Chapter 3
Ecosystem Ecology

Ecosystem Ecology Examines Interactions Between the Living and Non-Living World

- **Ecosystem-** A particular location on Earth distinguished by its particular mix of interacting biotic and abiotic components.
- Collectively, all the living organisms in an ecosystem represent that ecosystem's biodiversity.

Ecosystem Boundaries

- Some ecosystems, such as a caves and lakes, have very distinctive boundaries. However, in most ecosystems it is difficult to determine where one ecosystems stops and the next begins.

Ecosystem Boundaries

- Figure 3.2 (a) The Greater Yellowstone Ecosystem includes the land within Yellowstone National Park and many adjacent properties.

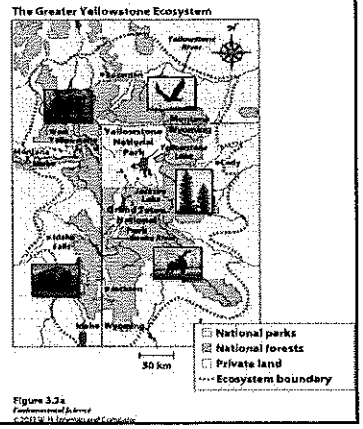
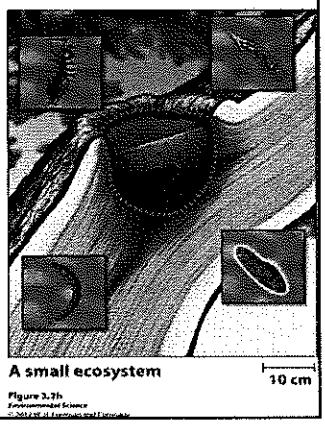


Figure 3.2a

Ecosystem Boundaries

- Figure 3.2 (b) Some ecosystems are very small, such as a rain-filled tree hole that houses a diversity of microbes and aquatic insects.



Ecosystem Processes

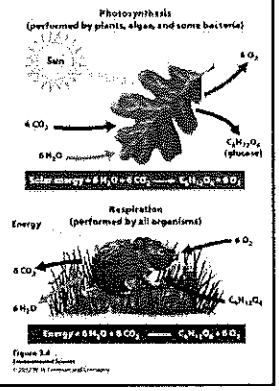
- Even though it is helpful to distinguish between two different ecosystems, ecosystems interact with other ecosystems.
- Changes in one ecosystem can ultimately have far-reaching effects on the global environment.

Energy Flows through Ecosystems

- Two main ways energy flows through an ecosystem are photosynthesis and respiration.
- **Producers (autotrophs)** are able to use the suns energy to produce usable energy through the process called **photosynthesis**.

Energy Flows through Ecosystems

- Figure 3.4 **Photosynthesis** is a process by which producers use solar energy to convert carbon dioxide and water into glucose and oxygen. **Cellular respiration** is a process by which organisms convert glucose and oxygen into water and carbon dioxide, releasing the energy needed to live, grow, and reproduce. All organisms including producers, perform respiration.

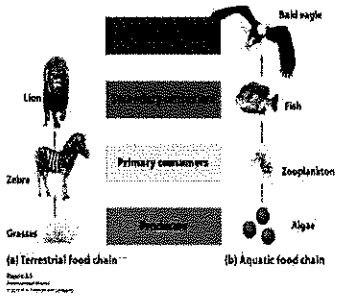


Trophic Levels, Food Chains, and Food Webs

- **Consumers (heterotrophs)**- obtain energy by consuming other organisms.
- **Primary Consumers (herbivores)**- consume producers.
- **Secondary Consumers (carnivores)**- obtain their energy by eating primary consumers.
- **Tertiary Consumers (carnivores)**- eat secondary consumers.

Trophic Levels, Food Chains, and Food Webs

- Figure 3.5 shows a simple food chain that links producers and consumers in a linear fashion illustrates how energy and matter move through the trophic levels of an ecosystem.



Trophic Levels, Food Chains, and Food Webs

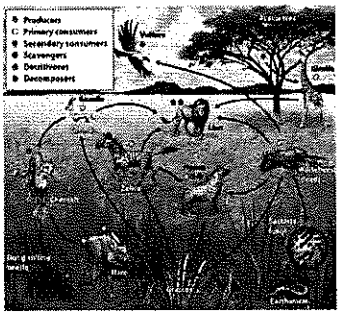
- **Food Chain**- The sequence of consumption from producers through tertiary consumers.
- **Food Web**- A more realistic type of food chain that takes into account the complexity of nature.

