Principles of Ecology

Ecologists study relationships in an environment.
Words to know: ecology, community, ecosystem, biome, organism, population

Ecology is the study of the interactions among living things, and between living things and their surroundings.
Levels of Organization in an Environment

- 1. **Organism** – an individual species.
  Ex: an alligator
- 2. **Population** – a group of the same species that lives in one area.
  Ex: alligators in the swamp
- 3. **Community** – a group of different species that live together in an area.
  Ex: alligators, turtles, birds, fish and plants in the Florida Everglades
- 4. **Ecosystem** – includes all of the organisms as well as the climate, soil, water and rocks.
  Ex: Florida everglades with all of the plants, animals, soil, water and sun
- 5. **Biome** – a major regional or global community of organisms.
  Ex: Tropical rainforest, Tundra, Desert

What level of organization describes a flock of pigeons in the park?

Ecological Research Methods include Observation, Experimentation, and Modeling
Observation

- Act of carefully watching something over time
- Can occur over short or long periods of time
- One type of population observation is surveys.
  - **Direct Surveys** - used for species that are easy to follow. (naked eye, binoculars)
  - **Indirect Surveys** - used for species that are difficult to track. (signs of presence)
- **Radio Telemetry** - used to track animal movement.
- **Population sampling** can also be used.
- **Quadrat Sampling –** used to monitor plant populations.
  - Scientists focus on the quadrat of plants in a random area and estimate from there.

How might a scientist use observation to study a population of mountain goats? Explain your answer.

Experimentation

- Experiments can be performed in the field or in the lab.
- A lab experiment allows for more control, but a field experiment gives a more accurate picture of how the organisms interact in a natural setting.

What is the difference between a lab experiment and a field experiment?

Modeling

- Modeling is used when a question cannot be answered by observation or experimentation.
- Models are created with the use of real data, but are lab tools.
- Models can be used to: track populations, find vegetation, predict snow.

How does modeling differ from experimentation?

Biotic and Abiotic Factors
Words to know: biotic, abiotic, biodiversity, keystone species

An ecosystem includes both biotic and abiotic factors.

- **Biotic Factors** - living things, such as plants, animals, fungi and bacteria
- **Abiotic Factors** - nonliving things, such as moisture, temperature, wind, sunlight, water and soil

What is the difference between biotic and abiotic factors?

Changing one factor in an ecosystem can affect many other factors.

- ALL species are affected by changes in biotic and abiotic factors in an ecosystem.

Biodiversity

- **Biodiversity** - the assortment, or variety, of living things in an ecosystem
- The amount of biodiversity found in an area depends on many factors, including moisture and temperature.

Keystone Species

- The change in a single biotic or abiotic factor can cause changes that are barely noticeable or cause the extinction of a species.
- **Keystone Species** - a species that has an unusually large effect on its ecosystem.
  Ex: Beavers fell trees and create ponds, wetlands, and streams, which can lead to huge changes in an ecosystem.

Explain why the Pacific Salmon could be considered a keystone species.

Energy in Ecosystems
Warm Up: $6H_2O + 6CO_2 \rightarrow C_6H_{12}O_6 + 6O_2$
Why does life as we know it depend upon the formula written above?
Words to know: producer, autotroph, consumer, heterotroph, chemosynthesis, photosynthesis.

Producers provide energy for other organisms in an ecosystem.

- **Producers** - organisms that get their energy from nonliving resources
- Producers are also called **autotrophs** meaning "self-nourishment".
- **Consumers** - organisms that get their energy by eating other living or once living resources, such as plants or animals
- Consumers are also called **heterotrophs** meaning "different-nourishment".
- ***All ecosystems depend on producers*** because they provide the basis for the ecosystem's energy.
- Most producers use sunlight to make food; therefore, almost all living things depend directly or indirectly on the sun as a main energy source.

How would a long-term drought affect producers and consumers?

Almost all producers obtain energy from sunlight.

- **Photosynthesis** - two-stage process used by most producers to make food
- **Chemosynthesis** - process in which an organism forms carbohydrates using chemicals rather than light, as an energy source

How do photosynthesis and chemosynthesis differ?

Food Chains and Food Webs

Warm Up: What do you get from food? How does energy and matter come from the food you eat? What other way could you get energy for your body?

