STUDYRESOURCES DISCORD

AP EXAM 2020

Notes

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APES STUDY GUIDE

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Unit 1

Introduction to Ecosystems

Definitions-

- ➔ Abiotic- non-living
- ➔ Biotic- living
- ➔ Aquatic Life Zones- ecosystems in aqueous environments
- ➔ Biomes- ecosystems based on land
- ➔ Ecotone- transitional area between two ecosystems
- ➔ Ecozones- small regions within ecosystems that share similar physical features
- ➔ Epiphytes- a plant that grows on another plant (not parasitic), such as the numerous ferns, bromeliads, air plants, and orchids growing on tree trunks in tropical rainforests.
- ➔ Law of Tolerance- describe the degree to which living organisms are capable of tolerating change in their environment.
- ➔ Law of the Minimum- states that living organisms will continue to live, consuming available materials until the supply of these materials is exhausted.
- ➔ Keystone species- species that maintains biotic balance in a community. Ex. Beavers, Jaguars, Wolves, Otters, Starfish, and Honey bees.
- ➔ Indicator Species- species used to measure the health of an ecosystem as they are more sensitive to changes than other organisms. Ex. Lichen, moss, frogs, and toads.
- ➔ Indigenous species- those that originate and live/occur naturally in an environment
- ➔ Invasive species- a species that is not native to a specific location, has a tendency to spread to a degree believed to cause damage to the environment, native species, human economy or human health. Ex. Kudzu vine (U.S), Killer bees (both Americas), Zebra mussel(Great Lakes), Cane toad (Australia)
- ➔ Macronutrient- One of six key elements that organisms need in relatively large amounts: nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur.
- ➔ Limiting nutrient- A nutrient required for the growth of an organism but available in a lower quantity than other nutrients.

Basic Information-

- ➔ Most ecologically diverse ecosystems are areas along fresh bodies of water which are known as wetlands.
  - ◆ Types of wetlands include- marshes, swamps, bogs, prairie potholes (exist seasonally), and floodplains.
- ➔ Organization of living things is as follows-
  - ◆ Biosphere → Ecosystems → Communities → Populations (of species with unique niches)

Terrestrial Biomes

Types of Ecosystems

Biome	Annual Rainfall, Soil Type	Major Vegetation	World Location
Deciduous forest (temperate and tropical)	75-250 cm, rich soil with high organic content; long and warm summers; cold winters	Hardwood trees	North America, Europe, Australia, and Eastern Asia
Tropical Rainforest	200-400 cm, poor and acidic quality soil; humid and very warm and wet year round	Tall trees with few lower limbs, vines, epiphytes, plants adapted to low light intensity	South America, West Africa, and Southeast Asia
Grasslands	10-60 cm, rich soil;	Sod-forming grasses	North American plains and prairies; Russian steppes; South African velds; Argentinean pampas
Coniferous Forest (Taiga)	20-60 cm mostly in the summer, soil is acidic due to vegetation; cold and snowy seasons	Coniferous trees	Northern North America, Northern Eurasia
Tundra(coldest biome)	Less than 25 cm, soil is permafrost; long dark winters	Herbaceous plants	The northern latitudes of North America, Europe, and Russia
Chaparral (scrub forest)	50-75 cm mostly in winter, soil is shallow and infertile; hot and dry summers	Small trees with large, hard leave, spiny shrubs	Western North America, the Mediterranean region
Deserts (cold and hot)	Less than 25 cm, soil has a coarse texture (ie, sandy)	Cactus, other low-water adapted plants	30 degrees north and south of the equator; tropical, subtropical, temperate, and polar regions

Aquatic Biomes

Freshwater-

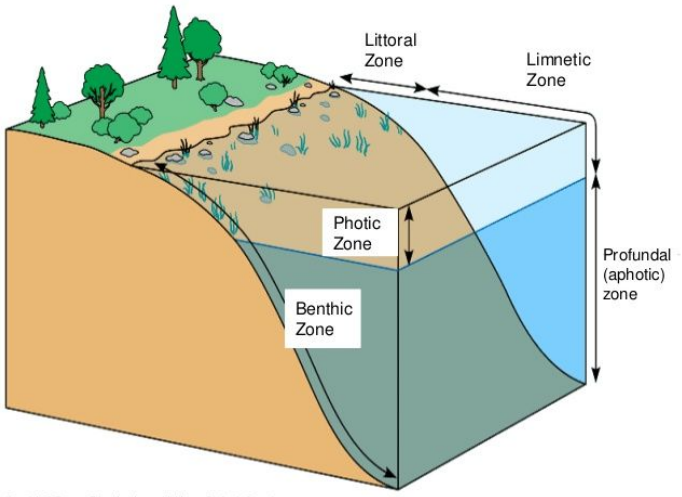
Basic Information-

- ➔ Freshwater contains minimum quantities of dissolved salts.
- ➔ Temperature layers in freshwater are called
  - ◆ Epilimnion is the uppermost (most oxygenated) layer
  - ◆ Hypolimnion is the lower, colder, denser layer.
  - ◆ Thermocline is the demarcation line between these two layers, where the temperature shifts dramatically.

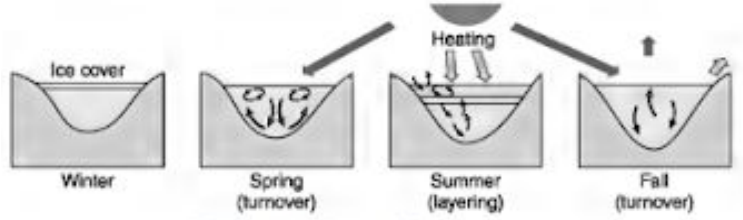
Lakes

Basic Information-

- ➔ Vertical stratification in Freshwater Biomes (lake layers)
  - ◆ Littoral Zone- Begins with shallow water at the shoreline. Abundant sunlight. Zone ends when rooted plants stop growing.
  - ◆ Limnetic zone- Surface of open water, extends to the depth that sunlight can penetrate. Organisms are short-lived and rely on sunlight for photosynthesis.
  - ◆ Profundal zone- Water that is too deep for sunlight to penetrate. It is an aphotic zone (no sunlight), so photosynthesizing plants or animals cannot live in this region.
  - ◆ Benthic Zone- Deepest layer. Low temperatures and low oxygen levels. No sunlight.



- ➔ Seasonal Turnover- Water is densest at 4 degrees celsius. After spring ice melts on the top of lakes and ponds, the temperature rises from 0 to 4 degrees celcius and the dense water will sink. The water on the bottom will be displaced upwards. This cycle brings oxygen to the bottom and nutrients to the top of the lake. This occurs in the spring and the fall seasons.



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Rivers/Streams-
Basic Information-

- ➔ Rivers are characterized by fast-flowing water that carries sediment and organic material.
- ➔ Rivers drop off their sediments as they meet the oceans, which create deltas (landforms of sediments). They also create Estuaries which are rich in plant and animal species because of the nutrients and sediments. The water is shallow, so the sun warms it.
    - ◆ Subcategories of estuaries include- Salt water marshes, mangrove forests, inlets, bays, and river mouths
- ➔ Three Zones-
    - ◆ Source zone- contains headwater streams and begins as springs or snowmelt of cold, clear water with little sediment and few nutrients. The rocky channels are usually narrow, so the water moves quickly. The water has high oxygen levels and can include freshwater species such as trout.
    - ◆ Transition Zone- contains slower, warmer, wider, and lower elevation moving streams, which eventually join to form tributaries. The water is less clear as it contains more sediment with the substrate beginning to accumulate silt. Species diversity is usually greater than in the source zone.
    - ◆ Floodplain Zone- large amounts of sediments and nutrients makes the water murky and warm. Tributaries join to form rivers, which empty into oceans at estuaries.

Oceans
Definitions-

- ➔ Barrier islands- landforms that lie off coastal shores
    - ◆ Block/buffer the wind and/or waves, which mitigate beach erosion, reduce storm surge, which protect the interior coastline from flooding, block/buffer the waves and create wetland ecosystems/pools, which serve as habitat for a variety of species (fish, turtles, migratory birds, etc.), and trap sediments/pollutants in wetland habitats/marsh grasses, which filter the water.
    - ◆ Coral reefs are a specific type of barrier island. Organisms that create coral reefs are cnidarians, which secrete a hard calciferous shell. They have a mutualistic relationship with the algae that grow on them, and when coral becomes stressed they disperse the algae in an event known as coral bleaching. Coral becomes stressed with large changes in temperature and acidity.
        - Coral is the most biologically diverse marine biome
- ➔ Upwellings- seasonal movement of water from the cold/nutrient rich bottom to the surface. Provide a new nutrient supply for organisms in photic regions, so they are followed by exponential growth of organisms in these zones.
    - ◆ Real world application- one of the causes of algal blooms. Single-cell algae grow exponentially with the new nutrients. These algae can then produce toxins that can kill or poison other organisms.

Basic Information-

- ➔ Ocean zones-

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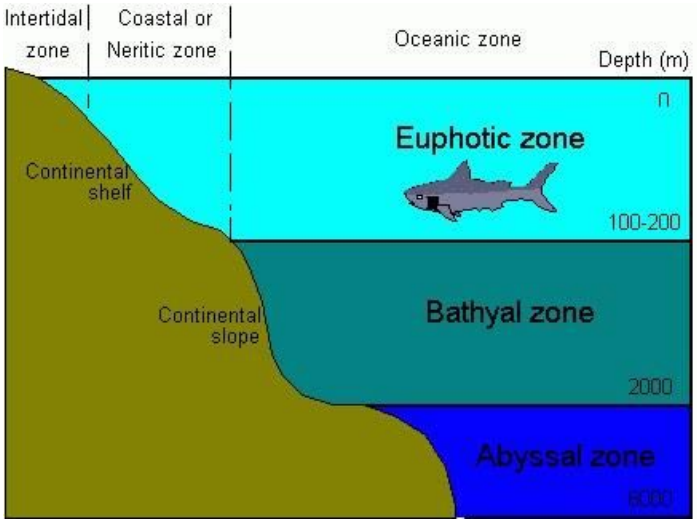
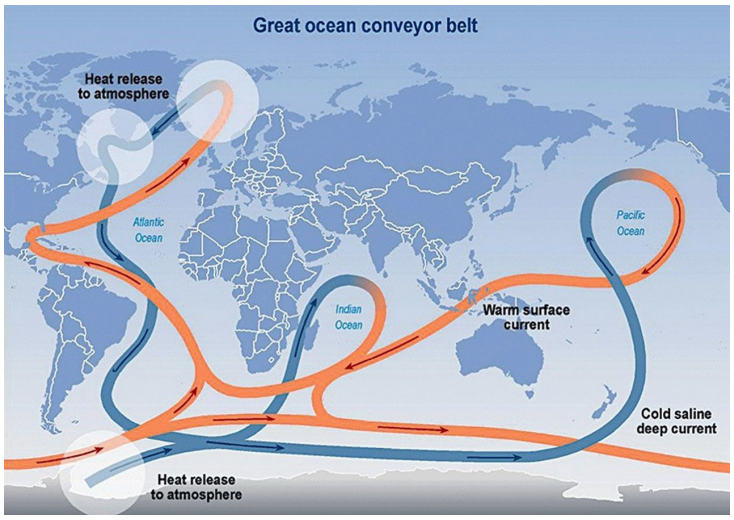
- Coastal zone- consists of ocean water closest to land. Defined as being between the shore and the end of the continental shelf.
- Euphotic zone- The photic (having light), upper layers of the water. Warmest region of ocean water and highest levels of dissolved oxygen.
- Bathyal zone- the middle region. Insufficient light for photosynthesis and is colder than the euphotic zone.
- Abyssal zone- Deepest part of the ocean. Very cold temperatures and low levels of dissolved oxygen, but high nutrient levels due to decomposition. Water does not freeze due to pressure.



➔ Ocean currents- As the sun warms water near the equator, prevailing winds, differences in salinity, and earth's rotation moves ocean water.



- Example- In the northern hemisphere, the gulf stream moves warm water along the East Coast of the US to Great Britain. This water displaces cold water near the polar regions, which then moves south to be rewarmed.
    - If the current were not present, northern Europe would be 5 to 10 degrees celsius cooler.

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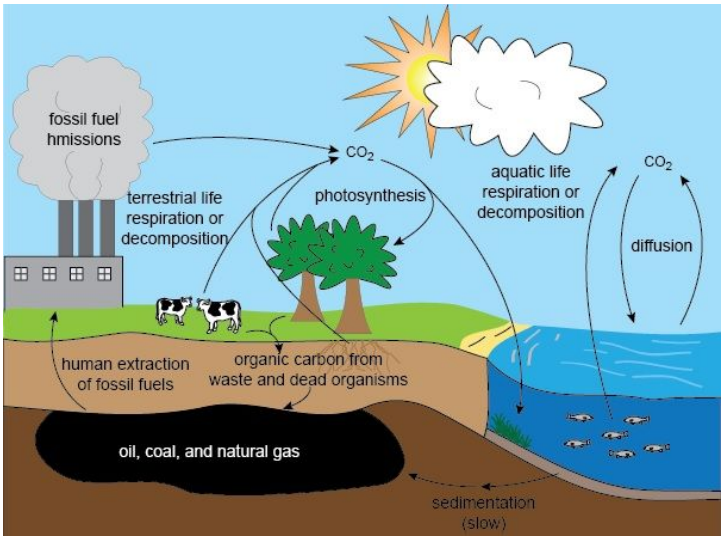
➔ Sea water is not uniformly saline throughout the world. Some places have a lot of salt and others have very little.

The Carbon Cycle

Definitions-

- ➔ Respiration- breathing
- ➔ Photosynthesis- plants take in carbon, water, and solar energy and gain carbohydrates (glucose)

Carbon Cycle Diagram



Explanation-

- ➔ Carbon has three main reservoirs- the ocean (because CO2 is soluble in water), rocks (as Calcium carbonate), and fossil fuels. Carbon is also stored in living organisms and travels through the food cycle, ending in decomposition, releasing CO2. In the cycle, carbon moves between the biosphere, hydrosphere, atmosphere, and geosphere.

Basic Information-

- ➔ The diffusion that carbon does with the ocean raises and lowers its pH.

The Nitrogen Cycle

Basic Information-

- ➔ The biggest reservoir for nitrogen is in the atmosphere

Steps of the cycle-

- ➔ Step 1- Nitrogen Fixation
  - ◆ Nitrogen (N2) makes up 78% of the atmosphere. This Nitrogen is unusable so bacteria in the soil convert it to ammonia (NH3) or nitrates (NO3-) which are needed by organisms (used to make DNA/RNA and amino acids for growth).
  - ◆ Things that convert nitrogen- soil bacteria, plants (specifically legumes like clover, peas, and beans or any plant with rhizobium (bacteria) on the roots), and lightning.
- ➔ Step 2- Nitrification
  - ◆ Soil bacteria convert ammonia (NH3) or ammonium (NH4+) into nitrites (NO2) and then to the usable form nitrate (NO3).

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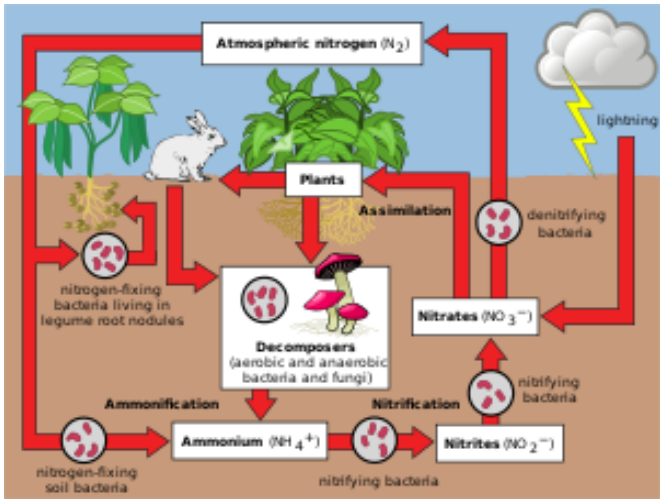
- ➔ Step 3- Assimilation
  - ◆ The process in which plants absorb ammonium (NH3), ammonia ions (NH4+), and nitrate ions (NO3) through their roots. Other organisms obtain that nitrogen when they eat plants.
- ➔ Step 4- Ammonification(mineralization)
  - ◆ Decomposing bacteria convert organisms and waste to ammonia (NH3) or ammonium ions (NH4+).
- ➔ Step 5- Denitrification
  - ◆ Specialized bacteria (anaerobic bacteria) convert ammonia to nitrites and nitrates and then to nitrogen gas and nitrous oxide gas (N2O).



The Phosphorus Cycle

Basic Information-

- ➔ PHOSPHORUS DOES NOT EXIST IN THE ATMOSPHERE!
- ➔ It is a limiting factor (reagent) for plant growth. It's needed because it makes nucleic acids, ATP (cellular energy), cell membranes, and other biological molecules.
- ➔ Found in soil, rock, and sediments. It's released through chemical weathering in the form of phosphate (PO4-3) which is soluble and can be absorbed by plants.
- ➔ Phosphates that travel to oceans can be mixed with rocks on the ocean floor and may rise up so they again join the cycle.
- ➔ Hypoxic means low in oxygen.