Trophic Levels, Food Chains, and Food Webs

- **Scavengers** are carnivores, such as vultures, that consume dead animals.
- **Detritivores** are organisms, such as dung beetles, that specialize in breaking down dead tissue and waste products into smaller particles.
- **Decomposers** (fungi and bacteria) complete the breakdown process by recycling nutrients from dead tissues and waste back into the ecosystem

Trophic Levels, Food Chains, and Food Webs

- Figure 3.6 Food webs are more realistic representation of trophic relationships than simple food chains. They include scavengers, detritivores, and decomposers, and they recognize that some species feed at multiple trophic levels.



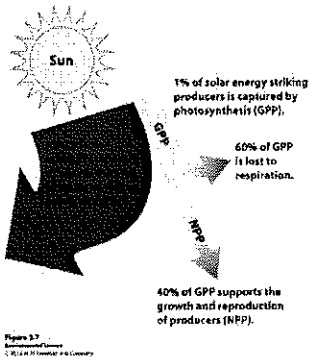
Ecosystem Productivity

- **Gross primary productivity (GPP)**- The total amount of solar energy that the producers in an ecosystem capture via photosynthesis over a given amount of time.
- **Net primary productivity (NPP)**- The energy captured (GPP) minus the energy respired by producers.

NPP = GPP – respiration by producers

Ecosystem Productivity

- Figure 3.7 Producers typically capture only about 1 percent of available solar energy via photosynthesis. The energy they capture (GPP) can be divided into energy used for the producers' respiration and energy available for the producers' growth and reproduction (NPP).

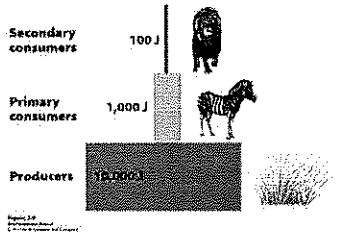


Energy Transfer Efficiency and Trophic Pyramids

- **Biomass**- The energy in an ecosystem is measured in terms of biomass, which is the total mass of all living matter in a specific area.
- **Standing crop**- The amount of biomass present in an ecosystem at a particular time.
- **Ecological efficiency**- The proportion of consumed energy that can be passed from one trophic level to another.
- **Trophic pyramid**- The representation of the distribution of biomass among trophic levels.

Energy Transfer Efficiency and Trophic Pyramids

- Figure 3.9 This trophic pyramid represents the amount of energy that is present at each trophic level, measured in joules (J). While this pyramid assumes 10 % ecological efficiency, actual ecological efficiencies range from 5 to 20% across different ecosystems.



Matter cycles through the biosphere

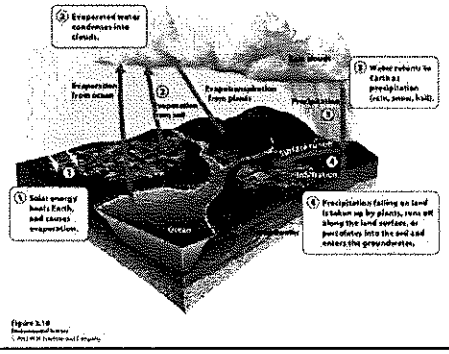
- **Biosphere**- The combination of all ecosystems on Earth.
- **Biogeochemical cycles**- The movement of matter within and between ecosystems involving biological, geologic and chemical processes.

The Hydrologic Cycle

- The movement of water through the biosphere, also known as the Water Cycle.
- Major processes in the hydrologic cycle are transpiration, evapotranspiration, and runoff.
- The hydrologic cycle is instrumental in the cycling of elements.

The Hydrologic Cycle

- Figure 3.10 shows the hydrologic cycle. Water moves from the atmosphere to Earth's surface and back to the atmosphere.



The Hydrologic Cycle

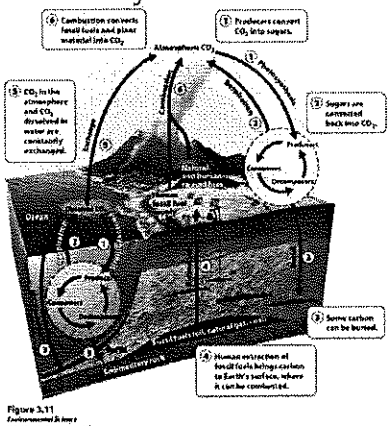
- **Transpiration**- The process where plants release water from their leaves into the atmosphere.
- **Evapotranspiration**- The combined amount of evaporation and transpiration.
- **Runoff**- When water moves across the land surface into streams and rivers, eventually reaching the ocean.

