

Core Case Study: Tropical Rainforests Are Disappearing

Rainforests only cover **2%** of the Earth, but contain up to **half** of the world's **terrestrial plant and animal species**.

What is the tropical rainforest land being used for when it is cut down? **cropland, grazing, building settlements**

What are the 3 harmful effects of disrupting these ecosystems?

1. **Reduce the Earth's vital biodiversity by destroying habitats causing premature extinction**
2. **Accelerates climate change by reducing the trees' uptake of CO₂**
3. **Changes regional weather patterns**

What Is Ecology?

Ecology is the study of **how organisms interact with their environment (living and nonliving)**

Ecology Levels of Organization from simplest to broadest

LEVEL	DESCRIPTION	PICTURE
1. Organism	-an individual living being	
2. Population	-group of individuals of the same species living in a particular place	
3. Community	-populations of different species living in a particular place and potentially interacting	
4. Ecosystem	-community of different species interacting with one another and with their nonliving environment	
5. Biome	-a particular area of similar climate, precipitation, etc	
6. Biosphere	-the Earth	

Science Focus: Have You Thanked the Insects Today?

Give examples of why insects are an important part of the earth's natural capital.

Pollination, controls other pest populations, loosen and renew the soil

What Keeps Us and Other Organisms Alive?

Earth's life support system components:

1. Atmosphere	<p><i>Thin envelope of gasses surrounding Earth</i></p> <p>Troposphere- <i>layer of the atmosphere that contains the air we breathe and where our weather occurs, extends about 4 miles above the surface</i> Greenhouse gases- <i>CO₂, water vapor, CH₄ (methane)</i></p> <p>Stratosphere- <i>contains O₃ has to filter out most of the sun's harmful ultraviolet radiation; "global sunscreen" that helps prevent skin cancer and cataracts</i></p>
2. Hydrosphere	<p><i>Consists of all of the water (liquid, ice, and water vapor) on or near the Earth's surface</i></p>
3. Geosphere	<p><i>Consists of the Earth's hot core, thick mantle (mostly rock), and thin outer crust</i></p>

Terrestrial biomes have distinct *climate and certain species adapted to them.*

Examples of biomes found across 39th parallel in US: *Chaparral, Coniferous Forest, Desert, Grassland, Deciduous Forest*

Aquatic life zones include *freshwater and marine life zones.*

Three factors that sustain life on Earth:

1. *the one way flow of high quality energy from the sun through living organisms in their feeding interactions and into the environment as low quality energy*
2. *the cycling of matter or nutrients*
3. *gravity*

Explain what happens to solar energy as it reaches the Earth.

The energy reaches the Earth in the form of electromagnetic waves, mostly as light, UV radiation, and heat.

Ozone gas in the lower stratosphere absorbs most of the sun's harmful UV radiation.

The UV, visible, and infrared energy that reaches the atmosphere warms the air, generates winds, and powers photosynthesis.

As the infrared radiation travels back up through the atmosphere it encounters greenhouse gases which trap the heat to warm the Earth.

What is the natural greenhouse effect? Why is the greenhouse effect good to a certain point?

The earth naturally has greenhouse gases that trap the heat from the sun. Without this natural greenhouse effect, the earth would be too cold for survival. Greenhouse gases are a good thing until there is too much- this leads to climate change (global warming).

What Are The Major Components of an Ecosystem?

<p>Biotic Factors <i>-living</i></p>	<p>vs.</p> <p>Abiotic Factors <i>-nonliving</i></p>
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How do abiotic factors affect biotic factors?
Species thrive under certain conditions such as level of sunlight, precipitation, temperature, etc.

Explain the term “range of tolerance” in relation to trout using the figure in the Prezi.

Variations in chemical and physical components of the environment in which the species can thrive (like pH, temperature, sunlight)

How do limiting factors regulate population growth? Give an example.

Too much or too little of any abiotic factor can limit or prevent growth of a population, even if all other facts are within the optimal range of tolerance

Draw a food chain. Make sure your arrow show energy flow.



Trophic levels- *feeding level*

Producer	<i>aka autotroph; make their own nutrients from photosynthesis (energy from the sun) or chemosynthesis (energy from chemicals like hydrogen sulfide) EX: plants, algae, phytoplankton</i>
Primary Consumer	<i>aka herbivores; plant eaters EX: rabbits, grasshoppers, deer, zooplankton</i>
Secondary Consumer	<i>aka carnivores; meat eaters that eat primary consumers EX: hyenas, spiders, frogs</i>
Tertiary Consumer	<i>meat eaters that eat secondary consumers EX: tigers, wolves, hawks, orcas</i>
Omnivore	<i>eat both plants and animals EX: pigs, foxes, humans</i>
Decomposer	<i>consumers that release nutrients from the dead bodies of plants and animals and return them to the soil, water, or air for reuse EX: bacteria, fungi</i>
Detritivore	<i>feeds on waste of dead bodies of other organisms called detritus EX: mites, earthworms, catfish, large scavengers like vultures</i>

Aerobic Respiration

Uses oxygen to convert glucose to Energy, CO₂, and water

vs.

Anaerobic Respiration

*Does NOT use oxygen to convert glucose to CH₄, ethyl alcohol, acetic acid
Hydrogen sulfide, and energy*

**KEY IDEA: Ecosystems are sustained through a combination of one way energy flow from the sun through these systems and nutrient cycling of key materials*

Science Focus: Many of the World's Most Important Species Are Invisible To Us
What are micro-organisms and why are they so important? *Microorganisms refer to thousands of species of bacteria, protozoa, fungi, and phytoplankton that often get a bad reputation as germs that cause infection. However, these microbes also help with digestion, purify water by breaking down waste, helps produce food like cheese and yogurt, decompose waste into nutrients in the soil, etc.*

What Happens to Energy in an Ecosystem?

