Ecological Succession

– Disturbances may cause a gradual replacement by other species in a process called **ecological succession**.

Primary succession	Secondary succession	
• begins in a virtually lifeless area with no soil	occurs where a disturbance has	

Ecological Succession

• **Primary succession** begins in a virtually lifeless area with no soil

• in places such as
  • the rubble left by a retreating glacier or
  • lava flows.

Ecological Succession

Secondary succession occurs where a disturbance has
destroyed an existing community but left the soil intact.

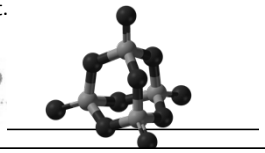
– Examples of secondary succession are areas recovering from
  • floods or
  • fires.

The General Scheme of Chemical Cycling

- Biogeochemical cycles can be
  - local or
  - global.
- Three important biogeochemical cycles are
  1. carbon,
  2. phosphorus, and
  3. nitrogen.

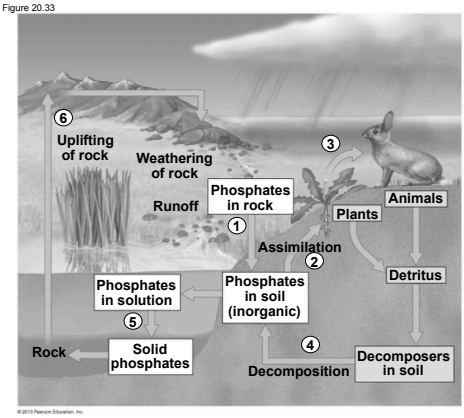
The Phosphorus Cycle

- Organisms require phosphorus as an ingredient of
  - nucleic acids,
  - phospholipids, and
  - ATP.
- Phosphorus is also required as a mineral component of vertebrate bones and teeth.
- The phosphorus cycle does not have an atmospheric component.



phosphorus
15
P
30.974

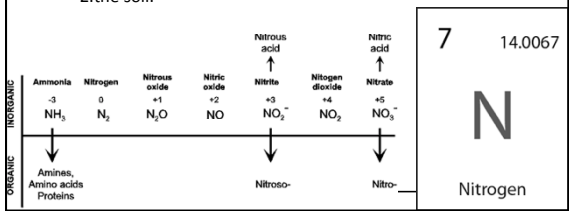
Figure 20.33



The Nitrogen Cycle

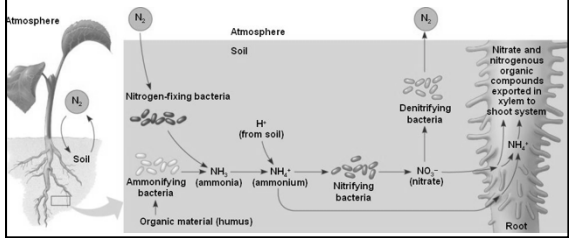
– Nitrogen is
  - an ingredient of proteins and nucleic acids and
  - essential to the structure and functioning of all organisms.

– Nitrogen has two abiotic reservoirs:
  1. the atmosphere and
  2. the soil.



The Nitrogen Cycle

– The process of **nitrogen fixation** converts gaseous N_2 to nitrogen compounds that plants can assimilate.

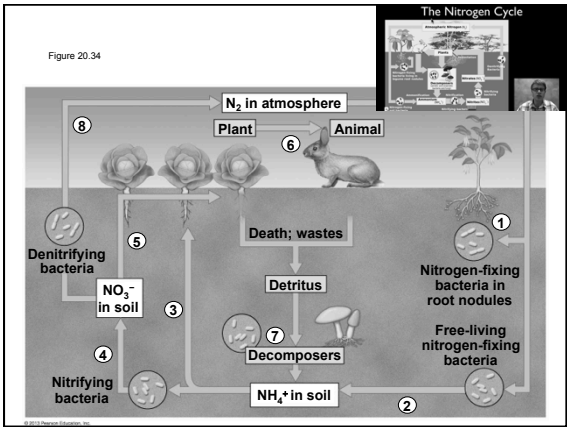


The Nitrogen Cycle

– Most of the nitrogen available in natural ecosystems comes from biological fixation performed by two types of nitrogen-fixing bacteria.

1. Some bacteria live symbiotically in the roots of certain species of plants, supplying their hosts with a direct source of usable nitrogen.
2. Free-living nitrogen-fixing bacteria in soil or water convert N_2 to ammonia, which then picks up another H^+ to become ammonium (NH_4^+).

PLAY Blast Animation: Nitrogen Cycle



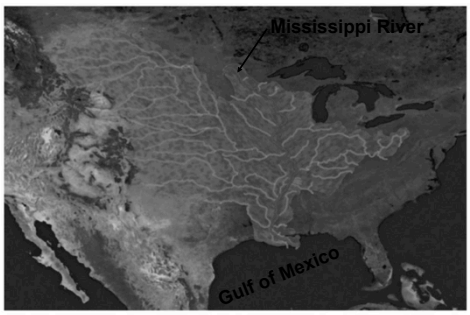
Nutrient Pollution

- The growth of algae and cyanobacteria in aquatic ecosystems is **limited** by low nutrient levels, especially
  - phosphorus and
  - nitrogen.
- Nutrient pollution occurs when human activities add excess amounts of these chemicals to aquatic ecosystems.

