= Sea =

A sea is a large body of salt water that is surrounded in whole or in part by land . More broadly , " the sea " is the interconnected system of Earth 's salty , oceanic waters ? considered as one global ocean or as several principal oceanic divisions . The sea moderates Earth 's climate and has important roles in the water cycle , carbon cycle , and nitrogen cycle . Although the sea has been travelled and explored since prehistory , the modern scientific study of the sea ? oceanography ? dates broadly to the British Challenger expedition of the 1870s . The sea is conventionally divided into up to five large oceanic sections ? including the IHO 's four named oceans (the Atlantic , Pacific , Indian , and Arctic) and the Southern Ocean ; smaller , second @-@ order sections , such as the Mediterranean , are known as seas .

Owing to the present state of continental drift , the Northern Hemisphere is now fairly equally divided between land and sea (a ratio of about 2 : 3) but the South is overwhelmingly oceanic (1 : 4 @.@ 7) . Salinity in the open ocean is generally in a narrow band around 3 @.@ 5 % by mass , although this can vary in more landlocked waters , near the mouths of large rivers , or at great depths . About 85 % of the solids in the open sea are sodium chloride . Deep @-@ sea currents are produced by differences in salinity and temperature . Surface currents are formed by the friction of waves produced by the wind and by tides , the changes in local sea level produced by the gravity of the Moon and Sun . The direction of all of these is governed by surface and submarine land masses and by the rotation of the Earth (the Coriolis effect) .

Former changes in the sea levels have left continental shelves , shallow areas in the sea close to land . These nutrient @-@ rich waters teem with life , which provide humans with substantial supplies of food ? mainly fish , but also shellfish , mammals , and seaweed ? which are both harvested in the wild and farmed . The most diverse areas surround great tropical coral reefs . Whaling in the deep sea was once common but whales ' dwindling numbers prompted international conservation efforts and finally a moratorium on most commercial hunting . Oceanography has established that not all life is restricted to the sunlit surface waters : even under enormous depths and pressures , nutrients streaming from hydrothermal vents support their own unique ecosystem . Life may have started there and aquatic microbial mats are generally credited with the oxygenation of Earth 's atmosphere ; both plants and animals first evolved in the sea .

The sea is an essential aspect of human trade , travel , mineral extraction , and power generation . This has also made it essential to warfare and left major cities exposed to earthquakes and volcanoes from nearby faults ; powerful tsunami waves ; and hurricanes , typhoons , and cyclones produced in the tropics . This importance and duality has affected human culture , from early sea gods to the epic poetry of Homer to the changes induced by the Columbian Exchange , from Viking funerals to Basho 's haikus to hyperrealist marine art , and inspiring music ranging from the shanties in The Complaynt of Scotland to Rimsky @-@ Korsakov 's " The Sea and Sinbad 's Ship " to A @-@ mei 's " Listen to the Sea " . It is the scene of leisure activities including swimming , diving , surfing , and sailing . However , population growth , industrialization , and intensive farming have all contributed to present @-@ day marine pollution . Atmospheric carbon dioxide is being absorbed in increasing amounts , lowering its pH in a process known as ocean acidification . The shared nature of the sea has made overfishing an increasing problem .

= = Definition = =

Both senses of sea date to Old English ; the larger sense has required a definite article since Early Middle English . As the term has been applied over time , there are no sharp distinctions between seas and oceans , although seas are smaller and are ? with the notable exception of the Sargasso Sea created by the North Atlantic Gyre ? usually bounded by land on a smaller scale than multiple continents . Seas are generally larger than lakes and contain salt water , but the Sea of Galilee is a freshwater lake . There is no accepted technical definition of " sea " among oceanographers . In international law , the United Nations Convention on the Law of the Sea states that all the ocean is " the sea " .

= = Physical science = =

Earth is the only known planet with seas of liquid water on its surface , although Mars possesses ice caps and similar planets in other solar systems may have oceans . It is still unclear where Earth 's water came from , but , seen from space , our planet appears as a " blue marble " of its various forms : oceans , ice caps , clouds . Earth 's 1 @,@ 335 @,@ 000 @,@ 000 cubic kilometers (320 @,@ 000 @,@ 000 cu mi) of sea contain about 97 @.@ 2 percent of its known water and cover more than 70 percent of its surface . Another 2 @.@ 15 % of Earth 's water is frozen , found in the sea ice covering the Arctic Ocean , the ice cap covering Antarctica and its adjacent seas , and various glaciers and surface deposits around the world . The remainder (about 0 @.@ 65 % of the whole) form underground reservoirs or various stages of the water cycle , containing the freshwater encountered and used by most terrestrial life : vapor in the air , the clouds it slowly forms , the rain falling from them , and the lakes and rivers spontaneously formed as its waters flow again and again to the sea . The sea 's dominance of the planet is such that the British author Arthur C. Clarke once noted that " Earth " would have been better named " Ocean " .

The scientific study of water and Earth 's water cycle is hydrology ; hydrodynamics studies the physics of water in motion . The more recent study of the sea in particular is oceanography . This began as the study of the shape of the ocean 's currents but has since expanded into a large and multidisciplinary field : it examines the properties of seawater ; studies waves , tides , and currents ; charts coastlines and maps the seabeds ; and studies marine life . The subfield dealing with the sea 's motion , its forces , and the forces acting upon it is known as physical oceanography . Marine biology (biological oceanography) studies the plants , animals , and other organisms inhabiting marine ecosystems . Both are informed by chemical oceanography , which studies the behavior of elements and molecules within the oceans : particularly , at the moment , the ocean 's role in the carbon cycle and carbon dioxide 's role in the increasing acidification of seawater . Marine and maritime geography charts the shape and shaping of the sea , while marine geology (geological oceanography) has provided evidence of continental drift and the composition and structure of the Earth , clarified the process of sedimentation , and assisted the study of volcanism and earthquakes .

= = = Seawater = = =

Seawater is invariably salty and , although its degree of saltiness (salinity) can vary , about 90 % of the water in the ocean has 34 ? 35 g (1 @.@ 2 oz .) of dissolved solids per liter , producing a salinity between 3 @.@ 4 and 3 @.@ 5 % . To easily describe small differences , however , oceanographers usually express salinity as a millage (?) or part per thousand (ppt) instead of using percents . The surface salinity of waters in the Northern Hemisphere are generally closer to the 34 ? mark , while those in the South are closer to 35 ? . The solutes in ocean water come both from inflowing river water and from the ocean floor . The relative composition of the solutes is stable throughout the world 's oceans : sodium (Na) and chloride (Cl) make up about 85 % . Other solutes include metal ions such as magnesium (Mg) and calcium (Ca) and negative ions such as sulfate (SO ?) , carbonate (CO ?) , and bromides . In the absence of other pollution , seawater would not be harmful to drink except that it is much too saline ; similarly , it cannot be used for irrigating most plants without being desalinated . For scientific and technical purposes , a standardized form of artificial seawater is often used .

Variations in salinity are caused by many factors : currents flowing between the seas ; incoming freshwater from rivers and glaciers ; precipitation ; the formation and melting of sea ice ; and evaporation , which is in turn affected by temperature , winds , and waves . For example , the upper level of the Baltic Sea has a very low salinity (10 to 15 ?) because the low temperatures of the surrounding climate produce minimal evaporation ; it has many inflowing rivers ; and its small connection to the North Sea tends to create a cold , dense under @-@ layer that hardly mixes with the surface waters . By contrast , the Red Sea lies between the Sahara and Arabian Deserts ; it has

high evaporation but little precipitation ; it has few (and mostly seasonal) inflowing rivers ; and its connection to other seas ? the Suez Canal in the north and the Bab @-@ el @-@ Mandeb in the south ? are both very narrow . Its salinity averages 40 ? . The Mediterranean is a little lower , at 37 ? , while some landlocked lakes are much higher : The Dead Sea has 300 grams (11 oz) of dissolved solids per liter (300 ?) .

Sea temperature chiefly depends on the amount of solar radiation it absorbs . In the tropics where sunlight falls more directly , the temperature of the surface layers can rise to over 30 ° C (86 ° F) ; near the poles , the temperature is in equilibrium with the sea ice at its freezing point . Its salinity makes this lower than freshwater 's , usually about ? 1 @.@ 8 ° C (28 @.@ 8 ° F) . These temperature differences contribute to the continuous circulation of water through the sea . Warm surface currents cool as they move away from the tropics ; as the water becomes denser , it sinks . The cold water in the deep sea moves back towards the equator before welling up again to the surface . Deep seawater has a temperature between ? 2 and 5 ° C (28 and 41 ° F) in all parts of the globe . In freezing seas , ice crystals begin to form on the surface . These break into small pieces and coalesce into flat discs that form a thick suspension known as frazil . In calm conditions , frazil will freeze into a thin , flat sheet called nilas , which thickens as new ice forms in the sea beneath it . In turbulent waters , frazil instead join together into larger flat discs known as " pancakes " . These slide over and under one another to form floes . During these processes , salt water and air are trapped amid the ice . Nilas forms with a salinity around 12 ? 15 ? and is grayish in color but grows fresher over time : after a year , it is bluish and closer to 4 ? 6 ? saline .

