Energy in Ecological systems

1st law of thermodynamics: energy can be changed from one form to another, but it cannot be created or destroyed (conservation of energy…just like conservation of matter).

2nd law of thermodynamics: in all energy exchanges, if no energy enters or leaves the system, the potential energy of the state will always be less than that of the initial state. The amount of usuable energy in a system is always becoming less. Energy will often be lost as HEAT to the atmosphere.

Food WEBS

- Most food chains have no more than four or five links.
- Limited links because the animals at the end of the chain would not get enough food (and hence energy) to stay alive.
- Each level only gets 10% of the energy of the proceeding levels
- Most animals are part of more than on food chain. Interconnected food chains form a food web.

Producers /Autotrophs - self-sustaining by producing food from inorganic compounds (and sunlight for plants). (plants,some bacteria, algae, Arachae (single-celled organisms)

- **Photosynthesis** - the conversion of light energy into chemical energy by living organisms
- **Chemosynthesis**- the biological conversion of 1-carbon molecules (usually carbon dioxide or methane) and nutrients into organic matter using the oxidation of inorganic molecules (e.g. hydrogen gas, hydrogen sulfide) or methane as a source of energy, rather than sunlight, as in photosynthesis

Consumers – (primary, secondary, tertiary, Heterotrophs)-an organism that requires other living organisms to get its carbon for growth and development

Decomposers - are organisms that consume dead plants and animals, and, in doing so, carries out the natural process of decomposition. (some bacteria, mold, fungus)

Detritivores –lives off the fragments of dead organisms-earthworms

Detritus - non-living particulate organic material (as opposed to dissolved organic material). It typically includes the bodies of dead organisms or fragments of organisms or faecal material.

Omnivores - a species of animal that eats both plants and animals as its primary food source

Scavenger - a consumer that eats dead animals (e.g. crab, crow, vulture, buzzard and hyena.)

Herbivores – Eats herbs and plants

Carnivores– Meat eater

Primary consumer Heterotrophs or herbivores

Secondary consumer Carnivore birds and fish (or omnivore)

Tertiary consumer- carnivore, birds, large mammals (or omnivore)

Aerobic respiration – Needs oxygen

Anaerobic respiration – Doesn't need oxygen

Biodiversity - variation of taxonomic life forms within a given ecosystem, biome or for the entire Earth

Trophic level - describe the position that an organism occupies in a food chain - what it eats and what eats it.

Biomass - refers to living and recently dead biological material, which can be used as fuel or for industrial production. Often measured as 'dry' biomass (so water doesn't count).

Biodegradable- can be broken down by other living organisms

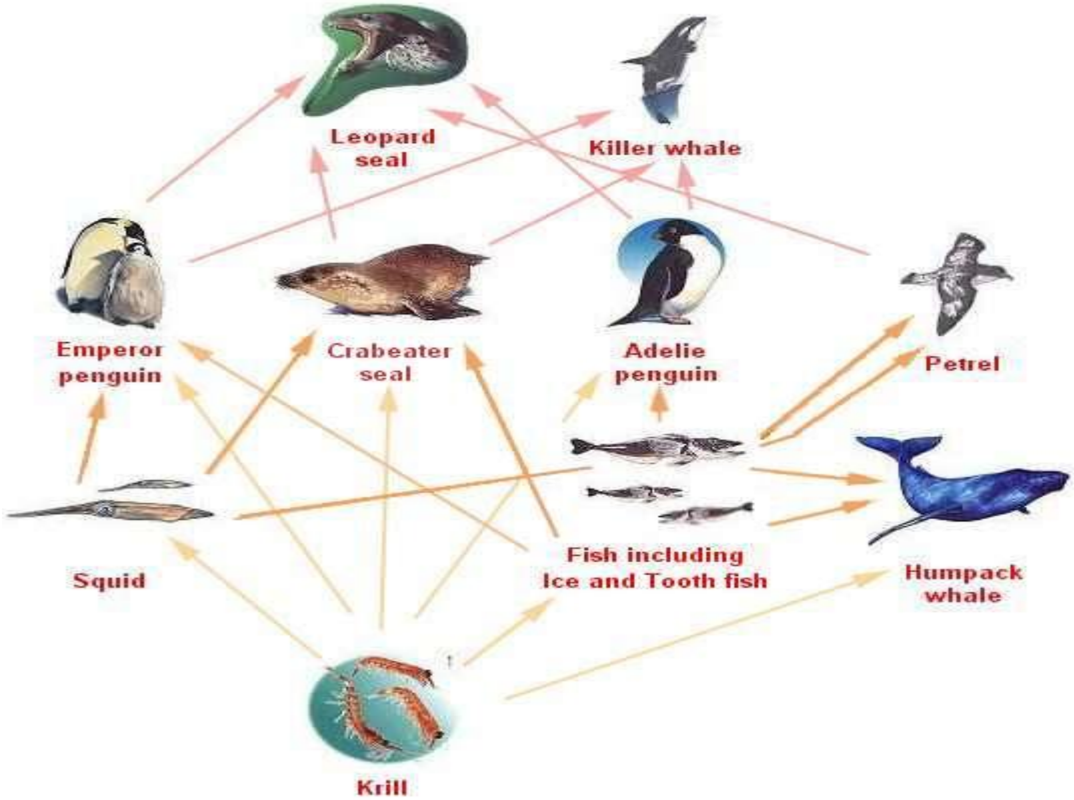
Gross primary productivity – the total energy assimilated by an organism or ecological unit

