The Web of Life: Ecology and Ecosystems – Part I

I. Definitions:

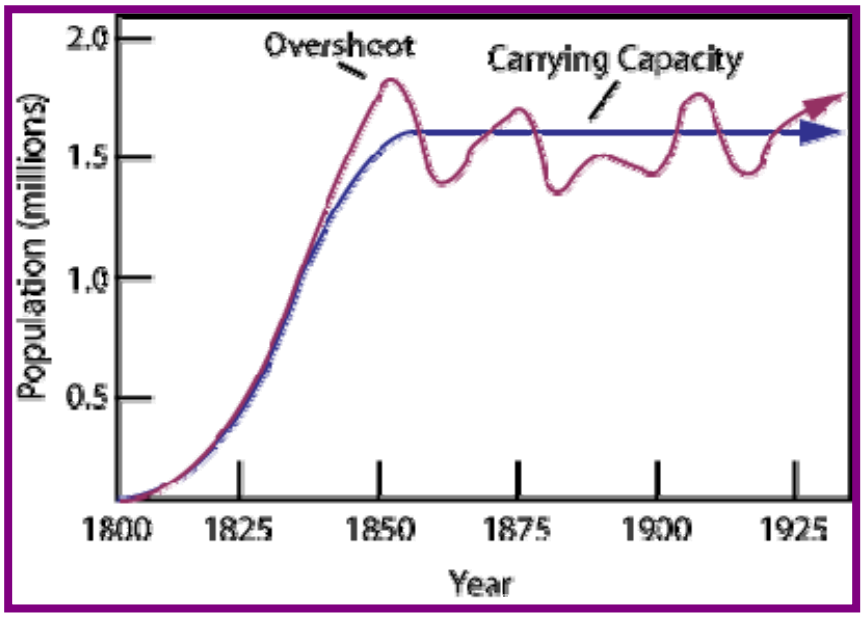
- A ***species*** is a group of organisms that share the most common characteristics and are capable of reproducing fertile offspring.
- A ***population*** is comprised of all the members of a single species in a given location
  ~ all the cows in the meadow
- A ***community*** is made up of all the interacting populations in a given location.
  ~all the grasses, plants, cows, horses, sheep, mice, and insects in the meadow
- An ***ecosystem*** is comprised of the community and the physical environment in which they live.
  ~all the grasses, plants, cows, horses, sheep, mice, and insects along with the rocks, soil, air, and water in the meadow.
- The ***biosphere*** is made up of all the ecosystems that exist on Earth.
  ~Essentially the biosphere is the ***zone of life*** on Earth.
  ~It includes the living and nonliving parts of ecosystems**.**

II. Characteristics of an Ecosystem:

- Species within an ecosystem compete for limited resources.
- Community members interact within and among their species.
- There also is interdependence between the community and the physical environment.
- ***Ecosystems are stable and self-sustaining if they have:***
  ~ A constant source of ***ENERGY***
  ~ A continual ***RECYCLING OF MATERIALS*** between the community members and the physical environment
- Nonliving and living factors affect the organisms that can inhabit an ecosystem.
- ***Abiotic factors*** are the non-living parts of the ecosystem and include:
  ~***Substratum:*** soil and rock
    --pH: acid rain can make soil pH too low for plant growth
    --texture of soil and clay content: determines the quantity of water the soil can hold
    --minerals such as nitrates & phosphates determine what vegetation can grow in a given area
    --humus quality: determined by the amount of decaying plant and animal life in the soil
  ~Sunlight: serves as the ultimate source of energy most living organisms
  ~Water: essential to all life and a major component of all living organisms
  ~Salinity: the relative saltiness of a given body of water
  ~Oxygen Supply
  ~Temperature
- ***Biotic Factors*** are the living parts of the ecosystem. Living organisms and/or their materials directly or indirectly affect other organisms in the environment.
  ~Biotic factors include:
    --Intraspecies/interspecies interactions
    --Organism wastes
    --Predation
    --Disease
    --Parasitism

IV Population Growth:

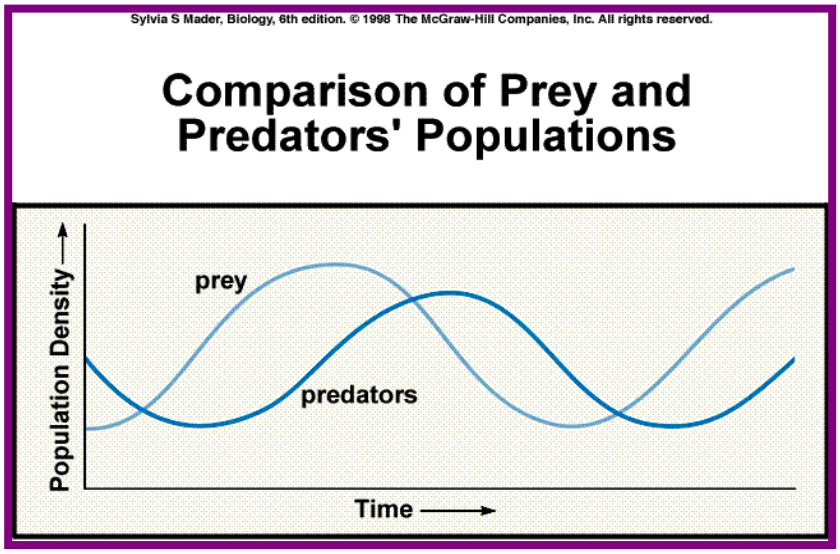
- ***Carrying Capacity:*** the maximum number of organisms an ecosystem can support.



- There is an initial ***exponential growth*** followed by overproduction of the species that is too large for the environment to sustain. In an effort to maintain ***dynamic equilibrium*** with the environment, the population fluctuates around the ***carrying capacity*.**

V. Limiting Factors of a Population:

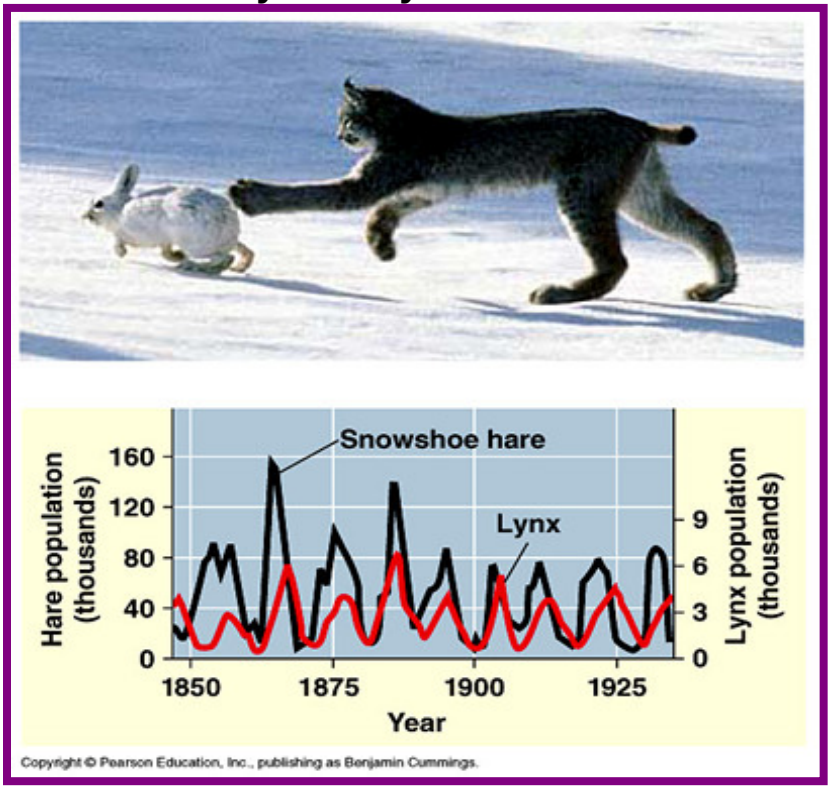
- ***factors*** that increase ***DIRECTLY*** as the population density increases.
  ~Examples include:
  -- competition for food and water, build up of wastes, predation, and disease.
- ***Factors that are UNRELATED*** to the population density.
  ~Examples include:
  -- earthquakes, hurricanes, tornadoes, and naturally occurring fires and floods.
- ***Competition****:* in an ecosystem, resources such as oxygen, carbon dioxide, water, nutrients, space, and sunlight are limited in supply. Organisms must ***COMPETE*** with one another for survival.
  ~***Interspecies competition:*** competition for limited resources **BETWEEN** species
  ~***Intraspecies competition:*** competition for limited resources **AMONG MEMBERS OF THE SAME** species.
  ~***Niche****:* the role of the organism in its environment (the way it relates to and uses the environment in which it lives).
- Other factors that limit the size of a given population include:
  ~***abiotic factors*** such as temperature range, intensity of light, mineral availability, water, type of rock/soil, pH of soil.
- One of the most important biotic factors that ***LIMITS*** the size of a population is the ***relationship between predator and prey*.** (see diagram on next page)