The amount of light that penetrates the sea depends on the angle of the sun , the local weather , and the sea 's turbidity . Of the light that reaches the surface of the sea , much of it is reflected at the surface and its red wavelengths are absorbed in the top few meters . Yellow and green reach greater depths , and the longer blue and violet wavelengths may penetrate as deep as 1 @,@ 000 m (3 @,@ 300 ft) .

The amount of oxygen present in seawater depends primarily upon its temperature and the photosynthetic organisms living in it , particularly algae , phytoplankton , and plants such as seagrass . During the day , their photosynthetic activity produces oxygen , which dissolves into the seawater and is used by marine animals . The water 's oxygen saturation is lower during the night and much lower in the deep sea . Below a depth of about 200 m (660 ft) , there is insufficient light for photosynthesis and consequently little dissolved oxygen . Below this , anaerobic bacteria break down falling organic material , producing hydrogen sulfide (H ? S) . It is projected that global warming will reduce oxygen both in surface and deep waters , due to oxygen 's decreased solubility as temperatures increase and increased oceanic stratification .

= = = Waves = = =

Ocean surface waves are oscillations caused by the friction from air moving across the surface of the water . This friction transfers energy and forms surface waves in the water perpendicular to the direction of the wind . The top of a wave is known as its crest and its foot as its trough ; the distance between two crests is the wavelength . These waves are mechanical : as they approach , the water molecules at a given point rise up and , as they pass , the water molecules go down , tracing a roughly circular path . The energy is passed across the surface and does not represent a horizontal motion of the water itself . The sea state of the ocean is determined by the size of these waves , which ? on the open ocean ? depends upon the wind speed and the fetch , the distance over which the wind blows upon the water . The smallest waves are called ripples . As strong and prolonged winds push against ripples ' raised crests , larger and more irregular waves form , which known as seas . These waves reach their maximum height when the rate at which they are traveling nearly matches the speed of the wind and , over time , they naturally separate into long , powerful waves with a common direction and wavelength . These swells are particularly common in the Roaring Forties of the Southern Hemisphere where the wind blows continuously . When the wind dies down , ripples easily disappear owing to water 's surface tension , but seas and swells are only slowly reduced by gravity and destructive interference from other waves . Constructive interference ,

however , can also cause individual rogue waves much higher than normal . Most waves are less than 3 m (10 ft) high and it is not unusual for strong storms to double or triple that height ; offshore construction such as wind farms and oil platforms use these measurements in computing the hundred @-@ year wave they are designed against . Rogue waves , however , have been documented at heights above 25 meters (82 ft) .

As waves approach land and move into shallow water , they change their behavior . If approaching at an angle , waves may bend or wrap rocks and headlands . When the wave reaches a point where its deepest oscillating molecules contact the seabed , friction begins to slow the wave down . This pulls the crests closer together and increases the waves ' height . When the ratio of a wave 's height to its wavelength exceeds 1 : 7 , it " breaks " , toppling over in a mass of foaming water . This rushes in a sheet up the beach before retreating into the sea under the influence of gravity .

= = = Tsunami = = =

A tsunami is an unusual form of wave caused by a sudden and powerful event such as an underwater earthquake or landslide , a meteorite impact , a volcanic eruption , or a collapse of land into the sea . These events can temporarily lift or lower the surface of the sea in the affected area , usually by a few feet . The potential energy of the displaced seawater is turned into kinetic energy , creating a shallow wave radiating outwards at a velocity proportional to the square root of the depth of the water . Tsunamis , therefore , travel much faster in the open ocean than on a continental shelf . Despite traveling at speeds of over 600 mph (970 km / h) , tsunamis in deep seas have wavelengths from 80 to 300 miles (130 to 480 km) and an amplitude of less than three feet . Standard surface waves in the same region may only have wavelengths of a few hundred feet and speeds up to 65 mph (105 km / h) but , when compared to their possible amplitudes of up to 45 ft (14 m) , tsunamis at this stage are often able to pass unnoticed . Tsunami warning systems rely on the fact that seismic waves caused by earthquakes travel around the world at around 14 @,@ 400 kilometers (8 @,@ 900 mi) per hour , allowing threatened regions to be alerted to the possibility of a tsunami . Measurements from a network of sea @-@ level measuring stations make it possible to confirm or cancel a tsunami warning . A trigger event on the continental shelf may cause a local tsunami on the land side and a distant tsunami that travels out across the ocean . The energy of the wave is dissipated only gradually but is spread out over the wave front . As the wave radiates away from the source , the front gets longer and the average energy reduces , so distant shores will generally be hit by weaker waves . However , as the speed of the wave is controlled by the water depth , it does not travel at the same speed in all directions and this affects the direction of the wave front . This effect , known as refraction , can focus the strength of an advancing tsunami on some areas while weakening it in others , according to the undersea topography along its path .

Just as with other waves , moving into shallow water causes the tsunami to slow but grow in height . Either the trough or the crest of the tsunami can arrive at the coast first . In the former case , the sea draws back and leaves subtidal areas unusually exposed . When the crest arrives , it does not usually break but rushes inland , flooding all in its path . Much of the disaster 's destruction can be produced by these flood waters , which drain back into the sea while pulling people and debris along . Several tsunamis can be caused by a single geological event . In such cases , it is common for the later waves to arrive between eight minutes and two hours after the first , which may not be the biggest or most destructive . Occasionally , in a shallow bay or estuary , a tsunami may transform into a bore .

= = = Tides = = =

Tides are the regular rise and fall in water level experienced by seas and oceans in response to the gravitational influences of the Moon and the Sun , and the effects of the Earth 's rotation . At any given place , the water rises over the course of the tidal cycle to a maximum height known as " high tide " before ebbing away again to a minimum " low tide " level . As the water recedes , it uncovers more and more of the foreshore or intertidal zone . The difference in height between the high tide

and low tide is known as the tidal range or tidal amplitude . Tidal bores can occur at the mouths of rivers , where the force of the incoming tide pushes waves of seawater upstream against the current . At Hangzhou in China , the bore can reach 9 meters (30 ft) high and travel up to 40 km (25 mi) per hour .

Most places experience two high tides each day , occurring at intervals of about 12 hours and 25 minutes , half the period that it takes for the Earth to make a complete revolution and return the Moon to its previous position relative to an observer . The Moon 's mass is some 27 million times smaller than the Sun , but it is 400 times closer to the Earth . Tidal force or tide @-@ raising force decreases rapidly with distance , so the moon has more than twice as great an effect on tides as the Sun . A bulge is formed in the ocean at the place where the Earth is closest to the Moon , because it is also where the effect of the Moon 's gravity is stronger . On the opposite side of the Earth , the lunar force is at its weakest and this causes another bulge to form . These bulges rotate around the Earth as the moon does . The Sun 's effect is less powerful but , when the Sun , Moon and Earth are all aligned at the full and new moons , the combined effect results in the high " spring tides " . In contrast , when the Sun is at 90 ° from the Moon as viewed from Earth , the combined gravitational effect on tides is correspondingly reduced , causing the lower " neap tides " .

Tidal flows of seawater are resisted by the water 's inertia and can be affected by land masses . In places like the Gulf of Mexico where land constrains the movement of the bulges , only one set of tides may occur each day . Inshore from an island , there may be a complex daily cycle with four high tides . The island straits at Chalkis on Euboea experience strong currents which abruptly switch direction , generally four times per day but up to 12 times per day when the moon and the sun are 90 degrees apart . Where there is a funnel @-@ shaped bay or estuary , the tidal range can be magnified . The Bay of Fundy in Canada can experience spring tides of 15 m (49 ft) . Although tides are regular and predictable , the height of high tides can be lowered by offshore winds and raised by onshore winds . The high pressure at the center of an anticyclones pushes down on the water and is associated with abnormally low tides while low @-@ pressure areas may cause extremely high tides . A storm surge can occur when high winds pile water up against the coast in a shallow area and this , coupled with a low pressure system , can raise the surface of the sea at high tide dramatically . In 1900 , Galveston , Texas , experienced a 15 ft (5 m) surge during a hurricane that overwhelmed the city , killing over 3 @,@ 500 people and destroying 3 @,@ 636 homes .

= = = Currents = = =

Wind blowing over the surface of the sea causes friction at the interface between air and sea . Not only does this cause waves to form but it also makes the surface seawater move in the same direction as the wind . Although winds are variable , in any one place they predominantly blow from a single direction and thus a surface current can be formed . Westerly winds are most frequent in the mid @-@ latitudes while easterlies dominate the tropics . When water moves in this way , other water flows in to fill the gap and a circular movement of surface currents known as a gyre is formed . There are five main gyres in the world 's oceans : two in the Pacific , two in the Atlantic , and one in the Indian Ocean . The North Atlantic gyre that produces the Sargasso Sea accumulates salinity levels as high as 38 ? . Other smaller gyres are found in lesser seas and a single gyre flows around Antarctica . These gyres have followed the same routes for millennia , guided by the topography of the land , the wind direction , and the Coriolis effect . The surface currents flow in a clockwise direction in the Northern Hemisphere and anticlockwise in the Southern Hemisphere . The water moving away from the equator is warm , while that flowing towards it has lost most of its heat . These currents tend to moderate the Earth 's climate , cooling the equatorial region , and warming regions at higher latitudes . Global climate and weather forecasts are powerfully affected by the world ocean , so global climate modelling makes use of ocean circulation models as well as models of other major components such as the atmosphere , land surfaces , aerosols , and sea ice . Ocean models make use of a branch of physics , geophysical fluid dynamics , that describes the large @-@ scale flow of fluids such as seawater .