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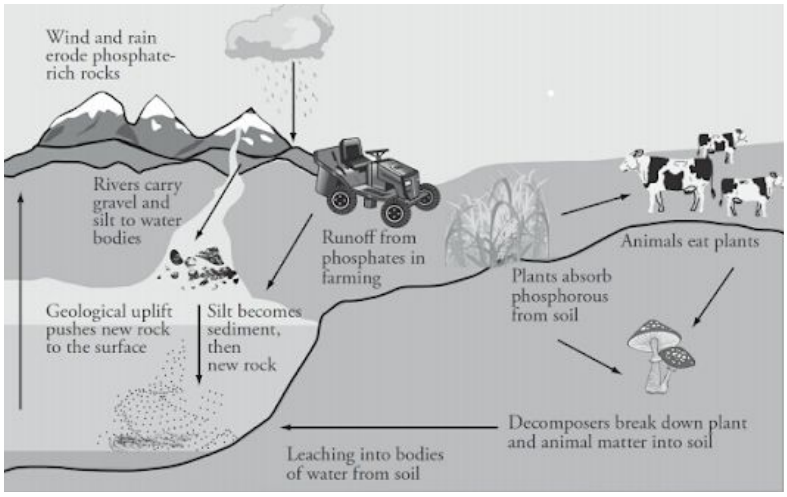
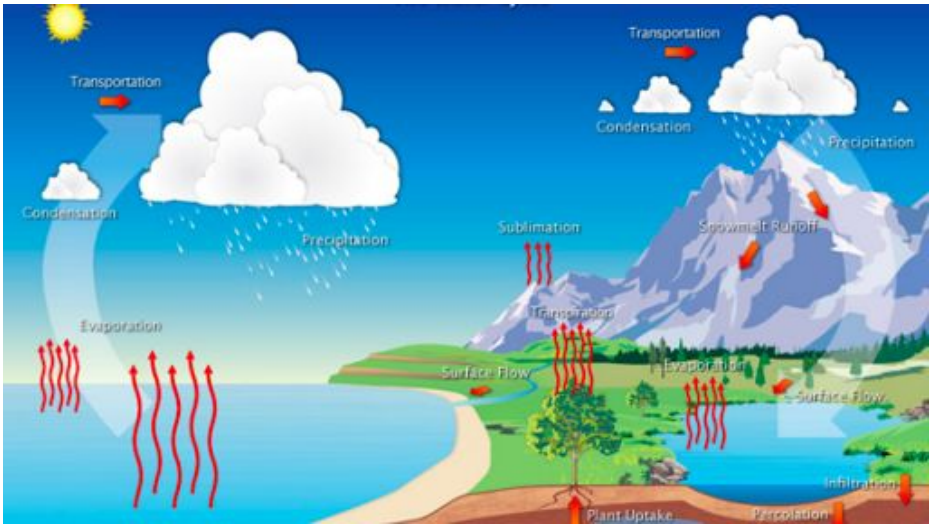


The Water (Hydrologic) Cyle

Definitions-

- ➔ Precipitation- water in the atmosphere condenses and is pulled down by gravity
- ➔ Groundwater- water in the water table
- ➔ Runoff- water travelling across land to enter drainage system (stream or river) and then a body of water (lake or ocean)
- ➔ Evaporation- water (water vapor) transfers to the atmosphere
- ➔ Transpiration- Evaporation, but occurs on plants
- ➔ Sublimation- the transition of a substance directly from the solid to the gas state



Basic Information

- ➔ Water moves to the atmosphere by evaporation, transpiration, and sublimation. It travels back down through precipitation. In between that, plants can uptake the water, water can infiltrate groundwater from lakes, it can flow in streams, and runoff can travel to rivers and then bigger bodies of water.
  - ◆ Don't forget that ice is a reservoir for water and that the sun powers the water cycle (melts ice, aids evaporation and transpiration, etc)

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Primary Productivity

Definitions-

- ➔ Net Primary Productivity (NPP)- amount of energy that plants pass on to other organisms in a system. NPP = GPP - Respiration
- ➔ Gross Primary Productivity (GPP)- amount of sugar that plants make in photosynthesis. Can be defined as the rate at which the producers are converting solar energy to chemical energy.

Real World Example-

- ➔ When the ozone layer decreased, UV rays passed through and killed phytoplankton and other primary producers. The decrease in primary productivity decreased fish and crops.

Basic Information-

- ➔ Plants need sunlight so without sunlight their primary productivity will be 0.
- ➔ Ecosystems with high NPP are those that are warmer, have high rainfall, and consistent sunlight. (aka, rainforests)

Trophic Levels

Definitions-

- ➔ Trophic level- each level of feeding in a food chain

Basic Information-

- ➔ Moving up a level decreases energy found Only 10% of the energy is passed between trophic level (10% rule)
- ➔ Biomagnification accumulates in higher trophic levels

Energy Flow and the 10% Rule

Three Rules of Thermodynamics-

1. 1st Law (Law of Conservation of Energy)- states that energy cannot be created or destroyed in an isolated system(universe has a set amount of energy)
2. 2nd law- states that the entropy of any isolated system always increases(as energy changes forms, the amount stays the same, but the efficiency/the work it can do decreases)
3. 3rd law- states that the entropy of a system approaches a constant value as the temperature approaches absolute zero.

Definitions-

- ➔ 10% Rule- The entropy of a system always increases, so when energy is transferred through food chains/webs, 90% is destroyed as heat and the other 10% is usable.

Energy Pyramid

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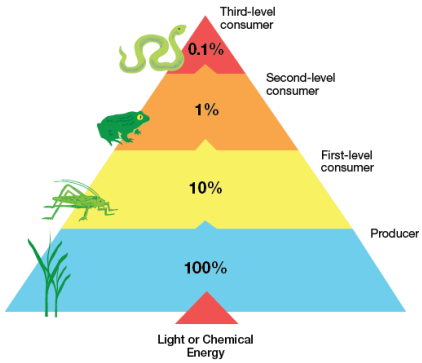

Food Chains and Food Webs

Definitions-

- ➔ Resource Partitioning- the division of limited resources by species to avoid competition in a niche. In any environment, organisms compete for limited resources, so organisms have to find ways to coexist.
  - ◆ Example- Two different bird species feed on the same oak tree; one eats acorns and the other eats insects in the bark
  - ◆ Types-
    - Morphological Partitioning- when 2 species share a resource but have evolved different structures to utilize it (e.g., two different species of bees have evolved to utilize various size flowers of the same species).
    - Spatial Partitioning- when competing species use the same resource by occupying different areas within the range of occurrence of the resource (e.g, different species of fish feeding at different depths in a lake or different species of monkeys feeding at different heights).
    - Temporal Partitioning- when two species eliminate direct competition by utilizing the same resource at different times (e.g., one species of spiny mouse feeds on insects during the day while a second species of spiny mouse feeds on the same insects at night)

Basic Information-

- ➔ The arrows in a food chain or web represent the flow of energy through a system

Producers

Definitions-

- ➔ Autotrophs- organisms that can produce organic compounds from inorganic chemicals
- ➔ Producers- organisms capable of converting radiant/chemical energy into carbohydrates

Photosynthesis

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

carbon dioxide + water → glucose + oxygen

- ➔ Anaerobic- process that does not use oxygen
- ➔ Chemotrophs- bacteria that carry out chemosynthesis.
  - ◆ Equation- CO2 + 4H2S + O2 ⍰ CH2 + 4S + 3H2O

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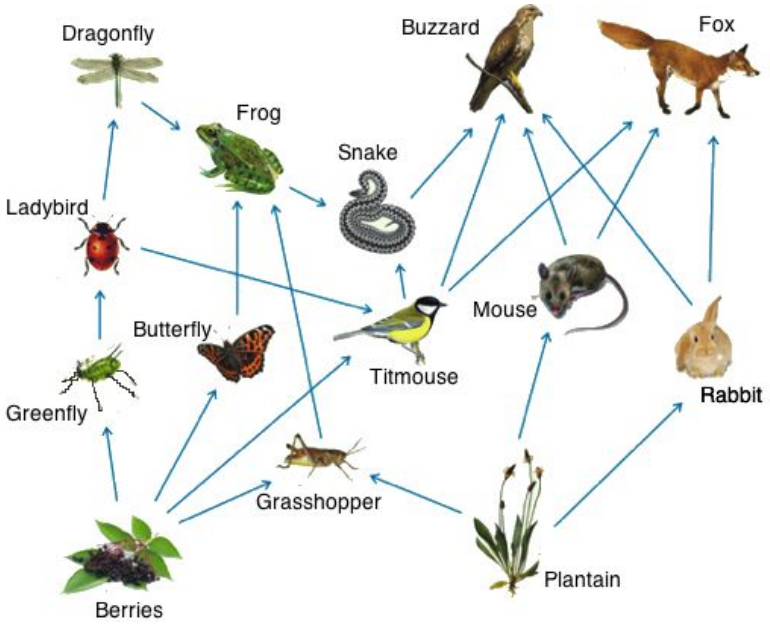
Consumers

Definitions-

- ➔ Heterotrophs- obtain food energy by consuming other organisms or products created by other organisms
- ➔ Primary Consumers- herbivores (consume only producers)
- ➔ Secondary Consumers- organisms that consume a primary consumer
- ➔ Tertiary Consumers- organisms that consume a secondary consumer
- ➔ Detritivores- organisms that get energy by eating non-living organic matter (dead animals or leaves). Examples include termites, earthworms, and crabs.
- ➔ Decomposers- organisms that consume dead plant and animal material AND return nutrients to the environment.
- ➔ Saprotrophs- decomposers that use enzymes to break down dead organisms and absorb the nutrients. Examples include bacteria and fungi.

Food Web



Food Chain

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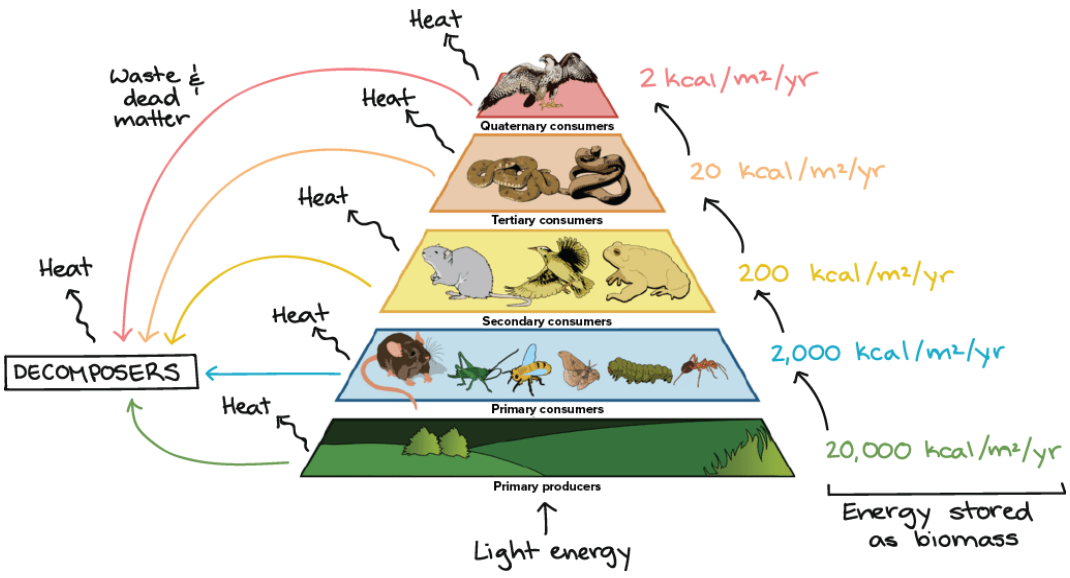

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Unit 2

Introduction to Biodiversity

Definitions-

- ➔ Species Diversity - # of different species in an ecosystem. Ecosystems with higher species diversity (i.e. coral reefs) have more highly-specific niches for specialist species. Highly diverse ecosystems are more capable of adapting/recovering from disturbances.
- ➔ Genetic Diversity - The variation of genes within a population. High genetic diversity is important for the survival of a species because it allows for more fit individuals to pass on their superior genes to offspring in the case of a disturbance that wipes out individuals that aren't carrying a specific gene. A drawback of monoculture farming is its low genetic diversity. Since all crops are genetically identical, they are very susceptible to being wiped out by a single disease that none of them are protected from. A population bottleneck can lead to a loss in genetic diversity.
- ➔ Habitat/ecosystem Diversity - variation of habitats within a region. The types of habitats in a region can provide information about what species or niches may be present in the region. Habitat loss leads to the loss of specialist species which can serve as indicator species.

Ecosystem Services

Service	Explanation	Examples
Provisioning	Creates energy, seafood, biomedical, transportation, and natural defense products.	Plants provide food for an ecosystem
Regulating	Flood prevention, climate regulation, erosion control, control of pests and pathogens.	Wetlands can serve as a water purifier by filtering nitrates and other sediments out of water
Cultural	Educational, recreational, heritage, and spiritual benefits obtained from nature.	Ecosystems high in species diversity promote ecotourism
Supporting	Biological diversity maintenance, nutrient recycling, primary productivity services.	Bees pollinate flowers to allow plants to reproduce

Island Biogeography

Definitions-

- ➔ Habitat Fragmentation- when the size of an organism's natural habitat is reduced, or when development occurs that isolates a habitat
- ➔ Island Biogeography- The larger the island and the closer the island is to the mainland, the more biodiversity it will have. Alternatively, the smaller the island and the further away it is to the mainland, the less biodiversity it will have.
- ➔ Species richness: The number of species in a given area
- ➔ Species evenness: The number of individuals in each species in a given area

Basic Information-

- ➔ This theory has been extrapolated to habitat fragmentation. Habitats that have been split by development act as separate islands. Smaller "islands" of habitat that are farther away from the main, undisturbed habitat will have less biodiversity.
- ➔ Knowing species richness/evenness gives environmental scientists a way to determine how much an ecosystem has changed

Ecological Tolerance

Basic Information-

- ➔ Natural Disruptions to Ecosystems- Earthquakes, hurricanes, meteor strikes, climate change, etc.
- ➔ There is a set of factors that impact the ability of individuals and/or species to survive and reproduce (i.e. temperature, salinity, and pH)
    - ◆ Organisms can endure a limited range of these factors before they become injured or die. This is known as their "range of tolerance"
    - ◆ Mutations: A random change in the genetic code produced by a mistake in the copying process. Sometimes a mutation improves an organism's chances of survival or reproduction. If such a mutation is passed along to the next generation, it adds new genetic diversity to the population.
        - Recombination: The genetic process by which one chromosome breaks off and attaches to another chromosome during reproductive cell division. It does not create new genes, but brings together new combinations of alleles on a chromosome, producing new traits.

Natural Disruptions to Ecosystems

- ➔ Wildfires, Flooding, Volcanic Eruptions, etc.
    - ◆ May cause short term or long term migration
    - ◆ Organisms may adapt in response to natural disruptions
- ➔ Types of wildfires-
    - ◆ Surface fires- burn only the forests' underbrush and do little damage to mature trees. These fires protect the forests from more harmful fires by removing underbrush and dead materials that could burn at higher temperatures.
    - ◆ Crown fires- can start on the ground or in the canopies of forests that have not had recent surface fires. They spread quickly and have high temperatures. These are a huge threat to wildlife, human life, and property.

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- Ground fires- smoldering fires in bogs or swamps and can burn underground for days or weeks. They originate from surface fires and can be hard to detect and extinguish.

➔ Sometimes disruptions can be beneficial (i.e. wildfires can return nutrients to soil, allowing surviving plants to access more nutrients)

Adaptations

Basic Information-

➔ Organisms adapt to changes to be more successful
➔ Adaptations can be short term behavioral changes or long term genetic changes
- Genetic diversity important for the survival of species and communities

➔ Environmental changes can be immediate or occur over time
- Organisms can typically adapt better to changes over time

➔ Survival of the fittest- organisms/species that are less able to adapt and less likely to survive/reproduce
➔ Phylogeny: the branching pattern of evolutionary relationships
- Evolution by artificial selection: The process where humans breed individuals to get a particular set of traits they desire
- Theory of Natural Selection:
  - There is a struggle for existence among organisms
  - There is physical and behavioral variation in living organisms (even within the species level)
  - Organisms with higher fitness are more likely to survive
  - Over time, a natural selection will ensure that certain characteristics appear more and more often as they are passed through generations. Entire species can change over time in this way.

➔ Evolution
- Theory of Evolution
  - Individuals produce an excess of offspring
  - Not all offspring survive
  - Individuals differ in their traits
  - Differences in traits can be passed on from parent to offspring
  - Differences in traits are associated with differences in the ability to survive and reproduce
- Evolution can occur through random processes
  - Mutation: As the number of mutations accumulates in a population over time, evolution occurs.
  - Gene flow: the process by which individuals move from one population to another and thereby alter the genetic composition of both populations(can help bring genetic variation).
  - Genetic Drift: A change in the genetic composition of a population over time as a result of random mating(can have an important role in altering the genetic composition of small populations).

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- Bottleneck effect: A reduction in the genetic diversity of a population caused by a reduction in its size.
- Founder effect: A change in the genetic composition of a population as a result of descending from a small number of colonizing individuals.

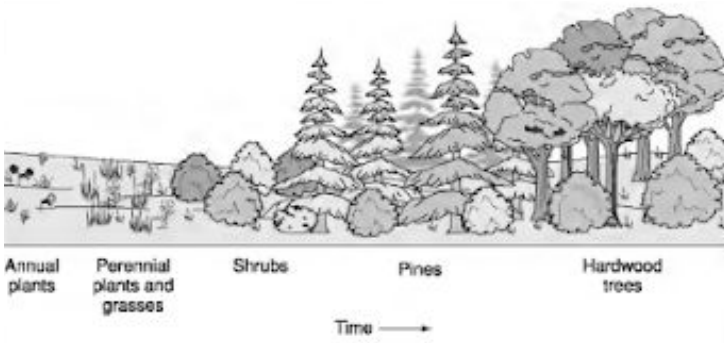
◆ Allopatric speciation: speciation that occurs through geographic isolation
◆ Sympatric speciation: speciation that occurs without geographic isolation
◆ Geographic isolation: Physical separation of a group of individuals from others of the same species
◆ Reproductive Isolation: The result of two populations within a species evolving separately to the point that they can no longer interbreed and produce viable offspring

➔ Genotype: The complete set of genes in an individual
➔ Phenotype: A set of traits expressed by an individual
➔ Symbiotic Relationships:
◆ Mutualism: both organisms benefit
◆ Parasitism: One organism benefits and one is harmed
◆ Commensalism: One organism benefits and one is not affected
◆ Ammensalism: One organism is harmed and one is not affected
◆ Interspecific Competition: Members of <u>different species</u> compete for the same resource
◆ Intraspecific competition: Members of the <u>same species</u> compete for resources

Ecological Succession

Definitions-

➔ Pioneer species- a species that is first to colonize barren or disrupted environments. Include mosses and lichen that break down the rock/decompose to produce soil.
➔ Ecological Succession comes in two types-
◆ Primary succession- Everything in the ecosystem gets wiped out. Rocks remain →pioneer species → breakdown of rock into soil → grasses → shrubs → trees and so on.
◆ Secondary succession occurs when there is an incomplete wipeout. Some soil remains → grasses → shrubs → trees.
◆ Climax Community: A stable group of plants and animals that is the end result of the succession process



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Unit 3

Generalist and Specialist Species

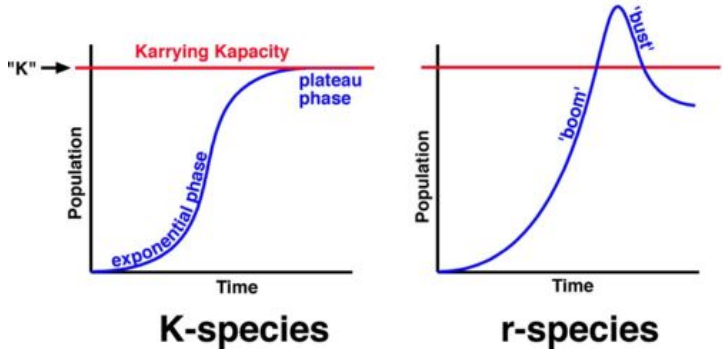
Definitions-

- ➔ Generalists are organisms able to thrive in a wide variety of environmental conditions and make use of a variety of different resources. Ex. Rats, Raccoons
- ➔ Specialists are organisms that can only thrive in a narrow range of environmental conditions or have a limited diet. Ex. Pandas, Koalas

K-Selected R-Selected Species

Definitions-

- ➔ K-Selected Species- organisms that have relatively few offspring and devote a large amount of time, energy, and resources toward nurturing and raising their young. These organisms usually are larger, have long gestation periods, and live longer. Because only a few offspring are produced, k-selected species have low biotic potential. Overall, these populations also remain close to carrying capacity and have a relatively constant population size. Ex. humans, elephants, horses, and cows.
- ➔ R-Selected Species- small organisms that have short gestation periods and produce thousands of offspring at one time; therefore, they have high biotic potential. Energy and resources are put into producing many offspring and not into raising the young. This strategy means that the young are left to their own survival, and survival depends on chance. R-selected species are short-lived and have population sizes that vary, usually not remaining near carrying capacity but well below it. Ex. Spiders, fish, frogs, rabbits, and rats.