Net primary productivity – energy that remains after respiration and is used to generate biomass

Below is a simple food web,

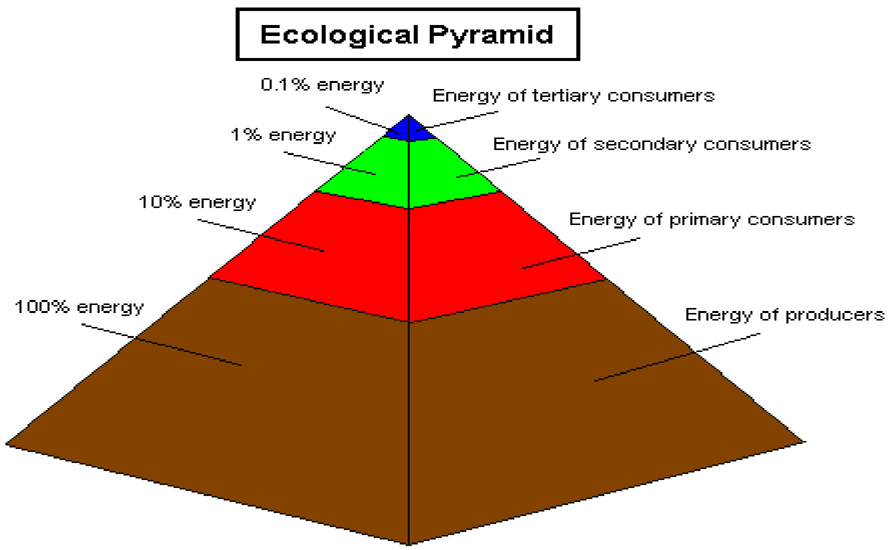
1. Note that the arrows go in the same flow as the energy.
2. In this example, those organisms at the top of the food web may be keystone species (they produce an impact on the ecosystem much greater than the number of them would suggest).

3. Predators help cull weak and old organisms from the gene pool.
4. In this web, if the krill are absorbing inorganic or organic pollutants they will be the entry point of those potential toxins into the food web. Typical toxins would include mercury (a heavy metal), atrazine and other pesticides or herbicides, oil and visible pollution such as plastics.
5. If we are eating the fish, we are taking food away from large ocean predators and it is a major reason they are in decline.



Below is a simple energy pyramid, but some applications of it are:

1. We lose 90% of energy in one level when you go up a food chain. People who eat on the first trophic level leave much smaller ecological footprints than those who eat more meat. (This also saves fresh water resources and eliminates the production of methane from livestock).
2. The pyramid explains why big secondary and tertiary consumers requires such large ranges in order to exist.
3. Every road, every parking lot, every field f monocultured corn or wheat or soybean or cotton, every pristine lawn is, effectively, habitat destruction. With this goes a few large predators, hundreds of snakes, thousands of frogs, tens of thousands of plants and insects.



Biogeochemical systems – how do they work?

1. One-way flow of solar energy into the earth's systems. As radiant energy, it is used by plants for food production. As heat, it warms the planet as greenhouse gases absorb outgoing IR radiation. Heat also powers the weather system. Eventually, the energy is lost into space in the form of infrared radiation. Most of the energy needed to cycle matter through earth's systems comes from the sun. (Geothermal energy and nuclear energy comes from radioactive decay).
2. The cycling of matter. Because there are only finite amounts of nutrients available on the earth, they must be recycled in order to ensure the continued existence of living organisms. The ones you should know in detail are those that are vital to growth: carbon, nitrogen, phosphorus, sulfur and water.
3. The force of gravity. This allows the earth to maintain the atmosphere encompassing its surface and provides the driving force for the downward movement of materials in processes involving the cycling of matter. (Think of infiltration for water or erosion to expose phosphorus sinks.)