Food Chain	vs.	Food Web
<i>Sequence of organisms that serves as a food source for the next</i>		<i>Shows the complex web of feeding interactions since organisms usually feed on more than one thing</i>

What is biomass and what happens to biomass as you move up a food chain?
Biomass- the dry weight of all organic matter contained in its organisms; the biomass decreases as you move up the food chain

What is ecological efficiency and what happens to it as you move up a food chain?
The percentage of usable chemical energy transferred as biomass from one trophic level to another; typically 10% of the energy is passed on while the other 90% is lost as a lower quality energy like heat

Energy flow pyramids explain why *there are usually only 4 to 5 trophic levels in a food chain because the amount of high quality energy is so low as you move higher in the food chain. It also explains why the Earth can support more people if we eat at a lower trophic level by consuming more grains, fruits, and vegetables.*

****This is difficult- make sure you really understand the next two terms:**

Gross Primary Productivity	vs.	Net Primary Productivity
<i>Rate at which a producer converts solar energy into chemical energy through photosynthesis</i>		<i>The total energy plants get through photosynthesis minus the energy needed for respiration</i>

EQUATION $NPP = GPP - R$

Which terrestrial ecosystem has the highest NPP?
Swamps and Marshes, Tropical Rainforests

Which aquatic ecosystem has the highest NPP?
Estuaries

What Happens to Matter in an Ecosystem?

What is the importance of biogeochemical cycles? *These cycles are responsible for continually moving nutrients through air, water, soil, rock, and living organisms*

What is a sink or reservoir? *Areas where nutrients accumulate in one portion of the cycle and can remain there for various lengths of time; storage*

Summarize/Draw each cycle below (These are really important concepts and will show up again and again!)

1. Water Cycle	
2. Carbon Cycle	
3. Nitrogen Cycle	
4. Phosphorus Cycle	
5. Sulfur Cycle	

Core Case Study: Blowing in the Wind: Connections between Wind, Climate, and Biomes

What is the general reason why some lands are deserts and others are forests?

a difference in climate, resulting mostly from long term differences in average temperature and precipitation caused by global air circulation

Wind is an indirect form of *solar* energy. Why is it an important factor in climate?

Wind circulates moisture, heat, plant nutrients, soil particles, and air pollutants.

Without wind, what would the Earth be like? *The tropics would be unbearably hot and other regions would freeze.*

Wind also transports nutrients. Give an example of why this is important.

Winds carry dust that is rich in phosphates and iron across the Atlantic Ocean from the Sahara Desert. These deposits help build agricultural soils in the Bahamas and Brazil.

Disadvantages to wind:

- 1. Particles of iron-rich dust promote the outbreak of toxic algal blooms (red tides) in coastal waters. These red tides kill fish and contaminate shellfish, which we eat.*
- 2. Dust, soot, and other air pollutants from China are blown across the Pacific Ocean and can degrade air quality in the western US.*

What Factors Influence Climate?

Weather	vs.	Climate
<i>-local area's short term temperature, precipitation, humidity, wind speed, and cloud cover</i>		<i>-general pattern of atmospheric or weather conditions over a long period of time</i>

Climate varies in different parts of the world because of *patterns of global air circulation and ocean currents distribute heat and precipitation unevenly.*

3 Major factors that determine how air circulates in the lower atmosphere:

1. Uneven heating of the Earth's surface by the sun- *the equator receives the greatest amount of heat*
2. Rotation of the Earth on its axis- *the equator spins faster than the polar regions, therefore heated air masses rising above the equator and moving north and south to cooler areas are deflected to the west or east*
The atmosphere over these areas are divided into huge *cells* distinguished by the direction of the air movement. The differing directions are called *prevailing winds* that help distribute air, heat, moisture, and dust.
3. Properties of air, water, and land- *heat from the sun evaporates ocean water and transfers heat from the oceans to the atmosphere, especially near the equator. This evaporation of water creates giant cyclical convection cells that circulate air, heat, and moisture.*

Prevailing winds blowing over the ocean produces mass movements of water called *currents*, which redistribute *heat from the sun from place to place, thereby influencing climate and vegetation*.

What causes currents to flow in roughly circular patterns?

Differences in water temperature creates differences in water density.

Cold water sinks, warm water rises.

Prevailing winds and irregularly shaped continents interrupt these currents and cause them to flow in roughly circular patterns. (clockwise in the northern hemisphere and counterclockwise in the southern hemisphere)

What happens when ocean water mixes vertically in shallow and deep currents?

Colder seawater has a higher density and therefore sinks beneath warmer, less dense sea water.

This creates a connected loop of deep and shallow ocean currents that act as a conveyor belt that moves heat in the ocean.

The ocean and atmosphere are strongly linked in 2 ways:

- 1. Ocean currents are affected by winds in the atmosphere.*
- 2. Heat from the ocean affects atmospheric circulation.*

Describe El-Nino (ENSO event) and what it causes.

El Nino is a large scale weather phenomenon that occurs every few years when the prevailing winds in the Pacific Ocean weaken and change direction.

Result: The resulting above-average warming of Pacific waters can affect populations of marine species by changing the distribution of plant nutrients. It also alters the weather by bringing more rain in some areas and drought in other areas.

The Earth's air circulation patterns, prevailing winds, and configuration of continents and oceans result in *six* giant *convection* cells. What do these do?

Warm, moist air rises and cools. Cool, dry air sinks.

Small amounts of gases like *water vapor*, *CO₂*, *CH₄*, and *N₂O* play a role in determining the Earth's *average temperature and climates*.

These gases are called *greenhouse gases* because *these gases hold in heat from the sun*.

What would the Earth be like without the natural greenhouse effect?

The earth would be too cold for our survival.

The problem occurs when human activities like *burning fossil fuels and burning forests* release more *greenhouse gases* into the atmosphere. This human enhanced global warming could cause *climate changes in various places on earth, altered precipitation patterns, a shift in areas where crops can be grown, a rise in average sea level, a shift in habitats, and even a spread in habitat area of disease causing insects*.

What creates sea breezes?

Heat is absorbed and released more slowly by water than land. This difference creates sea breezes.

