Name: _____Period:___Date:_____
Ms.Randall LE
Unit 8 Ecology and Human Impact

Upon completion of this unit students will be able to

- Define and exemplify the terms ecology, population, community, biosphere and ecosystem.
- Relate biotic and abiotic factors to ecosystem stability.
- Describe interactions and relationships between organisms in an ecosystem.
- Explain the limitations of an ecosystem and the ways in which it maintains homeostasis.
- Describe the nutritional relationships and list examples of saprophyte (decomposer), herbivore, carnivore, omnivore, predator, and scavenger.
- Compare and contrast the energy flow through an ecosystem through a food chain, food web, food pyramid and biomass pyramid.
- Define the term succession and explain how alterations in the environment may lead to successions.
- Explain the role of abiotic cycles to the stability of an ecosystem.
- Explain the cause and some negative consequences of human technology and influence on the environment.

Focus Questions for the Unit:
How do individuals and species interact to form an ecosystem?
How gave humans impacted the stability of the environment?

Define the following vocabulary:

Herbivore
Carnivore
Decomposer
Photosynthesis
Heterotroph
Autotroph
Biosphere
Food web
Carrying capacity
Biotic

Abiotic
Consumer
Producer
Habitat
Niche
Finite resource
pollution
succession
deforestation
symbiosis

<u>Lesson 1: What is Ecology?</u> **Date:_____**

Objective: Define and exemplify the terms ecology, population, community, biosphere and ecosystem.

Ecology is the study of how living and non-living things interact with their surroundings. All living things are interdependent and they interact with each other and the environment. Interactions result in a flow of energy and material cycling. The **environment** is defined as every living and non-living thing that surrounds an organism. The B**iosphere** is all locations in, on, and above earth where life exists; biologically inhabited part of the planet. A **habitat** is an ecological or environmental area that is inhabited by a particular species of animal, plant, or other type of organism.

Organism: an individual living thing ⇨ **Population** – all members of one kind of living things (species) in one place at one time ⇨ **Community:** all the different living things in one place at one time ⇨ **Ecosystem**: all the living and non-living things and their interactions in one place at one time

An **Ecosystem** is any portion of the environment and consists of

<u>Abiotic factors</u> – non-living things (or influences)
*Soil, water, physical space, energy, temperature, rainfall activity, light

<u>Biotic factors</u> – living things affecting others (ex. Predation; competition)
*Relationships between organisms include:
Predator/Prey relationships
Parasite/Host
Disease causer – pathogen
Producer/Consumer
Scavengers
Decomposers

Environmental Limits on Population Size

The growth and survival of organisms depends on physical conditions and the resources available to an organism

If resources were unlimited living things could produce populations of infinite (unlimited) size	If resources are finite (limited), organisms <u>compete</u>

Competition is the struggle among organisms for resources. Competition keeps the population size in check so that over time the population size remains the same. Many populations vary with seasons; populations increase or decrease depending on resources that are available at the time. Interdependence often results in approximate stability over 100's – 1000's of years. As one population increases it's held in check by one or more environmental factors or another species.

Limiting factors are those essential living (biotic) and non-living (abiotic) factors that a population runs out of first. It determines the types of organisms that may exist in an environment.

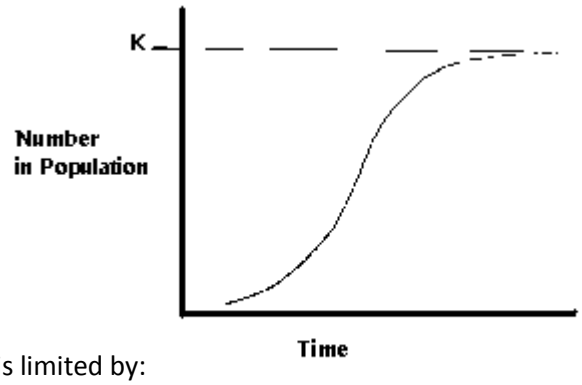
Ex. Abiotic factors that typically become limiting

- Dissolved oxygen in a pond – can limit the kind and numbers of fish living there
- The amount of sunlight – may limit the # of green plants living there
- Intensity of light
- Temperature range
- Minerals in water & soil
- Type of rock and/or soil in ecosystem (how well can it buffer acid)
- Relative acidity (measured on the pH scale)

Ex. Biotic factors that can be limiting

- Relationships between predators (eat) and prey (are eaten)
- Predators – limit the growth of prey
  - if they eat too many they'll use up their food source & predators can face starvation

Carrying capacity is defined as the number of organisms of any one species that an ecosystem can support



The number of organisms is limited by:

Abiotic Factors:

- Available Energy
- Water
- Oxygen
- Minerals

Biotic factors:

- By the ability of ecosystems to recycle residue of dead organisms through the activities of bacteria and fungi.
- By the # and kinds of other organisms present

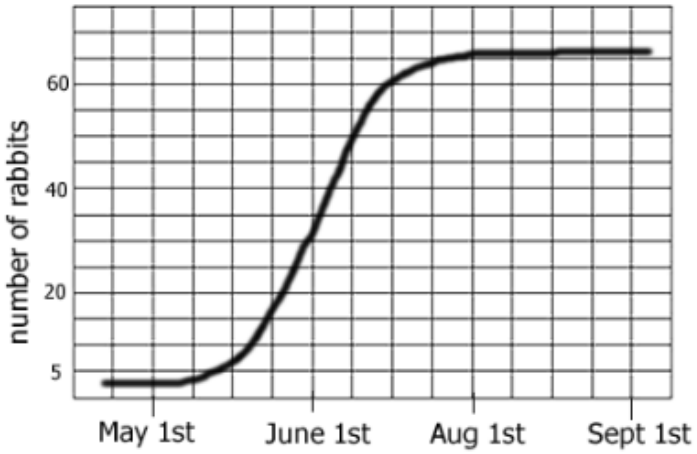
Check your understanding:

A. Ecosystem
B. Habitat
C. Community
D. Population

Choose the most appropriate vocabulary term from the list above

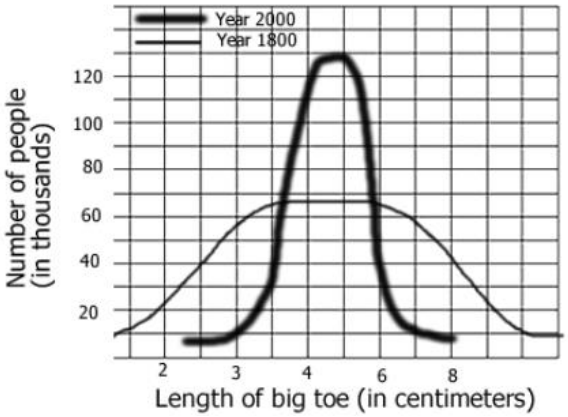
1 _____ All the living and nonliving things in an area
2 _____ All the ants in an anthill
3 _____ An area that provides food and shelter
4 _____ Fish, frogs, turtles, lily pads and dragonflies are all members of the same what?
5 _____ All the blackbirds in your neighborhood
6 _____ A forest
7 _____ The damp soil within a forest in which a mushroom grows
8 _____ Different populations that live together in a particular area
9 _____ A prairie dog, a hawk, and a badger all members of the same what?
10 _____ The rainbow trout in a stream

Practice:



Graph 1: Rabbits Over Time

a. The graph shows a(n) _____ growth curve.
b. The carrying capacity is for _____ rabbits.
c. During which month were the rabbits in exponential growth.

