AP Environmental Science

Comprehensive Study Guide

NOT A SUBSTITUTE FOR CLASS NOTES

(Some Info May Be Repetitive)

APES Exam Topic Outline

I. Earth Systems and Resources (10-15%)

A. Earth Science Concepts (Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude)

B. The Atmosphere (Composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere-ocean interactions; ENSO)

C. Global Water Resources and Use (Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)

D. Soil and Soil Dynamics (Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

II. The Living World (10-15%)

A. Ecosystem Structure (Biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes)

B. Energy Flow (Photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids)

C. Ecosystem Diversity (Biodiversity; natural selection; evolution; ecosystem services)

D. Natural Ecosystem Change (Climate shifts; species movement; ecological succession)

E. Natural Biogeochemical Cycles (Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)

III. Population (10-15%)

A. Population Biology Concepts (Population ecology; carrying capacity; reproductive strategies; survivorship)

B. Human Population

1. Human population dynamics (Historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age-structure diagrams)

2. Population size (Strategies for sustainability; case studies; national policies)

3. Impacts of population growth (Hunger; disease; economic effects; resource use; habitat destruction)

IV. Land and Water Use (10-15%)

A. Agriculture

1. Feeding a growing population (Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)

2. Controlling pests (Types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)

B. Forestry (Tree plantations; old growth forests; forest fires; forest management; national forests)

C. Rangelands (Overgrazing; deforestation; desertification; rangeland management; federal rangelands)

D. Other Land Use

1. Urban land development (Planned development; suburban sprawl; urbanization)

2. Transportation infrastructure (Federal highway system; canals and channels; roadless areas; ecosystem impacts)

3. Public and federal lands (Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)

4. Land conservation options (Preservation; remediation; mitigation; restoration)

5. Sustainable land-use strategies
E. Mining (Mineral formation; extraction; global reserves; relevant laws and treaties)
F. Fishing (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)
G. Global Economics (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. Energy Resources and Consumption (10-15%)
A. Energy Concepts (Energy forms; power; units; conversions; Laws of Thermodynamics)
B. Energy Consumption
1. History (Industrial Revolution; exponential growth; energy crisis)
2. Present global energy use
3. Future energy needs
C. Fossil Fuel Resources and Use
(Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/disadvantages of sources)
D. Nuclear Energy (Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)
E. Hydroelectric Power (Dams; flood control; salmon; silting; other impacts)
F. Energy Conservation (Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)
G. Renewable Energy (Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. Pollution (25-30%)
A. Pollution Types
1. Air pollution (Sources-primary and secondary; major air pollutants; measurement units; smog; acid deposition-causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
2. Noise pollution (Sources; effects; control measures)
3. Water pollution (Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
4. Solid waste (Types; disposal; reduction)
B. Impacts on the Environment and Human Health
1. Hazards to human health (Environmental risk analysis; acute and chronic effects; dose response relationships; air pollutants; smoking and other risks)
2. Hazardous chemicals in the environment (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)
C. Economic Impacts (Cost-benefit analysis; externalities; marginal costs; sustainability)

VII. Global Change (10-15%)
A. Stratospheric Ozone (Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)
B. Global Warming (Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)
C. Loss of Biodiversity

1. Habitat loss; overuse; pollution; introduced species; endangered and extinct species
2. Maintenance through conservation
3. Relevant laws and treaties

STANDARD GEOLOGIC TIME SCALE

EON	ERA	PERIOD	EPOCH	AGE (M.y.)	IMPORTANT EVENTS
PHANEROZOIC	CENOZOIC	Quaternary	Holocene	0.01 - present	Human civilization develops.
			Pleistocene	1.6 - 0.01	Continental glaciation in the northern hemisphere
		Tertiary	Pliocene	5.3 - 1.6	Humans appear for the first time.
			Miocene	23.7 - 5.3	Antarctic Ice Sheet develops.
			Oligocene	36.6 - 23.7	Himalaya Mountains begin to form.
			Eocene	57.8 - 36.6	The Alps form in Europe.
			Paleocene	66.4 - 57.8	Mammals become dominant land animals
	MESOZOIC	Cretaceous		144 - 66.4	Dinosaurs become extinct; Rocky Mountains begin forming.
		Jurassic		208 - 144	Atlantic Ocean begins to form between N. America & Africa.
		Triassic		245 - 208	1st dinosaurs; North America begins to separate from Africa.
	PALEOZOIC	Permian		286 - 245	All land masses joined to form a single supercontinent called Pangea.
		Pennsylvanian		320 - 286	Appalachian Mountains & Ouachita Mountains formed by continental collision with Africa.
		Mississippian		360 - 320	Extensive deposits of coal developed worldwide.
		Devonian		408-360	1st fossils of amphibians (animals which could live on land).
		Silurian		438 - 408	1st fossils of land plants.
		Ordovician		505 - 438	1st fossil fish; evidence of continental glaciation in Africa.
		Cambrian		545 - 505	Abundant fossils of marine organisms.
PROTEROZOIC	PRECAMBRIAN			2500 -	1st evidence of oxygen in

		545	atmosphere = 2.0 billion years ago.
ARCHEAN		4500 - 2500	Earliest evidence of life = 3.8 billion years ago. Earth forms = 4.5 billion years ago.

APES NOTES (Alpabetical by Topic) (Ctrl + F)

Agriculture and Food

NUTRITION & FOOD SUPPLIES
~ although enough food is being produced to feed everyone, it is unevenly distributed
~undernourished: consuming less than enough calories needed for an active, healthy life
~over nutrition: too many calories, a problem in wealthy countries, greatest risk in the US
affects 20% of the world, increases blood pressure, heart attacks, strokes, diabetes
~sub-Saharan Africa: food is becoming scarce (war, poor governments, drought, etc)
~800 million undernourished ~obese:30 lbs over (morbidly- 100 lbs over (5 million Americans)
~60% of Americans are obese (we consume 3500 calories/day)

Chronic Hunger and Food Security
~Undernourishment as a child can lead to stunted growth, mental development, and other disorders. Infectious diseases like diarrhea that are usually to no concern can become lethal.
~Food Security: ability to obtain sufficient food on a day-today basis, threatened by poverty, women are usually more effected than men
Other Essential Nutrients
~It is possible to have plenty of calories but still suffer from malnutrition (having a nutritional imbalance, or by lacking a dietary component)
~Kwashiorkor: a protein deficiency in children, mainly in West Africa, victims have reddish hair, puffy, discolored skin, and a bloated stomach
~Marasmus: caused by a diet low in calories and protein, the child is thin and shriveled
~Both diseases can cause anemia, lower one's resistance to infections, or cause stunted growth and mental retardation
~Vitamin A deficiencies can cause blindness, while lack of folic acid causes neurological problems in babies, such as small heads or no brains
~Anemia: most common dietary deficiency in the world (not enough iron), is a lack of hemoglobin in the blood
~A deficiency of iodine can cause goiter (a swollen thyroid gland) or cause brain damage
Eating a Balanced Diet
~Eating a balanced diet full of grains, fruits, and vegetables, with moderate meat, dairy, and fats will give you all the nutrients you need
Famines
~Large-scale food shortages, massive starvation, social disruption, economic chaos
~Even if condition improve, it will be hard to recover (they have ruined their resources in order to survive)
~Causes: politics, government failure, adverse weather, insects, war, natural disasters, poverty, political boundaries, democracies seldom have famines

MAJOR FOOD SOURCES
~Our diet: a dozen grains, 3 root crops, 20 fruits/veggies, 6 mammals, two fowl,
Major Crops
~Mainly wheat, rice, and maize, wheat and rice make up 60% of calories consumed
~Fruits and veggies: have lots of vitamins, minerals, fiber, and complex carbs
Milk, Meat, & Seafood

~N. America, Japan, 7 Europe (20% world population) consume 80% of animal products
~Average American eats 260 lbs/meat/year (Bangladesh-6.5 lbs)
~90% of grain grown is used to feed animals (for slaughter)
~over harvesting, habitat destruction are endangering fisheries: 13/17 gone, with new technology, we can exhaust entire populations, 70% of fish are declining
1/4 animals are unwanted "by-catch", includes birds and mammals (by lines, drift nets)
~trawl nets can destroy habitats, spawning areas, impossible to rebuild populations

SOIL: A RENEWABLE RESOURCE
~mixture of weathered minerals from rocks, decaying organic material, and living organisms
~with good husbandry, soil can be replenished and renewed
~1/2 of cropland is being destroyed quicker than replaced
Soil Composition
~1/2 mineral (from bedrock/sediments), plant & animal residue, air, water, organisms
~sandy soil: light soil, good drainage, dries quickly vs. clay (tiny particles), heavy, impermeable, holds water longer
~Humus: a sticky, brown residue from decaying plants & animals, gives structure to soil and helps drainage
Soil Organisms
~Topsoil contains millions of organisms, most microscopic (bacteria, algae), worms insects, animals, plant roots draw up minerals and release acids that decompose particles
~leaf litter creates new organic material
Soil Profiles
~soil horizons: layers of soil, reveal the history, classified by color, texture, composition,
~Horizons make up soil profiles
~Topsoil: A horizon, covered by O horizon (newly deposited material), minerals mixed w/ organic matter, where most plants spread their roots to absorb nutrients
~subsoil: B horizon, dense with clay and nutrients (soluble)
~C horizon: parent material, weathered rock, weathering allows soil to extend downward
Soil Types
~classified into soil orders by their structure and composition

WAYS WE USE AND ABUSE SOIL
~11% of Earth is used for agriculture
Land Resources
~the average land area available to each individual is decreasing
~ways to improve usage of land: variety, better fertilizers, irrigation, pesticides, labor, water- 95% of agricultural growth
~forests, plains being converted to farmland, will eventually have to increase output/acre
~some land shouldn't be farmed (more valuable in natural state)- nutrients in the plants, not soil, would result in loss of biodiversity

Land Degradation
~land destroyed by: 1) humans (buildings, etc) 2) desertification 3) erosion
~in some places, the degradation is so bad that no crops can be supported
~effects: less species, crops, biomass, diversity, vegetation, soil eroded, water runs off
~Causes: 1) water (55%) 2) wind (29%) 3) chemical (12%) 4) physical (4%)

Erosion: The Nature of the Problem
~Importance: redistributed sediments, part of soil formation and loss, sculpts landscapes, creates silt for farming
~However, erosion can destroy topsoil, (exposing the subsoil) reduce land fertility, load rivers with sediments, smother wetlands, clog water intakes, coat reservoirs with silt
~Erosion equals a 1% loss in cropland/year

Other Agricultural Resources:
water- 73% of all freshwater used for irrigation (15% crops are irrigated world wide)
-80% water irrigated never reach destination (because of evaporation and seepage)

water logging- water-saturated soil causing plants roots to die from lack of oxygen
salinization- when mineral salts accumulate in the soil (particularly occurs when soil in dry climates are irrigated with saline water)
-when water evaporates, leaves behind lethal salt accumulation for plants
-irrigation problems: 150 million acres worldwide crop land damaged by water logging and salinization.
Water Conservation: greatly reduced problems from excess water use
-makes water available for other uses
Fertilizer- inorganic nutrients
-plants need: nitrogen, potassium, phosphorus, calcium, magnesium and sulfur
-calcium and magnesium limited in areas w/ high rainfall: must be supplied in form of lime (fertilizer)
-lack of nitrogen, potassium and phosphorus also limits plants growth and these elements are added in fertilizers to enable plant growth
-crop production up since 1950: Nitrate levels in ground water have increased from fertilizers and young children are sensitive to this and it can be fatal
Alternatives for fertilizer:
-manure and green manure
-nitrogen-fixing bacteria in root nodules of legumes
-interplanting or rotating beans (or other leguminous crop) with other crops (corn, wheat)
Energy: Direct- Fossil fuels supply almost all energy for farming
Indirect-energy synthetic fertilizers, pesticides (agricultural chemicals)- increase in this energy
-food system in U.S.: 16% of total energy use
-more energy put to produce, process and transport than actual farming
-present energy usages unsustainable (need alternatives for future because going to run out)!
New Crops and Genetic Engineering:
-3,000 species of plants have been used for food
-most food only comes from 16 widely grown crops!
-new varieties of crops valuable for humans and good for areas that are limited by climate, soil, pests, etc (harsh environments)
-ex: winged beans, perennial plants (hot climates), tricale: drought resistant; grows in light, sandy, infertile soil
Green Revolution:
-50 years ago: agricultural research for tropical wheat and rice varieties (for developing countries)
-"miracle" variety- dwarf (Warmon Varlaug) in Mexico
-International Rice Institute in Philippines est. dwarf rice- dramatic increases with these varieties
-green rev. Breeds: "high responders": yield more than other varieties in optimal condition and produce less when under optimal conditions
Genetic Engineering-
-genetically modified organisms (GMO's) or Frankinsteinian foods!
-have DNA containing genes borrowed from unrelated species.
Ex: "golden rice": gene from daffodil- makes rice produce beta carotene (artificial nutrient in many poor countries).
-genetic engineering also creating new animals
-developed in 1980s
-2000 U.S. Dept of Agriculture reported more than 70 million acres of GM corn, soybeans and other crops planted.
-more than half of all soybeans and cotton and more than 1/4 of corn in the U.S. were GM varieties in the year of 2000
-most of these crops are in the U.S. - Canada and Argentina hold most of these crops outside the U.S.
Positives and Negatives: crops would require less chemicals, be nutrient rich and could withstand harsh conditions
-however, most are resistant to herbicides and can tolerate more chemical use
-some fear that traits will transfer to wild plants creating super, out-of-control weeds
-expensive
Pest Resistance:
-plants created with genes for insecticides
-Bacillus thuringiensis (Bt): bacterium makes toxins lethal to butterfly family and beetle family-
when transformed to crops, protects against these pests
-reduces insecticide spraying
-most Bt crops in North America
-concerns: plants used to perfect conditions and not immune to pests (this natural pesticide is likely to be useless in

the near future, so plants could be in danger in the future)
-effects on non-target species: can kill other species because susceptible and pesticides can travel long distances
-ex: can contaminate milkweeds that monarchs feed on
Weed Control- most popular transgenic crops: tolerates high doses of herbicides
-occupy 3/4 of all genetically engineered acreage
-2 main products: Monsanto's "Round up Ready" (resists glyphosate) and AgrEvo's "Liberty Link" crops (resists glufosinate).
-exterminates weeds but forces greater amounts of herbicides
-if widespread could create herbicide resistant "super weeds" (genes jump to wild relatives mostly in high biodiversity regions)
Public Opposition-
public shows concerns for safeness and making rich farmers richer and poor farmers bankrupt
-1999: protestors in India burnt crops suspected of genetic engineering
-objections strong in Europe (esp. Italy)
-2001 European Parliament passed rules requiring strict testing, monitoring and labeling of genetically engineered food products and seeds. Also banned genes for antibiotic resistance in plants: fear bacteria would become immune to it.
-potential risks to human health
-2000: StarLink corn only for livestock mixed into corn used in variety of human foods.
Sustainable Agriculture: (regenerative farming)
-aim to produce food and fiber on a sustainable basis and repair the damage caused by destructive practices.
Alternative Methods:
Soil conservation- soil is renewable resource
-most important elements in soil conservation: land management, ground cover, climate, soil type and tillage system
Managing Topography- water runoff downhill causes erosion: contour plowing- leave grass strips in waterways (plowing across hills, rather than up and down).
-like this is Strip Farming- planting of different kinds of crops in alternating strips along the land contours
-ridges created by cultivation make little dams that trap water to seep into the soil rather than runoff
terracing- shaping the land to create level shelves of earth to hold water and soil: edges of terraces planted with soil, anchoring plant species
-this is expensive and requires much hand labor (or expensive machines), but makes farming on steep hills possible
perennial species: plants that grow for more than two years- necessary for some crops to protect certain unstable soils on sloping gradients or watercourses (low areas w/ water runoff)
Ground Cover: protect soil
-cover crops (crop residues)
-interplanting of two different crops (or more) in same field (not only protects but produces double harvest) ex: beans or pumpkins planted in between corn rows- beans provide nitrogen for corn, pumpkin crowded out weeds and both crops provided balance of nutrients for corn
-Mulch: manure, wood chips, straw, seaweed, leaves, and other natural products
Reduced tillage: machines just cover seeds so do not disrupt ecosystem

Air

Weather is the day to day fluctuations in the atmosphere while Climate describes temperature and humidity changes over long periods of time. Climates are not static- they cycle through yearly, centurial (is that a word?) and millennial patterns.

Initially the climate on Earth was a deadly mixture of Hydrogen, Helium and Methane from the outgassing of molten rock. 3 billion years ago oxygen was added to our atmosphere with the evolution of photosynthetic organisms.

Air pressure at sea level 14.5 lbs per square inch known as one Atm. Air pressure decreases with altitude. The surface of the Earth also experiences low pressure when warm air masses rises due to low density.

Air composition of the Troposphere today:
Nitrogen- 78%
Oxygen- 21%
Traces of Water Vapor, Argon and Carbon dioxide

The Atmosphere has four distinct layers.
Troposphere (roughly 10 km up)
The layer closest to earth. Holds 75% air mass.
Gets colder with altitude
Weather happens here, also only layer with water
Stratosphere
The top of the stratosphere contains ozone- O3
Ozone absorbs high level UV radiation from the sun.
Temperature increases with altitude because of UV absorption
Ozone molecules are broken down by CFC (now outlawed ingredient in aerosol sprays, refrigerator coolants and electrical cleaning solvents)
Excessive UV light on the Earth causes skin cancer, cataracts and mutates and kills plankton (the ocean's bread basket).
Mesosphere
Temperature decreases with height
Thermosphere
Highly ionized gas interacts with magnetosphere to create Aurora borealis (Northern Lights)!

Global Energy Transfer- before man (and woman) global energy was in balance.
Most of the energy from the sun is in the high energy wavelengths- UV and visible light.
50% of this energy is absorbed at the surface.
Energy reflected from the surface is infrared (longer wavelengths)

Convection- the transfer of energy of a warm fluid (like gas or water) upwards into a cooler zone. The cycle of air upwards around and down is called Convection Currents.

Why it rains in a rain forest: The sun's energy is concentrated near the Equator. Rising hot air expands and cools (called Adiabatic cooling). Colder air can't hold as much moisture so after a certain altitude, the air dumps out its water vapor in the form of water droplets- the stuff of clouds. Rising air creates low pressure and lots of nasty weather, unless you are a tropical plant in which case you are very happy. As the water vapor condenses it gives up latent heat energy- this helps large cloud formations rise higher, cool more and build energy to form large storm systems like hurricanes.

Why it is dry in a desert: At 30 degrees North and South latitude the air is cooling, becoming more dense and sinking. Sinking air creates high pressure. High pressure days are cloudless great tanning weather kind of days, unless you are thirsty.

Global winds are caused by the constant balancing act going on in our atmosphere as moist, warm air travels upward from the Equator and then cools and sinks at the 30 degree latitude belt. The air rises again at the 60 latitude and sinks at the poles. When the air moves laterally across the Earth's surface from belt to belt (High to Low pressure) it creates winds- we live in the Westerly wind belt which is why all of our weather comes from West to East. Below us are the trade winds which blow towards the Equator.

All wind belts are curved to the rotation of the Earth knows as the Coriolis Effect. In the Northern hemisphere the air curves to the right. In the south it curves to the left. These curving winds are also partially responsible for the direction of the major ocean currents of the world.

The Coriolis effect is also what spins tornadoes and cyclones. Cyclones are low pressure centers with winds that blow inwards in a counterclockwise direction. Weather conditions are very stormy.

Anticyclones are high pressure centers with cooler, sinking air that then spin clockwise outwards. Clear skies are created.

Jet Streams- 200 km/hr currents of air 10 km up. Responsible for guiding weather systems. Generated by temperature differences in upper atmosphere and the shear from Earth's rotation.

Types of Fronts
Cold Front
Cold air mass moves into warm. Sudden rise in air.
Creates large cumulonimbus rain clouds, lightening and hail
Powerful, but brief rainstorms
Warm Front
Warm air mass moves into cold
Creates cirrus clouds and later stratus clouds.
Sleet or long, light, cold rain created.
Occluded Front
Cold Fronts take over warm fronts by sandwiching and then pushing the warm air off the ground. The system begins to spin (cyclone) and rain like crazy.

Hurricanes (or Typhoon in the Pacific Ocean) are a hundred mile wide cyclones that last several weeks. Despite their relatively puny wind speeds (75- 200 mph) hurricanes are much more deadly than tornadoes. Between the heavy rain fall, mud slides and storm surges, people lose their lives by drowning.

Tornadoes- a mini cyclone that begin when the jet streams shear off the top of an especially large cumulonimbus cloud (cool, huh?). The cloud tightens as it sinks downward and spins faster due to angular momentum. The fastest tornado winds have been clocked at 318 mph. Most lives are lost in a tornado due to being struck by something that has no business flying.

Monsoons- seasonal rains and droughts caused by the differential temperatures of land and oceans. In the summer, the land heats up faster than the sea, so a low pressure center develops on land. Moist air from the ocean rush in to "fill" in the pressure void and monsoon rains last for four months or more. Then, during the winter, the ocean, which has a higher heat capacity, is now warmer than the land and winds tend to move towards the sea. A long term drought ensues.

Milankovitch cycles-
Periodic shifts in earth's orbit (100,000 year cycle), tilt (40,000 year cycle) and axis wobble (a 26,000 year cycle). The timing of all three of these phenomenon are such that every 100,000 years or so the Earth finds itself very far from the sun- enough to trigger an ice age.

La Nina
The "normal" state of affairs with relatively cool ocean temperatures on the Equatorial Pacific Ocean. Trade winds blow warm water in the South Pacific towards the Western Pacific Ocean. This causes a low pressure system off of Australia and Indonesia which leads to lots of rain. Nutrient rich water upwells off the coast of South America feeding a burgeoning anchovie population.
Back in the states we experience warm winters in the SE and cold winters in NE and the Middle Atlantic. Southern California is sunny (the brats!) and Washington is rainy (poor Kurt).

El Nino- occur every 3-5 years. Used to last 2 weeks to a month, now lasts one month to over a year!!!
Unusually warm ocean temperatures on Equator (made worse by global warming) cause the Trade winds to weaken.
Warm water is sloshed back to South America
No upwelling of nutrient rich water occurs off of Peru and the anchovie population falls. Food chain disturbed
The jet stream splits over America causing lots of weird weather.
New Paltz gets mild winters while the South West US and Peru gets RAIN!!

Seattle goes dry as does the West Pacific causing large bush fires in Australia and Borneo-8 million acres burned just recently :(

Global Warming (now officially called Climate Change by our government)
The burning of fossil fuels creates greenhouse gases- especially carbon dioxide. Since 1800 we've gone from 280 ppm to 370 ppm of CO_2. Other gases implicated in global warming are water vapor, methane- mooo! (CH_4), N20 (laughing gas) and sulfur hexafluoride. The massive deforestation around the planet also adds to the greenhouse effect because our natural carbon dioxide sinks are compromised... ok, dead. Seasonal fluxations of CO_2 are natural due to the increased photosynthesis in the summer which aborbs CO_2 and the dormant plant life in the winter.

These greenhouse gases trap infrared heat energy trying to exit the planet and the Earth is heated up- already we've noticed a 1.4 degree F (.8 degrees C) change. That doesn't sound like much but it only took 5 degrees F to trigger an ice age!

Effects of Global Warming include:
Glaciers melting and huge icebergs calving off ice sheets. The Arctic sea is now 40% thinner. Many alpine glaciers are shrinking quickly or melting altogether. Decreased snow pack on land also results in more sunlight energy being absorbed by the Earth's surface. Snow caused light to be reflected from the Earth's surface (albedo).
Creates sea level rise (6 inches projected in next 100 years). If all of the glaciers/ice sheets melted the sea would rise 300 feet. Sea level would also rise due to thermal expansion.
Drought/ fires due to changes in weather patterns. Already the seas have risen 15 cm in the last 100 years.
Crop failure- US bread basket is now moving to Canada- only problem is that the soil is thin and not particularly fertile.
More tropical disease will spread due to more tropical areas- malaria is coming- agghhh!
Extreme weather- contrary to popular misconception- winters get more ferocious and of course summers get hotter.
Coral reefs are being "bleached" by the hotter temperatures. That means that the algae that lives commensually on the coral is dying. It is projected that the reefs have 50 years left... poor Nemo!
Extinctions- animals and plants can't migrate fast enough to out pace environmental changes especially if you are trapped on a mountain or if you've reached the limit of your park land.

Kyoto Protocol
In 1997, 162 countries gathered together in Japan to figure out how to slow global warming. EVERY COUNTRY agreed to limit their carbon dioxide production and signed a treaty to that effect, except for the US and Australia. It really shocked and disturbed the world, especially when George Bush senior said, "We are going to put the interests of our own country first and foremost" and "The American lifestyle is not up for negotiation." We tried really hard to create a "CO_2 credit" in exchange for the fair amount of land we have still forested, but the countries won't go for it. The US produces 24% of the world CO_2, and yet have less than 5% of the world's population. Presently the government has responded to environmentalists' pressure by pledging lots of money to investigate the NATURAL causes of global warming (okay volcanoes do make CO_2...). Many people argue that historically we've seen massive fluctuations in temperature on the Earth, but the point is that the present RATE of temperature change is unprecedented, and inconveniently coincides with human-caused increases in CO_2 levels... The plot thickens.

Air Pollution

compounds.
-air pollution is the most widespread environmental damage.
-147 million metric tons of air pollution released each year by the US.
-the world releases about 2 billion metric tons a year.
-air quality has improved over the past 20 years in developed countries.
- developing countries however have higher air pollution sometimes ten times higher than the pollution levels considered safe for human health.

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

Human caused air pollution
-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)

-US clean Air Act of 1970- 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
-Sulfur Compounds: about 114 million metric tons a year released from all sources. Humans release about 90% of the sulfur in the air in urban areas.
Natural sources: sea spray, erosion of sulfate containing dust, fumes from volcanoes.
Most sulfur released because of humans- burning fuel (coal and oil) containing sulfur China and US release the most sulfur because of their great amount of coal and oil burning
Sulfur dioxide- 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 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 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 : about 3 billion tons accumulate in the atmosphere a year. The level of CO_2 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 billon metric tons released into atmosphere each year, half of that by humans (internal combustion engines). CO binds to hemoglobin reducing the oxygen in the blood. Can be deadly. It also is a respiratory irritatant 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.
-Biomagnification in aquatic ecosystems and birds. It is dangerous to eat higher trophic level fish. Mercury is a neurotoxin. Reduction can be achieved with an electrostatic precipitator (a charge is given to the particulate as it tries to leave a smokestack. A charged plate inside the chimney attracts the pollutant.)
More toxic metals: nickel, beryllium, cadium, thallium, uranium, cesium, plutonium, arsenic.

Particulate Matter:
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 also 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 can cause cancer.
These seem to be the most apparent pollution because they reduce visibility. Reduction can be achieved by filtering, electrostatic precipitators and alternative energy.

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.
-Plants are the largest source
- 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 carcinogenic and neurotoxins.

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

INDOOR AIR POLLUTION:
- It has been found that indoor concentration of toxic pollutants are often higher than outdoors.
- 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)
- Leading cause of death for women because of advertising in the '50's
- These deaths cause us $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. Yikes!
- Less developed countries burn for cooking and heat- because of poor ventilation and cooking fires there is a large amount of indoor air pollution especially particulates. women and children are most effected.
- Levels of carbon monoxide, particulates, aldehydes and toxic chemicals can be 100 times greater than the safe outdoor concentrations in US

Sick Building: a building in which a number of people adverse health effects related to the time spent in the building. These symptoms disappear when they go outside.

Climate:
Temperature inversions: occur when a stable layer of warmer air overlays cooler air, reversing the normal temperature decline with increasing height and preventing convection currents from dispersing pollutants. This is really bad if the pollutants then build up.
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.

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.

Stratospheric Ozone:
- it was discovered in 1985 that the ozone levels in the stratosphere over the South Pole were dropping during September and October as the sun comes out after the polar winter has been happening since the 1960s.
- this hole was the largest ever found and is now spreading to other parts of the world. About 10% of ozone

disappears during the spring.
- This is dangerous because ozone filters out UV light and without it organisms would be exposed to life threatening radiation. Skin cancers increase.
- CFC's (Chlorofluorocarbons) are suspected to be the major cause of ozone loss. known as Freon. When discovered they were regarded as nontoxic, nonflammable and cheaply produced. But because they are so stable they remain in atmosphere for decades. When they are diffused into the stratosphere they release chlorine atoms which destroy the ozone.
- CFC's have been banned and minimized

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 directly toxic damaging to the sensitive cell membranes of plants. Within a few days of exposure mottling can occur and 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 together at the same together.

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.
Aquatic effects: acid in water effects 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.
Kills life in lakes and other aquatic ecosystems- 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 distroyed, 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. Even National Parks are effected by air pollution. 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!

Biodiversity

Biodiversity preserves three ecological systems -Genetic Diversity: the measure of the variety of different versions of the same genes with individual species -Species diversity: the number of different kinds of organisms (richness) -Ecological diversity: the richness and complexity of a biological community

Only 1.4 million species are known- a fraction of the total. 70% known species are invertebrates, only 10-15% species live in North America and Europe Hot Spots of the World: The centers of greatest biodiversity tend to be in the tropics, especially tropical rain forests and coral reefs.

How do we benefit from Biodiversity? -Food- 80,000 plants are edible to humans -Drugs and Medicines- more than half of prescription drugs come from natural products. ex. Madagascar periwinkle inhibits cancer growth! -Ecological Benefits-soil formation, waste disposal, air and water purification, nutrient cycling, etc. 95% of pests are controlled by other species that prey on them- better than chemicals! -Aesthetic and Cultural Benefits- nature as "church". Provides psychological and emotional rejuvenation. Ecotourism is big.
Loss of Biodiversity: -Extinction: the elimination of a species 99% of all species that have ever existed are now extinct! -Natural Causes of Extinction: in an undisturbed ecosystem. Mass extinctions (that wiped out dinosaurs at

the end of the Cretaceous period and two thirds of all marine life at the end of the Permian period) were caused by climate changes, perhaps triggered when large asteroids struck the earth. Now we are losing species at thousands of times the natural background rate of extinction. 1/3 to 2/3 of all current species could go extinct by the MIDDLE of this century. :(-Habitat Destruction: The biggest reason for the current increase in extinction is habitat loss. Habitat Fragmentation: Habitat fragmentation divides populations into isolated groups that are vulnerable to catastrophic events. -Over harvesting (hunting and fishing) is responsible for depletion or extinction of many species. Ex. Passenger pigeon: 3 to 5 BILLION birds lived 200 years ago. In addition to over harvesting wild species for food, we also obtain a variety of valuable commercial products from nature. ex. Rhino horns. -Predator and Pest Control- some animals are killed off because they are deemed as dangerous. ex. coyotes

Exotic Species Introduction -Exotic organisms are aliens introduced into habitats where they are not native and they are one of the greatest threats to native biodiversity. Exotics can be thought of as biological pollution. There are now more than 4,500 alien species in the United States. ex. Kudzu vine, purple loosestrife, asian longhorn beetles. They have no natural predators in their new home and can often out compete native plants for food and space. -Diseases- pathogens (disease organisms) can become predators when natural checks and balances are lost.

Endangered Species Management -Hunting and Fishing Laws- 1890's most states authorized laws. ex. white tailed deer -The Endangered Species Act- ESA of 1973 prohibits the killing of a endangered species. The act has now expired. Endangered: considered in imminent danger of extinction Threatened: those that are likely to become endangered Vulnerable species: naturally rare or have become so because of human activities. Problems arose with lawsuits. What about saving Mrs. Furbisher's lousewort??? Area in US with most endangered species is Southwest. Characteristics of endangered species: large body size, large or very small territory requirement, long-lived, specialist species, low reproduction rate. Successful Comebacks: American alligator, Bald Eagle and California condor Some people want the economic cost of recovery to be included in the decision making process. ex. Snail darter and Northern Spotted Owl. 80% of the habitat for more than half of endangered species live on nonpublic property. Land owners are resistant. Over the past decade, growing numbers of scientists, land managers, policy makers, and developers have been making that case that it is time to focus on a rational, continent-wide preservation of ecosystems that support maximum biological diversity rather than a species-by-species battle for the rarest or most popular organisms.

-Minimum Viable Populations: small numbers of surviving species are more vulnerable to extinction. Island Biogeography. The smaller and farther away an "island" is from a continent, the faster the extinction rate. -International Wildlife Treaties Convention on International Trade in Endangered Species (CITES). Prohibits the trade of endangered species internationally. ex. Elephants -Captive Breeding and Species Survival Plans: zoo breeding can reintroduce endangered species back into the wild

Land Use: Forests and Range lands

Land Use Distribution of World: -32% Forest and wetlands, -31% Tundra, desert, wetlands, and urban areas, -26% Range and pasture, -11% Cropland Forests regulate climate, control water runoff, provide shelter and food and purify the air. Plus they are pretty to look at! 50 to 60% of the world depends upon wood or charcoal for heating and/or cooking. Forests in NE USA (Temperate) are rejuvenating! Tropical Forests are critically threatened. Jungles contain 2/3 of all plants and 1/2 of all animal life. There needs to be laws preventing deforestation in developing countries.

Forest management: Monoculture forestry is the most profitable but the most destructive to the health of the forest. -Temperate Forests: In the United States and Canada, the two main issues in timber management are (1) cutting the last remains of old-growth forest and (2) methods used in timber harvest. Clear cutting is when every tree in a given area is cut regardless of size. The concentration of nitrates in the runoff increases. Strip cutting entails harvesting all tress in a narrow corridor. Sustainable Forestry: In both temperate and tropical regions, scores and certification programs are being developed to identify sustainably produced wood products. Selective cutting is when only a small percentage of the mature tress are taken in each 10- or 20- year rotation. Increasingly, non-timber forest products are seen as an alternative to timber production. Range lands: Pasture (generally enclosed domestic meadows or managed grasslands) and open range (unfenced, natural prairie and open woodlands) occupy about 26% of the world's land surface. Overgrazing and Protection: About one-third of the world's range is severely degraded by overgrazing, making this the largest cause of soil degradation. The process of denuding and degrading a once-fertile land initiates a desert-producing cycle that feeds on itself and is called desertification. Rotational grazing; confining animals to a small area for a short time (often only for a day or two) before shifting them to a new location; stimulates the effects of wild herds. This allows the animals to trample and fertilize the ground without damaging it.

Biological Communities

Evolution

Tolerance Limits and Species Abundance

tolerance limits- the maximum and minimum levels beyond which a particular species cannot survive or is unable to reproduce, ex. temperatures, moisture levels, nutrient supply, soil and water chemistry, and living space.
-different for each species
-later discovered that rather than a single factor that limited growth, it was several factors working together, that determined biogeographical distribution
-for some species there may be a critical factor that determines their abundance and distribution in an area
-ex. saguaro cactus, sensitive to low temperatures, will begin to die in 12 hours of freezing temps. -young saguaros are more susceptible to cold than adults
-young animals also have more critical tolerance limits than the adults, ex. pupfish
-requirements and tolerances of species often are helpful in understanding the environmental characteristics of an area. the presence of a species can say something about the community and ecosystem
environmental indicators- species with specific tolerance limits that tell us something about the area where they are present ex. locoweeds grow in areas with a high soil concentration of selenium

Natural Selection and Adaptations

-term adapt used in two ways
1. limited range of physiological modifications, called acclimations, available to individual organisms. ex. house plants inside all winter
2. inheritance of specific genetic traits that allow a species to live in a particular environment
evolution- species change gradually through competition for scarce resources and natural selection
natural selection-a process in which those members of a population that are best suited for a particular set of environmental conditions will survive and produce offspring more successfully than their ill-suited competitors
-natural selection acts of preexisting genetic diversity created by small random mutations and occur spontaneously in every population
-mutations alight, but in the long run, create amazing diversity
-theory developed by Charles Darwin
environmental factors that cause selective pressure and influence fertility or survivorship-
1. physiological stresses due to inappropriate levels of some critical environmental factor ex. moisture, light, temp. pH, specific nutrients
2. predation, including parasitism and disease
3. competition
4. luck, sometimes they're just lucky rather than better fir to survive
-selection affects individuals, but evolution and adaptation work at the population level, species evolve not individuals
-isolation can also drive evolution, and cause for variations in species
convergent evolution- when through time when unrelated organisms evolve to look and act very much alike

Niche Specialization

habitat- the place or set of environmental conditions in which a particular organism lives
ecological niche- description of either the role played by a species in a biological community or the total set or environmental factors that determine species distribution
-biophysical definition proposed by G.E. Hutchinson, he said every species has a range of physical and chemical conditions (temp. acidity, humidity etc) as well as biological interactions (predators, prey present, defenses, nutrition available) within which is can exist
-niches can evolve over time
-law of competitive exclusion states that no two species will occupy the same niche and compete for exactly the same resources in the same habitat for very long
resource partitioning- when competition forces one species to either migrate to a new area, become extinct, or change its behavior or physiology in ways that minimize competition

-niche specialization can cause subpopulations of a single species to diverge into separate species, but resources can only be partitioned so far

Species Interactions

Predation

-all organisms need food to live
predator- an organism that feeds directly upon another living organism
-in this broad sense parasites and pathogens may be considered predators
parasites- organisms that feed on a host organism or steal resources from it without killing it
pathogens-disease-causing organisms
-predation is a potent and complex influence on population balance of communities, it involves
1. all stages of the life cycles of predator prey species
2. specialized food obtaining mechanisms
3. specific prey-predator adaptations that either resist or encourage predation

-predation important factor in evolution because predators prey most successfully on the slowest, weakest, least fit members of their target population, causing the prey species to evolve with protective or defensive adaptations to avoid predation
coevolution- the process when predators evolve mechanisms to overcome the evolved defenses of their prey

Keystone Species

keystone species- a species of group of species whose impact on its community or ecosystem is much larger and more influential than would be expected from mere abundance
-many unexpected species can be a keystone species, ex. tropical figs, microorganisms

Competition

-organisms within a community much compete for all the survival necessities: energy and matter in usable forms, space, and specific sites for life activites
intraspecific competition- competition among members of the same species
interspecific competition- competition between members of different species
--competition more of a race than a fight, animals don't want to risk getting injured
-intraspecific competition intense because organisms are fighting directly for the exact same resources
territoriality- intense form of intraspecific competition in which organisms define an area surrounding their home site or nesting site and defend it, primarily against other members of their own species
-territorilaity helps to allocate resources by spacing members of a species

Symbiosis-intimate living together of members or two or more species

Mutualism- a type of symbiosis in which both members of the partnership benefit.
ex. lichens being a combination of fungus and a photosynthetic partner, alga or cyanobacterium
-mutualistic relationship may be important in evolution

Commensalism- a type of symbiosis in which one member clearly benefits and the other apparently is neither benefited nor harmed
ex. cattle and cattle egrets

Parasitism-a form of symbiosis in which one species benefits and the other is harmed.
ex. Ms. Law and tropical round worms

Defensive Mechanisms-the way that different prey adapt to either hide from or discourage predators
ex. toxic chemicals, body armor
-some organisms produce noxious odors or poisonous secretions
-plants too produce chemical compounds that make them unpalapable or dangerous to disturb
ex. poison ivy, stinging nettles

Batesian mimicry- harmless species that evolve colors, patterns, or body shapes that mimic species that are unpalpable or poisonous
Mullerian Mimicry- when two dangerous species evolve to look alike
-others use camouflage

Community Properties
-productivity, diversity, complexity, resilience, stability, and structure

Productivity-
primary productivity- rate of biomass production
-higher productivity in areas of high temperature moisture and nutrient availability

Abundance and Diversity-
abundance-expression of the total number of organisms in a biological community
diversity- measure of the number of different species, ecological niches, or genetic variation present
-as you go from the equator towards the poles, generally diversity decreases but abundance increases
-productivity is related to abundance and diversity

Complexity and Connectedness
complexity-refers to the number of species at each trophic level and the number of trophic levels in a community
-you can have an abundant community that isn't very complex

Ecological Succession-
-the process by which organisms occupy a site and gradually change environmental conditions b creating soil, shade, shelter, or increasing humidity
Primary Succession-occurs when a community begins to develop on a site previously unoccupied by living organisms
ex. island, new volcanic flow
pioneer species- in primary succession, the species that fist colonizes the new area
-often microbes, mosses and lichens
ecological development- process or environmental modification by organisms

Secondary Succession-occurs when an existing community is disrupted and a new one subsequently develops at the site
-disruption may be caused by natural catastrophe, human activity
climax community- in either primary or secondary succession, when a community develops that resists further change
equilibrium communities/disclimax communities- when landscapes never reach a stable climax in the traditional sense because they are characterized by periodic disruption
Aquatic Succession-process or succession taking place in a body or water

Biomes

BIOME : a broad, regional type of ecosystem characterized by distinctive climate and soil conditions and a distinctive kind of biological community adapted to those conditions.
~**Deserts**: characterized by low moisture levels and infrequent, unpredictable precipitation
-plant adaptations to conserve water and protect from predation
-seasonal leaf production, water storage tissues, thick epidermal layers
-spines and thorns
-warm, dry, descending air creates desert bands at 30 degrees N and S
-deserts at high latitudes are cool
-sand dunes are rare away from the coast
-2-2" of rain per year
-sparse but species-rich community dominated by shrubs and small trees

-animals- structural and behavioral adaptations
-hide in burrows or rocky shelters to escape daytime heat
-mice and rats obtain moisture from the seeds and grains they eat
-highly concentrated urine and dry feces to conserve water
-easily disturbed by humans
-slow to recover because of harsh climate
-EX. tracks still visible from army trucks in WWII, overgrazing, and use for farmland
~**Grasslands/Savannas**: rich biological communities of grasses, seasonal herbaceous flowering plants, and open
savannas.
-seasonal cycles for temperature and precipitation">vegetative growth">enriches soil->
good farmland
-10-60" rain per year
-few trees b/c of inadequate rainfall, daily and seasonal temperature ranges, and
frequent grass fires
-some are artificially created and maintained by native people using fire (balance
ecosystem)
-large grazing animals EX. bison, deer, elk
-human disturbances
-fire suppression
-conversion into farmland
-overgrazing">soil erosion
-hunting, fencing, wetland drainage, introduction of alien species">diminished
wildlife population
~**Tundra**: characterized by a short growing season, cold, harsh winters, and the potential for frost
at any time
-far N and S, and high elevations
-less than 10" rainfall per year
-no trees
-arctic-low productivity, low diversity, and low resilience
-long, dark winters
-in summer-only top few centimeters are unfrozen, the rest is permafrost
-surface soil waterlogged b/c of permafrost
-no deep root growth b/c of permafrost">not many plants
-alpine- thin mountain air">permits intense solar bombardment">plants w/dark
pigment that shields inner cells
-hot daytime ground temps, freezing nighttime temps
-gravelly, rocky soil
-slope causes quick moisture drainage
-ALL this adds up to a drought problem
-dominant plants- dwarf shrubs, sedges, grasses, mosses, and lichens
-animals must be adapted to harsh climate and sparse food supply
-EX. arctic musk ox and caribou, alpine mountain goats and mountain sheep
-migration and hibernation
-birds nest in the tundra during the summer
-human disturbances
-slow to heal
-oil and natural gas wells in the arctic
-mineral excavation in mountain regions
-truck ruts and tracks

~**Conifer Forest**: regulated by fires
-20-40" of rain per year
-conifer trees can survive harsh winters or extended droughts
-boreal forest- northern coniferous forest
-mixture of coniferous and deciduous trees
-b/w 45 and 50 degrees N latitude

-dominant conifers- pine, hemlock, spruce, cedar, and fir
-dominant deciduous trees- birches, aspens, and maples
-many lakes, potholes, bogs, and fens
-mosquitoes and biting flies are abundant
-taiga- northernmost edge of the boreal forest.
-harsh climate">limited productivity and resilience of community
-cold temps, wet soil, and acids produced by fallen conifer needles"> full decay of organic matter">peat (semi-decayed organic material)
-peat mining could be severe and long-lasting
-southern pine forest-characterized by a warm, moist climate and sandy soil
-managed for timber, turpentine, and rosin
-temperate coniferous forests of the pacific coast- mild temps and abundant precipitation
-up to 100" of rain per year
-luxuriant plant growth and huge trees
-EX. California redwood- largest tree in the world, largest organism EVER
-in its wettest parts, the coniferous forest becomes a temperate rain forest
~**Broad-Leaved Deciduous Forest:** lush summer plant growth when rain is plentiful
-requires adaptations for the frozen season
-30-100" rain per year
-four seasons
-deciduous trees- produce summer leaves and then shed them at the end of the growing season
-EX. oak, maple, birch, beech, elm, ash
-form canopy over smaller shrubs, trees, and herbaceous plants
-human disturbances- most hard hit by man (NE cleared 100 years ago)
-trees harvested for timber
~**Tropical Rain Forest:** one of the most complex and biologically rich biomes
-ample rainfall
-uniform temperatures (about 80 degrees)
-cloud forests- high in the mountains
-fog and mist keep vegetation wet
-tropical rain forest- rainfall abundant (90-180" per year)
-warm to hot temps year round
-thin, acidic, and nutrient-poor soil
-1/2 to 2/3 of all species of terrestrial plants and insects live in tropical forests
-90% of nutrients in the nutrient cycle are in the bodies of living organisms
-growth depends on the decomposition and recycling of dead organic material
-human disturbance
-deforestation">loss of soil fertility b/c the thin soil cannot support crops or resist Erosion
-forest doesn't recover from clear cutting
AQUATIC ECOSYSTEMS
~**Estuaries-** bays of brackish water (mix of salt and fresh water) from where river enters ocean
-contain rich sediments carried downstream
-forming mud flats that nurture aquatic life
-sheltered from most ocean action other than tides
-high species diversity and productivity
~**Wetlands**: land surface is covered with standing water at least part of the year
-vegetation is adapted for growth under these conditions
-swamps- wetlands with trees
-marshes- wetlands w/out trees
-bogs and fens- wetlands w/ or w/out trees that have waterlogged soils that accumulate peat
-low productivity
-swamps and marshes- flowing water and high productivity
-fens- fed by ground water and surface runoff

-bogs- fed by precipitation
-5% of world's landmass and one of the most devastated
-high biomass production
40% net primary productivity interfered by humans.
Benthic- bottom-dwelling organisms
Abyssal plain- flat ocean bottom
RESTORATION ECOLOGY
-to repair or reconstruct ecosystems damaged by humans or natural forces.
-Restoring the Earth conference in Berkeley, California brought 800 scientists, policy-makers and activists to share ideas and experiences
~Restoration: bring something back to a former condition
-re-create species composition and ecosystem processes as close to the original state as possible
~Rehabilitation: rebuild elements of structure or function in an ecosystem without achieving complete restoration to its original condition
-bring an area back to a useful state for human purposes
~Remediation: cleaning chemical contaminants from a polluted area by physical or biological methods
-a first step toward protecting human and ecosystem health
~Recreation: attempts to construct a new biological community on a severely disturbed site.
-may be modeled on what we think was there before human interruption
-may be something that never existed on the site, but we think it fits well with conditions there
~Mitigation: take steps to lessen risk by lowering probability of damaging events
The areas most severely underrepresented in protected areas are grasslands, aquatic ecosystems and islands. The least disturbed biomes are temperate conifer forests and arctic tundra.
Parks and Nature Preserves
History and Park Origins
- Most biologically productive land in private hands.
- Early parks were for higher classes to hunt and for royal recreation.
- Natural landscaping- (Lancelot Brown) A way of making nature look natural, rejecting strait lines, using rolling hills and all natural looking features.
- Used by modern zoos.
- Olmstead designed central park then left and became commissioner of Yosemite. (1864)
- Lincoln authorized Yosemite to save it from the exploitation of the settlers.
- Grant made first National parks, Yellowstone and Yosemite. After this, many other places designated National parks to save wild nature and places with scenic beauty and cultural importance.

North American Parks
- Mexico's Parks smaller than neighbors but encompass more diversity.
- US National Parks encompass 280000 + km2 w/ 376 different parks.
- Most visited parks are recreational; the best are the unspoiled ones.
- Alaska lands act double the area of the park system.
- Canada has 150000 km2 w/1471 parks
- Some Canadian parks allow hunting, logging, mining and environmental manipulation.
- Problems -
- Parks are being clear-cut right up to their boundaries.
- Mines contaminate water shed
- Tourist traps are at the entrances taking away from the beauty.
- Parks need money, traffic to parks increase by 1/3 in the last decade while funding went down _.
- Some have proposed to sponsor the parks, but most rejected.
- In Yosemite, people over crowd and destroy the valley floor, plans have been made to remove all buildings, and make inaccessible to cars to help preserve what is left.
- Other parks such as the ones in the Canadian Rockies, Jasper, California Desert, and the Everglades, are facing over commercialism and pollution.
- Smog is destroying beautiful vistas and reducing visibility.

- Conservation groups want to use federal money to buy private land in parks so that miners can't go in parks to private land.
- Wildlife -
- Bad animals were killed in the beginning of the parks to increase the amount of good animals.
- Favoring species creates an unbalanced eco system. Good species take over and deplete food sources so smaller species have no food.
- IUNC (International Union for the Conservation of nature and natural resources.) divides protection into five levels.
- 1. Ecological reserves and wilderness areas- little human impact
- 2 .National Parks- Low to little impact
- 3. Natural Monuments and Archeological sites- low/medium
- 4. Habitat and wildlife management areas/ National Wildlife Refuge- medium. hunting okay.
- 5. Cultural or scenic landscapes, recreational areas, National Forests- medium/high.
- Parks need more than just a large boundary to protect an ecosystem, it needs to protect watershed, air shed. Unfortunately, most parks are designed based on political not ecological considerations. A biogeographical area refers to the entire ecosystem.
- Grand Staircase-Escalante National monument made by presidential decree, locals outraged because it stopped them from using rich resources.
- Lesson, it's not easy to make a new park.
- Clinton made an 84,000,000 acre underwater preserve. This saved from tourism and fishing. He also made a combined 1.1 million ha of protection.
- Bush moved to revoke much of this once he took office.
- Canada's green plan called to double reserves, including an entire watershed.
- World parks and preserves -
- 530 million ha, reserves, nearly 4 % of earths surface.
- Most protected biomes, Tropical dry forests, Savannahs, Temperate deciduous forests, tundra. (many to small to protect ecosystem, excluding tundra.)
- Least protected areas: Islands, Lakes, Wetlands.
- IUNC Made the most significant areas of the world Biosphere Reserves.
- Best countries for reserves, Costa Rica, Tanzania, Rwanda.
- Protecting Natural Heritage -
- In many parks, there is political and economic priorities that come before preservation.
- IUNC made a world conservation strategy, maintain earth so humans can survive, preserve genetic biodiversity, and to ensure that any utilization of species and ecosystems is sustainable.
- SIZE AND DESIGN-
*Optimum size and shape for a preserve is large enough to support populations, keep ecosystems intact and isolate critical core areas from human disturbance
*Corridors between natural habitats allow for movement of animals between preserves and protect them from being wiped out in case of a calamity.
*Satisfy conflicting needs and desires of humans manage them this way:
(1) recreation areas- human entertainment
(2) historic areas- preserve a landscape from previous time
(3) conservation reserves- set aside to maintain ecological functions
(4) pristine research areas- baseline of nature for research
(5) inviolable preserves- for sensitive species human interference not allowed
*The smaller the reserve the faster species disappear. The exposed edge of the preserve is more vulnerable to destruction. The preserve with the least edge exposure make the best parks.
-Conservation and Economic Development-
*Tropics has a lot of threatened species and ecosystems
*Basic needs for humans take precedence over the environmental goals
*Tropics are suffering the greatest destruction and species loss in the world
*Ecotourism can benefit the environment more than logging or mining etc.
* Tourism can be utilized as a source of income for the people but also save the wildlife
-Indigenous Communities and Biosphere Reserves-
*UNESCO initiated Man and Biosphere (MAB) program that encourages division of protected areas into multi-use areas. The inner area, or core, is preserved while a buffer zone protects it. Multiple use areas make up the outside of

the park.
*Passeo Pantera- a plan to create a thousand mile long series of preservations with corridors linking them along the coast of Central America
-Wilderness Areas-
*indigenous people were significantly hurt by the European diseases
*wilderness: "an area of undeveloped land affected primarily by the forces of nature, where man is a visitor who does not remain; it contains ecological, geological, or other features of scientific or historic value; it possesses outstanding opportunities for solitude or a primitive and unconfined type of recreation; and it is an area large enough so that continued use will not change its unspoiled natural conditions."
*Arguments pro-wilderness:
(1) refuge for endangered wildlife
(2) chance for solitude and recreation
(3) baseline for research
(4) area where it is simply in its natural state and left that way
*people in developing countries don't regard environmental problems as very important matters
*Saving culture, landscapes and history are good reasons to protect an area
-Wildlife Refuges-
*1901 Teddy Roosevelt established 51 wildlife refuges. There are now 511 in nearly 40 million hectares of land
*Franklin D. Roosevelt and Harold Ickes impacted refuges as did Jimmy Carter who signed the Alaska National Interest Land Act which added 22 million ha to the already existing land
-Refuge Management-
*intended to be sanctuaries but by passing of a compromise in 1948 allowed hunting for duck etc on the land.
*Refuges face threats from external activities such as water pollution
*biggest battle currently is about drilling in Alaska
-International Wildlife Preserves-
*The ecosystems in Kenya and Tanzania are very diverse and can hold many species from elephants to hyenas and vultures
*poachers are the major threat in Africa they pursue elephants and rhinos even in the park. Wildlife is worth more alive as an ecotourism lure than dead as a one time commodity.
*makes the supposedly peaceful areas like war zones and the rangers try to stop it, but the poachers have a lot of gun power
-Wetlands, Floodplains and Coastal Regions-
*extremely important sources of biodiversity and a key component of natural freshwater storage and purification systems
-Wetland Values-
*wetlands occupy less than 5 % of land in the US
*they improve water quality and act as a natural water purification system removing silt and absorb nutrients and toxins
*coastal and inland wetlands also provide recreational activities
-Wetland Destruction-
*US Swamp Lands Act of 1850 allowed individuals to buy swamps and marshes for as little as 10 cents per acre. Most wetlands have been converted to farmlands.
*66% of wetlands were destroyed as a result of such acts
*1972 Clean Water Act began protecting wetlands because they requested permits for discharging waste into the waters.
-Floods and Flood Control-
*floodplains: low lands along riverbanks, lakes, coastlines subjected to periodic inundation of water
*The fertile soil in areas prone to floods gives the land it is on a lot of value
*$25 billion elaborate Mississippi river flooding plan works well, except for the fact that it does not allow the water to go anywhere but forces it down the river quickly with no place to go and levees break
*Federal Emergency Management Agency has National Flood Insurance Program that aids people who can't buy insurance and allows them to collect on damage to their house by floods only if they rebuild on the same sight
-Wetlands and Floodplain Conservation-
*Many different organizations work hard to preserve the floodplains and wetlands, such as Ducks Unlimited and The Department of Agriculture's Wetland Reserve Program
*Globally wetland losses are monitored by Ramsar Convention

-Beaches, Barrier Islands, and Estuaries-
*Estuaries- where salt water mixes with fresh water
*Construction directly on the beaches can cause a lot of damage to the ecosystem
*Damaging vegetation, breaching dune systems to create roads and sand dredging, building artificial barriers.
*Government policies tend to encourage building where there shouldn't be any
*Tactics employed such as "wise use" movement and dozens of "taking" bills, to repeal coastal and floodplain zoning and park and green belt establishment etc.