Surface currents only affect the top few hundred meters (yards) of the sea , but there are also

large @-@ scale flows in the ocean depths caused by the movement of deep water masses . A main deep ocean current flows through all the world 's oceans and is known as the thermohaline circulation or global conveyor belt . This movement is slow and is driven by differences in density of the water caused by variations in salinity and temperature . At high latitudes , the water is chilled by the low atmospheric temperature and becomes saltier as sea ice crystallizes out . Both these factors make it denser and the water sinks . From the deep sea near Greenland , such water flows southwards between the continental landmasses on either side of the Atlantic . When it reaches the Antarctic , it is joined by further masses of cold , sinking water and flows eastwards . It then splits into two streams that move northwards into the Indian and Pacific Oceans . Here it is gradually warmed , becomes less dense , rises towards the surface , and loops back on itself . Some flows back into the Atlantic . It takes a thousand years for this circulation pattern to be completed .

Besides gyres , there are temporary surface currents that occur under specific conditions . When waves meet a shore at an angle , a longshore current is created as water is pushed along parallel to the coastline . The water swirls up onto the beach at right angles to the approaching waves but drains away straight down the slope under the effect of gravity . The larger the breaking waves , the longer the beach , and the more oblique the wave 's approach , the stronger the longshore current is . These currents can shift great volumes of sand or pebbles , create spits , and make beaches disappear and water channels silt up . A rip current can occur when water piles up near the shore from advancing waves and is funnelled out to sea through a channel in the seabed . It may occur at a gap in a sandbar or near a man @-@ made structure such as a groyne . These strong currents can have a velocity of 1 m / s (3 @.@ 3 ft / s) , can form at different places at different stages of the tide , and can carry away unwary swimmers . Temporary upwelling currents occur when the wind pushes water away from the land and deeper water rises to replace it . This cold water is often rich in nutrients and creates blooms of phytoplankton and a great increase in the productivity of the sea .

= = = Basins = = =

Bathymetry is the mapping and study of the topography of the ocean floor . Methods used for measuring the depth of the sea include single or multibeam echosounders , laser airborne depth sounders and the calculation of depths from satellite remote sensing data . This information is used for determining the routes of undersea cables and pipelines , for choosing suitable locations for siting oil rigs and offshore wind turbines and for identifying possible new fisheries . The Earth is composed of a magnetic central core , a mostly liquid mantle , and a hard rigid outer shell (or lithosphere) , which is composed of the Earth 's rocky crust and the deeper and mostly solid outer layer of the mantle . The crust below land is known as continental while that under the abyssal sea is called oceanic . The latter is composed of relatively dense basalt and is some five to ten kilometers (three to six miles) thick . The relatively thin lithosphere floats on the weaker and hotter mantle below and is fractured into a number of tectonic plates . In mid @-@ ocean , magma is constantly being thrust through the seabed between adjoining plates to form mid @-@ oceanic ridges and here convection currents within the mantle tend to drive the two plates apart . Parallel to these ridges and nearer the coasts , one oceanic plate may slide beneath another oceanic plate in a process known as subduction . Deep trenches are formed here and the process is accompanied by friction as the plates grind together . The movement proceeds in jerks which cause earthquakes . Heat is also produced and magma is forced up , creating underwater mountains , some of which grow into volcanic islands . Near some boundaries between the land and sea , the slightly denser oceanic plates slide beneath the continental plates and more subduction trenches are formed . As they grate together , the continental plates are deformed and buckle causing mountain building and seismic activity .

The Earth 's deepest trench is the Mariana Trench which extends for about 2 @,@ 500 kilometers (1 @,@ 600 mi) across the seabed . It is near the Mariana Islands , a volcanic archipelago in the West Pacific . Though it averages just 68 km (42 mi) wide , its deepest point is 10 @.@ 994 kilometers (nearly 7 miles) below the surface of the sea . An even longer trench runs alongside the

coast of Peru and Chile , reaching a depth of 8 @,@ 065 m (26 @,@ 460 ft) and extending for approximately 5 @,@ 900 km (3 @,@ 700 mi) . It occurs where the oceanic Nazca Plate slides under the continental South American Plate and is associated with the upthrust and volcanic activity of the Andes .

= = = Coasts = = =

The zone where land meets sea is known as the coast and the part between the lowest spring tides and the upper limit reached by splashing waves is the shore . A beach is the accumulation of sand or shingle on the shore . A headland is a point of land jutting out into the sea and a larger promontory is known as a cape . The indentation of a coastline ? especially between two headlands ? is a bay ; a small bay with a narrow inlet is a cove and a large bay or bay @-@ shaped sea may be referred to as a gulf . Coastlines are influenced by a number of factors including the strength of the waves arriving on the shore , the gradient of the land margin , the composition and hardness of the coastal rock , the inclination of the off @-@ shore slope , and the changes of the level of the land due to local uplift or submergence . Normally , waves roll towards the shore at the rate of six to eight per minute . These are known as constructive waves as they tend to move material up the beach and have little erosive effect . Storm waves arrive on shore in rapid succession and are known as destructive waves , as their swash moves beach material seawards . Under their influence , the sand and shingle on the beach is ground together and abraded . Around high tide , the power of a storm wave impacting on the foot of a cliff has a shattering effect as air in cracks and crevices is compressed and then expands rapidly with release of pressure . At the same time , sand and pebbles have an erosive effect as they are thrown against the rocks . Along with other weathering processes such as frost , this tends to undercut the cliff . Gradually , a wave @-@ cut platform develops at the foot of the cliff and this has a protective effect , reducing further wave @-@ erosion .

Material worn from the margins of the land eventually ends up in the sea , where it is subject to attrition as currents flowing parallel to the coast scour out channels and transport material away from its place of origin . Sediment carried to the sea by rivers settles on the seabed causing deltas to form in estuaries . All these materials move back and forth under the influence of waves , tides , and currents . Dredging removes material and deepens channels but may have unexpected effects elsewhere on the coastline . Governments make efforts to prevent flooding through building breakwaters , seawalls , and other defenses against the sea . In Britain , the Thames Barrier protects London from storm surges , while the failure of the dykes and levees around New Orleans during Hurricane Katrina created a humanitarian crisis in the United States . Land reclamation in Hong Kong permitted the construction of Hong Kong International Airport through the leveling and expansion of two smaller islands .

Following the adoption of the present UNCLOS , the coastline under international law is a state 's baseline , which is generally but not always equivalent to its low @-@ water line .

= = = Sea level = = =

Over most of geologic time , the sea level has been higher than it is today . The main factor affecting sea level over time is the result of changes in the oceanic crust , with a downward trend expected to continue in the very long term . At the last glacial maximum some 20 @,@ 000 years ago , the sea level was 120 meters (390 ft) below its present @-@ day level . For at least the last 100 years , the sea level has been rising at an average rate of about 1 @.@ 8 mm (0 @.@ 071 in) per year . Most of this rise can be attributed to an increase in the temperature of the sea and the resulting slight thermal expansion of the upper 500 m (1 @,@ 600 ft) of water . Additional contributions , as much as one quarter of the total , come from water sources on land , such as melting snow and glaciers and extraction of groundwater for irrigation and other agricultural and human needs . The rising trend from global warming is expected to continue until at least the end of the 21st century .

= = = The water cycle = = =

The sea plays a part in the water cycle , in which water evaporates from the ocean , travels through the atmosphere as vapor , condenses , falls (usually as rain or snow) again , and then largely returns to the sea . Even in the Atacama Desert , where little rain ever falls , dense clouds of fog known as the camanchaca blow in from the sea and support plant life . In large land masses , geologic features can block the access of some regions to the main sea . These endorheic basins , particularly in central Asia , sometimes build up permanent salt lakes as inflowing waters evaporate and their dissolved minerals accumulate over time . The largest of these is the Caspian Sea , although it is sometimes counted as a proper sea owing to its basin of (now @-@ landlocked) oceanic crust . Other notable examples include the Aral Sea in central Asia and the Great Salt Lake in the western United States . The waters of these basins still eventually return to the sea through evaporation , the flow of ground water , and (over geologic time) the opening up of the basins by continental drift .

= = = The carbon cycle = = =

Oceans contain the greatest quantity of actively @-@ cycled carbon in the world and are second only to the lithosphere in the amount of carbon they store . The oceans ' surface layer holds large amounts of dissolved organic carbon that is exchanged rapidly with the atmosphere . The deep layer 's concentration of dissolved inorganic carbon is about 15 percent higher than that of the surface layer and it remains there for much longer periods of time . Thermohaline circulation exchanges carbon between these two layers .