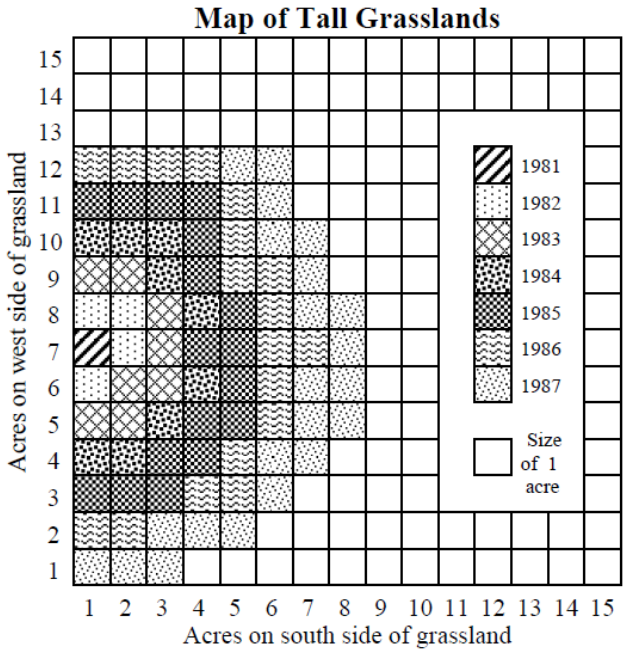


Graph 2: Average Toe Length

a. In 1800, how many people had a 3cm toe?_____
b. In 2000? _____.
c. In 2000, what is the average toe length?_____
d. In 1800? _____

Graph 3:

When immigrants enter a new area, they may change the food chain of the area. If the immigrants are plants eaters, they can destroy native plants. Suppose an animal enters an ecosystem where it has never lived before. A small gray grass mouse that lives on seeds and destroys the roots of grass was trapped in the Tall Grasslands area of a state park in the fall of 1981. The grasslands of the park are made up of a piece of land 15 acres by 15 acres (990' by 990'). From 1981 to 1987, a study took place to find out how many new areas the mice had moved into. The map below shows the Tall Grasslands area and the years that the mice entered each new area.



1. On how many acres did the mice live in 1981, in 1982, and in 1987?

2. In what year might the mice live in every acre of the grassland?

3. On what has the mouse population fed over the years?

4. If the mice kill the grass, what might happen to the mouse population?

5. If the mice kill the grass, what might they do to survive?

6. What can happen to the bare soil after the mice have destroyed the roots of the grasses?

Lesson 2: Population Interactions **Date:**

Objective: To describe interactions and relationships between organisms in an ecosystem

Every population is linked directly or indirectly with all the other populations in an ecosystem

Each population has a distinct role in the ecosystem

As a result, maintaining an ecosystem's diversity is essential to its stability

Diversity is important on all levels:

Cells --> Tissue --> Organ --> Systems--> Organism --> Community--> Energy

Diversity increases the chances that at least some will survive in the face of large environmental changes

Ecological niche = the role that a species plays in an ecosystem

Competitive exclusion principle: only one species can occupy a niche at one time (the other moves or dies out)

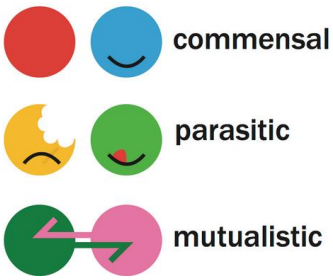
Ex. niche partitioning – moose/deer
warblers/spruce

Competition for a niche often occurs when a foreign species enters an area
-the newcomer may be more successful/may not have natural enemies to control the population
Ex. zebra mussels

Relationships in an ecosystem

1. **Competition –**
   a) between species – to occupy a niche
   b) within a species – for space, water, air, shelter (abiotic)
   - for food, mates (biotic)

2. **Symbiotic relationships** – members of 2 species living in close association
   a) mutualism (+,+)
   b) commensalism (+,0)
   c) parasitism (+,-)



3. **Disease agent** = vector
   Ex. viruses affecting the health of a fox population

4. **Food chains / Food webs** – who eats who?

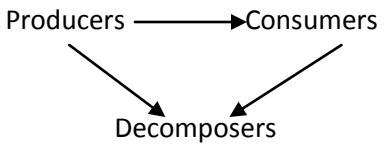
   Relationships between predators, prey & decomposers

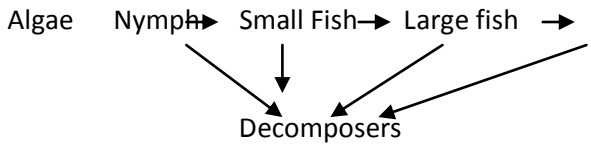
   How organisms obtain food:
   - Autotrophs = producers (make their own food; photosynthesis; chemosynthesis)

   - Heterotrophs = acquire food by consuming other organisms
     - a) Consumers
       - i) herbivores – eat plants
       - ii) carnivores – eat animals
       - iii) decomposers – eat wastes & dead bodies
         These organisms recycle materials so they can be used by other consumers
       - iv) scavengers – eat dead things (but decomposers still deal with wastes and dead bodies)
         Ex. vultures

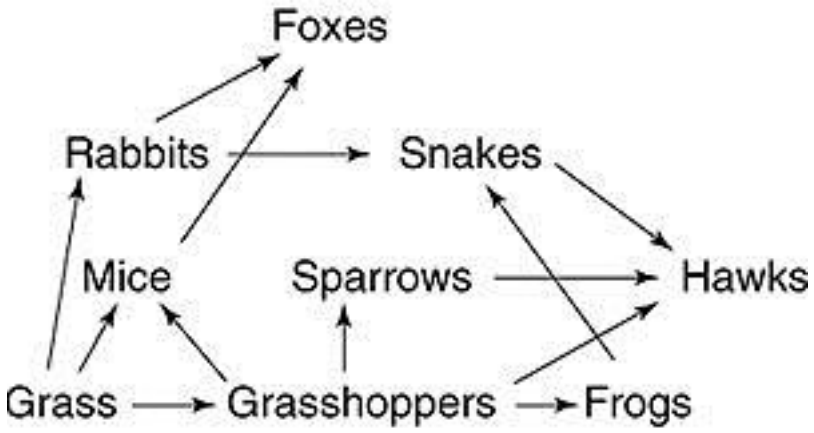
       - v) parasites – attack live organisms but rarely kill them
         *Killing their hosts would eliminate their food

