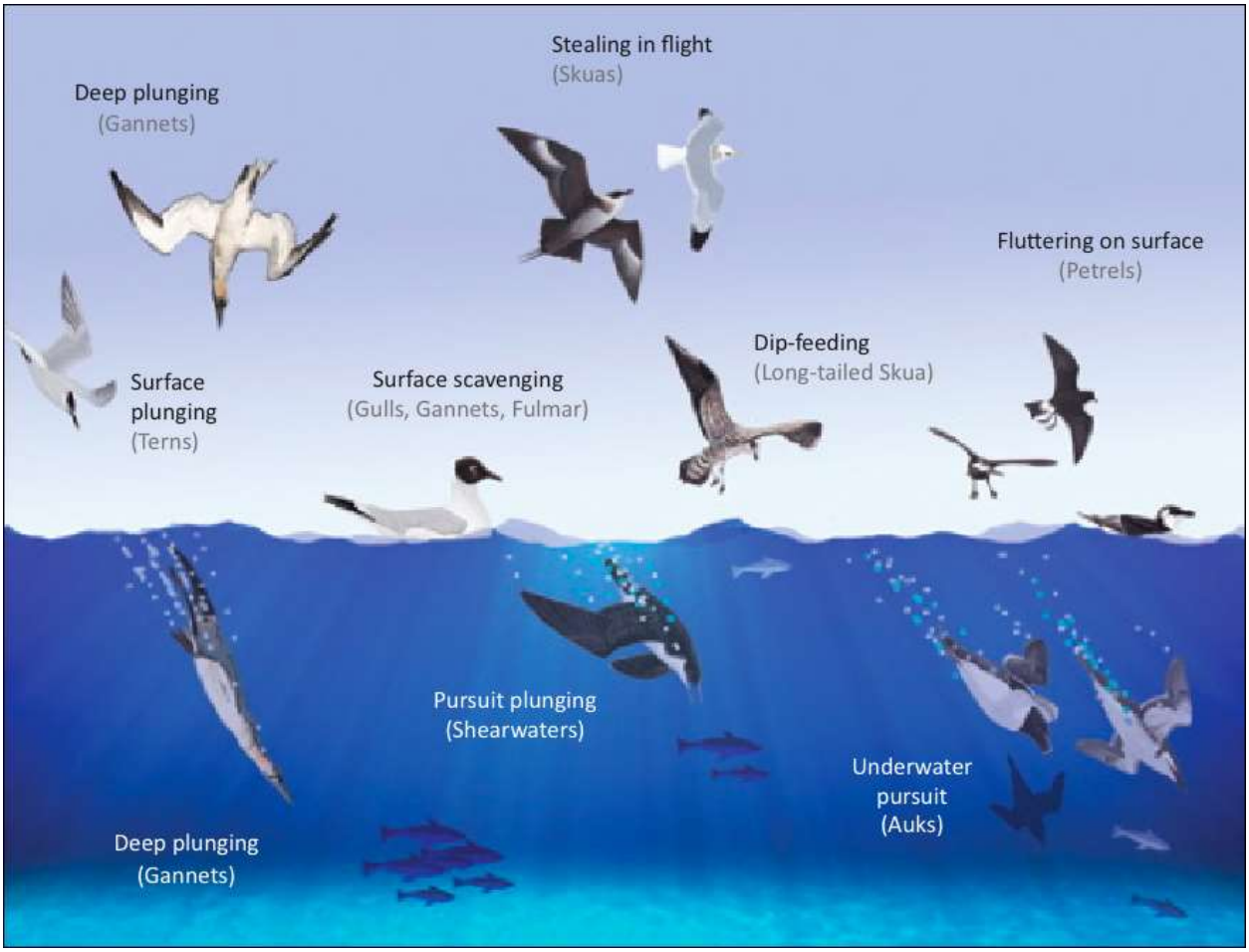
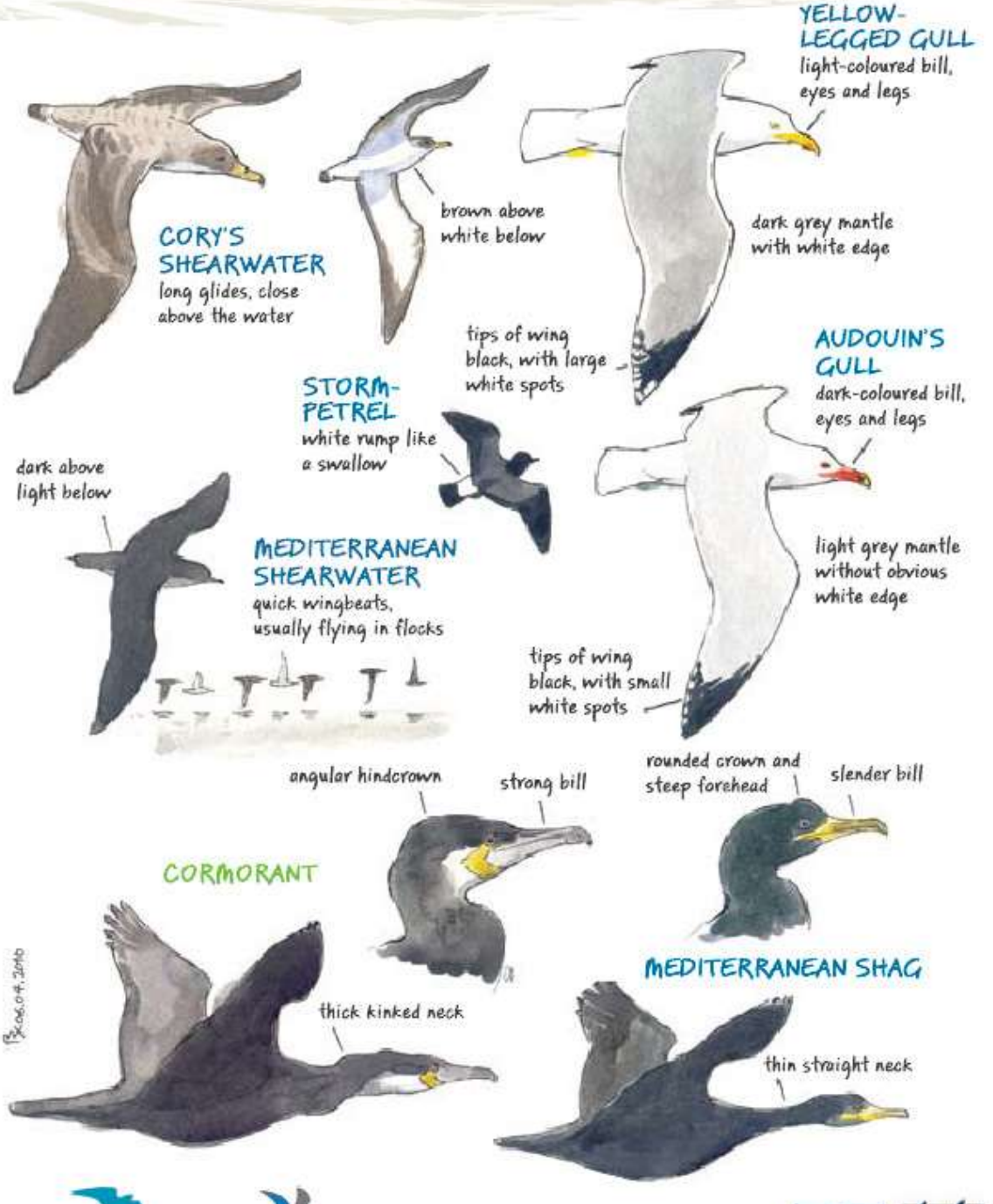
Birds

Although no birds spend their entire lives exclusively in the ocean, many do hunt fish and other sea life. Penguins are the most water adapted of all birds and seem far more graceful in the water than waddling around on the land.

Many birds are highly specialized for the kinds of “fishing” they do.