Terms to know: food chain, herbivore, carnivore, omnivore, detritivore, decomposer, specialist, generalist, trophic level, food web

Food Chain

- Model that shows a sequence that links species by their feeding relationships
- Rather than describe every potential relationship, this model chain only follows the connection between one producer and a single chain of consumers within an ecosystem.
- Ex: Sun → Grass → Cottontail → Hawk

Types of Consumers

- **Herbivores** - organisms that eat ONLY plants
  Ex: deer, rabbits
- **Carnivores** - organisms that eat ONLY animals
  Ex: hawks, sharks
- **Omnivores** - organisms that eat BOTH plants and animals
  Ex: humans, bears
- **Detritivores** - organisms that eat detritus, or dead organic matter
  Ex: vultures, hyena
- **Decomposers** - detritivores that break down organic matter into simpler compounds
  Ex: bacteria, fungus
- **Specialist** - consumer that primarily eats one specific organism or feeds on a very small number of organisms
  Ex: Florida snail kite depends primarily on apple snails
- **Generalists** - consumers that have a varying diet
  Ex: Grey wolf

Trophic Levels

- The levels of nourishment in a food chain
  Ex: Producer → Herbivore → Carnivore has THREE Trophic Levels.
  The carnivore is the highest trophic level.
- Energy flows up the food chain from the lowest trophic level to the highest.
- **Primary Consumers** - herbivores
- **Secondary Consumers** - carnivores that eat Herbivores
- **Tertiary Consumers** - carnivores that eat secondary consumers
- Organisms can fall at different trophic levels based on where they fall in a food chain.

What is the connection between food chains and trophic levels?

Food Web

- Model that shows the complex network of feeding relationships and the flow of energy within and sometimes beyond an ecosystem.
- At each link in a food web, some energy is stored within an organism, and some energy is dissipated into the environment.

How might the introduction of a new predator affect the flow of energy through a food web?

Cycling of Matter

Warm Up: As humans, we are made of cells. Where does all that material come from? What would you include on a shopping list of elements that are critical to a human?

Words to know: hydrologic cycle, biogeochemical cycle, nitrogen fixation

Water Cycles through the Environment

- Matter changes form, but it does not disappear, it is used over and over again in cycles.
- The **hydrologic cycle (water cycle)** is the circular pathway of water on earth from the atmosphere, to the surface, below, ground and back.
- **Water Storage → Evaporation → Condensation → Precipitation → Runoff → Water Storage**
  River liquid to gas gas to liquid rain, snow gravity pulls down

Elements essential for life also cycle through ecosystems.

- A **biogeochemical cycle** is the movement of a particular chemical through the biological and geological parts of an ecosystem.
- Just as water changes states, so may other chemicals as they pass though cycles.

The Oxygen Cycle

- Plants, animals, and most other organisms need oxygen for cellular respiration.
- Plants release oxygen as a waste product of photosynthesis.
- In turn, humans and other organisms take in this oxygen and release it as carbon dioxide through cellular respiration.

Explain how deforestation might affect the oxygen cycle.

The Carbon Cycle

- **Carbon** is the building block of life; it is key to the structure of all organisms on our planet.
- Carbon exists in several forms: CO_2 gas, bicarbonate dissolved in water, fossil fuels, limestone and organic matter in soil.
- The simplest transfer of carbon occurs between plants and animals.
  - Plants use energy from the sun to convert carbon dioxide from the air into organic material that becomes a part of the plant's structure. Carbon then moves through the biotic world as one organism eats another. Carbon is returned to the atmosphere as carbon dioxide by respiration or decomposition.

The Nitrogen Cycle

- 78% of the Earth's atmosphere is made of nitrogen gas.
- Certain types of bacteria convert gaseous nitrogen into ammonia (NH_3) in a process called **nitrogen fixation.**
- Some nitrogen fixing bacteria live on **nodules** (bumps) on the roots of bean and pea plants.
- Nitrates released by soil are taken up by plants that convert the nitrates into amino acids and proteins.
- Animals then eat the plants and get the nitrogen.
- When decomposers break down animal excretions or dead animal and plant matter, nitrogen is returned to the soil through **ammonification**.
- **Denitrifying** bacteria use nitrate as an oxygen source and release nitrogen gas into the atmosphere.

The Phosphorus Cycle

- Most of the phosphorus cycle takes place at and below ground level.
- Phosphate is released by the weathering of rocks.

- Plants and some fungus are able to take up phosphate.
- Phosphorus moves to consumers through the food chains and webs.
- When living things die and are decomposed, phosphorus is released back into the Earth.

Choose one of the biogeochemical cycles, and list the key processes involved in the cycling of elements.

Pyramid Models

Warm Up: How is food energy measure? What do Calories measure?

Words to know: biomass, energy pyramid

Energy Pyramid

- Shows the distribution of energy among trophic levels
- Ecosystems get their energy from sunlight. That energy then flows through food chains.
- Some energy gets lost in the process in the form of heat, so each level in a food chain contains much less energy than the group before it.

Loss of Available Energy

- **Biomass** is a measure of the total dry mass of organisms in a given area.
- When an organism consumes biomass a great deal of energy is given off as heat and waste.
- Scientists use the **"Rule of 10".**
    - Each level in a food chain only gets 10% of the available energy from what it eats.

