9
Sustaining Biodiversity: Saving Species and Ecosystem Services
Bees play a key role in pollination

Globally, about one third of the food supply comes from insect-pollinated plants

Currently, agriculture depends heavily on a single species of bee

- Suffering from Colony Collapse Disorder
  - Each year, 30-50% of colonies in Europe and the U.S.
Honeybee
• Species are becoming extinct 100 to 1,000 times faster than they were before modern humans arrived on the earth
  – By the end of this century, the extinction rate is expected to be 10,000 times higher than that background rate
Extinctions Are Natural but Sometimes They Increase Sharply

- Biological extinction
  - No species member alive
- Trophic cascade
  - Population declines or extinctions among connected species
- Mass extinction
  - Many species in a short amount of time
Some Human Activities Hasten Extinctions and Threaten Ecosystem Services

- Background extinction rate
  - 1 extinct species / year / 1 million species
- Extinction rates have risen recently
  - Current extinction rate is at least 100 times higher than typical background rate of 0.0001%
• Rate of extinction and threats to ecosystem services likely to rise sharply in the next 50-100 years
  – Due to harmful human impacts
• Biodiversity hotspots
  – Extinction rates projected to be much higher than average
• Biologically diverse environments are being eliminated or fragmented
• Endangered species
  – So few members that the species could soon become extinct

• Threatened species (vulnerable species)
  – Still enough members to survive, but numbers declining
  – May soon be endangered
Endangered and Threatened Species Are Ecological Smoke Alarms (cont’d.)

- Regionally extinct
  - In areas a species is normally found
- Functionally extinct
  - To the point at which species can no longer play a functional role in the ecosystem
a. Mexican gray wolf:
About 42 in the forests of Arizona and New Mexico

b. California condor:
226 in the southwestern United States (up from 9 in 1986)

c. Whooping crane:
437 in North America

d. Sumatran tiger: No more than 500 on the Indonesian island of Sumatra
Amphibians: 41%
Conifers: 30%
Mammals: 25%
Birds: 13%

(Compiled by the authors using data from 2012 IUCN Red List of Threatened Species.)
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low reproductive rate</td>
<td>Blue whale, giant panda, rhinoceros</td>
</tr>
<tr>
<td>Specialized niche</td>
<td>Blue whale, giant panda, Everglades kite</td>
</tr>
<tr>
<td>Narrow distribution</td>
<td>Elephant seal, desert pupfish</td>
</tr>
<tr>
<td>Feeds at high trophic level</td>
<td>Bengal tiger, bald eagle, grizzly bear</td>
</tr>
<tr>
<td>Fixed migratory patterns</td>
<td>Blue whale, whooping crane, sea turtle</td>
</tr>
<tr>
<td>Rare</td>
<td>African violet, some orchids</td>
</tr>
<tr>
<td>Commerially valuable</td>
<td>Snow leopard, tiger, elephant, rhinoceros, rare plants and birds</td>
</tr>
<tr>
<td>Large territories</td>
<td>California condor, grizzly bear, Florida panther</td>
</tr>
</tbody>
</table>
We should avoid speeding up the extinction of wild species because:

- Of the ecosystem and economic services they provide
- It can take millions of years for nature to recover from large-scale extinctions
- Many people believe that species have a right to exist regardless of their usefulness to us
Species Are a Vital Part of the Earth’s Natural Capital

• Major reasons to prevent extinctions
• Species provide vital ecosystem services
  – Help keep us alive and support our economies
• Many species also contribute economic services
  – Plants for food, fuel, lumber, and medicine
  – Ecotourism
Species Are a Vital Part of the Earth’s Natural Capital (cont’d.)