Deep plunging
(Gannets)
Stealing in flight
(Skuas)
Fluttering on surface
(Petrels)
Surface
plunging
(Terns)
Surface scavenging
(Gulls, Gannets, Fulmar)
Dip-feeding
(Long-tailed Skua)
Pursuit plunging
(Shearwaters)
Underwater
pursuit
(Auks)
Deep plunging
(Gannets)

Quick identification guide to Seabirds



Ornithological Society

BirdLife International

What you need to remember are the following phyla and some of the reasons they are important in this class

1. Porifera: (sponges) simplest animals. Used by people largely for cleaning but also used by Romans to line helmets to make them more comfortable. Biological sponges are not much in use any more. We will talk about sponge divers later in the term

2. Cnidaria: One of the two radially symmetrical animal phyla. This one includes most jellyfish, anemones, and corals. They are typified by their radial symmetry and their nematocysts or stinging cells. The coral, which form reefs, are an important ecological niche and also served as an example of relationship between the coral and a

dinoflagellate which lives in the coral. The dinoflagellate is a primary producer that photosynthesizes. Hence it gives off oxygen which the coral itself can use. The coral gives off carbon dioxide which the dinoflagellate needs to photosynthesize. The dinoflagellate gives the coral its color. When the coral is stressed (as for example the temperature rises (as say during an El Niño) the dinoflagellate is expelled (the coral turns white and the process in known as "bleaching") and may die if a cooler temperature does not occur. If the stressing mechanism does vanish, the dinoflagellates return to the coral.
Another example of this kind of relationship was between the clown fish and the anemone in which both benefit from the other.
Coral is also crucial in that coral reefs constitute an environment which is very important in the ocean and which will be discussed shortly.

3. Arthropods (joint legged animals). These are animals which are widely eaten around the world. They include the crustaceans (lobsters, crabs etc.) insects and spiders and the ever popular horseshoe crab (more closely related to the spiders than to the crabs). The blood of the horseshoe crab is important to pharmaceutical companies for its ability to detect impurities.

4. Mollusks. Another important food group and includes bivalves like clams. Also import are oysters and others which produce pearls as a result of an irritant which has appeared inside the shell (like a grain of sand) and which becomes covered by a secretion which forms the pearl. The deliberate placing of the irritant in the shell produces a pearl known as a "cultured" pearl.

5. **Echinoderms or Echinodermata**. This is the other radially symmetrical phylum and includes various kinds of starfish, sea cucumbers (Holothuroidea), sea urchins (echinoidea) echinoids and some others. They are considered to be closer to the chordate phylum than the others. They also have enormous regenerative powers in which parts of the animal can generate the entire animal while an animal having lost an "arm" or something can regenerate that.

6 Chordates: Animals which at some point in their life cycle have a stiffening rod down there backs known as a notochord. Within the phylum "chordata" is a subphylum called "vertebrata" or "vertebrates" which developed a backbone. The vertebrates are divided into 5 classes:

Fish
Amphibians
Reptiles
Mammals
Birds

Fish and amphibians are tied to the water. While some fish can live out of the water – sometimes even for a few days) it is their basic environment and a place where they need to spawn and where the young develop. Amphibians are basically odd ball fish except in their adult stage they are far more able to remain out of water. A commonly seen amphibian is the frog (the young are tadpoles). Amphibians are notoriously missing from marine animals while fish have been categorized as salt water (biologists say "marine") and fresh water (biologists say "aquatic") forms although this is not a recognized division in terms of taxonomy where the usual distinction is between agnatha (jawless fish) and gnathostomes (jawed fish). The gnathostomes currently greatly outnumber the agnathic fish. The most common distinction made taxonomically is between osteichthyes (bony fish) and chondrichthyes (cartilaginous fish – sharks and rays and the like). Fish are generally seen as being the dominant animal during the Devonian period.

Reptiles make the major shift in evolution to life on land by developing an egg which can be laid on the land, and hence no longer need to return to the water. There were a large number of marine reptiles in prehistoric times like the mosasaur, plesiosaur and others, but they all went extinct at the end of the Cretaceous period along with the dinosaurs and the flying reptiles like the pterodactyl. Of the major reptiles the crocodile/alligator crew managed to survive the extinction that did in the dinosaurs, but by and large these are not marine animals but usually found in more fresh water environments. Turtles also survived and the sea turtle is the major reptile found in the

oceans although some lizards are involved to a lesser degree with the water.

Mammals have returned to the ocean are in several orders: the cetaceans (whales), Sirena (manatees), pinnipeds (seals and sea lions) carnivore (walrus). These are the orders in which there are animals that are basically finned or with flippers that have returned to the sea. Others, like the sea otter and the polar bear, which are also considered marine mammals are far less adapted to ocean living. The seals are heavily adapted to living in the ocean, but can come out on the land and move around with some easy. The whales and manatees do not move between land and ocean.

The cetaceans are divided into two groups (toothed whales (Odontoceti) and baleen whales (Mysticeti). The toothed whales include animals like the killer whale (Orca), the sperm whale (Physeter) and the smaller members of the group – the porpoises and dolphins. The baleen whale includes the huge blue whale, the North Atlantic Right whale (the most endangered of the whales) It gets its name from whalers who claimed it was the "right" whale to take because it slept on the surface and floated when killed. It is still in danger from ships which tend to collide with the sleeping animal and injure or kill it. Ships in the area where there are right whales have to reduce their speed greatly and keep a watch for the whales The Pacific Gray whale (which once endangered) has made a comeback and is no longer on the endangered species list. Whales have been important largely in the U.S. as animals which were hunted for their whale oil and baleen. Other countries like Iceland and other Scandinavian countries along with Japan have hunts whales for food.

The Sirena or manatees live in estuaries and shore environments. They are thought by some to be the stimulus for "mermaids" The are dwindling in number and are often the victims of boat strikes. Virtually all of them show scars from boat propellers. They also fall victim to certain algal blooms which may in some instances be caused by anthropogenic eutrophication.

Seals which have been long hunted for their pelts are no longer hunted and are increasing in number. This had led to some problems in that they eat about 6% of their body weight in fish daily. As their numbers increase, the amount of fish they eat rises. Seals are the favorite food of some of the larger animals like White sharks and Orcas. The block on hunting has caused the number of seals to rise and they have become far more common in places like Cape Cod Bay. White sharks breed off Montauk Point and young sharks are fish eaters. As they approach adolescence, their diet switches to seals which they need to learn to hunt. They have moved up into Cape Cod Bay and the number of shark attacks on people in the Bay has risen. Sharks, learning to find seals, initially seem to mistake people on paddle board and surf boards for sharks and attack them. The growing seal population has caused more seals to be seen in places where they had not been for a long time like New York harbor which has raised for some the image of potential shark attacks on the Long Island beaches.

Sea Otters, like most animals have their own little niche and they are fond of eating sea urchins, thereby controlling the population of these echinoderms. Sea urchins eat kelp and control that population. Kelp is an important ecological zone and a kind of nursery for many animals. Sea otters figure centrally in several scenarios. Hunters in the 1800 and 1900 hunted them for their wonderful pelts. As a result, their numbers dropped off sharply and they were becoming endangered. Once the hunting was stopped their numbers grew again. When people started taking pollack fish in great numbers, it had an impact on the seal population which fell off to about ¼ of the original number. Seals are the favorite food of Killer Whales (orcas) who were then forced to eat other animals for food. They turned to the already dangerously endangered sea otter. As sea otter numbers plummeted, the sea urchin population rose. (When any trophic level is removed or lessened, the level below tends to increase in number and the one above decrease). Sea urchins then over ate the kelp and destroyed the kelp forests, thereby destroying the "nurseries" the kelp were serving for many animals.

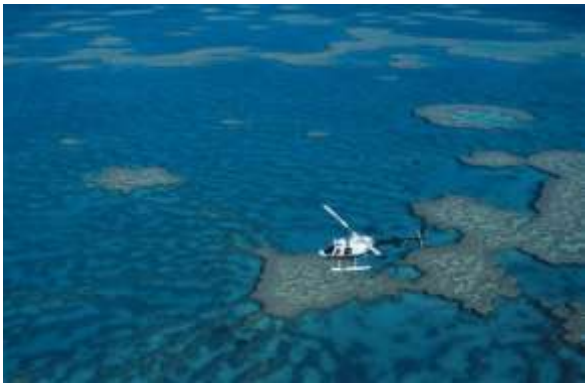
It is important at all times to keep in mind the idea of "a system" and that doing something in one part of the system will likely cause the

system to readjust to the changes – often in ways one does not expect. We have seen this with the anchovies, and seals and fish and now with the fish and the kelp

Birds: These are, like the mammals descended from reptiles but the affinities are much closer. Thought by many to have evolved from "saurischian dinosaurs" none of the birds actually has returned to the ocean as a permanent habitat. Penguins are perhaps the most involved. They no longer fly (like the ostrich ad emu) but unlike the ostrich and emu are remarkably at home in the water and can swim with great speed and efficiency and grace. On land they look peculiarly clumsy and waddle around.
Other birds, while spending less time actually in the water get much of their food from the ocean by diving onto and into it to take fish – often when a school of fish is being attacked from below by other predators. Many of the adaptations in the birds have to do with the way they take the food from the water – diving, plunging etc.