Food Chains

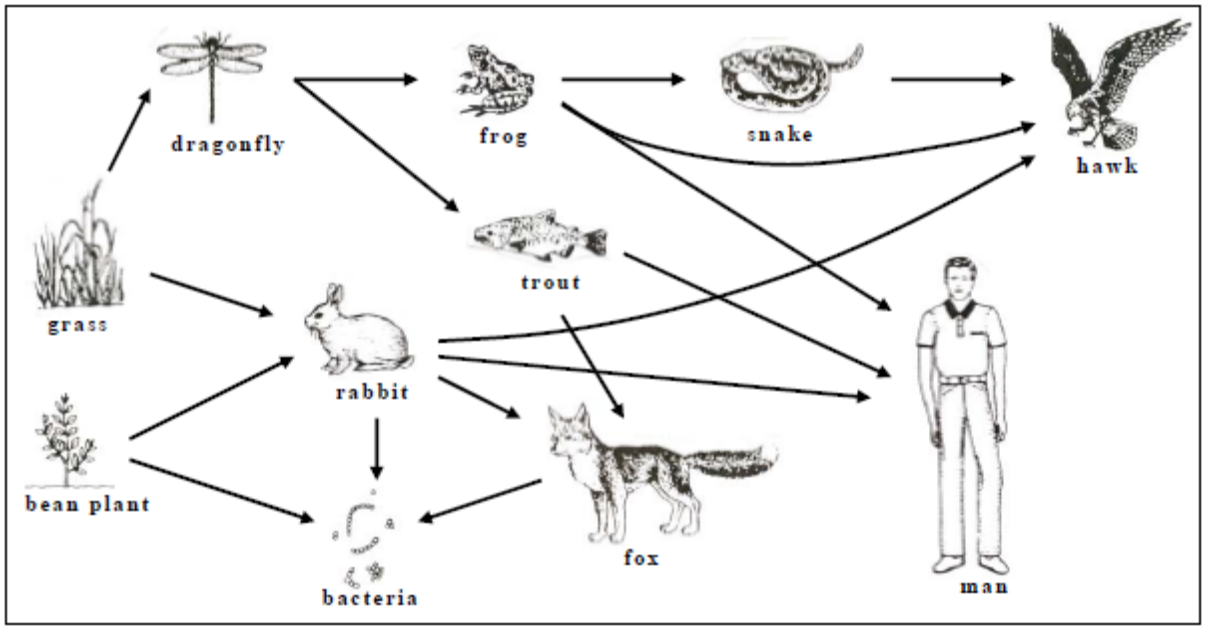




Food Webs – show more complex feeding relationships among producers, consumers, and decomposers
*Because organisms have several food choices ecosystems stay stable even when one population shows a major decline in numbers



Check your understanding:



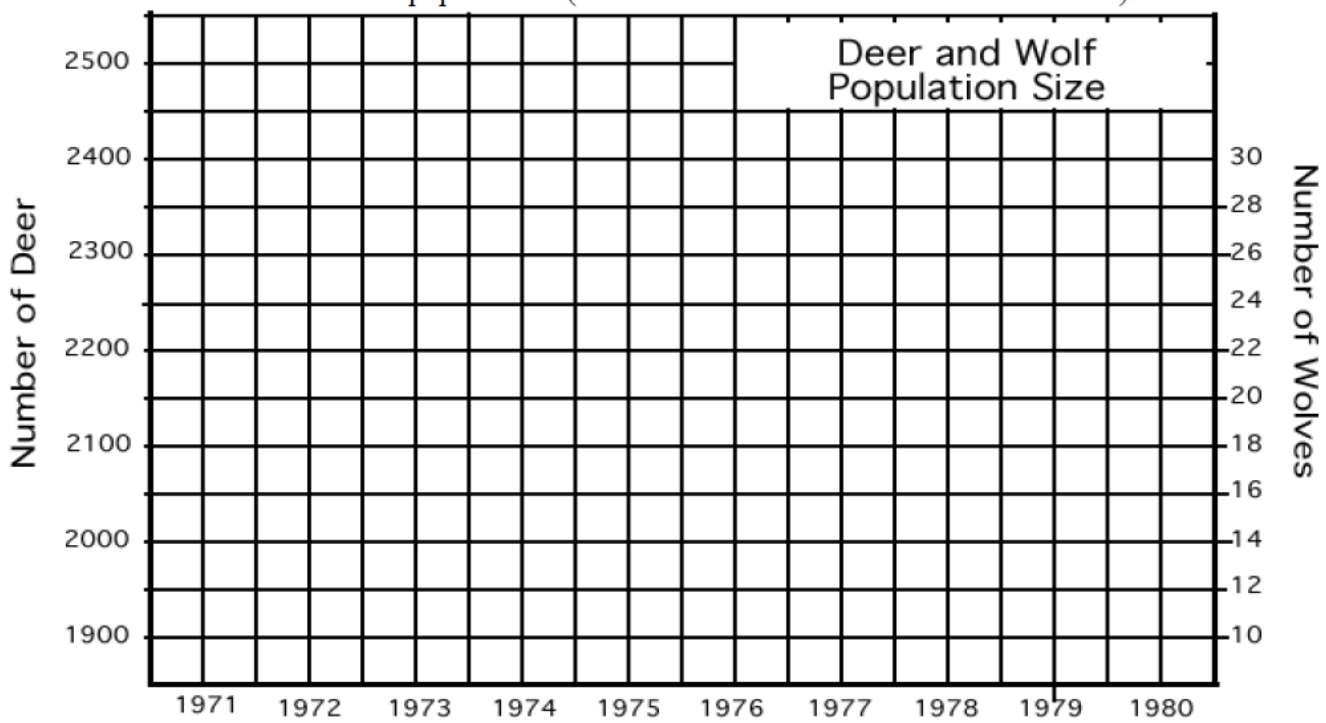
1. List the producers, consumers, and decomposers shown in the food web above.
    a. Producers _____
    b. Primary Consumers _____
    c. Secondary Consumers _____
    d. Tertiary Consumers _____
    c. Decomposers _____
2. What autotrophs are found in this food web? _____
_____
3. What Heterotrophs are found in this food web? _____
_____
4. List one food chain. _____
5. List a second food chain. _____
6. Add one organism to this food web. What is it? _____
    a. What other organisms in the food web will it eat?
    _____
    b. What other organisms in the food web will eat it?
    _____
7. Remove one organism from this food web. What was it? _____
    a. What organisms will benefit from this removal?
    _____
    b. What organisms will suffer from this removal?
    _____
8. Why is a complex food web better than a simple food chain for the survival of the community?
_____
_____

Practice: Deer: Predation or Starvation

Introduction: In 1970 the deer population of an island forest reserve about 518 square kilometers in size was about 2000 animals. Although the island had excellent vegetation for feeding, the food supply obviously had limits. Thus the forest management personnel feared that overgrazing might lead to mass starvation. Since the area was too remote for hunters, the wildlife service decided to bring in natural predators to control the deer population. It was hoped that natural predation would keep the deer population from becoming too large and also increase the deer quality (or health), as predators often eliminate the weaker members of the herd. In 1971, ten wolves were flown into the island. The results of this program are shown in the following table. The Population Change is the number of deer born minus the number of deer that died during that year. Fill out the last column for each year (the first has been calculated for you).

Year	Wolf Population	Deer Population	Deer Offspring	Predation	Starvation	Deer Population Change
1971	10	2,000	800	400	100	+300
1972	12	2,300	920	480	240	
1973	16	2,500	1,000	640	500	
1974	22	2,360	944	880	180	
1975	28	2,224	996	1,120	26	
1976	24	2,094	836	960	2	
1977	21	1,968	788	840	0	
1978	18	1,916	766	720	0	
1979	19	1,952	780	760	0	
1980	19	1,972	790	760	0	

1. Graph the deer and wolf populations on the graph below. Use one color to show deer populations and another color to show wolf populations. (Or make one line solid and the other dashed.)



Analysis:

1. Describe what happened to the deer population between 1971 and 1980.

2. Describe what happened to the wolf population between 1971 and 1980.

3. What do you think would have happened to the deer on the island had wolves NOT been introduced?

4. Most biology textbooks describe that predators and prey exist in a balance. This "balance of nature" hypothesis has been criticized by some scientists because it suggests a relationship between predators and prey that is good and necessary. Opponents of this hypothesis propose the following questions:

    a. Why is death by predators more natural or "right" then death by starvation?

    b. How does one determine when an ecosystem is in "balance"?

    c. Do predators really kill only the old and sick prey? What evidence is there for this statement?

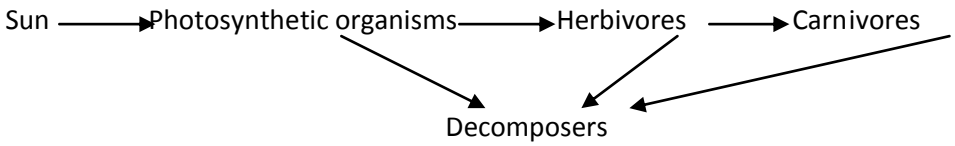
    d. What is your opinion of the balance of nature hypothesis?

    e. Would the deer on the island be better off, worse off, or about the same without the wolves? Defend your position.