- It will take 5-10 million years to regain species biodiversity after this century’s extinctions
- Many people believe species have an intrinsic right to exist
- How do we decide which species to protect?
Rauvolfia  
*Rauvolfia* sepentina, Southeast Asia  
Anxiety, high blood pressure  

Foxglove  
*Digitalis purpurea*, Europe  
Digitalis for heart failure  

Pacific yew  
*Taxus brevifolia*, Pacific  
Northwest  
Ovarian cancer  

Cinchona  
*Cinchona ledogeriana*, South America  
Quinine for malaria treatment  

Rosy periwinkle  
*Catharanthus roseus*, Madagascar  
Hodgkin's disease, lymphocytic leukemia  

Neem tree  
*Azadirachta indica*, India  
Treatment of many diseases, insecticide, spermicides  

Fig. 9-6, p. 196
The greatest threats to any species are (in order):

– Loss or degradation of its habitat
– Harmful invasive species
– Human population growth
– Pollution
– Climate change
– Overexploitation
Loss of Habitat Is the Single Greatest Threat to Species: Remember HIPPCO

- Habitat destruction, degradation, and fragmentation
- Invasive (nonnative) species
- Population and resource use growth
- Pollution
- Climate change
- Overexploitation
Loss of Habitat Is the Single Greatest Threat to Species (cont’d.)

• Habitat fragmentation
  – Large intact habitat divided by roads, crops, and urban development

• National parks and nature reserves as habitat islands
Indian Tiger
Range 100 years ago
Range today

Black Rhino
Range in 1700
Range today

African Elephant
Probable range 1600
Range today

Asian or Indian Elephant
Former range
Range today

Fig. 9-8, p. 198
Many species introductions are beneficial

Nonnative species may have no natural:
- Predators, competitors, parasites, pathogens

Nonnative species can crowd out native species
- Invasive species
Deliberately introduced species

- Purple loosestrife
- European starling
- African honeybee ("Killer bee")
- Nutria
- Salt cedar (Tamarisk)

Accidentally introduced species

- Marine toad (Giant toad)
- Water hyacinth
- Japanese beetle
- Hydrilla
- European wild boar (Feral pig)

- Sea lamprey (attached to lake trout)
- Argentina fire ant
- Brown tree snake
- Eurasian ruffe
- Common pigeon (Rock dove)

- Formosan termite
- Zebra mussel
- Asian longhorned beetle
- Asian tiger mosquito
- Gypsy moth larvae

Fig. 9-9, p. 199
Case Study: The Kudzu Vine and Kudzu Bugs

• Imported from Japan in the 1930s
  – Help control soil erosion
• Very difficult to kill
• Could there be benefits of kudzu?
• Kudzu bug – imported from Japan
  – Can kill Kudzu vine
  – Also kills soybeans

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Some Accidentally Introduced Species Can Disrupt Ecosystems

- Argentina fire ant – introduced in the 1930s
  - Reduced populations of native ants
  - Painful stings can kill
  - Pesticide spraying in 1950s and 1960s worsened conditions
  - Tiny parasitic flies may help control fire ants
Case Study: Burmese Pythons Are Eating Their Way through the Florida Everglades

- Accidentally introduced
- Reproduce rapidly and are hard to kill
- Greatly depleted Everglades populations of:
  - Rabbits, foxes, raccoons, opossums, and deer
Prevention Is the Best Way to Reduce Threats from Invasive Species

• Research programs identifying invaders
• Establishing international treaties banning transfer between countries
• Public education about exotic pets and plants
• What else can be done to prevent invasive species?
What Can You Do?

Controlling Invasive Species

- Do not buy wild plants and animals or remove them from natural areas.

- Do not release wild pets in natural areas.

- Do not dump aquarium contents or unused fishing bait into waterways or storm drains.

- When camping, use only local firewood.

- Brush or clean pet dogs, hiking boots, mountain bikes, canoes, boats, motors, fishing tackle, and other gear before entering or leaving wild areas.
Other Causes of Species Extinctions

• Human population growth and overconsumption
  – Degrading habitat

• Pollution
  – Bioaccumulation can cause extinctions of species not directly affected by pollution

• Climate change
  – Some species will become extinct, some will spread
DDT in water 
0.000003 ppm, or 3 ppt

DDT in small fish (minnows) 
0.5 ppm

DDT in zooplankton 
0.04 ppm

DDT in large fish (needle fish) 
2 ppm

DDT in fish-eating birds (ospreys) 
25 ppm

Fig. 9-13, p. 202
Case Study: Polar Bears and Climate Change

- Live only in the Arctic
- Arctic ice is melting
  - Decreasing polar bear habitat
  - Polar bears must swim farther between ice
    - Weaker females; less reproduction
Poaching and smuggling of animals and plants
  – Animal parts
  – Pets
  – Plants for landscaping and enjoyment

