**Ship**

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*For other uses, see* [*Ship (disambiguation)*](http://en.wikipedia.org/wiki/Ship_%28disambiguation%29)*.*

[Italian](http://en.wikipedia.org/wiki/Italy) [full-rigged ship](http://en.wikipedia.org/wiki/Full-rigged_ship) [*Amerigo Vespucci*](http://en.wikipedia.org/wiki/Amerigo_Vespucci_%28ship%29) in [New York Harbor](http://en.wikipedia.org/wiki/New_York_Harbor), 1976

Since the end of the [age of sail](http://en.wikipedia.org/wiki/Age_of_sail)a **ship** has been any large [buoyant](http://en.wikipedia.org/wiki/Buoyancy) [watercraft](http://en.wikipedia.org/wiki/Watercraft). Ships are generally distinguished from [boats](http://en.wikipedia.org/wiki/Boat) based on size and [cargo](http://en.wikipedia.org/wiki/Cargo) or passenger capacity. Ships are used on [lakes](http://en.wikipedia.org/wiki/Lake), [seas](http://en.wikipedia.org/wiki/Sea), and [rivers](http://en.wikipedia.org/wiki/River) for a variety of activities, such as the [transport of people](http://en.wikipedia.org/wiki/Ferry) or [goods](http://en.wikipedia.org/wiki/Cargo_ship), [fishing](http://en.wikipedia.org/wiki/Fishing), [entertainment](http://en.wikipedia.org/wiki/Cruise_ship), [public safety](http://en.wikipedia.org/wiki/Coast_guard), and [warfare](http://en.wikipedia.org/wiki/Warship). Historically, a "ship" was a vessel with sails rigged in a specific manner.

Ships and boats have developed alongside humanity. In armed conflict and in daily life they have become an integral part of modern commercial and military systems. Fishing boats are used by millions of fishermen throughout the world. Military forces operate vessels for combat and to transport and support forces ashore. Commercial vessels, nearly 35,000 in number, carried 7.4 billion tons of cargo in 2007. Total number of ships(with [IMO](http://en.wikipedia.org/wiki/IMO_ship_identification_number) number) as of 2011 is about 104,304.

Ships were a key in history's great explorations and scientific and technological development. Navigators such as [Zheng He](http://en.wikipedia.org/wiki/Zheng_He) spread such inventions as the [compass](http://en.wikipedia.org/wiki/Compass) and [gunpowder](http://en.wikipedia.org/wiki/Gunpowder). Ships have been used for such purposes as [colonization](http://en.wikipedia.org/wiki/Colonization) and the [slave trade](http://en.wikipedia.org/wiki/Slave_trade), and have served scientific, cultural, and humanitarian needs. After the 16th century, [new crops](http://en.wikipedia.org/wiki/Columbian_Exchange) that had come from and to the Americas via the European seafarers significantly contributed to the world's population growth. Maritime transport has shaped the world's economy into today's energy-intensive pattern.

**Nomenclature**

Main parts of ship. **1**: [Smokestack](http://en.wikipedia.org/wiki/Smokestack) or [Funnel](http://en.wikipedia.org/wiki/Funnel); **2**: [Stern](http://en.wikipedia.org/wiki/Stern); **3**: [Propeller](http://en.wikipedia.org/wiki/Propeller) and [Rudder](http://en.wikipedia.org/wiki/Rudder); **4**: [Portside](http://en.wikipedia.org/wiki/Portside) (the right side is known as [starboard](http://en.wikipedia.org/wiki/Starboard)); **5**: [Anchor](http://en.wikipedia.org/wiki/Anchor); **6**: [Bulbous bow](http://en.wikipedia.org/wiki/Bulbous_bow); **7**: [Bow](http://en.wikipedia.org/wiki/Bow_%28ship%29); **8**: [Deck](http://en.wikipedia.org/wiki/Deck_%28ship%29); **9**: [Superstructure](http://en.wikipedia.org/wiki/Superstructure)

For more details on this topic, see [Glossary of nautical terms](http://en.wikipedia.org/wiki/Glossary_of_nautical_terms).

Ships can usually be distinguished from boats based on size and the ship's ability to operate independently for extended periods. A commonly used [rule of thumb](http://en.wikipedia.org/wiki/Rule_of_thumb) is that if one vessel can carry another, the larger of the two is a ship. [Dinghies](http://en.wikipedia.org/wiki/Dinghy) are carried on [sailing yachts](http://en.wikipedia.org/wiki/Sailing_yacht) as small as 35 feet (10.67 m), clearly not ships; this rule of thumb is not foolproof.

In the [age of sail](http://en.wikipedia.org/wiki/Age_of_sail), a "ship" was a sailing vessel with at least three square-rigged masts and a full [bowsprit](http://en.wikipedia.org/wiki/Bowsprit); other types of vessel were also defined by their [sailplan](http://en.wikipedia.org/wiki/Sailplan), e.g. [barque](http://en.wikipedia.org/wiki/Barque), [brigantine](http://en.wikipedia.org/wiki/Brigantine), etc.

A number of large vessels are usually referred to as boats. [Submarines](http://en.wikipedia.org/wiki/Submarine) are a prime example. Other types of large vessel which are traditionally called boats are the [Great Lakes freighter](http://en.wikipedia.org/wiki/Lake_freighter), the [riverboat](http://en.wikipedia.org/wiki/Riverboat), and the [ferryboat](http://en.wikipedia.org/wiki/Ferryboat). Though large enough to carry their own boats and heavy cargoes, these vessels are designed for operation on inland or protected coastal waters.

In most maritime traditions ships have [individual names](http://en.wikipedia.org/wiki/Ship_naming_and_launching), and modern ships may belong to a [ship class](http://en.wikipedia.org/wiki/Ship_class) often named after its first ship. In English, a ship is traditionally referred to as "she", even if named after a man, but this is not universal usage; some journalistic [style guides](http://en.wikipedia.org/wiki/Style_guides) advise using "it", others advise "she" and "her".

**History**

*Further information:* [*Maritime history*](http://en.wikipedia.org/wiki/Maritime_history)

**Prehistory and antiquity**

A [raft](http://en.wikipedia.org/wiki/Raft) is among the simplest boat designs.

The first known vessels date back to the [Neolithic Period](http://en.wikipedia.org/wiki/Neolithic_Period), about 10,000 years ago, but could not be described as ships. The first navigators began to use animal skins or woven fabrics as [sails](http://en.wikipedia.org/wiki/Sail). Affixed to the top of a pole set upright in a boat, these sails gave early ships range. This allowed men to explore widely, allowing, for example the settlement of [Oceania](http://en.wikipedia.org/wiki/Oceania) about 3,000 years ago.

By around [3000 BC](http://en.wikipedia.org/wiki/30th_century_BC), [Ancient Egyptians](http://en.wikipedia.org/wiki/Ancient_Egypt) knew how to assemble wooden planks into a [hull](http://en.wikipedia.org/wiki/Hull_%28ship%29). They used woven [straps](http://en.wikipedia.org/wiki/Strap) to lash the planks together, and [reeds](http://en.wikipedia.org/wiki/Cyperus_papyrus) or [grass](http://en.wikipedia.org/wiki/Grass) stuffed between the planks helped to seal the seams. The [Greek](http://en.wikipedia.org/wiki/Ancient_Greece) [historian](http://en.wikipedia.org/wiki/Historian) and [geographer](http://en.wikipedia.org/wiki/Geographer) [Agatharchides](http://en.wikipedia.org/wiki/Agatharchides) had documented ship-faring among the early [Egyptians](http://en.wikipedia.org/wiki/Ancient_Egypt): *"During the prosperous period of the* [*Old Kingdom*](http://en.wikipedia.org/wiki/Old_Kingdom)*, between the* [*30th*](http://en.wikipedia.org/wiki/30th_century_BC) *and* [*25th centuries B. C.*](http://en.wikipedia.org/wiki/25th_century_BC)*, the* [*river*](http://en.wikipedia.org/wiki/Nile_River)*-routes were kept in order, and* [*Egyptian*](http://en.wikipedia.org/wiki/Ancient_Egypt) *ships sailed the* [*Red Sea*](http://en.wikipedia.org/wiki/Red_Sea) *as far as the* [*myrrh*](http://en.wikipedia.org/wiki/Myrrh)*-country."* [Sneferu](http://en.wikipedia.org/wiki/Sneferu)'s ancient cedar wood ship [Praise of the Two Lands](http://en.wikipedia.org/wiki/Praise_of_the_Two_Lands_%28ship%29) is the first reference recorded (2613 BCE) to a ship being referred to by name.

The [ancient Egyptians](http://en.wikipedia.org/wiki/Ancient_Egypt) were perfectly at ease building sailboats. A remarkable example of their [shipbuilding](http://en.wikipedia.org/wiki/Shipbuilding) skills was the [Khufu ship](http://en.wikipedia.org/wiki/Khufu_ship), a vessel 143 feet (44 m) in length entombed at the foot of the [Great Pyramid of Giza](http://en.wikipedia.org/wiki/Great_Pyramid_of_Giza) around 2500 BC and found intact in 1954.

It is known that ancient [Nubia](http://en.wikipedia.org/wiki/Nubia)/[Axum](http://en.wikipedia.org/wiki/Axum) traded with [India](http://en.wikipedia.org/wiki/India), and there is evidence that ships from Northeast Africa may have sailed back and forth between India/Sri Lanka and Nubia trading goods and even to [Persia](http://en.wikipedia.org/wiki/Persia), Himyar and [Rome](http://en.wikipedia.org/wiki/Ancient_Rome).[Aksum](http://en.wikipedia.org/wiki/Aksumite_Empire) was known by the [Greeks](http://en.wikipedia.org/wiki/Ancient_Greece) for having seaports for ships from Greece and [Yemen](http://en.wikipedia.org/wiki/Yemen).

Elsewhere in Northeast Africa, the [Periplus of the Red Sea](http://en.wikipedia.org/wiki/Periplus_of_the_Erythraean_Sea) reports that [Somalis](http://en.wikipedia.org/wiki/Somali_people), through their northern ports such as [Zeila](http://en.wikipedia.org/wiki/Zeila) and [Berbera](http://en.wikipedia.org/wiki/Berbera), were trading [frankincense](http://en.wikipedia.org/wiki/Frankincense) and other items with the inhabitants of the [Arabian Peninsula](http://en.wikipedia.org/wiki/Arabian_Peninsula) well before the arrival of [Islam](http://en.wikipedia.org/wiki/Islam) as well as with then [Roman](http://en.wikipedia.org/wiki/Roman_Empire)-controlled [Egypt](http://en.wikipedia.org/wiki/Egypt).

A panel found at [Mohenjodaro](http://en.wikipedia.org/wiki/Mohenjodaro), depicted a sailing craft. Vessels were of many types Their construction is vividly described in the Yukti Kalpa Taru, an ancient Indian text on shipbuilding. This treatise gives a technical exposition on the techniques of shipbuilding. It sets forth minute details about the various types of ships, their sizes, and the materials from which they were built. The Yukti Kalpa Taru sums up in a condensed form all the available information. The Yukti Kalpa Taru gives sufficient information and dates to prove that, in ancient times, Indian shipbuilders had a good knowledge of the materials which were used in building ships. In addition to describing the qualities of the different types of wood and their suitability for shipbuilding, the Yukti Kalpa Taru gives an elaborate classification of ships based on their size.