Survivorship Curves

Definitions-

- ➔ Type I- Organisms that reproduce at a relatively young age, have a small number of deaths at young ages, have a long lifespan, and experience mortality mostly at an older age. Ex. humans and most large mammals.
- ➔ Type II- Organisms that mature quickly and have even mortality rates at all ages. Ex. rodents, many reptiles, and most birds.

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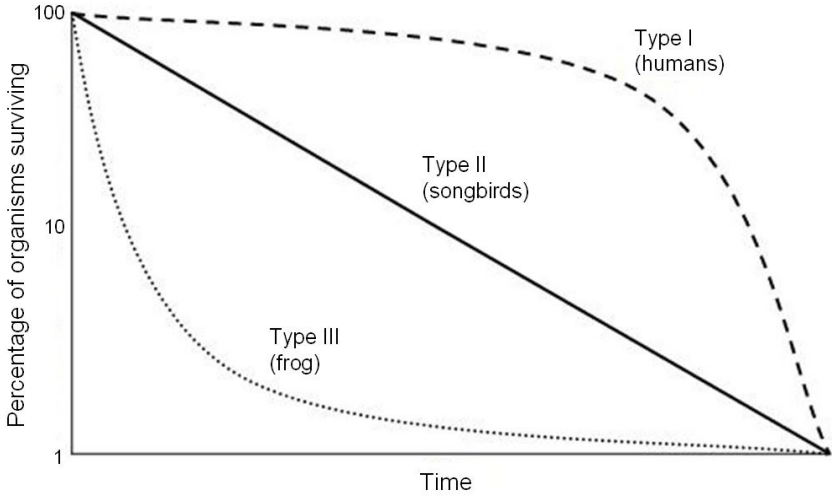
➔ Type III- Organisms that have many offspring, and reproduce often. Many individuals die at an early age, and there is less mortality later in life. Ex. sea turtles, parasites, frogs, and most insects.

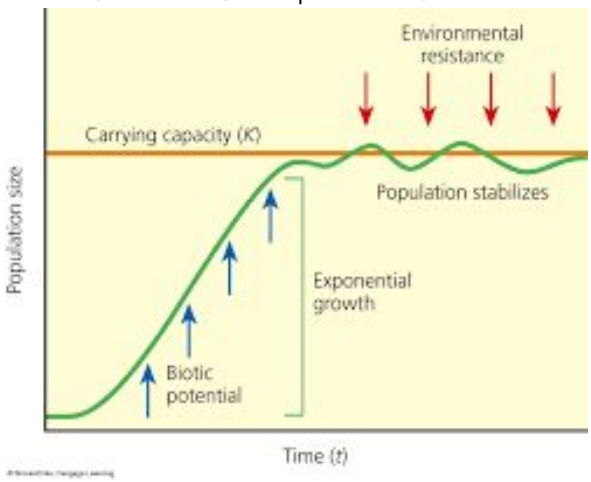


Carrying Capacity

Definitions-

➔ Density Dependent Factors (affected by population) that limit population growth- Competition, Food, Space for Habitats, Disease

➔ Density Independent Factors (NOT affected by population) that limit population growth- Natural disasters, Weather, Temperatures, Human influences, fires.



➔ Based on the graph above, explain biotic potential- Biotic potential is the unrestricted growth of populations resulting in the maximum growth of the population. (Exponential growth without any predators, disease, etc)

➔ Based on the same graph above, explain environmental resistance- Environmental resistance is the carrying capacity; environmental factors (droughts, mineral deficiencies, competition, limited resources) that tend to restrict the biotic potential of an organism and place limits on numerical increase.

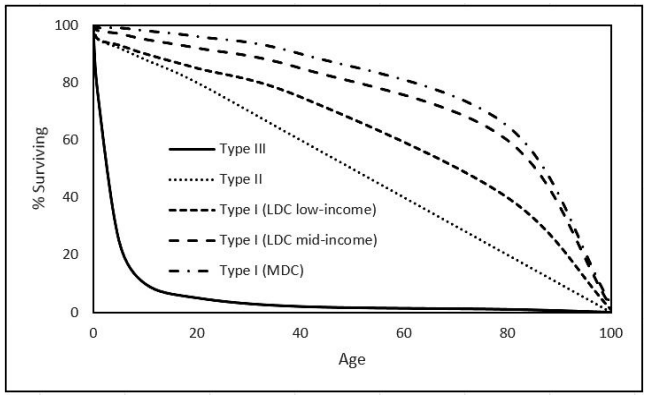
Population Growth and Resource Availability

Definitions-

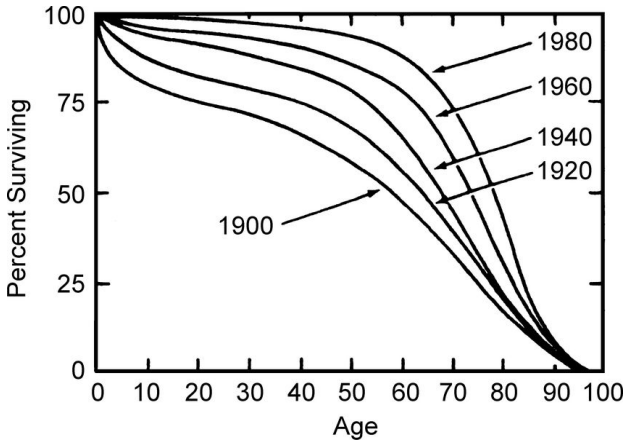
- ➔ Logistical growth- represented by a J-shaped curve (exponential growth) until it reaches a carrying capacity (represented by the letter "K"). Logistical growth predicts that we will overshoot our carrying capacity followed by a dieback. Founded by Paul Ehlich (wrote The Population Bomb), who predicted that there will be a population explosion once carrying capacity is reached.
- ➔ Irruptive growth- Characterized by constant fluctuations in the populations (think Predator Prey graph). There is a natural limiter that stabilizes the population (for example, predators, plagues, natural disasters, or lack of resources). Negative feedback loop that self corrects itself. Proposed by Thomas Malthus, who applied this theory to human populations.

Basic Information-

- ➔ Rule of 70's- $\frac{70}{\%\,(as\ a\ whole\ number)}$ = the # of years the population will take to double



- ➔ What can be concluded for the advanced survivorship curve above? The less developed countries with the lower incomes have the highest amount of infant mortality.



- ➔ What can you conclude from the survivorship curve above? The survival rates of human populations have increased with the decades, likely due to improvements in healthcare, industrialization, technology, agriculture, sanitation, etc.

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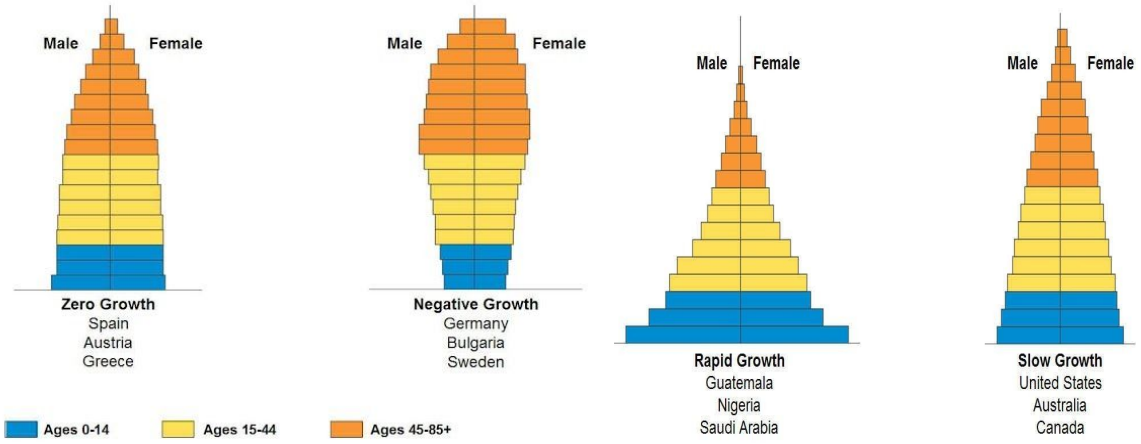
- Impacts of Population Growth-
  - Biodiversity- The Earth's biodiversity is crucial to the vitality of agriculture and medicine. Human activities are pushing plant and animal species into extinction with two-thirds of the world's species in decline.
  - Coastlines and Oceans- ½ of all coastal ecosystems are pressured by high population densities and urban development. Ocean fisheries are being overexploited, estuaries are being drained/filled, and fish catches are down.
  - Forests- ½ of the world's original forests have been lost, and each year another 16 million hectares are lost. Forests provide over $400 billion to the world economy annually and are vital to maintaining ecosystems.Current demand for forest products may exceed the limit of sustainable consumption by 25%.
  - Food Supply and Malnutrition- Today, ¼ of the world's population is malnourished. In 64 of 105 developing countries, most notably in Africa, Asia, and parts of Latin America, the population has been growing faster than food supplies. Population pressures have degraded 2 billion hectares of arable land.

Age Structure Diagrams



Total Fertility Rate

Definitions-

- Replacement Level Fertility- # of children parents should have to meet zero percent growth for the population. For example, if two parents have two children, they will eventually replace the parents when they die. As a result, the population has reached ZPG (mankind's goal). In developed countries, RLF is 2.1 children, and in developing nations, RLF is 2.3 children.
- Total Fertility Rate (TFR)- The average number of children a woman has. TFR>RLF results in positive population growth (BAD). TFR<RLF results in negative population growth (BAD). TFR = RLF results in zero percent growth (GOOD). In the US, TFR is 1.9, but we still have around 1% population growth due to immigration and emigration.
- Population Momentum- The ratio of the size of the population at a new equilibrium level to the size of the initial population-continued growth after ZPG is reached. In simpler terms, even though ZPG might be reached, the population will continue to increase or decrease for a while until everything stabilizes.

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Basic Information-

- ➔ Factors that affect fertility rate-
  - ◆ Availability of birth control
  - ◆ Demand for children in labor force
  - ◆ Education for women
  - ◆ Existence of public/private retirement systems
  - ◆ Population's religious beliefs, culture, and traditions
- ➔ Population change = [Births + Immigration] - [Deaths + emigration]
- ➔ National Population growth rate: ([CBR + Immigration] - [CDR + emigration])/10
- ➔ Global population growth rate: (CBR-CDR)/10

Human Population Dynamics

Definitions-

- ➔ Human Population Dynamics- studies the size and age composition of populations, and the biological and environmental processes driving them (such as birth and death rates, and by immigration and emigration).

Basic Information-

- ➔ Birth rates and Emigration add to the population
- ➔ Death rates and Immigration reduce the population

$$\text{Actual Growth Rate (\%)} = \frac{(\text{birth rate} + \text{immigration}) - (\text{death rate} + \text{emigration})}{1{,}000}$$

Demographic Transition

Demographic Transition	Birth Rate	Death Rate	Growth Rate	Description
Pre-Industrial (Stage 1)	High	High	ZPG	Remote places, basic. Limited healthcare/technology
Transitional (Stage 2)	High	Starts to decrease	++++% growth (lots)	Longest stage to get out of. High % growth means resources are being used
Industrial (Stage 3)	Starts to decrease	Declining	+% growth	Improved medicine, sanitation, technology, and jobs. Couples are having late marriages, having less children, etc.
Post-Industrial (Stage 4)	Low	Low	ZPG	Developed nations are in this stage. Lots of medicine, tech, jobs, and education. Late marriage, less children. Think of the USA.

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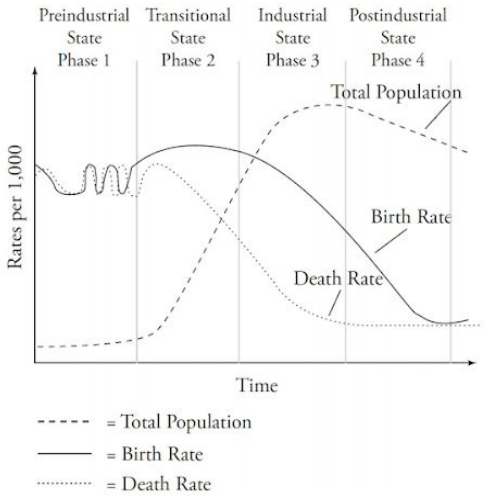
Location	Population
World	7.6 billion
#1 populated country- China	1.3 billion
#2 populated country- India	1.2 billion
#3 populated country- United States	360 million

Basic information-

- ➔ Ways to Decrease Birth Rate- Women's Rights (they have education, careers, societal support). Industrialization (cities, people have less babies). Contraceptives and improvements in healthcare (birth control, condoms). Religion, Laws, Incentives, Couples are having later marriages.
- ➔ Reasons for infant mortality- Lack of medical care, education, sanitation, and clean water.

Demographic Transition Model



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Unit 4

Plate Tectonics

Definitions-

- ➔ Plate tectonics theory states that the Earth's lithosphere is divided up into plates that float and travel independently over the mantle.
- ➔ Asthenosphere: The layer of Earth located in the outer part of the mantle, composed of semi-molten rock.
- ➔ Lithosphere: The outermost layer of Earth, including the mantle and crust.

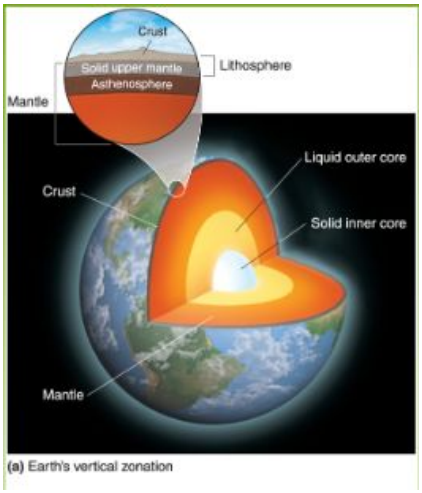
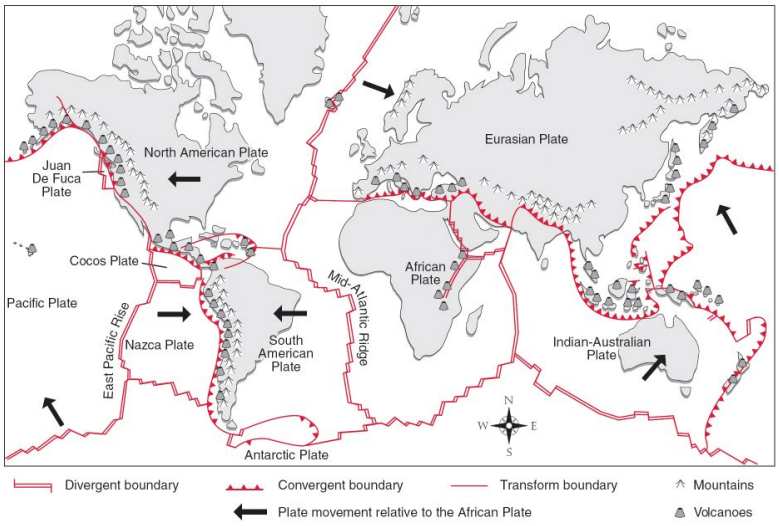


Plate Boundaries

Map of Tectonic Plates



Definitions-

- ➔ Earthquakes- Plates build up friction when they are stuck together. Eventually, enough friction gets built up and gets quickly released when the plate starts to move. This sudden release causes seismic waves to be released. Underwater earthquakes can cause tsunamis.
- ➔ Ring of Fire (Hot Spots)- Located in the Pacific Plate Boundaries

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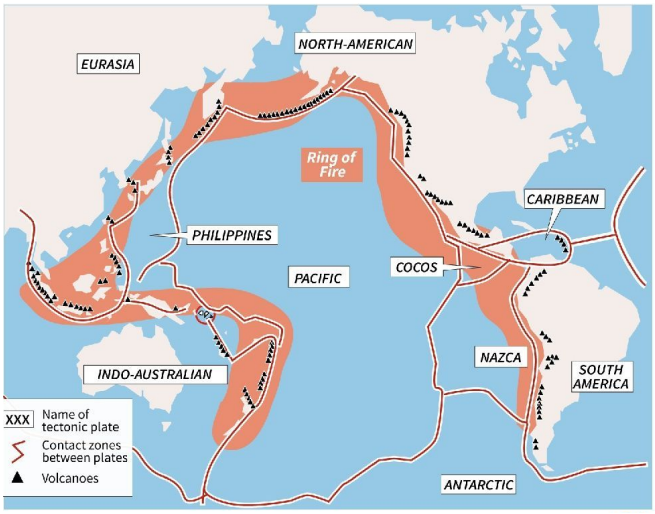

- ➔ Subduction- a heavy ocean plate is pushed below the other plate and melts in the hot mantle
- ➔ Convergent boundary- plates are pushed towards each other
  - ◆ When this occurs on two ocean plates or an ocean and a continent plate, subduction occurs.
  - ◆ When this occurs on two continental plates, mountains form
  - ◆ Convection cells rotating towards each other carry the plates on top towards each other
- ➔ Divergent Boundary- plates move away from each other
  - ◆ Convection cells rotating away from each other carry the plates on top away from each other
  - ◆ Lava will rise between the two plates and new crust is formed(sits higher than existing crust)
- ➔ Transform Boundary- plates slide past each other
  - ◆ Convection cells rotating in opposite directions make the plates on top slide past each other(horizontally)

Asthenosphere-Causes crust movement	Convergent(crust destroyed)	Divergent(crust created)	Transform
Movement	Together → ←	Away ← →	Laterally ⇅
Earthquakes	Yes (cannot feel them)	No	Yes (we can feel them)
Volcanoes	Yes	Yes	No

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Forms	Oceanic & Continental: Coastal volcanic mountain ranges and deep ocean trenches Continental & Continental: Mountain ranges Oceanic & Oceanic: deep ocean trenches and island arcs	ridges, rifts, and seafloor spreading Ex- African Rift Valley, Mid-Atlantic Ridge	The buildup and sudden release of friction between plates is an earthquake

Volcanoes

Definitions-

- ➔ Active Volcano- currently erupting or have erupted within recorded history
- ➔ Dormant Volcano- have not been known to erupt
- ➔ Extinct Volcano- will never erupt again
- ➔ Rift Valley- plates move away from each other. Magma is basaltic (thick and forms pillow lava when it hits cold ocean water)
- ➔ Hot Spots- do not form at the margin of plates. Magma is basaltic or rhyolitic.
- ➔ Basalt- Magnesium and iron Rich Lava
- ➔ Pyroclastic Flow- a fast-moving current of hot gas and volcanic matter (collectively known as tephra) that moves away from a volcano about 100 km/h (62 mph) on average but is capable of reaching speeds up to 700 km/h (430 mph).
- ➔ Rhyolitic- quartz, sandine, plagioclase. It is gas rich magma and can erupt explosively which creates pumice.

