sea trades fell by about 0.7 percent per year from 1993 to 1997, while crude-oil shipments declined by 6 percent, and other shipments increased by 2 percent per year. Furthermore, the decline in long-haul crude-oil shipments has contributed to a 23-percent drop in average haul (miles) in the deep-sea domestic trades from 1993 to 1997.

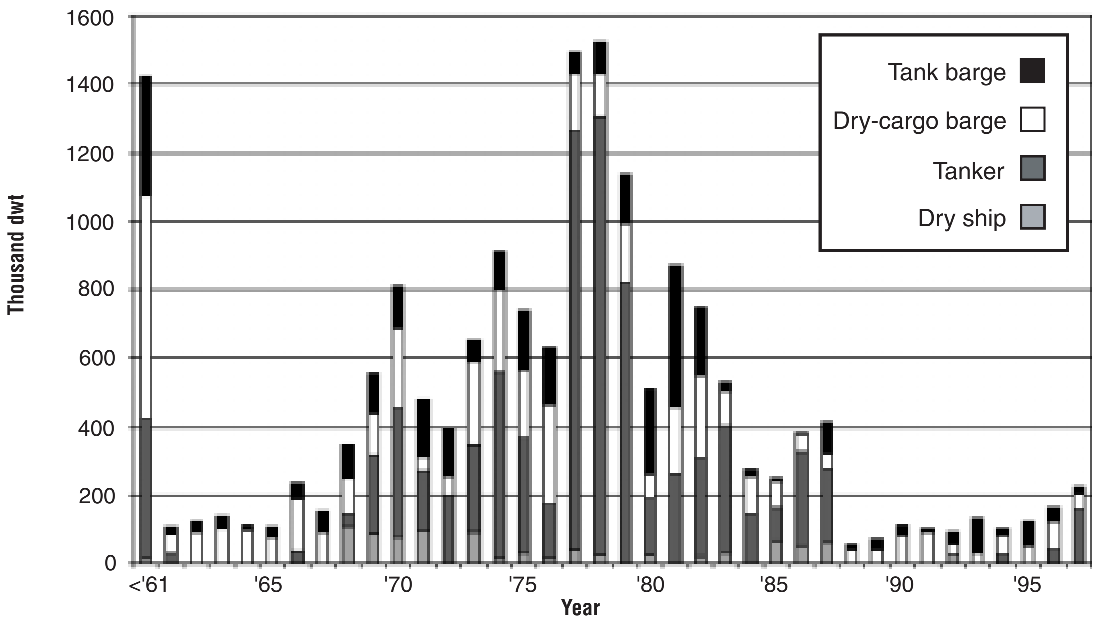
For the 1998 to 2002 period, total domestic deep-sea shipments are expected to decline by about 0.5 percent per year as shipments of crude oil fall by about 5 percent annually (McGraw-Hill and USDOC 1999). Shipments of other commodities are expected to increase at about 1 percent per year (below the 1993 to 1997 growth rate) because of an expected increase in petroleum product imports. (See the discussion on U.S. Foreign Waterborne Trade.)

Tanker shipments from U.S. Gulf refineries to the west coast are expected to increase in the late 1990s (USDOT MARAD OSEA 1999). Starting in 1995, the Clean Air Act Amendments of 1990 (CAAA)[6] required that reformulated gasoline be used year-round in air quality areas where high concentrations of carbon monoxide are found—principally on the Atlantic and Pacific coasts. According to the U.S. Department of Energy, the production capacity of methyl tertiary butyl ether (MTBE), which is an oxygenate mixed with gasoline to improve combustion, is concentrated at U.S. Gulf refineries. MTBE cannot be shipped through pipelines from U.S. Gulf refineries to the U.S. west coast. Consequently, long-haul (5,000 to 6,500 nautical miles) product tanker shipments of reformulated gasoline from the U.S. Gulf to the U.S. west coast doubled from 1995 to 1997.

Although the U.S. Gulf-west coast petroleum product trade is a significant source of demand for product tanker services, it represents only 1 percent of domestic

[6] Public Law 101-549.

Figure 1-7
Domestic Deep-Sea Fleet by Year Built



KEY: dwt = deadweight ton.

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Transportation Lines of the United States, computer file (Fort Belvoir, VA: August 1998).

ocean shipments in terms of metric tons and will have little impact on the forecast discussed earlier.

In 1997, fleets serving U.S. domestic deep-sea trades included 39 dry-cargo vessels (0.8 million dwt), 122 tankers (8.2 million dwt), 3,393 dry-cargo barges (4.8 million dwt), and 669 tank barges (3.4 million dwt) (McGraw-Hill and USDOC 1999). The capacity of the dry-cargo vessel fleet is expected to remain at its 1997 level through 2002, reflecting limited growth in U.S. noncontiguous trades.

While there is some limited construction of crude-oil tankers and product tankers underway for domestic trades, the capacity of the tanker fleet, particularly crude-oil carriers (most with a deadweight capacity of 70,000 plus metric tons), is expected to decline by about 8 percent per year from 1998 to 2002 (McGraw-Hill and USDOC 1999).

As of year-end 1997, approximately 72 percent of the crude-oil fleet was at least 20 years old (figure 1-7). A sizable part of this fleet likely will be scrapped or removed from service over the next few years as the domestic crude-oil trades continue to decline and these ships are phased out due to the double-hull requirements of OPA-90.

Table 1-12
U.S. Domestic Tanker Trade by Region, 1997 (Thousand metric tons)

	Received at										
Shipped from	Alaska	California	Hawaii	North Atlantic	North Central	Pacific Northwest	Puerto Rico, Virgin Islands	South Atlantic	South Central	Pacific Islands	Total
Alaska	1,811	36,744	2,066	–	–	24,421	1,510	–	116	–	66,669
California	294	9,235	29	9	–	1,736	–	79	324	–	11,706
Hawaii	–	–	13	–	–	–	–	–	–	38	51
North Atlantic	–	–	–	2,596	–	–	61	67	767	–	3,491
North Central	–	–	–	39	152	–	–	–	–	–	191
Pacific Northwest	199	2,745	160	–	–	516	–	–	148	–	3,768
Puerto Rico, Virgin Islands	–	254	40	9,813	–	–	1081	4,572	361	–	16,121
South Atlantic	–	–	–	–	–	–	–	40	220	–	260
South Central	–	1,829	–	5,814	–	152	519	20,462	1,941	–	30,717
Pacific Islands	–	–	–	–	–	–	–	–	–	–	–
Total	**2,304**	**50,807**	**2,308**	**18,272**	**152**		**3,171**	**25,219**	**3,878**	**38**	**132,975**

KEY: – = Less than 500 metric tons.

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Commerce of the United States, Calendar Year 1997, computer file (Fort Belvoir, VA: February 1998).

Table 1-13
U.S. Domestic Dry Vessel Trade by Region, 1997 (Thousand metric tons)

	Received at										
Shipped from	Alaska	California	Hawaii	North Atlantic	North Central	Pacific Northwest	Puerto Rico, Virgin Islands	South Atlantic	South Central	Pacific Islands	Total
Alaska	231	–	–	–	–	284	–	–	–	20	535
California	–	182	1872	–	–	124	–	–	–	277	2,455
Hawaii	–	442	–	–	–	69	–	–	–	25	536
North Atlantic	–	3	–	2,342	15	–	712	164	89	–	3,326
North Central	–	–	–	2,121	99,683	–	–	–	–	–	101,804
Pacific Northwest	1,165	102	466	–	–	176	–	–	–	39	1,948
Puerto Rico, Virgin Islands	–	–	–	244	–	–	145	146	169	–	705
South Atlantic	–	–	–	53	–	–	1,075	245	446	–	1,707
South Central	–	–	–	1	–	–	299	712	10,290	–	11,415
Pacific Islands	–	17	1	–	–	8	–	–	–	–	26
Total	**1,396**	**747**	**2,308**	**4,762**	**99,698**	**660**	**2,232**	**1,268**	**10,994**	**360**	**124,457**

KEY: – = Less than 500 metric tons.

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Commerce of the United States, Calendar Year 1997, computer file (Fort Belvoir, VA: February 1998).

Table 1-14
U.S. Domestic Tank Barge Trade by Region, 1997 (Thousand metric tons)

	Received at									
Shipped from	**Alaska**	**California**	**Hawaii**	**North Atlantic**	**North Central**	**Pacific Northwest**	**Puerto Rico, Virgin Islands**	**South Atlantic**	**South Central**	**Total**
Alaska	1,004	12	–	–	–	66	–	–	47	1,129
California	37	5,372	–	–	2	721	–	–	–	6,132
Hawaii	–	–	1,071	–	–	–	–	–	–	1,071
North Atlantic	–	–	–	82,944	305	–	26	477	234	83,986
North Central	–	–	–	1,417	14,243	225	–	4	4,125	20,014
Pacific Northwest	230	952	–	–	–	10,899	–	–	–	12,081
Puerto Rico, Virgin Islands	–	39	–	28	–	–	4,449	49	28	4,593
South Atlantic	–	–	–	45	5	–	–	5,332	454	5,836
South Central	–	–	–	2,304	13,859	–	97	22,019	112,632	131,093
Total	**1,271**	**6,378**	**1,071**	**86,738**	**28,415**	**11,911**	**4,570**	**27,882**	**117,522**	**285,758**

KEY: – = Less than 500 metric tons.

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Commerce of the United States, Calendar Year 1997, computer file (Fort Belvoir, VA: February 1998).

Table 1-15
U.S. Domestic Dry Cargo Barge Trade by Region, 1997 (Thousand metric tons)

	Received at										
Shipped from	**Alaska**	**California**	**Hawaii**	**North Atlantic**	**North Central**	**Pacific Northwest**	**Puerto Rico, Virgin Islands**	**South Atlantic**	**South Central**	**Pacific Islands**	**Total**
Alaska	1,275	32	–	–	–	373	–	8	–	–	1,687
California	–	3,342	1	–	–	240	–	–	–	–	3,584
Hawaii	–	1	5,041	–	–	9	–	–	–	15	5,066
North Atlantic	–	–	–	46,490	7,655	–	380	624	1,834	–	56,983
North Central	–	–	–	17,474	129,830	691	–	3,722	120,324	–	272,042
Pacific Northwest	704	151	150	–	79	12,576	–	–	–	–	13,660
Puerto Rico, Virgin Islands	–	–	–	–	–	–	13	316	34	–	471
South Atlantic	–	–	–	807	3	–	1,055	1,568	8,953	–	12,386
South Central	–	1	–	2,240	22,134	–	986	10,990	58,953	–	95,305
Pacific Islands	–	–	2	–	–	–	–	–	–	–	2
Total	**1,979**	**3,527**	**5,194**	**67,120**	**159,701**	**13,889**	**2,434**	**17,229**	**190,099**	**15**	**461,187**

KEY: – = Less than 500 metric tons.

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Commerce of the United States, Calendar Year 1997, computer file (Fort Belvoir, VA: February 1998).

The capacities of the dry-cargo and tank-barge fleets are projected to increase at about 2 percent per year from 1998 to 2002. The anticipated growth in tank-barge capacity reflects increasing demand for barges for intracoastal and short-haul intercoastal shipments of petroleum products. The projected growth of the dry-cargo barge fleet reflects an increase in demand for container/trailer barges for short-haul, noncontiguous trades (e.g., Florida to Puerto Rico) and for penetration of overland (truck and rail) container markets. The dry-cargo vessel fleet is expected to decline by about 0.5 percent per year from 1998 to 2002 as aging containerships are replaced with new container/trailer barges.

Regional Trade Patterns. Tables 1-12 through 1-15 show the regional patterns of U.S. domestic trades by vessel type. In 1997, tank barges carried most of the cargo in U.S. intraregional trades, while tankers were employed primarily in interregional trades. Dry-cargo barge shipments were concentrated in the North Central and South Central regions along the Mississippi River. The Central regions, specifically the Great Lakes and intra Gulf Coast, were the primary dry-cargo vessel trades.

Inland Waterways. The U.S. inland waterway system consists of more than 25,000 miles of navigable inland rivers and intracoastal waterways. In 1997, 655 million metric tons moved on the inland waterways, including the intracoastal waterways on the Atlantic and Gulf Coasts. Barges moved 96 percent of the tonnage, primarily coal, petroleum, crude materials, and farm products (table 1-16). Farm products accounted for 28 percent of the ton-miles (the largest single demand for transport services) on inland waterways in 1997. Average haul for inland shipments of farm products was 988 miles, compared with 332 miles for all other inland shipments. A temporary surge in shipments of grain exports in 1994 and 1995 had a positive impact on the demand for inland dry-cargo barge services and freight rates.

Table 1-16
Major Commodities Shipped on the Inland Waterways, 1997[a]

	Billion ton-miles	Million metric tons	Average haul-miles
Coal and coke	66.1	175.8	376
Petroleum	33.7	177.9	189
Chemicals	27.6	56.8	486
Crude materials	45.2	128.9	351
Primary manufactured goods	18.6	23.6	789
Farm products	75.7	76.6	988
Finished manufactured goods	1.0	10.7	94
Waste	0.3	5.0	60
Total	**268.2**	**655.3**	**410**

[a] Includes intraport shipments.

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Commerce of the United States, Calendar Year 1997, computer file (Fort Belvoir, VA: February 1998).

The projected growth rate for inland waterways trades (2 percent per year from 1998 to 2002) is higher than actual performance for the 1993 to 1997 period (1.5 percent per year), largely because of an expected increase in domestic consumption of eastern coal (McGraw-Hill and USDOC 1999). In the 1990s, many utilities complied with the emissions requirements of the CAAA by substituting low-sulfur western coal, carried primarily by rail, for high-sulfur eastern coal, which was carried primarily by barge. In order to satisfy the CAAA's more stringent year-

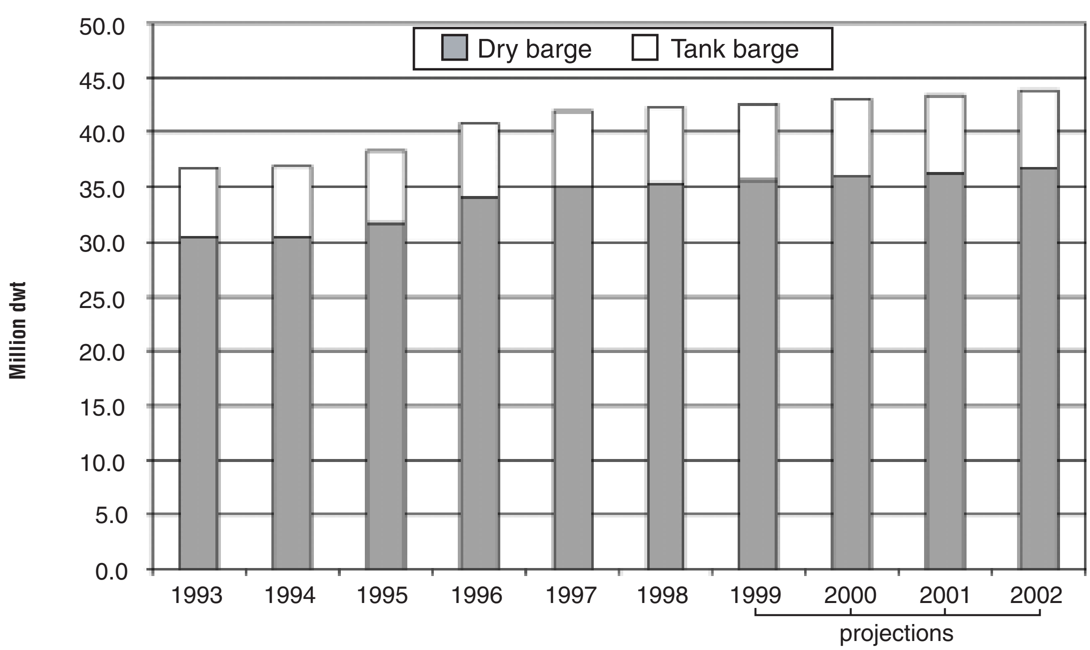
2000 emissions requirements, some utilities may decide to install emissions reducing equipment or employ other pollution-reduction strategies that enable them to use the higher sulfur eastern coal. As this equipment is installed and utilized, it is expected that the demand for eastern coal and related barge services will increase.

In 1997, the inland-barge fleet consisted of about 26,000 dry-cargo barges (35 million dwt) and nearly 3,400 tank barges (6.9 million dwt). Total inland-barge capacity increased by 6.2 percent from 1995 to 1996, the largest annual increase in capacity since the 1980 to 1981 increase. The 1996 increase was largely a function of the 1995 rise in barge freight rates that limited dry-cargo barge scrapping and led to a sharp increase in orders for new dry-cargo barges to be delivered in 1996 and 1997 (figures 1-8 and 1-9). In contrast, new deliveries, spurred by investment tax credits, accounted for the 1980 to 1981 increase.

Inland tank-barge capacity is expected to grow at about one percent per year from 1998 to 2002, reflecting modest growth in U.S. consumption of petroleum products. Although dry-cargo barge capacity on the inland waterways is also expected to increase by about 1 percent per year from 1998 to 2002, dry-cargo barge capacity growth will be limited by several factors:

- scrapping of a large percent of the inland barge fleet; approximately 41 percent of the inland barge fleet will be at least 25 years old by 2002,

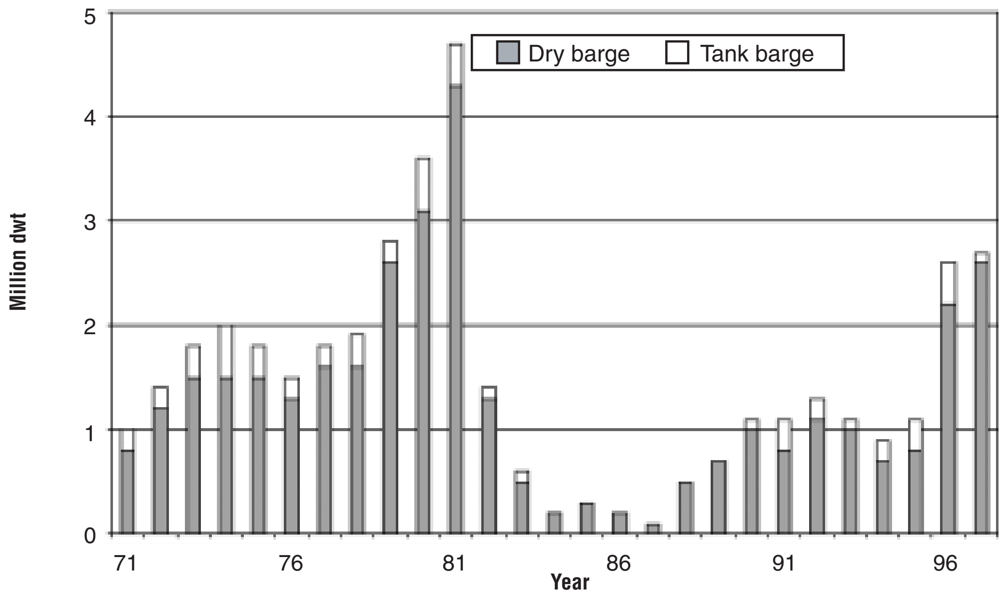
Figure 1-8
Inland Waterways Fleet, 1993-02



KEY: dwt = deadweight ton.

SOURCE: McGraw-Hill and U.S. Department of Commerce, Transportation, S. Barry, ed., *U.S. Industry & Trade Outlook 1999* (New York: February 1999).

Figure 1-9
Inland Barge Fleet by Year Built



KEY: dwt = deadweight ton.

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Transportation Lines of the United States, computer file (Fort Belvoir, VA: September 1998).

- low freight rates in 1996 and 1997, which tend to increase scrapping and limit the industry's financial resources for new barges, and
- weather-related factors that contribute to unexpected year-to-year fluctuations in traffic and barge freight rates.

Great Lakes. Ships in this segment of the water transportation industry move freight between U.S. ports on the Great Lakes and the St. Lawrence Seaway. In 1997, 111 million metric tons of domestic cargo moved on the Great Lakes. The major commodities transported were coal and coke and crude materials (table 1-17). About 91 percent of overall Great Lakes trade is moved in dry-bulk ships.

For several years in the 1990s, U.S. Great Lakes trade was in the 104 to 105 million metric-ton range. However, from 1996 to 1997, trade increased to 111 million metric tons, largely because of mild weather that facilitated shipping on the Lakes in the early spring of 1997 (McGraw-Hill and USDOC 1999).

As of year-end 1997, the U.S. Great Lakes fleet consisted of 129 dry-cargo vessels (1.9 million total dwt), 5 tankers (20,000 total dwt), 258 dry-cargo barges (400,000 total dwt), and 41 tank barges (100,000 total dwt). From 1993 to 1997, U.S. Great Lakes fleet capacity declined by about 2 percent per year. The decline of the fleet coupled with stable traffic levels suggests increased fleet utilization and/or productivity in the 1990s. These trends are expected to continue over the 1998 to 2002 period.

Table 1-17
Major Commodities Shipped on the Great Lakes, 1997

	Billion ton-miles	Million metric tons	Average haul-miles
Coal and coke	10.9	20.8	525
Petroleum	0.6	2	312
Chemicals	0.03	0.1	325
Crude materials	43.5	84.3	516
Primary manufactured goods	1	3.3	294
Farm products	0.4	0.4	906
Finished manufactured goods	–	–	–
Waste	–	–	–
Total	**56.4**	**110.9**	**509**

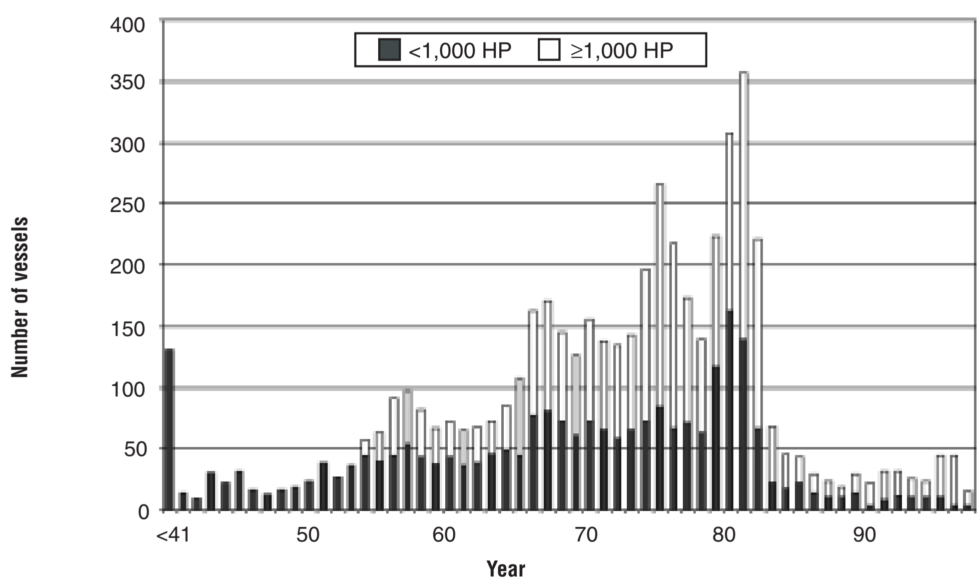
SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Commerce of the United States, Calendar Year 1997, computer file (Fort Belvoir, VA: February 1998).

Great Lakes vessels, called lakers, tend to have significantly longer economic lives than ocean vessels: as of year-end 1997, the average age of Great Lakes vessels was 38 years, compared to 27 years for domestic deep-sea vessels. For the period 1993 to 1997, the average age of vessels removed from the Great Lakes fleet was 41 years.

Tugs/Towboats. The tug and towboat fleet consists of coastal tugs and inland towboats (pushboats). Coastal tugs are used in ship assist, tanker escorts, barge towing, and salvage. Some recently built coastal tugs have oil spill skimming equipment, contributing to their usefulness in U.S. tanker and tank-barge trades. In contrast, inland towboats are used to push barges.

The number of tugs and towboats has declined steadily in the mid 1990s (USACE WCSC TLUS 1994-1998). This decline can be attributed to the fact that larger,

Figure 1-10
U.S. Tug/Towboat Fleet by Year Built and Horsepower



KEY: HP = horsepower

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Transportation Lines of the United States, year-end 1997 fleet, computer file (New Orleans, LA: September 1998).

Table 1-18
Domestic Deep-Sea Trade, Self-Propelled Vessel v. Barge, by Length of Haul, 1997 (Million metric tons)

Miles	Barge	Vessel	Total	Percent (barge)
< 500	55.6	9.2	64.8	85.8
500-1,000	32.7	12	44.7	73.1
1,001-1,500	11.7	42	53.7	21.8
1,501-2,000	3.7	35.3	39	9.4
> 2,000	3.6	38.4	42	8.6
Total	**107.3**	**137**	**244.3**	**43.9**

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Waterborne Commerce of the United States, Calendar Year 1997, computer file (Fort Belvoir, VA: February 1998).

more efficient vessels are replacing an aging fleet of smaller (less than 1,000 horsepower), less efficient vessels (figure 1-10). This trend is expected to continue over the 1998 to 2002 period.

Barges v. Self-Propelled Vessels. In 1997, barges carried approximately 86 percent of metric tons in ocean trades of less than 500 miles; self-propelled vessels carried approximately 91 percent of the metric tons moved in trades greater than 1,500 miles (table 1-18). Self-propelled vessels are generally preferred in long-haul, time-sensitive trades because they are faster than barges (15 to 20 knots v. 8 to 12 knots) and are not as likely as barges to get weatherbound.

Passenger Travel

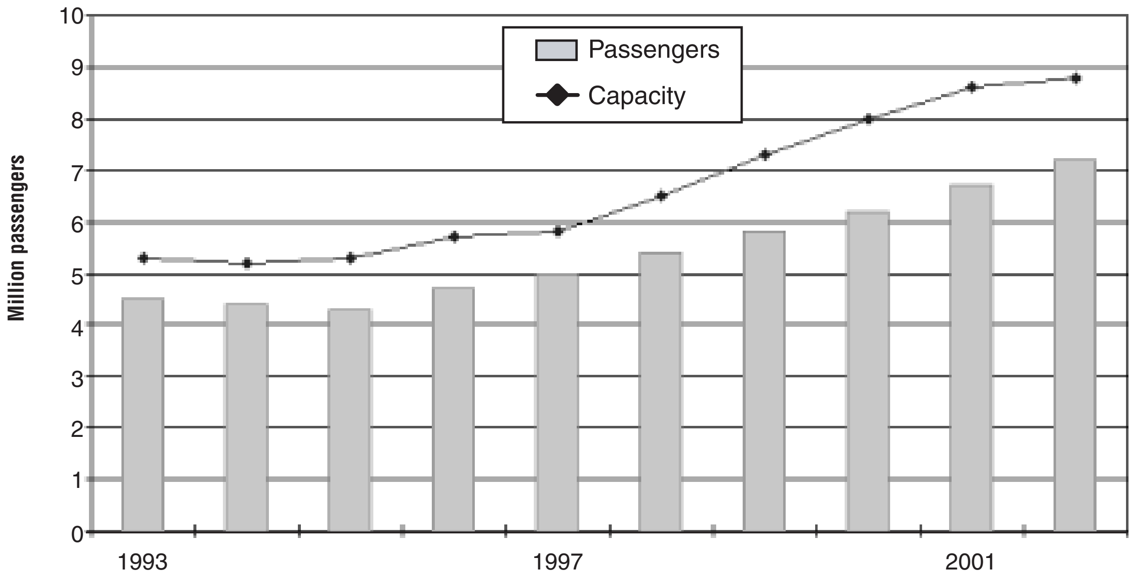
Cruise ships, ferries, and water taxis transport passengers. Cruise ships are floating resorts that are used primarily for multiday round trips, while ferries are used primarily for daily transportation, carrying passengers or vehicles on a regular schedule over a fixed route.