By about 2000 BC, the [Minoan civilization](http://en.wikipedia.org/wiki/Minoan_civilization) in [Crete](http://en.wikipedia.org/wiki/Crete) had evolved into a naval power exercising effective control of the sea in the eastern [Mediterranean](http://en.wikipedia.org/wiki/Mediterranean).

The [Phoenicians](http://en.wikipedia.org/wiki/Phoenicia), the first to sail completely around Africa, and [Greeks](http://en.wikipedia.org/wiki/Ancient_Greece) gradually mastered navigation at sea aboard [triremes](http://en.wikipedia.org/wiki/Trireme), exploring and colonizing the [Mediterranean](http://en.wikipedia.org/wiki/Mediterranean) via ship. Around 340 BC, the Greek [navigator](http://en.wikipedia.org/wiki/Navigator) [Pytheas of Massalia](http://en.wikipedia.org/wiki/Pytheas_of_Massalia) ventured from Greece to [Western Europe](http://en.wikipedia.org/wiki/Western_Europe) and [Great Britain](http://en.wikipedia.org/wiki/Great_Britain). In the course of the 2nd century BC, [Rome](http://en.wikipedia.org/wiki/Ancient_Rome) went on to destroy [Carthage](http://en.wikipedia.org/wiki/Carthage) and subdue the [Hellenistic](http://en.wikipedia.org/wiki/Hellenistic) kingdoms of the eastern Mediterranean, achieving complete mastery of the inland sea, that they called [*Mare Nostrum*](http://en.wikipedia.org/wiki/Mare_Nostrum). The [monsoon](http://en.wikipedia.org/wiki/Monsoon) wind system of the [Indian Ocean](http://en.wikipedia.org/wiki/Indian_Ocean) was first sailed by Greek navigator [Eudoxus of Cyzicus](http://en.wikipedia.org/wiki/Eudoxus_of_Cyzicus) in 118 BC. With 300 Greek ships a year sailing between [Roman Empire](http://en.wikipedia.org/wiki/Roman_Empire) and India, the annual trade may have reached 300,000 tons.

In China, by the time of the [Zhou Dynasty](http://en.wikipedia.org/wiki/Zhou_Dynasty) ship technologies such as stern mounted [rudders](http://en.wikipedia.org/wiki/Rudder) were developed, and by the [Han Dynasty](http://en.wikipedia.org/wiki/Han_Dynasty), a well-kept naval fleet was an integral part of the military. Ship technology advanced to the point where by the medieval period, water tight compartments were developed.

Roman [trireme](http://en.wikipedia.org/wiki/Trireme) mosaic from Carthage, [Bardo Museum](http://en.wikipedia.org/wiki/Bardo_Museum), [Tunis](http://en.wikipedia.org/wiki/Tunis).

The [Swahili people](http://en.wikipedia.org/wiki/Swahili_people) had various extensive trading ports dotting the coast of medieval East Africa and [Great Zimbabwe](http://en.wikipedia.org/wiki/Great_Zimbabwe) had extensive trading contacts with [Central Africa](http://en.wikipedia.org/wiki/Central_Africa), and likely also imported goods brought to Africa through the Southeast African shore trade of [Kilwa](http://en.wikipedia.org/wiki/Kilwa_District) in modern-day [Tanzania](http://en.wikipedia.org/wiki/Tanzania).

It is known by historians that at its height the [Mali Empire](http://en.wikipedia.org/wiki/Mali_Empire) built a large naval fleet under Emperor [Mansa Musa](http://en.wikipedia.org/wiki/Mansa_Musa) in the late 13th and early 14th century. Arabic sources describe what some consider to be visits to the New World by a Mali fleet in 1311.

The [Battle of Lepanto](http://en.wikipedia.org/wiki/Battle_of_Lepanto_%281571%29), 1571, naval engagement between allied Christian forces and the [Ottoman Navy](http://en.wikipedia.org/wiki/Ottoman_Navy).

Before the introduction of the compass, [celestial navigation](http://en.wikipedia.org/wiki/Celestial_navigation) was the main method for navigation at sea. In China, early versions of the [magnetic compass](http://en.wikipedia.org/wiki/Magnetic_compass) were being developed and used in navigation between 1040 and 1117. The true mariner's [compass](http://en.wikipedia.org/wiki/Compass), using a pivoting needle in a dry box, was developed in [Europe](http://en.wikipedia.org/wiki/Europe) no later than 1300.

**Renaissance**

Until the [Renaissance](http://en.wikipedia.org/wiki/Renaissance), navigational technology remained comparatively primitive. This absence of technology did not prevent some civilizations from becoming sea powers. Examples include the maritime republics of [Genoa](http://en.wikipedia.org/wiki/Republic_of_Genoa) and [Venice](http://en.wikipedia.org/wiki/Republic_of_Venice), [Hanseatic League](http://en.wikipedia.org/wiki/Hanseatic_League), and the [Byzantine navy](http://en.wikipedia.org/wiki/Byzantine_navy). The [Vikings](http://en.wikipedia.org/wiki/Viking) used their [knarrs](http://en.wikipedia.org/wiki/Knarr) to explore [North America](http://en.wikipedia.org/wiki/North_America), trade in the [Baltic Sea](http://en.wikipedia.org/wiki/Baltic_Sea) and plunder many of the coastal regions of Western Europe.

A replica of the [carrack](http://en.wikipedia.org/wiki/Carrack) [*Santa María*](http://en.wikipedia.org/wiki/Santa_Mar%C3%ADa_%28ship%29) of [Christopher Columbus](http://en.wikipedia.org/wiki/Christopher_Columbus)

Towards the end of the 14th century, ships like the [carrack](http://en.wikipedia.org/wiki/Carrack) began to develop towers on the bow and stern. These towers decreased the vessel's stability, and in the 15th century, the [caravel](http://en.wikipedia.org/wiki/Caravel), designed by the [Portuguese](http://en.wikipedia.org/wiki/Portugal), based on the Arabic *qarib* which could sail closer to the wind, became more widely used. The towers were gradually replaced by the [forecastle](http://en.wikipedia.org/wiki/Forecastle) and [sterncastle](http://en.wikipedia.org/wiki/Stern), as in the carrack [*Santa María*](http://en.wikipedia.org/wiki/Santa_Mar%C3%ADa_%28ship%29) of [Christopher Columbus](http://en.wikipedia.org/wiki/Christopher_Columbus). This increased [freeboard](http://en.wikipedia.org/wiki/Freeboard_%28nautical%29) allowed another innovation: the freeing port, and the artillery associated with it.

A Japanese [atakebune](http://en.wikipedia.org/wiki/Atakebune) from the 16th century

In the 16th century, the use of freeboard and freeing ports become widespread on [galleons](http://en.wikipedia.org/wiki/Galleon). The English modified their vessels to maximize their firepower and demonstrated the effectiveness of their doctrine, in 1588, by defeating the [Spanish Armada](http://en.wikipedia.org/wiki/Spanish_Armada).

At this time, ships were developing in Asia in much the same way as Europe. [Japan](http://en.wikipedia.org/wiki/Japan) used defensive naval techniques in the [Mongol invasions of Japan](http://en.wikipedia.org/wiki/Mongol_invasions_of_Japan) in 1281. It is likely that the Mongols of the time took advantage of both European and Asian shipbuilding techniques. During the 15th century, China's [Ming Dynasty](http://en.wikipedia.org/wiki/Ming_Dynasty) assembled one of the largest and most powerful naval fleet in the world for the [diplomatic and power projection voyages](http://en.wikipedia.org/wiki/Treasure_voyages) of [Zheng He](http://en.wikipedia.org/wiki/Zheng_He). Elsewhere in Japan in the 15th century, one of the world's first iron-clads, "Tekkōsen" ([鉄甲船](http://ja.wikipedia.org/wiki/%E9%89%84%E7%94%B2%E8%88%B9)), literally meaning "iron ships", was also developed. In Japan, during the [Sengoku era](http://en.wikipedia.org/wiki/Sengoku_era) from the fifteenth to 17th century, the great struggle for feudal supremacy was fought, in part, by coastal fleets of several hundred boats, including the [atakebune](http://en.wikipedia.org/wiki/Atakebune).

[Model](http://en.wikipedia.org/wiki/Physical_model) of a medieval [Mogadishan](http://en.wikipedia.org/wiki/Mogadishu) ship.

During the [Age of the Ajuuraan](http://en.wikipedia.org/wiki/Ajuuraan_State), the [Somali](http://en.wikipedia.org/wiki/Somalia) [sultanates](http://en.wikipedia.org/wiki/Sultanates) and [republics](http://en.wikipedia.org/wiki/Republics) of [Merca](http://en.wikipedia.org/wiki/Merca), [Mogadishu](http://en.wikipedia.org/wiki/Mogadishu), [Barawa](http://en.wikipedia.org/wiki/Barawa), [Hobyo](http://en.wikipedia.org/wiki/Hobyo) and their respective ports flourished, enjoying a lucrative foreign commerce with ships sailing to and coming from [Arabia](http://en.wikipedia.org/wiki/Arabia), [India](http://en.wikipedia.org/wiki/India), [Venetia](http://en.wikipedia.org/wiki/Venetia_%28region%29),[Persia](http://en.wikipedia.org/wiki/Persia), [Egypt](http://en.wikipedia.org/wiki/Egypt), [Portugal](http://en.wikipedia.org/wiki/Portugal) and as far away as [China](http://en.wikipedia.org/wiki/China). In the 16th century, [Duarte Barbosa](http://en.wikipedia.org/wiki/Duarte_Barbosa) noted that many ships from the [Kingdom of Cambaya](http://en.wikipedia.org/wiki/Khambhat) in what is modern-day [India](http://en.wikipedia.org/wiki/India) sailed to Mogadishu with [cloth](http://en.wikipedia.org/wiki/Textile) and [spices](http://en.wikipedia.org/wiki/Spices), for which they in return received [gold](http://en.wikipedia.org/wiki/Gold), [wax](http://en.wikipedia.org/wiki/Wax) and [ivory](http://en.wikipedia.org/wiki/Ivory). Barbosa also highlighted the abundance of [meat](http://en.wikipedia.org/wiki/Meat), [wheat](http://en.wikipedia.org/wiki/Wheat), [barley](http://en.wikipedia.org/wiki/Barley), [horses](http://en.wikipedia.org/wiki/Horses), and [fruit](http://en.wikipedia.org/wiki/Fruit) on the coastal markets, which generated enormous wealth for the merchants.

Middle Age [Swahili Kingdoms](http://en.wikipedia.org/wiki/Swahili_culture) are known to have had trade port islands and trade routes with the Islamic world and Asia and were described by Greek historians as "metropolises". Famous African trade ports such as [Mombasa](http://en.wikipedia.org/wiki/Mombasa), [Zanzibar](http://en.wikipedia.org/wiki/Zanzibar), and [Kilwa](http://en.wikipedia.org/wiki/Kilwa_Kisiwani) were known to Chinese sailors such as [Zheng He](http://en.wikipedia.org/wiki/Zheng_He) and medieval Islamic historians such as the Berber Islamic voyager [Abu Abdullah ibn Battua](http://en.wikipedia.org/wiki/Ibn_Battuta). In the 14th century CE King [Abubakari I](http://en.wikipedia.org/wiki/Abu_Bakr_%28mansa%29), the brother of King [Mansa Musa](http://en.wikipedia.org/wiki/Mansa_Musa) of the [Mali Empire](http://en.wikipedia.org/wiki/Mali_Empire) is thought to have had a great armada of ships sitting on the coast of [West Africa](http://en.wikipedia.org/wiki/West_Africa). This is corroborated by ibn Battuta himself who recalls several hundred Malian ships off the coast. This has led to great speculation, with historical evidence, that it is possible that Malian sailors may have reached the coast of [Pre-Columbian](http://en.wikipedia.org/wiki/Pre-Columbian) America under the rule of [Abubakari II](http://en.wikipedia.org/wiki/Abu_Bakr_II), nearly two hundred years before Christopher Columbus and that [black traders may have been in the Americas before Columbus](http://en.wikipedia.org/wiki/Pre-Columbian_Africa-Americas_contact_theories).