Basic Information-

- ➔ Types of Volcanoes-
  - ◆ Shield Volcano- broad base, gentle slope, slow lava flow. If water enters the volcano, it can be explosive and make a pyroclastic flow.
  - ◆ Composite Volcano- broad base, steep slope. Formed at subduction zones. Violent eruptions that eject lava, water, and gases as superheated ash and stones.
  - ◆ Cinder Volcano- formed when molten lava erupts and cools quickly in the air. They are small and form near other volcanoes.

Earthquakes

Definitions-

- ➔ Focus- place where earthquake begins inside the Earth
- ➔ Epicenter- initial surface location of the Earthquake
- ➔ Seismograph- the size of the quake (magnitude) is measured by this instrument
- ➔ S-wave- shear wave, shakes ground perpendicular to the way the wave is moving

- ➔ Tsunamis- large waves, or chains of waves, caused by the movement of the Earth during an earthquake or volcanic eruption.

Basic Information-

- ➔ Effects of earthquakes specifically on Haiti and Japan
  - ◆ Japan- March 2011, 9.0 magnitude earthquake off eastern coast, near Sendai. It caused a massive tsunami wave 33 ft high. Many buildings, roads, and railways were destroyed; major fires occurred; villages, homes, and people were washed away; and three nuclear power plants experienced dangerous explosions.
  - ◆ Haiti- In January 2010, 7.0 magnitude earthquake. Occurred in the boundary region separating the Caribbean plate and the North American plate. 222,570 people killed, 300,000 injured, 1.3 million displaced, 97,294 houses destroyed, and 188,383 houses damaged.

Rock Cycle

Definitions-

- ➔ Igneous: directly from molten magma
  - ◆ Intrusive igneous rock: igneous rock that forms when magma rises and cools underground
  - ◆ Extrusive igneous rock: igneous rock that forms when magma rises and cools above ground
- ➔ Sedimentary: compression of sediments
- ➔ Metamorphic: exposure to high temperatures and pressure(igneous & sedimentary create metamorphic)

Soil Formation and Erosion

Types of Weathering

Mechanical (physical)	Rocks breaking down, thermal expansion, frost wedging, wind
Biological	Tree roots, lichen (primary succession), animal paths
Chemical	Oxidation, Acid Rain, Salts

Basic information-

- ➔ Difference between weathering and erosion- Weathering is the breakdown of rock, whereas erosion is the movement of rock/soil.
- ➔ Ways to alleviate topsoil loss for agriculture-
  - ◆ Riparian Vegetation (roots keep the soil in place), covering crops, polyculture, terracing, agroforestry, contour plowing, minimum tilling, and mulch.
- ➔ Poor agricultural techniques that lead to soil erosion include-
  - ◆ Improper plowing of the soil
  - ◆ Monoculture
  - ◆ Overgrazing
  - ◆ Removing crop wastes instead of plowing the organic material back into the soil

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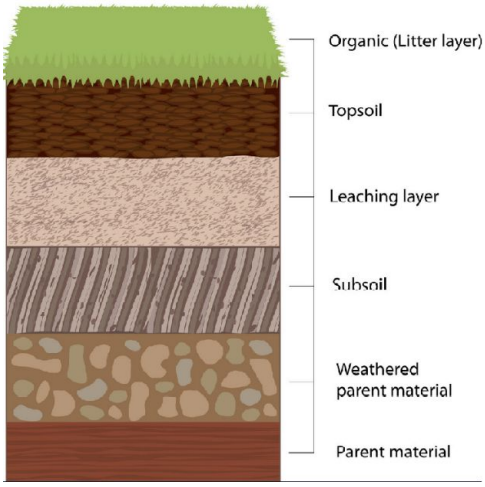
Soil Composition and Properties



Definitions-

- ➔ P (peat layer)- found in wetlands or waterlogged areas. Peat is the mud/grass mixture, is the basic form of coal
- ➔ O (organic material)- leaf litter, dead organisms. Decomposers break down organic material and release nutrients for the A layer
- ➔ A (topsoil layer)- Nutrients, Minerals, Nitrogen, Phosphorus, Potassium. Plants need to use these nutrients and materials for growth. This is where the most biological activity occurs and is dark in color.
- ➔ E (eluviation layer)- All the minerals leech downwards and form a layer above the compact subsoil. This is where the nutrients and minerals are trapped. This layer is also in some acidic soils. This layer is not always present and if it is, then it will always be above the B layer.
- ➔ B (subsoil)- minerals, sand, silt, clay. Below eluviation layer. This layer is the zone of accumulation of metals and nutrients and there is also very little organic matter.
- ➔ C (regolith)- Least weathered and most similar to parent material.
- ➔ R (parent rock/bedrock)- Igneous (granite and pumice), sedimentary (sandstone and shale), or metamorphic (quartzite, marble)

Sand	Large particles, not many holes, low porosity, high infiltration, low nutrients
Silt	Medium particles, medium porosity, medium infiltration, medium nutrients. Found on riverbanks.
Clay	Small particles, many holes, high porosity, low infiltration, high nutrients. Very compact
Loam	33% sand, 33% silt, 33% clay. The perfect mix for agriculture
Humus	Partially decomposed organic matter. At the bottom of the O layer, top of the A layer.

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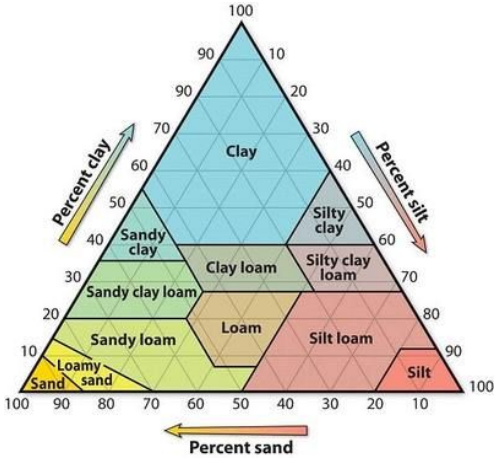
Surface mining techniques-

- Strip mining: The removal of strips of soil and rock to expose ore.
- Mine tailings: Unwanted waste material created during mining including mineral and other residues that are left behind after the desired metal or ore is removed.
- Open-pit mining: A mining technique that creates a large visible pit or hole in the ground.
- Mountaintop removal: A mining technique in which the entire top of a mountain is removed with explosives.
- Placer mining: The process of looking for minerals, metals, and precious stones in river sediments.
- Subsurface mining Mining techniques used when the desired resource is more than 100 m (328 feet) below the surface of Earth.

Definitions-

- ➔ Leaching- The downwards movement of nutrients in soil, typically because of rainfall
- ➔ Percolation/Infiltration- The downwards movement of water through the soil
- ➔ Importance of Leaf Litter- This is the O layer of the soil. Prevents nutrients from the A layer from leaving. It eventually provides nutrients when decomposed.
- ➔ Soil Triangle- Clay goes straight across. Silt goes downwards diagonally. Sand goes upwards diagonally.



Earth's Atmosphere

Basic Information-

- ➔ Gases and abundance in troposphere- 78% Nitrogen (N2), 21% Oxygen (O2), 1% Argon, 0.4% Carbon Dioxide (CO2)
- ➔ Layers of the Atmosphere-
  - ◆ Thermosphere- the outermost shell of the atmosphere between the mesosphere and outer space, where temperatures increase steadily with altitude. Where the aurora resides
  - ◆ Mesosphere has the greatest temperature drop
  - ◆ Stratosphere- contains the ozone layer which is composed of O_3. Temperature increases with latitude. Layer directly above the troposphere.

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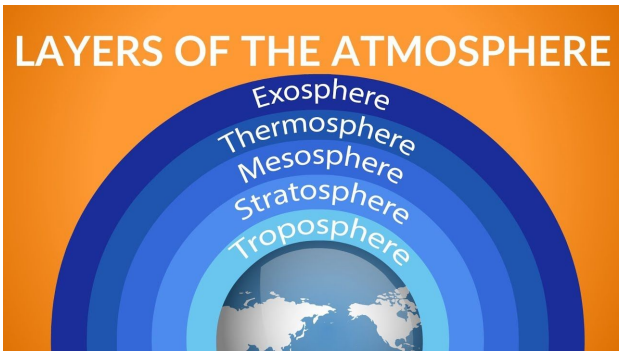
- Troposphere- closest to Earth, where weather occurs, fairly slim layer, warmest at lowest altitudes due to Earth absorbing heat and reflecting it, layer where most Earth's nitrogen, oxygen, and water vapor are, the higher up you are in the troposphere the colder it is

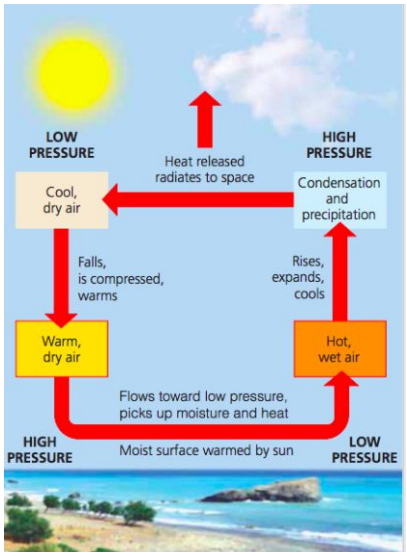


- ➔ Climate vs. Weather- Climate is long term patterns, whereas weather is current conditions
- ➔ Hurricanes/typhoons/Cyclones- caused when warm water interacts with cooler air (fall) or when cold water interacts with warmer air (spring-summer)

Global Wind Patterns

Definitions-

- ➔ Air density: mass of all molecules in the air in a given volume
- ➔ Water Vapor Capacity: the amount of water vapor present in the air
  - ◆ Warmer air has higher water vapor capacity(more humidity)
  - ◆ Cooler air has lower water vapor capacity(less humidity)
  - ◆ The higher the water vapor capacity, the higher the saturation point
- ➔ Saturation point: The maximum amount of water vapor that can be in air at a given temperature
- ➔ Adiabatic heating and cooling: Describes how pressure causes air to warm or cool
  - ◆ As altitude increases, pressure decreases. As pressure decreases, temperature decreases.
  - ◆ As altitude decreases, pressure increases. As pressure increases, temperature increases.
- ➔ Latent heat release
  - ◆ When water vapor condenses into precipitation, heat is released into the environment.
  - ◆ When precipitation turns into water vapor, heat is absorbed from the environment.
- ➔ Coriolis effect- Easterlies, Westerlies, Trade Winds, Doldrums (no wind), Trade Winds, Westerlies, Easterlies.
  - ◆ Westerlies- Blows from West to East;
  - ◆ Easterlies- Blows from East to West.
  - ◆ The Northern Hemisphere is clockwise, the Southern Hemisphere is counterclockwise.
- ➔ Pressure Systems- Warm air rises, cold air sinks = convection cell. Hadley cells = trade winds. Caused by the heating of the sun, leads to Coriolis effect.



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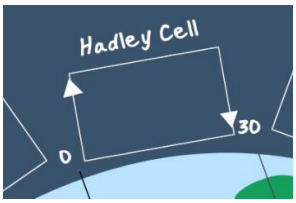
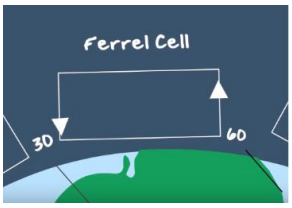
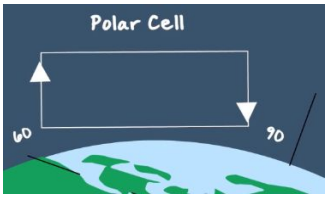
- ENSO- El Nino Southern Oscillation- The trade winds in the southern hemisphere (only in the Pacific Ocean) switch from CCW to CW.
- Lake effect- Water/Wind/Clouds move very quickly over flat land. All the water/clouds from the Pacific Ocean crash on the windward side of the Rocky Mountains, leaving a leeward/dry side on the opposite side. This can cause tornadoes. As the clouds move up the mountain, it becomes cold. The cold wind interacts violently with the warmer air of the leeward side, causing tornadoes.
- Hadley cell:
  - Starts at 0°(equator) and ends at 30°
  - The heat at the eq. causes hot, humid air to rise at 0°. The evaporated water here falls back down as rain. This leaves the air at the top hot and dry.
  - The hot, dry air way above the eq. then moves, cools, and comes back down at 30°.



- Ferrel cell:
  - Starts at 30° and ends at 60°
  - Cool, dry air high in the atmosphere drops to earth at 30°. Then the air sweeps across the earth, warming up
  - As the air sweeps across the earth and warms up, it will be warm enough to fully rise at 60°



- Polar cell:
  - Starts at 60° and ends at 90°
  - Warm air rises and cools as it reaches higher altitudes at 60°. Then the air moves toward the poles.
  - As the air moves toward the poles, it cools even more before finally coming back down to earth at 90°



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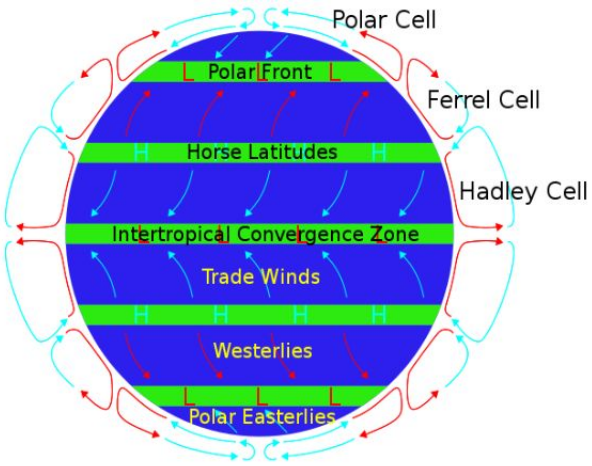
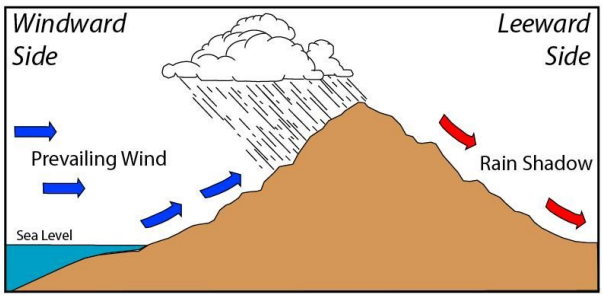
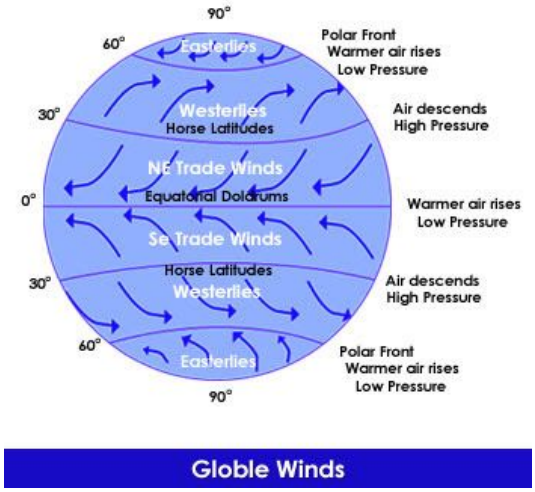






Watersheds

Definitions-

- ➔ Watershed- a common area where all the water drains to. Aka a drainage basin
- ➔ Characteristics
  - ◆ Area: Reflects volume of water that can be generated from a rainfall
  - ◆ Length: Length is measured from the beginning of the body water to the end of the body water.
  - ◆ Slope: Will affect momentum of runoff, velocity of overland flow, watershed erosion potential, and local wind systems. If the slopes of the watershed are big, water will move faster across the land. This faster runoff leads to soil erosion.
  - ◆ Soil: If soil is too permeable, than runoff of important nutrients into a water body may be too low. If soil has, for example, a very high clay content, then permeability will be very low. This could cause too much runoff, eroding away all

nutrients from the soil and introducing too many nutrients to the water body, dramatically altering the marine life.

- Vegetation: Adds organic matter to the soil
- Divides: The elevated boundary separating areas that are drained by different river systems.Water flowing on one side of a divide empties into one body of water, while water flowing on the other side empties into another.