Different Ecological Niches along the shore are important for many reasons. The Coral Reefs are found only along the shores of island volcanos or the remnants of such islands

CORAL REEFS



We have looked at the development of coral reefs starting with a volcanic island on which coral starts to appear. Coral is a kind of animal that needs to be in water. Being an animal, it also needs food. It has developed a relationship with a zooxanthella (ˌzōəzanˈTHelə) - a unicellular dinoflagellate that can photosynthesize.

These are frequently found in the deep ocean since the shore they are involved with is the one that was a volcanic island now submerged. The coral can grow where there is enough sunlight for the zooxanthella to photosynthesize so as the island "sinks", the coral is simply building on the coral which was laid down earlier.

Coral reefs are home to many organisms – Provide habitat and shelter for 25 percent of all fish species in the deeper parts of the ocean. Many of the shore line environments are also home to many organisms and act as nurseries affording protection to the small baby organisms which are living somewhat protected there

Coral Reefs are:

1. About as diverse as rain forest in animals.
2. Great Barrier Reef is more than 1,400 miles long
    a. Started 20,000 years ago Largest structure in the world made by non-human animals
    b. Now world heritage site.
3. Caribbean reefs
    a. many dead
    b. 9% of the world's coral reefs here.

c. About 1/6 remain. Much of the problem is caused by algae and sponges.
d. Attempts to restore (tires – disaster)

Kane'ohe Bay Hawai'i.

Eutrophication of bay from sewerage acting as fertilizer caused certain seaweeds and green "bubble" alga to grow extremely rapidly, covering much of the bottom of the bay. The alga began to overgrow the coral and smother it. Phytoplankton increased as the result of the nutrients and clouded the water blocking light.

Some public outcry reduced the amount of pollution and the green alga started to disappear and the coral began to recover – more rapidly than expected.

During the time of the pollution, the coral skeleton had weakened and become fragile and crumbly. When a hurricane hit the island, in 1982, the weak layer collapsed. However recovery continued because the coral had already started to rebound.

By 1990 the recovery seemed to have leveled off, but some areas started to decline and the green "bubble" algae starting to increase again. It is not clear why. The sewerage is no longer released in the bay.

Possible explanations.

1. Some sewerage remained in the sediment and is still being released (but that has been happening since the recovery started)

2. Some of the sewerage now released elsewhere has begun to flow into the bay

3. There is sewerage from boats, septic tanks and cesspools of private homes and other sources. The population is increasing so there is a change here. It seems unlikely though that the sewerage has increased as much as a result of population increase as had been there before.

4. Increased fishing may have reduced the number of fish that graze on the bubble algae.

5. Another seaweed has been introduced into the area which the fish prefer and so have stopped eating the bubble algae allowing it to increase again

6. Another algae has been introduced which is not a preferred food and so has started to proliferate and is beginning to suffocate the corals.

Eutrophication is not necessarily bad. In some cases is may be good for the zooxanthella and help the coral grow faster. However when the algal grazers are reduced then the eutrophication seems especially damaging.

THE COASTAL AREAS OF THE CONTINENTS ARE CRUCIAL TO MARINE LIFE. WHILE THERE ARE MANY DIFFERENT NICHES ALONG THE SHORE LINE SOME OF THE MOST CRUICIAL AND ENDANGERED ARE VARIOUS WETLANDS

Wetlands

Wetlands are areas where water covers the soil either all year or at different times of the year – which includes the growing season of plants. The kinds of plants and animals found there are determined by the amount of water "saturation" found there. Wetlands are crucial not only for water living organisms but many terrestrial or land living organisms as well. If the water is present, a good deal of the time, then plants that are especially adapted to that condition develop.

Tidal wetlands

In the US these are found along the coastlines. They are linked to the estuaries – places where the rivers meet the ocean and there are complex interactions between fresh water from the rivers and salt water from the ocean which vary the salinity or "salt" content of the water. In addition, the tides cause the water levels to vary as the tides ebb and flow. This is a difficult area for many plants, although some grasses and grass like plants have managed to deal with these variations in marshes along the Atlantic

Gulf and Pacific coasts. Some wetlands are found further away from the ocean in areas where the salinity is not varying.

If you would like more information about wetlands go to: https://www.epa.gov/wetlands/wetlands-factsheet-series

Estuaries

This is the area where rivers empty into the ocean. These are important areas, rich in nutrients which aid in allowing great numbers of primary producers to survive. Many organisms use estuaries as nurseries since food is so plentiful.

They are critical in that they contain a great deal of sediment that washes down the river that filters the water running into the oceans, purifying it and keeping the ocean from being "swamped" with pollutants. MOST POLLUTION COMES FROM RUN OFF FROM THE LAND. Usually it washes down with rain into streams and into rivers and finally into the ocean. Before it enters the ocean however, it drains through the sediment which has built up from being washed down the rivers and is "cleaned".

Estuaries form a transition zone between river environments and maritime environments. They are subject both to marine influences—such as tides, waves, and the influx of saline water— and to riverine influences—such as flows of fresh water and sediment. The mixing of sea water and fresh water provide high levels of nutrients both in the water column and in sediment, making estuaries among the most productive natural habitats in the world.

Estuaries are popularly known by many names including lagoons, sloughs, bays and rivers. Many formed as a result of rising sea levels at the end of the last glaciation.

Jamaica Bay is a saline EUTROPHIC (lots of nutrients because of sewerage) RICH estuary

Another estuary is Long Island Sound which is a tidal estuary as is the East River (which is not a river)

The greatest threat to them is development of cities along the ocean. New York, London, Tokyo are just a few of the cities located on estuaries. The cities tend to develop along them because they are often associated with good harbors. As a result, estuaries have been dredged, filled, had marinas built on them along with seaport, garbage dumps and industrial parks. Many have been destroyed and others are endangered.

Dredging increases exposure to wave action (the deeper the further in the wave can travel).

Fresh water in rivers for example can be dammed or diverted thus removing the fresh water component from the estuary.

Estuaries have been seen as nuisances as a result of their being a breeding ground for insects and have been used for land fill. Of course the insects have a role in the ecosystem as well (pollination and being a food source for frogs, bats etc.). About 1/3 of the estuaries in the US have disappeared. 67% of the ones in California have been lost.

Mangrove Forests/Swamps

Mangroves a group of trees and shrubs living in the coastal intertidal zone

Mangrove: Loxahatchee, Florida

These occur in areas where there isn't much oxygen in the soil. They are found only in tropical and subtropical areas near the equator since they cannot survive cold weather.

The tangle of roots above the water makes the mangrove easily recognizable. They need to be able to handle the rise and fall of the tide. Water is slowed and filtered by the roots and allows a build-up of a muddy bottom. This cleans the water of sediment.

The mangroves act as a stabilizing force for the coast line from the wear of tides, storm surges, currents and waves. The complicated root system is attractive to fish that need protection while looking for food. Larger

predators have difficulty getting into the small water areas between the roots.

Mangrove swamps, with salt-loving shrubs or trees, are common in tropical climates, such as in southern Florida and Puerto Rico.

Mangroves provide an array of ecosystem services, from coastal protection to fishery support to carbon sequestration, all of which are at risk in the Indo-Pacific region due to sea-level rise (SLR). SLR can lead to inundation of these habitats and shoreline retreat.

The mangroves are often cleared for crops, urban development, roads and garbage dumps.

About 75% of all sheltered tropical coast line were once covered by mangrove forests, but about ½ have been destroyed. Southeast Asia has a much higher rate of destruction

One of the places from which the water comes into the rivers is underground water. When rain falls, some falls into the ocean some into the rivers and streams and some is absorbed into the land where it permeates the ground and moves underwater to the same places that the rain falls – rivers, streams and ocean. Water moving through the ground brings with it many of the chemicals and materials. This includes fertilizer. Fertilizer is used to make plants grow and it does the same thing in the water that it does on the land. Fertilizer that enters the ocean causes eutrophication and the algae to grow in large numbers called "alga blooms". This increase initially causes an increase in the amount of photosynthesis which will produce a good amount of oxygen and uses up carbon dioxide. Since the algae grow in huge numbers, the cover the surface of the water that blocks sunlight from the plants on the bottom of the water. Without sunlight, they have no light to photosynthesize and die off. Heterotrophs in the water have some difficulty since there food supply is now cut off. On top of that, the algae die off and begin to decompose. The process of decomposition uses up the oxygen in the water and so the oxygen that is needed by the organisms, and so they may die off creating a "dead zone" where things can't live.