Cruise Ships

North American (refers to origins and destinations) cruise passenger travel has increased at an average rate of 7.8 percent per year from 1995 to 1997 (figure 1-11). This growth has been fueled by two factors.

- First, new ships that offer new technologies and a rich mix of cabins and amenities have been introduced. Thirty-three of the 122 cruise ships serving North American ports in 1998 were introduced as newbuilds since 1995. It is anticipated that an additional 26 newbuilds will be introduced by 2002 (Mathiesen 1998).
- Second, consolidation, through acquisitions and mergers, has provided the top companies with more financial strength and marketing muscle to promote their ships and control costs, contributing to the stability of the industry in the late 1990s. For instance, in 1998, the top four North American cruise lines controlled 82 percent of the North American cruise capacity, up from 61 percent in 1995. In fact, these companies control an even larger share of the market because their vessels are newer and tend to sail at higher capacities than those of smaller lines (Mathiesen 1998).

Figure 1-11
Cruise Capacity v. Cruise Passengers, North America, 1993-2002



SOURCE: *Cruise Industry News,* annual, Oivind Mathiesen (New York: Oivind and Angela Mathiesen, 1998).

Ferries

As of year-end 1997, there were 1,206 passenger vessels operating on U.S. waterways (USACE WCSC TLUS 1994-1998). Of these, 176 were considered fast ferries, defined here as vessels capable of speeds of at least 25 knots. Thirty-four percent of the overall ferry fleet (passenger capacity) was built before 1975, and a substantial part of this fleet will be replaced over the 1999 to 2002 period. In contrast, only 8 percent of fast-ferry fleet capacity was built before 1975. Fast-ferries have replaced other ferries on existing routes and have enabled new longer haul ferry routes to open up.

In 1997, fast ferries accounted for 7.4 percent of total ferry traffic, up from 5.8 percent in 1993 (USACE WCSC 1999). For the 1993 to 1997 period, fast-ferry passenger traffic increased at a rate of 6.8 percent per year. For the same period, other ferry traffic declined by 0.1 percent per year. These trends are expected to continue through 2002 (USDOT MARAD OSEA 1999).

Port and Cargo-Handling Services

This segment of the water transportation industry handles foreign and domestic marine cargo as it moves across or through a dock, pier, terminal, staging area, or

Table 1-19
Top 25 World Ports by Vessel Type and Calls, 1997[a]

	Tanker		Dry Bulk		Container		Other		Total	
	Calls	000 dwt	Calls	000 dwt	Calls	000 dwt	Calls	000 dwt	Calls	000 dwt
Singapore	11,918	500,335	5,383	265,812	13,948	340,529	14,567	134,300	45,816	1,240,976
Hong Kong	3,618	58,340	1,726	46,235	14,014	363,285	11,994	85,433	31,352	553,293
Rotterdam	3,925	42,189	595	18,686	2,620	51,991	8,712	49,379	15,852	162,245
Antwerp	3,079	41,266	1,030	44,593	2,266	63,191	7,890	78,571	14,265	227,621
Kaohsiung	2,368	61,986	1,367	65,088	5,656	172,665	4,011	32,016	13,402	331,755
Yokohama	1,316	50,715	1,240	27,444	4,625	109,428	5,862	62,555	13,043	250,142
Busan	385	6,201	793	28,981	5,127	111,985	5,653	40,343	11,958	187,510
Hamburg	1,854	26,159	715	32,576	2,228	75,357	6,907	43,073	11,704	177,165
Nagoya	614	34,224	1,021	64,456	3,808	97,193	4,831	51,814	10,274	247,687
Europort	2,314	144,251	897	104,702	1,886	74,934	4,951	32,695	10,048	356,582
Kobe	997	15,711	445	16,769	4,649	129,336	3,681	33,437	9,772	195,253
Port Kelang	1,197	16,724	973	29,188	3,617	75,555	3,896	33,656	9,683	155,123
Jakarta	1,252	18,243	566	16,224	1,847	32,762	4,686	33,755	8,351	100,984
Osaka	150	2,828	474	16,007	2,908	69,418	4,153	37,151	7,685	125,404
Felixstowe	64	421	1	42	2,512	75,701	4,689	30,132	7,266	106,296
Piraeus	681	19,347	784	26,813	1,396	19,528	4,162	28,038	7,023	93,726
Houston	3,450	132,185	807	33,273	515	16,558	2,031	25,798	6,803	207,814
New Orleans	1,660	94,621	3,337	150,999	399	10,071	1,366	20,802	6,762	276,493
Barcelona	968	15,017	248	7,151	1,424	33,514	4,009	27,956	6,649	83,638
London	1,036	6,265	252	5,751	613	11,413	4,548	28,536	6,449	51,965
Shanghai	1,202	12,625	909	43,982	1,612	30,273	2,653	24,490	6,376	111,370
Le Havre	1,443	53,428	104	6,151	2,219	83,030	2,194	17,741	5,960	160,350
Tokyo	15	217	302	8,824	3,684	106,753	1,936	19,522	5,937	135,316
Genoa	908	27,336	318	13,676	1,219	30,491	3,167	25,564	5,612	97,067
Los Angeles[b]	806	57,563	952	49,602	2,462	102,174	1,365	19,695	5,585	229,034
Top 25 ports	47,220	1,438,197	25,239	1,123,025	87,254	2,287,135	123,914	1,016,452	283,627	5,864,809
All ports	294,478	10,574,850	154,969	6,615,766	202,416	4,674,387	646,894	4,711,720	1,298,757	26,576,723
Top 25 (percent)	16	13.6	16.3	17	43.1	48.9	19.2	21.6	21.8	22.1

[a]Excludes calls by nonself-propelled vessels under 1,000 gross tons.

[b]Includes Long Beach.

KEY: dwt = deadweight ton.

SOURCE: Lloyd's Maritime Information Services, Lloyd's Vessel Movements, computer file (London: February 1998).

in-transit area before it is loaded or after it is unloaded. This segment also includes operation and maintenance of piers, docks, and associated buildings and facilities.

On a worldwide basis, only 22 percent of port calls were at the top 25 ports (table 1-19). Of these top ports, 12 were in the Far East, 10 were in Europe, and 3 were in the United States.

The top 25 accounted for 81 percent of vessel calls at U.S. ports in 1997 (table 1-20). Major ports on the Atlantic and Pacific coasts serve primarily container trades, while

Table 1-20
Top 25 U.S. Ports by Vessel Type and Calls, 1997[a]

	Tanker		Dry Bulk		Container		Other		Total	
	Calls	000 dwt	Calls	000 dwt	Calls	000 dwt	Calls	000 dwt	Calls	000 dwt
Houston, TX	3,450	132,185	807	33,273	515	16,558	2,031	25,798	6,803	207,814
New Orleans, LA	1,660	94,621	3,337	150,999	399	10,071	1,366	20,802	6,762	276,493
Los Angeles, CA[b]	806	57,563	952	49,602	2,462	102,174	1,365	19,695	5,585	229,034
New York, NY	1,219	62,216	485	21,148	2,150	77,153	1,270	21,848	5,124	182,365
San Francisco,CA[c]	773	55,922	361	12,497	1,643	67,874	382	7,575	3,159	143,868
Hampton Roads, VA	198	8,398	841	66,802	1,488	53,026	571	11,249	3,098	139,475
Philadelphia, PA	1,076	92,577	476	20,069	522	8,567	922	10,591	2,996	131,804
Port Everglades, FL	338	13,820	83	2,734	734	11,981	1,807	12,706	2,962	41,241
San Juan, PR	155	4,980	83	2,620	671	12,266	1,993	13,762	2,902	33,628
Miami, FL	10	321	26	1,073	607	15,193	1,946	12,673	2,589	29,260
Portland, OR	203	10,022	1,303	46,872	259	9,634	456	10,133	2,221	76,661
Charleston, SC	151	5,521	103	3,241	1,289	50,793	614	13,032	2,157	72,587
Baltimore, MD	146	4,116	499	26,989	579	17,887	809	14,250	2,033	63,242
Jacksonville, FL	195	7,632	217	6,504	497	11,426	680	8,761	1,589	34,323
St. Thomas, VI	8	117	21	126	4	56	1,442	8,966	1,475	9,265
Corpus Christi, TX	1,106	64,487	330	16,997	0	0	29	405	1,465	81,889
Texas City, TX	1,209	63,088	122	5,669	1	18	23	242	1,355	69,017
Savannah, GA	123	4,069	222	7,122	414	15,236	526	11,386	1,285	37,813
Seattle, WA	32	1,611	203	9,824	755	33,856	276	5,898	1,266	51,189
Tacoma, WA	82	3,168	307	13,441	526	17,943	338	5,616	1,253	40,168
Tampa, FL	267	7,032	492	17,613	5	62	457	3,843	1,221	28,550
Mobile, AL	137	7,059	465	25,468	0	0	560	10,193	1,162	42,720
Beaumont, TX	816	53,279	151	7,019	1	41	46	990	1,014	61,329
Honolulu, HI	165	9,180	93	4,504	448	12,002	201	2,815	907	28,501
Lake Charles, LA	538	34,817	135	5,729	0	0	177	1,963	850	42,509
Top 25	14,863	797,801	12,114	557,935	15,969	543,817	20,287	255,192	63,233	2,154,745
All Ports	20,584	1,270,890	14,481	645,945	16,930	568,868	25,858	315,205	77,853	2,800,908
Top 25 (percent)	72.2	62.8	83.7	86.4	94.3	95.6	78.5	81	81.2	76.9

[a]Excludes calls by nonself-propelled vessels and vessels under 1,000 gross tons.

[b]Includes Long Beach.

[c]Includes other Bay area ports.

KEY: dwt = deadweight ton.

SOURCE: Lloyd's Maritime Information Services, Lloyd's Vessel Movements, computer file (London: February 1998).

major Gulf coast ports serve primarily tanker and dry-bulk trades. For cruise ships, Miami, Florida, and San Juan, Puerto Rico, were by far the largest U.S. ports of call.

International container trade through U.S. ports is highly concentrated. The top 10 container ports accounted for almost 80 percent of container traffic (measured in metric tons) in U.S.-foreign trade in 1997 (table 1-21). Three of the top five container ports in the United States are on the west coast. Los Angeles and Long

Table 1-21
U.S. Waterborne Container Trade – Top 25 Ports (Thousands of metric tons)

U.S. port	1995	1996	1997
Long Beach, CA	16,282	18,000	20,142
Los Angeles, CA	13,938	13,947	15,231
New York, NY	13,275	13,416	15,003
Charleston, SC	7,311	7,596	8,996
Seattle, WA	8,781	8,164	7,980
Oakland, CA	7,817	7,004	7,289
Norfolk, VA	6,038	7,185	7,433
Houston, TX	5,033	5,435	6,207
Miami, FL	3,920	4,080	4,982
Savannah, GA	4,026	4,152	4,895
Tacoma, WA	4,357	4,160	4,537
Port Everglades, FL	3,383	3,563	3,654
Baltimore, MD	2,906	2,634	2,527
New Orleans, LA	2,112	2,089	2,378
Portland, OR	2,420	2,168	2,184
Jacksonville, FL	1,764	1,776	1,775
San Juan, PR	1,255	1,409	1,265
Gulfport, MS	956	921	1,048
Philadelphia, PA	852	852	1,024
Wilmington, DE	743	956	921
W. Palm Beach, FL	734	835	907
Wilmington, NC	653	682	663
Boston, MA	504	480	550
Richmond-Petersburg, VA	323	374	393
Honolulu	200	270	308
Total top 25	109,384	111,172	122,982
Top 25 % of total	97.2	97.8	97.8
Total all ports (67)	112,484	113,637	124,688

SOURCE: *Journal of Commerce,* Port Import/Export Reporting Service, computer file (New York: February 1996-98).

Beach, California, had the largest absolute growth in container traffic between 1995 and 1997 (measured in TEUs), but Miami and West Palm Beach, Florida; Savannah, Georgia; Charleston, South Carolina; Houston, Texas; and Newport News, Virginia, showed the largest rates of growth over the period, reflecting high growth in U.S.-Latin America container trades.

Marine Terminal Facilities

There are over 1,900 major coastal seaport and Great Lakes terminals and more than 3,100 berths in the United States. Overall, privately owned facilities account for approximately two-thirds of the deep-draft terminals (USDOT MARAD 1998).

A comparison of deep-draft facilities by type of berth and coastal region is shown in table 1-22. About 38 percent of total U.S. berths are of the general-cargo class. Within this class, the predominate single-use type is general cargo with 47.3 percent followed by container with 13.7 percent.

The dry- and liquid-bulk classes of berths account respectively for about 22 and 19 percent of the total. The distribution of dry-bulk berth types shows a fairly wide distribution pattern among the commodity-specific berth types. On the other hand, liquid bulk is highly concentrated with 82 percent of the berths associated with the handling of various types of crude oil and petroleum products.

U.S. inland waterway ports and terminals possess unique characteristics that distinguish them from coastal seaports. Aside from shallow water depths of 14 feet or less, the inland port and terminal system is less concentrated geographically and provides almost limitless access points to the waterways. There are over 1,800 river terminals located in 21 states (table 1-23). Dry-bulk facilities account for the majority—almost 60 percent of the total. Within the dry-bulk category, grain and coal terminals account for nearly half of the total. Liquid-bulk terminals comprise nearly 27 percent. Multipurpose and general-cargo terminals account for the balance (14 percent). Private ownership is more pronounced for inland waterway facilities (87 percent) than for coastal facilities (66 percent).

Table 1-22

U.S. Ocean Port Terminals by Type and Region[a]

Berth type	North Atlantic	South Atlantic	Gulf	South Pacific	North Pacific	Great Lakes	Total
General cargo	264	204	264	208	149	96	1,185
General cargo	135	78	193	63	56	35	560
Container	46	19	12	66	20	0	163
Lash/Seabee	0	1	2	0	0	0	3
Ro-Ro	6	19	3	4	3	0	35
Auto Carrier	17	4	0	9	2	0	32
General cargo/container	16	12	2	1	10	1	42
General cargo/Ro-Ro	13	9	14	6	6	4	52
General cargo/passenger	0	11	4	0	6	0	21
General cargo/dry bulk	19	15	20	26	24	51	155
General cargo/liquid bulk	2	27	11	22	11	4	77
Container/Ro-Ro	9	8	2	11	11	0	41
Container/dry bulk	1	1	1	0	0	0	4
Dry bulk	96	48	163	51	74	260	692
Coal	11	2	12	0	2	23	50
Grain	9	1	28	5	10	34	87
Ores	7	3	6	0	5	37	58
Logs	0	0	0	1	13	0	14
Wood chips	0	0	0	1	11	0	12
Cement	10	5	7	2	4	18	46
Chemicals	9	6	47	3	4	7	76
Other dry bulk	39	23	46	23	16	133	280
Dry/liquid bulk	11	8	17	16	9	8	69
Liquid bulk	188	51	182	73	71	45	610
Crude petroleum	8	0	37	10	5	0	60
Petroleum products	109	28	37	31	41	33	279
Crude & products	29	15	64	28	20	5	161
Liquid propane gas	1	1	5	0	0	0	7
Liquid natural gas	3	0	1	0	1	0	5
Other liquid bulk	38	7	38	4	4	7	98
Passenger	19	24	10	18	10	6	87
Passenger	13	24	10	18	0	1	66
Ferry	6	0	0	0	10	5	21
Other berths	194	22	167	64	61	76	584
Barge	126	11	133	33	36	15	354
Mooring	39	7	19	9	20	30	124
Inactive	29	4	13	14	5	31	96
Other	0	0	2	8	0	0	10
Total	**761**	**349**	**786**	**414**	**365**	**483**	**3,158**

[a]Includes those commercial cargo handling facilities with a minimum alongside depth of 25 feet for coastal ports and 18 feet for Great Lakes ports.

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Ports and Domestic Shipping, 1998.

Table 1-23
U.S. Inland/Riverport Terminal Facilities by River System and Type, 1997

System	General cargo	Dry bulk: Grain	Dry bulk: Coal	Dry bulk: Ore	Dry bulk: Other	Liquid bulk: Petroleum	Liquid bulk: LPG	Liquid bulk: Other	Multi-purpose	Total
Mississippi river	61	244	238	8	533	263	4	210	187	1,748
Columbia/Snake rivers	9	27	0	0	18	2	0	5	3	64
Total	**70**	**271**	**238**	**8**	**551**	**265**	**4**	**215**	**190**	**1,812**

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Ports and Domestic Shipping, 1998.

Port Issues

Many complex issues affect U.S. public ports, including financing current operations and future terminal development, complying with environmental laws and regulations, dredging, and addressing the challenges posed by global shipping alliances. (Environmental and dredging issues are discussed in chapter 4.) In addition, our nation's growing use of intermodal transportation depends on improved landside access to marine terminals, which in turn may depend on port involvement in transportation planning. How these issues are resolved is important not only to the public port industry, but to many other industries and the nation because of the key role ports play in intermodal transportation and national defense.

Impact of the Next Generation Containership. U.S. ports are continually faced with the challenge of handling larger ships. Currently, the next generation of containerships (megaships) is causing the most concern. These ships require sophisticated and efficient ports and terminal facilities with excellent landside intermodal connections.

Megaships are being constructed with carrying capacities ranging from 4,500 to over 8,500 TEUs and fully loaded design drafts of 40 to 46 feet (USDOT MARAD 1998). To accommodate these vessels, channels, berths, and turning basins will need depths approaching 50 feet. Most U.S. ports are currently unable to handle these ships (table 1-24). Only 4 of the top 10 U.S. container ports, which handle nearly 80 percent of the container traffic, have existing channel depths of 50 feet or more. Thus, dredging has become the leading issue concerning the ability of U.S. ports to handle megaships.

At many ports, the economics of these new vessels may result in fewer port calls or even no port calls from megaships. Additionally, megaships will impact terminal facilities, requiring larger cranes, berths, storage yards, and improved information systems. Landside access will also have to be improved to handle peak volumes of rail and truck traffic. Many U.S. ports have begun major expansion projects to address this issue.

Impact of Global Shipping Alliances. Today, global shipping alliances are a fact of life in world trade as carriers seek to reduce costs and increase their return on investment (USDOT MARAD 1998). These alliances could have major ramifications for U.S. public ports. Among the many possible outcomes resulting from these carrier alliances are fewer port tenants and a downward pressure on port tariffs and fees. Carrier alliances are likely to have greater leverage on ports than a single carrier in negotiating favorable tariffs, fees, financing, and services. For some ports, this could mean the loss of alliance business as a direct port call, or at a minimum, a reduction in cargo and vessel calls. Some ports may offset the loss of business by becoming feeder ports that shuttle goods to and from neighboring hub ports.

Table 1-24
Water Depth of Top 10 U.S. Container Ports

Port	Channel depth, ft.	Berth depth, ft.	Container port rank (1997)
Long Beach, CA	76	35-50	1
Los Angeles, CA[a]	45	45	2
NY/NJ[b]	40	35-45	3
Charleston, SC[b]	42	40	4
Seattle, WA	175	40-50	5
Oakland, CA	42	35-42	6
Hampton Roads, VA	50	32-45	7
Miami, FL	42	42	8
Houston, TX[b]	40	38-40	9
Tacoma, WA	40-50	40-50	10

[a] 50-foot project underway.
[b] 45-foot project authorized.

SOURCE: Mark Lambert, ed., (London: National Magazine Company, Ltd, 1999).

Global shipping alliances may provide benefits as well. These include the potential to reduce operating costs and expand trade routes. Participation in shipping alliances may also improve overall transit times, i.e., the time between load point to discharge point for cargoes. Improving transit time is critical as manufacturers and distributors reduce warehousing requirements by requiring just-in-time delivery standards.

Some ports may become alliance load centers. Although many factors determine port selection, those ports with modern facilities, deep channels, good landside transportation access, and large local markets will be in the strongest position to negotiate with carrier alliances.

Landside Access. Landside access, which is often impeded by inadequate highway and rail access from the port or marine terminal to the distribution centers, is a persistent problem at many U.S. ports.

A 1997 update of a 1991 American Association of Port Authorities survey indicated that landside access to U.S. ports and marine terminals showed some improvement during the six-year period, but significant obstacles remain. Over one-third of ports still experience major truck-access impediments. Rail-access impediments, due to bridge clearances or distance from terminals, still affect nearly one-third of all survey respondents. Overall, one-third of all U.S. coastal ports still experience infrastructure impediments in rail (and/or) truck access (USDOT MARAD OPDS 1998).

The National Highway System (NHS) Designation Act of 1995[7] identified 104 highway connectors to marine terminals. An additional 143 connectors to marine terminals were identified in a recent MARAD Report to Congress on the status of public ports (USDOT MARAD OPDS 1998).

[7] Public Law 104-59, 109 Stat. 568 (1995).

Table 1-25

Operation and Maintenance Cost per Commercial Lockages per Lock Site, Traffic per Lock Site, Fuel Tax Waterway System, 1990-94

Segment	Lock site reporting	Average annual ton-miles (thousands)	Average annual ton-miles per lock site (thousands)	Average annual O&M cost ($ thousands)	Average annual commercial lockage per year, LPMS and estimates	Average annual commercial lockage per lock site, LPMS and estimates	Average O&M $ cost per commercial lockage
Green-Barren	2	525,543	262,772	1,320.93	4,477	2,239	295
Gulf Intracoastal (GIWW)	12	21,353,637	1,779,470	32,773.44	104,147	8,679	315
Monongahela	9	1,441,407	160,156	12,886.99	33,467	3,719	385
Ohio	20	58,465,957	2,923,298	45,391.90	103,179	5,159	440
Atchafalaya-Old-River	2	587,550	293,775	1,507.42	2,679	1,340	563
Illinois	8	9,024,253	1,128,032	16,431.54	24,473	3,059	671
Black Warrior-Tonbigbee	6	5,876,988	979,498	13,367.28	19,679	3,280	679
Kanawha	3	1,537,022	512,341	8,447.72	11,949	3,983	707
Columbia-Snake	7	1,387,730	198,247	7,768.86	8,347	1,192	931
Tennessee	9	6,876,376	764,042	11,406.32	11,820	1,313	965
Tennessee-Tonbigbee	10	984,071	98,407	15,740.24	11,846	1,185	1,329
Middle Mississippi	1	18,594,214	18,594,214	11,765.14	8,595	8,595	1,369
Allegheny	8	50,475	6,309	7,975.50	5,523	690	1,444
Upper Mississippi	28	15,641,025	558,608	87,238.70	60,293	2,153	1,447
Kaskaskia	1	55,587	55,587	1,719.62	1,131	1,131	1,520
Arkansas	17	1,814,784	106,752	25,558.22	14,961	880	1,708
Cumberland	4	1,342,155	335,539	7,901.68	2,514	629	3,143
Red	3	368,405	122,802	5,497.62	1,679	560	3,274
Ouchita-Black	4	127,259	31,815	4,426.78	661	165	6,697
Alabama-Coosa	3	149,604	49,868	7,372.90	1,017	339	7,250
Appalachicola-Chattahoochee-Flint	3	66,024	22,008	8,427.14	1,089	363	7,738
Atlantic Intracoastal (AIWW)	3	356,604	118,868	17,705.40	1,274	425	13,897
Kentucky	4	17,118	4,280	not included	-	-	-
Pearl (West Pearl)	3	7	2	not included	-	-	-
Williamette	1	8,587	8,587	not included	-	-	-
Total	**171**	**146,652,382**	**857,616**	**352,631.34**	**434,800**	**2,667**	**811**

NOTE: This table excludes data for the following segments without locks: Lower Mississippi, White and Missouri Rivers. Lock sites reporting to the U.S. Army Corps of Engineers totaled 199 in 1994.

SOURCE: Institute for Water Resources, *Traffic and Cost Relationships of the Inland Waterway System.* L. Warner and J. Lane, eds.

The Transportation Equity Act for the 21st Century (TEA-21),[8] Section 1106(d), directed the Federal Highway Administration to conduct a freight study to evaluate NHS connections to terminals and their related investments. The purpose of the NHS Connector Condition and Investment Study is to characterize the nature and extent of physical and operational problems on freight connectors. This effort culminated in a report to Congress delivered in the spring of 2000, as mandated by TEA-21.

[8] Public Law 105-178 (July 22, 1998).

Waterways Issues

Locks and Dams. Locks and dams represent the most important public capital investments in waterway infrastructure. The costs of operating and maintaining these facilities are funded by general federal revenues. The U.S. Army Corps of Engineers (USACE) is charged with the task of allocating funds for operation and maintenance (O&M) costs of locks and dams based on the condition and performance of each lock. The condition of a lock is a major factor that influences delays and other measures of service quality.

For the commercial waterway operator, the time a tow spends underway converts directly to ton-miles, while time spent at locks is an expense, regardless of whether the tow is waiting or processing through the lock. Delay costs range between $250 to $350 per hour, based on a 15-barge tow pushed by a 2,200 to 4,400 horsepower towboat (USACE 1997). Time delay and related expenses are a prime concern of vessel operators and may be a factor used to prioritize improvements to the inland waterway system. Delay time and lock-processing time can give some indication of the benefits foregone when specific improvement projects are put off. During fiscal years 1991 through 1996, USACE capital outlays on that part of the inland waterway system subject to the fuel tax averaged approximately $184 million annually, while operation and maintenance costs attributable to navigation averaged $447 million per year.

Table 1-25 presents selected data on locks and lockages (lock transits) along with their O&M costs. The USACE estimates the systemwide average cost per commercial lockage at approximately $800. However, average cost per commercial lockage vary somewhat between segments of the same waterway and vary significantly between different waterways depending on the number of locks and length of the segment. For example, on six of the segments, costs exceeded $3,000 per lockage during the 1990 to 1994 period (USACE 1997).