Carbon enters the ocean as atmospheric carbon dioxide dissolves into the surface layers and is converted into carbonic acid , carbonate , and bicarbonate : CO2 (aq) + H2O ? H2CO3 ? HCO3 ? + H + ? CO32 ? + 2 H + . The process liberates hydrogen ions (H +) , decreasing ocean pH and increasing its acidity .

It can also enter as dissolved organic carbon through rivers and is converted by photosynthetic organisms into organic carbon . This can either be exchanged throughout the food chain or precipitated into the deeper , more carbon @-@ rich layers as dead soft tissue or in shells and bones as calcium carbonate . It circulates in this layer for long periods of time before either being deposited as sediment or being returned to surface waters through thermohaline circulation .

= = = Acidification = = =

Seawater is slightly alkaline and had a preindustrial pH of about 8 @.@ 2 . More recently , anthropogenic activities have steadily increased the carbon dioxide content of the atmosphere ; about 30 ? 40 % of the added CO2 is absorbed by the oceans , forming carbonic acid and lowering the pH (now below 8 @.@ 1) through a process called ocean acidification . The pH is expected to reach 7 @.@ 7 (representing a 3 @-@ fold increase in hydrogen ion concentration) by the year 2100 , which is a significant change in a century .

One important element for the formation of skeletal material in marine animals is calcium , but calcium carbonate becomes more soluble with pressure , so carbonate shells and skeletons dissolve below its compensation depth . Calcium carbonate also becomes more soluble at lower pH , so ocean acidification is likely to have profound effects on marine organisms with calcareous shells , such as oysters , clams , sea urchins , and corals , because their ability to form shells will be reduced , and the carbonate compensation depth will rise closer to the sea surface . Affected planktonic organisms will include the snail @-@ like molluscs known as pteropods , and single @-@ celled algae called coccolithophorids and foraminifera . All of these are important parts of the food chain and a diminution in their numbers will have significant consequences . In tropical regions , corals are likely to be severely affected as it becomes more difficult to build their calcium carbonate skeletons , in turn adversely impacting other reef dwellers .

The current rate of ocean chemistry change appears to be without precedent in Earth 's geological history , making it unclear how well marine ecosystems will be able to adapt to the shifting conditions of the near future . Of particular concern is the manner in which the combination of acidification with the expected additional stressors of higher temperatures and lower oxygen levels will impact the seas .

= = Marine life = =

The oceans are home to a diverse collection of life forms that use it as a habitat . Since sunlight illuminates only the upper layers , the major part of the ocean exists in permanent darkness . As the different depth and temperature zones each provide habitat for a unique set of species , the marine environment as a whole encompasses an immense diversity of life . Marine habitats range from surface water to the deepest oceanic trenches , including coral reefs , kelp forests , seagrass meadows , tidepools , muddy , sandy and rocky seabeds , and the open pelagic zone . The organisms living in the sea range from whales 30 meters (100 ft) long to microscopic phytoplankton and zooplankton , fungi , bacteria and viruses , including recently discovered marine bacteriophages which live parasitically inside bacteria . Marine life plays an important part in the carbon cycle as photosynthetic organisms convert dissolved carbon dioxide into organic carbon and it is economically important to humans for providing fish for use as food .

Life may have originated in the sea and all the major groups of animals are represented there . Scientists differ as to precisely where in the sea life arose : the Miller @-@ Urey experiments suggested a dilute chemical " soup " in open water , but more recent suggestions include volcanic hot springs , fine @-@ grained clay sediments , or deep @-@ sea " black smoker " vents , all of which would have provided protection from damaging ultraviolet radiation which was not blocked by the early earth 's atmosphere .

= = = Habitats = = =

Marine habitats can be divided horizontally into coastal and open ocean habitats . Coastal habitats extend from the shoreline to the edge of the continental shelf . Most marine life is found in coastal habitats , even though the shelf area occupies only 7 percent of the total ocean area . Open ocean habitats are found in the deep ocean beyond the edge of the continental shelf . Alternatively , marine habitats can be divided vertically into pelagic (open water) , demersal (just above the seabed) , and benthic (sea bottom) habitats . A third division is by latitude : from tropical to temperate to polar waters .

Coral reefs , the so @-@ called " rainforests of the sea " , occupy less than 0 @.@ 1 percent of the world 's ocean surface , yet their ecosystems include 25 percent of all marine species . The best @-@ known are tropical coral reefs such as Australia 's Great Barrier Reef , but cold water reefs harbor a wide array of species including corals (only six of which contribute to reef formation) .

= = = Algae and plants = = =

Marine primary producers ? plants and microscopic organisms in the plankton ? are widespread and very diverse . Microscopic photosynthetic algae , phytoplankton , contribute a larger proportion of the world 's photosynthetic output than all the terrestrial forests combined . About 45 percent of the sea 's primary production of living material is contributed by diatoms . Much larger algae , commonly known as seaweeds , are important locally ; Sargassum forms floating drifts , while kelp form seabed forests . Flowering plants in the form of seagrasses grow in " meadows " in sandy shallows , mangroves line the coast in tropical and subtropical regions , and salt @-@ tolerant plants thrive in regularly inundated salt marshes . All of these habitats are able to sequester large quantities of carbon and support a biodiverse range of larger and smaller animal life .

Light is only able to penetrate the top 200 m (660 ft) so this is the only part of the sea where plants can grow . The surface layers are often deficient in biologically @-@ active nitrogen compounds .

The marine nitrogen cycle consists of complex microbial transformations which include the fixation of nitrogen , its assimilation , nitrification , anammox , and denitrification . Some of these processes take place in deep water so that where there is an upwelling of cold waters or near estuaries where land @-@ sourced nutrients are present , plant growth is higher . This means that the most productive areas , rich in plankton and therefore also in fish , are mainly coastal .

= = = Animals and other life = = =

There is a broader spectrum of higher animal taxa in the sea than on land , many marine species have yet to be discovered , and the number known to science is expanding annually . Some vertebrates such as seabirds , seals , and sea turtles return to the land to breed but fish , cetaceans , and sea snakes have a completely aquatic lifestyle and many invertebrate phyla are entirely marine . In fact , the oceans teem with life and provide many varying microhabitats . One of these is the surface film which ? despite being tossed about by the movement of waves ? provides a rich environment and is home to bacteria , fungi , microalgae , protozoa , fish eggs , and various larvae .

The pelagic zone contains macro- and microfauna and myriad zooplankton which drift with the currents . Most of the smallest organisms are the larvae of fish and marine invertebrates which liberate eggs in vast numbers because the chance of any one embryo surviving to maturity is so minute . The zooplankton feed on phytoplankton and on each other and form a basic part of the complex food chain that extends through variously @-@ sized fish and other nektonic organisms , which are in turn eaten by larger squids , sharks , porpoises , dolphins , and whales . Some marine creatures make large migrations , either to other regions of the ocean on a seasonal basis or up and down its vertical layers , often ascending to feed at night before descending to safety by day . Ships can introduce or spread invasive species through the discharge of ballast water or through the transport of organisms that have accumulated as part of the fouling community on the hulls of vessels .

The demersal zone supports many animals that feed on benthic organisms or seek protection from predators . The seabed provides a range of habitats on or under the surface of the substrate which are used by creatures adapted to these conditions . The tidal zone with its periodic exposure to dehydrating air is home to barnacles , molluscs , and crustaceans . The neritic zone has many organisms that need light to flourish . Here , sponges , echinoderms , polychaete worms , sea anemones , and other invertebrates live among algal @-@ encrusted rocks . Corals often contain photosynthetic symbionts and live in shallow waters where light penetrates . The extensive calcareous skeletons they extrude build up into coral reefs which are an important feature of the seabed . These provide a diverse habitat for reef dwelling organisms . There is less sea life on the floor of deeper seas but marine life also flourishes around seamounts that rise from the depths , where fish and other animals congregate to spawn and feed . Close to the seabed live demersal fish that largely feed on pelagic organisms or benthic invertebrates . Exploration of the deep sea by submersibles revealed a new world of creatures living on the seabed that scientists had not previously expected . Some like the detritivores rely on organic material falling to the ocean floor . Others cluster round deep @-@ sea hydrothermal vents where mineral @-@ rich flows of water emerge , supporting communities whose primary producers are sulphide @-@ oxidizing chemoautotrophic bacteria and whose consumers include specialized bivalves , sea anemones , barnacles , crabs , worms , and fish . A dead whale sinking to the bottom of the ocean provides food for an assembly of organisms which similarly rely largely on the actions of sulphur @-@ reducing bacteria . Such places support unique biomes where many new microbes and other lifeforms have been discovered .

= = Humans and the sea = =

= = = Navigation and exploration = = =

Humans have travelled the sea since prehistoric times , originally on rafts and in dugout , reed , and bark canoes . Most of the early human migrations occurred over land : even areas now separated by open sea such as the Americas , Japan , and Britain were accessible by land bridges or fast ice during the last ice age . However , the dwarf Flores man probably needed to cross a 19 @-@ kilometer (12 mi) wide strait from Sundaland to reach Komodo and , although the exact details remain uncertain , the ancestors of Australia 's Aborigines must have crossed the broader deep @-@ sea Wallace Line to Near Oceania tens of thousands of years ago . Despite earlier theories , modern bathymetric soundings now suggest that even the earliest settlement of the Philippines required crossing deep water at the Mindoro Strait or the Sibutu Passage .