Water Cycle

- The SUN drives the cycle heating water in the oceans and some evaporates. Most precipitation falls back into the ocean.
- Ice and snow can sublimate directly into water vapor.
- Water transpires from plants and water evaporates from the soil or bodies of water.
- Rising air currents take the vapor into the atmosphere where cooler temperatures cause it to condense into clouds
- Air currents move clouds around the globe, cloud particles collide, grow and fall out of the sky as precipitation.
- Some precipitation falls as snow and can accumulate as ice caps and glaciers, which can store frozen water for thousands of years.
- Snow packs can thaw and melt and the melted water flows over land as snowmelt.
- Runoff goes to rivers, lakes and streams and much of it soaks into the ground as infiltration
- Some water replenishes aquifers

How humans impact the water cycle

1. By damming rivers to create reservoirs, we increase evaporation and in some cases, infiltration of surface water into aquifers.

2. By altering earth's surface and vegetation, we increase surface runoff and erosion
3. By irrigating crops, we deplete rivers, lakes and streams and can increase evaporation
4. By removing forests we reduce transpiration and may lower water tables.
5. By emitting pollutants into the air, we change the chemical nature of precipitation
6. We overdraw groundwater to the surface for irrigation, industrial use and personal use. Some aquifers do NOT get recharged from infiltration. Once we use the water up, it is gone for the 'freshwater' side of our saltwater/freshwater equation.

Carbon cycle

- Sedimentary rocks containing carbonates (limestone) are the biggest sinks with 80,6000,000 petagrams with oceans next at 38,400 gigatons then fossil fuels at 4130 Gt and the atmosphere at 765 Gt. Carbon comprises .03% of the gases in the air.
- Carbon dioxide is taken up by plants during photosynthesis on land and in the ocean and returned through the atmosphere by animal and producer respiration, decomposition and the burning of fossil fuels and biomass.
- Geological forces return carbon from the rocks to the atmosphere
  - Volcanic eruptions
  - Erosion of carbonate rocks cases carbonates to return to the sea.
- A carbon atom cycles from the atmosphere through living things and back through the atmosphere every six years. Human activity threatens to disrupt the natural cycle of carbon.
- Carbon dioxide from the atmosphere can move directly into the ocean (without a biotic component).
  - Carbon dioxide dissolves in the oceans.
  - Dissolved carbon dioxide (carbonates) get incorporated ino the shells of microorganisma (e.g. diatoms, plankton, marine invertebrates.) when these organisms die, the carbonates settle to the bottom ocean sediments (Calcium carbonate CaCO3…same as chalk…yummy!)
- Photosynthesis $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$
- Respiration $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

Human impact on carbon cycle

1) The release of carbon dioxide into the atmosphere during the burning of fossil fuels and biomass, and
2) The clearing of trees and other plants (deforestation) that absorb carbon dioxide from the atmosphere during photosynthesis faster than they can be replanted

The net effect of these actions is to increase the concentration of carbon dioxide in the atmosphere. It is estimated that global atmospheric carbon dioxide is increasing by about 0.4% annually. Carbon dioxide is a **greenhouse gas** (i.e., it prevents infrared radiation from the earth's surface from escaping into space.)

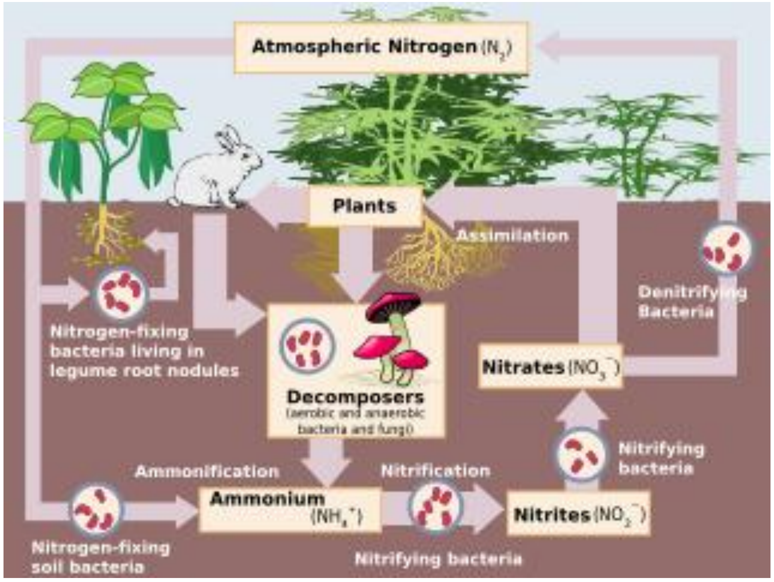
Sulfur

- Sulfur is important as it is found in proteins as part of amino acid cysteine and cystine.
- Sulfur is similar to the phosphorus cycle. It is mainly found in rocks and soil (and fossil fuels) as sulfate minerals. Sulfur sinks are sulphate salts in the ocean and hydrogen sulphide
- Weathering exposes sulfate from the rocks in the soil and into aquatic ecosystems.
- Sulfur in soluble form is taken up by plant roots and incorporated into amino acids. It travels through the food chain and is release back to the soil during anaerobic bacterial decomposition.
- In the soil, various chemosynthetic bacteria can convert hydrogen sulfide back into inorganic sulfates, to sulfuric acid, and/or to elemental sulfur. If iron is present, it reacts to form iron sulfide, which gets incorporated into rocks by geological processes.