Energy Pyramids

- An **energy pyramid** is a diagram that compares energy used by producers, primary consumers, and other trophic levels.
- Producers **ALWAYS** make up the bottom layer of the pyramid (they have the most energy).
- Sections become progressively smaller as you go up the pyramid since the amount of usable energy sharply decreases.
- **RULE: As you move up the energy pyramid, the amount of available energy goes down.**

Draw an energy pyramid for a desert food chain. Use arrows to illustrate the flow of energy.

Other pyramid models illustrate an ecosystem's biomass and distribution of organisms.

- A **biomass pyramid** is a diagram that compares the biomass of different trophic levels within an ecosystem.
- The pyramid shows the mass of producers needed to support primary consumers, the mass of primary consumers required to support secondary consumers, and so on.
- A **pyramid of numbers** shows the numbers of individual organisms at each trophic level in an ecosystem.

If a scientist wanted to compare the exact number of organisms at each trophic level within a desert ecosystem, which pyramid model would he or she use? Explain.

Interactions in Ecosystems

Habitat and Niche

Objectives: Differentiate between habitat and niche.
Differentiate between competitive exclusion and ecological equivalents.

Warm Up: How would you define the word niche? What are some niches found in a school community?

Words to know: habitat, ecological niche, competitive exclusion, ecological equivalent

A habitat differs from a niche.

- **Habitat** - all of the biotic and abiotic factors in the area where an organism lives.
  - A lion's habitat includes: grass, trees, lions and watering holes.
- An **Ecological Niche** is composed of all the physical, chemical and biological factors that a species needs to survive, stay healthy and reproduce. (food, abiotic conditions, behavior)
  - A lion's niche is eating, drinking and finding mates.

What are some of the abiotic and biotic factors of your habitat?

Resource availability give structure to a community.

- **Natural selection** states that in a given environment, the organism that is best suited to obtain necessary resources are more likely to survive and reproduce.

What happens when two organisms are competing over those limited resources?

Competitive Exclusion

- **The principle of competitive exclusion** states that when two species are competing for the same resources, one species will be better suited to the niche, and the other species will be pushed into another niche or become extinct.
- Competitive exclusion produces two other results:
  - **Niche Partitioning**: Two species establish new niches in the same area.
    Ex: two squirrel species can naturally divide based on competitive advantage. One group eats the nuts at the tops of trees and the other eats the ones on the bottom.
  - **Evolutionary Response**: Divergent evolution may occur. Two species of squirrel may evolve where squirrels with larger teeth eat large nuts and those with smaller teeth eat small seeds.

Ecological Equivalents

- **Ecological Equivalents** are species that occupy similar niches but live in different geographical regions.
  - Ex: The mantel frog of Madagascar and the poison dart frog of South America have pretty much the same habitat and niche.
  - Because they live in different regions of the world they are never in direct competition.

Are these frogs experiencing competitive exclusion? Explain.

Community Interactions

Objectives: Compare and contrast interspecific and instraspecific competition.
Describe three types of symbiosis.

Warm Up: What are some ways that you compete or cooperate with others? How does cooperation and competition among organisms differ from human cooperation and competition?

Words to know: competition, predation, symbiosis, mutualism, commensalism, parasitism, community

Competition and predation are two important ways in which organisms Interact.

Competition occurs when two organisms fight for the same limited resources.

- There are two different types of competition:
    - 1. **Interspecific competition** occurs when two DIFFERENT species compete for the same limited resources. Ex: Grass and Dandelions compete for water.
    - 2. **Intraspecific competition** occurs when two of the SAME species compete for the same limited resources. Ex: Ex: Lions fight to compete for mates and territory.

Predation

- **Predation** is the process by which one organism captures and feeds upon another organism.
    - Ex: Snakes and mice.
- The **predator** hunts and eats.
- The **prey** is the hunted.
- Each organism adapts behaviors to help them better survive.

How does natural selection shape predator-prey relationships?

Symbiosis

- A close ecological relationship between two or more organisms of different species that live in direct contact with one another
- **Mutualism**
    - An interspecies interaction in which both organisms benefit from one another.
    - Ex: lesser long-nosed bat and the saguaro cactus: bats pollinate the cactus and get nectar from the cactus
    - Ex: birds on the back of rhinos: the bird gets protection and food, and the rhino gets the bugs off of its back
- **Commensalism**
    - A relationship between two organisms in which one receives an ecological benefit from another, while the other neither benefits nor is harmed
    - Ex: eyelash mites feed off the oil secretions and dead skin on our bodies; they neither help nor harm us
- **Parasitism**
    - Similar to predation but one organism benefits while the other is harmed
    - A parasite, however, benefits by keeping its host alive.
    - Ex: the braconid wasp lays its eggs inside a caterpillar; when the larvae hatch, they eat the caterpillar from the inside out
    - Ex: ticks on dogs
    - Many parasites are also dangerous because they are known to carry diseases.

