

Section A: Intro to Ecology

"The wolves and moose of Isle Royale are known world-wide, and they are the focus of the longest-running study of a predator-prey system in the wild. Both species are relatively recent arrivals to Isle Royale -- moose apparently swam to the island and established a population in the early 1900s, and wolves followed decades later after traveling over the ice from Ontario, Canada in the late 1940s. Annual monitoring of wolves and moose began in 1958 when Durward Allen of Purdue University began an ambitious "10-year" study of the wolf-moose relationship. This study continues today, under the direction of John Vucetich and Rolf Peterson of Michigan Technological University." <http://www.nps.gov/isro/naturescience/ecological-studies-of-wolves-on-isle-royale.htm>

1. Why is this relationship important for scientist to study? _____

2. After watching the video, 'The Wolves and Moose of Isle Royale', explain how the populations have been affected. <http://www.youtube.com/watch?v=PdwnfPurXcs>

Section B: Concept Check

Use the wordbank to match the definition with the term. (#1-8)

| | | | |
|-----------|----------|-----------|------------|
| Ecosystem | Organism | Biome | Biosphere |
| Abiotic | Biotic | Community | Population |


1. Living part of the environment _____
2. Collection of abiotic and biotic factors in an environment _____
3. A single living thing that can breed/produce fertile offspring _____
4. Ecosystem with same climate and similar communities _____
5. Individuals of the same species that live in the same area _____
6. Earth with all the ecosystems _____
7. Different interacting populations that live together in an area _____
8. Nonliving part of the environment _____
9. Arrange these levels of organization in order from 1 to 4 starting with the simplest.

| | | | |
|----------|-----------|-----------|------------|
| Organism | Community | Ecosystem | Population |
| _____ | _____ | _____ | _____ |
10. Identify the level of organization.
 - a. Group of bats living in a cave _____
 - b. Red-eyed tree frog _____
 - c. Insects, fish and algae in a lake _____
 - d. An ocean _____

Section C: Habitat vs. Niche

1. The red fox is a predator which feeds on the small mammals, amphibians, insects, and fruit. Red foxes are active at night. They provide blood for blackflies and mosquitoes, and are host to numerous diseases. The scraps, or carrion, left behind after a fox's meal provide food for many small scavengers and decomposers.
 - a. Is this an example of the red fox's habitat or niche? _____
 2. The red fox occupies a niche in the meadow-forest edge communities. In other plant communities different species of animal may occupy a similar niche to that of the red fox. For example, in the grassland communities of western Canada and the United States, the coyote occupies a similar niche (to that of the red fox.)
 - a. Explain what would happen if the two organisms tried to occupy the same niche in the same habitat. _____
 2. What is the difference between a habitat and a niche? _____
-

**** Index Card - Vocabulary:** Get 7 index cards - one for each vocab word. Use this example as a guide to help create flashcards. **** Vocab - organism, population, community, ecosystem, biome, niche, habitat**

| | |
|----------------------|--|
| (vocab word) Abiotic | (definition) nonliving part of the environment |
| (example) rock | (visual)  |

Section D: Population Density (<http://worldatlas.com/aatlas/populations/ctydensityh.htm>)

1. Calculate the population density of the following countries.

| Country | Population | Land Area (km ²) | Density (km ²) |
|----------------|---------------|------------------------------|----------------------------|
| Canada | 32,805,000 | 9,976,140 | |
| China | 1,306,313,800 | 9,596,960 | |
| Japan | 127,417,200 | 377,835 | |
| India | 1,080,264,400 | 3,287,590 | |
| Monaco | 32,410 | 2 | |
| Spain | 40,341,500 | 504,782 | |
| United Kingdom | 60,441,500 | 244,820 | |
| United States | 295,734,100 | 9,629,091 | |

2. What does population density indicate? _____
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Section E: Dispersion Patterns & Biotic Potential