Replica of Magellan’s [*Victoria*](http://en.wikipedia.org/wiki/Victoria_%28ship%29). [Ferdinand Magellan](http://en.wikipedia.org/wiki/Ferdinand_Magellan) led the first expedition that [circumnavigated](http://en.wikipedia.org/wiki/Circumnavigated) the globe in 1519-1522.

Fifty years before [Christopher Columbus](http://en.wikipedia.org/wiki/Christopher_Columbus), Chinese navigator [Zheng He](http://en.wikipedia.org/wiki/Zheng_He) traveled the world at the head of what was for the time a [huge armada](http://en.wikipedia.org/wiki/Chinese_treasure_fleet). The largest of his ships had nine masts, were 130 meters (430 ft) long and had a beam of 55 meters (180 ft). His fleet carried 30,000 men aboard 70 vessels, with the goal of bringing glory to the Chinese emperor.

The [carrack](http://en.wikipedia.org/wiki/Carrack) and then the [caravel](http://en.wikipedia.org/wiki/Caravel) were developed in [Iberia](http://en.wikipedia.org/wiki/Iberian_Peninsula). After Columbus, [European exploration](http://en.wikipedia.org/wiki/Age_of_Discovery) rapidly accelerated, and many new trade routes were established. In 1498, by reaching India, [Vasco da Gama](http://en.wikipedia.org/wiki/Vasco_da_Gama) proved that the access to the [Indian Ocean](http://en.wikipedia.org/wiki/Indian_Ocean) from the [Atlantic](http://en.wikipedia.org/wiki/Atlantic) was possible. These explorations in the Atlantic and Indian Oceans were soon followed by [France](http://en.wikipedia.org/wiki/France), [England](http://en.wikipedia.org/wiki/England) and the [Netherlands](http://en.wikipedia.org/wiki/Netherlands), who explored the Portuguese and Spanish trade routes into the [Pacific Ocean](http://en.wikipedia.org/wiki/Pacific_Ocean), reaching [Australia](http://en.wikipedia.org/wiki/Australia) in 1606 and [New Zealand](http://en.wikipedia.org/wiki/New_Zealand) in 1642. A major sea power, the [Dutch](http://en.wikipedia.org/wiki/Dutch_Republic) in 1650 owned 16,000 merchant ships. In the 17th century Dutch explorers such as [Abel Tasman](http://en.wikipedia.org/wiki/Abel_Tasman) explored the coasts of Australia, while in the 18th century it was British explorer [James Cook](http://en.wikipedia.org/wiki/James_Cook) who mapped much of [Polynesia](http://en.wikipedia.org/wiki/Polynesia).

**Specialization and modernization**

The British [HMS *Sandwich*](http://en.wikipedia.org/wiki/HMS_Sandwich_%281759%29) fires at the French [flagship](http://en.wikipedia.org/wiki/Flagship) [*Bucentaure*](http://en.wikipedia.org/wiki/French_ship_Bucentaure_%281803%29) (completely dismasted) at the battle of [Trafalgar](http://en.wikipedia.org/wiki/Battle_of_Trafalgar) (1805). The *Bucentaure* also fights [HMS *Victory*](http://en.wikipedia.org/wiki/HMS_Victory) (behind her) and [HMS *Temeraire*](http://en.wikipedia.org/wiki/HMS_Temeraire_%281798%29) (left side of the picture). In fact, HMS *Sandwich* never fought at Trafalgar, it's a mistake from [Auguste Mayer](http://en.wikipedia.org/wiki/Auguste_%C3%89tienne_Fran%C3%A7ois_Mayer), the painter.

Parallel to the development of warships, ships in service of marine fishery and trade also developed in the period between antiquity and the Renaissance. Still primarily a coastal endeavor, fishing is largely practiced by individuals with little other money using small boats.

Maritime trade was driven by the development of shipping companies with significant financial resources. Canal barges, towed by draft animals on an adjacent [towpath](http://en.wikipedia.org/wiki/Towpath), contended with the [railway](http://en.wikipedia.org/wiki/Railway) up to and past the early days of the [industrial revolution](http://en.wikipedia.org/wiki/Industrial_revolution). Flat-bottomed and flexible [scow](http://en.wikipedia.org/wiki/Scow) boats also became widely used for transporting small cargoes. Mercantile trade went hand-in-hand with exploration, self-financed by the commercial benefits of exploration.

During the first half of the 18th century, the [French Navy](http://en.wikipedia.org/wiki/French_Navy) began to develop a new type of vessel known as a [ship of the line](http://en.wikipedia.org/wiki/Ship_of_the_line), featuring seventy-four guns. This type of ship became the backbone of all European fighting fleets. These ships were 56 meters (184 ft) long and their construction required 2,800 oak trees and 40 kilometers (25 mi) of rope; they carried a crew of about 800 sailors and soldiers.

[RMS *Titanic*](http://en.wikipedia.org/wiki/RMS_Titanic) departs from Southampton. Her sinking would [tighten safety regulations](http://en.wikipedia.org/wiki/Changes_in_safety_practices_following_the_RMS_Titanic_disaster)

During the 19th century the [Royal Navy](http://en.wikipedia.org/wiki/Royal_Navy) enforced a ban on the [slave trade](http://en.wikipedia.org/wiki/Slave_trade), acted to suppress [piracy](http://en.wikipedia.org/wiki/Piracy), and continued to map the world. A [clipper](http://en.wikipedia.org/wiki/Clipper) was a very fast sailing ship of the 19th century. The [clipper route](http://en.wikipedia.org/wiki/Clipper_route) fell into commercial disuse with the introduction of [steam ships](http://en.wikipedia.org/wiki/Steamboat), and the opening of the [Suez](http://en.wikipedia.org/wiki/Suez_Canal) and [Panama Canals](http://en.wikipedia.org/wiki/Panama_Canal).

Ship designs stayed fairly unchanged until the late 19th century. The industrial revolution, new mechanical methods of propulsion, and the ability to construct ships from metal triggered an explosion in ship design. Factors including the quest for more efficient ships, the end of long running and wasteful maritime conflicts, and the increased financial capacity of industrial powers created an avalanche of more specialized boats and ships. Ships built for entirely new functions, such as firefighting, rescue, and research, also began to appear.

In light of this, classification of vessels by type or function can be difficult. Even using very broad functional classifications such as fishery, trade, military, and exploration fails to classify most of the old ships. This difficulty is increased by the fact that the terms such as sloop and frigate are used by old and new ships alike, and often the modern vessels sometimes have little in common with their predecessors.

**Today**

The [*Colombo Express*](http://en.wikipedia.org/wiki/Colombo_Express), one of the largest container ships in the world, owned and operated by [Hapag-Lloyd](http://en.wikipedia.org/wiki/Hapag-Lloyd) of [Germany](http://en.wikipedia.org/wiki/Germany)

In 2007, the world's fleet included 34,882 commercial vessels with [gross tonnage](http://en.wikipedia.org/wiki/Gross_tonnage) of more than 1,000 [tons](http://en.wikipedia.org/wiki/Ton_%28volume%29), totaling 1.04 billion tons. These ships carried 7.4 billion tons of cargo in 2006, a sum that grew by 8% over the previous year. In terms of tonnage, 39% of these ships are [tankers](http://en.wikipedia.org/wiki/Tanker_%28ship%29), 26% are [bulk carriers](http://en.wikipedia.org/wiki/Bulk_carrier), 17% [container ships](http://en.wikipedia.org/wiki/Container_ship) and 15% were [other types](http://en.wikipedia.org/wiki/General_cargo_ship).

In 2002, there were 1,240 [warships](http://en.wikipedia.org/wiki/Warship) operating in the world, not counting small vessels such as [patrol boats](http://en.wikipedia.org/wiki/Patrol_boat). The [United States](http://en.wikipedia.org/wiki/United_States) accounted for 3 million tons worth of these vessels, [Russia](http://en.wikipedia.org/wiki/Russia) 1.35 million tons, the [United Kingdom](http://en.wikipedia.org/wiki/United_Kingdom) 504,660 tons and [China](http://en.wikipedia.org/wiki/China) 402,830 tons. The 20th century saw many naval engagements during the two [world wars](http://en.wikipedia.org/wiki/World_war), the [Cold War](http://en.wikipedia.org/wiki/Cold_War), and the rise to power of naval forces of the two blocs. The world's major powers have recently used their naval power in cases such as the [United Kingdom](http://en.wikipedia.org/wiki/United_Kingdom) in the [Falkland Islands](http://en.wikipedia.org/wiki/Falkland_Islands) and the [United States](http://en.wikipedia.org/wiki/United_States) in [Iraq](http://en.wikipedia.org/wiki/Iraq).

The size of the world's [fishing fleet](http://en.wikipedia.org/wiki/Fishing_fleet) is more difficult to estimate. The largest of these are counted as commercial vessels, but the smallest are legion. [Fishing vessels](http://en.wikipedia.org/wiki/Fishing_vessel) can be found in most seaside villages in the world. As of 2004, the United Nations [Food and Agriculture Organization](http://en.wikipedia.org/wiki/Food_and_Agriculture_Organization) estimated 4 million fishing vessels were operating worldwide. The same study estimated that the world's 29 million fishermencaught 85,800,000 [tons](http://en.wikipedia.org/wiki/Tonne) (84,400,000 [long tons](http://en.wikipedia.org/wiki/Long_ton); 94,600,000 [short tons](http://en.wikipedia.org/wiki/Short_ton)) of fish and shellfish that year.

**Types of ships**

See also: [List of types of naval vessels](http://en.wikipedia.org/wiki/List_of_types_of_naval_vessels) and [List of boat types](http://en.wikipedia.org/wiki/List_of_boat_types)

Ships are difficult to classify, mainly because there are so many criteria to base classification on. One classification is based on propulsion; with ships categorized as a [sailing ship](http://en.wikipedia.org/wiki/Sailing_ship), a [steamship](http://en.wikipedia.org/wiki/Steamship), or a [motorship](http://en.wikipedia.org/wiki/Motorship). Sailing ships are propelled solely by means of sails. Steamships are propelled by steam engines. Motorships use internal combustion engines; they include ships propelled by a combination of sail and internal combustion.

Ships can also be classified by other criteria such as:

* The number of hulls: monohull, catamaran, trimaran.
* The shape, size, and function, giving categories such as dinghy, keelboat, and icebreaker.
* The hull material: steel, aluminum, wood, fiberglass, and plastic.
* The type of propulsion system used, giving human-propelled (e.g., historical triremes), mechanical, and sails.
* The epoch in which the vessel was used, triremes of Ancient Greece, ships of the line of battle in the 18th century.
* The geographic origin of the vessel; many vessels are associated with a particular region, such as the [pinnace](http://en.wikipedia.org/wiki/Full_rigged_pinnace) of Northern Europe, the [gondolas](http://en.wikipedia.org/wiki/Gondola) of [Venice](http://en.wikipedia.org/wiki/Venice), and the [junks](http://en.wikipedia.org/wiki/Junk_%28ship%29) of China.
* The manufacturer, series, or class.

