NELSON EDUCATION | Canada's Learning Advantage

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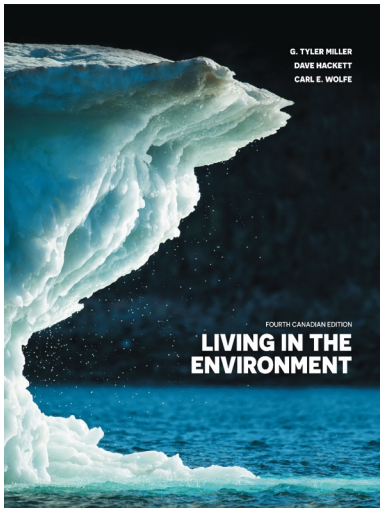
to accompany



prepared by
Ian Dawe

Chapter 4

Ecosystems:
What Are They, and How Do They Work?

Key Concepts

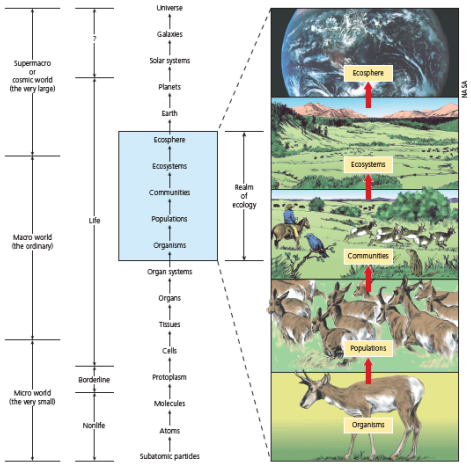
- Ecology and learning about ecosystems
- Earth's life support systems
- Ecosystem components and energy flows
- Soils and biogeochemical cycles

What Is Ecology?

The study of connections in nature

- How do organisms interact with each other?
- In what ways are they connected?

Levels of Organization in Nature



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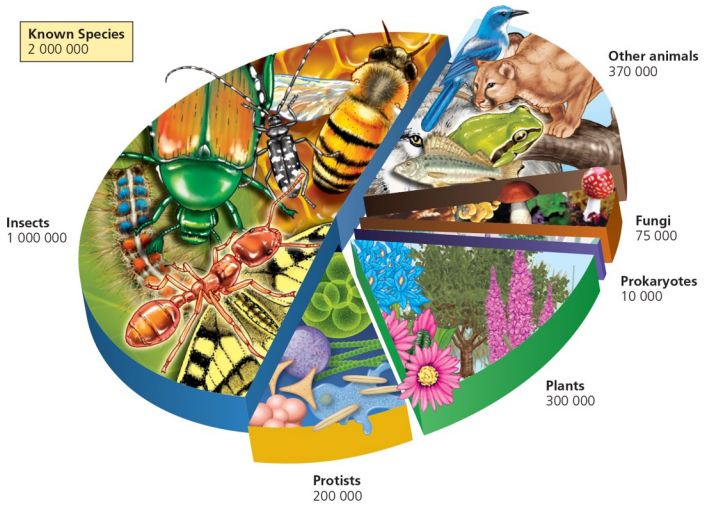
Known Species on Earth



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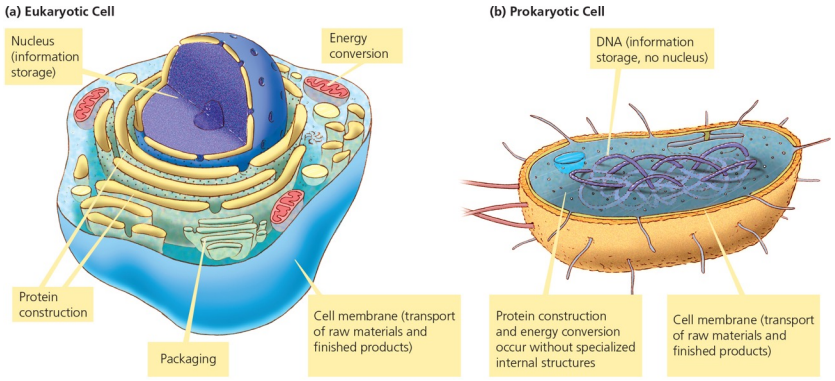
Cellular Diversity of Life



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What Species Rule the World? Small Matters!