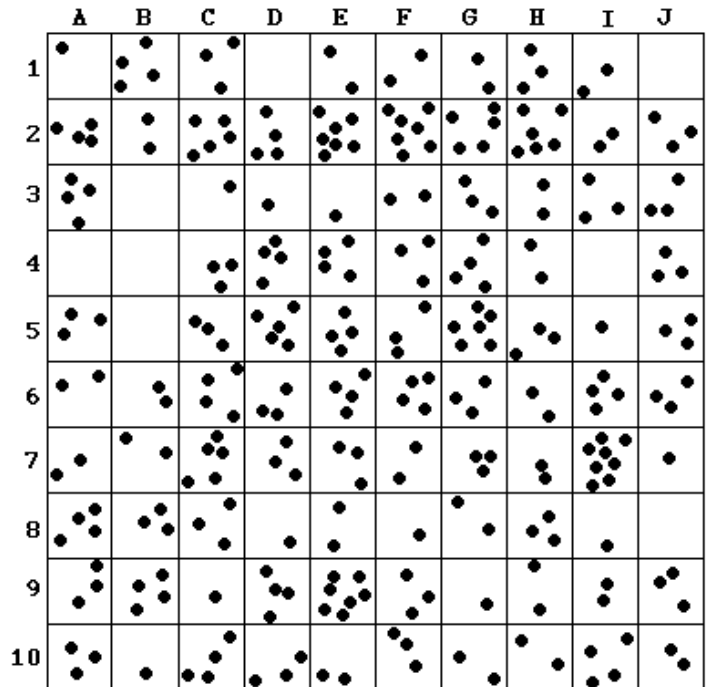
1. Identify the type of dispersion pattern. (clumped, uniform, random)
 - a. _____ A bunch of mushrooms growing on a rotting log.
 - b. _____ The sage plant secretes toxins, a chemical that kills off surrounding plants in a circle around the individual sage plants.
 - c. _____ Dandelions have wind-dispersed seeds that germinate wherever they happen to fall in a favorable environment.
 - d. _____ A herd of elephants gather around a watering hole.
2. Why do most organisms rarely reach their biotic potential? _____

Section F: Estimating Population Size

Random Sampling --- When studying a population, it is usually impossible to count every member of the population. One way to estimate the size of a population is by collecting data by random samples. This method works well when estimating a population of plants in a large field.

Procedure:

1. Get a slip of paper with 1-10 and cut into individual pieces. Put them in one container.
2. Get a slip of paper with A-J and cut into individual pieces. Put them in a second container.
3. The grid below represents your study area. It is a field measuring 10 m on each side. Each of the grid segments is 1m x 1m. Each black dot represents a single sunflower dot. Randomly remove one slip from each container. Record the number-letter combination in the data table. Find the grid segment that matches the combination and count the number of sunflower plants in that grid segment.
4. Record the number of sunflowers in the data table. Return the slip to the appropriate container. Repeat step 5 until you have data for 10 different grid segments. This represents your sample.



| Trials | Grid Coordinates | | # of sunflowers in grid segment |
|--------|------------------|--------|---------------------------------|
| | Letter | Number | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |

Calculations:

1. Find the total number of sunflower plants in the 10 segment sample. Total number of sunflower plants _____
2. Divide the total number by 10 to determine the average number of sunflower plants per square meter in the sample. (round to the nearest tenth) Average number of plants per square meter _____
3. Multiply the average number of sunflower plants per square meter by 100 (the total number of grid segments in the field) to find the total number of plants in the field to find your population estimate. Population estimate _____
4. Count all the sunflower plants actually shown in the field. Actual population count _____
5. Now find the percentage error in your estimate. The difference is always positive, so subtract the smaller of the two numbers from the larger. Actual count - estimated count = difference
 - a. Difference _____
 - b. Now divide the difference by the actual count and multiply by 100.
 $\text{difference/actual count} \times 100 = \% \text{ error}$
% Error _____

Analysis:

1. What are some problems with this technique? What could affect its accuracy?
2. A biologist collected 1 gallon of pond water and counted 50 paramecium. Based on the sampling technique, how many paramecium could be found in the pond if the pond were 20,000 gallons?