Conventional Energy

History of Energy Use in United States- in order of supremacy.

Wood, slaves, coal, steam engine, and oil. Undeveloped countries still use biomass as 90% of their energy source. Amercians and Canadians (at 5% of the world population) use over one quarter of the WORLD's available energy. Hummer=Dummer. If we stopped driving gas hogs and living in sieves we could drastically reduce the amount of oil we use. Each person in the US uses an average of 60 barrels of oil/year- most of which is imported.

The 20 richest countries (1/5 the world's population) use 80% of the world's gas, 65% of the world's oil and 50% of the coal produced each year.

Calorically:

Hunter-gatherers required 2500 cal/day

World consumption is 31,000 cal/day

US consumption is 108,000 ca/day (including oil)

Fossil Fuels- provide 64% of the worlds electricity. Made from fossilized remains of once living organisms buried for years under intense heat and pressure.

Oil (liquid form of petroleum)- our primary source of energy.

Oil is formed when microorganisms accumulate at the bottom of the sea where oxygen is limited. There it is chemically transformed anaerobically into oil and gas by a process called maturation. The longer the hydrocarbon molecule, the more solid it is. Less than 5 carbon atoms is gas. Huge numbers of carbon atoms turn into crude oil. Geologists drill exploratory wells to find a "proven" reserve, a known large quantity of oil. Measured in barrels which are equal to 42 gallons of oil. We have a very vague idea of how much oil is left, but most estimates place our world reserves at 50 more years and US reserves at 25 years. The Hubbert peak theory predicts that the oil production will soon reach a peak and then decline rapidly. We reached peak world oil production in the mid-90's most likely. Iran and Saudia Arabia are a little touchy about informing us of EXACTLY how much oil they have. The US peaked in the 70's.

Petrochemicals are chemicals refined from oil. They include plastic, synthetic fibers, medicine, wax, synthetic rubber, insecticides, fertilizers, detergents, shampoos!!!

Extraction from a reserve is done by pumping (first 25%), then another 50-60% is done by pressure extraction- whereby steam, salt water is pumped into the oil field and pushes out the oil. As oil prices rise it will be more cost effective to remove more of the oil from the field. Right now removing oil from tar sands and oil shale is cost prohibitive.

Oil prices in the US are heavily subsidized by the government. Europeans pay at least twice as much for oil. The US imports more than half of its oil.

Coal

Most coal orginally formed from a dense swampy mat of decaying plants during the Carboniferous period- 300 million years ago. As plant material becomes buried it turns to peat (5% carbon). Further compaction and burial create lignite coal which is 60% carbon. Coal has various grades depending on purity and degree of metamorphism. The least favorable is lignite, then bituminous (sedimentary, 75% carbon) then anthracite (metamorphic, over 90% carbon).

We have roughly 200 years left of coal supplies. It is the most abundant fossil fuel and creates over one half of our electricity in US. Most of the coal supplies are in US, Russia and China.

Coal mining occurs through strip mining and underground mining. Underground mining requires shafts to be sunk to reach deposits. Networks of tunnels are created to reach the deposits and can be very unstable and dangerous. Stip mining is horrible for the environment. The earth is removed all the way to the coal seam. Hazardous slag heaps are created containing sulfur which can leach out and damage the water table.

Coal fired electric plants are only 30% efficient AND they emit tons of sulfur and mercury into the air.. floating on the wind currents.... straight to NPZ! Scrubbers should be mandatory to remove S from coal's combustion gases.

Natural Gas

Its convenient, cheap and cleaner burning the the previous two fossil fuels. It emits considerably less CO_2 when combusted. Only 10% of energy lost during conversion. (As opposed to 95% energy lost in a light bulb!) Difficult to transport as it has a tendancy to blow up if hit. If transporting must keep under pressure to keep in liquid form or put into pipelines.

2/3 of natural gas is burned off when activating a oil well. Maybe they should rethink that.

Nuclear Fusion

2 isotopes of light elements are forced together at high temperatures till they fuse to form a heavier nucleus. 15 million degrees C to fuse H into He. Forgetaboutit. Too unstable. Cars running on nuclear fusion keep on blowing up. Very annoying trait. Takes

Nuclear Power

India and China create the most nuclear power

-Designs and Disasters

Nuclear reactors have fuel rods of uranium and some kind of control rod (cadmium, boron, graphite) to absorb neutrons and slow the chain reaction in the core inside a containment building, a heat exchanging material, steam generator, cooling system and a turbine. The greatest danger is a cooling system failure.

Types of reactors include- Boiling reactors, pressurized water reactors, heavy water reactors and graphite reactors.

After the Three Mile Island partial meltdown in Penn in 1979 and Chernobyl disaster in Russia in 1986 all new nuclear power plant construction projects in the US have been on hold.

-Radioactive Waste Management

-"Too cheap to meter?"
"Technology and engineering would tame the evil genie of atomic energy and use its enormous power to do useful work."
-nuclear power was supposed to be a cheap and safe solution for the projected natural oil and gas deposits being depleted.
-a lot of the future projections for the use of nuclear power were made under the assumption that future advancements in technology would figure out a way to get rid of the waste.
-1970-1974, 140 new reactors for power plants were ordered. Only forty of which were actually built.
-Nuclear energy supplies 20% of power in the US, 8% world wide.
-Nuclear power first developed in the 1950's after WWII, and the invention of the atomic bomb.
-Scientists thought this would be a safe and renewable energy source, but it was proven dangerous to work around, and even minor accidents could have long lasting, and long ranging affects.
-Technology did not catch up with the expectations of the scientists for disposing of the hazardous wastes.
-Another major problem is that because the reactor can not be allowed to melt down, all the systems had to be redundant, making an extremely complex and delicate system that causes more accidents than it prevents.
-Nuclear power plants need to be located next to an abundant source of water to provide the power plant with water. This harms the natural environment of the waterway, and poses great risk if the power plant were to leak nuclear waste. The Hudson river has thermal pollution from Indian Point.

"How does our misunderstood friend work"
-the thing that makes something radioactive is the fact that it is an unstable isotope. All isotopes long to be stable. That is their goal in life. Most plants use 97% U-238 and 3% U-235.
The way they attain this goal is by releasing charged particles. These particles can alter animal DNA by mutating it in undesirable ways. Exposure to high levels of radiation creates bizarre types of cancer.
This very same process is what gives us power.
-when radioactive isotopes like U238 come in contact with neutrons, they break up into more stable isotopes releasing massive amounts of energy such as heat and light. This is called nuclear fission. It also releases other neutrons, 2 or 3,making a chain reaction. The way this reaction is controlled is by the use of neutron absorbing materials like graphite. When the operators want to slow down the reaction, they put neutron absorbing material between the fuel rods. This material is removed if the reaction is to speed up. The way the energy is harnessed is through the use of steam. The nuclear rods sit in a pool of water causing the water to become super heated. This heat is then transferred to another water pool that boils which then spins a turbine that spins a generator that creates electricity.
... And there is no harmful air pollution- no NOx or SOx. Environmentalists are pessimists. Air pollution will kill us slowly, nuclear power will kill us within a few short days! The half-life of uranium (the amount of time it takes for one half of uranium to decay is 4.5 billion years! It would take 10 half lives for uranium to decay to a safe level.

Waste disposal aka just put it where no one will find it.
- There are many ways to dispose of the waste that is generated by nuclear power.
-Waste is generated when the isotopes are first mined, and again when the isotopes are refined, and later when the isotopes are used. All the equipment that comes in contact with the isotopes also becomes waste.
-Countries that use nuclear power have devised many interesting ways to get rid of the waste.
Some countries, ahh, like America, have chosen to store the waste on the nuclear reactor site for many years, and then beginning in 2010 move it to Yucca Mountain, Nevada. This long term storage facility is between two active fault lines, above a major aquifer! Other countries, like Russia took the NIMBY approach, and decided to transport the waste to unprotected cites that are easily accessible by hostile peoples. They even dumped a bunch of nuclear waste on the bottom of the Arctic Ocean!

Economics

Ecological Economics

Natural Resource
-anything with potential use in creating wealth or giving satisfaction.

Renewable vs. Nonrenewable Resources

Nonrenewable resource
-resources that cannot be replaced (in a human time scale) because they take long periods of time to generate by earth's geological development or they are finite: the minerals, fossil fuels and metals.

-present supplies are becoming exhausted by human standards and will be gone.. soon. Yikes!

Renewable Resources
-things that can be replenished or replaced (usually refers to energy resources) such as sunlight, biological organisms, fresh water, fresh air, wind, and used cooking oil!!!

-but if we rip apart habitats we disrupt self renewing biological cycles. Yikes!

Tragedy of the Commons

-Article written in 1968 by biologist Garret Hardin.

-resources are being destroyed or degraded because people care more about the interest of themselves than they do about public interests. People who use or destroy more than their fair share of common property.

-Hardin described an open access system- no rules to manage resource use. (ex. Native American management of rice beds and hunting grounds, Maine lobster fisheries)

-communal resource management systems- resources managed by a community for long-term sustainability- can work IF collectively enforced and community anticipates continually living on the land which will be then be passed onto their children.

Classical Economics

The theory is built on the idea that a free capitalistic market is the best method to govern our financial well-being... maybe.

Law of Supply and Demand. As supply (how much product is available) increases its demand (the amount of product the consumers will buy) decreases and the price of the good also decreases. As supply decreases, the demand increases and its price increases. Kind of like a school dance when too many students of the same sex show up.

Market equilibrium is when the demand for a good equals its supply. Supply and demand are inversely proportionate.

GNP- Gross National Product. A nations' wealth is measured by the sum total of all the goods and services it provides.

GDP- Gross Domestic Product. The amount of goods and services produced only within its national boundaries within a year.

Natural Resource Management

Cost Benefit Analysis (CBA)
-This concept is used to evaluate the pollution prevention with the costs and social benefits of a project. It assigns values to resources and evaluates whether the pollution cost of a project is "worth" the social benefits. Legislators use this process to determine whether a given undertaking is a "good idea" by how cost efficient it is and what benefits it will create as well as how much pollution there will be. This can be looked at as a way for businesses to assign values to natural resources and hopefully a way to mitigate the extent of environmental damage done by any project before it is undertaken.

Often the true cost of using environmental resources are "externalized" meaning the price of permanently distroying nature and polluting our air, water and soils are not taken into consideration when goods are valued on the market. Note with neither of the above calculations are the natural resources (biodiversity, fresh air), human capital (fair wages) or social capital (indigenous societies) taken into consideration.

Marginal Costs

Fixed costs- the costs paid to make a product or provide a service that does not change as production increases. For instance, the mortagage on a property.

Variable costs- costs that increase as the number of products produced increases, such as for raw materials to manufacture a product.

Marginal costs- the cost of making one additional unit of product or service. The total cost per item when one more item is produced. The marginal cost increases as more units are produced, but as more products are made the cost goes down for the consumer.

Margin of diminishing returns- additional benefits gained by the buyer by procuring one more unit of product or service. ex. eating TWO bowls of ice cream or having two oil changes back to back. What is the added value of having that second helping or service?

Internal Costs- immediate costs that are experienced to manufacture a product.

External Costs- costs to people or society that are not experienced by the company and are NOT passed down on to the consumer directly. External costs are felt by someone but NOT those that turn the resources into a profit or those that establish the price of the product. Ligitation is one way to INTERNALIZE the external costs. ex. Erin Brockovich. So are laws and taxes. ex. Surface mining control and reclamation act (SMCRA) and cigarette taxes.

To internalize external costs means that the consumer is paying for the full cost of the product or the TRUE Cost. Also called the full-cost analysis or true-cost pricing.

Technological Developments

Pollution Tax
-This is used to ensure more environmental protection concerns in national or local economies. Taxes are paid per unit of effluent.
Businesses are taxed which creates an incentive for these industries to find more ecological ways to deal with their pollution.

Green Business
-businesses are starting to realize that businesses cannot be sustainable over a long time period.

-new approach to business to how we can achieve both environmental protection and social welfare.

-promotes eco-efficiency, clean production pollution prevention, industrial ecology, natural capitalism, restorative technology, and environmentally preferable products.

Green Consumers
-includes: the Body Shop, Patagonia, Aveda, Malden Mills, Johnson and Johnson and Interface, Inc.

Environmental Geology

- Forces inside the earth cause continents to drift, split and crash into each other (very slowly).

A Layered Sphere
-core: interior of the earth, composed of hot metal (mostly iron), solid center, semi fluid outer, 2,900-5,000 km in diameter.
-Mantel: surrounds core, much less dense, high concentration of light elements (O_2, Si, and Mg), 2,900 km in depth.
-Crust: cool, lightweight brittle rock that floats on the mantle (oceanic crust is like the mantle but has more Si while the continents are thicker, lighter regions of crust rich in Ca, Na, K, and Al).
Tectonic Processes and Shifting Continents
-Tectonic Plates: large pieces of land broken and moved by huge convection currents on the upper layer of the mantle.
-Magma: molten rock that gets pushed up from the mantle through cracks in the oceanic crust and piles underwater to create ocean ridges. Huge mountains and trenches are formed, greater than anything on the continents.
-Earthquakes are caused by grinding and jerking as plates slide past each other.
-When plates collide mountain ranges are pushed up.
-When an oceanic plate collides with a continental landmass, the ocean plate will be subducted and move into the magma where it is melted and the continent will be pushed up (deep ocean trenches form where the ocean plates submerge and volcanoes form where magma erupts though vents and fissures in the crust usually due to this process).
-"Ring of Fire" is the place where oceanic plates are subducted under the continental plates. More earthquakes and volcanoes occur here than any other place on the planet.
-The continents are known to have been connected at least once (Pangea). The moving plates and changing climates may have something to do with the mass extinctions that have occurred.

ROCKS AND MINERALS:

-Mineral: a naturally occurring, inorganic solid element or compound with a defiant chemical composition and a regular internal crystal structure (must be solid therefore ice is a mineral but liquid water is not) (when an element is purified and in a solid noncrystaline structure, it is no longer a mineral but the ore it was extracted from is).
-Rock: a solid, cohesive, aggregate of one or more minerals.
-Each rock is made of grains of different minerals and the size of the grains will depend on how the rock was formed.
Rock Types and How They Were Formed

-Rock Cycle: creation, distraction and metamorphosis of rocks. Knowing this cycle can explain the origin and characteristics of rocks and how they are shaped, worn away, transported, deposited, and altered by geologic forces.
-Igneous Rocks: solidified from magma from the earth's interior. Magma that reaches the earth's surface cools quickly into basalt, rhyolite, andesite. These rocks have fine grains. Magma that is cooled in subsurface chambers has coarser grains and forms granite, gabbro etc.
-Weathering: exposure to air, changing temps and chemical reactions cause the breakdown of even durable rocks. (Mechanical weathering -physical breakup of rocks into smaller particles w/o a change in chemical composition. Chemical weathering- selective removal or alteration of specific components that leads to the weakening and disintegration of rocks ex. oxidation and hydrolysis. The products of chemical weathering are very susceptible to mechanical weathering and dissolving in water).
-Sedimentation: deposition of particles of weathered rock
-Sedimentary Rock: when deposited material remains in one place long enough or covered with enough material to compact it will become this type of rock. These rocks usually have layers.
-Relatively soft sedimentary rocks can be formed into unique shapes by the wind.
-Geomorphology- study of the processes that shape the earth's surface and the structures they create.
-Metamorphic rocks: preexisting rocks that have been modified by heat, pressure (sediments pile on top and tectonic buckling) and chemical agents. These rocks often hold the most economically important minerals such as talc, graphite and gemstones.

ECONOMIC GEOLOGY AND MINERALOGY:
-Economic Mineralogy: the study of minerals that are valuable for manufacturing and are important parts of domestic and international commerce. Metal bearing ores are the most economic minerals.
-The most valuable crystal resources are everywhere but concentrated and in places of easy access is what is needed.
Metals
-The metals consumed in greatest quantity by world industry include iron, aluminum, manganese, copper, chromium and nickel.
Nonmetal Mineral Resources
-Include gemstones, mica, talc, asbestos, sand, gravel, salts, limestone, and soils.
-Sand and gravel have the highest economic value of nonmetals and metals.
-Evaporites: are materials deposited by evaporation of chemical solutions. They are mined for halite, gypsum, and potash. Often found at 97% purity. Halite is used for water softeners and as road salt and refined as table salt.
Strategic Metals and Minerals
-World industry depends on about 80 minerals and metals, some of which exist in plentiful supplies
others do not like gold, silver and lead.
-Strategic metals and minerals: resources a country uses but cannot produce itself. A government usually will consider these materials as capable of crippling its economy or military strength if unstable global economics or politics were cut off to supplies.
-Usually less developed countries sacrifice the environment to mine and become producers of resources other countries need. This emphasis on a single export is not a stable foundation for an entire economy to be built since steady international markets are not a reality.
Environmental Effect on Research Extraction:
-Physical processes of mining and physical or chemical properties of separating minerals, metals, and other geological resources from ores or other materials.
-Ore: A rock in which valuable or useful metal occurs at a concentration high enough to make mining it economically attractive.
-Copper: concentration is close to 1 percent.
-Gold and other precious metals: concentration is close to 0.0001 percent.
Methods of Mining:
-Placer Mining: process in which native metals deposited in the gravel of streambeds are washed out hydraulically. Streambeds and aquatic life are destroyed.
-Strip mining and open-pit mining: Materials are removed from large, deep ores by big equipment.
-nearly a million acres of US land have been destroyed by strip mining
-50 percent of US coal is strip mined
-Underground tunnels- used to reach the deepest deposits.
-Mountaintop removal mining: mountain is removed from coal which devastates ecosystems.
Mining Hazards:

-tunnels collapse
-natural gas in coal mines can cause explosion
-fires produce smoke and gases
-acidic and toxic waste runoff is caused by surface waste deposits called tailings
-tailings from uranium can caused wind scattering of radioactive dust
-water dissolves metals and toxic materials which causes pollution
- Long ridges called spoil banks are susceptible to erosion and chemical weathering.
-19,000 km or rivers and streams in US are contaminated by mine drainage
-soil is destroyed which prevents vegetation
Controlling Mining:
-1977 federal Surface Mining Control and Reclamation Act requires better restoration of strip-mined lands, especially farmlands
-expense of reclamation is high, approximately $1,000 per acre
Processing:
-Metals are released from ores by heating or treatment with chemical solvents
-Smelting: roasting ore to release metals is a major source of air pollution
-Ducktown Tennessee: mid-1800s mining companies extracted copper with huge open-air wood fires which acidified soil and poisoned vegetation
-1907: sulfur emissions from Ducktown were reduced when Supreme Court ruled to stop interstate transport of air pollution
-1930s: Tennessee Valley Authority began treating soil and replanting trees
- two-thirds are areas is now considered adequately covered
-heap-leach extraction: technique used to separate gold from low-grade ores. It has a high potential for water pollution.
-Cyanide spills have occurred in Summitville mine near Almosa, Colorado and in a gold operating mind near Baia Mare in Romania.

Conserving Geological Resources:
Recycling:
-advantages of recycling: less waste, less land lost to mining, less consumption of money, energy and water resources
-recycling aluminum consumes one-twentieth of the energy of extracting new aluminum
-1/2 of aluminum cans will be made into another can in 1 to 2 months
-platinum is recycled for used cars
commonly recycled metals are gold, silver, copper, lead, iron, and steel.
-recycled metals are used for copper pipes, lead batteries, and steel and iron auto parts.
Steel and Iron Recycling:Minimills:
-Minimills: remelt and reshape scrap iron and steel
-produce half of US steel production
-use less energy than integrated mills
-Minimills produce steel at between $225 and $480 per metric tons
-Integrated mills produce steel at $1,425 to $2250 per metric tons
Substituting New Materials for Old:
-plastic pipes have decreased our consumption of copper, lead and steel pipes
-in automobile industry, steel is being replaced by polymers (long-chain organic molecules similar to plastics) , aluminum, ceramics, and high-technology alloys
-new materials reduce vehicle weight and cost, and increase fuel efficiency
-Electronics and communication technology use glass cables to transmit light pulses instead of copper and aluminum wires
Geological Hazards:
Earthquakes:
-sudden movements in the earth's crust that occur along faults where one rock mass slides under another.
-Kobe, Japan and Mexico cities are built on soft landfills and they suffer the greatest damage from earthquakes

-contractors plan to build heavily reinforced structures, strategically placed on weak spots in buildings, to absorb vibrations from earthquakes.
-tsunami: giant seismic sea swells that can move at 1,000 km/hr or faster from the center of and earthquake
-1883 Indonesian volcano Krakatoa created a tsunami that killed 30,000 people.
Volcanoes:
-source of most of the earth's crust
-fertile soils are weathered volcanic materials
Nuees ardentes (glowing clouds) are denser-than-air mixtures of hot gases that move faster than 100 km/hour and destroys towns such as St. Pierre on the Caribbean island of Martinique
-Mudslide associated with volcanoes have devastated Armero and Chinchina in Columbia
-volcanic eruptions release large volumes of ash and dust into air which blocks sunlight
-1991:Mt Pinatubo in Philipines emitted 20 million tons of sulfur dioxide producing sulfuric acid
Landslides:
-rapid downslope movement of soil or rock
-In US, $ 1 billion in property damage is done every year by landslides and related mass wasting
-threats: road construction, forest clearing, agricultural cultivation, and building on steep slopes

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-Include gemstones, mica, talc, asbestos, sand, gravel, salts, limestone, and soils.
-Sand and gravel have the highest economic value of nonmetals and metals.
-Evaporites: are materials deposited by evaporation of chemical solutions. They are mined for halite, gypsum, and potash. Often found at 97% purity. Halite is used for water softeners and as road salt and refined as table salt.
Strategic Metals and Minerals
-World industry depends on about 80 minerals and metals, some of which exist in plentiful supplies
others do not like gold, silver and lead.
-Strategic metals and minerals: resources a country uses but cannot produce itself. A government usually will consider these materials as capable of crippling its economy or military strength if unstable global economics or politics were cut off to supplies.
-Usually less developed countries sacrifice the environment to mine and become producers of resources other countries need. This emphasis on a single export is not a stable foundation for an entire economy to be built since steady international markets are not a reality.
Environmental Effect on Research Extraction:
-Physical processes of mining and physical or chemical properties of separating minerals, metals, and other geological resources from ores or other materials.
-Ore: A rock in which valuable or useful metal occurs at a concentration high enough to make mining it economically attractive.
-Copper: concentration is close to 1 percent.
-Gold and other precious metals: concentration is close to 0.0001 percent.
Methods of Mining:
-Placer Mining: process in which native metals deposited in the gravel of streambeds are washed out hydraulically. Streambeds and aquatic life are destroyed.
-Strip mining and open-pit mining: Materials are removed from large, deep ores by big equipment.
-nearly a million acres of US land have been destroyed by strip mining
-50 percent of US coal is strip mined
-Underground tunnels- used to reach the deepest deposits.
-Mountaintop removal mining: mountain is removed from coal which devastates ecosystems.
Mining Hazards:
-tunnels collapse
-natural gas in coal mines can cause explosion
-fires produce smoke and gases

-acidic and toxic waste runoff is caused by surface waste deposits called tailings
-tailings from uranium can caused wind scattering of radioactive dust
-water dissolves metals and toxic materials which causes pollution
- Long ridges called spoil banks are susceptible to erosion and chemical weathering.
-19,000 km or rivers and streams in US are contaminated by mine drainage
-soil is destroyed which prevents vegetation
Controlling Mining:
-1977 federal Surface Mining Control and Reclamation Act requires better restoration of strip-mined lands, especially farmlands
-expense of reclamation is high, approximately $1,000 per acre
Processing:
-Metals are released from ores by heating or treatment with chemical solvents
-Smelting: roasting ore to release metals is a major source of air pollution
-Ducktown Tennessee: mid-1800s mining companies extracted copper with huge open-air wood fires which acidified soil and poisoned vegetation
-1907: sulfur emissions from Ducktown were reduced when Supreme Court ruled to stop interstate transport of air pollution
-1930s: Tennessee Valley Authority began treating soil and replanting trees
- two-thirds are areas is now considered adequately covered
-heap-leach extraction: technique used to separate gold from low-grade ores. It has a high potential for water pollution.
-Cyanide spills have occurred in Summitville mine near Almosa, Colorado and in a gold operating mind near Baia Mare in Romania.

Conserving Geological Resources:
Recycling:
-advantages of recycling: less waste, less land lost to mining, less consumption of money, energy and water resources
-recycling aluminum consumes one-twentieth of the energy of extracting new aluminum
-1/2 of aluminum cans will be made into another can in 1 to 2 months
-platinum is recycled for used cars
commonly recycled metals are gold, silver, copper, lead, iron, and steel.
-recycled metals are used for copper pipes, lead batteries, and steel and iron auto parts.
Steel and Iron Recycling:Minimills:
-Minimills: remelt and reshape scrap iron and steel
-produce half of US steel production
-use less energy than integrated mills
-Minimills produce steel at between $225 and $480 per metric tons
-Integrated mills produce steel at $1,425 to $2250 per metric tons
Substituting New Materials for Old:
-plastic pipes have decreased our consumption of copper, lead and steel pipes
-in automobile industry, steel is being replaced by polymers (long-chain organic molecules similar to plastics) , aluminum, ceramics, and high-technology alloys
-new materials reduce vehicle weight and cost, and increase fuel efficiency
-Electronics and communication technology use glass cables to transmit light pulses instead of copper and aluminum wires
Geological Hazards:
Earthquakes:
-sudden movements in the earth's crust that occur along faults where one rock mass slides under another.
-Kobe, Japan and Mexico cities are built on soft landfills and they suffer the greatest damage from earthquakes
-contractors plan to build heavily reinforced structures, strategically placed on weak spots in buildings, to absorb vibrations from earthquakes.
-tsunami: giant seismic sea swells that can move at 1,000 km/hr or faster from the center of and earthquake

-1883 Indonesian volcano Krakatoa created a tsunami that killed 30,000 people.
Volcanoes:
-source of most of the earth's crust
-fertile soils are weathered volcanic materials
Nuees ardentes (glowing clouds) are denser-than-air mixtures of hot gases that move faster than 100 km/hour and destroys towns such as St. Pierre on the Caribbean island of Martinique
-Mudslide associated with volcanoes have devastated Armero and Chinchina in Columbia
-volcanic eruptions release large volumes of ash and dust into air which blocks sunlight
-1991:Mt Pinatubo in Philipines emitted 20 million tons of sulfur dioxide producing sulfuric acid
Landslides:
-rapid downslope movement of soil or rock
-In US, $ 1 billion in property damage is done every year by landslides and related mass wasting
-threats: road construction, forest clearing, agricultural cultivation, and building on steep slopes

Environmental Health and Toxicology

Disease
Pathogens- Disease causing organisms, such as bacteria, viruses and parasites
Morbidity- illness
Mortality- death
* Illness Factors include diet and nutrition, infectious agents, toxic chemicals, physical factors and psychological stress.
* Antibodies are introduced to prevent disease, by introducing a foreign particle
* The Top Three Leading killers
  1. Cardiovascular Disease
  2. Cancers and Tumors
  3. Acute Respiratory Disease
* Higher Death Rates occur in less fortunate counties where conditions are not ideal for human health and survival
* Pesticides- used to eliminate insect vectors. Problem: Insects tend to become very resistant to the pesticides being used to destroy them, therefore allowing the insect population to come back and infect others
- Currently, death rate is decreasing and life expectancy is increasing

AIDS- the largest cause of deaths in the world...killing 3 MILLION people in YEAR 2000!!!
* Over 36 million people are currently living with HIV.
* Largest occurrence in Africa
* Drug Addictions and Unprotected Sex are the two main causes, Heterosexuality
* Places such as Botswana, Zimbabwe and Zambia tend to have survival only of the very young and very old, as the middle ages of those living in these communities have died due to AIDS

Other Diseases
Viruses
  - Ebola- 90% Mortality
  - AIDS- 40 Million People now affected
Bacteria
  - Tuberculosis- 256 cases resistant to drugs
  - Anthrax-
  - Botulism- most recognized in Botox injections (beauty purposes)
Malaria- One million die a year
- More people are being able to afford vaccines, as they are being made faster and cheaper
- U.S. spends $75 Million a year on infectious disease research
*DALY or The Disability-Adjusted Life Years measure the total burden of disease on productivity and quality of life.
*DALY measures are very high in poor countries such as Africa due to lack of sanitation, bad water and polluted drinking water

- Malnutrition creates many diseases
*Approximately 2 billion people suffer from worms, flukes, protozoa and other internal parasites...affects the immune system greatly!
* 30 new diseases have been introduced in the past two decades
*Emergent diseases are those never known before or that has been absent for at least 20 years
* Flu Epidemic of 1918 was LARGEST loss of life from an individual disease in a single year...(between 30 and 40 million)
*Most flu strains are transmitted by air, or by pigs, birds, monkeys and rodents
- As population grows, the faster a disease will spread
* Outbreaks can occur among livestock as well
* Strep is the most common form of hospital-acquired conditions

Toxicology (Toxic and Hazardous Materials)
- Hazardous = dangerous, including flammables, explosives, irritants, sensitizers, acids and caustics
- Toxins = poisons so they react with cellular components that kill cells
- Allergens = substances that activate the immune system, can act directly as antigens
* Antigens *- foreign white blood cells

****Four Main Categories of TOXINS****
1. Neurotoxins- kill neurons in the nervous system...example/ Mercury and Lead
2. Mutagens- cause mutations by altering DNA
3. Carcinogens- cause cancer
- The Delaney Clause to the US Food and Drug Act states that no known carcinogen causing "reasonable harm" may be added to food and drugs.
4. Teratogens- toxins that cause abnormal embryonic cell division and result in birth defects...example/ Alcohol and Thalidomide

* LD50- measures toxicity of a chemical, LD50 is the dose lethal to 50% of a test population; the lower the LD50, the more toxic the chemical
- The established dose curve will determine the dose below which none of the test subjects were harmed...creating the threshold level, or guide for setting human tolerance levels
- The Dose/Response Curves are not always symmetrical, making it difficult to compare toxicity of unlike chemicals
**Bioaccumulation of a toxin occurs when an organism absorbs and stores the toxin in its tissues
**Biomagnification, and the best-known example is with the insecticide DDT

1. Effects of DDT were explained in Rachel Carson's book "Silent Spring"

Famous Cases
- "Silent Spring" mentioned the persistence of pesticides in the environment, Bioaccumulation and biomagnification and effect on non-target species
- Love Canal- Mentions Social Justice, Persistence of toxic wastes and Superfund Site. Canal was dug beginning in 1892. When canal failed to be completed, it was used as an industrial dump for several toxic chemicals. The property was sold in order to build several homes and a community school. Many people became ill and when tests were conducted high toxic levels of chemicals were found and the company who originally sold the property was forced to pay for the removal of the waste found. Today, the people are allowed to move back to their old homes, the site is clean.
- Other cases include the Bhopal Crisis, Ebola and the Hot Zone, Agent Orange and the Vietnam Conflict and the Flu Vaccine

*Acute Toxicity occurs when a large dose inflicts immediate harm on an organism
*Chronic Toxicity occurs when a smaller dose is expressed over a long period of time, harder to detect because it may not be seen for years
*Chemical Synergism- when two toxins together have a greater effect than the SUM of the effects of the two toxins separately...example/ small amount of alcohol with small amount of barbiturates can have a severe effect on the

central nervous system...or smoking and asbestos can expose a person to cancer ten times greater than if they were exposed to just one of the factors.
*Best way to destroy these chemicals and toxins-through neutralization or oxidation... Incineration, Air Stripping, Carbon Absorption or Flocculation
* Waste Disposal...Landfills and Dumps, Incineration or a huge problem creator, Selling the Waste to Poor Counties, by doing this the people of the country absorb these toxic wastes into their bodies, all so they get more money.

*HAZMAT Alternatives- You can replace your everyday cleaner with the right combination of harmless substances...things such as Lemon Juice, Vinegar, Water, Club Soda and so much more can replace more hazardous chemicals to make the result safer
*How to Help- Conserve, Recycle and Reduce!

Environmental Philosophies

Understanding our Environment and Environmental Ethics and Philosophy

"The more clearly we can focus our attention on the wonders and realities of the universe about us,
the less taste we shall have for destruction."
-- Rachel Carson

Environmental History of the World
1 BIBLE-nature: dark + evil (viewed by Western Civilization)
2.UTILITARIAN CONSERVATION- Nature is for man's use.
~Gifford Pinchot- 1st head of Forest Service
~anthropocentric- what's in it for man?
3. BIOCENTRIC PRESERVATION- nature for nature's sake.
~ John Muir -started Sierra Club. ex. Mineral King Valley court case
4. MODERN ENVIRONMENTAL MOVEMENT-
~Rachel Carson- wrote Silent Spring (DDT softens egg shells)
~ David Brower-saved the Grand Canyon

*Population Explosion
-6.4 billion & averaging 85 million more each year. Most populated countries: China and India
-Most growth & occurring in poor countries
- Theories vary on long-term population standing (up or down?)
Are there enough resources to provide for this population let alone an increase (drinkable water, food?

*Deforestation= "destruction of tropical forest, wetland, coral reefs"
-extreme lose of species abundance and diversity
If continued, how will this impact the earth's future?

*Pollution
-50% toxic waste produced by U.S.
-26% toxic air emissions by U.S.
-Growing problem in industrialized nations
- Hundreds of millions of toxic waste is produced annually
-"No one wants it in their backyard"= exporting to other countries
When there is no room left, where will waste go and at what cost?
~Combination of toxic waste & other environmental ills cause more destruction than infectious diseases

*Global Warming
- Fossil Fuels (FF)=80% of energy used in industrialized nations (non-renewable....yikes!)
-Burning Fossil Fuels creates CO_2 & heat absorbing gases= *GLOBAL WARMING!!!!!!!!
- effects: sea level rises, drastic climate changes, & massive extinctions

Signs of Hope:
-some cities are cleaner and less polluted than in the past
-population stabilized in industrialized countries
-# of children/women decreased from 6.1 to 3.4
-Infectious diseases have been reduced, life expectancy nearly doubled

-the relative gap between the rich and poor has increased but the percentage of those living in poverty has decreased slightly.

Still Need to have:
-Clean renewable energy sources
- Process of safely disposing toxic waste
-Control birth rate & minimizing poverty

Interrelationship of society and the environment
- North/South Division of haves and have nots
--income ratio of poor to wealthy in 2000 =100 to 1

Economic Classification:
First World-industrialized, democratic, market economies.
Second World- previous socialist countries.
Third World- developing, non-industrialized.

Acute Poverty-1/5% world making less than $1/day.
How can we work within the boundaries of nature and continue to improve economic status of all humanity? (Sustainable Development)

Perspectives
-Neo-Malthusian: world full of too many people fighting over to few resources (pessimistic)
-Technological optimists: human innovations and advancements will solve the earth's problems (critics refer to as Cornucopian Fallacy)

Environmental Ethics and Philosophy

morals: distinction between right and wrong
values: the ultimate worth of actions or things

Environmental Ethics~~> moral relationships between humans + the world around them

A. Other Ethics:
1) Universalists~~> the principles of ethics are universal, unchanging, and eternal
2) Relativists~~> moral rules always apply to a particular person, society, or situation
"There are no facts, only interpretations"-Nietzsche
3) Nihilists~~>there are no truths, life is hard, and dark. The world makes no sense at all!
4) Utilitarians~~>an action is right when it produces the greatest good for the greatest number of people. Pleasures on the intellect are superior to pleasures on the body.

Modern Environmentalism- Silent Spring, written by Rachel Carson, is often viewed as initiating the environmental movement. Her book documented the tragic effects of DDT on birds.

B. World views and Ethical Perspectives
"What people do about their ecology depends on what they think about themselves in relation to the things around them" - Lynn White Jr.

1.) Anthropocentric~~> "human-centered" Environmental responsibility and duties are derived from human interest.
2.) Stewardship~~> a strong sense of responsibility to manage and care for a particular place.
3.)Biocentric~~> "life-centered" All forms of life have the right to exist! Everything in this world is important.
4.) Ecocentric~~> "Earth-centered" the environment deserves moral consideration on its own, not associated with human interest.
5.) Ecofeminism~~> a philosophy that suggests how humans could reconceived themselves and their relationship to nature in non-demanding ways.

C. Environmental Justice~~> combines civil rights with environmental protection to demand a safe, healthy, beautiful environment for everyone.
ex: 3 out of 5 African-Americans and Hispanics, and nearly half of all NATIVE AMERICANS, ASIANS AND PACIFIC islanders live in communities with one or more toxic waste sites or major landfills. (LULU's Locally Unwanted Land Uses)

D. Environmental Racism~~> inequitable distribution of environmental hazards based on race. Ex: the people who have the highest lead content in their bodies are Latino, Native American, African American, and Asian children.

>>>Dumping Across Borders:
Paying a poorer country/community to allow the dumping of toxic wastes in their land.
Ex: nearly every tribe in America has been approached with proposals for some dangerous Industry or waste facility

Toxic Colonialism~~> targeting poor communities of color in the 3rd or 4th world countries for waste disposal and/or experimentation with risky technologies.
This has gotten worse over the years. Millions of tons of hazardous materials have been moved (legally or illegally) from richer to poorer countries every year.

1992 - The Environmental Justice Act introduced in US.
identify areas threatened by toxic chemicals, assess health effects, ensure residents chance for public discussion concerning cleanup of industrial facilities.

>>>"Green" Organizations.

Most Environmental Activist groups seem to only care about wildlife preservation, instead of inner-city problems (which are much more pressing to people who are struggling for survival)

NIMBY- Not In My Back Yard- protests the dumping of pollution in one's own neighborhood. The protests too often end with dumping in someone ELSE's backyard.

National People of Color Environmental Leadership Summit (1991) decided to combine civil rights with Environmental justice.

====>Science as a way of knowing(!), exploring and explaining the world around us.

>>>The Scientific Process:

Inductive and Deductive Reasoning:
Deductive Reasoning~~>Deriving Testable predictions about specific cases from general principles.

Inductive Reasoning~~>Inferring general principles from specific examples.

>>>Hypothesis and Scientific Theories

Hypothesis~~> A provisional explanation that can be tested scientifically

Scientific Theory~~> An explanation supported by many tests and accepted by a general consensus of scientists.

Scientific Method~~> A systematic, precise objective study of a problem.

When asked to create your own scientific test for a phenomenon you must include:

Hypothesis
Equipment and materials needed
Description of test (control and one variable at a time)
Detailed list of procedures include time frame of test
How data collected and organized
Possible outcomes of test and how it would relate to your hypothesis

>>>Paradigms and Scientific Consensus

Paradigms~~> A model that provides framework for interpreting observations.
They determine which phenomena are worth investigating.

>>>Technology and Progress

Luddites~~> opponents of rampant technology.
(They smashed power looms and other machines in the 19th century because they threatened craft guilds and cottage industries.)

Neo-Luddites~~> Like Luddites except they're the 'new wave." They say we should revert back to low-tech Pastoral or hunting-gathering society. Some resort to terrorism and bombings.

>>>Appropriate Technology

Appropriate Technology~~> Technology that does the least harm to human society and the environment. Cheap and easy to make.

Human Population

Population Growth rate
History of Human Population
-Human populations were kept in check by diseases, famines and wars until the middle ages ex: Infanticide, Bubonic Plagues
-Populations began to increase rapidly after A.D. 1600 (Increased sailing and navigating skills, agricultural

developments, better sources of power, better health care and hygiene)
-We are now in a J-curve, population is increasing at an exponential rate. Our present population is 6.6 billion people and growing by 100 million people per year.

Demographics-vital statistics about people (births, deaths, where people live, total population size)
1) Crude Birth rate-the number of births in a year per thousand persons
2) Crude Death rate-the number of deaths per thousand persons in any given year
3) Life Expectancy-the average age that a newborn infant can expect to attain in any given society
To calculate the annual rate of population growth subtract the crude death rate from the crude birth rate and divide by 10.

The replacement fertility rate is the number of children a couple must have to keep the population stable. In the third world it is 2.7, in the US it is 2.1.
-Developing countries have seen the greatest progress
-Discrepancies in how benefits are distributed within a country are shown by varying life expectancies at different areas in a country
-Annual income has a strong correlation to life expectancy
    Developing Countries-residents live for about twice as long as they used to
    Developed Countries-increase not as great because it was higher to begin with

Impact on Resources-The more people there are, the more resources are used. Especially in developed countries like the U.S. where the amount of resources used per person is greater then in less developed countries.

Carrying Capacity-local, regional and global
-The number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural social, cultural and/or economic environment for present and future generations. As the environment is degraded, carrying capacity gets smaller. The maximum carrying capacity for humans on the Earth is 13-15 billion. The average ecological footprint an American makes is approximately 12 acres/person. Our footprint is the number of acres required to meet the resource needs of an individual.

Population Projections and Solutions
-There could be a population overshoot past the carrying capacity and then a die-off or we could adjust our population growth to an S-curve

-Estimated Demographic Transitions-from high birth and death rates to lower birth and death rates due to improved living conditions and economic development

-Cairo Conference-179 countries met in 1994 to develop an action plan to deal with population growth and included issues such as poverty and health care
    -5 Basic Components
    1) Provides family-planning services
    2) Promotes free trade, private investment, and assistance to countries that need help.
    3) Addresses issues of gender equity.
    4) Addresses issues of equal access to educational opportunity.
    5) Educates men.

*Female Education and Economic Status-If females are educated about birth control, and made aware that they do not need to have many children to replace them, they will not have as many babies. Also, if their economic status is improved, many women will get jobs instead of having children

-Family Planning
-Fertility Decline in Rich Countries
-Abortion-RU486, methotrexate, misprostol, surgical abortion
  -Avoidance-Body temp. technique, celibacy/abstinence

-Barrier-Condom, diaphragm, cervical cap, vaginal sponge, spermicide, IUD
-Chemical-"The Pill"
-Surgical-Tubal litigation, vasectomy

Laws

-Federal Insecticide, Fungicide, Rodenticide Act of 1947 (FIFRA): regulates the manufacture and use of pesticides
-Wilderness Act of 1964: established the national wilderness preservation system
-Water Quality Act of 1965: attempt to reduce non-point source pollution by creating government watch dog under Dept of Heath, Ed and Welfare.
-National Environmental Policy Act of 1969: Environmental Impact statements must be done before any project effecting federal lands is started. Created a council on environmental quality.
-Clean Air Act of 1970: established national primary and secondary air quality standards. Set emission standards for cars, and limits for release of air pollutants.
-Clean Water Act of 1972: set maximum permissible amounts of water pollutants that can be discharged into waterways and created pollutant discharge permits. Goal: To make all water swimmable and fishable.
-Endangered Species Act of 1973: protects threatened and endangered animals in the US, and puts their protection over economic considerations.
-Safe Drinking Water Act (SDWA) of 1974: set maximum contaminant levels for pollutants that may have adverse effects on human health.
-Superfund Amendments and Reauthorization Act (SARA): increased superfund to $8.5 Billion. Shares responsibility for cleanup among potentially responsible parties.
-Toxic Substance Control Act of 1976: EPA- ban or regulate chemicals deemed a risk to health to the environment.
-Resource Conservation & Recovery Act (RCRA) of 1976: Controls hazardous waste with a cradle to grave system from storage, treatment, transportation to disposal.
-Surface Mining Control & Reclamation Act of 1977 (SMCRA): requires coal strip mines to reclaim the land
-Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980: Created $1.6 billion superfund designed to identify and clean up abandoned hazardous waste dump sites. Established liability for clean up costs if source could be identified.
-Ocean Dumping Ban Act of 1988: Bans dumping of sewage, sludge and industrial waste into oceans.
-Food Quality Protection Act of 1996 (FQPA0: Set pesticide limits in food, and all active and inactive ingredients must be screened for estrogenic/endocrine effects.
-Low Level Radioactive Policy Act: all states must have facilities to handle low level radioactive wastes.
-Nuclear Waste Policy Act: US government must develop a high level nuclear waste site by 2015
-Coastal Zone Management Act (CZMA)- A 1972 Federal law that provides guidance and federal assistance to voluntary state and local coastal management programs. Goals are for the protection of natural resources and management of land development along coasts.
-Federal Land Policy and Management Act (FLPMA)- A 1976 Federal law that outlines procedures concerning the use and preservation of public US lands.
-Food Drug and Cosmetic Act- A federal law passed in 1906 that regulates the sanitary condition and safety of food, drugs and cosmetics. It includes food additives.

International Treaties, Laws and Conventions

-Convention on International Trade in Endangered Species (CITES): lists species that cannot be commercially traded as live specimens or wildlife products.
-Madrid protocol: Moratorium on mineral exploration for 50 years in Antarctica
-Kyoto Protocol of 1997: Controlling global warming by setting greenhouse gas emissions targets for developed countries. Not signed by the U.S.
-Montreal Protocol of 1987: A plan to limit and eventually phase out ozone depleting substances (CFC's)
-Earth Summit: held in 1970's, discussed clean water and air. Held in South Africa. The last summit tried to pass a

world law by the year 2010 that 15% of our power was to be created by air and solar power. But the Summit was shut down.
-The World Trade Organization (WTO): designed to make international trade more fair and encourage development. It has been used to subvert national environmental laws. Has the effect of hurting small, local farmers and businesses.
-North American Free Trade Agreement (NAFTA): Trade alliance between U.S., Canada and Mexico

Role of Government in Environmental Affairs Module

History

? In 1639 Rhode Island Colony established a closed season on deer hunting
  1. Colonies and later states established similar regulations
  2. Enforcement of regulations not really dealt with until warden systems developed in the 1850's

? Lacey Act - 1900
  1. Prohibited the transportation of illegally killed game across state lines, curbed trafficking of plumage and other wildlife products and initiated permit requirements and controls for the introduction of mongooses, starlings and other exotic species
  2. Established federal control over wildlife, broadened the areas of interest, strong deterrent to the unwarranted exploitation of wildlife

? Migratory Bird Treaty Act (1918)
  1. International treaty for the protection of whooping cranes, swans, most shorebirds and wood ducks, bird nests and eggs and establishment of closed seasons for waterfowl, and authorization for the states to adopt and enforce regulations that were not inconsistent with federal provisions
  2. Beginnings of an expanded wildlife refuge system, endangered species management and federal law enforcement

? Pittman-Robertson Act (1937)
  1. Levied a 10% tax on the sales of sporting arms and ammunition, money returned to the state based on a formula
  2. Through matching program ($1 from state: $3 P-R) state projects approved at the federal level; research, land acquisition and construction

? Dingell - Johnson Act (1950)
  1. Levied a 10% excise tax on fishing tackle
  2. Similar matching program as P-R and supported research projects, fish hatcheries, land acquisition

? Fish and Wildlife Coordination Act (1934)
  1. Ensured that fish and wildlife receive equal consideration with other features of water-development programs at the federal level
  2. Massive dislocations of water must consider fish and wildlife values
  3. If project jeopardizes existing wildlife habitat, land acquisition may be required part of the project

? Wetland Loan Act (1961) - Money loaned to the U.S. Fish and Wildlife Service for wetland acquisition in the face of rapid loss of wetlands

? Wilderness Act (1964)
  1. Maintain the pristine nature of land where man is a visitor who does not remain
  2. Established the value of pristine wilderness, protected areas from any development, habitat preservation, use for research

Current Federal legislation

? Freedom of Information Act (1966)
? National Environmental Policy Act (1969)
? Clean Air Act (1970)
? Occupational safety and Health Act (1970)

? Federal Insecticide, Fungicide and Rodenticide Act (1972)
? Endangered Species Act (1973)
? Safe Drinking Water Act (1974)
? Resource Conservation and Recovery Act (1976)
? Toxic Substances Control Act (1976)
? Clean Water Act (1977)
? Comprehensive Environmental Response, Compensation and Liability Act
? Emergency Planning and Community Right to Know Act (1986)
? Superfund Amendments and Reauthorization Act (1986)
? Oil Pollution Act of 1990
? Pollution Prevention Act (1990)

Pertinent New York State Legislation

? Where to find the Environmental Conservation Laws

1. Seasons, bag limits, regulations etc.
2. Recycling laws
3. Air pollution standards
4. Endangered species related laws

Interpretation of the fundamental principles of ecology to further the understanding of why these laws have been instituted

Key Agencies

? U.S. Environmental Protection Agency
? U.S. Department of the Interior - Fish and Wildlife Service
? U.S. Agencies whose work impacts on the environment

1. Department of Justice
2. Department of Transportation
3. Federal Emergency Management Agency
4. U.S. Geological Survey
5. Department of Health and Human Services
6. Department of Labor

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Matter

Energy Flow -First Law of Thermodynamics- Energy is conserved, not created or destroyed. It can only change in form.
-Second Law of Thermodynamics- Energy transfers lead to the energy being in a less "useful", lower form.
Matter recycles itself, unlike energy. Energy always degrades to a less concentrated level.

High Quality Energy: Very concentrated, rich, intense, has high temperatures.
Low Quality Energy: dispersed, diffused, sporadic, low temperature

-Photosynthesis: Plants convert energy from sun along with carbon dioxide and water into sugars ($C_6H_{12}O_6$) and oxygen within the chlorophyll. Only 1-2% of the sunlight ever makes it into the plant's tissue!
-Aerobic Respiration: Oxygen consuming producers, consumers and decomposers break down complex organic compounds (glucose, etc) and convert carbon back into carbon dioxide. The energy stored in the glucose bonds is transformed into chemical and heat energy- it is not lost! The formulas for photosynthesis and respiration are the same but reversed!

