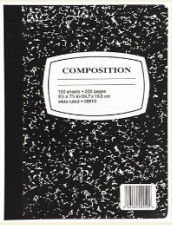
CHAPTER3
Ecosystems: What Are They and How Do They Work?

To halt the decline of an ecosystem, it is necessary to think like an ecosystem.
- Douglas Wheeler

Core Case Study: Tropical Rain Forests Are Disappearing

Fig. 3-1a, p. 54

- Cover about 2% of the earth's land surface
- Contain about 50% of the world's known plant and animal species
- Disruption will have three major harmful effects



What are three harmful effects resulting from the clearing and degradation of tropical rain forests?

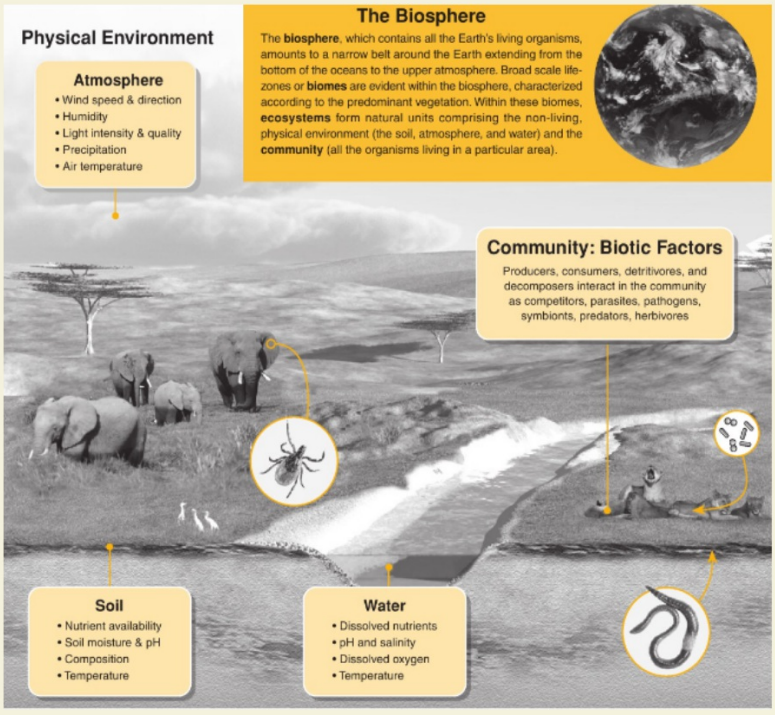
3-1 What Keeps Us and Other Organisms Alive?

- ***Concept 3-1A*** *The four major components of the earth's life-support system are the atmosphere (air), the hydrosphere (water), the geosphere (rock, soil, and sediment), and the biosphere (living things).*

- ***Concept 3-1B*** *Life is sustained by the flow of energy from the sun through the biosphere, the cycling of nutrients within the biosphere, and gravity.*

Components of an Ecosystem

Directions: Cut and paste the diagram and answer the questions in your composition book.



1. Distinguish between biotic and ab factors.

2. Choose the letter of the term tha corresponds to each of the stater below

   a. All the green tree frogs prese a rainforest
   b. An entire forest
   c. The humidity in a rainforest
   d. A community of organisms a their environment
   e. An association of different sp interacting together

The Earth's Life-Support System Has Four Major Components

1. **Atmosphere: AIR**
   - **Troposphere**: where weather happens
   - **Stratosphere**: contains ozone layer
2. **Hydrosphere: WATER**
3. **Geosphere: SOLID EARTH**
4. **Biosphere: LIVING**

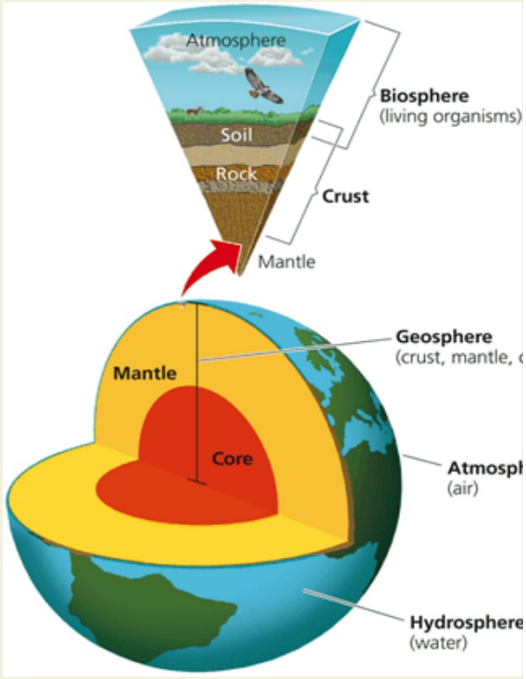


Fig. 3-2, p. 56

The Diversity of Life

Fig. 3-3a, p. 56

Three Factors Sustain Life on Earth

- One-way flow of high-quality energy:
  - Sun → plants → living things → environment as heat → radiation to space
- Cycling of nutrients through parts of the biosphere
- Gravity holds earths atmosphere

Sun, Earth, Life, and Climate

- Sun: UV, visible, and IR energy
- Radiation
  - Absorbed by ozone and other atmosphere gases
  - Absorbed by the earth
  - Reflected by the earth
  - Radiated by the atmosphere as heat
- **Natural greenhouse effect**

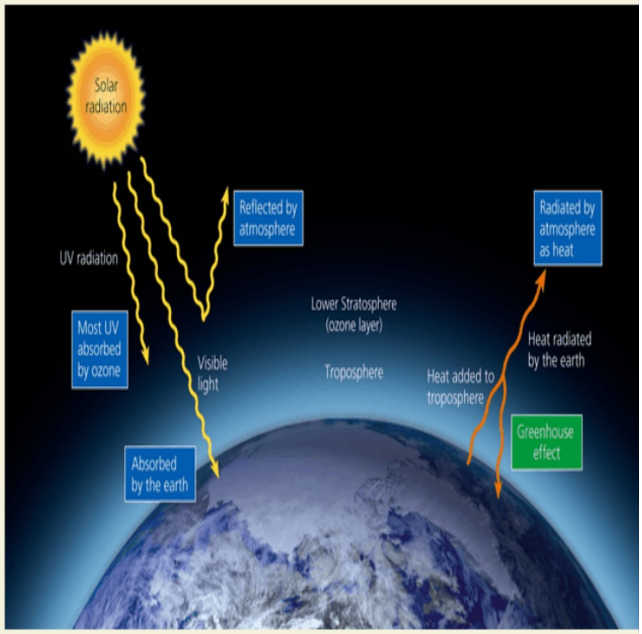
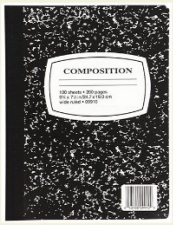