Mark and Recapture - Because it may be difficult or impossible to count each individual, mark-recapture (tagging) is a useful method for determining the size of an animal population. The first step is to capture a known number of individuals from a population. The individuals are marked or tagged and then released back into the population. After the tagged individuals have had time to assimilate back into the population, random samples of the population are captured. The number of marked or tagged individuals is determined and recorded along with the total number of individuals captured in the sample.

Procedure:

1. You will receive a bag that represents your population. The bag is the environment and the white beans are your animal population.
2. Capture 10 animals (white beans) by removing them randomly from the bag. To mark these beans merely replace them with the colored beans. Set the 10 white beans aside and put the 10 marked beans back into the bag (the environment).
3. Shake the bag - not too hard - and without looking grab 15 beans, this represents your second trapping, Count the number of "marked" individuals, and record them in the chart. Continue until you have trapped 10 times. Calculate the estimated population size using the equation.
4. Repeat step 3 and do ten more trials of the same population. Recalculate the population estimate.

$$\text{Estimate of Total Population} = \frac{(\text{total number captured}) \times (\text{number marked})}{(\text{total number recaptured with mark})}$$

Analysis:

1. Calculate the estimated population size after 10 trials using the formula provided.

Estimated Size = $(150 \times 10) /$ total number recaptured with mark

2. Calculate the estimated population size after 20 trials using the formula provided.

Estimated Size = $(300 \times 10) /$ total number recaptured with mark

3. Now count the number of beans in your environment (bag). Actual population size _____

4. Calculate the percent error. Remember this number is always positive.
 $\text{difference/actual count} \times 100 = \% \text{ error}$
 % Error _____

| Trapping | Number Captured | Number recaptured with mark |
|----------|-----------------|-----------------------------|
| 1 | 15 | |
| 2 | 15 | |
| 3 | 15 | |
| 4 | 15 | |
| 5 | 15 | |
| 6 | 15 | |
| 7 | 15 | |
| 8 | 15 | |
| 9 | 15 | |
| 10 | 15 | |
| Total: | 150 | |
| | | |
| 11 | 15 | |
| 12 | 15 | |
| 13 | 15 | |
| 14 | 15 | |
| 15 | 15 | |
| 16 | 15 | |
| 17 | 15 | |
| 18 | 15 | |
| 19 | 15 | |
| 20 | 15 | |
| Total: | 300 | |

5. Was there a large difference between 10 trials and 20 trials? What does this say about the number of trials that should be conducted in a real mark and recapture?
6. Given the following data, what would be the estimated size of a butterfly population in Wilson Park? A biologist originally marked 40 butterflies in Wilson Park. Over a month long period, butterfly traps caught 200 butterflies. Of these 200, 80 were found to have tags. Based on this information, what is the estimated population size of the butterflies in Wilson Park?
7. In what situations would sampling work best for estimating population size and in what situations would mark and recapture work best. You'll probably have to think about this one. Justify your answer.

Section G: Population Growth & Carrying Capacity

1. The two *Paramecium* species were grown alone then grown together in a culture. Based on the graphs, what can you conclude about the population density when they are grown separately?