Biotic- living components of the ecosystem
Abiotic-nonliving components of the ecosystem

Trophic Levels:

1. Tertiary Consumers- eats secondary consumers
2. Secondary Consumers- eats primary consumers
3. Primary Consumers/Herbivores -eats plants
4. Producers/Autotroph- Photosynthesize energy

The biomass of each level is 90% greater than the one below it! Only 10% of useable energy is transferred up to the next trophic level because so much is lost.
-Some of the food source many be inedible or indigestible.
-Energy may be expended catching the prey
-Energy is degraded through normal metabolic processes (Second law of thermodynamics).

--Food Chain- A linear list of who eats who. The arrow points to who is doing the consuming.
--Food Web- A more complex interwoven diagram of which organisms prefers to eat each other.

Scavenger- Feeds on dead animals. ex. coyote
Detritivore- Eats leaf litter, dung. ex. ants
Decomposers- organsims that break down or feeds on dead organic matter. ex. Fungus or bacteria

Nutrient Cycles

Carbon Cycle

The building blocks of life.
Short cycle: Photosynthesis and Respiration. Carbon is incorporated into a sugar during photosynthesis and then released during respiration. Plants, animals and microbes all respire which send the CO_2 back into the air.

Long term cycle:
Carbon can stay in one form for years to thousands of years before changing.
Carbon sinks: plants, animals, ocean life (especially in plankton, coral and fish skeletons), coal, oil, atmosphere, and limestone ($CaCO_3$).

Largest storage reservoirs of carbon are in carbonate rocks.

Man is upsetting this cycle by burning fossil fuels and tearing down the jungles and woodlands of the world.

Nitrogen Cycle

Nitrogen is a critical limiting factor for plant growth. A majority of nitrogen exists as an inert gas (N_2) the in air (78%), yet plants can't take it up. How can a plant access it?
1. Nitrogen Fixing: Atmospheric nitrogen is "fixed" or transformed by bacteria living symbiotically on plant roots of legumes or in blue green algae (cynobacteria). The bacteria change the N_2 into ammonia. (This form of nitrogen is toxic to most plants). Examples of legumes are peas, beans, soy, clover and alfalfa.
2. Nitrification- A different set of bacteria break down the ammonia by combining it with oxygen to create nitrites and then finally nitrates. Plants can absorb nitrates nicely.
3. Assimilation- The plants then incorporate the nitrogen into organic molecules (DNA, amino acids, proteins, etc!). Animals might then chow on the plants incorporating the nitrogen into their bodies.
4. Ammonification- Dead plants and organic waste (like cow dung) convert their stored nitrogen back into ammonia with the help of decomposers.

5. Denitrification- Some of the nitrates can be converted back into atmospheric N2 through the help of (you guessed it)- bacteria!

Man is upsetting the natural balance of nitrogen by fixing nitrogen artifically to make fertilizers. These fertilizers as well as excess sewage rich in nitrogen (from large animal farms or crappy munipal waste systems for humans) is added to aquatic ecosystems by rain runoff or sewage overflows. This in turn destroys the health of our fresh water streams and ponds by promoting rampant algae growth, which eventually renders the aquatic environment lifeless!!! :(

Phosphorus Cycle

A veeerrry sllloow cycle.
Soils contain very little phosporous naturally, so it is also major limiting factor for growth.

Phosphorous does not circulate as easily as nitrogen because it does not exist as a gas, but is released by weathering of phosphate rocks. The phosphorous (PO4) is then dissolved in water and absorbed by plants. Animals that eat plants then pass the phosphorous along to the decomposers through their waste products, or when they die and decay. The decomposers then break down the phosphorous to the soil.

The largest storage reservoir of phosphorous is in rocks.

Man is creating an imbalance in phosphorous levels by mining Guano (bird poop rich in phospates) for fertilizers and detergents. These products then make their way to our fresh waterways causing massive algae blooms and wide zones devoid of life.

Sulfur Cycle

Another slow cycle upset by mans influence. Most sulfur is bound up inside rocks (like pyrite and gypsum). On a good day sulfur can become mobile through volcanic eruptions or deep-sea vents. Unfortunately, burning coal and other fossil fuels adds massive amounts of sulfur into the air, which causes the rain to be damagingly acidic.

Pests

Persistence and Mobility in the Environment
-Because DDT and other chlorinated hydrocarbons are so stable, have high solubility, and high toxicity, it makes them effective pesticides, as well as environmental nightmares.
-Often bio-accumulate in animal fat, leading to bio-magnification in predators like falcons.
-Grasshopper Effect: substances evaporate from warm regions and precipitate in colder regions, accumulating in great concentrations in top predators up north.
-DDT byproduct has been found to be able to enter a woman's amniotic fluid, which can be dangerous to the developing baby even in small amounts.
-POPs (persistent organic pollutants) like Atrazine and alochlor are so dangerous and long-lasting, 127 countries agreed to ban them. The 12 most dangerous (dirty dozen) have been banned
-Pesticide can either have short term effects on human health or long term effects. Short term effects include poisoning and illness from high exposure doses. Long term effects include cancer, birth defects, Parkinsons, and other degenerative diseases.
-3.5- 5 million people suffer acute pesticide poisoning each year. 20,000 die from it.
-farmers who use pesticides are 8 times more likely to develop non-Hodgkin's lymphoma.
-long-term exposure and consumption of contaminated foods can cause learning disorders in the generations that were developing with the pesticides.

Alternatives
Behavioral changes
-crop rotations, flooding fields, burning crop residues, restoring windbreaks, hedge rows, and groundcover allows bird and other predators perches from which to eat insects. Adjusting planting times could avoid pest concentration, growing where pests are not prevalent, and tilling and diversifying species can prevent losses from pests.

-Biological controls- predator insects (mantises, wasps, ladybugs), pathogens, as well as ducks and geese, which eat insects and weeds, and are harmless to crops. Often times they will continually provide protection year after year. Herbivorous insects also control populations of hardy weeds.
-bio-engineered sterile males can fight against pests or plants that are engineered to be resistant to insects or weeds.
-development of upsetting hormones and sex lure traps have been used to stop the spread of pest insects.
Integrated Pest Management
-a flexible, ecologically based pest control strategy that carefully applies techniques at specific times, intervals, and aimed at specific pests. It determines economic threshold at which pesticides need to be applied to justify returns.
-trap crops are grown a week before other crops, mature early, attract the insects, and are sprayed with pesticides. Thus, they detract pests away from the real crop.
-many countries and states like Massachusetts, Brazil, Cuba, and Costa Rica have had remarkable success transforming their agriculture with IPM.
-in Indonesia, pests that once ran rampant were controlled by the education of poor farmers in the benefits of IPM. Because the staple crop is rice, it could be important for other countries.

Reducing Pesticide Exposure
Regulating pesticides
-many of the thousands of tons of pesticides in the U.S. contain suspected carcinogens and pose human health hazards.
-EPA regulates through scientific studies which pesticides pose health risks.
-FDA & USDA- enforce EPA rulings, have authority to destroy food shipments that do not conform.
- Delaney Clause- added in 1958 to the U.S. FFDCA that states that any cancer causing agent cannot be added to processed food, drugs, or cosmetics.
-has been revamped, now law has been restated, saying that if the risk is so slight that it has "little" effect (it just kills you slowly), the additive can be used.
-now, pesticides like methyl parathion and other harmful ones have been banned for use on fruit because of human health concerns. These pesticides can damage human internal organs.
-however, many people agree that carcinogens from food are relatively unimportant as opposed to the natural carcinogens all around us.

A Personal Plan
-don't use chemicals on your yard and garden. Clean up spilled food to eliminate insects. Wash houseplants to get rid of pests. Drown slugs in stale beer in a saucer. Drain stagnant water to discourage mosquito breeding. Use toxic chemicals in only the smallest possible amounts. Read magazines on being organic and healthy.

HISTORY:
-5,000 yrs, ago. Sumerians: sulfur
-2,5000 yrs ago: China: mercury, arsenic. Greek/Roman: oil sprays, ash, sulfur, lime.
Also: burn fields, rotate crops, spices and alcohol for spoilage
-1,200 yrs ago: predatory ants in China used for caterpillar control
-1934 DDT discovered by Paul Muller controls insects
-1943 first DDT produced on large scale, used on fields, forests, and cities.
-1960's discovery that predatory birds had softened egg shells from DDT- passed through food webs
-1970s DDT use banned

PESTICIDE USE:
US uses the most pesticides in the world :(
Monoculture growing practices causes need for more insecticide use

PESTICIDE TYPES
-Inorganic pesticides- arsenic, copper, lead and mercury compounds. Highly toxic, indestructible, neurotoxin, harmful to humans.
-Natural organic pesticides (botanicals)- extracted from plants, nicotine, rotenone (from roots of debris plants- kills fish), pyrethrum (Chrysanthemum extractions), coniferous oils.
-Fumigants- easily dispersed gasses to sterilize soil, prevent decay/rodents/insects harmful to humans- banned [ex:

carbon disulfide]
-Chlorinated hydrocarbons (organochlorines)- synthetic organic insecticides, toxic and long lasting, banned, blocks nerve signals, [ex: DDT, aldrin]
-Organophosphates- lethal, but only for short time period, quickly dissipate, damages nervous system not persistent, low bioaccumulation [ex: DDVP]
-Carbamates (urethanes)- not persistent, low bioaccumulation, damages nervous system, kills bees esp. [ex: Sevin, Temik, Baygon]
-Microbial agents & Biological controls- pest control using living organisms [ex: ladybugs eat aphids, parasitic wasps lay eggs in caterpillars]

PESTICIDE BENEFITS:
-Disease control- insects that carry diseases are killed, thus decreasing human suffering [ex: malaria via mosquitoes]
-crop production- crop loss is decreased by eliminating pest, farmers save $3-5 for every $1 spent on pesticides

PESTICIDE PROBLEMS:
-other species- sometimes wipe out area of all living organisms [ex: bees die, thus bee keeper profit goes down, and crops not well pollinated. Sacramento River herbicide dumped and river ecosystem decimated]
-pest and pesticide resurgence. Resistant genes are being communicated between species problem is having used pesticides so abundantly, no longer as useful and effective
-pest creation- predators are reduced by pesticides, predator controls are gone, thus lower trophic levels explode [ex: Canete Valley, Peru]

DEFINITIONS:
Biological pest- organism that inhibits use of resources
Pest control- any method of killing pests
Pesticide- chemical that kills pests
Biocide- kills many kinds of organisms
Herbicide- kills plants
Insecticide- kills insects
Fungicides- GUESS. (kills fungi)
Pest resurgence (rebound)- quick reproduction cycle causes pests to re-populate with pesticide-resistant individuals
Pesticide treadmill- using increasing dosages of pesticides to catch up with higher resistance in pests

STATS:
90% of pesticides world wide used in agriculture or food storage/transport
34 pesticides used in US are in agriculture
59% herbicides
22% insecticides
11% fungicides
8% other
90% pesticides never get to organism intended!!!!

Population Dynamics

Population Ecology
- Exponential growth and doubling time:
- Exponential growth: growth at a constant rate of increase per unit of time. The sequence follows a geometric rate of increase (ex. 2,4,8,16)
- Doubling time: Amount of time necessary for the population to double. 70 / annual % growth (ex. Populations growing at 35% will double every 2 years.)

- Population Oscillations:
- Population exceeds carrying capacity or limiting factors come into effect, death rates surpass birth rates = crash or dieback

- Extent to which a population exceeds the carrying capacity = overshoot
- Population explosion followed by a population crash = irruptive/ Malthusian growth
- Sometimes populations go through cycles of exponential growth and catastrophic crashes, usually they are quite regular if they depend on certain factors like seasonal light, temperature. May be irregular if they depend on complex environmental and biotic relationships.

- Carrying Capacity:
- Carrying Capacity: the maximum number of individuals of any species that can be supported by a particular ecosystem on a long-term basis.

- Catastrophic Population Decline:
- Catastrophic System: when the population jumps from one seemingly steady state to another without any intermediate stages.

Factors that Increase/Decrease Populations

- Natality, Fecundity and Fertility:
- Natality: production of new individuals, main source of adding to populations, sensitive to environmental conditions (nutritional levels, climate, soil and water conditions, social interaction between species),
- Fecundity: physical ability to reproduce
- Fertility: measure of the actual number of offspring produced.
- Immigration: Seeds, spores, and small animals may be introduced by wind, water (major source of organisms to islands), carried inside other animals, walking, swimming, flying,
- Mortality and Survivorship:
- Mortality: death rate, death rate is found by dividing the number of organisms that die in a certain time period by the number alive at the beginning of the period.
- Survivorship: the percentage of a certain organism that lives to be a certain age.
- Life Expectancy: probable number of years of survival of an individual of a given age.
- Life Span: longest period of life reached by a given type of organism.

Survivorship Curves gives us the predicted life expectancy at each age interval. Humans in the first world have a high survivorship when young and most likely live to old age. Most marine organisms have a low survivorship- they are cast out into the waters, but once they survive that trauma they are likly to live out their full age. Hyrdas and sea gulls randomly die throughout their lives.

-Age Structure Diagrams/Histograms:

- An outcome of the interaction between mortality and natality.
- Bigger towards the bottom- rapidly expanding population
- Pretty equal throughout- stable population
- Bigger at the middle/top- diminishing population
- Emigration: movement of members out of the population

Factors that Regulate Population Growth

- Density dependent and independent factors and Biotic/Abiotic:
- Mostly these things affect natality and mortality, therefore changing the population.
- Intrinsic: operating within individual organisms or between organisms of the same species.
- Extrinsic: imposed from outside the population
- Biotic: caused by living organisms
- Abiotic: caused by non-living components of the environment
- Density dependent: effects are stronger or a higher percentage of the population is affected as the population density increases (food shortage)
- Density independent: the effect is the same or a constant proportion of the population is affected regardless of the population density (fire, climate conditions, volcano)
- In general, biotic factors are density- dependent while abiotic factors are density-independent

Solid, Toxic, and Hazardous Waste

Most common = least desirable
USA makes 33% world's waste

The three R's: reduce reuse recycle

<u>Ocean Dumps</u>
illegal in US
55 million lbs/yr of packaging are dumped into ocean
330 million lbs/yr of fishing gear lost or discarded
deadly to marine life (ex. seals)

<u>Landfills</u>
fate of most municipal solid waste
Paper is most common in landfill
trash buried within impermeable lining (clay, plastic) to prevent leaching
controls pollution of aquifer (oil, chemical compounds, toxic metals, contaminated rainwater)
methane gas burned for energy
Once very effective, landfills are now expensive land hogs- $1 billion/hectare
many aquifers already toxic from leaks
Natural Hydrogeologic Setting-
New landfills must now be set on stable, impermeable bedrock, away from streams rivers lakes etc.
Must include Leachate Collection System - contaminated fluids seep to bottom of landfill where they are collected by complex drainage pipes

<u>Exporting</u>
Often sent to poor, un-educated communities or countries ex. American Indians
Bet Trang plastics calamity- $3 million bribe for dumping toxic waste in Cambodia
"garbage imperialism" and NIMBY

<u>Incineration</u>
volume of waste reduced 90%
45,000 tons/day burned in US
energy production as by product- stream or electricity
expensive to build and operate
high levels of toxins in smoke & ash
ex. dioxins, mercury, lead, cadmium, PVC
Need to remove batteries and plastics first for cleaner burn but expensive
Mass burn- throw everything in smaller than Volkswagen. Dirty air

<u>Reduction and Reuse</u>
- reduce- is minimizing the amount of waste to begin with. Don’t buy it!
- reuse is simply reusing an item (Tupperware and cloth shopping bags)
- recycling is reprocessing discarded materials (glass, aluminum)

Recycling - ITS A GOOD THING
glasses to glasses, rust to rust
bottles may be reforged as bottles
tires may be turned into roadways or sandals!
benefits include more efficient use of non-renewable resources
- cheaper method of waste disposal
- less air and water pollution
- cuts waste volume in landfill

Alternatives to Household Chemicals
Use garlic and ginger for an insecticide
Vinegar or citrus oil make solvent for cleaning counters, etc. (but not both at the same time!)

Long Term Storage
It has to go somewhere
non bio-degradables
- permanent retrievable storage vs. non-retrievable storage

EPA ranks best strategy for Municipal Solid Waste
1. Source reduction (including reuse)
2. Recycling and composting
3. Incineration
4. Landfilling

Hazardous and Toxic Waste
Hazardous waste if any waste that poses a danger to human health. It could be corrosive, ignitable, reactive or toxic.
The fate of hazardous waste

1. Recycled
2. Converted to less hazardous form
3. Bioremediated ex. Brassica (broccoli family) absorbs Fe
4. Placed in permanent storage- deep well injection-agh! or surface impoundment- the creation of shallow pools from which the hazardous liquid evaporates.

or the hazardous/toxic wastes could be "temporarily" located in

1. Brownfields- polluted properties that have been abandoned because of real or suspected contamination
2. Superfund Sites- highly polluted waste site that is (hopefully) undergoing rapid containment, cleanup and remediation. Money for clean up comes from a Superfund which is funded by the federal government (our taxes) and a tax on the producers of toxic or hazardous waste. IF responsible parties can be identified they will be held responsible for the cleaning up cost.

Long-term storage of nuclear waste at Yucca Mountain is a controversial topic because of NIMBY and that fact that the mountain has two active fault lines and is above a huge aquifer. So the short-term storage of the nuclear waste is at the nuclear power plants in huge pools or giant land "coffins". High-level nuclear waste is the high level of ionizing radiation that is created at uranium mines, manufacture of nuclear weapons, and the waste from spent nuclear fuel. Low-level waste is waste from industrial or research industries like clothing, needles, animal carcasses and stuff.

Laws to Know
1. Ocean Dumping Ban Act: bans ocean dumping of sewage sludge & industrial waste
2. Comprehensive Environmental Response, Compensation & Liability Act (CERCLA): Otherwise known as the Superfund Act- calls for a rapid cleanup of abandoned dumpsites containing toxic waste.
3. National Priorities List (NPL)- lists sites most in need of immediate cleanup. but many have yet to be contained
4. Surface Mining Control & Reclamation Act (SMCRA): requires coal strip mines to reclaim the land after they are finished mining. Money is put aside in escrow for clean up BEFORE mining begins.
5. Resource Conservation & Recovery Act (RCRA): requires generators, shippers and disposers of hazardous waste to keep accurate accounts of the management of the waste from the "cradle to grave".

Sustainable Cities and Personal Action

Urbanization- an increasing concentration of the population in cities and the
transformation of land use and society to a metropolitan pattern of organization

-Nearly half the people in the world now live in urban areas
-By the end of the 21st Century 80-90% will live in urbanized areas
-Rural area- most residents depend on agriculture or other ways of harvesting and natural resources for their livelihood
-Urban area- a majority of the people are not directly dependent on natural resource based occupations
-Village- a collection of rural households linked by culture, custom, family ties and an association with the land, sense of community and connection, can be stifling
-City- a differentiated community with a population and resource base large enough to specialize in arts, crafts, services rather than natural resource based occupations, freedom to experiment, be upwardly mobile and break from restrictions, can be harsh and impersonal
-Mega-city- beyond about 10 million inhabitants

World Urbanization
-19th and early 20th centuries-US undergoes major shift
-Many developing countries are experiencing similar demographic movement
-In 1850 only 2% of the world's population lived in cities
-2000-47% live in cities
-Only Africa and South Asia remain predominantly rural
Some urbanologists believe that the whole world will be urbanized to the level of developed countries by 2100
-90% of pop. Growth in next 25 years is expected to occur is less developed countries- mostly in already overcrowded cities of poor countries such as India, China and Brazil
-in 1900- 13 cities had a population over 1 million- all in NA or Europe by 1995 there were 1300 metropolitan areas with over 1 million people only 3 in developing countries

Causes of Urban Growth
-2 ways that urban populations can grow-natural increase-more births than deaths, immigration
-Natural increase is fueled by improved food supplies, better sanitation, and advances in medical care-reduced death rates can cause populations to grow both in cities and rural areas around them
-Immigration to cities can be caused by push factors (force people out of the country) pull factors (draw them into the city)
-Push factors- people migrate to cities for many reasons
-Countryside can not support massive populations
-"Surplus" population is forced to migrate to cities in search of jobs, housing in some places economic forces or political, religious or racial conflicts drive people out of their homes
-UN estimated that in 1992 at least 10 million fled their native country and that another 30-40 million were internal refugees within their own countries, displaced by political, economic or social instability
-Land tenure patterns and changes in agriculture also play a role in pushing people into cities
-Pull factors- jobs, excitement, vitality and desire to meet people who are similar
-Jobs, housing, entertainment and freedom of constraints of village traditions
-Possibilities exist in the city for upward social mobility, prestige of power not ordinarily available in the countryside
-City supports specialization in arts, crafts, and markets, which do not exist elsewhere
-Modern communication
-90% of the people in Egypt have access to a television set
-Government policies often favor urban over rural areas in ways that both push and pull people into the cities
-Developing countries spend most of their budgets on improving urban areas even though only a small percentage of the population lives their or benefits from the industry
-Governments often manipulate exchange rates for the benefit of more politically powerful urban populations but at the expense of rural people

Current Urban Problems in the developing world
-90% of human pop growth in next century is expected to occur in the developing world in Asia, Africa and South America
-Problems will occur especially in largest cities, which already have trouble supplying food, jobs and basic services for their residents
Traffic and congestion- in less developed countries there is an overwhelmingly amount of pedestrians and vehicles that clog the streets
-Noise, congestion and confusion of traffic make it seem suicidal to venture into the street
-Air pollution- dense traffic, smoky factories and use of wood/coal fires create a thick pall of air pollution in the world's super cities
-Lenient pollution laws corrupt officials, inadequate testing equipment, ignorance about the sources and lack of funds to correct the situations cause the problem
Sewer systems and water pollution-
-Modern waste treatment systems are too expensive to build for rapidly growing populations
-35% of urban residents in developing countries have sanitary systems
-400 million people (one third) of the population in developing cities have safe drinking water
-Many rivers and streams, little more than open sewers, used for washing clothes, cooking, bathing, and drinking
-Diarrhea, dysentery, typhoid, cholera are widespread diseases
-Infant mortality high
-Housing-
Slums- legal but inadequate multifamily tenements rooming houses
Shantytowns- settlements created when people move onto undeveloped lands and build their own houses
Shacks- built of corrugated metal, discarded packing crates, plastic sheets, or whatever building materials people can scavenge
Squatter towns- people occupy land without owners permission
-Three quarters of residents of Addis Ababa, Ethiopia, Luwanda live in refugee camps
Current problems in the developed world:
-Urban Sprawl- pattern of urban growth where cities spread out and consume open space and waste resources
-In a study of 213 American urban areas, David Russ found that between 1960 and 1990 total population grew 47% while land use increased by 107%
-Atlanta, Georgia (1990-2000) 32% growth
-In some metropolitan areas, 1/3 of land is used for automobiles
-Traffic congestion costs the U.S. 78 billion dollars in wasted time and fuel.
-To solve this, people want to buy more freeways, but this will cause people to drive even further than before.
-Sprawl causes the city to be unable to maintain its infrastructure (schools, parks, streets and other buildings fall into disrepair)

Sustainable Community Design:
-Smart Growth- proposed by many urban planners, makes effective and efficient use of land resources and existing infrastructure, aims to provide a mix of land uses to create a variety of affordable housing choices and opportunities. Goal: not to block growth, but to channel it to areas where it can be sustainable in the long term. Protects environmental quality by conserving farmland, wetlands and open space. Portland, Oregon has a boundary on outward expansion and is considered one of the best cities in America because of its urban amenities. Between 1970-1990, the population grew 50%, land use only grew by 2%.
-Garden Cities- neighborhoods separate from the central city by a green belt of forests and fields. Done in the early 1900s in London by Ebeneezer Howard who wrote a book called Garden Cities of Tomorrow
-Planned Communities are built in the United States as well.
New Urbanist Movement:
-Redesign metropolitan areas to make them more efficient, appealing and livable.
-Examples: Stockholm, Sweden, Helinski, Finland and Leicester, England
-Urban Ecology Research- LTER (Long Term Ecological Research) in Phoenix and Baltimore,

funded by national science foundation, researches every aspect of urban ecology, advocate for environmental justice (toxic materials and how they affect the health of the population)
Examples: Detroit has many children with elevated levels of lead in their blood, linked to low-income, old housing
-Design for Open Space-
-Conservation Development- cluster housing or open space zoning preserves at least half of the subdivision is natural spaces, farmland etc.
-Ian McHarg, Frederic Steiner and Randall Arendt have led these movements in places such as Farmview, PA, Hawksnest, WI

Sustainable Development in the Third World-
-Immediate needs are housing, clean water, sanitation, food, education, health care and basic transportation for the residents
-Redistribute unproductive land
-Some people believe that social justice and sustainable economic development are the answers, because if people have the opportunity and money to buy better housing, adequate food, clean water, sanitation and other things they need for a decent life, they will do so.
- Social Welfare system ensures that old people will not be alone and abandoned.

Sustainable Development
Environmental Literacy
- every citizen is fluent in the principles of ecology and has a "working knowledge of the basic grammar and underlying syntax of environmental wisdom"- according to EPA administrator William K. Reilly
- An important part of environmental education
- Creates a stewardship ethic-care for environment and its resources for the long run
- Helps prepare for life in the next century
- Hope for students to continue learning about the environment:
Books to read to help with this:
- My First Summer in the Sierra by John Muir
- Silent Spring by Rachel Carson
- Walden by Henry David Thoreau

Environmental Movement
1. Student Environmental Groups
- Projects to teach ecology and environmental ethics to students as well as to get them involved in active projects to clean up their local community.
- Kids Saving the Earth
- Eco-Kids Corps.
- Student Environmental Action Coalition (SEAC)-work on activities like promoting recycling and lobby against industrial projects
2. Mainline Environmental Organizations
- Influential and powerful forces in environmental protection
- Help pass legislation like the Clean Air Act
- National Wildlife Federation
- Sierra Club
- Ducks Unlimited
3. Radical Environmental Groups
- Direct action groups
- Often associated with the deep ecology philosophy and bioregional ecological perspective
- Main tactics: civil disobedience, attention-grabbing actions like guerrilla street theater and picketing. (rar!)
- Earth First!
- Sea Shepard
- Earth Liberation Front

4. Wise Use Movement
- Advocate conservation rather than preservation of natural resources
- National Cattlemen's Association
- National Farm Bureau (these organizations have great names, don't they?)

Personal Choices and Personal Action
- Write to elected officials and urge them to support environmental causes.
- Petition
- Email them political folks
- Run for a local office
- Participate in practical environmental projects-i.e. litter cleanup- Clean Sweep!, restoration projects

Sustainable Energy

***Solar*:**

.1% of the electricity in US produced through solar panels.

Constant, free energy supply
-Amount of solar energy reaching the earth's surface is 10,000 times all the commercial energy used each year.
-Until this century it was too diffuse and low in intensity to use except for environmental heating and photosynthesis.

-*Passive Solar Heat*

Much of passive solar heat is simply orientating your home toward the sun and absorbing the heat- naturally.

- Indirect gain: Absorption-using natural materials or absorptive structures with no moving parts to simply gather and hold heat.
-Old Method: Thick-walled stone and adobe dwellings that slowly collect heat during the day and gradually release heat during the night. After cooling at night, they maintain a comfortable daytime temperatures while still absorbing external warmth.
-New Method: glass-walled "sunspace" or greenhouse on the south side of a building. Uses massive energy-storing materials such as brick walls, stone floors, or barrels of heat-absorbing water to collect heat to be released at night.

-Direct gain: Use a roof overhang that blocks the direct sunlight in the summer, but lets the sun in when its at a lower angle in the winter.

-*Active Solar Heat*

-Solar panels-Photovoltaic Cells-capture solar energy and convert it directly to electrical current by separating electrons from their parent atoms and accelerating them across a one-way electrostatic barrier formed by the junction between two different types of semiconductor material. This is known as the photovoltaic effect.

-They used to be too expensive for practical use but prices are falling.
-In 2001 prices were approaching $5 per watt.
-By 2020 it will be down to about $1 per watt and nuclear energy will cost twice as much.
-World market for solar energy is expected to grow rapidly in the near future, especially in remote places where conventional power isn't available.

-Already used in watches, solar-powered calculators and toys
-Solar energy could mean being able to build a house anywhere and have a cheap, reliable, clean, quiet source of energy with no moving parts to wear out, no fuel to purchase, and little equipment to maintain.

Pro:

No pollution, unlimited resource, can store energy during the day and release it at night, cost going down- decreased by a factor of ten in 2 years!

Con:

Needs a storage system like deep cell batteries, not efficient if climate too cloudy, high costs for purchasing solar panels and have limited life span, Visual pollution, efficiency between 10 and 25%.

-Solar water heaters- generally pump a heat-absorbing, fluid medium through a relatively small collector instead of passively collecting heat.
-Can be located next to or on top of buildings.
-Flat, black surface sealed with a double layer of glass makes a good solar collector.
-A fan circulates air over the hot surface and into the house through ductwork, like standard forced-air heating.
-A simple flat panel of 5 square meters can provide enough hot water for an average family of four.
-What about when it's not sunny?
    1) For climates where sunless days are rare- small, insulated water tank makes a good solar energy storage system.
    2) For winter months-A large, insulated bin containing a heat-storing mass, such as stone, water, clay provides solar energy storage.

Fuel Cells:

- Devices that use an ongoing electrochemical reaction to produce an electric current.
- Discovered by William Grove in 1839 during his study of electrolysis.
- Fuel cells consist of a cathode (positive electrode) and an anode (negative electrode) and are separated by an electrolyte.
- an electrolyte is a material that allows ions (positively charged atoms) to pass through but not electrons.

How a fuel cell works: hydrogen passes over the anode and a catalyst on the anode takes an electron from each hydrogen atom, creating a positive hydrogen ion. The ion can pass through the electrolyte to the cathode, but not the electron. The electron then passes through an external circuit going into the cathode creating an electrical current. Then, at the cathode the electrons and positive ions rejoin and combine with oxygen creating water.

Pro:

-Emits water as waste! no pollution, minimal environmental impact, easily transported, not explosive when stored in compounds

Con:

- takes energy to produce hydrogen, changing from fossil fuels to hydrogen would take a lot of money to build the infrastructure, hydrogen gas is explosive which is inconvenient- how could we store it in a car?

Biofuels:

-Biofuels produce 15% of the world's energy, 4% of that energy is used by the U.S (.1% electricity).

-Types of biofuels include switchgrass, woodchips, sawdust, wood residue, any kind of wood or plant material. Maybe we should use all the paper we throw into the dumps... if I were queen...- Biomass (plants, wood, etc.) converted into a liquid form making storage and transportation easier.

Pro:
-It is a renewable resource if used in moderation; biofuel could produce 1/2 of the world's electrical needs if managed properly; many marginal areas of the world could support biomass plantations with plants like cottonwoods, populars, sycamores and shrubs; its inexpensive, and the burning of biofuels produce less SOx and NOx then coal.

Con:
-Deforestation and soil erosion occur, requires fertilization and water. It is expensive to transport and can cause the loss of wildlife and habitats. Some methods of burning biomass causes air pollution such as CO2 emission. Also the use of corn to produce ethanol takes more energy than it creates and is driving the price of corn up for the poor who depend on it for food (ex. Mexicans).
-When biofuels are converted to electricity, 70% of the energy is lost!

Hydroelectric Power:

-Dams trap water which is then released and channeled through turbines which generate electricity.
- 9% of USA's electricity, 3% worldwide. There are 2000 dams in the US.

Pro:

- Good because there's no pollution, low operation costs and they control flooding. They also have a high to moderate energy yield and a long life span.

Con:

Dams create large floods, which uproot people, destroy habitats, and disrupt natural soil fertilization of agricultural land downstream. Sediments eventually need to be dredged from the reservoir. Also dams upset fish migration patterns (salmon!) andthe natural beauty of rivers. Also dams are extremely expensive to build.

Tidal and Wave energy:

The natural movement of tides spin turbines which generate electricity. Very few plants exist- only in US, France and Scotland.

Pro:

No pollution, moderate energy yield, minimal environmental impact, cheap to maintain.

Con:
Costs a lot to construct, few suitable sites. Plants get hurt by corrosion from salt and storms.

Wind Power:

Large blades of wind mills spin create electricity. Now make less than .1% of electricity in US but growing!

Pro:
-Fastest growing renewable energy resource today- no pollution
-Very promising
-Unlimited source (quick fact: all electrical needs of the US could be met by wind in North Dakota, South Dakota and Texas!)
-Wind farms can be built quickly
-Maintenance is low and automated
-Moderate to high net-energy yield
-Production of wind turbines would be a boost to economy
-Land underneath turbines can be used for agriculture

Con:
-Steady wind is required to make it economical. Back up systems needed when wind is not blowing
-Visual Pollution- ugly
-Noise pollution
-May interfere with communications (radio, TV, Microwave)

- may kill some birds if on migrational pattern

Geothermal Power:

-Two kinds: Heat contained in underground rocks and and fluids from magma are used or just the stable subsurface ground temperature is used to heat air in winter and cool it in summer.

-Geothermal energy supplies less then 1% of energy needs in the U.S.
-It is being utilized in Hawaii, Iceland, Japan, Mexico, New Zealand, Russia and California

Pro:
-Moderate net-energy yield
-Limitless and reliable source if managed
-Little air pollution
-Competitive cost

Con:
-Reservoir sites for hot geothermal power are scarce
-Source can be depleted if not managed
-Non-renewable
-Noisy
-Odor
-Local climate changes
-Land damage involved for pipes and roads- can cause land sinks.
-Can degrade ecosystems due to hot water wastes and corrosive or saline water

Water

~Water- essential for all living processes: dissolves nutrients and distributes them to cells, regulates body temperature, supports structures, and removes waste products; 60% of our body is water and 70% of the world's surface is covered in it.
~The hydrologic cycle- the circulation of water as it evaporates from land, water, and organisms, enters the atmosphere, condenses and precipitates to the earth's surfaces, and moves underground by infiltration or overland by runoff into rivers lakes and seas: Allows for a fresh supply of water, maintains a habitable climate and moderates world temperatures. Plants help add water vapor to the air through transpiration.

Evaporation= process through which liquid is turned into a gas way below its boiling point
*Sublimation= when water moves from the solid to the gaseous form with out ever being liquid (occurs on bright, dry cold winter days)
*Saturation point= when a volume of air contains the most water vapor that it can at a given temperature
*Relative humidity= the amount of water vapor in the air expressed as a percentage in terms of the saturation point
*Condensation= when saturation point is exceeded and water molecules begin to aggregate
*Dew point= the temperature at which condensation occurs
*Condensation nuclei= tiny particles that help facilitate the condensation process (smoke, dust, sea salts, spores, etc)
*Cloud= accumulation of condensed water vapor in droplets or ice crystals
~Mountains have two different climates: the windward side is cool wet and cloudy; the leeward side is warm dry and sunny, ex. Himalayans (dry spot on mtn= rain shadow)
~Deserts lack moisture and have much evaporation due to the descending air masses. The air will condense under the higher pressure and warms through adiabatic heating. This typically occurs at 30 degree latitudes North and South of the equator. Typical deserts include the Sahara, Gobi, and Death Valley.
~Tropical rainforests receive much rain
~Oceans make up 86% of evaporation, 90% returns directly to the ocean: the other ten percent is carried onto the continents- once there some is incorporated into plants and animals, the rest seeps into the underground but all eventually returns to the ocean. 40,000 km2 of surface runoff and underground flow represents the renewable supply for us and freshwater-deep ecosystems.
~Evaporation and condensation help regulate the climate, as winds redistribute the heat and moisture
~Oceans= contain 90% of all bio mass and 97% of all the liquid in the world. They moderate the global temperature- warm water flow from tropics to poles and vice versa,
*Residence time= that length of time an individual molecule spends circulating in the ocean before evaporation, on average its 3,000 years
~Glaciers hold almost 90% of the earths freshwater. These frozen rivers slowly move downhill. Antarctic glaciers contain 85 % of all the ice in the world.

GROUNDWATER:
-Second largest freshwater reservoir
~Ground water= holds next largest amount of fresh water
*Infiltration= precipitation that doesn't evaporate and runs through fractures of the rocks in the soil
*Zone of aeration= upper soil layers that hold both air and water, moisture for plant growth comes from here. The depth varies.
*Zone of saturation= lower levels where all soil air spaces are filled with water. The top of the zone is called the water table and it is neither flat nor stationary. Aquifers: porous layers of sand etc. below water table
-Artesian well: water gushes out without being pumped

Should We Remove Dams?

YES!
*Storage reservoirs drown free-flowing rivers
*They can submerge towns, farms, and cemeteries and important historic sites
*Block fish migration- salmon migration routes impeded
*Can change aquatic habitats that were important to species
*Siltation of reservoir behind dam builds up requiring dredging.
*Nutrients carried within the silt and clay are lost to down stream farmlands that would normally be deposited during floods.
*Dam breakage could devastate communities living downstream.

NO!
*Stores water, and generates electricity
*Create jobs for workers

*Help economic development
*Allows arid and unfarmable lands to grow crops through irrigation of water

Main problem with dams are their inefficiency!!! Dams lose water through evaporation, and seepage through porous rocks~~~> wasting more water than they make available.
* Accumulating sediments can clog reservoirs and make dams completely useless~~~> lose a lot of valuable nutrients. Silts can be replaced with commercial fertilizers costing more than 100 million bucks a year!

LOSS OF FREE-FLOWING RIVERS

Hetch Hetchy Valley in Yosemite National Park: San Francisco wanted to dam the Tuolumne River in the park to produce hydroelectric power and provide water for the city. Some people liked it because it supported clean water and power. John Muir opposed the dam project (He founded the Sierra Club and Yosemite Park!! Wahoo!) He said that Hetch Hetchy valley's beauty should be protected. The people fought a hard fight but the dam builders won.

WATER MANAGEMENT AND CONSERVATION

*Goal: prevent flood damage and store water for future use instead of building dams and reservoirs.
Watershed-> also known as a "catchment" is all the land drained by a stream or river. Retaining vegetation and ground cover in watersheds help hold back rainwater and decrease downstream floods.
*More environmentally sound farming and forestry techniques can help reduce runoff.
*Retaining crop residue on fields can reduce flooding
*Minimizing plowing and forest cutting on steep slopes protect watersheds
*Conserving wetlands helps preserve natural water storage capacities and aquifer recharge zones.

Small dams can be just as useful as big dams:
Small dams on tributary streams have the ability to hold back water before it turns into a big flood. These dams can form ponds, and they provide useful wildlife habitats! Small dams can be built with simple equipment and local labor.
More than 60 million people in 33 states obtain their drinking water from national forest lands

DOMESTIC CONSERVATION

How can we help stop water shortages?
Take shorter showers!! Stop leaks!! Efficiently wash your cars, dishes, and clothes!!! What about appliances? Use low-volume showerheads, and efficient dishwashers and washing machines!! **If you plant native ground cover in a "natural lawn" or make a rock garden, landscape in harmony with the surrounding environment- xeriscaping (choosing plants that require little moisture) can be great instead of constantly watering and feeding a dry, arid garden.***
:0) Our biggest domestic water use is toilet flushing!! eeeew. We use about 13,000 gallons of drinking quality water annually to flush toilets. People are now creating low-volume and waterless toilets.

RECYCLING AND WATER CONSERVATION

*In 3rd world countries 70% of all the agricultural water used is lost to leaks in irrigation canals, application to areas where plants don't grow, runoff, and evaporation. People have been trying to turn to new farming techniques such as leaving crop residue on fields and ground cover on drainage ways, using mulches, and low-volume irrigation in order to reduce water losses. And its been working!
*Cooling electric power plants = bad water usage
*Installing dry cooling systems= better water usage

PRICE MECHANISMS AND WATER POLICY

In the past, water policies were been against conservation. Some parts of the US were based on riparian use rights= people who lived near a river could use as much as they wanted as long as they didn't taint its quality or the limit others who wanted to access to the water down stream. In many places, like NYC, water used to be very cheap. People didn't have any incentive to repair leaks, or restrict usage. The drought of 1988 changed all of these practices...

*The US is currently saving 38 million gallons a day compared to per capita rates 20 yrs ago. However, we have 10% less water because of the growing population!
*Drip irrigation= AWESOME! It applies water directly to plant roots, but its very expensive. Used on only 1% of farmland worldwide.
*Charging higher proportion of costs to users of public water projects~~~> encourages conservation!

Water Pollution

A Flood of Pigs

- Hurricane Floyd flooded Cape Fear in North Carolina on September 16, 1999
- The flooding created a lake that was 300 km (200 miles) across covering towns, farms, factories and forests
- The worst of this flood was the open manure lagoons submerged by the water
- North Carolina was the leading turkey-producing state and the second largest pork producing state which contained ponds of 40,000 cubic meters of liquid waste that isn't protected against floods
- It is believed that the waste found in wells is from the waste and bacteria that leaked into areas that the flood got into
- Dead animals were buried in the ground where they continue to contaminate groundwater

What is Water Pollution?

- Point sources-factories, power plants, underground coal mines and oil wells that discharge pollution from specific locations such as drain pipes, ditches or sewer outfalls
- Nonpoint sources-scattered or diffuse so that they have no specific location where they discharge into a particular body of water
- Nonpoint sources include runoff from farm fields and feedlots as well as golf courses, lawns and gardens
- Atmospheric deposition of contaminants carried by air currents and precipitated into watersheds or directly onto surface waters as rain, snow or dry particles
- Sources of some nonpoint chemicals can be thousands of kilometers away
- It is estimated that there is 600,000 kilograms of herbicide atrazine in the Great Lakes
- Studies have shown that health problems are occurring among those who eat fish regularly from the Great Lakes

Infectious Agents

- Serious water pollutants in terms of human health world-wide are pathogenic organisms
- Some of these diseases like malaria, yellow fever and filariasis are transmitted by insects that have aquatic larvae
- The main source for these pathogens is from untreated or improperly treated human wastes as well as inadequately treated animal waste from feedlots
- If everyone had pure water and satisfactory sanitation, the World Bank estimates that 200 million fewer episodes of diarrheal illness would occur each year and 2 million and 2 million childhood deaths would be avoided
- 450 million people would be spared debilitating roundworm or fluke infections
- Coliform bacteria-any type of bacteria that lives in the colon or intestines of humans and other animals
- To test for coliform bacteria, a water sample is placed in a dish containing a nutrient medium that supports bacterial growth
- The EPA recommended maximum coliform count for swimming water is 200 colonies per 100 ml, but some cities and states allow higher levels

Oxygen-Demanding Wastes

- The amount of oxygen in water can help to determine the quality of the water
- Game fish and other desirable forms of aquatic life exist above 6 parts per million (ppm) while worms, bacteria and fungi exist below 2 ppm of oxygen
- Oxygen is added to the water through diffusion with the air and removed through respiration and chemical processes that consume oxygen
- The affects of materials on water quality is expressed in terms of biochemical oxygen demand (BOD) which is a standard test of the amount of dissolved oxygen consumed by aquatic microorganisms over a five-day period
- The chemical oxygen demand (COD) uses a strong oxidizing agent (dichromate ion in 50% sulfuric acid) that completely breaks down all organic matter in a water sample
- Dissolved oxygen (DO) content measured directly using an oxygen electrode also measures the affects of organic materials on water quality
- Oxygen sag-the decline in oxygen downstream of a pollutant source
- Rough fish such as carp, bullheads and gar can survive oxygen-poor environments

<u>Plant Nutrients and Cultural Eutrophication</u>

- Rivers and lakes hat have clear water and low biological productivity are said to be oligotrophic (oligo = little + trophic = nutrition)
- Eutrophic (eu + trophic = truly nourished) waters are rich in organisms and organic materials
- Eutrophication, an increase in nutrient levels and biological productivity is a normal part of successional changes in most lakes
- An increase in biological productivity and ecosystem succession caused by human activities is called cultural eutrophication
- "Dead zones" often form where rivers dump nutrients into estuaries and shallow seas

<u>Inorganic Pollutants</u>

- Some toxic inorganic chemicals are released from rocks by weathering and are carried by runoff into lakes or rivers
- Other inorganic materials such as acids, salts, nitrates and chlorine that are normally not toxic at low concentrations may become concentrated enough to lower water quality or adversely affect biological communities
- Metals such as mercury, lead cadmium and nickel are highly toxic
- Levels in the parts per million that are so little that you can't see them or taste them and they can be fatal
- Miners in the Amazon River who look for gold use mercury to trap the gold and separate it from sediments
- The mercury is boiled off with a blow torch which is believed to be why miners and their families suffer nerve damage from breathing the toxic fumes
- Lead poisoning has been known since Roman times to be dangerous to human health
- In 1990 the EPA lowered the maximum limit for lead in public drinking water from 50 parts per billion to 20 parts per billion
- Desert soils often contain high concentrations of soluble salts including toxic selenium and arsenic
- Sodium chloride (table salt) is nontoxic at low concentrations and can become toxic to plants when mobilized by irrigation and concentrated by evaporation
- Acids are by-products of industrial processes such as leather tanning, metal smelting and plating, petroleum distillation, and organic chemical synthesis coal mining is an especially important source of acid water pollution because of the sulfur compounds in coal react with oxygen and water to make sulfuric acid
- 200 lakes in the Adirondack Mountains of New York State have been reported having aquatic damage due to acid precipitation

<u>Surface Waters in the United States and Canada</u>

- The 1972 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
- Since the Clean Water Act 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
- The goal of the Clean Water Act 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 not meeting water quality goals and to develop total maximum daily loads (TMDL) for each pollutant and each listed water body
- The 1970 Water Act in Canada has produced comparable results
- 70% of all Canadians in towns over 1,000 population are now served by some form of municipal sewage treatment
- In the USA as much as 25% of the 46,800,000 metric tons of (52 million tons) of fertilizer spread on farmland each year is carried away by runoff
- Nitrates and phosphates in surface water have decreased from point sources but have increased about four-fold since 1972 from nonpoint sources
- Fossil fuel combustion has become a major source of nitrates, sulfates, arsenic, cadmium, mercury and other toxic pollutants that end up in water

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Surface Waters in Other Countries

- The fall of the “iron curtain” in 1989 revealed appalling environmental conditions in much of the former Soviet Union and its satellite states in eastern and central Europe
- Parts of Russia itself and some other former socialist states in the Balkans and Central Asia remain some of the most polluted places on earth
- In Russia, only half of the tap water is fit to drink
- Life expectancies for Russian men have plummeted from about 72 years in 1980 to 59 years in 1999 and deaths now exceed births by about 1 million per year
- There are also some encouraging pollution control stories such as in 1997 Minamata Bay in Japan, long synonymous with mercury poisoning was declared officially clean again
- Less-developed countries such as South America, Africa and Asia have even worse water quality than do the poorer countries of Europe
- The coliform count in the Yamuna River in New Delhi has 7,500 coliform bacteria per 100 ml that increases to 24 million cells per 100 ml as the river leaves the city

Groundwater and Drinking Water Supplies

- Half the people in the United States including 95% of those in rural areas depend on underground aquifers for their drinking water
- One of the serious sources of groundwater pollution throughout the US is MTBE (methyl tertiary butyl ether) a suspected carcinogen and is added to gasoline
- In one US Geological Survey (USGS) study, 27% of shallow urban wells tested contained MTBE
- The US EPA estimates that every day some 4.5 trillion liters of contaminated water sep into the ground in the United States from septic tanks, cesspools municipal an industrial landfills and waste disposal sites, surface impoundments, agricultural fields, forests and wells
- Although most of the leaky, single-walled underground storage tanks once common at filling stations and factories have now been removed and replaced by more modern ones, a great deal of soil in American cities remains contaminated by previous careless storage and disposal of petroleum products

- A 1996 survey concluded that nearly 20,000 public drinking water systems in the US expose consumers to contaminants such as lead, pesticides and pathogens at levels that violate EPA rules

Human Waste Disposal

- In poorer countries of the world, most rural people simply go out into the fields and forests to relieve themselves as they have always done
- Major cities of many less-developed countries are often littered with human waste which has been left for rains to wash away or for pigs, dogs, flies, beetles or other scavengers to consume
- Studies have shown that a significant portion of the airborne dust in Mexico City is actually dried, pulverized human feces
- Grease and oils rise to the top of a septic tank while solids settle to the bottom where they are subject to bacterial decomposition
- Primary treatment is the first step in municipal waste treatment, it physically separates large solids from the waste stream
- Secondary treatment is the biological degradation of the dissolved organic compounds
- Tertiary treatment removes plant nutrients such as nitrates and phosphates from the secondary effluent
- Effluent sewerage is a hybrid between traditional septic tanks and a full sewer system in which the effluents are pumped into a central treatment plant instead of a drainfield

The Clean Water Act

- The Clean Water Act of 1972 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
- To fulfill the main goal of the act make all surface waters "fishable and swimmable" 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 their operations or spend money on water protection aren't happy with the Clean Water Act
- These people who aren't happy often times feel imposed upon
- Another flaw with the act is when state or local governments spend money that 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 especially hard hit by requirements that they upgrade municipal sewer and water systems

Acid Rain

The pH of rainwater is normally slightly acidic, at about 5.6, due mainly to reaction of carbon dioxide with water to form carbonic acid.

Other natural events can contribute to the acidity of precipitation. Volcanic eruptions, forest fires, and lightning bolts produce sulfur dioxide, sulfur trioxide, and nitrogen dioxide. These gases can react with atmospheric water in much the same way that carbon dioxide does to produce sulfurous acid, sulfuric acid, nitric acid and nitrous acid.

Air Pollution Control and Prevention

: Formula that represents the process of "scrubbing" products of industrial combustion processes. Sulfur dioxide gas is removes by using an aqueous solution of calcium hydroxide, also called limewater. The sulfur dioxide reacts with the limewater to form solid calcium sulfite. Scrubbers that utilize this “wet” scrubbing method can remove up to 95% of sulfur oxides.

Another process for scrubbing that utilizes magnesium hydroxide instead of limewater. The sulfur dioxide dissolves in the water and reacts with the magnesium hydroxide to form a salt. The magnesium sulfite that is formed can be isolated and heated to regenerate sulfur dioxide. The recovered sulfur dioxide can be collected and used as a raw material in other commercial processes.

Air Pollution Formulas

Impurities such as pyrite or iron pyrite are found in coal, when we burn coal it interacts with atmospheric oxygen to form iron oxide and sulfur dioxide (a primary air pollutant).

The primary air pollutant, sulfur dioxide, is oxidized, once in the atmosphere, to sulfur trioxide.

Sulfur trioxide dissolves it atmospheric water droplets to form sulfuric acid. Sulfuric acid is a major component of acid rain. Sulfuric acid is considered a secondary air pollutant:

The generalized representation of sulfur oxides, whether it be sulfur dioxide or sulfur trioxide. The Sulfur oxides are considered primary air pollutants.:

Molecules of nitrogen and atmospheric oxygen combine AT VERY HIGH TEMPERATURES to form nitric oxide, a colorless gas. The high temperatures of natural processes like lightening or those of the combustion chambers of an engine are effective in causing this conversion. Nitric oxide is a primary air pollutant:

Once in the atmosphere, nitric acid reacts with additional oxygen to form nitrogen dioxide, a red-brown toxic gas that causes irritation to the eyes and respiratory system:

Further reaction of nitrogen dioxide with water can produce nitric acid, another component of acid rain

Ozone Formation and Destruction

As sunlight penetrates into the stratosphere, high-energy UV photons react with oxygen gas molecules, splitting them into individual oxygen atoms. These highly reactive oxygen atoms are examples of free radicals; they quickly enter into chemical reactions that allow them to attain stable arrangements of electrons. In the stratosphere free radicals can combine with oxygen molecules to form ozone. A third molecule, typically nitrogen gas or atmospheric oxygen (represented by M in the equation), carries away excess energy from the reaction but remains unchanged.

Each ozone molecule formed in the stratosphere can absorb a UV photon with a wavelength of less than 320nm. This energy absorption prevents potentially harmful UV rays from reaching the earth’s surface. The energy also causes the ozone to decomposed, producing an oxygen molecule and an oxygen free radical. These products can then carry on the cycle by replacing ozone in the protective stratospheric layer.

CFC’s (chlorofluorocarbons) are highly stable molecules in the troposphere, however, high energy UV photons in the stratosphere split chlorine radicals from CFC’s by breaking their C-Cl bond. The freed chlorine radicals are very reactive and can participate in a series of reaction that destroy ozone by converting it to diatomic oxygen. Every chlorine radical that participates in the first reaction can later be regenerated . Thus each chlorine radical acts as a catalyst participating in not just one, but an average of 100,000 ozone –destroying reactions. In doing so, it speeds up ozone destruction but remains unchanged itself.

Photochemical Smog

Nitrogen oxide is an essential ingredient of photochemical smog that is produced during the high temperatures associated with combustion of vehicle’s engines.