The Carbon Cycle

- Carbon is the most important element in living organisms. It makes up about 20% of their total body weight.
- Carbon is the basis of the long chains of organic molecules that form the membranes and walls of cells, constitute the backbones of proteins, and store energy for later use.

The Carbon Cycle

- Figure 3.11 Producers take up carbon from the atmosphere and water via photosynthesis and pass it on to consumers and decomposers.



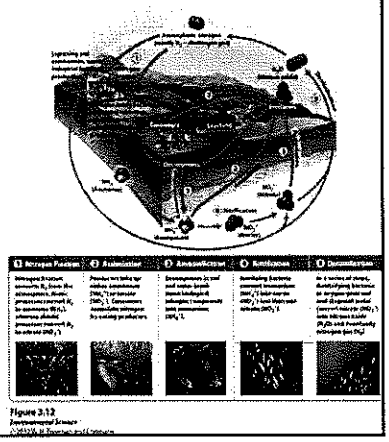
The Nitrogen Cycle

- Five major parts of the nitrogen cycle are **nitrogen fixation**, nitrification, assimilation, ammonification, denitrification.
- Nitrogen is considered a **macronutrients** because organisms need it in large amounts.
  - There are 6 key macronutrient elements:

    N, P, K, Ca, Mg, S

The Nitrogen Cycle

- Figure 3.12 The nitrogen cycle moves nitrogen from the atmosphere and into the soil through several fixation pathways, including the production of fertilizers by humans. In soil, nitrogen can exist in several forms.

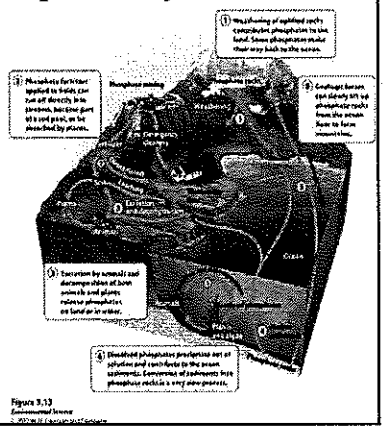


The Phosphorus Cycle

- Phosphorus is a major component to DNA and RNA as well as ATP, the molecules used by cells for energy transfer.
- Phosphorus is a limiting nutrient second only to nitrogen in its importance for successful agricultural yields. Thus, phosphorus, like nitrogen is commonly added to soils in the form of fertilizer.

The Phosphorus Cycle

- Figure 3.13 The phosphorus cycle begins with the weathering or mining of phosphate rocks and use of phosphate fertilizer, which releases phosphorus into the soil and water.



Algal Bloom

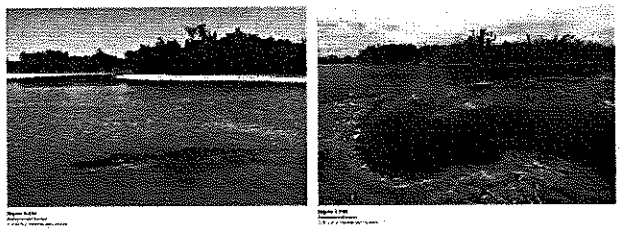
- Figure 3.14 When excess phosphorus enters waterways, it can stimulate a sudden and rapid growth of algae that turns the water bright green. The algae eventually die, and the resulting increase in decomposition can reduce dissolved oxygen to levels that are lethal (dead zone) to fish and shellfish.

Ecosystems respond to disturbance

- **Disturbance-** An event caused by physical, chemical or biological agents that results in changes in population size or community composition.
- Natural ecosystem disturbances include hurricanes, ice storms, tsunamis, tornadoes, volcanic eruptions, and forest fires.

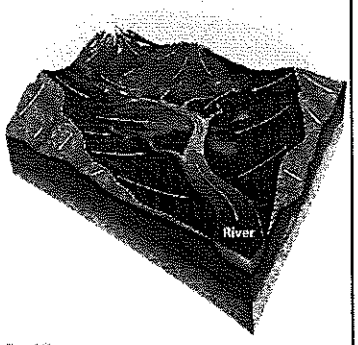
Ecosystems respond to disturbance

- Figure 3.15 The Chandeleur Islands in Louisiana were almost completely submerged by Hurricane Katrina in August 2005. (a) shows the island in July of 2001 (b) shows a photo two days after hurricane Katrina in August 2005.