The hunter @-@ gatherer Ortoiroid people began spreading through the Caribbean from Venezuela 's Orinoco valley by at least the 6th millennium BC . Around the same time , Mesopotamians were using bitumen to caulk their reed boats and , a little later , masted sails . Lothal in India boasted the earliest known dock around 2400 BC . By c . 2000 BC , Austronesians on Taiwan had begun spreading into maritime Southeast Asia . From 1300 to 900 BC , the Austronesian " Lapita " peoples displayed great feats of navigation , reaching out from the Bismarck Archipelago to as far away as Fiji , Tonga , and Samoa . Their descendants continued to travel thousands of miles between tiny islands on outrigger canoes : the Austronesians of the Sunda Islands settled Madagascar off southeast Africa before AD 500 and the Polynesians settled the Hawaiian islands before 800 , Easter Island before 1200 , and New Zealand shortly after . The Egyptian pharaoh Necho II initiated construction on a canal which eventually linked the Mediterranean and Red Seas around 600 BC . Herodotus records Egyptian claims that he also commissioned a 3 @-@ year @-@ long expedition which circumnavigated Africa from the Red Sea to the Nile delta . Around 500 BC , the Carthaginian navigator Hanno left a detailed periplus of an Atlantic journey that reached at least Senegal and possibly Mount Cameroon ; and the Greek Pytheas left another exploring the seas around Great Britain around 325 BC . The massive 3rd @-@ century BC Lighthouse of Alexandria was considered one of the Seven Wonders of the World . In the 2nd century , the Alexandrian Ptolemy mapped the known world , using the " Fortunate Isles " as his prime meridian and including details as distant as the Gulf of Thailand . A modified form was used by Columbus for his voyages .

In the Mediaeval era , the Vikings used clinker @-@ built ships to colonize Iceland , Greenland , Canada , and Russia . A compass showing magnetic north is first attested ? in the form of a " south @-@ pointing spoon " ? in the 1st @-@ century Chinese Lunheng . The first evidence of its use in Chinese maritime navigation , however , dates to Zhu Yu 's c . 1115 Pingzhou Table Talks . Alexander of Neckham 's De naturis rerum , the first European mention of a magnetized needle , dates to 1190 and immediately notes its use among sailors . Latitude (the ship 's position ranging from 0 ° at the equator to 90 ° north and south) could be determined by inclinometers ? including the astrolabe , sextant , and Jacob 's staff ? measuring the angle between the horizon and heavenly bodies like the sun or moon . Accurately determining longitude (the ship 's position east or west of some fixed point) proved much harder .

In the 15th century , West European mariners ? beginning with Portugal ? started making still longer voyages of exploration , using improvements on translated Islamic star charts and a variation on African fishing boats called the caravel . In 1473 , Lopes Gonçalves crossed the equator and disproved the Aristotelian notion that a ring of fire would bar exploration of the southern hemisphere . Bartolomeu Dias rounded the Cape of Good Hope in 1487 ; in 1498 , Vasco da Gama reached Malindi , where a local pilot showed him how to follow the monsoon to India . In 1492 , relying on incorrect estimates of the circumference of the Earth , the Genovese Christopher Columbus sailed from Cadiz to the Canaries and thence into the open Atlantic in a Spanish attempt to reach the Orient . Instead , he made landfall on an island in the Caribbean Sea . The resulting Columbian Exchange introduced potatoes , corn , and chili peppers to the Old World while smallpox epidemics devastated the indigenous peoples of the Americas . This disruption and depopulation permitted rapid Spanish conquests and led to the widespread adoption of African slavery to man lucrative tobacco , sugar , indigo , and cotton plantations . In 1519 , Juan Sebastián Elcano completed Magellan 's Spanish expedition to sail around the world . These and other voyages permitted European maps to attain a previously impossible degree of accuracy . In 1538 , Gerardus Mercator

devised a map projection conveniently making constant bearings (rhumb lines) straight . In the Arctic , in 1594 , the Dutch captain Willem Barentsz reached Svalbard and the Barents Sea while , in the south , Anthony de la Roché crossed the Antarctic Convergence in 1675 and three separate expeditions ? one British , one American , and one Russian ? all claimed to have discovered Antarctica in 1820 . Not all voyages of discovery originated in Western Europe . Although accurate charting of the coasts of Russia only began in the 18th century and the archipelago of Severnaya Zemlya was not discovered until 1910 , Novgorodians had been sailing the White Sea since at least the 13th century . Despite a long @-@ standing preference for autarky , China briefly opened up under the Song and Mongol Yuan dynasties . In the early 15th century , Zheng He 's fleet of treasure ships repeatedly sailed from Ming China with 37 @,@ 000 men aboard 317 ships , reaching as far as the African coast . Chinese exploration , however , was soon curtailed again and finally outlawed . The peoples of East Asia were introduced to the true shape of the other continents from the maps of Matteo Ricci .

Meanwhile , the determination of longitude continued to involve approximations and guesswork : its true calculation required an accurate clock which permitted comparison between noon aboard ship and the exact time at a fixed point , such as the Royal Observatory at Greenwich . Great Britain 's Longitude prize was effectively awarded in 1773 to the self @-@ educated John Harrison for his sea watch of 1761 . James Cook used a copy of this on his second and third voyages , which studied the Pacific and inspired studies from Russia , France , the Netherlands , and the United States . The completion of a submarine telegraphic cable across the English Channel in 1850 and subsequent links of the All Red Line led to greater interest in the deep sea . Earlier ideas that no life could exist below 300 fathoms (550 meters or 1 @,@ 800 feet) were disproved in 1860 when a Mediterranean line failed and was pulled up from depths four times lower , completely encrusted with marine life . Michael Sars 's discovery of " living fossils " deep in Norway 's fjords helped spur British efforts including HMS Challenger ? s expedition during the 1870s that effectively created modern oceanography . From 1878 to 1880 , the SS Vega successfully completed the Northeast Passage and went on to circumnavigate Eurasia for the first time . During the mid @-@ 1890s , Fridtjof Nansen used a specially @-@ designed ship to drift through the northern pack ice , establishing that the Arctic was an open sea . In 1898 & 1899 , Carl Chun raised and studied many new life forms from over 4 @,@ 000 m (13 @,@ 000 ft) below the surface of the South Atlantic .

In the 20th century , the Gjøa was the first vessel to accomplish the Northwest Passage in 1906 . From 1921 , the International Hydrographic Organization in Monaco has standardized surveying and charting of the sea and , from 1924 , the Discovery Investigations studied whales and mapped the seas around Antarctica . The spherical Bathysphere was able to descend to 434 meters (1 @,@ 424 ft) in 1930 on a cable and , in the 1940s , Jacques Cousteau helped develop the first successful scuba gear and popularize underwater diving . The Cold War and oil exploration funded further deep sea research : by 1960 , the self @-@ powered Trieste could take her crew 10 @,@ 915 m (35 @,@ 810 ft) into the Mariana Trench and a US Navy diver in an atmospheric diving suit reached 2 @,@ 000 feet (610 m) below sea level in 2006 .

Today , the American Global Positioning System (GPS) enables accurate navigation worldwide using over thirty satellites and message timing so exact as to involve general relativity . Ongoing oceanographic research includes marine lifeforms , conservation , the marine environment , the chemistry of the ocean , the studying and modelling of climate dynamics , the air @-@ sea boundary , weather patterns , ocean resources , renewable energy , waves and currents , and the design and development of new tools and technologies for investigating the deep . Researchers make use of satellite @-@ based remote sensing for surface waters , with research ships , moored observatories and autonomous underwater vehicles to study and monitor all parts of the sea .

= = = Trade = = =

Water @-@ borne trade has been practiced since at least the dawn of civilization , when Sumeria was connected to Harappan India . Around 2000 BC , the Minoans of Crete established the earliest thalassocracy , a maritime empire heavily dependent upon its trade and naval power . The city @-@

states of the Phoenicians and Greeks then replaced them in the centuries after 1200 BC , ultimately establishing far @-@ flung colonial empires which spread from the Sea of Azov to the Atlantic coast of Morocco . Under the Romans , commerce continued to thrive . In the first centuries BC , steppe nomads ' interruption of India 's access to Siberian gold caused them to open up maritime routes to Malaysia and Indonesia , exposing them first to Hindu and then Muslim traders . With the collapse of the Roman Empire , European trade dwindled but it continued to flourish elsewhere . The Tamil Chola dynasty thrived on trade between Tang China , the Javanese Srivijaya Empire , and the Abbasid Caliphate in the west . Following further conquests , Arabians came to dominate maritime trade in the Indian Ocean , spreading Islam along the East African coast and , eventually , Southeast Asia . A major effect of the Age of Discovery was the unification of the world 's regional trade networks into a single world market , largely run by and for the European monarchs and the merchants of Amsterdam , London , and other Atlantic ports . From the 16th to the 19th centuries , about 13 million people were shipped across the Atlantic to be sold as slaves in the Americas . The Hales Trophy was an award for the fastest commercial crossing of the Atlantic and was won by the SS United States in 1952 for a crossing that took three days , ten hours , and forty minutes .

