Chapter I. Ecosystems

Biome

A biome is a large area with similar flora, fauna, and microorganisms. Most of us are familiar with the tropical rainforests, tundra in the arctic regions, and the evergreen trees in the coniferous forests. Each of these large communities contain species that are adapted to its varying conditions of water, heat, and soil. For instance, polar bears thrive in the arctic while cactus plants have a thick skin to help preserve water in the hot desert. The major Biomes of the world are as follows: Mountains (High Elevation), Tundra, Temperate Forest, Marine/Island, Desert, Tropical Dry Forest, Cold Climate Forest, Grassland, Savannah and Tropical Rainforest.

Ecosystem

Most of us are confused when it comes to the words ecosystem and biome. What's the difference? There is a slight difference between the two words. An ecosystem is much smaller than a biome. Conversely, a biome can be thought of many similar ecosystems throughout the world grouped together. An ecosystem can be as large as the Sahara Desert, or as small as a puddle or vernal pool.

Ecosystems are dynamic interactions between plants, animals, and microorganisms and their environment working together as a functional unit. Ecosystems will fail if they do not remain in balance. No community can carry more organisms than its food, water, and shelter can accommodate. Food and territory are often balanced by natural phenomena such as fire, disease, and the number of predators. Each organism has its own niche, or role, to play.

The May 15, 1997 edition of the journal Nature had an article that estimated the value of ecosystem services in the world. The authors estimated that the 'goods' delivered to humans, by earth's ecosystems, had a value of about 33 trillion dollars per year. That estimate dwarfs the estimated human produced gross economic product of 18 trillion dollars. The implication is that if we damage our ecosystems too much, this 33 trillion dollar service will not be there for us to use, and we will be poorer in many ways.

The Ecological Society of America points out that many ecosystem services are well known. All the food we eat, whether grown in a farmer’s field or caught from the ocean, is produced from the earth’s ecosystems. Clothing is made from cotton; paper and homes are made from wood—ecosystem products. An estimated 118 of the top 150 medicines in the United States are from natural sources including plants, fungi, bacteria, and even snakes. Many insecticides (e.g., pyrethrins) and industrial chemicals (e.g., turpentine) are produced by our ecosystems too. But these services are the tip of the proverbial iceberg.

Most ecosystem services are things most people never really think of. Consider the air we breathe--it is 20 percent oxygen. ALL that oxygen came from photosynthesis. Without green plants--we would suffocate. Yet we take each breath for granted. The Ecological Society of America lists the following examples of ecosystem services; things we often take for granted:

- Purification of air and water
- Mitigation of droughts and floods
- generation and preservation of soils and renewal of their fertility

- detoxification and decomposition of wastes
- pollination of crops and natural vegetation
- dispersal of seeds
- cycling and movement of nutrients
- control of the vast majority of potential agricultural pest
- maintenance of biodiversity
- protection of coastal shores from erosion by waves
- protection from the sun's harmful ultraviolet waves
- partial stabilization of climate
- moderation of weather extremes and their impacts
- provision of aesthetic beauty and intellectual stimulation that lift the human spirit.

Protecting ecosystem services will take more work in the future. In the year 1900, it was estimated that humans converted about 1 percent of the biosphere's photosynthetic energy to our uses. Now, it is estimated that humans divert 40 percent of the photosynthetic energy on earth to our use. Photosynthetic energy includes things such as the plants we eat, the animals we eat, forestry products we harvest for fiber or fuel, and other plants we use such as medicinal or industrial chemicals, plant based pesticides, and so on. Obviously, when we take increasing amounts of photosynthetic energy for ourselves, it leaves less for the ecosystems to sustain themselves--less for the ecosystems to provide 'ecosystem services'.

The moral of this story is that humans live off ecosystem services. If we destroy the ability of ecosystems to perform these functions, we will destroy ourselves. We should not be alarmed--it is within our abilities to protect ecosystem services, but that protection will not happen unless planned. The Envirothon is all about ecosystem services. This section is about the role of wildlife in ecosystem services.

As you read this section, and all sections of the Envirothon packet, you should keep ecosystem services in mind and relate each topic to the role they play in ecosystems.

How have humans affected the ecosystems?

We have affected ecosystems in almost every way imaginable! Every time we walk out in the wilderness or bulldoze land for a new parking lot we are drastically altering an ecosystem. We have disrupted the food chain, the carbon cycle, the nitrogen cycle, and the water cycle. Mining minerals also takes its toll on an ecosystem. We need to do our best to not interfere in these ecosystems and let nature take its toll.