Another way to categorize ships and boats is based on their use, as described by Paulet and Presles. This system includes military ships, commercial vessels, fishing boats, pleasure craft and competitive boats. In this section, ships are classified using the first four of those categories, and adding a section for lake and river boats, and one for vessels which fall outside these categories.

**Commercial vessels**

Main article: [Commercial vessel](http://en.wikipedia.org/wiki/Commercial_vessel)

Two modern [container ships](http://en.wikipedia.org/wiki/Container_ship) in [San Francisco](http://en.wikipedia.org/wiki/San_Francisco)

Commercial vessels or [merchant ships](http://en.wikipedia.org/wiki/Merchant_ship) can be divided into three broad categories: [cargo ships](http://en.wikipedia.org/wiki/Cargo_ship), [passenger ships](http://en.wikipedia.org/wiki/Passenger_ship), and special-purpose ships. Cargo ships transport dry and liquid cargo. Dry cargo can be transported in bulk by [bulk carriers](http://en.wikipedia.org/wiki/Bulk_carrier), packed directly onto a [general cargo ship](http://en.wikipedia.org/wiki/General_cargo_ship) in break-bulk, packed in [intermodal containers](http://en.wikipedia.org/wiki/Intermodal_container) as aboard a [container ship](http://en.wikipedia.org/wiki/Container_ship), or driven aboard as in [roll-on roll-off ships](http://en.wikipedia.org/wiki/Roll-on_roll-off_ship). Liquid cargo is generally carried in bulk aboard tankers, such as [oil tankers](http://en.wikipedia.org/wiki/Oil_tanker) which may include both crude and finished products of oil, [chemical tankers](http://en.wikipedia.org/wiki/Chemical_tanker) which may also carry vegetable oils other than chemicals and [LPG/LNG tankers](http://en.wikipedia.org/w/index.php?title=LPG/LNG_tanker&action=edit&redlink=1), although smaller shipments may be carried on container ships in [tank containers](http://en.wikipedia.org/wiki/Tank_container).

Passenger ships range in size from small river ferries to very large [cruise ships](http://en.wikipedia.org/wiki/Cruise_ship). This type of vessel includes [ferries](http://en.wikipedia.org/wiki/Ferry), which move passengers and vehicles on short trips; [ocean liners](http://en.wikipedia.org/wiki/Ocean_liner), which carry passengers from one place to another; and [cruise ships](http://en.wikipedia.org/wiki/Cruise_ship), which carry passengers on voyages undertaken for pleasure, visiting several places and with leisure activities on board, often returning them to the port of embarkation.

Special-purpose vessels are not used for transport but for other tasks. Examples include [tugboats](http://en.wikipedia.org/wiki/Tugboat), [pilot boats](http://en.wikipedia.org/wiki/Pilot_boat), [rescue boats](http://en.wikipedia.org/wiki/Rescue_boat), [cable ships](http://en.wikipedia.org/wiki/Cable_ship), [research vessels](http://en.wikipedia.org/wiki/Research_vessel), [survey vessels](http://en.wikipedia.org/wiki/Survey_vessel), and [icebreakers](http://en.wikipedia.org/wiki/Icebreaker).

Most commercial vessels have full hull-forms to maximize cargo capacity. Hulls are usually made of steel, although aluminum can be used on faster craft, and fiberglass on the smallest service vessels. Commercial vessels generally have a crew headed by a [captain](http://en.wikipedia.org/wiki/Captain_%28nautical%29), with [deck officers](http://en.wikipedia.org/wiki/Deck_officer) and [marine engineers](http://en.wikipedia.org/wiki/Marine_engineer) on larger vessels. Special-purpose vessels often have specialized crew if necessary, for example scientists aboard [research vessels](http://en.wikipedia.org/wiki/Research_vessel).

Commercial vessels are typically powered by a single propeller driven by a [diesel](http://en.wikipedia.org/wiki/Diesel_engine) or, less usually, [gas turbine engine](http://en.wikipedia.org/wiki/Gas_turbine_engine). The fastest vessels may use [pump-jet engines](http://en.wikipedia.org/wiki/Pump-jet_engine).

**Naval vessels**

Main article: [Naval ship](http://en.wikipedia.org/wiki/Naval_ship)

American [aircraft carrier](http://en.wikipedia.org/wiki/Aircraft_carrier) *Harry S. Truman* and a [replenishment ship](http://en.wikipedia.org/wiki/Replenishment_ship)

Naval vessels are those used by a [navy](http://en.wikipedia.org/wiki/Navy) for [military](http://en.wikipedia.org/wiki/Military) purposes. There have been many [types of naval vessel](http://en.wikipedia.org/wiki/List_of_types_of_naval_vessels). Modern naval vessels can be broken down into three categories: [surface warships](http://en.wikipedia.org/wiki/List_of_naval_ship_classes_in_service), [submarines](http://en.wikipedia.org/wiki/List_of_submarine_classes_in_service), and [support and auxiliary vessels](http://en.wikipedia.org/wiki/List_of_auxiliary_ship_classes_in_service).

Modern warships are generally divided into seven main categories: [aircraft carriers](http://en.wikipedia.org/wiki/Aircraft_carrier), [cruisers](http://en.wikipedia.org/wiki/Cruiser), [destroyers](http://en.wikipedia.org/wiki/Destroyer), [frigates](http://en.wikipedia.org/wiki/Frigate), [corvettes](http://en.wikipedia.org/wiki/Corvette), [submarines](http://en.wikipedia.org/wiki/Submarine) and [amphibious assault ships](http://en.wikipedia.org/wiki/Amphibious_assault_ship). The distinction between cruisers, destroyers, frigates, and corvettes is not rigorous; the same vessel may be described differently in different navies. [Battleships](http://en.wikipedia.org/wiki/Battleship) were used during the [Second World War](http://en.wikipedia.org/wiki/Second_World_War) and occasionally since then (the last battleships were removed from the [U.S. Naval Vessel Register](http://en.wikipedia.org/wiki/U.S._Naval_Vessel_Register) in March 2006), but were made obsolete by the use of carrier-borne aircraft and [guided missiles](http://en.wikipedia.org/wiki/Guided_missile).

Most military submarines are either [attack submarines](http://en.wikipedia.org/wiki/Attack_submarine) or [ballistic missile submarines](http://en.wikipedia.org/wiki/Ballistic_missile_submarine). Until the end of [World War II](http://en.wikipedia.org/wiki/World_War_II) the primary role of the diesel/electric submarine was anti-ship warfare, inserting and removing covert agents and military forces, and intelligence-gathering. With the development of the homing torpedo, better [sonar](http://en.wikipedia.org/wiki/Sonar) systems, and [nuclear propulsion](http://en.wikipedia.org/wiki/Nuclear_navy), submarines also became able to effectively hunt each other. The development of [submarine-launched nuclear](http://en.wikipedia.org/wiki/Submarine-launched_ballistic_missile) and [cruise missiles](http://en.wikipedia.org/wiki/Cruise_missiles) gave submarines a substantial and long-ranged ability to attack both land and sea targets with a variety of weapons ranging from [cluster bombs](http://en.wikipedia.org/wiki/Cluster_bomb) to [nuclear weapons](http://en.wikipedia.org/wiki/Nuclear_weapon).

Most [navies](http://en.wikipedia.org/wiki/Navy) also include many types of support and auxiliary vessel, such as [minesweepers](http://en.wikipedia.org/wiki/Minesweeper_%28ship%29), [patrol boats](http://en.wikipedia.org/wiki/Patrol_boat), [offshore patrol vessels](http://en.wikipedia.org/wiki/OPV_%28naval%29), [replenishment ships](http://en.wikipedia.org/wiki/Replenishment_ship), and [hospital ships](http://en.wikipedia.org/wiki/Hospital_ship) which are designated [medical treatment](http://en.wikipedia.org/wiki/Healthcare) facilities.

Fast combat vessels such as cruisers and destroyers usually have fine hulls to maximize speed and maneuverability. They also usually have advanced electronics and communication systems, as well as weapons.

**Fishing vessels**

Main article: [Fishing vessels](http://en.wikipedia.org/wiki/Fishing_vessels)

The *Albatun Dos*, a tuna boat at work near [Victoria, Seychelles](http://en.wikipedia.org/wiki/Victoria%2C_Seychelles)

Fishing vessels are a subset of commercial vessels, but generally small in size and often subject to different regulations and classification. They can be categorized by several criteria: architecture, the type of fish they catch, the fishing method used, geographical origin, and technical features such as rigging. As of 2004, the world's fishing fleet consisted of some 4 million vessels. Of these, 1.3 million were decked vessels with enclosed areas and the rest were open vessels. Most decked vessels were mechanized, but two-thirds of the open vessels were traditional craft propelled by sails and oars. More than 60% of all existing large fishing vessels were built in Japan, Peru, the Russian Federation, Spain or the United States of America.

Fishing boats are generally small, often little more than 30 meters (98 ft) but up to 100 meters (330 ft) for a large tuna or [whaling ship](http://en.wikipedia.org/wiki/Whaling_ship). Aboard a [fish processing vessel](http://en.wikipedia.org/wiki/Fish_processing_vessel), the catch can be made ready for market and sold more quickly once the ship makes port. Special purpose vessels have special gear. For example, trawlers have winches and arms, stern-trawlers have a rear ramp, and tuna seiners have skiffs.

In 2004, 85,800,000 [tons](http://en.wikipedia.org/wiki/Tonne) (84,400,000 [long tons](http://en.wikipedia.org/wiki/Long_ton); 94,600,000 [short tons](http://en.wikipedia.org/wiki/Short_ton)) of fish were caught in the marine capture fishery. [Anchoveta](http://en.wikipedia.org/wiki/Anchoveta) represented the largest single catch at 10,700,000 tons (10,500,000 long tons; 11,800,000 short tons). That year, the top ten marine capture species also included [Alaska pollock](http://en.wikipedia.org/wiki/Alaska_pollock), [Blue whiting](http://en.wikipedia.org/wiki/Blue_whiting), [Skipjack tuna](http://en.wikipedia.org/wiki/Skipjack_tuna), [Atlantic herring](http://en.wikipedia.org/wiki/Atlantic_herring), [Chub mackerel](http://en.wikipedia.org/wiki/Chub_mackerel), [Japanese anchovy](http://en.wikipedia.org/wiki/Anchovy), [Chilean jack mackerel](http://en.wikipedia.org/wiki/Trachurus), [Largehead hairtail](http://en.wikipedia.org/wiki/Largehead_hairtail), and [Yellowfin tuna](http://en.wikipedia.org/wiki/Yellowfin_tuna). Other species including [salmon](http://en.wikipedia.org/wiki/Salmon), [shrimp](http://en.wikipedia.org/wiki/Shrimp), [lobster](http://en.wikipedia.org/wiki/Lobster), [clams](http://en.wikipedia.org/wiki/Clam), [squid](http://en.wikipedia.org/wiki/Squid) and [crab](http://en.wikipedia.org/wiki/Crab), are also commercially fished.