- Unlike phosphorus, sulfur has an atmospheric component as H_2S during fossil fuel combustions, volcanic eruptions and hot springs, gas exchange at ocean surfaces and decomposition by bacteria
- H_2S is immediately oxidized to sulfur dioxide
- Sulfur dioxide combines with water to make weak sulfuric acid that comes back to earth as rainfall. (Acid rain)
- It is an EPA criterion pollutant (2^{nd} semester)

Human Impact

- Anthropogenic sources are sulfur dioxide emissions from industry and some from fertilizers
- These emissions produce acid rain, particularity from the burning of 'dirty' coal.



Nitrogen

- Nitrogen is biologically important as it is part of all proteins and nucleic acids.
- The biggest store of nitrogen is in the atmosphere (78% of atmosphere); $3.9 * 10^{21}$ g of atmospheric nitrogen. BUT it must be altered to be available to almost all plants/animals.
- This is 'non-reactive' nitrogen until it is fixed by a reaction with hydrogen, water or decomposition by rhizobium bacteria that live in legumes or human industrial processes (the Haber process) or lightning for 1% . This is called **nitrogen fixation.**
- Once this nitrogen becomes ammonia (um) it generally goes through **nitrification** with soil bacteria producing nitrites and then nitrates
- The **nitrates** are then **assimilated** by plants and incorporated into plant proteins and nucleic acids.
- Animals eat plants! Plants and animals die
- **Ammonification** is when decomposing bacteria convert nitrogen compounds into ammonium
- Denitrifying bacteria convert nitrates in soil or water back to gaseous nitrogen through several steps called **denitrification.**
- In aquatic systems, **cyanobacteria** perform the nitrogen-fixation steps and other bacteria perform ammonification and denitrification.

Human impact on nitrogen cycle

- Humans have doubled the rate of nitrogen entering the land-based nitrogen cycle, and that rate is continuing to climb.
- Humans add nitrogen to farmland through the use of fertilizers when these fertilizers go into surface waters they can result in eutrophication and apoxia…lack of oxygen.
- Increased atmospheric concentration of a potent greenhouse gas, nitrous oxide, N_2O and other oxides of nitrogen, including nitric oxide, NO, that drive the formation of photochemical smog. These increases come from the burning of biomass and fossil fuels and allowing anaerobic bacteria to break down the tremendous volume of animal waste in agricultural feedlots. We also create acid rain through this process
- Losses of soil nutrients such as calcium and potassium that are essential for long-term soil fertility, because the use of fertilizer help flush them out.
- Substantial acidification of soils and of the waters of streams and lakes in several regions;
- Greatly increased transport of nitrogen by rivers into estuaries and coastal waters where it is a major pollutant.
- Accelerated losses of biological diversity, especially among plants adapted to low-nitrogen soils, and subsequently, the animals and microbes that depend on these plants;
- Caused changes in the plant and animal life and ecological processes of estuarine and near shore ecosystems, and contributed to long-term declines in coastal marine fisheries.

Phosphorus cycle

- Key component of cell membranes and of several molecules vital for life such as DNA, RNA, ATP ad ADP.
- The vast majority of phosphorus is contained within rock (mineral called appetite) and is released only by weathering, which releases phosphate ions into water.
- Phosphates in lakes or oceans precipitate into solid form, settle to the bottom and reenter the lithospheres' phosphorus reservoir in sediments.
- No gaseous phase, tiny amounts of wind blow dust and sea spray
- Most phosphorus bound up in rock only slowly releases, so environment concentrations available to organisms tends to be very low.
- Phosphorus is frequently a limiting factor for plant growth and this is why an artificial inflow of P can produce immediate and dramatic effects.
- Plants uptake phosphorus when phosphate dissolves in water (as phosphates).
- Primary consumers acquire phosphorus from water and plants and pass it on to higher consumers.
- Decomposers help return phosphorus to the soil.
- Animal excretions contain phosphate that gets back into the soil.
- Weathering and erosion leach some phosphate from the rocks and soils into stream and rivers. Here, the phosphorus cycle is similar to terrestrial systems.