- Microorganisms are the key to life on earth.
- Microbes, for example, help you digest food.
- Microbes clean water.
- Microbes act as natural pesticides.
- Microbes are *essential* for life.

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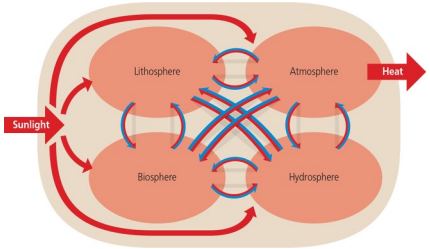
Populations

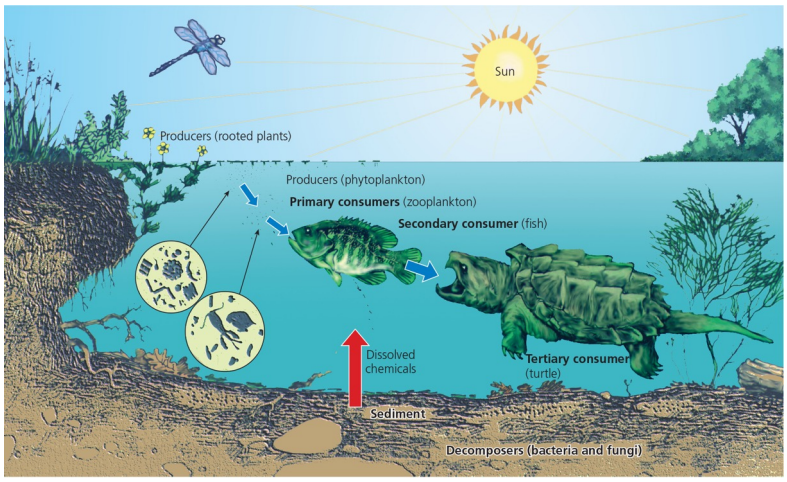
- Populations are groups of organisms of the same species living in the same habitat.
- Populations have genetic diversity.
- This sets the stage for natural selection.

Communities and Ecosystems

- A group of populations is a community.
- Ecosystems add in all the non-living elements (abiotic).
- The earth can be understood as a system.

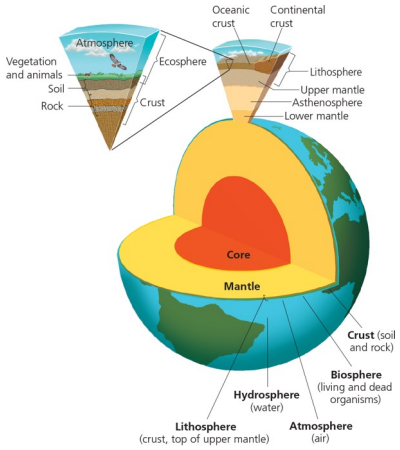


Example: A Freshwater Ecosystem



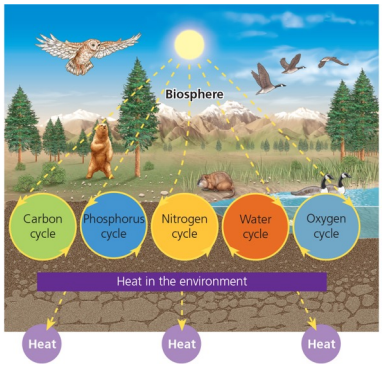
Major Parts of Earth's Life-Support Systems

- **Atmosphere**
  - Troposphere
  - Stratosphere
- **Geosphere**
  - Crust
    - Lithosphere
    - Upper mantle
  - Asthenosphere
  - Lower mantle
  - Core