Fig. 3-4, p. 57

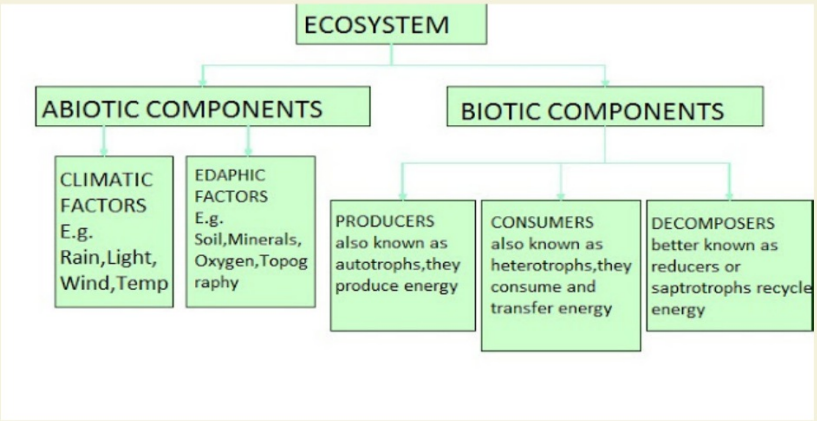
VIDEO:Earth's Giant Game of Tetris



1. **Explain the greenhouse effect.**
2. **What are greenhouse gases and why are they important?**
3. **What are the negative effects of climate change?**

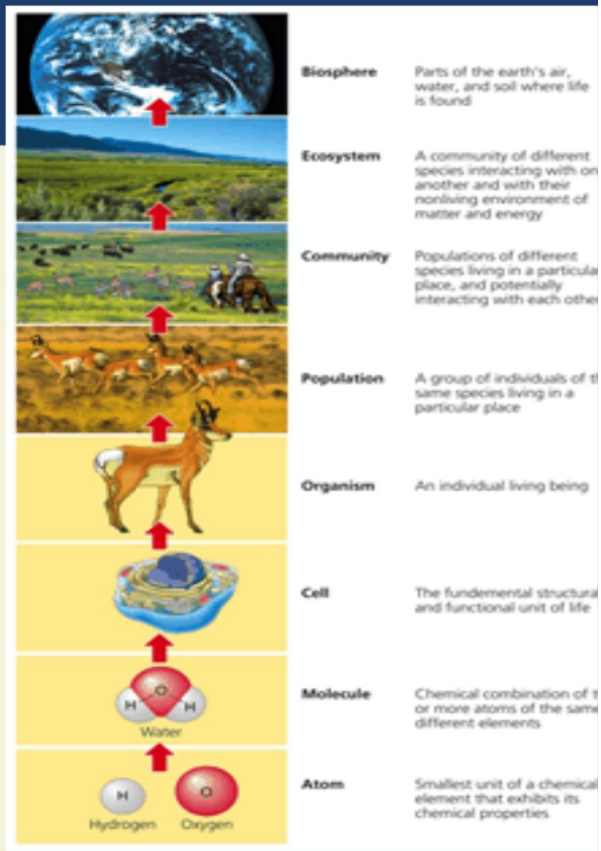
3-2 What Are the Major Components of an Ecosystem?

- ***Concept 3-2*** *Some organisms produce the nutrients they need, others get their nutrients by consuming other organisms, and some recycle nutrients back to producers by decomposing the wastes and remains of organisms.*



Ecologists Study Interactions in Nature

Ecology: how organisms interact with each other and their nonliving environment



Ecosystems Have Living and Nonliving Components

Abiotic

- Water
- Air
- Nutrients
- Rocks
- Heat
- Solar energy

Biotic

- Living and once living

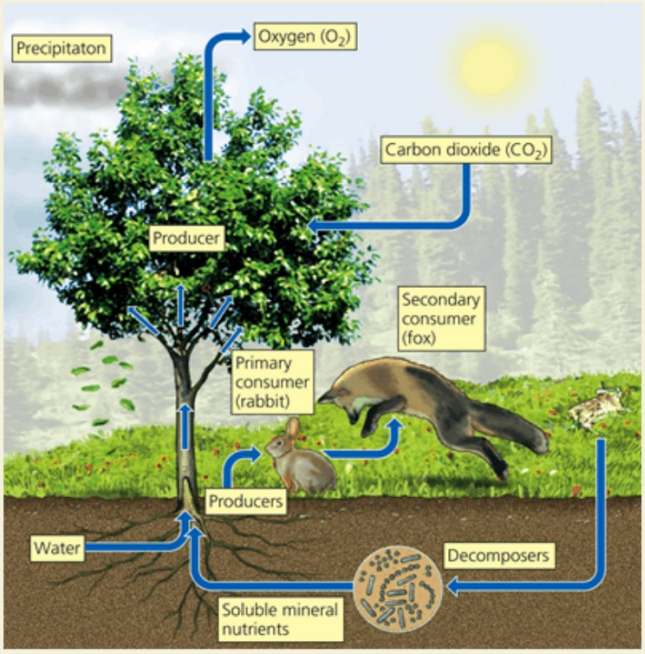


Fig. 3-6, p. 59

Producers

Producers or autotrophs- makes their own food from compound obtained from environment.