Initial reaction of nitrogen dioxide with sunlight:

The oxygen atom generated from the initial reaction reacts with atmospheric, diatomic oxygen, to form ozone. This is not the good, protective ozone of the stratosphere, this is the polluting ozone of the lithosphere, which traps heat and contributes to thermal inversion.

This simplified equation represents the key ingredients and products of photochemical smog. Hydrocarbons (including VOC’s), carbon monoxide, and nitrogen oxides from vehicle exhausts are irradiated by sunlight in the presence of oxygen gas. The resulting reactions produce a potentially dangerous mixture that include other nitrogen oxides, ozone, and irritating organic compounds, as well as carbon dioxide and water vapor.

The Carbon Cycle

The different forms and compounds in which carbon atoms are found are considered chemical reservoirs of carbon. These reservoirs include atmospheric carbon dioxide, calcium carbonate (in limestone), natural gas, and organic molecules, to name a few.

Plants use carbon dioxide and energy from the sun to form carbohydrates in photosynthesis. The carbohydrates are consumed by other organisms, and are eventually broken down, or “oxidized”.

The process of respiration. The chemical representation of how carbohydrates are broken down, or oxidized, thereby releasing energy for use by the consuming organisms. The carbon used and circulated in photosynthesis represents only a tiny portion of the available global carbon.

Atmospheric carbon dioxide levels have increased by 30% since the 1800’s (industrial revolution).This increase can be explained, primarily, but several human activities. The most significant of these activities is the burning of fossil fuels.

The Nitrogen Cycle

Atmospheric nitrogen is converted to ammonia or ammonium ion by nitrogen-fixing bacteria that live in legume root nodules or in soil, or atmospheric nitrogen is converted to nitrogen oxides by lightening.

Ammonia and Ammonium are oxidized by soil bacteria first to nitrite ions and then to nitrate ions

After plants have taken up nitrogen from the soil in the form of nitrate ions, the nitrogen is passed along the food chain. When those plants and animals dies, bacteria and fungi take up and use some of the nitrogen from the plant/animal protein and other nitrogen containing molecules. The remaining nitrogen is released as ammonium ions or ammonia gas. Denitrifying bacteria convert some ammonia, nitrite, and nitrate back to nitrogen gas, which returns to the atmosphere.

Haber-Bosch Process: A technique for making ammonia from hydrogen and nitrogen, according to the first equation. To get the reactants, nitrogen gas is liquefied form air and hydrogen gas is obtained chemically from methane (natural gas). First natural gas is treated to remove sulfur-containing compounds; then the present methane is allowed to react with steam. Carbon monoxide, a product of methane reacting with steam, is converted to carbon dioxide which allows for the additional production of nitrogen gas.

<u>Major Environmental Laws and Summaries</u>

<u>Clean Air Act</u>

42 U.S.C. s/s 7401 et seq. (1970)

The Clean Air Act is the comprehensive Federal law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the U.S. Environmental Protection Agency to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment.

The goal of the Act was to set and achieve NAAQS in every state by 1975. The setting of maximum pollutant standards was coupled with directing the states to develop state implementation plans (SIP's) applicable to appropriate industrial sources in the state.

The Act was amended in 1977 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines. The 1990 amendments to the Clean Air Act in large part were intended to meet unaddressed or insufficiently addressed problems such as acid rain, ground-level ozone, stratospheric ozone depletion, and air toxics.

<u>Clean Water Act</u>

Clean Water Act History

Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. The Act established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also continued requirements to set water quality standards for all contaminants in surface waters. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. It also funded the construction of sewage treatment plants under the construction grants program and recognized the need for planning to address the critical problems posed by non-point source pollution.

Subsequent enactments modified some of the earlier Clean Water Act provisions. Revisions in 1981 streamlined the municipal construction grants process, improving the capabilities of treatment plants built under the program. Changes in 1987 phased out the construction grants program, replacing it with the State Water Pollution Control Revolving Fund, more commonly known as the Clean Water State Revolving Fund. This new funding strategy addressed water quality needs by building on EPA-State partnerships.

Over the years, many other laws have changed parts of the Clean Water Act. Title I of the Great Lakes Critical Programs Act of 1990, for example, put into place parts of the Great Lakes Water Quality Agreement of 1978, signed by the U.S. and Canada, where the two nations agreed to reduce certain toxic pollutants in the Great Lakes. That law required EPA to establish water quality criteria for the Great Lakes addressing 29 toxic pollutants with maximum levels that are safe for humans, wildlife, and aquatic life. It also required EPA to help the States implement the criteria on a specific schedule.

The electronic version of the Clean Water Act (available below) is a thirtieth anniversary snapshot of the law, as amended through the enactment of the Great Lakes Legacy Act of 2002 (Public Law 107-303, November 27, 2002). Provided by the Congressional Great Lakes Task Force, it is the amended law as of that particular point in time. This electronic version annotates the sections of the Act with the corresponding sections of the U.S. Code and footnote commentary on the effect of other laws on the current form of the Clean Water Act.

Introduction to the Clean Water Act

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. (The Act does not deal directly with ground water nor with water quantity issues.) The statute employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

For many years following the passage of CWA in 1972, EPA, states, and Indian tribes focused mainly on the chemical aspects of the "integrity" goal. During the last decade, however, more attention has been given to physical and biological integrity. Also, in the early decades of the Act's implementation, efforts focused on regulating discharges from traditional "point source" facilities, such as municipal sewage plants and industrial facilities, with little attention paid to runoff from streets, construction sites, farms, and other "wet-weather" sources.

Starting in the late 1980s, efforts to address polluted runoff have increased significantly. For "non-point" runoff, voluntary programs, including cost-sharing with landowners are the key tool. For "wet weather point sources" like urban storm sewer systems and construction sites, a regulatory approach is being employed.

Evolution of CWA programs over the last decade has also included something of a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining state water quality and other environmental goals is another hallmark of this approach.

Take the "Fact or Fiction" Clean Water Act Quiz: http://www.epa.gov/watertrain/cwa/

Endangered Species Act

7 U.S.C. 136; 16 U.S.C. 460 et seq. (1973)

The Endangered Species Act provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service of the Department of the Interior maintains the list of 632 endangered species (326 are plants) and 190 threatened species (78 are plants).

Species include birds, insects, fish, reptiles, mammals, crustaceans, flowers, grasses, and trees. Anyone can petition FWS to include a species on this list. The law prohibits any action, administrative or real, that results in a "taking" of a listed species, or adversely affects habitat. Likewise, import, export, interstate, and foreign commerce of listed species are all prohibited.

EPA's decision to register a pesticide is based in part on the risk of adverse effects on endangered species as well as environmental fate (how a pesticide will affect habitat). Under FIFRA, EPA can issue emergency suspensions of certain pesticides to cancel or restrict their use if an endangered species will be adversely affected. Under a new program, EPA, FWS, and USDA are distributing hundreds of county bulletins that include habitat maps, pesticide use eliminations, and other actions required to protect listed species.

Emergency Planning & Community Right to Know Act (EPCRA)

42 U.S.C. 11001 et seq. (1986)

Also known as Title III of SARA, EPCRA was enacted by Congress as the national legislation on community safety. This law was designated to help local communities protect public health, safety, and the environment from chemical hazards.

To implement EPCRA, Congress required each state to appoint a State Emergency Response Commission (SERC). The SERC's were required to divide their states into Emergency Planning Districts and to name a Local Emergency Planning Committee (LEPC) for each district.

Broad representation by fire fighters, health officials, government and media representatives, community groups, industrial facilities, and emergency managers ensures that all necessary elements of the planning process are represented.

Federal Insecticide, Fungicide, and Rodenticide Act

7 U.S.C. s/s 136 et seq. (1996)

The primary focus of FIFRA was to provide federal control of pesticide distribution, sale, and use. EPA was given authority under FIFRA not only to study the consequences of pesticide usage but also to require users (farmers, utility companies, and others) to register when purchasing pesticides.

Through later amendments to the law, users also must take exams for certification as applicators of pesticides. All pesticides used in the U.S. must be registered (licensed) by EPA. Registration assures that pesticides will be properly labeled and that if in accordance with specifications, will not cause unreasonable harm to the environment.

National Environmental Protection Act

42 U.S.C. s/s 4321 et seq. (1969)

The National Environmental Policy Act was one of the first laws ever written that establishes the broad national framework for protecting our environment. NEPA's basic policy is to assure that all branches of government give proper consideration to the environment prior to undertaking any major federal action that significantly affects the environment.

NEPA requirements are invoked when airports, buildings, military complexes, highways, parkland purchases, and other federal activities are proposed. Environmental Assessments (EAs) and Environmental Impact Statements (EISs), which are assessments of the likelihood of impacts from alternative courses of action, are required from all Federal agencies and are the most visible NEPA requirements.

Oil Pollution Act of 1990

33 U.S.C. 2702 to 2761

The Oil Pollution Act (OPA) of 1990 streamlined and strengthened EPA's ability to prevent and respond to catastrophic oil spills. A trust fund financed by a tax on oil is available to clean up spills when the responsible party is incapable or unwilling to do so. The OPA requires oil storage facilities and vessels to submit to the Federal government plans detailing how they will respond to large discharges. EPA has published regulations for aboveground storage facilities; the Coast Guard has done so for oil tankers. The OPA also requires the development of Area Contingency Plans to prepare and plan for oil spill response on a regional scale.

Pollution Prevention Act

42 U.S.C. 13101 and 13102, s/s et seq. (1990)

The Pollution Prevention Act focused industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials use. Opportunities for source reduction are often not realized because of existing regulations, and the industrial resources required for compliance, focus on treatment and disposal. Source reduction is fundamentally different and more desirable than waste management or pollution control.

Pollution prevention also includes other practices that increase efficiency in the use of energy, water, or other natural resources, and protect our resource base through conservation. Practices include recycling, source reduction, and sustainable agriculture.

Resource Conservation and Recovery Act

42 U.S.C. s/s 6901 et seq. (1976)

RCRA (pronounced "rick-rah") gave EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous wastes.

The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites (see CERCLA).

HSWA (pronounced "hiss-wa")—The Federal Hazardous and Solid Waste Amendments are the 1984 amendments to RCRA that required phasing out land disposal of hazardous waste. Some of the other mandates of this strict law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program.

Safe Drinking Water Act

42 U.S.C. s/s 300f et seq. (1974)

The Safe Drinking Water Act was established to protect the quality of drinking water in the U.S. This law focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources.

The Act authorized EPA to establish safe standards of purity and required all owners or operators of public water systems to comply with primary (health-related) standards. State governments, which assume this power from EPA, also encourage attainment of secondary standards (nuisance-related).

Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) (CERCLA)

42 U.S.C. s/s 9601 et seq. (1980)

CERCLA (pronounced SIR-cla) provides a Federal “Superfund” to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

EPA cleans up orphan sites when potentially responsible parties cannot be identified or located, or when they fail to act. Through various enforcement tools, EPA obtains private party cleanup through orders, consent decrees, and other small party settlements. EPA also recovers costs from financially viable individuals and companies once a response action has been completed.

EPA is authorized to implement the Act in all 50 states and U.S. territories. Superfund site identification, monitoring, and response activities in states are coordinated through the state environmental protection or waste management agencies. In Region 5, CERCLA is administered by the Superfund Division.

CERCLA Overview The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress on December 11, 1980. This law 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. CERCLA:

- established prohibitions and requirements concerning closed and abandoned hazardous waste sites;
- provided for liability of persons responsible for releases of hazardous waste at these sites; and
- established a trust fund to provide for cleanup when no responsible party could be identified.

The law authorizes two kinds of response actions:

- Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response.
- Long-term remedial response actions, that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on EPA's National Priorities List (NPL).

CERCLA also enabled the revision of the National Contingency Plan (NCP). The NCP provided the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The NCP also established the NPL.

CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) on October 17, 1986

Topic Oulines

Chapter 2

Science, Systems, Matter, and Energy

Summary

1. Science is an attempt to discover the natural world's order and use that in describing what is likely to happen in nature. Scientists ask a question or identify a problem to investigate. Then, they collect scientific data through observation and measurement. Experiments may be used to study specific phenomena.

2. The major components of complex systems are environmental inputs, flows within the system, and outputs to the environment.

3. The basic forms of matter are elements and compounds. Matter is useful to us as a resource because it makes up every material substance.

4. The major forms of energy are kinetic energy and potential energy. Energy is useful to us as a resource because it moves matter.

5. The Law of Conservation of Matter states that matter is neither created nor destroyed when a physical or chemical change occurs.

6. Matter can undergo three types of nuclear changes: natural radioactive decay, nuclear fission, and nuclear fusion.

7. The First Law of Thermodynamics states that in all physical and chemical changes, energy may be converted from one form to another but it is neither created nor destroyed. The Second Law of Thermodynamics states that when energy is changed from one form to another, there is always less usable energy left.

8. These laws, then, show that energy goes from a more useful to a less useful form and that high-quality energy cannot be recycled. So, the quality as well as the quantity of our resources and our environment will be reduced.

Chapter 3

Ecosystems: What Are They and How Do They Work

Summary

1. Ecology is the study of connections in nature.

2. Life on earth is sustained by the one-way flow of high-quality energy from the sun, by the cycling of matter, and by gravity.

3. Matter, energy, and life are the major components of an ecosystem.

4. Energy in an ecosystem decreases in amount to each succeeding organism in a food chair or web.

5. Soil is a complex mixture of eroded rock, mineral nutrients, water, air, decaying organic matter, and billions of living organisms. It covers most of the earth and provides nutrients for plant growth. Soils are formed by a breaking down of rock, decomposing surface litter and organic matter. Bacteria and other decomposer microorganisms break down some of soil's organic compounds into simpler inorganic compounds.

6. Matter is recycled through the earth's ecosystem of air, land, water, and living organisms. This vast global recycling system is composed of nutrient cycles.

7. Scientists study ecosystems through the use of aquarium tanks, greenhouses, and controlled indoor and outdoor chambers. Specific variables are carefully controlled, like temperature, light, carbon dioxide, and humidity.

8. Two principles of sustainability found from learning how nature works are the law of conservation of matter and the two laws of thermodynamics.

Chapter 4

Evolution and Biodiversity

Summary

1. Life emerged on the earth through two phases of development: a chemical evolution of the organic molecules, biopolymers, and systems of chemical reactions to form the first cells and the biological evolution from single-celled prokaryotic bacteria to single-celled eukaryotic creatures, and then to multicellular organisms.

2. Evolution is the change in a population's genetic makeup over time. Evolution forces adaptations to changes in environmental conditions in a population. The diversity of life on earth reflects the wide variety of adaptations necessary and suggests that environmental conditions have varied widely over the life of the earth.

3. An ecological niche is a species' way of life or its functional role in a community. Everything that affects its survival and reproduction (temperature tolerance, water needs, space needs, interactions with other organisms, etc.) is a part of that niche. The ecological niche helps a population survive by the adaptive traits that its organisms have acquired.

4. Extinction of species and formation of new species constantly change the biodiversity of the earth.

5. In the future, evolution will continue to influence our environment. Man's use of artificial selection and genetic engineering to evolve species may have unintended consequences because evolution is a long, slow process and is unpredictable.

Chapter 5

Biodiversity, Species Interactions, and Population Control

Summary

1. Two major factors affect the number of species in a community: the latitude in terrestrial communities and pollution in aquatic systems.

2. Species play different roles in a community. Native species sustain the ecosystem in which they are a part. Some nonnative species will crowd out native species. Indicator species alert us to harmful changes in the community. Keystone species play ecological roles in the specific community: they may assist in pollination help regulate populations. Foundation species affect the community's habitat to benefit other species.

3. Species interact with each other in these different ways: interspecific competition, predation, parasitism, mutualism, and commensalism.

4. As environmental conditions change, one species may be replaced by other groups of species. This gradual change in the composition of species in a given area is called ecological succession.

5. A community has three aspects of sustaining itself: its persistence, the ability to resist being altered, its constant population, and its resilience in repairing damage. High biodiversity may give a community some edge in surviving, but we do not know this for certain.

Chapter 6

The Human Population and Its Impact

Summary

1. Birth, death, fertility, and migration rates are the factors that determine population size. As birth rates have declined in developed countries, population has increased due to people's migrating into these countries. Women's fertility rates have dropped but are still above the replacement-level fertility around the world.

2. Population size is profoundly affected by age structure. If women are past their primary child-bearing ages, population increase will be limited. If, however, the population has a large percentage of young women entering their childbearing years, the potential for large population increases is present. In general, the closer a country's young women are to 15–40 years of age, the more potential for a rapidly increasing population.

3. We can influence population size by encouraging smaller families, by encouraging adoption of children already born and discouraging new births. Population size is, also, affected by health care or its lack; by epidemics (such as AIDS); by losses through war, etc. Lack of prenatal care for expectant mothers, failure to protect children from communicable diseases (like measles) or wide-spread diseases (like malaria), can contribute to a smaller population. In the past economic development, family planning, and economic opportunities for women have reduced birth rates.

4. India and China have both made efforts to control their population growth. China has been more successful because, as a dictatorship, it has imposed restrictions on family size with rewards and punishments for those who support or defy the government's direction. India, without a policy of coercion, has reduced its birth rate; but the wish for male children and several children for the care of old parents has helped to maintain a growing population.

5. Effective methods for slowing the growth of world population include investing in family planning, reducing poverty, and elevating the status of women.

Chapter 7

Climate and Terrestrial Biodiversity

Summary

1. Key factors that determine the earth’s weather are short-term atmospheric conditions such as temperature, pressure, moisture content, sunshine, cloud cover, precipitation, wind direction, and wind speed.

2. Climate is a region’s long-term atmospheric conditions over decades. The two main factors in determining climate are average temperature and average precipitation.

3. The average climate—annual precipitation and temperature—determines terrestrial regions with characteristic types of natural ecological communities. According to these two factors, biomes form.

4. The major types of desert biomes are hot, medium, and cold. Human activities have created large desert cities, destroyed soil through urban development and off-road vehicles, salinized the soil through irrigation, depleted underground water supplies, disturbed land and polluted, stored toxic and radioactive wastes, and located arrays of solar cells and solar collectors.

5. The three major types of grasslands are tropical or savannas, temperate grasslands, and polar grassland/tundra. The savannas have been destroyed by grazing cattle, which destroy vegetation and kills grass through fecal droppings. The temperate grasslands have been used to grow crops and graze animals. As a result, the grasslands have disappeared. The arctic tundra has been compromised by oil drilling, mines, and military bases.

6. The three main types of forest biomes are tropical, temperate, and polar/boreal. Human activities have destroyed much of the native trees; grazing has compromised the vegetation and eliminated food sources for native animals. And the deforestation has changed the tropical forest’s ecosystem, leading to death of plants and animals. The temperate forest has a fewer number of broadleaf trees and rich forest soil; but fires, logging, and hunting have undermined this type of forest. The evergreen firs of the polar forest support a variety of wildlife. But oil drilling and oil spills have compromised the water, the wildlife, and the vegetation in the arctic.

7. Mountain and arctic biomes play important ecological roles; they help regulate climate and effect sea levels. Mountain biome degradation arises from timber and mining extraction, from hydroelectric dams and reservoirs, from air pollution, increased tourism, and radiation from ozone depletion.

Chapter 8

Aquatic Biodiversity

Summary

1. The basic types of aquatic life zones are the surface, middle, and bottom layers. The life in aquatic life zones is influenced by temperature, access to sunlight for photosynthesis, dissolved oxygen content, and availability of nutrients.

2. The major types of saltwater life zones are the coastal zone and the open sea. Coastal ecosystems contain estuaries, wetlands, and mangrove swamps. Because of their close proximity to man's activities, they are under constant strain from water pollution, industrial run-off, construction and soil erosion, agricultural pesticides flowing into rivers and streams, and aquaculture farming. The open sea contains the euphotic zone, which is the lighted upper zone of the ocean. The bathyal zone is in the middle and is dimly lit. The lowest zone, the abyssal zone, is dark and very cold. But all are being affected by human activities: over-harvesting, oil spills, filling-in of wetland areas, agricultural and industrial development and pollution, rising sea levels, and careless fishing/trawling techniques.

3. The major types of freshwater life zones are lakes, wetlands, and rivers. Human activities, such as dams or canals; flood control levees and dikes; and industrial, urban, agricultural pollutants all affect the flow and health of freshwater zones. Much of U.S. wetlands have been drained and filled to farm and/or to construct homes and businesses. These actions increase flood potential and encourage droughts. People overfish the waters; pollute the streams, rivers, and lakes; and dump excessive nutrients from pesticides and waste lots into the fresh water sources.

4. We must protect aquatic life zones from the pollutants, water controls, and deterioration that we press upon them every day.

Chapter 9

Sustaining Biodiversity: The Species Approach

Summary

1. Biologists estimate extinction rates in one of three levels. Local extinction occurs when a species in a specific area is lost but the species is still found in other places. Ecological extinction describes a species that is so small it cannot play out its ecological role where it is found. Biological extinction means that the species is gone from the earth. Scientists use measurement and models to estimate extinction rates: studying past records, identifying species-area relationships, examining lists of threatened species. Extinction rates are increasing because of human activities. Our growing population, degrading and eliminating biological environments and biological hot spots all contribute to growing extinction rates.

2. Biodiversity and species extinction are important because species provide enormous economic and ecological services we need to survive. In 100 years, mankind will destroy species that it would take five million years to rebuild. These species may provide genetic information, medicines, and information about natural processes we need to discover. These wild plants and animals are economic, recreational, and health resources.

3. Many human activities endanger wildlife, such as degradation/loss of habitat; capture of wild animals, which prevents their breeding; overfishing, oil spills, and exposure to pesticides; and extinction from nonnative species, which we introduce.

4. To prevent premature extinction of species, we must reduce threats from nonnative species; end illegal poaching and hunting; provide means for people to survive economically without killing native animals for food; maintain predator species, not destroy them; reduce greenhouse emissions and deforestation throughout the world; develop governmental policies to support biodiversity; and protect wild species in sanctuaries.

Chapter 10

Sustaining Terrestrial Biodiversity: The Ecosystem Approach

Summary

1. Conservation biology attempts to slow down the rate at which we are destroying and degrading the earth's biodiversity through the use of rapid response strategies. Hot spots, the most endangered and species-rich ecosystems, receive emergency action to slow down/stop the loss of biodiversity in these systems. Bioinformatics manages, analyzes, and communicates basic biological and ecological information to help sustain biodiversity.

2. Forests provide important ecological and economic services, are storehouses of biodiversity, and affect weather and climate throughout the world. Forest resource management varies according to the type of forests. In diverse forests, the age and size of trees are preserved to foster natural regeneration. Government policies will primarily determine the future of forests, including old-growth forests.

3. Forests in the United States should be managed so as to retain as much of the forests as possible. Clear-cutting and seed-tree cutting methods of harvesting are scourges on the forest; selective cutting is the most reasonable way to harvest trees.

4. Deforestation is one of the most serious ecological problems of this century. The earth's forests have been reduced by 20–50% and the destruction continues to this day. Deforestation has many harmful environmental effects: reduces ecological services of forests, releases large amounts of carbon dioxide in the air, produces a drier and hotter climate; reduces the control of water movements, and increases soil erosion.

5. Tropical deforestation is one of the biggest threats to world economic health and climate. To help sustain tropical forests, nations of the world must unite to discourage deforestation and degradation.

6. Problems affecting parks run from little/no protection from their governments or being too small to sustain large animal species, to being too popular and, therefore, overused by people. Some methods for managing parks include: limiting the number of visitors, raising entry fees to provide funds for maintenance and management, managing parks in reference to nearby federal lands, discouraging development around already established parks, and providing more volunteers and better paid employees to maintain the parks.

7. Only about 7% of the world's terrestrial areas are protected from potentially harmful human activities; these areas need to be expanded throughout the world. In order to adequately conserve biodiversity, at least 20% of the earth's land area should be protected in a global network of reserves.

8. Wilderness is an amount of land legally set aside to prevent/minimize harm from human activities. This is land where human beings may visit but not remain. Wilderness areas are important for: (1) their natural beauty, (2) their natural biological diversity, (3) their enhancement of mental and physical health of visitors, and (4) their contributions to biodiversity and to evolutionary possibilities.

9. Ecological restoration is the process of repairing damage caused by humans to the biodiversity and dynamics of natural ecosystems.

10. Initiatives that would help to sustain the earth's biodiversity include:
    – Immediately preserving the world's biological *hot spots*
    – Protecting the remaining old-growth forests
    – Mapping the world's terrestrial and aquatic biodiversity
    – Identifying and taking action for the world's marine hot spots, just as for the terrestrial hot spots
    – Protecting and restoring the world's lakes and river systems
    – Developing a global conservation strategy that protects the earth's terrestrial and aquatic ecosystems
    – Making conservation profitable
    – Initiating ecological restoration projects worldwide

Chapter 11

Sustaining Aquatic Biodiversity

Summary

1. Aquatic biodiversity refers to the composition of plants and animals in the fresh and salt waters of the planet. The economic importance of aquatic diversity lies in the conservative estimate of the value of their ecological services, which is $21 trillion a year. Additionally, at least 3.5 billion people depend on the seas for their primary source of food and this number could double to 7 billion in 2025. Many medicines have been developed from sea organisms: sponges, anemones, puffer fish, porcupine fish, seaweeds, etc. The waters are used for extensive recreational activities, not to mention commercial transportation.

2. Human activities are undermining aquatic biodiversity by destroying and degrading coastal wetlands, coral reefs, seagrass beds, kelp beds, mangroves, and the ocean bottom.

3. We can protect and sustain marine biodiversity by using laws, international treaties, and education. We must identify and protect species that are endangered and/or threatened. This entails cleaning up aquatic environments, as well as inventing fishing methods that do not destroy animals and birds inadvertently caught in fishing nets. Poaching and illegal harvesting of marine creatures must also be eliminated. Public aquariums can also educate the public about protecting marine animals and birds. Marine sanctuaries and coastal management can protect aquatic environments as well as their creatures.

4. The world's marine fisheries can be managed by setting catch limits below the maximum sustained yield limits, by reducing/eliminating fishing subsidies, and by charging fees for fishing in publicly owned offshore waters. Some areas can be protected from any kind of fishing; there should be more marine protected areas and more integration of coastal management practices. Develop net-escape devices for fishing boats. Restriction of coastal locations for fish farms, control of pollution, and decreasing the pollution of ship ballast water into the sea will all protect marine fisheries. Multispecies management of large marine systems offers hope for conserving marine resources and for renewing those resources.

5. Wetlands can be protected, sustained, and restored by government regulations that prevent wetland loss. Destroyed wetlands can also be restored and adequately monitored for their protection. Development can be kept away from wetland areas and control of nonnative species needs to be instituted to prevent invasion into wetlands.

6. Freshwater fisheries, lakes, and rivers can be protected, sustained, and even restored by building and protecting populations of desirable species, by prevention of overfishing, and by decreasing populations of less desirable species. Laws can be enacted, and enforcers of these laws must be funded to protect scenic rivers; they should be protected from development and dam construction projects.

Chapter 12

Food, Soil, and Pest Management

Summary

1. Even though food production has leveled off in the last 25 years, the world still produces enough food to meet the basic nutritional needs of people. However, the food cannot be evenly distributed throughout the world, leading to malnutrition and starvation. Many of these deaths come from malnutrition, which leads to a lack of resistance to diseases. Modern agricultural techniques create significant environmental harm, but the green revolution is also responsible for large increases in agricultural productivity.

2. Three systems produce foods for human consumption. Croplands produce mostly grains, about 77% of the world's food. Rangelands provide meat, about 16% of the world's food. Ocean fisheries supply about 7% of the world's food.

3. Soils are degraded and eroded by water, wind, and people. Soil erosion is primarily caused by flowing water and wind. Human activities, such as farming, logging, construction, off-road vehicles, etc., also disturb soil and hasten erosion. In much soil there is also salt buildup and waterlogging. Crops can be planted today with less soil disturbance through conservation-tillage, tillage, contour farming, and strip farming. Farmers may also use cover crops to help hold the soil in place. Several crops planted between trees and shrubs, alley cropping, help preserve soil and its productivity. And windbreaks are used to prevent soil from being blown away. Conservation and fertilization can be used to restore soil fertility, but fertilizing with commercial pesticides brings its own set of problems.

4. The green revolution uses particular methods to raise crops. Monocultures are developed and planted, bred selectively, or genetically engineered to produce high yields of particular crops. Large amounts of fertilizer, pesticides, and water are added to the crops. Yields of crops are increased through multiple cropping throughout the year. The second green revolution since 1967 involved using fast-growing dwarf varieties of wheat and rice in countries with tropical and subtropical climates. Traditional agriculture: uses interplanting, several crops grown together on the same area of land; uses agroforestry, which grows crops and trees together; and applies polyculture, where various plants are planted together but mature at different times.

5. Food production can be increased by using crossbreeding techniques on similar organisms and using genetic engineering on different organisms. Genetic engineering, including using advanced tissue culture techniques, is growing in use; but many people are concerned about the potential harm such crops may cause. Irrigating more land and cultivating more land are additional solutions but they may not prove sustainable. Rangelands can be managed more efficiently, with the land area better protected; but a meat-based diet requires substantially more resources than a plant-based diet. Overfishing and habitat degradation dominate the marine environment; better management of this food source and protection of the marine environment would ensure continued availability of fish worldwide.

6. More sustainable agricultural systems can be created by reducing resource throughput and working with nature. Technologies based on ecological knowledge are used to increase crop production, to control pests, and to build soil fertility. Such low-input organic farming is often more friendly to the environment by using less energy than conventional farming demands, and by improving soil fertility. Low-input organic farming is also more profitable for farmers.

7. Pesticides are chemicals that kill or control populations of organisms we consider undesirable. Types include insecticides, herbicides, fungicides, and rodenticides. The advantages of using pesticides include the fact that they save lives, increase food supplies, lower food cost, increase profit for farmers, and work fast. The disadvantages include the acceleration of pest resistance to pesticides and pesticides dispersing widely, harming wildlife, and threatening human lives. The Federal Insecticide, Fungicide, and Rodenticide Act established in 1947 and amended in 1972, as well as the 1996 Food Quality Protection Act regulate pesticide use in the United States. Alternatives to pesticides include integrated pest management, cultivation practices, food irradiation, genetic engineering, biological control, hot water, and pheromones. These all reduce pesticide use but may prove timely, costly, and not as reliable.

Chapter 13

Water

<u>Summary</u>

1. Approximately 0.024% of the earth's water supply is available as liquid freshwater. Management of the world's water supply is a huge 21^{st} century challenge.

2. Freshwater shortages are caused by dry climate, droughts, desiccation, and water stress. Solutions for this problem include building dams and reservoirs, transporting freshwater between locations, withdrawing groundwater, and desalination.

3. Advantages of dams and reservoirs include cheap electricity, reduction of downstream flooding, and year-round water for irrigation. Disadvantages include displacement of people and disruption of aquatic systems, and the hydrological cycle.

4. Transferring large amounts of water from one area to another can give stream runoff from water-rich areas to water-poor areas and aid in irrigation of farmland. It can also cause ecological, economical, and health disasters.

5. The advantages of withdrawing groundwater include water for drinking and irrigation; availability and locality; low cost, no evaporation losses; and it is renewable. Disadvantages include aquifer depletion from over pumping, subsidence, pollution, saltwater intrusion, and reduced water flow. Desalination increases the supply of fresh water but is expensive and produces large quantities of wastewater.

6. We can waste less water by lining canals, leveling fields, irrigating at night or using new irrigation techniques, polyculture or organic farming, seasonal farming, irrigating with treated waste water, and importing water-intensive crops and meat.

7. Flooding is caused by heavy rain or melting of snow within a short time. To reduce flood damage or the risk of flooding we can avoid building on floodplains, removing water-absorbing vegetation, or draining wetlands.

8. Methods for achieving more sustainable use of the earth's water include not depleting aquifers, preserving aquatic systems and water quality, integrated watershed management, agreements among regions and countries sharing surface water resources, outside party mediation of water dispute nations, marketing of water rights, raising water prices, wasting less water, decreasing government subsidies for reducing water waste, and slowing population growth.

Chapter 14

Geology and Nonrenewable Mineral Resources

Summary

1. Tectonic plates have rearranged the earth's continents and ocean basins over millions of years like pieces of a gigantic jigsaw puzzle. The plates have three types of boundaries. Natural hazards such as earthquakes and volcanoes are likely to be found at plate boundaries.

2. Rocks are large, natural, continuous parts of the earth's crust. There are three major types of rocks: igneous, sedimentary, and metamorphic. Rocks are affected by changes of physical and chemical conditions that change them over time from one type to another through the rock cycle.

3. Mineral resources include all naturally occurring materials that are used for human purposes. These resources include metals and fossil fuels, and the distribution of these materials across the earth's surface is highly variable leading to concentrated deposits in certain areas (e.g., diamonds in Angola or oil in Saudi Arabia). This unequal distribution can lead to conflicts and has implications for national security and international relations.

4. Mineral resource extraction methods include surface and subsurface mining. Surface mining types are open-pit, strip, contour strip mining, and mountain removal. Resource extraction technologies are constantly changing but always create some environmental disturbance. In some cases, the environmental impacts of mineral extraction can be severe.

5. All mineral resources are finite but the lifetime of materials varies with the rate of use and the size of the resource. Recycling of mineral resources leads to a longer depletion time compared to those that cannot be reused or recycled.

6. Scientists are developing new types of materials as substitutes for many metals. Mineral conservation and more sustainable manufacturing processes are helping to decrease our use and waste of such resources. Recent, dramatic increases in the cost of minerals are driving aggressive recycling of many resources and particularly metals (e.g., copper).

Chapter 15

Nonrenewable Energy

Summary

1. Nonrenewable energy sources are obtained from the earth's crust and primarily from carbon-containing fossil fuels. They are non-renewable because they have finite lifetimes, but the different forms of non-renewable fuels (e.g., oil, coal, uranium) have highly variable lifetimes.

2. The advantages of oil include low cost, high net energy yield, easy transportation, low land use, well-developed technology, and efficient system of distribution. Disadvantages include need for a substitute discovery; low price encourages waste, air pollution, and water pollution. Oil supplies are estimated to be approximately 80% depleted between 2050 and 2100.

3. The advantages of natural gas include plentiful supplies, high net energy yield, low cost, less air pollution than oil, moderate environment impact, and easy transport. Disadvantages include the fact that it is a nonrenewable resource, comparative high cost, release of carbon dioxide when burned (although lower than other fossil fuels such as coal), leaks, and requirement for pipeline infrastructure for transport.

4. The advantages of coal include plentiful supplies, high net energy yield, low cost, well-developed technology, and air pollution can be partially managed with appropriate technology. Disadvantages include very high environmental impact, land disturbance, air and water pollution, threat to human health, high carbon dioxide emissions, and release of radioactive particles and mercury.

5. The advantages of nuclear power include large fuel supply, low environmental impact, low carbon dioxide emissions (none from energy generation), moderate land disruption and use, and low risk of accidents. Disadvantages include high cost, low net energy yield, high environmental impact in case of accident, catastrophic accidents, long-term storage of radioactive waste, and potential for nuclear proliferation.

Chapter 16

Energy Efficiency and Renewable Energy

Summary

1. The advantages of improving energy efficiency include benefits to the environment, people, and the economy through prolonged fossil fuel supplies, reduced oil imports, very high net energy yield, low cost reduction of pollution, and improved local economies.

2. The advantages of solar energy include reduction of air pollution, reduction of dependence on oil, and low land use. Disadvantages include production of photocells results in release of toxic chemicals, life of systems is short, need backup systems, and high cost.

3. The advantages of hydropower include high net energy yield, low cost electricity, long life span, no carbon dioxide emissions during operation, flood control below dam, water for irrigation, and reservoir development. Disadvantages include high construction cost, high environmental impact, high carbon dioxide emissions from biomass decay, flooding of natural areas, conversion of land habitats to lake habitats, danger of dam collapsing, people relocation, limits fish populations below dam, and decrease flow of silt.

4. The advantages of wind power include high net energy yield and efficiency, low cost and environmental impact, no carbon dioxide emissions, and quick construction. Disadvantages include need for winds and backup systems, high land use, visual and noise pollution, interfering with bird migrations.

5. The advantages of biomass include large potential supplies, moderate costs, no net carbon increase, and use of agricultural, timber, and urban wastes. Disadvantages include nonrenewable resource if not harvested sustainably, moderate to high environmental impact, low photosynthetic efficiency, soil erosion, water pollution, and loss of wildlife.

6. The advantages of geothermal energy include very high efficiency, low carbon dioxide emissions, low cost and land use, low land disturbance, and moderate environmental impact. Disadvantages include scarcity of suitable sites, potential depletion, moderate to high air pollution, noise and odor, and high cost.

7. The advantages of hydrogen gas include the fact that it can be produced from water, the low environmental impact, no carbon dioxide emission, competitive price, ease of storage, safety, and high efficiency. Disadvantages include energy needed to produce the fuel, negative energy yield, nonrenewable, high cost, and no fuel distribution system exists.

8. The advantages of using smaller, decentralized micropower sources include size, fast production and installation, high energy efficiency, low or no CO_2 emissions, low air pollution, easy repair, reliable, increased national security, and easily financed.

9. We can improve energy efficiency by increasing fuel efficiency standards, large tax credits for purchasing energy efficient cars, houses, and appliances, encouraging independent energy production, and increasing research and development.

Chapter 17

Environmental Hazards and Human Health

Summary

1. Major types of hazards faced by humans include cultural, physical, chemical, and biological hazards.

2. Toxicology is the scientific field that measures the degree of harm a hazardous agent can cause. Scientists measure toxicity based on dosage, solubility, persistence, bioaccumulation, biomagnification, and chemical interactions.

3. Chemical hazards include agents that are flammable or explosive, damage or irritate lungs or skin, interrupt oxygen uptake, and cause allergies. Chemical hazards are defined by their toxicity, the person's acute and chronic reactions to it, and its pervasiveness in the environment.

4. The types of disease threatening people in developing countries are primarily infectious diseases of childhood, while those threatening people in developed countries tend to be chronic diseases of adults, such as heart disease, stroke, cancer, and respiratory conditions.

5. Risks can be estimated, managed, and reduced by identifying hazards, evaluating related risks (risk assessment), ranking risks (comparative risk analysis), determining alternative solutions, making decisions about reducing risks (risk management), and informing decision-makers about risk (risk communication).

Chapter 18

Air Pollution

Summary

1. The layers of the atmosphere are the troposphere, stratosphere, mesosphere, and thermosphere.

2. Major classes of air pollutants include carbon, sulfur, and nitrogen oxides, volatile organic compounds, suspended particulate matter, photochemical oxidants, radioactive substances, and hazardous chemicals that can cause health problems. Primary sources of these pollutants include cars, industry, and natural phenomena such as volcanic eruptions.

3. The two types of smog are the photochemical and the industrial, or gray-air, smog.

4. Acid deposition includes wet deposition of acidic rain, snow, fog, and cloud vapor with pH less than 5.6, and dry deposition of acidic particles. Major sources of acid deposition are nitrogen oxides produced during fossil fuel combustion and sulfur oxides produced primarily from coal-fired power plants.

5. Harmful effects of air pollution include various respiratory diseases, premature deaths, damage to plants, and materials such as buildings, cars, statues, etc.

6. We can reduce air pollution by reducing emission through the use of low-sulfur coal, shifting to less polluting fuels (e.g., coal to natural gas), removal of pollutants after combustion or lower emissions through the use of mass transit or alternative transportation, improving fuel efficiency, and tax incentives.

Chapter 19

Climate Change and Ozone Depletion

Summary

1. The earth's average surface temperature and climate has changed in the past. The changes include prolonged periods of global cooling and global warming.

2. There is a natural greenhouse effect in the earth's atmosphere caused by the presence of gases that trap long-wave radiation (water, CO_2, and others). Human emissions of carbon dioxide, methane, and nitrogen oxide increase the concentrations of greenhouse gases and cause additional warming of the earth's surface.

3. Factor's influencing changes of earth's average surface temperature include changes in the solar output, the earth's reflectivity, the ability of oceans and land ecosystems to store carbon dioxide, the ocean currents, the average sea level, cloud cover, and air pollution.

4. Possible effects from a warmer earth include shifts in plant-growing areas, crop yields and pests, extinction of some species, loss of habitats, prolonged heat waves and droughts, increased flooding, changes in water supplies, decreased water quality, changes in forest composition, increased fires, rising sea levels, beach erosion, contamination of aquifers, spread of tropical diseases into temperate zones, increased respiratory diseases and allergies, increased deaths, and migration.

5. To prevent or slow global warming we can limit fossil fuel use, shift from coal to natural gas use, place energy efficient technologies in developed and developing countries, improve energy efficiency, shift to renewable resources, reduce deforestation, use sustainable agriculture, limit urban sprawl, reduce poverty, and slow population growth.

6. Human activities that cause ozone depletion include emissions of chlorofluorocarbons, methyl bromide, hydrogen chloride, carbon tetrachloride, methyl chloroform, and others. The stratosphere contains high concentrations of ozone that absorbs UV radiation as it enters the atmosphere. Ozone depletion can lead to sunburns, cataracts, skin cancers, immune suppression, and reduced crop yields, particularly in the Southern Hemisphere. Note that students often confuse tropospheric ozone (air pollution) and stratospheric ozone (UV absorption), and confuse ozone depletion with global warming.

Chapter 20

Water Pollution

Summary

1. Water pollutants include infectious agents from human or animal wastes; oxygen-demanding wastes from sewage, paper mills, and food processing; inorganic chemicals from surface runoff, industrial effluents, and household cleaners; organic chemicals from oil, plastics, pesticides, and detergents; sediment from erosion; and thermal pollution from power plant cooling.

2. Water pollution problems in streams and lakes relate to chemical and biological pollutants, with the greater problems being cultural eutrophication.

3. Groundwater pollution is caused by leaks from waste ponds and underground storage tanks, chemical dumping or spilling, surface runoff, and fertilizers. It can be prevented by finding substitutes for toxic chemicals, installing monitoring wells near landfills and underground tanks, requiring leak detectors on underground tanks, banning hazardous waste disposal in landfills and injection wells, and storing harmful liquids in aboveground tanks.

4. Water pollution of oceans relates to nitrogen oxide from industry and cars, heavy metals from effluents, toxic sediment, sewage, runoff of pesticides, manure, fertilizers, and red tides from excess nitrogen.

5. Reduction or prevention of water pollution can be achieved through reduction of use of toxic pollutants, banning of ocean dumping of sludge, protection of sensitive areas from oil drilling and oil transport, regulation of coastal development, and regulation of sewage treatment.

6. The U.S. Safe Drinking Water Act of 1974 requires that drinking water contain less than the maximum contaminant levels for any pollutants that may have adverse effects on human health. Restructuring of water treatment systems, enforcing current regulations, banning the use of lead in new structures, and chemical tests and biological indicators can be used to make drinking water safer.

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Chapter 21

Solid and Hazardous Waste

Summary

1. Solid waste is any unwanted or discarded material that is not a liquid or a gas. Thirty-three percent of the world's solid wasted is produced by one country—the United States—which represents 4.6% of the world's population.

2. Waste management, waste reduction, reduced usage, and pollution prevention can all be used to reduce, reuse, or recycle solid waste.

3. The advantages of burning waste include reducing trash volume, minimizing the need for landfills, and lowering water pollution. The disadvantages include high cost, air pollution, producing toxic ash, and encouraging waste production. The advantages of burying wastes include safety, wastes can be retrieved, ease of application, and low cost. Disadvantages include leaks and spills, existing fractures or earthquakes can cause waste escape, and encouraging waste production.

4. Hazardous waste is any discarded solid or liquid material that is toxic, ignitable, corrosive, or reactive enough to explode or release toxic fumes. We can use a pollution prevention or waste reduction approach to reduce production and manage existing hazardous waste mostly by burning or burying it.

5. Physical methods such as filtering and distilling, chemical reactions, bioremediation, phytoremediation, and plasma torches can all be used to detoxify hazardous waste.

6. Advantages of burning hazardous waste include reducting waste volume, minimizing the need for storage space, and lowering water pollution. The disadvantages include air pollutants such as toxic dioxins and production of toxic ash that must be stored. Advantages of burying hazardous waste include safety, wastes can be retrieved, ease of application, and low cost. Disadvantages include leaks and spills, existing fractures or earthquakes can cause waste escape, and encouraging waste production.

7. The United States regulates hazardous waste through the 1976 Resource Conservation and Recovery Act, which was amended in 1984.

Chapter 22

Sustainable Cities

Summary

1. Almost half of the world's population lives in urban areas and half in rural areas. Government policies, poverty, lack of land to grow food, declining agricultural jobs, famine, and war that force people out of rural areas are all factors that determine how urban areas develop.

2. Urban areas are rarely self-sustaining, threaten biodiversity, destroy and damage ecosystems, lack trees, grow little of their own food, concentrate pollutants and noise, spread infectious disease, and are centers of poverty, crimes, and terrorism.

3. Urban areas relying on mass transportation spread vertically and urban areas relying on automobiles spread horizontally. Advantages of automobiles include convenience, personal benefits, and boosted economies, Disadvantages include air pollution, promotion of urban sprawl, increase in death rate, and time- and gas-wasting traffic jams. Advantages of bicycles and motor scooters include low cost, little to no air or noise pollution, require little space, and are energy efficient. Disadvantages include little accident protection, impractical for long distances, can be tiring, little parking, and gas scooter engines emit high air pollution. Mass transit rail systems are more energy efficient than cars, produce lower air pollution, require less land, cause fewer injuries and deaths, and reduce car congestion. Disadvantages include high cost to build and maintain, rigid schedules, noise pollution, and they are cost effective only in densely populated areas. Buses are more flexible than rail systems, can easily be rerouted, cost less to develop, and can reduce car use. Disadvantages include rigid schedules, noise pollution, and they are not always cost efficient. Rapid rail systems can reduce car and plane travel, are ideal for long trips, and are more efficient than cars and planes. Disadvantages include high operation and maintenance cost, noise pollution, and they are not always cost efficient.

4. Land-use planning, zoning, and smart growth can be used for planning and controlling urban growth.

5. Cities can be made more sustainable and more desirable places to live by creating parks, greenbelts, urban growth boundaries, cluster developments, mixed-use villages, greenways, and ecocities.

Chapter 23

Economics, Environment, and Sustainability

Summary

1. Economic systems are the social institutions through which goods and services are produced, distributed, and consumed to satisfy people's wants in the most efficient possible way. Natural capital, human capital, financial capital, and manufactured capital all comprise economic resources, which must be managed to sustain the world's environmental health.

2. Neoclassical economists see natural resources as a part of the economic system and assume that economic growth potential is essentially unlimited. Ecological economists see economic systems as a component of nature's economy and would have higher optimum levels of pollution control and lower optimum levels of resource use than would neoclassical economists.

3. Economic and environmental progress is monitored through the gross national income (GNI), gross domestic product (GDP), and per capita GNI and GDP indicators.

4. Full-cost pricing includes the internal and external costs in the market price of any good or service.

5. Some components of an environmental economics perspective include phasing out environmentally harmful subsidies, levying taxes on environmentally harmful goods and services, passing laws to regulate pollution and resource depletion, and using tradable permits for pollution or resource use.

6. Poverty can be reduced by forgiving dept to developing countries, through increase of nonmilitary government and private aid, and by stabilizing populations.

7. Shifting to more environmentally sustainable economies includes rewarding sustainable activities and penalizing non-sustainable resource use, use of full-cost pricing, and reduction of poverty.

Chapter 24

Politics, Environment, and Sustainability

Summary

1. In this century, we have increased concern about human activities and the harmful effects on biodiversity, shifted from local to regional and global concerns, focused on climate change, become aware of pollution in developing countries, increased concern about trace amounts of some chemicals, and are starting to rely more on our international community to deal with environmental problems.

2. Democracies are governments in which people elect officials and representatives who pass laws, develop budgets, and formulate regulations. Democracies are designed to deal mostly with short-term, isolated problems and are not always efficient when dealing with environmental problems.

3. Environmental policy in the United States is made through: persuasion of lawmakers that an environmental problem exists, influence on how the laws are written, finding funds to implement and enforce each law, drawing up regulations for implementing each law by the appropriate government department, and the enforcement of these regulations.

4. Environmental groups range from small grassroots groups to major global organizations. Their roles include monitoring environmental activities, working to pass and strengthen environmental law, and working with corporations to find solutions to problems. Opponents of these groups include some corporate leaders, some corporations, and some citizens.

5. There are currently environmental protection agencies in 115 countries, over 500 international environmental treaties and agreements, UNEP to negotiate and monitor international environmental treaties, Rio Earth Summit, and Johannesburg Earth Summit. These can be improved by monitoring and evaluating effectiveness.

Chapter 25

Environmental Worldviews, Ethics, and Sustainability

Summary

1. The planetary management worldview is the human-centered environmental worldview that guides most industrial societies. This worldview has as a key component the idea that humans are the most important species and that the earth should be managed for our benefit. Variations include the no-problems school, the free-market school, the responsible planetary management school, the spaceship school, and the stewardship school.

2. Life-centered and earth-centered worldviews include environmental wisdom worldview, species centered, biosphere centered, and ecosystem centered. All of these worldviews have far less emphasis on management for human benefit alone and all are far less human-centered.

3. Education is an important component of living sustainably. Education includes understanding ecosystems, developing environmental literacy, and viewing the earth as a complex, interconnected system.

4. We can live sustainably through pollution prevention, waste prevention, species protection, and environmental restoration.

Miscellaneous

One BTU is the energy required to raise the temperature of one pound of water by one degree Fahrenheit.

The density of water is 1 gram/milliliter or approximately 8 pounds/gallon (U.S.).

Math Review

Per Capita= divide by the total population

US Population currently about 300,000,000

Rate of Change: (old-new) / old

Percent Change: {(old-new) / old } x 100

Annual % Change:

$$\frac{\text{(births + immigrants)–(deaths + emigrants)}}{\text{number of people}} \times 100$$

Doubling Time: 70 / % growth = years to double

Determining Percentage: $\frac{\text{part}}{\text{whole}} = \frac{\%}{100}$

Half Life Fractions:

1/2; 1/4; 1/8; 1/16; 1/32; 1/64; 1/128; 1/256

Primary Productivity:

Net Productivity = Gross Product. – Cell Respiration

Conversions:

1 Megawatt = 1,000 kilowatts

1 kilowatt = 1,000 watts

1 kilowatt hour = 10,000 BTU's

kilowatts x hours = kwh

1L = 1,000 mL

Scientific Notation:

**To S.N.

0.00068 → 6.8×10^{-4}

6,845 → 6.8×10^{3}

**To Standard

5.56×10^{-6} → 0.00000556

5.56×10^{6} → 5,560,000

Messing with Scientific Notation:

**Multiplication→ add exponents; multiply bases

$(3 \times 10^{3})(4 \times 10^{5}) = 12 \times 10^{8} = 1.2 \times 10^{9}$

** Division→ subtract exponents; divide bases

$(5.2 \times 10^{4}) / (2.6 \times 10^{2}) = 2 \times 10^{2}$

**Addition→ convert both #'s to the same exponent; add bases; exponents stay the same

$(3000 \times 10^{6}) + (14 \times 10^{5}) = 3001.4 \times 10^{6} = 3.0 \times 10^{9}$

**Subtraction→ convert both #'s to same exponent; subtract bases; exponents stay the same

$(2000 \times 10^{3}) – (1000 \times 10^{2}) = 1900 \times 10^{3} = 1.9 \times 10^{6}$

Chemistry Review
Basics

- Neutrons, protons, and electrons are the components of atoms, which combine to form molecules.
- The basic unit of all chemical compounds, whether natural or man-made, is the molecule.

Abbreviations

- C carbon S sulfur U uranium Cl2 chlorine
- O2 oxygen N2 nitrogen H2 hydrogen P phosphorus
- NO2
- -1 nitrite NO3
- -1 nitrate SO4
- -2 sulfate NH3 ammonia
- NOx oxides of nitrogen or nitrogen oxides (NO, NO2)
- SOx oxides of sulfur or sulfur oxides (SO2, SO3)
- VOC volatile organic compounds (compounds containing carbon which readily evaporate, ex. methane, benzene)
- PAN peroxyacyl nitrates

pH

- pH is the negative log of the hydrogen ion concentration (sometimes called the potential of hydrogen ion).
- Mathematically it is represented by the equation: pH = –log[H+] or pH = –log[H3O+]
- [H+] is the molarity (# of moles per liter) of H+ ions
- [H+] and [H3O+] are essentially the same. H3O+ is called the hydronium ion, it results when H+ are in water.
- Low pH corresponds to being more acidic. High pH corresponds to being more basic.

