Biodiversity and Conservation

Chapter 15
Disappearing Frogs

• Approximately 1/3 of all amphibian species are threatened
• At least 42% of the 6000+ known amphibian species are declining
• About 165 amphibian species are thought to have become extinct since the 1970s
Disappearing Frogs

- No single cause of massive die-offs
  - Habitat loss, chemical pollutants, infectious diseases, UV radiation, climate change are all suspects
  - Chytridiomycosis, a fungal disease, has been found in 43 countries and 36 U.S. states; it exacerbates harm from other causes
Species Richness and Biological Diversity

• Species
  – A group of distinct organisms that are capable of interbreeding with one another in the wild but that do not interbreed with organisms outside their group

• How many species?
  – 5–100 million species total estimate
  – 10,000 new species identified per year
Species Richness and Biological Diversity

- Species richness
  - The number of different species in a community
  - Varies from community to community
  - Related to the abundance of potential niches
  - Inversely related to isolation of community
    - Species have difficulty reaching and colonizing isolated places (e.g., islands)
    - Locally extinct species are not replaced quickly
  - Inversely related to environmental stress
Species Richness and Biological Diversity

• Species richness
  – Usually greater at the edges of adjacent communities than at the center of a community
    • Ecotone—a transitional zone where communities meet
    • Edge effect—change in species composition that occurs at ecotones
  – Geologic history affects species richness
    • In some areas long-term stable climates have enabled a wide variety of species to evolve over time and form very biologically diverse communities
    • Areas with repeated disruptions to climate tend to have lower species richness
Why We Need Biodiversity

• Biodiversity
  – The number and variety of Earth’s organisms
  – Three components
    • Genetic diversity
    • Species richness
    • Ecosystem diversity
Why We Need Biodiversity

• Humans depend on thousands of species for survival
  – Insects for pollination, weed control, pest control
  – Bacteria and fungi for food, antibiotics, medicines

• At least 250,000 out of 310,000 plant species have not been assessed for medicinal, agricultural, or industrial value
Species Richness and Biological Diversity

- Ecosystem services and species richness
  - The activities of all organisms in an ecosystem are interrelated
    - When one species declines, other species linked to it may either decline or increase in number
    - Increased species richness improves ability of community to withstand environmental disturbances
Species Richness and Biological Diversity

- Ecosystem services
  - The activities of all organisms in an ecosystem are interrelated

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Services provided</th>
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<tbody>
<tr>
<td>Forests</td>
<td>Purify air and water</td>
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<td></td>
<td>Produce and maintain soil</td>
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<td>Absorb carbon dioxide (carbon storage)</td>
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<td>Provide wildlife habitat</td>
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<td>Provide humans with wood and recreation</td>
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<td>Freshwater systems</td>
<td>Moderate water flow and mitigate floods</td>
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<td>(rivers and streams,</td>
<td>Dilute and remove pollutants</td>
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<td>lakes, and groundwater)</td>
<td>Provide wildlife habitat</td>
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<td>Provide humans with drinking and irrigation water, food, transportation</td>
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<td>corridors, electricity, and recreation</td>
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<td>Grasslands</td>
<td>Purify air and water</td>
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<td>Absorb carbon dioxide (carbon storage)</td>
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<td>Provide wildlife habitat</td>
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<td>Provide humans with livestock and recreation</td>
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<td>Coasts</td>
<td>Provide a buffer against storms</td>
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<td>Dilute and remove pollutants</td>
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<td></td>
<td>Provide wildlife habitat, including food and shelter for young marine species</td>
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<td></td>
<td>Provide humans with food, harbors, transportation routes, and recreation</td>
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Importance of Genetic Diversity

• Evolution has taken hundreds of millions of years to produce genetic diversity we see today

• Diversity may hold solutions to today’s problems and to problems we have not begun to imagine
  – Genetic engineering uses gene diversity
  – Variation in wild relatives of crops allows us to introduce variation and resistance to diseases
Medicinal and Industrial Importance of Organisms

• Genetic resources of organisms are important to pharmaceutical industry
  – AIDS medication AZT is a derivative of a compound extracted from sponges
  – 20 best-selling prescription drugs in U.S. are natural products slightly modified or synthetic chemicals derived from organisms
  – Biopiracy

• Modern industrial technology
  – Oils, lubricants, perfumes, fragrances, dyes, paper, lumber, waxes, latex
Aesthetic, Ethical, Spiritual Value of Organisms

• Recreation, inspiration, spiritual solace
• Our world is a thing of beauty largely because of the diversity of living forms in it
Endangered and Extinct Species