Modern commercial fishermen use many methods. One is fishing by [nets](http://en.wikipedia.org/wiki/Fishing_net), such as [purse seine](http://en.wikipedia.org/wiki/Seine_fishing), beach seine, lift nets, [gillnets](http://en.wikipedia.org/wiki/Gillnet), or entangling nets. Another is [trawling](http://en.wikipedia.org/wiki/Trawl), including [bottom trawl](http://en.wikipedia.org/wiki/Bottom_trawling). [Hooks](http://en.wikipedia.org/wiki/Fish_hook) and lines are used in methods like [long-line fishing](http://en.wikipedia.org/wiki/Long-line_fishing) and [hand-line fishing](http://en.wikipedia.org/wiki/Hand-line_fishing). Another method is the use of [fishing trap](http://en.wikipedia.org/wiki/Fishing_trap).

**Weather vessels**

Main article: [Weather ship](http://en.wikipedia.org/wiki/Weather_ship)

The weather ship [MS *Polarfront*](http://en.wikipedia.org/wiki/MS_Polarfront) at sea.

A [weather ship](http://en.wikipedia.org/wiki/Weather_ship) was a ship stationed in the [ocean](http://en.wikipedia.org/wiki/Ocean) as a platform for surface and upper air meteorological observations for use in [marine weather forecasting](http://en.wikipedia.org/wiki/Marine_weather_forecasting). Surface weather observations were taken hourly, and four radiosonde releases occurred daily. It was also meant to aid in search and rescue operations and to support transatlantic flights. Proposed as early as 1927 by the [aviation](http://en.wikipedia.org/wiki/Aviation) community, the establishment of weather ships proved to be so useful during [World War II](http://en.wikipedia.org/wiki/World_War_II) that the [International Civil Aviation Organization](http://en.wikipedia.org/wiki/International_Civil_Aviation_Organization) (ICAO) established a global network of weather ships in 1948, with 13 to be supplied by the United States. This number was eventually negotiated down to nine.

Their crews were normally out to sea for three weeks at a time, returning to port for 10 day stretches. Weather ship observations proved to be helpful in wind and wave studies, as they did not avoid weather systems like other ships tended to for safety reasons. They were also helpful in monitoring storms at sea, such as [tropical cyclones](http://en.wikipedia.org/wiki/Tropical_cyclone). The removal of a weather ship became a negative factor in forecasts leading up to the [Great Storm of 1987](http://en.wikipedia.org/wiki/Great_Storm_of_1987). Beginning in the 1970s, their role became largely superseded by [weather buoys](http://en.wikipedia.org/wiki/Weather_buoy) due to the ships' significant cost. The agreement of the use of weather ships by the international community ended in 1990. The last weather ship was [*Polarfront*](http://en.wikipedia.org/wiki/Polarfront), known as weather station M ("Mike"), which was put out of operation on 1 January 2010. Weather observations from ships continue from a fleet of [voluntary merchant vessels](http://en.wikipedia.org/wiki/Voluntary_observing_ship_program) in routine commercial operation.

**Inland and coastal boats**

See also: [Riverboat](http://en.wikipedia.org/wiki/Riverboat) and [Barge](http://en.wikipedia.org/wiki/Barge)

Passenger ship of [Köln-Düsseldorfer](http://en.wikipedia.org/wiki/K%C3%B6ln-D%C3%BCsseldorfer) on the river [Rhine](http://en.wikipedia.org/wiki/Rhine)

Many types of boats and ships are designed for inland and coastal waterways. These are the vessels that trade upon the lakes, rivers and canals.

Barges are a prime example of inland vessels. Flat-bottomed boats built to transport heavy goods, most barges are not self-propelled and need to be moved by [tugboats](http://en.wikipedia.org/wiki/Tugboat) towing or [towboats](http://en.wikipedia.org/wiki/Towboats) pushing them. Barges towed along canals by draft animals on an adjacent [towpath](http://en.wikipedia.org/wiki/Towpath) contended with the [railway](http://en.wikipedia.org/wiki/Railway) in the early [industrial revolution](http://en.wikipedia.org/wiki/Industrial_revolution) but [were out competed](http://en.wikipedia.org/wiki/History_of_the_British_canal_system) in the carriage of high value items because of the higher speed, falling costs, and route flexibility of [rail transport](http://en.wikipedia.org/wiki/Rail_transport).

[Riverboats](http://en.wikipedia.org/wiki/Riverboat) and [inland ferries](http://en.wikipedia.org/wiki/Ferry_boat) are specially designed to carry passengers, cargo, or both in the challenging river environment. Rivers present special hazards to vessels. They usually have varying water flows that alternately lead to high speed water flows or protruding rock hazards. Changing siltation patterns may cause the sudden appearance of shoal waters, and often floating or sunken logs and trees (called snags) can endanger the hulls and propulsion of riverboats. Riverboats are generally of shallow draft, being broad of beam and rather square in plan, with a low freeboard and high topsides. Riverboats can survive with this type of configuration as they do not have to withstand the high winds or large waves that are seen on large lakes, seas, or oceans.

[Lake freighters](http://en.wikipedia.org/wiki/Lake_freighter), also called lakers, are [cargo](http://en.wikipedia.org/wiki/Cargo) vessels that ply the [Great Lakes](http://en.wikipedia.org/wiki/Great_Lakes). The most well-known is the [SS *Edmund Fitzgerald*](http://en.wikipedia.org/wiki/SS_Edmund_Fitzgerald), the latest major vessel to be wrecked on the Lakes. These vessels are traditionally called boats, not ships. Visiting ocean-going vessels are called "salties." Because of their additional [beam](http://en.wikipedia.org/wiki/Beam_%28nautical%29), very large salties are never seen inland of the [Saint Lawrence Seaway](http://en.wikipedia.org/wiki/Saint_Lawrence_Seaway). Because the smallest of the [Soo Locks](http://en.wikipedia.org/wiki/Soo_Locks) is larger than any Seaway lock, salties that can pass through the Seaway may travel anywhere in the Great Lakes. Because of their deeper draft, salties may accept partial loads on the Great Lakes, "topping off" when they have exited the Seaway. Similarly, the largest lakers are confined to the Upper Lakes ([Superior](http://en.wikipedia.org/wiki/Lake_Superior), [Michigan](http://en.wikipedia.org/wiki/Lake_Michigan), [Huron](http://en.wikipedia.org/wiki/Lake_Huron), [Erie](http://en.wikipedia.org/wiki/Lake_Erie)) because they are too large to use the Seaway locks, beginning at the [Welland Canal](http://en.wikipedia.org/wiki/Welland_Canal) that bypasses the [Niagara River](http://en.wikipedia.org/wiki/Niagara_River).

Since the [freshwater](http://en.wikipedia.org/wiki/Freshwater) lakes are less corrosive to ships than the [salt water](http://en.wikipedia.org/wiki/Seawater) of the oceans, lakers tend to last much longer than ocean freighters. Lakers older than 50 years are not unusual, and as of 2005, all were over 20 years of age.

The *St. Mary's Challenger*, built in 1906 as the *William P Snyder*, is the oldest laker still working on the Lakes. Similarly, the *E.M. Ford*, built in 1898 as the *Presque Isle*, was sailing the lakes 98 years later in 1996. As of 2007 the *Ford* was still afloat as a stationary transfer vessel at a riverside cement silo in [Saginaw, Michigan](http://en.wikipedia.org/wiki/Saginaw%2C_Michigan).

**Architecture**

*Further information:* [*Naval architecture*](http://en.wikipedia.org/wiki/Naval_architecture)

Some components exist in vessels of any size and purpose. Every vessel has a hull of sorts. Every vessel has some sort of propulsion, whether it's a pole, an ox, or a nuclear reactor. Most vessels have some sort of steering system. Other characteristics are common, but not as universal, such as compartments, holds, a superstructure, and equipment such as anchors and winches.

**Hull**

A ship's hull endures harsh conditions at sea, as illustrated by this [reefer ship](http://en.wikipedia.org/wiki/Reefer_ship) in bad weather.

For a ship to float, its weight must be less than that of the water displaced by the ship's hull. There are many types of hulls, from logs lashed together to form a raft to the advanced hulls of [America's Cup](http://en.wikipedia.org/wiki/America%27s_Cup) sailboats. A vessel may have a single hull (called a monohull design), two in the case of [catamarans](http://en.wikipedia.org/wiki/Catamaran), or three in the case of [trimarans](http://en.wikipedia.org/wiki/Trimaran). Vessels with more than three hulls are rare, but some experiments have been conducted with designs such as pentamarans. Multiple hulls are generally parallel to each other and connected by rigid arms.

Hulls have several elements. The [bow](http://en.wikipedia.org/wiki/Bow_%28ship%29) is the foremost part of the hull. Many ships feature a [bulbous bow](http://en.wikipedia.org/wiki/Bulbous_bow). The [keel](http://en.wikipedia.org/wiki/Keel) is at the very bottom of the hull, extending the entire length of the ship. The rear part of the hull is known as the [stern](http://en.wikipedia.org/wiki/Stern), and many hulls have a flat back known as a [transom](http://en.wikipedia.org/wiki/Transom_%28nautical%29). Common hull appendages include [propellers](http://en.wikipedia.org/wiki/Propeller) for propulsion, [rudders](http://en.wikipedia.org/wiki/Rudder) for steering, and [stabilizers](http://en.wikipedia.org/wiki/Stabilizer_%28ship%29) to quell a ship's rolling motion. Other hull features can be related to the vessel's work, such as fishing gear and [sonar domes](http://en.wikipedia.org/wiki/Sonar).

Hulls are subject to various hydrostatic and hydrodynamic constraints. The key hydrostatic constraint is that it must be able to support the entire weight of the boat, and maintain stability even with often unevenly distributed weight. Hydrodynamic constraints include the ability to withstand shock waves, weather collisions and groundings.

Older ships and pleasure craft often have or had wooden hulls. Steel is used for most commercial vessels. Aluminum is frequently used for fast vessels, and [composite materials](http://en.wikipedia.org/wiki/Composite_material) are often found in sailboats and pleasure craft. Some ships have been made with [concrete hulls](http://en.wikipedia.org/wiki/Concrete_ship).

**Propulsion systems**

A ship's engine room

Main article: [Marine propulsion](http://en.wikipedia.org/wiki/Marine_propulsion)

Propulsion systems for ships fall into three categories: human propulsion, [sailing](http://en.wikipedia.org/wiki/Sailing), and mechanical propulsion. Human propulsion includes [rowing](http://en.wikipedia.org/wiki/Watercraft_rowing), which was used even on large [galleys](http://en.wikipedia.org/wiki/Galley). Propulsion by sail generally consists of a sail hoisted on an erect mast, supported by stays and spars and controlled by ropes. Sail systems were the dominant form of propulsion until the 19th century. They are now generally used for recreation and competition, although [experimental sail systems](http://en.wikipedia.org/wiki/Future_Boat_Developments), such as the [turbosails](http://en.wikipedia.org/wiki/Turbosail), [rotorsails](http://en.wikipedia.org/wiki/Rotorsail), and [wingsails](http://en.wikipedia.org/wiki/Wingsail) have been used on larger modern vessels for fuel savings.