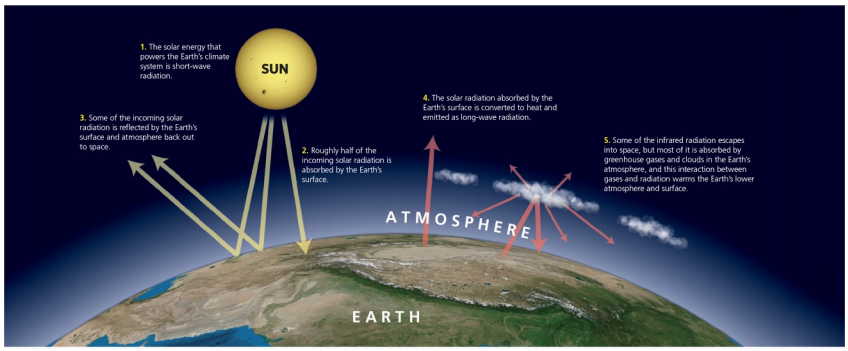


What Sustains Life on Earth?

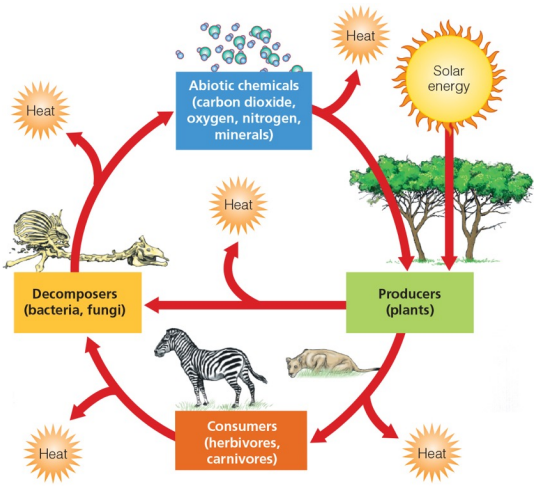
- One-way flow of high-quality energy, with energy loss due to heat
- Cycling of essential forms of matter, such as water, carbon, and nitrogen
- Gravity



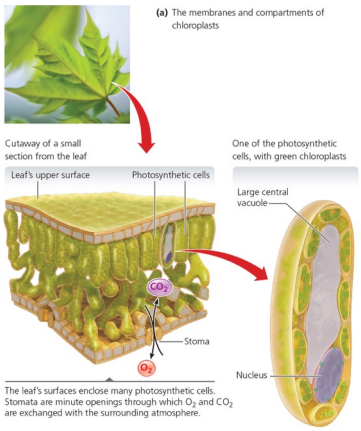
How Does the Sun Sustain Life on Earth?