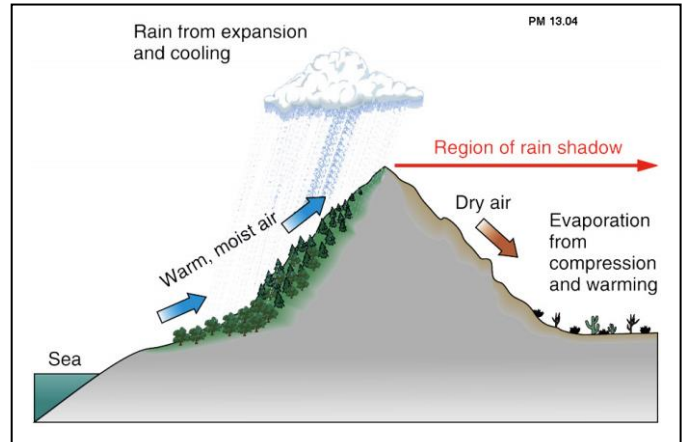
Rainshadow Effect-

How do mountains affect weather and climate?

When moist air blowing inland from the ocean hits a mountain, it is forced upward.

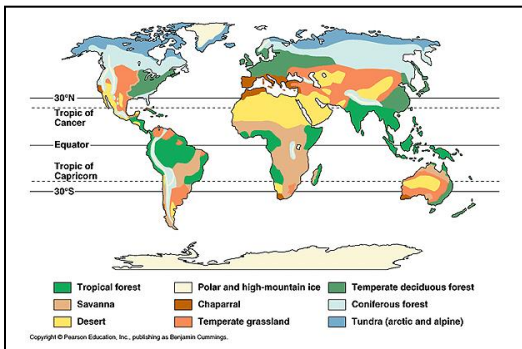
As it rises, it cools and expands and loses its moisture as rain or snow on the windward side of the mountain.

As the drier air mass passes over the mountain it flows down the leeward side of the mountain, warms up, and sucks the moisture from plants and soil, resulting in a semi-arid region on this side of the mountain.



How Does Climate Affect the Nature and Location of Biomes?

What are biomes and what makes biomes different from one another?



Biome- large terrestrial region with similar climate, soil, plants, and animals

How does elevation affect vegetation?

Tropical Forests to Deciduous Forests to Coniferous Forests to Herbs, Lichen, and Mosses

Desert- low precipitation, soil with little vegetation		
3 Major Types of Desert:	Description:	Location example:
1. Tropical Desert	<i>Hot and dry most of the year; few plants; rocks and sand; sand is disturbed often by off-road vehicles</i>	<i>Sahara Desert, Namib of Africa</i>
2. Temperate Desert	<i>High daytime temps in summer, low temps in winter, more precipitation than tropical deserts, sparse vegetation, drought resistant shrubs, cacti, and succulents</i>	<i>Mojave Desert</i>
3. Cold Desert	<i>Winters are cold, summers are warm, and precipitation is low, plants and animals have adaptations that help them stay cool and to get enough water to survive</i>	<i>Gobi Desert</i>

****Why are desert ecosystems fragile? *The soils take decades to hundreds of years to recover from disturbances (such as off-road vehicles). This is because of their slow plant growth, low species diversity, slow nutrient cycling (due to low bacteria), and lack of water.***

Grassland- mostly in the interior of continents; areas too moist for deserts, but too dry for forests		
3 Major Types of Grassland:	Description:	Location example:
1. Tropical Grassland (Savanna)	<i>Scattered clumps of trees, warm temps year round; alternating wet and dry seasons; herds of grazing and browsing animals; plants are adapted to survive drought and extreme heat</i>	<i>East Africa</i>
2. Temperate Grassland (Tall and Short Grass Prairies)	<i>Winters are bitterly cold; summers are hot and dry; uneven precipitation throughout the year; many grasses die and decompose therefore there is a high level of organic matter that accumulates leading to fertile soil; drought tolerant grasses; plants can survive fires because the roots below are not harmed</i>	<i>Montana</i>
3. Cold Grassland (Tundra)	<i>Bitterly cold, treeless plains; low growing grasses, lichen, moss; permafrost; animals have adaptations of thick fur; seasonal wetlands are home to mosquitoes and flies; migratory birds and caribou,</i>	<i>South of the Arctic Polar Ice Caps</i>

Why is the tundra a fragile biome and how is global warming affecting it? *Global warming has a large effect on this biome due to the melting of permafrost which releases CH₄ and CO₂ from the soil. This biome is fragile due to very slow soil formation and human activities due to drilling and pipelines.*

Shrubland- many coastal regions that border deserts	Description:	Location example:
aka: <i>Chaparral</i>	<i>Closeness to the sea provides a longer winter rainy seasons; dense growths of low lying shrubs and occasional small trees; the soil is thin and not very fertile; warm and dry summers that cause plants to become dry and flammable; this ecosystem is often maintained by fires; adaptations in which plants store food reserves in fire resistant roots or seeds that only sprout under hot fire; many people live here due to mild winters and warm, dry summers</i>	<i>Southern California, central Chile, Southern Australia</i>

Forest Systems- dominated by trees		
3 Major Types of Forests:	Description:	Location example:
1. Tropical Rain Forest	<p><i>Hot, moisture filled air; high precipitation; lush forests; uniformly warm temperatures; high humidity; wide variety of plant and animal species; high NPP; broadleaf evergreen plants; tops of trees form a dense canopy, therefore little vegetation on forest floor; specialized niches in distinct layers of the forest that enables coexistence of a great variety of species</i></p> <p><i>**The soil is very poor here due to rapid decomposition and recycling of scarce soil nutrients. Heavy rainfall also leaches nutrients from the soil</i></p>	<i>Found near equator, Congo Basin</i>
2. Temperate Forest	<p><i>4 distinct seasons in which temps change significantly; long, warm summers; cold winters; abundant precipitation; dominated by deciduous trees that lose their leaves during the winter; slow rate of decomposition; therefore has a thick layer of leaf litter; this biome has been disturbed the most by humans, once home to large predators (bears, wolves, pumas, etc), but have since been displaced</i></p>	<i>Georgia</i>
3. Cold Forest(Coniferous, aka: Boreal, aka: Taiga)	<p><i>Long, dry, cold winters; short, cool summers; dominated by coniferous (cone-bearing) evergreen trees; needle-shaped, waxy leaves are able to withstand intense cold and drought; low plant diversity; slow decomposition; nutrient poor, acidic soil; wide variety of wildlife</i></p>	<i>Northern regions of North America, Asia, and Europe</i>

Explain how specialized niches reduce competition in the rainforest.