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Shipbuilding

MARAD

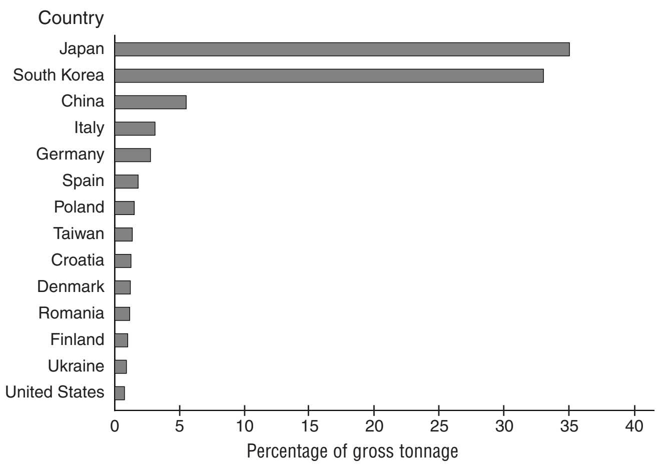
Shipbuilding is an important industry in the United States and around the world. U.S. shipbuilding is dominated by two main components: the commercial market for large merchant ships and the military market. Although the U.S. share of the global market for merchant vessels has declined in recent years, the U.S. merchant shipbuilding market has recently rebounded. U.S. Navy construction, while still below levels of the 1980s, has also increased slightly.

This chapter discusses the world orderbook for merchant vessels and U.S. shipbuilding and repair activities, including the conversion and construction of barges and ships used in inland waterways and coastal waters. It also reviews employment in the U.S. shipbuilding and repair industry and describes federal assistance programs for U.S. ship owners.

WORLD ORDERBOOK

As of December 31, 1997, the world orderbook for merchant vessels 1,000 gross tons (gt) and over comprised 2,604 vessels totaling 57 million gt *(Lloyd's Register of Shipping)*. As shown in figure 2-1, Japan was the world's leader in merchant shipbuilding, accounting for 35 percent of the gross tonnage of merchant ships on order, followed closely by South Korea with about 33 percent. The People's Republic of China was a distant third, with slightly under 6 percent of commercial shipbuilding orders.

Figure 2-1
Top 14 World Shipbuilding Orders (as of Dec. 31, 1997)



SOURCE: Lloyd's Register of Shipping, *World Shipbuilding Statistics,* (London: December, 1997).

The United States ranked 14th among all nations, with about 1 percent of the world's gross tonnage on order, a decline from 1.8 percent recorded in the previous year. This decrease from 854,435 gt to 541,355 gt reflects ship deliveries made between the fourth quarter of 1996 and the fourth quarter of 1997, without compensating replacement orders (USDOT MARAD 1999).

U.S. SHIPBUILDING AND REPAIR

The U.S. shipbuilding industry, historically, has constructed a large variety of oceangoing merchant ships, such as freighters, roll on/roll off cargo vessels, containerships, bulk carriers, very large crude oil carriers, passenger ships, and sophisticated liquefied natural gas carriers (USDOT MARAD 1999). It also constructs military combatant and auxiliary ships for the U.S. Navy.

Major Shipbuilding Yards

As shown in figure 2-2, commercial shipbuilding orders reached a low point in the 1980s. However, during this period, the largest naval construction program in peacetime history took place, offsetting the drop in commercial orders for some shipyards. But, since that time, U.S. Navy construction programs have also dwindled. The 1999 through 2004 U.S. Navy shipbuilding program calls for private shipyards to build an average of fewer than 8 new ships per year, compared with an average of 19 new ships per year in the 1980s (US DOT MARAD OSC 1999). This curtailment in Navy contracts has forced U.S. shipyards to find commercial work to survive.

MARAD

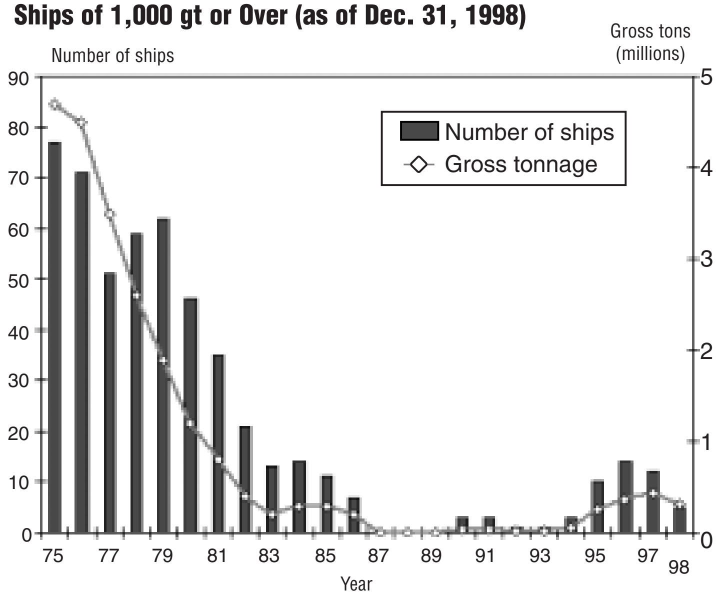
Of the 19 major shipbuilding and repair shipyards in the United States, Newport News Shipbuilding, in Virginia, is one of only two that construct large, oceangoing vessels; the other is Avondale Industries of New Orleans, Louisiana.

The U.S. Major Shipbuilding and Repair Base (MSRB) provides information on ship construction and repair capability and activity in U.S. shipyards. It includes only privately owned shipyards that can build or repair vessels of at least 122 meters in length. The Major Shipbuilding Base (MSB) includes those privately owned shipyards with one or more shipbuilding positions consisting of an inclined way, a launching platform, or a building basin capable of accommodating a vessel at least 122 meters in length and a channel depth leading to the facility of at least 3.7 meters (USDOT MARAD OSC 1999). With few exceptions, these shipbuilding facilities are also major repair facilities with dry-docking capability.

The MSB comprises 19 major private shipbuilding and repair shipyards (table 2-1). The geographic location of these shipbuilding yards is shown in figure 2-3. Although 11 shipyards were involved in private new construction, only two yards were involved in constructing large ocean-going commercial vessels: Newport News Shipbuilding, Newport News, Virginia; and Avondale Industries of New Orleans, Louisiana.

Figure 2-2

U.S. Commercial Shipbuilding Orderbook History–Nonmilitary Ships of 1,000 gt or Over (as of Dec. 31, 1998)



SOURCE: U.S. Department of Transportation, Maritime Administration, *Shipyard Activity Reports, 1975-1998.*

More than 200 privately owned firms are involved in repairing ships in the United States, but only 73 yards are classified as major repair yards with the capacity to handle vessels over 122 meters in length. However, only 33 of the major repair shipyards have drydocking capabilities. Table 2-2 lists the dry-docking facilities by geographical area. These firms provide a variety of services, from simple repairs to major topside overhauls that can be done while the ship is still in the water. Reflecting a worldwide trend to maintain schedule integrity, ship repairers are often deployed to the ship rather than having the vessel detained at a repair facility. This practice requires mobility on the part of ship repair personnel.

Table 2-1

Major U.S. Shipbuilding and Repair Base, October 1998

	East Coast	**Gulf Coast**	**West Coast**	**Great Lakes**	**Noncontiguous[a]**	**Total by type**
Shipbuilding	5	8	3	3	0	19
Repair w/ drydock	13	8	7	2	3	33
Topside repair	10	19	8	2	1	40
Total (by coast)	**28**	**35**	**18**	**7**	**3**	**92**

[a] Alaska, Hawaii, Puerto Rico, and the Virgin Islands

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Ship Construction, 1999.

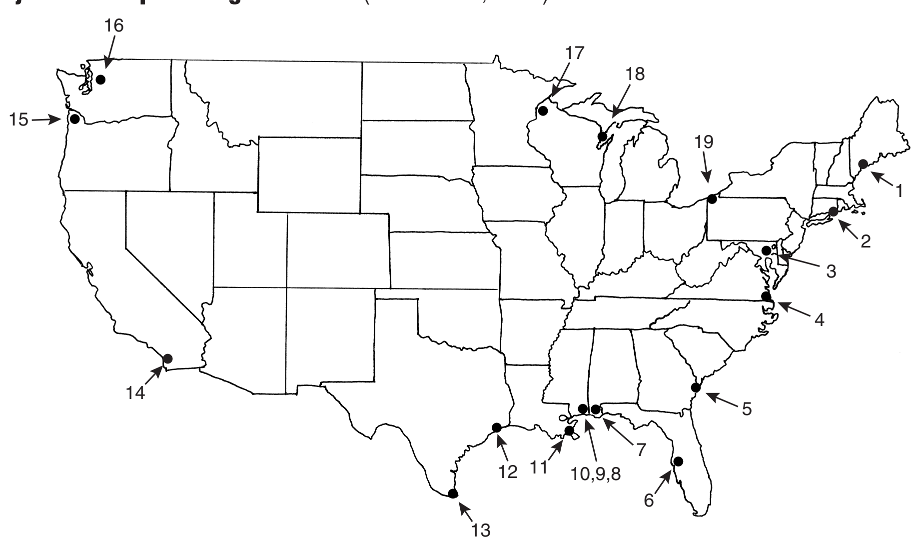
Table 2-2
Private Shipyard Drydocking Facilities, October 1998

	East Coast	Gulf Coast	West Coast	Great Lakes	Non-contig-uous[a]	Total by type
Graving docks	19	4	1	6	1	31
Floating docks	12	16	16	1	2	47
Marine railways	2	0	0	0	0	2
Total (by coast)	**33**	**20**	**17**	**7**	**3**	**80**

[a] Alaska, Hawaii, Puerto Rico, and the Virgin Islands

SOURCE: Department of Transportation, Maritime Administration, Office of Ship Construction, 1999.

Figure 2-3
Major U.S. Shipbuilding Facilities (as of Jan. 1, 1999)



1. Bath Iron Works Corp
2. Electric Boat Corp.
3. Baltimore Marine Industries
4. Newport News Shipbuilding
5. Intermarine USA
6. Tampa Bay Shipbuilding Co.
7. Alabama Shipyard, Inc.
8. Halter Moss Point Shipyard
9. Halter Marine - Pascagoula
10. Ingalls Shipbuilding
11. Avondale Shipbuilding
12. Newpark Shipbuilding
13. AMFELS, Inc.
14. National Steel and Shipbuilding
15. Gunderson, Inc.
16. Todd Pacific Shipyard Corp.
17. Fraser Shipyards, Inc.
18. Marinette Marine Corp.
19. Metro Machine of Pennsylvania, Inc., Industrial Products Division

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Ship Construction, January 1999.

It is important to note that clear distinctions between shipbuilding yards and ship repair yards are difficult to make because major shipyards usually combine repair, overhaul, and conversion work with their shipbuilding capabilities.

Commercial Deliveries

During 1998, U.S. shipyards delivered six commercial oceangoing ships and two nonoceangoing ferries.

Several tankers delivered or under construction were financed with the assistance of the U.S. Department of Transportation, Maritime Administration's (MARAD) Title XI Federal Ship Financing Program. Other crude oil carriers under construction are being financed by their owners and withdrawals from the MARAD administered Capital Construction Fund.

Military Ship Construction

For the foreseeable future, the U.S. Navy shipbuilding program will continue to be the principal customer of the U.S. shipbuilding industry. Although the number of military orders have declined in recent years, a small upward trend is expected, beginning with contracts for the New Attack Submarine, multiyear procurements of the Arleigh Burke-class guided missile destroyer, continued procurement of amphibious assault ships, aircraft carriers, and other planned programs such as build and charter.

During 1998, the Navy ordered 17 new ships (1,000 light displacement tons (ldt) or larger) from private U.S. shipyards, totaling 171,699 ldt with a total original contract value of $6.7 billion. During the same period, private U.S. shipyards delivered 13 new Navy vessels and completed 2 conversions, totaling 319,251 ldt with a total original contract value of $5.3 billion.

As of December 1998, 7 of the 19 major shipbuilding yards were engaged in the construction or conversion of U.S. Navy combatant and auxiliary ships (US DOT MARAD OSC 1999). Four yards had only Navy repair and overhaul work, construction orders for smaller U.S. Navy and U.S. Coast Guard vessels, and nonship construction work; two shipyards had only commercial new construction; and three had no new construction orders. The backlog

USN

Orders for naval ships, such as this Arleigh Burke-class guided missile destroyer, continue to make the U.S. Navy a principal customer of the U.S. shipbuilding industry. But peacetime scaling back of naval construction has prompted U.S. shipyards to find additional commercial work to augment earnings.

Table 2-3
Military Ships Under Construction, as of Dec. 31, 1999 (1,000 ldt or greater)

Symbol	Type	Number
CVN	Aircraft carrier (nuclear powered)	1
DDG	Guided missile destroyer	26
LHD	Amphibious assault ship (multipurpose)	1
LPD	Amphibious transport ship	2
SSN-21	Attack submarine (nuclear powered)	1
SSN-774	Attack submarine (nuclear powered)	1
T-AKR	Military sealift ship	11
WAGB	Ice breaker	1
T-AGS-60	Ocean survey ship	2
Total		**46**

KEY: ldt = light displacement tons.

SOURCE: U.S. Department of Transportation, Maritime Administration, Naval Sea Systems Command, Office of Ship Construction, 1999.

of U.S. Navy ships 1,000 ldt or larger on order or under construction in private shipyards comprised 46 ships: 29 combatants and 17 amphibious, auxiliary, or T-ships[1] (see table 2-3). Eight of these Navy vessels are scheduled for delivery by the end of 1999, nine before the end of 2000, and eight by the end of 2001.

The fiscal year (FY) 2000 U.S. Navy ship construction budget is $6.7 billion, about 12 percent more than the $6.0 billion appropriated in FY 1999, but 17 percent less than the $8.1 billion appropriated in FY 1998. The FY 1998 budget for ship construction was the largest since FY 1990, when the funding level was $11.4 billion (USDOT MARAD 1999).

The U.S. Navy's FY 1998 ship repair and modernization budget of $2.0 billion, which is 10.8 percent larger than its FY 1997 budget, will also affect both public and private shipyards engaged in repair work and other activities. The U.S. Navy's FY 1999 shipbuilding construction and repair budget, if approved, is expected to at least double by FY 2001 (USDOD USN 1999).

Small and Mid-Sized Shipbuilding and Repair Industry

Small and mid-sized shipyards that primarily support inland waterway and coastal operators constitute an important segment of the U.S. shipbuilding and repair industry. They build and repair smaller type vessels such as barges, tugboats and towboats, offshore crew and supply boats, ferries, casino boats, fishing boats, military and nonmilitary patrol boats, fire and rescue vessels, as well as oil rigs. The small and mid-sized shipyards are rich with orders for barges, offshore supply vessels, tugboats, and other shallow-draft vessels. Several Gulf Coast yards have been expanding their facilities, as well as business lines, in an attempt to take full advantage of the thriving Gulf Coast oil and gas markets.

Figure 2-4 shows the number of dry-cargo barges built over the past four years. It is estimated that about half of the newly delivered barges have drafts of 4 to 4.3 meters,

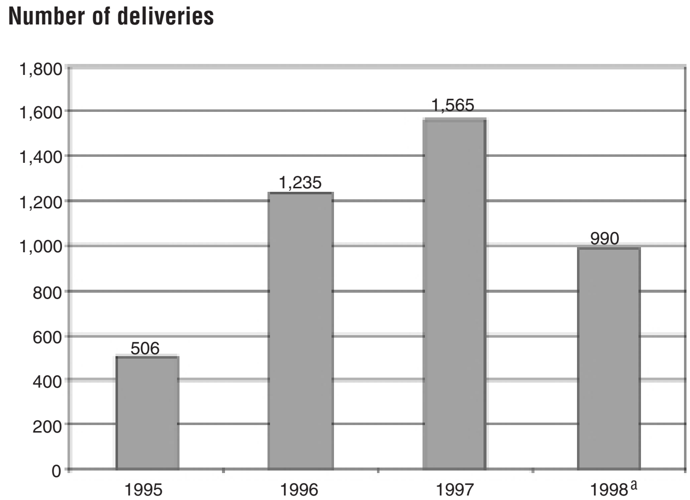
[1] T-ships are auxiliary vessels funded by the U.S. Navy but designed to be civilian crewed and under the control of the Military Sealift Command.

compared to the industry standard of 3.7 meters (USDOT MARAD OSC 1999). This is equivalent to about a 10- to 15-percent increase in barge capacity. Higher capacity barges represent the biggest change in construction in some years. Larger barges can carry 200 to 300 more tons than standard barges, but cost only slightly more to build.

According to MARAD, in 1997, small and mid-sized shipyards received orders for more than 1,000 dry-cargo hopper barges. Over 30 percent of the hopper barges ordered in 1997 were placed in Gulf Coast shipyards during the final quarter of the year.

Figure 2-4

Dry-Cargo Barge Fleet, New Construction



[a]Estimated

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, *Transportation Lines of the United States, National Summaries, 1997* (New Orleans, LA: 1997) and *Water Resources Center, Waterborne Commerce of the United States,* data file, 1998.

According to the USDOD, about 4,000 tank barges ply the inland and coastal trades (USDOD USACE 1997). The tank barge fleet is aging and will have to be replaced. MARAD estimates that by the year 2000 about 25 percent of the current domestic tank barge fleet, between 10,000 and 30,000 tons, will be more than 25 years old, and more than 8 percent of the tank-barge fleet will be at least 30 years old. Approximately 66 of the tank barges in the U.S. domestic trade will have to be phased out by 2005 and another 22 tank barges by 2010 because of the double-hull requirements of the Oil Pollution Act of 1990 (OPA-90).[2] Given the advanced age of the tank barge fleet and the double-hull requirements of OPA-90, the outlook for the offshore tank barge construction industry remains bright.

Additionally, the boom in the Gulf Coast offshore oil and gas industry has caused a surge in orders for offshore supply vessels (OSVs). As oil drilling companies move further from shore to search in ever deeper waters for oil and gas, larger and more technologically sophisticated OSVs are needed to carry supplies to the rigs, especially large quantities of liquid mud. OSVs are also required to remain near the rigs for prolonged periods in waters that are rougher than those found in inland waterways.

Also, the U.S. ship repair industry is competing aggressively in domestic and foreign markets for ship repair and conversion work. The large number of ships on tight sched-

[2] Public Law 101-380, August 18, 1990.

ules calling at U.S. ports has provided employment for U.S. ship repair yards that are able to offer timely service and competitive prices. The continued high level of activity in the U.S. offshore oil and gas industry has also created a need for additional ship repair and conversion services, as well as increased maintenance capabilities.

EMPLOYMENT

According to the U.S. Department of Labor, as of December 31, 1998, employment in the U.S. shipbuilding and repair industry (classified as standard industrial classification code (SIC) 3731) was 100,300, a slight increase from the revised 1997 number of 98,600 (USDOL BLS 1999). The 19 MSB shipyards employ about two-thirds of the total shipbuilding and repair industry workforce. The remainder were employed by the 550 additional establishments (with 10 or more employees) in SIC 3731. Not included in this employment total are 14,477 people employed in five government shipyards (one U.S. Coast Guard and four U.S. Navy) that only overhaul and repair U.S. Navy and U.S. Coast Guard ships.

In the Gulf Coast area, increased demand for repair and construction of offshore rigs and supply vessels and barges, coupled with consolidation and expansion of capabilities within this region's shipbuilding and repair industry, has resulted in a shortage of skilled labor.

FEDERAL ASSISTANCE PROGRAMS

For over 40 years, MARAD has provided financial assistance to U.S. ship owners through the Federal Ship Financing Program (Title XI) of the Merchant Marine Act of 1936, as amended, and the Capital Construction Fund program.

Title XI

The Title XI program provides for loan guarantees by the U.S. Government for promoting growth and modernization of the U.S. merchant marine and U.S. shipyards. The Title XI loan guarantee program allows MARAD to guarantee private sector debt financing for the construction or reconstruction in U.S. shipyards of U.S.-flag vessels and export (foreign flag) vessels, and U.S. shipyard modernization and improvement projects. Title XI guarantees enable ship owners and shipyards to borrow funds from the private markets on more favorable terms than may otherwise be available, at a fixed rate, with longer maturities. The government's liability on these loans is limited to defaults. Statutory program authority allows for a guarantee ceiling of $11.125 billion (although actual annual authority may be limited by congressional appropriations). As of May 31, 1999, total outstanding loan guarantees totaled $3.52 billion, with applications pending for an additional $1.07 billion (USDOT MARAD OSF 1999). Vessels eligible for Title XI assistance include, but are not limited to, commercial vessels such as passenger, bulk carriers, cargo, tankers, tugs, towboats, barges, dredges, oceanographic research, and offshore oil supply vessels.

Capital Construction Fund

The Capital Construction Fund (CCF) is a tax deferral program designed to encourage owners and operators to construct, reconstruct, or acquire vessels in U.S. shipyards for operation in foreign, Great Lakes, or noncontiguous domestic trades. Deposits may come from vessel income, depreciation, and net proceeds from vessel disposition. Deferred taxes are recouped by the government through a reduction in the depreciable basis of a vessel corresponding to the amount of CCF funds used for the vessel. If funds are withdrawn for a nonqualified purpose, the withdrawal is taxable.

Revitalization Efforts

Recognizing that U.S. shipyards must compete in the international commercial shipbuilding market to remain viable, the federal government has developed a multifaceted program to improve the industry's competitiveness. In 1993, the administration issued a report detailing a five-part plan to assist the U.S. shipbuilding industry in translating its skills from military requirements to a commercial focus.

The five-part plan included:

1. ensuring fair international competition,
2. eliminating unnecessary government regulation,
3. assisting international marketing,
4. financing ship sales through Title XI loan guarantees, and
5. improving commercial competitiveness.

The National Shipbuilding and Shipyard Conversion Act of 1993 expanded the existing Title XI Federal Ship Financing Program by authorizing the Secretary of Transportation to guarantee obligations issued to finance the construction, reconstruction, or reconditioning of eligible export vessels. It also authorized guarantees for shipyard modernization and improvement projects. In addition, the Act established a National Shipbuilding Initiative program to support the industrial base for national security objectives. Its goal was to help reestablish the American shipbuilding industry as an internationally competitive industry.

Under a five-year program, called MARITECH, the federal government provided matching funds to encourage shipbuilders to develop and apply advanced technologies to improve their competitiveness and preserve their industrial base. The industry-led program was administered through the Defense Advanced Research Projects Agency of the Department of Defense in collaboration with MARAD.

The availability of long-term Title XI guarantees for eligible vessels constructed or reconstructed in U.S. shipyards and for shipyard modernization projects, together with the extension of a MARITECH program, are important in the commercial revitalization of U.S. shipyards.

Other Government Assistance

The federal government continues to provide significant direct support to the industry through the procurement of goods and services from a large number of shipyards and related industries to repair government-owned vessels. Principal government contracting agencies include the Naval Sea Systems Command, the Military Sealift Command, the Army Corps of Engineers, the U.S. Coast Guard, the National Oceanic and Atmospheric Administration, the National Science Foundation, and the Maritime Administration.

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Waterborne Transportation and the U.S. Economy

USACE

From 1993 to 1997, U.S.-foreign waterborne trade grew by 4.6 percent per year while domestic waterborne trade increased by only 1 percent per year. The recovery of U.S. grain exports from the 1993 Midwest floods had a substantial impact on the industry, increasing both dry-bulk exports and long-haul domestic barge shipments on the inland waterways (McGraw-Hill 1999).

REAL GROSS DOMESTIC PRODUCT AND EMPLOYMENT

In the 1990s, growth of real gross domestic product (GDP) from for-hire water transportation has been below the growth rate for other for-hire transportation services. Water carriers are heavily involved in primary products trades (e.g., grains, crude oil, coal, and ores), which have grown at lower rates than manufactured trades. As shown in table 3-1, the average annual growth rate for water transportation was about 1.3 percent between 1992 and 1997. By comparison, real GDP from nonwater transportation grew, on average, by about 4.8 percent per year during this period (USDOC BEA 1999).

Over this period, water transportation accounted for only about 5 percent of total real GDP from all for-hire transportation services. This low percentage can be attributed to two factors:

Table 3-1
Real Gross Domestic Product by For-Hire Transportation Mode (Chained 1992 $ billions)

Mode	1992	1993	1994	1995	1996	1997	Annual growth rate, 1992-97 (percent)
Rail	22.1	23.0	25.6	26.1	28.2	28.2	5.0
Trucking and warehousing	82.2	86.2	88.7	89.1	86.5	87.3	1.2
Water	10.3	10.5	10.8	11.0	10.7	11.0	1.3
Air	43	44.2	51.4	50.6	63.5	72.6	11.0
Pipelines*	4.9	5.2	4.8	4.9	6.3	6.8	6.8
Local and interurban passenger transit	10.9	11.0	11.0	11.4	11.3	11.3	0.7
Total	**192.8**	**201.1**	**214.3**	**216.1**	**222.9**	**241.5**	**4.5**
(Water)	10.3	10.5	10.8	11.0	10.7	11.0	1.3
(Nonwater)	182.5	190.6	203.5	205.1	212.2	230.5	4.8

* Except natural gas.
SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, National Accounts Data–Gross Product by Industry. Available as of Mar. 26, 1999 at http://www.bea.doc.gov/bea/dn2/gpox.html.

- The United States has had a persistent U.S. balance of payments deficit in water transportation. In 1997, foreign carriers received $11.9 billion for transporting foreign goods to U.S. ports, but paid out $7.6 billion for U.S. port and handling services, resulting in a balance-of-payments outflow of $4.3 billion for the United States. That same year, U.S. carriers received $4.6 billion transporting U.S. exports to foreign ports while paying $2.2 billion in foreign port and cargo-handling services—a balance-of-payments inflow of $2.4 billion. With receipts from and payments for passenger fares, this outflow-inflow imbalance resulted in a $2.0 billion deficit for the United States (see table 3-2).[1]

- Freight rates per ton-mile for waterborne shipments tend to be substantially lower than rates for overland shipments. The Bureau of Transportation Statistics estimates that the freight rate per ton-mile for rail transportation is about four times that for water transportation (USDOT BTS 1998a). As noted earlier, this reflects heavy involvement of water carriers in primary product trades, which tend to have lower freight rates per ton-mile than manufactured and semimanufactured trades.

Real GDP from water transportation is expected to increase at an average rate of about 2 percent per year from 1998 to 2003 (McGraw-Hill 1999). This is less than the projected growth in international waterborne trades (4.6 percent per year), but above the projected growth for domestic trades (1 percent per year). The primary

[1] The Jones Act (Section 27 of the Merchant Marine Act of 1920) prohibits foreign-owned or foreign-flagged vessels from participating in U.S. domestic trade. Thus, U.S.–based companies receive all payments for domestic water transportation, including payments for port and cargo handling services.

Table 3-2
Water Transportation: U.S. Balance of Payments, 1995-1997
($ million)

	1995	1996	1997
Receipts			
Passenger fares	285	329	329
Export freight*	5,278	4,703	4,577
Port expenditures	8,298	7,799	7,626
Total	**13,861**	**12,831**	**12,532**
Payments			
Passenger fares	353	453	453
Import freight*	11,514	11,258	11,896
Port expenditures	2,555	2,231	2,186
Total	**14,422**	**13,942**	**14,535**
Balance	**-561**	**-1,111**	**-2,003**

*Includes charter hires.
SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business* (Washington, DC: U.S. Government Printing Office, October, 1998).

drag on the industry is expected to be the decline in Alaska crude oil production (-4.1 percent per year), which will reduce domestic ocean crude-oil movements (USDOE EIA 1998).

