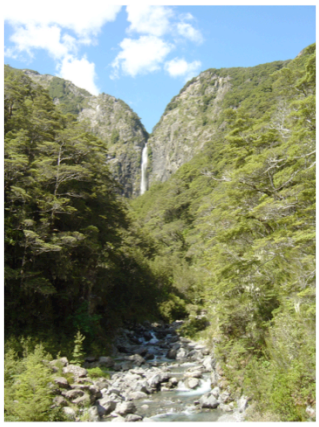
Ecology

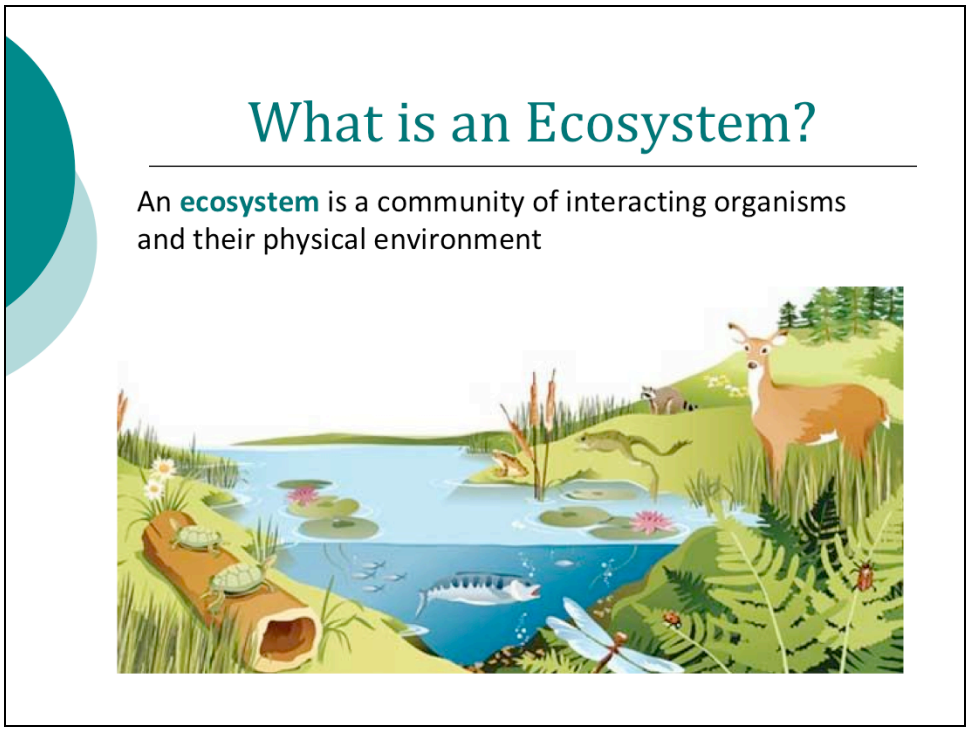
Ecology is the study of the living world and the interactions between organisms and its physical environment.

What is one's Environment?

- One's **environment** is everything in its surroundings both living and not.
- Living components (**biotic**):
  - Plants and animals
  - All need sun, air, water, and earth
  - All grow, eat, drink, breathe, move, and reproduce
- Non-living components (**abiotic**):
  - Air, water, sunlight
  - Rocks & minerals



An animal's environment is everything in its surroundings. The **environment** in which a living thing exists is made up of living (**biotic**) and non-living (**abiotic**) components. Biotic components are the living parts such as plants and animals. Abiotic components are non-living parts which include air, water, rocks and minerals, and sunlight.



An **ecosystem** refers to the interactions between plants and animals and their relationship to the non-living parts of their environment. It refers to a community of living organisms and their environment working together and in a natural balance. To clarify the difference between an ecosystem and an environment: The environment refers to the surroundings where an animal lives. The term "environment" does not include the relationships that exist between living organisms and their physical surroundings. The ecosystem includes the interactions between the environment and the organisms that dwell within it.

What is a Habitat?

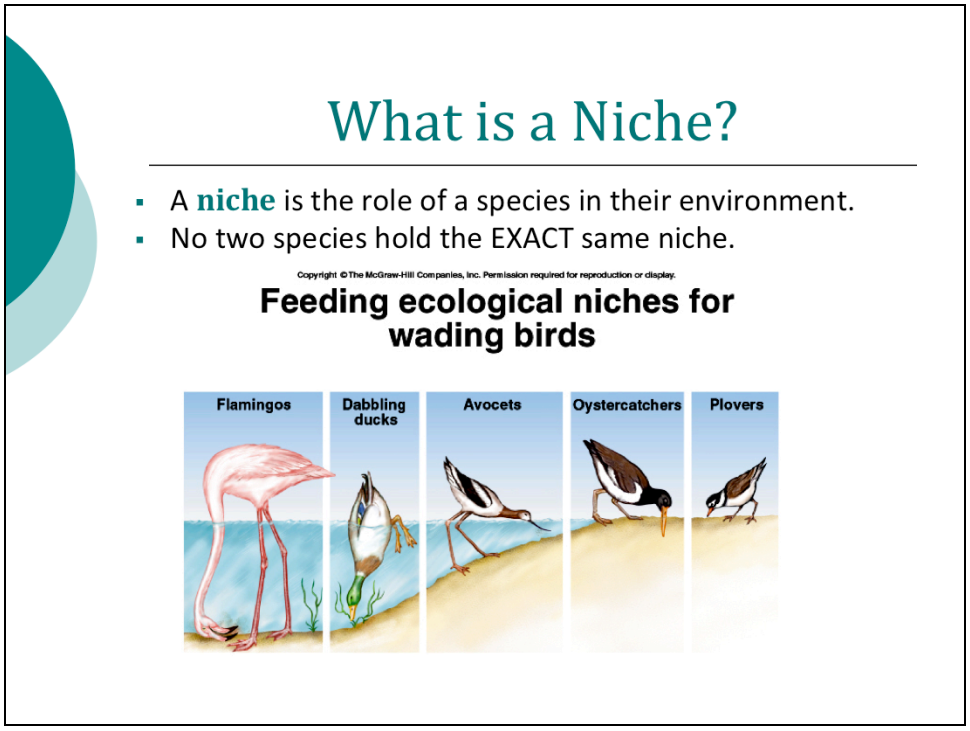
- A **habitat** is where something lives; its address
- This includes everything an organism needs to survive:
  - Food
  - Air and water
  - Shelter and space
  - Sunlight
  - Others of its kind

A **habitat c**ontains everything that an animal needs to survive, including air, food, water, shelter, sun, space and other animals of its own kind so that it can reproduce. A habitat is the specific environment in which any given organism or any given population lives. Factors that determine whether an organism can live in a specific habitat include climate, available food sources, available plant life (provides food and shelter), other species it interacts with and predators (presence or absence of).