- Predators kill their prey, reducing their numbers. When there are too few prey, predators begin to die off. With few predators to feed on them, the prey begin to repopulate.

- Note that prey populations peak before predator populations so there is enough food to support the increase in predators.

Classic Case Study: The Lynx and the Snowshoe Hare



- For over 300 years, the Hudson Bay Company has been involved in the fur trade in Canada. Detailed company records list the number of snowshoe hare and lynx pelts collected by hunters and trappers every year since the late 1700s. The data they collected demonstrates a cyclical pattern of population changes between the showshoe hare and lynx populations.

VI. Symbiotic Relationships (organisms live in close association with one another)

- ***Mutualism:*** symbiotic relationship were both organisms benefit (+,+)
  --Examples include nitrogen fixers and legumes, termites and protozoa, rhino and tick bird (oxpecker), crocodile and Egyptian plover (crocodile bird)
- ***Commensualism:*** symbiotic relationship where one organism benefits and the other organism neither benefits nor is harmed (+.0).
  --Examples include orchids that wind around a tropical tree, barnacles on a whale, remoras and sharks
- ***Parasitism:*** symbiotic relationship where one organism, the parasite benefits, and the other organism, the host, is harmed (+,-)
  --Examples include athlete's foot, ringworm, tapeworms and mammals, heartworm and dogs.

VII. Community Structure

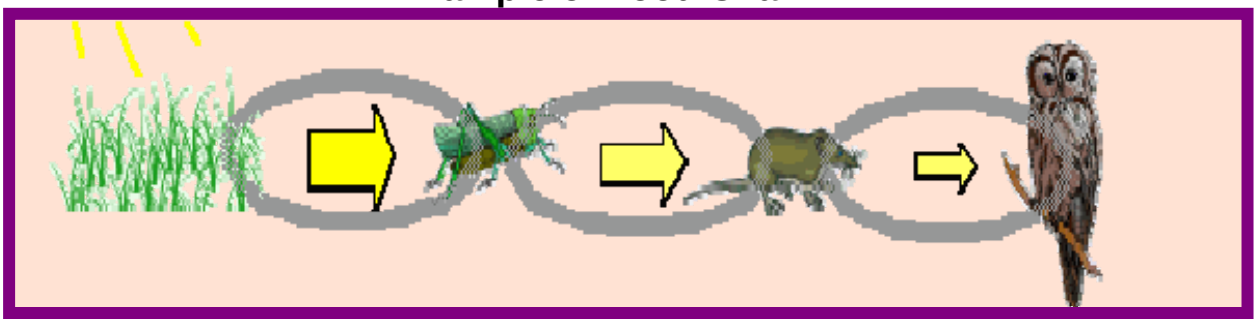
- ***Producers:*** convert light energy (sun) into chemical bond energy of food. ***Autotrophs are producers.***
  ~Producers are the ***FOUNDATION*** of any community, passing their energy to other organisms.
  ~***Terrestrial Environments:*** green plants and photosynthetic bacteria are producers (autotrophs)
  ~***Aquatic Environments:*** algae and phytoplankton are the producers
- ***Consumers****:* must obtain nutrients from the environment. ***Heterotrophs are consumers.***
  ~***Herbivores:*** plant eaters (***primary consumers***)
  ~***Carnivores:*** meat eaters (secondary, tertiary consumers)
  ~***Omnivores****:* eat both plants and meat (secondary or tertiary
- ***Scavengers:*** eat left over remains of dead organisms killed by other predators, helping to clean carcasses of their flesh.
  ~ Examples of scavengers include hyenas and vultures.
- ***Organisms of Decay:*** also known as ***saprophytes or decomposers (detrivores)***
  ~Decompose dead organisms and recycle materials such as carbon dioxide, nitrogen, phosphorous, and other inorganic compounds back into the environment.
  ~***Bacteria and fungi*** are the primary decomposers in most communities.