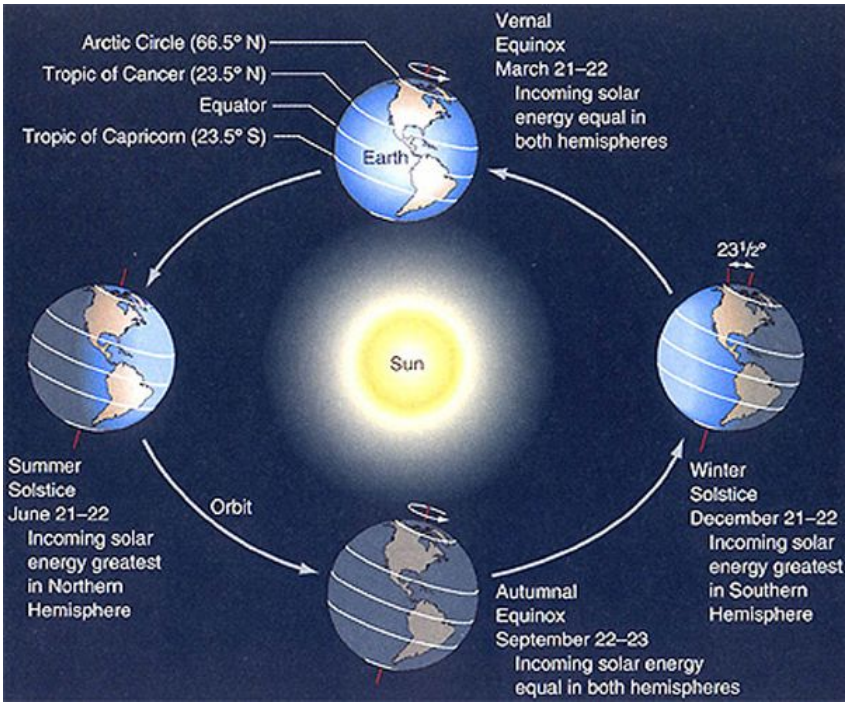
Solar Radiation and Earth's Seasons

Definitions-

- ➔ Insolation- The amount of solar radiation reaching an area
- ➔ Seasons- caused by the tilt of the Earth and the amount of insolation

Basic Information-

- ➔ The southern Hemisphere experiences summer while Northern experiences winter due to earth's tilt(and vice versa).
- ➔ June solstice- 24 hrs of daylight in the north pole , 24 hrs of night in the south pole. Longest day of the year in the northern hemisphere and shortest in the southern hemisphere. Summer begins in the northern hemisphere and winter begins in the southern hemisphere.
- ➔ December solstice- 24 hrs of daylight in the south pole, 24 hrs of night in the north pole. Shortest day of the year in the northern hemisphere and longest in the southern hemisphere. Winter begins in the northern hemisphere and summer begins in the southern hemisphere.
- ➔ March Equinox- Sun is directly over the equator. All regions of the Earth receive 12 hours of light. Spring begins in the northern hemisphere and fall begins in the southern hemisphere.
- ➔ September Equinox- Sun is directly over the equator. All regions of the Earth receive 12 hours of light. Fall begins in the northern hemisphere and spring begins in the southern hemisphere.



Earth's Geography and Climate

Basic Information-

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- ➔ Factors that impact climate- Earth is a sphere, resulting in the uneven heating of different latitudes depending on the location from the sun. Additionally topography, ocean currents, and tilt affect climate in different areas
- ➔ Rain shadows- Rain Shadows occur where humid winds blowing inland from the ocean meet a mountain range.
    - ◆ On the side of the mountain that is facing the wind, air rises, cools and precipitates.
    - ◆ On the opposite side of the mountain, the now cool, dry air descends and warms up due to adiabatic heating and causes much drier conditions.

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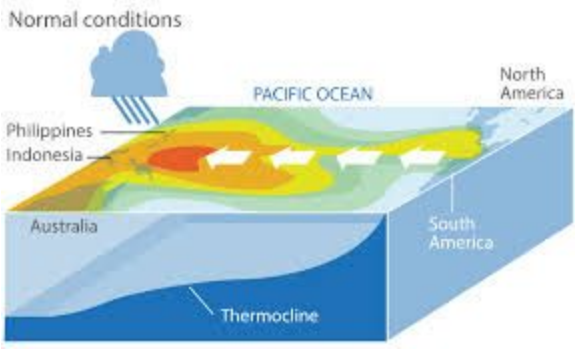
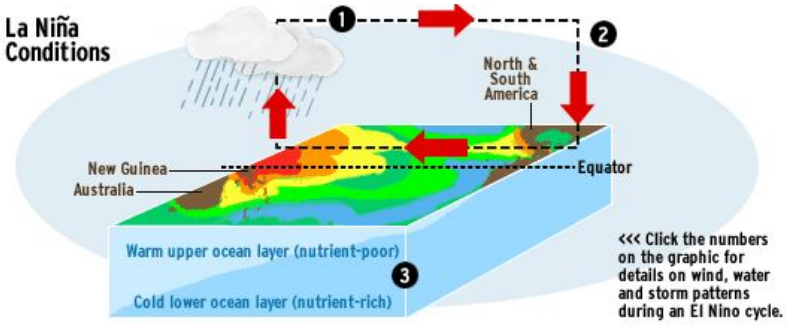
El Nino et La Nina

- ➔ Normal conditions-
  - ◆ Prevailing winds go east, which causes a pile up of warm water near Indonesia, and cold water rises towards
- ➔ El Nino-
  - ◆ Southern Oscillation (ENSO); Shift in atm pressure, sea surface temp and ocean circulation
  - ◆ Happens every 2-8 years
  - ◆ Drought in Indonesia region, "wet" in California
- ➔ La Nina-





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Unit 5

The Tragedy of the Commons

Basic Information-

- ➔ Tragedy of the Commons- degradation of common property resources
  - ◆ Shared resources are eventually depleted by overuse of the resource
  - ◆ Hardin's thesis is that humans will behave selfishly to benefit themselves but may overuse and pollute the commons (Hardin views human nature as selfish)
  - ◆ An article was written by Garrett Hardin, where he explains the tragedy of the commons as an economic problem that results in overconsumption and depletion of a common resource where public land is used for private benefit
  - ◆ For this to occur, resources must be scarce, big on consumption
  - ◆ Solutions to the tragedy of commons include giving more private property rights, more government regulation, and different agreements
  - ◆ Examples of the tragedy of the commons include collapse of north Atlantic cod fisheries and extinction of the dodo bird
- ➔ Critiques of the tragedy of the commons
  - ◆ Hardin suggests that part of the solution to environmental problems is to privatize the commons. This assumes that the private owner would act in the interest of others, contradicting his belief that humans are inherently selfish.
  - ◆ Hardin's notion of privatization/ownership can be applied to land but is much more difficult to apply to the oceans or air
  - ◆ Hardin also suggests that populations of human beings should be limited to governmental controls. In response to concerns about population growth, The People's Republic of China instituted this sort of policy in 1979. The most striking (and unintentional) impact of this policy is that there are now many more males than females, which suggests that girls—traditionally valued less than boys—have been either selectively aborted or abandoned after birth.

Clear Cutting / How are trees harvested?

- ➔ Clear-cutting- Removal of all trees from an area in one cutting
  - ◆ Reforested naturally by seed or artificially by seedlings raised in a nursery
- ➔ Pros-
  - ◆ increases timber yield per hectare
  - ◆ permits reforesting of genetically "improved" trees
  - ◆ shortens growing time
  - ◆ takes less time and planning
  - ◆ provides maximum economic return
- ➔ Cons-
  - ◆ Leaves forest openings
  - ◆ eliminates recreational value
  - ◆ reduces biodiversity
  - ◆ disrupts the ecosystem

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- destroys habitats
- leads to severe erosion, water pollution, and flooding

Selective Cutting

- Remove intermediate matured age trees singly or in small groups
- High-grading: Remove only largest and best trees of desirable species; many tropical forests

Shelterwood Cutting

- Removes all mature trees in 2-3 cuttings over a period of time

Seed-Tree Cutting

- Cut all trees but leave behind a few evenly distributed seed producing trees to regenerate

Strip Cutting

- Type of clear-cutting but in smaller strips of land; more sustainable than clear-cutting

The Green Revolution

- Green Revolution- A process in which global food production increased due to increased yields
  - Started a shift to new agricultural strategies in order to increase food production with both positive and negative results
  - Increased yields are due to-
    - Developing & planting monocultures of high-yield crops
    - Using large inputs of fertilizer and pesticides
    - Increase in intensity and frequency of cropping
    - Mechanization of farming
      - Increases profits and efficiency and increases reliance on fossil fuels
  - First green revolution increased crop yields in developed countries
  - Second green revolution implemented fast growth plants and multiple cropping

Impacts of Agricultural Practices

Definitions-

- Salinization- Occurs when soil becomes waterlogged from excess irrigation and then dries out. As the water evaporates, the salt crystallizes and forms a layer on the soil surface. This excess of salt prevents the growth of plants.

Basic Information-

- How to Reduce Salinization-
  - Less irrigation
  - use salt tolerant crops (ex. cotton)
  - allow soil to recover by not growing crops

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- What are the local impacts of agriculture?
  - Deforestation
  - Desertification
  - Salinization
  - Accumulation of heavy metals and toxic organics compounds
- What are the global impacts of agriculture?
  - Changes in land
  - Changes the climate
- how does farming affect nutrient cycles- harvesting depletes nutrients while intensive livestock operations concentrate nutrients
- Soil is renewable, but it is often be removed faster than it is formed
- Plowing is unlike any natural process because it accelerates erosion and causes nutrient loss

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Irrigation Methods

Basic Information-

- Four types of irrigation-
  - Surface- entails water flowing by gravity over soil. Water supplied through canals, pipes or ditches (water may be pumped to a field at a higher elevation). They are typically used for field crops, pastures and orchards. Efficiency of surface irrigation systems vary because of variations in soil type, field uniformity, crop type and management. Surface irrigation is often considered less efficient because soil, not a pipe, conveys the water within surface irrigated fields. However, a well managed surface irrigation system on a uniform soil with a runoff reuse system can approach 90% efficiency.
  - Sprinkler- applies water to soil by spraying or sprinkling water through the air onto the soil surface. Water is pressurized and delivered to the irrigation system by a pipe, which is often buried so it does not interfere with farming operations.
  - Drip/trickle- a method of supplying irrigation water through tubes that drip water onto the soil at the base of each plant
  - Subsurface (Subirrigation)- applies water below the soil surface to raise the water table into or near the plant root zone. Subirrigation is not often used in arid or semi-arid irrigated areas where irrigation is needed to germinate crops. It is typically used in conjunction with subsurface drainage, or controlled drainage. Subsurface drainage lowers the water table and removes excess water through open ditches or perforated pipe. Water Table depth can be controlled by installing a weir on the drainage system. During wet periods, the water table is lowered so the root zone remains unsaturated. During dry periods, water is pumped into the drainage system to raise the water table and provide additional water for plant growth.

Pest Control Methods

Definitions-

- Biocides/Pesticides- Chemicals to kill organisms we consider undesirable
  - Insecticide, Herbicide, Fungicide, Nematicide (kills roundworms), Rodenticide
- Biological Methods-
  - Synthetic Pyrethroids- Non chemical pesticide
  - Sterile male method- sterile males of a pest are released, decreasing offspring count.
    - Used for screwworm fly and Mediterranean fruit fly and tsetse fly
  - Food irradiation- extends food shelf life and kills insects, pests, and parasitic worms.
- Integrated Pest Management- See later subunit
- Types of Pesticides- insecticides, herbicides, rodenticides
- 1st generation pesticides- natural chemical obtained from plants that have been used by people since the 1600s (ex. nicotine sulfate from tobacco plants, neem oil)
- 2nd generation pesticides- chemicals produced synthetically
- Broad spectrum agents- pesticides that are toxic to many organisms (pests and non pests alike- ex. DDT, parathion)

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- ➔ Narrow spectrum agents- pesticides that target specific types of organisms
- ➔ Persistence- pesticides vary in their persistence, some remain deadly for years
- ➔ Boomerang Effect- banned chemicals end up back in U.S. on food growth in other countries

Basic Information-

- ➔ Pros-
  - ◆ Decrease insect transmitted disease (ex. malaria, plague); can kill insects that threaten crops
- ➔ Cons-
  - ◆ Create genetically resistant strains of insects (pesticide treadmill- pests are becoming resistant of farmers spray)
  - ◆ Can kill many types of organisms besides pests (often kill natural pest predators- ex. spiders; kill bees, fish, birds)
  - ◆ Can pollute environment
  - ◆ Pose a threat to human health (ex. cancers, immune and nervous system disorders, poisonings)
  - ◆ Pesticide use has not decreased U.S. crop loss to pests
- ➔ FDA regulates pesticides; many controlled or banned chemicals are used in other countries (sometimes made in U.S.)
- ➔ Alternatives to Pesticides-
  - ◆ Cultivation practices (rotating crops, planting times, pick proper locations)
  - ◆ Use biological control (bring in predators, pest diseases, parasites); GMOs (genes for pest resistance can be implanted)
  - ◆ Hot water, attractants, insect hormones

Meat Production Methods

Definitions-

- ➔ Meat production refers to the slaughter, in slaughterhouses and farms, of animals whose carcass is declared fit for human consumption.
- ➔ Concentrated Animal Feeding Operation (CAFO)- Many meat or dairy animals are reared in confined spaces, maximizing the number of animals that can be grown in a small area.
- ➔ Soil Compaction- When soil is pressed down tightly resulting in the removal of air pockets; therefore not allowing water to penetrate or plants to grow.
- ➔ Desertification- The process in which fertile land becomes desert, typically due to drought, deforestation, or inappropriate agriculture
- ➔ Nomadic grazing- Feeding herds of animals by moving them to seasonally productive feeding grounds

Impacts of Overfishing

Definitions-

- ➔ International Whaling Commission (IWC)- established to regulate the whaling industry by setting annual quotas for various whale species to prevent overharvesting.

Basic Information-

- ➔ Bottom Trawling destroys the ocean floor, which takes hundreds to thousands of years to regenerate.
- ➔ Purse Seining kills dolphins
- ➔ Longlining kills endangered marine species and has a lot of by catch
- ➔ Drift nets kill a lot of bycatch and endangered species
- ➔ Government subsidies encourage overfishing, causing too many people to chase small amounts of fish.
- ➔ Major effects of overfishing
  - ◆ Commercial extinction
  - ◆ Larger individuals of commercially valuable species wild species are becoming scarce, such as cod, tuna, and swordfish
  - ◆ Invasive species are rapidly reproducing
- ➔ Collapse of the Atlantic cod fishery- collapse due to overfishing which led to commercial extinction. The resulting effects on the fishery's economy included at least 20,000 fishers and fish processors and damage to Newfoundland's economy.

Impacts of Mining

Definitions-

- ➔ Spoils/Tailings (unwanted waste materials)

Basic Information-

- ➔ Mining techniques
  - ◆ Surface
    - Types of surface mining-
      - Strip mining- removal of strips of soil/rock to expose ore, remove overburden, extract resource, return mining spoils/tailings (unwanted waste materials)
      - Open-pit mining- uses a large visible pit/hole, resource close to surface, mainly for copper
      - Mountaintop removal- done with explosives, tailings deposited in nearby regions
      - Placer mining- looking for minerals and metals in river sediments, mainly find diamonds, tantalum, gold (CA gold rush)
  - ◆ Subsurface- resources are more than 100m below surface, much more expensive, usually find coal, diamonds, gold. A horizontal tunnel is made, then vertical shafts are drilled, and elevators bring you down.
- ➔ Effects of Mining-
  - ◆ Scarring and disruption of land surface, increased erosion
  - ◆ Collapse or subsidence of land above underground mines

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- Erosion of toxin-laced mining wastes
- Acid mine drainage (contaminates water)
- Emissions of toxic chemicals
- Exposure of wildlife to toxic mining wastes
- Destruction of habitat which leads to loss in biodiversity
- Dust particles, methane, CO2 (fossil fuel emissions)

Impacts of Urbanization

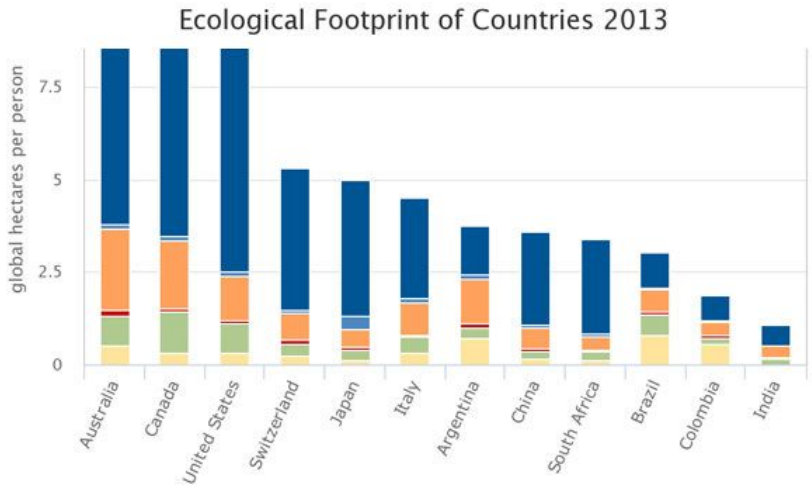
Basic Information-

- ➔ Impacts of Urbanization
  - Deforestation/Habitat destruction due to land development
  - Biodiversity loss (deforestation/habitat destruction)
  - Heat Island effect- Increased temperature around urban areas due to use of materials that retain heat
  - Creation of dust domes above urban areas
  - Soil erosion due to disruption of natural drainage patterns
  - Water loss as runoff caused by pavement
  - Water, air, soil, and noise pollution
- ➔ Impacts of Urban Sprawl
  - Loss of cropland
  - Fragmentation of forests, grasslands, wetlands, and wildlife habitats
  - Increased use and pollution of surface water and groundwater
  - Increased runoff and flooding
  - Increased energy use and waste
  - Increased emissions of carbon dioxide and other air pollutants
  - Decline of downtown business districts
  - More unemployment in central cities/ other economic effects
  - Land and biodiversity

Ecological Footprints

Definitions-

- ➔ Ecological Footprint- the impact of a person or community on the environment, expressed as the amount of land required to sustain their use of natural resources.