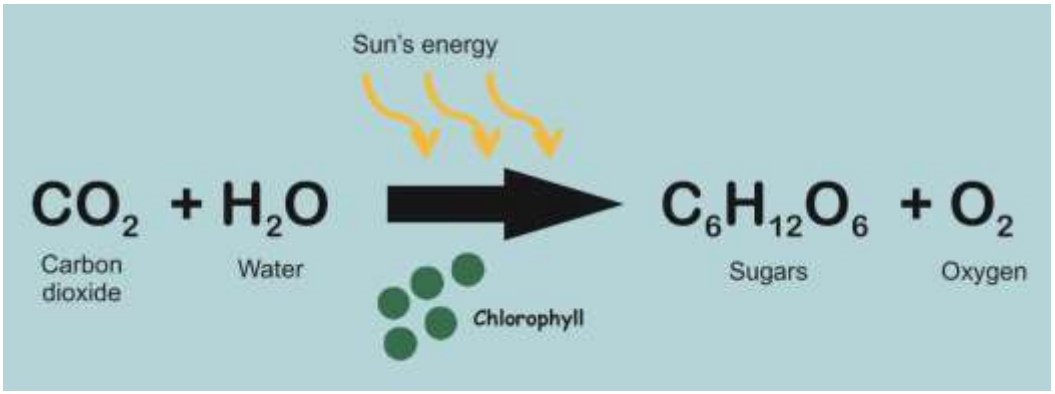
The wetlands are capable of purifying some of the water, but as they are destroyed, more of the nutrients from the run off do not get filtered and the eutrophication cycle begins.

In some cases, large bodies of water have formed as the result of rising sea levels over the last tens of thousands of years.

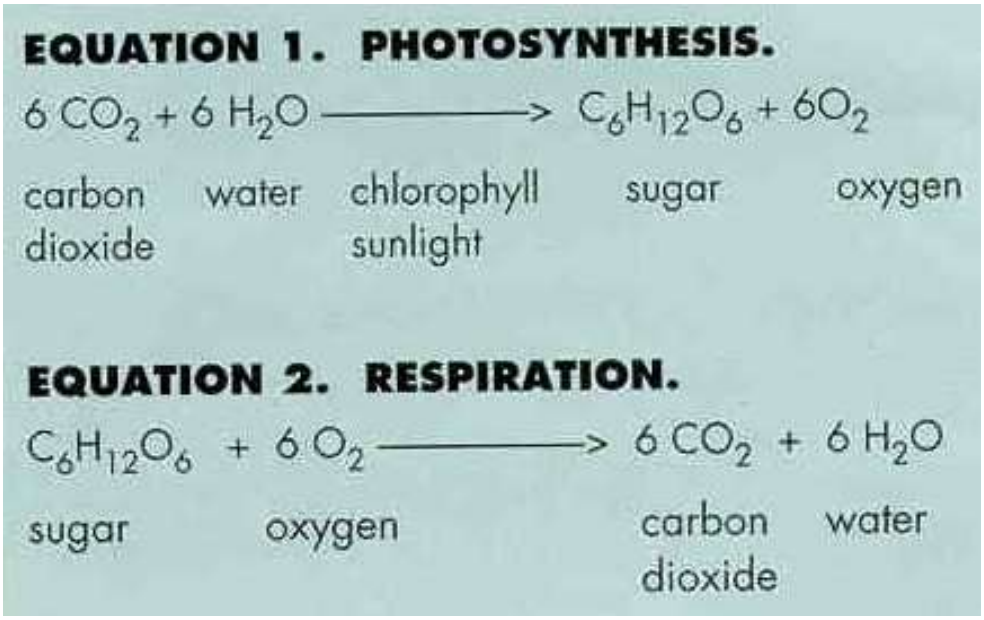
RED SEA: plate movement. As the plates move apart here, the Indian Ocean moved into the space.

ARABIAN GULF: Rising sea levels flooded into the area.

In addition to the animals there are many plant like organisms in the water. Most are photosynthetic storing energy by converting CO_2 and H_2O in the presence of sunlight into sugar and oxygen



These organisms also respire and take in oxygen and produce carbon dioxide.



More oxygen is generally produced than carbon dioxide.

Most of the organisms in the ocean that do this are microscopic protists. Algae, which are photosynthetic organisms, may be multicellular, like sea weeds,

and some like kelp may grow a hundred or more feet in length!

They lack true roots, although kelp have “hold fasts” which look like roots, but are not involved in transportation of food and water, but rather are used to attach the organism to a substrate or base.

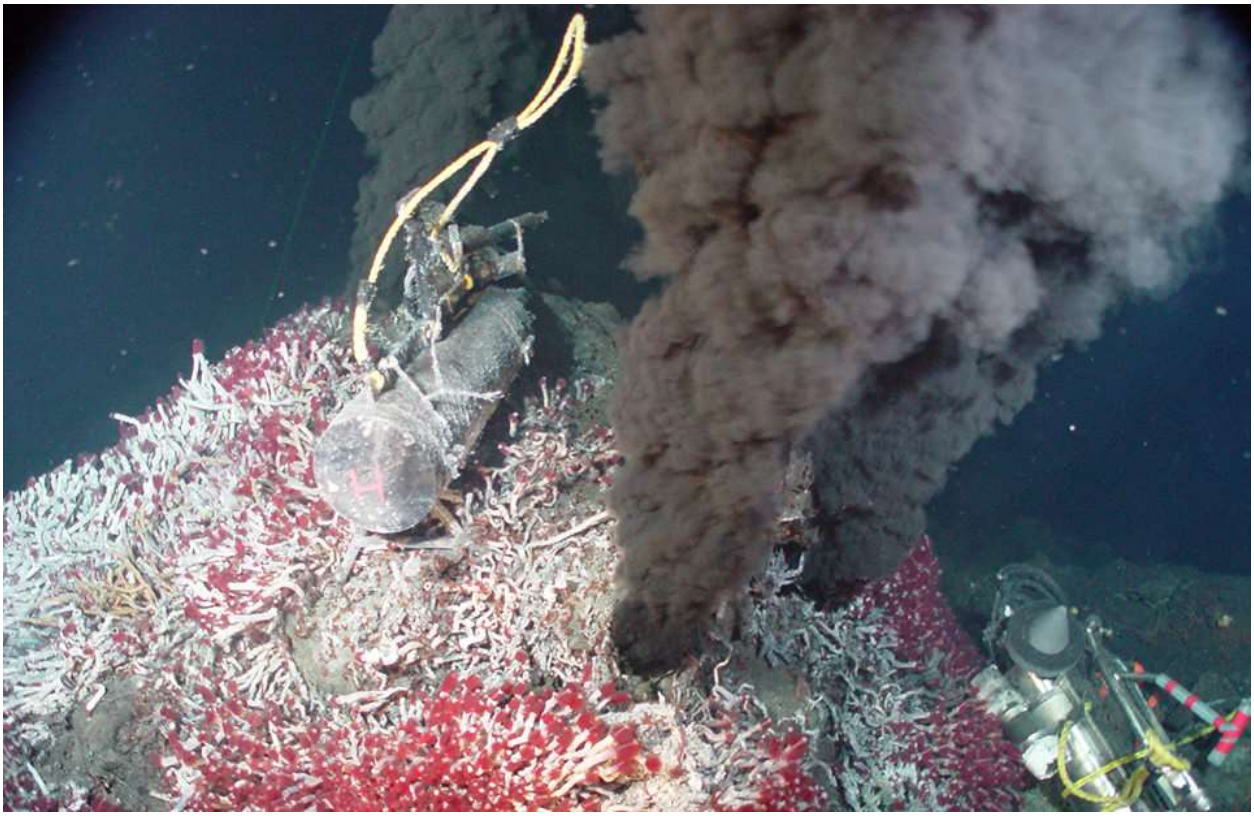
Some organisms live deep in the ocean where light does not penetrate and photosynthesis is not possible. Some organisms are able to produce a carbohydrate through a process called chemosynthesis. In this process one of more carbon containing molecules (carbon dioxide or methane)

The organisms that do this are largely bacteria and archaea.

Here 12 molecules of hydrogen sulfide and 6 molecules of carbon dioxide are converted into a carbohydrate along with 6 molecules of water and 12 sulfur atoms.