Compare the adaptations of the animals at the zoo who live in similar habitats. For example, compare the North American river otter and the Magellenic penguin. They both live mostly in the water and have streamline bodies, designed for swimming, but one is a mammal and the other is a bird.

Compare the meerkat and the prairie dog adapted similar social structures in their underground burrows but one is a herbivore and lives in grasslands and the other is a carnivore, living in the desert.

What type of adaptations do animals of the desert have?



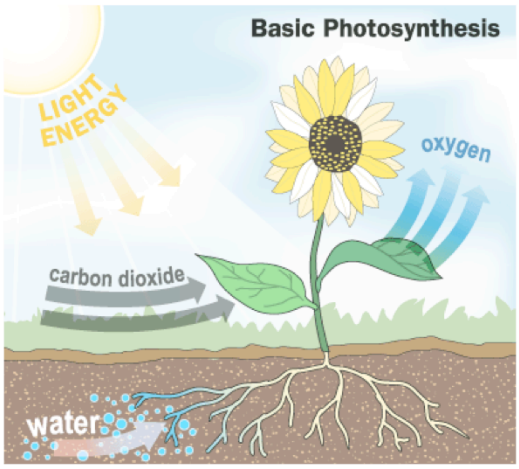
The **niche** refers to the "role" or "job" a species plays in its environment; it describes the way of life of that species and how they use resources and respond to their competitors. In describing a niche, you want to ask where it lives, when it is active and what it eats. For example, the niche of a two-toed sloth would be a herbivorous, nocturnal, arboreal species and a giraffe's niche is a herbivorous, diurnal, and terrestrial.

Each species is thought to have a separate, unique niche; no two species can occupy exactly the same niche. Species may share the same habitat, but their roles (or jobs) are different. If two species are competing for the same niche, the one that is best adapted to the range of conditions present will prevail.

In a natural situation, species may occupy the same habitat, but they may use the habitat at different times of day, eat different foods or use different parts of the habitat. Those who forage at night are **nocturnal**. Those who hunt during the day are **diurnal** and those who hunt during the twilight (either dawn or dusk) hours are considered **crepuscular**. Competition for resources affects the number of individuals in a particular species and the total number of species that can coexist in a given habitat.

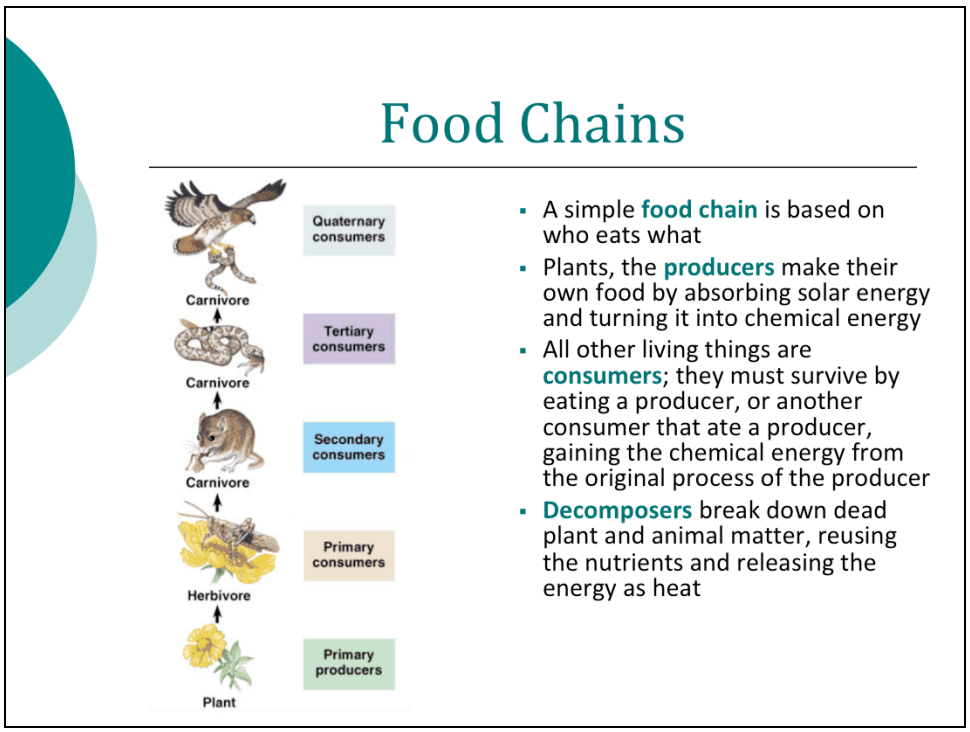
Again, compare animals in similar habitats. How do they share/compete for resources? In the photo above, all these shore birds live in similar habitats but eat different types of food in slightly different parts of the shore. Another example of this is the great migration herds of Africa. These animals move around seasonally to follow the water and find sufficient graze. How is it possible that so many large herbivores coexist in Africa? That incredible diversity is possible because each species has a distinct diet. These grazers eat different part of the grass blade or even different grass species. The Zebra eats the coarser tips of the grass and are the first herd to come through, while the Impala and the wildebeest like the newer lower part of the blade.

Photosynthesis



Almost all of life on the surface of the earth is fueled by energy from the sun. Light from the sun is absorbed by chlorophyll contained in the plant's leaves. The leaves absorb carbon dioxide from the atmosphere and water is brought to the leaves through vessels that start in the plant's roots in the soil. The solar energy fuels a chemical reaction between carbon dioxide and water to produce glucose, the main nutrient that supports plant growth.

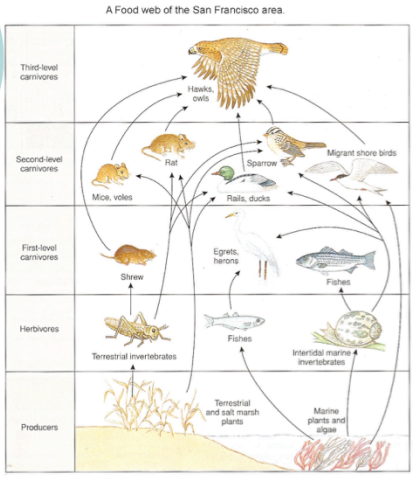
Oxygen is a by-product of this reaction and is released into the air. This is the process of **photosynthesis**. The oxygen released during photosynthesis can be used during respiration by both plants and animals. Plants must respire just as animals do; they take in carbon dioxide and give off oxygen. Their photosynthetic activity is however greater than their respiratory activity resulting in an increase in atmospheric oxygen levels.