- □□The opposite of acidic is basic.
- □□The range of pH is from 0 to 14.
- pH=1 □□[H+]=1 x 10-1 moles/liter (very acidic) pH=4 □□[H+]=1 x 10-4 moles/liter (acidic)
- pH=6 □□[H+]=1 x 10-6 moles/liter (slightly acidic) pH=7 □□[H+]=1 x 10-7 moles/liter (neutral)
- pH=8 □□[H+]=1 x 10-8 moles/liter (slightly basic) pH = 13 □□[H+]=1 x 10-13 moles/liter (very basic)

Nuclear Fission

- □□Nuclear fission (splitting atoms) is the source of energy in today's nuclear power plants. The reactions used are chain reactions, in
- which one neutron initiates the reaction of millions of Uranium nuclei.
- 1 U-235 + 1 n □□1 Kr-92 + 1 Ba-141 + 3 n + energy (the 3 neutrons (n) initiate further reactions)
- 3 U-235 + 3 n □□3 Kr-92 + 3 Ba-141 + 9 n + energy (the 9 neutrons initiate further reactions)
- 9 U-235 + 9 n □□9 Kr-92 + 9 Ba-141 + 27 n + energy (the 27 neutrons initiate further reactions)
- This continues until there are millions of neutrons being produced and millions of times more energy, as well.
- □□A moderator and control rods are used to absorb neutrons to prevent the chain reaction from getting out of control which would
- result in a meltdown.
- David Hong Diamond Bar High School hongyon@yahoo.com page 2

Air Pollution in the Troposphere

- □□All fossil fuels contain large amounts of carbon (from the molecules of decomposed lifeforms). The combustion of fossil fuels
- (reaction with oxygen) produces carbon dioxide and carbon monoxide:
- C + O2 □□CO2 (the #1 man-made greenhouse gas)
- 2C + O2 □□2CO (incomplete combustion)
- □□Coal may also contain sulfur which reacts during combustion:
- S + O2 □□SO2
- □□During combustion, the nitrogen that composes 80% of the air in the troposphere reacts:
- N2 + O2 □□2NO
- □□The reactions above all show the formation of primary air pollutants
- □□Primary air pollutants undergo reactions in the atmosphere to form secondary air pollutants.

Photochemical Smog

- 2NO + O2 □□2NO2 (causes brownish haze)
- NO2 + UV light □□NO + O followed by:
- + O2 □□O3 (O3 is ozone and is very hazardous to plants, animals, and materials in the troposphere)
- hydrocarbons + O2 + NO2 □□PANs (peroxyacyl nitrates cause burning eyes and damage vegetation)

Acid Precipitation

- 3NO2 + H2O □□2HNO3 + NO (HNO3 is nitric acid and causes acid precipitation)
- 2SO2 + O2 □□2SO3 followed by:
- SO3 + H2O □□H2SO4
- □□Acid deposition can be neutralized by the addition of lime (CaCO3) which is a base (a base will neutralize an acid)

Air Pollution in the Stratosphere

- **The reaction that is supposed to happen, which protects the Earth from UV light**
- 2O3 + UV light □□3O2
- **The destruction of ozone by CFCs**
- CCl3F + UV light □□CCl2F + Cl (CCl3F is a CFC) followed by:
- Cl + O3 □□ClO + O2 followed by:
- ClO + O □□Cl + O2 followed by:
- Cl + O3 □□ClO + O2 (same as first step above) followed by:
- ClO + O □□Cl + O2 (same as second step above) followed by:
- (these reactions are repeated thousands of times to destroy thousands of ozone molecules)

Populations to Know

World~ 7 Billion

China= 1,354,040,000 ~1.3 Billion

India= 1,210,193,422 ~ 1.2 Billion

United States= 315,791,000 ~ 300 Million

Indonesia= 237,641,326 ~ 200 Million

World Top Ten Countries by Coal Production

Country	Coal Production (2010e) in MT
China	3162
USA	932
India	538
Australia	353
South Africa	255
Russia	248
Indonesia	173
Kazakhstan	105
Poland	77
Colombia	74

Top Ten Oil Reserves Countries

Country	Billions of Barrels
Saudi Arabia	261.8
Canada	180
Iraq	112.5
U.A.E.	97.8
Kuwait	96.5
Iran	89.7
Venezuela	77.8
Russia	60
Libya	29.5
Nigeria	24

World Top Ten Countries With Most Reliance On Nuclear Power

Country	Nuclear Electricity As Percentage Of Total Electricity
Lithuania	78
France	77
Belgium	58
Slovakia	53
Ukraine	46
Sweden	44
Bulgaria	42
Hungary	39
Slovenia	39
South Korea	39

Top 10 wind power countries

Country	**Total capacity end 2012 (MW)**
China	75,564
United States	60,007
Germany	31,332
Spain	22,796
India	18,421
United Kingdom	8,445
Italy	8,144
France	7,196
Canada	6,200
Portugal	4,525

- Technically because of tar sand, Canada's oil supply is second to Saudi Arabia.
- Most likely on AP exam, France will be known for highest Nuclear energy production.
- US has most Geothermal but Iceland depends more on it.
- US consumes the most of almost everything.
- Energy waste should be prevented.

GLOSSARY 1

pH	Scientists use pH as a measure of acidity, based on the amount of hydrogen ions (H^+) and hydroxide ions (OH^-) contained in a particular volume of a solution.
physical change	When a sample of matter undergoes a physical change, its *chemical composition*, or the arrangement of its atoms or ions within molecules does not change.
positive feedback loop	causes a system to change further in the same direction.
potential energy	The other major type of energy is potential energy, which is stored and potentially available for use.
protons (p)	If you could view atoms with a supermicroscope, you would find that each different type of atom contains a certain number of three different types of *subatomic particles*: positively charged protons (p), neutrons (n) with no electrical charge, and negatively charged electrons (e).
radioactive decay	occurs when nuclei of unstable isotopes spontaneously emit fast-moving chunks of matter (alpha particles or beta particles), high-energy radiation (gamma rays), or both at a fixed rate. A particular radioactive isotope may emit any one or a combination of the three items shown in the diagram.
radioactive isotopes or radioisotopes	unstable isotopes
reliable science	consists of data, hypotheses, theories, and laws that are widely accepted by scientists who are considered experts in the field under study.
science	an endeavor to discover how nature works and to use that knowledge to make predictions about what is likely to happen in nature.
scientific hypothesis	a possible and testable explanation of what they observe in nature or in the results of their experiments.
scientific law, or law of nature	a well-tested and widely accepted description of what we find happening over and over again in the same way in nature.
scientific theory	A well-tested and widely accepted scientific hypothesis or a group of related hypotheses
second law of thermodynamics	When energy changes from one form to another, we always end up with lower-quality or less usable energy than we started with. This lower-quality energy usually takes the form of heat given off at a low temperature to the environment.
synergistic interaction, or synergy	occurs when two or more processes interact so that the combined effect is greater than the sum of their separate effects.
system	a set of components that function and interact in some regular way.
tentative science or frontier science	Sometimes, preliminary results that capture news headlines are controversial because they have not been widely tested and accepted by peer review. They are not yet considered reliable, and can be thought of as tentative science or frontier science.
time delays	Complex systems often show time delays between the input of a feedback stimulus and the response to it.
tipping point	Time delays can also allow an environmental problem to build slowly until it reaches a *threshold level*, or tipping point, causing a fundamental shift in the behavior of a system.
trait	Each of these coded units of genetic information concerns a specific trait, or characteristic passed on from parents to offspring during reproduction in an animal or plant.

unreliable science	Scientific hypotheses and results that are presented as reliable without having undergone the rigors of peer review, or that have been discarded as a result of peer review, are considered to be unreliable science.
abiotic	Two types of components make up the biosphere and its ecosystems: One type, called abiotic, consists of nonliving components such as water, air, nutrients, rocks, heat, and solar energy.
aerobic respiration	Producers, consumers, and decomposers use the chemical energy stored in glucose and other organic compounds to fuel their life processes. In most cells this energy is released by aerobic respiration, which uses oxygen to convert glucose (or other organic nutrient molecules) back into carbon dioxide and water.
anaerobic respiration, or fermentation	Some decomposers get the energy they need by breaking down glucose (or other organic compounds) in the absence of oxygen. This form of cellular respiration is called anaerobic respiration, or fermentation.
aquatic life zones	Scientists divide the watery parts of the biosphere into aquatic life zones, each containing numerous ecosystems.
atmosphere	a thin spherical envelope of gases surrounding the earth's surface.
biogeochemical cycle	(literally, life-earth-chemical cycles) or nutrient cycles—prime examples of one of the four scientific principles of sustainability
biomass	the dry weight of all organic matter contained in its organisms.
biomes	large regions such as forests, deserts, and grasslands, with distinct climates and certain species (especially vegetation) adapted to them.
biosphere	consists of the parts of the earth's air, water, and soil where life is found.
biotic	Two types of components make up the biosphere and its ecosystems: The other type, called biotic, consists of living and once living biological components—plants, animals, and microbes.
carbon cycle	Carbon is the basic building block of the carbohydrates, fats, proteins, DNA, and other organic compounds necessary for life. It circulates through the biosphere, the atmosphere, and parts of the hydrosphere, in the carbon cycle.
cell theory	The idea that all living things are composed of cells is called the cell theory and it is the most widely accepted scientific theory in biology.
cells	All organisms (living things) are composed of cells: the smallest and most fundamental structural and functional units of life.
chemosynthesis	A few producers, mostly specialized bacteria, can convert simple inorganic compounds from their environment into more complex nutrient compounds without using sunlight, through a process called chemosynthesis.
community, or biological community	consists of all the populations of different species that live in a particular place.
consumers	All other organisms in an ecosystem are consumers, or heterotrophs ("other-feeders"), that cannot produce the nutrients they need through photosynthesis or other processes and must obtain their nutrients by feeding on other organisms (producers or other consumers) or their remains.
decomposers	primarily certain types of bacteria and fungi, are consumers that release nutrients from the dead bodies of plants and animals and return them to the soil, water, and air for reuse by producers. They feed by secreting enzymes that speed up the break down of bodies of dead organisms into nutrient compounds such as water, carbon dioxide, minerals, and simpler organic compounds.
detritus	Detritus feeders, or detritivores, feed on the wastes or dead bodies of other organisms, called

	detritus ("di-TRI-tus," meaning debris).
detritus feeders, or detritivores	feed on the wastes or dead bodies of other organisms, called detritus ("di-TRI-tus," meaning debris). Examples include small organisms such as mites and earthworms, some insects, catfish, and larger scavenger organisms such as vultures.
ecological efficiency	The percentage of usable chemical energy transferred as biomass from one trophic level to the next is called ecological efficiency.
Ecology	(from the Greek words oikos, meaning "house" or "place to live," and logos, meaning "study of") is the study of how organisms interact with their living (biotic) environment of other organisms and with their nonliving (abiotic) environment of soil, water, other forms of matter, and energy mostly from the sun.
ecosystem	is a community of different species interacting with one another and with their nonliving environment of soil, water, other forms of matter, and energy, mostly from the sun.
eukaryotic cell	is surrounded by a membrane and has a distinct nucleus and several other internal parts called organelles, which are also surrounded by membranes.
food chain	A sequence of organisms, each of which serves as a source of food or energy for the next, is called a food chain.
food web	organisms in most ecosystems form a complex network of interconnected food chains called a food web
genetic diversity	In most natural populations, individuals vary slightly in their genetic makeup, which is why they do not all look or act alike. This variation in a population is called genetic diversity.
geosphere	consists of the earth's intensely hot core, a thick mantle composed mostly of rock, and a thin outer crust.
greenhouse gases	The remaining 1% of the air includes water vapor, carbon dioxide, and methane, all of which are called greenhouse gases, because they trap heat and thus warm the lower atmosphere. Almost all of the earth's weather occurs in this layer.
gross primary productivity (GPP)	is the rate at which an ecosystem's producers (usually plants) convert solar energy into chemical energy as biomass found in their tissues.
habitat	The place where a population or an individual organism normally lives is its habitat.
hydrologic cycle, or water cycle	collects, purifies, and distributes the earth's fixed supply of water.
hydrosphere	consists of all of the water on or near the earth's surface.
limiting factor principle	A variety of abiotic factors can affect the number of organisms in a population. Sometimes one or more factors, known as limiting factors, are more important in regulating population growth than other factors are. This ecological principle is called the limiting factor principle: Too much or too little of any abiotic factor can limit or prevent growth of a population, even if all other factors are at or near the optimal range of tolerance.
limiting factors	A variety of abiotic factors can affect the number of organisms in a population. Sometimes one or more factors, known as limiting factors, are more important in regulating population growth than other factors are.
natural greenhouse effect	Without this the earth would be too cold to support the forms of life we find here today.
net primary productivity (NPP)	is the rate at which producers use photosynthesis to produce and store chemical energy minus the rate at which they use some of this stored chemical energy through aerobic respiration.
nitrogen cycle	Fortunately, two natural processes convert or fix N2 into compounds useful as nutrients for plants and animals. One is electrical discharges, or lightning, taking place in the atmosphere.

	The other takes place in aquatic systems, soil, and the roots of some plants, where specialized bacteria, called nitrogen-fixing bacteria, complete this conversion as part of the nitrogen cycle.
omnivores	such as pigs, foxes, cockroaches, and humans, play dual roles by feeding on both plants and animals.
phosphorus cycle	Phosphorus circulates through water, the earth's crust, and living organisms in the phosphorus cycle.
photosynthesis	Most producers capture sunlight to produce energy-rich carbohydrates (such as glucose, C6H12O6) by photosynthesis, which is the way energy enters most ecosystems.
population	is a group of individuals of the same species that live in the same place at the same time.
primary consumers, or herbivores	(plant eaters), are animals such as rabbits, grasshoppers, deer, and zooplankton that eat producers, mostly by feeding on green plants.
producers	sometimes called autotrophs (self-feeders), make the nutrients they need from compounds and energy obtained from their environment.
prokaryotic cell	is also surrounded by a membrane, but it has no distinct nucleus and no other internal parts surrounded by membranes.
pyramid of energy flow	The more trophic levels there are in a food chain or web, the greater is the cumulative loss of usable chemical energy as it flows through the trophic levels. The pyramid of energy flow illustrates this energy loss for a simple food chain, assuming a 90% energy loss with each transfer.
range of tolerance	Each population in an ecosystem has a range of tolerance to variations in its physical and chemical environment. Individuals within a population may also have slightly different tolerance ranges for temperature or other factors because of small differences in genetic makeup, health, and age.
secondary consumers, or carnivores	(meat eaters), are animals such as spiders, hyenas, birds, frogs, and some zooplankton-eating fish, all of which feed on the flesh of herbivores.
species	For a group of sexually reproducing organisms, a species is a set of individuals that can mate and produce fertile offspring.
stratosphere	The next layer, stretching 17–50 kilometers (11–31 miles) above the earth's surface, is the stratosphere. Its lower portion contains enough ozone (O3) gas to filter out most of the sun's harmful ultraviolet radiation.
sulfur cycle	Sulfur circulates through the biosphere in the sulfur cycle.
third- and higher-level consumers	are carnivores such as tigers, wolves, mice-eating snakes, hawks, and killer whales (orcas) that feed on the flesh of other carnivores.
transpiration	Over land, about 90% of the water that reaches the atmosphere evaporates from the surfaces of plants through a process called transpiration.
trophic level	Ecologists assign every organism in an ecosystem to a feeding level, or trophic level, depending on its source of food or nutrients.
troposphere	a thin spherical envelope of gases surrounding the earth's surface. Its inner layer, the troposphere, extends only about 17 kilometers (11 miles) above sea level at the tropics and about 7 kilometers (4 miles) above the earth's north and south poles.
adaptation, or adaptive trait	any heritable trait that enables an individual organism to survive through natural selection and to reproduce more than other individuals under prevailing environmental conditions.
background extinction	Throughout most of history, species have disappeared at a low rate, called background extinction.

biological diversity, or biodiversity	the variety of the earth's species, the genes they contain, the ecosystems in which they live, and the ecosystem processes such as energy flow and nutrient cycling that sustain all life.
biological evolution	the process whereby earth's life changes over time through changes in the genes of populations.
differential reproduction	For natural selection to occur, a trait must be heritable, meaning that it can be passed from one generation to another. The trait must also lead to differential reproduction, which enables individuals with the trait to leave more offspring than other members of the population leave.
ecological niche	Scientists describe the role that a species plays in its ecosystem as its ecological niche, or simply niche (pronounced "nitch"). It is a species' way of life in a community and includes everything that affects its survival and reproduction, such as how much water and sunlight it needs, how much space it requires, and the temperatures it can tolerate.
endemic species	Species that are found in only one area are called endemic species and are especially vulnerable to extinction.
extinction	Another process affecting the number and types of species on the earth is extinction, in which an entire species ceases to exist.
fossils	Most of what we know of the earth's life history comes from fossils: mineralized or petrified replicas of skeletons, bones, teeth, shells, leaves, and seeds, or impressions of such items found in rocks.
foundation species	Another important type of species in some ecosystems is a foundation species, which plays a major role in shaping communities by creating and enhancing their habitats in ways that benefit other species.
generalist species	Generalist species have broad niches. They can live in many different places, eat a variety of foods, and often tolerate a wide range of environmental conditions.
geographic isolation	occurs when different groups of the same population of a species become physically isolated from one another for long periods.
indicator species	Species that provide early warnings of damage to a community or an ecosystem are called indicator species.
keystone species	A keystone is the wedge-shaped stone placed at the top of a stone archway. Remove this stone and the arch collapses. In some communities and ecosystems, ecologists hypothesize that certain species play a similar role. Keystone species have a large effect on the types and abundances of other species in an ecosystem.
mass extinction	is a significant rise in extinction rates above the background level.
mutations	The first step in this process is the development of genetic variability in a population.This genetic variety occurs through mutations: random changes in the structure or number of DNA molecules in a cell that can be inherited by offspring.
native species	are those species that normally live and thrive in a particular ecosystem.
natural selection	Darwin and Wallace concluded that these survival traits would become more prevalent in future populations of the species through a process called natural selection, which occurs when some individuals of a population have genetically based traits that enhance their ability to survive and produce offspring with the same traits.
nonnative species	Other species that migrate into or are deliberately or accidentally introduced into an ecosystem are called nonnative species, also referred to as invasive, alien, or exotic species.
reproductive isolation	mutation and change by natural selection operate independently in the gene pools of geographically isolated populations.
specialist species	In contrast, specialist species occupy narrow niches. They may be able to live in only one type of habitat, use one or a few types of food, or tolerate a narrow range of climatic and other

	environmental conditions.
speciation	Under certain circumstances, natural selection can lead to an entirely new species. In this process, called speciation, two species arise from one.
species diversity	An important characteristic of a community and the ecosystem to which it belongs is its species diversity the number of different species it contains (species richness) combined with the relative abundance of individuals within each of those species (species evenness).
species evenness	An important characteristic of a community and the ecosystem to which it belongs is its species diversity: the number of different species it contains (species richness) combined with the relative abundance of individuals within each of those species (species evenness).
species richness	An important characteristic of a community and the ecosystem to which it belongs is its species diversity: the number of different species it contains (species richness) combined with the relative abundance of individuals within each of those species (species evenness).
age structure	A population's age structure—the proportions of individuals at various ages—can have a strong effect on how rapidly it increases or decreases in size.
biotic potential	Species vary in their biotic potential or capacity for population growth under ideal conditions.
carrying capacity (K)	Together, biotic potential and environmental resistance determine the carrying capacity (K): the maximum population of a given species that a particular habitat can sustain indefinitely without being degraded.
coevolution	When populations of two different species interact in this way over a such long period of time, changes in the gene pool of one species can lead to changes in the gene pool of the other species. Such changes can help both sides to become more competitive or can help to avoid or reduce competition. Biologists call this process coevolution.
commensalism	is an interaction that benefits one species but has little, if any, effect on the other.
ecological succession	The gradual change in species composition in a given area is called ecological succession, during which, some species colonize an area and their populations become more numerous, while populations of other species decline and may even disappear.
environmental resistance	is the combination of all factors that act to limit the growth of a population.
inertia, or persistence	It is useful to distinguish among two aspects of stability in living systems. One is inertia, or persistence: the ability of a living system, such as a grassland or a forest, to survive moderate disturbances.
interspecific competition	occurs when members of two or more species interact to gain access to the same limited resources such as food, light, or space.
intrinsic rate of increase (r)	is the rate at which the population of a species would grow if it had unlimited resources.
K-selected species	At the other extreme are competitor or K-selected species. They tend to reproduce later in life and have a small number of offspring with fairly long life spans.
logistic growth	involves rapid exponential population growth followed by a steady decrease in population growth until the population size levels off.
mutualism	two species behave in ways that benefit both by providing each with food, shelter, or some other resource.
parasitism	occurs when one species (the parasite) feeds on the body of, or the energy used by, another organism (the host), usually by living on or in the host.
population density	is the number of individuals in a population found in a particular area or volume.
population	Populations differ in factors such as their distribution, numbers, age structure (proportions of

dynamics	individuals in different age groups), and density (number of individuals in a certain space). Population dynamics is a study of how these characteristics of populations change in response to changes in environmental conditions.
predation	In predation, a member of one species (the predator) feeds directly on all or part of a living organism of another plant or animal species (the prey) as part of a food web.
predator	In predation, a member of one species (the predator) feeds directly on all or part of a living organism of another plant or animal species (the prey) as part of a food web.
predator–prey relationship	Together, the two different species, such as lions (the predator or hunter) and zebras (the prey or hunted), form a predator–prey relationship.
prey	In predation, a member of one species (the predator) feeds directly on all or part of a living organism of another plant or animal species (the prey) as part of a food web.
primary succession	involves the gradual establishment of biotic communities in lifeless areas where there is no soil in a terrestrial ecosystem or no bottom sediment in an aquatic ecosystem.
r-selected species	Species have different reproductive patterns that can help enhance their survival. Species with a capacity for a high rate of population increase (r) are called r-selected species
resilience	A second factor is resilience: the ability of a living system to be restored through secondary succession after a moderate disturbance.
resource partitioning	It occurs when species competing for similar scarce resources evolve specialized traits that allow them to use shared resources at different times, in different ways, or in different places.
secondary succession	The other more common type of ecological succession is called secondary succession, in which a series of communities or ecosystems with different species develop in places containing soil or bottom sediment.
tipping point	there are limits to the stresses that ecosystems and global systems such as climate can take. As a result, such systems can reach a tipping point, where any additional stress can cause the system to change in an abrupt and usually irreversible way that often involves collapse.
age structure	the distribution of males and females among age groups in a population—in this case, the world population.
birth rate, or crude birth rate	the number of live births per 1,000 people in a population in a given year
cultural carrying capacity	This would be an optimum level that would allow most people to live in reasonable comfort and freedom without impairing the ability of the planet to sustain future generations.
death rate, or crude death rate	the number of deaths per 1,000 people in a population in a given year
demographic transition	as countries become industrialized, first their death rates and then their birth rates decline.
family planning	provides educational and clinical services that help couples choose how many children to have and when to have them.
fertility rate	the number of children born to a woman during her lifetime.
infant mortality rate	the number of children per 1,000 live births who die before one year of age.
life expectancy	the average number of years a newborn infant can expect to live
migration	the movement of people into (immigration) and out of (emigration) specific geographic areas.
population change	We can calculate population change of an area by subtracting the number of people leaving a population (through death and emigration) from the number entering it (through birth and immigration) during a specified period of time (usually one year).

replacement-level fertility rate	is the average number of children that couples in a population must bear to replace themselves.
total fertility rate (TFR)	is the average number of children born to women in a population during their reproductive years.
biomes	large terrestrial regions characterized by similar climate, soil, plants, and animals, regardless of where they are found in the world.
climate	an area's general pattern of atmospheric or weather conditions measured over long periods of time ranging from decades to thousands of years.
currents	Prevailing winds blowing over the oceans produce mass movements of surface water called currents.
desert	In a desert, annual precipitation is low and often scattered unevenly throughout the year. During the day, the baking sun warms the ground and causes evaporation of moisture from plant leaves and soil. But at night, most of the heat stored in the ground radiates quickly into the atmosphere.
forest systems	are lands dominated by trees.
grasslands	occur mostly in the interiors of continents in areas too moist for deserts and too dry for forests. Grasslands persist because of a combination of seasonal drought, grazing by large herbivores, and occasional fires—all of which keep large numbers of shrubs and trees from growing.
greenhouse effect	The natural warming effect of the troposphere.
greenhouse gases	allow mostly visible light and some infrared radiation and ultraviolet (UV) radiation from the sun to pass through the atmosphere.
permafrost	underground soil in which captured water stays frozen for more than 2 consecutive years.
rain shadow effect	The loss of moisture from the landscape and the resulting semiarid or arid conditions on the leeward side of high mountains create the rain shadow effect.
weather	a local area's
aquatic life zones	The aquatic equivalents of biomes are called aquatic life zones.
benthos	The third type, benthos, consists of bottom dwellers such as oysters, which anchor themselves to one spot; clams and worms, which burrow into the sand or mud; and lobsters and crabs, which walk about on the sea floor.
coastal wetlands	coastal land areas covered with water all or part of the year
coastal zone	the warm, nutrient-rich, shallow water that extends from the high-tide mark on land to the gently sloping, shallow edge of the continental shelf.
coral reefs	form in clear, warm coastal waters of the tropics and subtropics.
cultural eutrophication	Human inputs of nutrients from the atmosphere and from nearby urban and agricultural areas can accelerate the eutrophication of lakes, a process called cultural eutrophication.
decomposers	A fourth major type is decomposers (mostly bacteria), which break down organic compounds in the dead bodies and wastes of aquatic organisms into nutrients that can be used by aquatic primary producers.
estuaries	are where rivers meet the sea
eutrophic lake	A lake with a large supply of nutrients needed by producers is called a eutrophic (well-nourished) lake.
freshwater	lakes, rivers, streams, and inland wetlands
hypereutrophic	Cultural eutrophication often puts excessive nutrients into lakes, which are then described as

	hypereutrophic.
inland wetlands	lands covered with freshwater all or part of the time (excluding lakes, reservoirs, and streams) and located away from coastal areas.
intertidal zone	The area of shoreline between low and high tides is called the intertidal zone.
lakes	large natural bodies of standing freshwater formed when precipitation, runoff, or groundwater seepage fills depressions in the earth's surface.
mesotrophic lakes	Many lakes fall somewhere between the two extremes of nutrient enrichment. They are called mesotrophic lakes.
nekton	A second major type of organisms is nekton, strongly swimming consumers such as fish, turtles, and whales.
oligotrophic lakes	Lakes that have a small supply of plant nutrients are called oligotrophic (poorly nourished) lakes. Often, this type of lake is deep and has steep banks.
open sea	The sharp increase in water depth at the edge of the continental shelf separates the coastal zone from the vast volume of the ocean called the open sea.
plankton	Saltwater and freshwater life zones contain several major types of organisms. One such type consists of weakly swimming, free-floating plankton.
runoff	Precipitation that does not sink into the ground or evaporate becomes surface water. It becomes runoff when it flows into streams.
saltwater or marine	oceans and their accompanying estuaries, coastal wetlands, shorelines, coral reefs, and mangrove forests
surface water	Precipitation that does not sink into the ground or evaporate
turbidity	The depth of the euphotic zone in oceans and deep lakes can be reduced when the water is clouded by excessive algal growth (algal blooms) resulting from nutrient overloads. This cloudiness, called turbidity, can occur naturally, such as from algal growth, or can result from disturbances such as clearing of land, which causes silt to flow into bodies of water.
watershed, or drainage basin	the land area that delivers runoff, sediment, and dissolved substances to a stream.
background extinction	During most of the 3.56 billion years that life has existed on the earth, there has been a continuous, low level of extinction of species known as background extinction.
endangered species	has so few individual survivors that the species could soon become extinct over all or most of its natural range (the area in which it is normally found).
extinction rate	expressed as a percentage or number of species that go extinct within a certain time period such as a year.
HIPPCO	Habitat destruction, degradation, and fragmentation; Invasive (nonnative) species; Population and resource use growth (too many people consuming too many resources); Pollution; Climate change; and Overexploitation.
instrumental value	their usefulness to us in providing many of the ecological and economic services that make up the earth's natural capital
intrinsic or existence value	Some scientists and philosophers believe that each wild species has intrinsic or existence value based on its inherent right to exist and play its ecological roles, regardless of its usefulness to us.
mass extinction	The extinction of many species in a relatively short period of geologic time
precautionary principle	When substantial preliminary evidence indicates that an activity can harm human health or the environment, we should take precautionary measures to prevent or reduce such harm, even if

	some of the cause-and-effect relationships have not been fully established, scientifically.
threatened species	(also known as a vulnerable species) is still abundant in its natural range but, because of declining numbers, is likely to become endangered in the near future.

biodiversity hotspots	an idea first proposed in 1988 by environmental scientist Norman Myers. These “ecological arks” are areas especially rich in plant species that are found nowhere else and are in great danger of extinction.
deforestation	the temporary or permanent removal of large expanses of forest for agriculture, settlements, or other uses.
ecological restoration	the process of repairing damage caused by humans to the biodiversity and dynamics of natural ecosystems.
old-growth forest	an uncut or regenerated primary forest that has not been seriously disturbed by human activities or natural disasters for 200 years or more.
overgrazing	occurs when too many animals graze for too long and exceed the carrying capacity of a rangeland area.
pastures	managed grasslands or enclosed meadows usually planted with domesticated grasses or other forage.
rangelands	unfenced grasslands in temperate and tropical climates that supply *forage*, or vegetation, for grazing (grass-eating) and browsing (shrub-eating) animals.
reconciliation or applied ecology	This science focuses on inventing, establishing, and maintaining new habitats to conserve species diversity in places where people live, work, or play.
second-growth forest	a stand of trees resulting from secondary ecological succession
tree plantation, also called a tree farm or commercial forest	a managed tract with uniformly aged trees of one or two genetically uniform species that usually are harvested by clear-cutting as soon as they become commercially valuable.
undergrazing	Some grasslands suffer from undergrazing, where absence of grazing for long periods (at least 5 years) can reduce the net primary productivity of grassland vegetation and grass cover.
wilderness	One way to protect undeveloped lands from human exploitation is by legally setting them aside as large areas of undeveloped land called wilderness.

fishprint	is defined as the area of ocean needed to sustain the consumption of an average person, a nation, or the world.
	the dung and urine of cattle, horses, poultry, and other farm animals. It improves soil structure, adds organic nitrogen, and stimulates beneficial soil bacteria and fungi.
aquaculture	raising marine and freshwater fish in ponds and underwater cages
chronic malnutrition	deficiencies of protein and other key nutrients—which weakens them, makes them more susceptible to disease, and hinders the normal physical and mental development of children.
chronic undernutrition, or	People who cannot grow or buy enough food to meet their basic energy needs suffer from chronic undernutrition, or hunger.

hunger	
commercial inorganic fertilizer	The best way to maintain soil fertility is through soil conservation. The next best option is to restore some of the plant nutrients that have been washed, blown, or leached out of the soil, or that have been removed by repeated crop harvesting. To do this, farmers can use commercial inorganic fertilizer produced from various minerals.
compost	produced when microorganisms in soil break down organic matter such as leaves, crop residues, food wastes, paper, and wood in the presence of oxygen.
desertification	It occurs when the productive potential of soil, especially on arid or semiarid land, falls by 10% or more because of a combination of prolonged drought and human activities that reduce or degrade topsoil.
famine	occurs when there is a severe shortage of food in an area accompanied by mass starvation, many deaths, economic chaos, and social disruption.
fishery	a concentration of particular aquatic species suitable for commercial harvesting in a given ocean area or inland body of water.
food insecurity	living with chronic hunger and poor nutrition, which threatens their ability to lead healthy and productive lives.
food security	means that every person in a given area has daily access to enough nutritious food to have an active and healthy life.
green manure	consists of freshly cut or growing green vegetation that is plowed into the topsoil to increase the organic matter and humus available to the next crop.
green revolution	Since 1950, about 88% of the increase in global food production has come from using high-input industrialized agriculture to increase yields in a process called the green revolution.
industrialized agriculture, or high-input agriculture	uses heavy equipment and large amounts of financial capital, fossil fuel, water, commercial fertilizers, and pesticides to produce single crops, or monocultures.
integrated pest management (IPM)	Many pest control experts and farmers believe the best way to control crop pests is a carefully designed integrated pest management (IPM) program. In this more sustainable approach, each crop and its pests are evaluated as parts of an ecological system. Then farmers develop a control program that uses a combination of cultivation, biological controls, and chemical tools and techniques, applied in a carefully coordinated way.
organic agriculture	crops that are grown with little or no use of synthetic pesticides, synthetic fertilizers, or genetically engineered seeds.
organic fertilizer	The best way to maintain soil fertility is through soil conservation. The next best option is to restore some of the plant nutrients that have been washed, blown, or leached out of the soil, or that have been removed by repeated crop harvesting. To do this, farmers can use organic fertilizer made from plant and animal wastes.
overnutrition	occurs when food energy intake exceeds energy use and causes excess body fat. Too many calories, too little exercise, or both can cause overnutrition.
pest	any species that interferes with human welfare by competing with us for food, invading lawns and gardens, destroying building materials, spreading disease, invading ecosystems, or simply being a nuisance.
pesticides	chemicals used to kill or control populations of organisms that humans consider undesirable.
plantation agriculture	is a form of industrialized agriculture used primarily in tropical developing countries.
polyculture	Some traditional farmers focus on cultivating a single crop, but many grow several crops on the

	same plot simultaneously, a practice known as polyculture.
salinization	Repeated annual applications of irrigation water in dry climates lead to the gradual accumulation of salts in the upper soil layers—a soil degradation process called salinization.
slash-and-burn agriculture	This type of subsistence agriculture involves burning and clearing small plots in tropical forests, growing a variety of crops for a few years until the soil is depleted of nutrients, and then shifting to other plots.
soil conservation	involves using a variety of ways to reduce soil erosion and restore soil fertility, mostly by keeping the soil covered with vegetation.
soil erosion	the movement of soil components, especially surface litter and topsoil, from one place to another by the actions of wind and water.
traditional intensive agriculture	farmers increase their inputs of human and draft-animal labor, fertilizer, and water to obtain higher crop yields.
traditional subsistence agriculture	uses mostly human labor and draft animals to produce only enough crops for a farm family's survival, with little left over to sell or store as a reserve in hard times.
waterlogging	Another problem with irrigation is waterlogging, in which water accumulates underground and gradually raises the water table.
aquifers	underground caverns and porous layers of sand, gravel, or bedrock through which groundwater flows.
dam	a structure built across a river to control the river's water flow.
desalination	involves removing dissolved salts from ocean water or from brackish (slightly salty) water in aquifers or lakes for domestic use.
drought	a prolonged period in which occasional precipitation is at least 70% lower and evaporation is higher than normal in an area that is normally not dry.
floodplain	A flood happens when water in a stream overflows its normal channel and spills into the adjacent area, called a floodplain.
groundwater	Some precipitation infiltrates the ground and percolates downward through spaces in soil, gravel, and rock until an impenetrable layer of rock stops it. The water in these spaces is called groundwater—one of our most important sources of freshwater and a key component of the earth's natural capital.
reliable surface runoff	the amount of surface runoff that we can generally count on as a source of freshwater from year to year.
reservoir	After a river is dammed, the river's flow creates an artificial lake, or reservoir, behind the dam.
surface runoff	Precipitation that does not infiltrate the ground or return to the atmosphere by evaporation is called surface runoff.
surface water	the freshwater from precipitation and snowmelt that flows across the earth's land surface and into rivers, streams, lakes, wetlands, estuaries, and ultimately to the oceans.
water table	The top of this groundwater zone
watershed or drainage basin	The land from which surface water drains into a particular river, lake, wetland, or other body of water.
zone of saturation	The spaces in soil and rock close to the earth's surface hold little moisture. Below a certain depth, in the zone of saturation, these spaces are completely filled with water.
area strip mining	In area strip mining, used where the terrain is fairly flat, gigantic earthmovers strip away the

	overburden, and power shovels—some as tall as a 20-story building—remove the mineral deposit.
contour strip mining	Contour strip mining is used mostly to mine coal on hilly or mountainous terrain.
core	the earth’s innermost zone. It is extremely hot and has a solid inner part, surrounded by a liquid core of molten or semisolid material.
crust	The outermost and thinnest zone of the earth is the crust.
depletion time	the time it takes to use up a certain proportion—usually 80%—of the reserves of a mineral at a given rate of use.
earthquake	When a fault forms, or when there is abrupt movement on an existing fault, energy that has accumulated over time is released in the form of vibrations, called seismic waves, which move in all directions through the surrounding rock. This internal geological process is called an earthquake.
geology	the science devoted to the study of dynamic processes occurring on the earth’s surface and in its interior.
high-grade ore	A high-grade ore contains a fairly large amount of the desired nonrenewable mineral resource
igneous rock	forms below or on the earth’s surface when magma wells up from the earth’s upper mantle or deep crust and then cools and hardens.
lithosphere	thick plates are composed of the continental and oceanic crust and the rigid, outermost part of the mantle (above the asthenosphere), a combination called the lithosphere.
low-grade ore	A high-grade ore contains a fairly large amount of the desired nonrenewable mineral resource, whereas a low-grade ore contains a smaller amount.
mantle	Surrounding the core is a thick zone called the mantle.
metamorphic rock	forms when a preexisting rock is subjected to high temperatures (which may cause it to melt partially), high pressures, chemically active fluids, or a combination of these agents.
mineral	an element or inorganic compound that occurs naturally in the earth’s crust as a solid with a regular internal crystalline structure.
mineral resource	a concentration of naturally occurring material from the earth’s crust that can be extracted and processed into useful products and raw materials at an affordable cost.
mountaintop removal	Another surface mining method is mountaintop removal. In the Appalachian Mountain area of the United States, where this form of mining is prominent, explosives, large power shovels, and huge machines called draglines are used to remove the top of a mountain and expose seams of coal, which are then removed.
open-pit mining	The type of surface mining used depends on two factors: the resource being sought and the local topography. In open-pit mining machines dig holes and remove ores (of metals such as iron, copper, and gold), sand, gravel, and stone (such as limestone and marble).
ore	rock that contains a large enough concentration of a particular mineral—often a metal—to make it profitable for mining and processing.
overburden	In surface mining, gigantic mechanized equipment strips away the overburden, the soil and rock overlying a useful mineral deposit.
reserves	identified resources from which the mineral can be extracted profitably at current prices.
rock	a solid combination of one or more minerals found in the earth’s crust.
rock cycle	The interaction of physical and chemical processes that change rocks from one type to another.
sedimentary rock	made of sediments—dead plant and animal remains and existing rocks that are weathered and

	eroded into tiny particles.
smelting	Heating ores to release metals is called smelting.
spoils	In surface mining, gigantic mechanized equipment strips away the overburden, the soil and rock overlying a useful mineral deposit. It is usually discarded as waste material called spoils.
strip mining	Strip mining is useful and economical for extracting mineral deposits that lie close to the earth's surface in large horizontal beds.
subsurface mining	After suitable mineral deposits are located, several different mining techniques are used to remove them, depending on their location and type. Shallow deposits are removed by surface mining, and deep deposits are removed by subsurface mining.
surface mining	After suitable mineral deposits are located, several different mining techniques are used to remove them, depending on their location and type. Shallow deposits are removed by surface mining.
tectonic plates	The flows of energy and heated material in the mantle's convection cells cause a dozen or so huge rigid plates, called tectonic plates, to move extremely slowly atop the denser mantle on hot soft rock in the underlying asthenosphere.
tsunami	a series of large waves generated when part of the ocean floor suddenly rises or drops
volcano	An active volcano occurs where magma reaches the earth's surface through a central vent or a long crack, called a fissure.
weathering	the physical, chemical, and biological processes that break down rocks into smaller particles that help build soil.

coal	a solid fossil fuel that was formed in several stages out of the remains of land plants that were buried 300–400 million years ago and subjected to intense heat and pressure over many millions of years.
liquefied natural gas (LNG)	So that it can be transported across oceans, natural gas is converted to liquefied natural gas (LNG) at a very low temperature and high pressure. This highly flammable liquid is then put aboard refrigerated tanker ships.
liquefied petroleum gas (LPG)	When a natural gas field is tapped, propane and butane gases are liquefied and removed as liquefied petroleum gas (LPG). LPG is stored in pressurized tanks for use mostly in rural areas not served by natural gas pipelines.
natural gas	a mixture of gases of which 50–90% is methane (CH_4). It also contains smaller amounts of heavier gaseous hydrocarbons such as ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}), and small amounts of highly toxic hydrogen sulfide (H_2S).
nuclear fusion	a nuclear change in which two isotopes of light elements, such as hydrogen, are forced together at extremely high temperatures until they fuse to form a heavier nucleus, releasing energy in the process.
oil sand, or tar sand	a mixture of clay, sand, water, and a combustible organic material called *bitumen*—a thick and sticky, heavy oil with a high sulfur content that makes up about 10% of the gooey mixture.
petrochemicals	Some of the products of oil distillation, called petrochemicals, are used as raw materials in industrial organic chemicals, cleaning fluids, pesticides, plastics, synthetic fibers, paints, medicines, and many other products.
petroleum, or crude oil	Petroleum, or crude oil (oil as it comes out of the ground), is a thick and gooey liquid consisting of hundreds of different combustible hydrocarbons along with small amounts of sulfur, oxygen, and nitrogen impurities.

shale oil	Oily rocks are another potential supply of heavy oil. Such rocks, called *oil shales*, contain a solid combustible mixture of hydrocarbons called *kerogen*. It can be extracted from crushed oil shales by heating them in a large container, a process that yields a distillate called shale oil.
synthetic natural gas (SNG)	Solid coal can be converted into synthetic natural gas (SNG) by a process called *coal gasification* and into a liquid fuel such as methanol or synthetic gasoline by *coal liquefaction*.

active solar heating system	An active solar heating system absorbs energy from the sun by pumping a heat-absorbing fluid (such as water or an antifreeze solution) through special collectors usually mounted on a roof or on special racks to face the sun.
biofuels	Biomass consists of plant materials (such as wood and agricultural waste) and animal wastes that can be burned directly as a solid fuel or converted into gaseous or liquid biofuels.
cogeneration, or combined heat and power (CHP)	Some companies save energy and money by using cogeneration, or combined heat and power (CHP), systems. In such a system, two useful forms of energy (such as steam and electricity) are produced from the same fuel source.
energy conservation	a decrease in energy use based primarily on reducing unnecessary waste of energy.
energy efficiency	the measure of how much work we can get from each unit of energy we use.
geothermal energy	heat stored in soil, underground rocks, and fluids in the earth’s mantle.
passive solar heating system	A passive solar heating system absorbs and stores heat from the sun directly within a well-insulated structure without the need for pumps or fans to distribute the heat.
photovoltaic (PV) cells	Solar energy can be converted directly into electrical energy by photovoltaic (PV) cells, commonly called solar cells.
carcinogens	Carcinogens are chemicals, types of radiation, or certain viruses that can cause or promote cancer
dose	the amount of a harmful chemical that a person has ingested, inhaled, or absorbed through the skin.
dose-response curve	Scientists estimate the toxicity of a chemical by determining the effects of various doses of the chemical on test organisms and then by plotting the results in a dose-response curve. One approach is to determine the lethal dose—the amount needed to kill an animal.
infectious disease	An infectious disease is caused when a pathogen such as a bacterium, virus, or parasite invades the body and multiplies in its cells and tissues.
mutagens	The second major type of toxic agent, mutagens, includes chemicals or forms of radiation that cause mutations, or changes, in the DNA molecules found in cells, or that increase the frequency of such changes.
nontransmissible disease	A nontransmissible disease is caused by something other than a living organism and does not spread from one person to another.
pathogen	A pathogen is a living organism that can cause disease in another organism.
risk	the probability of suffering harm from a hazard that can cause injury, disease, death, economic loss, or damage.
risk analysis	involves identifying hazards and evaluating their associated risks ranking risks (comparative risk analysis), determining options and making decisions about reducing or eliminating risks and informing decision makers and the public about risks.

risk assessment	The scientific process of using statistical methods to estimate how much harm a particular hazard can cause to human health or to the environment.
risk management	involves deciding whether or how to reduce a particular risk to a certain level and at what cost.
toxic chemical	A toxic chemical is one that can cause temporary or permanent harm or death to humans and animals.
toxicity	a measure of how harmful a substance is—its ability to cause injury, illness, or death to a living organism.
toxicology	the study of the harmful effects of chemicals on humans and other organisms. In effect, it is a study of poisons.
transmissible disease	(also called a contagious or communicable disease) is an infectious disease that can be transmitted from one person to another.
acid deposition	Acidic substances remain in the atmosphere for 2–14 days, depending mostly on prevailing winds, precipitation, and other weather patterns. During this period, they descend to the earth's surface in two forms: wet deposition consisting of acidic rain, snow, fog, and cloud vapor with a pH less than 5.6* and dry deposition consisting of acidic particles. The resulting mixture is called acid deposition—sometimes termed acid rain.
air pollution	the presence of chemicals in the atmosphere in concentrations high enough to harm organisms, ecosystems, or human-made materials.
atmospheric pressure	the force, or mass, per unit area of a column of air. This force is caused by the bombardment of a surface such as your skin by air molecules.
carbon oxides	Carbon monoxide (CO) is a colorless, odorless, and highly toxic gas that forms during the incomplete combustion of carbon-containing materials.
density	the air we breathe at sea level has a higher density—more molecules per liter—than the air we would inhale on top of the world's highest mountain.
industrial smog	consisting mostly of sulfur dioxide, suspended droplets of sulfuric acid, and a variety of suspended solid particles.
nitrogen oxides and nitric acid	Nitric oxide (NO) is a colorless gas that forms when nitrogen and oxygen gas in air react at the high-combustion temperatures in automobile engines and coal-burning plants.
ozone	Ozone (O3), a colorless and highly reactive gas, is a major component of photochemical smog.
ozone laye	Much of the atmosphere's small amount of ozone (O3) is concentrated in a portion of the stratosphere called the ozone layer, found roughly 17–30 kilometers (11–19 miles) above sea level.
particulates	Suspended particulate matter (SPM) consists of a variety of solid particles and liquid droplets small and light enough to remain suspended in the air for long periods.
photochemical smog	a mixture of primary and secondary pollutants formed under the influence of UV radiation from the sun.
primary pollutants	harmful chemicals emitted directly into the air from natural processes and human activities.
secondary pollutants	While in the atmosphere, some primary pollutants react with one another and with the basic components of air to form new harmful chemicals, called secondary pollutants.
stratosphere	The atmosphere's second layer is the stratosphere, which extends from about 17 to about 48 kilometers (from 11 to 30 miles) above the earth's surface.
sulfur dioxide and sulfuric acid	Sulfur dioxide (SO2) is a colorless gas with an irritating odor. About one-third of the SO2 in the atmosphere comes from natural sources as part of the sulfur cycle.
temperature	Under certain atmospheric conditions, however, a layer of warm air can temporarily lie atop a

inversion	layer of cooler air nearer the ground. This is called a temperature inversion.
troposphere	About 75–80% of the earth's air mass is found in the troposphere, the atmospheric layer closest to the earth's surface.
volatile organic compounds (VOCs)	Organic compounds that exist as gases in the atmosphere are called volatile organic compounds (VOCs).

carbon capture and storage (CCS).	It involves removing CO_2 from the smokestacks of coal-burning power and industrial plants and then storing it somewhere.

cultural eutrophication	Near urban or agricultural areas, human activities can greatly accelerate the input of plant nutrients to a lake—a process called cultural eutrophication involving mostly nitrate- and phosphate-containing effluents from various sources.
eutrophication	the name given to the natural nutrient enrichment of a shallow lake, estuary, or slowmoving stream, mostly from runoff of plant nutrients such as nitrates and phosphates from surrounding land.
nonpoint sources	broad, and diffuse areas, rather than points, from which pollutants enter bodies of surface water or air.
point sources	discharge pollutants at specific locations through drain pipes, ditches, or sewer lines into bodies of surface water.
primary sewage treatment	Raw sewage reaching a treatment plant typically undergoes one or two levels of wastewater treatment. The first is primary sewage treatment—a physical process that uses screens and a grit tank to remove large floating objects and to allow solids such as sand and rock to settle out.
secondary sewage treatment	Raw sewage reaching a treatment plant typically undergoes one or two levels of wastewater treatment. The second level is secondary sewage treatment—a biological process in which aerobic bacteria remove as much as 90% of dissolved and biodegradable, oxygen-demanding organic wastes.
septic tank	In rural and suburban areas with suitable soils, sewage from each house usually is discharged into a septic tank with a large drainage field.
water pollution	any chemical, biological, or physical change in water quality that harms living organisms or makes water unsuitable for desired uses.

environmental justice	an ideal whereby every person is entitled to protection from environmental hazards regardless of race, gender, age, national origin, income, social class, or any political factor.
hazardous, or toxic, waste	Another major category of waste is hazardous, or toxic, waste, which threatens human health or the environment because it is poisonous, dangerously chemically reactive, corrosive, or flammable.
industrial solid waste	Solid waste can be divided into two types. One type is industrial solid waste produced by mines, agriculture, and industries that supply people with goods and services.
integrated waste management	a variety of strategies for both waste reduction and waste management.

municipal solid waste (MSW)	Solid waste can be divided into two types. The other is municipal solid waste (MSW), often called *garbage* or *trash*, which consists of the combined solid waste produced by homes and workplaces.
open dumps	There are two types of landfills. Open dumps are essentially fields or holes in the ground where garbage is deposited and sometimes burned.
primary or closed-loop recycling	Households and workplaces produce five major types of materials that can be recycled: paper products, glass, aluminum, steel, and some plastics. Such materials can be reprocessed in two ways. In primary or closed-loop recycling, these materials are recycled into new products of the same type—turning used aluminum cans into new aluminum cans, for example.
recycle	Waste reduction is based on three Rs: Recycle: separate and recycle paper, glass, cans, plastics, metal, and other items, and buy products made from recycled materials.
reduce	Waste reduction is based on three Rs: Reduce: consume less and live a simpler lifestyle.
reuse	Waste reduction is based on three Rs: Reuse: rely more on items that can be used repeatedly instead of on throwaway items. Buy necessary items secondhand or borrow or rent them. Take a refillable coffee cup to class or to the coffee shop and use it instead of using throwaway cups.
sanitary landfills	In newer landfills, called sanitary landfills, solid wastes are spread out in thin layers, compacted, and covered daily with a fresh layer of clay or plastic foam, which helps to keep the material dry and reduces leakage of contaminated water (leachate) from the landfill.
secondary recycling	In secondary recycling, waste materials are converted into different products.
solid waste	any unwanted or discarded material we produce that is not a liquid or a gas.
waste management	We can deal with the solid wastes we create in two ways. One is waste management, in which we attempt to reduce the environmental impact of MSW without seriously trying to reduce the amount of waste produced.
waste reduction	We can deal with the solid wastes we create in two ways. The second approach is waste reduction, in which much less waste and pollution are produced, and the wastes that are produced are viewed as potential resources that can be reused, recycled, or composted.

land-use planning	Most urban and some rural areas use some form of land-use planning to determine the best present and future use of each parcel of land.
noise pollution	any unwanted, disturbing, or harmful sound that impairs or interferes with hearing, causes stress, hampers concentration and work efficiency, or causes accidents.
smart growth	one way to encourage more environmentally sustainable development that reduces dependence on cars, controls and directs sprawl, and cuts wasteful resource use. It recognizes that urban growth will occur. At the same time, it uses zoning laws and other tools to channel growth into areas where it will cause less harm.
urban growth	the rate of increase of urban populations.
urban sprawl	the growth of low-density development on the edges of cities and towns—is eliminating surrounding agricultural and wild lands.
urbanization	the creation and growth of urban areas or cities and their surrounding developed land. It is measured as the percentage of the people in a country or in the world living in urban areas.

zoning	Once a land-use plan is developed, governments control the uses of various parcels of land by legal and economic methods. The most widely used approach is zoning, in which various parcels of land are designated for certain uses.
cost–benefit analysis	Another widely used tool for making economic decisions about how to control pollution and manage resources is cost–benefit analysis. This is done by comparing estimated costs and benefits for actions such as implementing a pollution control regulation, building a dam on a river, or preserving an area of forest.
discount rate	an estimate of a resource's future economic value compared to its present value.
economic system	a social institution through which goods and services are produced, distributed, and consumed to satisfy people's needs and wants, ideally in the most efficient possible way.
high-throughput economies	Most of today's advanced industrialized countries have high-throughput economies, which attempt to boost economic growth by increasing the flow of matter and energy resources extracted from the environment through their economic systems to produce goods and services.
human capital, or human resources	Three types of capital, or resources, are used to produce goods and services. Human capital, or human resources, includes people's physical and mental talents, which provide labor, innovation, culture, and organization.
low-throughput (low-waste) economy	The three scientific laws governing matter and energy changes and the four scientific principle of sustainability suggest that the best long-term solution to our environmental and resource problems is to shift from an economy based on high and increasing matter and energy flow to a more sustainable low-throughput (low-waste) economy.
manufactured capital, or manufactured resources	Three types of capital, or resources, are used to produce goods and services. Manufactured capital, or manufactured resources, are items such as machinery, equipment, and factories made from natural resources with the help of human resources.
matter recycling and reuse economies	mimic nature by recycling and reusing most matter outputs instead of dumping them into the environment.
natural capital	Three types of capital, or resources, are used to produce goods and services. Natural capital includes resources and services produced by the earth's natural processes, which support all economies and all life.
poverty	the inability to meet basic economic needs.

administrative laws	consist of administrative rules and regulations, executive orders, and enforcement decisions related to the implementation and interpretation of statutory laws.
arbitration	a formal effort, somewhat similar to a trial, to resolve a dispute.
civil suits	Most environmental lawsuits are civil suits brought to settle disputes or damages between one party and another.
common law	a body of unwritten rules and principles derived from thousands of past legal decisions along with commonly accepted practices, or norms, within a society.
defendant	the party being charged, for injuries to health or for economic loss.
democracy	government by the people through elected officials and representatives.
environmental law	a body of statements defining what is acceptable environmental behavior for individuals and groups, according to the larger community, and attempting to balance competing social and private interests.

environmental policy	environmental laws and regulations that are developed, implemented, and enforced and the environmental programs that are funded by one or more government agencies.
lobbying	Converting a bill introduced in the U.S. Congress into a law is a complex process. An important part of this process is lobbying, in which individuals or groups use public pressure, personal contacts, and political action to persuade legislators to vote or act in their favor.
mediation	Another approach for settling a dispute is mediation, in which the parties involved are encouraged to sit down and talk under the guidance of a professional mediator.
plaintiff	the party bringing the charge
policies	The exact role played by a government is determined by its policies—the set of laws and regulations it enforces and the programs it funds.
politics	the process by which individuals and groups try to influence or control the policies and actions of governments at local, state, national, and international levels.
statutory laws	The body of law includes statutory laws, administrative laws, and common laws. Statutory laws are those developed and passed by legislative bodies such as federal and state governments.

deep ecology worldview	Another earth-centered environmental worldview is the deep ecology worldview. It consists of eight premises developed in 1972 by Norwegian philosopher Arne Naess, in conjunction with philosopher George Sessions and sociologist Bill Devall.
environmental ethics	what one believes about what is right and what is wrong in our behavior toward the environment.
environmental wisdom worldview	One earth-centered worldview is called the environmental wisdom worldview. According to this view, we are part of—not apart from—the community of life and the ecological processes that sustain all life.
environmental worldviews	how people think the world works and what they believe their role in the world should be.
planetary management worldview	One human-centered worldview held by many people is the planetary management worldview. According to this view, we are the planet's most important and dominant species, and we can and should manage the earth mostly for our own benefit. Other species and parts of nature are seen as having only *instrumental value* based on how useful they are to us.
stewardship worldview	Another largely human-centered environmental worldview is the stewardship worldview. It assumes that we have an ethical responsibility to be caring and responsible managers, or *stewards*, of the earth.