Plants and animals have specific niches that they fill in different layers of the rainforest. This minimizes competition for resources and allows for coexistence of a variety of species.

Describe the importance of mountains in their ecosystems.

- contain the majority of the world's forests that provide habitat for much of the plant's terrestrial biodiversity*
- sanctuary for many migrating species*
- regulate Earth's climate because of mountaintops that are covered with ice/snow that reflect solar radiation back into space that helps cool the Earth; if the ice melts, the darker mountain top actually absorbs heat which leads to a warmer climate*
- affects sea levels by storing water in glacial ice*

How Have We Affected the World's Terrestrial Ecosystems?

Humans have degraded or are using unsustainably **62%** of the Earth's major terrestrial ecosystems.

How have humans impacted the following terrestrial ecosystems? Give 2 examples for each ecosystem:			
Deserts	Grasslands	Forests	Mountains
1. <i>soil destruction by off-road vehicles</i>	1. <i>conversion to cropland</i>	1. <i>clearing for agriculture</i>	1. <i>timber extraction</i>
2. <i>depletion of groundwater</i>	2. <i>release of CO₂ from burning grasslands</i>	2. <i>conversion to tree plantations</i>	2. <i>mineral extraction</i>

CHAPTER 4 continued

Aquatic Biomes

Core Case Study: Why Should We Care about Coral Reefs?

Where are coral reefs found? *Clear, warm coastal waters of tropics and subtropics*

How are coral reefs formed? *Colonies of polyps secrete limestone around themselves that hardens to form a crust*

Explain how coral reefs represent mutualism. *Single celled algae called zooxanthellae live in the tissues of the polyp. The algae provides polyps with food and oxygen and helps produce calcium carbonate (coral skeleton). Polyps provide algae a well-protected home and nutrients.*

Describe ecological & economic services provided by coral reefs.

Ecological

- help moderate temperate by removing CO₂ from the atmosphere
- act as natural barriers to protect coastlines from erosion by waves and storms
- provides habitat for 1/4 of all marine organisms

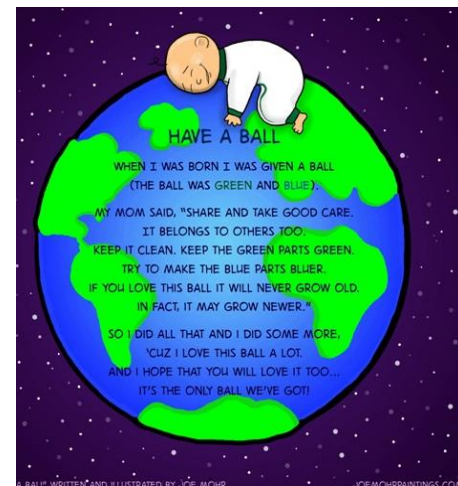
Economic

- produce about 1/10 of global fish catch in developing countries
- provide jobs and building materials
- supports fishing and tourism industries

Coral reefs are being destroyed by *coastal development, pollution, overfishing, warmer ocean temperatures, and increasing ocean acidity.*

What is coral bleaching? (Very important!)

This occurs when corals die and turn white. They are dying due to increased ocean temperature and increased ocean acidity. Ocean acidification occurs when the ocean absorbs too much atmospheric CO₂ from the burning of fossil fuels. That CO₂ in the water then forms a weak acid (carbonic acid) that dissolves calcium carbonate.



What is the General Nature of Aquatic Systems?

Saltwater covers **71%** of the Earth's surface and freshwater covers **2.2%**.

The distribution of aquatic organisms is based on the water's **salinity**.

Aquatic life zones are classified into 2 major groups:

1. **Marine (saltwater)- oceans, estuaries, wetlands, shorelines, coral reefs, mangrove forests**
2. **Freshwater- lakes, rivers, streams, inland wetlands**

*Estuaries are a mix of **saltwater and freshwater**.

Saltwater and freshwater contain major types of organisms:

1. Plankton- **free-floating organisms**
 - a. Phytoplankton- **drifting plants, including algae**
 - b. Zooplankton- **drifting animals, including single celled protozoa and jellyfish**
 - c. Ultraplankton- **photosynthetic bacteria, responsible for most of primary productivity near the ocean's surface**
2. Nekton- **strongly swimming consumers such as fish, turtles, and whales**
3. Benthos- **bottom dwellers such as oysters, clams, worms, lobsters, and crab**
4. Decomposers- **breaks down organic compounds in the dead bodies and waste of aquatic organisms into nutrients that are used by producers**

Key factors determining the types and numbers of organisms in each layer of aquatic zones:

1. **Temperature**
2. **Dissolved oxygen**
3. **Availability of food**
4. **Availability of light and nutrients**

Why does photosynthesis take place in the euphotic zone? **This is the zone in which sunlight can penetrate through the water.**

Light penetration can be reduced by **cloudiness in the water** aka: Turbidity which can occur due to **excessive algal blooms**.

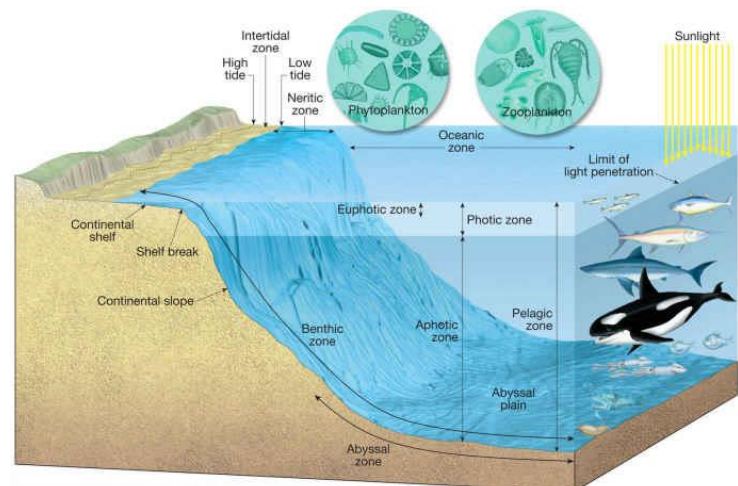
Why Are Marine Aquatic Systems Important?