Nowadays , large quantities of goods are transported by sea , especially across the Atlantic and around the Pacific Rim . A major trade route passes through the Pillars of Hercules , across the Mediterranean and the Suez Canal to the Indian Ocean and through the Straits of Malacca ; much trade also passes through the English Channel . Shipping lanes are the routes on the open sea used by cargo vessels , traditionally making use of trade winds and currents . Over 60 percent of the world 's container traffic is conveyed on the top twenty trade routes . Increased melting of Arctic ice since 2007 enables ships to travel the Northwest Passage for some weeks in summer , avoiding the longer routes via the Suez Canal or the Panama Canal . Shipping is supplemented by air freight , a more expensive process mostly used for particularly valuable or perishable cargoes . Seaborne trade carries more than US $ 4 trillion worth of goods each year .

There are two main kinds of freight , bulk cargo and break bulk or general cargo , most of which is now transported in containers . Commodities in the form of liquids , powder or particles are carried loose in the holds of bulk carriers and include oil , grain , coal , ore , scrap metal , sand and gravel . Break bulk cargo is usually manufactured goods and is transported in packages , often stacked on pallets . Before the arrival of containerization in the 1950s , these goods were loaded , transported and unloaded piecemeal . The use of containers has greatly increased the efficiency and decreased the cost of moving them with most freight now traveling in standard sized , lockable containers loaded on purpose @-@ built container ships at dedicated terminals . Freight forwarding firms book cargo , arrange pickup and delivery , and manage documentation . The safety of shipping is regulated by the International Maritime Organization , based in London and first convened in 1959 . Its objectives include developing and maintaining a regulatory framework for shipping , maritime safety , environmental concerns , legal matters , technical co @-@ operation and maritime security .

= = = Fishing = = =

Humans in East Asia were consuming large amounts of freshwater fish around 40 000 years ago . Spearfishing with barbed harpoons along the coast was widespread by the Palaeolithic . Fish ponds surrounded Sumerian temples by 2 500 BC and a Chinese classical text credited to the 5th @-@ century BC businessman Fan Li is the earliest known work on fish farming . A surviving fragment of Isidore of Charax 's 1st @-@ century Parthian itinerary describes locals freediving for pearls in the Persian Gulf , and Oppian 's 2nd @-@ century Halieutics relates the four main Greek and Roman fishing methods as hook @-@ and @-@ line , netting , passive traps , and trident . Traditional fishing boats operate in near @-@ shore waters but , during the late Middle Ages and early Modern period , fishing on the open sea ? particularly cod ? became important to the economic and naval development of Northern Europe , New England , and Canada . Overfishing along the coasts of the North Sea spurred the development of deep @-@ sea fishers such as the Brixham and otter trawlers , which might serve as motherships for longlining dories ; in the 19th century , advances

such as rail transport , canning , and refrigeration allowed fishing to become a full @-@ fledged industry . Improvements in sonar during the world wars were adapted as fishfinders and , during the 1950s , great factory ships caught and processed as many fish in an hour as earlier trawlers had in a season . By the 1960s , the North Atlantic and North Pacific fisheries were close to maximal exploitation . After the catch from wild marine fisheries grew from 18 million metric tons (20 million tons) in 1950 to around 85 million metric tons (93 1 ? 2 million tons) by the late 1980s , it has remained essentially constant since . Chinese economic reform led to massive growth of its fishing production , from 7 % of the world total in 1961 to 35 % by 2010 . Scientific studies of population dynamics and nationalization of formerly shared waters are both helping to cope with overexploitation but the success of modern commercial fishing has required major corrective actions : the collapse of the Grand Banks cod fishery to less than 1 % of its historic levels required a complete moratorium by Canada in 1992 and China has enforced a zero @-@ growth policy in its wild catch since 2000 , redirecting its industry towards aquaculture ; its annual months @-@ long bans on fishing in disputed areas of the South China Sea is enforced over the protest of neighboring states .

As of 2006 , there were an estimated 43 @.@ 5 million people involved in capturing or raising seafood , 85 @.@ 5 % of whom lived in Asia . About 3 ? 4 were fishers and the remainder fish farmers . In 2012 , total global production of fish , crustaceans , molluscs , and other aquatic animals was a record 158 million metric tons (174 million tons) , of which 91 @.@ 3 million metric tons (100 million tons) were caught in the wild . This is also a record if ignoring the Peruvian anchovy , whose population can vary dramatically with the El Niño cycle . The overall trend remains increasing , but due to expanding aquaculture in inland waters and mariculture in the sea rather than higher catches in the wild . The exclusive economic zones around coastal countries under the UNCLOS regime have permitted states to institute quota and other management systems over the most productive regions of the sea , accounting for around 87 % of the annual harvest . The results are sometimes dramatic ? the lull in fishing over the course of the First World War saw the North Sea 's 1919 catch double 1913 's ? and sometimes much less so : two decades on , the levels of cod in the Grand Banks remain only 10 % of their peak . At present , the species most frequently landed are herring , cod , anchovy , tuna , flounder , mullet , squid , and salmon . A number of these , as well as large predatory fish , remain well below historical levels .

Over 3 million vessels are employed in sea fishing . Modern fishing vessels include fishing trawlers with a small crew , stern trawlers , purse seiners , long @-@ line factory vessels , and large factory ships which are designed to stay at sea for weeks , processing and freezing great quantities of fish . The equipment used to capture the fish may be purse seines , other seines , trawls , dredges , gillnets , and long @-@ lines . The Food and Agriculture Organization of the United Nations is encouraging the development of local fisheries to provide food security to coastal communities and help alleviate poverty .

As well as the wild stock , about 79 million metric tons (87 million tons) of food and non @-@ food products were produced by sea farming in 2010 , an all @-@ time high . About six hundred species of plants and animals were cultured , some for use in seeding wild populations . The animals raised included finfish , aquatic reptiles , crustaceans , molluscs , sea cucumbers , sea urchins , sea squirts , and jellyfish . Integrated mariculture has the advantage that there is a readily @-@ available supply of planktonic food and waste is removed naturally ; in cases where the waste would otherwise be harmful , multi @-@ species techniques can used to , e.g. , feed farmed shellfish from the waste being produced by farmed salmon . Various methods are employed . Mesh enclosures for finfish can be suspended in the open seas , cages can be used in more sheltered waters , or ponds can be refreshed with water at each high tide . Shrimps can be reared in shallow ponds connected to the open sea . Ropes can be hung in water to grow algae , oysters , and mussels . Oysters can be reared on trays or in mesh tubes . Sea cucumbers can be ranched on the seabed . Captive breeding programmes have raised lobster larvae for release of juveniles into the wild resulting in an increased lobster harvest in Maine . At least 145 species of seaweed ? red , green , and brown algae ? are eaten worldwide , some long farmed in Japan and other Asian countries ; there is great potential for additional algaculture . Few maritime flowering plants are widely used for food but one

example is marsh samphire , which is eaten both raw and cooked . A major difficulty for aquaculture is the tendency towards monoculture and the associated risk of widespread disease . In the 1990s , disease wiped out China 's farmed Farrer 's scallop and white shrimp and required their replacement by other species . Shrimp farming has also caused the destruction of important mangrove forests throughout southeast Asia .

= = = Law = = =

Admiralty law is the particular body of national laws applied to maritime questions and offenses , as the uncertainty of sea voyages has caused the sea to be viewed as a unique jurisdiction since antiquity . Rhodian , Roman , Byzantine , Trani , and Amalfian laws were important influences on the French , Genovese , and Hanseatic codes which established the first English courts of admiralty . Unlike the usual English common law system , the courts of admiralty hewed closer to Continental practice , leaving it open for abuse that contributed to the American Revolution . The adoption of the present constitution reintroduced admiralty law to the United States , but with a relatively larger sphere for trials by jury .

The Law of the Sea is the particular body international law applied to maritime questions and offenses . Empires such as Rome and China long claimed universal jurisdiction ; during the Middle Ages , Italian maritime republics such as Venice and Genoa recognized the existence of rival states but claimed the right to close the seas to their traffic . Portuguese and Spanish pursuit of similar rights over new seas and lands during the Age of Discovery and papal support of their claims was a factor in the Wars of Religion ; in 1609 , a jurist hired to defend a lucrative act of piracy by the Dutch East India Company penned Mare Liberum , an argument in favor of freedom of the seas that ultimately produced the compromise that territory extended as far as land @-@ based cannonshot could reach , standardized to 3 nautical miles (5 @,@ 556 m or 18 @,@ 228 ft) , and that everything beyond was international waters . President Woodrow Wilson argued this principle as part of America 's entrance into World War I and as one of his Fourteen Points afterwards ; nonetheless , President Truman 's unilateral claim of jurisdiction over the oil reserves of America 's continental shelf in 1945 directly led to the end of the regime . The three rounds of the United Nations ' conferences on the Law of the Sea eventually reshaped international maritime law but the United States has not ratified the present treaty but instead adopted its policies piecemeal via presidential proclamations .