GLOSSARY 2

1. **Ionizing radiation:** enough energy to knock electrons from atoms forming ions, capable of causing cancer (gamma-Xrays-UV)
2. **High Quality Energy: organized & concentrated, can perform useful work (fossil fuel & nuclear)**
3. **Low Quality Energy: disorganized, dispersed (heat in ocean or air wind, solar)**
4. **First Law of Thermodynamics: energy is neither created nor destroyed, but may be converted from one form to another**
5. **Second Law of Thermodynamics: when energy is changed from one form to another, some useful energy is always degraded into lower quality energy (usually heat)**
6. **Natural radioactive decay: unstable radioisotopes decay releasing gamma rays, alpha & beta particles**
7. **Half life: the time it takes for ½ the mass of a radioisotope to decay**
8. **Estimate of how long a radioactive isotope must be stored until it decays to a safe level: approximately 10 half-lives**
9. **Nuclear Fission: nuclei of isotopes split apart when struck by neutrons**
10. **Nuclear Fusion: 2 isotopes of light elements (H) forced together at high temperatures till they fuse to form a heavier nucleus. Expensive, break even point not reached yet**
11. **Ore: a rock that contains a large enough concentration of a mineral making it profitable to mine**
12. **Organic fertilizer: slow acting & long lasting because the organic remains need time to be decomposed**
13. **Best solution to Energy shortage: conservation and increase efficiency**
14. **Surface mining: cheaper & can remove more mineral, less hazardous to workers**
15. **Humus: organic, dark material remaining after decomposition by microorganisms**
16. **Leaching: removal of dissolved materials from soil by water moving downwards**
17. **Illuviation: deposit of leached material in lower soil layers (B)**
18. **Loam: perfect agricultural soil with equal portions of sand, silt, clay**
19. **Conservation: allows the use of resources in a responsible manner**

Preservation: setting aside areas & protecting them from human activities

20. **Parts of the hydrologic cycle: evaporation, transpiration, runoff, condensation, precipitation, infiltration**
21. **Aquifer: any water bearing layer in the ground**
22. **Cone of depression: lowering of the water table around a pumping well**
23. **Salt water intrusion: near the coast, overpumping of groundwater causes saltwater to move into the acquifer**
24. **ENSO: El Nino Southern Oscillation, see-sawing of air pressure over the S. Pacific**
25. **During an El Nino year: trade winds weaken & warm water sloshed back to SA**

During a Non El Nino year: Easterly trade winds and ocean currents pool warm water in the western Pacific, allowing upwelling of nutrient rich water off the West coast of South America

26. **Effects of El Nino: upwelling decreases disrupting food chains, N US has mild winters, SW US has increased rainfall, less Atlantic Hurricanes**
27. **Nitrogen fixing: because atmospheric N cannot be used directly by plants it must first be converted into ammonia by bacteria (rhizobium)**
28. **Ammonification: decomposers covert organic waste into ammonia**
29. **Nitrification: ammonia is converted to nitrate ions (NO-3)**
30. **Assimilation: inorganic N is converted into organic molecules such as DNA/amino acids & proteins**
31. **Denitrification: bacteria convert ammonia back into N**
32. **Phosphorus does not circulate as easily as N because: it does not exist as a gas, but is released by weathering of phosphate rocks**
33. **Sustainability: the ability to meet humanities current needs without compromising the ability of future generations to meet their needs**
34. **Excess phosphorus is added to aquatic ecosystems by: runoff of animal wastes, fertilizer, discharge of sewage**
35. **Photosynthesis: plants convert atmospheric C (CO_2) into complex carbohydrates (glucose $C_6H_{12}O_6$)**
36. **Aerobic respiration: oxygen consuming producers, consumers & decomposers break down complex organic compounds & convert C back into CO_2**
37. **Largest reservoirs of C: carbonate rocks first, oceans second**

38. **Biotic/abiotic**: living & nonliving components of an ecosystem

39. **Producer/Autotroph**: photosynthetic life

40. **Fecal coliform/Enterococcus:** : indicator of sewage contamination

41. **Energy flow in food webs**: only 10% of the usable energy is transferred because usable energy lost as heat (2nd law), not all biomass is digested & absorbed, predators expend energy to catch prey

42. **Chlorine**: (good>disinfection of water)(bad>forms trihalomethanes)

43. **Primary succession**: development of communities in a lifeless area not previously inhabited by life (lava)

Secondary succession: life progresses where soil remains (clear cut forest, fire)

44. **Cogeneration**: using waste heat to make electricity

45. **Mutualism**: symbiotic relationship where both partners benefit

46. **Commensalism**: symbiotic relationship where one partner benefits & the other is unaffected

47. **Parasitism**: relationship in which one partner obtains nutrients at the expense of the host

48. **Biome**: large distinct terrestrial region having similar climate, soil, plants & animals

49. **Carrying capacity**: the number of individuals that can be sustained in an area

50. **R strategist**: reproduce early, many small unprotected offspring

K strategist: reproduce late, few, cared for offspring

51. **Positive feedback**: when a change in some condition triggers a response that intensifies the changing condition (EX: warmer Earth - snow melts - less sunlight is reflected & more is absorbed, therefore warmer earth)

52. **Natural selection**: organisms that possess favorable adaptations pass them onto the next generation

53. **Malthus**: said human population cannot continue to increase..consequences will be war, famine & disease

54. **Doubling time**: rule of 70 70 divided by the percent growth rate

55. **Replacement level fertility**: the number of children a couple must have to replace themselves (2.1 developed, 2.7 developing)

56. **World Population is**: 6 1/2 billion

US Population: 300 million

57. **Preindustrial stage**: birth & death rates high, population grows slowly, infant mortality high

58. **Transitional stage**: death rate lower, better health care, population grows fast

59. **Industrial stage**: decline in birth rate, population growth slows

60. **Postindustrial stage**: low birth & death rates

61. **Age structure diagrams**: (broad base, rapid growth)(narrow base, negative growth)(uniform shape, zero growth)

62. **1st & 2nd most populated countries**: China & India

63. **Most important thing affecting population growth**: low status of women

64. **Ways to decrease birth rate**: family planning, contraception, economic rewards & penalties

65. **Percent water on earth by type**: 97.5% seawater, 2.5% freshwater

66. **Salinazation of soil**: in arid regions, water evaporates leaving salts behind

67. **Ways to conserve water**: (agriculture, drip/trickle irrigation)(industry,recyling)(home, use gray water, repair leaks, low flow fixtures)

68. **Point vs non point sources**: (Point, from specific location such as pipe)(Non-point, from over an area such as runoff)

69. **BOD**: biological oxygen demand, amount of dissolved oxygen needed by aerobic decomposers to break down organic materials

70. **Eutrophication**: rapid algal growth caused by an excess of N & P

71. **Hypoxia**: when aquatic plants die, the BOD rises as aerobic decomposers break down the plants, the DO drops & the water cannot support life

72. **Minamata Disease**: mental impairments caused by mercury

73. **Primary air pollutants**: produced by humans & nature (CO,CO_2,SO_2,NO,hydrocarbons, particulates)

74. **Negative feedback**: when a changing in some condition triggers a response that counteracts the changed condition (EX: warmer earth - more ocean evaporation - more stratus clouds - less sunlight reaches the ground - therefore cooler Earth)

75. **Particulate matter (source,effect,reduction)**: (burning fossil fuels & diesel exhaust) (reduces visibility & respiratory irritation) (filtering, electrostatic precipitators, alternative energy)

76. Nitrogen Oxides: (Source: auto exhaust) (Effects: acidification of lakes, respiratory irritation, leads to smog & ozone) (Equation for acid formation: NO + O2 = NO2 + H2O = HNO3) (Reduction: catalytic converter)
77. Sulfur oxides: (Source: coal burning) (Effects: acid deposition, respiratory irritation, damages plants) (Equation for acid formation: SO2 + O2 = SO3 + H2O = H2SO4) (Reduction: scrubbers, burn low sulfur fuel)
78. Carbon oxides: (Source: auto exhaust, incomplete combustion) (Effects: CO binds to hemoglobin reducing bloods ability to carry O, CO2 contributes to global warming) (Reduction: catalytic converter, emission testing, oxygenated fuel, mass transit)
79. Ozone: (Formation: secondary pollutant, NO2+UV=NO+O O+O2=O3, with VOC's) (Effects: respiratory irritant, plant damage) (Reduction: reduce NO emissions & VOCs)
80. Radon: radioactive gas, formed from the decay of Uranium, causes lung cancer and is a problem in the Reading Prong
81. Photochemical smog: formed by chemical reactions involving sunlight (NO, VOC,O)
82. Acid deposition: caused by sulfuric and nitric acids resulting in lowered pH of surface waters
83. Greenhouse gases: (Examples: H2O, CO2, O3, methane (CH4), CFC's) (EFFECT: they trap outgoing infrared (heat) energy causing earth to warm
84. Effects of global warming: rising sealevel (thermal expansion), extreme weather, droughts (famine), extinctions
85. Ozone depletion caused by: CFC's, methyl chloroform, carbon tetrachloride, halon, methyl bromide all of which attack stratospheric ozone
86. Effects of ozone depletion: increased UV, skin cancer, cataracts, decreased plant growth
87. Love Canal, NY: chemicals buried in old canal and school & homes built over it causing birth defects & cancer
88. Municpal solid waste is mostly: paper and most is landfilled
89. True cost / External costs: harmful environmental side effects that are not reflected in a products price
90. Sanitary landfill problems and solutions: (leachate, liner with collection system) (methane gas, collect gas and burn) (volume of garbage, compact & reduce)
91. Incineration advantages: volume of waste reduced by 90% & waste heat can be used
92. Incineration disadvantages: toxic emissions (polyvinyl chloride—dioxin), scrubbers & electrostatic precipitators needed, ash disposal (contains heavy metals)
93. Best way to solve waste problem: reduce the amounts of waste at the source
94. Keystone species: species whose role in an ecosystem are more important than others, ex sea otter
95. Indicator species: species that serve as early warnings that an ecosystem is being damaged ex trout
96. Most endangered species: have a small range, require large territory or live on an island
97. In natural ecosystems, 50-90% of pest species are kept under control by: predators, diseases, parasites
98. Major insecticide groups and examples: (chlorinated hydrocarbons, DDT) (organophosphates, malathion) (carbamates, aldicarb)
99. Pesticide pros: saves lives from insect transmitted disease, increases food supply, increases profits for farmers
100. Pesticide cons: genetic resistance, ecosystem imbalance, pesticide treadmill, persistence, bioaccumulation, biological magnification
101. Natural pest control: better agricultural practices, genetically resistant plants, natural enemies, biopesticides, sex attractants
102. Electricity is generated by: using steam (from water boiled by fossils fuels or nuclear) or falling water to turn a generator
103. Petroleum forms from: microscopic aquatic organisms in sediments converted by heat & pressure into a mixture of hydrocarbons
104. Pros of petroleum: cheap, easily transported, high quality energy
105. Cons of petroleum: reserves depleted soon, pollution during drilling, transport and refining, burning makes CO2
106. Steps in coal formation: peat, lignite, bituminous, anthracite
107. Major parts of a nuclear reactor: core, control rods, steam generator, turbine, containment building
108. Two most serious nuclear accidents: (Chernobyl,Ukraine) (Three Mile Island, PA)

109. **Alternate energy sources: wind, solar, waves, biomass, geothermal, fuel cells**
110. **LD50: the amount of a chemical that kills 50% of the animals in a test population**
111. **Mutagen, Teratogen, Carcinogen: causes hereditary changes, Fetus deformities, cancer**
112. **Endangered species: North spotted Owl (loss of old growth forest), Bald Eagle (thinning of eggs caused by DDT), Piping Plover (nesting areas threatened by development)**
113. **LI Exotic species: gypsy moth, Asian Long Horned Beetle**
114. **Garret Hardin & The Tragedy of the Commons: Freedom to breed is bringing ruin to all. Global commons such as atmosphere & oceans are used by all and owned by none**
115. **Volcanoes and Earthquakes occur: at plate boundaries (divergent, spreading, mid-ocean ridges) (convergent, trenches) (transform, sliding, San Andreas)**
116. **Sources of mercury: burning coal, Compact Fluorescent bulbs**
117. **Major source of sulfur: burning coal**
118. **Threshold dose: the maximum dose that has no measurable effect**

LAWS, LAWS & MORE LAWS

MINING

1. **Surface Mining Control & Reclamation Act: requires coal strip mines to reclaim the land**
2. **Madrid Protocol: Moratorium on mineral exploration for 50 years in Antarctica**

WATER

3. **Safe Drinking Water Act: set maximum contaminant levels for pollutants in drinking water that may have adverse effects on human health**
4. **Clean Water Act: set maximum permissible amounts of water pollutants that can be discharged into waterways..aim to make surface waters swimmable and fishable**
5. **Ocean Dumping Ban Act: bans ocean dumping of sewage sludge & industrial waste in the ocean**

AIR

6. **Clean Air Act: Set emission standards for cars, and limits for release of air pollutants**
7. **Kyoto Protocol: controlling global warming by setting greenhouse gas emissions targets for developed countries**
8. **Montreal Protocol: phaseout of ozone depleting substances**

WASTE

9. **Resource Conservation & Recovery Act: controls hazardous waste with a cradle to grave system**
10. **Comprehensive Environmental Response, Compensation & Liability Act: Superfund, designed to identify and clean up abandoned hazardous waste dump sites**
11. **Nuclear Waste Policy Act: US government must develop a high level nuclear waste site (Yucca Mtn)**

LIFE

12. **Endangered Species Act: identifies threatened and endangered species in the US, and puts their protection ahead of economic considerations**
13. **Convention on International Trade in Endangered Species: lists species that cannot be commercially traded as live specimens or wildlife products**
14. **Magnuson- Stevens Act: Mangaement of marine fisheries**
15. **Food Quality Protection Act: set pesticide limits in food, & all active and inactive ingredients must be screened for estrogenic/endocrine effects**

GENERAL

16. **National Environmental Policy Act: Environmental Impact Statements must be done before any project affecting federal lands can be started**
17. **Stockholm Convention on Persistent Organic Pollutants: Seeks to protect human health from the 12 most toxic chemicals (includes 8 chlorinated hydrocarbon pesticides / DDT can be used for malaria control)**

GLOSSARY 3

First Law of Thermodynamics: energy is neither created nor destroyed, but may be converted from one form to another.

Second Law of Thermodynamics: when energy is changed from one form to another, some useful energy is always degraded into lower quality energy (usually heat).

Ionizing radiation: radiation w/enough energy to free electrons from atoms forming ions, may cause cancer (ex. gamma, X-rays, UV).

High Quality Energy: organized & concentrated, can perform useful work (ex. fossil fuels & nuclear).

Low Quality Energy: disorganized, dispersed (ex. heat in ocean or air/wind, solar).

Natural radioactive decay: unstable radioisotopes decay releasing gamma rays, alpha & beta particles (ex. Radon).

Half-life: the time it takes for 1⁄2 of the mass of a radioisotope to decay. A radioactive isotope must be stored for approximately 10 half-lives until it decays to a safe level.

Nuclear Fission: nuclei of isotopes split apart when struck by neutrons.

Nuclear Fusion: 2 isotopes of light elements (H) forced together at high temperatures till they fuse to form a heavier nucleus. Happens in the Sun, very difficult to accomplish on Earth, prohibitively expensive.

Ore: a rock that contains a large enough concentration of a mineral making it profitable to mine.

Mineral Reserve: identified deposits currently profitable to extract.

Surface mining: cheaper, can remove more minerals, less hazardous to workers.

Humus: organic, dark material remaining after decomposition by microorganisms.

Leaching: removal of dissolved materials from soil by water moving downwards through soil.

Loam: perfect agricultural soil with equal portions of sand, silt, and clay.

Soil Conservation Methods: conservation tillage, crop rotation, contour plowing, organic fertilizers.

Soil Salinization: in arid regions, water evaporates leaving salts behind. (ex. Fertile crescent, southwestern US)

Water Logging: water completely saturates soil starves plant roots of oxygen, rots roots

Hydrologic Cycle Components: evaporation, transpiration, runoff, condensation, precipitation, and infiltration.

Watershed: all of the land that drains into a body of water.

Aquifer: underground layers of porous rock allow water to move slowly.

Cone of Depression: lowering of the water table around a pumping well.

Salt Water Intrusion: near the coast, overpumping of groundwater causes saltwater to move into the aquifer.

ENSO: El Nino Southern Oscillation, trade winds weaken & warm surface water moves toward South America. Diminished fisheries off South America, drought in western Pacific, increased precipitation in southwestern North America, fewer Atlantic hurricanes.

La Nina: “Normal” year, easterly trade winds and ocean currents pool warm water in the western Pacific, allowing upwelling of nutrient rich water off the West coast of South America.

Nitrogen Fixation: because atmospheric N cannot be used directly by plants, it must first be converted into ammonia by bacteria.

Ammonification: decomposers covert organic waste into ammonia.

Nitrification: ammonia is converted to nitrate ions (NO_3^-).

Assimilation: inorganic N is converted into organic molecules such as DNA/amino acids & proteins.

Denitrification: bacteria convert ammonia back into N.

Phosphorus: does not exist as a gas; released by weathering of phosphate rocks, it is a major limiting factor for plant growth. Phosphorus cycle is slow, and not atmospheric.

Photosynthesis: plants convert CO_2 (atmospheric carbon) into complex carbohydrates (glucose $C_6H_{12}O_6$).

Aerobic Respiration: oxygen consuming producers, consumers & decomposers break down complex organic compounds & convert C back into CO_2.

Biotic: the living components of an ecosystem.

Abiotic: the nonliving components of an ecosystem.

Producer/Autotroph: organisms that make their own food—photosynthetic life (plants).

Trophic Levels: producers → primary consumer → secondary consumer → tertiary consumer.

Energy Flow through Food Webs: 10% of the usable energy is transferred to the next trophic level. Reason: usable energy lost as heat (2nd law of Thermodynamics), not all biomass is digested & absorbed, predators expend energy to catch prey.

Primary succession: development of communities in a lifeless area not recently inhabited by life (ex. lava flow, retreating glacier).

Secondary succession: life progresses where soil remains (ex. clear-cut/burned forest, old farm, vacant lot).

Mutualism: symbiotic relationship where both organisms benefit.

Commensalism: symbiotic relationship where one organism benefits & the other is unaffected.

Parasitism: relationship in which one organism (the parasite) obtains nutrients at the expense of the host.

Carrying Capacity: the number of individuals that can be sustained in an area.

r-strategist: reproductive strategy in which organisms reproduce early, bear many small, unprotected offspring (ex. insects, mice).

K-strategist: reproductive strategy in which organisms reproduce late, bear few, cared for offspring (ex. humans, elephants).

Natural Selection: organisms that possess favorable adaptations pass them onto the next generation.

Thomas Malthus: "human population cannot continue to increase. Consequences will be war, famine & pestilence (disease)."

Doubling Time: (rule of 70) doubling time equals 70 divided by percent growth rate. (ex. a population growing at 5% annually doubles in 70 ÷ 5 = 14 years)

Replacement Level Fertility: the number of children a couple must have to replace themselves (averages 2.1 in more developed nations, 2.7 in less developed nations).

World Population: a little over 6 billion.

Demographic Transition Model:

Preindustrial stage: birth & death rates high, population grows slowly, infant mortality high.

Transitional stage: death rate (infant mortality) lower, birth rates remain high, better health care, population grows fast.

Industrial stage: decline in birth rate, population growth slows.

Postindustrial stage: low birth & death rates.

Age Structure Diagrams: broad base → rapid growth; narrow base → negative growth; uniform shape → zero growth

Most Populous Nations: (1) China; (2) India; (3) U.S.; (4) Indonesia

Low Status of Women: Most important factor keeping population growth rates high.

Methods to Decrease Birth Rates: family planning, contraception, economic rewards & penalties.

Composition of Water on Earth: 97.5% seawater, 2.5% freshwater.

Aquaculture: farming aquatic species, commonly salmon, shrimp, tilapia, oysters.

Point Source: source from specific location such as pipe or smokestack

Non-Point Source (Area/Dispersed Source): source spread over an area such as agricultural/feedlot runoff, urban runoff, traffic.

Primary Sewage Treatment: first step of sewage treatment; eliminates most particulate material from raw sewage using grates, screens, and gravity (settling).

Secondary Sewage Treatment: second step of sewage treatment; bacteria breakdown organic waste, aeration accelerates the process.

BOD: Biological Oxygen Demand, amount of dissolved oxygen needed by aerobic decomposers to break down organic materials.

Eutrophication: rapid algal growth (algal bloom) caused by an excess of nitrogen & phosphorus, blocks sunlight, causing the death/decomposition of aquatic plants, decreasing dissolved oxygen (DO), suffocating fish.

Hypoxia: water with very low dissolved oxygen levels, the end result of eutrophication, for example.

CAFE standards: Corporate Average Fuel Economy standards enacted into law in 1975, established fuel efficiency standards for passenger cars and light trucks. The fuel economy ratings for a manufacturer's entire line of passenger cars must currently average at least 27.5 mpg for the manufacturer to comply with the standard.

Primary Air Pollutants: produced by humans & nature (CO, CO_2, SO_2, NO, hydrocarbons, particulates).

Secondary Air Pollutants: formed by reaction of primary pollutants.

Particulate Matter: sources include burning fossil fuels and car exhaust. Effects include reduced visibility, respiratory irritation. Methods of reduction include filtering, electrostatic precipitators, alternative energy).

Nitrogen Oxides: (NO_x) Major source is auto exhaust. Primary and secondary effects include acidification of lakes, respiratory irritation, leads to smog and ozone. Reduced using catalytic converters.

Equation for acid formation: $NO + O_2 \rightarrow NO_2 + H_2O \rightarrow HNO_3$.

Ozone: Secondary pollutant, $NO_2 + UV \rightarrow NO + O$; $O + O_2 \rightarrow O_3$, with VOCs. Causes respiratory irritation and plant damage. Reduced by reducing NO emissions and VOCs.

Sulfur Oxides: (SO_x) Primary source is coal burning. Primary and secondary effects include acid deposition, respiratory irritation, plant damage. Reduction methods include: scrubbers, burn low sulfur fuel.

Equation for acid formation: $SO_2 + O_2 \rightarrow SO_3 + H_2O \rightarrow H_2SO_4$

Carbon Dioxide: (CO_2) Sources include the combustion of fossil fuels. Effects: greenhouse gas–contributes to global warming. Reduction accomplished by increased fuel efficiency (gas mileage), mass transit (reduction).

Carbon Monoxide: (CO) Sources include incomplete combustion of fossil fuels. Effects: binds to hemoglobin reducing bloods ability to carry O_2. Reduction accomplished by catalytic converters, oxygenated fuel, mass transit (reduction).

Photochemical Smog: formed by chemical reactions involving sunlight (NO, VOC, O_2)

Acid Deposition: caused by sulfuric and nitric acids resulting in lowered pH of surface waters

Greenhouse Gases: Most significant: H_2O, CO_2, methane (CH_4), CFCs. Trap outgoing infrared energy (heat) causing earth to warm.

Greenhouse Effect: a vital process, required for life to exist on Earth. If accelerated, bad, leads to global warming.

Effects of Global Warming: rising sea level (due to thermal expansion not melting ice), extreme weather, droughts (famine), and extinctions.

Ozone Depletion: caused by CFCs, methyl chloroform, carbon tetrachloride, halon, methyl bromide all of which attack stratospheric ozone. Negative effects of ozone depletion include increased UV, skin cancer, cataracts, and decreased plant growth.

Municipal Solid Waste: is mostly paper and mostly put into landfills.

Sanitary Landfill: problems include leachate, which is solved using a liner with a collection system; methane gas, which may be collected and burned; and the volume of garbage, which may be compacted and/or reduced.

Incineration: Advantages–volume of waste reduced by 90% and waste heat can be used. Disadvantages–toxic emissions (polyvinyl chloride, dioxin), scrubbers and electrostatic precipitators needed, ash disposal.

Best Solution for Waste Problem: reduce the amount of waste at the source.

Brownfield: abandoned industrial sites.

Keystone Species: species whose role in an ecosystem is more important than others.

Indicator Species: species that serve as early warnings that an ecosystem is being damaged.

In Natural Ecosystems: 50-90% of pest species are kept under control by: predators, diseases, parasites.

Major Insecticide Groups: chlorinated hydrocarbons—ex. DDT; organophosphates—ex. malathion; carbamates—ex. aldicarb

Pesticide Pros: saves lives from insect transmitted disease, increases food supply, and increases profits for farmers. Cons: genetic resistance, ecosystem imbalance, pesticide treadmill, persistence, bioaccumulation, and biological magnification.

Natural Pest Control: better agricultural practices, genetically resistant plants, natural enemies, and biopesticides, sex attractants.

Genetically Modified Organisms (GMOs): new organisms created by altering the genetic material (DNA) of existing organisms; usually in an attempt to remove undesirable or create desirable characteristics in the new organism.

Electricity Generation: steam, from water boiled by fossils fuels or nuclear energy, or falling water is used to turn a generator.

Petroleum (Crude Oil) Formation: microscopic aquatic organisms in sediments converted by heat & pressure into a mixture of hydrocarbons.

Petroleum Pros: cheap, easily transported, high-quality energy. Cons: reserves depleted soon, pollution during drilling, transport and refining, land subsidence, burning oil produces CO_2.

Coal Formation: prehistoric plants buried un-decomposed in oxygen-depleted water of swamps/bogs converted by heat and pressure.

Ranks of Coal: peat, lignite, bituminous coal, anthracite coal.

Nuclear Reactor: consists of a core, control rods, moderator, steam generator, turbine, containment building.

Alternate Energy Sources: wind, solar, waves, biomass, geothermal, fuel cells

Remediation: return a contaminated area to its original state.

LD-50: the amount of a chemical that kills 50% of the animals in a test population.

Troposphere: first layer of atmosphere 0-10 miles above the Earth's surface. Contains weather, greenhouse gases (bad ozone).

Stratosphere: second layer of atmosphere 10-30 miles above the Earth's surface. Contains protective ozone layer (good ozone).

Inversion Layer (Temperature Inversion): a warm layer of air above a cooler layer traps pollutants close to the Earth's surface.

Mutagen: substances that cause changes in DNA; may result in hereditary changes.

Teratogen: substances that cause fetus deformities (birth defects).

Carcinogen: substances that cause cancer.

Dioxin: one of the most toxic human-made chemicals. Stable, long-lived, by-product of herbicide production enters environment as fallout from the incineration of municipal and medical waste and persists for many years.

PCBs (Polychlorinated Biphenyls): Stable, long-lived, carcinogenic chlorinated hydrocarbons. Produced by the electronics industry.

Multiple Use Public Lands: National Forest & National Resource lands.

Moderately Restricted Use Public Lands: National Wildlife Refuges

Restricted Use Public Lands: National Parks & National Wilderness Preservation System

Divergent Plate Boundaries: tectonic plates spreading apart, new crust being formed (ex. mid-ocean ridges, rift valleys).

Convergent Plate Boundaries: tectonic plates with the oldest crustal material on Earth moving together, one moving under another (ex. mid-ocean trenches). Mineral deposits and volcanoes are most abundant at convergent plate boundaries

Transform Fault: tectonic plates sliding past one another (ex. San Andreas fault).

Endangered Species

Most Endangered Species: have a small range, require large territory, have long generations, have a very specialized niche, or live on an island.

Atlantic Salmon: interbreeding with and competition from escaped farm-raised salmon from the aquaculture industry threaten the wild salmon population.

California Condor: reasons for decline include shootings, poisoning, lead poisoning, collisions with power lines, egg collecting, pesticides, habitat loss, and the decline of large and medium-size native mammals due to encroachments of agriculture and urbanization.

Delhi Sands Flower-Loving Fly: a 1-inch long insect currently restricted to only 12 known populations in San Bernardino and Riverside counties. An estimated 98% of its habitat has been converted to residential, agricultural, and commercial use.

Florida Panther: hunting and development that resulted in habitat loss and fragmentation.

Gray Wolf: subject of predator eradication programs sponsored by the Federal government. Prior to Endangered Species Act (1973), exterminated from the lower 48 states except for a few hundred inhabiting extreme northeastern Minnesota and a small number on Isle Royale, Michigan

Grizzly Bear: conflict with humans and development that resulted in habitat loss and fragmentation

Piping Plover: predation and human disturbance are thought to be the main causes of the plover's decline. It is listed as endangered in the Great Lakes region and as threatened in the Great Plains and on the Atlantic coast

Manatee: initial population decreases resulted from overharvesting for meat, oil, and leather. Today, heavy mortality occurs from accidental collisions with boats and barges, and from canal lock operations.

Whooping Crane: drainage of wetlands, conversion of grasslands to agriculture, and hunting for feathers.

NOT Endangered Species

American Alligator: overhunting and destruction of habitat caused original listing, removed from the list of endangered species by the Fish and Wildlife Service in 1987.

Bald Eagle: ingested DDT by eating contaminated fish. The pesticide caused the shells of the bird's eggs to thin and resulted in nesting failures. Loss of nesting habitat and hunting for feathers also contributed to the population decline. Reclassified from endangered to threatened (1995).

Peregrine Falcon: ingested DDT by eating smaller birds, which had eaten contaminated prey. The pesticide caused the shells of the bird's eggs to thin and resulted in nesting failures. Removed from the list of endangered species by the Fish and Wildlife Service in August 1999.

Gray Whale: the eastern North Pacific stock of gray whale has the distinction of being the first population of a marine mammal species to be removed from the List of Endangered and Threatened Species.

Biomes

Biome: large distinct terrestrial region having similar climate, soil, plants & animals.

Tropical Rain Forests: characterized by the greatest diversity of species, believed to include many undiscovered species. Occur near the equator. Soils tend to be low in nutrients. Distinct seasonality: winter is absent, and only two seasons are present (rainy and dry).

Temperate Forests: occur in eastern North America, Japan, northeastern Asia, and western and central Europe. Dominated by tall deciduous trees. Well-defined seasons include a distinct winter. Logged extensively, only scattered remnants of original temperate forests remain.

Boreal Forests or Taiga: represent the largest terrestrial biome. Dominated by needleleaf, coniferous trees. Found in the cold climates of Eurasia and North America: two-thirds in Siberia with the rest in Scandinavia, Alaska, and Canada. Seasons are divided into short, moist, and moderately warm summers and long, cold, and dry winters. Extensive logging may soon cause their disappearance.

Temperate Shrub Lands: occurs along the coast of Southern California and the Mediterranean region. Characterized by areas of Chaparral–miniature woodlands dominated by dense stands of shrubs.

Savannas: grassland with scattered individual trees. Cover almost half the surface of Africa and large areas of Australia, South America, and India. Warm or hot climates where the annual rainfall is 20-50 inches per year. The rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur.

Temperate Grasslands: dominated by grasses, trees and large shrubs are absent. Temperatures vary more from summer to winter, and the amount of rainfall is less than in savannas. Temperate grasslands have hot summers and cold winters. Occur in South Africa, Hungary, Argentina, the steppes of the former Soviet Union, and the plains and prairies of central North America.

Deserts: covers about one fifth of the Earth's surface and occur where rainfall is less than 50 cm/year. Most deserts occur at low latitudes, have a considerable amount of specialized vegetation, as well as specialized animals. Soils have abundant nutrients, need only water to become productive, and have little or no organic matter. Common disturbances include occasional fires or cold weather, and sudden, infrequent, but intense rains that cause flooding.

Tundra: treeless plains that are the coldest of all the biomes. Occur in the arctic and Antarctica. Dominated by lichens, mosses, sedges, and dwarfed shrubs Characterized by extremely cold climate, permanently frozen ground (permafrost) low biotic diversity, simple vegetation structure, limitation of drainage, short season of growth and reproduction.

Wetlands: areas of standing water wet all or most of the year that support aquatic plants including marshes, swamps, and bogs. Species diversity is very high. Includes bogs, swamps, sloughs, marshes

Fresh Water: defined as having a low salt concentration (less than 1%). Plants and animals are adjusted to the low salt content and would not be able to survive in areas of high salt concentration (i.e., ocean). There are different types of freshwater regions: ponds and lakes, streams and rivers, and estuaries.

Oceans: the largest of all the ecosystems. The ocean regions are separated into separate zones: intertidal, pelagic, abyssal, and benthic. All four zones have a great diversity of species.

Places to Know

Chernobyl, Ukraine: April 26, 1986, unauthorized safety test (irony), leads to fire and explosion at nuclear power plant—millions exposed to unsafe levels of radiation.

Three-Mile Island, Pennsylvania: March 29, 1979, nuclear power plant loses cooling water 50% of core melts, radioactive materials escape into atmosphere, near meltdown (disaster).

Yucca Mountain, Nevada: controversial as proposed site for permanent storage of high-level nuclear waste, 70-miles northwest of Las Vegas, near volcano and earthquake faults.

Aral Sea, Uzbekistan/Kazakhstan (former Soviet Union): large inland sea is drying up as a result of water diversion.

Love Canal, NY: chemicals buried in old canal, school and homes built over it led to birth defects and cancers.

Aswan High Dam, Egypt: the silt that made the Nile region fertile fills the reservoir. Lack of irrigation controls causes waterlogging and salinization. The parasitic disease schistosomiasis thrives in the stagnant water of the reservoir.

Three Gorges Dam, China: world's largest dam on Yangtze River will drown ecosystems, cities, archeological sites, fragment habitats, and displace 2 million people.

Ogallala Aquifer: world's largest aquifer; under parts of Wyoming, South Dakota, Nebraska, Kansas, Colorado, Oklahoma, New Mexico, and Texas (the Midwest). Holds enough water to cover the U.S. with 1.5 feet of water. Being depleted for agricultural and urban use.

Minamata, Japan: mental impairments, birth defects, and deaths were caused by mercury dumped in Minamata Bay by factory. Mercury entered humans through their diet (fish).

Bhopal, India: December 2,1984, methyl isocyanate released accidentally by Union Carbide pesticide plant kills over 5,000.

Valdez, Alaska: March 24, 1989, tanker Exxon Valdez hits submerged rocks in Prince William Sound—worst oil spill in US waters.

Environmental Laws and Treaties

Safe Drinking Water Act: set maximum contaminant levels for pollutants that may have adverse effects on human health.

Ocean Dumping Ban Act: bans ocean dumping of sewage sludge & industrial waste.

National Wild and Scenic Rivers Act: protects rivers with due to aesthetic, recreational, wildlife, historical, or cultural reasons.

Clean Water Act: set maximum permissible amounts of water pollutants that can be discharged into waterways. Aim: to make surface waters swimmable and fishable.

Surface Mining Control & Reclamation Act: requires coal strip mines to reclaim the land.

National Environmental Policy Act (NEPA): Environmental Impact Statements must be done before any project affecting federal lands can be started.

Clean Air Act: Set emission standards for cars, and limits for release of air pollutants.

Kyoto Protocol: controlling global warming by setting greenhouse gas emissions targets for developed countries.

Montreal Protocol: phase out of ozone depleting substances.

Resource Conservation & Recovery Act (RCRA): controls hazardous waste with a cradle to grave system.

Comprehensive Environmental Response, Compensation & Liability Act (CERCLA): The "Superfund" act, designed to identify and clean up abandoned hazardous waste dumpsites.

Endangered Species Act: identifies threatened and endangered species in the US, and puts their protection ahead of economic considerations.

Convention on International Trade in Endangered Species: (CITES) lists species that cannot be commercially traded as live specimens or wildlife products.

Lacey Act: prohibits interstate transport of wild animals dead or alive without federal permit.

U.S. Marine Mammal Protection Act: prohibits taking marine mammals in U.S. waters and by U.S. citizens, and the importing marine mammals and marine mammal products into the U.S.

Federal Insecticide, Fungicide, and Rodenticide Act: regulates the effectiveness of pesticides.

Food Quality Protection Act: set pesticide limits in food, & all active and inactive ingredients must be screened for estrogenic/endocrine effects.

Low-Level Radioactive Policy Act: all states must have facilities to handle low-level radioactive wastes.

Nuclear Waste Policy Act: US government must develop a high level nuclear waste site by 2015 (see Yucca Mountain).

People to Know

Rachel Carson: published *Silent Spring* in 1962; documented the environmental damage done by DDT and other pesticides. Which heightened public awareness at the start of the modern environmental movement.

John Muir: founded Sierra Club in 1892; fought unsuccessfully to prevent the damming of the Hetch Hetchy Valley in Yosemite National Park.

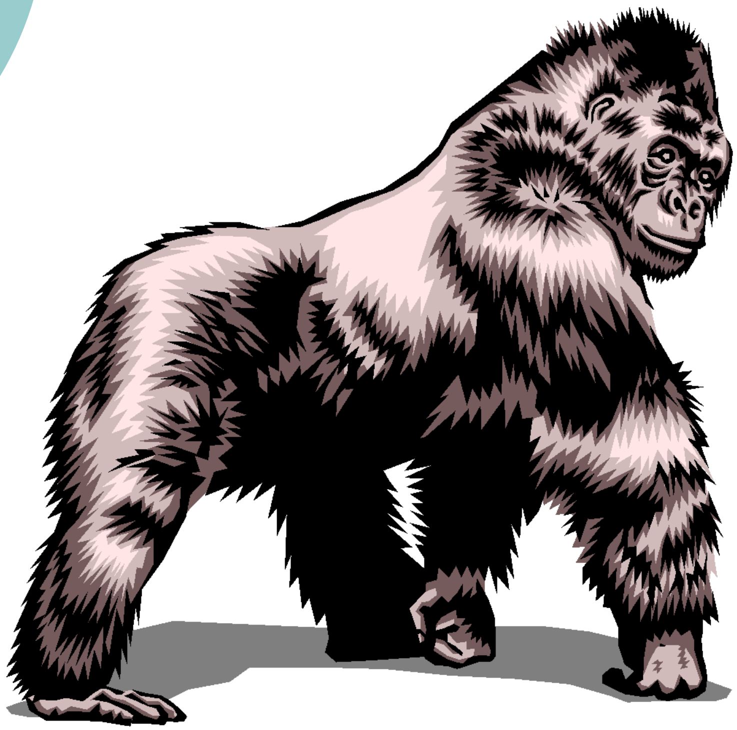
Gifford Pinchot: first chief of the US Forest Service; advocated managing resources for multiple use using principles of sustainable yield.

Garrett Hardin: published "The Tragedy of the Commons" in the journal *Science* in 1968; argued that rational people will exploit shared resources (commons).

Aldo Leopold: wrote *A Sand County Almanac* published a year after his death in 1948; promoted a "Land Ethic" in which humans are ethically responsible for serving as the protectors of nature.

Sherwood Rowland & Mario Molina: in 1974, determine that CFCs destroy stratospheric (good) ozone.

APES



Introduction

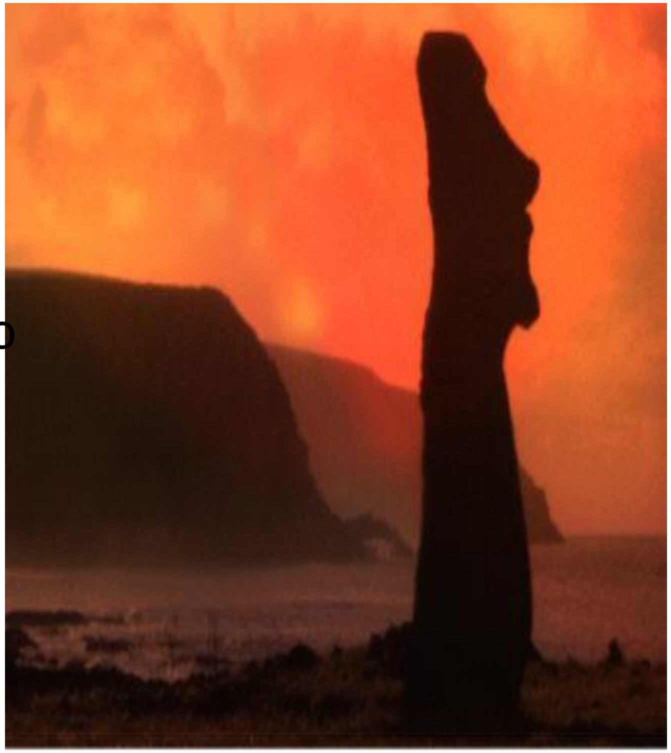
- Understand how natural world works
- Understand how human systems interact with natural system
- Accurately determine environmental problems
- Develop and follow a sustainable relationship with natural world

Easter Island

<u>Sustainability</u>
- A system/process can continue indefinitely without depleting resources used.
no sacrifice to future generations

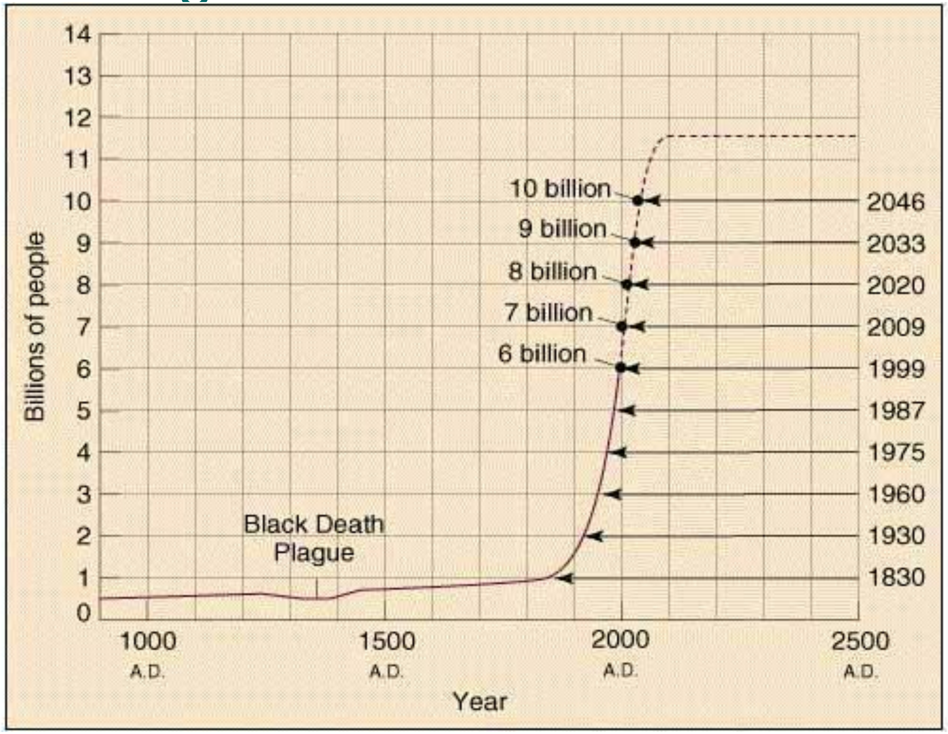
<u>Stewardship</u>
Caring for something that does not belong to you

<u>Sound Science</u>
Use the scientific method



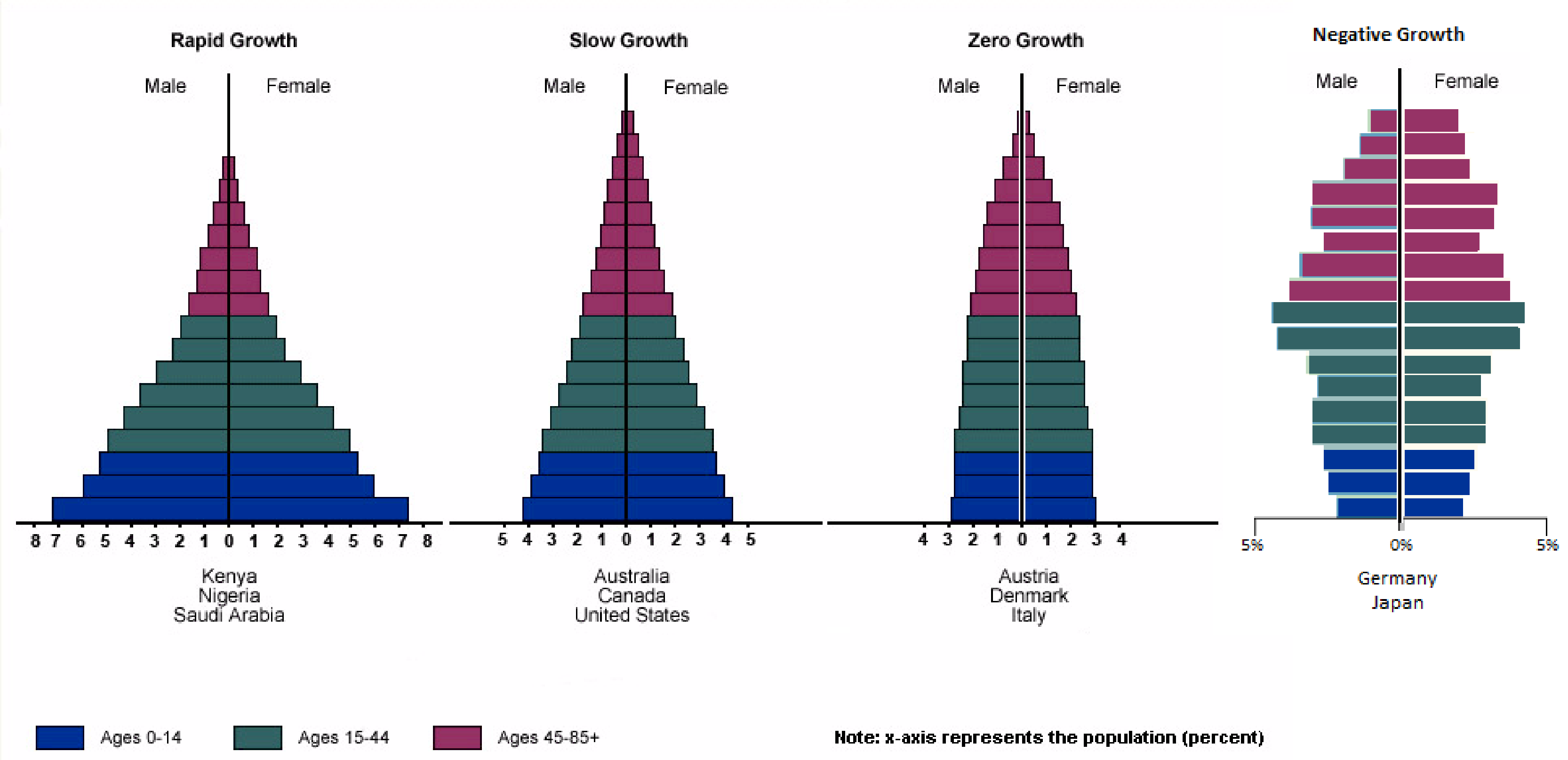
Only the moai have the answers...

A. Human population growth



- More than 7 billion people currently
- last 25 yrs population grew by 2 billion
- Birth Rate-Death Rate= Pop Growth Rate
- Rule of 70. 70 divided by % rate of increase= doubling time
- increase pop → increase need for resources

Age Structure Diagrams



B. SOIL DEGRADATION

- Demand for food destroys the soil
  - erosion
  - minerals in soil are depleted
  - salinization
  - increased use of pesticides
  - Overuse of fresh water

C. Global Atmospheric Changes

Global Warming

- CO_2 produced from fossil fuel burning acts like a blanket around the earth.
- Plants take CO_2 out of the atmosphere through photosynthesis
  - $6CO_2 + 6H_2O => 60_2 + C_6H_{12}O_6$

Ozone depletion

- Chemicals released from the surface of the earth destroy our ozone shield.
- No stratospheric ozone, no protection from the UV rays of the sun.

OZONE DEPLETION AND CLIMATE CHANGE ARE DIFFERENT FROM EACHOTHER AND HAVE DIFFERENT CAUSES!

D. Loss of Biodiversity

- Habitat destruction leads to a loss of many species starting with the plants
- exact # of species lost is unknown because not all species are identified
- strong ecosystems need biodiversity
- 1959-1980   25% of all prescription drugs from natural resources
- Wild species keep domestic species vigorous
- Aesthetics

- Rachel Carson was a scientist who wrote Silent Spring in 1962.
- It addressed the growing use of pesticides (DDT) and their unpredicted effects on song birds.
- Original users of pesticides did not know that the poisons used to kill insects would accumulate in other living things and kill them too.

BIOACCUMULATION

More Cool Environmentalist

- John Muir – Sierra Club
- Ansel Adams – Photography (Yosemite)
- Aldo Leopold – Sand County Almanac
- Henry David Thoreau – Walden
- Garrett Hardin – Tragedy of the Commons

Ecosystems

Levels of organization of matter

Universe

Ecosphere/biosphere

Ecosystems

Communities

Populations

Organisms

Cells

Atoms

Cool Web Animation (Click Here)

Ecosystems

Plants and animals interacting with their abiotic environment. Ecosystems exist in biomes.