What type of symbiosis is the relationship between a dog and its owner?

Population Density and Distribution

Objectives: Consider Density and geographic dispersal as characteristics of populations.
Describe three basic types of survivorship curves in relation to reproductive strategies.

Warm Up: Which parking lot has a higher density of cars – a 40-car lot with 40 cars parked or a 1000-car lot with 40 cars parked in it?

Words to know: population density, population dispersion, survivorship curves

Population density is a measurement of the number of individuals that live in a defined area.

- By collecting data about a population in a particular area, measurement of the number of individuals living in a defined space can be made.
- The formula is $\frac{\#\text{of individuals}}{\text{Area (units}^2\text{)}}$ = Population density

What might a decrease in the density of a deer population over a specific time period tell scientists about the habitat in the area?

Geographic dispersion of a population shows how individuals in a population are spaced.

- **Population dispersion** is the way in which individuals of a population are spread in an area or a volume.
- There are three types of population dispersion:
    - 1. Clumped Dispersion – individuals may live close together in groups in order to facilitate mating, gain protection, or access food resources.
    - 2. Uniform Dispersion – Territoriality and intraspecies competition for limited resources lead to individuals living at specific distances from one another.
    - 3. Random Dispersion – Individuals are spread randomly within an area or volume.

What type of intraspecies interaction might cause a uniform dispersion?

Survivorship curves help to describe the reproductive strategy of a species.

- A **survivorship curve** is a generalized diagram showing the number of surviving members over time from a measured set of births.
- There are three types of curves:
    - 1. **Type I Curve** – Shows a life history common in large mammals, including humans. There is a low level of infant mortality and they survive longer.
    - 2. **Type II Curve** – Organisms such as birds, small mammals, and some reptiles show a survivorship rate that is roughly equal at all ages of an organism's life. At all times they have an equal chance of dying.
    - 3. **Type III Curve** – Organisms with type III survivorship have a very high birth rate and also a very high infant mortality rate. These are typically reptiles, amphibians and plants.

Is there any connection between survivorship curves and reproductive strategies? Explain.

Population Growth Patterns

Warm Up: What are some of the factors that affect the size of a population?

Words to know: immigration, emigration, exponential growth, logistic growth, carrying capacity, population crash, limiting factor, density-dependent limiting factor, density-independent limiting factor

Changes in a population's size are determined by immigration, births, emigration, and deaths.

- **Immigration** – The movement of individuals into a population from another population.
    - Ex: Let's say you leave a banana in your backpack and find that you now have a population of fruit flies. The fruit flies in your bag immigrated from the banana to your book bag.
- **Births** – an increase in births increases the population size
    - More fruit flies are born in your book bag.
- **Emigration** – the movement of individuals out of a population into another population
    - When you opened your book bag, some of the fruit flies emigrated and decreased the population size.

- **Death** – when individuals die, the population decreases
    - When you opened the book bag you might have squashed some of the fruit flies.

Population growth is based on available resources.

Exponential Growth

- When resources are unlimited, a population has the opportunity to grow rapidly.
- **Exponential growth** occurs when a population size increases dramatically over a period of time.
- The resulting curve is called a **J-curve**.

Logistic Growth

- Most populations face limited resource however and do not continue to grow rapidly.
- **Logistic growth** occurs when a population begins with a period of slow growth followed by a brief period of exponential growth before leveling off at a stable size.
- The point at which the population reaches limited resources and STOPS growing is called **carrying capacity.**
- The resulting curve is called an **S-curve**.

Carrying Capacity

- The **carrying capacity** in an environment is the maximum number of individuals of a particular species that the environment can normally and consistently support.
- Carrying capacity typically changes when the environment changes.

Population Crash

- A Population crash is a dramatic decline in the size of a population over a short period of time.
    - Ex: 29 Reindeers were introduced to St. Matthews Island in Alaska where there were large fields of lichens. In less than 20 years, the reindeer population reached 6000 and had depleted most of the food source. In the following year, only 50 reindeer remained.

What would have eventually happened to the reindeer herd if the winter had not made finding food so difficult? Explain.

Ecological Factors Limit Population Growth.

- Any factor that has the greatest effect in keeping down the size of a population is called a Limiting Factor.

Density-Dependent Limiting Factors

- **Density-dependent limiting factors** are limiting factors that are affected by the number of individuals in a given area.
- There are three major density-dependent limiting factors:
    - **Competition** – the larger a population size, the greater the competition for food, water, shelter, and mates.
    - **Predation** – population of a predator can be directly affected by the number of available prey
        - Ex: Wolves and moose. More wolves, moose population drops. Moose population goes down, so does the wolf population.
    - 3. **Parasitism and Disease** – spread more quickly in more dense populations. The more crowded an area, the easier the spread of disease and parasites.