VIII. Food Chains and Food Webs

- Simply, food chains show what eats what.
- The ***arrows indicate the flow of energy*** through the food chain. (See diagram on next page.)
- ***Decomposers (bacteria and fungi) may be included at the end of a food chain, but they are NOT considered upper level consumers since they consume and break down chemical materials in dead organisms from all levels, recycling necessary materials back into the environment.***
- In stable ecosystems, most organisms have more than one kind of food source.

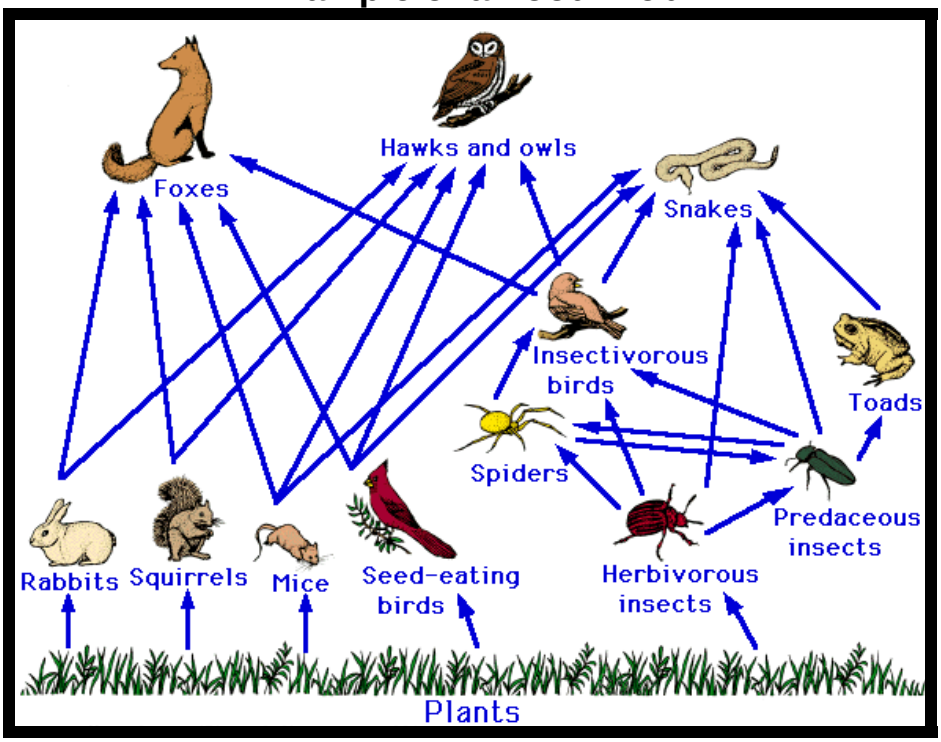
- Food webs illustrate the more complex feeding relationships among organisms in an ecosystem (see diagram below).
  ~Food webs help to maintain the stability of an ecosystem. If one population has a major decline in numbers, organisms that feed on that declining population will then rely more heavily on their other food sources until the declining population recovers.

Example of Food Chain



In this food chain, the grass, the producer, is being eaten by the grasshopper (herbivore and primary consumer), which is eaten by the shrew (carnivore and secondary consumer), which is then eaten by the owl (carnivore and tertiary or third level consumer.