Plants derive energy from the sun and nutrients from the earth; they in turn supply both to the animals. Plants are the **producer**, and make their own energy by **photosynthesis**. All other living things are **consumers**; they get energy from the food they eat. A **primary consumer** or **herbivore** eats plants, whereas a **secondary consumer** eats a primary consumer and is a **carnivore**. An **omnivore** may eat both meat and vegetation. **Folivores** eat only stems and leaves. **Frugivores** eat only fruit. **Insectivores** eat only insects. **Note**: insects are considered meat.

Decomposers break down dead plant and animal matter at any level and help **recycle nutrients** back into the soil so that they can be used again. In this way nutrients are cycled through the food chain. (Note: decomposers act as a consumer at all levels).

Food Webs



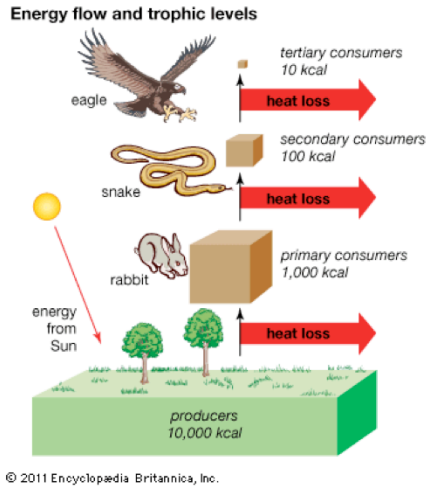
- Food chains are linear and interconnect to form **food webs.**
- A **food web** shows the more complex relationships present in ecosystems, with circular patterns between producers and consumers
- A **keystone species** is a plant or animal that plays a unique and critical role in maintaining the relationships with an ecosystem

All living things are closely related to their environment; any change in one part of an environment, like an increase or decrease of a species of animal or plant, causes a ripple effect of change in other parts of the environment. All species depend on each other to survive, so if one becomes extinct, another species that relies on it could go extinct as well. Individual traits can allow some species to adapt to environmental changes, but many species cannot adapt if their habitat and food chains are greatly altered. Deficiency in any one part of a habitat's ecosystem changes the entire system. If the deficiency is too great, the entire ecosystem can collapse and many species may decline or disappear. Diversity would decrease.

A **keystone species** is a species on which other species in an ecosystem largely depend, such that if it were removed the ecosystem would change drastically. Other species may disappear from that ecosystem or even become extinct. If you keep losing species the ecosystem may collapse. An example of a keystone species is bees. Bees are major pollinators and plants are shelter and food for other animals so losing bees would be a major problem for our ecosystems.

Wolves are top of the food chain and are also keystone species. Wolves prey primarily on large ungulates, hoofed mammals such as deer, elk and moose. They usually prey on the most vulnerable (diseased, young, old, weak, injured) individuals. By doing this, wolves keep prey populations healthier and more vigorous. Without the wolves, these large ungulates become too abundant for their habitat and overgraze the vegetation leading to habitat degradation. Thus wolves influence their prey and indirectly influence other animal species and the plant life these species depend on.

Energy Flow and Trophic Levels

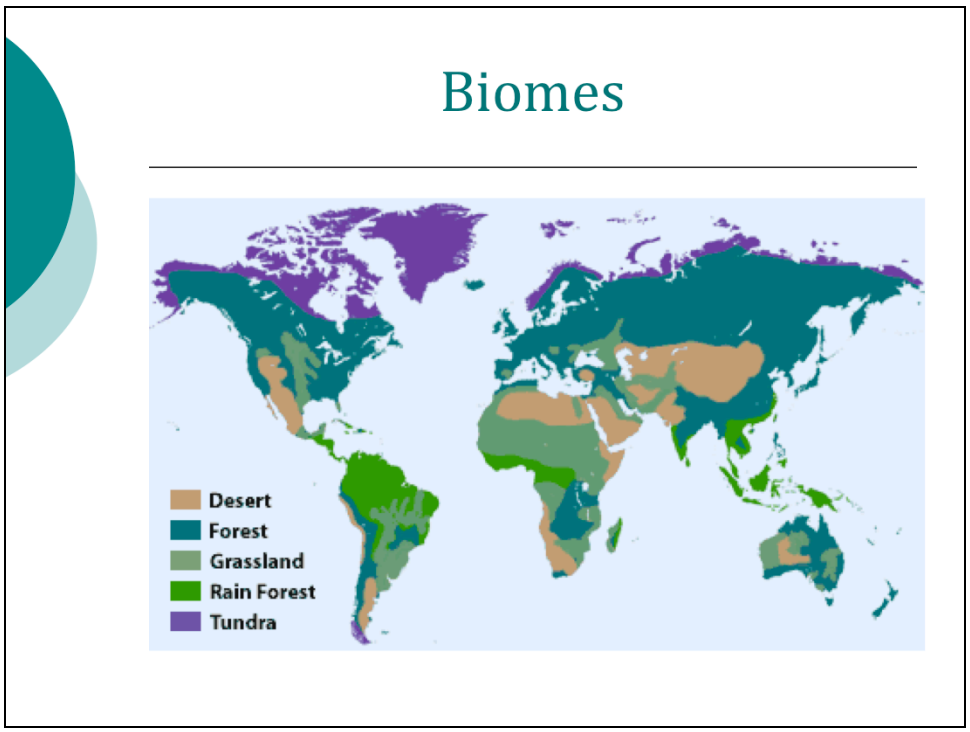


- Organisms of a food chain are classified into levels on the basis of their feeding behavior (**trophic level**)
- **Producers** are on the first trophic level. They collect 1% of the sun's energy
- Energy is used by an organism or lost as heat at each level
- Only 10% of the available energy at any trophic level is transferred to the next level
- The collective mass of all organisms (**biomass**) at each level decreases as the trophic level increases

Energy is transferred from the producer, to herbivore, to consumer/predator and also to the decomposer in an ecosystem. On the first trophic level, plants are able to collect about 1% of the sun's energy. At each successive trophic level only 10% of available energy from that level is transferred to the next level. The rest is used up in metabolic processes, in movement of the animal or is lost as heat.

There are fewer and fewer species at each higher level of the food chain **(trophic level**) as you progress to the top of the pyramid. Since there is a net loss of energy as you move up the food chain, fewer animals are able to be supported at each higher level. The collective mass of all the biological material derived from living, or recently living organisms in an ecosystem at any given time (the **biomass**) becomes less at each higher trophic level.

An important thing to remember is that nutrients are cycled through a food web and returned to the soil by the decomposers. Energy on the other hand is lost at each trophic level to the environment as heat and cannot be recycled.