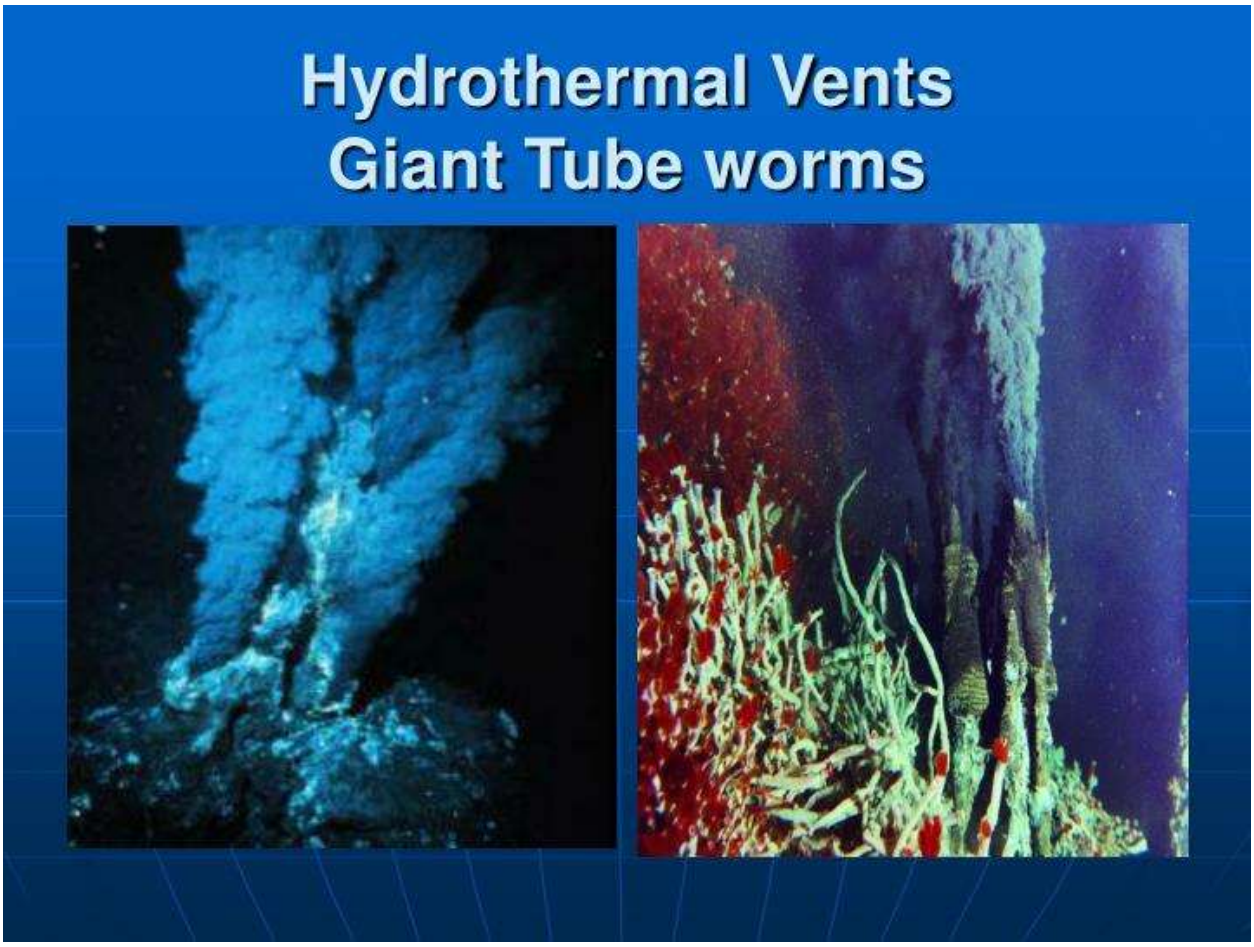
$12\mathbf{H_2S} + 6C\mathbf{O_2} \rightarrow C_6\mathbf{H_{12}O_6}$ (=carbohydrate) $+ 6\mathbf{H_2O} + 12S$

In the depths of the ocean there are "hydrothermal vents". These are places where geothermally heated water occurs – that is the water is heated by volcanic action. These areas are also known as "black smokers". An incredible amount of life forms exist in this very heated area which lacks sunlight and often oxygen.



The life forms (along with the photosynthetic forms) are the base of the food chain. All energy needs to be converted into a form that can be used by life forms. The bottom of the food chain consists of those organisms that can manufacture their own "food" from either sunlight by photosynthesis or by some chemical reaction (chemosynthesis). These organisms are called "primary producers" upon which all other life forms are dependent.

In many instances some symbiotic relationships have formed. The giant tube worm (Riftia pachyptila), for example grows as large as 8 feet. They lack a mouth and digestive tract. Within the giant tube worm live bacteria that "make" their food for them by converting chemicals from the hydrothermal vents into organic molecules. The bacteria are given a "safe" place to live within the worm, and get oxygen, carbon dioxide and hydrogen sulfide from the worms "tentacles".



The food chain starts with those organisms which do not eat, but can manufacture their own food. They are called "Primary Producers" and are at the lowest level of the food chain. Being autotrophs they need only energy and certain minerals to be able to survive. The energy may be light (photosynthesis) or some other source (chemosynthesis). These range in size from one celled organisms to huge plants like Sequoyah trees.

Algae: a group of photo-synthetic organisms that range from unicellular to multicellular

Kelp (a kind of large algae). It is not a true plant. It lacks a true root system

Primary producers are at the bottom of the food chain, but without them, all forms of life above them would cease to exist. The various levels of the food chain are known as “trophic levels”

Heterotrophs

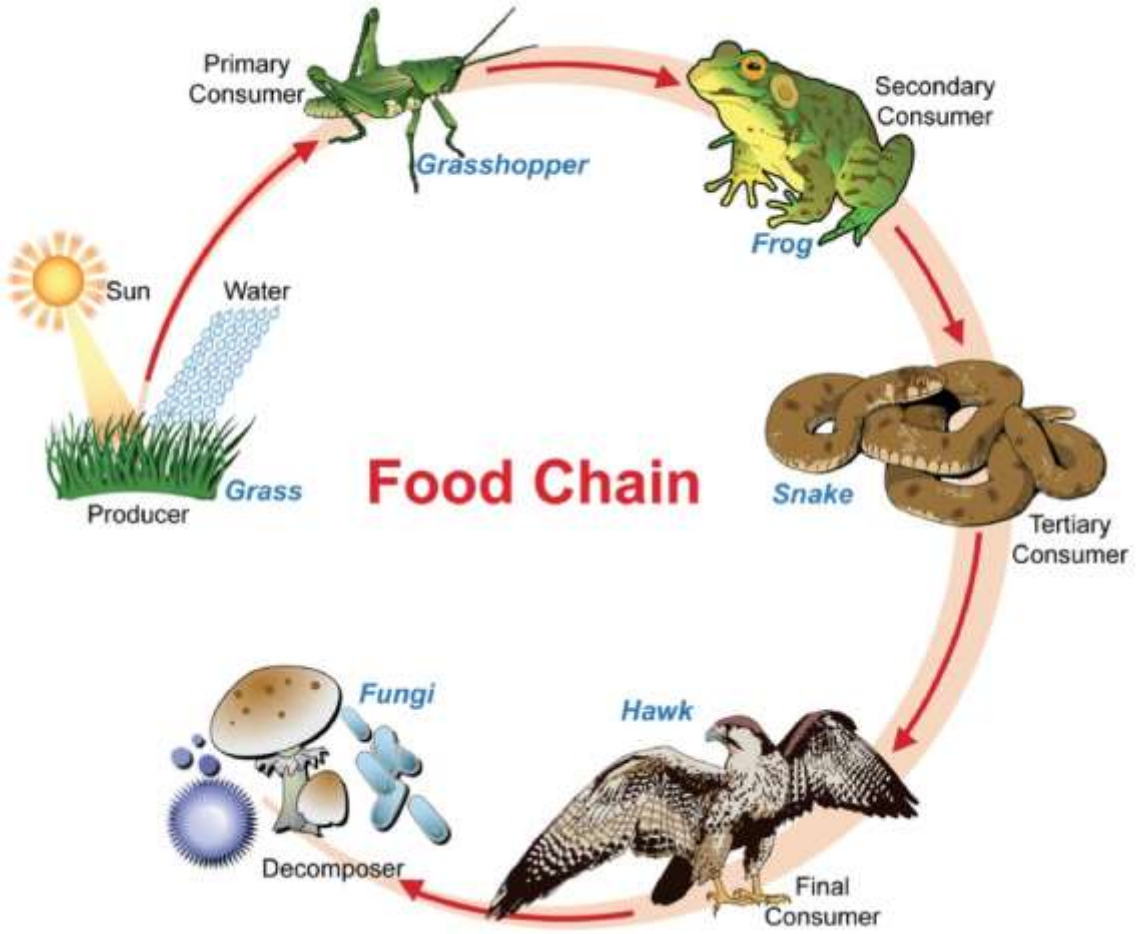
Apex predators (eat level I predators)