In 1997, employment in the for-hire water transportation industry was 187,000. Its share of total for-hire transportation employment was about 4 percent. (USDOT BTS forthcoming). Employment varies by season, with spring and summer employment about 6 percent higher than during the rest of the year. The seasonal employment pattern reflects a combination of patterns in Great Lakes bulk trades (coal, iron ore, and limestone), inland barge trades (grains), and coastwise petroleum product trades.

Employment in water transportation is expected to increase at a rate of about 1 percent per year from 1998 to 2003. Historically, water transportation employment growth has not kept pace with real GDP growth—a sign that labor productivity is going up—and this relationship is expected to continue.

CAPITAL STOCK

The growth in capital stock for water transportation (ships and boats) has not kept pace with that of other transportation modes in the 1990s due to the following factors (see table 3-3).

- A surge in vessel newbuilding (fleet capacities) in the late 1970s and early 1980s depressed freight rates in the 1980s and 1990s, which in turn limited financial

Table 3-3
Net Stock of Fixed Private Capital, Transportation Equipment ($ billions)

	1993	1994	1995	1996	1997
Trucks, buses & trailers	185	210	236	261	282
Ships & boats	46	45	45	45	46
Railroad equipment	69	73	79	79	79
Aircraft	127	129	136	140	146
Total	**427**	**457**	**496**	**525**	**553**

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business* (Washington, DC: U.S. Government Printing Office, November, 1998).

resources for new vessel construction and dampened expected returns on new vessel investment. (See figures 1-1 and 1-7 in chapter 1.) Actual freight rates in the early 1990s have generally been below newbuilding breakeven rates.

- Large, unexpected year-to-year fluctuations in waterborne freight rates (market risks) in primary product trades generate uncertainty about expected returns on vessel investment. For example, inland dry-cargo (grains) barge freight rates on the lower Mississippi River increased by 61 percent from 1994 to 1995, but fell by 48 percent from 1995 to 1996 (St. Louis Merchants Exchange 1994-1996 issues). Although the drop in freight rates occurred in a specific area, it had a broad impact on the waterborne freight market.

FOR-HIRE WATER TRANSPORTATION INCOME

As shown in table 3-4, the Southeast accounted for the largest share (34 percent) of total personal income and earnings (income) from the for-hire water transportation industry, which totaled $8.1 billion in 1997. The Far West was the next highest income-producing region, with 29 percent, followed by the Northeast (21 percent), Southwest (8 percent), and the Great Lakes (6 percent).[2]

The Southeast had the highest growth in water transportation income from 1995 to 1997, reflecting growth in container traffic through southeast ports and a resurgence in demand for offshore supply boat services in the U.S. Gulf (related to offshore oil exploration and development).

On a state basis, in 1997, California had the largest share (17 percent) of water

[2] The **Northeast region** includes Maine, Connecticut, Massachusetts, New Hampshire, Vermont, Rhode Island, New York, New Jersey, Delaware, Washington, DC, Maryland, and Pennsylvania. The **Southeast region** includes Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. The **Far West region** includes Alaska, California, Hawaii, Nevada, Oregon, and Washington. The **Great Lakes region** includes Illinois, Indiana, Michigan, Ohio, and Wisconsin. The **Southwest region** includes Arizona, New Mexico, Oklahoma, and Texas. Other states not included in these regions are Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Colorado, Idaho, Montana, Utah, and Wyoming. Collectively, they account for 2 percent of water transportation income.

transportation income, followed by Louisiana (13 percent), Florida (10 percent), Texas (8 percent), New Jersey (7 percent), Washington (7 percent), and New York (6 percent) (see table 3-5).

Table 3-4
Personal Earnings and Income from Water Transportation by Region, 1995-1997

Region	1995		1996		1997		Annual Compound growth rate, 1995-97
	$ million	Percent	$ million	Percent	$ million	Percent	
Northeast	1,612	22.5	1,620	21.7	1,699	20.9	2.7
Southeast	2,303	32.1	2,445	32.7	2,749	33.8	9.3
Great Lakes	453	6.3	476	6.4	496	6.1	4.6
Far West	2,080	29.0	2,171	29.0	2,372	29.1	6.8
Southwest	600	8.4	626	8.4	678	8.3	6.3
Other	123	1.7	140	1.9	140	1.7	6.7
Total	**7,171**	**100.0**	**7,478**	**100.0**	**8,144**	**100.0**	**6.6**

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business* (Washington, D.C: U.S. Government Printing Office, October, 1998).

Table 3-5
Personal Earnings and Income from Water Transportation, Top 10 States, 1995-97

State	1995		1996		1997	
	$ millions	Percent	$ millions	Percent	$ millions	Percent
California	1,194	16.7	1,270	17.0	1,405	17.3
Louisianna	857	12.0	897	12.0	1,058	13.0
Florida	681	9.5	713	9.5	816	10.0
Texas	589	8.2	614	8.2	665	8.2
New Jersey	563	7.9	541	7.2	569	7.0
Washington	510	7.1	519	6.9	562	6.9
New York	436	6.1	438	5.9	469	5.8
Virginia	197	2.7	215	2.9	217	2.7
Pennsylvania	208	2.9	208	2.8	210	2.6
Hawaii	164	2.3	165	2.2	174	2.1
Total, top 10	**5,399**	**75.3**	**5,580**	**74.6**	**6,145**	**75.5**
Remaining states	1,777	24.7	1,898	25.4	1,999	24.5
Total	**7,171**	**100**	**7,478**	**100**	**8,144**	**100**

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business* (Washington, DC: U.S. Government Printing Office, October, 1998).

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Safety and Environment

Bob Heims, USACE

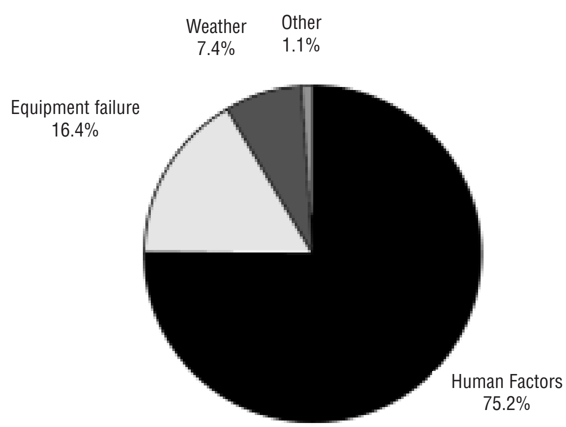
Water transportation provides economic benefits, mobility, and recreational opportunities, but it also creates unintended consequences, such as fatalities and injuries due to accidents, and environmental damage. Hence, promoting safety and protecting the environment are key goals in the Department of Transportation's (DOT's) strategic plan.

This chapter discusses the safety of commercial shipping and recreational boating and the environmental impacts associated with these activities. It also discusses several safety or environmental programs, including Prevention Through People, Port State Control, and the International Safety Management Code. The focus is primarily on U.S. Coast Guard (USCG) activities because the USCG is the lead DOT agency responsible for maritime safety and environmental activities.

SAFETY

There are four broad categories of causes of waterborne accidents: human factors, equipment failure, weather, and hazardous materials. As shown in USCG data, human factors are the dominant cause of marine accidents (75 percent) (USDOT USCG MSMIS 1997) (figure 4-1). Examples of human error include misinterpreting or ignoring hazard warnings, operating in adverse conditions without adequate weather monitoring, and navigational errors. Human errors may be caused by fatigue, inattention, lack of training, inadequate communications and coordination,

Figure 4-1
Causes Ascribed to Marine Transportation Accidents, 1990-June 1996



NOTE: Only accidents involving a fatality, a missing person, an injury, or at least $25,000 in damages are included.

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, Marine Safety Information Management System (MSMIS) database.

inadequate information, and lack of clarity about work roles and procedures (NRC CETS CHP 1997).

Equipment failure is the next largest cause of waterborne accidents (16 percent). Typical cases of equipment failure include malfunctioning deck machinery and steering and faulty propulsion, electrical, and fuel systems.

Propulsion failure occurs when a vessel loses its ability to maneuver. Propulsion failure could create major marine casualties, particularly if it occurs in the middle of heavy vessel traffic, near obstructions such as icebergs, or near shore. From 1994 through 1996, the Los Angeles-Long Beach Vessel Traffic Information Service monitored 16,130 deep-draft vessel arrivals. It was found that 0.7 percent of total arrivals had propulsion problems (USDOT USCG MSC 1997). These propulsion problems were either due to propulsion failure or the need for propulsion maintenance. The largest number of propulsion failures occurred within three miles of the Los Angeles-Long Beach breakwater. The highest rate of propulsion-related incidents occurred in bulk-cargo vessels, but 62 percent of propulsion problems occurred in container vessels.

Weather (excluding navigational hazards mentioned above) accounts for 7 percent of waterborne accidents. A hazard for operations in confined waterways, particularly with high vessel traffic, is the risk of collision between vessels or between a vessel and a facility such as a pier or bridge in conditions of poor visibility. This is especially a factor for inland waterways, such as the Mississippi River, and in and around ports.

Commercial Marine Transportation

Commercial marine transportation accidents can result not only in loss of life, but also costly damage to ships, cargo, surrounding infrastructure, shoreline property, and the environment (table 4-1). Major accidents tend to receive broad media attention. An example was the ramming of the Sunshine Bridge in Tampa, Florida, by a bulk carrier in 1980, which caused 35 deaths when a bus and 7 cars fell into the water, $30 million in damage to the bridge, and $1 million in damages to the

Table 4-1

Waterborne Transport Safety Data and Property Damage Resulting from Vessel Casualties

	1970	1975	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997
Fatalities [a]	178	243	206	131	85	30	96	110	69	46	50	46
Injuries	105	97	180	172	175	110	167	160	179	145	129	109
Accidents [b]	2,582	3,310	4,624	3,439	3,613	2,222	3,244	3,425	3,972	4,196	3,799	3704
Vessels [c]	4,063	5,685	7,694	5,694	5,494	3,514	4,910	5,309	6,433	6,849	6,075	5819
Property damage												
(millions of current $)	U	U	U	U	U	U	174.6	160.9	218.5	127.2	111.8	128.5

[a] Fatalities includes the number of people who died or were declared missing subsequent to a marine accident.
[b] Accidents in this table are what the U.S. Coast Guard calls "marine casualty cases."
[c] More than one vessel may be involved in a marine accident.

KEY: U = data are unavailable.

NOTES: All deaths and injuries cited result from vessel casualties, such as groundings, collisions, fires, or explosions. The data is for all vessels under U.S. jurisidiction, including U.S. flag vessels anywhere in the world, and foreign flag vessels within the jurisdiction of the United States (within 12 nautical miles of the U.S. Coast, or having an interaction with a U.S. entity, such as a platform within 200 nautical miles, or a collision with a U.S. flag ship).

1992-96 data come from the Marine Safety Management Information System (MSMS), which derives its data from the Marine Safety Information System (MSIS). Data for prior years may not be directly comparable.

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, Office of Investigations and Analysis, Compliance Analysis Division, G-MOA-2.

vessel (USDOT BTS 1997). Although not resulting in any fatalities, a bulk carrier on the Mississippi River rammed a wharf in New Orleans, Louisiana, in December 1996, causing $20 million in property damage and four serious injuries (USDOT BTS 1998).

Water transportation workers suffered an average of 37.6 fatalities per 100,000 workers annually—about four times the national average for all workers—over the 10-year period 1984 to 1993 (USDOT OBPP 1996). In 1997, 46 people died as a result of vessel casualties (e.g., groundings, collisions, fires, or explosions) (see table 4-1). Crewmember fatalities from tugboats and fishing vessels exceeded the water transportation worker average.

Difficulties in Measuring Risk Exposure

The USCG collects extensive data on incidents, fatalities, injuries, property damage, and pollution, but there are no equivalent risk-exposure data. One of the major problems with selecting an appropriate exposure measure is that the nature of the risk is very different for a vessel on coastal waters, on the deep sea, or on inland waterways.

Vessels being capsized by waves and winds or crew being swept overboard are concerns for both deep sea and coastal navigation. However, the risk profile for oceangoing vessels approaching ports is very different from that of the same vessels crossing oceans.

Michael Maples, USACE

Although workers who make a living on the water suffer four times the number of job-related fatalities as other workers, crewmembers of tugboats and fishing vessels are at higher risk.

For inland waterway navigation, near-port hazards are present in all phases of operation. Because of shoaling, grounding is a major risk on inland waterways, especially on the Mississippi River, and sharp turns and complex maneuvers are risky on inland waterways for large vessels and for tows with multiple barges.

Although considered inland navigation, Great Lakes shipping presents a range of risk-exposure situations. A vessel sailing from a Lake Superior port to a Lake Michigan port encounters the equivalent of deep sea exposure in Lake Superior, Lake Huron, and Lake Michigan, and near-port type exposure in the passages between the lakes. Ice can also be a problem during the winter. Several different safety-related data sets using standard measures would be needed to characterize safety regimes as diverse as those described above.

Recreational Boating

Most fatalities, injuries, and accidents on the water involve recreational boating. Boat operators involved in recreational boating accidents are required by law to file a boating accident report with state or U.S. territorial officials, or directly to the USCG if the accident occurred in Alaska. Reportable accidents are those that result in any of the following outcomes:

- loss of life,
- personal injury that requires medical treatment beyond first aid,
- property damage to the vessel of at least $500 or complete loss of the vessel, or
- disappearance of a person from the vessel under circumstances that indicate death or injury.

Recreational boating activity has increased over the past several years. Despite significant recreational boating safety efforts, 8,047 recreational boating accidents, involving 11,396 boats, were reported in 1997. The casualty data for 1997 show 821 fatalities, compared with 709 reported in 1996 and 829 in 1995 (USDOT USCG Annual issues). Most fatalities involved open motor boats (table 4-2) (USDOT USCG BARD n.d.). However, fatalities involving personal watercraft (PWC) (i.e., jet skies and other watercraft less than 13 feet in length), canoes, and kayaks have increased recently.

Human factors were ascribed as the cause for three out of five recreational boats involved in accidents between 1985 and 1994 (USDOT USCG Annual issues) (figure 4-2). (Note that the recreational boating data reports number of vessels rather

Table 4-2
Recreational Boating Accident Statistics, 1997

Boat type	Boats in accidents	Number of injuries	Drownings	Other fatalities	Total fatalities
Auxiliary sail	347	52	13	1	14
Cabin motorboat	1,342	377	24	27	51
Canoe/kayak	171	79	96	14	110
Houseboat	105	8	1	1	2
Inflatable	21	11	8	2	10
Open motorboat	4,183	1,897	307	106	413
Other	127	68	12	4	16
Personal watercraft	4,070	1,812	22	62	84
Pontoon	208	68	20	1	21
Rowboat	82	30	47	7	54
Sail (only)	164	39	16	3	19
Unknown	576	114	20	5	25
Totals	**11,396**	**4,555**	**586**	**233**	**821**[a]

[a] Reflects revised total that does not equal sum of column (819).

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, Office of Boating Accident Safety-G-OPB and Boating Accident Reporting Database (BARD).

than number of accidents. Thus, if two or more vessels were involved in an accident, each vessel would be recorded as having been involved in an accident caused by human factors).

In recreational boating, there are two broad classes of human factors:

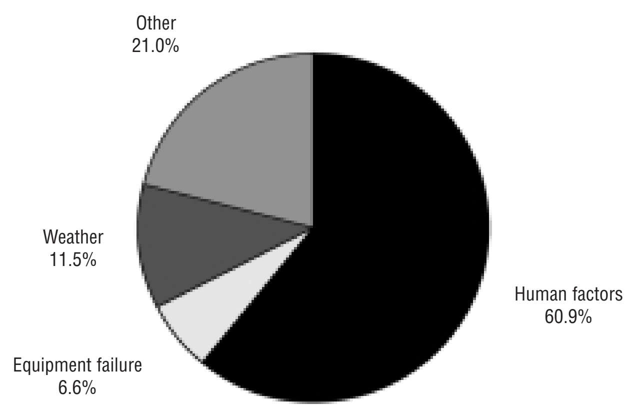
1. incorrect loading of passengers and gear, including overloading, improper weight distribution, and leaning over the edge of the boat; and

2. incorrect vessel operation, including improper lookout, inattention and carelessness, errors by other vessels, high-speed maneuvers, and navigational errors.

Alcohol is a major factor in recreational boating accidents and is generally under reported in statistics. In the 1990s, about 800 Americans died each year from boating accidents, and more than 50 percent of all fatalities on the water are alcohol-related (USDOT USCG OBS 1998a).

According to USCG research (USDOT, USCG, OBS 1998a), boaters with a blood alcohol concentration (BAC) of 0.1 percent (the minimum level of legal intoxication in most states for operators of recreational ves-

Figure 4-2
Causes of Recreational Boating Accidents, 1985-94 (10-year average)



SOURCE: U.S. Department of Transportation, U.S. Coast Guard, *Boating Statistics* (Washington, DC: Annual issues)

Table 4-3
Personal Flotation Devices (PFDs) and Recreational Boating Accident Statistics, 1997

Boat type	Was PFD worn? Yes	No	Total drownings
Auxiliary sail	2	11	13
Cabin motorboat	2	22	24
Canoe/kayak	22	74	96
Houseboat	0	1	1
Inflatable	4	4	8
Open motorboat	19	288	307
Other	2	10	12
Personal watercraft	7	15	22
Pontoon	2	18	20
Rowboat	1	46	47
Sail (only)	3	13	16
Unknown	1	19	20
Totals	**65**	**521**	**586**

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, Office of Boating Safety-G-OPB and Boating Accident Reporting Database (BARD).

sels used only for pleasure) were 10 times more likely to die in a boating accident than boaters with no alcohol in their blood. Operating a vessel while intoxicated has been a specific federal offense since January 1998. The USCG is pursuing federal rulemaking that would lower the threshold for boating under the influence of alcohol to a BAC of .08 percent.

Boaters also can take such precautions as adhering to safe boating speeds and using life jackets/personal flotation devices (PFDs). In 1997, over 85 percent of victims who drowned in fatal boating accidents were not wearing life jackets (table 4-3). It is estimated that life jackets could have saved the lives of at least 560 drowning victims in 1998 (USDOT USCG OBS 1998b).

Weather was cited as a cause for about 11.5 percent of accidents involving recreational boats between 1985 and 1994. The percentage is higher than the corresponding percentage (7.4 percent) for commercial waterborne transportation because recreational boats are smaller and more vulnerable to wind and waves, and generally have less experienced crews. The weather category includes strong currents and rough waters, a wake or wave striking a vessel, free water in the boat, and poor visibility.

Equipment failure caused less than 7 percent of recreational boating accidents in this 10-year period. Equipment failure is relatively less important for recreational boating than for commercial waterborne transportation because of the greater number of boating accidents due to weather and miscellaneous, nonequipment failures.

Difficulties in Measuring Risk Exposure

Recreational boating differs from most other transportation modes in two ways: almost all usage of this mode is discretionary, and the purpose of trips is primarily to spend time on the water, not to get from one point to another. The recreational purpose of most boating makes it hard to quantify risk exposure. Miles of travel are difficult to estimate because many boats do not have equipment to record travel distance. Moreover, distance is not a very meaningful risk exposure measure, since traveling a predetermined distance is seldom the purpose of a recreational boating trip. The number of trips is also not a good risk exposure measure, as a trip of longer distance or duration involves greater exposure to risk than a short-distance, short-duration trip. The longer in distance the trip, the more likely the boaters are to be exposed to hazards such as submerged rocks or bad weather. Duration of trips (in boat-hours) may be a better measure of exposure. It reflects exposure to common hazards (e.g., human errors, inclement weather, and equipment failure) and also expresses activity time on the water. Trip duration data are hard to collect, however.

As shown in table 4-4, the USCG presently uses the number of registered boats as an exposure measure and relates this information to the number of reported fatalities. Chapter 123 of Title 26, U.S. Code, requires each undocumented vessel equipped with propulsion machinery to be numbered in the state in which it is principally operated. About one-half of the states number additional types of craft. The numbered-boat statistics in table 4-5 are derived from reports of the actual counts of valid boat numbers that have been issued by states and other jurisdictions. All boats, however, are not registered, and all registered boats may not be in active use. Moreover, among boats in active use, some are used very infrequently, some are used seasonally, and some are used throughout the year.

The USCG's Recreational Boating/Personal Watercraft Exposure Study has information on the amount and type of recreational boating activity in 1997 (USDOT USCG OBS 1998b). One-third of new recreational boat sales in the United States are PWCs, with more than 1 million PWCs in operation. Unlike an open motorboat, in which the operator and passengers sit within a bulkhead that provides some protection from the water, PWC operators stand or sit astride the engine com-

Table 4-4
Recreational Boating Safety Trends, Alcohol Involvement, and Property Damage

	1960	1970	1980	1985	1990	1994	1995[R]	1996[P]	1997
Fatalities	819	1,418	1,360	1,116	865	784	829	709	821
Injuries	929	780	2,650	2,757	3,822	4,084	4,141	4,442	4,555
Accidents	2,738	3,803	5,513	6,237	6,411	6,906	8,019	8,026	8,047
Vessels involved	3,785	4,762	6,954	8,305	8,591	9,722	11,534	11,306	11,396
Numbered boats* (millions)	2.5	7.4	8.6	9.6	11	11.4	11.7	11.9	12.3
Rates per 100,000 numbered boats									
Fatality	32.8	19.2	15.8	11.6	7.8	6.9	7.1	6	6.7
Injury	37.1	10.5	30.8	28.7	34.7	35.8	35.4	37.3	37
Accident	110	51	64	65	58	61	69	67	65
Accident reports with alcohol involvement	N	N	N	279	568	389	472	601	697
Property damage (millions of current dollars)	3.2	8.2	16.4	20	23.8	25.2	21.5	22.8	28.9

* = In 1994, the U.S. Coast Guard changed its methodology for calculating the number of recreational boats; from 1975 to present, the figures cited represent the number of numbered boats, not an estimate, as previously reported. Accident, fatality, and injury rates have been recalculated accordingly.

KEY: N =data do not exist; P=preliminary; R=revised

NOTE: Only a small fraction of property damages and nonfatal accidents are reported to the U.S. Coast Guard.
SOURCE: U.S. Department of Transportation, U.S. Coast Guard, *Boating Statistics* (Washington, DC: Annual issues).

Michael Nevins, USACE

Unlike other recreational boating fatalities in which drowning is the leading cause of death, the primary killer in personal watercraft mishaps is blunt force trauma.

partment and use handlebars to control steering and speed. Some models also accommodate one or two passengers.

PWCs are the only type of recreational watercraft for which the leading cause of death is not drowning. PWC fatalities primarily result from blunt force trauma. From January through July 1997, there were 814 PWC accidents reported. Eighty-four percent of the operators in these accidents had no boating safety training. One quarter of the accidents involved rentals, and 68 percent of the renters were under age 25 (USDOT USCG 8th Dist. 1998).

Total annual PWC riding time was approximately 291 million hours, which was nearly the same aggregate level as canoe/kayak riding time (318 million hours). Open motorboat riding time totaled approximately 2.0 billion hours (USDOT USCG OBS 1998b). On an exposure-adjusted basis, the 1997 risk of fatality per million PWC exposure hours (0.29) was very similar to those for open motorboats (0.20) and canoes and kayaks (0.35). On an exposure-adjusted basis, injury risk was higher for PWCs (6.22 injuries per million exposure hours) than for the other two types of vessels studied (open motorboats 0.94 and canoes and kayaks 0.25).

Safety-Related Operations and Programs

Prevention Through People

Developed by the USCG in cooperation with the maritime industry, Prevention Through People (PTP) provides a strategy for guiding the maritime community's safety efforts. Some of the components of a system that affect safety—–human behavior, technology, management, and the work environment—are interdependent and changes in one may bring changes to other components (NRC MB CETS CHP 1997).

Currently, PTP is being "exported" to the London-based International Maritime Organization (IMO) (see box 4-1). The high ratio of foreign ships calling at U.S. ports, the need to achieve a level playing field for U.S. operators, and the opportunities to learn on a global scale make work through the IMO imperative.

The USCG performs a wide range of activities to promote maritime safety. Each year the USCG expends more than 40,000 operational hours—hours of operation for a ship, boat, aircraft, or other resource—on boating-safety activities, using pri-

Box 4-1
International Safety Management Code

The International Maritime Organization (IMO) adopted the International Safety Management (ISM) Code in May 1994 (IMO Assembly Resolution A.741(18)). Each vessel-operating company and its vessels must have a safety management system that has been audited and certificated in accordance to IMO's International Convention for the Safety of Life at Sea (SOLAS).

As of July 1, 1998, four kinds of vessels engaged in international trade were required to be in compliance with the ISM Code: vessels transporting more than 12 passengers; oil, gas, or chemical tankers; bulk-freight vessels; and high-speed freight vessels of 500 gross tons or more.

Since September 16, 1998, the vessels listed above, except vessels less than 500 gross tons carrying more than 12 passengers, have been expected to provide their ISM Code certification status to the U.S. Coast Guard (USCG) Captain of the Port 24 hours before entering a U.S. port (USDOT USCG MSEPD 1998).

Verification of shipboard safety management systems under the ISM Code is an additional area of inspection that has been added to the Port State Control program. USCG boarding officers verify that ships have valid ISM certificates and review the Document of Compliance issued to the owner, operator, or charterer. Expanded examination is conducted in any area of noncompliance with the ISM Code. Major classification societies provided the USCG with ISM statistics regarding their respective fleets as part of the USCG's ISM precompliance program.

In the period July 1, 1998 to June 15, 1999, the U.S. Coast Guard has detained 19 foreign flagged vessels for ISM-related deficiencies. Of these 19 vessels, 6 vessels were ordered out of U.S. waters for noncompliance with the ISM Code.

The Coast Guard Authorization Act of 1998 has directed the Coast Guard to conduct a study and report to Congress on the effects of the ISM Code. This report is due May 2000. The timeline from July 1, 1998 to December 31, 1998 will be the baseline by which the USCG will evaluate future detention numbers under ISM implementation. This report will compare the statistics from January 1, 1999 to June 30, 1999 with the baseline data. This may provide an indication of the effectiveness of the ISM Code on foreign flagged ships calling in the United States.

marily small, shallow-draft boats, larger multimission boats, or patrol boats. Boating safety activities include boarding recreational boats to ensure proper safety equipment is on board and enforcing safety zones at marine events.

The USCG publishes approximately 2 million Local Notices to Mariners (LNMs) annually, distributing them to 44,000 weekly subscribers. These LNMs contain time-sensitive navigation safety information on changes to aids to navigation; hazards to navigation; bridge, chart, and publication corrections; and other related information of interest to mariners. In addition, the USCG broadcasts more than 35,000 notices to mariners each year, advising users of waterway conditions and hazards.

Prototype Incident Reporting System

Although the maritime community captures much information on marine casualties, many situations that involve unsafe occurrences, such as near-misses, environmental close-calls, or hazardous situations involving vessels, their crews and/or passengers, and cargo are not reported. The intent of the National Maritime Safety

Incident Reporting System, a joint U.S. Coast Guard and Maritime Administration (MARAD) initiative, is to capture causal information and lessons learned about near collision situations, near pollution events, and other occurrences, and related precursor events (hazardous situations), such as crew fatigue, equipment maintenance/failure, communication failure, and policy and procedural issues.