- **Ex: plant gets energy or food from sun**

Video: Photosynthesis Rap

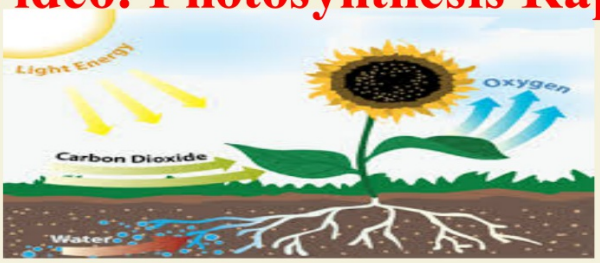


Fig. 3-7a, p. 59

Consumers

also known as HETEROTROPHS

Obtain energy and nutrients by feeding on other organisms or their remains

Fig. 3-8a, p. 60

Primary Consumers - Herbivores

- plant eaters
- primary consumers

Feed directly on producers

- Deer, goats, rabbits

Video: Triumph of the Herbivores - Life of Mamma

Fig. 3-8a, p. 60

Secondary Consumers - Carnivores

- meat eaters
- secondary consumers

Feed directly on primary consumers

- Lion, tiger

Video: World's Deadliest - Lion vs. Zebra

Higher Level Consumers

- meat eaters
- tertiary or quartenary consumers

Feed only on other carnivores

- Wolf

Video: Whales Gang Up on Se

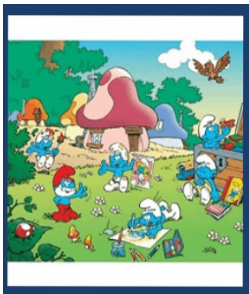
Other Type of Consumers

Scavengers

- feed on dead organisms
- EX: vultures, flies, crows, shark

Omnivores

- consume both plants and animals
- EX: pigs, humans, bears



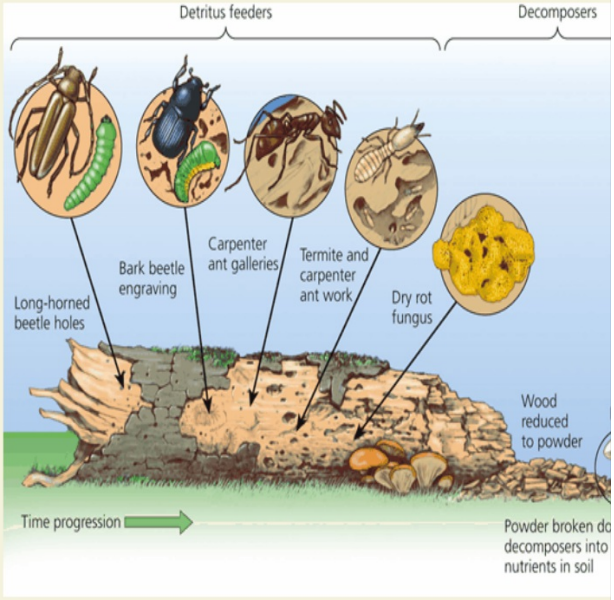
Decomposers and Detrivores

Decomposers

- release nutrients
- break down and recycle organic materials from organisms' wastes and from dead organisms
- EX: Bacteria, Fungi

Detritivores

- feed on dead bodies of other organisms
- extract nutrients from partly decomposed organic matter plant debris, and animal dung
- EX: Earthworms, Vultures



Ecosystem Components

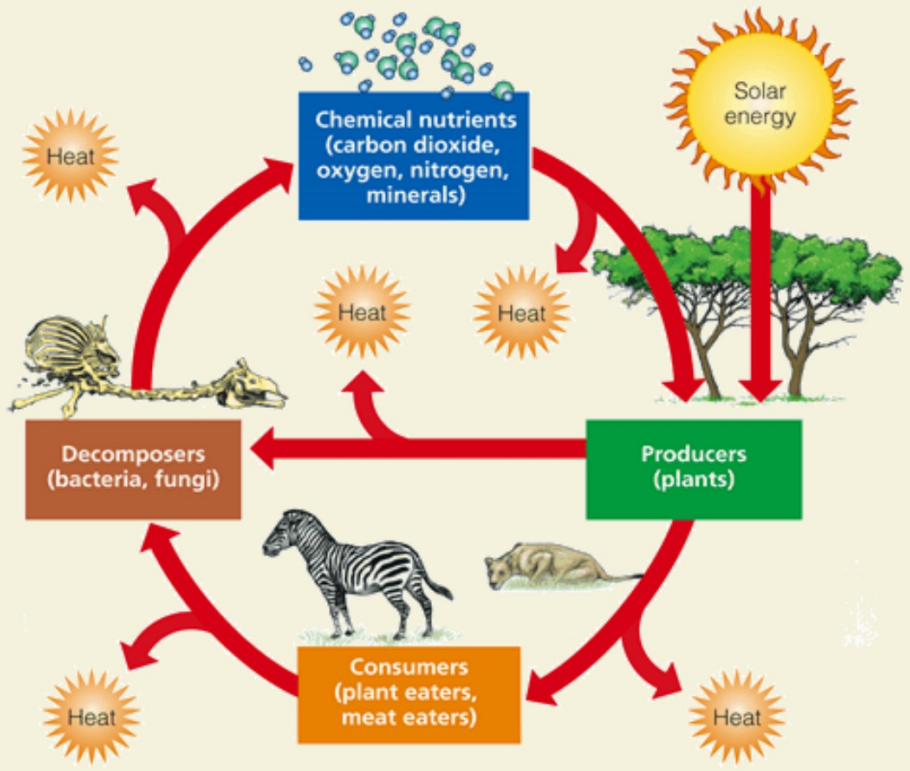


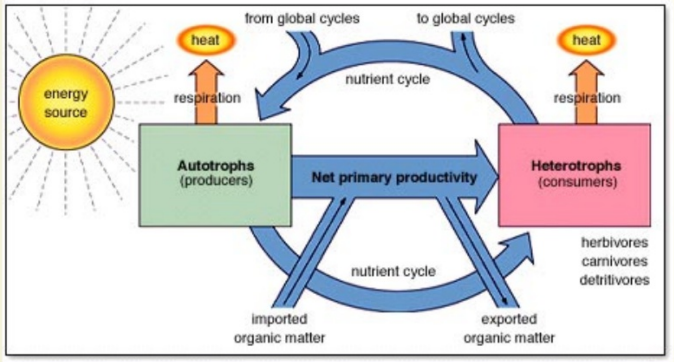
Fig. 3-11, p. 62


Let's Practice: Food Chain Game
the food chain game
Instructions: Drag the parts of the food chain to their correct place.
(If you drag something incorrectly, it won't stay there).
Visit the food chain pages to get ready or if you need help!
When the chain is complete, it will come to life and you can watch the food chain in action!
Play the game!

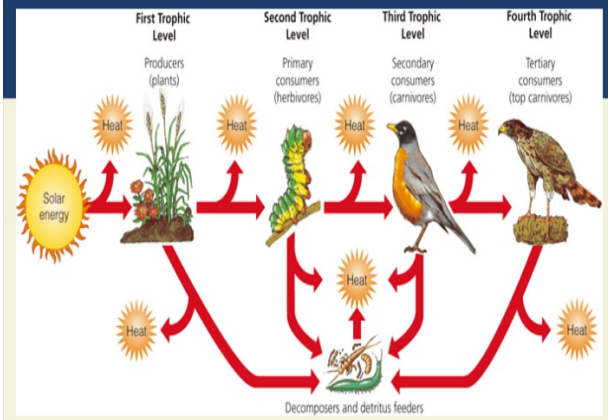
Fig. 3-11, p. 62

3-3 What Happens to Energy in an Ecosystem?