Major Components of an Ecosystem

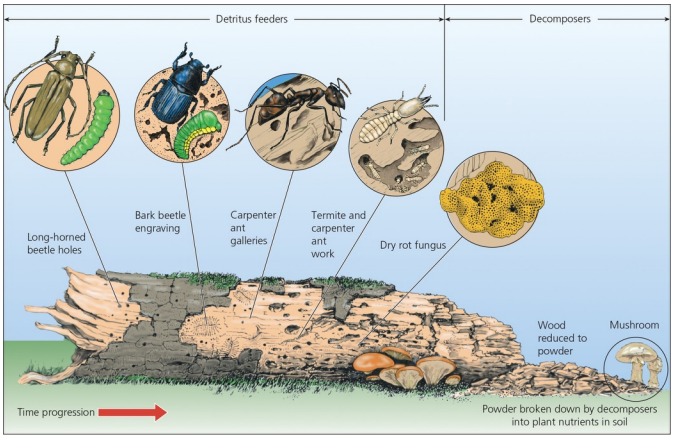


Major Components of an Ecosystem: Producers

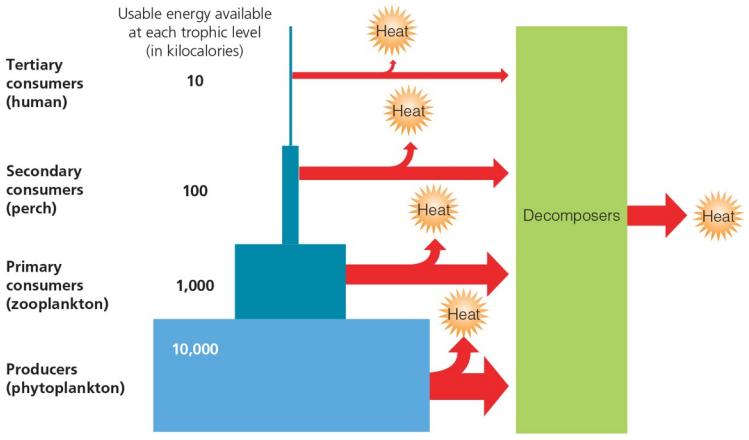


Art: From RUSSELL/WOLFE/HERTZ/STARR. Biology, 1E.

Major Components of an Ecosystem: Detritivores

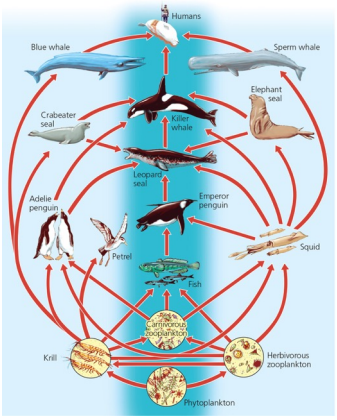


Energy Flow in Ecosystems

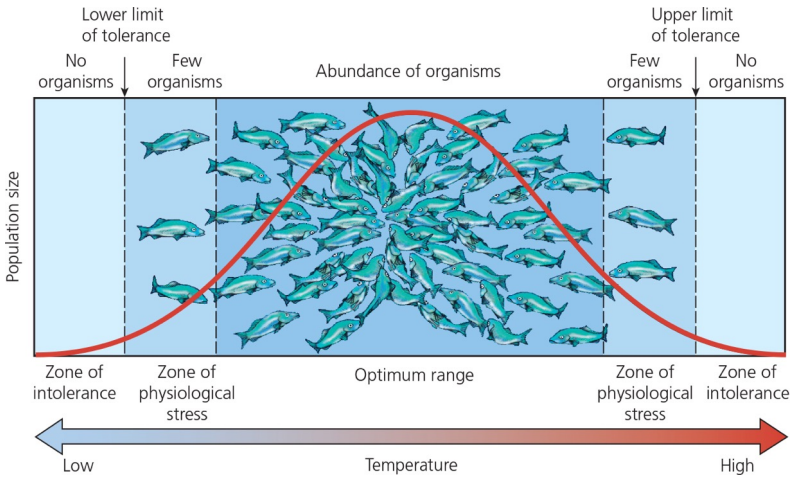


Food Web

- Represents energy flow in a real ecosystem
- Webs are a better model than "chains," as the system is not necessarily linear.



How Tolerant Are Organisms to Environmental Conditions?

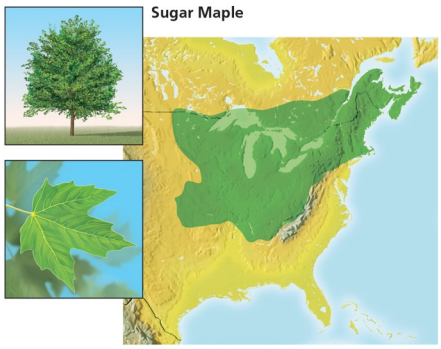


What Factors Limit Population Growth?

Limiting factor principle

Too much or little of a single abiotic factor can limit or prevent growth of a population.