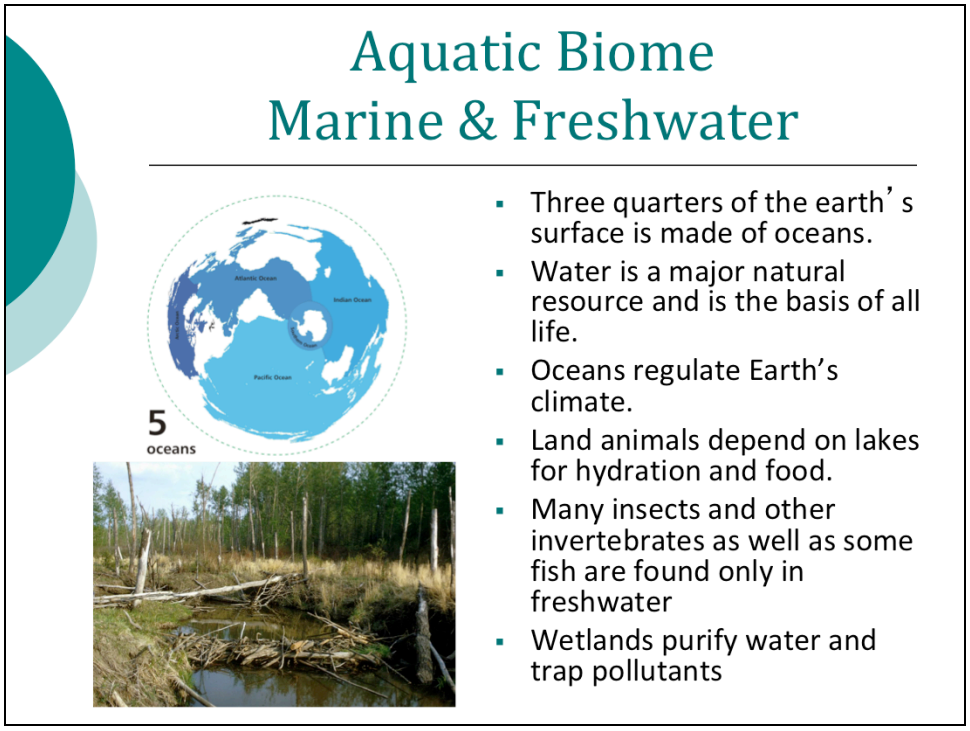
Biologists divide the planet up into different regions that share characteristic vegetation, climate, and wildlife. These **biomes** are defined by climate and dominate plants. The climate is mainly determined by the temperature and rainfall. A biome has a distinctive plant formation and because animal groups depend on plants, each biome supports a characteristic fauna, which are adapted to that particular environment. Each biome consists of many ecosystems whose communities have adapted to the small differences in climate and the environment inside the biome.

There are five principal biomes that you should be aware of: **aquatic**, **desert**, **tundra**, **grassland**, and **forest**.

When giving a habitat tour, you want to compare the different biomes. Ask about the type of vegetation, temperature, and the amount of water that is available for these animals.

Compare animals that live in the same type of biomes. Do you see similar types of adaptations among these animals? What do the animals on the African savanna have in common? What do aquatic mammals have in common?

Note: some animals may live in multiple biomes. For example the grizzly bear can be found in the temperate forests but can also be found in higher latitudes in the tundra. This is especially true when animals live at the boundaries of two biomes. You should remember that biomes transition from one biome into the next. There is usually not a clear distinction where one biome starts and the other ends.



The **aquatic biome** includes marine habitats (ocean, coastal waters, estuaries, coral reefs) as well as freshwater habitats (ponds, lakes, streams, wetlands). The marine and freshwater biomes are probably the most important of all the biomes. Water is the basis of life; it supports life and countless species live in it for all or part of their lives.

The world's oceans regulate Earth's climate and have an even greater effect on global climate than forests do. Water has a high capacity for heat, and because the Earth is mostly covered by water, the temperature of the atmosphere is kept fairly constant and able to support life. Oceans circulate heat and water throughout the planet, establishing the underlying conditions that lead to storms and rainfall patterns that can cause droughts and floods. In addition to this climate-buffering capacity, the oceans contain several billion photosynthetic plankton which account for most of the photosynthesis occurring on Earth and the oxygen we breathe.

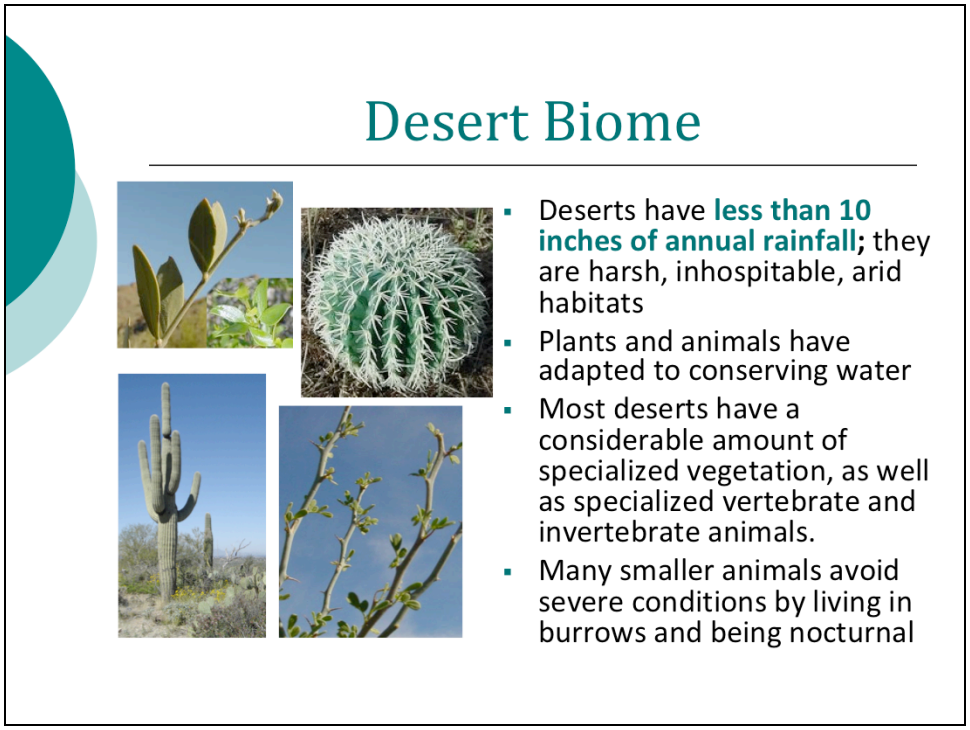
The types of life that live in the **marine biome** are extremely diverse; conditions in water are generally less harsh than those on land. Marine mammals require special adaptations to be able to survive in a marine environment. Extra layers of blubber help to retain body temperatures in cold ocean waters; bodies are streamlined for swimming and they must be able to regulate the salt in their systems. Mammals must come to the surface to breathe air. Marine animals at the Zoo include the California sea lion, Magellanic penguin and the pelicans (white, brown and pink-backed).