Concept 3-3 *As energy flows through ecosystems in food chains and webs, the amount of chemical energy available to organisms at each succeeding feeding level decreases.*

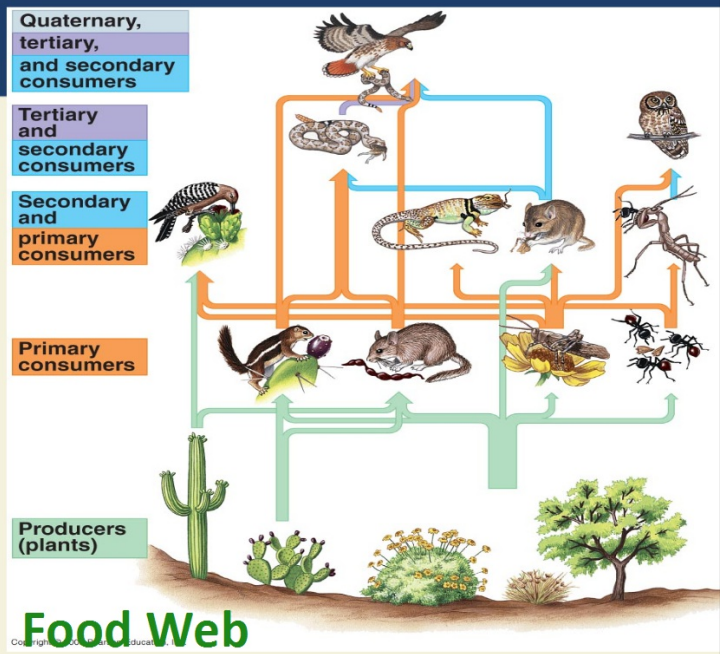


Energy Flows Through Ecosystems in Food Chains and Food Webs



Food Chain

- movement of energy and nutrients from one **trophic level** to the next
- photosynthesis → feeding → decomposition



Food Web

- network of interconnected food chains

Directions: Complete the diagram to illustrate the movement of energy from one trophic level to the next.

100,000

Units of Energy

10,000

Units of Energy

1,000

Units of Energy

100

Units of Energy

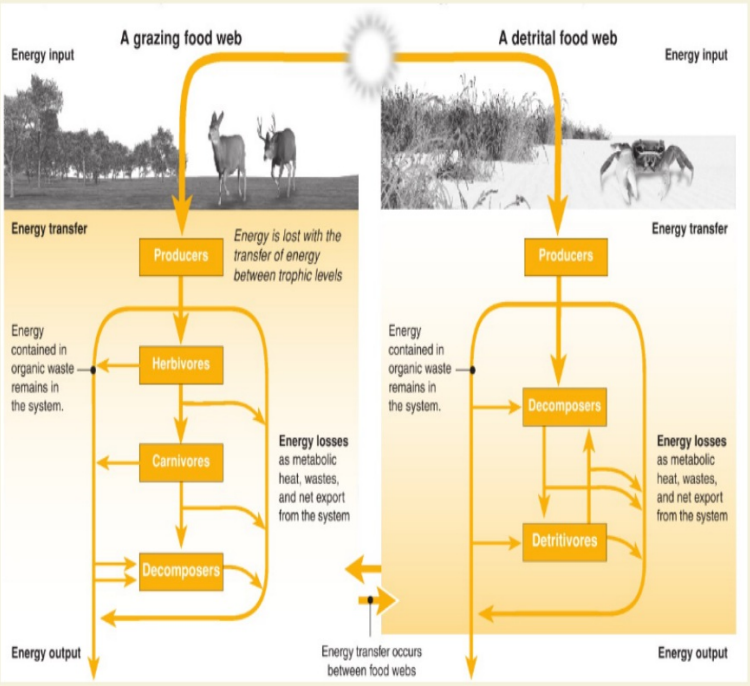
SUN

10

Units of Energy

Energy Inputs and Outputs

Directions: Cut and paste the diagram and answer the questions in your composition book.



1. Compare the differences betv producers and consumers wit respect to their role in energy transfers.
2. With respect to energy flow, describe a major difference between a detrital and a graz food web.
3. Distinguish between detrivor and decomposers with respe how their contributions to nu cycling.

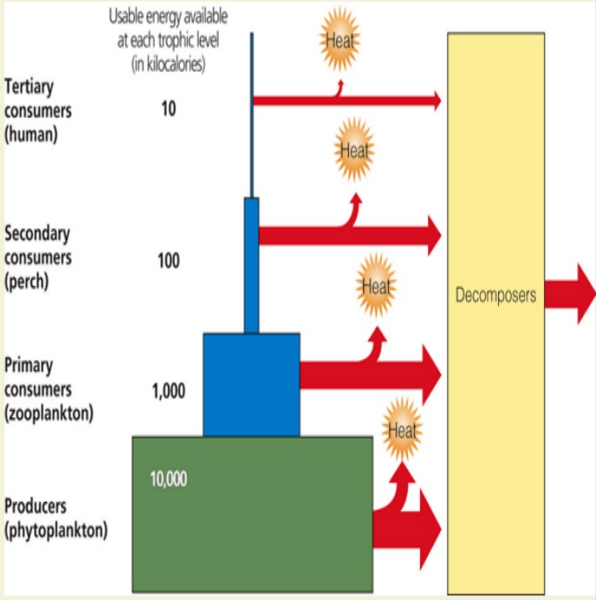
Usable Energy Decreases with Each Link in a Food Chain or Web

Biomass

- Dry weight of all organic matter of a given trophic level in a food chain or food web
- Decreases at each higher trophic level due to heat loss

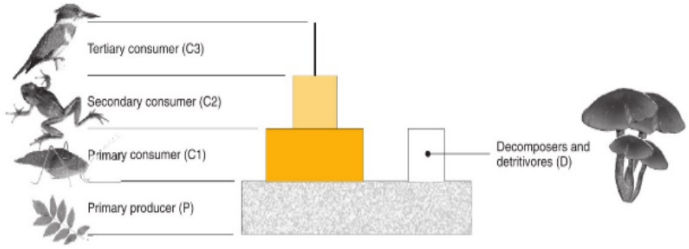
Pyramid of energy flow

- 90% of energy lost with each transfer
- Less chemical energy for higher trophic levels

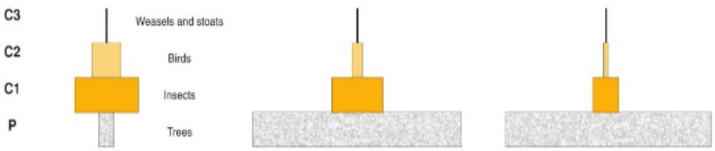


Ecological Pyramids

Directions: Cut and paste the diagram and answer the questions in your composition book.