- Precipitation
- Dissolved oxygen (DO)
- Salinity



Source: Data from U.S. Department of Agriculture and the Canadian Forest Service

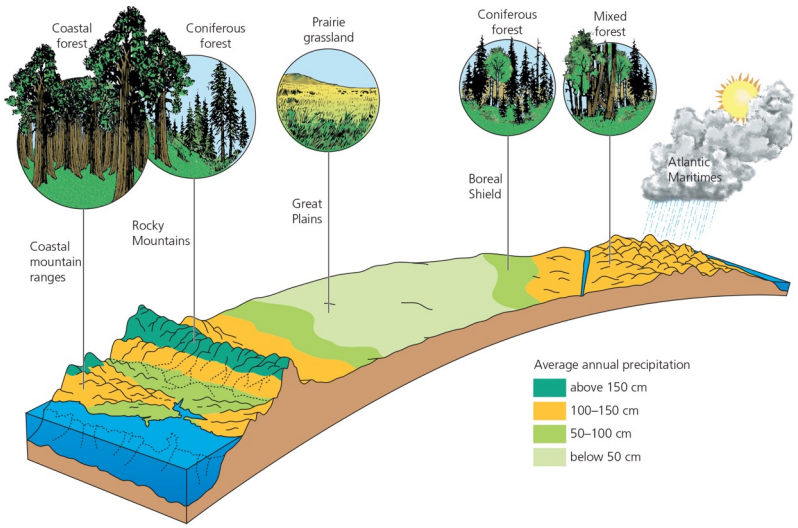
What Is Biodiversity?

- **Genetic** diversity
- **Species** diversity
- **Ecological** diversity
  - Ecosystems
- **Functional** diversity
  - Biological and chemical processes
- **Structural** diversity
  - Physical characteristics of a habitat

What Are Biomes and Aquatic Life Zones?

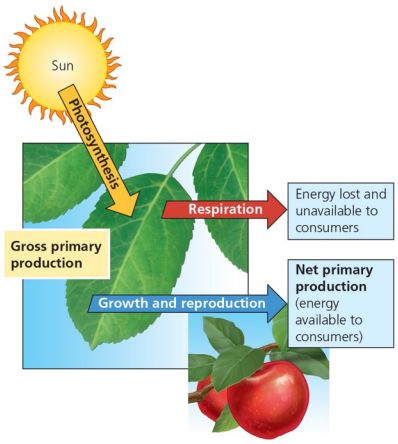
- **Biomes**
  - Terrestrial component
  - Distinct climate and specific species
- **Aquatic life zones**
  - Freshwater life zones
  - Marine life zones

Major Biomes Along the 49th Parallel in Canada

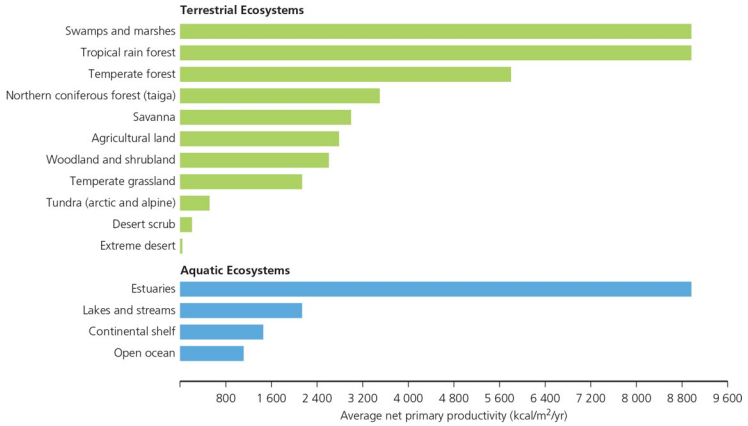


Primary Productivity of Ecosystems

- **NPP** limits population of all consumers
- Humans consume majority of NPP
  - 27% of total
  - 10 - 55% terrestrial



Net Primary Productivity (NPP)

