Chapter 2

Ecosystems and Sustainability
生态环境与可持续发展

Key contents

1. The Nature of ecology
2. The Earth's life-support systems
3. Ecosystem concepts and major components
4. Food webs and energy flow in ecosystems
5. Matter cycles in ecosystems
6. Ecosystem studies
7. Ecosystem services and sustainability

New words and Phrases

- community (群居体)
- ecosystem (生态系统)
- troposphere (对流层)
- stratosphere (平流层)
- hydrosphere (水圈)
- lithosphere(岩石圈)

New words and Phrases

- biosphere (生物圈)
- producer (生产者)
- photosynthesis(光合作用)
- consumer (消费者)
- aerobic respiration (有氧呼吸)
- decomposer (分解者)
- food chain(食物链)

New words and Phrases

- food web(食物网)
- primary consumer(初级消费者)
- secondary consumer (次级消费者)
- tertiary (higher-level) consumers (三级消费者)
- pyramid of energy flow(能量流金字塔)
- pyramid of biomass (生物量金字塔)

New words and Phrases

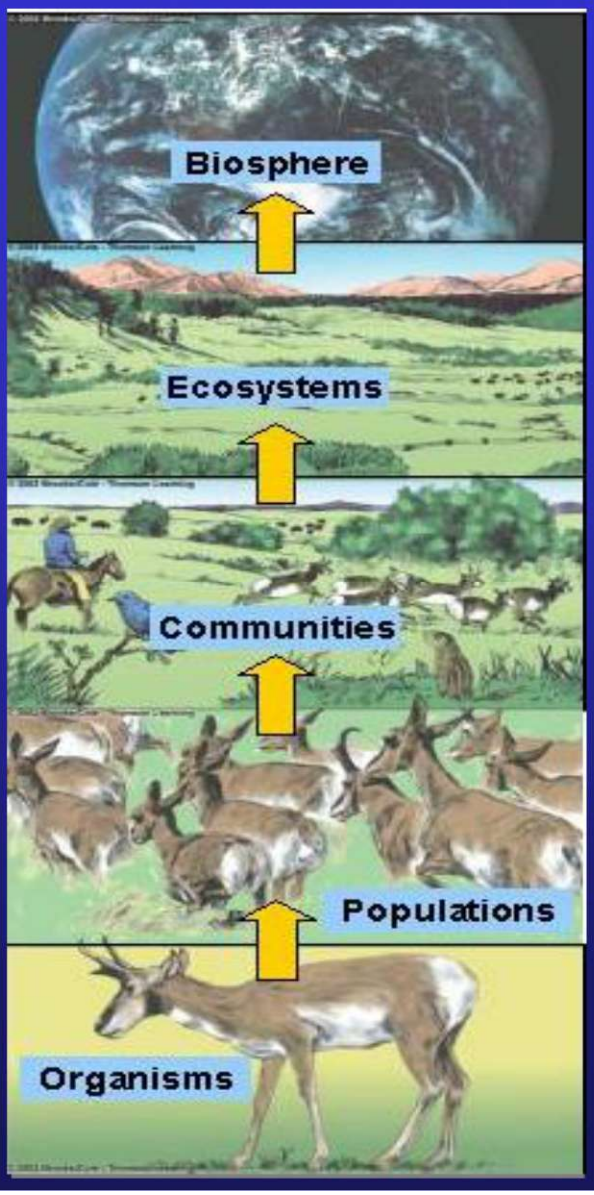
- pyramid of numbers (数量金字塔)
- hydrologic cycle (水文循环)
- carbon cycle(碳循环)
- nitrogen cycle (氮循环)
- phosphorus cycle(磷循环)
- sulfur cycle (硫循环)
- ecosystem services(生态服务)

1 The nature of ecology

Ecology is a study of the connections among organisms (生物体) and their living and nonliving environment.

Organisms may reproduce by asexual reproduction(无性生殖) or sexual reproduction(有性繁殖).

Organisms that reproduce sexually are classified as members of the same species if they can interbreed(杂交). Members of a species that reside in the same area at the same time constitute a population. A population normally lives in a particular habitat. Populations of many species make up a community. An ecosystem is a community and its nonliving environment.



Main concept

- **Community (群居体)**

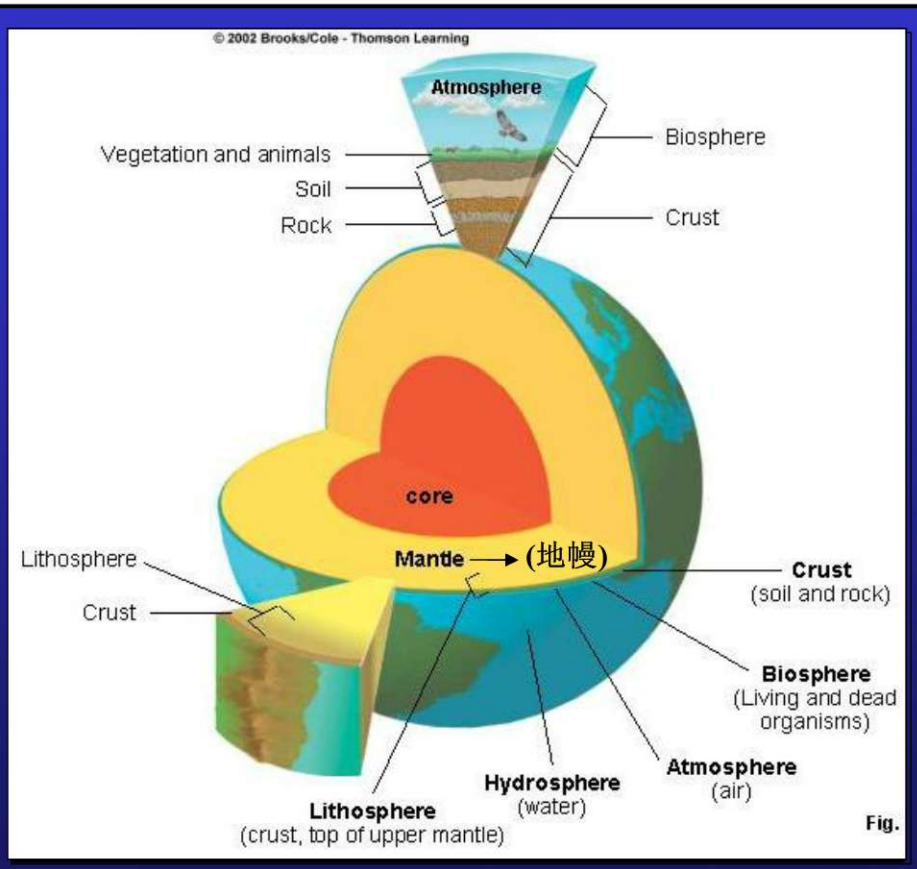
  Populations of all species living and interacting in an area at a particular time.

- **Ecosystem (生态系统)**

  Community of different species interacting with one another and with the chemical and physical factors making up its nonliving environment.

2 The Earth's life-support systems

- **Troposphere** (对流层)
- **Stratosphere** (平流层)
- **Hydrosphere** (水圈)
- **Lithosphere** (岩石圈)
- **Biosphere** (生物圈)



The lower portion of the earth's atmosphere is the troposphere. The next layer is the stratosphere. The portions of the earth's atmosphere, hydrosphere, and lithosphere in which living organisms exist constitute the biosphere.

Life on the earth is sustained by three interconnected factors: the one-way flow of energy from the sun through the biosphere and back into space, the cycling of matter that living organisms need as nutrients for their survival, and gravity.

Main concept

➢ Troposphere (对流层)

Innermost layer of the atmosphere. It contains about 75% of the mass of earth's air and extends about 17 kilometers (11 miles) above sea level. Compare *stratosphere*.

➢ Stratosphere (平流层)

Second layer of the atmosphere, extending about 17-48 kilometers (11-30 miles) above the earth's surface. It contains small amounts of gaseous ozone (O_3), which filters out about 95% of the incoming harmful ultraviolet (UV) radiation emitted by the sun. Compare *troposphere*.

Main concept

- **Hydrosphere (水圈)**

  The earth's (1) liquid water (oceans, lakes, other bodies of surface water, and underground water), (2) frozen water (polar ice caps, floating ice caps, and ice in soil, known as permafrost), and (3) small amounts of water vapor in the atmosphere. See also *hydrologic cycle*.

- **Lithosphere(岩石圈)**

  Outer shell of the earth, composed of the crust and the rigid, outermost part of the mantle(地幔) outside the asthenosphere; material found in earth's plates. See *crust*, *mantle*.