The generalized ecological pyramid pictured above shows a conventional pyramid shape, with a large number (or biomass) of producers forming the base for an increasingly small number (or biomass) of consumers. Decomposers are placed at the level of the primary consumers and off to the side. They may obtain energy from many different trophic levels and so do not fit into the conventional pyramid structure. For any particular ecosystem at any one time (e.g. the forest ecosystem below), the shape of this typical pyramid can vary greatly depending on whether the trophic relationships are expressed as numbers, biomass or energy.



Numbers in a forest community
Pyramids of numbers display the number of individual organisms at each trophic level. The pyramid above has few producers, but they may be of a very large size (e.g. trees). This gives an 'inverted pyramid' although not all pyramids of numbers are like this.

Biomass in a forest community
Biomass pyramids measure the 'weight' of biological material at each trophic level. Water content of organisms varies, so 'dry weight' is often used. Organism size is taken into account, so meaningful comparisons of different trophic levels are possible.

Energy in a forest community
Pyramids of energy are often very similar to biomass pyramids. The energy content at each trophic level is generally comparable to the biomass (i.e. similar amounts of dry biomass tend to have about the same energy content).

1. **Describe what the three types of ecological pyramids measure:**
   (a) Number pyramid
   (b) Biomass pyramid
   (c) Energy pyramid

2. **Explain the advantage of using a biomass or energy pyramid rather than a pyramid of numbers to ex the relationship between differe trophic levels.**

Some Ecosystems Produce Plant Matter Faster Than Others Do

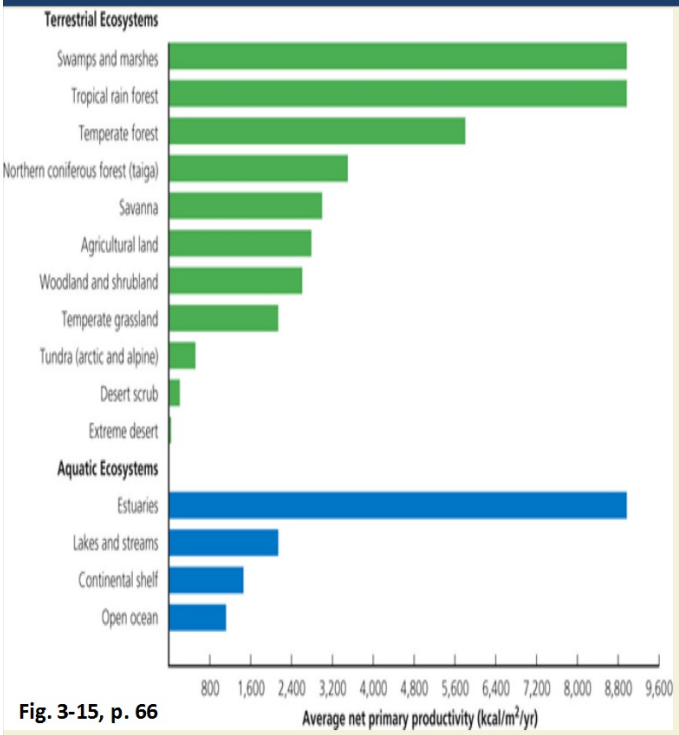


Fig. 3-15, p. 66

Gross primary productivity (GPP)

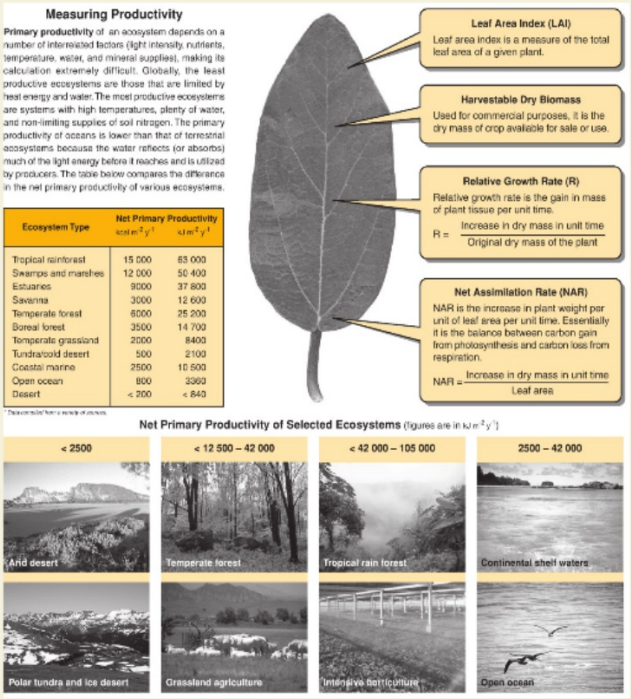
- Rate at which an ecosystem's producers convert solar energy to chemical energy and biomass
- Kcal/m^2/year

Net primary productivity (NPP)

- Rate at which an ecosystem's producers convert solar energy to chemical energy, minus the rate at which producers use energy for aerob respiration
- Ecosystems and life zones differ in th NPP

Primary Productivity

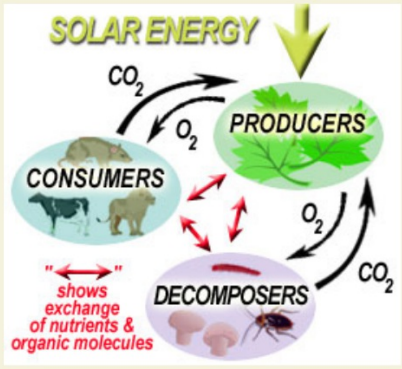
Directions: Cut and paste the diagram and answer the questions in your composition book.



1. Define NPP and GPP.
2. What three factors can affect the primar productivity of an ecosystem?
3. Predict the effects of LAI on the rate of primary production.
4. Use the data table provided, to plot the differences between primary productivi tropical rain forests, tundra, desert, ope ocean and grasslands. (use either data columns but not both)
   a. Suggest why tropical forests are m productive than tundra and desert ecosystems.
   b. Suggest why the NPP of open ocear low relative to that of coastal syste

3-4 What Happens to Matter in an Ecosystem?