Human influence

- We mine rock to add to fertilizers
- Our wastewater discharge tends to be rich in phosphates
- Phosphate in waterways can boost algal growth and cause eutrophication

Biomes

- Biome: major regional complex of similar communities, recognized primarily by its dominant plant type and vegetation structure.
- Which biome covers any potion of the planet depends on
- Temperature, precipitation, atmospheric circulations and soil characteristics

- Parts of biomes tend to occur at the same latitudes
- Aquatic systems are shaped by water temperature, salinity, dissolved nutrients wave action, currents depth and type of substrate. Marine communities are based on animal life more than plant life
- High net primary productivity: freshwater wetlands, tropical forest, coral reefs and algal beds
- Deserts, tundra and open oceans tend to have the lowest primary productivity
- In terrestrial ecosystems, NPP goes up with temperature and precipitation. In aquatic ecosystem, NPP tends to rise with light and the availability of nutrients.

Biome Summary Chart

Biome	Location	Climate	Soil	Plants	Animals
Desert	midlatitudes	generally very hot days, cool nights; precipitation less than 10 inches a year	poor in animal and plant decay products but often rich in minerals	none to cacti, yuccas, bunch grasses, shrubs, and a few trees	rodents, snakes, lizards, tortoises, insects, and some birds. The Sahara in Africa is home to camels, gazelles, antelopes, small foxes, snakes, lizards, and gerbils
Tundra	high northern latitudes	very cold, harsh, and long winters; short and cool summers; 10-25 centimeters (4-10 inches) of precipitation a year	nutrient-poor, permafrost layer a few inches down	grasses, wildflowers, mosses, small shrubs	musk oxen, migrating caribuou, arctic foxes, weasels, snowshoe hares, owls, hawks, various rodents, occasional polar bears
Savanna	Above the tropical rainforest	Tropical wet and dry seasons. The climate varies, with an average temperature of 27°C with peaks of 30°C in April and October, and between 300 and 1500 millimetres of rain per year	Thin layer of humus and porous; during the wet season rapid leaching occurs. The soil suffers from a lack of nutrients.	Grasses, shrubs, and small trees	African grasslands include elephants, lions, zebras, giraffes
Temperate Grassland	midlatitudes, interiors of continents	cool in winter, hot in summer; 25-75 centimeters of precipitation a year	rich topsoil	mostly grasses and small shrubs, some trees near sources of water	American grasslands include buffalo, prairie dogs, foxes, small mammals, snakes, insects, various birds. .

Temperate Deciduous Forest	midlatitudes	relatively mild summers and cold winters, 76-127 centimeters (30-50 inches) of precipitation a year	rich topsoil over clay	hardwoods such as oaks, beeches, hickories, maples	wolves, deer, bears, and a wide variety of small mammals, birds, amphibians, reptiles, and insects.
Taiga (boreal or coniferous forests)	mid- to high latitudes	very cold winters, cool summers,; about 50 centimeters (20 inches) of precipitation a year	acidic, mineral-poor, decayed pine and spruce needles on surface	mostly spruce, fir, and other evergreens	rodents, snowshoe hares, lynx, sables, ermine, caribou, bears, wolves, birds in summer
Tropical Rainforest	near the equator	hot all year round, 200-400 centimeters (80-100 inches) of rain a year	nutrient-poor	greatest diversity of any biome; vines, orchids, ferns, and a wide variety of trees	more species of insects, reptiles, and amphibians than anyplace else; monkeys, other small and large mammals, including in some places elephants, all sorts of colorful birds

Aquatic biomes

There two major types of aquatic biomes, **the marine regions**, and **the freshwater regions**.

The marine regions

The marine regions are divided into **coral reefs**, **estuaries,** and **oceans**. Oceans represent the largest and most diverse of the ecosystems; salt water evaporates and turns to rain which falls on the land regions, while most of the oxygen in our atmosphere is generated by algae. Algae is also responsible for the absorption of large amounts of carbon dioxide from our atmosphere.

The ocean connect to the land via what is called **the inter-tidal zone**. Because of rising and falling tides, coastal areas are constantly changing, with various animals and marine plants living at the bottom, and on the seashore. In those areas usually submerged during high tide, there is a more diverse array of algae and small animals, such as herbivorous snails, crabs, sea stars, and small fishes. At the bottom of the intertidal zone, which is only exposed during the lowest tides, many invertebrates, fishes, and seaweed can be found. Rocky coastal areas are host to fewer species due to the fact that only the highest of tides will reach the top of the cliffs.