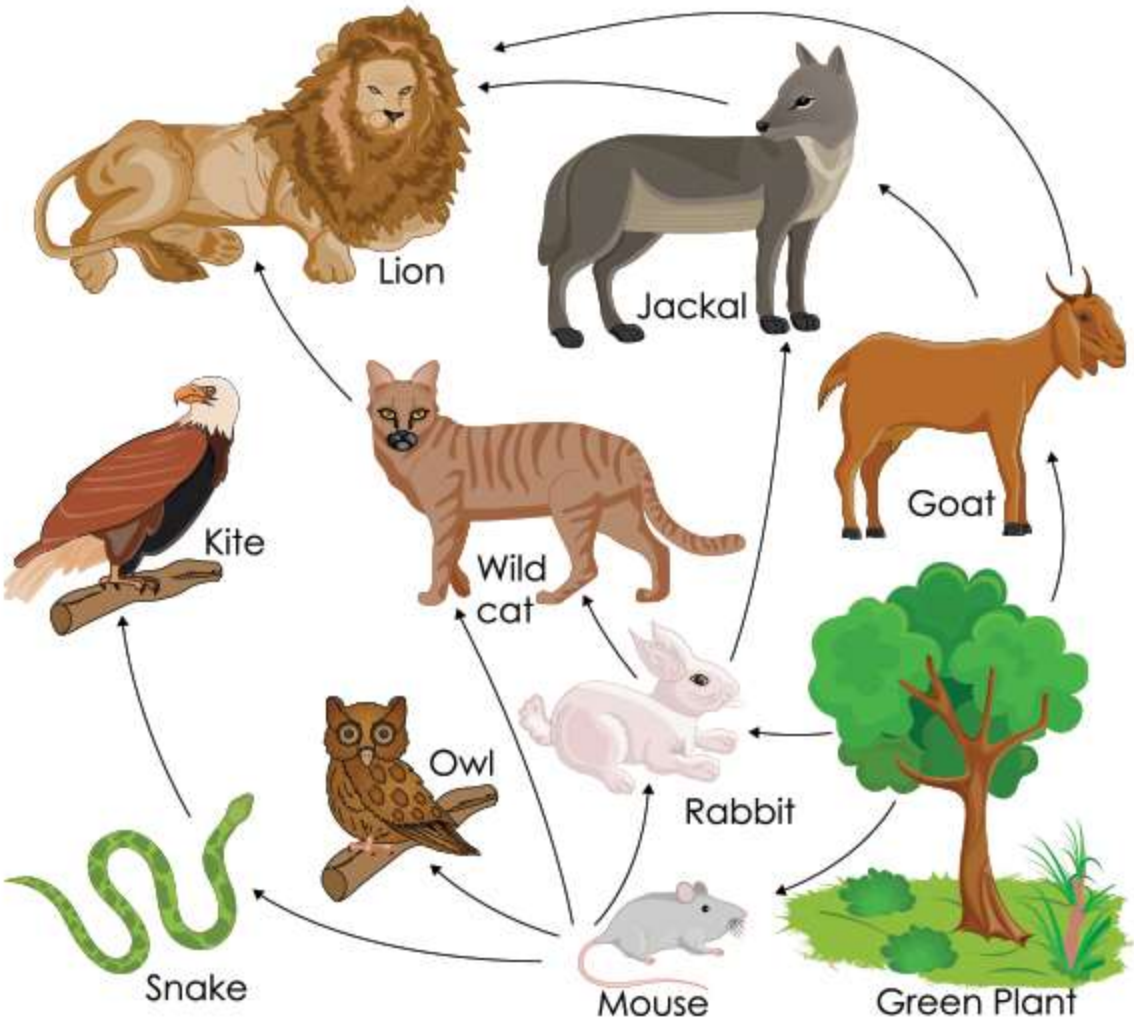
Predators (eat grazers)

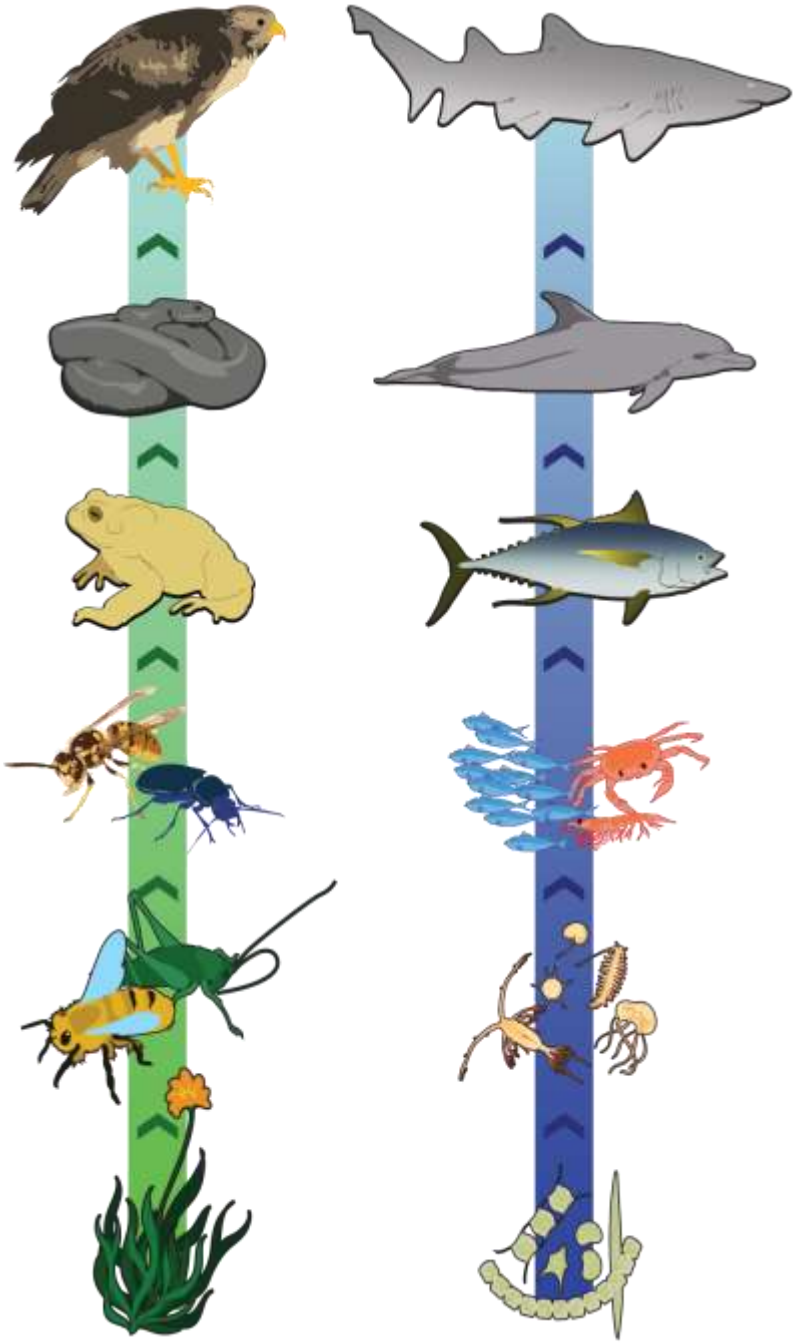
Grazers (eat primary producers)

Autotrophs

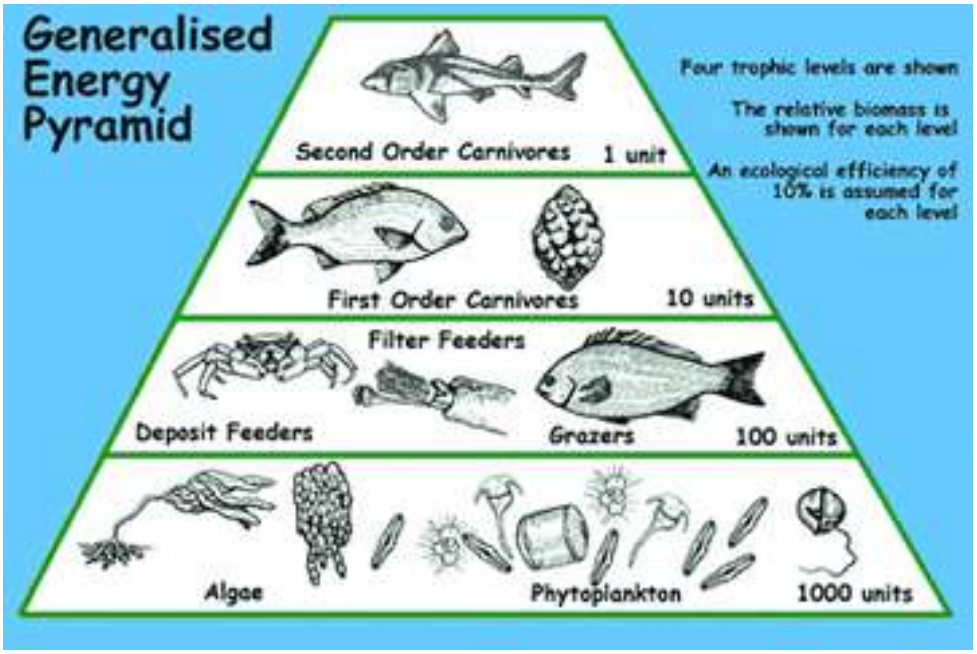
Primary producers (autotrophs)