The reporting system may help the maritime community identify system vulnerabilities and weaknesses before failures or accidents occur. The knowledge gained from a systematic analysis of near-misses and hazardous situations promises to point the way to those key interventions that could reduce the number of future casualties and operational and response costs for both the private and public segments of the maritime community.

The goal is to have a prototype reporting system in place by the beginning of the year 2000 that is operated by a nonregulatory third party or network of parties. Success will depend on the extent of industry involvement in its development and eventual use.

Search and Rescue

The statutory authority for the Search and Rescue (SAR) program is contained in the United States Code Title 14, Sections 2, 88, and 141. The code states that the USCG shall develop, establish, maintain, and operate SAR facilities and may render aid to distressed persons and protect and save property on and under the high seas and waters subject to the jurisdiction of the United States. It also states that the USCG may utilize its resources to assist other federal and state entities.

Between 1993 and 1997, an average of more than 47,000 Search and Rescue (SAR) cases a year were conducted that involved the USCG. The USCG estimates that these cases saved the lives of about 5,000 people per year, on average. These people were determined to be in imminent danger of death (table 4-5).[1] The unusually high number of lives estimated to have been saved in 1994 (7,889) reflects USCG assistance to a large number of people migrating by boat from Haiti and Cuba. U.S. Coast Guard cutters on patrol rescued many of these people even though no distress calls or requests for help were received. Many of these migrants used unsafe crafts (e.g., inner tubes held together by netting) or were in crudely built, overloaded boats. A single mission could save many people in extreme distress. Tables 4-6 and 4-7 provide information on the nature of incidents and vessel ownership for search and rescue cases from 1995 through 1997.

SAR missions operate in all types of weather and geographic conditions. Demand for some services, such as recreational boating safety, short-range aids to navigation, and many law enforcement activities, decrease when waterways freeze; how-

[1] As defined in the USCG's Search and Rescue Management Information System (SARMIS) manual, a case is "Any situation in which the USCG renders assistance to a unit (vessel or person) in distress whether or not a resource is dispatched."

Table 4-5
Search and Rescue Statistics, 1993-97

Number of missions	1993	1994	1995	1996	1997
Cases	52,455	53,266	49,136	42,956	40,639
Lives saved	4,689	7,889	4,411	4,992	3,836
Lives lost					
Before notification	796	579	457	593	444
After notification	414	336	299	358	287
Persons otherwise assisted	118,190	115,622	100,425	84,248	74,740
Property loss prevented ($ millions)	908.8	1,452.40	2,448.60	2,213.80	877.5

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, data file, Search and Rescue Management Information System (SARMIS) incident reports, 1993-97.

Table 4-6
Nature of SAR Incidents, 1995-97

Incident	1995	1996	1997
Vessel disabled/adrift	10,468	7,379	6,350
Vessel aground	10,405	9,010	8,359
Vessel overdue/loc Unk	1,157	1,280	1,376
Vessel fire/explosion	1,084	1,110	1,100
Vessel lost/disoriented	1,179	1,200	1,176
Vessel flooding/sinking	1,046	680	596
Swimmer in danger	646	723	633
False alarms	11,135	9,649	10,397
Other	12,016	11,925	10,652
Total	**49,136**	**42,956**	**40,639**

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, data file, Search and Rescue Management Information System (SARMIS) incident reports, 1993-97.

Table 4-7
Owner of Vessels Involved in SAR Incidents, 1995-97

Owner	1995	1996	1997
U.S. private	30,451	25,951	23,898
U.S. commercial	4,925	4,352	4,601
U.S. rental	746	539	472
U.S. government	392	408	427
State/local government	190	208	140
Foreign owner	709	603	692
No vessel involved	5,031	4,571	4,122
Other/not recorded	6,692	6,324	6,287
Total	**49,136**	**42,956**	**40,639**

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, data file, Search and Rescue Management Information System (SARMIS) incident reports, 1993-97.

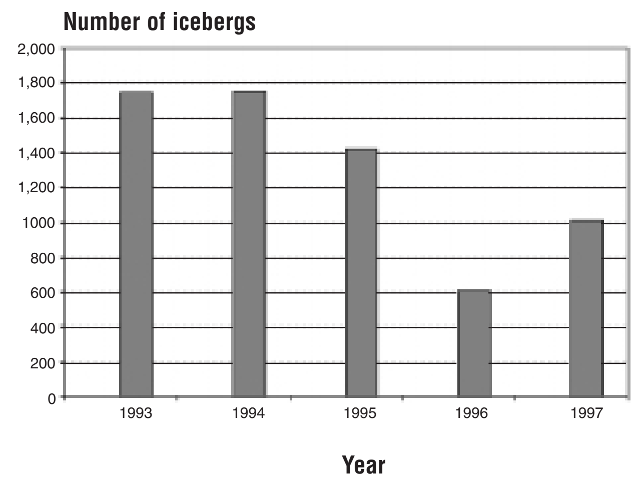
ever, other demands increase, such as clearing iced-over channels and assisting icebound mariners.

Frequently, commercial vessels require multiple icebreaking services while in-transit on the Great Lakes. Level ice can reach up to 3 feet in thickness, while brash (broken) ice and pressure ridges (where two plates of ice meet) can be more than 12 feet thick. In most instances, ice thickness varies depending on weather severity. However, large ice jams can occur even during a mild winter as a result of brash ice being pushed together by strong winds, requiring icebreakers with drafts of more than 12 feet to clear waterways.

International Ice Patrol

Since 1913, one year after the RMS *Titanic* collided with an iceberg and sank, the USCG has participated in the International Ice Patrol (IIP) to detect icebergs and warn cargo and passenger ships of their location in North Atlantic shipping lanes. Since establishment of the IIP, no vessels have been lost to icebergs within the IIP patrol

Figure 4-3
Number of Icebergs Detected South of 48° N, 1993-97



SOURCE: U.S. Department of Transportation, U.S. Coast Guard, International Ice Patrol database, 1993-97.

area. The 17 signatory nations[2] fund the IIP in proportion to their share of total tonnage transiting the North Atlantic area during the ice season.

USCG long-range aircraft (C-130), Canadian Ice Center Assets, satellite imagery, and reports from the shipping industry are all used by the IIP to detect icebergs south of 48° N latitude and determine the limits of all known ice in the patrol region. A computer model of iceberg drift and deterioration is used to predict future iceberg positions, which are validated by later reconnaissance flights. The model requires data on current, winds, waves, and sea-surface temperatures from the Fleet Numerical Oceanographic Center, in Monterey, California, and satellite-tracked drift buoys.

The number of icebergs south of 48° N latitude varies from year to year. In 1996, 611 "bergs" crossed 48° N latitude compared with 1,011 in 1997 (figure 4-3). Using data collected since 1913, the 1997 IIP season would be classified as "severe."

Maritime Information Systems

The safety of maritime transportation in the United States depends in part on the quality of port and waterways information systems. Mariners can obtain precise, real-time information about harbor and waterway conditions from communication and navigation systems that are relatively easy to use and do not cause undue distractions (NRC 1999). These systems have much promise in efforts to improve maritime safety.

The federal government encourages public and private sector partnerships in the design, implementation, and operation of maritime information systems. Agencies such as MARAD, USCG, and the National Oceanic and Atmospheric Administration in the U.S. Department of Commerce are supporting and/or developing information systems that involve such technology as electronic charting, vessel tracking, and standards. These technologies are further discussed in chapter 6.

[2] Signatory nations to the International Ice Patrol include the United States, Denmark, Greece, Finland, France, Italy, Japan, Norway, Netherlands, Poland, Spain, Sweden, Panama, Israel, the United Kingdom, Canada, and Germany.

ENVIRONMENT

A key challenge for U.S. ports and for the maritime industry is to efficiently and effectively meet the growing demands and diverse needs of waterborne transportation while protecting environmentally sensitive harbors, coastal areas, and marine resources. Environmental protection is a particular concern for dredging and new terminal development, where controversies have arisen over dredged material disposal, environmental impacts, and impact mitigation.

Among environmental concerns affecting the maritime industry are:

- dredging navigation channels and managing the disposal or beneficial use of dredged material in a timely, cost-effective, and environmentally sound manner;
- managing the wastes generated by facilities and ships in a safe and environmentally sound manner;
- providing prompt and adequate response to spills of oil and hazardous substances;
- controlling air pollution emitted from vessels and port operations;
- preventing water pollution;
- providing for the safe handling of hazardous cargo;
- rehabilitating old industrial properties that may be contaminated;
- complying with wetland and endangered species regulations; and
- dealing with various legal, liability, and financial obligations associated with environmental regulations.

Sediment Dredging in U.S. Ports

Dredging and dredged material disposal are key environmental issues for the U.S. port industry (USDOT, BTS 1997). Most ports and harbors are not deep enough for modern vessels and require periodic dredging to maintain depths (USDOT MARAD 1998). As world trade increases and shipping practices and technology evolve, many ports will likely need deeper and broader channels and harbors.

Dredged sediments contaminated with heavy metals and other pollutants require special handling and disposal methods (e.g., confinement in upland disposal sites), which raises the costs of dredged material management. New rules on sediment management are increasing the percentage of sediments deemed contaminated.

Dredging of sediments is carried out by the U.S. Army Corps of Engineers (USACE) and U.S. port authorities. Ports spent $129.4 million on new construction and modernization/rehabilitation dredging in 1997 (USDOT MARAD OPDS 1998). For 1992 through 1997, the USACE dredged an average of 273 million cubic yards


USACE

As ships increase in size and the need to deepen ports and waterways grows, economical and environmentally friendly ways to dispose of dredged material pose a major challenge.

per year of sediments in ports and harbors, for an annual average cost of $542 million (USACE 1998).[3] The most costly dredging involves sediments contaminated with heavy metals or other pollutants. These contaminated sediments constitute an estimated 5 to 10 percent (by volume) of all sediments dredged nationally each year, although the proportion varies widely by region.

When navigational dredging is the issue, the applicable federal statutes include Section 115 of the Clean Water Act (CWA); the Rivers and Harbors Act of 1899 (P.L. 55-525); the Marine Protection, Research, and Sanctuaries Act (MPRSA, commonly known as the Ocean Dumping Act) (P.L. 92-532); and the Coastal Zone Management Act (P.L. 92-583). In addition, states also exercise important authority related to water quality certification and coastal zone management. In some cases, local regulations may also apply (NRC CETS MB CCMS 1997).

In 1997, the U.S. Environmental Protection Agency (EPA) published a preliminary assessment of the national incidence and severity of sediment contamination (USEPA OST 1997). EPA found 96 watersheds in the United States with areas of potential concern for sediment contamination. These areas are clustered in coastal and inland territory, primarily east of the Mississippi River and in California and Washington. Limitations in available data and evaluation tools narrowed the scope of EPA's analysis. Hence, the data are not sufficient to determine the real extent of contamination on a national scale. EPA considers the study output analogous to a screening assessment, not firm confirmation of sediments that require special management. The agency recommends further investigation and assessment of contaminated sediments.

Management approaches and technologies that would reduce the costs of managing existing contaminated marine sediments could improve the benefits of dredging. A 1997 National Research Council (NRC) report rated a range of technologies in terms of their feasibility, effectiveness, practicality, and cost for managing contaminated marine sediments on an interim or long-term basis (NRC CETS MB CCMS 1997). The report also noted that many seemingly appropriate technologies have only been used (and evaluated) in inland water conditions or on ground soils and need to be demonstrated for special marine sediment conditions (e.g., salt content) and properties.

[3] Port and U.S. Army Corps of Engineers expenditures on dredging cannot be combined. Data sources and methodologies differ, and combination may result in some double counting.

The NRC also found a need for decisionmaking improvements, such as greater use of risk analysis, cost-benefit analysis, and decision analysis, and simplification of the applicable regulatory framework. As a result of a 1994 interagency report ("The Dredging Process in the United States: An Action Plan for Improvement") to the Secretary of Transportation, the agencies now work together as a National Dredging Team comprising eight Regional Dredging Teams.

Oil Spills

Oil spills can have major impacts on nearby ecosystems, aquatic species, wildlife, and birds, but the extent and severity of environmental contamination vary greatly with the location and size of the spill. Even a small amount of petroleum in the groundwater system can contaminate large quantities of water. Improper disposal of used motor oil and other chemicals from transportation vehicles and facilities, both land- and water-based, are also major sources of surface water and groundwater contamination.

Large tanker spills, such as the 10 million gallons of crude oil discharged from the *Exxon Valdez* into Alaska's Prince William Sound in 1989, are the most visible examples. Depending on the concentration and nature of the pollution, the location of the spill, and the environmental resources affected, such spills can have major adverse environmental impacts.

According to the American Waterways Operators/U.S. Coast Guard Action Team on Tank Barge Transfer Spills, the total number of reported spills from self-propelled vessels and barges in U.S. waters increased from 1986 to 1995, while the volume of spills (table 4-8) and the number of large spills declined (AWO/USCG 1997). This is attributable to a stricter regulatory environment and definitions regarding spills, and increased awareness of customers and vessel facility operators.

Table 4-8
Average Annual Volume Spilled

	1986-90	1991-95
Barges	1.6 million gallons	0.5 million gallons
All vessels	6.3 million gallons	0.9 million gallons

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, The American Waterways Operators/U.S. Coast Guard Action Team on Tank Barge Transfer Spills, *Managing Toward Zero Spills* (Washington, DC: October 1997).

Table 4-9 shows progress in the 1991 to 1995 period that followed enactment of the Oil Pollution Act of 1990 and other preventive initiatives. Some other improvements were also made:

- The average number of oil spills over 10,000 gallons dropped by approximately 50 percent from pre-1991 levels.
- The number of gallons spilled per million gallons shipped fell by 50 percent.

Table 4-9
Medium and Major Oil Spills

Source type	Number	%	Volume	%
Waterfront facilities	19	27	851,882	14
Barges	24	34	4,038,791	67
Tankship	8	11	485,791	8
Freight ship	8	11	365,727	6
Other vessel	12	17	296,916	5

SOURCE: The American Waterways Operators/U.S. Coast Guard Action Team on Tank Barge Transfer Spills, *Managing Toward Zero Spills* (Washington, DC: 1997).

- There were no spills over 1 million gallons.
- The total volume of tankship oil spills in the United States, which peaked in 1989, was below 200,000 gallons (USDOT USCG MSEP 1999).

Most spills result from equipment malfunctioning or stem from mistakes, carelessness, or inexperience. For example, in the case of tank barge transfer spills, the two most frequently cited causes, accounting for 16 and 27 percent respectively, are equipment malfunction and procedural violations (AWO/USCG 1997). Water pollution also results from spillage of fuel and oil from recreational motorboats.

Cumulatively, very large volumes of oil and petroleum products enter the environment from smaller spills and the improper disposal of used automobile motor oil. For example, it is estimated that the volume of used motor oil improperly dumped into sewers, drains, and soil annually is 15 to 20 times greater than the *Exxon Valdez* spill (USDOT BTS 1996). The cumulative effect of these smaller incidents is large and costly to clean up.

Oil Spill Detection

In recent years, new technologies have improved the USCG's ability to detect oil spills, especially at night. These technologies enhance the efficiency of environmental protection efforts in two ways: they allow oil-spill cleanup activities to take place during nighttime hours and they enable USCG units to actively survey areas for illegal oil dumping at night, a time when the risk of illegal oil discharge is greatest. These technologies also help document violations; infrared camera video, for example, can provide critical evidence in the case of an oil slick emanating from an offshore vessel, whether in daylight or in darkness. Photo documentation might lessen the need for oil samples or reliance on the statements of aircraft crewmembers as evidence of the violation. Two widely used systems for nighttime oil detection are the Aireye system and portable infrared cameras.

The Aireye system includes two sensor subsystems, which are called the side-looking airborne radar (SLAR), and the infrared/ultraviolet line scanner. The SLAR, like any other radar, generates an electromagnetic signal and creates energy from the target object. In the case of oil, the SLAR detects oil on the water because of the variation in roughness of the water's surface with or without oil on it.

In the 1990s, the USCG began to investigate the use of portable infrared sensors for oil-spill detection. These sensors can be used on any available aircraft, and USCG's capability to detect and monitor oil at night is increasing as personnel are trained and become proficient in the use of the sensors.

Nighttime oil detection technology was used during a major oil spill that occurred off the coast of Rhode Island in January 1996. Nightly SLAR overflights during the week-long spill tracked the migration of the oil, allowing continuous monitoring of its extent and movement, which was important for implementing precautionary measures should the oil slick approach critical intakes in Narragansett Bay. Nighttime oil detection also saved precious time, allowing skimmers to be in the area of the oil slicks and ready to begin recovery at first light. A portable infrared camera was also used during this spill. The contribution that it made toward cleanup, however, was limited due to problems with cold weather operation. Lessons learned from this spill will be used to enhance the cold weather operability of this equipment (USDOT USCG 1996b).

Air Pollution from Ships and Recreational Watercraft

The prevention of air pollution from ships has become the focus of treaty, legislative, and regulatory activities at both the national and international levels. Major implementing authorities, as far as the U.S. maritime industry is concerned, are the International Maritime Organization, the U.S. Environmental Protection Agency, and the U.S. Coast Guard. Small marine engines (e.g., those on PWCs) primarily use gasoline. Almost all commercial engines are diesels.

Recreational gasoline-powered marine engines are one of transportation's largest nonroad emitters of hydrocarbons (HC) and oxides of nitrogen (NOx). There are more than 12 million recreational marine engines operated in the United States. EPA regulations to control exhaust from new outboards and PWC went into effect in July 1996. EPA estimates that this program will result in a 50-percent reduction in HC emissions from such engines by 2020 and a 75-percent reduction by 2025 (USEPA OAR 1996).

In November 1998, EPA proposed regulations (40 CFR Part 94) for the control of exhaust emissions from new marine diesel engines rated at or above 37 kilowatts. The emissions limits will vary according to the size of the engine. These limits would apply beginning with engines manufactured in 2004 (USEPA OMS 1999).

In 1997, Annex VI was added to the International Convention for the Prevention of Pollution from Ships (put in place in 1973, modified in 1978, and known as MARPOL 73/78 (Marine Pollution Convention)). Among its provisions, the new annex makes mandatory the technical code on controlling NOx emissions from marine diesel engines (NOx Technical Code). It includes regulations for ozone depleting substances, NOx emissions control, engine design parameters, sulfur oxides emissions control, fuel-oil quality, vapor emission control systems for volatile organic compounds, and shipboard incineration. For the first time, a MARPOL annex explicitly provides for port and coastal state enforcement of its regulations consistent with the modern Law of the Sea.

Harmful Effects of Antifouling Paints

Tributyltin (TBT), a compound of tin (organotin) that acts as a biocide, has been widely used in ship hull paints to prevent fouling by marine organisms, thereby reducing the frequency of hull scrapings (USEPA OECA 1997). As the metallic compounds slowly leach from the antifouling paint into the seawater, barnacles and other marine life that have attached to the ship are killed. However, studies have shown that these compounds remain in the water, killing sealife, harming the environment, and possibly entering the food chain.

In 1990, IMO's Marine Environment Protection Committee (MEPC) recommended that governments adopt measures to eliminate the use of antifouling paint containing TBT on nonaluminum hulled vessels of less than 25 meters in length and eliminate the use of antifouling paints with a leaching rate of more than 4 micrograms of TBT per day (IMO MEPC 1997). Some countries, such as Japan, have already banned the use of TBT in antifouling paint for most ships.

Large-ship maintenance (including the application of antifouling paints) often takes place in countries that do not regulate TBT in antifouling paints, and ships treated with the paint may subsequently visit the waters of countries that do regulate TBT.

At present, the principal alternatives to organotin antifouling paints are copper-based coatings and silicon-based paints. These alternatives are generally not as effective or pose other problems, such as polluting the air during application. Development of antifouling systems that have little environmental impact while minimizing economic disruption caused by frequent vessel lay-ups for bottom scraping would be ideal.

In 1998, the MEPC approved a draft resolution to be submitted to the IMO Assembly by November 1999 that would "ensure a global prohibition on the application of organotin compounds which act as biocides in antifouling systems on ships by Jan. 1, 2003 and a complete prohibition on the presence of organotin compounds, which act as biocides in antifouling systems on ships by Jan. 1, 2008" (IMO MEPC 1998).

Port State Control Program

In 1978, the supertanker *Amoco Cadiz* grounded on the coast of France, producing a huge oil spill that caused great environmental and economic damage to Brittany's scenic coastline and marine life habitat. In reaction, 16 European nations (now 17) and Canada signed a Memorandum of Understanding (MOU) on Port State Control (PSC) (Paris MOU) in 1982. This MOU covers the coastal waters of the North Atlantic and Mediterranean Sea. Since then, other maritime nations have formed MOUs covering most of the oceans and many waterways of the world. The Latin American Agreement on Port State Control was signed by 11 Latin American Countries on November 5, 1992 and the Tokyo MOU on December 1, 1993 (covering 17 Pacific Rim nations). The Indian Ocean MOU (covering 15 Maritime authorities) was signed in June 1998 (IMO 1996-1998).

PSC inspections are conducted to ensure that foreign ships are seaworthy, do not pose a pollution risk, provide a healthy and safe working environment, and comply with relevant international conventions. Under PSC, substandard vessels can be detained while they are within the waters of the PSC nation. Detentions may be brief if repairs or deficiencies are easily remedied. For serious defects, a vessel can be diverted to a secure anchorage and in extreme cases denied entry into the PSC country (USDOT USCG PSC 1999).

While the IMO has developed voluntary guidelines for PSC implementation and compiled statistics on existing PSC programs, it does not take an active enforcement role in PSC. Enforcement is handled by individual PSC nations or through various port state control MOUs around the world.

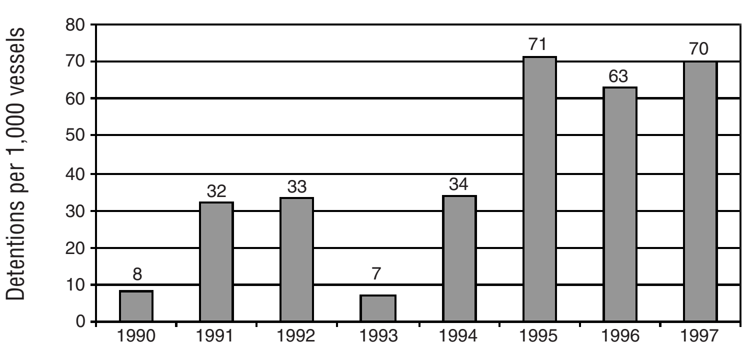
The U.S. Port State Control Program

The United States is not a member of any PSC MOU but has developed its own Port State Control system, which is copied by many nations around the world. U.S. law prevents the USCG from accepting non-U.S.-based certification of inspections on U.S. flag vessels, effectively prohibiting full MOU membership and acceptance of a MOU member country's standards of inspection or targeting criteria.

Non-U.S.-flag vessels carry more than 90 percent of the international commercial freight arriving in or departing from the United States (USDOT USCG MSIS 1997). According to USCG statistics, 95 percent of all passenger ships and 75 percent of all cargo ships (including tankers) entering the country were flagged by other countries.

The large number of non-U.S.-flag vessels calling at U.S. ports has raised concerns about adherence of these vessels to U.S. safety and environmental standards. USCG analysis has revealed that substandard foreign-flag vessels accounted for a majority

Figure 4-4
Vessel Detentions That Call in the United States[a]



1997 detentions by flag

Panama	139
Cyprus	65
Malta	38
Liberia	37
Bahamas	28
Greece	21
Turkey	20
Saint Vincent and the Grenadines	18
Belize	16
Singapore	14
Philippines	13
Antigua and Barbuda	10
All others	129

NOTES:
[a] 1997 Detentions based on information reported by field personnel through March 1998.
SOURCE: U.S. Department of Transportation, U.S. Coast Guard, Strategic Planning and Analysis Division, 1997.

of safety or environmental incidents. Thus, in 1994, Congress directed the USCG to develop a program to eliminate substandard vessels (i.e., vessels that do not meet safety or environmental criteria) from the nation's waters and to submit annual reports on the status of this program (Port State Control Initiative).

Because the United States lacks the resources to board all vessels, Captains of the Port (COTP) use a risk-based targeting methodology to select vessels for boarding. The histories of arriving vessels are reviewed for such matters as prior violations, casualties, outstanding deficiencies, or substandard records by owners and flag states. Based on a risk-assessment matrix, vessels are prioritized and boardings are scheduled depending on perceived risk and resources available.

To verify PSC compliance, the USCG has established partnerships with such entities as the classification societies. Principal classification societies include Lloyd's Register of Shipping, London; American Bureau of Shipping, New York; Bureau Veritias, Paris; Germanisher Lloyd, Berlin; Det Norske Veritias, Oslo; Registro Navale Italiano, Rome; Japan Marine Corp., Tokyo. These classification societies place vessels in grades or classes according to a society's rules for a particular type of vessel. Although it is not compulsory to build a vessel according to classification societies' standards, in practice, a shipowner would have difficulty acquiring adequate insurance coverage for an unclassed vessel. Thus, these standards are a de facto commercial requirement.

Several of these societies have carefully analyzed the detention statistics of vessels classed by their organizations and have initiated substantive remedial measures to enhance their vessel survey or inspection effectiveness. In 1997, 20 percent of detentions were certified by classification societies. Figure 4-4 provides information on vessel detentions for countries that exceed the average detention rate.

These measures have enhanced safety aboard thousands of foreign-flag vessels calling in U.S. ports. In 1996, for example, 35 percent of substandard vessels were detained for failure to comply with international standards.

Since 1993, Lloyd's Register has reduced the number of its nonexclusive surveyors —contract inspectors not directly trained and supervised by the society—from 500 to 6. Since 1993, Bureau Veritias has removed over 1,500 substandard vessels from its registers. In addition, 16 European and Canadian PSC authorities, including Canada, were signatories to the Paris MOU, which adopted the USCG's method of ranking the performance of a classification society against the number of substandard vessel detentions certified by the society.

The overall number of detentions per 1,000 distinct foreign-flag vessel arrivals was 70.4 in 1997 (figure 4-4).