Marine Ecosystems-

Ecological Services	Economic Services
- climate moderation	- food
- CO₂ absorption	- pharmaceuticals
- nutrient cycling	- harbors and transportation
- reduces storm impact	- recreation
- habitat space and nursery areas	- employment
	- building materials

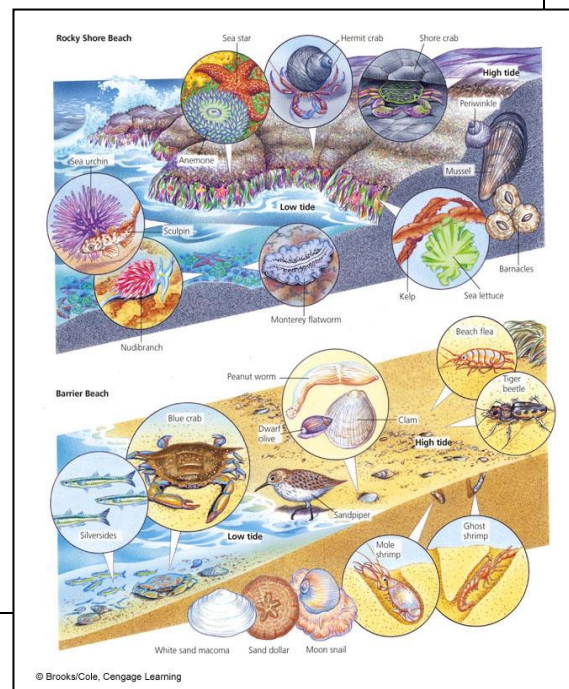
Marine life is found in 3 major life zones:

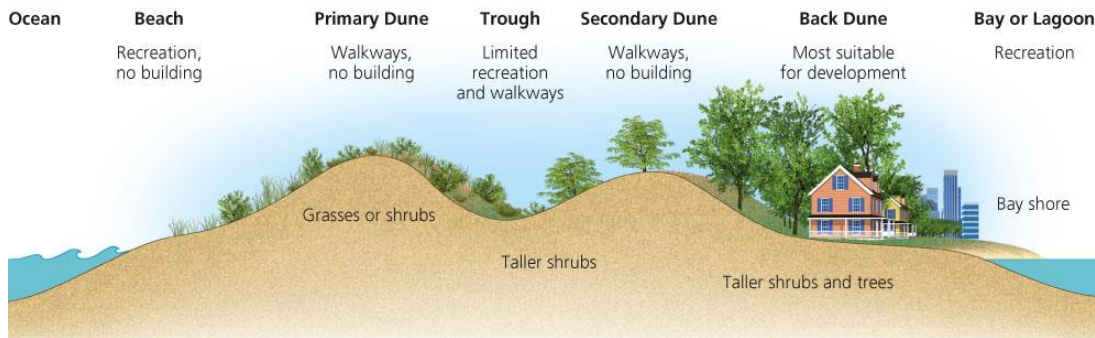
1. **Coastal Zone**
2. **Open Ocean**
3. **Ocean Bottom**



Coastal Zone

Description:	<p>*warm, <i>nutrient</i>-rich, shallow water that extends from the high-tide mark on land to the gently, sloping shallow edge of the <i>continental shelf</i>.</p> <p>*makes up 10% of the ocean, but contains 90% of all marine species.</p> <p>*many areas have a high NPP because <i>ample sunlight and plant nutrients that flow into this area from land</i>.</p>
Estuaries:	<p>*where <i>fresh</i> water mixes with <i>salt</i> water.</p>
Coastal Wetlands:	<p>*coastal land covered with water all or part of the year includes <i>river mouths, inlets, bays, sounds, seagrass beds and salt marshes</i> in temperate zones and <i>mangrove forests</i> in tropical zones</p> <p>*Earth's most productive ecosystems because <i>of high nutrient input, rapid circulation of nutrients, and ample sunlight</i>.</p> <p>*Seagrass beds are highly productive, help stabilize <i>shorelines</i> and reduce <i>wave impact</i>.</p> <p>*Why is life hard in these coastal ecosystems?</p> <ul style="list-style-type: none"> -<i>must adapt to daily and seasonal changes in tidal and river flow, water temperature, salinity, and sediment and pollution runoff.</i>
Mangrove Forests:	<p>*Found in <i>sub-tropical</i> regions like Southeast Asia and South America</p> <p>*69 different tree species can grow in salt water where their roots can be seen <i>above water</i> where they can obtain oxygen.</p> <p>*Describe 3 ecological or economic services provided by this aquatic system:</p> <ul style="list-style-type: none"> -<i>maintain water quality by filtering pollutants</i> -<i>provide food, habitat, and nursery sites</i> -<i>reduce storm impact and coastal erosion</i> -<i>supplies timber and fuelwood</i> <p>*Loss of mangrove forests can lead to:</p> <ul style="list-style-type: none"> -<i>polluted drinking water caused by salt water intrusion</i>
Intertidal Zone:	<p>*area of shoreline between <i>high tide and low tide</i>.</p> <p>*What must organisms deal with that live in this zone?</p> <ul style="list-style-type: none"> -<i>must be able to avoid being swept away by waves</i> -<i>must be able to survive changes in salinity</i> <p>*Rocky Shores- lives in pools and other crevices</p> <p>*Barrier Beaches or Sandy Shores- burrow between the tides</p> <p>What is the importance of sand dunes?</p> <ul style="list-style-type: none"> -<i>they are the first line of defense Against the waves; help protect against Flooding</i> <p>*both areas have lots of birds that feed on these creatures that are exposed in between tides</p>





Description:

- *sharp increase in *water depth* at the edge of the *continental shelf*
- *zones are based on the penetration of *sunlight*
- *Divided into 3 vertical zones:
 1. Euphotic Zone-
 - brightly lit upper zone with drifting phytoplankton*
 - nutrient levels are low*
 - DO (dissolved oxygen) levels are high*
 2. Bathyal Zone-
 - dimly lit middle zone that gets little sunlight*
 - does not contain photosynthetic organisms*
 - zooplankton & smaller fish migrate to the surface to feed at night*
 3. Abyssal Zone-
 - dark and very cold, no sunlight, no photosynthesizing producers*
 - has little DO (dissolved oxygen)*
 - has a decent level of plant nutrients from decomposition*
- *Marine Snow- *showers of dead and decaying organisms*
- *Deposit Feeders- *take mud into their gut to extract nutrients*
- *Filter Feeders- *pass water through or over their bodies to remove nutrients*
- *NPP is low in the open sea, but *upwellings* bring nutrients from ocean bottom.