Lesson 3: Energy Flow through an Ecosystem **Date:_____**

Objective: To compare and contrast the energy flow through an ecosystem.

Energy flows through an ecosystem in one direction



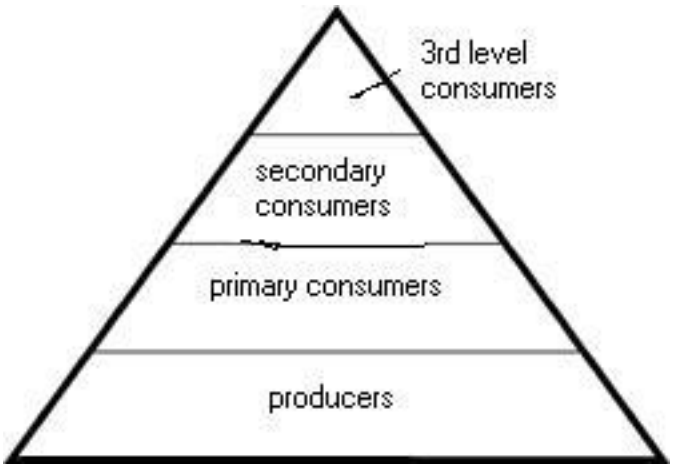
Chemical elements that make up living things pass through food webs and are combined and recombined in different ways

- At each link in a food web, some E is stored in newly made structures – but

MOST of the energy is lost (dissipated) into the environment as heat.

Food chains are usually short because Energy is lost at each stage

Energy Pyramid



*Each block gets smaller as you go up because energy is lost.

*These pyramids also illustrate the relationships between the numbers of organisms belonging at each level and the relative amount of biomass present

*Decomposers aren't shown in the energy pyramid because they get their energy from each level

*The sun provides continual energy input
-required to start the process & keep it going

***Biomagnification** = the concentration of toxins increases as you move up the food chain.
*Producers absorb a small amount of the compound, herbivores eat lots of producers so their concentrations are higher; carnivores eat lots of herbivores so even more toxin is present in the higher level consumers

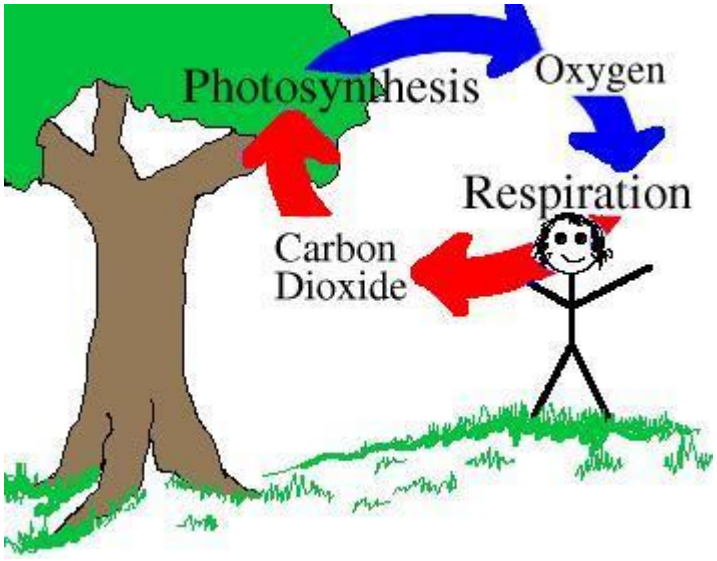
Recycling and reusing materials

Decomposition = the process of breaking down dead organisms and their wastes & returning materials to the ecosystem

Decomposers – Ex. bacteria and fungi

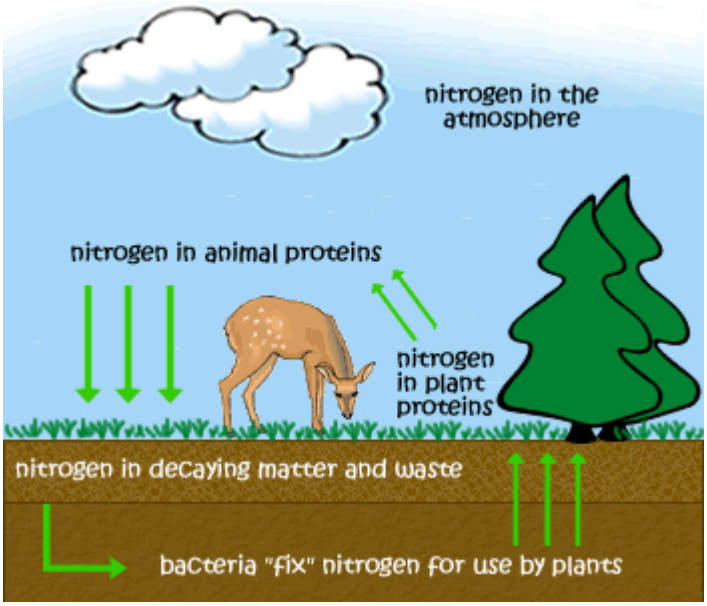
Nutrient cycling

CO_2 – O_2 cycle



Nitrogen cycle

Excretion – recycling of nitrogenous wastes
Decomposition – recycling of nitrogenous wastes



Check your understanding:

1. Where does a majority of life on earth originally get its energy from?

2. Explain how heterotrophs get their energy from the sun even though they cannot make their own food from the sun.

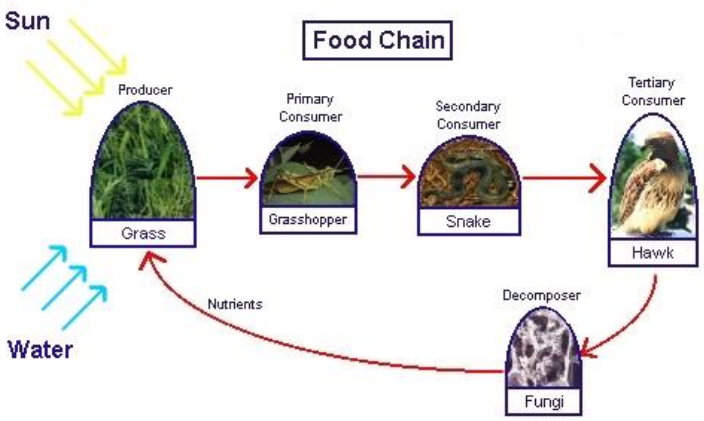
3. Organisms that make their own food from the sun are called _____, whereas organisms that must obtain energy from the foods they consume are called _____.

4. Describe what an energy pyramid shows.

<u>Practice:</u> FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

In an ecosystem, plants capture the sun's energy and use it to convert inorganic compounds into energy-rich organic compounds. This process of using the sun's energy to convert minerals (such as magnesium or nitrogen) in the soil into green leaves, or carrots, or strawberries, is called ***photosynthesis***.

Photosynthesis is only the beginning of a chain of energy conversions. There are many types of animals that will eat the products of the photosynthesis process. Examples are deer eating shrub leaves, rabbits eating carrots, or worms eating grass. When these animals eat these plant products, food energy and organic compounds are transferred from the plants to the animals. These animals are in turn eaten by other animals, again transferring energy and organic compounds from one animal to another. Examples would be lions eating zebras, foxes eating rabbits, or birds eating worms.