Main concept

- **Biosphere (生物圈)**

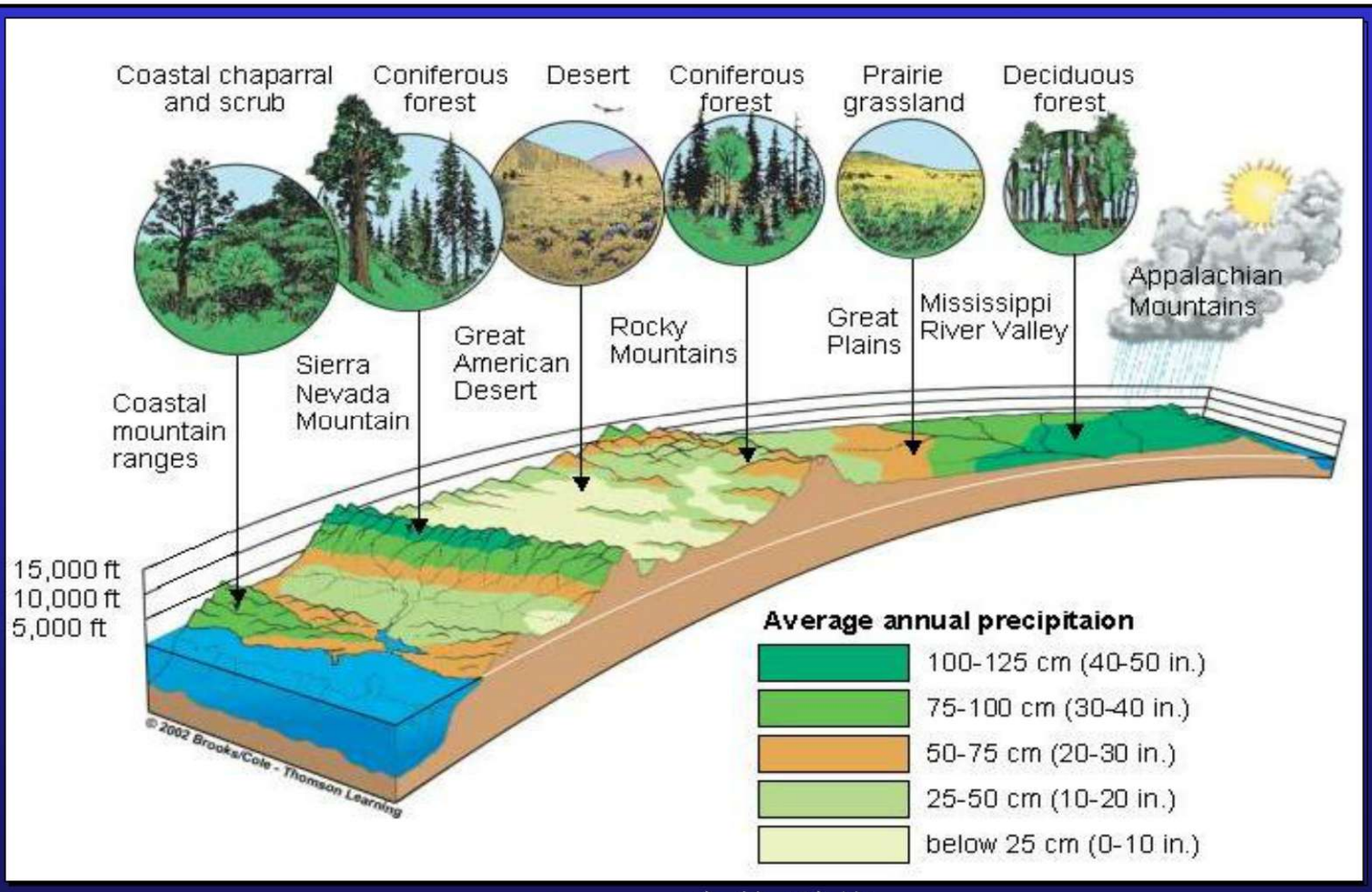
Zone of earth where life is found. It consists of parts of the atmosphere (the troposphere), hydrosphere (mostly surface water and groundwater), and lithosphere (mostly soil and surface rocks and sediments on the bottoms of oceans and other bodies of water) where life is found. Sometimes called the ecosphere.

3 Ecosystem concepts and components

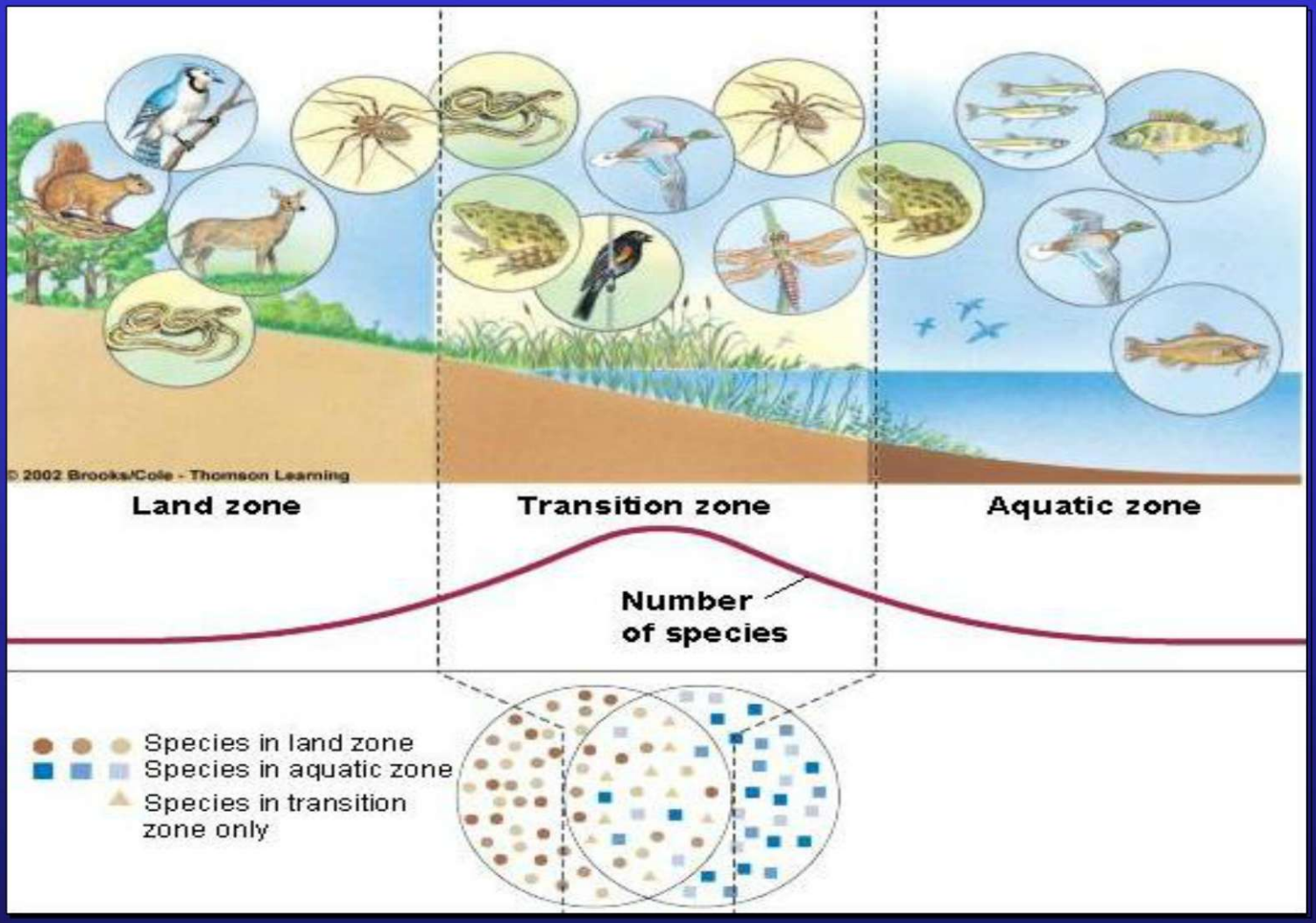
3.1 Ecosystem concepts

3.2 Ecosystem components

3.1 Ecosystem concepts



biomes(生物群落)



Ecosystem boundaries: Ecotones (交错带)

Biologists have classified the terrestrial portion of the biosphere into biomes(生物群落). Each has a distinct climate and specific life forms. Marine and freshwater portions of the biosphere are divided into aquatic life zones(水生生物区).