The **freshwater biome** biome provides an excellent source of food and minerals to the plants and animals that thrive in and around the water. **Freshwater** is an important resource for animals that live within them as well as on land; amphibians are highly dependent on water for reproduction; diving birds, storks and waterfowl depend on freshwater resources; reptiles such as turtles, alligators, and water snakes live most of their lives in or next to freshwater; mammals such as bears, otters, and beavers are found only near these habitats. Many insects and other invertebrates as well as fish are found only in freshwater.

Some of the same adaptations that are seen in the marine environment are seen in the freshwater environments. Animals are usually streamlined for swimming and are insulated against cold temperatures. Freshwater Zoo animals include the green anaconda, the North American river otter, plumed basilisk and capybara.

Compare and contrast the Magellanic penguin to the North American river otter. One lives in a marine environment, one in freshwater. Compare how they swim. What appendages do they use for propulsion? When you go swimming, you get cold easily. How do the penguin and the otter keep warm?

How do hippos use the water? Hippos use the water during the day to remain cool and to help protect their skin. Look at the location of their eyes and nostrils; they are located high on their heads, which allows them to see and breathe while mostly submerged. How are the position of the eyes and nose of the hippo similar in the green anaconda, another freshwater animal?



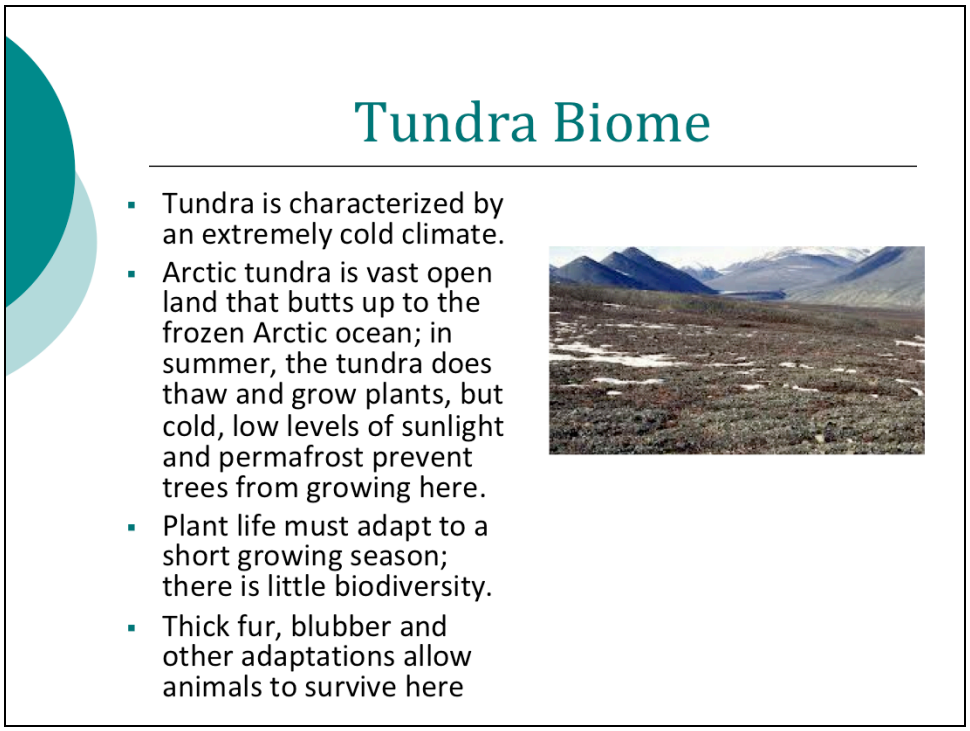
The tundra and desert biomes occupy the most extreme environments, with little or no moisture and extremes of temperature. These two biomes have the fewest number of species due to the stringent environmental conditions.

Deserts cover about one-fifth of the Earth's land surface. They receive **less than ten inches of rain per year**. Deserts have a varying amount of vegetation. Most deserts, however, are home to a limited variety of plants and animals. Water conservation is very important for plants and animals of the desert.

Desert animals have evolved both behavioral and physiological ways to extreme temperatures, arid conditions and limited available food. Most of their water intake comes from the food they eat. Desert dwelling animals at the Zoo include the meerkat, desert tortoise, and the giant desert centipede.

What is the biome of Antarctica? Some say it is a tundra biome and some say it is a desert. What is the right answer? Most of Antarctica is a desert, as it gets less than 10"/year of rainfall. Scientists that work in Antarctica mostly refer to the majority of the continent as being cold desert or polar desert. A lot of people call Antarctica a tundra because they don't know that a desert could be that cold. However, some locations in and around Antarctica have a slightly milder climate. Because it's less harsh, there are more plants (mostly moss and algae, but also some grass). The soils therefore have more organic matter, making these locations more like a tundra ecosystem. However, Antarctica is not as diverse or complex as the Arctic tundra.

What adaptations do the tortoise and the centipede have that protect them from predation as well as prevent them from drying out? What adaptations do some of the plants have?



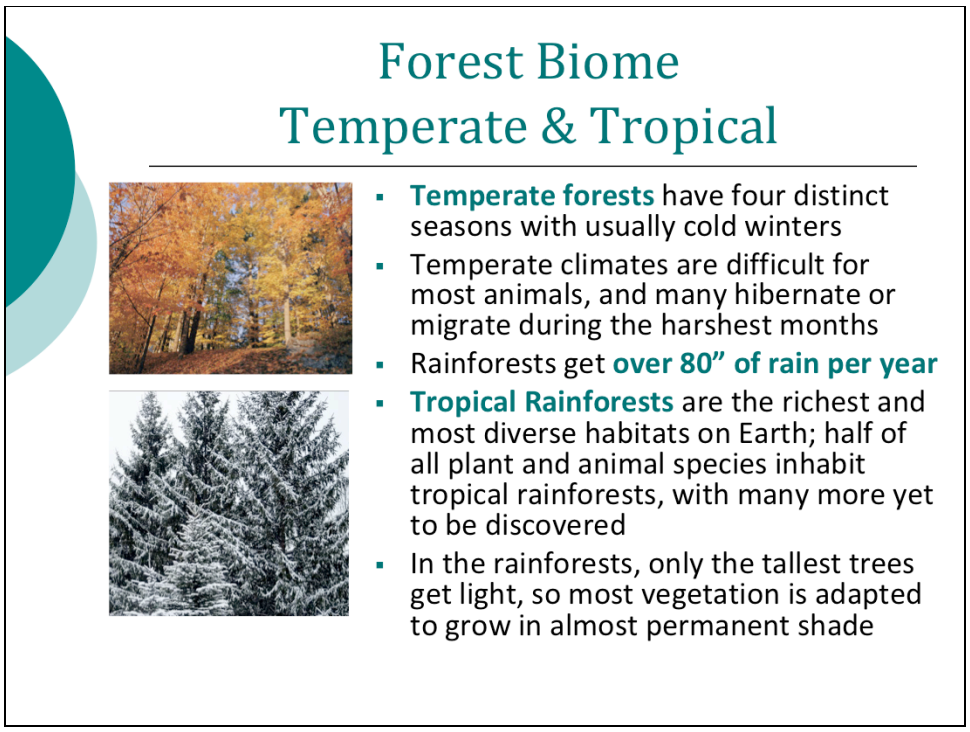
The **tundra** is characterized by severe cold. The tundra covers the northernmost regions of North America and Eurasia, about 20% of the Earth's land area. This biome receives about **8-10 inches/year** of rainfall. Snow melt makes water plentiful during summer months. Winters are long and dark, followed by very short summers. Water is frozen most of the time, producing frozen soil, permafrost. The tundra is a very fragile environment.

