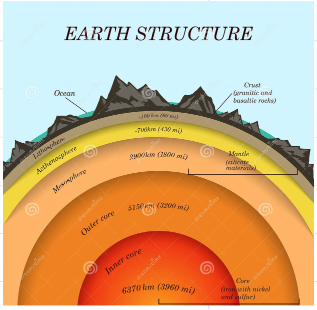
Mr. Holtzman

Ecology

Apes Summer Assignment 2021

Major Divisions of Earth (spheres)

Lithosphere: contains the crust and upper portion of mantle, contains fossil fuels, minerals, soil, & rock made up of silicon and oxygen



Hydrosphere: liquid water, ice, and water vapor in atmosphere- 71% of Earths surface (97% saltwater 3% fresh

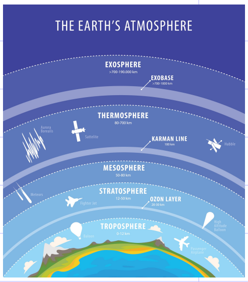
Atmosphere: thin layer of air that surrounds the solid earth:

Made up of 4 divisions:

1. Troposphere: The air we breathe, weather events and air pollution present here (78%-N & 21%-O
2. Stratosphere: Commercial passenger jets fly in the lower stratosphere, ozone (O_3) layer- absorbs harmful UV radiation
3. Mesosphere: Aurora borealis present here, meteors and comets are destroyed here
4. Thermosphere: thermosphere absorbs a lot of the UV radiation and X-ray given off by the sun

Biosphere: living organisms exist and interact with the nonliving (abiotic) environment

The Major Divisions of Earth are broken down into ecosystems



- Group of interacting species and their physical environment

Biotic Factors: living organisms such as:

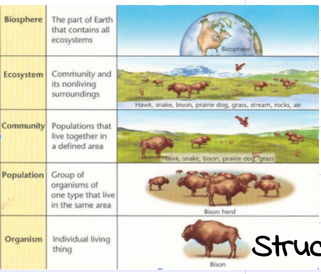
1. vegetation: Trees or algae
2. Animals: large mammals or even tiny insects
3. Ecotone: Ecosystems that are have many different characteristics. Transitional area between a forest ecosystem and aquatic ecosystem--> wetlands

Self Sustaining Ecosystems have basic requirements / needs

Energy: Constant supply of energy into the system (sun's energy)

Cycling of Matter and Nutrients: Carbon, Phosphorus, sulfur, Oxygen, Nitrogen, water and decomposers

Levels of Ecological organization-used to describe organisms and their relationship to one another



Organism: one individual organism

Population: Group of individuals of the same species, organisms that are able to reproduce together

Community: Groups of different species that interact with one another

Ecosystem: Communities that interact with each other and their physical environment (abiotic factors)

Biosphere: All ecosystems of our planet combined

Structure of Ecosystems and how they sustain their basic requirements / needs

Producers: organisms that capture energy form the sun or chemical reactions to create organic matter. Producers are absolutely essential to every ecosystem. Convert simple inorganic to complex organic compounds. Also known as: Autotrophs. Mostly green plants

- Photosynthesis- Converts simple inorganic substance to complex organic compounds

$$6CO_2 + 6H_2O + Energy \rightarrow C_6H_{12}O_6 \text{ (Glucose)} + 6O_2$$

- Chemosynthesis- occurs in deep ocean vents; bacteria generate energy with hydrogen sulfide to support plant-less ecosystems of tubeworms, sea spiders, & bacteria

Consumers: organisms that obtain energy from other living organisms (Heterotrophs)

- Primary Consumer-Feed directly on producers. Also known as, herbivores
- Secondary Consumer- Feed on primary consumers, Carnivores (meat eaters) omnivores (meat and plant eaters)

Decomposers: Breakdown dead organic matter. Convert complex organic matter into simple inorganic matter. without decomposers nutrients would not be cycled in an ecosystem

- Detritivore: organism that specializes in breaking down dead tissue and waste products into smaller pieces
- Decomposer: fungi and bacteria that convert organic matter into simple inorganic compounds