How does the wolf population on Isle Royale affect the carrying capacity of the moose population?

Density-independent limiting factors

- **Density-Independent limiting factors** are the aspects of the environment that limit a population's growth regardless of the density of the population.

- There are three major examples of density-independent limiting factors:
    - 1. **Unusual weather** – Extreme cold or drought.
    - 2. **Natural disasters** – Floods, fires and volcanoes don't care how many organisms are in the population.
    - 3. **Human activity** – Destruction of habitat and hunting.

A population of algae in a pond is limited in size by the amount of sunlight that strikes the pond's surface. Is sunlight a density-dependent or density-independent limiting factor for the algae population?

Ecological Succession

Warm Up: What happens to a garden or field when plants are removed in the fall and not replanted in the spring?

Words to know: succession, primary succession, pioneer species, secondary succession

Succession occurs following a disturbance in an ecosystem. Succession is the sequence of biotic changes that regenerate a damaged community or create a community in a previously uninhabited area.

Primary Succession

- **Primary succession** is the establishment and development of an ecosystem in an area that was previously uninhabited.
- Primary succession is typically caused by a volcanic eruption or glacier movement.
- The first organisms to move in to an area that was uninhabited are called **pioneer species**.
- The most common pioneer species are **lichens and moss** which can break down solid rock into smaller pieces.
- Once pioneer species are established and break down rock, soil can begin to form.
- Once soil forms, plants grow and herbivores will come in.
- Once herbivores are established carnivores can establish themselves.

Secondary Succession

- **Secondary succession** is the reestablishment of a damaged ecosystem in an area where the soil was left intact.
- Because there is soil, plants and other organisms that remain can begin to restart the growth process.
- Secondary succession can be caused by fires, floods, humans, and abandoned land.

Where might succession occur in the ocean?

The Biosphere

Life in the Earth System

Words to know: biosphere, biota, hydrosphere, atmosphere, geosphere, biotic, abiotic

The biosphere is the portion of earth that is inhabited by life.

- The biosphere is the part of Earth where life exists.
- All of the Earth's ecosystems put together make up the biosphere.
- The biota is the collection of living things that live in the biosphere.
- There are three other Earth systems other than the biosphere:
    - 1. Hydrosphere – all of Earth's water, ice and water vapor.
    - 2. Atmosphere – the air blanketing Earth's solid and liquid surface.
    - 3. Geosphere – the features of the Earth's surface.

Is the air in your classroom part of the biosphere or the biota? Explain

Biotic and abiotic factors interact in the biosphere.

- All four Earth systems are connected.
- A change in one sphere can affect the others.
    - Ex: Plants removed from a riverbank may allow more water to flow and gather dirt making the water dirty. This then affects the growth of aquatic plants and the release of oxygen.
- The Gaia Hypothesis explains how biotic and abiotic factors interact in the biosphere.

Climate is the prevailing weather of a region.

- **Weather** is the day to day change in temperature and precipitation.
    - Ex: Today it will be warm with a 20% chance of rain.
- **Climate** is the long-term pattern of weather conditions in a region.
    - Ex: Atlanta in the summer is HOT!
- Key factors that shape climate are temperature, sunlight, water and wind.
- A microclimate is the climate of a small specific place within a larger area.
    - Ex: A hole in a log where a mushroom grows or a city neighborhood

Earth has three main climate zones.

- The three main climate zones are: polar, tropical, and temperate climates.
- Polar climate – located in far northern and far southern reaches of the planet where the temperature is typically cold and below freezing
- Tropical climate – surrounds the equator and is characterized by warm, moist conditions
- Temperate climate – located in the broad areas ling between the polar and tropical climate zones. This zone experiences summer and winter seasons of about equal lengths.

The Influence of Sunlight

- The area of Earth that receives the most direct radiation from the Sun all year is the region at and around the equator where the tropical climate zone is.
- Areas near the north and south poles get little direct sunlight so those are the polar zones.

Air and Water Movement

- Heating of the Earth's surface causes movements in both water and air.
- Warm water and air rise and cool water and air drop, so they cycle.

Landmasses

- Areas near water tend to have fewer changes in climate than do areas that are land locked.

Adaptations to Climate

- Organisms have adaptations that allow them to be successful in a given climate.
- Altering that climate can have dramatic effects on the organisms living there.

Biomes

Earth has six major biomes.

- Tropical
- Grassland
- Desert
- Temperate
- Taiga
- Tundra

Tropical Biomes

- Warm temperatures and abundant rainfall all year.
- Flora includes lush thick forests.
- Branches of tall trees form the canopy, a covering the blocks light from the lower lying vegetation.
- Animals live anywhere from the high canopy to ground level.