Introduction to Sustainability

Basic Information-

- ➔ Indicators of urban sustainability
  - ◆ Low children in poverty
  - ◆ Low violent crime
  - ◆ High access to healthcare
  - ◆ High air and water quality
  - ◆ Low vacant or deteriorating housing
  - ◆ High participation in neighborhood organizations
  - ◆ High access to public transportation
  - ◆ Shopping and services within walking distance
  - ◆ High quality of schools

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Methods to Reduce Urban Runoff

Definitions-

- ➔ Urban Runoff- Surface runoff of rainwater created by urbanization. Hard, non-permeable surfaces, such as concrete and asphalt, replace soil, preventing water from entering aquifers. Rainwater instead flows over the hard surfaces, gathering pollutants and chemicals until it eventually rejoins a water source.
- ➔ Permeable Pavement- pavement that allows water to seep in between the paving materials and be absorbed into the ground
- ➔ Infiltration Rate- The quantity of water that enters the soil surface in a specified time interval. Expressed in volume of water per unit of soil surface area per unit of time.
- ➔ Seepage- the slow escape of a liquid or gas through porous material or small holes.

Basic Information-

- ➔ How to reduce urban runoff- increase water infiltration. This can be accomplished by replacing pavement and concrete with more permeable pavement materials such as pavers (stones) with pore holes in them. Also planting trees and building buildings up (taller) and not out taking up more area on a streetblock will reduce urban runoff.

Integrated Pest Management

- ➔ Integrated Pest Management- Crop and its pests are evaluated as part of an ecological system. Then a control program is developed that includes a mix of cultivation, biological, and chemical methods.
  - ◆ Fields are monitored by field scouts
- ➔ Benefits: lowers cost for pesticides, reduces amounts of pesticides in environment, several weaknesses of pests can be exploited, reduces use of fertilizers, improves crop yields, lowers genetic resistance issues
- ➔ Disadvantages: needs expert knowledge of pest life cycle, takes time to implement management practices, initial costs might be higher, governments subsidize pesticide use, training takes a long times, methods for one area might not apply in other areas

Sustainable Agriculture

Definitions-

- ➔ Sustainable agriculture- farming in sustainable ways; meeting society's food and textile needs without compromising the ability for current/future generations to meet their needs. based on an understanding of ecosystem services.

Basic Information-

- ➔ Basic principles in sustainable agriculture-
  - ◆ Building and maintaining healthy soil
  - ◆ Managing water wisely
  - ◆ Minimizing air, water, and climate pollution
  - ◆ Promoting biodiversity
- ➔ Several key sustainable farming practices have emerged-
  - ◆ Rotating crops/Embracing diversity- Planting a variety of crops can make healthier soil and improve pest control. Crop diversity practices include

intercropping and multi-year crop rotations. The crops are picked so that the crops planted replenish the nutrients and salts from the soil that were absorbed by the previous crop cycle. For example, row crops are planted after grains in order to balance the used nutrients.

- Planting cover crops- Cover crops (clover or hairy vetch) are planted off-season when soils might be bare. These crops protect and build soil health by preventing erosion, replenishing nutrients, and keeping weeds in check, reducing the need for herbicides.
- Reducing or eliminating tillage- Traditional plowing (tillage) prepares fields for planting and prevents weed problems, but can cause soil loss. No-till or reduced till methods, which involve inserting seeds directly into undisturbed soil, can reduce erosion and improve soil health.
- Integrated Pest Management (IPM)- A range of methods, including mechanical and biological controls, can be applied systematically to control pest populations while minimizing use of chemical pesticides. Not all pests are harmful and so it makes more sense to let them co-exist with the crop than spend money eliminating them.
- Integrating livestock and crops- Industrial agriculture separates plant and animal production, with animals living far from where feed is produced, and crops grow far from manure fertilizers. Evidence shows that integration of crop and animal production can make efficient/profitable farms.
- Transportation costs- Targeting the sales of the production in the local market saves transportation and packaging hassles. It also eliminates the need of storage space. When stuff is grown and sold in local markets, it makes a community self-sufficient, economically sound, saves energy and doesn't harm the environment.
- Adopting agroforestry practices- By mixing trees/shrubs, farmers provide shade/shelter to protect plants, animals, and water resources.
- Managing whole systems and landscapes- Sustainable farms treat uncultivated areas, such as riparian buffers or prairie strips, as integral to the farm—valued for their role in controlling erosion, reducing nutrient runoff, and supporting pollinators and other biodiversity.
- Make use of Renewable Energy Sources- Farmers can use solar panels to store solar energy and use it for electrical fencing and running of pumps and heaters. Running river water can be a source of hydroelectric power and be used to run machines on farms. Similarly, farmers can use geothermal heat pumps to dig beneath the earth and can take advantage of earth's heat.
- Avoid Soil Erosion- Manure, fertilizers, and cover crops help improve soil quality. Crop rotations prevent the occurrence of diseases in crops. Diseases such as crown rot and tan spot can be controlled. Also pests like septoria, phoma, etc can be eliminated by crop rotation techniques, since diseases are crop specific.
- Managed Grazing- periodic shift of the grazing lands. Moving livestock offers them a variety of grazing pastures. The excreta of these animals serves as a

natural fertilizer. Change of location also prevents soil erosion as the same patch of land is not trampled upon constantly.
    - Better Water Management- The first step in water management is selection of the right crops. One must choose the local crops as they are adaptable to the regional weather. Crops that do not need too much water are good for dry areas. Irrigation systems need to be planned or they lead to other issues like river depletion, dry land and soil degradation. One can also build rainwater harvesting systems and use them in drought prevailing conditions.
- The most sustainable and productive systems are more diverse and complex (like nature itself)
- Benefits of Sustainable Farming
    - Environment Preservation
    - Economic Profitability
    - Most efficient use of non-renewable resources
    - Protection of Public Health
    - Social and Economic Equity

Aquaculture

Definitions-

- By-Catch- any other species of fish, mammals, or birds that are caught that are not the target organism
- Capture Fisheries- fish production in which fish are caught in the wild and not raised in captivity for consumption
- Aquaculture- Fish & shellfish are raised for food
    - Fish-farming- cultivating fish in a controlled environment
    - Fish-ranching- holding anadromous (live in freshwater for part of their life and saltwater for part of their life) species captive, releasing them, and harvesting when they come back
- Fisheries- Concentrations of particular aquatic species
- Types of fishing-
    - Trawling- a fishing technique in which the ocean floor is scraped by heavy nets that smash everything in their path
    - Drift Nets- nets that drift free in the water and indiscriminately catch everything in their path
    - Long Lining- the use of long lines with baited hooks, which will be taken by numerous aquatic organisms

Sustainable Forestry

Definitions-

- Deforestation- the removal of trees for agricultural purposes or purposes of exportation
- Conservation- the management or regulation of a resource so that its use does not exceed the capacity of the resource to regenerate itself
- Selective Cutting- the removal of select trees in an area, leaving the majority of the habitat in place and therefore having less of an impact on the ecosystem

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- ➔ Shelter-Wood Cutting- when mature trees are cut over a period of time (usually 10–20 years), leaving mature trees, which can reseed the forest, in place
- ➔ Uneven-Aged Management- the broad category under which selective cutting and shelter-wood cutting fall; selective deforestation
- ➔ Second growth forests- areas where cutting has occurred and a new, younger forest has arisen

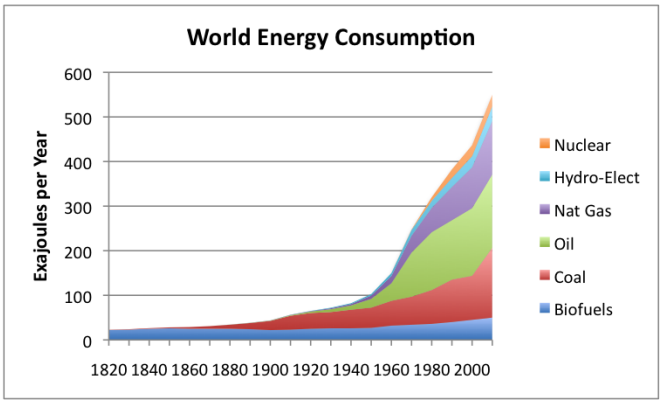
Unit 6

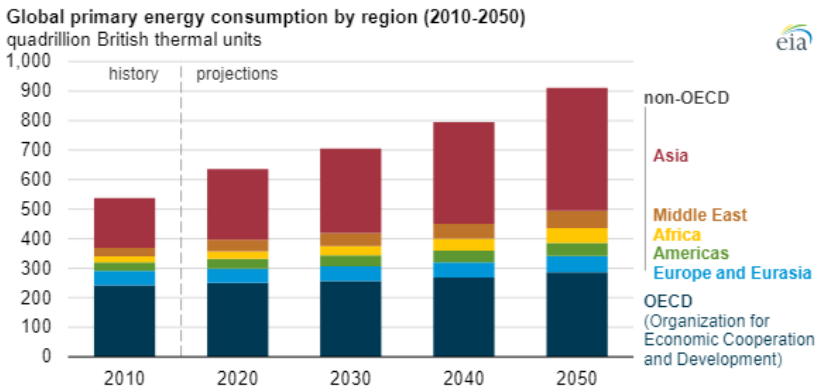
Renewable and Nonrenewable Resources

Definitions-

- ➔ Nonrenewable Resources- resources that are formed by slow geologic processes, therefore considered incapable of being regenerated within the realm of human existence
- ➔ Renewable Resources- refers to resources, such as plants and animals, which can be regenerated if harvested at sustainable yields
- ➔ Cogeneration: The use of a power plant to generate electricity and heat at the same time. Example: Using wastewater from electricity production for heating homes.

Global Energy Consumption





Fuel Types and Uses

Basic Information-

- ➔ Many states and the federal government are working to increase the use of alternative fuels, such as electricity, natural gas, hydrogen, and biofuels, to diversify the fuels used in transportation as well as to support greater energy security, reduce greenhouse gas

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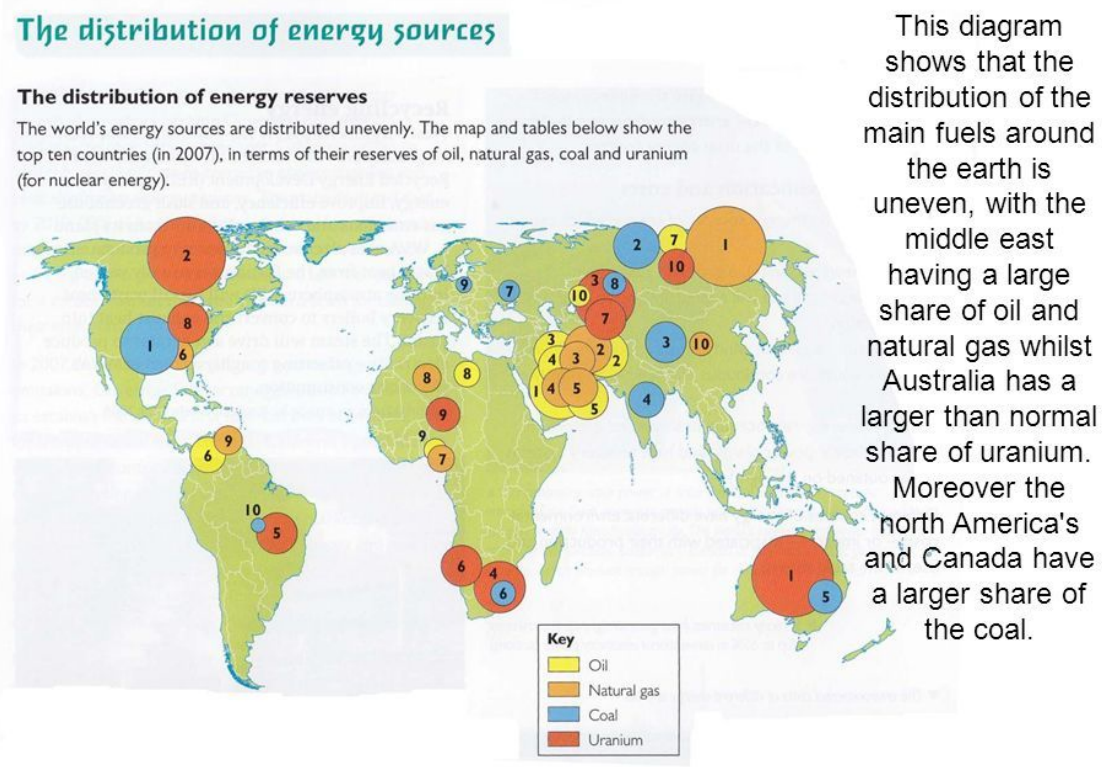
emissions, and provide price stability. Methods that are used or that could be used to encourage the use of environmentally friendly vehicles include-

- Allowing cars that use alternative energy sources the right to travel in HOV (High Occupancy Vehicle) lanes
- Building more charging stations
- Governments only buying vehicles that use alternative energy
- Increasing CAFE standards
- Increasing taxes on traditional fossil fuels n Providing subsidies to companies to develop vehicles capable of using alternative fuels
- Providing tax rebates for the purchase of alternative fuel vehicles

Distribution of Natural Energy Resources



This diagram shows that the distribution of the main fuels around the earth is uneven, with the middle east having a large share of oil and natural gas whilst Australia has a larger than normal share of uranium. Moreover the north America's and Canada have a larger share of the coal.

Fossil Fuels

Coal

Basic information-

- ➔ Formation-
  1) Coal is formed in an anaerobic environment, one in which there is no oxygen. Dead plant matter is buried under mud.
  2) Over time, it is buried deeply and becomes more compressed until it turns into peat.
  3) After millions of years of high pressure and temperature, the peat becomes lignite.

4) After more time under high pressure and temperature, the lignite becomes bituminous.
5) After even more time under the same conditions, the bituminous coal becomes anthracite.

- ➔ Extraction- Underground mining and surface mining. Approximately 60% of the world's coal production is from underground mining. 40% is from surface mining.
- ➔ Fossil fuel extraction: Air pollutants, such as methane and particulate matter, are entered into the atmosphere.
- ➔ Purification- Mined coal may go through a variety of processes to remove sulfur and contaminants. A process for purification of coal comprises forming an aqueous leaching solution containing nitric and hydrofluoric acid.
- ➔ Use- Coal may be burned to create heat energy. Significant uses include in electricity generation, steel production, and cement manufacturing.
- ➔ Found at coal deposit: Peat, peat, sedimentary rock, igneous rock
- ➔ Large oil and gas reserves, sedimentary rocks will be presented
- ➔ Pros-
  - ◆ Relatively inexpensive
  - ◆ Easily mined
- ➔ Cons-
  - ◆ Nonrenewable resource
  - ◆ Contains the most CO2 of all fossil fuels (largest contributor to global warming)
  - ◆ Destruction of the environment around coal mines
  - ◆ Coal ash (health hazard)
  - ◆ Burning releases Sulfur Dioxide and Nitrogen Dioxide which cause acid rain
  - ◆ Burning also releases mercury and heavy metals that pose major health risks

Oil

Basic Information-

- ➔ Formation-
  1) Microscopic aquatic plants and animals die and are buried on the seafloor, they are covered by layers of silt and sand
  2) Over millions of years, the remains are buried deeper and the immense heat and pressure turn them into kerogen, then into oil and gas
  3) Forms in the absence of oxygen
- ➔ Extraction- Crude oil is obtained by drilling through the Earth's surface into deposits and pumping it out
- ➔ Purification- Crude oil is heated and its different components are separated by their boiling points
- ➔ Fracking: Creating fractures in rocks by injecting fluids into cracks to force them to open. The larger fissures allow more gas and oil to flow out to be extracted.
- ➔ Environmental problem of fracking:
- ➔ Pros- Wastewater from fracking operations is injected into porous rock formations, which can induce seismic activity.
  - ◆ It is a liquid (easy to transport)

- It has a high energy density
- Crucial for a wide variety of industries
- Cleaner than coal

➔ Cons-

- Nonrenewable resource
- Releases CO2
- Oil spills are devastating to the environment

Natural Gas

Basic Information-

➔ Natural gas formation is similar to crude oil- from the remains of tiny aquatic plants and animals. When large amounts of these organisms die over many years, they sink to the ocean floor and then are covered with silt and mud, decaying anaerobically (without oxygen). Over time, mud accumulates, and the pressure and heat on the organic materials increases, leading to the creation of natural gas.

➔ Russia has the largest natural gas reserves followed by Iran and Qatar.

➔ Extraction- A hole is punctured into a natural gas reservoir, the gas flows from the hole under its own pressure into a pipeline that is connected to a pipeline system which transports the natural gas directly to the processing plant.

➔ Purification- Natural gas requires processing that includes the removal of water, water vapor, acid gas, and mercury. Natural gas also can be processed to obtain methane,ethane, propane, butane, and pentane.

➔ Use-

- Electricity generation
- Extraction of hydrogen gas
- Heating

➔ Pros-

- Cleaner than oil and coal
- Can be used in heating
- Lower carbon dioxide emissions than coal and oil

➔ Cons-

- Contains methane, a potent greenhouse gas
- Exploration to find natural gas destroys sediment
- Hydraulic Fracturing causes earthquakes and can contaminate the water table

Nuclear Power

Definitions-

➔ Core- contains up to 50,000 fuel rods, each filled with fuel pellets, each pellet containing the energy equivalent of 1 ton of coal

➔ Fuel- concentrated U-235

➔ Control Rods- move in and out of core to absorb neutrons and slow down the reaction

➔ Moderator- reduces speed of fast neutrons

➔ Coolant- removes heat and produces steam to generate electricity

➔ Extraction- Uranium ore is mined from the ground

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- ➔ Purification- The mined uranium ore is ground up then treated with chemical leaching to extract the uranium

Basic Information-

- ➔ Formation and reserves- Nuclear fission requires uranium, a nonrenewable resource, found almost everywhere with the largest reserves located in Australia, followed by Kazakhstan and Canada.
- ➔ Pros
  - ◆ Produces significantly less greenhouse gases than fossil fuels
  - ◆ Low water pollution
  - ◆ Contains a high concentration of energy
- ➔ Cons-
  - ◆ Creates thermal pollution
  - ◆ Creates nuclear waste, which is radioactive and takes a very long time to decay in addition to being hazardous to humans and the environment.
  - ◆ It is a nonrenewable resource
- ➔ Accidents-
  - ◆ Chernobyl (1986)- 572 million people among 40 different countries received some exposure to radioactivity (40 times more fallout than Hiroshima/Nagasaki). The disaster was a nuclear accident that occurred in a light water graphite moderated reactor in northern Ukraine and resulted in 23,000 radiation-induced cancers and 16,000 thyroid cancers because of iodine-131 exposure.
  - ◆ Fukushima-Daiichi (2011)- following the 2011 Tohoku, Japan, earthquake, measured at a Richter scale reading of 9.0, a series of equipment failures, explosions, and release of radioactive materials occurred at the nuclear power plant. A 50 foot tsunami that followed the earthquake flooded the emergency generators that circulated coolant, causing the reactor to overheat and explode.
  - ◆ Three Mile Island (1979)- two-unit nuclear plant on the Susquehanna River in Pennsylvania caused safety concerns and fears of radiation leakage. At Three Mile Island, the reactor lost cooling water and overheated, and some of the fuel rods melted and ruptured. This resulted in a release of radioactive gases into the atmosphere and critical damage to the reactor. People within a 1-mile radius of the reactor were evacuated, but no one was injured. The U.S. nuclear industry has been stopped in its tracks since the Three Mile Island accident, the worst nuclear accident, in U.S. history. No company has continued with plans to build a new nuclear plant since the accident.
- ➔ Proposed waste disposal- Storage in deep underground facilities, Ex. Yucca mountain nuclear waste repository.