Example of a Food Web

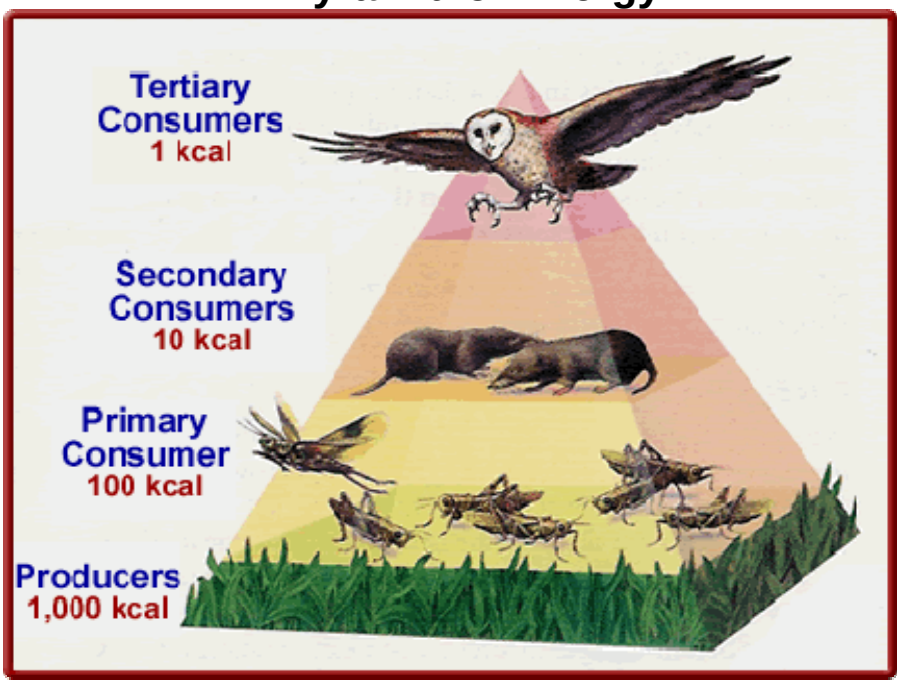


IX. Energy Flow in an Ecosystem

- Much of the energy producers absorb from the sun is used to "fuel" their metabolic life processes.
- As producers maintain their metabolic processes, some of the energy is converted to heat and lost to the environment.
- In fact***, only 10% of the solar energy absorbed by producers is available to primary consumers for their life activities.***

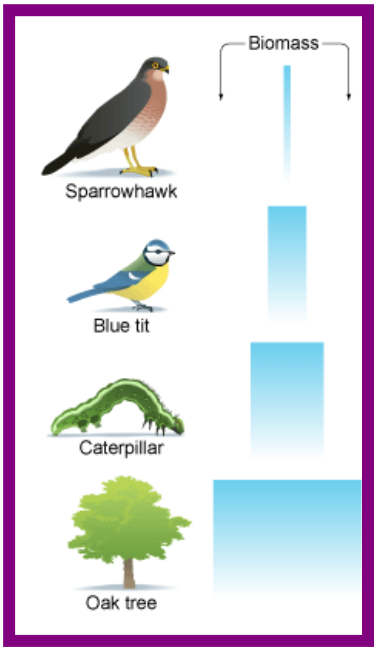
- As energy moves through the food chain, only 10% of the energy taken in by the primary consumers is available to the secondary consumers.
- Since most of the available stored energy is lost in a few steps, most food chains are usually very short.
- Food chains can be arranged into pyramids to illustrate the loss of energy at each consumer level (known as trophic levels).

Pyramid of Energy



- In the above diagram, 900 kcal of energy are used by the producers for metabolic processes or lost to the environment in the form of heat. This means that only 10% of the original energy taken in by the producers or 100 kcal is available to the grasshoppers. Similarly, the grasshoppers use 90 kcal of energy for their life activities (with some heat energy lost to the environment), leaving only 10 kcal available in their tissues for their consumers, the shrews, to use to keep them alive.

Biomass Pyramid



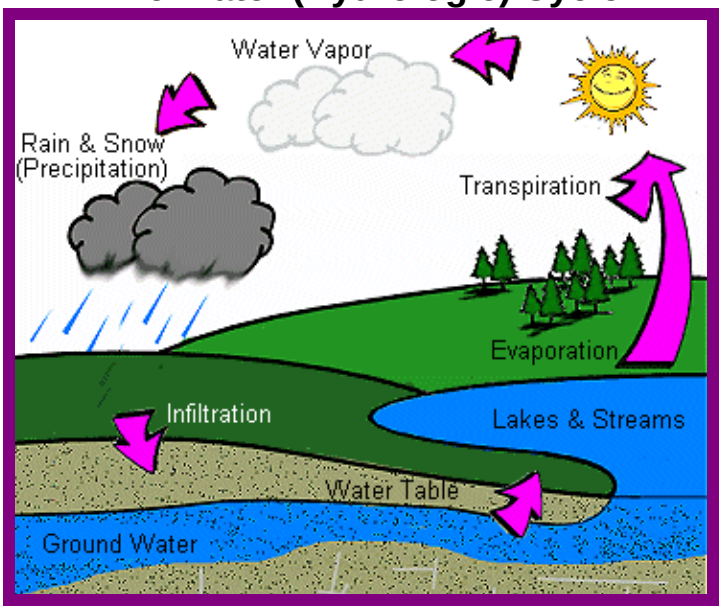
- Each trophic level provides less energy to the level above it.
- Therefore, each succeeding level of the food chain has to have less mass than the level below it in order to survive.
- In other words, a large mass of producers is needed at the based of the pyramid to support a few connivers at the top of the pyramid.
- Looking at the diagram to the left, each trophic level must have a mass smaller than the level below it in order to obtain enough energy to survive.