Grasslands

- There are two types of Grasslands:
    - **Tropical Grasslands** – temperatures are warm throughout the year, with definite dry and rainy seasons. Flora includes tall grasses with scattered trees and shrubs. Fauna includes gazelles and other herbivores.
    - **Temperate Grassland** – dry and warm during the summer; most precipitation is snow in the winter. Flora includes short or tall grasses. Many animals live below ground.

Desert

- Has a VERY DRY climate.
- Flora includes cacti, and must have a storage system for water and deep roots.
- Animals are nocturnal and limit their activities during the day.

Temperate

- Temperatures are hot in summer and cold in winter; precipitation is spaced evenly over the year.
- Deciduous trees are those that shed their leaves in the fall and winter.
- Broadleaf forests with deciduous trees are dominant.

Taiga

- Long, cold winters and short, warm and humid summers.
- Coniferous trees dominate this area.
- Coniferous trees are those with needle-like leaves that stay green yearlong (evergreens)
- Most animals hibernate or migrate in the winters.

Tundra

- Subzero temperatures are the norm.
- Little precipitation (frozen desert)
- Permafrost is the permanently frozen soil found in these areas
- Mosses and low growing plants are common.
- Animal diversity is low.

Chaparral (minor biome)

- Chaparral (Mediterranian Shrublands) has hot, dry summers and cool, moist winters.

Marine Ecosystems

The ocean can be divided into zones.

- Intertidal Zone – strip of land between the high and low tide lines. Beach line has tidal pools.
- Nertic Zone – extends from the intertidal zone out to the edge of the continental shelf; ranges out to 200 meters.
- Bathyl Zone – extends from the edge of the nertic zone to the base of the continental shelf; between 200 – 2000 meters. Increased water pressure, organisms have to be adapted.
- Abyssal Zone – lies below 2000 meters and is in complete darkness. No photosynthetic organisms; will find chemosynthetic organisms.

Life in the Neritic Zone

- The neritic zone contains 40 times more biomass than the rest of the ocean.
- Plankton, tiny free-floating organisms, make up most of this biomass.
    - Zooplankton are animal-like.
    - Phytoplankton are plant-like.
- Blue-Green Algae carry out the bulk of photosynthesis on Earth and provide MOST of the oxygen.
- 70% of the oxygen you breathe can be traced back to phytoplankton.

What other adaptations might organisms have in the abyssal zone?

Coastal water contains unique habitats.

- Coral Reefs are found within the tropical climate zone.
    - A single coral reef can be home to 400 species of coral, along with hundreds of other species, including fishes, sponges and sea urchins.
    - Exist in warm waters
- Kelp Forests exist in COLD, nutrient-rich water.
    - Kelp can extend from the ocean floor up 30 meters high.
    - Provides a food source for invertebrates and even mammals.

Estuaries and Freshwater Ecosystems

Words to know: estuary, 2atershed, littoral zone, limnetic zone, benthic zone, ecosystem

Estuaries are dynamic environments where rivers flow into the ocean.

- An estuary is a partially enclosed body of water formed where a river flows into an ocean.
- Ex: Louisiana bayous, Florida Bays in the Everglades and Chesapeake Bays
- The distinctive feature of an estuary is the mixture of fresh water from a river with salt water from the ocean.
- Large numbers of species thrive in this environment.

Estuary Characteristics

- Populations of fish and crustaceans depend on plankton as their primary food source.
- Birds and other secondary consumers then eat the fish and crustaceans.
- 75% of the fish we eat depend on estuary ecosystems.

What characteristics make estuaries such a productive ecosystem?

Freshwater ecosystems include moving and standing water.

- A watershed is a region of land that drains into a river, river system, or another body of water.

Freshwater Ecosystems

- Rivers and streams are examples of flowing water ecosystems.
- Wetlands are also freshwater ecosystems BUT there is very little water flow.
- Ex: bogs, marshes and swamps

Adaptations of Freshwater Organisms

- Factors that affect freshwater organisms include water temperature, oxygen levels, pH and water flow rate.
- Ex: Trout live in fast-moving rivers. They have streamlined bodies that help them move upstream against the current.
- Some aquatic insects have hooks on their bodies to avoid being swept away.

What effect would the construction of a dam have on a river ecosystem?

Ponds and lakes share common features

- Freshwater ponds and lakes are also divided into zones:
    - Littoral Zone – located along the shoreline at high and low water marks
    - Limnetic Zone (Pelagic Zone) – open water further out from shore
    - Benthic Zone – the bottom of the lake, pond
- Water cycles through these areas due to temperature changes in the water.
    - Warm water rises and cold water sinks forming a cycle.