2. When grown separately, what day did each paramecium reach its carrying capacity?

3. Explain what occurred when the two populations were grown together.

4. What is carrying capacity?

5. What happens to a population when they exceed their carrying capacity?

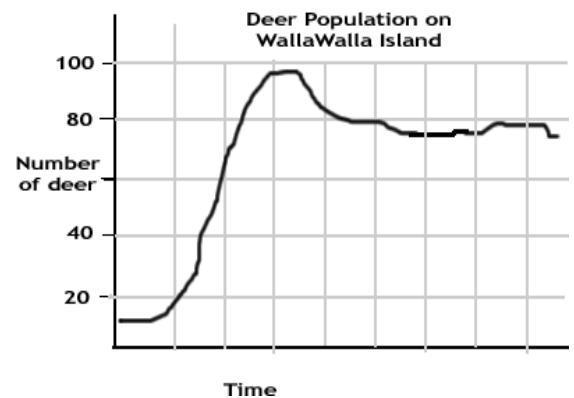
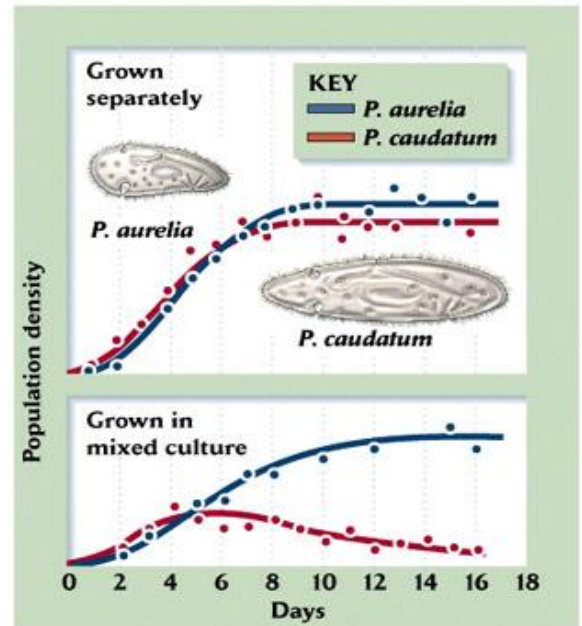
6. What is the carrying capacity of the deer population on Walla Walla Island?

7. Describe the conditions under which logistic growth occurs.

8. Describe the conditions under which exponential growth occurs.

9. Analyze the data and predict what type of growth pattern has occurred in the rabbit population? _____

- a. Animals such as foxes and cats often prey on rabbits. Based on the growth curve of the rabbit population, what might have happened if a group of predators moved into the rabbit's habitat during the 10th generation?



| Rabbit Population Growth | |
|--------------------------|-------------------|
| Generations | Number of Rabbits |
| 1 | 100 |
| 2 | 105 |
| 25 | 1000 |
| 37 | 1600 |
| 55 | 2400 |
| 72 | 3350 |
| 86 | 8000 |
| 100 | 13150 |

10. In 1906, the Kaibab Plateau was established as a preserve to reestablish the deer population. Unfortunately, the Kaibab forest area had already been overgrazed by livestock and predator populations were firmly established. As a result, the deer population was well below its carrying capacity of 30,000. To protect the deer, hunting was banned, predators were exterminated and livestock grazing was limited. By 1923, the deer were on the verge of starvation. Predators were then reintroduced and hunting was allowed.

| DATA TABLE | |
|------------|-----------------|
| Year | Deer Population |
| 1905 | 4,000 |
| 1910 | 9,000 |
| 1915 | 25,000 |
| 1920 | 65,000 |
| 1924 | 100,000 |
| 1925 | 60,000 |
| 1926 | 40,000 |
| 1928 | 35,000 |
| 1929 | 30,000 |
| 1931 | 20,000 |
| 1939 | 10,000 |

- a. Were the methods successful? Explain your answer.
- b. Why did the population decline after 1925?
- c. What type of growth pattern did the deer population exhibit?
- d. What factors influenced this growth pattern?