Nuclear Fission Diagram

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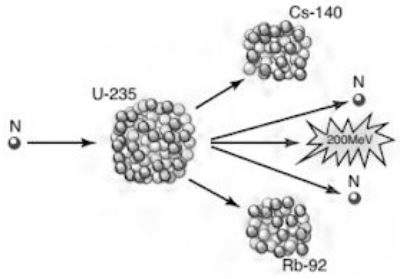

Energy from Biomass

Basic Information-

- ➔ Animal wastes and plant material used as fuels
  - ◆ Ex- wood, crops, manure, and food scraps that are garbage
- ➔ Indirect sources of energy from the sun, since the sun is the source of energy that plants need to survive
- ➔ Biomass energy is created by burning biomass (chemical can be transformed into heat energy)
- ➔ Developing world gets most energy from burning biomass (e.g. Wood or animal dung is collected, dried, and burned) and it is an unregulated practice
- ➔ Advantages and Disadvantages of Biomass energy
  - ◆ Always available. Using biomass for heat reduces need for fossil fuels and reduces landfills
  - ◆ Cons- carbon dioxide and particulate matter (pollution) can be released, and land used for growing what is used as biomass energy may not be a use for a primary agricultural crop for food
  - ◆ Much of biomass in the U.S. ends up as municipal solid waste (MSW)
    - MSW- waste from residences and businesses that include durable goods, non-durable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes
  - ◆ The MSW contains biomass in the form of food, grass clippings, and dead leaves
  - ◆ Combustion of municipal waste generates heat, produces particulate matter, plentiful indeterminate chemical substances, and ash
  - ◆ Keeps trash out of landfills
  - ◆ Not all trash is burned for heat, some is just burned to reduce landfill
  - ◆ Can be converted into other fuels such as methane, ethanol, or biodiesel
  - ◆ Rotting materials release methane (biogas, gas, or methane)

Solar Energy

Definitions-

- ➔ Active Collection- the use of devices, such as solar panels, to collect, focus, transport, or store solar energy
- ➔ Passive Collection- the use of building materials, building placement, and design to passively collect solar energy that can be used to keep a building warm or cool peak oil (see Hubbert peak)

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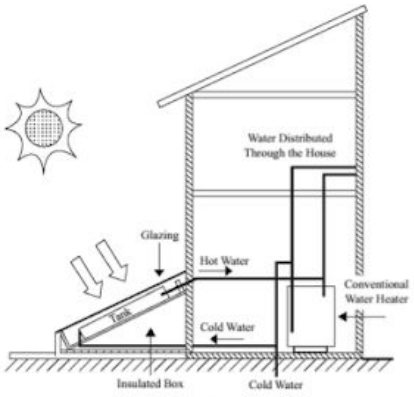
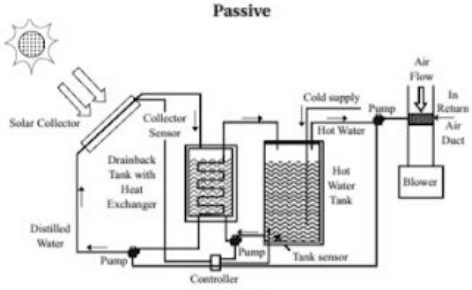


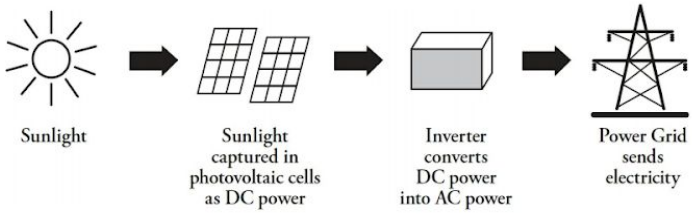
Passive



Active

➔ Photovoltaic Cell (PV cell)- a semiconductor device that converts the energy of sunlight into electric energy

Solar Power Process



Basic Information-

➔ Pros-
- The only form of pollution is the manufacturing and disposal of collectors. No air, water, nuclear, or thermal pollution is produced during the generation of electricity
- The supply of solar energy is limitless
- Little impact on wildlife/local habitats as collectors are usually mounted on rooftops.
- When connected to the grid, home solar photovoltaic systems can be smaller and thus less expensive, no back-up system is required, and excess energy can be sold back to the energy companies.

➔ Cons-
- Commercial facilities require large amounts of land, resulting in changes to native habitats.
- Current efficiency is 10% - 25% and is not expected to increase
- Inefficient where sunlight is limited or seasonal, thus requiring backup systems
- Systems deteriorate and must be replaced

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- Toxic materials are required in the manufacturing of photovoltaic systems, including battery backup systems, and safe disposal procedures and practices are required.

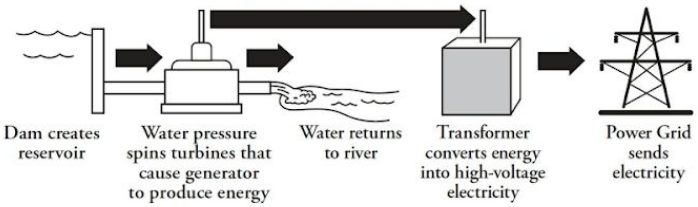
Hydroelectric Power

Definitions-

- Hydroelectric Power- Dams are built to trap water, which is released and channeled through turbines that generate electricity. Hydroelectric generation accounts for approximately 44% of renewable electricity generation and 6.5% of total electricity generation in the United States, according to the U.S. Department of Energy.

Basic Information-

- Pros-
  - Dams help control flooding.
  - Long life spans.
  - Low operating and maintenance costs, which result in affordable electricity. n Moderate to high net-useful energy.
  - No polluting waste products.
  - Provide water storage for municipal and agricultural use and serve as areas for water recreation (e.g., boating, fishing, and swimming).
- Cons-
  - Dams help control flooding
  - Long life spans
  - Low operating and maintenance costs, which result in affordable electricity
  - Moderate to high net-useful energy
  - No polluting waste products
  - Provide water storage for municipal and agricultural use and serve as areas for water recreation (e.g., boating, fishing, and swimming)



Geothermal Energy

Basic Information-

- Energy from the heat of the earth; heat is harnessed closed to the surface at wells that bring hot air or steam up to the surface. Within the earth, radioactive elements decay and produce heat
- Most geothermal resources occur along the ring of fire and in hot spots
  - Ring of fire- extensive subduction zones in the pacific ocean basin, resulting in a ring of active volcanoes
  - Hot spots- exceptionally hot regions in the mantle

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- ➔ Most of the geothermal energy produced in the U.S. is produced in western portion near the ring of fire (mostly in california). But only 0.5% of electricity produced in the U.S. comes from geothermal resources
- ➔ Geothermal electrical power plants have low emissions because they don't burn coal or other fossil fuels
    - ◆ Hydrogen sulfide, normally found in hydrothermal water, is removed from steam and hot water with scrubbers, where there is great potential in geothermal energy
- ➔ Reasons why geothermal energy is hard to replace all our needs-
    - ◆ We don't live near any geothermal sources or a grid that could harness geothermal energy
        - A grid- extensive network that carries electricity from a centralized power plant to distributors and then to users, such as homes/businesses
    - ◆ Many geothermal sources in the U.S., such as yellowstone, are protected and power plants cannot be built there
- ➔ Iceland takes advantage of its geography in mid-atlantic ridge to harness geothermal energy, so energy consumption comes from geothermal energy and hydropower
    - ◆ 90% of energy used to heat buildings comes from geothermal, 80% of electricity from hydropower, and 20% of electricity from geothermal
- ➔ Geothermal heat pump system can be used to heat homes, as the heat in the house is exchanged for heat in Earth through fluid-filled pipes similar to a radiator; takes heat from 3 to 6 meters below ground, where the temperature of the earth is relatively constant

Hydrogen Fuel Cell

Basic Information-

- ➔ Hydrogen fuel cells are considered to be the best, cleanest, and safest fuel source.
- ➔ Free hydrogen is not found on Earth, but it can be released through electrolysis
- ➔ Pros-
    - ◆ Does not destroy wildlife habitats and has minimal environmental impact.
    - ◆ Hydrogen can be stored in compounds to make it safe to handle. Hydrogen is explosive, but so are methane, propane, butane, and gasoline.
    - ◆ Hydrogen is easily transported through pipelines.
    - ◆ Ordinary water (either ocean water or freshwater) can be used to obtain hydrogen.
    - ◆ The energy to produce hydrogen could come from fusion reactors or other less-polluting sources.
    - ◆ The waste product is pure water.
- ➔ Cons-
    - ◆ As of now, it is difficult to store hydrogen gas for automobiles.
    - ◆ Changing from a current fossil fuel-based system to a hydrogen-based system would be very expensive.
    - ◆ Energy is required to produce the hydrogen from either water or methane.
    - ◆ Hydrogen gas is explosive.

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Wind Energy

Basic Information-

- ➔ Pros-
  - ◆ All electrical needs of the United States could be met by wind in North Dakota, South Dakota, and Texas.
  - ◆ Destruction and changes in the natural habitat are minimal.
  - ◆ Maintenance is low, and wind farms are automated.
  - ◆ Moderate to high net-energy yield.
  - ◆ No pollution. Wind farms are in remote areas so noise pollution is minimal to humans.
  - ◆ The land underneath wind turbines can be used for agriculture (multiple-use).
  - ◆ Wind farms can be built quickly and can also be built out on sea platforms.
- ➔ Cons-
  - ◆ Backup systems need to be in place when the wind is not blowing.
  - ◆ Causes visual and noise pollution.
  - ◆ May interfere with communication, such as microwaves, TVs, and cell phones.
  - ◆ May interfere with the flight patterns of birds.
  - ◆ Steady wind is required to make the investment in wind farms economical; few places are suitable.

Energy Conservation

Basic Information

- ➔ Ways to conserve energy-
  - ◆ Add extra insulation and seal air leaks. Improving attic insulation and sealing air leaks can save 10% or more on annual energy bills.
  - ◆ Change to a programmable HVAC (heating-ventilation air conditioning) thermostat. A programmable thermostat can save as much as 15% on heating and cooling costs.
  - ◆ Change to more efficient LED lighting—unlike fluorescent lights, LED lights do not contain mercury and can be disposed of with the regular household trash.
  - ◆ Minimize phantom loads—"phantom load" refers to the energy that an appliance or an electronic device consumes when it is not actually turned on. 75% of the electricity used to power home electronics is consumed while the products are off.
  - ◆ Use more energy-efficient appliances. Energy Star® appliances use between 10% - 50% less energy and water than their conventional counterparts.

Unit 7

Introduction to Air Pollution

Definitions-

- ➔ Natural Air pollution-
  - ◆ natural fires (smoke)
  - ◆ Volcanoes- ash, acid mists, hydrogen sulfide and toxic gases.
  - ◆ Sea spray and decaying organics reactive sulfur compounds
  - ◆ Trees and bushes- emit volatile organic compounds
  - ◆ pollen, spores, viruses, bacteria also are air pollution
  - ◆ the effects of natural contamination and human contamination can be the same
- ➔ Primary pollutants- released directly from the source into the air in a harmful form.
- ➔ Secondary pollutants- changed into hazardous form after released into air by chemical reactions.
- ➔ Fugitive emissions- do not go through a smoke stack (most commonly dust from soil erosion, strip mining, rock crushing, and building construction)

Basic Information-

- ➔ Long range transport- Many pollutants can be carried long distances by the wind currents.
  - ◆ Some of the most toxic and corrosive materials brought by long range transport are secondary pollutants.
- ➔ Areas considered the cleanest in the world still have pollutants in the air, even National Parks are affected by air pollution.
- ➔ Sulfur Compounds- about 114 million metric tons a year released from all sources.
  - ◆ Natural sources- sea spray, erosion of sulfate containing dust, fumes from volcanoes.
  - ◆ 90% of sulfur is released because of humans by burning fuel (coal and oil) containing sulfur. China and US release the most sulfur because of coal and oil burning
  - ◆ Sulfur dioxide is directly damaging to plants and animals. Once in the air it can turn into sulfur trioxide and react to water vapor contributing to acid rain.
  - ◆ Sulfate particles reduce visibility in the US 80%. Reduction of SOX can be achieved with scrubbers and by burning coal low in sulfur.
- ➔ Nitrogen compounds-
  - ◆ Nitrogen oxides- formed when nitrogen in fuel or combustion in air is heated to above 650 degrees C.
  - ◆ Total emissions are about 230 million tons a year. About 60% is because of humans. Natural sources- lightening, fires and bacteria in soil. Anthropogenic sources- formed from auto exhaust and electrical power generation. NOX irritates the lungs, makes smog, is a potent greenhouse gas and makes acid rain. Reduction of NOX can be achieved with a catalytic converter

- Carbon Oxides-
  - Carbon Dioxide is causing global warming. 3 billion tons accumulate in the atmosphere a year. The level of CO2 is increasing .5%/year. 90% of C02 in air is consumed by photochemical reactions that produce ozone.
  - Carbon Monoxide- colorless, highly toxic gas. Produced by incomplete combustion of fuel. 1 billion metric tons released into the atmosphere each year, half of that by humans (internal combustion engines). CO binds to hemoglobin reducing the oxygen in the blood. It also is a respiratory irritant and strong oxidant. Reduction of CO can be achieved with a catalytic converter, emission testing/laws, oxygenated fuel and mass transit!
- Metals and Halogens-
  - Lead emissions are about 2 millions tons a year, 2/3 of all metallic air pollution. Most of the lead is from leaded gasoline.
  - About 20% of inner city children suffer from some kind of mental retardation because of lead poisoning.
  - Radon is a radioactive gas found naturally in the bedrock that contains radioactively decaying Uranium. It can cause lung cancer.
  - Mercury sources- coal burning power plants and waste incinerators.
- Benzene, toluene, formaldehyde, vinyl chloride and other chemicals are released into the air by human activities through mainly unburned or partially burned hydrocarbons from transportation.
  - They are also caused by power plants, chemical plants, oil refineries, oil based paint, cheap 70's carpets and furniture and dry cleaning solvents.
  - They can cause asthma and respiratory disease also some are carcinogens and neurotoxin

Effects of air pollution-

- 50,000 Americans die prematurely because of illnesses related to air pollution. (5-10 year decrease in life span)
- Bronchitis- persistent inflammation of bronchi and bronchioles that causes mucus build up, painful cough, and involuntary muscle spasms that constrict airways.
  - Bronchitis can lead to emphysema- an irreversible obstructive lung disease in which airways become permanently constricted and alveoli are damaged or even destroyed.
  - Smoking is the leading cause of both these diseases.
- Plants-
  - Pollutants can be damaging to the sensitive cell membranes of plants. Within a few days of exposure, mottling can occur and the plant eventually dies.
  - Damage because of pollutants can be hard to distinguish from insect damage.
  - Environmental factors can have synergistic effects, injury caused by exposure to each factor individually is less than at the same together.
- Aquatic effects- acid in water affects fish. To protect their gills, fish produce a mucus lining over their gills and eventually suffocate themselves. Acid shock is especially bad in the spring run off from melting snow.

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- Usually the small fry and older fish die first.

➔ Forest damage- seedling production, tree density, and viability of spruce-fir trees at high elevations have declined about 50% because of air pollution. Plants waxing coating is destroyed, they have an increased vulnerability to insects, and they take up heavy metals in the soil that were previously inert at a higher pH.

➔ Visibility has been reduced greatly

Photochemical Smog

Definitions-

➔ Gray Smog (industrial smog)- smog resulting from emissions from industry and other sources of gases produced by the burning of fossil fuels, especially coal

➔ Photochemical oxidants- from secondary atmospheric reactions driven by the sun. Creates smog and ozone which damages buildings, vegetation, eyes and lungs.

Photochemical Smog

$2NO + O_2 \rightarrow 2NO_2$ (causes brownish haze)

$NO_2 + UV \rightarrow$ light $NO + O$ followed by:

$O + O_2 \rightarrow O_3$ (O_3 is ozone and is very hazardous to plants, animals, and materials in the troposphere)

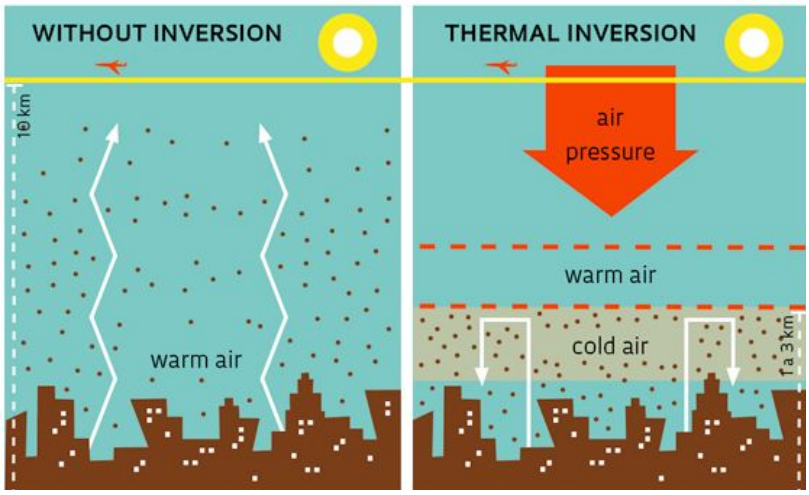
hydrocarbons $+ O_2 + NO_2 \rightarrow$ PANs (peroxyacyl nitrates cause burning eyes and damage vegetation)

Thermal Inversion

Basic Information-

➔ Thermal inversion occurs when a layer of warm air settles over a layer of cooler air that lies near the ground. The warm air holds down the cool air and prevents pollutants from rising and scattering.