The present Convention on the Law of the Sea (UNCLOS) was drafted in 1982 and came into force in 1994 . It states that " the high seas are open to all states , whether coastal or land @-@ locked " and provides a non @-@ exhaustive list of freedoms including navigation , overflight , the laying of submarine cables , the building of artificial islands , fishing , and scientific research . It extended territorial waters up to 12 nautical miles (22 @.@ 2 km or 13 @.@ 8 mi) from a baseline generally (but not always) equivalent to the low @-@ water line ; this area is subject to national laws but free to both innocent and transit passage . (The " internal waters " landward of the baseline are solely under national control .) A " contiguous zone " of a further 12 nmi are permitted for hot pursuit of vessels charged with violating customs , taxation , immigration , or pollution laws in the territorial waters . An " exclusive economic zone " or EEZ places all exploitation of marine life and minerals within 200 nmi (370 km or 230 mi) of the baseline under national supervision . For legal purposes , the " continental shelf " is considered to be the actual continental shelf (to a depth of 200 m or 660 ft) contiguous to the baseline or 200 nmi , whichever is greater ; the marine life and minerals " attached to " (or below) the seabed within this area also fall under national supervision .

Ships may cross numerous time zones on a voyage , so nautical time , introduced in the 1920s , is used in international waters . Each such zone is uniformly 15 degrees of longitude wide , the ship 's clock going forward one hour per zone when travelling eastwards .

= = = War = = =

Since the development of coordinated fleets of ships capable of landing an invasion force , naval

warfare has been an important aspect in the defense (or conquest) of maritime states . The first naval battle in recorded history saw Suppiluliuma II of the Hittites burn a Cypriot fleet at sea in 1210 BC . Shortly after , the fleets of the Sea Peoples disrupted the entire Eastern Mediterranean : over a period of about 50 years , raids and invasions violently destroyed nearly every coastal city between Pylos and Gaza . As empires grew and their armies became too large to live off the lands through which they passed , disruption of their supply fleets also became a powerful tactic . The 480 BC Battle of Salamis largely determined the course of the Persian Wars not because of its inherent damage (however considerable) but because Themistocles 's deception and superior strategy left the Athenians capable of disrupting sea @-@ borne supplies at will and potentially striking at the pontoon bridges across the Hellespont , cutting off the Persians ' line of retreat . During the age of wooden ships , however , great fleets were burdensome to maintain and always liable to destruction by contrary weather , most famously in the case of the two kamikaze typhoons that destroyed the Mongol invasions of Japan in AD 1274 and 1281 .

Piracy ? both illicit in ancient Cilicia and China and state @-@ supported among the Cretans , Vikings , Japanese , English , and Berbers ? has remained a problem into the present day , given the expense involved in securely protecting every merchant vessel or in policing extensive coastlines .

In the ancient world , in addition to Salamis , major naval engagements included the Battle of Actium , which permitted the establishment of Augustus 's empire . In the modern era , important naval battles include the English victories against the Armada in 1588 and at Trafalgar in 1805 , which broke the threats of invasion by the superior land forces of the Spanish and French empires .

With steam , mass @-@ produced steel plate , and exploding shells , European gunships permitted the New Imperialism of the 19th century , forcing open access to Africa , China , Korea , and Japan for their merchants on favorable terms . Although internal politics hampered Chinese modernization , American naval power produced a major reform in Japan which bore fruit during the 1905 Battle of Tsushima when the Japanese were able to decisively defeat Russia . The great navies initially focused their efforts on constructing great dreadnoughts and battleships , but these fought inconclusively in the First World War . By contrast , the much cheaper German U @-@ boats showed that submarines could cripple shipping even in waters nominally controlled by the enemy . Convoys , intelligence , and airborne ASW won a hard @-@ fought victory in the Second World War 's Battle of the Atlantic , but developments in applied physics meant that by the 1960s nuclear @-@ powered ballistic missile submarines were being maintained on constant patrol as a second @-@ strike force along with a second set of hunters intended to counter them . Meanwhile , the battles of the Mediterranean and Pacific theaters of the war had shown that air power was capable of overcoming the strongest warships .

= = = Travel = = =

Although the use of small private vessels for personal transport undoubtably extends back into prehistory , large ships capable of braving the open ocean were typically dedicated to trade or fishing for most of human history . Even military campaigns would often simply hire or commandeer these private fleets to serve as troop transports , as did the traders , pilgrims , and wealthy tourists of antiquity and the Middle Ages . The voyages of exploration and colonization were often provided for by the crown out of naval funds ; where they were not , they were usually chartered or else purchased and then used for shipping supplies after the initial settlement . Dedicated and scheduled local passenger services came to be offered in the 16th and 17th centuries , but the 1817 Black Ball was the first trans @-@ Atlantic passenger line . In the Age of Sail , the duration of such passages depended much on the prevailing winds and the weather . The 18th @-@ century coastal Margate hoys began the popularization of leisure travel in Britain and Ireland that later gathered steam with Thomas Cook 's package tours in the next century . During the 19th century , steam @-@ powered ocean liners connected the railroad networks of the world . By 1900 , the Atlantic crossing took about five days and the passenger lines competed to win the Blue Riband , an unofficial accolade accorded to the fastest liner in regular service . For twenty years from 1909 , the prize went to the

RMS Mauretania for its average speed of 26 @.@ 06 knots (48 @.@ 26 km / h) . This era waned as cheaper and faster intercontinental flights became available , most importantly the 1958 New York ? Paris route .

The sea still remains a venue for recreational boating and large cruise ships . It is also a route for refugees and economic migrants , some traveling in small unseaworthy craft and others smuggled into shipping vessels . Some flee persecution while many are economic migrants attempting to reach countries where they believe their prospects are brighter .

= = = Leisure = = =

Use of the sea for leisure developed in the nineteenth century and became a significant industry in the twentieth century . Maritime leisure activities are varied and include self @-@ organized trips cruising , yachting , powerboat racing and fishing ; commercially organized voyages on cruise ships ; and trips on smaller vessels for ecotourism such as whale watching and coastal birdwatching .

Many humans enjoy venturing into the sea : children paddle and splash in the shallows , while others swim or relax on the beach . This was not always the case , with sea bathing becoming the vogue in Europe in the 18th century after Dr. William Buchan advocated the practice for health reasons . Surfing is a sport in which a wave is ridden by a surfer , with or without a surfboard . Other water sports include kite surfing , where a power kite propels a manned board across the water ; windsurfing , where the power is provided by a fixed , maneuverable sail ; and water skiing , where a powerboat is used to pull a skier .

Beneath the surface , freediving is necessarily restricted to shallow descents . Pearl divers have traditionally greased their skins , put cotton in their ears and clips on their noses , and dived to 40 ft (12 m) with baskets in order to collect pearl oysters . Human eyes are not adapted for use underwater , but vision can be improved by wearing a diving mask . Other useful equipment includes fins and snorkels . Scuba equipment allows underwater breathing , permitting hours of time beneath the surface . The depths that can be reached by divers and the length of time they can stay underwater is limited by the increase of pressure they experience as they descend and the need to prevent decompression sickness as they return to the surface . Recreational divers are advised to restrict themselves to depths of under 100 feet (30 m) beyond which the danger of nitrogen narcosis increases . Deeper dives can be made with specialized equipment and training .

= = = Power generation = = =

The sea offers a very large supply of energy carried by ocean waves , tides , salinity differences , and ocean temperature differences which can be harnessed to generate electricity . Forms of ' green ' marine energy include tidal power , marine current power , osmotic power , ocean thermal energy and wave power .

Tidal power uses generators to produce electricity from tidal flows , sometimes by using a dam to store and then release seawater . The Rance barrage , 1 kilometer (0 @.@ 62 mi) long , near St Malo in Brittany opened in 1967 ; it generates about 0 @.@ 5 GW , but it has been followed by few similar schemes .

The large and highly variable energy of waves gives them enormous destructive capability , making affordable and reliable wave machines problematic to develop . A small 2 MW commercial wave power plant , " Osprey " , was built in Northern Scotland in 1995 about 300 meters (1000 ft) offshore . It was soon damaged by waves , then destroyed by a storm . Marine current power could provide populated areas close to the sea with a significant part of their energy needs . In principle , it could be harnessed by open @-@ flow turbines ; sea bed systems are available , but limited to a depth of about 40 m (130 ft) .

Offshore wind power is captured by wind turbines placed out at sea ; it has the advantage that wind speeds are higher than on land , though wind farms are more costly to construct offshore . The first offshore wind farm was installed in Denmark in 1991 , and the installed capacity of European offshore wind farms reached 3 GW in 2010 .

Electricity power stations are often located on the coast or beside an estuary so that the sea can be used as a heat sink . A colder heat sink enables more efficient power generation , which is important for expensive nuclear power plants in particular .