During the summer months, the tundra does thaw and plants such as grass and shrubs grow, but it's too cold for trees. There are also plenty of patches of lichens and mosses. Dwarf woody shrubs flower and produce seeds quickly during the short growing season.

A few animals highly adapted to cold live in the tundra year-round. Thick fur, blubber and other adaptations allow animals to survive in these harsh conditions. During the summer the tundra hosts numerous insects and migratory animals.

What special adaptations do wolverines have that allow them to survive the winter months without hibernating? What adaptations does the reindeer have? Look at their splayed hooves. How is this an adaptation to their cold, snowy habitat? Look at their large nose. How does this help them to survive? Of course, their sense smell of helps the reindeer find food hidden under snow, locate danger, and recognize direction. Their noses also act as heat exchangers, warming the inhaled arctic air before it enters their lungs and retaining the heat from the exhaled air.

The zoo's Arctic species include the wolverine, grizzly bear (this is one habitat of the grizzly; they can also be found in temperate forests) and during the Christmas holiday season, reindeer.



The **forest biome** includes areas that are dominated by trees and other woody vegetation. Today, forests occupy approximately one-third of Earth's land area. They are found in tropical and temperate areas. Tropical areas are around the equator between the Tropic of Cancer (latitude ~23.4 N) and the Tropic of Capricorn (latitude ~23.4 S). Temperate zones (~30-60^0 latitude) lie between the tropics and the polar regions.

Temperate forests are made up of a mixture of coniferous and deciduous trees (see photos). Wind pollinated species are predominant. The average yearly precipitation is 30 – 60" and there is a well-defined growing season. The winter season is difficult for most animals, and many hibernate during the harshest months, with many birds migrating. Predators have a hard time finding food during these harsh months and may have to travel long distances to find sufficient food. Why might denning up for the winter be an adaptation for the grizzly bear in a temperate forest? How does the birth of bear cubs sync with the seasons and their denning up?

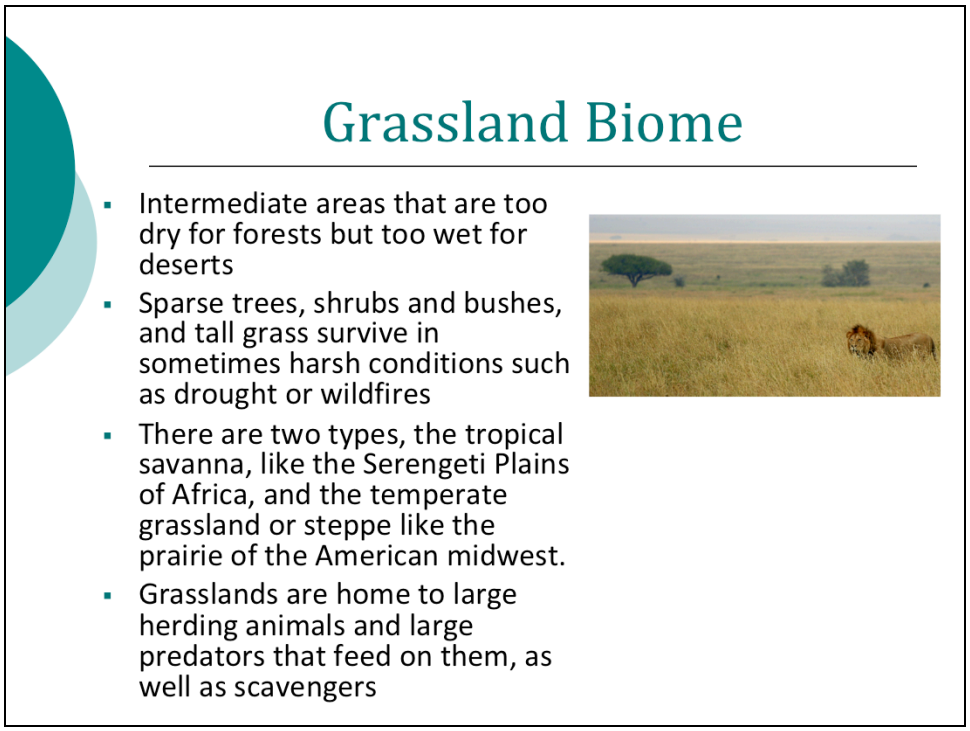
Temperate forests are dominated by relatively few species, in contrast to the tropical forests which contain thousands of species, none of which dominates. Birds are plentiful here because there are many insects for them to feed upon. You will also find quite a few larger animals living in the temperate forest biome. Some temperate forests animals that are at the zoo include grizzly bear, Amur tiger, wolverine and the bald eagle.

Rainforests get **over 80 inches of rain per year,** which falls throughout the year; they are very lush and wet. There are rainforests in both tropical and temperate environments. **Note:** only a small percentage of tropical forests are rainforests. Both temperate rainforests and tropical rainforests are rich in plant and animal species although the diversity is greater in the tropical rainforest. Tropical rainforests are warm and moist; while temperate rainforests are cooler. An example of a temperate rainforest would be along the coast of the Pacific Northwest from Northern California up through Oregon, Washington and into Canada.

Tropical **rainforests** are the richest and most diverse biome on earth. Scientists estimate that more than half of all the world's plant and animal species live in tropical rain forests, with many more yet to be discovered. Tropical rainforests have a warm, wet climate year round, and vegetation is dense. Flowering plants are predominant and are fertilized mainly by insects, birds and bats. Only the tallest trees get light, so most vegetation is adapted to grow in almost permanent shade. With its yearlong growing season, tropical forests have a rapid cycling of nutrients. Soils in tropical rain forests tend to have very little organic matter since most of the organic carbon is tied up in the standing biomass of the plants.

Why do you think that carnivorous plants adapted to eating insects? Why do you think birds migrate north (in the northern hemisphere) in the summer when there are so many diverse plants and insects that they could feed from in the tropical rain forest?