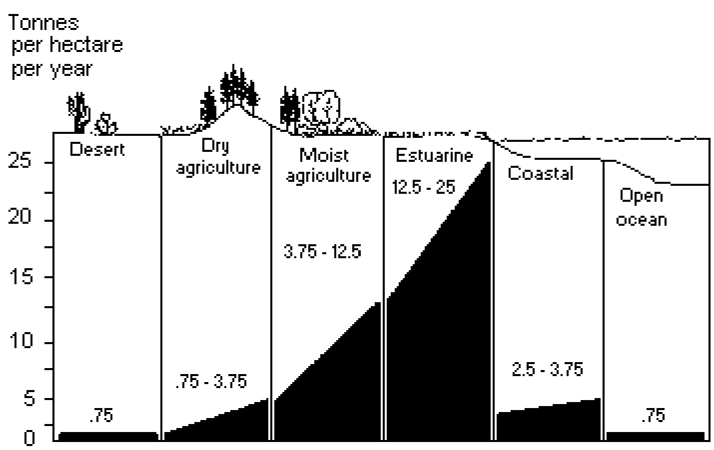
Open ocean **- the pelagic zone**, which is host to many species of fish and marine mammals, plankton ,and some floating seaweed. The area underneath the pelagic zone is called **the benthic zone**, or deep-sea, and at its deeper levels is host to silt, sand, and slowly decomposing organisms. This area is very cold due to its depth, which is untouched by the light of the sun. There are few plants at this level, and the animals include mostly bottom feeding organisms such as sea stars, anemones, sponges, all sorts of bacteria, fungi, worms, and fishes.

The deepest part of the ocean**-the abyssal zone**. Water is 3° C, highly pressured, high in oxygen content, but low in nutrient content. It is host to many species of invertebrates and fish including such oddities as the **coelacanth**, a prehistoric fish once thought extinct and found in the depths of the Indian Ocean, and other fish that glow in the dark via a process called photoluminescence. Mid-ocean ridges (spreading zones between tectonic plates), often with hydrothermal vents releasing hydrogen sulfide and other minerals are found in the abyssal zones along the ocean floors. Chemosynthetic bacteria thrive near these vents because of the large amounts of hydrogen sulfide and other minerals they emit. These bacteria are thus the start of the food web as they are eaten by invertebrates and fishes.

In the warm shallow waters which line the continents and surrounding islands lie barriers called **coral reefs.** Corals are interesting since they consist of both algae (zooanthellae) and tissues of animal polyp. Since reef waters tend to be nutritionally poor, corals obtain nutrients through the algae via photosynthesis and also by extending tentacles to obtain plankton from the water. Besides corals, the fauna include several species of microorganisms, invertebrates, fishes, sea urchins, octopuses, and sea stars.

Estuaries

- are where fresh water from rivers meets and mingles with salt water from oceans
- are among the most biologically productive ecosystems on Earth
- are the source of a food web that begins with conversion of the sun's energy into food energy by marsh plants
- are home to only certain types of plants—those that can flourish in the physical conditions peculiar to estuaries
- provide critical habitat for certain wild animals at some stage of their lives
- Most of the primary production in these estuaries is carried out by marsh plants, bottom-dwelling algae, and eelgrass that grow in abundance in the marshes and mudflats (the muddy land that is left uncovered at low tide) that are part of



estuaries.

Freshwater Regions

Freshwater is so called because of its extremely low salt content. It exists as lakes, rivers, ponds, swamps, or wetlands such as the Florida everglades.

As the Earth warmed up following the Pleistocene era, or ice-age, the accumulation of melted ice went on to form the various **lakes** which are found around the globe. Because lakes are generally separated from one another, they are home to few species and plant life. While lakes can exist for centuries, other inland bodies of water such as **ponds** tend to dry up fairly quicker. Because of that factor, the species which breed and inhabit these areas are often threatened by extinction, especially when related to development of the land.

Lakes and ponds are divided into separate zones which are defined by their distance from the shore. **The littoral zone-** closet to the shore is host to a wide variety of species due to its warm, shallow environment. Various species of invertebrates, crustaceans, plants and amphibians thrive in this environment, and in turn provide food for predators such as birds, reptiles and other creatures inhabiting the shoreline.

The limnetic zone, the open water near the surface of a lake or pond, is home to a variety of phytoplankton, and zooplankton, which play an important role in the food chain. Several species of freshwater fish such as bass and lake trout can also be found this area, mainly feeding on insects and plankton. The deeper region of a lake or pond is called the **profundal zone**. This zone, shrouded in darkness, and serves as a repository for dead plankton, and is inhabited by creatures which feed mostly on decaying organisms. Because freshwater biomes are inland, they are more subject to seasonal changes

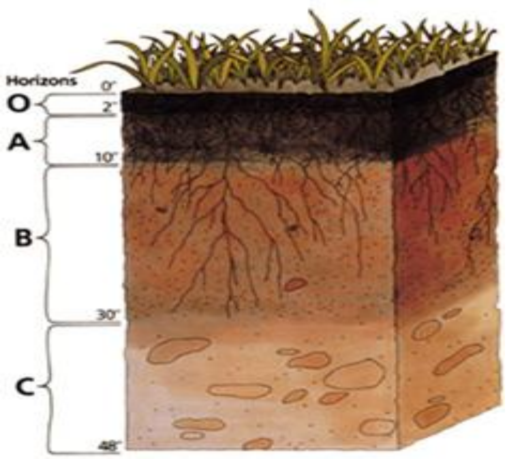
Other areas of still waters, or **wetlands**, such as glades, swamps, and marshes support a large variety of aquatic flora and fauna. Aside from plants such as sedges and pond lilies, the wetlands also support a few types of trees, such as cypress, which are highly adapted to the high humidity of these regions. The wetlands are rich in life forms, from reptiles, to mammals, to amphibians and birds, to hundreds of insects.