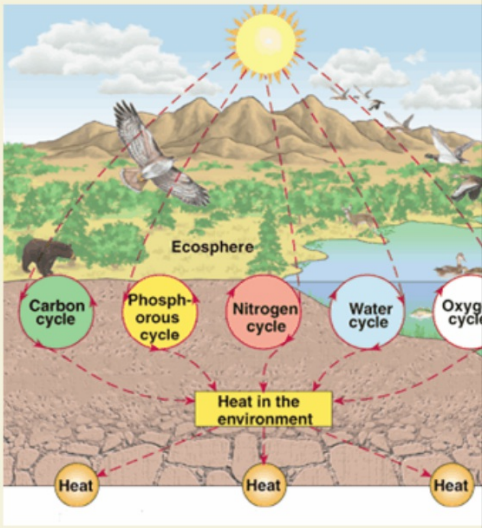
- ***Concept 3-4*** *Matter, in the form of nutrients, cycles within and among ecosystems and the biosphere, and human activities are altering these chemical cycles.*



Nutrients Cycle in the Biosphere

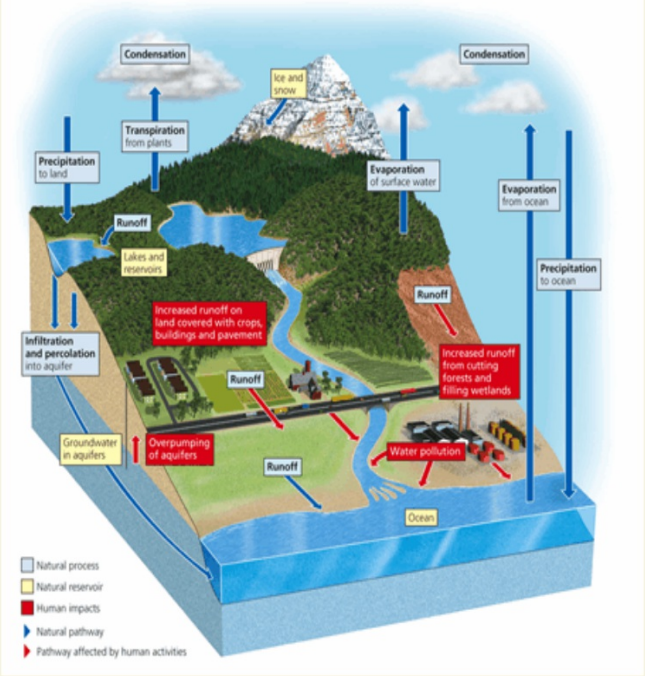
Biogeochemical cycles, nutrient cycles

- Hydrologic
- Carbon
- Nitrogen
- Phosphorus
- Sulfur



- Nutrients may remain in a reservoir for a period of time

Water Cycles through the Biosphere



Natural renewal of water quality: three major processes

- Evaporation
- Precipitation
- Transpiration

Alteration of the hydrologic cycle by humans

- Withdrawal of large amounts of freshwater at rates faster than nature can replace it
- Clearing vegetation
- Increased flooding when wetlands are drained

Glaciers Store Water

Fig. 3-17, p. 68

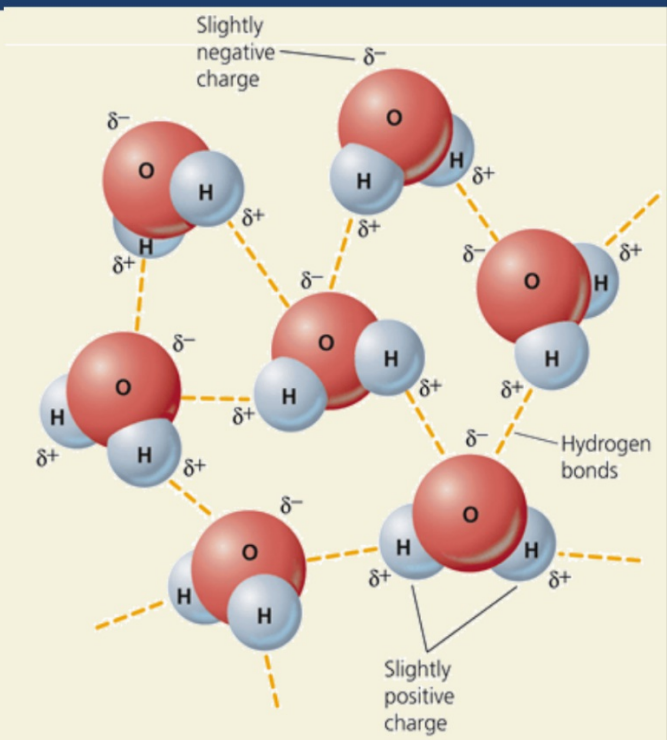
Fig. 3-18,

Water Erodes Rock in Antelope Canyon

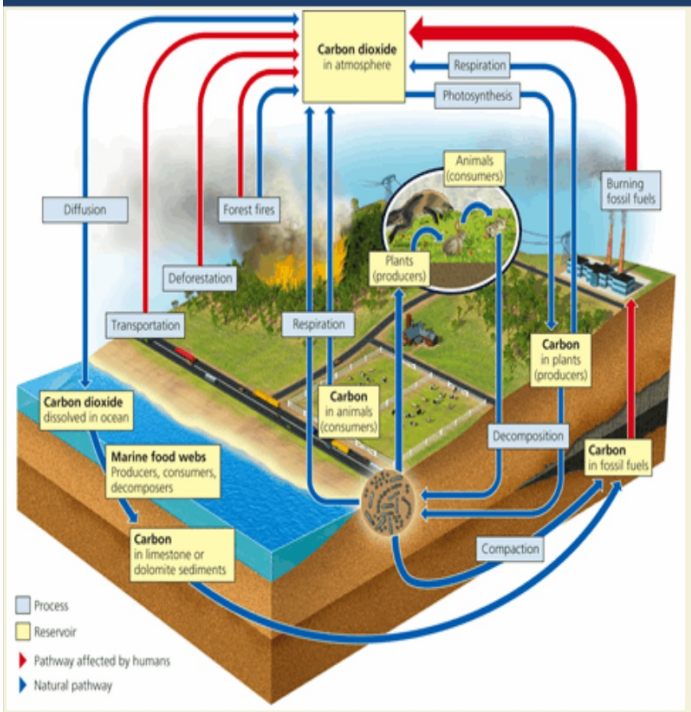
Science Focus: Water's Unique Properties

Properties of water due to hydrogen bonds between water molecules:

- Exists as a liquid over a large range of temperature
- Changes temperature slowly
- High boiling point: 100˚C
- Adhesion and cohesion
- Expands as it freezes
- Solvent
- Filters out harmful UV