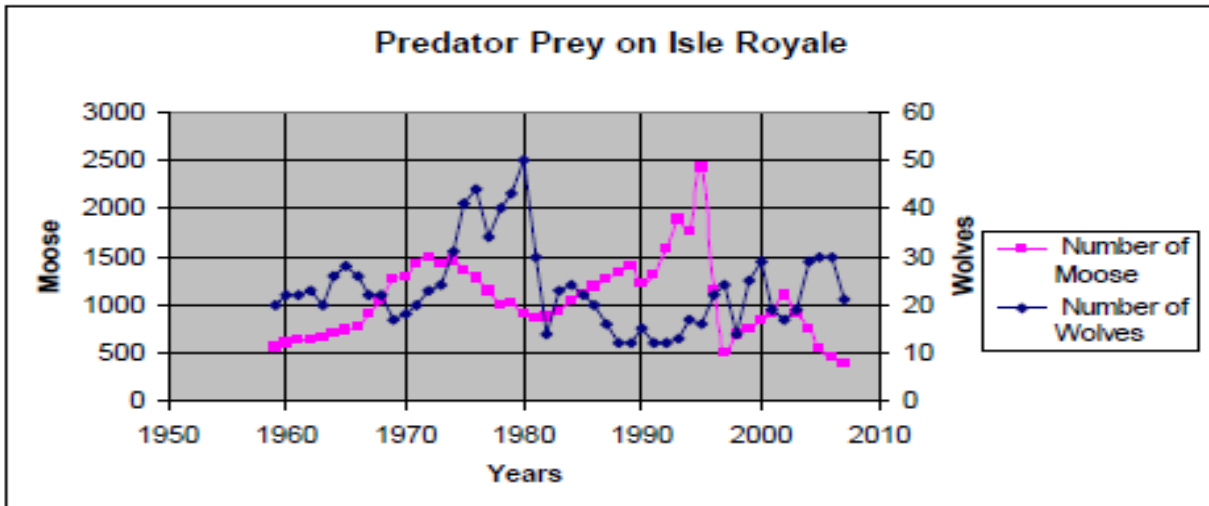
Section H: Limiting Factors

Lake Winnipeg is a shallow lake composed of two basins: a wide north basin and a narrow south basin that provides a habitat for over 50 different species of fish. Each of the statements below involves a situation that will affect the growth of a population. Classify each of the statements as DD (density dependent) or DI (density independent) and give a reason for your choice.

1. Rainbow smelt and yellow perch attempt to occupy the same area. The more aggressive smelt survive; the perch do not. _____
2. A severe flood brings a lot of sediment and silt into Lake Winnipeg. The turbidity of the lake increases greatly. _____
3. Since northern pike prey on yellow perch, an increase in the perch population causes an increase in the pike population. _____
4. Many fish die due to an increase in water temperature. _____
5. Due to over-fishing, the number of walleye in Lake Winnipeg decreases. _____
6. A population is growing quickly when parasites cause disease to spread quickly. _____
7. Lake sturgeon migrate long distances to spawn and many do not survive the trip. _____

Section I: Isle Royale

Moose first arrived at Isle Royale around 1900. The moose population tends to increase in years with mild winters, early spring green-up, abundant winter forage, low wolf numbers and low levels of tick infestation. Wolves first arrived at the island on an ice bridge from Canada in 1940. Between 1980 and 1982, the wolf population declined from 50 to 14, due to canine parvovirus.



1. What would happen to the moose population if the wolves were removed from the island?

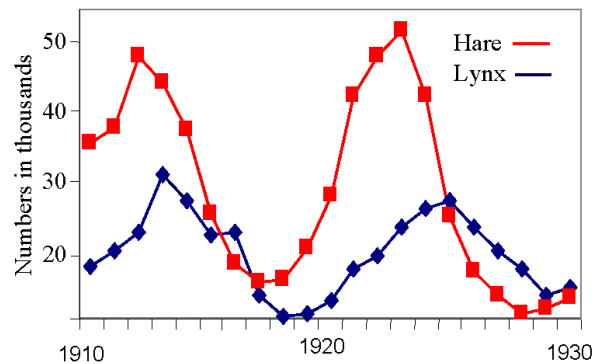
2. What happens to the wolf population when the moose population decreases? _____

3. Identify 2 limiting factors that have influenced the wolf population. _____

4. What type of limiting factor are predator-prey relationships? _____

Section J: Community Ecology

1. Explain how the relationship between predator (lynx) and prey (hare) affect population density.



Identify the type of interactions: predation, competition, mutualism, parasitism, or commensalism

2. Tapeworm living inside the intestines of an animal. _____
3. The Cattle Egret forages in pastures and fields among livestock such as cattle and horses, feeding on the insects stirred up by the movement of the grazing animals. The livestock do not benefit. _____
4. The cuckoo bird attacks another bird's nest and removes the bird's eggs. She then lays her eggs in the attacked nest and lets the unsuspecting bird raise the cuckoo's young.