Watershed Studies

- Figure 3.16 **Watershed-** All of the land in a given landscape that drains into a particular stream, river, lake or wetland.

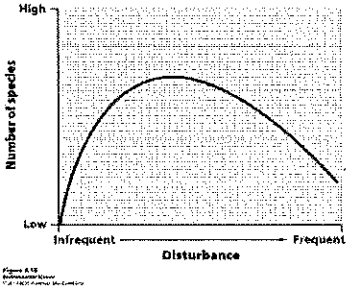


Resistance versus Resilience

- **Resistance-** A measure of how much a disturbance can affect the flow of energy and matter in an ecosystem.
- **Resilience-** The rate at which an ecosystem returns to its original state after a disturbance.
- **Restoration ecology-** A new scientific discipline that is interested in restoring damaged ecosystems.

The Intermediate Disturbance Hypothesis

- The **intermediate disturbance hypothesis**- states that ecosystems experiencing intermediate levels of disturbance are more diverse than those with high or low disturbance levels.

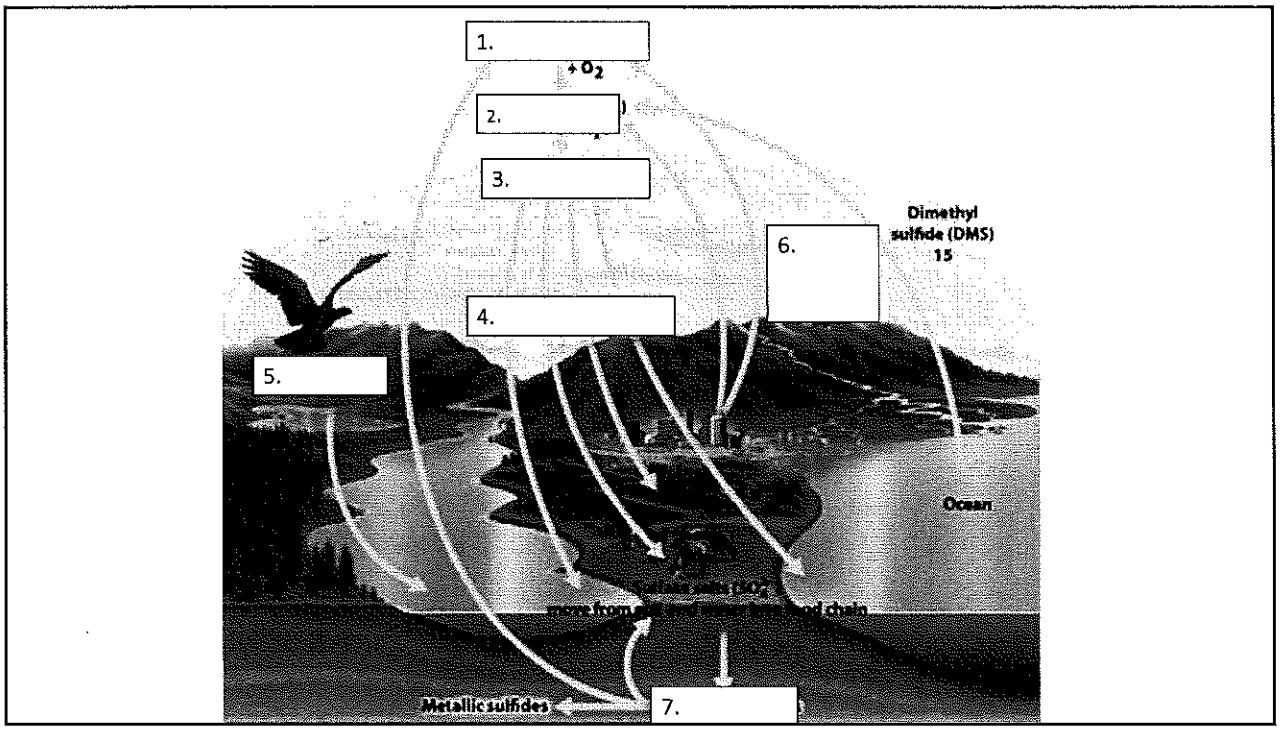


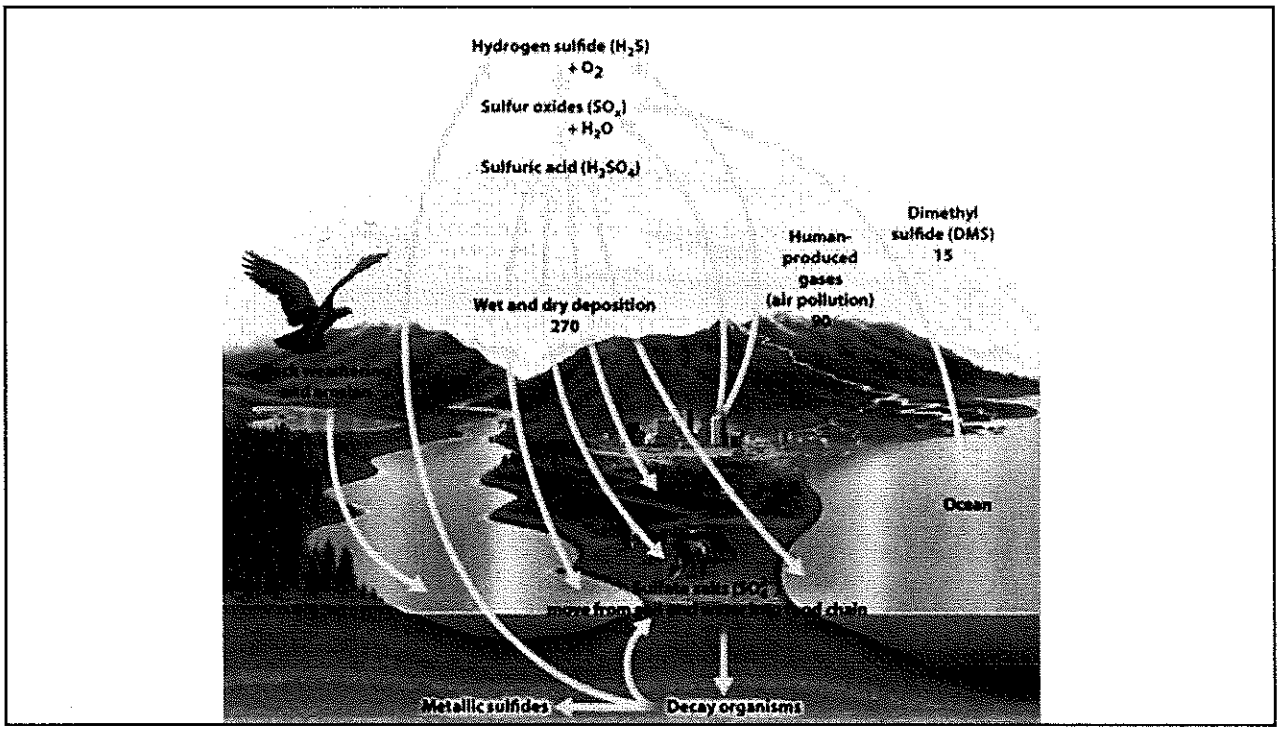
Ecosystems Provide Valuable Services

- A species may have **instrumental value**, meaning that it has worth as an instrument or tool that can be used to accomplish a goal.
- Alternatively, a species may have **intrinsic value**, meaning that it has worth independent of any benefit it may provide to humans. Intrinsic values include the moral value of an animal's life; they cannot be quantified.

Instrumental Values of Ecosystems

- **Provisions**- Goods that humans can use directly.
- **Regulating services**- The service provided by natural systems that helps regulate environmental conditions.
- **Support systems**- The support services that natural ecosystems provide such as pollination, natural filters and pest control.
- **Resilience**- Resilience of an ecosystem ensures that it will continue to provide benefits to humans. This greatly depends on species diversity.
- **Cultural services**- Ecosystems provide cultural or aesthetic benefits to many people.


1.
+ O_2
2.
3.
Dimethyl sulfide (DMS) 15
6.
4.
5.
Ocean
Metallic sulfides
7.


Hydrogen sulfide (H_2S)
+ O_2
Sulfur oxides (SO_x)
+ H_2O
Sulfuric acid (H_2SO_4)
Dimethyl sulfide (DMS) 15
Human-produced gases (air pollution) 80
Wet and dry deposition 270
Ocean
Metallic sulfides
Decay organisms