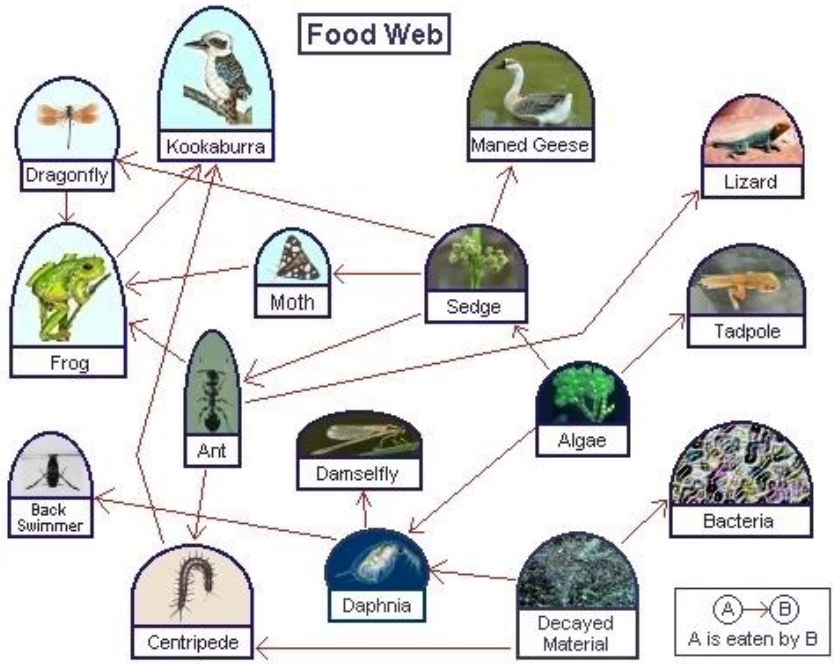


This chain of energy transferring from one species to another can continue several more times, but it eventually ends. It ends with the dead animals that are broken down and used as food or nutrition by bacteria and fungi. As these organisms, referred to as decomposers, feed from the dead animals, they break down the complex organic compounds into simple nutrients. Decomposers play a very important role in this world because they take care of breaking down (cleaning) many dead material. There are more than 100,000 different types of decomposer organisms! These simpler nutrients are returned to the soil and can be used again by plants. The energy transformation chain starts all over again.

Producers: Organisms, such as plants, that produce their own food are called autotrophs. The autotrophs, as mentioned before, convert inorganic compounds into organic compounds. They are called producers because all of the species of the ecosystem depend on them.

Consumers: All the organisms that can not make their own food (and need producers) are called heterotrophs. In an ecosystem heterotrophs are called consumers because they depend on others. They obtain food by eating other organisms. There are different levels of consumers. Those that feed directly from producers, i.e. organisms that eat plant or plant products are called primary consumers. In the figure above the grasshopper is a primary consumer.

Organisms that feed on primary consumers are called secondary consumers. Those who feed on secondary consumers are tertiary consumers. In the figure above the snake acts as a secondary consumer and the hawk as a tertiary consumer. Some organisms, like the squirrel are at different levels. When the squirrel eats acorns or fruits (which are plant product), it is a primary consumer; however, when it eats insects or nestling birds, it is a tertiary consumer. Consumers are also



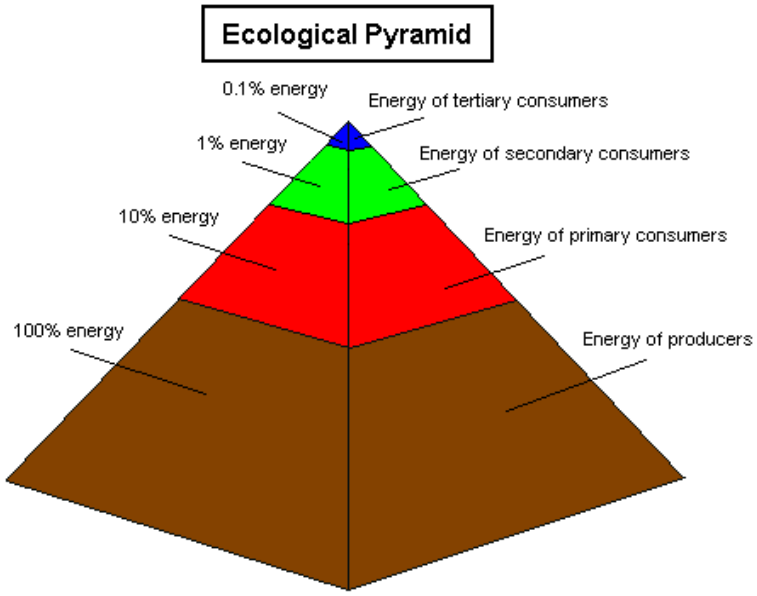
classified depending on what they eat; they can be herbivores, carnivores, omnivores or scavengers.

In looking at the previous picture, the concept of food chain looks very simple, but in reality it is more complex. Think about it. How many different animals eat grass? And from the Facts about Red-tailed Hawks page, how many different foods does the hawk eat? One doesn't find simple independent food chains in an ecosystem, but many interdependent and complex food chains that look more like a web and are therefore called food webs.

We described in the previous sections how energy and organic compounds are passed from one trophic level to the next. What was not mentioned is the efficiency of the transfer. In a highly efficient transfer almost all of the energy would be transferred -- 80% or more. In a low efficiency transfer very little energy would be transferred -- less than 20%. In a typical food chain, not all animals or plants are eaten by the next trophic level. In addition, there are portions or materials (such as beaks, shells, bones, etc.) that are also not eaten. That is why the transfer of matter and energy from one trophic level to the next is not an efficient one.

One way to calculate the energy transfer is by measuring or sizing the energy at one trophic level and then at the next. Calorie is a unit of measure used for energy. The energy transfer from one trophic level to the next is about 10%. For example, if there are 10,000 calories at one level, only 1,000 are transferred to the next. This 10% energy and material transfer rule can be depicted with an ecological pyramid that looks like the one below.

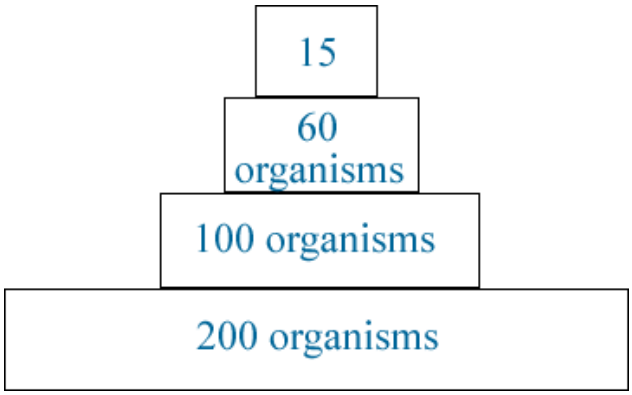
This pyramid helps one visualize the fact that in an ecological system there need to be many producing organisms at the bottom of the pyramid to be able to sustain just a couple of organisms at the top. In looking at the pyramid, can you guess how much larger the volume of each layer is as compared to the one just above it? Take a guess. It might not look like it but they are close to 10 times larger.



A basic pyramid shape often represents a typical food chain or food web. The pyramid represents the decrease in the amount of energy, the number of organisms and the biomass from the producer to the high - order consumer levels. The decrease in the numbers and in the biomass represent the fact that, due to energy loss, fewer organisms can be supported at each successive trophic level.