Mechanical propulsion systems generally consist of a motor or engine turning a [propeller](http://en.wikipedia.org/wiki/Propeller), or less frequently, an [impeller](http://en.wikipedia.org/wiki/Impeller) or [wave propulsion fins](http://en.wikipedia.org/wiki/Wave_power_ship). [Steam engines](http://en.wikipedia.org/wiki/Steam_engine) were first used for this purpose, but have mostly been replaced by [two-stroke](http://en.wikipedia.org/wiki/Two-stroke_engine) or [four-stroke](http://en.wikipedia.org/wiki/Four-stroke_engine) diesel engines, outboard motors, and [gas turbine engines](http://en.wikipedia.org/wiki/Gas_turbine_engine) on faster ships. [Nuclear reactors](http://en.wikipedia.org/wiki/Nuclear_marine_propulsion) producing steam are used to propel [warships](http://en.wikipedia.org/wiki/Warship) and [icebreakers](http://en.wikipedia.org/wiki/Icebreaker), and there have been attempts to utilize them to power commercial vessels (see [NS *Savannah*](http://en.wikipedia.org/wiki/NS_Savannah)).

In addition to traditional fixed and controllable pitch propellers there are many specialized variations, such as contra-rotating and nozzle-style propellers. Most vessels have a single propeller, but some large vessels may have up to four propellers supplemented with [transverse thrusters](http://en.wikipedia.org/wiki/Bow_thruster) for maneuvering at ports. The propeller is connected to the main engine via a propeller shaft and, in case of medium- and high-speed engines, a reduction gearbox. Some modern vessels have a [diesel-electric powertrain](http://en.wikipedia.org/wiki/Diesel-electric_transmission) in which the propeller is turned by an [electric motor](http://en.wikipedia.org/wiki/Electric_motor) powered by the ship's generators.

**Steering systems**

The rudder and propeller on a newly built [ferry](http://en.wikipedia.org/wiki/Ferryboat)

For ships with independent propulsion systems for each side, such as manual oars or some [paddles](http://en.wikipedia.org/wiki/Paddle_steamer), steering systems may not be necessary. In most designs, such as boats propelled by engines or sails, a steering system becomes necessary. The most common is a rudder, a submerged plane located at the rear of the hull. Rudders are rotated to generate a lateral force which turns the boat. Rudders can be rotated by a [tiller](http://en.wikipedia.org/wiki/Tiller), manual wheels, or electro-hydraulic systems. [Autopilot](http://en.wikipedia.org/wiki/Autopilot) systems combine mechanical rudders with navigation systems. [Ducted propellers](http://en.wikipedia.org/wiki/Ducted_propeller) are sometimes used for steering.

Some propulsion systems are inherently steering systems. Examples include the [outboard motor](http://en.wikipedia.org/wiki/Outboard_motor), the [bow thruster](http://en.wikipedia.org/wiki/Bow_thruster), and the [Z-drive](http://en.wikipedia.org/wiki/Z-drive). Some sails, such as jibs and the [mizzen sail](http://en.wikipedia.org/wiki/Mizzen) on a [ketch rig](http://en.wikipedia.org/wiki/Ketch_rig), are used more for steering than propulsion.

**Holds, compartments, and the superstructure**

Larger boats and ships generally have multiple decks and compartments. Separate [berthing’s](http://en.wikipedia.org/wiki/Berthing) and [heads](http://en.wikipedia.org/wiki/Head_%28watercraft%29) are found on sailboats over about 25 feet (7.6 m). Fishing boats and cargo ships typically have one or more cargo holds. Most larger vessels have an engine room, a [galley](http://en.wikipedia.org/wiki/Galley_%28kitchen%29), and various compartments for work. Tanks are used to store fuel, engine oil, and fresh water. Ballast tanks are equipped to change a ship's trim and modify its stability.

Superstructures are found above the main deck. On sailboats, these are usually very low. On modern cargo ships, they are almost always located near the ship's stern. On passenger ships and warships, the superstructure generally extends far forward.

**Equipment**

Shipboard equipment varies from ship to ship depending on such factors as the ship's era, design, area of operation, and purpose. Some types of equipment that are widely found include:

* [Masts](http://en.wikipedia.org/wiki/Mast_%28sail%29) can be the home of antennas, navigation lights, radar transponders, fog signals, and similar devices often required by law.
* [Ground tackle](http://en.wikipedia.org/wiki/Ground_tackle) includes equipment such as mooring winches, windlasses, and anchors. Anchors are used to [moor](http://en.wikipedia.org/wiki/Mooring_%28watercraft%29) ships in shallow water. They are connected to the ship by a rope or chain. On larger vessels, the chain runs through a [hawsepipe](http://en.wikipedia.org/wiki/Hawsepipe).
* Cargo equipment such as [cranes](http://en.wikipedia.org/wiki/Crane_%28machine%29) and [cargo booms](http://en.wikipedia.org/w/index.php?title=Cargo_boom&action=edit&redlink=1) are used to load and unload cargo and ship's stores.
* Safety equipment such as [lifeboats](http://en.wikipedia.org/wiki/Lifeboat_%28shipboard%29), [liferafts](http://en.wikipedia.org/wiki/Liferaft), and [survival suits](http://en.wikipedia.org/wiki/Survival_suit) are carried aboard many vessels for emergency use.

**Design considerations**

**Hydrostatics**

Some vessels, like the [LCAC](http://en.wikipedia.org/wiki/Air-cushioned_landing_craft), can operate in a non-displacement mode.

Boats and ships are kept on (or slightly above) the water in three ways:

* For most vessels, known as displacement vessels, the vessel's weight is offset by that of the water displaced by the hull.
* For planing ships and boats, such as the hydrofoil, the lift developed by the movement of the foil through the water increases with the vessel's speed, until the vessel is foilborne.
* For non-displacement craft such as [hovercraft](http://en.wikipedia.org/wiki/Hovercraft) and [air-cushion vehicles](http://en.wikipedia.org/wiki/Air-cushion_vehicle), the vessel is suspended over the water by a cushion of high-pressure air it projects downwards against the surface of the water.

A vessel is in equilibrium when the upwards and downwards forces are of equal magnitude. As a vessel is lowered into the water its weight remains constant but the corresponding weight of water displaced by its hull increases. When the two forces are equal, the boat floats. If weight is evenly distributed throughout the vessel, it floats without trim or heel.

A vessel's stability is considered in both this [hydrostatic](http://en.wikipedia.org/wiki/Initial_stability) sense as well as a [hydrodynamic](http://en.wikipedia.org/wiki/Ship_stability) sense, when subjected to movement, rolling and pitching, and the action of waves and wind. Stability problems can lead to excessive pitching and rolling, and eventually capsizing and sinking.

**Hydrodynamics**

Fishing boat *Dona Delfina*

The advance of a vessel through water is resisted by the water. This resistance can be broken down into several components, the main ones being the friction of the water on the hull and [wave making resistance](http://en.wikipedia.org/wiki/Wave_making_resistance). To reduce resistance and therefore increase the speed for a given power, it is necessary to reduce the wetted surface and use submerged hull shapes that produce low amplitude waves. To do so, high-speed vessels are often more slender, with fewer or smaller appendages. The friction of the water is also reduced by regular maintenance of the hull to remove the sea creatures and algae that accumulate there. [Antifouling](http://en.wikipedia.org/wiki/Antifouling) paint is commonly used to assist in this. Advanced designs such as the [bulbous bow](http://en.wikipedia.org/wiki/Bulbous_bow) assist in decreasing wave resistance.

A simple way of considering wave-making resistance is to look at the hull in relation to its wake. At speeds lower than the wave propagation speed, the wave rapidly dissipates to the sides. As the hull approaches the wave propagation speed, however, the wake at the bow begins to build up faster than it can dissipate, and so it grows in [amplitude](http://en.wikipedia.org/wiki/Amplitude). Since the water is not able to "get out of the way of the hull fast enough", the hull, in essence, has to climb over or push through the bow wave. This results in an [exponential](http://en.wikipedia.org/wiki/Exponential_function) increase in resistance with increasing speed.

This [hull speed](http://en.wikipedia.org/wiki/Hull_speed) is found by the formula:

or, in [metric](http://en.wikipedia.org/wiki/Metric_system) units:

where *L* is the length of the waterline in feet or meters.

When the vessel exceeds a speed/length ratio of 0.94, it starts to outrun most of its [bow wave](http://en.wikipedia.org/wiki/Bow_wave), and the hull actually settles slightly in the water as it is now only supported by two wave peaks. As the vessel exceeds a speed/length ratio of 1.34, the hull speed, the wavelength is now longer than the hull, and the stern is no longer supported by the wake, causing the stern to squat, and the bow rise. The hull is now starting to climb its own bow wave, and resistance begins to increase at a very high rate. While it is possible to drive a displacement hull faster than a speed/length ratio of 1.34, it is prohibitively expensive to do so. Most large vessels operate at speed/length ratios well below that level, at speed/length ratios of under 1.0.

Vessels move along the three axes: 1. heave, 2. sway, 3. surge, 4. yaw, 5. pitch, 6. roll

For large projects with adequate funding, hydrodynamic resistance can be tested experimentally in a hull testing pool or using tools of [computational fluid dynamics](http://en.wikipedia.org/wiki/Computational_fluid_dynamics).

Vessels are also subject to [ocean surface waves](http://en.wikipedia.org/wiki/Ocean_surface_wave) and [sea swell](http://en.wikipedia.org/wiki/Sea_swell) as well as effects of [wind](http://en.wikipedia.org/wiki/Wind) and [weather](http://en.wikipedia.org/wiki/Weather). These movements can be stressful for passengers and equipment, and must be controlled if possible. The rolling movement can be controlled, to an extent, by ballasting or by devices such as [fin stabilizers](http://en.wikipedia.org/wiki/Stabilizer_%28ship%29). Pitching movement is more difficult to limit and can be dangerous if the bow submerges in the waves, a phenomenon called pounding. Sometimes, ships must change course or speed to stop violent rolling or pitching.

**Lifecycle**

A ship will pass through several stages during its career. The first is usually an initial contract to build the ship, the details of which can vary widely based on relationships between the [shipowners](http://en.wikipedia.org/wiki/Shipowner), operators, [designers](http://en.wikipedia.org/wiki/Naval_architect) and the [shipyard](http://en.wikipedia.org/wiki/Shipyard). Then, the design phase carried out by a naval architect. Then the ship is constructed in a shipyard. After construction, the vessel is launched and goes into service. Ships end their careers in a number of ways, ranging from [shipwrecks](http://en.wikipedia.org/wiki/Shipwreck) to service as a [museum ship](http://en.wikipedia.org/wiki/Museum_ship) to [the scrapyard](http://en.wikipedia.org/wiki/Ship_breaking).

Lines plan for the hull of a basic [cargo ship](http://en.wikipedia.org/wiki/Cargo_ship)

**Design**

See also: [Naval architecture](http://en.wikipedia.org/wiki/Naval_architecture)

A vessel's design starts with a specification, which a [naval architect](http://en.wikipedia.org/wiki/Naval_architect) uses to create a project outline, assess required dimensions, and create a basic layout of spaces and a rough displacement. After this initial rough draft, the architect can create an initial hull design, a general profile and an initial overview of the ship's propulsion. At this stage, the designer can iterate on the ship's design, adding detail and refining the design at each stage.

The designer will typically produce an overall plan, a general specification describing the peculiarities of the vessel, and construction blueprints to be used at the building site. Designs for larger or more complex vessels may also include sail plans, electrical schematics, and plumbing and ventilation plans.

As environmental laws are strictening, ship designers need to create their design in such a way that the ship -when it nears its end-of-term- can be [disassembled](http://en.wikipedia.org/wiki/Ship_breaking) or [disposed](http://en.wikipedia.org/wiki/Ship_disposal) easily and that waste is reduced to a minimum.

