Chapter 11: Sustaining Biodiversity-The Species Approach

• PASSENGER PIGEON
  > Uncontrolled commercial hunting
  > Habitat loss (farms and cities)
  > Behavior made them easy to hunt
  > Only lay 1 egg per nest each year
Three Types of Species Extinction

• **Local extinction**: Species no longer found in an area it once inhabited, but still found elsewhere in the world.
  > Often involves losses of one or more populations of species. *Why??*
• **Ecological extinction**: So few left that no longer fulfill ecological role.
• **Biological extinction**: No longer found anywhere on earth. *(Is it forever?)*
Endangered v. Threatened Species

• **Endangered species**: so few individual survivors that species could soon become extinct over all or most of its natural range
• **Threatened species** (vulnerable species): still abundant in natural range but declining numbers and is likely to become endangered in the near future.
Characteristics of species that are vulnerable to extinction:

"The first animal species to go are the big, the slow, the tasty, and those with valuable parts such as tusks and skins". -Edward O. Wilson

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Examples</th>
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<tbody>
<tr>
<td>Low reproductive rate</td>
<td>Blue whale, giant panda, rhinoceros</td>
</tr>
<tr>
<td>(K-strategist)</td>
<td>Blue whale, giant panda, Everglades kite</td>
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<tr>
<td>Specialized niche</td>
<td>Many island species, elephant seal, desert pupfish</td>
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<td>Narrow distribution</td>
<td></td>
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<td>Feeds at high trophic level</td>
<td>Bengal tiger, bald eagle, grizzly bear</td>
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<td>Fixed migratory patterns</td>
<td>Blue whale, whooping crane, sea turtles</td>
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<td>Rare</td>
<td>Many island species, African violet, some orchids</td>
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<tr>
<td>Commercially valuable</td>
<td>Snow leopard, tiger, elephant, rhinoceros, rare plants and birds</td>
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<tr>
<td>Large territories</td>
<td>California condor, grizzly bear, Florida panther</td>
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Behavioral characteristics
- Nesting in large flocks
- Key deer

Fig. 11-4, p. 225
Human activities threaten many species with premature extinction

- Data below shows percentage of species threatened with premature extinction as a result of human activities.
- Why are so many species of fish, particularly freshwater species, threatened?
Estimating extinction rates

- Estimating extinction rates is useful but difficult
- 3 problems:
  > Extinction takes a long time: Not easy to document
  > Only 1.4 million of 4-100 million species known
  > Know little about most of species that have been identified.
Estimating extinction rates

Methods:
1. Compare fossil records of extinction with current rates of extinction since humans have arrived
   > Underestimate: World's threatened species published in Red List. Only assessed known species, not all species on earth.

http://evolution.berkeley.edu/evolibrary/news/120501_habitatloss
Estimating extinction rates

Methods:
1. Compare fossil records of extinction with current rates of extinction since humans have arrived.

2. Species-area relationship: observe how # of species present increases with size of area
   > On average, 90% habitat loss = 50% species loss
   > Theory of island biogeography
   > Applied to "islands" of habitat

http://en.wikipedia.org/wiki/SAR%28Species-area_curve%29.gif
Estimating extinction rates

Methods:
1. Compare fossil records of extinction with current rates of extinction since humans have arrived.

2. Species-area relationship: observe how # of species present increases with size of area

3. Models to estimate risk based on factors:
   > Population size
   > Habitat availability
   > Interactions with other species
   > Genetic factors
Impact of human activities on extinction rates

- Estimating extinction rates is difficult and current methods are inadequate
  > regardless of estimate, it is clear that human activity has increased rate of extinction. Rate is increasing.
- Natural extinction rate before humans: 1 species per million species on earth (0.0001% per year)
  > Current rate w/human: 0.01%-1% per year
Impact of human activities on extinction rates

• 0.01-1% is a conservative estimate
  > Rate of species loss and biodiversity loss will increase because of projected human pop. growth
  > Rates higher in hot spots than global average
  > Humans are eliminating, degrading, and simplifying environments that serve as sites for speciation *speciation crisis
• *May increase speciation for r-selected species.
  > May result in erosion in variety of species but not number of species?
Importance of Wild Species