3.2 Ecosystem components

3.2.1 Abiotic components(非生物成分)

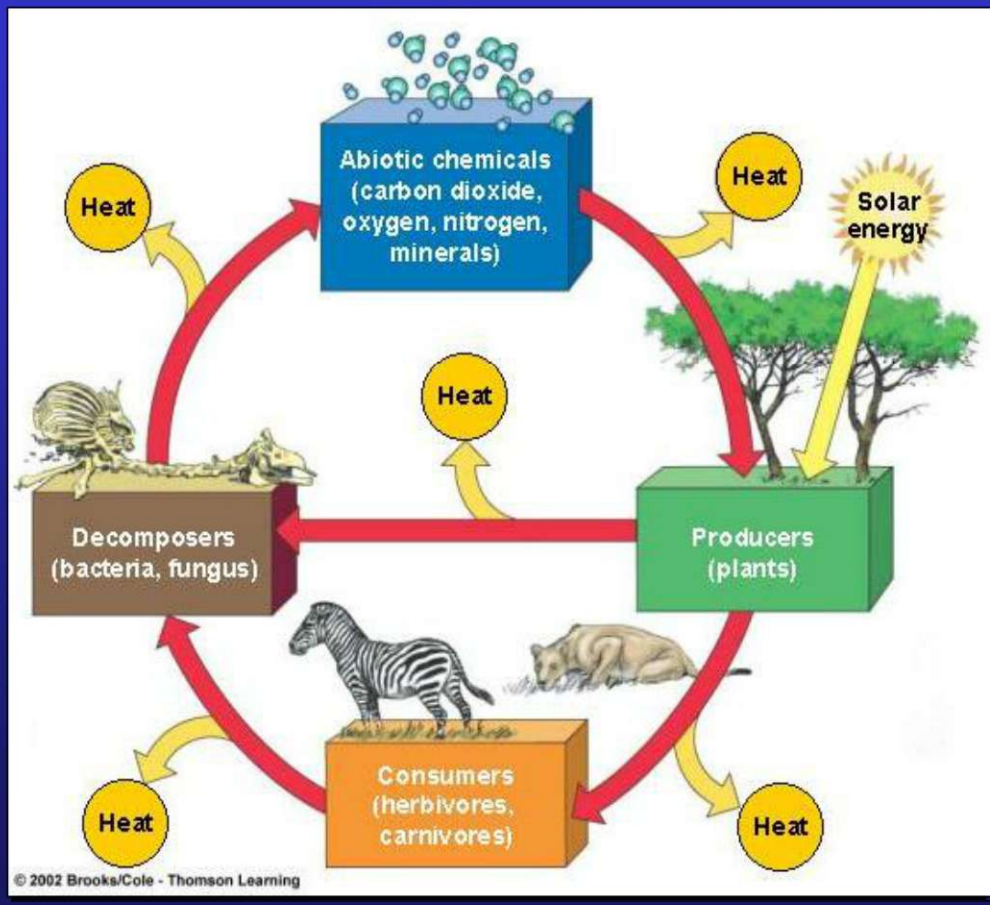
3.2.2 Biotic components (生物成分)

3.2.1 Abiotic components(非生物成分)

Abiotic components of an ecosystem are physical and chemical factors that influence living organisms. Each population has a range of tolerance to various abiotic factors and its tolerance limits determine its abundance and distribution. The number of organisms in a population can be affected by a single limiting factor.

3.2.2 Biotic components (生物成分)

- Producers (autotrophs)
- Consumers (heterotrophs)
- Decomposers



Most producers capture sunlight energy and make carbohydrates by way of photosynthesis. Some producers carry out chemosynthesis. All other organisms in an ecosystem are consumers or heterotrophs(异养).

Most organisms release energy by aerobic respiration, which requires oxygen. Some get energy by anaerobic respiration.

Biological diversity is an important renewable resource.

Main concept

- **Producer (生产者)**

  Organism that uses solar energy (green plant) or chemical energy (some bacteria) to manufacture the organic compounds it needs as nutrients from simple inorganic compounds obtained from its environment. Compare *consumer*, *decomposer*.

- **Photosynthesis(光合作用)**

  Complex process that takes place in cells of green plants. Radiant energy from the sun is used to combine carbon dioxide (CO_2) and water (H_2O) to produce oxygen (O_2) and carbohydrates (such as glucose, $C_6H_{12}O_6$) and other nutrient molecules. Compare aerobic respiration, chemosynthesis.

Main concept

- **Consumer (消费者)**

Organism that cannot synthesize the organic nutrients it needs and gets its organic nutrients by feeding on the tissues of producers or of other consumers; generally divided into primary consumers (herbivores), secondary consumers (carnivores), tertiary (higher-level) consumers, omnivores, and detritivores (decomposers and detritus feeders). In economics, one who uses economic goods.

Main concept

- **Aerobic respiration (有氧呼吸)**

  Complex process that occurs in the cells of most living organisms, in which nutrient organic molecules such as glucose ($C_6H_{12}O_6$) combine with oxygen (O_2) and produce carbon dioxide (CO_2), water (H_2O), and energy. Compare photosynthesis.

- **Decomposer (分解者)**

  Organism that digests parts of dead organisms and cast-off fragments and wastes of living organisms by breaking down the complex organic molecules in those materials into simpler inorganic compounds and then absorbing the soluble nutrients. Producers return most of these chemicals to the soil and water for reuse. Decomposers consist of various bacteria and fungi. Compare *consumer*, *detritivore*, *producer*.

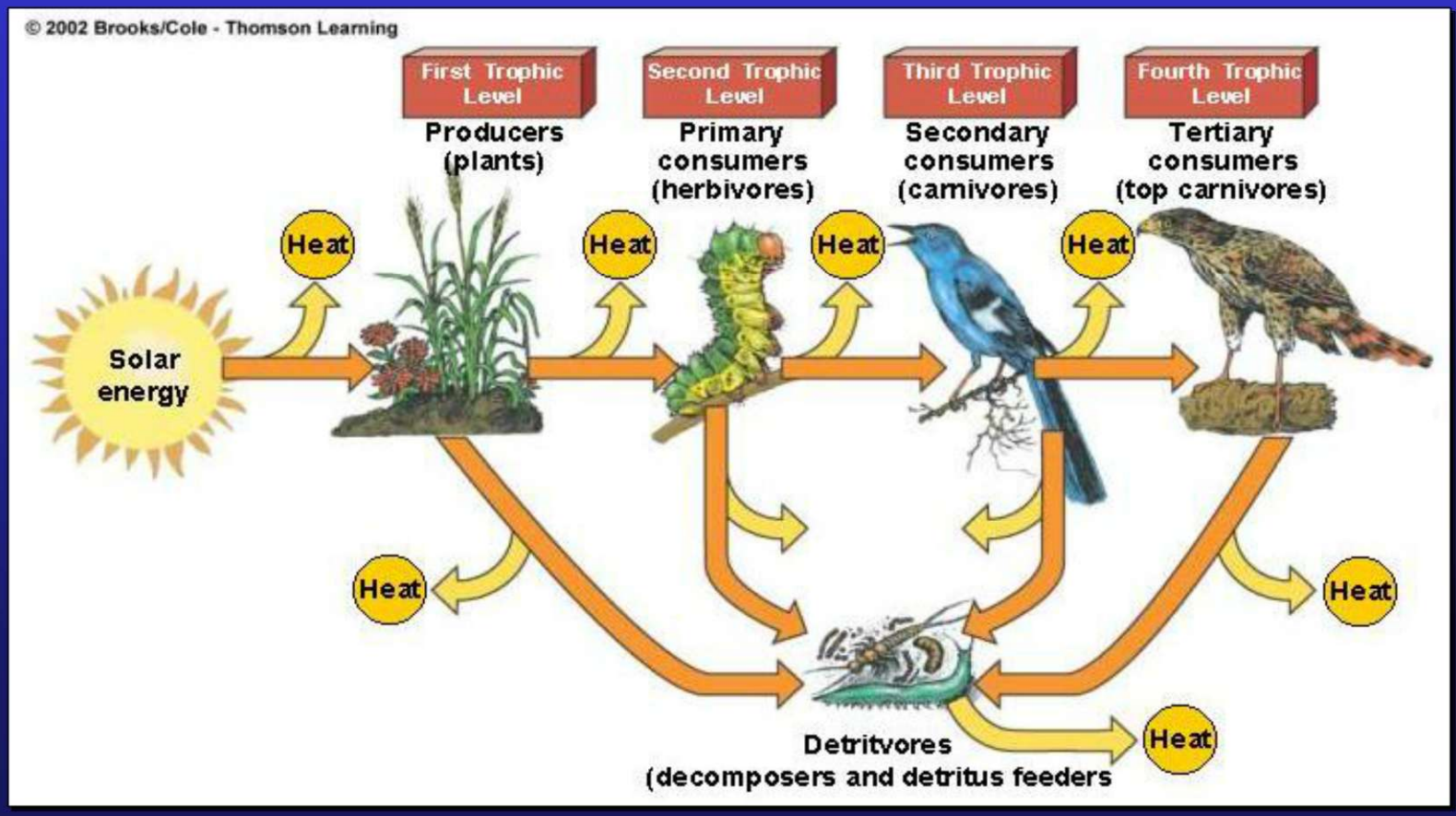
4 Food webs and energy flow in ecosystems

4.1 Food chains and food webs

4.2 Trophic levels(营养水平)

4.3 Ecological efficiency

4.1 Food chains and food webs



Organisms get the food and nutrients they need by participating in a food chain. Various food chains can link together to form a food web.