The Web of Life: Ecology and Ecosystems – Part II

X. Biogeochemical Cycles

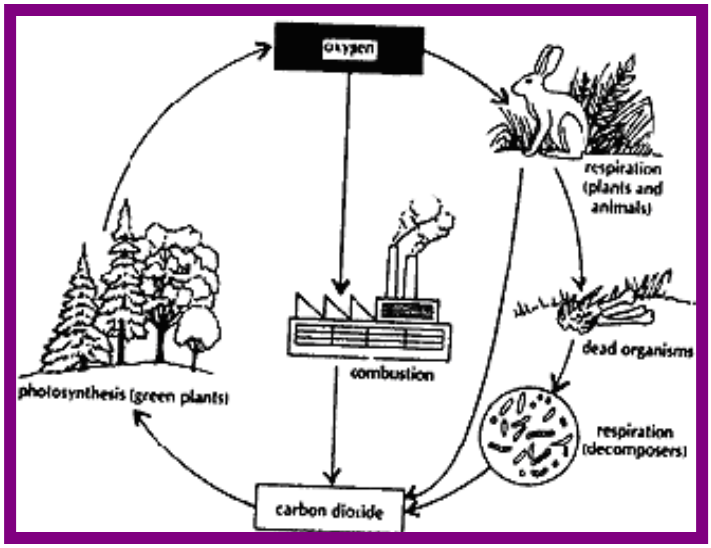
- ***The Water Cycle*** (see handout)
  ~**Physical Changes**
  -- **EVAPORATION** from bodies of water and **TRANSPIRATION** (evaporation of water from the stomates or openings in leaves) into the air
  --**CONDENSATION** of water vapor that leaves the air and comes down as rain, snow, sleet, and hail.
- ~**Chemical Changes**
  --During the process of **PHOTOSYNTESIS**, plants and algae release the metabolic waste of water, as they synthesis food such as glucose, to the environment
  --During the process of cellular **RESPIRATION**, all living organisms release the metabolic waste of water as they break the bonds of food materials like glucose to the environment.

The Water (Hydrologic) Cycle



- Notice in the above diagram that when some water returns to the Earth, the water falls on land. This water will ***infiltrate*** the soil and will eventually enter a body of water through the process of ***percolation*** (the downward movement of water through saturated or nearly saturated soil).

- **The Carbon Oxygen Cycle** (see handout)
  ~Photosynthesis releases oxygen to the environment.
  ~***Oxygen*** is used by living organisms during ***Respiration***, releasing ***carbon dioxide*** as a metabolic waste of this process.
  ~***Oxygen*** is also used during industrial and residential



Combustion (burning of fuel) releasing ***carbon dioxide*** to the atmosphere.
~***Carbon dioxide*** is used by autotrophic organisms during ***photosynthesis***
~When living organisms die, ***decomposers*** (bacteria and fungi) consume these dead carcasses, breaking down chemicals in the tissues, releasing ***carbon dioxide*** back into the atmosphere.

The Nitrogen Cycle

Nitrogen is the most abundant element in our planet's atmosphere. Approximately 78% of the atmosphere is comprised of this important element. Nitrogen is used by lifeforms to carry out many of the functions of life. This element is especially important to plant life. Yet, nitrogen in its gaseous form is almost entirely unusable to lifeforms. It must first be converted or 'fixed' into a more usable form. The process of converting nitrogen is called fixation.

There are specialized bacteria whose function it is to fix nitrogen, converting it, so that it can be used by plants. There are still other bacteria that do the reverse. That is, they return nitrogen to its gaseous form. After nitrogen is fixed, it can be absorbed and used by plants, and subsequently by animals. The process of nitrogen being fixed, used by plants and animals, and later returned to the atmosphere is referred to as the **nitrogen cycle.**