Some tropical rainforest animals at the zoo include two-toed sloth, howler monkeys, black and white and red ruffed lemur, Sumatran tiger, and green-winged macaw as well as many birds, reptiles, and amphibians that are in the tropical rainforest building. You will also find some tropical rainforest arthropods in the Insect zoo.

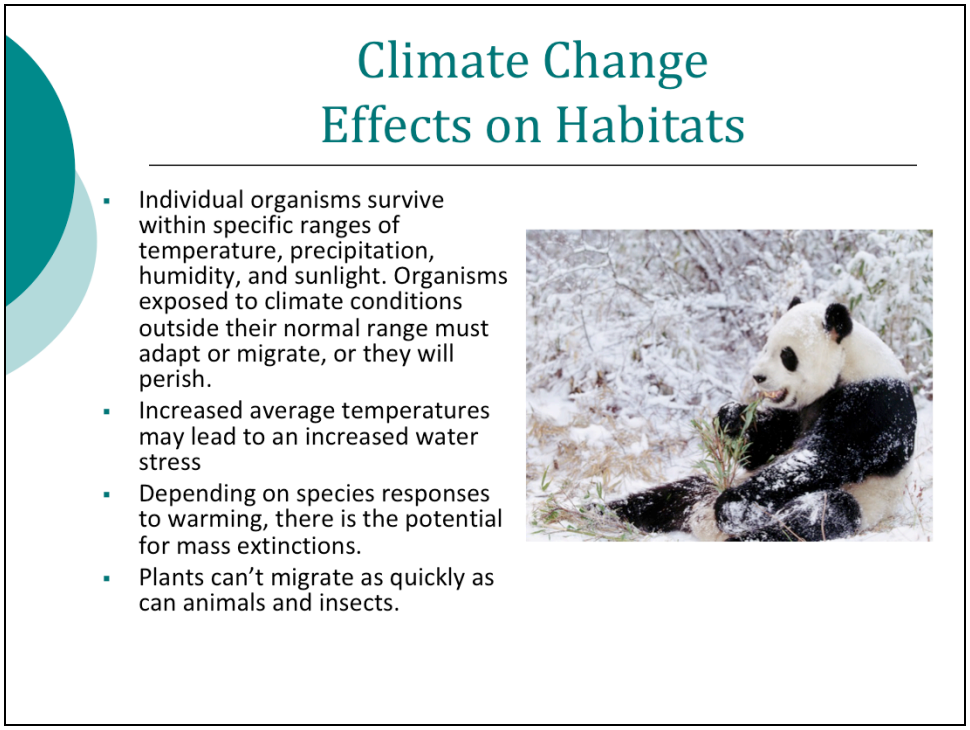


Grasslands are the intermediate areas that are too dry for forests but too wet for deserts. There are sparse trees, shrubs and bushes, and tall grass survive in sometimes harsh conditions such as drought or wildfires; grasses can survive fires because they grow from the bottom instead of the top. Grasslands occur in temperate and tropical areas with reduced rainfall (10-30 inches per year) or prolonged dry seasons.

There is quite a bit of diversity found among the animals living in the grassland biome. They include those that burrow under the ground, those that graze and eat the grass, and those that consume other animals that live in this biome. **Grazers** and **browsers** are plentiful. They divide up resources, eating from all different parts of the shrub or grass shoot; some eat only the tips, some eat the middle, and some only eat new shoots or roots. Grazers eat the grass on the ground and browsers eat the vegetation on bushes and trees. The differentiation between browsers and grazers is one way in which ungulates (hoofed mammals) can partition food resources. Resource partitioning, in response to competition for food, ultimately allows species to exploit different diets and to co-exist without competing. This is the whole idea that no two species can occupy the same **niche**.

Zoo animals that inhabit grasslands include the lion, giraffe, zebra, kudu, black rhino, kangaroo, and prairie dog.

What does a kangaroo do to remain cool and help conserve water in the hot/dry environment? Many animals use panting to remain cool. A kangaroo will rest during the hottest part of the day or may lick its wrists to help maintain its body temperature (**thermoregulation**).



Climate change poses a fundamental threat to the habitats and species who live in them; there is increased extinction pressure on plant and animal species. With these changes, species have to adapt to new climate patterns (variations in rainfall; longer, warmer summers, etc.). This gradual climate pressure, in combination with other sources of habitat loss, degradation, and over-exploitation, is already putting some species at greater risk of extinction.

The polar bear is a poster child for climate change. They rely heavily on Arctic sea ice when hunting for food. During the long summer months, they are starving as the ice melts earlier each spring and arrives later in the fall.

In freshwater habitats, warmer water temperatures will cause population declines for trout, salmon and many other species that require cold water to survive. These changes all effect the food web.

Climate change has altered food availability for migratory species too; birds arrive on schedule to find their food sources (insects, seeds, flowering plants) have hatched or bloomed too early or not at all. If the growing season starts earlier and earlier, the production of flowers and the arrival (either by migration or birth) of their pollinator might not be coordinated and the flowers may not get pollinated.

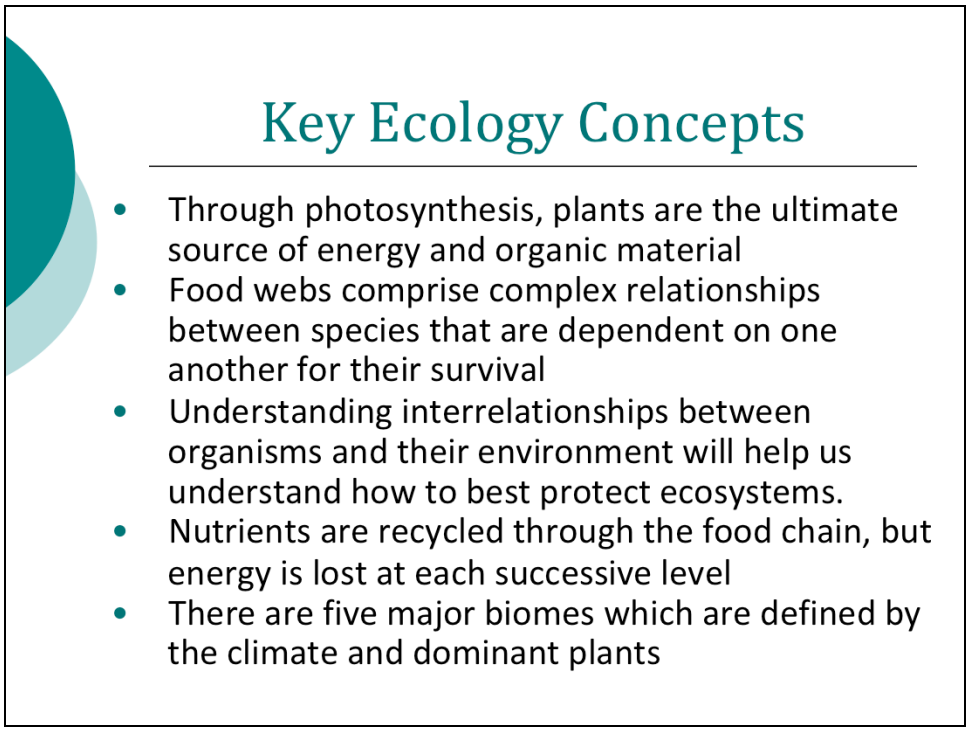
San Francisco is on the Pacific flyway, a major migratory passageway for many species of birds. Along the Pacific Coast is a critical waterfowl habitat consisting of coastal marshes and estuaries which all could be affected by sea-level rise, changes in inland precipitation patterns and a significant decline in average mountain snowpack.