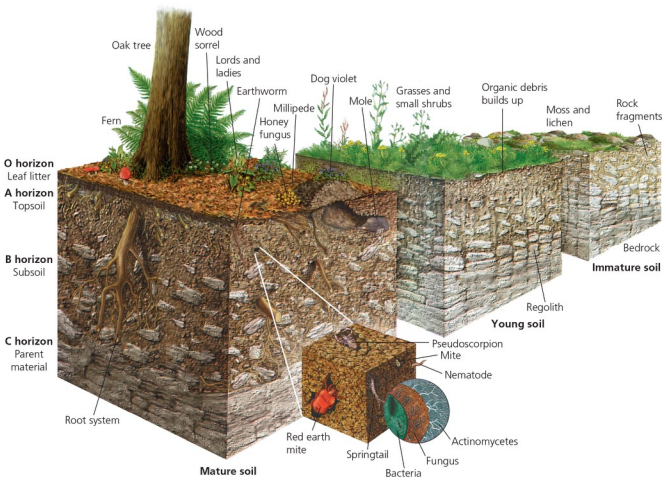


Source: Data from Communities and Ecosystems, 2nd ed, by R.H. Whittaker, 1975. New York: Macmillan.

What Is Soil?

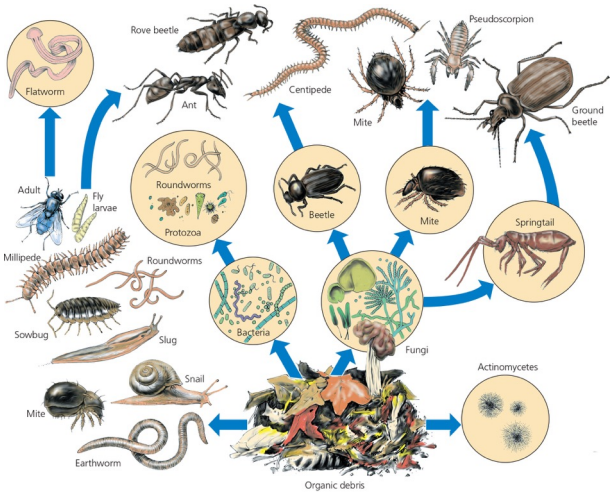
- Thin covering over most land
  - Minerals, eroded rock, decaying organic matter, water, air, microscopic organisms…
- Renewable at slow rate
- Critical nutrients for plant growth
- Earth's primary filtration system
- Water storage and recycling

Major Layers in Mature Soil



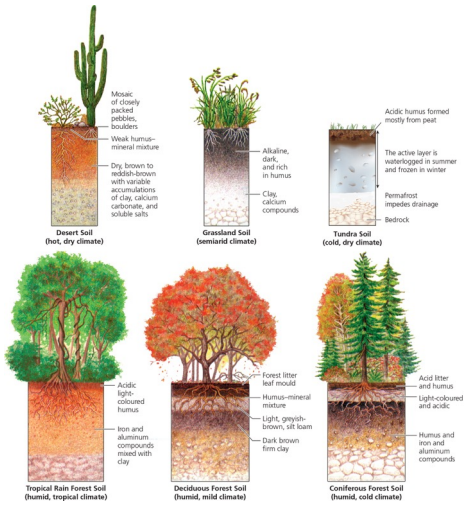
Art: From Derek Elsom, *Earth: The Making, Shaping and Workings of a Planet,* 1992. Copyright © 1992 by Marshall Editions Developments Limited. New York: Macmillan. Used by permission.