[MS *Freedom of the Seas*](http://en.wikipedia.org/wiki/MS_Freedom_of_the_Seas) under construction in a shipyard in [Turku](http://en.wikipedia.org/wiki/Turku).

**Construction**

Main article: [Shipbuilding](http://en.wikipedia.org/wiki/Shipbuilding)

Ship construction takes place in a [shipyard](http://en.wikipedia.org/wiki/Shipyard), and can last from a few months for a unit produced in series, to several years to reconstruct a wooden boat like the frigate *Hermione*, to more than 10 years for an aircraft carrier. Hull materials and vessel size play a large part in determining the method of construction. The hull of a mass-produced fiberglass sailboat is constructed from a mold, while the steel hull of a cargo ship is made from large sections welded together as they are built.

A [ship launching](http://en.wikipedia.org/wiki/Ship_naming_and_launching) at the Northern Shipyard in [Gdansk, Poland](http://en.wikipedia.org/wiki/Gdansk%2C_Poland)

A shipyard at [Kerala](http://en.wikipedia.org/wiki/Kerala), Southern India

Generally, construction starts with the hull, and on vessels over about 30 meters (98 ft), by the laying of the keel. This is done in a [drydock](http://en.wikipedia.org/wiki/Drydock) or on land. Once the hull is assembled and painted, it is launched. The last stages, such as raising the superstructure and adding equipment and accommodation, can be done after the vessel is afloat.

Once completed, the vessel is delivered to the customer. [Ship launching](http://en.wikipedia.org/wiki/Ship_naming_and_launching) is often a ceremony of some significance, and is usually when the vessel is formally named. A typical small rowboat can cost under US$100, $1,000 for a small speedboat, tens of thousands of dollars for a cruising sailboat, and about $2,000,000 for a [Vendée Globe](http://en.wikipedia.org/wiki/Vend%C3%A9e_Globe) class sailboat. A 25 meters (82 ft) trawler may cost $2.5 million, and a 1,000-person-capacity high-speed passenger ferry can cost in the neighborhood of $50 million. A ship's cost partly depends on its complexity: a small, [general cargo ship](http://en.wikipedia.org/wiki/General_cargo_ship) will cost $20 million, a [Panamax](http://en.wikipedia.org/wiki/Panamax)-sized [bulk carrier](http://en.wikipedia.org/wiki/Bulk_carrier) around $35 million, a [supertanker](http://en.wikipedia.org/wiki/Supertanker) around $105 million and a large [LNG carrier](http://en.wikipedia.org/wiki/LNG_carrier) nearly $200 million. The most expensive ships generally are so because of the cost of embedded electronics: a [*Seawolf*-class](http://en.wikipedia.org/wiki/Seawolf_class_submarine) [submarine](http://en.wikipedia.org/wiki/Submarine) costs around $2 billion, and an aircraft carrier goes for about $3.5 billion.

**Repair and conversion**

An [able seaman](http://en.wikipedia.org/wiki/Able_seaman) uses a [needlegun scaler](http://en.wikipedia.org/wiki/Needlegun_scaler) while refurbishing a mooring winch at sea

Ships undergo nearly constant maintenance during their career, whether they be underway, pier side, or in some cases, in periods of reduced operating status between charters or shipping seasons.

Most ships, however, require trips to special facilities such as a [drydock](http://en.wikipedia.org/wiki/Drydock) at regular intervals. Tasks often done at drydock include removing biological growths on the hull, [sandblasting](http://en.wikipedia.org/wiki/Sandblasting) and repainting the hull, and replacing [sacrificial anodes](http://en.wikipedia.org/wiki/Sacrificial_anode) used to protect submerged equipment from corrosion. Major repairs to the propulsion and steering systems as well as major electrical systems are also often performed at dry dock.

Vessels that sustain major damage at sea may be repaired at a facility equipped for major repairs, such as a shipyard. Ships may also be converted for a new purpose: [oil tankers](http://en.wikipedia.org/wiki/Oil_tanker) are often converted into [floating production storage and offloading units](http://en.wikipedia.org/wiki/Floating_production_storage_and_offloading_unit).

A ship graveyard in France

**End of service**

Main article: [Ship disposal](http://en.wikipedia.org/wiki/Ship_disposal)

Most ocean-going cargo ships have a life expectancy of between 20 and 30 years. A sailboat made of plywood or fiberglass can last between 30 and 40 years. Solid wooden ships can last much longer but require regular maintenance. Carefully maintained steel-hulled yachts can have a lifespan of over 100 years.

As ships age, forces such as corrosion, osmosis, and rotting compromise hull strength, and a vessel becomes too dangerous to sail. At this point, it can be [scuttled](http://en.wikipedia.org/wiki/Scuttling) at sea or [scrapped](http://en.wikipedia.org/wiki/Ship_breaking) by [shipbreakers](http://en.wikipedia.org/wiki/Ship_breaking). Ships can also be used as [museum ships](http://en.wikipedia.org/wiki/Museum_ships), or expended to construct [breakwaters](http://en.wikipedia.org/wiki/Breakwater_%28structure%29) or [artificial reefs](http://en.wikipedia.org/wiki/Artificial_reef).

Many ships do not make it to the scrapyard, and are lost in fires, collisions, [grounding](http://en.wikipedia.org/wiki/Ship_grounding), or sinking at sea. There are more than 3 million [shipwrecks](http://en.wikipedia.org/wiki/Shipwreck) on the ocean floor, the United Nations estimates. The Allies lost some 5,150 ships during [World War II](http://en.wikipedia.org/wiki/World_War_II).

**Measuring ships**

One can [measure ships](http://en.wikipedia.org/wiki/Molded_depth) in terms of overall length, length of the ship at the waterline, beam (breadth), depth (distance between the crown of the weather deck and the top of the keelson), [draft](http://en.wikipedia.org/wiki/Draft_%28hull%29) (distance between the highest waterline and the bottom of the ship) and [tonnage](http://en.wikipedia.org/wiki/Tonnage). A number of different tonnage definitions exist and are used when describing merchant ships for the purpose of tolls, taxation, etc.

In Britain until Samuel Plimsoll's [Merchant Shipping Act of 1876](http://en.wikipedia.org/w/index.php?title=Merchant_Shipping_Act_of_1876&action=edit&redlink=1), ship-owners could load their vessels until their decks were almost awash, resulting in a dangerously unstable condition. Anyone who signed on to such a ship for a voyage and, upon realizing the danger, chose to leave the ship, could end up in [jail](http://en.wikipedia.org/wiki/Jail). Plimsoll, a [Member of Parliament](http://en.wikipedia.org/wiki/Member_of_Parliament), realized the problem and engaged some [engineers](http://en.wikipedia.org/wiki/Engineer) to derive a fairly simple [formula](http://en.wikipedia.org/wiki/Formula) to determine the position of a line on the side of any specific ship's hull which, when it reached the surface of the water during loading of cargo, meant the ship had reached its maximum safe loading level. To this day, that mark, called the "[Plimsoll Line](http://en.wikipedia.org/wiki/Waterline)", exists on ships' sides, and consists of a [circle](http://en.wikipedia.org/wiki/Circle) with a horizontal line through the center. On the Great Lakes of North America the circle is replaced with a diamond. Because different types of water (summer, fresh, tropical fresh, winter north Atlantic) have different densities, subsequent regulations required painting a group of lines forward of the Plimsoll mark to indicate the safe depth (or freeboard above the surface) to which a specific ship could load in water of various densities. Hence the "ladder" of lines seen forward of the Plimsoll mark to this day. This is called the "[freeboard mark](http://en.wikipedia.org/wiki/Freeboard_mark)" or "[load line mark](http://en.wikipedia.org/wiki/Waterline#Standard_load_line_marks)" in the [marine industry](http://en.wikipedia.org/wiki/Marine_industry).

**Ship pollution**

Ship pollution is the pollution of air and water by [shipping](http://en.wikipedia.org/wiki/Shipping). It is a problem that has been accelerating as trade has become increasingly globalized, posing an increasing threat to the world’s oceans and waterways as [globalization](http://en.wikipedia.org/wiki/Globalization) continues. It is expected that, “...shipping traffic to and from the [USA](http://en.wikipedia.org/wiki/USA) is projected to double by 2020." Because of increased traffic in ocean [ports](http://en.wikipedia.org/wiki/Port), pollution from ships also directly affects coastal areas. The pollution produced affects [biodiversity](http://en.wikipedia.org/wiki/Biodiversity), climate, food, and human health. However, the degree to which humans are polluting and how it affects the world is highly debated and has been a hot international topic for the past 30 years.

**Oil spills**

Main article: [Oil spill](http://en.wikipedia.org/wiki/Oil_spill)

The [*Exxon Valdez* spilled](http://en.wikipedia.org/wiki/Exxon_Valdez_oil_spill) 10,800,000 US gallons (8,993,000 imp gal; 40,880,000 L) of oil into Alaska's [Prince William Sound](http://en.wikipedia.org/wiki/Prince_William_Sound).

Oil spills have devastating effects on the environment. Crude oil contains [polycyclic aromatic hydrocarbons](http://en.wikipedia.org/wiki/Polycyclic_aromatic_hydrocarbons) (PAHs) which are very difficult to clean up, and last for years in the [sediment](http://en.wikipedia.org/wiki/Sediment) and marine environment. Marine species constantly exposed to PAHs can exhibit developmental problems, susceptibility to disease, and abnormal reproductive cycles.

By the sheer amount of oil carried, modern oil tankers must be considered something of a threat to the environment. An oil tanker can carry 2 million barrels (318,000 m3) of crude oil, or 84,000,000 US gallons (69,940,000 imp gal; 318,000,000 L). This is more than six times the amount spilled in the widely known [*Exxon Valdez* incident](http://en.wikipedia.org/wiki/Exxon_Valdez_oil_spill). In this spill, the ship ran aground and dumped 10,800,000 US gallons (8,993,000 imp gal; 40,880,000 L) of oil into the ocean in March 1989. Despite efforts of scientists, managers, and volunteers, over 400,000 [seabirds](http://en.wikipedia.org/wiki/Seabirds), about 1,000 [sea otters](http://en.wikipedia.org/wiki/Sea_otters), and immense numbers of fish were killed.

The International Tanker Owners Pollution Federation has researched 9,351 accidental spills since 1974. According to this study, most spills result from routine operations such as loading cargo, discharging cargo, and taking on fuel oil. 91% of the operational oil spills were small, resulting in less than 7 tons per spill. Spills resulting from accidents like collisions, groundings, hull failures, and explosions are much larger, with 84% of these involving losses of over 700 tons.

Following the *Exxon Valdez* spill, the United States passed the [Oil Pollution Act of 1990](http://en.wikipedia.org/wiki/Oil_Pollution_Act_of_1990) (OPA-90), which included a stipulation that all tankers entering its waters be [double-hulled](http://en.wikipedia.org/wiki/Double-hulled_tanker) by 2015. Following the sinking of the [*Erika*](http://en.wikipedia.org/wiki/Erika_%28tanker%29) (1999) and [*Prestige*](http://en.wikipedia.org/wiki/Prestige_oil_spill) (2002), the [European Union](http://en.wikipedia.org/wiki/European_Union) passed its own stringent anti-pollution packages (known as Erika I, II, and III), which require all tankers entering its waters to be double-hulled by 2010. The Erika packages are controversial because they introduced the new legal concept of "serious negligence"

**Ballast water**

Main article: [Ballast water discharge and the environment](http://en.wikipedia.org/wiki/Ballast_water_discharge_and_the_environment)

A cargo ship pumps ballast water over the side

When a large vessel such as a [container ship](http://en.wikipedia.org/wiki/Container_ship) or an oil tanker unloads cargo, seawater is pumped into other compartments in the hull to help stabilize and balance the ship. During loading, this ballast water is pumped out from these compartments.