Food Chain
Primary Consumer
Grasshopper
Secondary Consumer
Frog
Tertiary Consumer
Snake
Final Consumer
Hawk
Decomposer
Fungi
Producer
Grass
Sun
Water


Lion
Jackal
Goat
Kite
Wild cat
Owl
Rabbit
Snake
Mouse
Green Plant

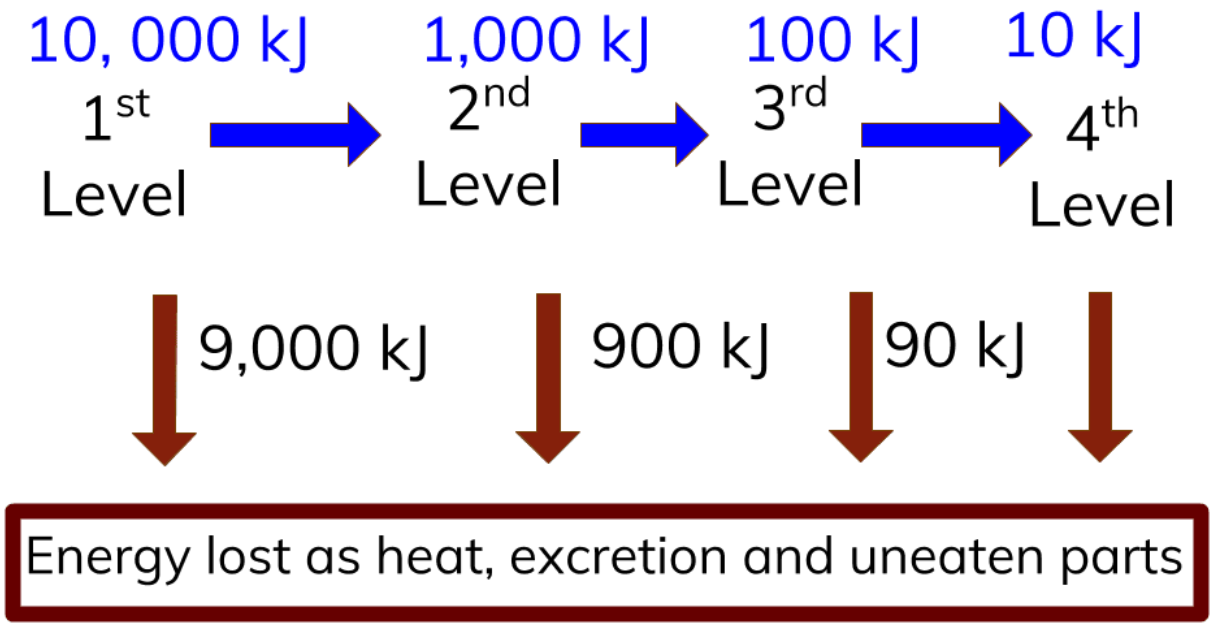


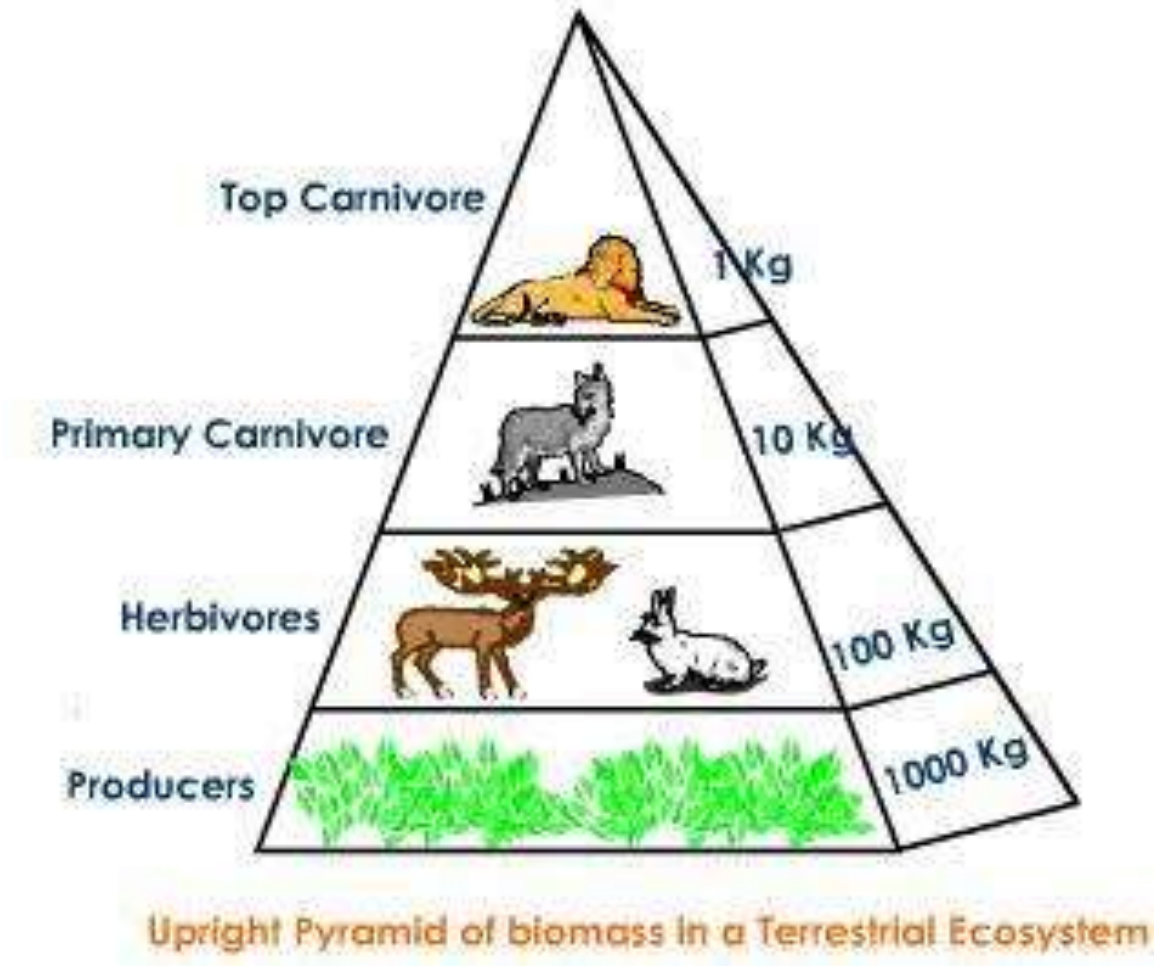
A food chain may have many levels and is often far more complex than the one pictured here. What is important to note is that upper level consumers are dependent on, and to some degree control the growth of the population of the organism they eat. Changes in the population numbers of any organism can seriously impact the organisms below it and above it. Lower Level organisms may grow out of control while upper level organisms may find that their food supply is gone.



All heterotrophs need to use energy to search for food, eat it, digest it and excrete non digestible parts. All of this takes energy and about 90% of what is eaten is used for that purpose. Only about 10% on the average is used for maintaining the organism and building tissue etc. So only 10% of what each level eats gets used for its own needs outside of food gathering.

Biomass in level:





Upright Pyramid of biomass in a Terrestrial Ecosystem

So, almost all energy ultimately comes from the sun. Those organisms that can turn the sun's energy into food are called "primary producers". The do not need to eat. They are able to take carbon dioxide and water and with the energy from the sun, change those into sugar and oxygen. This process is called "photosynthesis". Organisms which cannot photosynthesize (or in rare cases - chemosynthesize - that is use chemical energy to make their own food) have to eat other life forms. So there is a food chain - called trophic levels, starting with the bottom level of primary producers and working up to apex predators.