Trophic Relationships

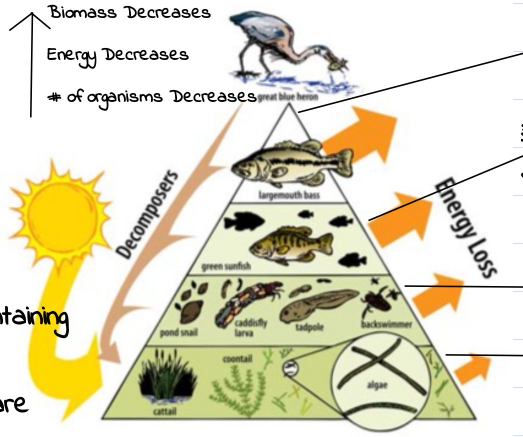
Trophic Levels: energy levels in an ecosystem (Producer-> Secondary Consumer)

Food Chain: one way flow of energy through an ecosystem. Energy Input-Sun / Cycling of Matter-Decomposers

Food Web: Complex overlapping set of food chains, shows how energy and matter move through trophic levels

Biomass & Energy Pyramid

Biomass: world-wide combined mass of all organic matter (living organisms) in an area or trophic (energy/feeding) level



4th Trophic Level
Tertiary Consumers / Carnivores

3rd Trophic Level
Secondary Consumers / Carnivores

2nd Trophic Level
Primary Consumers / Heterotrophs/ Herbivores

1st Trophic Level
Producers/ Autotrophs

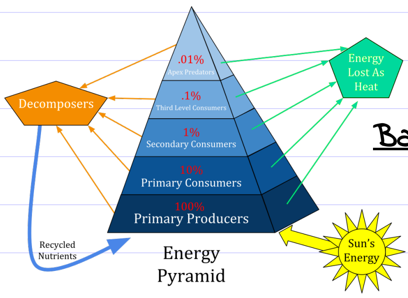
Changes in Biomass are caused by:

Heat-energy is lost as heat while maintaining body temperatures

Not all parts of organisms or plants are eaten or digested / absorbed

Life Processes: respiration, regulation, etc

Ecological Efficiency: The amount (in %) of energy that is transferred from one trophic level to the next. 10% of energy from one trophic level is passed onto the next trophic level. 90% of energy (& heat) is lost to the environment



Based on 2nd Law of Thermodynamics

- fundamental principle of energy that states that energy always tends to go from a more usable (higher quality) form to a less usable (lower quality) form

Abiotic Conditions vs. Abiotic Resources

Conditions: Not consumed by organisms (Temperature, wind, pH, Turbidity, Salinity, & Particulate Matter)

Resources: Consumed by organisms (sometimes converted or transformed into something else. Can be biotic. (water, light, oxygen, Nutrients-like CO_2 or water, and space resources

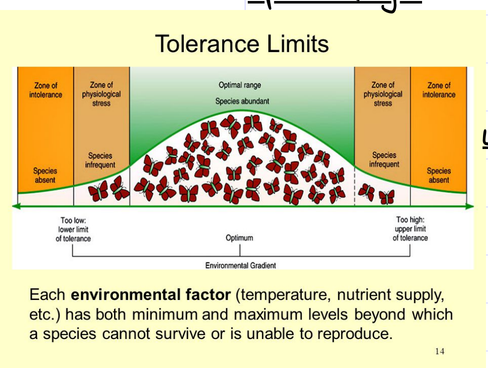
Optimum Zone, Zone of Stress and Limits of Tolerance

Different species thrive under varying environmental conditions:

- Temperature: warmer vs Colder
- Light: Bright direct vs Shade
- Salinity: Low salinity context vs high salinity context (Freshwater vs Saltwater)

For every condition in an ecosystem, there is an optimum: the range or level at which the organism does best, thrives or prospers

Optimal Range: The range of a factor that supports ideal growth of a species. The population thrives at this level

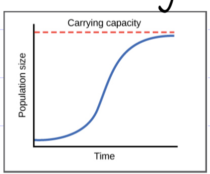


Range of Tolerance: The entire range that supports any growth of a species, this includes the optimal range, the organism can tolerate the conditions of that ecosystem

Limits of Tolerance: Points or values at the high and low ends of the range of tolerance scale