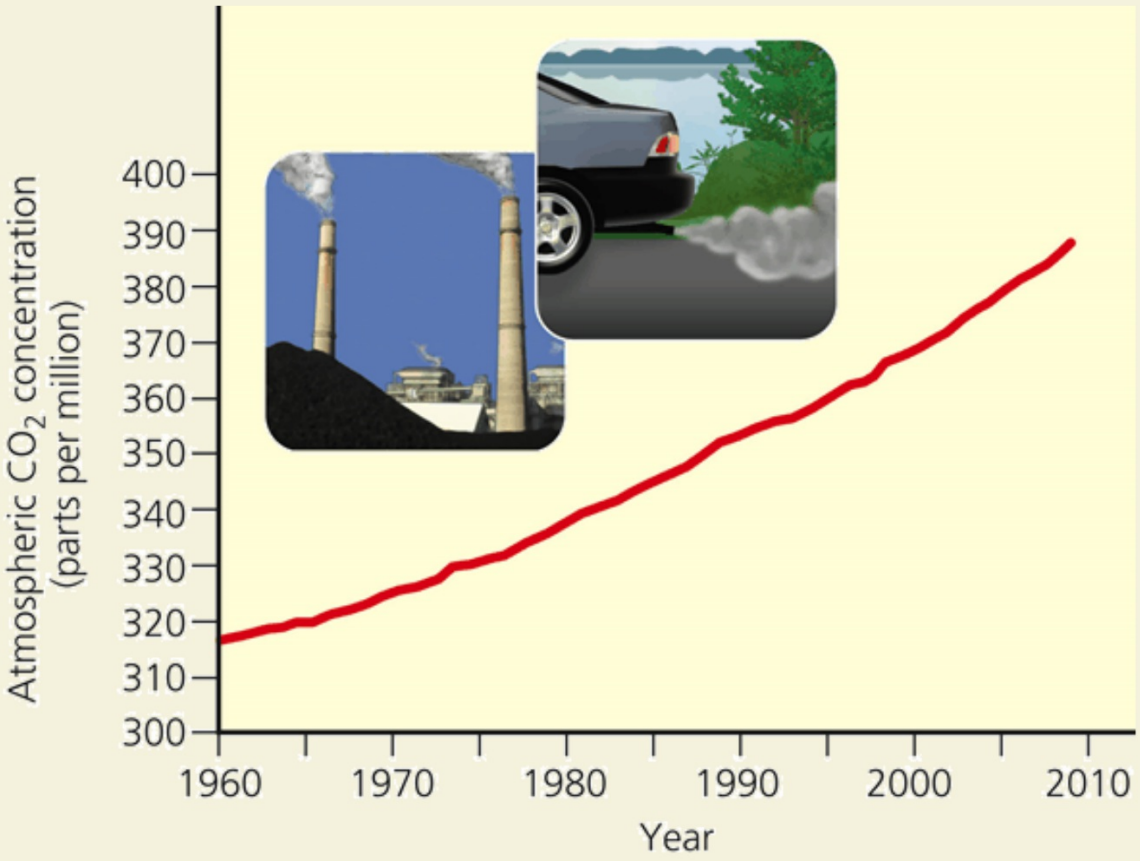


Carbon Cycle Depends on Photosynthesis and Respiration



- Link between photosynthesis i producers and respiration in producers, consumers, and decomposers
- Additional CO_2 added to the atmosphere
  - Tree clearing
  - Burning of fossil fuels
  - Warms the atmosphere

Increase in Atmospheric Carbon Dioxide, 1960-2009



Supplement 9, Fig 14

Nitrogen Cycles through the Biosphere: Bacteria in Action

- Nitrogen fixed by lightning
- Nitrogen fixed by bacteria and cyanobacteria
  - Combine gaseous nitrogen with hydrogen to make ammonia (NH_3) and ammonium ions (NH_4^+)
- Nitrification
  - Soil bacteria change ammonia and ammonium ions to nitrate ions (NO_3^-)
- Denitrification
  - Nitrate ions back to nitrogen gas

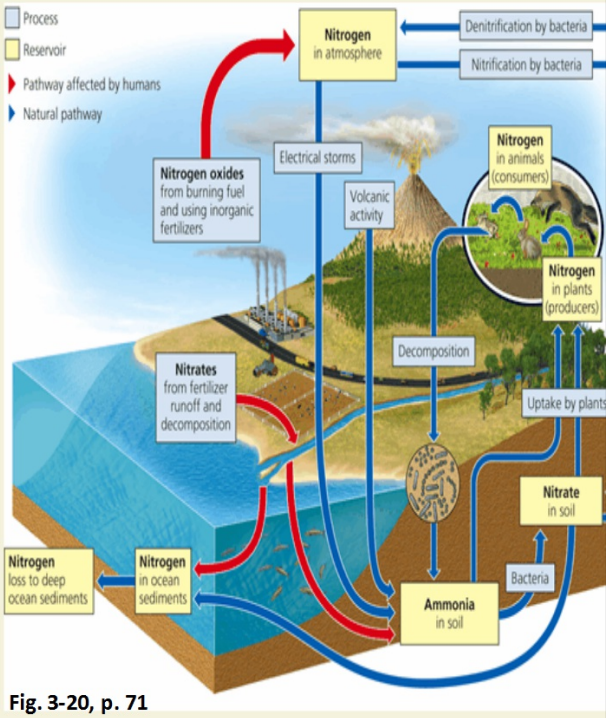
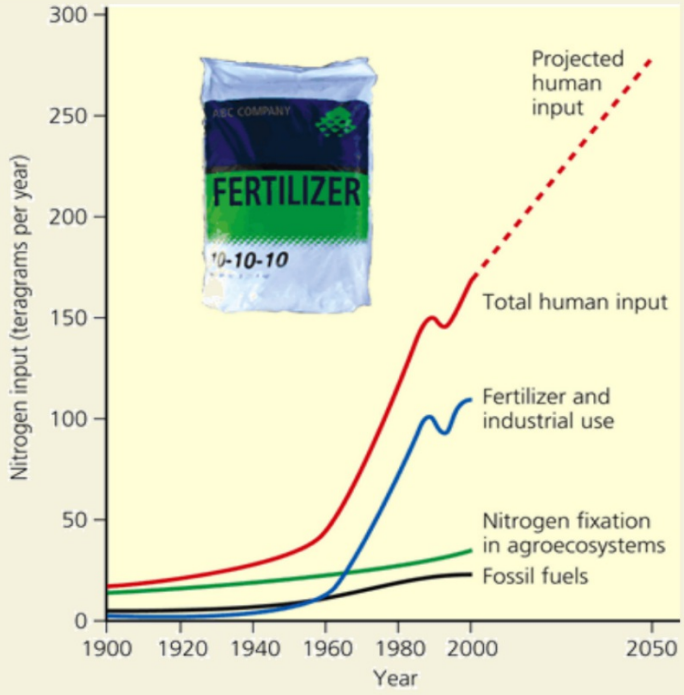