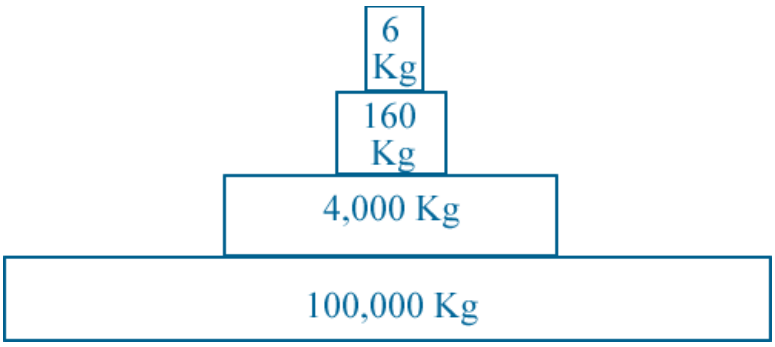
Pyramid of Energy

Energy is lost between each link in a food chain. Much of the potential energy at each level never reaches the next level. Where does the energy go as it moves through a food chain? Some of the energy that enters a food chain is used as each organism carries out its life functions (i.e. foraging, metabolic processes, reproduction, predator/prey behavior, etc.). Producers manufacture their own food source directly from sunlight by the process of photosynthesis. In order to carry out life functions, consumers acquire energy through the 'burning' or breaking down of food molecules they consume (eat). Thermal energy (heat) is produced as a result of the burning of these food molecules. More than half of the energy from each food molecule is lost as heat. Only about 10% - 20% of energy at each trophic level is available to pass on to the next level. In other words, at each level there is only about 10% available energy to put on new biomass (growth).



Pyramid of Numbers

The loss of energy at each trophic level also explains why there are usually fewer organisms in each higher trophic level. The total number of plants in a particular area would generally be higher then the number of herbivores that the plants support and the number of herbivores would be higher than the number of higher order carnivores.



Pyramid of Biomass

Biomass is the total mass of dry organic matter per unit of area. Each higher trophic level contains less biomass than the previous trophic level. Therefore a drawing or graph that represents the amount of biomass at each trophic level would also produce the basic pyramid shape. Biomass is related to the abundance of organisms at each trophic level.

Human Impact on Food Chains and Webs

Humans have the ability to have a great impact on ecosystems. Living organisms are a significant portion of any ecosystem; therefore any activity that affects an ecosystem is also likely to affect the organisms within that ecosystem. If organisms are affected the food chains webs that the organisms are a part of will also feel the effects.

Questions:

1. Give three examples of food chains that exist in nature.

2. In an ecological pyramid, what happens to energy, biomass and # of species as you move up? ***Why***?

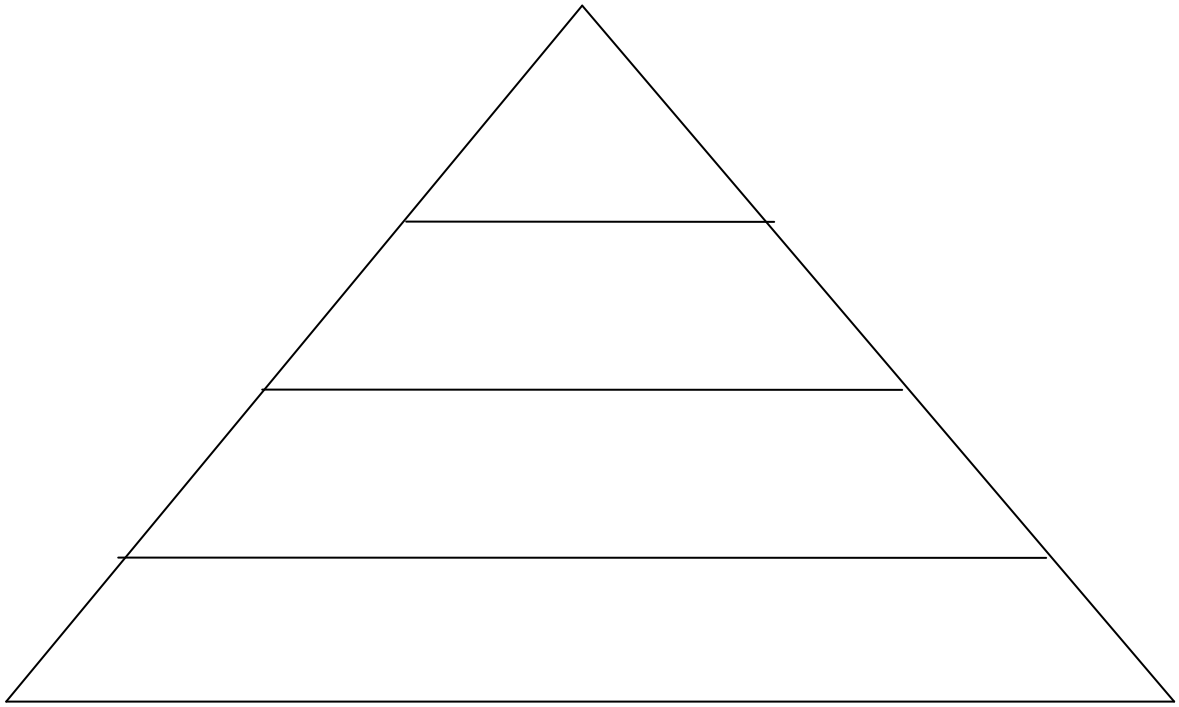
3. What is biomass?

4. In an ecosystem, can there be more carnivores than herbivores? ***Explain*** why or why not?

5. What is the 10% rule? What is its significance? Why is energy lost?

6. Brainstorm to create a list of 4 human activities that interfere with ecosystems, food chains and food webs. For each explain how it happens, why we do it, and mention short and long-term effects.

7. Label the ecological pyramid below with the following words: producers, tertiary consumer, secondary consumer, autotroph, heterotroph, primary consumer, decomposers, hawk, grass, chicken, grasshopper. ***Also*** label and explain what happens to energy, biomass and number of organism.



8. Discuss what trophic level humans occupy on an ecological pyramid, and explain what happens to contaminants and environmental pollution (such as mercury) as you move down and up the ecological pyramid (what is this called?).

_____

_____

_____

9. Look at the food web on the first page of the article. Who does the Maned Geese depend on for survival?
   _____

10. Using the same food web, which organism may <u>not</u> increase in population if all the frogs were removed from this ecosystem?
    _____

11. Using the same food web, which organisms would be affected if the algae were to overproduce?
    _____
    _____

Using the same food web, who eats the sedge? _____

<u>Lesson 4</u>: Factors affecting Biodiversity **Date:_____**

Objective: To describe the role biodiversity and succession play in maintaining ecosystem stability.

Biodiversity: the relative number of different organisms living in an ecosystem

*The measurement of the degree to which the number of different species vary within an ecosystem

Biodiversity increases the stability of the ecosystem

-it ensures the availability of genetic material for future ag/medical discoveries

-when diversity is lost, potential sources of these materials are also lost

Ex. National Forest – many different species of trees

If insects attach one species the others survive; It's more difficult for disease to spread, than if all the trees were one species like in a Tree Farm

Loss of biodiversity – upsets stability

*organisms that filled key ecological niches are gone

Stable ecosystem can be altered rapidly or slowly by

1. The activities of organisms including humans

   a) habitat destruction – Ex. clearing rainforests

   b) lack of consideration of environmental impact – Ex. Bounties on Mtn lions (increased deer which increased erosion)

   c) clear land for agriculture

   -increased disease and insect pests

2. Climatic changes

3. Natural disasters

Elements of biodiversity

Genetic – genes govern specific traits

Populations – different groups in specific areas

Ecosystems – different habitats in certain regions (Ex. swamp; forest)