= = = Extractive industries = = =

There are large deposits of petroleum (as oil and natural gas) in rocks beneath the seabed . Offshore platforms and drilling rigs extract the oil or gas and store it for transport to land . Offshore oil and gas production can be difficult due to the remote , harsh environment . Drilling for oil in the sea has environmental impacts . Animals may be disorientated by seismic waves used to locate deposits , probably causing the beaching of whales . Toxic substances such as mercury , lead , and arsenic may be released . The infrastructure may cause damage and oil may be spilt .

The sea holds enormous quantities of valuable dissolved minerals . The most important , Salt for table and industrial use has been harvested by solar evaporation from shallow ponds since prehistoric times . Bromine , accumulated after being leached from the land , is economically recovered from the Dead Sea , where it occurs at 55 @,@ 000 parts per million (ppm) . Other minerals on or within the seabed can be exploited by dredging . This has advantages over land @-@ based mining in that equipment can be built at specialized shipyards and infrastructure costs are lower . Disadvantages include problems caused by waves and tides , the tendency for excavations to silt up , and the washing away of spoil heaps . There is a risk of coastal erosion and environmental damage . Sulphide deposits are potential sources of silver , gold , copper , lead , zinc , and trace metals which were only discovered in the 1960s . They form when geothermally superheated water is emitted from deep sea hydrothermal vents known as " black smokers " : in contact with the cold waters of the deep ocean , the minerals precipitate and settle around the vent . The ores are of high quality but currently very costly to extract . Small scale mining of the deep sea floor is being developed off the coast of Papua New Guinea using robotic techniques , but the obstacles are formidable .

Desalination is the technique of removing salts from seawater to leave fresh water suitable for drinking or irrigation . The two main processing methods , vacuum distillation and reverse osmosis , use large quantities of energy . Desalination is normally only undertaken where fresh water from other sources is in short supply or energy is plentiful , as in the excess heat generated by power stations . The brine produced as a by @-@ product contains some toxic materials and is returned to the sea .

Large quantities of methane clathrate exist on the seabed and in ocean sediment at a temperature of around 2 ° C (36 ° F) and these are of interest as a potential energy source . Some estimates put the amount available at between one and 5 million cubic kilometers (0 @.@ 24 to 1 @.@ 2 million cubic miles) . Also on the seabed are manganese nodules formed of layers of iron , manganese , and other hydroxides around a core . In the Pacific these may cover up to 30 percent of the deep ocean floor . The minerals precipitate from seawater and grow very slowly . Their commercial extraction for nickel was investigated in the 1970s but abandoned in favour of more convenient sources . In suitable locations , diamonds are gathered from the seafloor using suction hoses to bring gravel ashore . In deeper waters , mobile seafloor crawlers are used and the deposits are pumped to a vessel above . In Namibia , more diamonds are now collected from marine sources than by conventional methods on land .

= = = Pollution = = =

Many substances enter the sea as a result of human activities . Combustion products are transported in the air and deposited through precipitation . Agricultural , industrial , and sewage outflows contribute heavy metals , pesticides , PCBs , disinfectants , cleaning products , and other synthetic chemicals . These become concentrated in the surface film and in marine sediment , especially estuarine mud . The result of all this contamination is largely unknown because of the large number of substances involved and the lack of information on their biological effects . The

heavy metals of greatest concern are copper , lead , mercury , cadmium , and zinc which may be accumulated by marine invertebrates . They are then passed up the food chain .

Run @-@ off of fertilizers from agricultural land is a major source of pollution in some areas and the discharge of raw sewage has a similar effect . The extra nutrients provided by these sources can cause excessive plant growth . Nitrogen is often the limiting factor in marine systems and the addition of nitrogen sparks algal blooms and red tides , which then may lower the oxygen level of the water to the point where it kills marine animals . Such events have created dead zones in the Baltic Sea and the Gulf of Mexico . Some algal blooms are caused by cyanobacteria that make shellfish that filter feed on them toxic , harming animals like sea otters . Nuclear facilities too can pollute . The Irish Sea was contaminated by radioactive caesium @-@ 137 from the former Sellafield nuclear fuel processing plant and nuclear accidents sometimes cause radioactive material to seep into the sea , as at the Fukushima in 2011 .

The dumping of waste (including oil , noxious liquids , sewage , and garbage) at sea is governed by international law . The London Convention (1972) is a United Nations agreement to control ocean dumping which had been ratified by 89 countries by 8 June 2012 . MARPOL 73 / 78 is a convention to minimize pollution of the seas by ships . By May 2013 , 152 maritime nations had ratified MARPOL .

Much floating plastic trash does not biodegrade , instead disintegrating over time and eventually breaking down to the molecular level . Rigid plastics may float for years . In the center of the Pacific gyre , there is a permanent floating accumulation of mostly plastic waste and there is a similar garbage patch in the Atlantic . Foraging sea birds such as the albatross and petrel may mistake debris for food and accumulate indigestible plastic in their digestive systems . Turtles and whales have been found with plastic bags and fishing line in their stomachs . Microplastics may sink , threatening filter feeders on the seabed .

Most oil pollution in the sea comes from cities and industry . Oil is dangerous for marine animals . It can clog the feathers of sea birds , reducing their insulating effect and the birds ' buoyancy , or be ingested when they preen themselves in an attempt to remove the contaminant . Marine mammals are less seriously affected but may be chilled through the removal of their insulation , blinded , dehydrated , or poisoned . Benthic invertebrates are swamped when the oil sinks , fish are poisoned , and the food chain is disrupted . In the short term , oil spills result in wildlife populations being decreased and unbalanced , leisure activities being affected , and the livelihoods of people dependent on the sea being devastated . The marine environment has self @-@ cleansing properties and naturally @-@ occurring bacteria will act over time to remove oil from the sea . In the Gulf of Mexico , where oil @-@ eating bacteria are already present , they take only a few days to consume spilt oil .

= = = Indigenous sea peoples = = =

Several nomadic indigenous groups in Maritime Southeast Asia live in boats and derive nearly all they need from the sea . The Moken people live on the coasts of Thailand and Burma and islands in the Andaman Sea . The Bajau people are originally from the Sulu Archipelago , Mindanao , and northern Borneo . Some Sea Gypsies are accomplished free @-@ divers , able to descend to depths of 30 m (98 ft) , though many are adopting a more settled , land @-@ based way of life .

The indigenous peoples of the Arctic such as the Chukchi , Inuit , Inuvialuit , and Yupik hunt marine mammals including seals and whales and the Torres Strait Islanders claim ownership of the Great Barrier Reef . They live a traditional life on the islands involving hunting , fishing , gardening , and trading with neighboring peoples in Papua New Guinea and Australia .

= = = In culture = = =

The sea appears in human culture in contradictory ways , as both powerful but serene and as beautiful but dangerous . It has its place in mythology and religion , literature , art , poetry , film , theater , and music . The Ancients personified it , believing it to be under the control of a being who

needed to be appeased . It has been populated by fantastic creatures : the Leviathan of the Bible , Scylla in Greek mythology , Isonade in Japanese mythology , and the kraken of late Norse mythology . The sea is especially common in Christian imagery , where several of Jesus 's disciples were said to have been fishermen on the Sea of Galilee .

The sea , its life , and its ships have been depicted in art ranging from the simple drawings on the walls of caves outside Les Eyzies , France , to the early Christian ichthys to the Dutch Hendrik Vroom to Hokusai 's ukiyo @-@ e to seascapes by Winslow Homer . During the Golden Age of the Netherlands , artists such as Jan Porcellis , Hendrick Dubbels , Willem van de Velde the Elder and his son , and Ludolf Bakhuizen celebrated the sea and the Dutch navy at the peak of its military prowess .

Music too has been inspired by the ocean . Sea shanties were chanted by mariners to help coordinate arduous tasks and impressions in music have been created of calm waters , crashing waves , and storms at sea . Classical sea @-@ related music includes Richard Wagner 's The Flying Dutchman , Claude Debussy 's La mer (1903 ? 05) , Charles Villiers Stanford 's Songs of the Sea (1904) and Songs of the Fleet (1910) , Edward Elgar 's Sea Pictures (1899) , and Ralph Vaughan Williams 's A Sea Symphony (1903 ? 1909) .

As a symbol , the sea has for centuries played a role in literature and poetry . Sometimes , it is there just as a gentle background but often it introduces such themes as storm , shipwreck , battle , hardship , disaster , the dashing of hopes , or death . In his epic poem the Odyssey , written in the 8th century BC , Homer describes the ten @-@ year voyage of the Greek hero Odysseus who struggles to return home across the sea 's many hazards after the war described in the Iliad . The sea is a recurring theme in the Haiku poems of the Japanese poet Matsuo Bash? (1644 ? 1694) . In modern literature , sea @-@ inspired novels have been written by the sailors Herman Melville , Joseph Conrad , and Herman Wouk . The psychiatrist Carl Jung argued that , in dream interpretation , the sea symbolizes the personal and the collective unconscious . Although the origin of life on Earth is still a matter of debate , naturalist Rachel Carson wrote in The Sea Around Us that " it is a curious situation that the sea , from which life first arose , should now be threatened by the activities of one form of that life . But the sea , though changed in a sinister way , will continue to exist : the threat is rather to life itself . "