Ecology of a Compost Heap: Making Soil



Soil Types in Major Biomes

Variations in Soil
- Soil texture
- Soil porosity
- Soil permeability

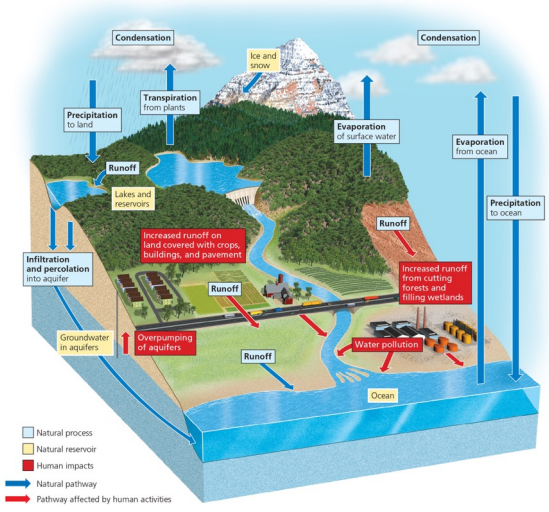


Matter Cycling in Ecosystems

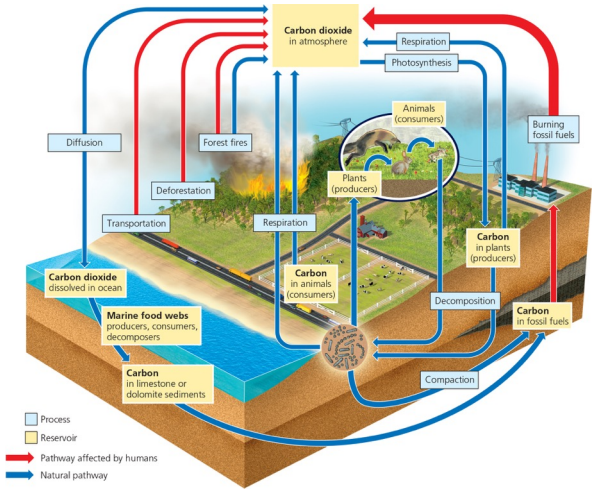
Biogeochemical cycles of nutrients

- Water
- Carbon
- Nitrogen
- Phosphorus
- Sulfur

The Hydrologic (Water) Cycle



The Carbon Cycle



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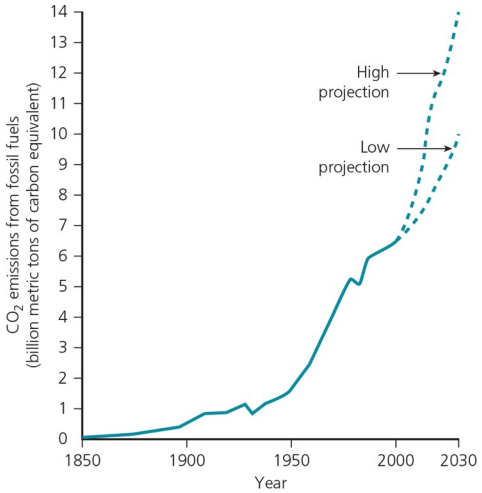
How Are Human Activities Affecting the Carbon Cycle?



Source: Data from UN Environment Programme, British Petroleum, International Energy Agency, and U.S. Department of Energy