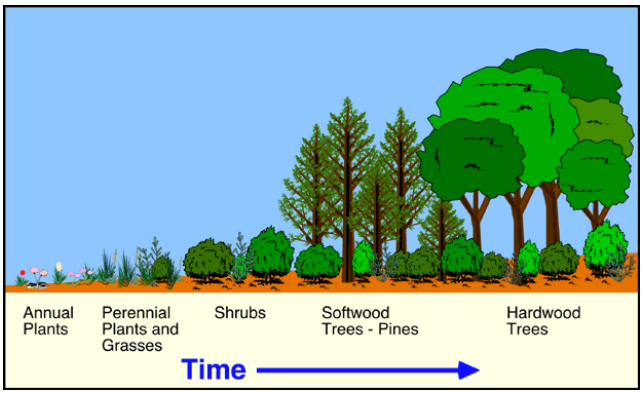
Benefits of biodiversity

- Insures availability of a rich variety of genetic material
- As diversity is lost, potentially valuable resources are lost with it.
- Organisms perform ecosystem services (Ex. trees release oxygen; bees pollinate)

Environmental changes

Ecological succession – the series of changes by which one habitat changes into another

* One ecological community modifies the environment making it more suitable for another community



Bedrock --> Lichens --> Moss --> Grasses --> Trees & Shrubs --> Climax forest

*As the depth of soil increases it can support root systems of larger plants

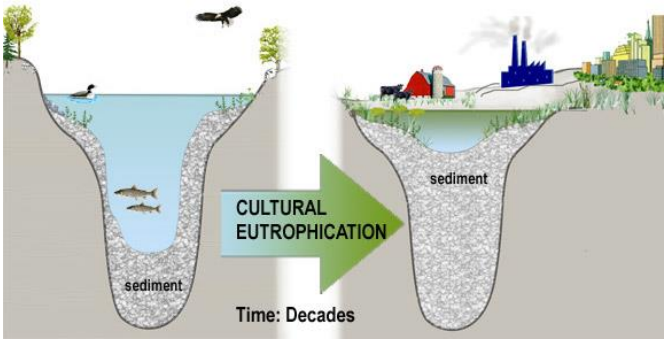
*Original species may find it harder to adapt to changes while new species may be able to compete more successfully for new niches

*In dry or cold climates succession may not advance to the forest stage – but the final stage will be stable for many years

Lake --> Accumulates sediments from erosion --> Shallower --> Swamp --> Forest
& (more light; more
Build up of organic debris from photosynthesis; more
dead plants/organisms plants)

Eutrophication

Cultural eutrophication – when growth is accelerated due to human activity



Invasive Species

- Arrive from other ecosystems by boat, plane, wind, people
- Often have no natural predators
- Are fierce competitors that often force native species out of an area
- Decrease biodiversity

Check your understanding:

1. What is biodiversity?

2. What does biodiversity provide and how does it help the ecosystem?

3. How do human actions affect biodiversity? What is the effect of loss of habitat and pollution?

Practice: Read the following passage and answer the questions.

Invasive Species

Unlike native species, invasive species are animals or plants that colonize a place where they originally do not belong. Often, humans are the reason for the introduction of such species, and unfortunately, this can have disastrous consequences for native wildlife. Approximately 42% of all threatened or endangered species are in danger because of invasive species. Therefore, they are considered a huge threat to our earth's biodiversity. According to the experts, more than 12.000 plants have been imported to middle Europe since the fifteenth century, and over a 1000 introduced animals have been discovered in Germany. Some species have successfully spread all over the world, like the Norwegian black rat, the house mouse and the domestic cat.

Fig. 1: Asian lady beetle, an invasive species that is "conquering" central Europe

How are invasive species introduced?

When humans settle in new places, they often bring along familiar plants and animals. Especially during the era of colonization, settlers started importing different kinds of species on board of sailing ships to feel more at home in their new surroundings. Another reason for importing plants or animals was food (like cattle and grain). If a species is introduced purposely, biologists often speak of ecosystem manipulation. But the introduction of invasive species can also happen by accident. In our globalized world, there are more and more means of transportation. Food is flown all over the world on airplanes: insects can travel inside of fruit and snakes or other animals sometimes sneak on board of a plane. Many aquatic species travel in the ballast water of ships and are accidentally released into the ocean thousands of miles away from their home. When people release unwanted pets into the wild, these can also become invasive species and cause harm.

Danger?

Because of their incredible abilities to adapt to so many different kinds of surroundings, invasive species often drive native species to extinction since both have compete for resources and habitat. Often, native wildlife hasn't developed enough defense mechanisms against invasive species, which makes them very vulnerable. Therefore, invasive species are a major threat to biodiversity. However, they can also lead to positive outcomes: the Romans for instance are responsible for bringing apple trees and wheat to Germany, both sources of food that we rely heavily on. The main problem with the introduction of new species is that it is impossible to know the consequences that might follow. The cane toad for example was introduced on many Caribbean and Pacific islands for pest control: Australia introduced it to help control a beetle that eats sugarcane crops. However, the cane toad quickly spread all over Australia and didn't just eat the beetles, but also many native reptiles, frogs and even small mammals and birds. Biologists consider the invasion of the cane toad to be a huge factor in the decline of Australia's native wildlife. Invasive species can also cause economic damage: according to the German federal environmental agency, the damage caused by 20 of the most harmful invasive species cost Germany 156 Million € in 2003 alone!

Characteristics of Invasive species

There are several reasons why invasive species are such good competitors and have been so successful at conquering their new habitats:

1) They have a **high physical tolerance**:
   Invasive species can adjust to a wide range of physical conditions. Fish species that need a very specific water temperature or salinity level are not able to survive in many waters and therefore are not successful invasive species.

2) They **reproduce fast**.

3) They usually **don't have any natural predators** in their new environment.

4) They have an ability to **live off high variety of foods**:
   Being able to eat many different kinds of foods is also very important for colonizing new and different habitats. Bird species for example that can adapt to eating a large variety of seeds will have an easier time colonizing new habitats.

Case study: the European starling in North America

One example for a successful invasive species is the introduction of the European Starling to North America. In 1890, 60 starlings were released in Central Park, because the bird was mentioned in so many of Shakespeare's plays and the British immigrants wanted to feel more at home. Ever since, the starling population has exploded, today an estimated number of 200 Million birds inhabit the North American continent. The starlings have harmed native bird populations, can survive in almost any climate (even Florida and Alaska), and have eaten many crops. The introduction of the starling is a good example for what can happen when humans interfere with nature.

Questions:

1. How come biologists say that invasive species reduce biodiversity – although technically, the biodiversity of a region should be increased by the introduction of new species?

2. How can we prevent invasive species?

3. There are many different ways in which invasive species are introduced. Which ones can you think of?

<u>Lesson 5:</u> Human Impact on the Environment **Date:_____**

Objective: To explain the cause and some negative consequences of human technology and influence on the environment.

The world's biodiversity is under threat from various dangers, the majority of which have been caused by humans.

1. **Habitat loss and fragmentation** is considered by conservation biologists to be the primary cause of biodiversity loss. Clearance of native vegetation for agriculture, housing, timber and industry, as well as draining wetlands and flooding valleys to form reservoirs, destroys these habitats and all the organisms in them. In addition, this destruction can cause remaining habitats to become fragmented and so too small for some organisms to persist, or fragments may be too far apart for other organisms to move between.

2. **Invasive alien species** are the second greatest threat to biodiversity worldwide. Whether introduced on purpose or accidentally, non-native species can cause severe problems in the ecosystems they invade, from affecting individuals to causing huge changes in ecosystem functioning and the extinction of many species. Virtually all ecosystems worldwide have suffered invasion by the main taxonomic groups. This problem will probably get worse during the next century driven by climate change, and an increase in global trade and tourism. As well as the risks to human health, alien species inflict massive economic costs to agriculture, forestry, fisheries and other human activities.