Rivers and streams mostly get started from mountainous ice and snow melting and springs. Ultimately, rivers and streams end up at the ocean or another waterway. Since this water is in constant motion, it is quite different in fauna and flora to that of lakes and ponds. Animals and plants which thrive in lakes would have trouble surviving the colder water and limited shorelines of rivers. Some fish, such as river trout, and small scavengers such as crayfish can be found in various areas of the river; usually depending on water temperature and the exposure of a riverbank to sunlight. The colder areas are host to salmon and other more vigorous fish, whilst the warmer areas, rich in sediment and decaying matter are inhabited by catfish, carp, and other bottom feeders. River plants include floating weeds and algae, mostly found forming around rocks and submerged tree roots.

Soil

Soil is made up of inorganic materials, organic materials, microorganisms, water and air.

Soil is somewhat 'nonrenewable' as it take hundreds to thousands of years for soil to form by weathering of bedrock, transport of sediment and mixing with humus, rainwater and air.



Mature soils have layers: **soil horizons** with distinct texture and composition. A typical soil has a soil profile with four horizons O, A, B and C. (R is the abbreviation for bedrock and E is used (usually under A) if the soil is prone to leaching of minerals.)

O horizon-top layer at the earth's surface. Contains surface litter, such as fallen leaves (duff), and other plant material, animal waste and dead organisms. A distinct O horizon may not exist in all soil environments (e.g., desert soil). It protects the topsoil from erosion and moisture loss. O and A have abundance of microorganisms, earthworms and insects. (decomposers).

A horizon is also known as **topsoil**. This layer contains organic humus, which usually gives it a distinctive dark color. Holds water and nutrients…is the most fertile layer! Shallow rooted plants anchor here.

The **B horizon,** or sub-soil consists mostly of inorganic rock materials such as sand, silt and clay. Deep rooted plants use the water and leached minerals here.

The **C horizon** sits atop bedrock and therefore is made up of weathered rock fragments. The bedrock is the source of the parent inorganic materials found in the soil. Lacks organic material, but may be saturated with water.

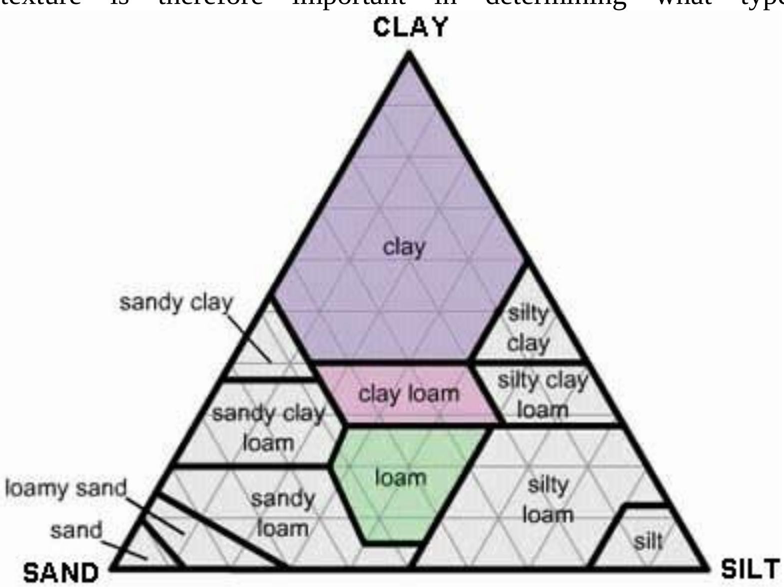
Water from upper layers dissolve water-soluble minerals and transport them to lower layers in a process called **leaching**. Very fine clay particles can also be transported by seeping water and accumulate in the subsoil layer. The accumulation of clay particles and leached minerals can lead to **compaction** of the B horizon. This compaction can limit the flow of water through the layer and cause the soil above to become waterlogged.

Different types of soil may have different numbers of horizons, and the composition and thickness of those horizons may vary from soil to soil.