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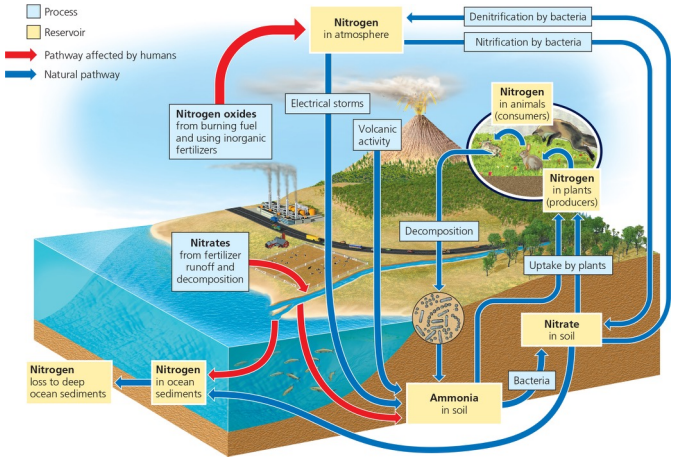
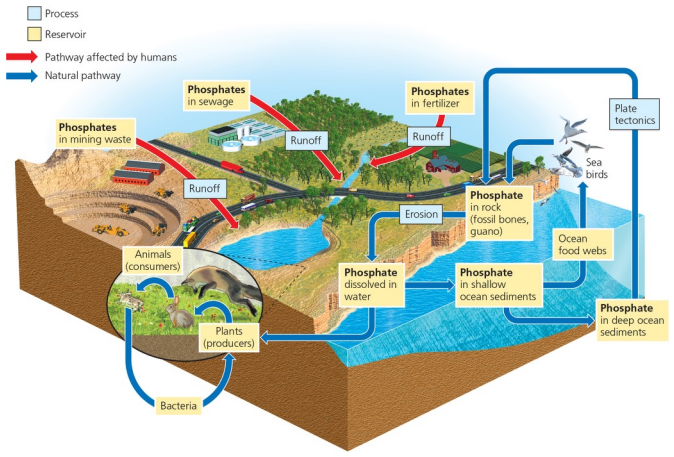
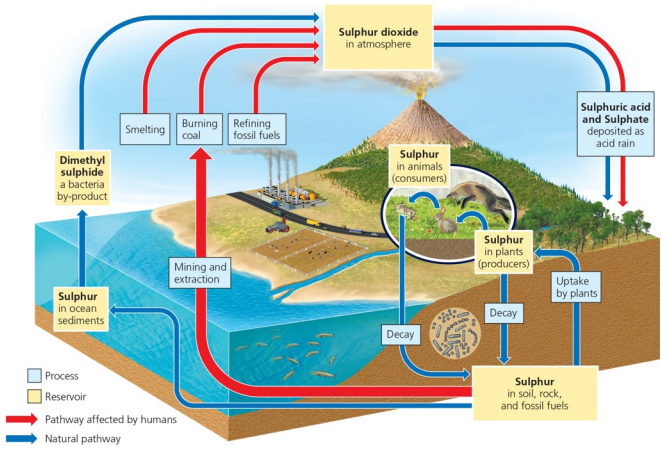
The Nitrogen Cycle



The Phosphorus Cycle



The Sulphur Cycle



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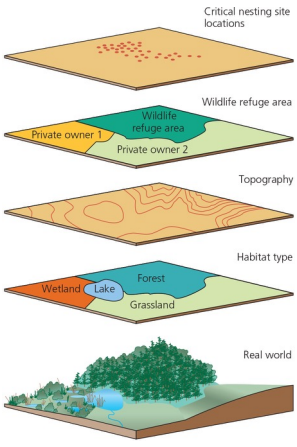
Geographic Information Systems (GIS)

- **Complex data analysis**
  - Remote sensing data
  - Field studies
  - Satellite data
  - Geographic coordinates
- **Landscape ecology**
  - Effects of spatial patterns on ecological systems



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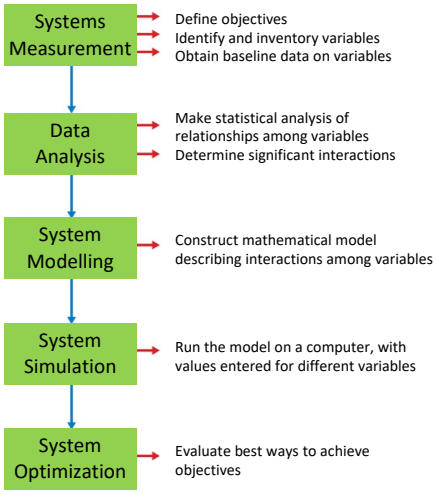
Systems Analysis



Source: Modified data from Charles Southwick

Conclusion

- Ecology is the study of interactions between living things, and between biotic and abiotic parts of the ecosphere.
- Nutrients cycle, energy flows
- Living things are restricted by their environmental conditions and trophic level.