Main concept

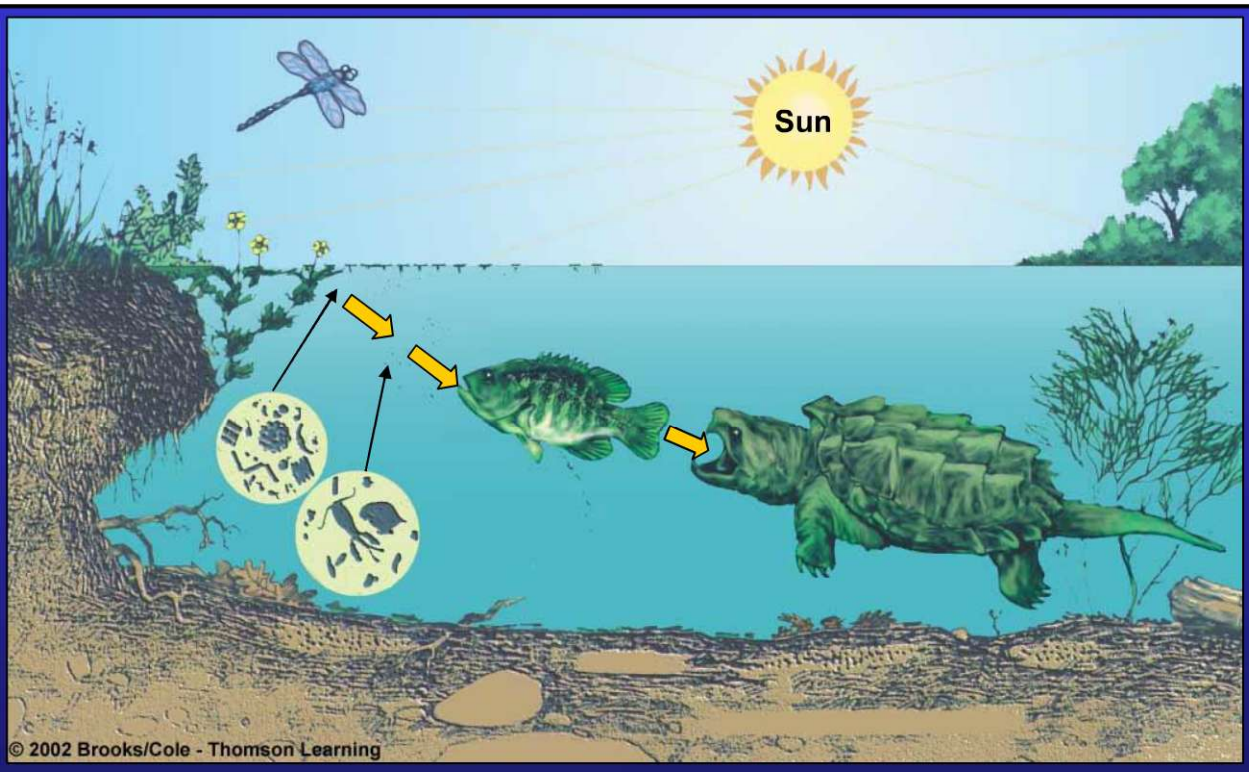
- **Food chain(食物链)**

  Series of organisms in which each eats or decomposes the preceding one. Compare *food web*.

- **Food web(食物网)**

  Complex network of many interconnected food chains and feeding relationships. Compare *food chain*.

4.2 Trophic levels(营养水平)



- **Primary consumer** (herbivore)(初级消费者)
- **Secondary consumer** (carnivore)(次级消费者)
- **Tertiary consumer** (三级消费者)

Each organism in an ecosystem can be assigned to a trophic level in its food chain or food web. Each trophic level contains a certain amount of biomass. The transfer of energy between these levels has a certain ecological efficiency.

Main concept

- **Primary consumer(初级消费者)**

  Organism that feeds on all or part of plants (herbivore) or on other producers. Compare *detritivore*, *omnivore*, *secondary consumer*.

- **Secondary consumer (次级消费者)**

  Organism that feeds only on primary consumers. Compare *detritivore*, *omnivore*, *primary consumer*.

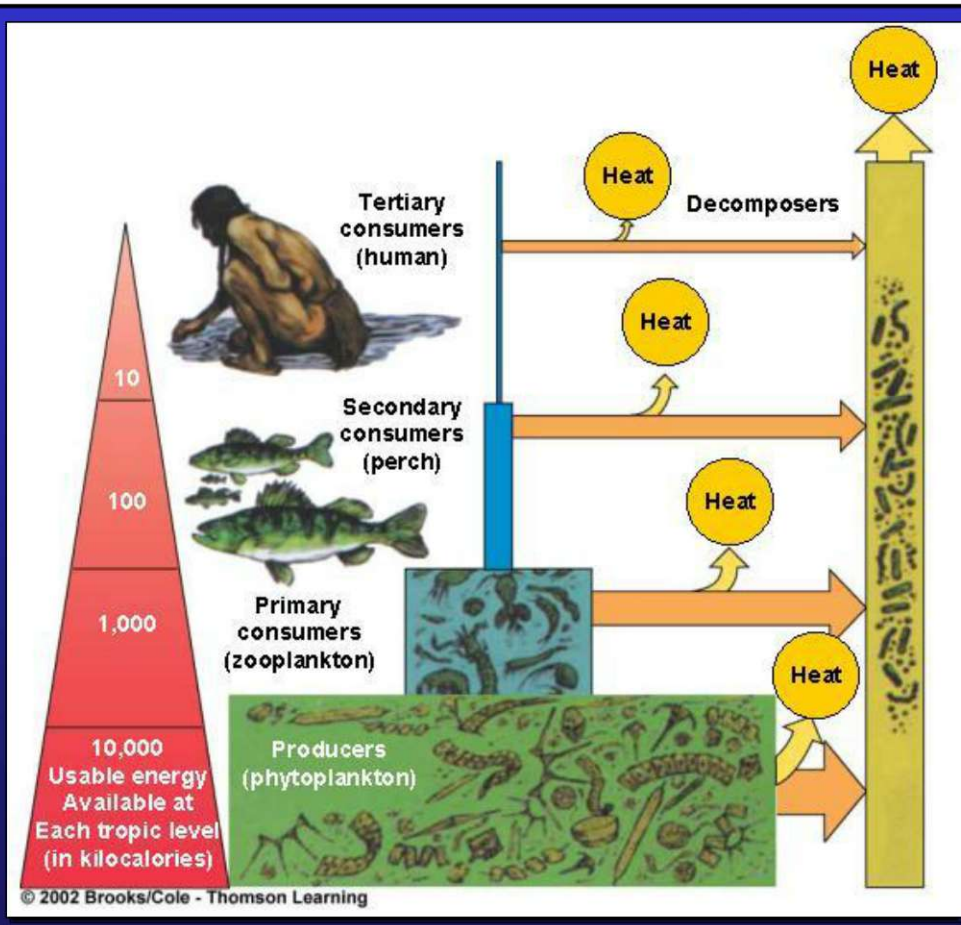
Main concept

- **Tertiary (higher-level) consumers (三级消费者)**

Animals that feed on animal-eating animals. They feed at high trophic levels in food chains and webs. Examples are hawks, lions, bass, and sharks. Compare *detritivore*, *primary consumer*, *secondary consumer*.