➔ Can occur when a cold air mass slides under an adjacent warmer air mass -or- Cool air subsides down a mountain slope to displace warmer air in the valley below.



Atmospheric CO2 and Particulates

Particulate Matter-

Definitions-

- ➔ Aerosol- any system of solid particles or liquid droplets suspended in a gaseous medium.
- ➔ Particulate material- dust, ash, soot, pollen, leaf mildew.
  - ◆ Can be natural- dust, volcanic ash can be suspended in the air.
  - ◆ Anthropogenic sources are from burning fossil fuels, car exhaust, asbestos, and cigarettes.
  - ◆ Particulates irritate the lungs, diffuse into the blood and react with tissues. Sometimes it causes cancer.
  - ◆ These are most apparent pollution because they reduce visibility.
- ➔ Volatile Organic Compounds (VOC's)- organic chemicals that exist as gases in air. 2/3 of the air toxins regulated by the Clean Air Act are VOCs.

Indoor Air Pollutants

Indoor Pollutant	Description	Health Effect	Reduction Techniques
Asbestos	A mineral used for insulation in homes and businesses	- Lung cancer - Mesothelioma- a form of cancer on the mesothelium almost always caused by exposure to asbestos	Stabilization of existing asbestos is possible and preferable to removal because removing asbestos releases particulate matter
Radon	- colorless, odorless, radioactive gas - breaks down in uranium under homes and becomes trapped in the home	- Lung cancer	Four major types of suction removal exist- sub slab suction, drain tile suction, sump hole suction, and block wall suction
Environmental tobacco smoke	Includes smoke from cigarettes, tobacco, or pipes and the exhaled smoke from the smoker (often called secondhand smoke)	- eye, nose, and throat irritation - aggravation of asthma symptoms in children - reduced lung function - lung cancer	- smoke outdoors and away from children and fire hazards - quit smoking - install improved ventilation systems that remove inside air and allow outside air in

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Biological contaminants	- anything associated with life - e.g. bacteria, mold, mildew, pollen, dust mites, rats, mice, cat + dog saliva, dander cockroaches + feces associated with these organisms	- allergic reactions - asthma - sneezing - watery eyes - coughing - shortness of breath - dizziness - lethargy - fever - digestive problems	- keep a relative humidity of 30% to 50% by using an exhaust fan over the stove or bathroom to vent to the outdoors - vent attic and basement - clean home regularly
Household chemicals	Includes cleaning, disinfecting, degreasing, and hobby products	- eye irritation - respiratory tract irritation - memory impairment	- use natural alternatives - buy limited amounts of household chemicals - use products according to their label - dispose of the chemicals safely
Formaldehyde	A colorless, pungent gas that is used in building materials and dry cleaning (for permanent press) and is a byproduct of combustion	- watery eyes - burning sensations in the eyes and throat - nausea - difficulty breathing - asthma attacks - potentially cancer causing	Research pressed wood content in products before purchasing products containing formaldehyde, including furniture and cabinets
Pesticides	Includes insecticides, termiticides, rodenticides, fungicides, and disinfectants sold as sprays, liquids, sticks, powders crystals, balls, and foggers	- Highly dependent on specific chemical composition - eye irritation - respiratory tract irritation - memory impairment	- use natural alternatives - buy limited amounts - increase ventilation when using pesticides - use pesticides in the manner described on the container since otherwise it is illegal

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Carbon Monoxide	Odorless,	- headaches - dizziness - weakness - nausea - confusion and disorientation - unconsciousness - death	Keep heating systems in good repair. Install exhaust fans
Nitrogen Dioxide	Odorless,	- irritation to mucous membranes in eye, nose, and throat - shortness of breath - respiratory infections - lung disease	Keep heating systems in good repair. Install exhaust fans

Definitions-

- ➔ Sick Building- a building in which a number of people have adverse health effects related to the time spent in the building
  - ◆ Sick building syndrome- a condition in which the occupants or residents of a building become acutely sick because of the building, but no specific illness or cause can be found
  - ◆ Building-related illness- a condition in which the occupants or residents of a building become acutely sick with a diagnosable illness attributed to indoor air pollutants in the building (symptoms disappear when people go outside)

Basic Information-

- ➔ Smoking is the most severe air pollutant. 400,000 people die each year from Emphysema, heart attacks, lung cancer, strokes, and other diseases caused by smoking. (20% of all mortality in US)
  - ◆ These deaths cost $100 billion a year
  - ◆ Eliminating smoking would save more lives than any other pollution control.
- ➔ Concentration of benzene, carbon tetrachloride, formaldehyde, and strene has been found to be 70 times higher in indoor air than outdoor air.
- ➔ Less developed countries burn for cooking and heat. Because of poor ventilation, there is a large amount of indoor air pollution especially particulates. women and children are most affected.
- ➔ Levels of carbon monoxide, particulates, aldehydes and toxic chemicals can be 100 times greater than the safe outdoor concentrations in US
- ➔ Prevention of Indoor Air Pollutants-
  - ◆ Cover ceiling tiles and lining of AC to prevent release of mineral fibers
  - ◆ Ban smoking indoors

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- Set strict formaldehyde emissions standards
- Prevent radon infiltration
- Use office machines in well-ventilated areas
- Use less polluting substitutes for cleaning agents
- Cleanup- Use adjustable fresh air vents
- More outdoor air
- Solar Ovens
- Rooftop greenhouses
- Use exhaust hoods
- Install efficient chimneys

Reduction of Air Pollutants

Definitions-

- ➔ Electrostatic Precipitator- After particulates in a smokestack are given negative charge, they're attracted to a positively charged precipitator wall and fall off the wall into a collector. Simple to maintain and remove up to 99% of particulate matter
  - Dirty air enters precipitator unit,Particles in combustion exhaust stream pass by negatively charged plates, which gives them a negative charge, The negatively charged particles are attracted to positively charged collection plates, Cleaner air moves out of the unit, The positive collection plates are periodically discharged, which causes the particles to fall off so that they can be removed from the system.
- ➔ Low-Sulfur Coal- Reduces SO2 emissions, located in the West as most coal is burned in the East
- ➔ Coal Gasification- Coal being converted to gaseous and liquid fuels that burn cleaner than coal. Expensive and burning them adds more CO2 than burning coal
- ➔ Fluidized-Bed Combustion- Burns coal more efficiently by blowing streams of hot air into a boiler to burn a picture of powdered coal and crushed limestone. Expensive.
- ➔ Scrubbers- technologies that chemically convert or physically remove pollutants before they leave the smokestacks.
  - Dirty fuel gas enters and rises through mist, which captures pollutants and brings them down, excess mist condenses on screen, purified gas exits, dirty water is drained/cleansed, water is reused, sludge is disposed of as hazardous waste.
  - Wet Scrubber- Fine mists of water vapor trap particulates, SO2 passing through a watery mix of lime(stone) is converted to a calcium sulfite that can be disposed of in a landfill. Removes 98% of SO2 and 98% of particulate matter in smokestack emissions. Expensive and hard to maintain
- ➔ Baghouse filter
  - Dirty air enters housing, Combustion exhaust stream moves through and dust particles are trapped in a series of filter bags, Cleaner, filtered air moves out of the unit, A shaker mechanism is activated periodically to dislodge trapped particles, which can then be collected from beneath the unit. Used to control particulate matter emissions.

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Acid Rain

Definitions-

- ➔ Acid Rain- normal pH of rain is about 5.6. Most acid rain in NPZ is due to coal- burning plants upwind. The pH scale is logarithmic.

Basic Information

- ➔ Acid rain can be reduced by limiting fossil fuel use and alternative energy. Lime is added to acidic lakes but that is a temporary solution. Just increasing the size of smoke stacks is a bad idea!

Effects of Acid Deposition

- ➔ Increased solubility of toxic metals
- ➔ Increased leaching of soil nutrients
- ➔ Reduced buffering capacity of the soil
- ➔ An increase in fish skills, due to the increased acidity of the water and the increase in the levels of the toxins released into the water
- ➔ Changes in vegetation because of changes in soil pH and in the soil ecosystems
- ➔ Changes in animal due to changes in the amount and types of vegetation available
- ➔ Acid shock, which results from the rapid melting of the snow pack that contains dry acidic particles and which results in acid concentrations in lakes and streams
- ➔ Effects of Acid Deposition
  - ◆ Leaching of some minerals from soil, altering soil chemistry
  - ◆ Creating a buildup of sulfur and nitrogen ions in soil
  - ◆ Increasing the aluminum concentration in soil to levels that are toxic for plants
  - ◆ Leaching calcium ions from the needles of conifers
  - ◆ Elevating the aluminum concentration in lakes to levels that are toxic to fish
  - ◆ Lowering the pH of streams, rivers, ponds, and lakes, which may lead to fish kills
  - ◆ Causing human respiratory irritation
  - ◆ Damaging all types of rocks, including statues, monuments, and buildings
  - ◆ Increased solubility of toxic metals
  - ◆ Increased leaching of soil nutrients
  - ◆ Reduced buffering capacity of the soil
  - ◆ Changes in animal due to changes in the amount and types of vegetation available
  - ◆ Acid shock, which results from the rapid melting of the snow pack that contains dry acidic particles and which results in acid concentrations in lakes and streams

Noise Pollution

Definitions-

- ➔ Noise pollution is unwanted human-created (anthropogenic) sound that disrupts the environment

Basic information

- ➔ Dominant form is from transportation sources
- ➔ Noise regulation by governmental agencies effectively began in the United States with the 1972 Federal Noise Control Act

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Effects of Noise Pollution

- ➔ Sensory hearing loss is caused by damage to the inner ear and is the most common form associated with noise.
- ➔ Excessive noise can cause cardiovascular problems
  - ◆ Accelerated heartbeat
  - ◆ High blood pressure
  - ◆ Gastrointestinal problems
  - ◆ Decrease in alertness
  - ◆ Decrease in ability to memorize
  - ◆ Nervousness
  - ◆ Anxiety

Noise Control Measures

- ➔ Techniques to reduce roadway noise
  - ◆ Create noise barriers
  - ◆ Place limitations on vehicle speeds
  - ◆ Introduce newer roadway surface technologies
  - ◆ Limit times for heavy-duty vehicles
  - ◆ Create computer-controlled traffic flow devices that reduce braking and acceleration, and implement changes in tire designs
- ➔ Techniques to reduce aircraft noise
  - ◆ Develop quieter jet engines
  - ◆ Reschedule takeoff and landing times
- ➔ Techniques to reduce industrial noise
  - ◆ Create new technologies in industrial equipment
  - ◆ Install noise barriers in the workplace

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Earning Full Credit on Free Response Questions

The most important thing to know- nearly all your answers should be in complete answer form. Exception- questions asking you to "Calculate."

Key Words

- "Identify" means name it. No further justification or clarification needed.
- "Define" means you should provide a brief, dictionary-like definition.
- "Calculate" means find a final answer. You must show work, and you must use units. Use dimensional analysis
  - Example- (5 kg fertilizer) * (0.34 N/1 kg fertilizer) * (1 kg compost / 0.025 N) = 68 kg compost
- "Describe" means you must provide a brief explanation of your characterization.
- "Propose" merely means provide a possible solution to the given situation. This should be one or two sentences, maximum. This is usually followed by a "Justify" component.
- "Justify" means you must provide a detailed explanation of why your answer is correct. You must follow through entirely, going from your given answer straight into a detailed explanation of why it's correct. For example, "The planet gets warm because Carbon Dioxide is a greenhouse gas" is insufficient. "Higher Carbon Dioxide levels in the atmosphere caused by CO2 emissions trap more heat reflected from the surface in the atmosphere, therefore global temperature rises on average" is a much better answer that does earn the points.
- "Compare" implies Contrast. You must identify both similarities and differences (one of each should suffice).

What to Do

- Don't overthink it! Provide the simple answer that gets to the point.
- Don't waste time! You've only got 45 minutes, which is just barely enough to finish if you're wasting no time thinking.
- If you have extra time after finishing, spend every minute of that extra time elaborating for "Describe" or "Justify" parts. When in doubt, write more! You cannot lose points for excess information
  - Exception- If you contradict your own information, you will lose points

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Required Legislation

Clean Air Act (1970) (US only)

- ➔ Seven major pollutants for which maximum ambient air (air around us) levels are mandated-
  - ◆ sulfur dioxide, carbon monoxide, particulates, hydrocarbons, nitrogen oxides, photochemical oxidants and lead

Clean Water Act (1972) (US only)

- ➔ The Clean Water Act along with the endangered Species Act and the Clean Air Act are the most significant and effective pieces of environmental legislation ever passed by the US Congress.
- ➔ The Clean Water Act established a National Pollution Discharge Elimination System (NPDES) which requires an easily revoked permit for any industry, municipality or other entity dumping wastes in surface waters
- ➔ Goal- to make all surface waters "fishable and swimmable." So they used a best practicable control technology (BPT) which sets national goals of best available, economically achievable technology (BAT) for toxic substances and zero discharge for 126 priority toxic pollutants
- ➔ Industries, state and local governments, farmers, land developers, and others who have been forced to change aren't happy with the Clean Water Act
- ➔ A flaw is when state or local governments spend money, it is not repaid by Congress
- ➔ Small cities that couldn't afford or chose not to participate in earlier programs in which the federal government paid up to 90% of water quality programs are hard hit by requirements that they upgrade municipal sewer and water systems
- ➔ Since this was passed, the US has spent more than $180 billion in public funds and perhaps ten times as much in private investments on water pollution control
- ➔ Goal- to make all US surface waters "fishable and swimmable" has not been fully met, but in 1999 the EPA reported that 91.4% of all monitored river miles and 87.5% of all assessed lake acres are suitable for their designated uses
- ➔ States are required to identify waters missing water quality goals and to develop total maximum daily loads (TMDL) for each pollutant and each water body

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973) (International, 183 countries)

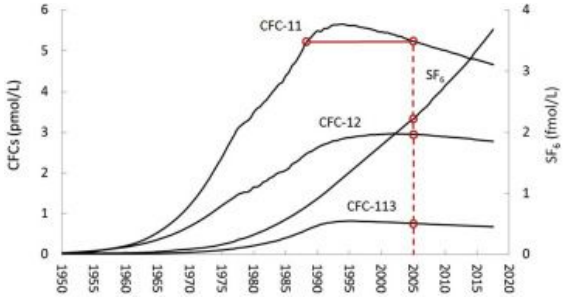
- ➔ Goal- to ensure that international trade in specimens of wild animals and plants does not threaten their survival
- ➔ What they do- subject international trade in specimens of selected species to certain controls. All import, export, re-export and introduction from the sea of species covered by the Convention has to be authorized through a licensing system. Species covered by CITES are listed in three Appendices, according to the degree of protection they need

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (1980) (US only)

- ➔ Goal- Address uncontrolled/abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment
- ➔ What they do- created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites.

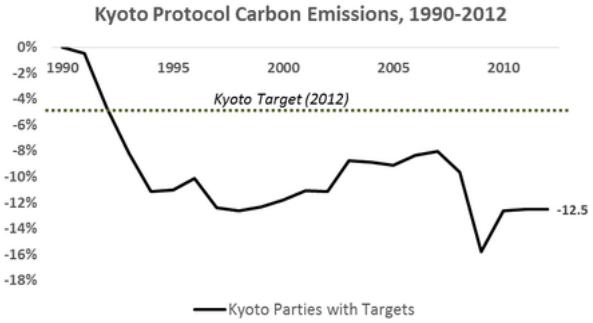
Montreal Protocol (1987) (International, 197 countries/universal)

- ➔ Goal- Fight ozone depleting substances primarily through the control of CFCs in the production of aerosols and refrigerants. CFCs are a significant cause of stratospheric ozone depletion. UV rays separate Chlorine. Cl + O3 -> ClO + O2. ClO + O -> Cl +O2. This process cycles. CFCs can stay in the atmosphere for a long time because they are so stable. This is dangerous because ozone filters out UV light and without it organisms would be exposed to life threatening radiation. Skin cancers increase.
- ➔ What they do- Reduce and phase out the production of ozone depleting chemicals (primarily CFCs). Arguably the most effective and successful piece of environmental legislation because it met its goal of eliminating the production of CFCs



Kyoto Protocol (1997) (International, 191 countries) (US dropped in 2001)

- ➔ Goal- Control/reduce annual emissions of main greenhouse gases primarily among industrialized nations.
- ➔ What they do- This legislation split countries into two groups- developed and developing. Heavier burden was placed on developed nations to reduce annual GHG emissions. Developing nations were asked to comply voluntarily.



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Endangered Species Act (1973)

- ➔ Goal- Program for the protection of threatened plants and animals and their habitats
- ➔ The act prohibited the commerce of those species considered to be endangered or threatened

Safe Drinking Water Act (SWDA) (1974)

- ➔ intended to ensure safe drinking water for the public

Resource Conservation and Recovery Act (RCRA) (1976)

- ➔ Principal federal law in the United States governing the disposal of solid waste and hazardous waste

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Names to Know

- ➔ Rachel Carson- Wrote Silent Spring, which spurred a reversal in national pesticide policy, led to a nationwide ban on DDT and other pesticides, and inspired a grassroots envi-ronmental movement that led to the creation of the Environmental Protection Agency.
- ➔ Aldo Leopold- Best known for his book A Sand County Almanac. Influential in the development of modern environmental ethics and in wilderness conservation, emphasiz-ing biodiversity and ecology. Developed the science of wildlife management.
- ➔ John Muir- Helped to save the Yosemite Valley, Sequoia National Park, and other wilderness areas. The Sierra Club, which he founded, is now one of the most important environmental conservation organizations in the United States.
- ➔ Theodore Roosevelt- As the twenty-sixth president of the United States, he used his position to pave the way for environmentalists of the future. He is known for setting aside land for national forests, establishing wildlife refuges, developing the farmlands of the American West, and advocating protection of natural resources. Roosevelt set aside 150 million acres for forest reserves, created 50 wildlife refuges, turned much of the arid land of the southwestern United States into farmland, and initiated sixteen major reclamation projects in the southwest.
- ➔ Henry David Thoreau- Author of Walden, who viewed unity and community as impor-tant aspects of nature, and wrote that all disturbances in these links are caused by human beings and that modern materialism would lead to the destruction of the envi-ronment needed for humans and other living things to survive. Wrote about the need for national forest preserves and about the destruction caused by dams. His work raised the environmental consciousness of many generations of readers.
- ➔ Garret Hardin- An article was written by Garrett Hardin, where he explains the tragedy of the commons as an economic problem that results in overconsumption and depletion of a common resource where public land is used for private benefit.

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