Carbon dioxide comes into the water from respiration and also because the ocean is able to absorb it from the atmosphere. This is something that becomes significant when we talk later about pollution and climate change.

WHAT KINDS OF THINGS DO WE GET FROM THE OCEAN?

(a) Food.

All kinds of edible material come from the ocean. The most obvious is probably fish (Pisces) but also shellfish, which are not "fish" at all. In addition to animal life, some algae (including seaweeds) are edible. Sea mammals are also edible and people in different parts of the world eat whales and seals. What people regard as food is part of their "culture"

(b) Minerals.

Salt is one of the most common minerals taken from the ocean. One need only let the water evaporate and the minerals remain. Salt is used for food, but was used as money for the Roman legions. The word "salary" is derived from the Latin word for salt.

Along the shores of South Africa and Namibia there are large numbers of diamonds found. They are formed by pressure deep in the Earth and are moved to the surface through volcanic vents.

Heavy metals known as placers are more often mined along the coasts. These are moved by waves and being heavy than the water, get deposited in pockets and depressions along the coast. Gold has been mined off shore of Nova Scotia; tin ore off Malaysia, Indonesia and Thailand.

Aggregates. These are needed for building materials (concrete etc.) Marine aggregate resources are the second largest off shore extraction industry after hydrocarbons. These aggregates were obtainable from beaches, but with the growth of the tourism industry, beaches are a conflict area. The tourism industry is a greater source of dollars so the extraction of aggregates has moved out onto the continental shelf – half of the surface of which is covered with supplies of aggregates (sand and gravel). Japan, the major producer, generates about ½ the world's production.
Many other minerals are found that in the ocean as well that are mined.

(c) Energy

Energy comes from the ocean as well. In some places, hydroelectric power is derived from turbines driven by tidal movements. Fuels

like oil do not literally come from the ocean, but can be found from the land under the ocean.

(d) Pharmaceutical/Medical materials.

Most currently come from terrestrial sources.
NOAA reports (http://oceanexplorer.noaa.gov/facts/medicinesfromsea.html)

Systematic searches for new drugs have shown that marine invertebrates produce more antibiotic, anti-cancer, and anti-inflammatory substances than any group of terrestrial organisms. Particularly promising invertebrate groups include sponges, tunicates, ascidians, bryozoans, octocorals, and some mollusks, annelids, and echinoderms.
Some chemicals produced by marine animals that may be useful in treating human diseases include:

a. Ecteinascidin: Extracted from tunicates; being tested in humans for treatment of breast and ovarian cancers and other solid tumors
b. Discodermalide: Extracted from deep-sea sponges belonging to the genus *Discodermia*; anti-tumor agent
c. Bryostatin: Extracted from the bryozoan, *Bugula neritina*; potential treatment for leukemia and melanoma
d. Pseudopterosins: Extracted from the octocoral (sea whip) *Pseudopterogorgia elisabethae*; anti-inflammatory and analgesic agents that reduce swelling and skin irritation and accelerate wound healing

e. w-conotoxin MVIIA: Extracted from the cone snail, *Conus magnus*; potent pain-killer

A striking feature of this list is that all of the organisms (except the cone snail) are sessile (non-moving) invertebrates. To date, this has been true of most marine invertebrates that produce pharmacologically active substances. Several reasons have been suggested to explain why sessile marine animals are particularly productive of potent chemicals. One possibility is that they use these chemicals to repel predators, because they are basically "sitting ducks." Another possibility is that since many of these species are filter feeders, they may use powerful chemicals to repel parasites or as antibiotics against disease-causing organisms.

Competition for space may explain why some of these invertebrates produce anti-cancer agents. If two species are competing for the same piece of bottom space, it would be helpful to produce a substance that would attack rapidly dividing cells of the competing organism. Since cancer cells often

divide more rapidly than normal cells, the same substance might have anti-cancer properties.

Up to this point we have been talking about the ocean and the ways that it has an impact on people. The way in which the people make use of the ocean and the way the ocean is perceived are all based on questions of "culture".

The nature of culture.

There are two ways in which "culture" is used. One is something we have just defined – something which is uniquely human, while the other is peculiar to a specific group. These are sometime designated as "Culture" with an upper case letter for the universal meaning and "culture" with a lower case for a specific culture (e.g. Japanese culture, Navajo culture, Swazi culture and so on).

You can compare this with language as well. All human societies have Language (with an upper case "L") but specific societies have specific languages (with a lower case "l"). So German is a different language than Japanese, both are "languages" so they share something in common which allows people to classify them as "Language". Similarly, some group A has culture A; group B has culture B. A and B are not alike, but they share enough in common to be called "cultures" What "languages" share in common is "Language".

First, we need to think about two kinds of differences: qualitative and quantitative. Quantitative changes indicate changes in amount; qualitative changes indicate changes in kind. In English, quantitative changes are indicated by the comparative and superlative forms of an adjective:

Tall	taller	tallest
Rich	richer	richest
Pale	paler	palest

A change in the nature of something requires a different word. Compare

Sick	sicker	sickest
Sick	sicker	dead

The first shows a quantitative, the second a qualitative one. Being dead is not being extremely sick.

The social sciences deal largely with human societies, but not exclusively. This indicates that societies are not exclusively human. The study of societies is unlike many aspects of science as it occurs in the physical sciences because it is often not possible to experiment the way one can in the physical sciences.

It is possible to organize the world along levels of complexity:

Societies
Organisms
Organ systems
Organs
Tissues
Cells
Bio-molecules
Molecules
Atoms
Subatomic structures

Typically physics deals with the lowest levels, chemistry is above that, biology a bit higher and geology tends to be more or less like biology but with inorganic materials.

We can look at the organization of things as levels of organization:

Sub atomic particles come together to make atoms, which combine to make molecules. Some molecules combine in such a way that they constitute bio molecules. These become sub cellular parts that can become cells which become tissues, that becomes organs and organ systems which make organisms.

At each level of organization some new attribute appears which does not exist at the lower level. So going from molecule to bio-molecule the characteristic of life appears. This is not a new idea. It generally contrasts with something called reductionism – If something is in the whole it must be in the parts. So we could ask under this idea "Are you alive?" If your answer is "yes", then the next question would be "Is your circulatory system alive". If "yes", then "Is your heart alive?" If "yes", then "Is the muscle tissue on your heart alive?" If "yes", then "Are the muscles cells in the muscle tissue alive?" If "yes", then "Are the sub cellular parts alive?" If "yes", "Is the DNA in your cells alive?" If "yes", is the carbon in the DNA alive"? Hmmm. If it isn't then, non-organic material combined to make organic material. This is a QUALITATIVE leap rather than simply a quantitative one. In effect, each

level can be defined relative to something that appears at that level but not the one below it. There is as additive property involved.

It is also clear though, that what happens at a lower level can also have an effect on what happens at a higher level.

If we take hydrogen and put a lit splint in it, it will flare up.

It will do the same thing if you put a lit splint in oxygen.
If you combine hydrogen and oxygen you get water, and if you put a lit splint in water it does not explode or flare up, but goes out. So water does not behave like the elements which make it up.

At the same time we recognize that different atoms when combined will produce different molecules with different properties. Combining carbon and oxygen makes carbon dioxide not water. So there is something about the things which combine that has some impact on the higher level, but is still qualitatively different from the lower level.

So, while societies all share something in common, they can also be rather different in the same way that all molecules share something in common, but are uniquely different from one another.

In this sense, we can ask what is the "new" attribute that occurs at each level. At the moment our concern is about the level of organisms combining to form societies. We don't have a name for what the new attribute is that appears at that level. But we can say that whatever appears when organisms come together will be different depending on the organisms. When chimps come together in social organization, something "extra-chimp" will appear. The same will happen if the organisms are humans. We can use the term "culture" for the new attribute that appears when humans come together in social organization.

This is one "operational" definition of culture.

However, there are two ways in which "culture" is used. One is something we have just defined – something which is uniquely human, while the other is peculiar to a specific group. These are sometime designated as "Culture" with an upper case letter for the universal meaning and "culture" with a lower case for a specific culture (e.g. Japanese culture, Navajo culture, Swazi culture and so on).

You can compare this with language as well. All human societies have Language (with an upper case "L") but specific societies have specific

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So one definition of culture is “What occurs when humans come together in social organization”.

This is a definition of “Culture” (upper case) whereas the specific form it takes in specific groups is “culture” with a lower case.
Culture can have variations in it the way there are different languages. There can be variations in cultures, the way languages have dialects.