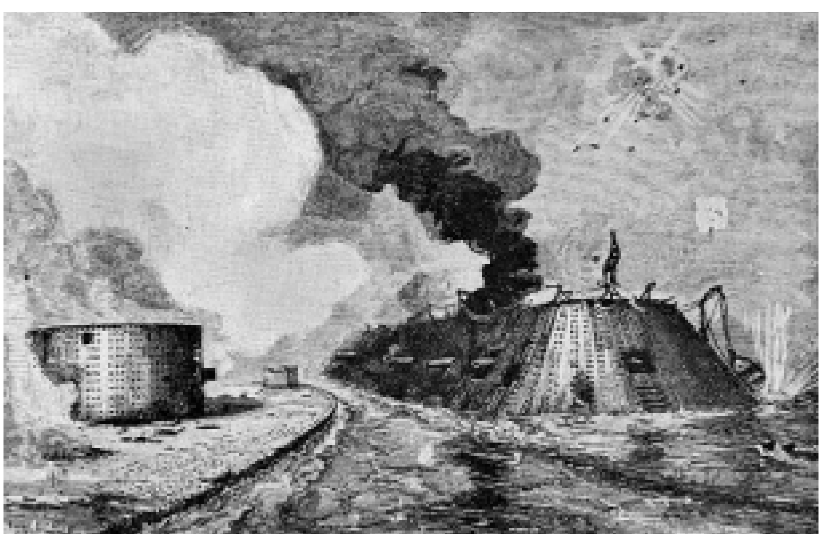
Fisheries Enforcement Operations

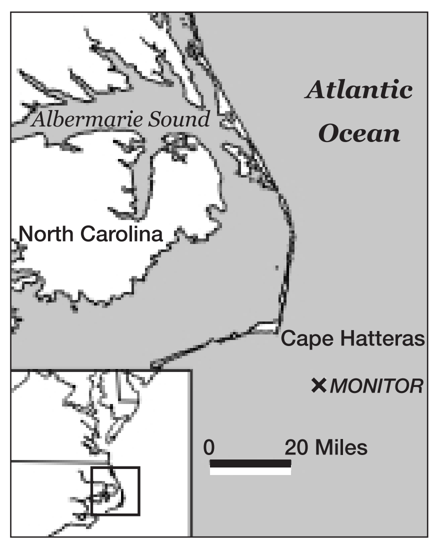
Oceans are a source of renewable wealth, providing a livelihood for commercial fishers, a source of recreation, and a rich supply of seafood. Commercial and recreational fisheries annually contribute an estimated $20 billion and $10 billion, respectively, to the U.S. economy each year. There are intangible ecosystem benefits from protection of marine mammals and endangered species (USDOT USCG Fifth District). The importance of responsible management of ocean resources will continue to grow as the oceans are seen as an increasingly critical source of food for the world's growing population.

As authorized by the Magnuson-Stevens Fishery Conservation and Management Act (P.L. 94-265), the USCG works closely with National Marine Fisheries Service (NMFS) in the Department of Commerce in implementing fisheries law enforcement. The National Marine Fisheries Service, as part of the National Oceanic and Atmospheric Administration, manages the fisheries and shares enforcement responsibility with the USCG. The USCG is the only agency with the maritime authority and infrastructure to project its federal law enforcement presence in the Exclusive Economic Zone (EEZ) and on the high seas. The U.S. EEZ is the largest in the world, containing 3.3 million square miles of ocean and 90,000 miles of coastline. (USDOT USCG OLE 1999).

The Coast Guard's fisheries enforcement efforts are focused mainly in four areas:

• protecting the U.S. EEZ from incursions by foreign fishing vessels,





Our nation's first marine sanctuary protects the resting place of the U.S. Civil War ironclad U.S.S. *Monitor.* Depicted to the left in this period engraving, the *Monitor* sank in a storm off Cape Hatteras shortly after its epic 1862 dual with the Confederate ironclad C.S.S. *Virginia* (formerly U.S.S. *Merrimack*).

- providing enforcement in support of domestic fisheries management plans and marine mammal and endangered species protection,
- safeguarding U.S.-origin anadromous stocks (salmon) throughout their range on the high seas, and
- monitoring compliance with international agreements and United Nations moratorium on high seas drift nets.

Marine Sanctuaries

The Marine Protection, Research, and Sanctuaries Act of 1972 authorizes the Secretary of Commerce to designate national marine sanctuaries and directs the USCG to enforce marine sanctuary regulations against those responsible for destroying or injuring a sanctuary resource or possessing, selling, delivering, carrying, or transporting a sanctuary resource.

The United States has 12 coastal marine sanctuaries. National marine sanctuaries may be designated in coastal and ocean waters, submerged lands, and in the Great Lakes and their connecting waters. Sanctuaries harbor an array of plants and animals, from the great whales to tiny, brightly colored sea snails. These protected waters provide habitat for species threatened by extinction and protect historically significant shipwrecks and prehistoric artifacts.

Artificial Fish Reef Program

Established in 1972, the Maritime Administration's Artificial Fish Reef Program authorized the Secretary of Commerce (MARAD was formerly an agency within the Department of Commerce) to transfer scrap World War II Liberty ships in the National Defense Reserve Fleet (NDRF) to any state filing an application in accordance with the law's procedures. The law provided that the transfer was at no cost to the government and that the state take custody of the vessel "as-is where-is." In addition, it provided for states to salvage items from vessels to offset the costs of towing, preparation, and sinking. The law was amended in 1984 to include any obsolete vessel in the NDRF that was designated for scrapping and to give the Secretary of Transportation authority to transfer title of the vessels.

Aquatic Nuisance Species Control Program

The United States and other federal agencies of the Aquatic Nuisance Species Task Force are taking steps to slow the spread of Aquatic Nuisance Species (ANS) via ships' ballast water. ANS are invading U.S. waters at an alarming rate, causing significant environmental and economic impacts. Historical records and recent studies indicate that hundreds of ANS have been introduced into North America; 100 non-native species have been identified in the Great Lakes alone. The Zebra Mussel, European Ruffle, Round Goby, and Spiny Water Flea are recent examples of invading species. The cost to the Great Lakes region alone to control Zebra Mussels could reach $500 million by the year 2000 (USDOT USCG 1998). The great majority of ANS invasions, worldwide, are thought to be due to the uptake and discharge of ballast water from ships. Currently, over 58 million gallons of ballast water, originating in foreign ports, are discharged into U.S. waters every day; that is more than 21 billion gallons per year.

The United States passed the Nonindigenous Aquatic Prevention and Control Act (P.L. 101-646) in 1990 (NAPCA). NAPCA required the USCG to promulgate regulations requiring the exchange of ballast water with open seawater by vessels bound for U.S. Great Lakes ports prior to entering the Great Lakes system (USDOT USCG 1998). Ballast water usually originates in coastal water, rich with organisms capable of establishing themselves in new environments. Exchanging this water with open ocean water containing sparse and less diverse organisms generally minimizes the opportunity for invasion. The regulations went into effect in 1993. Recently, the USCG published regulations and guidelines that cover all U.S. waters. The international community has also recognized the severity of the ANS problem; in 1991, the IMO developed and published international guidelines for ship's ballast water management. The Marine Environmental Protections Committee of the IMO is currently developing an international treaty that may become part of the International Convention for the Prevention of Pollution from Ships.

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National Security

USCG

The United States has had a longtime interest in maintaining a U.S.-flag merchant fleet that can support economic and national security needs in times of political or economic turmoil. Throughout this Nation's history, many programs have been instituted to meet these needs, ranging from the Ocean Mail Contracts of the middle and late 19th century to the direct subsidy programs of recent decades. This chapter discusses major U.S. national security programs and operations administered by the Maritime Administration (MARAD) and the U.S. Coast Guard of the U.S. Department of Transportation.

MARITIME SECURITY PROGRAM

Created by the Maritime Security Act of 1996[1], the Maritime Security Program (MSP) is designed to maintain an active core of privately owned, U.S.-flagged, and U.S.-crewed dry-cargo vessels that meet national security requirements while maintaining a competitive U.S.-flag presence in international commerce. The program, which is administered by MARAD, also helps preserve a labor base of skilled American seafarers available to crew the U.S. government-owned strategic sealift fleet, as well as the U.S. commercial fleet, in both peacetime and war.

MARAD, in close cooperation with Transportation Command (USTRANSCOM) in the U.S. Department of Defense (DOD), has awarded MSP operating agreements

[1] Public Law 104-239.

to 10 U.S.-flag operators of 47 commercial vessels. Under the 10-year program, through FY 2005, up to $100 million annually can be provided to participants to partially offset the high costs associated with operating vessels under U.S. registry. Table 5-1 lists program participants and the numbers and types of vessels.

Through this program, the U.S. government ensures access to commercial maritime capital assets valued at more than $8.5 billion and the associated intermodal infrastructure needed to support overseas military deployment. MSP has also been instrumental in reflagging 15 modern foreign-flag vessels under U.S. registry.

Table 5-1
Maritime Security Program Participants

Participants	Vessels
American Ship Management, LLC	9 container ships
Central Gulf Lines, Inc.	3 roll on/roll off vessels
Crowley Maritime Corp.	3 container roll on/roll off vessels
Farrell Lines, Inc.	3 container ships
First American Bulk Carrier Corp.	2 container ships
First Ocean Bulk Carriers Corp., I, II, & III	3 container ships
Maersk Line, Ltd.	4 container ships
OSG Car Carriers, Inc.	1 roll on/roll off vessel
Sea-Land Service, Inc.	15 container ships
Waterman Steamship Corp.	4 LASH (barge-carrying ship)
Total	**47 vessels**

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Sealift Support, 1999.

The MSP replaced the Operating Differential Subsidy program (ODS), which expired for liner vessels on December 31, 1998. Under the ODS program, U.S. vessel operators were fully compensated on a reimbursable cost basis for additional expenses incurred while operating ships under the U.S. flag, as compared to those of foreign-flag competitors. However, because subsidies were limited to cost differentials, the ODS system provided little incentive to cut costs or upgrade the fleet.

Unlike the ODS program, MSP compensation is not paid on a cost-differential basis, but is similar to a retainer payment. As an incentive to improve efficiency and reduce costs, Congress established MSP funding levels at $2.1 million per year, per vessel. As of July 31, 1998, 9 out of 10 participating MSP operators, representing 45 vessels, were receiving MSP payments (USDOT MARAD OSS 1998). The remaining operator and two vessels will start operations under the MSP upon expiration of the last ODS liner contract in fiscal year (FY) 1999. MSP funding is subject to annual appropriations, and operating agreements are automatically renewable on a yearly basis, subject to sufficient appropriations, through FY 2005.

VOLUNTARY INTERMODAL SEALIFT AGREEMENT

The Voluntary Intermodal Sealift Agreement (VISA) is DOD's principal sealift readiness program. Authorized by the Secretary of Defense on January 30, 1997[2], VISA was jointly developed by USTRANSCOM and MARAD.

[2]Executive Order 12919.

Like the Maritime Security Program, VISA's principal function is to provide DOD with access to state-of-the-art U.S. commercial intermodal capacity to move ammunition and other cargo during contingencies while minimizing disruptions to commercial operations. By partnering with the U.S. commercial maritime industry, the U.S. government also ensures access to the global intermodal network, which includes management services, terminals and equipment, and communications and logistics systems, as well as a cadre of well-trained, professional seafarers and shore-side employees.

VISA is open to all U.S.-flag vessel operators who possess a qualified vessel but, as an inducement to join the program, DOD gives preference to VISA participants in awarding peacetime business. All vessel operators receiving MSP benefits are required to enroll their MSP vessels in VISA. The FY 1999 VISA fleet comprises 35 U.S.-flag commercial vessel-operating companies and 109 oceangoing commercial dry-cargo liner vessels, which together represent 80 percent of the U.S.-flag commercial dry-cargo fleet; 22 VISA/DOD Charter ships; 141 oceangoing tugs; 100 oceangoing barges; and 52 offshore supply vessels. About 70 percent of the vessels enrolled in VISA are leveraged by MSP commitments. Table 5-2 lists VISA participants.

Table 5-2
Voluntary Intermodal Sealift Agreement – Fiscal Year 1999 Participants

Alaska Cargo Transport, Inc.
American Auto Carriers, Inc.
American Automar, Inc.
American President Lines, Ltd.
American Ship Management, LLC*
Central Gulf Lines, Inc.*
Crowley American Transport, Inc.*
Crowley Maritime Services
Dixie Fuels II, Ltd.
Double Eagle Marine
Farrell Lines, Inc.*
First American Bulk Carrier Corp.*
Foss Maritime Co.
Lynden
Lykes Lines Ltd., L.L.C.
Maersk Line, Ltd.*
Matson Navigation Co., Inc.
Maybank Shipping Company, Inc.
McAllister Towing & Transportation
Moby Marine Corp.
NPR, Inc.
OSG Car Carriers, Inc.*
Osprey Shipholding Corp., L.L.C.
Resolve Towing & Salvage, Inc.
Sea-Land Service, Inc.
Seacor Marine International, Inc.
Sealift, Inc.
Smith Maritime
Totem Ocean Trailer Express, Inc.
Trailer Bridge, Inc.
Trico Marine Operators, Inc.
Troika International, Ltd.
Van Ommeren Shipping (USA), LLC
Waterman Steamship Corp.*
Weeks Marine, Inc.

* Denotes Maritime Security Program operators.

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Sealift Support, March 1999.

Activation of the VISA program during a deployment is time-phased in three stages. In Stages I and II, participating commercial operators can volunteer their capacity; but in Stage III, participants must commit at least 50 percent of their non-MSP vessel capacity and 100-percent of their MSP vessel capacity. This time-phased approach allows carriers to arrange to maintain their commercial schedules while meeting DOD's transportation requirements during contingencies.

The program's Joint Planning Advisory Group (chaired by USTRANSCOM and MARAD) and the maritime industry, identify and discuss DOD classified requirements and recommend operation concepts to meet those requirements. The

Advisory Group also tests program arrangements and ensures that pooling and teaming arrangements comply with antitrust requirements.

THE NATIONAL DEFENSE RESERVE FLEET

The Merchant Ship Sales Act of 1946 established, under MARAD, the National Defense Reserve Fleet (NDRF) to meet shipping requirements during national emergencies. Since the 1950s, the NDRF has been activated several times. For example, during the Korean War, 540 NDRF vessels supported military forces. A worldwide vessel tonnage shortfall from 1951 to 1953 required activation of over 600 NDRF ships to transport coal to Northern Europe and grain to India. From 1955 through 1964, 600 ships were used to store grain for the Department of Agriculture. Another tonnage shortfall, following the Suez Canal closing in 1956, resulted in activation of 223 cargo ships and 29 tankers. During the Berlin crisis of 1961, 18 vessels were activated and remained in service until 1970. In the Vietnam conflict, rather than requisition commercial vessels from trade, 172 vessels were activated to meet military requirements.

MARAD is responsible for maintaining vessels in the NDRF so they can be activated at a minimum cost. NDRF ships are placed in a preservation program designed to keep them in the same condition as when they entered the fleet. At its peak, the NDRF maintained 2,277 ships in lay-up. Currently, the NDRF consists of 258 vessels, primarily dry-cargo ships, with some tankers, military auxiliaries, and other types of vessels. However, 85 are no longer militarily useful and are slated for scrapping. In addition to the 258 NDRF vessels, another 51 ships are held for other government agencies on a reimbursable basis. Forty-one of these are naval vessels awaiting disposal. These vessels are maintained at Benicia (Suisun Bay), California; Beaumont (Neches River), Texas; and Fort Eustis (James River), Virginia and at designated outported berths.

MARAD

The Ready Reserve Force (RRF) is an important part of the National Defense Reserve Fleet, which was established to meet shipping requirements during national emergencies. Some ships in the RRF can be activated in as little as 4 days to support the deployment of U.S. Armed Forces.

Ready Reserve Force

The Ready Reserve Force (RRF) program was initiated in 1976 to support the rapid worldwide deployment of U.S. military forces. Known as the Ready Reserve Fleet until 1985, the RRF is the largest element of the strategic sealift triad and an important part of the NDRF. The RRF is specifically structured to transport U.S. Army and U.S. Marine Corps equipment and initial resupply to forces during the critical surge period of a military deployment before commercial ships can be marshaled. An August 26, 1997 Memorandum of Agreement between DOD and DOT governs the administration and operation of the RRF. Ships in the RRF may be activated to support the deployment of U.S. Armed Forces for military or civilian contingency operations, for testing purposes, or for other defense purposes when other sealift assets are unavailable.

The RRF contributed to the success of Operations Desert Shield, Desert Storm, and Desert Sortie from August 1990 through June 1992, when 79 vessels were activated and used to meet military sealift requirements. In 1993, the RRF placed eight ships in the U.S. Army's new pre-positioning program, and two tankers were kept with the Afloat Pre-positioning Force. Four of these pre-positioned RRF ships were needed in Somalia in 1993 for Operation Restore Hope along with one activated troopship, and seven were required in late 1994 for Operation Vigilant Warrior in the Persian Gulf. In September 1994, 14 ships were activated for Uphold Democracy Operations in Haiti. Starting in December 1995, five roll on/roll off (RO/RO) ships were used on four separate occasions to deliver military cargo from Northern Europe to the former Yugoslavia as part of North Atlantic Treaty Organization peace-keeping missions. In the aftermath of Hurricane Mitch, in November 1998, four RO/RO ships were activated to haul relief supplies to Central America (USDOT MARAD, DRF 1998).

As of March 1999, the RRF consisted of 91 ships: 29 breakbulk ships, 31 RO/RO vessels, 7 heavy-lift ships or barge-carrying ships, 10 auxiliary crane ships, 10 tankers, 2 aviation logistic support ships, and 2 troopships (USDOT MARAD, DRF 1998). DOD requirements determine the size of the fleet, which is expected to be reduced to 77 ships by FY 2002 as 14 older, less useful breakbulk vessels are removed from service.

MARAD maintains RRF ships in a specified 4-, 5-, 10-, 20-, or 30-day readiness status at a reserve fleet site or designated outport. The readiness status is the number of days expected to make a ship fully operational and ready for sea after activation notice. Ships in higher readiness (4- and 5-day) are outported at port facility lay berths and are provided with a Reduced Operating Status maintenance crew.

Twenty-two of the 91 RRF ships are homeported at the 3 reserve fleet sites, while the majority are berthed at potential U.S. loading ports. Lay berths are acquired from commercial sources as well as by negotiating for government-owned facilities suitable for the long-term berthing of RRF ships. Outporting avoids congestion at the fleet sites should activation occur; and outporting enhances arrival at probable loadout locations.

NATIONAL PORT READINESS NETWORK

The National Port Readiness Network (NPRN) was formed in 1985 to provide coordination and cooperation of commercial ports to ensure their readiness to support force deployment during contingencies and other defense emergencies. This coordination is vital to identify lift requirements, port capabilities, cargo staging areas, and potential commercial disruption impacts. Other NPRN initiatives include supporting local Port Readiness Committees, enhancing port readiness exercises, and updating publications.

Nine agencies participate in the NPRN. In addition to MARAD, current members include the U.S. Army Forces Command, U.S. Transportation Command, U.S. Army Military Traffic Management Command, U.S. Navy Military Sealift Command, U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Atlantic Command, and Commands of the Maritime Defense Zone (USDOT MARAD, NPRN 1997). MARAD is the permanent chair of the NPRN Steering Group and the NPRN Working Group. As chair, MARAD has the lead in developing new initiatives to ensure port readiness.

DOD evaluates its requirements and selects ports based on its assessments. Thirteen commercial ports have been selected for use during a deployment and each has been issued a port planning order, which is a nonbinding letter of intent that provides information on deployment. Planning orders are issued for a 1-year period in an effort to encourage communication among ports, terminal operators, and the military. NPRN conducts semiannual visits to selected ports to improve the deployment process (see NPRN website: http://www.marad.dot.gov/NPRN).

SUPPORT OF DEFENSE INTERMODAL TRANSPORTATION

Because of recent changes in national defense strategy and U.S. military downsizing, increased emphasis has been placed on the use of commercial equipment, such as containers and chassis, and the intermodal transportation system to assist in the deployment of forces during a national emergency. MARAD is required by law (46 CFR Part 340) to identify container and/or chassis suppliers that can provide DOD with the equipment needed to meet contingency requirements with minimum disruption to the commercial sector.

By using the commercial intermodal transportation system and suppliers, the military can derive the same benefits from containerization and intermodal transportation as does the commercial sector: lower costs, decreased transit times, and reduced damage rates. Recent DOD directives and publications reinforce the concepts of containerization and intermodalism. A Joint Chiefs of Staff publication entitled *Joint Tactics, Techniques and Procedures for Use of Intermodal Containers in Joint Operations* (USDOD USTRANSCOM 1997) states "Intermodal transportation that is flexible and fast is used by the Department of Defense to prepare, deploy, support, and sustain forces assigned or committed to a theater of operations or objective area." Other DOD directives specify minimum containerization requirements for certain military cargoes.


USCG

The scope of U.S. Coast Guard duties ranges from enforcing federal laws at sea to port security and defense to drug and alien migration interdictions. Often, rescuing undocumented aliens from open seas temporarily displaces other Coast Guard operations because of the immediate potential for loss of life.

U.S. COAST GUARD

A primary mission of the U.S. Coast Guard (USCG) is to enforce all federal laws at sea, which include stopping piracy, enforcing vessel safety regulations and fisheries conservation, apprehending foreign fishing vessels poaching in U.S. waters, arresting drunken boaters, and interdicting drug and migrant smugglers and boats carrying illegal migrants. The USCG also assists other law enforcement agencies, inspects U.S. ports and waterside facilities, and monitors foreign facilities used by U.S. citizens.

A major component of the USCG's mission is national defense. It performs a wide range of defense-related duties for the U.S. Navy, such as convoy escorts, search and rescue and salvage operations, surveillance and interdiction, boardings, and aids to navigation. Other defense-related activities include maritime interception operations, port security and defense, and Maritime Defense Zone (MDZ) operations.

In 1997, which is representative of a typical year of peacetime activity, the USCG devoted more than 3,000 resource (e.g., vessel or helicopter) hours to military operations and port security in the Coastal Zone,[3] primarily conducting military exercises, escorting military vessels, and enforcing security zones at military installations or support facilities. Operations conducted in station boats and patrol boats accounted for one-half and one-fourth of total resource hours, respectively. Both buoy tenders (primarily large ocean-going vessels) and aircraft (mostly helicopters)—accounted for about 300 resource hours each. Should a military operation occur (e.g., Operations Desert Shield and Desert Storm), the number of USCG resource hours dedicated to military operations and port security would increase significantly and result in prioritizing resources and workload to meet surge requirements. (USDOT USCG 1998).

Deployed Port Operations, Security, and Defense Mission

The Deployed Port Operations, Security, and Defense's (DPOSD's) mission is to ensure that port and harbor areas are free of hostile threats, terrorist actions, and

[3] The term "coastal zone" delineates an area of federal responsibility for response action. Precise boundaries are determined by agreements between the U.S. Coast Guard and the Environmental Protection Agency, and are identified in Federal Regional Contingency Plans and Area Contingency Plans.

safety deficiencies that would threaten defense support and resupply operations. DPOSD serves both political and military purposes, often following show-of-force demonstrations, and may be conducted either in preparation for a military action or, following such action, to restore order to a geographic area. DPOSD is conducted worldwide, as the need arises, and involves naval surface combatants, naval aviation, command and control platforms, and supporting forces of various services organized as Harbor Defense Commands of the Maritime Defense Zones. Teams and assets are normally deployed overseas in low- or medium-threat environments. The DPOSD mission is a resource-intensive operation that requires special training and continued, sustained presence within the area of operations and includes port safety and security, marine environmental protection, waterway management, and search and rescue.

Under a Memorandum of Understanding between DOD and DOT, the Coast Guard provides support to DOD operations in times of emergency. In recent years, USCG involvement in the DPOSD mission has ranged from providing Port Security Units to the Middle East to supplying a number of surface assets and aircraft to assist the U.S. Navy in providing a Harbor Defense Command in support of Operation Restore Democracy off the coast of Haiti.

The USCG expects to continue to play a role in DPOSD equal to or greater than its present role. Should the United States become involved in a regional conflict where cargo must be transported through a seaport, then the DPOSD mission may be implemented and the USCG may provide personnel, expertise, and assets in support of the National Military Strategy.

Defense Operations

Because defense operations are reactive in nature and dependent on the needs of the Area Commander-In-Chief (CINC), it is difficult to estimate future demand for USCG assistance. USCG involvement in defense operations depends on the threat posed to U.S. interests and the CINC's requests. For example, the USCG participates in Operation Southern Watch in the Persian Gulf by providing the area CINC with law enforcement detachments who participate in at-sea boardings and provide technical assistance in support of United Nations sanctions against Iraq. The USCG is likely to continue to play a role in this area at least equal to its present role.

Drug Interdiction Operations

The USCG is the lead agency for maritime and the colead agency for airborne counterdrug interdiction. The USCG also plays a vital role in the National Drug Control Strategy.

The USCG's counterdrug law enforcement program consist of four major activities:

- denying maritime drug smuggling routes,

Table 5-3
Multiagency Migrant Interdictions, Fiscal Year 1996 – June 18, 1999

Nationality	FY 1996	FY 1997	FY 1998	FY 1999 (as of 6/18/99)
Dominicans	6,273	1,200	1,097	345
Cubans	411	421	903	1,149
Haitians	2,295	288	1,369	991
PRC	61	240	212	718
Others	40	45	67	230
Total	**9,080**	**2,194**	**3,648**	**3,433**

SOURCE: U.S. Department of Transportation, U.S. Coast Guard, Office of Law Enforcement, *Migrant Year in Review FY 1998,* 1999.

- strengthening ties with source and transit zone nations to increase their law enforcement capabilities,
- supporting interagency operations, and
- promoting efforts to reduce drug and alcohol abuse in the maritime environment.

These activities form the basis for planning and executing operations, cooperative efforts, and regional engagement activities that support the counterdrug mission.

In FY 1998, the USCG seized (or assisted in seizing) 82,623 pounds of cocaine and 31,390 pounds of marijuana products. The wholesale value of these seizures is more than $3 billion (USDOT USCG 1999a).

Alien Migration Interdiction Operations

The USCG has the lead responsibility for enforcing U.S. immigration law and related international agreements at sea. Using patrols, the USCG deters would-be migrants from leaving their homelands or interdicts undocumented migrants at sea before they reach the United States. Interdiction of undocumented aliens is a labor- and resource-intensive operation, usually displacing the immediacy of other USCG missions because of the potential for catastrophic loss of life at sea.

In FY 1998, multiagency efforts led to the interdiction of 3,648 undocumented migrants. As shown in table 5-3, the total number of migrant interdictions dropped significantly due, in large part, to successful operations in the Mona Passage located between the Dominican Republic and Puerto Rico (USDOT USCG 1999b). In addition to the USCG Seventh District, located in Miami, other agencies involved in this effort include the U.S. Border Patrol, the U.S. Customs Service, the Puerto Rican Air National Guard, the Dominican Navy, and local law enforcement agencies.

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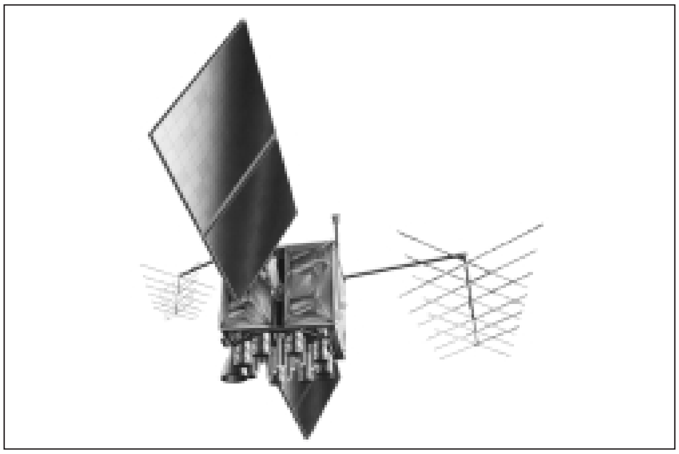
Navigational Technologies and Related Programs



USAF

Major technological advances have occurred in the 1990s in navigation, positioning, charting, and traffic management. Charting advances include the use of aerial photography to accurately annotate areas such as the National Shoreline and the use of electronic devices and software to replace paper charts. New traffic management systems rotate vessel traffic efficiently and safely through ports and other areas. Electronic navigation aids use satellites to provide real-time position information to mariners and improve safety of life and property. These and other technological advances also promote environmental protection.