5. A lynx is attacking a hare. _____
6. Barnacles attach to the shell of a scallop and gain a place to live. The scallop is not harmed by the presence of the barnacle. _____
7. Lichen is composed of a fungus that protects the algae while the algae provide food produced during photosynthesis. _____
8. The Nile crocodile open its mouth to permit the Egyptian plover feed on any leeches attached to its gums. The small bird gets to eat and the croc gets its teeth cleaned.

9. Interaction is beneficial to one species and detrimental to the other. _____
10. Cattle egrets and cow birds feed on insects flushed out of the grass by grazing bison, cattle and other herbivores. _____
11. One species benefits from the interaction but the other is unaffected.

12. When populations of two or more species in a community rely on similar limiting resources.

13. An acacia tree provides food and housing for ants while the ants kill any invading insects.

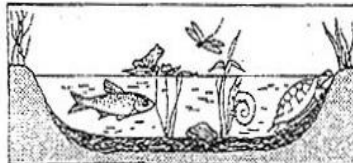
14. Sea anemones trying to occupy the same territory in a tide pool.

Section K: Succession

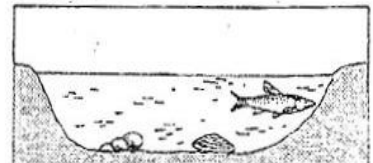
1. The evolution of a body of water from a lake to a marsh can last for thousands of years. The water level of Lake Michigan was once 18 meters higher than it is today. As the water level fell, land was exposed. Many small lakes or ponds were left behind where there were depressions in the land.

a. Examine the pictures and list them in order from older to younger in the establishment of the marsh.

Pond A

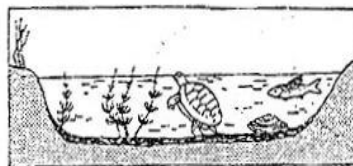


Pond B



b. Is this an example of primary or secondary succession?

Pond C



Pond D



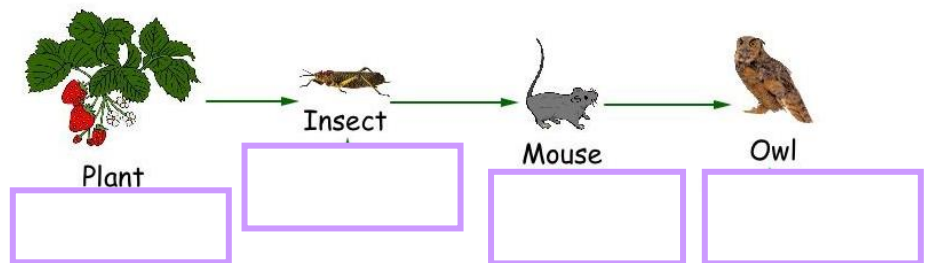
2. A small, cold creek flows through a dense forest. The trees line the banks of the creek providing shade most of the day. Algae grow well only in a few areas of the creek that receive direct sunlight. Most of the food energy enters the ecosystem in the form of dead leaves that fall from the trees. A fire swept through the forest, burning all the leaves, but leaving the trees standing. This greatly increased the amount of direct sunlight reaching the creek. As a result of the fire, what most likely increased in the creek? What type of succession will occur to open up new available niches and resources?