Nutrient Pollution

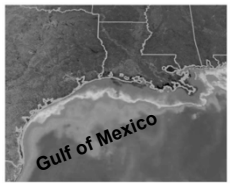
- Nitrogen runoff from Midwestern farm fields has been linked to an annual summer "dead zone" in the Gulf of Mexico.

Figure 20.36a



Light blue lines represent rivers draining into the Mississippi River (shown in dark blue)

Figure 20.36b



Summer

Figure 20.36c

Winter

Restoring Ecosystems

- **Bioremediation** uses living organisms to detoxify polluted ecosystems.
- Researchers are investigating the use of plants to remove toxic substances from contaminated soil.

Figure 20.41

Restoring Ecosystems

- The Kissimmee River was straightened into a canal between 1962 and 1971, draining the floodplain.
- The Kissimmee River restoration project is reversing the engineering of the river by
  - removing water control structures such as dams and reservoirs and
  - filling in about 35 km of the canal.
- The first phase of the project was completed in 2004.

Figure 20.42

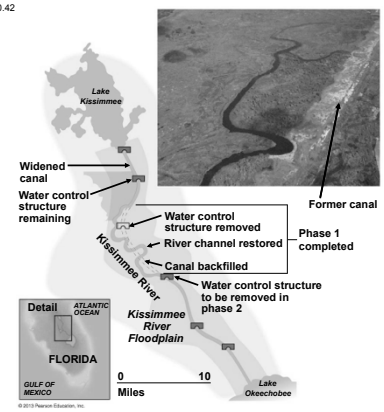
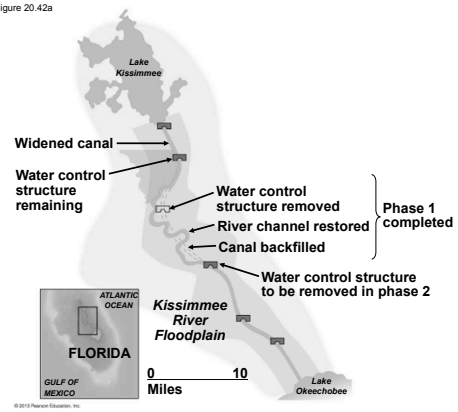


Figure 20.42a



CONSERVATION AND RESTORATION BIOLOGY

- Ecologists have discovered many environmental problems caused by human enterprises.
- Ecological research is the foundation for
  - finding solutions to these problems and
  - reversing the negative consequences of ecosystem alteration.

CONSERVATION AND RESTORATION BIOLOGY

- **Conservation biology** is a goal-oriented science that seeks to understand and counter the loss of biodiversity.
- **Restoration ecology** uses ecological principles to develop methods of returning degraded areas to their natural state.

Conservation at the Ecosystem Level

- Conservation biology increasingly aims at sustaining the biodiversity of entire
  - communities,
  - ecosystems, and
  - **landscapes**,
    - regional assemblages of interacting ecosystems,
    - such as an area with forest, adjacent fields, wetlands, streams, and streamside habitats.

Conservation at the Ecosystem Level

- **Landscape ecology** is the application of ecological principles to the study of land-use patterns.
- Edges between ecosystems
  - are prominent features of landscapes, whether natural or altered by people, and
  - have their own sets of physical conditions, such as
    - soil type and
    - surface features.

Figure 20.38

Natural edges

Edges created by human activity

The Process of Science: How Does Tropical Forest Fragmentation Affect Biodiversity?

- **Observation**: Forests are becoming fragmented when cleared for agriculture.
- **Question**: How does fragmentation of tropical forests affect species diversity within the fragments?
- **Hypothesis**: Species diversity declines with the size of the forest fragment.

Figure 20.40

The Process of Science: How Does Tropical Forest Fragmentation Affect Biodiversity?

- **Prediction**: Predators will only be found in the largest areas.
- **Results**: Fragmentation of forests into smaller pieces does lead to a decline in species diversity.

The Goal of Sustainable Development

- As the world population grows and becomes more affluent, the demand increases for the provisioning services of ecosystems, such as
  - food,
  - wood, and
  - water.

The Goal of Sustainable Development

- The goal of **sustainable development** is to acquire the ecological information necessary for the responsible
  - development,
  - management, and
  - conservation of Earth's resources.

The Goal of Sustainable Development

- Sustainable development depends on
  - continued research,
  - the application of ecological knowledge, and
  - the connection of the life sciences with
    - social sciences,
    - economics, and
    - humanities.

The Goal of Sustainable Development

- Sustainable development aims to
  - conserve biodiversity and
  - improve the human condition.

Evolution Connection: Can Biophilia Save Biodiversity?

- Edward O. Wilson uses the term **biophilia** to describe the human desire to affiliate with other life in its many forms.

Evolution Connection:
Can Biophilia Save Biodiversity?

- Most biologists have
  - embraced the concept of biophilia and
  - turned their passion for nature into careers.
- If biophilia is evolutionarily embedded in our genomes, then there is hope that we can become better custodians of the biosphere.

Figure 20.44