4.3 Ecological efficiency

- Pyramid of energy flow
- Pyramid of biomass
- Pyramid of numbers



Ecological Pyramids(生态金字塔)

Food chains can be represented as a pyramid of energy flow. Biomass storage in various trophic levels of a food chain or webs can be represented by a pyramid of biomass. The number of organisms at each trophic level in a food chain or web can be represented by a pyramid of numbers.

Main concept

- **Pyramid of energy flow(能量流金字塔)**

Diagram representing the flow of energy through each trophic level in a food chain or food web. With each energy transfer, only a small part (typically 10%) of the usable energy entering one trophic level is transferred to the organisms at the next trophic level. Compare *pyramid of biomass*, *pyramid of numbers*.

- **Pyramid of biomass (生物量金字塔)**

Diagram representing the biomass, or total dry weight of all living organisms, that can be supported at each trophic level in a food chain or food web. See *pyramid of energy flow*, *pyramid of numbers*.

Main concept

- **Pyramid of numbers (数量金字塔)**

Diagram representing the flow of energy through each trophic level in a food chain or food web. With each energy transfer, only a small part (typically 10%) of the usable energy entering one trophic level is transferred to the organisms at the next trophic level. Compare *pyramid of biomass*, *pyramid of numbers*.

5 Matter cycling in ecosystems

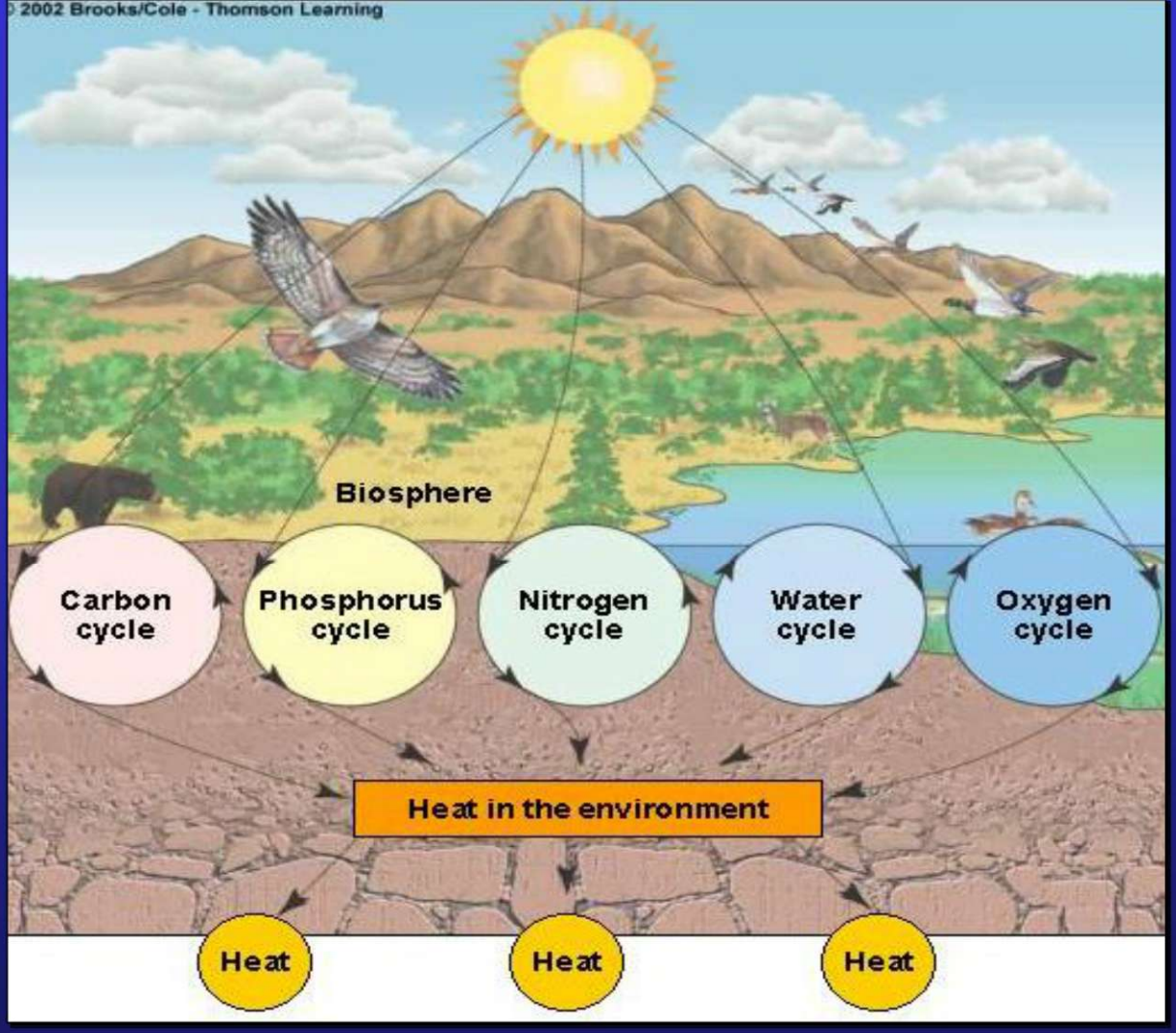
5.1 Hydrologic cycle (H_2O)

5.2 Atmospheric cycles (C, N)

5.3 Sedimentary cycles (P, S)

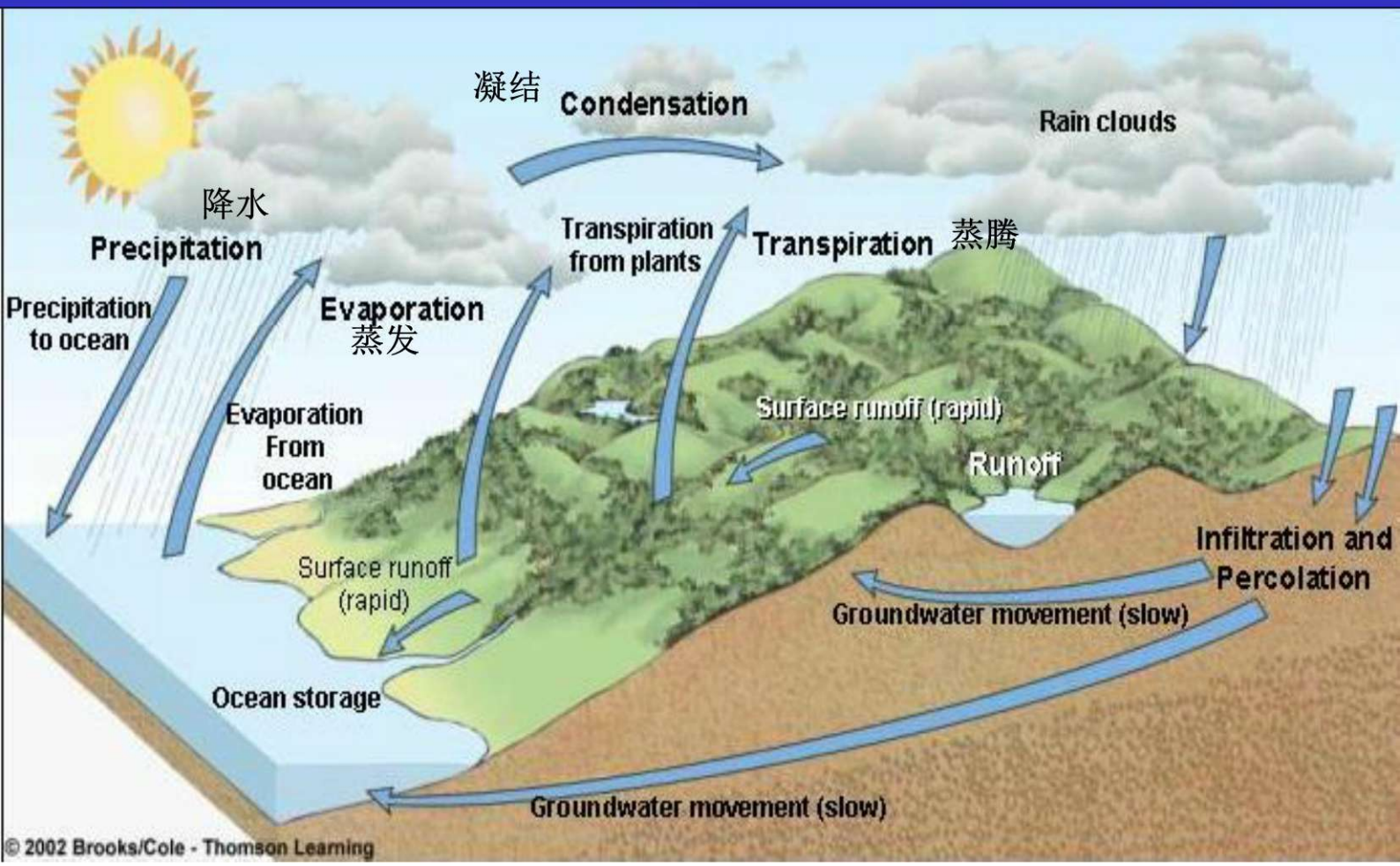
5 Matter cycling in ecosystems

Nutrients, atoms, ions, and molecules are continuously cycled in nutrient cycles or biogeochemical cycles. The hydrologic cycle collects, purifies, and distributes the earth's water. Other examples are the carbon cycle, the nitrogen cycle, the phosphorus cycle, and the sulfur cycle. Human activities are altering these cycles.