How Have Human Activities Affected Marine Ecosystems?

Major Threats to Marine Systems:

1. Coastal Development- *destroys and pollutes coastal habitats*
2. Overfishing- *depletes populations of commercial fish species*
3. Runoff of Nonpoint Pollution- *such as fertilizers, pesticides, and livestock waste*
4. Point Source Pollution- *sewage from passenger cruise ships and spills from oil tankers*
5. Habitat Destruction- *from coastal development and trawler fishing boats that drag weighted nets across the ocean bottom*

6. Invasive Species- *introduced by humans; can deplete populations of native species and cause economic damage*
7. Climate Change- *enhanced by human activities that could cause a rise in sea levels, which could destroy coral reefs and flood coastal marshes and coastal cities*
8. Climate Change- *from burning fossil fuels, which warms and acidifies oceans*

Name 3 Major Human Impacts on Coral Reefs:

1. *Coral Bleaching*
2. *Ocean Warming*
3. *Soil Erosion*

Case Study: The Chesapeake Bay- an Estuary in Trouble

How has population growth affected the Chesapeake Bay?

The estuary receives a massive amount of waste from the huge population.

Nitrates and phosphate levels have risen sharply which causes algal blooms and eventually dissolved oxygen is depleted.

Point source pollution affecting Chesapeake Bay- *primarily sewage treatment plants and industrial plants account for much of the phosphate pollution*

Nonpoint source pollution affecting Chesapeake Bay- *mostly runoff of fertilizer and animal waste*

The native oyster population is nearly gone. What is the importance of oysters in the Chesapeake Bay?

Oysters filter and clean the water by removing excess nutrients that may lead to algal blooms. Because of this, oysters help keep the DO levels in the water stable.

Officials are thinking about introducing nonnative Asian oysters.

Give one PRO and one CON to this idea.

Pro- the invasive oysters are resistant to deadly parasites and grow bigger and faster than native oysters, therefore they will better clean the water

Con- unpredictable and irreversible; could have negative effect on other organisms

Why Are Freshwater Ecosystems Important?

Freshwater life zones include standing (*lentic*) bodies of water such as *lakes, ponds, and wetlands*, and flowing (*lotic*) bodies of water such as *rivers and streams*.

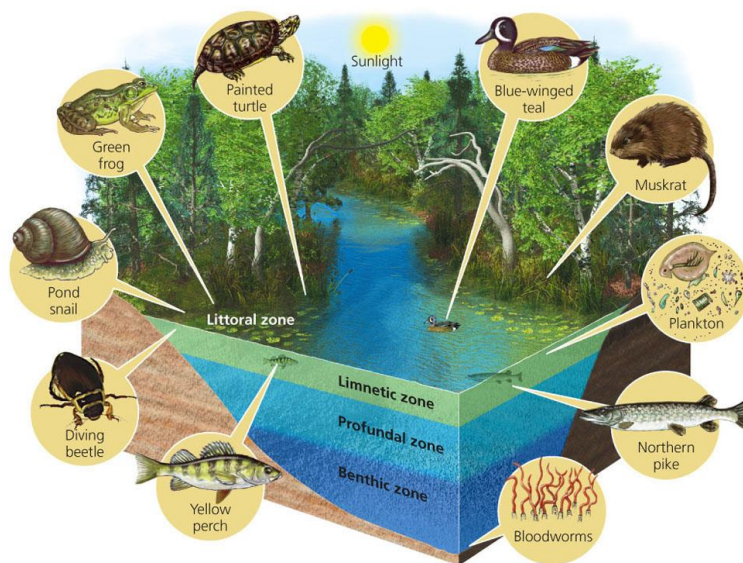
Lakes are formed when *precipitation, runoff, and groundwater seepage fills depressions in the earth's surface*

What can cause these depressions in the land? *Glaciation, crustal displacement, and volcanic activity*

Deep lakes consist of 4 distinct zones:

1. Littoral Zone- *near the shore and consist of the shallow sunlit waters; high biodiversity because of ample sunlight and runoff of nutrients; rooted plants, frogs, turtles, crayfish, bass*
2. Limnetic Zone- *open, sunlit surface layer away from the shore; many photosynthetic organisms; high levels of DO; zooplankton, phytoplankton, larger fish*
3. Profundal Zone- *deep, open water where it is too dark for photosynthesis; low DO; fish that are adapted to cooler, darker waters live here*
4. Benthic Zone- *inhabited mostly by decomposers, detritus feeders, and some fish; nourished mainly by dead matter that falls from the littoral and limnetic zones*

Label the 4 zones of a lake:



Two main types of lakes based on nutrient content and primary productivity:

1. Oligotrophic Lakes- *low NPP*
very little plant nutrients, usually clear water, and surrounded by steep banks
2. Eutrophic Lakes- *high NPP*
large supply of plant nutrients; usually shallow, murky water; high turbidity

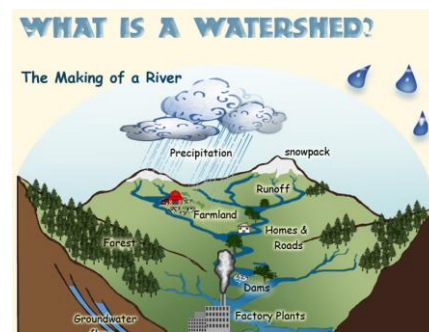
*Cultural Eutrophication- acceleration of eutrophication of lakes caused by *humans* which puts excessive *plant nutrients from fertilizers* into lakes.

Many lakes fall somewhere between the two extremes of Oligotrophic and Hypereutrophic and are called *Mesoeutrophic*.

Precipitation that doesn't sink into the ground or evaporates becomes *surface water* and that becomes *runoff*

What is a watershed (drainage basin)?