This chapter discusses new developments in navigation, positioning, charting, and traffic-management systems. It also briefly describes ongoing related activities and programs, including the Smart Bridge project and the Vessel Optimization and Safety System.

NAVIGATION

Navigation is generally defined as safe movement from one point to another. Navigation aids are the road signs of waterways, providing location and safe passage for vessels. Two navigation systems mark waterways in the United States:

- The Uniform State Waterways System, which is used on inland waterways not navigable to the sea and is not discussed in this report; and

- The International Association of Lighthouse Authorities system, of which the U.S. component is known as the Aids to Navigation (AtoN) program. AtoN applies to all navigable waters of the United States and connecting waters under Federal jurisdiction. In this system, the shape, color, number, and light characteristics of buoys indicate the navigable channel by their position.

The U.S. Coast Guard (USCG) maintains the AtoN to promote the safety of marine transportation and commerce on the navigable waters of the United States. Thousands of these aids assist mariners and are classified as either radionavigation or short-range aids.

Radionavigation Aids

The Radionavigation Aids Program, which manages and operates federal maritime radio aids, provides continuous, all-weather navigation capability. Signatory nations to the Safety of Lives at Sea Convention are required to establish, maintain, and provide information on navigation aids, including electronic aids, as the degree of risk requires.

A variety of electronic aids, ranging from direction-indicating beacons to satellites, have been used in radionavigation. Navigation aids can be grouped into two categories: short-range and long-range.

Short-Range Navigation

Short-Range Navigation aids include lighthouses, buoys, daymarkers, foghorns, and fog signals that help mariners determine their position and indicate maritime hazards such as shallows and wrecks. As shown in table 6-1, the USCG maintains about 50,000 short-range AtoNs, and a similar number are maintained by private concerns (USDOT USCG n.d.).

Under Title 33 of the U.S. Code, Part 66, subpart 66.01, privately owned and maintained AtoNs are USCG approved and include the following:

- Class I private aids to navigation, which by law must be placed on marine structures or other works. Owners of sunken vessels or other obstructions are also required to mark them with a Class I aid and maintain a lantern at night.
- Class II aids to navigation are located in waters used by general navigation to mark objects such as fishing reefs and race courses.
- Class III aids to navigation are located in waters not ordinarily used by general navigation and include aids that mark approaches to terminals or marinas. Private aids to navigation are buoys, lights, or day beacons owned and maintained by any individual or organization other than the U.S. Coast Guard. These aids are used to mark privately owned marine structures or potential hazards to aid private operations. However, the placement at mooring buoys in federal navigable waters is handled by the USACE.

Table 6-1
Number of Federal, State and Local/Private Navigation Aids

Navigation aids	1994	1995	1996	1997	1998
Lights[1]	12,215	12,244	12,305	12,384	12,397
Buoys[2]	26,689	25,959	25,908	25,807	25,692
Sound signals[3]	1,589	1,512	1,524	1,498	1,484
RAdar beaCONS[4]	86	102	113	122	124
Day beacons[5]	11,182	10,810	10,884	10,484	10,514
Other federal aids	922	922	923	933	922
Total federal aids	51,008	49,935	50,020	49,608	49,525
	49,810	50,022	48,563	48,587	48,639
TOTAL aids	**100,818**	**99,957**	**98,583**	**98,195**	**98,164**

[1] Range from simple poles with lights attached to elaborate, multistructure, and often historic lighthouses.
[2] Floating aids.
[3] Audible signals attached to buoys, etc.
[4] Racon.
[5] Aids to navigation without lights.

SOURCE: U.S. Department of Transportation, U.S. Coast Guard.

Long-Range Navigation

Loran, or long-range navigation, relies on a grid of low-frequency radio waves transmitted from ground-based stations located around the world, providing position accuracy within one-quarter mile for both civil and military air, land, and marine users (USDOT USCG NMC 1997). Loran A, the first Loran system, was built during World War II. Because greater accuracy was needed, Loran C was developed to replace Loran A. In the 1960s, Loran C was deployed worldwide to support U.S. Department of Defense (DOD) navigation of the Northern Hemisphere. In 1974, it became the government-provided radionavigation system for the coastal and continental United States. Loran is used on commercial and government vessels and some large privately owned vessels.

POSITIONING

Global Positioning Systems

Highly accurate and affordable, global positioning systems (GPSs) make real-time position information available worldwide. Just as early navigators needed charts and astronomical almanacs to derive their position using a sextant and chronometer, GPS and other modern systems operate in concert with high-precision digital maps.

Many GPS applications involve position determination equipment on vessels that communicate (often via satellite link) to a central computer for fleet or traffic management functions. The private sector and the U.S. government, for example, use tracking technology to monitor shipments, particularly containers, and to maintain contact with personnel.

Various Global Positioning Systems offer different levels of precision (USDOC TA OASC 1996). The Precision Positioning System is the most accurate, but is restricted to military use and is protected by encryption. The Standard Positioning System is accurate within 100 meters and is available worldwide to civilian users without charge.

Differential Global Positioning System

The Differential Global Positioning System (DGPS) was developed by the U.S. Coast Guard and provides coastal coverage of the continental United States, the Great Lakes, Puerto Rico, portions of Alaska and Hawaii, and portions of the Mississippi River Basin. DGPS enables ships with special receivers to pinpoint their positions to an accuracy of 5 to 10 meters, compared with 100 meters for standard positioning systems (USDOT USCG 1996a). This is a critical advance, especially for large-ship navigation, as some channels are less than 100 meters wide (see figure 6-1).

On March 15, 1999, the DGPS became fully operational. By incorporating surplus Defense Department facilities, DGPS is broadening its operational areas to include large portions of inland America. This expanded application is known as the National Differential Global Positioning System (NDGPS) and is broadening its application to include crash avoidance for trains and motor vehicles to airborne crop spraying to improving cartographic surveying.

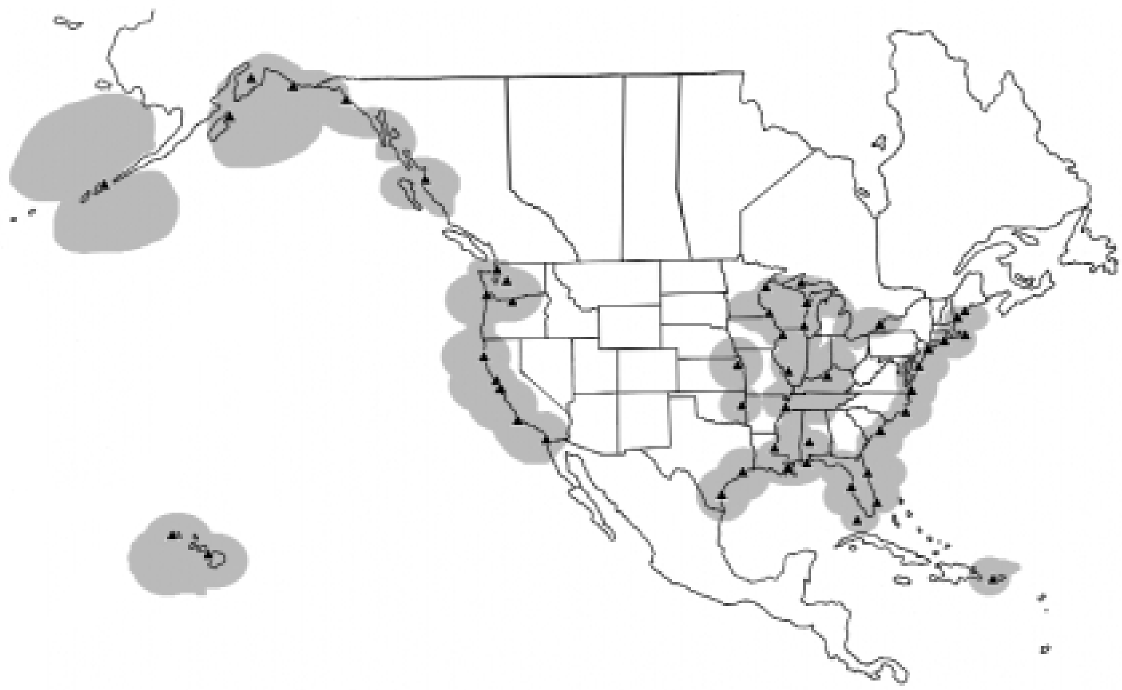
The President's Commission on Critical Infrastructure Protection recognized GPS as part of the U.S. critical infrastructure (PCCIP 1997). However, there is concern about the reliability of GPS and the need to retain backup systems, such as Loran-C. Back-ups would alleviate vulnerability to GPS or DGPS system failures due to Y2K problems or unintentional interference (Peterson and Spalding 1998).

Charting

The National Oceanic and Atmospheric Agency (NOAA), in the U.S. Department of Commerce, surveys the U.S. coastal regions and navigable shoreline water areas and produces the official delineation of the National Shoreline. NOAA's Office of Coast Survey (OCS) produces nautical charts and navigational publications, such as *Coast Pilots,* for use by DOD and transportation-related organizations and industries in the United States. Federal law requires all ships in excess of 1,600 gross tons to have and use current editions of OCS navigation products (USDOC NOAA OCS1998).

Over the next 5 to 10 years, NOAA's Remote Sensing Division of the National Geodetic Survey intends to resurvey critical areas of the National Shoreline. The method used today to plot the shoreline is analytical stereo photogrammetry using tide-coordinated aerial photography controlled by GPS techniques.

Figure 6-2
DGPS Coverage



In the Differential Global Positioning System (DGPS), land-based reference stations determine the exact location of all GPS satellites within view and broadcast that data for users on land, at sea, or in the air. With this corrected data, the user can precisely determine his or her position within a few meters.

SOURCE: U.S. Department of Transportation, U.S. Coast Guard.

As use of electronic charts has increased, so too has international interest in the International Maritime Organization establishing or recommending electronic system performance standards.

Docking Charts

Very large-scale (1:1,000) docking charts are used to aid pilots and ship masters in maneuvering vessels alongside a pier or dock. When docking very large ships, the person maneuvering the vessel may have difficulty seeing the entire dock. Using an electronic chart system linked to a DGPS and the overall dimensions of the ship, an accurate docking chart or representation of the dock can be drawn as the ship comes alongside (USDOT USCG NMC 1996b).

NOAA has explored opportunities with private producers of electronic chart systems and with port facility managers to develop techniques and standards that will facilitate creating docking charts for ports within the San Francisco Bay region (USDOT USCG 1996b).

Electronic Charts

Electronic chart systems can help navigators avoid collisions and groundings by relieving them of distracting work and allowing them to focus on navigation safety. One chart system, the Electronic Chart Display and Information System (ECDIS), displays data from multiple sources using the DGPS, thus providing the mariner with real-time position information. With additional data inputs, the ECDIS can also superimpose radar images, real-time tide and current data, vessel traffic information, and marine weather forecasts.

While ECDIS has great promise for the future, it is currently limited by the quality and quantity of available data. Approximately 60 percent of bottom soundings are based on data collected with a lead line or primitive echo sounders, and real time tide, current, weather, and Vessel Traffic Service (VTS) data (see discussion below) are limited to a few geographical regions or are still in development. Some mariners have noted that condensing all of this critical information into one or two small electronic screens can clutter the information and make it more difficult to understand. Mariners and manufacturers are working together to increase the usability and level of safety provided by the ECDIS system.

TRAFFIC MANAGEMENT

Vessel Traffic Service

The Vessel Traffic Service (VTS) promotes the safe and orderly flow of traffic in and out of a port or waterway. The USCG operates the VTS in nine major U.S. ports[1] and has shared responsibilities with the state of California at the Port of Los Angeles/Long Beach since passage of the Ports and Waterways Safety Act of 1972.[2]

VTS increases the quality and timeliness of information the mariner needs for safely navigating a vessel. The location and intentions of other vessels, navigation discrepancies, hazards to navigation, weather reports, and other navigation information are passed to vessels choosing to participate in the service. VTS also alerts participants to potential danger, such as a vessel obstructing a channel, and recommends or advises a course of action to avoid conflicts. In most cases, the operator or "master" will voluntarily act on the VTS recommendation. Ninety-nine percent of all communications between the VTS and a ship's operator involve information exchange or advisories (USDOT USCG OVTM 1998).

[1] VTS locations include: Prince William Sound (Valdez), Alaska; San Francisco, California; Berwick Bay (Morgan City) and New Orleans, Louisiana; Sault Ste. Marie, Michigan; New Jersey; New York; Houston/Galveston, Texas; Puget Sound (Seattle), Washington; and a seasonal high water VTS in Louisville, Kentucky. The Port of Los Angeles/Long Beach, California, has a Vessel Traffic Information Service (VTIS) that is jointly operated by the U.S. Coast Guard, Marine Exchange, and the state of California.

[2] 92 Stat:1471; 33 U.S.C. 1221-1232; 33 CFR 126 and 160-167.

In rare cases, when information is ignored and a vessel proceeds in an unsafe manner, the VTS may intervene by issuing a "direction" either under the authority of the Captain of the Port (see box 6-1) or under VTS regulations, where implemented. Failure to follow the direction of the VTS would subject the ship's master to the possibility of administrative hearings and civil or criminal penalties. Examples of VTS directions include:

1. directing a vessel not to proceed beyond a specific point until another vessel has passed,
2. directing a vessel to pass astern of another vessel,
3. directing a vessel to slow down in reduced visibility, or
4. directing a vessel not to enter a channel in the VTS area until the area is clear.

During the summer of 1997, the USCG recorded 83 incidents in which the VTS intervened in potentially unsafe situations (USDOT USCG OVTM 1998). Under USCG policy, the vessel master is ultimately responsible for safe navigation. Thus, the operator ultimately chooses how to proceed in an emergency situation. In the event of a collision or grounding, a court of law or an administrative hearing determines whether the master properly used the information or advice provided by the VTS or properly followed its direction, if given.

Each VTS includes a Vessel Traffic Center staffed by experienced USCG personnel. Through the Vessel Movement Reporting System and by monitoring other very high frequencies (VHFs) in the area, the VTS can inform a vessel about nearby ships. Radar, closed circuit television, radiotelephone, or a combination of these devices provides surveillance of critical areas. Over 130 VTSs are now in operation, with many more in the planning stages (USDOT USCG OVTM 1998).

Automated Identification System

The Automated Identification System (AIS) is a shipboard broadcast transponder system, operating in the VHF maritime band, that is capable of sending identification, position, heading, ship length, beam, type, draught, and hazardous cargo information to ships and to shore. Designed to reduce the number of vessel accidents in ports and busy waterways by providing ships with up-to-the-minute data on traffic conditions on the water, it is capable of handling over 2,000 reports per minute and updates as often as every two seconds (USDOT USCG AIS n.d.).

The AIS transponder normally works in an autonomous and continuous mode, regardless of whether it is operating in the open seas or coastal or inland areas. Although only one radio channel is necessary, each station operates over two radio channels to avoid interference problems and to allow channels to be shifted without communications loss from other ships.

Box 6-1
Captain of the Port

The Captain of the Port (COTP) administers and enforces the Port Evaluation and Security, Marine Environmental Response and Waterways Management Programs within the boundaries of the "COTP zone" (defined as a port area and surrounding waters). The COTP is designated by the U.S. Coast Guard (USCG) Commandant and answers to the district commander.

The COTP's unit is loosely referred to as a "captain of the port." If the unit duties include vessel safety elements, the unit is referred to as a "marine safety office." When the Commandant has not designated a COTP, the district commander serves in that position. The COTP is responsible for:

1. supervision and control of vessel movements, moorings and anchorages within the zone;
2. monitoring transfer of bulk liquid cargoes;
3. enforcement of the regulations concerning port security, port and waterways safety, tank vessel operations, shipment of military explosives, bulk solid cargoes, and packaged hazardous materals;
4. periodic examination of foreign vessels of novel design or construction or the operation of which involves potential unusual risks in U.S. waters;
5. ensure compliance with load-line regulations for vessels making foreign and domestic voyages;
6. enforcement of all marine pollution prevention laws and regulations and immediate response to discharges of oil, refuse, and hazardous substances into the navigable waters or environment of the United States;
7. surveillance and enforcement of ocean dumping and incineration operations;
8. issuance, suspension or termination of general permits to handle dangerous cargoes at a particular waterfront facility, as warranted;
9. promotion of the Automated Mutual Assistance Vessel Rescue (AMVER) system among members of the maritime industry and fostering of the AMVER Educational Program;
10. issuance of COTP Orders and establishment of safety and security zones, when necessary to prevent accidental or intentional damage to any vessel, waterfront facility, or structure, or when otherwise appropriate; and
11. ensuring the general safety and security of ports and waterways, including General Coast Guard law enforcement activities within the COTP zone.

The USCG is supporting international efforts to complete Universal Shipborne AIS standards and institute carriage requirements for ships nationally and internationally as early as July 2002 (USDOT USCG AIS n.d.). Display information previously available only to modern vessel traffic service operations centers would be available to every AIS-equipped ship.

Physical Oceanographic Real-Time Systems

In the San Francisco Bay area, a partnership among NOAA's National Ocean Service, the San Francisco Bay Conservation and Development Commission, the USCG, maritime interests, and other state and federal agencies has worked to introduce safety technologies, such as Physical Oceanographic Real-Time Systems (PORTS).

Mariners consider the Bay's Golden Gate and its approaches to be among the world's most challenging waters to navigate. Confined maneuvering space, submerged rocks, fog, and strong currents increase the risk of accidents. In the shallower parts of the Bay's shipping channels, some large vessels have less than a foot of clearance. PORTS provides pilots and masters with actual measured currents and water levels that help them plan and execute safe transits. For example, knowledge of real-time currents gives the right-of-way to the vessel with the least maneuverability, thus reducing the likelihood of collisions. Similarly, real-time knowledge of tides and tidal forecasts allows deep-draft ships to adjust loads and transit times to prevent groundings.

PORTS provides real-time data gathered from instruments placed throughout the harbor and its approaches. Measurements of currents at various depths, water levels, winds, water temperature, and density are automatically relayed to a central receiving station. Ship masters and pilots can access this information from the U.S. Coast Guard's VTS, by telephone, personal computer with a modem, the Internet, and NOAA's radio broadcast.

Electronic Piloting

Ten regional ship pilot's organizations around the country are evaluating an electronic aid called the Portable Pilot Unit (PPU). The goal of the evaluation, which is sponsored by the American Pilots Association's Navigation Technical Committee and funded by the Maritime Administration (MARAD), is to examine the utility of portable technology in assisting ship-piloting efforts. A PPU combines three systems, the DGPS, an electronic chart system (ECS), and automated dependent surveillance (ADS) into a single portable unit. Through a DGPS receiver, highly accurate position data can be input to the ECS, thus enabling precise own-ship navigation. The radio transceiver then sends the ship's identity, position, course, and speed to a central site that plots the ship's position. This process is called automated surveillance and is dependent on the ship for position input.

More ships are now carrying ECDIS and ADS systems, and carriage requirements will inevitably make them mandatory. Pilots would prefer to carry their own PPUs aboard for reasons of familiarity, reliability, and ease of use, just as most pilots carry aboard their own portable radios. The PPU can also serve as a repository, ready reference, and visual representation for the vast store of knowledge a pilot maintains. The unit also must be small enough so that the pilot's safety is not jeopardized while boarding. Equipment from several manufacturers is being tested by the pilot organizations. The goal is not to declare a single PPU the best, but to examine the maturity of the component technologies and then work with vendors to design several practical units (USDOT USCG 1996b).

Integrated Bridge Systems

In light of the variety of navigation, tracking, and positioning systems available to the maritime industry, there is a need to consolidate processes into easily accessible units. The concept is to house the radar, charting, GPS, and other steering related activity in a compact workstation, known as an integrated bridge system (IBS). This technology can be the safe and efficient way to operate several different systems, similar to a LAN (local area network) environment. The information and telecommunications system is complex and interdependent. Tremendous development has occurred in each area. Government and the Maritime Industry acknowledge the need for smooth interface and standardization technology.

RELATED ACTIVITIES

Under the Clinton administration's shipbuilding revitalization plan, the Maritime Administration's Office of Shipyard Revitalization, the National Maritime Resource and Education Center, and DOD are collaborating in funding research and development (R&D) under MARITECH, an industry-led and industry-driven program of applied research with costs shared between industry and government. MARITECH R&D focuses on projects that could help revitalize U.S. shipbuilding, ship repair, and marine supplies. An example of a MARITECH project is SmartBridge—an effort that involves developing and demonstrating an affordable and reliable bridge system that accommodates upgraded and new sensors (radar, infrared, and electro-optical), a navigation display fully suited to ECDIS, an integrated sensor display, and an automated advisory/decision aid for piloting and navigation. Open architecture database structures, LAN technology, and communications protocols will be included to support system functionality and additional growth (USDOT MARAD 1998).

Vessel Optimization and Safety System

MARITECH initiated the Vessel Optimization and Safety System (VOSS) project to integrate all shipboard navigation, passage planning, and real-time monitoring subsystems into a single system that monitors a ship's operating status. VOSS should decrease voyage costs and reduce the risk of vessel and cargo damage and loss.

VOSS Vessel Performance Analysis routines are now in use at American President Lines, Ltd., American Ship Management, Matson Navigation Co., and Chevron Shipping Co. The U.S. Navy Space and Naval Warfare Systems Command has assigned the VOSS Project the task of developing a prototype Smart Center Ship Routing Program (SSRP). The SSRP is a direct outgrowth of the VOSS Voyage Route Planning System (USDOT MARAD 1998).

Cargo-Handling Cooperative Programs

Since 1983, MARAD has sponsored the Cargo-Handling Cooperative Program (CHCP), a public-private partnership designed to foster cargo-handling research and technology development among U.S.-flagged ocean carriers. The organization also formulates standards such as requirements and alternatives for automatic equipment identification. For example, CHCP members collaborated with the technical committees and working groups of the American National Standard Institute (ANSI) and the International Standardization Organization to establish the international standard for automatic identification of freight containers.

While progress is slow in standardizing systems throughout the world, it is anticipated that by 2025 much of the world will be using the same systems to identify intermodal equipment — mostly containers. One example of this trend is the adoption of the ISO/ANSI standard for automatic equipment identification by the International Air Transport Association, EURORAIL, the Association of American Railroads, the American Trucking Associations, and some international ocean carriers.

Ship Operations Cooperative Program

The purpose of the Ship Operations Cooperative Program (SOCP) is to address and promote commercially beneficial innovations in ship operations through the identification, development, and application of new methods, procedures, and technologies. SOCP's overall objective is to improve the competitiveness, productivity, efficiency, safety, and environmental responsiveness of U.S. vessel operations. All U.S.-based vessel operators and organizations that support vessel operations are eligible to participate in the program. With the support of MARAD, the public and private sectors are working together to address common challenges and identify solutions for improving ship operations (USDOT MARAD 1999). This cooperative program allows members to participate in research that would not be economically feasible on an individual basis, or possibly within a single area of industry.

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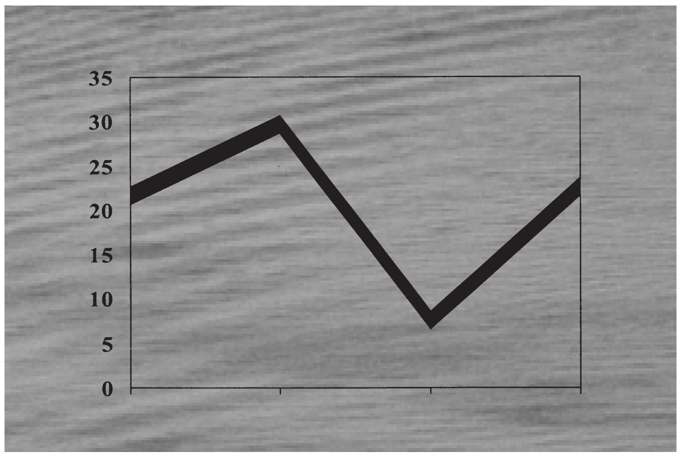
Maritime Data Issues



Sound analysis requires sound data. Several data gaps and uncertainties exist in the data needed to analyze trends affecting water transportation. This chapter discusses some of the limitations of available data.

FLOW DATA

World Trade

There are several sources of world seaborne trade data estimates. These estimates can differ by as much as 20 percent, due largely to differences in coverage (e.g., cargo types and regions) (see table 7-1). Although absolute trade volumes differ, the respective trends are similar. Nevertheless, there is a need for consistent world seaborne trade-volume estimates. These estimates should also be broken down to basic cargo and inter/intra regional flows that yield meaningful estimates such as demand, measured in ton-miles for deep sea transportation services.

Ton-Miles

Ton-miles are widely used as a measure of the demand for freight transportation services, and global estimates of water transportation ton-miles exist (see table 7-2). However, the data needed to calculate ton-miles associated with U.S.-foreign

Table 7-1
World Sea Trade Estimates
(Million metric tons)

Source	1993	1994	1995	1996	1997
Fearnley	4,339	4,506	4,687	4,859	5,074
Clarkson	4,566	4,724	4,922	5,076	5,299
DRI/McGraw-Hill	3,586	3,810	4,122	4,273	4,423

SOURCE: A. Fearnley, ed., *Fearnley's Review, 1998* (Oslo: Fearnresearch, February 1999). Clarkson Research Studies, C. Tyler, ed., *Shipping Review and Outlook, Autumn 1998* (London: November 1998). DRI/McGraw-Hill, *World Sea Trade Service, Third Quarter 1998,* computer file (Lexington, MA: November 1998).

Table 7-2
World Waterborne Trade, 1993-97, Metric Tons, Ton-Miles, and Average Haul (Miles)

Cargo	1993	1994	1995	1996	1997
Crude petroleum					
Million metric tons	1,356	1,403	1,415	1,466	1,525
Billion metric ton-miles	7,251	7,330	7,224	7,363	7,550
Average haul-miles	5,327	5,224	5,015	5,022	4,951
All other					
Million metric tons	2,983	3,103	3,272	3,393	3,549
Billion metric ton-miles	11,603	12,131	12,963	13,315	13,863
Average haul-miles	3,890	3,909	3,962	3,942	3,906
Totals					
Million metric tons	4,339	4,506	4,687	4,859	5,074
Billion metric ton-miles	18,854	19,461	20,187	20,678	21,413
Average haul-miles	4,345	4,319	4,307	4,256	4,220

SOURCE: A. Fearnley, ed., *Fearnley's Review, 1997* (Oslo: Fearnresearch, February 1998).

cargo flows generally have not been collected.[1] Hence, in chapter one, ton-mile estimates for U.S.-foreign trade in table 1-8 were developed specifically for this publication by the U.S. Department of Transportation's Maritime Administration (MARAD). The importance of sound ton-mile estimates is clear; from table 1-8 it can be inferred that U.S. demand for water transportation services in foreign trade, as measured in ton-miles, is higher than might be expected given the U.S. share of world trade (measured in metric tons). This is because, relative to most other trading nations, trade involving the United States involves comparatively few short-distance shipments.