One of the problems with ballast water transfer is the transport of harmful organisms. Meinesz believes that one of the worst cases of a single invasive species causing harm to an ecosystem can be attributed to a seemingly harmless [jellyfish](http://en.wikipedia.org/wiki/Jellyfish). [*Mnemiopsis leidyi*](http://en.wikipedia.org/wiki/Mnemiopsis_leidyi), a species of comb jellyfish that inhabits estuaries from the United States to the Valdés peninsula in [Argentina](http://en.wikipedia.org/wiki/Argentina) along the [Atlantic](http://en.wikipedia.org/wiki/Atlantic) coast, has caused notable damage in the [Black Sea](http://en.wikipedia.org/wiki/Black_Sea). It was first introduced in 1982, and thought to have been transported to the Black Sea in a ship’s ballast water. The population of the jellyfish shot up exponentially and, by 1988, it was wreaking havoc upon the local [fishing](http://en.wikipedia.org/wiki/Fishing) industry. "The [anchovy](http://en.wikipedia.org/wiki/Anchovy) catch fell from 204,000 [tons](http://en.wikipedia.org/wiki/Tonne) (225,000 [short tons](http://en.wikipedia.org/wiki/Short_ton); 201,000 [long tons](http://en.wikipedia.org/wiki/Long_ton)) in 1984 to 200 tons (220 short tons; 197 long tons) in 1993; sprat from 24,600 tons (27,100 short tons; 24,200 long tons) in 1984 to 12,000 tons (13,200 short tons; 11,800 long tons) in 1993; [horse mackerel](http://en.wikipedia.org/wiki/Horse_mackerel_%28disambiguation%29) from 4,000 tons (4,410 short tons; 3,940 long tons) in 1984 to zero in 1993." Now that the jellyfish have exhausted the [zooplankton](http://en.wikipedia.org/wiki/Zooplankton), including fish larvae, their numbers have fallen dramatically, yet they continue to maintain a stranglehold on the [ecosystem](http://en.wikipedia.org/wiki/Ecosystem). Recently the jellyfish have been discovered in the [Caspian Sea](http://en.wikipedia.org/wiki/Caspian_Sea). Invasive species can take over once occupied areas, facilitate the spread of new [diseases](http://en.wikipedia.org/wiki/Diseases), introduce new [genetic](http://en.wikipedia.org/wiki/Genetics) material, alter landscapes and jeopardize the ability of native species to obtain food. "On land and in the sea, invasive species are responsible for about 137 billion dollars in lost revenue and management costs in the U.S. each year."

Ballast and [bilge](http://en.wikipedia.org/wiki/Bilge) discharge from ships can also spread human [pathogens](http://en.wikipedia.org/wiki/Pathogens) and other harmful diseases and [toxins](http://en.wikipedia.org/wiki/Toxins) potentially causing health issues for humans and marine life alike. Discharges into coastal waters, along with other sources of marine pollution, have the potential to be toxic to marine plants, animals, and [microorganisms](http://en.wikipedia.org/wiki/Microorganisms), causing alterations such as changes in growth, disruption of [hormone](http://en.wikipedia.org/wiki/Hormone) cycles, birth defects, suppression of the [immune system](http://en.wikipedia.org/wiki/Immune_system), and disorders resulting in [cancer](http://en.wikipedia.org/wiki/Cancer), [tumors](http://en.wikipedia.org/wiki/Tumors), and genetic abnormalities or even death.

**Exhaust emissions**

Exhaust stack on a container ship.

[Exhaust](http://en.wikipedia.org/wiki/Exhaust_gas) emissions from ships are considered to be a significant source of [air pollution](http://en.wikipedia.org/wiki/Air_pollution). “Seagoing vessels are responsible for an estimated 14 percent of emissions of nitrogen from fossil fuels and 16 percent of the emissions of sulfur from petroleum uses into the atmosphere.” In Europe ships make up a large percentage of the sulfur introduced to the air, “...as much sulfur as all the cars, [lorries](http://en.wikipedia.org/wiki/Lorries) and factories in Europe put together.” “By 2010, up to 40% of air pollution over land could come from ships.” Sulfur in the air creates [acid rain](http://en.wikipedia.org/wiki/Acid_rain) which damages crops and buildings. When inhaled sulfur is known to cause [respiratory](http://en.wikipedia.org/wiki/Respiratory) problems and increase the risk of a [heart attack](http://en.wikipedia.org/wiki/Myocardial_infarction).

**Ship breaking**

Main article: [Ship breaking](http://en.wikipedia.org/wiki/Ship_breaking)

**Ship breaking** or **ship demolition** is a type of [ship disposal](http://en.wikipedia.org/wiki/Ship_disposal) involving the breaking up of ships for [scrap](http://en.wikipedia.org/wiki/Scrap) [recycling](http://en.wikipedia.org/wiki/Recycling), with the hulls being discarded in [ship graveyards](http://en.wikipedia.org/wiki/Ship_graveyard). Most ships have a lifespan of a few decades before there is so much wear that refitting and repair becomes uneconomical. Ship breaking allows materials from the ship, especially steel, to be reused.

Ship breaking near [Chittagong](http://en.wikipedia.org/wiki/Chittagong), [Bangladesh](http://en.wikipedia.org/wiki/Bangladesh)

In addition to steel and other useful materials, however, ships (particularly older vessels) can contain many substances that are banned or considered dangerous in [developed countries](http://en.wikipedia.org/wiki/Developed_countries). [Asbestos](http://en.wikipedia.org/wiki/Asbestos) and [polychlorinated biphenyls](http://en.wikipedia.org/wiki/Polychlorinated_biphenyls) (PCBs) are typical examples. Asbestos was used heavily in ship construction until it was finally banned in most of the developed world in the mid-1980s. Currently, the costs associated with removing asbestos, along with the potentially expensive insurance and health risks, have meant that ship-breaking in most developed countries is no longer economically viable. Removing the metal for scrap can potentially cost more than the scrap value of the metal itself. In the developing world, however, shipyards can operate without the risk of [personal injury lawsuits](http://en.wikipedia.org/wiki/Personal_injury) or [workers' health claims](http://en.wikipedia.org/wiki/Workers%27_compensation), meaning many of these shipyards may operate with high health risks. Protective equipment is sometimes absent or inadequate. Dangerous vapors and fumes from burning materials can be inhaled, and dusty asbestos-laden areas around such breakdown locations are commonplace.

Aside from the health of the yard workers, in recent years, ship breaking has also become an issue of major [environmental concern](http://en.wikipedia.org/wiki/Environmentalism). Many developing nations, in which ship breaking yards are located, have lax or no [environmental law](http://en.wikipedia.org/wiki/Environmental_law), enabling large quantities of highly toxic materials to escape into the environment and causing serious health problems among ship breakers, the local population and wildlife. Environmental campaign groups such as [Greenpeace](http://en.wikipedia.org/wiki/Greenpeace) have made the issue a high priority for their campaigns.

**Buoyancy**

See also: [Buoyancy](http://en.wikipedia.org/wiki/Buoyancy)

A floating boat [displaces](http://en.wikipedia.org/wiki/Displacement_%28fluid%29) its weight in water. The material of the boat hull may be denser than water, but if this is the case then it forms only the outer layer. If the boat floats, the mass of the boat (plus contents) *as a whole* divided by the volume *below the waterline* is equal to the [density](http://en.wikipedia.org/wiki/Density) of water (1 kg/l). If weight is added to the boat, the volume below the waterline will increase to keep the weight balance equal, and so the boat sinks a little to compensate.

**See also**

|  |  |
| --- | --- |
|  | [***Nautical portal***](http://en.wikipedia.org/wiki/Portal%3ANautical) |

* [Airship](http://en.wikipedia.org/wiki/Airship)
* [Chartering (shipping)](http://en.wikipedia.org/wiki/Chartering_%28shipping%29)
* [Dynamic positioning](http://en.wikipedia.org/wiki/Dynamic_positioning)
* [Environmental issues with shipping](http://en.wikipedia.org/wiki/Environmental_issues_with_shipping)
* [Factory ship](http://en.wikipedia.org/wiki/Factory_ship)
* [Ferry](http://en.wikipedia.org/wiki/Ferry)
* [Flag State](http://en.wikipedia.org/wiki/Flag_State)
* [Glossary of nautical terms](http://en.wikipedia.org/wiki/Glossary_of_nautical_terms)
* [Marine electronics](http://en.wikipedia.org/wiki/Marine_electronics)
* [Marine fuel management](http://en.wikipedia.org/wiki/Marine_fuel_management)
* [Maritime history](http://en.wikipedia.org/wiki/Maritime_history)
* [Maritime law](http://en.wikipedia.org/wiki/Maritime_law)
* [Mother ship](http://en.wikipedia.org/wiki/Mother_ship)
* [Naval architecture](http://en.wikipedia.org/wiki/Naval_architecture)
* [Navy](http://en.wikipedia.org/wiki/Navy)
* [Propulsion system](http://en.wikipedia.org/wiki/Propulsion_system)
* [Sailing](http://en.wikipedia.org/wiki/Sailing)
* [Sailing ship](http://en.wikipedia.org/wiki/Sailing_ship)
* [Sailor](http://en.wikipedia.org/wiki/Sailor)
* [Ship burial](http://en.wikipedia.org/wiki/Ship_burial)
* [Ship transport](http://en.wikipedia.org/wiki/Ship_transport)
* [Shipwreck](http://en.wikipedia.org/wiki/Shipwreck)
* [Spaceship](http://en.wikipedia.org/wiki/Spacecraft)
* [Train ferry](http://en.wikipedia.org/wiki/Train_ferry)
* [Vessel safety survey](http://en.wikipedia.org/wiki/Vessel_safety_survey)
* [Whaler](http://en.wikipedia.org/wiki/Whaler)

**Model ships**

* [Ship model](http://en.wikipedia.org/wiki/Ship_model)
* [Ship model basin](http://en.wikipedia.org/wiki/Ship_model_basin)
* [Ship replica](http://en.wikipedia.org/wiki/Ship_replica)

**Lists**

* [List of civilian nuclear ships](http://en.wikipedia.org/wiki/List_of_civilian_nuclear_ships)
* [List of fictional ships](http://en.wikipedia.org/wiki/List_of_fictional_ships)
* [List of historical ship types](http://en.wikipedia.org/wiki/List_of_historical_ship_types)
* [List of ships](http://en.wikipedia.org/wiki/List_of_ships)
* [List of shipwrecks](http://en.wikipedia.org/wiki/List_of_shipwrecks)
* [List of the world's largest cruise ships](http://en.wikipedia.org/wiki/List_of_the_world%27s_largest_cruise_ships)
* [List of world's largest ships by gross tonnage](http://en.wikipedia.org/wiki/List_of_world%27s_largest_ships_by_gross_tonnage)
* [List of world's longest ships](http://en.wikipedia.org/wiki/List_of_world%27s_longest_ships)

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