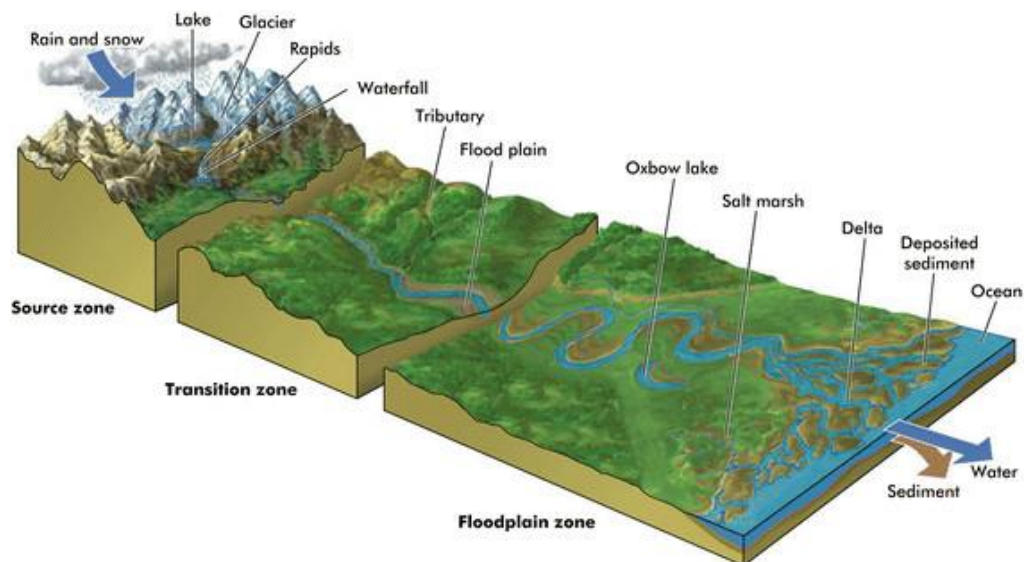
Land area that delivers runoff, sediments, and dissolved substances to a stream



Streams often begin in mountainous or hilly areas and flows through 3 aquatic life zones to the sea:

<p>1. Source Zone</p>	<ul style="list-style-type: none"> * The waters here are usually <i>shallow, cold, clear, and swiftly moving.</i> * As it flows it dissolves large amounts of <i>oxygen</i> from the air. * Nutrients come mostly from <i>organic matter (leaves, branches) that fall into the water.</i> * Populated by <i>cold water fish (like trout)</i> that need lots of <i>dissolved oxygen.</i> * Name 1 animal adaptation for this area: <i>Compact and flattened bodies to live under stones, muscular bodies to swim in the fast currents</i> * Name 1 plant adaptation for this area: <i>Able to attach to rocks or survive under the surface of the water</i>
<p>2. Transition Zone</p>	<ul style="list-style-type: none"> * Headwaters merge to form <i>wider, deeper, and warmer streams that flow down gentle slopes with fewer obstacles.</i> * More turbid, <i>slower</i> flowing, and has less dissolved <i>oxygen.</i> * Supports more <i>producers</i> and fish that have less O2 demand.
<p>3. Floodplain Zone</p>	<ul style="list-style-type: none"> * Streams join into <i>wider and deeper rivers</i> that flow across broad, flat <i>valleys.</i> * Water in this zone has a higher <i>temperatures</i> and less <i>dissolved oxygen.</i> * Supports a large population of <i>producers</i> and aquatic plants. * Water in this zone is usually muddy and contains a high concentration of silt because <i>erosion.</i> * At its mouth, the river may divide into many <i>channels</i> as it flows through <i>deltas built up as sediments are deposited.</i>

Sketch the path water takes as it moves through each zone.



Case Study: Dams, Deltas, Wetlands, Hurricanes, and New Orleans

Coastal deltas, mangrove forests, and coastal wetlands provide natural protection against *flood damage from storms, hurricanes, and typhoons.*

Louisiana has lost more than *1/5* of its wetlands since 1950 due to: *oil and gas wells and coastal development*

What has been built in this area to reduce flooding along rivers and trap sediments?
Dams and levees

This has caused the river deltas to *sink* and no longer provide protection.
What has caused New Orleans to now be 3 meters below sea level?

land subsidence (sinking) due to lack of sediments being deposited and groundwater extraction; also sea levels have risen

Why would building taller levees not really work for New Orleans?

Increasingly stronger hurricanes and rising sea levels will take over

What are inland wetlands?

Land covered with freshwater all or part of the time & located away from the coast

Name 3 types of inland wetlands:

1. *marshes*
2. *swamps*
3. *floodplains*

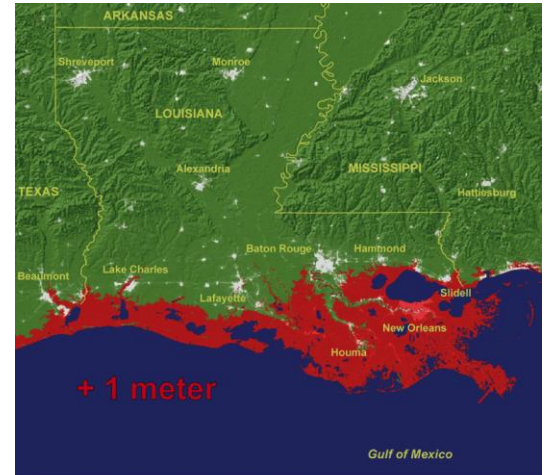
Describe 3 ecological or economic services provided by inland wetlands.

1. *Filtering and degrading toxic waste and pollutants*
2. *Reducing flooding and erosion by acting as a storm barrier*
3. *Helping to recharge groundwater*

How Have Human Activities Affected Freshwater?

Humans are affecting freshwater ecosystems in 4 major ways:

1. *Dams and canals fragment about 40% of the world's 237 large rivers which alter and destroy wildlife habitats*
2. *Flood control levees and dikes built along rivers disconnect the rivers from their floodplains, destroying aquatic wildlife habitats*
3. *Cities and farms add pollutants and excess plant nutrients to nearby streams, rivers, and lakes causing cultural eutrophication.*
4. *Many inland wetlands have been drained or filled to grow crops or have been covered with concrete, asphalt, and buildings.*



Core Case Study: Why Should We Care about the American Alligator?