Human Impact on Ecosystems

Human Population Growth and Natural Resources

Words to know: nonrenewable resource, renewable resource, ecological footprint, carrying capacity, population, limiting factor

Earth's human population continues to grow.

- The predictions of Earth's human carrying capacity have changed over time.
- In the 1700's, Thomas Malthus wrote an essay stating that the Earth's population was growing faster than the Earth's resources. The population at the time was about 1 billion people.
- Today, the population is over 6 billion, and we are still unsure when we will reach carrying capacity.

Technology and Human Population

- As humans have modified their environment through agriculture, transportation, medical advances and sanitation, the carrying capacity of Earth has greatly increased.
- Think what would happen if ALL technology were gone. The human population would far exceed carrying capacity.

The growing human population exerts pressure on Earth's natural resources.

- Oil and coal currently support the majority of our country's energy use.
- Oil and coal are nonrenewable resources.
- Nonrenewable resources are those that are used faster than they form.
- Resources that CANNOT be used up or can replenish themselves over time are called renewable resources.
- Wind, solar energy, plants and animals, and water are renewable resources. However, if overused or not used correctly, they can become nonrenewable.

Explain how a renewable resource such as water could become a nonrenewable resource.

Effective management of Earth's resources will help meet the needs of the future.

- Ex of careless use of Resources: Easter Island. Easter Island was thickly forested on rich soil with many bird species when first discovered in 400 AD.
- The human colony grew quickly over the next 100 years.
- They cut down forests for lumber and for building boats.
- The trees were cut down faster than they could regrow and eventually the island was left with NO trees.
- Much of the habitat for animals was destroyed as were the human supplies.
- The Easter Islanders disappeared.

Ecological Footprint

- We need natural resources to survive, but we must pay attention to how we use those resources.
- The amount of land necessary to produce and maintain enough food and water, shelter, energy, and waste is called an ecological footprint.
- The average U.S. footprint is the size of 24 football fields.
- Other nations have smaller footprints but have many more people (India and China).

Why is our ecological footprint related to an area of land?

Air Quality

Warm Up: What are some current environmental issues? In general, why is pollution a problem for Earth?

Words to know: pollution, smog, particulate, acid rain, greenhouse effect, global warming

Pollutants accumulate in the air.

- Pollution describes any undesirable factor, or pollutant, that is added to the air, water, or soil.
- Pollution can be microscopic air particles, or waste products from factories and sewers, to household chemicals poured down the kitchen sink.

Smog and Ozone

- The most common air pollution comes from the waste products produced by burning fossil fuels, such as oil and coal.
- Smog is a type of air pollution caused by the interaction of sunlight with pollutants produced by fossil fuel emissions.
- Particulates are microscopic bits of dust, metal, and unburned fuel produced in many industrial processes.
    - These can be inhaled and cause breathing problems.
- Ground level ozone: Nitrogen oxides that come from fossil fuel combustion combine with ozone (O_3).
    - These particles stay close to the ground and can cause problems to humans and ecosystems.

Acid Rain

- Acid rain is a type of precipitation produced when pollutants in the water cycle cause rain pH to drop below normal levels.
- Nitrogen oxides and sulfur oxides are major components of acid rain.
- All rain that falls is slightly acidic, with a pH around 5.6.
- Acid rain is any precipitation that falls below 5.6 on the pH scale.
- Acid rain can cause a drop in pH in water ecosystems as well as speed up erosion of soil and the breakdown of leaves and tree bark.

As the human population continues to increase and use more fossil fuels, why might acid rain become a bigger problem?

Air pollution is changing Earth's biosphere.

- Earth's atmosphere naturally includes molecules of carbon dioxide that play an important part in keeping the biosphere at a temperature that can support life.
    - These levels rise and fall in normal cycles over time.

The Greenhouse Effect

- Earth gets nearly all of its energy from the wavelengths of both visible and invisible light emitted by the Sun.
- Some energy is absorbed by the Earth's surface while some is lost and some is trapped as heat.
- The Earth's atmosphere acts like a greenhouse, trapping heat to maintain the Earth's temperature.
- The Greenhouse Effect occurs when carbon dioxide, water and methane molecules absorb energy reradiated by Earth's surface and slow the release of this energy from the atmosphere.

Global Warming

- Over the past 100 years, the average global temperature has risen 0.6° C.
- Global temperature fluctuations are a normal part of Earth's climate cycle, but these changes have taken place faster than normal over the past 40 years.

- The trend of increasing global temperature is known as global warming.
- This increase is believed to be caused by increases in greenhouse gases.
- Scientists do not know what changes this increase will cause.
- Research does show that ecosystems are being negatively impacted by the changes.
- Scientists also believe that weather patterns are also being affected.