3. **Pollution** is currently poisoning all forms of life, both on land and in the water, and contributing to climate change (see below). Any chemical in the wrong place or at the wrong concentration can be considered a pollutant. Transport, industry, construction, extraction, power generation and agroforestry all contribute pollutants to the air, land and water. These chemicals can directly affect biodiversity or lead to chemical imbalances in the environment that ultimately kill individuals, species and habitats.

4. **Climate change**, brought about by emissions of greenhouse gases when fossil fuels are burnt, is making life uncomfortably hot for some species and uncomfortably cold for others. This can lead to a change in the abundance and distribution of individual species around the globe and will affect the crops we grow, cause a rise in sea levels and problems to many coastal ecosystems. In addition, the climate is becoming more unpredictable and extreme devastating events are becoming more frequent.

5. **Over exploitation** by humans causes massive destruction to natural ecosystems. Exploitation of biodiversity occurs for food (e.g. fish), construction (e.g. trees), industrial products (e.g. animal blubber, skins), the pet trade (e.g. reptiles, fish, orchids), fashion (e.g. fur, ivory) and traditional medicines (e.g. rhino horn). Selective removal of an individual species can unbalance ecosystems and all other organisms within them. In addition, the physical removal of one species often harms other (e.g. fishing by-catches)

6. **Human populations** are growing at an exponential rate, resulting in the problems above. There are more than 7 billion people in the world, and although natural disasters, disease and famines cause massive human mortality, we are getting better at surviving and the population just keeps growing. Human population numbers tripled in the twentieth century and although growth is slowing, one estimate predicts it will take until the twenty-third century for them to level out at around 11 billion.

Check your understanding:

1. Explain biodiversity in your own words.

2. What are some things that cause habitat loss?

3. How do invasive species harm ecosystems?

4. How are habitat loss and biodiversity connected?

Practice: Read the following article and answer the questions

Since the beginning of time, humans have learned to make use of many things in nature such as fire and electricity. From the early times through the Industrial Revolution to the Space Age, humans have produced inventions that use many of the earth's varied energy resources to make living easier. In many cases the energy comes from burning fossil fuels—coal, oil and natural gas.

Some of the inventions that make our lives easier are also causing pollution. Pollution is the release of harmful substances into the environment. One form of pollution is acid rain. Acid rain is any form of rain that is more acidic than normal (with a pH lower then 5.6). Pure water has a pH of 7, normal rainfall has a pH of a bit less than 7, but acid rain can have a pH of about 5.0-5.5, and even in the 4 range in the northeastern United States.

Acid rain can damage plants, animals, soil, water, building materials, and people. Scientists have discovered that air pollution from the burning of fossil fuels is the major cause of acid rain. People burn fossil fuels such as coal and oil to make electricity. Electricity heats up and lights buildings and runs appliances such as televisions and video recorders. Fossil fuels power our cars, buses, and airplanes. The air pollution created when these fuels burn does not stay in the air forever. It can return to the earth as acid rain. And when it does, it may weaken the plant and animal life it contacts. Acid rain is only one form of pollution that results from burning fossil fuels. It is one of particular interest, however, because it can be transported over long distances. Scientists, engineers, and researchers are learning how to measure the amount and effects of pollution in the air, forests, water, and soil. They are inventing ways to reduce the amount of pollution that enters the environment and prevent new damage in the future. The smoke and fumes from burning fossil fuels rise into the atmosphere and combine with the moisture in the air to form acid rain. The main chemicals in air pollution that create acid rain are sulfur dioxide (SO2) and nitrogen oxide (NOX). Acid rain usually forms high in the clouds where sulfur dioxide and nitrogen oxides react with water, oxygen, and oxidants. This mixture forms a mild solution of sulfuric acid and nitric acid. Sunlight increases the rate of most of these reactions. Rainwater, snow, fog, and other forms of precipitation containing mild solutions of sulfuric and nitric acids can fall to earth as acid rain. The chemical reactions that change air pollution to acid rain can take from several hours to several days. Years ago, when smokestacks were only a few stories high, pollution from smokestacks usually stayed near the ground and settled on land nearby. This caused unhealthy conditions for plants and animals near the smokestacks.

To reduce this pollution, the government passed a law permitting the construction of very tall smokestacks. At that time, people thought that if the pollution were sent high into the air it would no longer be a problem. Scientists now know that this is incorrect. Sending pollution high into the sky increases the time that the pollution stays in the air. The longer the pollution is in the air, the greater are the chances that the pollutants will form acid rain. In addition, the wind can carry these pollutants for hundreds of miles before they become joined with water droplets to form acid rain. For that reason, acid rain can also be a problem in areas far from the polluting smokestacks. The region of the Continental United States most affected by acid rain is the Northeast, where pH levels of between 4.0 and 4.5 are commonplace.

Notably, the most rapid increase in acid precipitation in the U.S. seems to be in the Southeast, an increase paralleling the expansion of Southeastern urban and industrial activities that result in sulfur and nitrogen emissions. West of the Mississippi, rain is generally neutral or even alkaline. Colorado, the Los Angeles Basin, the San Francisco Bay Area, Spokane, Tucson, and Portland are the known exceptions. In these locations, as in the Northeast, precipitation ranges from between pH 4.0 to 5.0.

Source: Acid Rain. A Student's First Sourcebook.
EPA, Washington, DC

1. Define Acid

_____
_____
_____

2. Explain the difference between acid rain and water

_____
_____
_____
_____

3. Describe the major causes of acid rain

_____
_____
_____
_____

4. Why is acid rain of particular interest?

_____
_____
_____
_____
_____

5. What are the main chemicals in pollution that cause acid rain?

_____
_____
_____

6. What did the US government do at first to reduce the pollution from smokestacks?

_____
_____
_____
_____
_____
_____

7. How successful was this government action?

_____
_____
_____
_____
_____

8. Which region of the Continental United States is the most affected by acid rain?

_____
_____
_____

Project: ENDANGERED SPECIES POSTAGE STAMP

Your task is to design; using information you will research along with your imagination and creativity, a postage stamp that will help bring attention to the endangered organism that you selected. When choosing the organism you are going to report on, you might want to consider more than one as each student will present a different organism and the one you picked might have already been taken. The stamp can be on and made of any suitable medium, but must not be larger than 8.5 x 11 inches. Information on the stamp must, in one way or another, include all of the above information. The only written information allowed is the generic and scientific name along with the stamp denomination; all other information must be represented in a data table chart. In order to be graded, the chart must be completed in full and turned in with the stamp. Students will give a short presentation of their organism to the class the day the project is due.

Rubric	**Points**
Table information (2 points each)	20
Sources Listed (2 points each)	6
Stamp Amount (must be in the denomination of the country where the organism is native to)	4
Creativity	5
Neatness	5
Presentation(should be clear and consise)	5
	Total 45 points

* Correct scientific format: Scientific names will contain a genus and a species. The genus is always capitalized and the species is always lower case; both the genus and the species are either underlined or italicized.

For example: Human beings Homo sapiens
Black Bears *Ursus americanus*

Research web pages: there are others, but these will get you started

http://www.wildaid.org
http://www.worldwildlife.org
http://www.ecologyproject.org
http://www.endangeredspecie.com
http://www.nrdc.org/wildlife
http://www.fws.gov/endangered
http://www.scvas.org

Things To Consider	Response
endangered species researched	
scientific name (in correct format)*	
natural habitat (where it is found in nature)	
adult size	
dietary needs	
life cycle	
reproductive pattern (number of offspring in lifetime)	
size of area needed to survive	
population decline over time	
causes of endangerment	
sources: must include three sources	