The fate of many species in a rapidly warming world will likely depend on their ability to migrate away from increasingly less favorable climatic conditions to new areas that meet their physical, biological, and climatic needs. Some species are more adaptable than others. Many species will not be able to relocate themselves fast enough to keep up with these changes. Ecosystems will likely be changed by filtering out species that are not highly mobile and favoring a less diverse, more "weedy" vegetation and ecosystems that are dominated by pioneer species, invasive species.

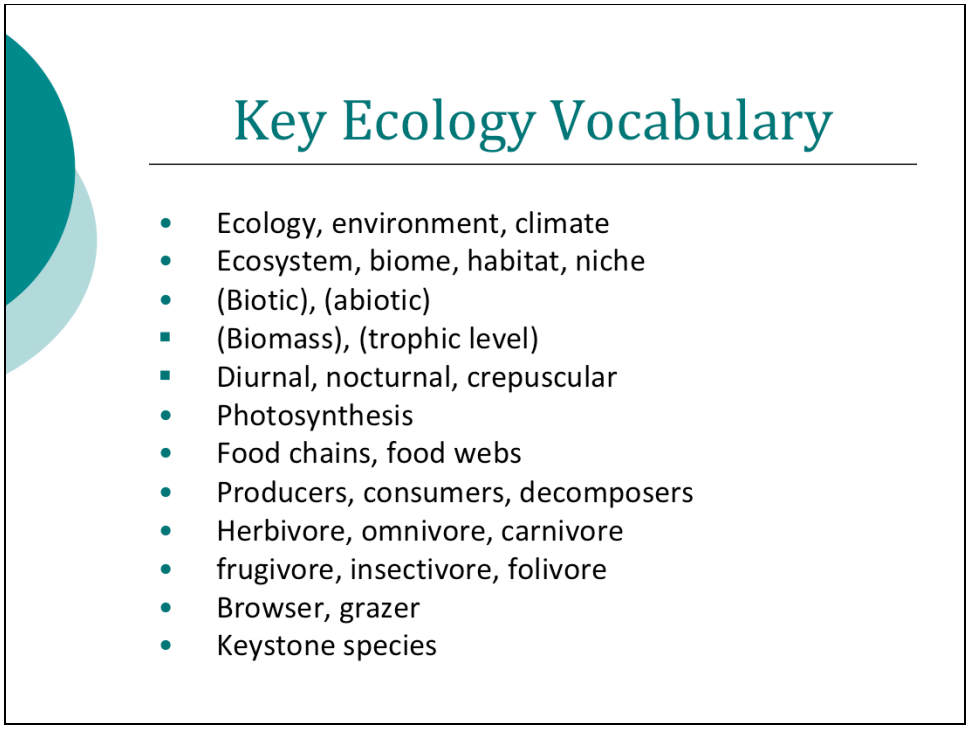
The giant Burmese python is thought to be a species that would thrive in the warming temperatures; they are highly adaptable to new environments. USA Today published an article in February 2008 that states the giant Burmese python could colonize one-third of the USA, including San Francisco. The pythons can be 20 feet long and 250 pounds.

Most plants can't migrate very quickly, compared to animals and insects. They are restricted by how far their seed or pollen can travel. Thus, the climate will change too fast for plants to migrate if current trends continue. Many animals and insects need specific plants, or types of plants, as part of their habitat. So the loss of plant species will have a ripple effect, leading to more animal and plant extinctions.

What about the species that are particular in what they eat such as the giant panda, red panda and koala?



Corresponds to pages 10-16 in Zoology Study Guide, 6, 9-11 in the Botany Study Guide and the Habitats Touring Guide of the Docents Notebook.



Definitions:

Biomass: collective mass of the biological material derived from living, or recently living organisms in an ecosystem at any given time.

Biome: a large community of plants and animals that occupies a distinct region. Terrestrial biomes, typically defined by their climate and dominant vegetation, include grassland, tundra, desert, tropical rainforest, and temperate forests; biomes are defined by their climate and dominant vegetation.

Browser: type of feeding where an animal eats the vegetation on bushes and trees.

Carnivore: an animal that gets its energy from eating other animals.

Climate: the long term prevailing weather patterns of a region as temperature, humidity, wind, precipitation, air pressure in an area are averaged over a series of years. Climate is influenced by latitude, altitude, terrain, and nearby bodies of water.

Consumer: organisms of an food chain that receive energy by consuming other organisms.

Crepuscular: of or relating to activity occurring during the twilight hours, of dawn or dusk.

Decomposer: organisms that break down dead or decaying organisms.

Diurnal: of or relating to activity occurring during the daylight hours.

Ecology: the study of the relationships between living organisms and their physical environment.

Ecosystem: a community of living (**biotic**) and non-living (**abiotic**) things that work together.

Environment: an animal's environment is everything in its surroundings.

Food chain: the linear sequence of who eats what in an ecosystem to obtain nutrition.

Food web: depicts feeding connections in an ecological community.

Frugivore: an animal that eats only fruit

Folivore: an animal that eats only leaves and stems

Grazer: type of feeding where an animal eats the grass on the ground.

Habitat: the specific environment in which any given organism or any given population lives. It is the "address" of the organism. A habitat **c**ontains everything that an animal needs to survive, including air, food, water, shelter, sun, space and other animals.

Herbivore: an animal that gets its energy from eating plants, and only plants.

Insectivore: an animal that eats only insects.

Keystone species: a species on which other species in an ecosystem largely depend, such that if it were removed the ecosystem would change drastically.

Niche: the role or function of an organism or species in an ecosystem

Nocturnal: of or relating to activity occurring during the night hours.

Omnivore: an animal that eats both plants and animals.

Photosynthesis: process used by plants and other organisms to convert light energy, normally from the sun, into chemical energy that can be later released to fuel the organisms' activities.

Producer: organisms in an ecosystem that produce biomass from inorganic compounds; they are plants.