Zones of Stress: Exists between the optimal range and the limits of tolerance. In the species zone of stress, they may survive but not thrive. They may be unable to reproduce, have weaker immune systems and unable to efficiently hunt for food or compete

The greatest population sizes will be in ecosystems where the conditions are optimal



Limiting Factors

Definition: A factor that prevents or inhibits the growth (development, distribution, & abundance) of a species

- Amount of food, Competition, Sunlight, Temperature, Predation, Oxygen, Disease, Nutrients, & wastes

Species Interactions Shape Biological Communities

Habitat: Location where an organism resides / lives

Niche: The role of an organism, includes all physical, chemical, and biological conditions a species needs to live and reproduce in an ecosystem

- Fundamental Niche: The full potential range of the physical, chemical, and biological factors a species can use if there is no competition from other species
- Realized Niche: Parts of the fundamental niche of a species that are actually used by that species

Specialist vs Generalist Species

Specialist: Species with a narrow ecological niche.

- live in only one type of habitat, tolerate only a narrow range of climatic and other environmental conditions, or use only one type or a few types of food

Generalist: Species with a broad ecological niche

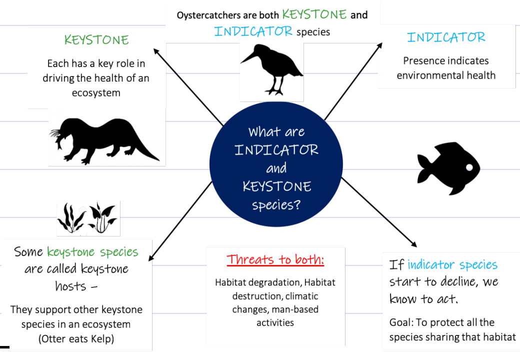
- They can live in many different places, eat a variety of foods, and tolerate a wide range of environmental conditions.

Indicator Species

Examples:
Amphibians- they absorb toxins
Lichens- Sensitive to heavy metals / acids
Birds- Chemicals or pesticide issues

- Definition: A species that can be used as a measurable natural warning system for the health of an ecosystem. This can be interpreted as the presence, absence or abundance of a species reflects a specific environmental condition (for better or for worse).
- Keystone Species-Species whose role is absolutely vital for the survival of many other species in an ecosystem. Without this species the ecosystem could be in risk of collapse.

Examples:
Starfish- removed from tidal flats- decreased biodiversity by 50%
Sea otter-Control sea urchin population overpopulation would destroy food chain



Symbiosis

- Definition: A close physical relationship between two organisms, in which at least one of them benefits
- Types
  - Mutualism: interaction between species which increases or improves both species' fitness or quality of life
  - Commensalism: interaction between species in which one species benefits but the other is neither harmed nor helped
  - Parasitism: One organism benefits while the other is negatively impacted

Competition

- Definition: Organisms that fight / contend for resources. Such as food, water, space or mates
- Types of Competition
  i. Intraspecific Competition: Competition between the same species. Common because they share the same ecological niche
  ii. Interspecific Competition: Competition between different species. Not as common because different species occupy different ecological niches

Resource Partioning: Process of dividing up resources in an ecosystem so species with similar needs (niches) use the same scarce resources at different times, in different ways, or in different places

Competitive Exclusion Principle: 2 species that are competing for the same resource:

Interference Competition: when an organism prevents or blocks the use of a resource that could be shared
Exploitation Competition: when an organism depletes a resource more quickly than another organism / species
Predation: Predator- Prey Relationship

Invasive Species increase the competition in an ecosystem

- Native Species: Exist in a balanced relationship with their natural ecosystem
- Native species exist in a balance relationship with their natural ecosystem (predator -prey relationships)

Invasive Species: Introduced Species can disrupt the ecosystems they invade or a shipped to or for recreation

- Reasons why introduced species outcompete other native species is because they:
  Have no natural predators or limits on population, exponential growth of a species. Direct predation of native species and eventually invasive species outcompete native species for resources, are commonly generalists and they decrease biodiversity

Examples of Invasive Species:

1. Rabbits in Australia- Rabbits were introduced when Europeans settled in Australia in 1859. They were brought there because the domesticated rabbit was a ready source of meat, and the wild rabbit introduced later for hunting. The rabbit populations increased exponentially. To control the problem from spreading, a fence was built to try to prevent the rabbits from spreading, but it was a complete failure. Kangaroos and emus were negatively affected as they would get caught in the fence. The rabbits are partially blamed for the extinction of almost an eighth of the mammal species in Australia and have caused millions of dollars of agricultural and soil damage a year. To control the problem, a virus was injected into the rabbit population that usually killed the infected rabbit within 14 days, but could be spread to others by mosquitoes or fleas.
2. Water Hyacinths in Louisiana-The water hyacinth was first brought from South America to the U.S. as part of a fair held in New Orleans. They proved to be popular gifts and were transported to garden ponds around the city. The hyacinths reproduced and quickly spread to neighboring waterways. With no natural controls, such as disease or predators, it soon covered immense areas of Louisiana, clogging canals used for boating and fishing. Water hyacinths have been considerably reduced by the introduction of insects that would feed on the plants, heavy doses of herbicides, and physical removal.
3. Asian Long-horned Beetles in New York- Native to Eastern Asia, the long-horned beetle was introduced in New York due to wood packing material. Spread of the Asian long-horned beetle is accomplished through infested tree-based materials, including live trees, fallen timbers and firewood. This was a major issue because the larvae live deep within the wood. The larvae can leave thousands of the holes that the adults appear from an infested tree. By making so many holes, adults cause the tree to lose nutrients to maintain its life needs, such as water and sap. To prevent the spread, tree removal and then quarantines are established which prohibit the movement of infected wood
4. Brown Tree Snakes in Guam- Indigenous to Australia, Indonesia, and the Solomon Islands, the brown tree snake was accidentally transported from its native range in the South Pacific to Guam as a stowaway in ship cargo or by crawling into the landing gear of Guam-bound aircraft shortly after World War II. Because of the absence of natural predators, brown tree snake populations reached unprecedented numbers. Snakes caused the local extinction of most of the native forest vertebrate species, especially birds (the Guam rail) and lizards. This, in turn, caused a spike in the spider population. To control the problem, mouse bait injected with Tylenol (which was poisonous to the snakes), was released in the environment.
5. Cane Toads in Australia- were intentionally introduced in Australia in 1935 to help combat cane beetles that were destroying sugar cane crops. Instead the toads were eating native insects, creating an imbalance in the native food webs. Initial release of 3,000 toads, has increased to over 200 million In Australia. Since then they're found in south Florida, throughout the Caribbean, and in other tropical and subtropical locales. Cane toads are poisonous throughout their lifecycle. Cane toad have been known to impact pets, such as dogs, has become quite common in Australia and Hawaii. Manual removal is the main management strategy for cane toads. Although toads can be removed as adults, it's easiest to collect the jelly-like strings of cane toad eggs from local creeks or ponds. Also, mesh fencing is used to stop the spread of the toad, but native fauna can also get caught up in the nets. In Australia especially, there is a widespread education campaign to warn people about the dangers of cane toads and invasive species.
6. Asian Carp in the Mississippi River- were brought to the United States in the 1970s to help control algae in catfish farms of the Deep South. The carp escaped into the Mississippi River system during flooding episodes in the early 1990s, established self-sustaining populations in the lower Mississippi River, and then began moving northward. Thus far, the fish have been restricted to the Mississippi River watershed; however, it is feared that they will be able to enter the Great Lakes. They are fierce competitors, capable of pushing aside native fishes to obtain food, and their populations grow rapidly, accounting for 90% of the biomass in some stretches of the Mississippi and Illinois rivers. Once in the Great Lakes ecosystem, they could wreak havoc on the foundations of the food chains of the major lakes and adjoining rivers. To deal with this potential menace, two electric fish barriers have been placed within a 1,500-foot stretch of the canal. Electrical pulses emanating from the barriers keep the fish at bay while also allowing barge traffic to move up and down the waterway. This measure, however, may not be 100% effective. In addition, rotenone, a biodegradable piscicide (fish poison) is added to the water whenever repairs to the electric barriers are required.