Fig. 3-20, p. 71

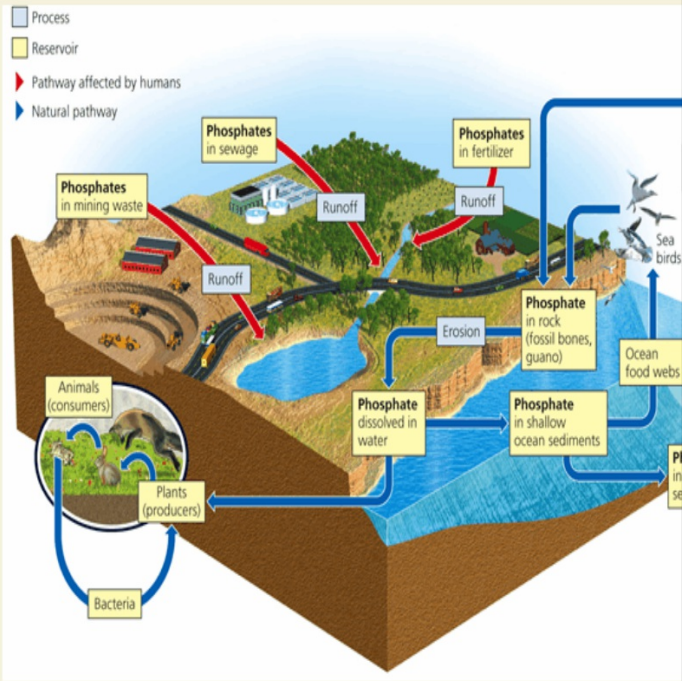
Human Intervention - Nitrogen Cycle



- Additional NO and N_2O in atmosphere from burning foss fuels; also causes acid rain
- N_2O to atmosphere from bact acting on fertilizers and manur
- Destruction of forest, grasslan and wetlands
- Add excess nitrates to bodies water
- Remove nitrogen from topsoil

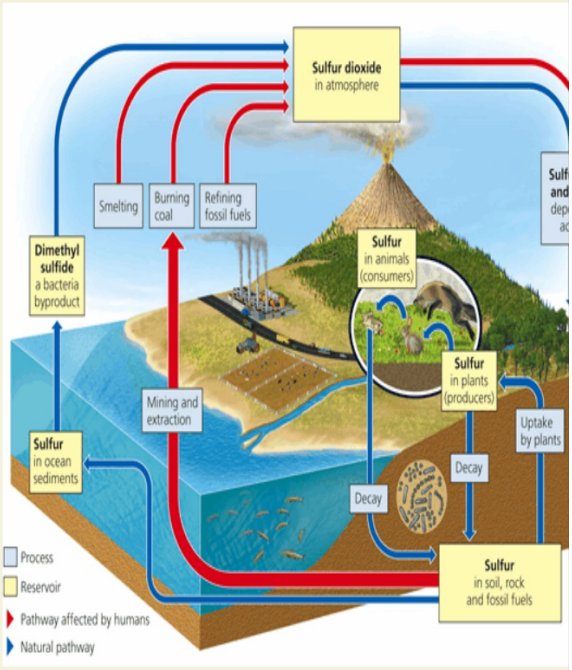
Phosphorus Cycles through the Biosphere

- Cycles through water, the earth's crust, and living organisms
- Limiting factor for plant growth
- Impact of human activities
  - Clearing forests
  - Removing large amounts of phosphate from the earth to make fertilizers
  - Erosion leaches phosphates into streams



Sulfur Cycles through the Biosphere

- Sulfur found in organisms, ocean sediments, soil, rocks, and fossil fuels
- SO_2 in the atmosphere
- H_2SO_4 and SO_4^-
  - Human activities affect the sulfur cycle
    - Burn sulfur-containing coal and oil
    - Refine sulfur-containing petroleum
    - Convert sulfur-containing metallic mineral ores



3-5 How Do Scientists Study Ecosystems?

- ***Concept 3-5*** *Scientists use both field research and laboratory research, as well as mathematical and other models to learn about ecosystems.*

Some Scientists Study Nature Directly

- Field research: "muddy-boots biology"
- New technologies available
  - Remote sensors
  - Geographic information system (GIS) software
  - Digital satellite imaging

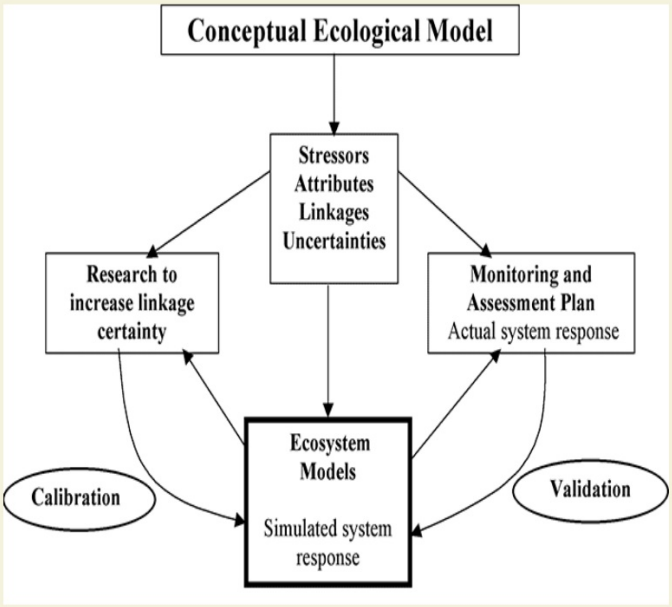
Some Scientists Study Ecosystems in the Laboratory

Simplified systems carried out in

- Culture tubes and bottles
- Aquaria tanks
- Greenhouses
- Indoor and outdoor chambers

Supported by field research

Some Scientists Use Models to Simulate Ecosystems



- Mathematical and other models
- Computer simulations and projections
- Field and laboratory research needed for baseline data

Three Big Ideas

1. Life is sustained by the flow of energy from the sun through the biosphere, the cycling of nutrients within the biosphere, and gravity.
2. Some organisms produce the nutrients they need, others survive by consuming other organisms, and some recycle nutrients back to producer organisms.
3. Human activities are altering the flow of energy through food chains and webs and the cycling of nutrients within ecosystems and the biosphere.