Water Quality
Words to know: indicator species, biomagnification, pollution

Water pollution affects ecosystems.

- Chemical contaminants, raw sewage, trash, and other waste products are only a few pollutants that make their way into rivers, lakes, and streams. Runoff containing detergents and fertilizers can cause an increase in algae, dissolving the levels of oxygen and contributing to the death of fish species.
- One way scientists determine the health of an ecosystem is through the study of natural indicator species.
- An indicator species (bioindicator) is a species that provides a sign or indication of the quality of the ecosystem's environmental conditions.

If the population of an indicator species is increasing, what might you infer about the conditions of the ecosystem?

Biomagnification causes accumulation of toxins in the food chain.

- Some pollutants are water-soluble. Other pollutants are fat-soluble and stay in the body fat of an organism.
- Fat-soluble pollutants can also move from one organism to another in a process known as biomagnification.
- In biomagnification, a pollutant moves up the food chain as predators eat prey, accumulating in higher concentrations in the bodies of predators.
    - The higher in the food chain, the greater the concentration of the pollutant.
    - Ex: DDT (a pesticide) almost wiped out the population of bald eagles.

Why would tertiary consumers have higher concentrations of toxins than primary consumers?

Threats to Biodiversity

Objectives: Assess the consequences of loss of biodiversity.
Explain how loss of habitat and introduced species affect ecosystems and biodiversity.

Warm Up: How would you describe the species diversity locally?

Words to know: habitat fragmentation, introduced species, biodiversity

Preserving biodiversity is important to the future of the biosphere.

- Ecosystems are constantly changing, and populations are always adjusting.
- Human actions can often alter ecosystems and threaten species.
- Biodiversity is the diverse world of living things.
- A decrease in biodiversity will have a ripple effect through the entire ecosystem.

Why is biodiversity highest in tropical rain forests?

Loss of habitat eliminates species.

- Governments and organizations around the world are developing programs to protect species that are threatened by overhunting, overcollecting and habitat loss.
- Ecologists are very worried about habitat fragmentation.
- Habitat fragmentation occurs when a barrier forms that prevents an organism from accessing its entire home range. This is often caused by building roadways or harvesting of forests.

Why is wetland habitat important for migrating birds?

Introduced Species

- An introduced species is any organism that was brought to an ecosystem as the result of human actions.
- They can pose a great threat to the stability of an ecosystem if they prey on or crowd out native species.
    - Ex: Kudzu and Burmese pythons

Effect on Native Species

- The Burmese Python was introduced into the Florida Everglades by irresponsible pet owners and has now produced a breeding species.
    - They feed off raccoons, birds, rats and dogs.
    - They also feed off endangered species protected by the Everglades.
- Kudzu: native of South East Asia; choking out native plants in the South Eastern United States.

Economic Damage

- Can eat or destroy crops that are sold.

How might a species of carnivorous fish introduced into a lake have a negative impact on the lake ecosystem?

Conservation

Words to know: sustainable development, umbrella species, ecosystem, habitat, keystone species

Sustainable Development

- Sustainable development is a practice in which natural resources are used and managed in a way that meets current needs without hurting future generations.
- There are several ways to support sustainable development.
    - **Rotation** – rotating catches between different species gives the "off" species time to recover their numbers following a harvest.

- **Fishing Gear Review** – reviewing and banning some fishing gear could help avoid damaging the sea floor and prevent ecologically important organisms from being killed.
- **Harvest Reduction** – slowing the harvests of deep-water species that grow very slowly allows them more time to recover their populations.
- **Fishing Bans** – stopping fishing in some areas can help maintain populations of fishes.

What important services do forests provide? How might their destruction have an effect on humans?

Conservation

- Conservation means protecting available resources.
- When a single species within an ecosystem is placed on a list of endangered species, many other species within the ecosystem also benefit.
- The listed species is an umbrella species because its protection means a wide range of other species will also be protected.

What factors might scientists consider when developing a recovery plan for the endangered grizzly bear of western North America?

Protecting Earth's resources helps protect our future.

- The cycling of nutrients and the regulation of water provide essential resources that are almost impossible for humans to manufacture.

Protecting Natural Resources

- The Environmental Protection Agency was created as part of the National Environmental Policy Act in 1970.
  - It helped develop policies and regulations to protect the environment across the U.S.
  - Laws include Clean Air Act, Clean Water Act, and Endangered Species Act.
- Setting aside public land is another way to protect ecosystems.
  - The city of Suwanee has bought up "green space." These are areas that are to remain natural with NO development.

A Sustainable Earth

- We have the ability and technology to control what happens.
  - Controlling birth rates (this was done in China in the past)
  - Develop technology to produce more food with less waste.
  - Change practices to protect and maintain ecosystems.