Matter cycling in ecosystems

5.1 Hydrologic cycle (H_2O)



Main concept

- **Hydrologic cycle (水文循环)**

Biogeochemical cycle that collects,purifies and distributes the earth's fixed supply of water from the environment to living organisms and then back to the environment .

5.2 Atmospheric cycles (C, N)

5.2.1 Carbon cycle cycles (C)

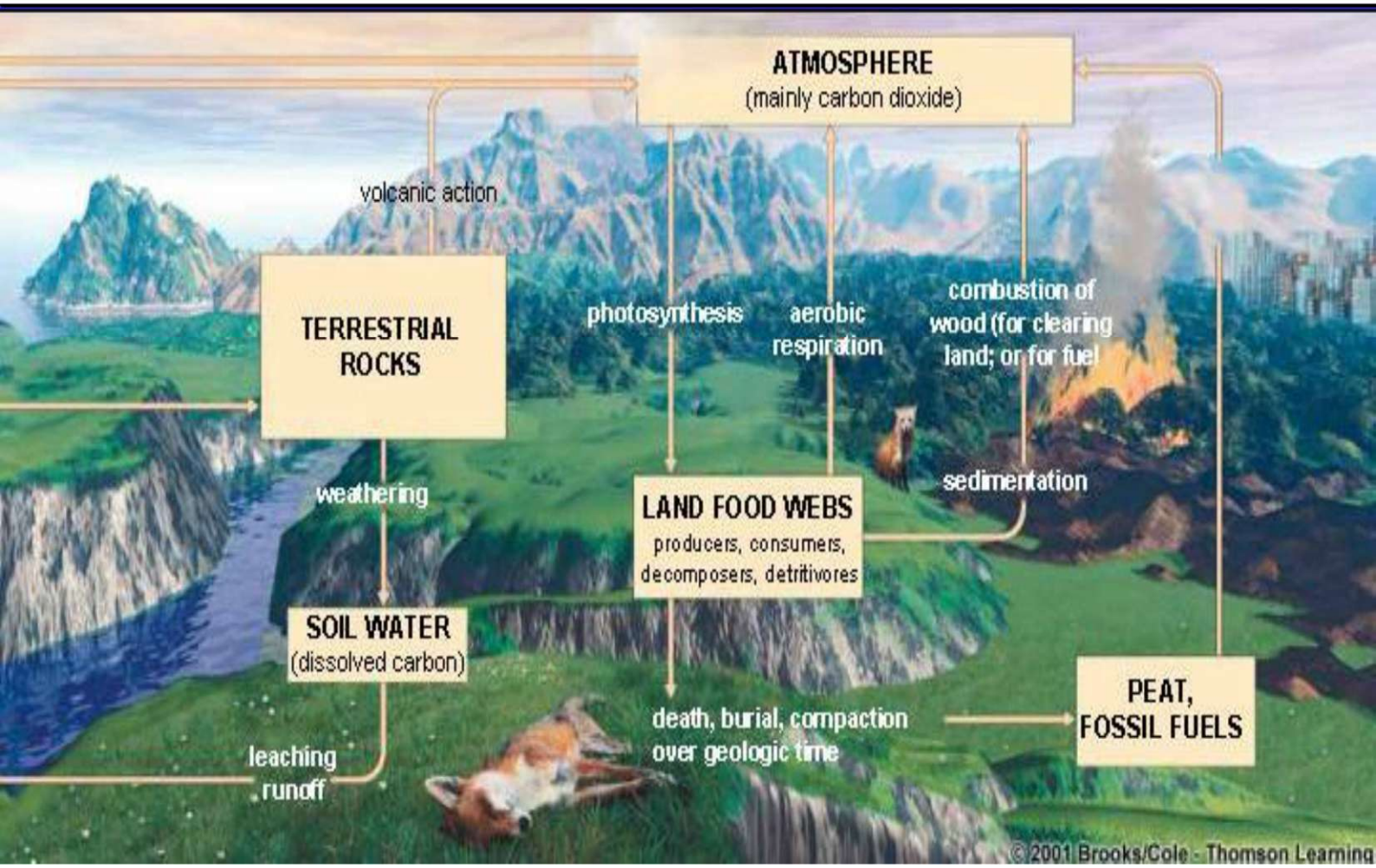
5.2.2 Nitrogen cycles (N)

5.2.1 Carbon cycles (C)

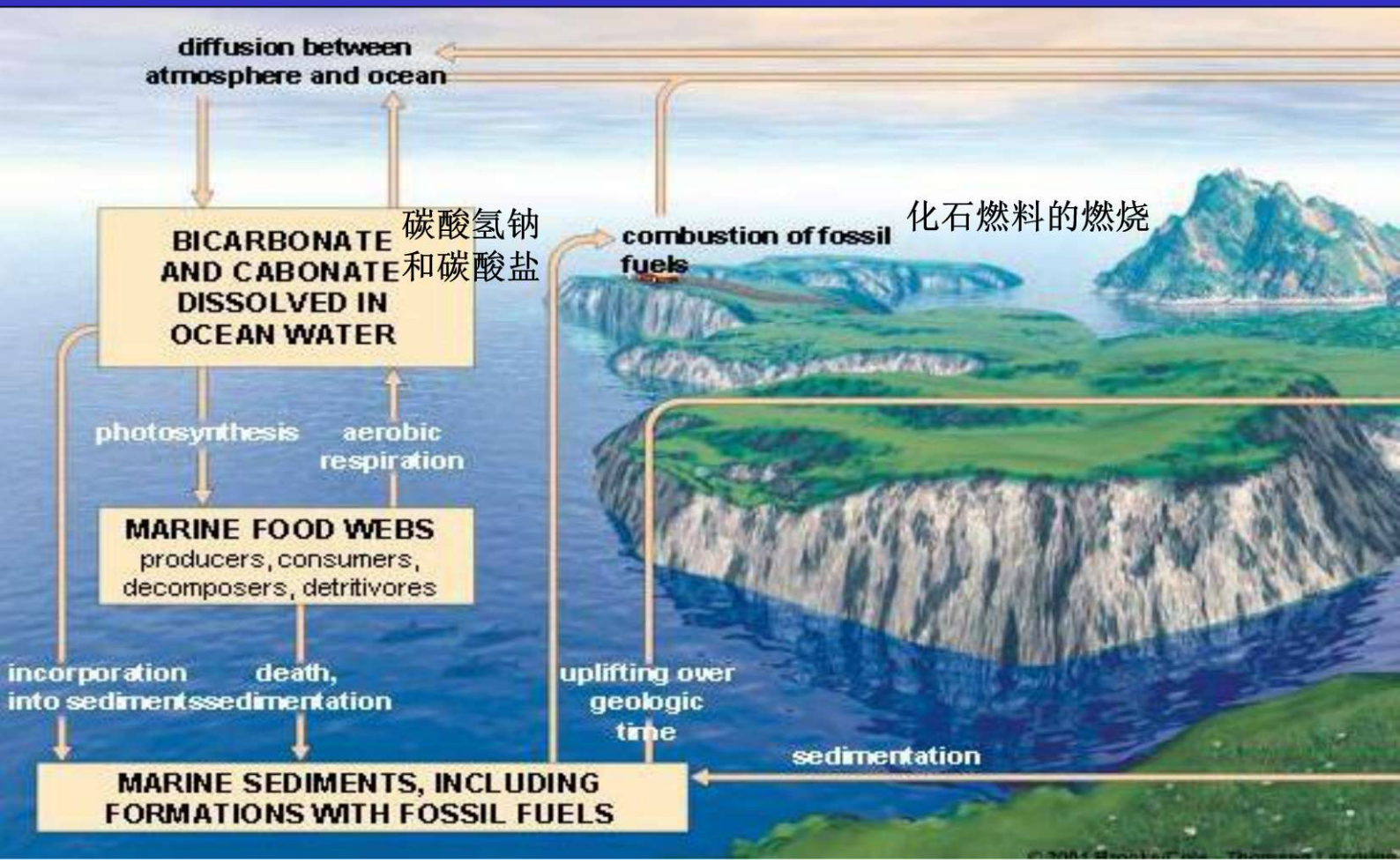
5.2.1-A The carbon cycle (Terrestrial(陆地))