- Climate – ave temperature over time
- *Weather – daily variations in temp and precipitation
- Microclimate and Other Abiotic Factors

    * light intensity

    * Soil type

    * topography

TROPHIC RELATIONSHIP

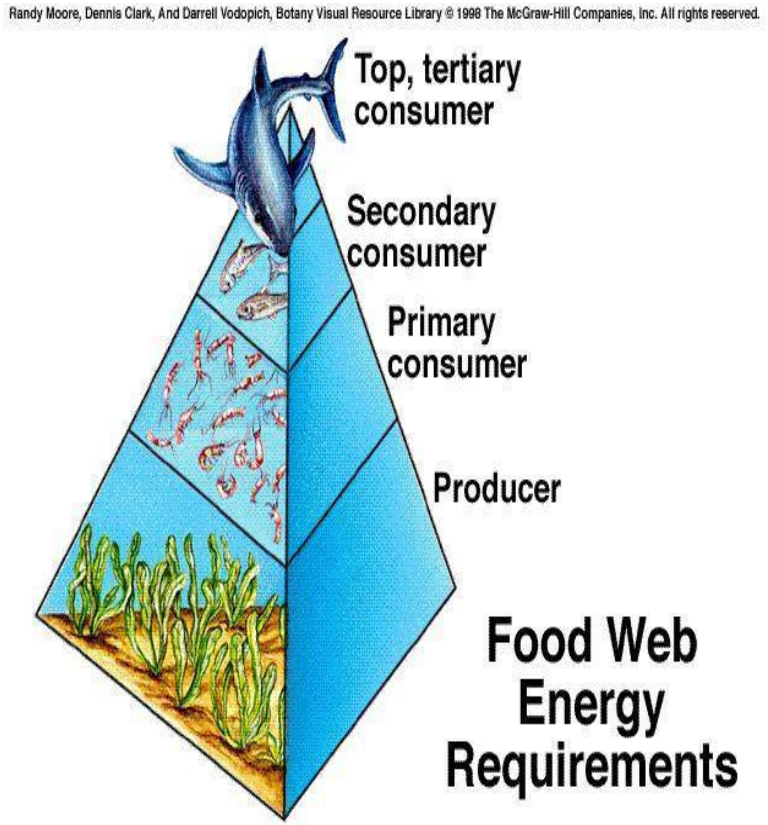
Food webs

- Trophic levels

  * producers

  * herbivores

  *primary carni



Biomass and Biomass Pyramid

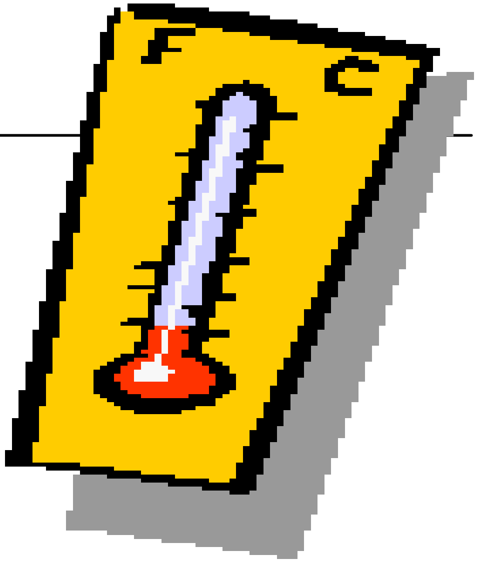
- All biomass gets its energy from the sun
- Only 10% of energy from one trophic level moves to the next trophic level
- Energy released is high potential energy molecules (like glucose) then converted to low potential energy molecules (like carbon dioxide)

  * concept of eating lower on the biomass pyramid

Relationships

- Mutualism
  * Flowers & insects
- Commensalism
- Predator/prey
- host parasite
- Competition
- habitat vs. niche

LIMITING FACTORS



Temperature, light, oxygen, carbon dioxide, precipitation

- Optimum levels
- Zones of stress
- Limits of Tolerance
- Range of Tolerance

Synergistic effects – The interaction of two or more factors is greater than the sum of the effects when each acts alone. Example: pollution and disease

Ecosystems, how they work

- Recycle or Die
- All matter is recycled through the lithosphere, hydrosphere, and atmosphere.
- Nothing is created nothing is destroyed
- All stable ecosystems recycle matter and get energy from the sun

Physics

- Energy is measured in calories
  - Calorie – amount of heat needed to raise 1 gram of water 1 degree Celsius.
  - Kilocalorie = 1,000 calories
- 1st law of thermodynamics
  - Energy cannot be created nor destroyed, only change forms (light to chemical)
- 2nd law of thermodynamics
  - Energy transformation increases disorder (entropy) of the universe.
  - Heat is the lowest grade of energy.

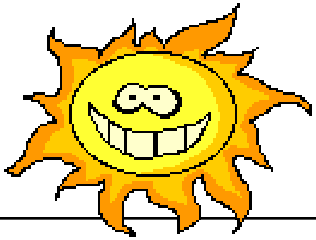
CHEMISTRY

- **Atoms –** basic units of matter
  - Electron
  - Proton
  - Neutron
- **Chemical bonds -** how atoms are held together
  - **Ionic**
  - **Covalent**
- **Molecule/compound** – two or more atoms bonded together
- **pH scale**
  - Base/alkaline
  - Acid

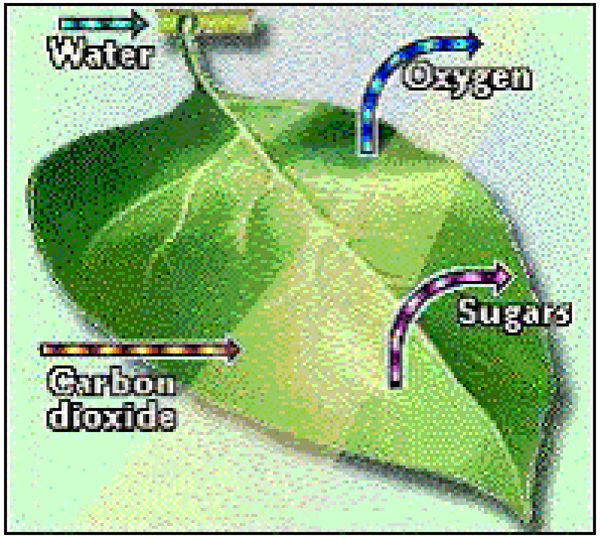
Organic Compounds

- C-C bonds and/or C-H bonds
- They can be natural or synthetic
  - **Natural:** compounds that make up living systems
  - **Synthetic:** man-made compounds

PHOTOSYNTHESIS



- Very inefficient (Only 1% of the energy from the sun is used)
  - Chlorophyll – absorbs light to drive photosynthesis
- Plants use glucose to:
  - Construct other molecules
  - Build their cell wall
  - Store energy
  - Source of energy



Carbon cycle

- Remember the carbon cycle game
- Photosynthesis!
- Moving fossil fuels (which took millions of years to form) to the atmosphere (in hundreds of years) is a major component of global warming.
- Hydrocarbon fuels to CO_2

Nitrogen cycle

- Main reserve in the atmosphere
- Living things must get N from ammonium (NH_4) or nitrate (NO_3)
- N from the atmo must be fixed
    - Change N_2 into ammonium or nitrate
  - Rhizobium (bacteria living in roots of legumes) fig 3-10
  - Industrial
  - Lightning
  - Burning fossil fuels

PHOSPHORUS CYCLE

- No gas phase, only solid and liquid
- Man-made fertilizers contain organic phosphates
- Because P is a limiting factor in aquatic systems, it leads to eutrophication
- The rain forest is very good at recycling P, except when we cut it down…

element	Main nonliving reservoir	Main living reservoir	Other nonliving reservoir	Human-induced problem
Carbon C	Atmo CO_2	Carbohydrates $(CH_2O)_n$ And all organic molecules	Hydro Carbonate (CO_3^{-2}) Bicarbonate (HCO_3^-) Litho minerals	Global warming Carbon from fossil fuels underground are burned and released into the air as CO_2
Nitrogen N	Atmo N_2	Proteins and other N-containing organic molecules	Hydro Ammonium NH_4^+ Nitrate NO_3^- Nitrite NO_2^-	Eutrophication Fertilizers contain human-made nitrates that end up in the water
Phos-phorous P	Litho rocks as PO_4^{-3} *no gas phase	DNA ATP phospholipids	Hydro Phosphate PO_4^{-3}	Eutrophication Fertilizers contain human-made phosphates that end up in the water Cutting down rainforest stops recycling of P

Population and Succession

- Top 6 most abundant elements in living things (not in order)

  * NCHOPS

- Top 8 elements in the earths crust (in order)

* O, Si, Al, Fe (iron), Ca, Na (sodium), P, Mg

Only silly apes in college study past midnight.

BIOSPHERE II (REMEMBER ECOCOLUMNS)

Purpose: recreate conditions of Earth (Biosphere I)

* to understand our world better
* space travel

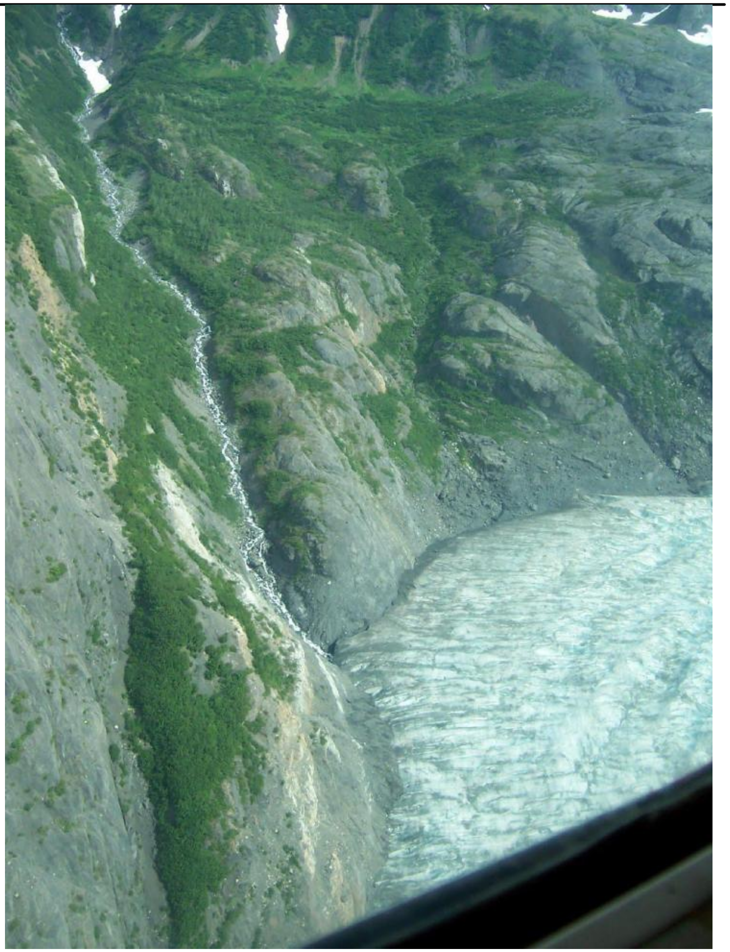
- 5 acres in Arizona, 4000 species, 10 humans
  * problem: 0_2 + CO_2 were absorbed by concrete
  * ants and cockroaches took over

Fires in Ecosystem

- Maintain balance of species and energy in ecosystems over the long run.
- Beneficial b/c provide nutrients for soil
- We avoid natural fires, but the problems like Crown Fires- (not natural) kill the whole tree
- 1988 Yellowstone fires changed climax ecosystems of white bark pine trees to huckle berries. Grizzlies eat both

Succession - One species gradually replaced by another in an ecosystem

- Primary – new ecosystem where there were no living things before. Cooled lava, receded glacier, mud slide
- Secondary- ecosystem used to be there. Fire, humans clear an area
- Aquatic – lakes taken over by terrestrial ecosystem
- Climax ecosystem- in balance only changes if major interference



Primary succession

- Must create new soil for plants to grow
- The first plants to come in are called pioneer species
- Lichen
- Moss
- Microbes

Main Topics

1. Energy flow and the biomass pyramid figs 3-13 and 3-21
2. Population dynamics fig 4-2, 4-3
3. Biotic potential vs environmental resistance fig 4-4
4. Population equilibrium and balanced herbivory figs 4-5, 4-15
5. Introduced species effects on ecosystems fig 4-6, 4-7

Evolutionary Change

Vocabulary that you need to know

* DNA
* Chromosome
* Gene
* allele

Central Dogma:

DNA- blueprint
RNA- carpenter
Protein- house, wood

MUTATIONS

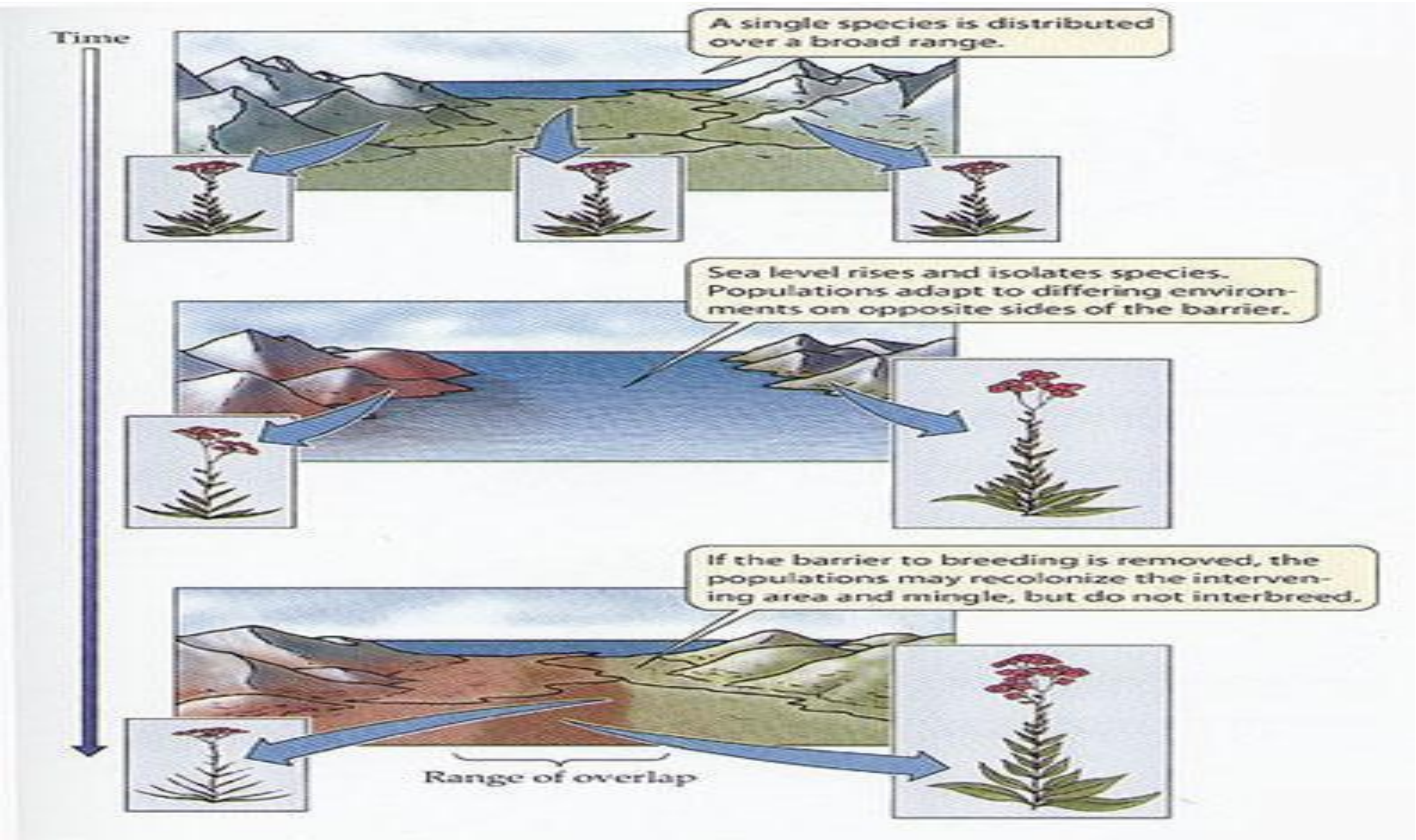
- Mutations are naturally random events
  * Normal variation
  * Chemical
  * UV
  * Radiation
- Genetic Trait- only passed down if an organism reproduces

Why do species change?

- Environmental resistance and biotic potential
- Selective pressure on mutations
- Speciation

  * creation of a new species based on reproductive isolation

Speciation (Galapagos Finches)



Geological Context (space and time for evolution)

- Plate tectonics
- Geological time scale (fig. 5-21)
- Cambrian explosion
- Selective breeding
- Artificial selection
- Natural selection

The Human Population

Chapter 6

- World population trends
- Calculations
- Demographic transition
- Age structure diagrams
- Developed vs. developing countries

Chapter 7

- Fertility rates
- World bank
- 1994 UN conference in Cairo- program of action

[redacted]

(b) crude birth rate= number birth per 1000 individuals

(d) crude death rate= number death per 1000 individuals

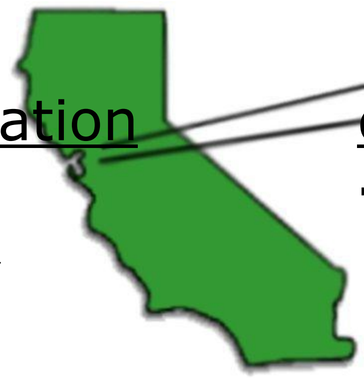
(r) growth rate = natural increase in population expressed as percent per years (If this number is negative, the population is shrinking.)

equation:

rate = birth – death

But other factors affect population growth in a certain area…

POPULATION GROWTH RATES



increase population | decrease population
births ➔ | ➔ deaths
immigration ➔ | ➔ emigration (exit)

r = (birth - death)+ (immigration-emigration)

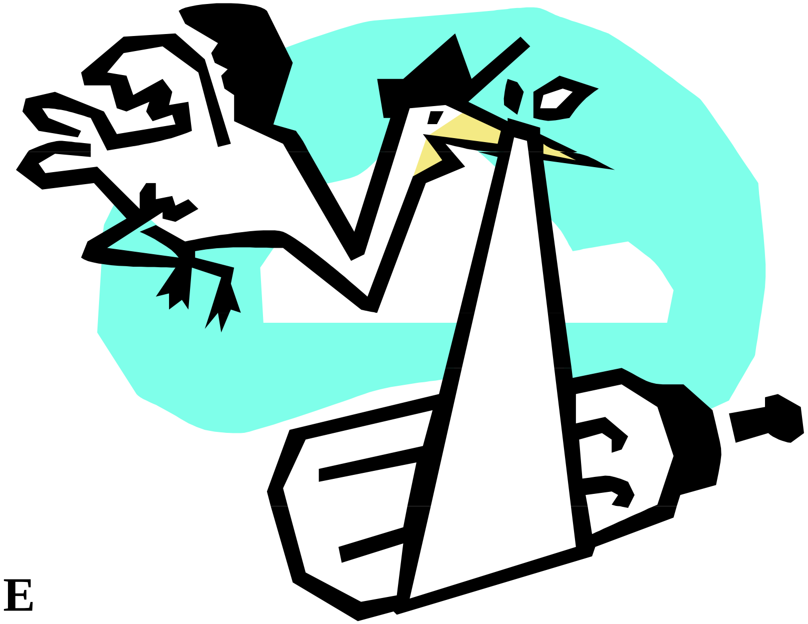
immigration = migration of individuals into a population from another area or country

emigration = migration of individuals from a population bound for another country

r = (birth - death)+ (immigration-emigration)

example: population of 10,000 has
100 births (10 per 1000)
50 deaths (5 per 1000)
10 immigration (1 per 1000)
100 emigration (10 per 1000)

You try.



B **D** **I** **E**

r=(10/1000) – (5/1000) + (1/1000) – (10/1000)

r=(0.01-0.005) + (0.001 – 0.01)

r = 0.005 – 0.009 = -0.004 or –0.4% per year

If the growth rate is 1% and the population size is 10,000, how many years will it take to get to a population of 40,000?

Population doubling:

70/rate =70/1% =70 years to double

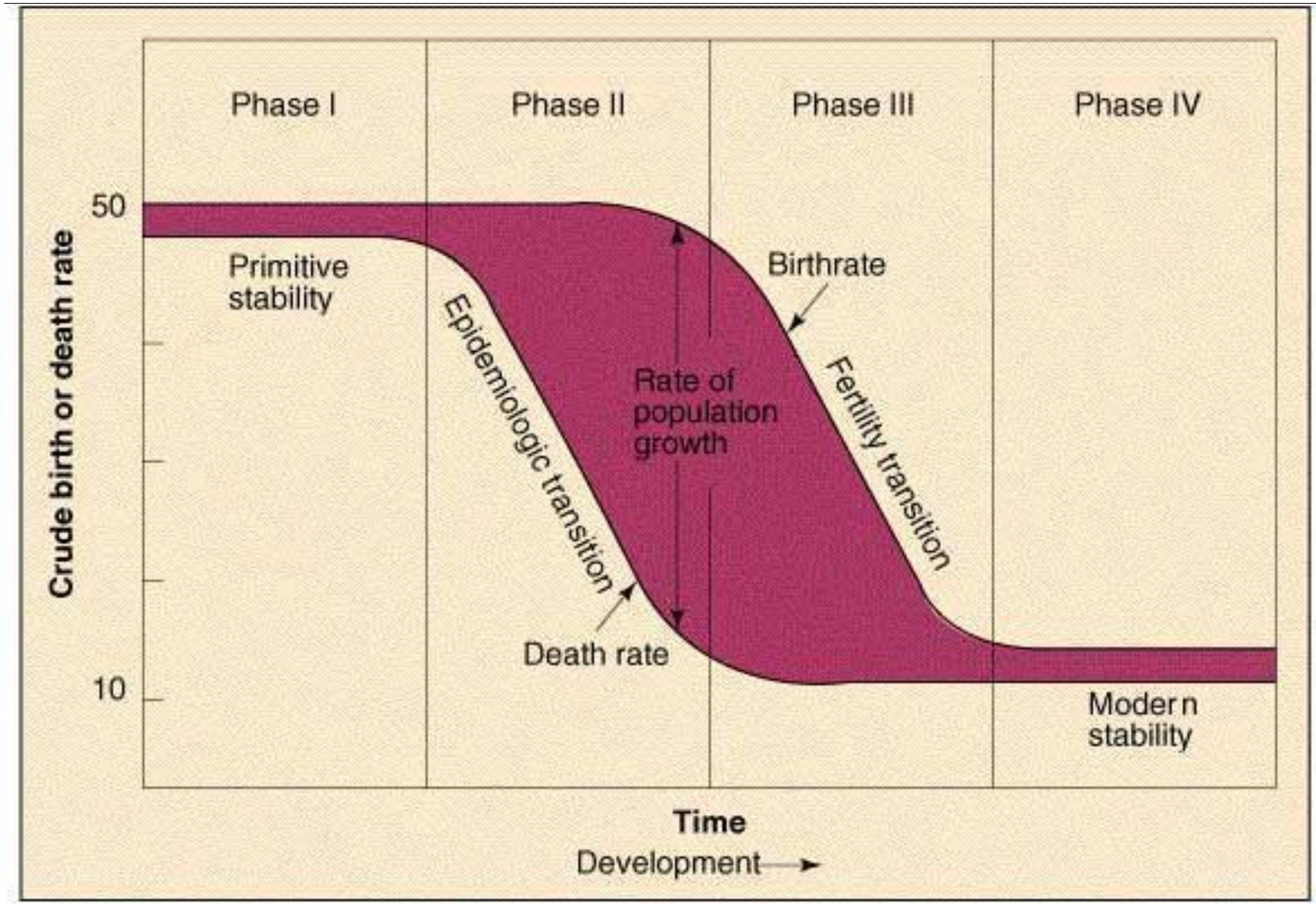
In 70 years the population will be 20,000

1 D.T. □ 20,000

2 D.T. □ 40,000

(70 years)(2) =140 years

In 140 years, the population will be 40,000 people.
SHOW YOUR WORK!!!!!!!!!


Phase I
Phase II
Phase III
Phase IV
50
10
Crude birth or death rate
Primitive stability
Epidemiologic transition
Rate of population growth
Birthrate
Fertility transition
Death rate
Modern stability
Time
Development

Bottom Line= as countries develop, first their death rate drops and then their birth rate drops

Reasons for the phases:

Phase II:
- medical care
  - nutrition (births still high)
  - technology

Phase III:
- birth control
  - education (of women)
  - lower mortality rate of infants
  - less child labor

Developed Countries

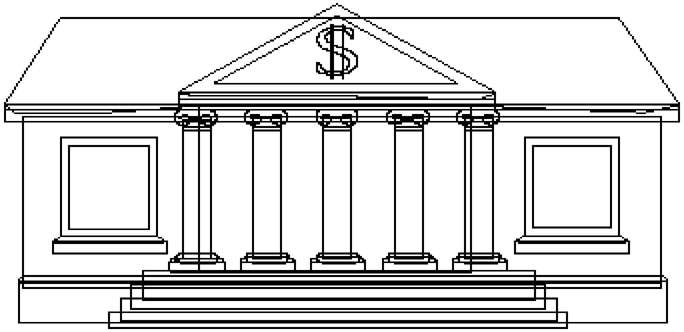
- Canada, U.S., Australia, Western Europe (Denmark)

Developing Countries

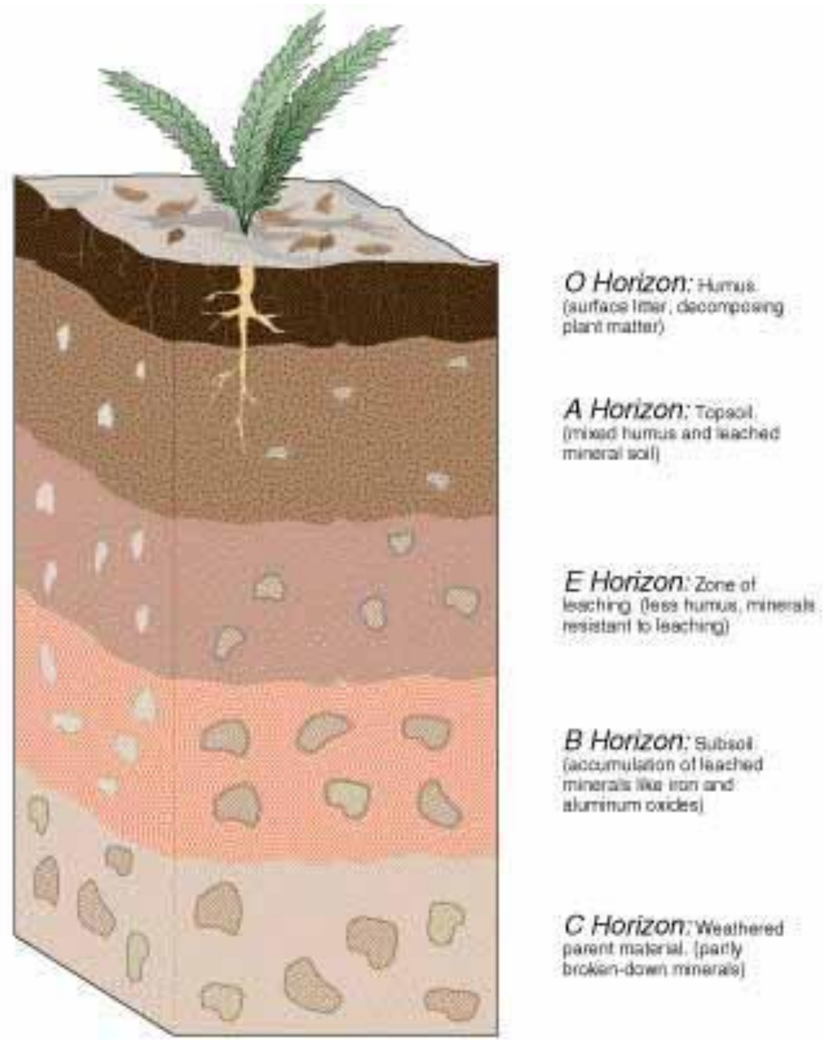
- Latin America, China, Africa (Kenya)
  - 1/5 of the world’s pop. Lives in absolute pove illiterate, lack clean H_2O and don’t have enough food
  - 80% of world’s pop. Lives in developing co. and growing

- Total fertility= avg. # of children born per woman
- For developed countries = 2.1
- For developing countries = 2.6
- Fertility of 2.0= replacement level
    - Under 2.0 = shrinking population
    - Over 2.0 = growing pop.
- For developed countries = 2.1
- For developing countries = 2.6(or higher)

- Special agency of the United Nations
- Receives $$ from developed co. and loans $$ to developing co.
    - Sometimes this backfires by increasing debt
- Oversees all types of issues, not just environmental issues
    - Ex. electricity, roads, new modern technology



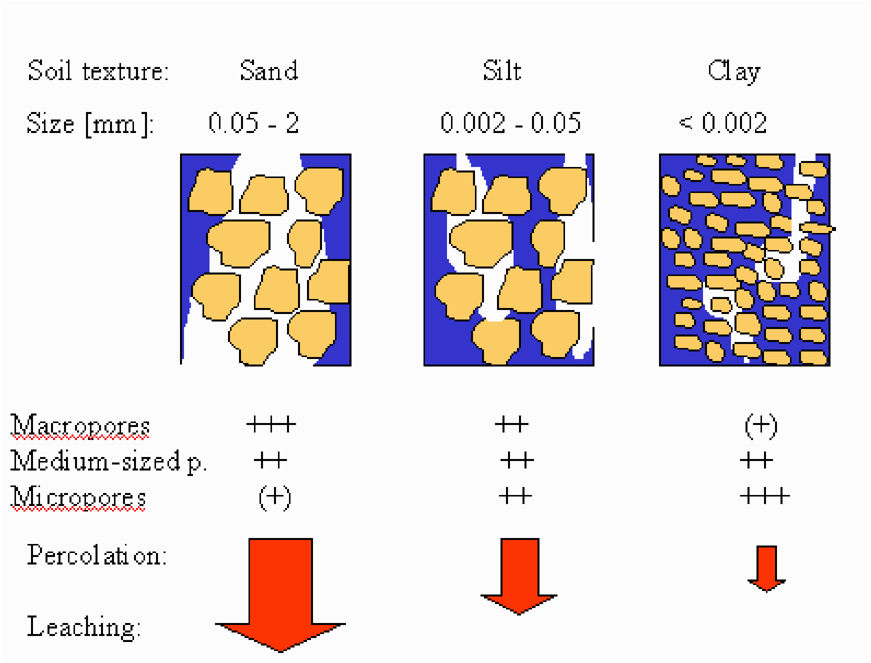
Soil
(Dust Bowl, Porosity and Permeability Lab)



Texture

- Sand 2.0-.02 mm
- Silt .02-.002 mm
- Clay.002mm ≥

some microscopic



LOAM: 40%SAND 40% SILT 20% CLAY

LOAM IS THEORETICALLY THE IDEAL SOIL

CLASSES OF SOIL

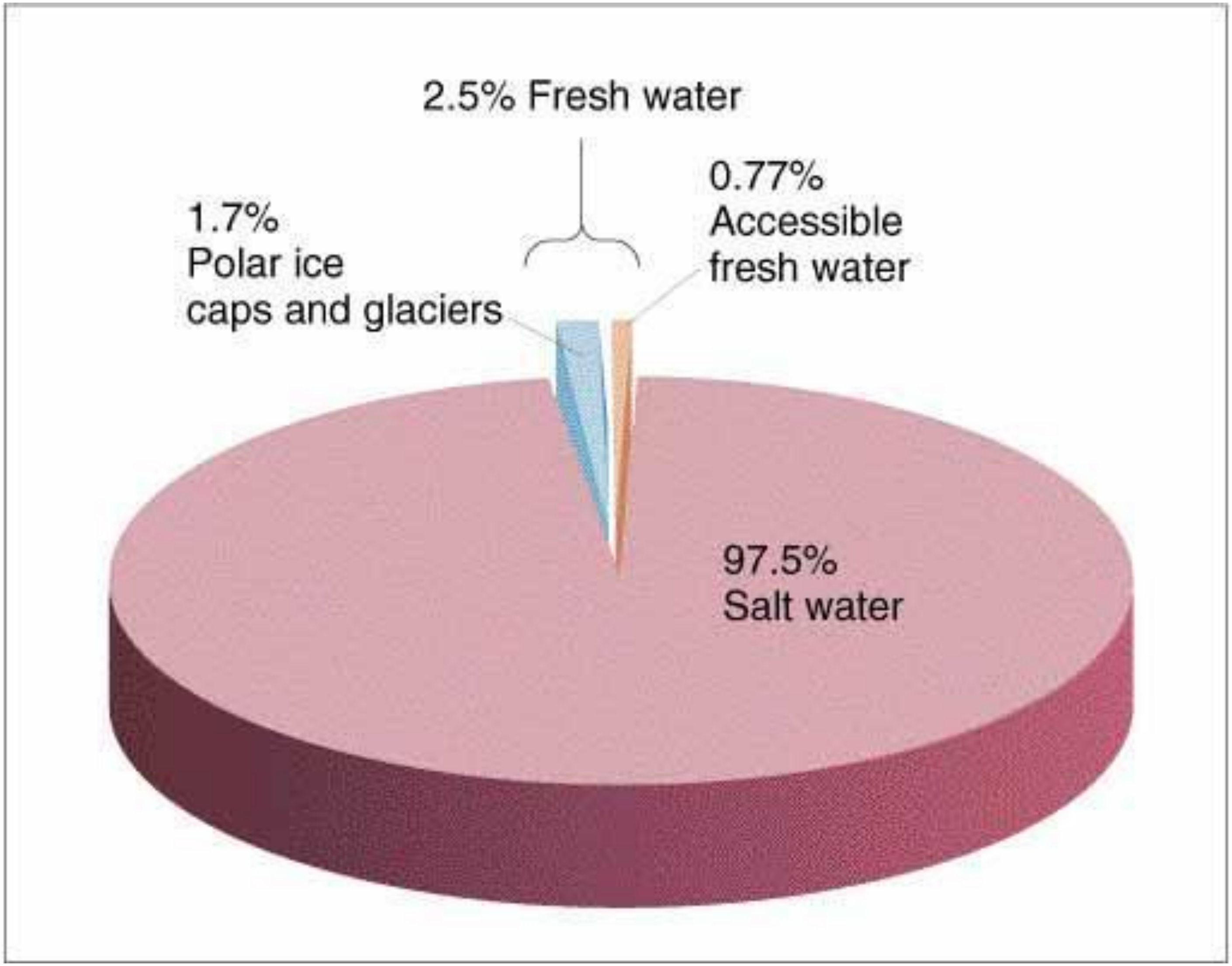
Mollisols- very fertile, dark, found in temperate grasslands, best agricultural soil, Deep A horizon

Oxisols- soil of tropical and subtropical rainforest layer of iron and Al oxides in B horizon, little O horizon

Alfisols- weathered forest soil, not deep, but developed OAE+B typical of most temperate forest biome. Need fertilizer for agriculture

Aridsols- dry lands + desert, lack of vegetation, lack of rain → unstructured vertically, irrigation leads to salinization b/c of high evaporation.

Water



- Figure 9-1 Earth’s water supply

Water Facts

- The primary use for fresh water in U.S. is for agriculture.
- In our homes, we use the most fresh water to wash, clean and flush.
- The typical person in an industrialized nation uses 700-1000 gallons per week!

HUMAN EFFECTS ON THE HYDROLOGIC CYCLE

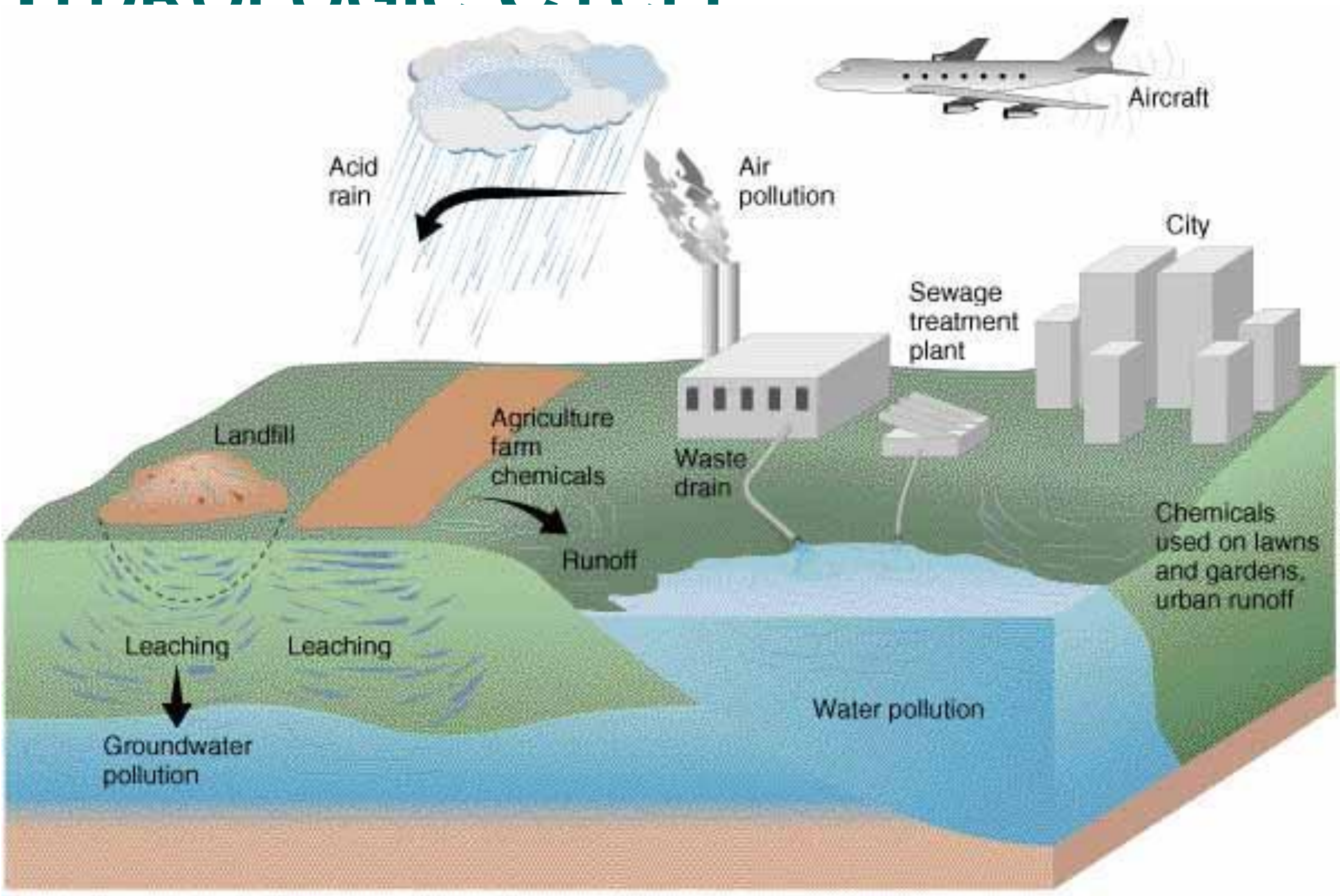
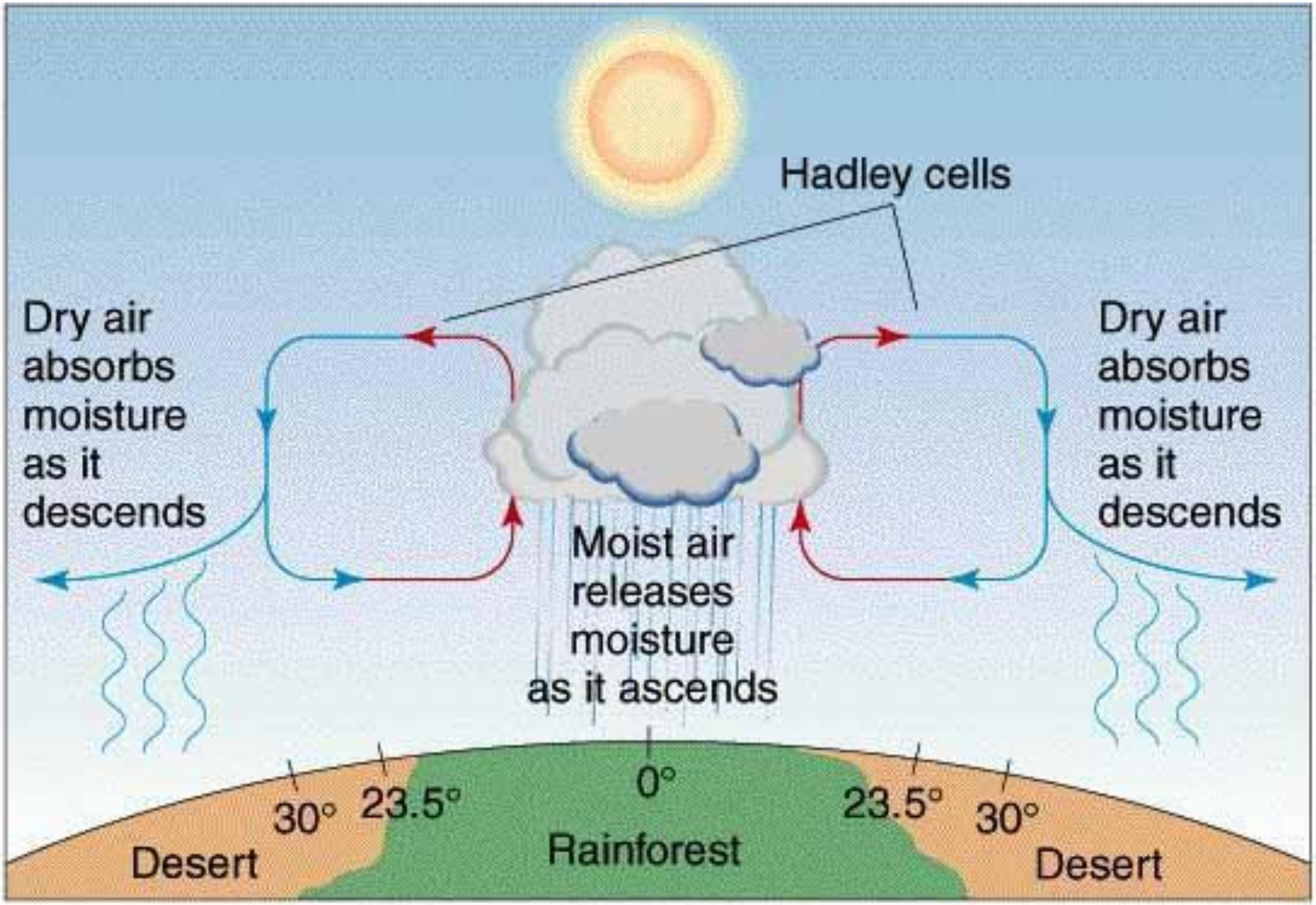


Figure 9-3 The Hydrologic cycle



(a) Hadley cells at the equator

- Figure 9-5a Global air circulation

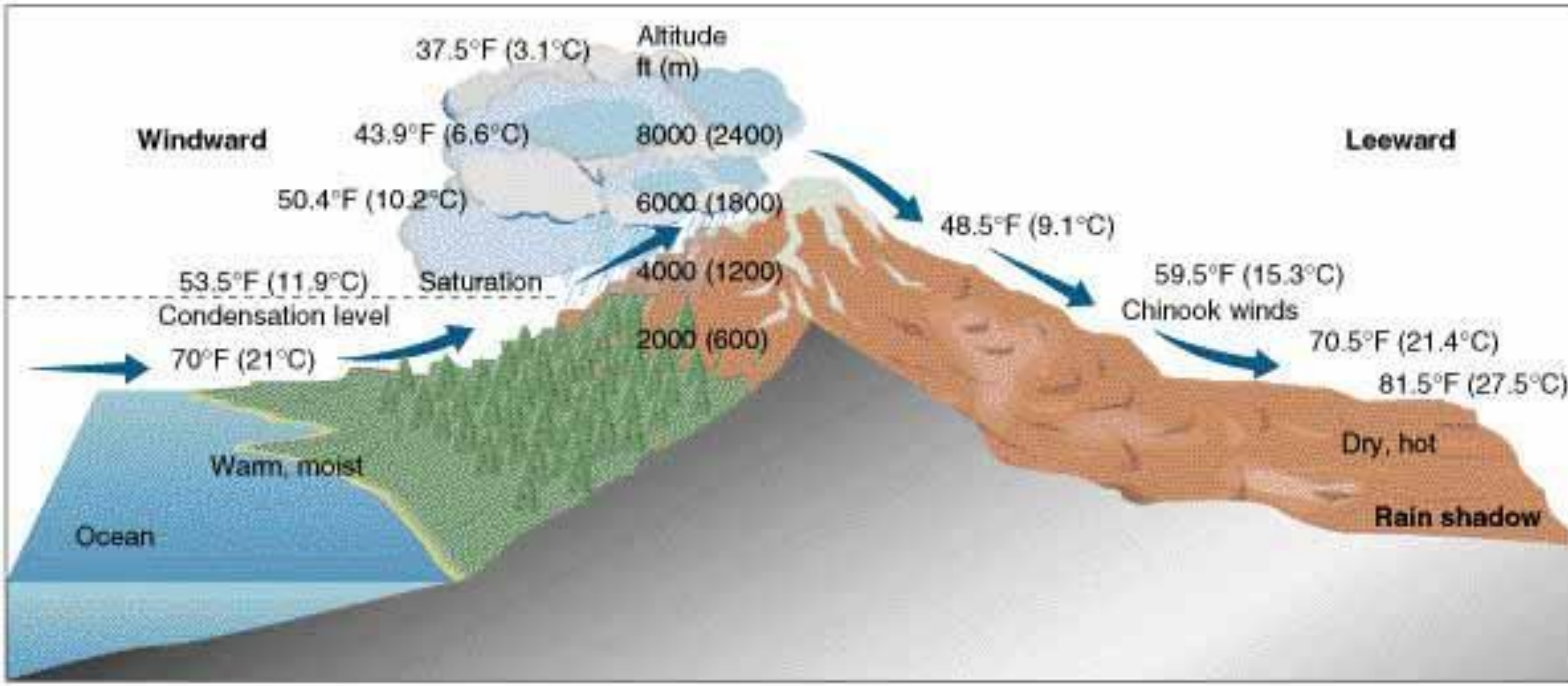


Figure 9-6 Rain shadow

THE OGALLALA AQUIFER

Figure 9-16 Exploitation of an aquifer

Mono Lake

- Excellent example of human interference with the water supply.
- The water in the lake was diverted from the lake to the city of Los Angeles. It became a salt bed.
- ↑ Salt concentration due to evaporation

Three Gorges Dam in China

- China needs to meet the growing demand for energy
- Huge environmental impact
- Hundreds of thousands of people will be displaced (not to mention the ecosystems which will be flooded)

Food

Genetically altered food, Irish Potato Famine

Air

- Greenhouse gas emissions from fossil fuels
- Other air pollutants from fossil fuels
- Pollutions from pesticide sprays

Soil

- Erosion
- Loss of fertility
- Salinization
- Waterlogging
- Desertification

Water

- Aquifer depletion
- Increased runoff and flooding from land cleared to grow crops
- Fish kills from pesticide runoff
- Surface and groundwater pollution from pesticides and fertilizers
- Over fertilization of lakes >> eutrophication

Major Environmental Effects of Food Production

Biodiversity Loss

- Loss and degradation of habitat from clearing grasslands and forests and draining wetlands
- Fish kills from pesticide runoff
- Killing of wild predators to protect live stock
- Loss of genetic diversity from replacing thousands of wild crop strains with a few monoculture strains

Human Health

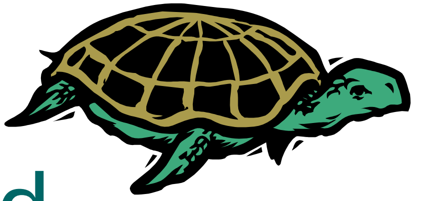
- Nitrates in drinking water
- Pesticide residues in drinking water, food, and air
- Contamination of drinking and swimming water with disease organisms from livestock wastes

The Green Revolution

- To eliminate hunger by improving crop performance
- Movement to increase yields by using:
  - New crop cultivars
  - Irrigation
  - Fertilizers
  - Pesticides
  - Mechanization

Results:

- Did not eliminate famine
- Population still increasing
- Increase cost of production
- An increased negative environmental impact
- Didn’t work for everyone



Protection of Biodiversity and Ecosystems

- <u>Threatened</u> – if the trend continues, the species will be endangered.
- <u>Endangered</u> – if the trend continues, the species will go extinct.
- Pharmaceuticals and native plants → Approximately 25% of drugs used as medicines come from natural plant sources.
- The Exxon Valdez Oil Spill (1989) → 300,000 birds died as a result of that particular oil spill. The area, Prince William Sound, is still recovering.

Know Specific Details about…

These Endangered animals (and check Barron's examples):

- Whooping Crane- Eggs raised by sandhill cranes led to problems, but the efforts proved successful overall.
- Peregrine Falcon- DDT
- Spotted Owl- deforestation
- Fish living in George's Bank (off New England)-The marketable fish were over fished and other species took over. An example of poor management of fisheries.

Endocrine Disrupters

- Interfere with normal hormone action
- Can interfere with development
- Are often connected to cancer
- Can interfere with sexual activity (alligators)
- Are found in plastics and some pesticides

Fossil Fuels Exxon Valdez

Coal-several (400) hundred years

Natural Gas – at least a 50 year supply in the United States

Oil- about a decade until supplies peak

IMPORTANT ENERGY FACTS

- Brief history of energy
    - 1700-1800 Fire wood
    - 1900-1920 Coal
    - 1950- now crude oil
- "production of crude oil" = with drawing it from reserves
- OPEC (pg 319) organization of petroleum exporting countries (Mid-east countries mainly)

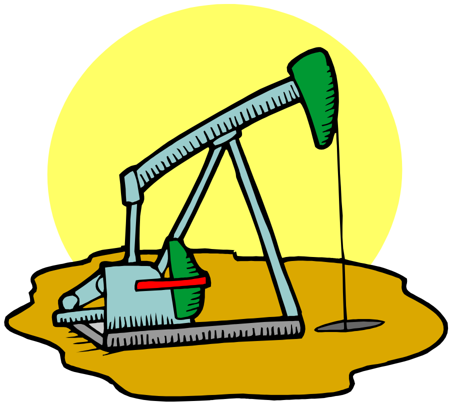
More Energy Facts

- We get 50% of our crude oil from foreign sources
- Alaska pipeline built to help increase production of domestic crude oil
- Types of coal:
- Peat (not coal) → Lignite (brown coal) → Bituminous coal (soft coal with high sulfur) → Anthracite (hard coal with low sulfur)

OIL: THE MOST IMPORTANT FOSSIL FUEL IN THE AMERICAN ECONOMY

Environmental Consequences

1. Production: local ecosystems damage possible
2. Transport: oil spills cause local and regional ecosystem damage
3. Use: photochemical smog, particulates, acid precipitation, carbon dioxide



Coal

- Environmental Consequences

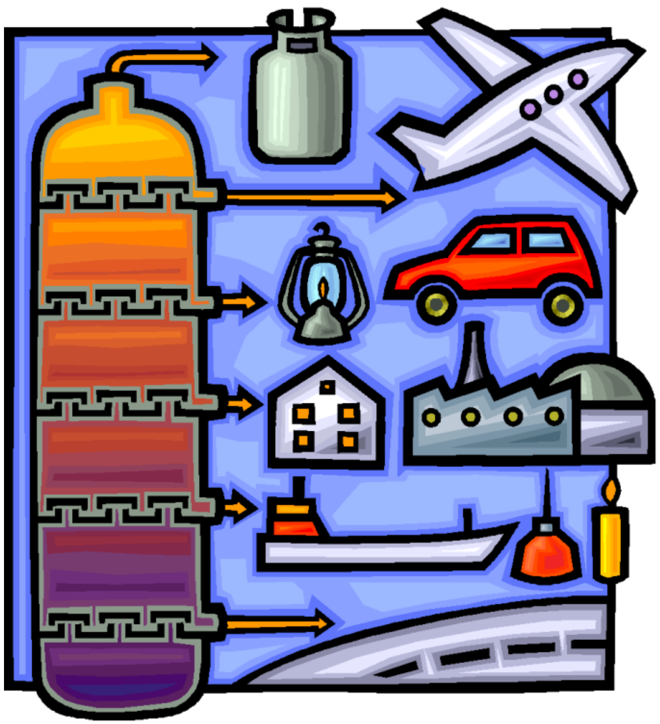
1. Production: ecosystem damage, reclamation difficult, acid mine runoff, mine tailings, erosion, black lung, radon
2. Transport: energy intensive because of weight and number of train cars needed
3. Use: fossil fuel with largest source of carbon dioxide and greatest quantity of contaminants, large volume of waste, acid precipitation

Natural Gas

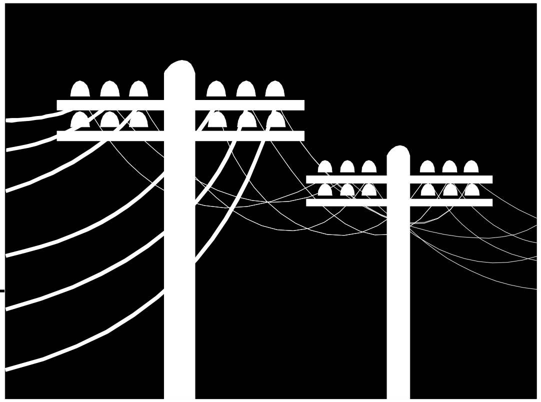
Possibly a transition fuel between fossil fuel and alternative energy sources.