3. What are pioneer species? Explain the establishment of organisms in a primary succession scenario.
4. How is primary and secondary succession different? List an example of each.

| Primary Succession | Secondary Succession |
|--------------------|----------------------|
| | |

Section L: Food Chains/Webs

1. In the diagram, label the trophic levels.
2. Explain how the energy is flowing.



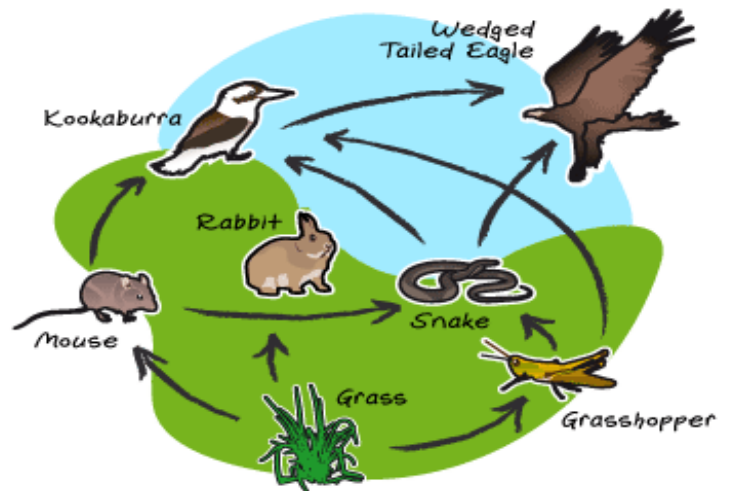
3. Does the amount of available energy increase or decrease in a chain? _____
4. What are trophic levels? _____
5. What is the main source of energy for life on Earth? _____
6. Which organism in the web has the greatest amount of energy available?

7. Which organism in the web has the least amount of energy available?

8. What is the rabbit in this web?

9. What organism is missing from this web? It feeds at all levels.

- a. Why are these organisms beneficial for the environment?



10. How would the extinction of the snake affect this food web? _____

Section M: Food Pyramids

1. Suppose 10,000 units of energy are available for the grass. What is the amount of energy available for the hawk? _____
2. How much energy is lost at each level and what is it lost as? _____
3. Who has the greatest biomass in the food chain?

4. What is biomass? _____
5. Why does the population decrease as you move up the pyramid? _____



- Need more help? On the "Websites-Ecology" page, click on 'Food Webs'. Read and create your own web.

Section N: Matter Cycles

1. Water Cycle - Briefly explain how water cycles through the biosphere?
2. How have humans impacted the water cycle?
3. Carbon Cycle - What are the ways that Carbon Dioxide is put into the atmosphere?
4. Carbon Cycle - Which process is responsible for removing most of the CO₂ from the atmosphere?
5. How have humans impacted the Carbon Cycle?
6. Nitrogen Cycle - How can atmospheric Nitrogen become available for use by organisms?
7. Nitrogen Cycle - How does soil Nitrogen convert back into atmospheric Nitrogen?
8. How have humans impacted the Nitrogen Cycle?

9. Phosphorus Cycle - In living organisms, where is phosphorus found?

10. Phosphorus Cycle - In the environment, where is phosphorus found?

11. Phosphorus Cycle - How does living organism obtain phosphorus?

12. How have humans impacted the Phosphorus Cycle?

13. How do algal blooms form?

➤ Need more help? On the "Websites-Ecology" page, click on the different cycle links and watch the animations.

Quizzes:

<http://www.sciencegeek.net/Biology/review/U7BasicEcology.htm>

<http://www.sciencegeek.net/Biology/review/U7Cycles.htm>

<http://www.sciencegeek.net/Biology/review/U7Populations.htm>

<http://www.sciencegeek.net/Biology/review/U7Change.htm>

<http://www.sciencegeek.net/Biology/review/U7Review.htm>

http://edhsgreensea.net/Biology/taters/populations_mc.htm

http://edhsgreensea.net/Biology/taters/basic_ecology_mc.htm

http://edhsgreensea.net/Biology/taters/nutrient_cycles.htm

http://edhsgreensea.net/Biology/taters/ecosystem_changes_mc.htm