5.2.1-B The carbon cycle (Aquatic)

5.2.1-A The carbon cycle (Terrestrial(陆地))



5.2.1-B The carbon cycle (Aquatic)

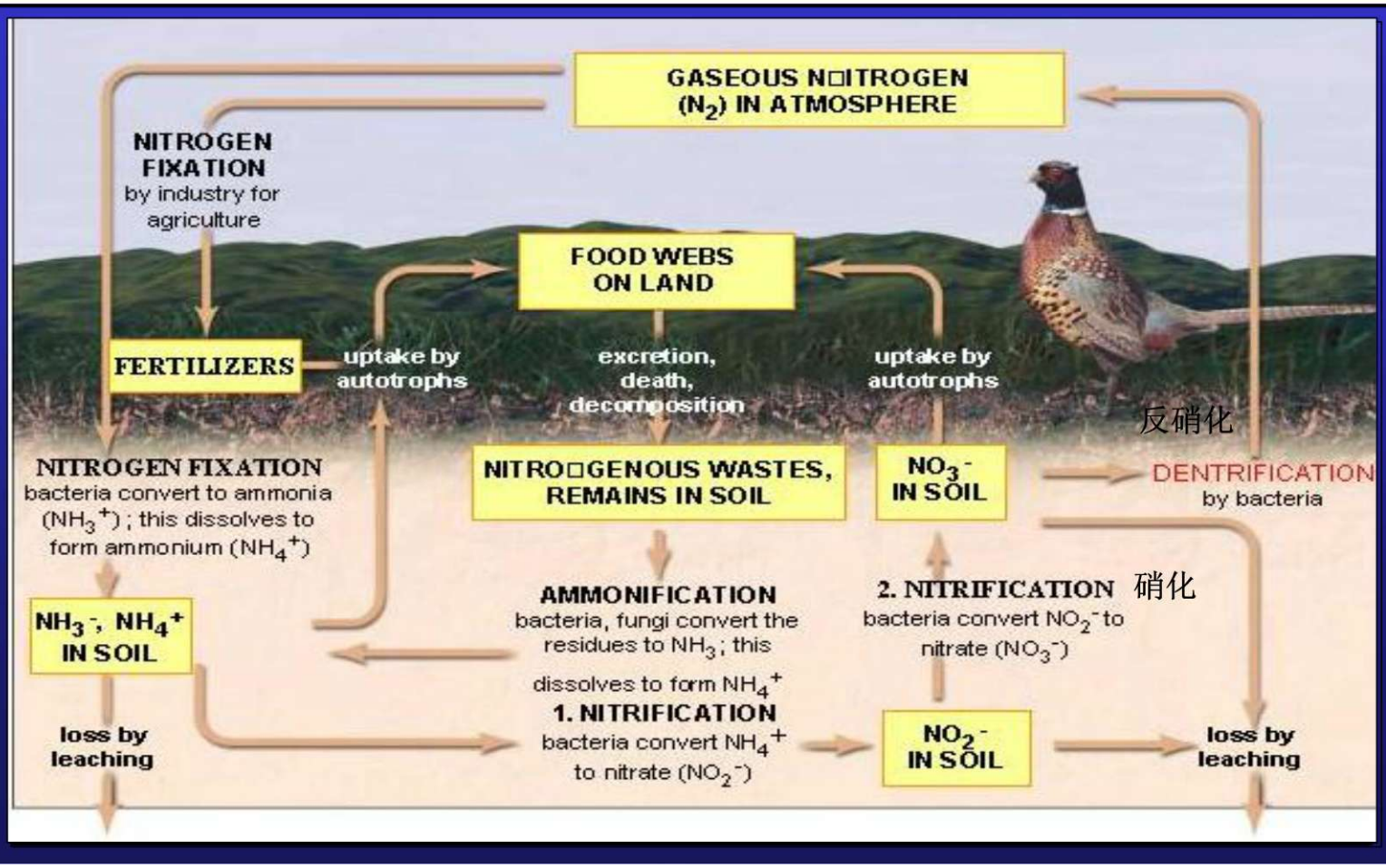


Main concept

- **Carbon cycle(碳循环)**

Cyclic movement of carbon in different chemical forms from the environment to organisms and then back to the environment.

5.2.2 Nitrogen cycles (N)



Main concept

Nitrogen cycle (氮循环)

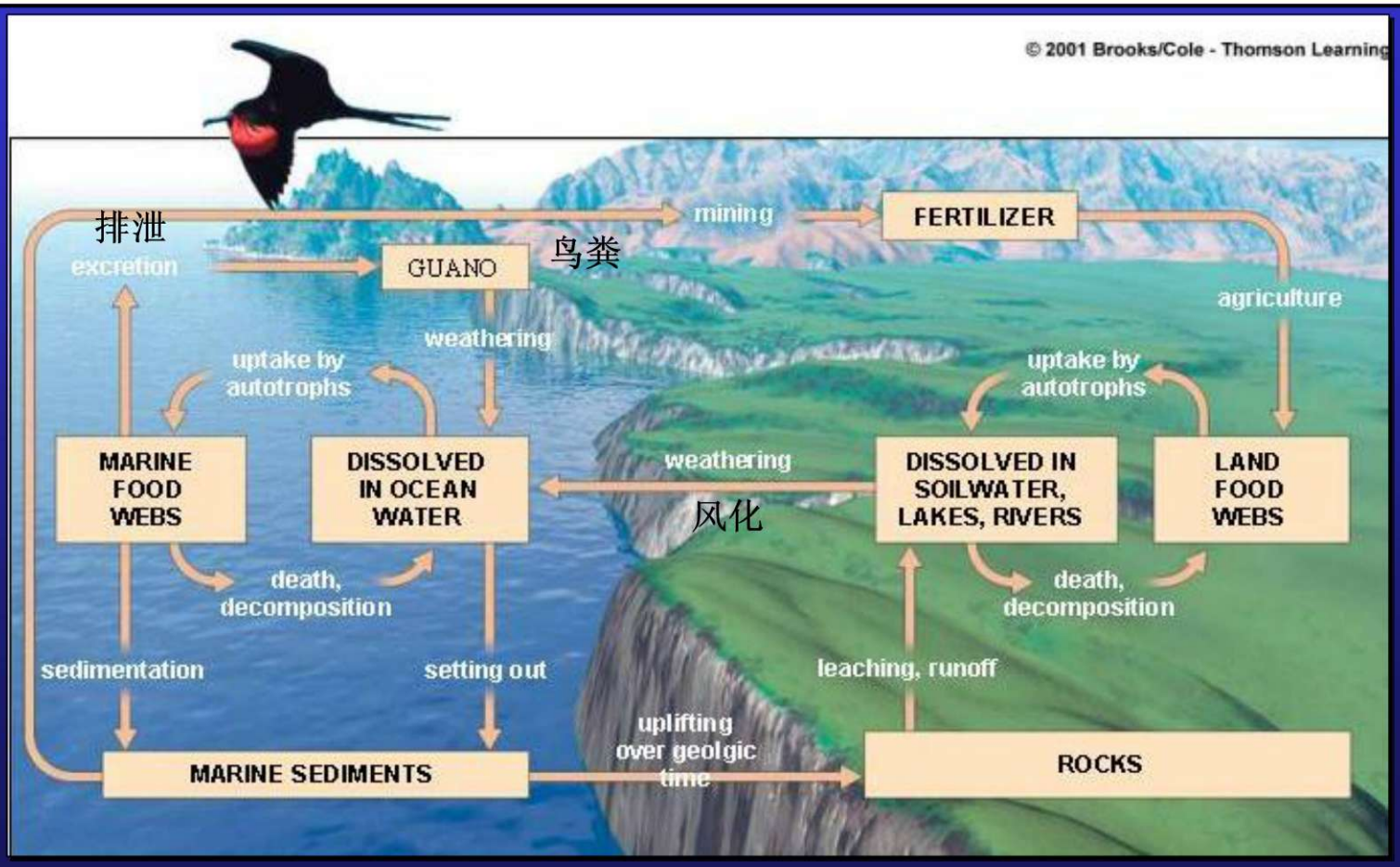
Cyclic movement of nitrogen in different chemical forms from the environment to organisms and then back to the environment.