- Environmental Consequences:

1. Production: local ecosystem damage possible if oil or coal is part of the deposit
2. Transport: can be explosive
3. Use: produces the least air pollutants of all the fossil fuels



ELECTRICITY



- Electricity is a secondary energy source because it relies on another energy source to create the electricity.
- Basic production of electricity-boil water to produce steam to turn turbines to generate electron flow through a wire.
- Examples of primary sources for electrical production
- 20% from nuclear
- 57% from coal
- Oil, geothermal, solar, wind, hydroelectric (no boiling water required for these sources)

Is electricity a clean energy source?

Nuclear Power

A. Pros: No CO_2 emissions, no particulate emissions

B. Cons: Radiation can lead to damaged DNA, costs, radioactive waste, thermal pollution

C. Basically- the splitting of uranium's nucleus gives off heat that can be used to boil water and turn a turbo generator to create electricity.

D. Naturally occurring Uranium is mined.

NUCLEAR IMPORTANT FACTS

- Fusion- the combination of 2 atoms to form a larger atom
- Fission- splitting an atom
- Nuclear Regulatory Commission is the US governmental Agency that regulates nuclear power plants
- Radioisotope= unstable radioactive isotope

Uranium

- Uranium 235 has 92 protons and 143 neutrons. It is radioactive and used as fuel in nuclear reactors.
- When U235 is hit by a neutron, it is split (fission) into two smaller elements such as Kr and Ba plus three neutrons which sustain the chain reaction.
- Most (99.3%) of the naturally occurring uranium is U238.
- For a nuclear reactor, this must be purified to 4% U235 and 96% U238. (very expensive)

D. How does a Power Plant Operate?

a. Water moderator: slows down neutrons

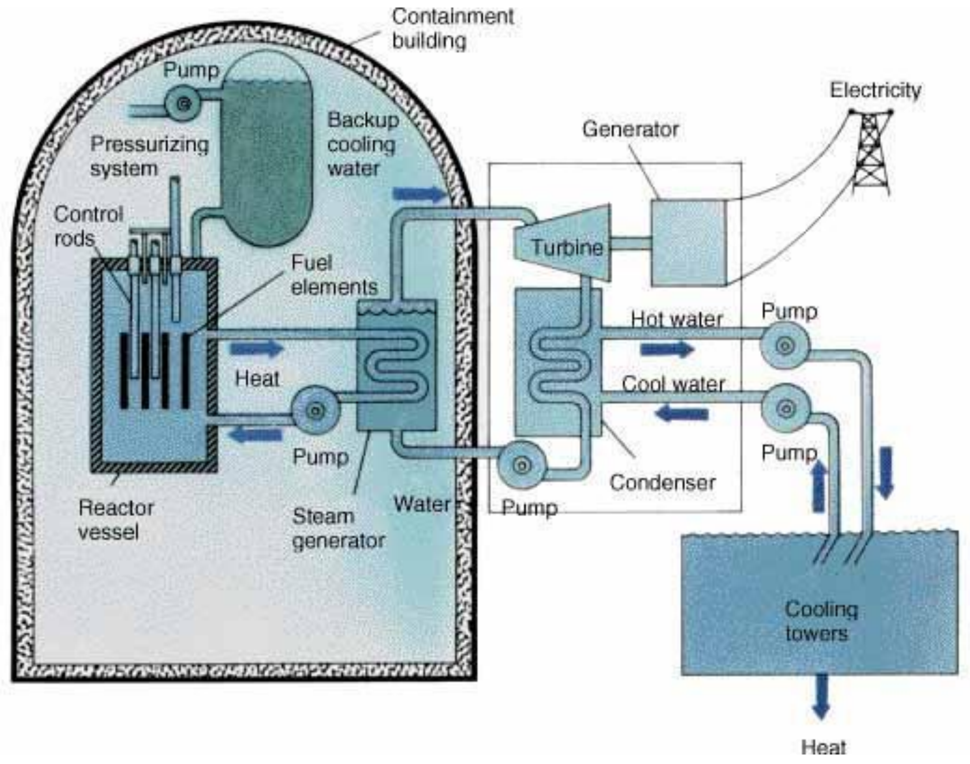
b. Neutron-absorbing material- control rod

c. Fuel Rods- approximately one third replaced each year

d. Heat transfer system

e. Cooling system

f. Redundant safety systems

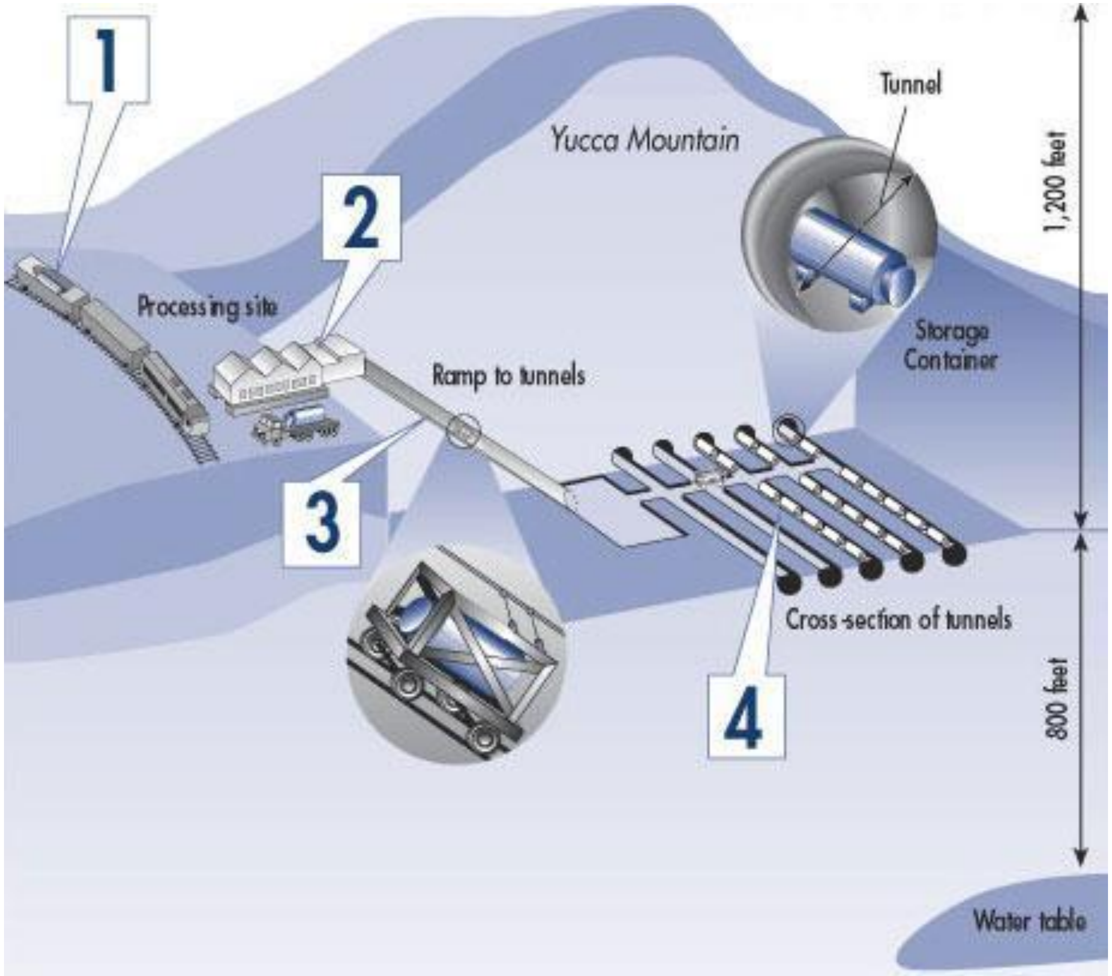


Waste Disposal

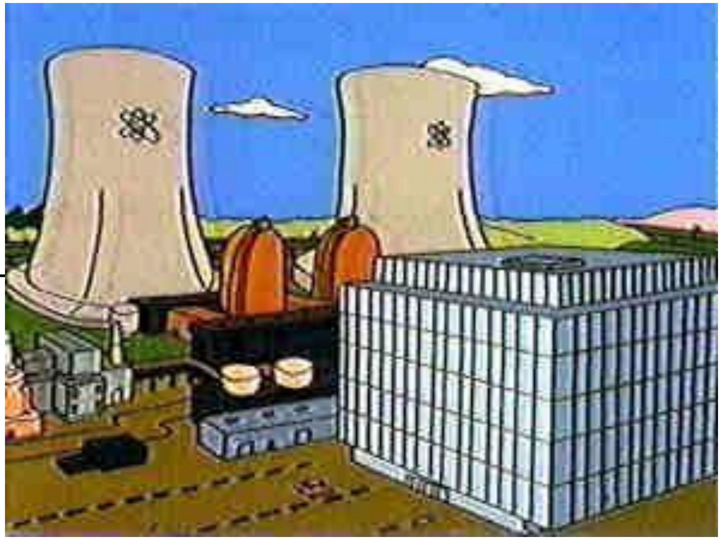
All fuel rods are still in cooling ponds at commercial nuclear facilities

Proposed site for disposal - Yucca Mountain in SE Nevada

Concerns: Geological active area, Intrusion of water table, distances for wastes travel, radioactive decay and half-lives



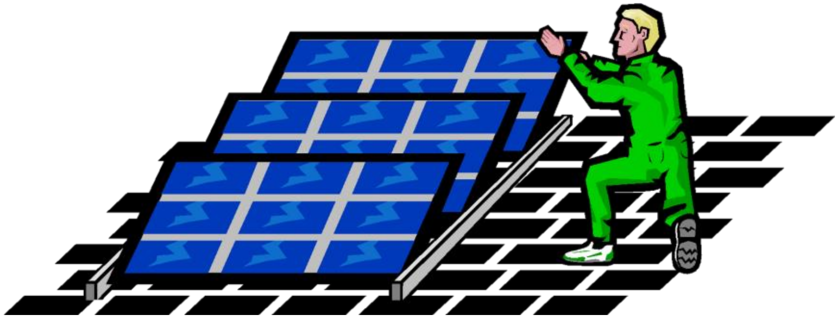
ACCIDENTS

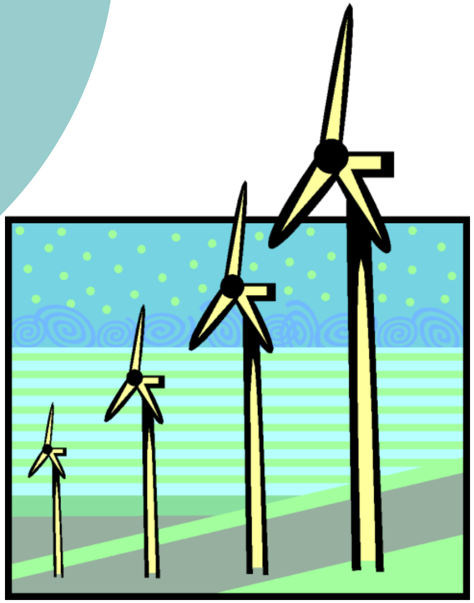


- Chernobyl:
  - 4/26/86
  - Ukraine
  - complete meltdown.
- Three Mile Island:
  - 3/28/79
  - Pennsylvania (Harrisburg)
  - partial meltdown, no one known to be hurt.

Renewable Energy

- Sunlight, wind, falling H_2O, geothermal
- Not fossil fuels, not nuclear





Indirect Solar power

- How does it affect…
- Wind?
- Hydropower?
- Firewood?
- Hydro carbon fuels?
- Nuclear and Geothermal are not indirect solar

SOLAR ENERGY

Passive solar

- Large south-facing windows, heavy drapes to trap heat at night, interior bricks to trap heat
- Shade windows in summer
- Even though back up systems are required, and solar heating may only lessen the need for heating oil a few %, it will help us adapt to diminishing oil supplies.

Active solar

- Photovoltaic (PV) panels can be used to convert the energy from the sun into electricity.
- Electrons from the silicon in the PV panel are “pushed” through a wire by photons from the sun creating an electric current.

Risks, Toxicology and Pests Borneo (DDT), MTBE

Hazard - Anything that causes:

- Injury, disease, or death to humans
- Damage to property
- Destruction of the environment

Cultural hazard - a risk that a person chooses to engage in

Risk

The probability of suffering (1, 2, or 3) as a result of a hazard

Perception

What people think the risks are

Cigarette Smoking

- Leading cause of cancer in U.S.
- Can cause cancer, lung disease, a bigger risk of death in addition with other types of air pollution.
- Highest health risk in U.S.

INSECTICIDES/PESTICIDES

- Integrated pest management includes:
  - adjusting environmental conditions
  - chemical pesticides
  - disease resistant varieties
  - crop rotation
  - biological controls
- Insecticides kills plants, mammals, fish, birds
- A broad spectrum pesticide is effective towards many types of pests

- DDT accumulates in fat body tissues of animals
- DDT was not used for handling weeds
- DDT is, persistent, synthetic organic compound and a subject to biomagnifications in food chains

Diseases

- Lyme disease can be processed to humans through a bite from an infected tick
- Mosquitoes causes Malaria, the vector for Plasmodium
- The protozoan of the genus Plasmodium is the causative agent of malaria

Diseases cont’d

- Lack of access to safe drinking water is a major cause of disease transmission in developing countries.
- Epidemiology is the study of the presence, distribution and control of a diseases in a population
- <u>Morbidity</u> is the incidence of disease in a population
- <u>Mortality</u> is the incidence of death in a population

Water Pollution

- Sewage treatment is a common practice
- In the 1970's many cities were still dumping raw sewage into waterways
- In 1972, the Clean water act provided funding for upgrading sewage treatment plants
- Currently water ways are the much better
- 1°, 2° use preliminary but no more
- Test for sewage contamination in drinking H2O → Fecal Coliform test

Sewage Treatment

- Raw sewage (99% H2O)
- Preliminary Treatment- allow grit to settle
- 1° separating Raw Sludge from H2O
- 2° AKA Biological Treatment- bacteria feeds on the organic materi
- Trickling filters contain bacteria → remove raw sludge from the H2O

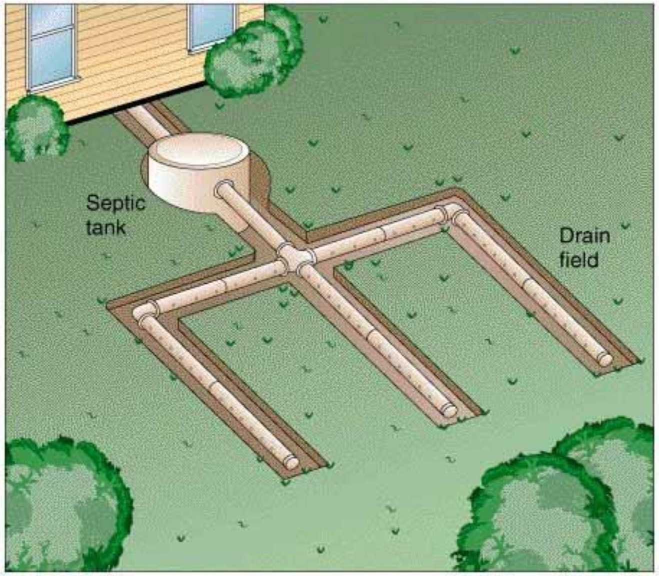
- Raw Sludge <u>May</u> contain heavy metals

  If it does it needs 3° treatment, to remove the toxic chemicals

Home Septic Systems:

→do not use Chlorine

- Do use settling tank to settle organic solids
- Lets waste water percolate into the soil bacterial decomposition



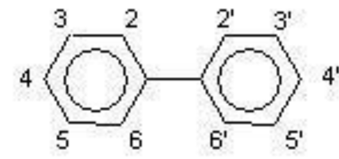
Solid Waste

- 210,000,000 tons of municipal solid waste (MSW) are disposed of annually in the United States.
- Most of that waste is paper.
- Fifty-five percent of MSW is disposed of in landfills.
- 17% of MSW is combusted, mostly in waste-to-energy (WTE) combustion facilities. What are the advantages and disadvantages of WTE combustion?
- The best solution to solid waste problems is to reduce waste at its source.
- More than 75% of MSW is recyclable. What role is recycling playing in waste management, and how is recycling best promoted?
- Much more can be done to move MSW management in a more sustainable direction. What are some recommendations to improve MSW management?

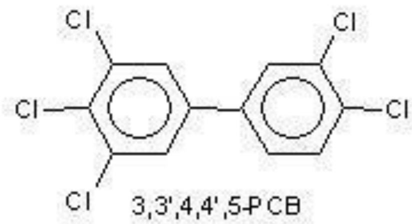
HAZARDOUS WASTE

Halogenated hydrocarbons

- Organic compounds with a halogen (bromine, iodine, ect.) replacing a hydrogen
- Used as pesticides
- Used to make plastic
- Resistant to biodegradation



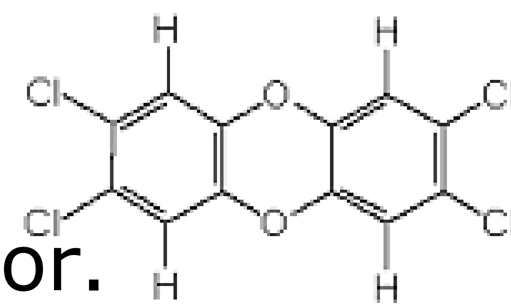
Biphenyl



3,3',4,4',5-PCB

Chlorinated hydrocarbons

- **Chlorinated hydrocarbons**
- Are synthetic organic compounds
- **Dioxin**
- Mainly caused by burning PVC pipe (medical waste)
- Linked to cancer.
- Also an endocrine disruptor.



2,3,7,8-TCDD

Love Canal, NY

- The government allowed housing to be build over the toxic waste dump and people got sick
- Problem first discovered in 1978
- First national emergency in the US because of toxic waste
- Led to the superfund legislation.

Superfund sites:

- $ comes from taxes on chemical industries
- 50% of the $ spent on legal costs

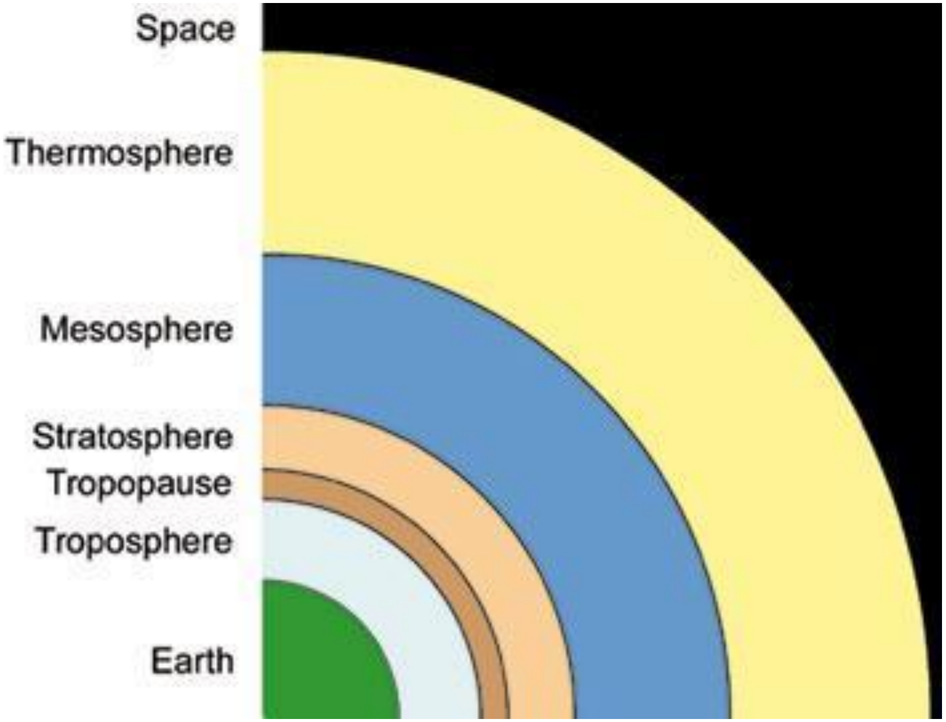
Layers of the Atmosphere

- Troposphere

  ---------Tropopaus
- Stratosphere

Stratopause
- Mesosphere

  --------- Mesopaus
- Thermosphere



Composition of the troposphere

- 78% N_2
- 20% O_2
- Less than 2%
- H_2O vapor (.01%-4%)
- Argon gas (1%)
- CO_2 (0.04%)
- Trace gases

Global warming

The greenhouse effect is natural and important to deep the earth warm enough for life to exist

- Global warming occurs when humans contribute too much of these greenhouse gases leading to a small (1-3 degree C) but significant rise in the global average temperature.
- Analogy – Car on a sunny day

Ozone (O_3)

Tropospheric ozone is BAD

- If we breath it, it causes lung damage
- It is also a greenhouse gas

Stratospheric ozone is GOOD

- It shields us from the harmful UVB rays of the sun.
- Ozone depletion is the thinning of the stratospheric ozone shield (mostly over the South Pole, Australia story)
- Analogy – Stratospheric O_3 is like sunscreen for the earth.

AIR POLLUTION

- Expensive: health care costs, human lives
- -acute
  - Chronic
  - Carcinogenic
- Damages buildings, bridges, statues, books
- Aesthetics
- Damage to Plants
  - Agriculture – crops loss ~$5 billion/year
  - Forests

Acids and Bases

pH-log of hydrogen ions in a solution. Therefore each number higher on the pH scale is 10X more basic

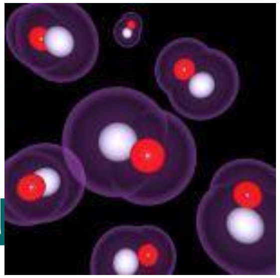
- Basic- OH- (hydroxyl ions) over 7 on the pH scale
- Acidic-H+ ions under 7 on the pH scale
- Neutral- pure water is 7 on the pH scale
- Normal rain is slightly acidic-pH 6.4
- Acid rain is defined as less than a pH of 5.5

INDOOR AIR POLLUTANTS

1. Types: benzene, formaldehyde, radon, cigarette smoke

- 2. Sources: off gassing from furniture, rugs and building materials, dry cleaning, cleaning fluids, disinfectants, pesticides, heaters
- 3. Buildings with too many indoor air pollutants are called “sick buildings” because more than 20% of the people are sick due to occupying the building.

Major Outdoor Air Pollutan



- Primary – direct products of combustion and evaporation
- Secondary – when primary pollutants undergo further reactions in atmosphere

1. Suspended particulate matter (primary)
2. Volatile Organic Compounds (secondary)
3. Carbon Monoxide (primary)
4. Nitrogen Oxides (can be both)
5. Sulfur Oxides(primary from combustion of coal)
6. Ozone and other photochemical oxidants (secondary)

SOURCES OF AIR POLLUTION

- Natural:

a. Sulfur: Volcanoes, sea spray, microbial

b. Nitrogen oxides: lightening, forest fires, microbial

- Anthropogenic (human caused)

a. Sulfur oxides: coal burning plants, industry, fossil fuels.

b. Nitrogen oxides: power plants, industrial fuel combustion, transportation

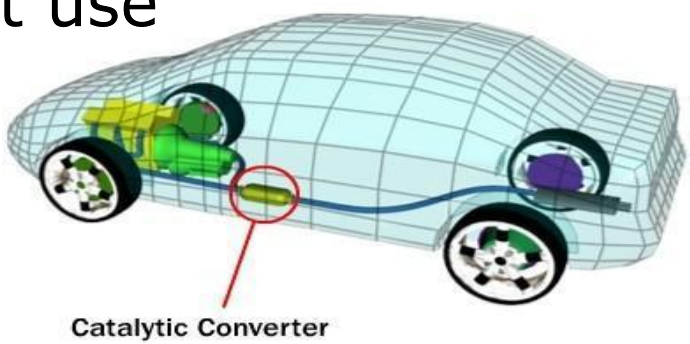
c. Effect areas hundreds of miles from the source of emissions, generally not the whole globe

Solutions: Reducing Emissions

Best way = Conservation, just use less!

Input Control

a. Cleaner burning gasoline
b. increased fuel efficiency
c. alternative modes of transportation
d. decrease the number of miles driven
e. changes in land use decisions
f. catalytic converter



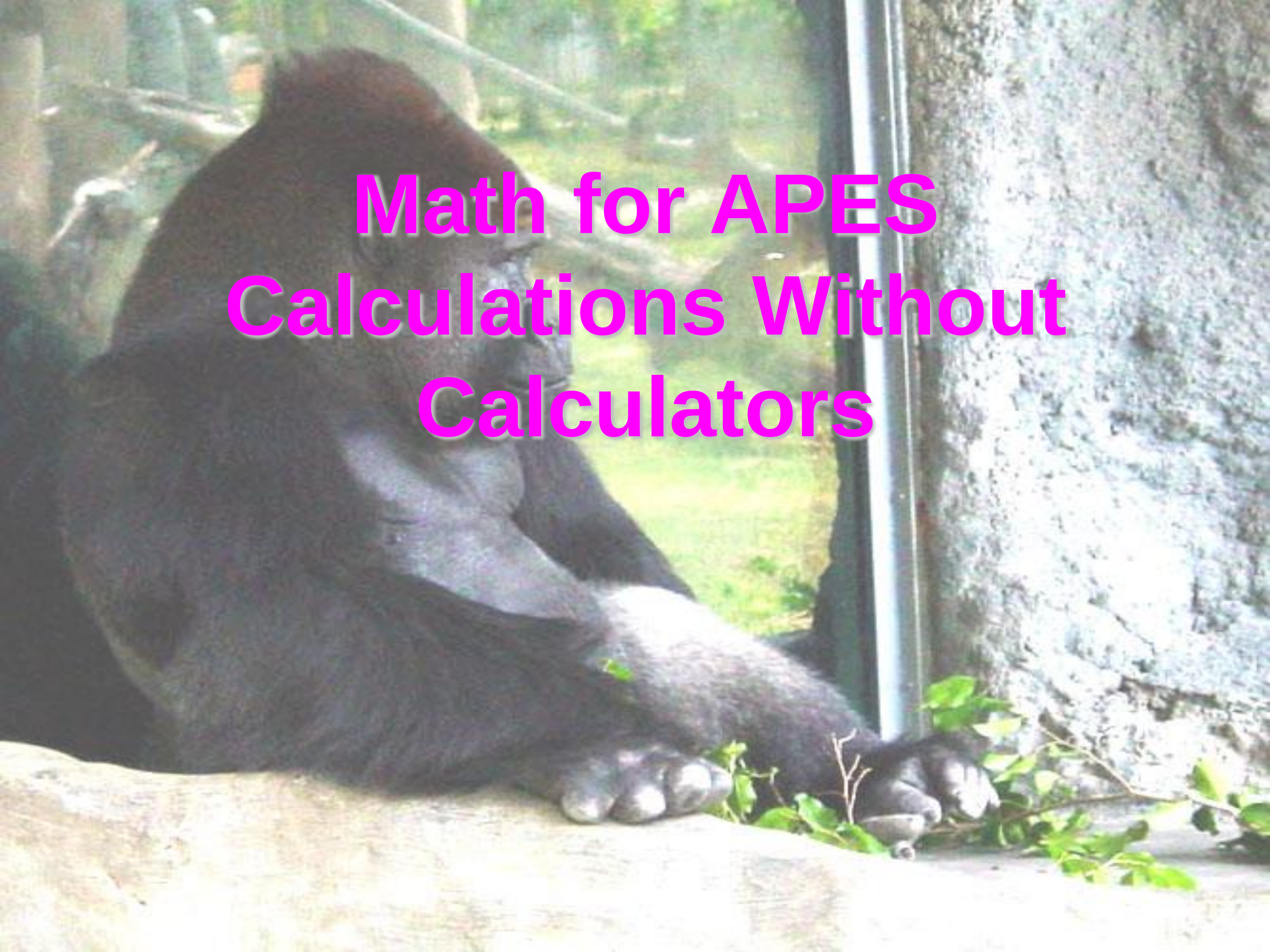
Output Control

A. Scrubbers: exhaust fumes through a spray of H_2O containing lime ($CaCO_3$) $SO_2 \rightarrow CaSO_3$

B. Coal washing to get rid of sulfur

C. Fluidized bed combustion (produces a waste ash that must be disposed of)

Math for APES Calculations Without Calculators



The Problem:

How do we help our students achieve success on AP Environmental Science Exams when they cannot use calculators?

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AP® ADVANCED PLACEMENT PROGRAM®

Solutions:

1. **Teach your students to use exponents whenever numbers are especially large or small.**

Scientific notation **is a way to express, numbers the form of exponents as the product of a number (between 1 and 10) and raised to a power of 10.**

For 650000 use 6.5×10^5

For 0.000543 use 5.43×10^{-4}

In scientific notation remember to have one number to the left of the decimal and to use correct significant figures.

2. Practice math manipulations with exponents

- **When adding or subtracting numbers with exponents the exponents of each number must be the same before you can do the operation.**

Example: $(1.9 \times 10^{-3}) - (1.5 \times 10^{-4}) =$

$(19 \times 10^{-4}) - (1.5 \times 10^{-4}) = 17.5 \times 10^{-4}$

When multiplying numbers with base 10 exponents, multiply the first factors, and then add the exponents.

Example, (3.1 x 105) (4.5 x 10^5) = 13.95×10^{10} or 1.4×10^{11}

When dividing numbers, the exponents are subtracted, numerator exponent minus denominator exponent.

Example: $\frac{9 \times 10^{5}}{3 \times 10^{3}} = 3 \times 10^{2}$

3. Use Dimensional analysis or factor/label method for calculations

The following formula based on the cancellation of units is useful:

$$\text{Given Value} \times \frac{\text{Conversion factor}}{1} = \text{Answer}$$

OR

$$\text{old unit} \times \frac{\text{new unit}}{1 \text{ old unit}} = \text{new unit}$$

Example: Convert 12 km into mm. Report your answer using scientific notation.

$$12 \text{ km} \times \frac{1000\text{m}}{1 \text{ km}} \times \frac{1000 \text{ mm}}{1 \text{ m}} = 12000000\text{mm} = 1.2 \times 10^{7}\text{mm}$$

4. Be sure to know how to convert numbers to percentages and percent change.

Example: If 200 households in a town of 10000 have solar power, what percent does this represent?

200/10000 x 100 = ?

answer = 2.0%

Example: If a city of population 10,000 experiences 100 births, 40 deaths, 10 immigrants, and 30 emigrants in the course of a year, what is its net annual *percentage* growth rate?

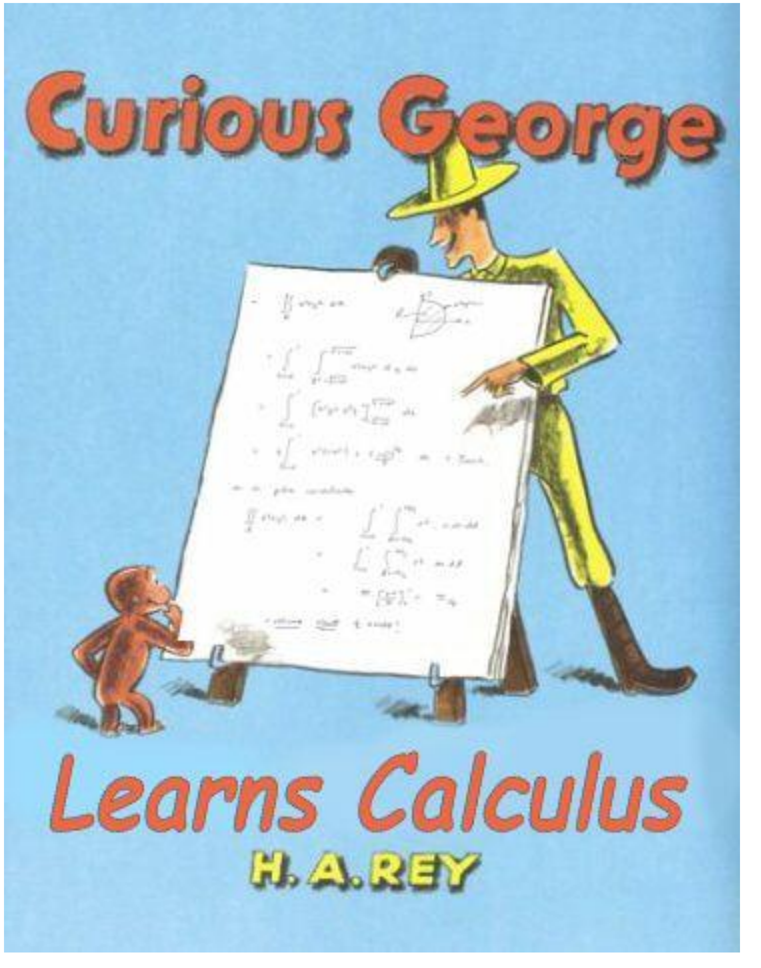
answer = 4.0%

5. Keep it simple. They don't expect you to do calculus without a calculator!

Try reducing the fraction from the previous problem 200/10000 to 20/100= 1/50

Then solve:

1/50 x 100%= 2.0%

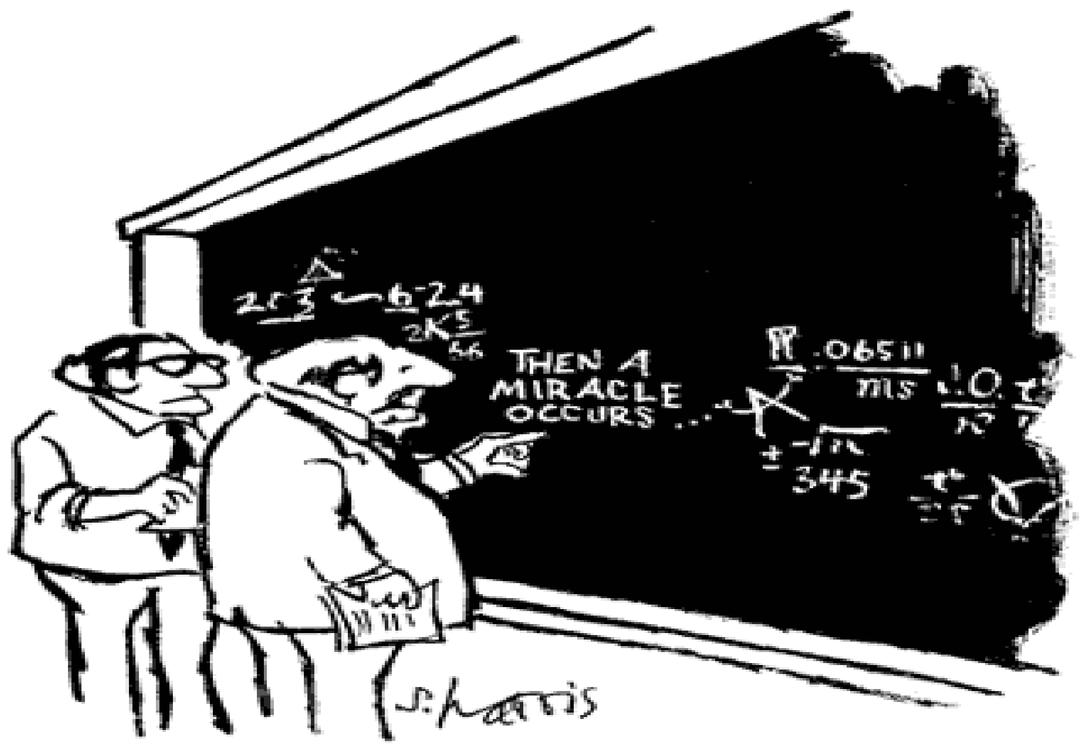


6. Remember that the numbers will likely be simple to manipulate.

- The APES folks know you only have limited time to do 100 multiple choice and 4 essays
- If you are getting answers like 1.365, then it is likely wrong

7. Show ALL of your work and steps of calculations, even if they are so simple you think they are implied.

NO WORK – NO CREDIT !



"I think you should be more explicit here in step two."

8. Show all of your units, too!

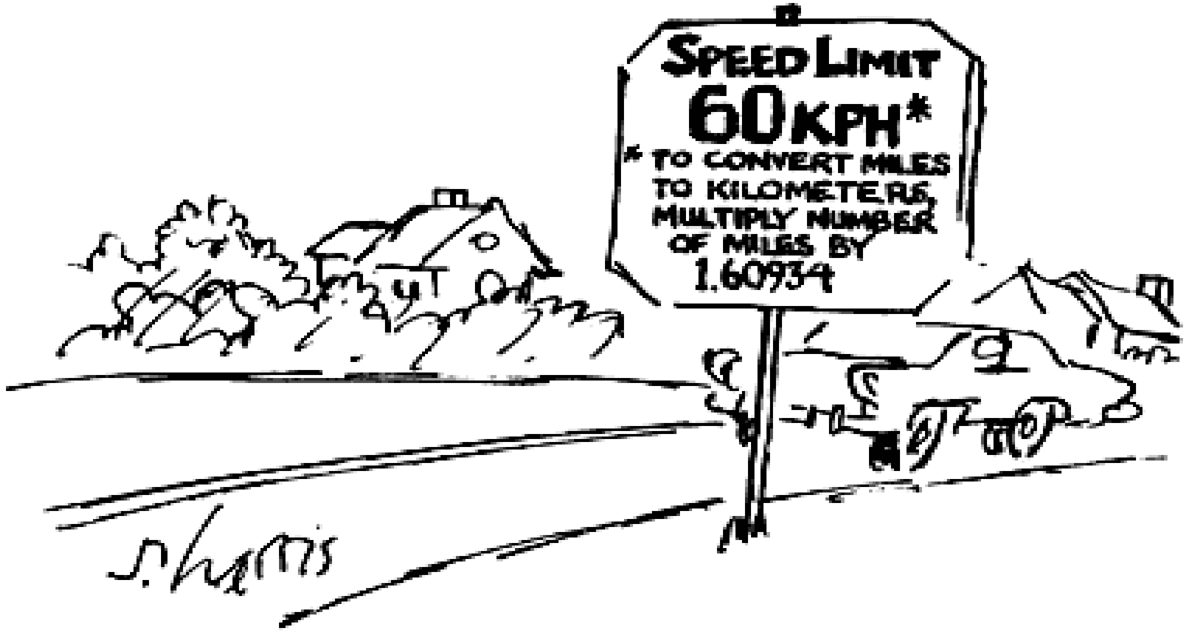
Numbers given without units are often not counted even if correct.

9. Answers should make sense! LOOK them over before you finish

Example:

No one is going to spend 1 billion dollars per gallon of water or $10,000 per kWh electrical energy!

10. Know some basic metric prefixes for simple conversions



Giga	G	10^{9}	= 1 000 000 000
Mega	M	10^{6}	= 1 000 000
Kilo	k	10^{3}	= 1 000
Hecto	h	10^{2}	= 100
Deka	dk	10^{1}	= 10
Base Unit		(m, l, g)	10^{0} =1
Deci	d	10^{-1}	= .1
Centi	c	10^{-2}	= .01
Milli	m	10^{-3}	= .001
Micro	µ	10^{-6}	= .000 001
Nano	n	10^{-9}	= .000 000 01

Conversions from US to metric will probably be given and do not need to be memorized. They should be practiced, however.

Gallons to Liters	1 gal= 3.8 L
Liters to Gallons	1 L, l= .264 gal
Meters to Yards	1 m= 1.094 yd
Yards to Meters	1 yd= .914 m
Grams to Ounces	1 g= .035 oz
Ounces to Grams	1 oz= 28.35 g
Kilograms to Pounds	1 kg= 2.2 lb
Pounds to Kilograms	1 lb= 454 g
Miles to Kilometers	1 mi= 1.609km
Kilometers to Miles	1 km= .621 mi

11. Know some simple energy calculations.

2004 Exam: West Freemont is a community consisting of 3000 homes. The capacity of the power plant is 12 megawatts (MW) and the average household consumes 8,000 kilowatt hours (kWh) of electrical energy each year. The price paid for this energy is $0.10 per kWh.

(a) Assuming that the existing power plant can operate at full capacity for 8,000 hours per year, how many kWh of electricity can be produced by the plant in one year?

$$12\ \text{MW} \times \frac{1000\ \text{kW}}{1\ \text{MW}} \times \frac{8000\ \text{hours}}{\text{Year}} = 96000000\ \text{kWh/year}$$

or 9.6 X 107 kWh/year

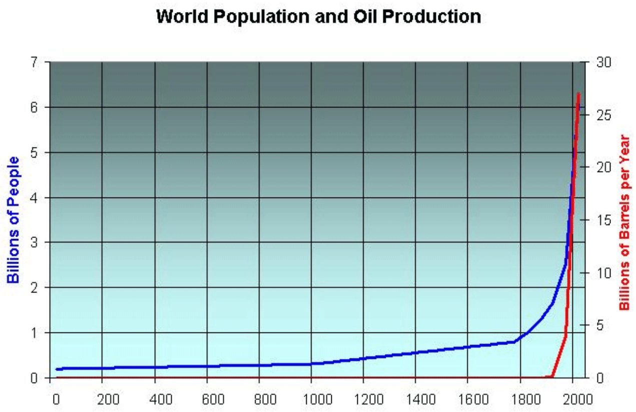
(b) How many kWh of electricity does the community use in one year?

$$3000\ \text{houses} \times \frac{8000\ \text{kWh}}{\text{yr}} = 24000000\ \text{kWh/yr}$$

or 2.4 X 107 kWh/yr

12. Rule of 70

- Based on exponential growth
- Doubling Time = 70/annual growth rate

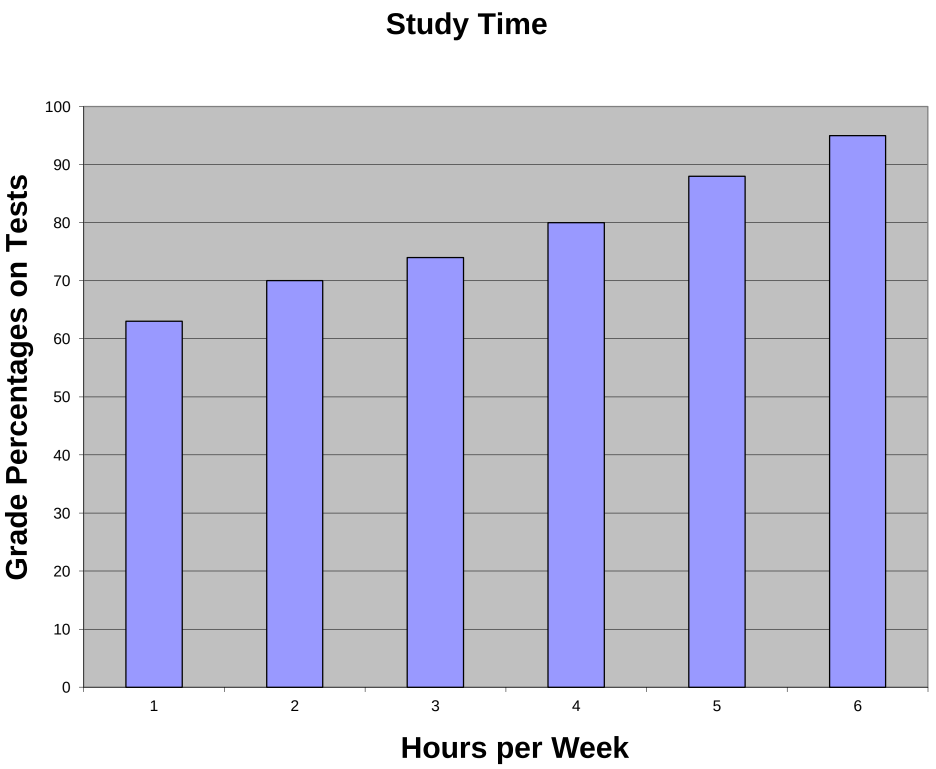


For example, if a population is growing at an annual rate of 2%, the number of years it will take for that population to double can be found by dividing 70 by 2, i.e., DT = 70/2 = 35 years.

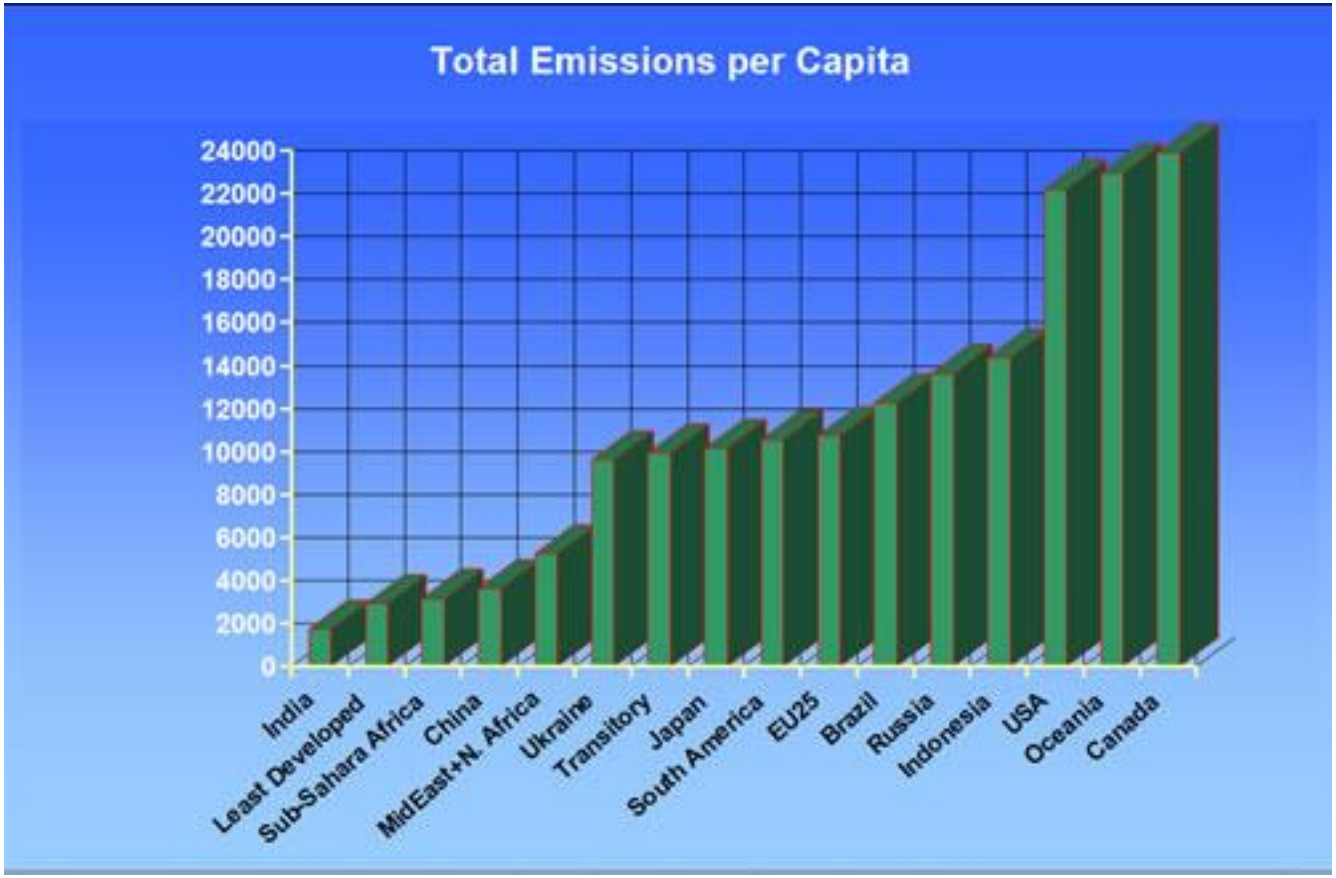
Calculate the doubling time for a population growing at 1.4%.
Answer = 70/1.4 = 50 years

14. Know how to graph data

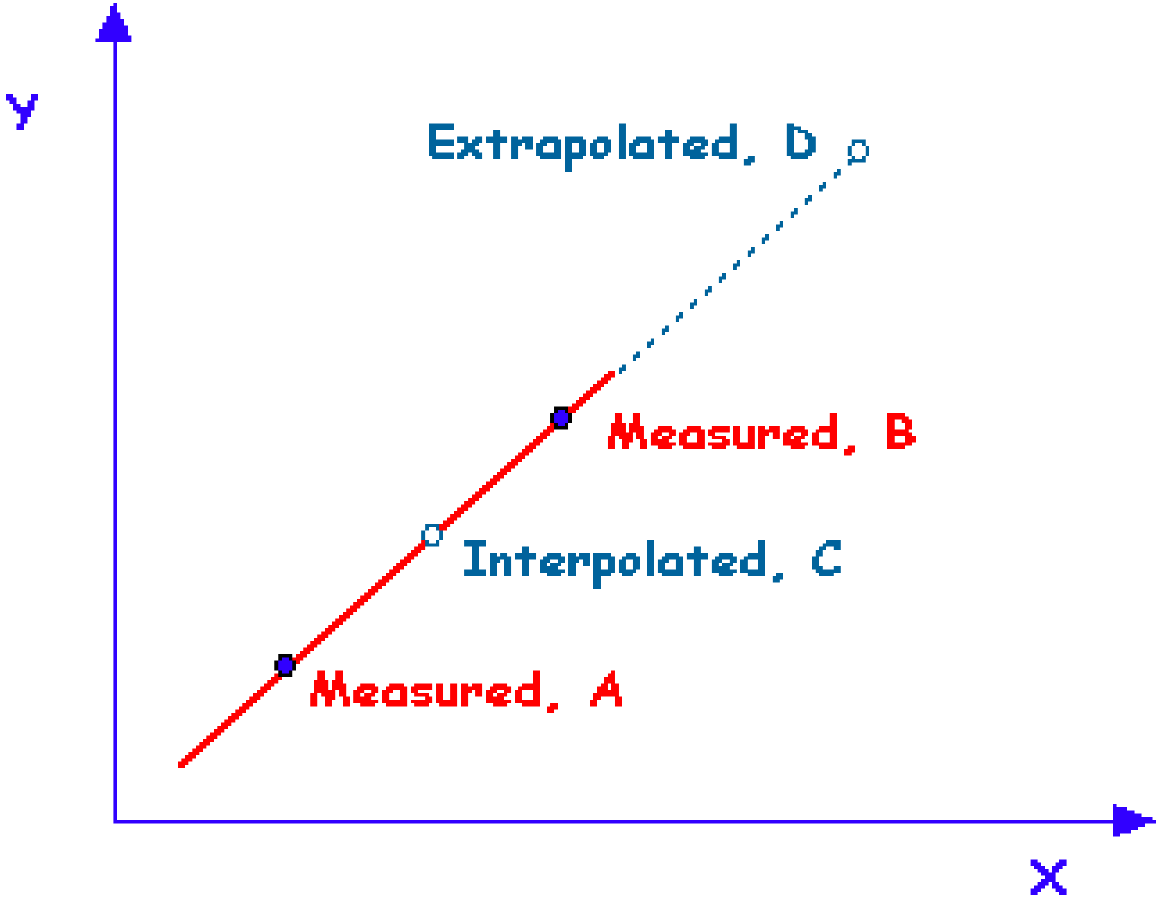
- Title the graph
- Set up the independent variable along the X axis
- Set up the dependent variable along the Y axis
- Label each axis and give the appropriate units
- Make proportional increments along each axis so the graph is spread out over the entire graph area
- Plot points and sketch a curve if needed. Use a straight edge to connect points unless told to extrapolate a line.
- Label EACH curve if more than one is plotted.



15. Know what is meant by “per capita” when solving a problem or interpreting a graph



16. Be able to *interpolate* and *extrapolate* data



17. Practice real APES exam multiple choice and free response questions!

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AP Environmental Science Summed Up
The best way to save the planet is to lower population growth and live sustainably.