- Mass extinctions have occurred in the past. Why are we so concerned about it now?
- It will take 5 million years for natural speciation to rebuild the biodiversity humans destroy during this century.
  > Unlikely that effects of human population on biodiversity will be reduced (or stop) at any point.
Importance of Wild Species

• Instrumental value: usefulness
  > Ecological services
    – ex: bats
  > Economic services
    – Food and other resources
  > Bioprospecting
  > Genetic information (evolution and genetic engineering)
  > Recreation
  > Ecotourism
    – Pros: $ into local economy, education about nature
    – Cons: Disruption to nature
Importance of Wild Species

• Intrinsic value and existence value
  > Ethical responsibility to protect species
  > Biophilia: affinity for other living things
    – plants v. animals
    – pests v. other organisms?
    – don't forget microorganisms! Huge ecological roles that are invisible to people.
HIPPO! Causes of premature extinction

* H:
  I:
  P:
  P:
  O:
Habitat loss, degradation, and fragmentation is the greatest threat to wild species.

1. deforestation of tropical rain forest
2. degradation of coral reefs and wetlands
3. plowing of grasslands
4. pollution of streams, lakes, oceans

• Temperate biomes more affected than tropical biomes because of economic development in temperate countries.
• Shift to tropical biomes

[Map of biomes across the world]
Island species, endemic species, and habitat islands

- **Endemic species**: species found only in one place
- **Habitat islands**: Any habitat surrounded by a different one. Encircled on edge by human activities that endanger ecosystems
  > national parks, nature reserves
  > freshwater lakes
Island species, endemic species, and habitat islands

- **Habitat fragmentation**: large area reduced in area, divided into habitat islands
  - block migration routes
  - divide populations into isolated groups (*genetics!*)
    - more vulnerable to predators, competitive species, storms/fire
  - limit ability to expand population
  - limit resources
What kinds of species are vulnerable to extinction because of habitat fragmentation?

- rare
- need to roam
- low reproductive capacity
- specialized niche
- valuable to humans
Case Study: Birds

- 70% of world's 9775 species of birds are declining, 1/8 threatened
- Why?

1. Forests are the most affected by human activities.
   > 3/4 bird species live in forests
   > deforestation
   > lumber
   > palm plantation (Indonesia)
   > farms/ranches (Brazil)

Birds are important:
- Control populations of rodents and insects
- Pollinators
- Spread seeds
2. Introduction of nonnative species
3. Capture for pets
4. Death associated with fishing
5. Loss of wetlands
6. Collision with power lines, towers (1 million / year in US from glass windows)
7. Oil spill, pesticides, herbicides, lead pellets and sinkers
8.*Climate change
   • Environmental indicators
   • Live in every climate, biome, easy to track, respond quickly to changes
Ivory-billed woodpecker

- Thought to be extinct
- Sighted in Arkansas 2005
Invasive Species

• 2nd biggest cause of premature extinction after habitat loss and degradation
• Beneficial invasive species
  > food, shelter, medicine, aesthetic
• Harmful invasive species
  > no natural predators, competitors, parasites, or pathogens
  > cause ecological disruption
  > threaten ~50% endangered and threatened species in US, 95% in Hawaii
Invasive Species

• Deliberately introduced
  > lots of food crops, animals, things that are useful
  > European wild boar roams FLorida, other states
    and competes for food, roots up fields, cause
    traffic accidents
• Accidentally introduced
  > Increased w/global trade
  > Can hitchhike on imported products, ballast
    water, tires, etc.
Accidentally Introduced Species

- Sea lamprey (attached to lake trout)
- Argentina fire ant
- Brown tree snake
- Eurasian ruffe
- Common pigeon (Rock dove)
- Formosan termite
- Zebra mussel
- Asian long-horned beetle
- Asian tiger mosquito
- Gypsy moth larvae

Fig. 11-11b, p. 234
Additional causes of premature extinction:

1. Population growth
   > Associated increase in consumption of resources and production of waste
   > Affluenza
   > Pollution (pesticides-DDT)
     - Biomagnification in birds
Additional causes of premature extinction:

2. Climate change
   > Too fast for adaptation?

Global Temperature Land-Ocean Index

http://www.ecy.wa.gov/climatechange/whatis.htm
Additional causes of premature extinction:

3. Overexploitation
   > Wildlife product
   > Legitimate trade $10 billion/year, illegal trade $6-10 billion
   > Increased by poverty
Additional causes of premature extinction:

4. Killing predators and pests
   > Elephants
   > Coyotes, prairie dogs, wolves, bobcats
   > Can have unintended consequences to other animals that are part of food web and ecosystem

5. Exotic pets and plants
   > For every live animal captured and sold in market, 50 others are killed
Case study: Bushmeat-hunted wildlife

• Increase in bushmeat trade
  > Growing population + supply to restaurants
  > Logging roads = access
  > Not enough fish
• Problem with hunting bushmeat
  > Local extinction of species
  > Depletes food for predators
  > Disease (HIV, ebola)
How can we protect wild species?

• Laws/treaties
  > International Treaties
  > ESA (general)
  > ESA (private landowners)
• Sanctuary
  > Wildlife Refuges
  > Gene banks/botanical gardens
  > Zoos and aquariums
• Reconciliation Ecology
International treaties

• Convention on International Trade in Endangered Species (CITES) (1975)
  > signed by 169 countries
  > lists 900 endangered species that cannot be commercially traded as live specimen or wildlife products
  > Lists additional 5,000 threatened animals and 28,000 threatened plan species
  > Enforcement is limited
    – varies from country to country
    – punishment may only be a small fine
    – countries can exempt themselves from certain species
    – not all countries have signed the treaty
International treaties

- Convention on Biological Diversity (CBD)
  > ratified by 188 countries
  > commits governments to
    - reversing the global decline of biological diversity
    - equitable sharing of benefits of world's genetic resources
  > focuses on ecosystems, not single species
US Endangered Species Act

• ESA (1973 original, amended multiple times)
  > most far-reaching environmental law
  > *Read ESA for HW and answer HW questions!
Wildlife Refuge

• US: National Wildlife Refuge System
  > 544 refuges (81% in Alaska)
  > 1/5 US endangered and threatened species have habitats in refuge system
    – migratory waterfowl in wetlands
    – brown pelican
    – key deer
  > Problems in refuge system
    – too much hunting and fishing
    – too much use of boats and vehicles
    – invasive species
Gene banks, botanical gardens, wildlife farms

- Gene or seed banks
  - preserve genetic information and endangered plant species by storing seeds
  - some species can't be preserved in seed banks
  - expensive, could be destroyed by fire or power outage
- Botanical gardens and arboreta
  - represent 1/3 of world's known plant species (only 3% of rare and threatened species)
  - education
  - limited space and funding
- Wildlife farms
  - take pressure off of collection of species by raising species for sale
Zoos and Aquariums

- Zoos and aquariums preserve individuals of endangered animal species
  > long-term goal is to reintroduce them into wild
- **Egg pulling**: collect wild eggs, hatch them in research centers
- **Captive breeding**: capture individuals and breed in research center, release offspring into wild
  > Success is rare: black-footed ferret, California condor, golden lion tamarin
  > Lack of suitable habitat, inability of offspring to survive in wild
  > Initial problem not resolved

http://nationalzoo.si.edu/SCBI/EndangeredSpecies/GLTProgram
http://nationalzoo.si.edu/SCBI/reproductivescience/recoverbferret/default.cfm
Zoos and Aquariums

- Role in public education and research
- Criticized for entertainment aspect, imprisoning animals
- Not biologically nor economically feasible way to maintain biodiversity
Reconciliation Ecology

- **Reconciliation Ecology**: focus on establishing and maintaining new habitats to conserve species diversity in places where people exist.
  - Protect insects by reducing use of pesticides and plant native species of flowers/gardens to attract pollinators and other species.
  - Design and build more biologically diverse spaces that are also designated for human use: parks, golf courses
  - Rooftop gardens