5.3 Sedimentary cycles (P, S)

5.3.1 Phosphorus cycle (磷循环)

5.3.2 Sulfur cycle (硫循环)

5.3.1 Phosphorus cycle (磷循环)

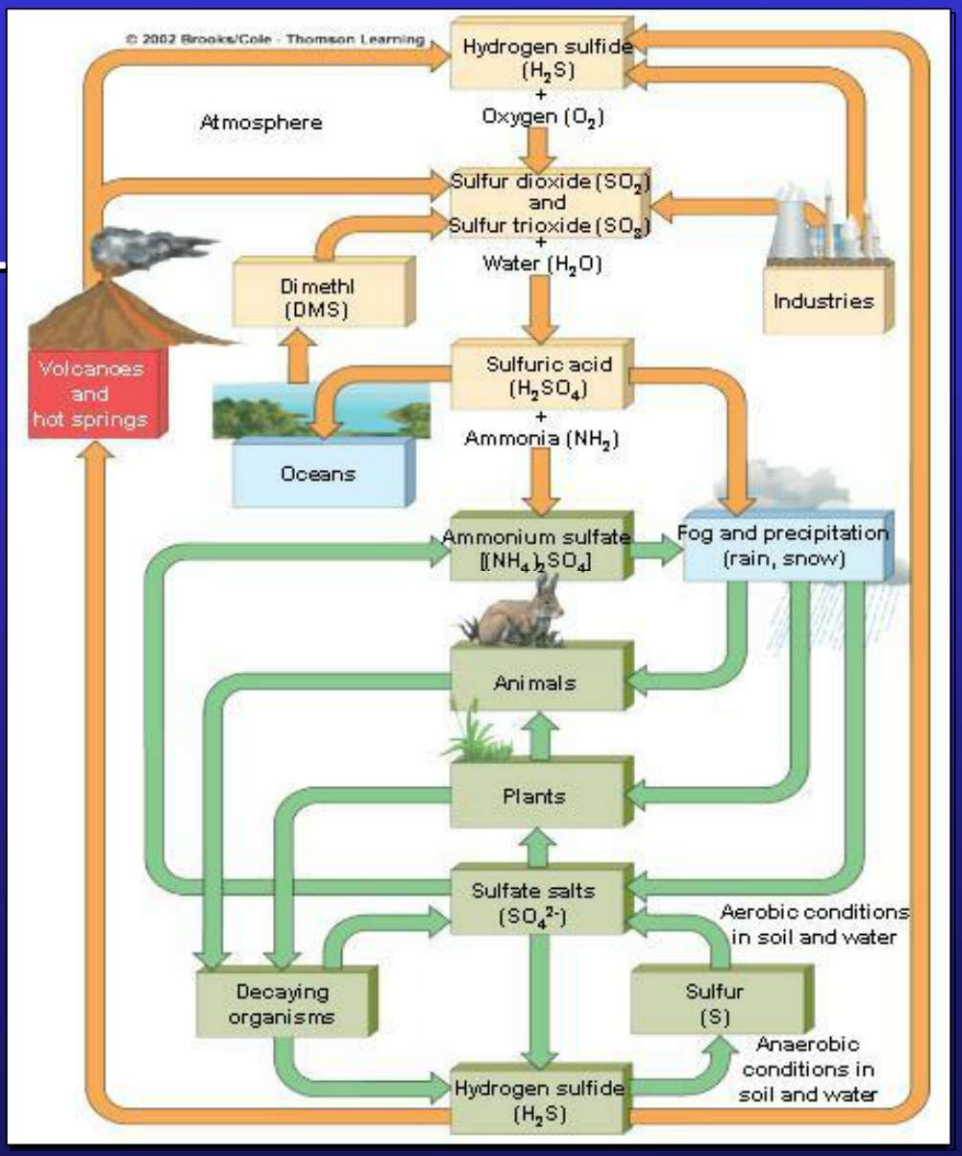


Main concept

- **Phosphorus cycle(磷循环)**

Cyclic movement of phosphorus in different chemical forms from the environment to organisms and then back to the environment.

5.3.2 Sulfur cycle (硫循环)



Main concept

- **Sulfur cycle (硫循环)**

  Cyclic movement of sulfur in different chemical forms from the environment to organisms and then back to the environment.

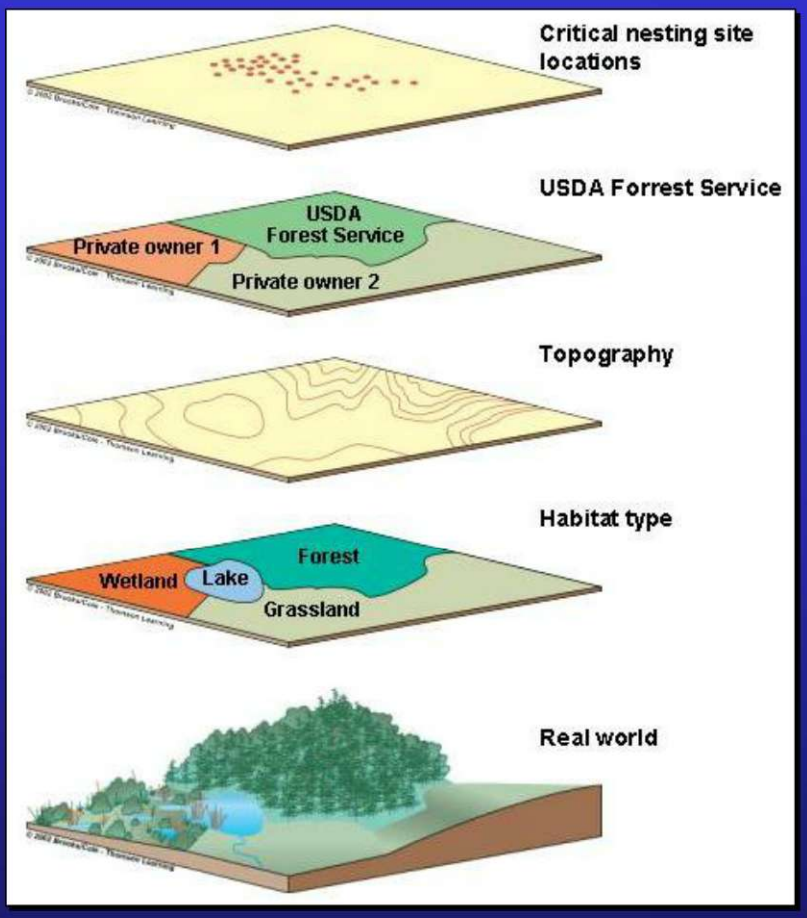
6 Ecosystem studies

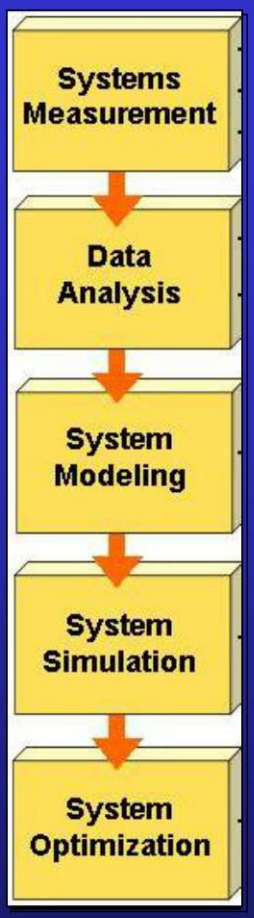
How do ecologists learn about ecosystems?

Ecologists use field research and laboratory research to gather data. They use systems analysis to develop mathematical models that simulate ecosystems and generate predictions.

How do ecologists learn about ecosystems?

- Field research(实地研究)
- Remote sensing(遥感)
- Geographic information systems (GIS)
  (地理信息系统)
- Laboratory research
- Systems analysis





GIS and systems analysis

7 Ecosystem services and sustainability

Ecosystems provide ecosystem services that sustain all species (including humans) and economies. A sustainable society lives off the biological income provided by these ecological services but does not deplete or degrade them. All ecosystems and the biosphere operate sustainably by using renewable energy and recycling chemical nutrients.

Main concept

- **Ecosystem services(生态服务)**

  Natural services or natural capital that support life on the earth and are essential to the quality of human life and the functioning of the world's economies .

Key points and difficulties

- chapter 2(key points).doc
- chapter 2(notes of difficulties). doc

Supplementary reading materials