Prevention
  – Research and education
A Rising Demand for Bushmeat Threatens Some African Species

• West and Central African wild animals
  – Supply major cities with exotic meats
• Hunting has driven one species to extinction
  – Miss Waldron’s red colobus monkey
• Threatened species:
  – Monkeys, apes, antelope, elephants, and hippos
• 70% of the world’s bird species are declining
• Habitat loss and fragmentation of the birds’ breeding habitats
  – Forests cleared for farms, lumber plantations, roads, and development
• Intentional or accidental introduction of nonnative species
  – These species eat the birds
Case Study: A Disturbing Message from the Birds (cont’d.)

- Exposure to pesticides
- Overexploitation
  - For pets
- Birds are indicator species
  - Respond quickly to environmental changes
- Birds perform critical ecosystem and economic services
  - Extinctions could affect many other species
We can reduce species extinction and sustain ecosystem services by:

– Establishing and enforcing national environmental laws and international treaties
– Creating protected wildlife sanctuaries
– Taking precautionary measures to prevent such harm
• 1975 – Convention on International Trade in Endangered Species (CITES)
  – Signed by 172 countries

• Convention on Biological Diversity (BCD)
  – Focuses on ecosystems
  – Ratified by 190 countries (not the U.S.)
   – Identify and protect endangered species in the U.S. and abroad

National Marine Fisheries Service for ocean species

U.S. Fish and Wildlife Service for all others
• Forbids federal agencies (except Defense) from funding or authorizing projects that jeopardize endangered or threatened species
  – In 2012, 1,394 species officially listed
• Offer incentives to private property owners to help
Case Study: The U.S. Endangered Species Act (cont’d.)

• Is the ESA a failure?
  – Species are listed only when in serious danger
  – Conditions for more than half of listed species are stable or improving
  – Budget is about 57 cents per U.S. citizen
We Can Establish Wildlife Refuges and Other Protected Areas

• In 1903, Theodore Roosevelt established the first federal wildlife refuge
  – Pelican Island, Florida

• Wildlife refuges
  – Most are wetland sanctuaries
  – More needed for endangered plants
  – Are not immune from disturbance
Seed Banks, Botanical Gardens, and Wildlife Farms Can Help Protect Species

- Seed banks
  - Preserve genetic material of endangered plants
- Botanical gardens and arboreta
  - Living plants
- Farms can raise organisms for commercial sale
Zoos and Aquariums Can Protect Some Species

- Techniques for preserving endangered terrestrial species
  - Egg pulling
  - Captive breeding
  - Artificial insemination
  - Embryo transfer
  - Use of incubators
  - Cross-fostering
Zoos and Aquariums Can Protect Some Species (cont’d.)

- Goal of ultimately releasing/reintroducing populations to the wild
- Limited space and funds
What Can You Do?

Protecting Species

- Do not buy furs, ivory products, or other items made from endangered or threatened animal species.
- Do not buy wood or wood products from tropical or old-growth forests.
- Do not buy pet animals or plants taken from the wild.
- Tell friends and relatives what you’re doing about this problem.
The Precautionary Principle

• Precautionary principle
  – Act to prevent or reduce harm when preliminary evidence indicates acting is needed

• Species are the primary components of biodiversity

• Should we focus on the preservation of species or the preservation of ecosystems?
Failure to protect honeybees
  - Loss of vital ecosystem services

Farmers are:
  - Breeding bees resistant to harmful parasitic mites and fungi
  - Raising their own colonies
  - Improving bee nutrition
Three Big Ideas

• We are hastening the extinction of wild species and degrading the ecosystem services they provide by:
  – Destroying and degrading habitats
  – Introducing harmful invasive species
  – Increasing human population growth, pollution, climate change, and overexploitation
Three Big Ideas (cont’d.)

• We should avoid causing the extinction of wild species
  – Species provide vital ecosystem and economic services
  – Their existence should not depend primarily on their usefulness to us
We can work to prevent the extinction of species and to protect overall biodiversity and ecosystem services by:

– Using laws and treaties
– Protecting wildlife sanctuaries
– Making greater use of the precautionary principle