• Extinction
  – The elimination of a species from Earth
  – Natural part of life
    • Background extinction
      – Continuous low level of extinction of species
    • Mass extinction
      – Large number of species disappear during a relatively short period of geologic time
  – Although natural process, it can be greatly accelerated by human activities
    • Human population growth has disrupted habitats
    • Biodiversity is disappearing at an unprecedented rate
      – 100 to 1000 times the natural rate of background extinction
Endangered and Extinct Species

- Puerto Rican crested toad
- Fringed campion
- Dusky seaside sparrow
- Snow leopard
- Golden lion tamarin
- Yellow-blotched map turtle
- Loggerhead sea turtle
- Texas blind salamander
- Boulder darter
- Delhi Sands flower-loving fly
- Hawaiian goose
- Polar bear
- Ivory-billed woodpecker
- White rhinoceros
- Coelacanth
- Mexican spotted owl
- Wolverine
- Tiger
- Mount Graham red squirrel
- Pygmy ground-plum
Endangered and Threatened Species

- Hunting and fishing laws
- Endangered Species Act legally defines
  - Endangered species
    - A species is in imminent danger of extinction throughout all or a significant portion of its range
  - Threatened species
    - A species whose population has declined to the point that it may be at risk of extinction
  - Lower genetic diversity heightens the risk of extinction
Endangered and Extinct Species

• Areas of declining biological diversity
  – A concern throughout the U.S., but mostly
    • Hawaii (63% of species are at risk), at least 2/3 of native forests are gone
    • California (29% of species at risk)
  – Very serious concern in tropical rain forests
    • Being destroyed for human settlements, banana plantations, oil and mineral exploration, etc.
    • Home to thousands or millions of species
Endangered and Extinct Species

• Human causes of species endangerment
  – Loss of habitat is greatest threat
    • Spread of invasive species
    • Overexploitation
    • Pollution
  – All this is caused by
    • Growth of human populations
Conservation Biology

• The scientific study of how humans affect organisms and of the development of ways to protect biological diversity
  – In situ - ‘in place’
    • Includes establishment of parks and reserves, concentrates on preserving biological diversity in nature
  – Ex situ - ‘outside its place’
    • Involves preserving biodiversity in human controlled settings—zoos, botanical gardens, seed banks of genetically diverse plant crops
Conservation Biology

Human development threatens some protected areas—for example, the harvest of natural resources for human use.

Human knowledge of ecosystems is limited, and more scientific data are needed to make good management decisions.

Conservation management must be adaptive (flexible to meet new problems) rather than adhere to old procedures because “that’s what has always been done.”

Human-affected environments often surround protected areas, threatening them with invasive species, pollution, and other problems.

Protected areas are often too small to support certain populations and ecological processes in the long term.

Humans are an important part of nature. Human values, needs, and desires must be considered when making management decisions.

Protected areas are often so fragmented that, when a local population declines in number, natural migration to rebuild the population can’t occur.
Conservation Biology

• Restoring damaged or destroyed habitats
  – Restoration ecology—the study of the historical condition of a human-damaged ecosystem, with the goal of returning it as closely as possible to its former state
  – Reclaim disturbed lands and convert them into areas with high biodiversity, using ecological principles, to return them to a functional and sustainable ecosystem
    • Creates habitats, regenerates soil
    • Requires time and expense
Kissimmee Restoration

Before Restoration

Before Kissimmee restoration began, dense mats of floating vegetation filled much of the river channel.

After Phase I Restoration

Increased water flow, achieved with various construction projects, has returned sections of the river to its historic, free-flowing state.

This dry prairie was once the Kissimmee River’s floodplain, home to countless species of wading birds, fish, invertebrates and aquatic plants.

Today it is a floodplain again, restored with water and filled with abundant wetland life.
Conservation Biology

• Conserving species
  – Conservation organizations are essential part of the effort to maintain biodiversity
    • Educate policymakers, galvanize public support, provide financial support for projects
    • Work in conjunction with zoos, aquaria, botanical gardens, etc.
Conservation Policies and Laws

• International policies and laws
  – World Conservation Strategy—1980
    • Plan to preserve biodiversity and essential ecosystem services on which all life depends for survival
  – Earth Summit—1992
    • Each signatory nation must inventory its biodiversity and develop a national conservation strategy
  – CITES—1975
    • Bans the hunting, capturing, and selling of endangered and threatened species
    • Protects about 30,000 species
    • Enforcement varies from country to country—penalties are not severe enough
    • Illegal trade continues
• Is your coffee bird friendly?
  – Many species of migratory songbirds are in decline
    • American’s coffee habits may play a role
    • Sun plantations (growing coffee in full sunlight) are becoming more common
      – High-input, outproduce shade plantations
      – Lots of chemical fertilizers and pesticides
      – 94–97 fewer species of birds
• Traditional shade plantations are more environmentally friendly
  – Do not require cutting rain forest
  – Support populations of songbirds
  – Provide variety of forest products
  – Often organic and hand picked