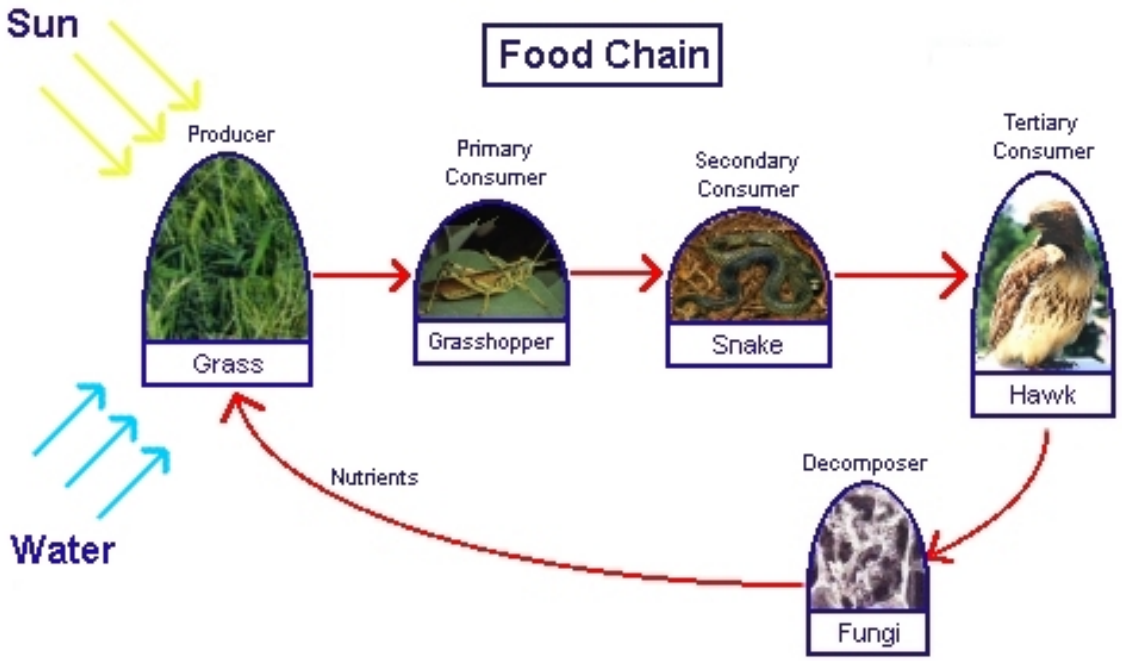
In an ecosystem, plants capture the sun's energy and use it to convert inorganic compounds into energy-rich organic compounds[1]. This process of using the sun's energy to convert minerals (such as magnesium or nitrogen) in the soil into green leaves, or carrots, or strawberries, is called photosynthesis.

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 deer, 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 the plants. The energy transformation chain starts all over again.

Here is a figure showing one such food and energy chain:



Consumers are also classified depending on what they eat.

Herbivores are those that eat only plants or plant products. Example are grasshoppers, mice, rabbits, deer, beavers, moose, cows, sheep, goats and groundhogs.

Carnivores, on the other hand, are those that eat only other animals. Examples of carnivores are foxes, frogs, snakes, hawks, and spiders.

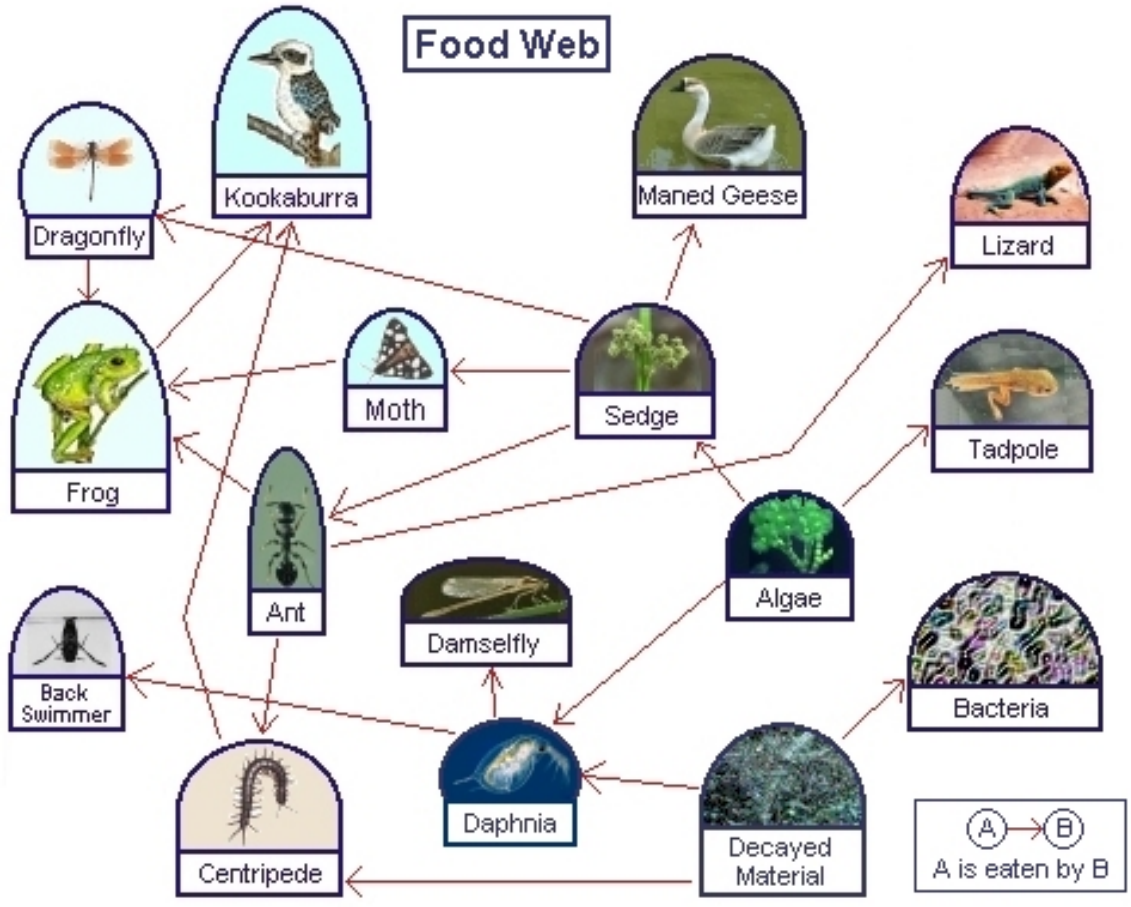
Omnivores are the last type and eat both plants (acting a primary consumers) and meat (acting as secondary or tertiary consumers). Examples of omnivores are:

- Bears --They eat insects, fish, moose, elk, deer, sheep as well as honey, grass, and sedges.
- Turtles -- They eat snails, crayfish, crickets, earthworms, but also lettuce, small plants, and algae.
- Monkeys -- They eat frogs and lizards as well as fruits, flowers, and leaves.
- Squirrels -- They eat insects, moths, bird eggs and nestling birds and also seeds, fruits, acorns, and nuts.

Trophic level. The last word that is worth mentioning in this section is trophic level, which corresponds to the different levels or steps in the food chain. In other words, the producers, the consumers, and the decomposers are the main trophic levels.

Food Webs

The concept of food chain looks very simple, but in reality it is more complex. Think about it. How many different animals eat grass? 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. A food web that shows the energy transformations in an ecosystem.

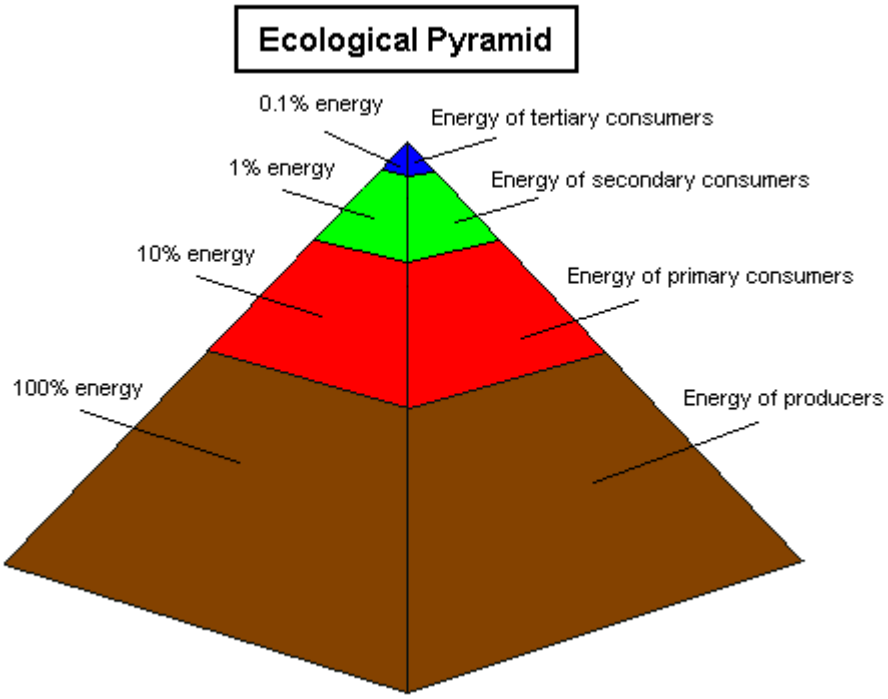


As you can see from this picture, food webs, with all their dependencies, can be very complex, but somehow nature balances things out so that food webs last a long time. Many species share the same habitat, their populations survive for many years, and they all live happily together.

The Ecological Pyramid

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.



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.

Examples

Oaks rate a position at or very near the top of the wildlife food chain (or bottom of the ecological pyramid). They are the "staff of life" for many wild life species. The greatest food value comes from the acorn, especially during the winter season when other foods are scarce.

Squirrels, which are omnivores, are neither at the bottom or the top of the food chain. Since the feed from producers as well as primary consumers, one could say that they occupy two layers in the pyramid.

Hawks, which are mature birds of prey, are at the top of the food chain and of the ecological pyramid.