What has happened to the American Alligator population since 1930? Why should we care?

-Populations declined drastically due to hunting for their exotic meat and skin used for shoes belts, and purses.

-American Alligators are keystone species and plays a huge role in sustaining their environment. These alligators dig holes in the mud which hold water during dry spells that provide refuge for aquatic life and a food source for others like fish, turtles, snakes, etc. --

-The alligator's nesting mounds also provide nesting and feeding sites for herons and turtles. Their role as a top predator also keeps other populations in check.

American Alligators became classified as a threatened species in 1977 and they have made a comeback since then.

What Is Biodiversity and Why Is It Important?

Biodiversity- *variety of Earth's species, genes, ecosystems, and processes*

Species Diversity- *different types of species in an ecosystem*

Ecosystem Diversity- *variety of deserts, grasslands, forests, mountains, oceans, lakes, rivers, wetlands*

Functional Diversity- *variety of processes like matter cycling, energy flow, etc*

Genetic Diversity- *variety of genes within a species that allows for adaptation*

Where Do Species Come From?

Why do we have so much biodiversity? Use the term natural selection in your answer.

Life changes over time through changes in genes of populations. Natural selection is when the strongest are able to survive in certain environments, therefore reproducing and passing on desirable traits.

How does the fossil record prove organisms have changed over time? *Most of what we know about Earth's history comes from fossils. The fossil record, although incomplete, gives clues as to past species and how they may have evolved over time. The fossil record probably only represents about 1% of the species that have ever lived!*

How does the genetic makeup of a population change over time? *Populations change, not the individual! Genetic variability occurs through mutations. If those mutations allow for better survival, then those mutations may be passed on to the next generation.*

Explain how individuals that have a beneficial trait are able to survive to reproduce.

An adaptation is a heritable trait that enables an individual to survive through natural selection and to reproduce more than others. The trait must lead to differential reproduction which enables individuals to leave more offspring than other members of the population.

Give 3 reasons why humans are such a powerful species.

- 1. Strong opposable thumb*
- 2. Walks upright*
- 3. Complex brain*

How Do Geological Processes and Climate Change Affect Evolution?

Tectonic plates have drifted apart over time, which has 2 major effects on evolution:

1. *The location of continents and oceanic basins greatly influences the earth's climate and thus determine where plants and animals live.*
2. *The movement has allowed species to move, adapt, and form new species through natural selection.*

How have earthquakes and volcanoes affected evolution?

Earthquakes cause fissures in the crust that can separate and isolate populations. Over time this can lead to formation of new species.

Volcanoes destroy habitats and can reduce or wipe out entire populations of species.

How has climate change affected natural selection? *Periods of warming and cooling can affect ice sheets, sea level, temperature, precipitation etc. The change in climate determines where different types of plants and animals can survive. Some species go extinct, therefore opening up niches for other species.*

How Do Speciation, Extinction, and Human Activities Affect Biodiversity?

Speciation- *formation of new species*

Common Mechanisms for Speciation:

1. Geographic Isolation- *different groups of the same population of a species become physically separated from one another for a long period of time. This can be due to migration, physical barriers (mountains, roads, rivers), and natural disasters (earthquakes and volcanoes)*
2. Reproductive Isolation- *When members of a population become so different that they can no longer reproduce to create fertile offspring.*

Endemic Species- *species that are found in only 1 area are vulnerable to extinction*

Extinction- *when an entire species ceases to exist*

Background Extinction- *low rate of extinction that may take place naturally*

Mass Extinction- *significant rise in extinction rates above background level due to a catastrophic, widespread, event in which large groups of species are wiped out. Earth has experienced 5 mass extinctions in the last 500 millions years.*

What Is Species Diversity and Why Is It Important?

Species Diversity (aka species *richness*)- *the number of different species*

Species Evenness- *relative abundance of individuals within each species*

Science Focus: Species Richness on Islands: Theory of Island Biogeography

Why do large islands tend to have more species than small islands? *The species richness on an island is determined by the island's size (smaller islands tend to have fewer species), and the island's distance from the mainland (the closer the island, the easier to immigrate).*

Why are species-rich ecosystems sustainable? *If there is a large variety of producers, then that will support a greater variety of consumers. Also, if there are more species, then they're more likely to withstand environmental disturbances (like drought, disease, pests, climate change, etc)*

What Roles Do Species Play in an Ecosystem?

Niche- *a species role in the ecosystem (interactions, biotic and abiotic needs)*

Habitat- *where species live*

What happens if two species try to occupy the same niche?

Competition will occur in which there is a winner and a loser.

Generalist Species

-broad niches, live in many places, eat a variety of foods, and has a wide range of tolerance

EX: mice, rates, deer, raccoons

vs.

Specialist Species

-narrow niches, live in 1 habitat, eats a small variety of food, and has a narrow range of tolerance; prone to extinction

EX: tiger salamanders, China's Giant Panda

Cockroaches are *generalist*. How has this helped them to survive forever? *They can eat almost anything, live and breed almost anywhere, high reproductive rates, and can go for up to a month without food.*

Native Species

The species that normally live and thrive in a particular ecosystem

vs.

Invasive Species

aka- non-native species that are intentionally or accidentally introduced to an ecosystem

What are indicator species and why are they important? Give an example.

Species that provide early warnings of damage to a community or ecosystem

EX: Trout indicate if the water is polluted or low on oxygen because they need clean water and high dissolved oxygen to survive.

Describe 3 reasons why amphibians are vanishing:

- 1. Habitat loss and fragmentation of wetlands, deforestation and urban development*
- 2. Prolonged drought that can dry breeding pools*
- 3. Pollution, especially exposure to pesticides*

What are keystone species and why are they important? Give an example.

Keystone species play a large role in sustaining their ecosystem's balance. For example, these species may be pollinators, top predators, creators of breeding grounds or other habitat space

Ex: American Alligator, Bees, Sea Lion, Sea Stars, Lions

What are foundation species and why are they important? Give an example.

Species that play a large role in shaping communities by creating or enhancing habitats that benefit other species

Ex: elephants, beavers