In late 1998, responsibility for production of U.S.-foreign waterborne transportation statistics was transferred from the U.S. Commerce Department's Bureau of the Census to the U.S. Army Corps of Engineers (USACE) and MARAD. A priority will be to develop foreign ton-mile information, which will obviate the need for estimates. Expectations are that these ton-mile data will be available from the regular production datasets, possibly as early as the year 2000. With additional resources, suitable methodologies could be developed to refine the initial MARAD estimates reflected in table 1-8.

Service v. Vessel Type

U.S.-foreign cargo movement data have traditionally been presented in terms of the type of service offered—liner, tanker, and tramp (i.e., nonliner) service. Each service includes multiple vessel types. For example, vessels in liner service include con-

[1] While the U.S. Army Corps of Engineers (USACE) estimates ton-miles of U.S. waterborne domestic cargo movement, its reporting of foreign trade related ton-miles only covers the movement of imports, exports, and in-transit cargo on U.S. waterways and across the Great Lakes.

tainerships, roll on/roll off ships (RO/RO), partial containerships, and general cargo ships. But, these types of vessels also can operate in nonliner services. Analysts generally assume that bulk commodity groups, such as grain, coal, and ore, are shipped on bulk vessels in nonliner service. However, these commodities are also carried on nonbulk vessels in nonliner service. Commodity subgroups, such as bagged grain, may be shipped in small quantities in liner service.

Useful knowledge could be gained by arraying data on commodity movements by ship type, or by associating port throughput with vessel type and size. Data presented by vessel type could be used to identify vessel-use trends (e.g., the use of controlled-atmosphere containers on containerships to transport perishable commodities and the shipment of automobiles in containers) as well as size, type, and age profiles of vessels serving U.S. ports. Efforts are underway to change data structures to enable publication of trade flows by vessel type.

Tracking Domestic Transportation of U.S. Foreign Trade

Geographic representation varies among water transportation datasets because of the proliferation of coding structures and a lack of standard definitions. For example, official U.S. waterborne transportation statistics use one code (Schedule D) for domestic ports (4-digit) and another code (Schedule K) for foreign ports (5-digit). The first three digits of the Schedule K foreign port code identify the country. There is a separate 4-digit country code (Schedule C) to indicate the origin or destination of the cargo.

Comparison and reconciliation of data between countries is complicated by a lack of consistency between codes and definitions. Transportation detail may be lost when the coding structure reflects consolidation by political jurisdiction rather than physical locations of origins or destinations. For example, Mexican imports reported as coming from New Orleans may have been shipped from Destrehan or St. Rose, Louisiana. Or, a shipper may indicate Los Angeles or San Francisco, California, as the discharge port on trade documents when, in fact, the containers are to be discharged at Long Beach or Oakland, California. Standardized definitions would help facilitate useful interchange of data among nations. At the very least, uniformity among codes is needed. For example, adoption of the United Nations Location Code would resolve many of the issues related to the use of multiple port and country codes. However, care must be taken to provide concordance among codes for the benefit of those data users who are unable to adopt new coding schemes. Geocoding of data also offers considerable promise.

Trade documents, such as an export declaration or import entry, are not completely reliable sources of transportation data. The vessel specified in the import trade document may not come to the United States. Moreover, a load port specified in an import document may not be used by the vessel actually bringing the cargo to the United States. As for exports, cargo may be relayed to another vessel or transferred to another carrier at a different location than that listed in the trade document as the port of discharge.

Finally, a major data gap exists regarding accurate inland origin and destination data—information that is critical for intermodal analysis and identification of the domestic transportation implications of international trade. The 1993 and 1997 Commodity Flow Surveys, conducted by the Bureau of the Census and the U.S. Department of Transportation's Bureau of Transportation Statistics, have provided considerable information on domestic movements of exports from certain types of establishments. However, because the surveys focus on domestic shippers, imports are not well covered. Additional resources are needed to close this significant data gap.

VESSEL INVENTORY DATA

Vessel Categories

Although Panamax, Suezmax, and Handymax are commonly used terms for grouping vessels, it is not clear what size vessels to include in each group. In addition, data previously reported under one category may not be valid today. Consequently, for statistical presentations, precise tonnage categories are preferred.

Similarly, data presentations frequently abbreviate the number of vessel-type categories. But this practice raises coverage issues: Is container shipping adequately represented by a category that includes only full containerships without RO/ROs, partial containerships, or container/bulk vessels? Should combination oil carriers be included with tankers or dry-bulk vessels or kept in the "all other" category?

Vessel Operating Status

Data suppliers use a wide range of status codes to indicate whether a vessel is operating, laid-up, under repair, on order, etc. There is a lack of consensus as to how to measure surplus vessel capacity, partly because there are no standards as to what constitutes "idle" and "laid-up." One data supplier defines surplus capacity as vessels that are laid up or idle (casualty, under repair, or in use for storage), and the estimates do not include vessels that are repositioning, slow steaming, or waiting for charters. Another data supplier estimates surplus capacity by subtracting demand deadweight tons (dwt) from fleet dwt without consideration of inevitable logistical hindrances such as weather, port delays, and cleaning. Consequently, there is a need to rationalize approaches to surplus capacity calculations to improve supply estimates.

Database Consistency

With respect to fleet size, the U.S. government has maintained various databases for different purposes. MARAD has traditionally maintained U.S. fleet data for self-propelled oceangoing merchant vessels larger than 1,000 gross tons (gt). A sepa-

Box 7-1.
Proposed U.S. Fleet Framework

The U.S. water transportation market is complex. It includes global, U.S.-foreign, and domestic segments; self-propelled and nonself-propelled vessels; a large number of vessels smaller than 1,000 gross tons; and Jones Act eligible domestic vessels that operate in foreign trade. In the domestic tanker segment, oceangoing barges compete with tankers over certain distances. There are container and roll on/roll off barges that compete with containerships in noncontiguous domestic trades. A largely untapped potential exists for coastwise container services, either barge or containership, that might compete with trucking and perhaps help ease highway congestion. Highly efficient bulk carriers operating on the Great Lakes carry significantly more cargo than their predecessors. New generations of fast ferries may offer attractive alternatives to traditional ferries and/or overland services.

As evidenced in this limited discussion of data issues, underlying issues exist about data quality and consistency and about the portrayal of the U.S. fleet. Table 7-3 provides a framework for presenting U.S. fleet statistics, using Maritime Administration (MARAD), U.S. Army Corps of Engineers (USACE), and U.S. Coast Guard (USCG) databases to reflect both vessel types and usage. The numbers are subject to revision following further work on vessel type classifications and database reconciliation work between USACE and the USCG. The USACE, for example, has recently made proposals to the International Maritime Statistics Forum (which created the International Classification of Ships by Type) for certain revisions to that classification.

This framework has several key elements that improve on prior U.S. fleet statistics. By combining type, size, propulsion, and area of deployment, this framework shows the diversity of the U.S. fleet and the interaction among its segments. By including size in the foreign trade section and a separate line for the Great Lakes, existing time series data can be preserved. Only active vessels are reflected in the presentation (although this requires a standardized definition of an "active vessel").

The table shows principal vessel-type categories; improvement and standardization of type classifications will ultimately lead to higher levels of detail. It is also expected that, as this work continues, additional areas of deployment will be presented. For example, passenger vessels, tugboats and other workboats now need to be shown separately as inventory data (table 7-4). Orderbook data can be incorporated into the presentation when the issues associated with that dataset have been resolved.

It is MARAD's intention to publish the U.S. fleet statistics provisionally in the new framework and to establish a dialog on the approach to maximize the presentation and utility of high-quality, consistent data.

rate dataset has been maintained for self-propelled Great Lakes vessels. The U.S. Coast Guard (USCG) database includes self-propelled and nonself-propelled vessels, but does not include undocumented barges, which are covered in the USACE's database. The USCG may be capturing certain vessels from its licensing data that the USACE may be missing from the operations side. Fortunately, the USACE and the USCG are undertaking a cooperative effort to reconcile their databases. Box 7-1 proposes a framework for characterizing the U.S. fleet.

Vessel Ownership

Ownership data present another set of data issues. Traditional registry flag data becomes less meaningful as more fleets are placed in open registries. Even historically strong flag states, such as Japan, have placed significant tonnage into open registries.

Table 7-3
Cargo-Carrying U.S.-Flag Fleet by Area of Operation as of January 1, 1999

	Liquid carriers		Dry-bulk carriers		Containerships		Other freighters[a]		Total fleet	
Area of operation	**Number**	**Tons**	**Number**	**Tons**	**Number**	**Tons**	**Number**	**Tons**	**Number**	**Tons**
Foreign trade	**75**	**2,835**	**235**	**1,083**	**36**	**1,359**	**43**	**1,033**	**389**	**6,310**
Self-propelled	**37**	**2,602**	**10**	**476**	**36**	**1,359**	**43**	**1,033**	**126**	**5,470**
< 1,000 gross tons	0	0	0	0	0	0	0	0	0	0
≥ 1,000 gross tons	37	2,602	10	476	36	1,359	43	1,033	126	5,470
Nonself-propelled	**38**	**233**	**225**	**607**	**0**	**0**	**0**	**0**	**263**	**840**
< 1,000 gross tons	5	3	76	48	0	0	0	0	81	51
≥ 1,000 gross tons	33	230	149	559	0	0	0	0	182	789
Domestic trade										
Coastal	**558**	**9,106**	**494**	**1,497**	**71**	**1,818**	**1,503**	**1,877**	**2,626**	**14,298**
Self-propelled	**94**	**5,308**	**1**	**33**	**51**	**1,659**	**162**	**196**	**308**	**7,196**
< 1,000 gross tons	17	6	0	0	0	0	153	74	170	80
≥ 1,000 gross tons	77	5,302	1	33	51	1,659	9	122	138	7,116
Nonself-propelled	**464**	**3,798**	**493**	**1,464**	**20**	**159**	**1,341**	**1,681**	**2,318**	**7,102**
< 1,000 gross tons	95	131	341	532	0	0	1,212	840	1,648	1,503
≥ 1,000 gross tons	369	3,667	152	932	20	159	129	841	670	5,599
Internal waterways	**2,790**	**7,125**	**20,689**	**36,484**	**1**	**1**	**2,823**	**2,895**	**26,303**	**46,505**
Self-propelled	**3**	**22**	**0**	**0**	**1**	**1**	**609**	**162**	**613**	**185**
< 1,000 gross tons	0	0	0	0	1	1	608	160	609	161
≥ 1,000 gross tons	3	22	0	0	0	0	1	2	4	24
Nonself-propelled	**2,787**	**7,103**	**20,689**	**36,484**	**0**	**0**	**2,214**	**2,733**	**25,69**	**46,320**
< 1,000 gross tons	1,557	2,663	20,398	35,282	0	0	2,135	2,355	24,090	40,300
≥ 1,000 gross tons	1,230	4,440	291	1,202	0	0	79	378	1,600	6,020
Great Lakes	**45**	**225**	**88**	**2,479**	**0**	**0**	**76**	**146**	**209**	**2,850**
Self-propelled	**3**	**22**	**59**	**2,253**	**0**	**0**	**1**	**23**	**63**	**2,298**
< 1,000 gross tons	1	1	4	2	0	0	0	0	5	3
≥ 1,000 gross tons	2	21	55	2,251	0	0	1	23	58	2,295
Nonself-propelled	**42**	**203**	**29**	**226**	**0**	**0**	**75**	**123**	**146**	**552**
< 1,000 gross tons	18	29	20	34	0	0	71	112	109	175
≥ 1,000 gross tons	24	174	9	192	0	0	4	11	37	377
National Defense Reserve Fleet[b]	**28**	**886**	**0**	**0**	**4**	**70**	**146**	**2,463**	**178**	**3,419**
Ready Reserve Force (RRF)	10	304	0	0	2	34	77	1,542	89	1,880
Other reserve	18	582	0	0	2	36	69	921	89	1,539
TOTAL	**3,496**	**20,177**	**21,506**	**41,543**	**112**	**3,248**	**4,591**	**8,414**	**29,705**	**73,382**

[a] Includes breakbulk, roll on/roll off, LASH vessels, deck and container barges; excludes offshore supply vessels.
[b] Self-propelled vessels => 1,000 gross tons; excludes two Ready Reserve Force passenger vessels of 25,588 dwt and 10 other passenger vessels of 90,977 dwt.

NOTE: tons = capacity of vessels expressed in thousands of metric tons.

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Statistical and Economic Analysis; adapted from U.S. Army Corps of Engineers, *Waterborne Commerce of the United States* (Fort Belvoir, VA), and U.S. Customs Service Forms CF 1400/1401.

The United States' 11th position as a flag state does not reflect the fact that U.S. interests rank 3rd in terms of world fleet ownership (see tables 1-3 and 1-4).

Vessel ownership concepts are clouded by a lack of standard definitions within commercially available data products that reflect vessel ownership, management, and nationality. This makes it difficult to quantify the economic contribution of the shipping industry to the U.S. economy, to define true "national" fleets, and to identify the nationality of maritime transport operators. There is a clear need to develop the means for objective and consistent comparisons among fleets and transport operators. Efforts are underway within the International Maritime Statistics Forum to develop a framework for such comparisons.

Table 7-4
U.S.-Flag Fleet of Passenger Vessels, Tugs/Towboats, and Other Work Boats[a] as of January 1, 1999[b]

Vessel type	Number	Capacity unit
Passenger vessels		**Passengers**
< 150 passenger capacity	839	56,020
≥ 150 passenger capacity	652	354,665
Total	**1,491**	**410,685**
Tugs/towboats		**Horsepower**
< 1,500 horsepower	3,418	2,476,896
≥ 1,500 horsepower	2,028	7,148,189
Total	**5,446**	**9,625,085**
Other work boats[c]		**Metric tons**
< 1,000 tons capacity	1,377	271,029
≥ 1,000 tons capacity	47	75,051
Total	**1,424**	**346,080**

[a] Inventory data
[b] Preliminary data
[c] Includes crewboats, supply, and utility vessels.

SOURCE: U.S. Department of Transportation, Maritime Administration, Office of Statistical and Economic Analysis; adapted from U.S. Army Corps of Engineers, *Waterborne Commerce of the United States* (Fort Belvoir, VA).

Passenger/Ferry Vessels

U.S. data on passenger/ferry vessels have coverage and classification issues that need to be resolved, particularly in light of the growing interest in fast-ferry operations. Passenger vessels with similar structural characteristics may have a wide range of potential uses, such as ferries, excursion boats, dinner boats, water taxis, crew boats, etc. The same vessel may have multiple uses depending on time of day or season. With no clear definitions or classifications, it is difficult to determine fleet size. With respect to fast ferries, there is no consensus as to what speed constitutes a fast ferry, and the USACE does not record vessel speed. Fast-ferry classification can be inferred from horsepower.

Vessel Type Classification

There has been some progress in vessel-type classifications following development of the International Classification of Ships by Type (ICST). However, the ICST is based on vessel structure, while there is also clearly a demand for usage-based classification. The problem comes when structure and usage are commingled in a single data field.

MARAD

Accurate data on ferry vessels and operations are hard to compile for many reasons, including a lack of recorded data and construction characteristics that fill a wide range of potential uses.

New Construction

Good orderbook information is difficult to collect from shipyards. There does not seem to be a single, fully reliable data provider, particularly for the smaller yards in the United States. Addition of new orders and deletion of cancelled orders from databases may not occur on a timely basis. Options may be reported as firm orders before they are exercised.

If shipyards do not consistently report all of their work to data collectors on a timely basis, then alternatives need to be sought to fill this gap. For example, since owners must report new vessels to the USCG and the USACE when they enter service, it may be possible to collect relevant information as the vessels are built, thereby creating orderbook data as detailed as data that now ultimately appears in the regular fleet databases. The USACE has undertaken a pilot project in this area with its 1999 annual survey of owners.

SAFETY, LAW ENFORCEMENT, AND ENVIRONMENTAL DATA ISSUES

Safety and Law Enforcement

Denominators of exposure need to be developed so that the level of risk can be compared year to year with the increase or decrease in the number of incidents reported. Solely enumerating outputs can yield misleading performance measurements. For example, the performance of a recreational boating-safety program cannot be measured using recreational boating fatalities only; exposure risk (e.g., fatalities or injuries in relation to the number of boats in use, or activity levels) must be part of the equation. Likewise, law enforcement success cannot be measured simply by tallying the number of arrests, vessels detained, or drugs seized, but must consider whether there is a measurable decrease or increase in the rate of unlawful activity.

Currently, maritime data that might be used for evaluation of risk are not readily available. Such data are most often drawn from disparate sources and collected for reasons unrelated to statistical applications. Usually, different databases of varying quality and completeness must be combined in order to show safety performance trends. The results of calculations that combine data from different sources are themselves questionable and often unreliable.


USCG

Uncertainty about activity levels and numbers of boats in use, fluctuating employment, and databases of varying quality make measuring risk levels for maritime workers and recreational boaters difficult. The USCG is developing information systems that will improve data.

To resolve these issues, the USCG is developing new information systems, such as the Marine Information for Safety and Law Enforcement system, to meet its operational data needs for more accurate and reliable statistical data.

Search and Rescue

The Search and Rescue Management Information System is currently being updated to improve accuracy and reliability of data. For "lives saved" data, USCG quality analysis suggests that the current data collection system slightly understates the number of lives lost, producing a slightly inflated percentage of lives saved. With respect to "property saved" data, revalidation of fiscal years 1994 to 1996 data were needed to address discrepancies that may have skewed the data upwards.

Maritime Worker Fatalities

Fatality data are obtained through the Marine Safety Information System. However, denominator estimates are based on data provided by the U.S. Commerce Department's National Marine Fisheries Service, the U.S. Labor Department's Bureau of Labor Statistics, and the U.S. Interior Department's Mineral Management Service. Employment estimates can fluctuate dramatically from year to year, and substantial estimating errors exist, particularly in the fishing industry.

Recreational Boating Fatalities

There is a need to normalize fatality data by developing a denominator of exposure so that the level of risk in recreational boating can be compared from year to year without being skewed by the increase or decrease in the number of boats or boat usage.

Pollution Response

In recent years, attempts have been made to use oil removal rates as a measure of response effectiveness. This approach, however, has led to validity problems. Spill removal data are susceptible to bias in the form of underestimated spill sizes and inflated removal amounts. Removal estimates are confounded by the dynamics of weathering. A multiple factor rating system, for post-incident assessment of preparedness for the incident and performance of the mitigation effort, might provide a better indicator of pollution response effectiveness and readiness.

Navigation Aids

Current data used to measure reliability of equipment and personnel performance tends to overstate the impact of a failed navigational aid. Complete system outages are rare, and a single aid outage usually does not degrade a waterway's entire aid system and vessels are still able to transit normally. Any new datasets developed need to focus more directly on movement of commerce or accident prevention.

Vessel Traffic and Incident Occurrence

To gauge how well the USCG prevents incidents that might impede the efficient movement of vessels in ports and waterways, good data are required. Possible future refinements to the datasets may include normalizing data against the number of vessel transits, excluding incidents not preventable by USCG activities, and quantifying the number of USCG interventions that prevented a dangerous incident from occurring.

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Glossary, Acronyms, and Initialisms

GLOSSARY

Amphibious: Operates on land and sea.

Ballast: Anything heavy that is loaded on a vessel to improve stability.

Barge: A nonmotorized water vessel, usually flat-bottomed and towed or pushed by a tugboat or pushboat.

Berth: A place in which a vessel is moored or secured.

Breakbulk Vessel: A cargo ship that carries a variety of products of nonuniform sizes, often bound on pallets to facilitate loading and unloading.

Bulk Carrier: Vessels designed to carry dry-bulk cargo such as grain, fertilizers, and ore.

Buoy: A float moored or anchored in water.

Classification Societies: Nonprofit-making bodies directed by committees representing shipowners, engine builders, and underwriters for the purpose of ensuring that ships are constructed and maintained in a seaworthy and safe condition. They make rules governing ship construction and arrange and carry out surveys during the building of a ship and throughout the vessel's trading life. They also research forms of construction and the efficiency and safety of sea-going vessels and offshore equipment, such as oil rigs and shore plant.

Common Carrier: A transportation company that provides service to the general public at published rates.

Containership: A cargo vessel designed and constructed to transport, within specifically designed cells, portable freight containers and tanks that can be loaded and unloaded with their contents intact. There are two types of containerships—full and partial. Full containerships are equipped with permanent container cells with little or no space for other types of cargo. Partial containerships are considered multipurpose container vessels, where one or more but not all compartments are fitted with permanent container cells, and the remaining compartments are used for breakbulk cargoes.

Deadweight Tons: A measure of ship-carrying capacity. The total cargo, bunkers, and stores that a ship can carry up to its waterline, measured in metric tons (2,204.6 pounds) or long tons (2,240 pounds).

Deep Sea Domestic Trade: Transportation of freight on the deep seas between U.S. ports, including noncontiguous U.S. territories.

Draft (loaded): The depth of a vessel's keel below the waterline when carrying a full cargo.

Dredge: To clean, deepen, or widen waterways with a vessel equipped with a scooping or suction device or a vessel equipped with such devices.

Drydock: An artificial basin fitted with a gate or caisson into which a vessel may be floated and from which the water may be pumped out to expose the bottom of the vessel.

Exclusive Economic Zone: Limits of U.S. national sovereignty, 200 miles off U.S. coastline.

Ferry: A ship or boat used to carry passengers or goods between two or more points across a body of water on a regular schedule.

Fouling: Marine organisms and vegetative matter that grow on the bottom of a ship.

Flag (registry): The nation to which a ship is registered and which holds legal jurisdiction over the operation of that ship.

Global Positioning System: A satellite navigation system developed by the U.S. Department of Defense.

Global Shipping Alliance: An agreement among carriers to operate joint services involving the coordination of schedules and the sharing of vessels and routes to achieve global coverage and improve vessel utilization.

Gross Tonnage: A vessel's interior space expressed in units of 100 cubic feet.

Inland Waterway: Navigable waters located within the boundaries of the contiguous 48 states or within the boundaries of the state of Alaska.

Intermodal: Pertaining to the transportation of a unit load using a combination of two or more land, sea, or air systems.

International Maritime Organization (IMO): A permanent body established by the 1948 United Nations Maritime Conference convened to address safety at sea. IMO is devoted exclusively to maritime matters, determines acceptable maritime standards, and develops and monitors international treaties related to shipping.

Knot: A measure of speed in navigation that is the rate of one nautical mile (6,083 feet) per hour.

Laker: A long, narrow dry-bulk vessel that trades on the Great Lakes.

Lighterage: Carriage of goods by a lighter (a ship or barge used to load or unload a vessel) and the charges assessed therefrom.

Lock: A facility containing one or more enclosed chambers, situated at a point (canal or dam) on a waterway, with gates at each end for raising or lowering vessels by admitting or releasing water.

Open Registry: A term used to denote a type of registry offered by a country to foreign nationals or corporations that provides favorable tax, regulatory, and other incentives.

Personal Flotation Device: Floats designed as life preservers or life jackets.

Roll on/Roll Off Vessel: Vessel designed to carry wheeled containers, trailers, or other wheeled cargo that are loaded or unloaded by use of ramps.

Tanker Barge: A nonself-propelled, flat-bottomed vessel that, like a tanker, has a hull that is usually divided into tanks to allow transportation of one or more liquid products.

Tanker: A self-propelled vessel with a hull subdivided to allow transportation of one or more liquid products and to prevent the destabilizing movement of liquids.

Terminal: An area or enclosed structure that is used to load or unload passengers or cargo or to transfer them between different vehicles on the same transportation modal network.

Tug: A small, powerful, and highly maneuverable vessel designed for towage or salvage operations. Also called a towboat or pushboat.

Twenty-Foot Equivalent Unit: A measure of containership cargo-carrying capacity determined by totaling the length of all containers a vessel can carry and then dividing that total by 20.

Vessel Sharing Agreement: An agreement between ocean common carriers whereby a carrier or carriers agree(s) to provide vessel capacity for the use of another carrier or carriers in exchange for compensation or services.

Waterway: Any body of water wide enough and deep enough to accommodate the passage of water craft, particularly commercial vessels.

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ACRONYMS AND INITIALISMS

ADS	Automated Dependent Surveillance
AIS	Automated Identification System
ANSI	American National Standards Institute
AtoN	Aids to Navigation
BAC	Blood Alcohol Level
BTS	Bureau of Transportation Statistics
CAAA	Clean Air Act Amendments

CCF	Capital Construction Fund
CHCP	Cargo Handling Cooperative Program
CINC	Commander-In-Chief
CWA	Clean Water Act
DGPS	Differential Global Positioning System
DOD	Department of Defense
DOT	Department of Transportation
DPOSD	Deployed Port Operations, Security, and Defense
dwt	Deadweight Ton
ECS	Electronic Chart System
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
GDP	Gross Domestic Product
GPS	Global Positioning System
gt	Gross Ton
HC	Hydrocarbon
ICST	International Classification of Ships by Type
IIP	International Ice Patrol
IMO	International Maritime Organization
ISM	International Safety Management
ISO	International Organization for Standardization
LNM	Local Notice to Mariners
LORAN	Long-Range Navigation
MARAD	Maritime Administration
MARPOL	Maritime Pollution Convention
MEPC	Marine Environment Protection Committee
MOU	Memorandum of Understanding
MSB	Major Shipbuilding Base

MSP	Maritime Security Program
MTBE	Methyl Tertiary Butyl Ether
NDRF	National Defense Reserve Fleet
NHS	National Highway System
NOAA	National Oceanic and Atmospheric Agency
NOx	Oxides of Nitrogen
NPRN	National Port Readiness Net
NRC	National Research Council
OCS	Office of Coast Survey
ODS	Operating Differential Subsidy program
OSV	Offshore Supply Vessel
O&M	Operation and Management
PFD	Personal Flotation Device (life jacket)
PORTS	Physical Oceanographic Real-Time Systems
PPU	Portable Pilot Unit
PTP	Prevention Through People
PWC	Personal Watercraft
RO/RO	Roll On/Roll Off
RRF	Ready Reserve Fleet
RTW	Round-the-World
SAR	Search and Rescue
SIC	Standard Industrial Classification
SOCP	Ship Operations Cooperative Program
SOLAS	Safety of Life at Sea
SSRP	Smart-center Ship Routing Program
TBT	Tributyltin (an organotin)
TEA-21	Transportation Equity Act for the 21st Century
TEU	Twenty-Foot Equivalent Units

USACE	U.S. Army Corp of Engineers
USCG	U.S. Coast Guard
USDOT	U.S. Department of Transportation
USN	U.S. Navy
VISA	Voluntary Intermodal Sealift Agreement
VOSS	Vessel Optimization and Safety System
VTS	Vessel Traffic Service

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