- Grassland and desert soils lack a significant O horizon as they generally have no leaf litter.
- Grassland (temperate grasslands) soil may have a very thick, fertile A horizon. Best agricultural soils (mollisoils)
- Desert soils and tropical rain forest soils may have very thin, nutrient poor A horizons. Desert soils are thin and very susceptible to salinization. (Aridisols)
- Rain forest soil is infertile. (oxisols)
- The A horizons in coniferous forests may be severely leached. Adequate for farming if supplemented. (alfisols)

Soil texture-based on amounts and size of rock particles. 3 types: **sand**, **silt** and **clay**. Sand grains have the largest grain sizes (0.05 - 2.0 mm) of the three. Silt particles are fine-grained (0.05-0.002 mm) and clay particles are very fine-grained (<0.002 mm). Soils are named according to where their sand silt and clay composition plots on a soil structure triangle.
Loam-mixture of all 3 soil types. 40% sand, 40% silt, 20% clay. Generally good for farming.

The texture of the soil determines its porosity and permeability. **Soil porosity** is a measure of the volume of pore spaces between soil grains per volume of soil. Porosity typically goes down as grain size goes up. Porosity determines the water and air (oxygen) holding capacity of the soil. Coarse grains with large pores provide better aeration and fine grains with small pores provide good water retention. Sandy soils have low porosities and high permeabilities (i.e. water is not retained well, but flows through them easily, and aeration is good). On the other hand, clay soils have high porosities and low permeabilities (i.e. water is retained very well, but does not flow through it easily and aeration is poor). Soil texture is therefore important in determining what type of vegetation thrives on a particular soil.



Population Ecology Definitions

- **Population-**A number of individuals of the same species in a given area
- **Habitat** –address of population
- **Niche-**job of the population.
- **Community-**all the populations in a given region. (e.g., In an area of tropical grassland, a community might be made up of grasses, shrubs, insects, rodents and various species of hoofed mammals.)
- **Abiotic** limiting factors **-**the physical and chemical characteristics of the environment that determine what lives where.
- **Range of tolerance-**each population has a range for each abiotic factor with maximum and minimum requirements known as tolerance limits, above and below which no member of a population is able to survive.
- The range of an abiotic factor that results in the largest population of a species is known as the **optimum range** for that factor. Some populations may have a narrow range of tolerance for one factor. For example, a freshwater fish species may have a narrow tolerance range for dissolved oxygen in the water. If the lake in which that fish species lives undergoes eutrophication, the species will die. This fish species can therefore act as an **indicator species,** because its presence or absence is a strict indicator of the condition of the lake with regard to dissolved oxygen content.

Abiotic limiting factors

- amounts of sunlight, annual rainfall, available nutrients, oxygen levels, pH, salinity and temperature.
  For example, the amount of annual rainfall may determine whether a region is a grassland or forest, which in turn, affects the types of animals living there. We can measure these abiotic limiting factors with test kits, pH strips etc.

Biotic limiting factors- involve interactions between different populations, such as competition for food and habitat.

- Predator-prey; Symbiosis; Intra and Interspecific competition; Parastitsm; Mutualism; Disease. In a salt marsh, biotic factors would include all of the plants (grasses and shrubs), animals (fish, work, shellfish, crabs, insects , birds, small mammals, reptiles and amphibians) and microorganisms (bacteria, phytoplankton, zooplankton), that live in the water, in and on the mud flats, and on the shoreline and how they interact with one another.

If the presence of a certain species significantly affects the community make up it is a **keystone species**. For example, a beaver builds a dam on a stream and causes the meadow behind it to flood. A starfish keeps mussels from dominating a rocky beach, thereby allowing many other species to exist there. **Native species** are those species that normally lie within a given ecosystem. (**Endemic species** are similar to native, but are unique only to that ecosystem). **Alien species** are that's e that are deliberately or accidentally introduced into an ecosystem, usually by human. For example the zebra mussel was accidentally introduce into the Great Lakes region of the U.S. with foreign freighters dumped bilge water containing zebra mussel larva. The mussels have no natural predator and thrive. They now present huge problems by fouling intakes to power plants, ports and other industries on the Great lakes.

Relationships

- Predator-prey
  - Carnivore-prey
  - Herbivore-plant
- Strategies to elude predators
  - Protective shells,
  - Toxins
  - Running or flying faster
  - Camouflage
  - Hiding
  - Being active at different time than predator
  - Mimicking other objects
- Symbiosis
  - Parasitism, the host gets injured or killed. (tapeworms, lice, ticks, mistletoe plants and leeches)
  - Mutualism-both benefit. Insects that are pollinators; bacteria (rhizobium) in the roots of legume plants

- Commensalism-one benefits, the other species neither benefits or gets harmed. Epiphytes that live on trees.
- Amensalism-one species is harmed and the other species gets no benefit or harm. For example, tree branches falling on plants below it.