11

Biodiversity and Conservation Biology

Chapter Objectives

This chapter will help students:

Characterize the scope of biodiversity on Earth

Describe ways to measure biodiversity

Contrast background extinction rates and periods of mass extinction

Evaluate the primary causes of biodiversity loss

Specify the benefits of biodiversity

Assess conservation biology and its practice

Explain island biogeography theory and its application to conservation biology

Compare and contrast traditional and more innovative biodiversity conservation efforts

Lecture Outline

I. Central Case: Saving the Siberian Tiger

A. Up until the past 200 years, tigers roamed widely across the Asian continent from Turkey to northeast Russia to Indonesia.

B. Of the tigers that still survive in small pockets of their former range, those in the subspecies known as the Siberian tiger are the largest cats in the world.

C. For thousands of years, the Siberian tiger coexisted with the native people of what is today the Russian Far East, who equated the tiger with royalty and viewed it as a guardian.

D. The Russians who moved into and exerted control over the region in the early to mid-20th century had no cultural traditions that expressed respect for the animal, leading to the decline of the species.
E. International conservation groups began to get involved, working with Russian biologists to try to save the dwindling tiger population.
F. Today, the Siberian tiger population is up to roughly 330 to 370, and 600 more survive in zoos around the world. However, 40% of the tiger's habitat has disappeared in the last decade.

II. Our Planet of Life

A. What is **biodiversity?**
   1. **Biological diversity,** or biodiversity, is the sum total of all organisms in an area.
   2. Biodiversity takes into account the diversity of species, their genes, their populations, and their communities.

B. Biodiversity encompasses several levels of life's organization.
   1. **Species diversity** is expressed in terms of the number or variety of species in the world or in a particular region.
      a. Taxonomists, the scientists who classify species, use an organism's physical appearance and genetic makeup to determine to which species it belongs.
      b. Speciation, the generation of new species, adds to species diversity, while extinction decreases species diversity.
      c. Biodiversity exists below the species level in the form of subspecies.
   2. **Genetic diversity** encompasses the differences in DNA composition among individuals within a given species.
      a. Whether genetic diversity is extremely minor or great enough to warrant subspecies status, such diversity has repercussions for the well-being of a species in at least two major ways.
      b. First, as a species becomes adapted to local environmental conditions, its genetic diversity may decrease.
      c. In the long term, species with more genetic diversity have better chances of persisting, because their built-in variation better enables them to cope with environmental change.
   3. Ecosystem diversity, community diversity, habitat diversity, and landscape diversity are all ways to view biodiversity.

C. Measuring biodiversity is not easy.
D. You may be able to help measure biodiversity where you live.
E. Global biodiversity is not distributed evenly.

III. Biodiversity Loss and Species Extinction

A. Extinction occurs when the last member of a species dies and the species ceases to exist; in contrast, the extinction of a certain population from a given area, but not the entire species globally, is called **extirpation.**
B. Extinction is a natural process.

1. Most extinctions preceding the appearance of humans have occurred one by one, at a rate that paleontologists refer to as the **background rate of extinction.**

C. Earth has experienced five previous **mass extinction** episodes.
D. Humans set the sixth mass extinction in motion years ago.
E. Current extinction rates are much higher than normal.
   1. To keep track of the current status of endangered species, the World Conservation Union (IUCN) maintains the **Red List.**
F. Biodiversity loss involves more than extinction.
G. There are several major causes of biodiversity loss:
   1. Habitat alteration
   2. Invasive species
   3. Pollution
   4. Overharvesting
   5. Climate change
H. Causes of biodiversity loss can be difficult to determine.

IV. Benefits of Biodiversity

A. Biodiversity provides ecosystem services free of charge.
B. Biodiversity helps maintain ecosystem function.
C. Biodiversity enhances food security.
D. Biodiversity provides traditional medicines and high-tech pharmaceutical products.
E. Biodiversity provides economic benefits through tourism and recreation.
F. People value and seek out connections with nature.
   1. E. O. Wilson described the phenomenon of **biophilia,** "the connections that human beings subconsciously seek with the rest of life."
G. Do we have an ethical responsibility to prevent species extinction?

V. Conservation Biology: The Search for Solutions

A. **Conservation biology** arose in response to biodiversity loss.
   1. Conservation biology is a scientific discipline devoted to understanding the factors, forces, and processes that influence the loss, protection, and restoration of biological diversity.
B. Conservation biologists work at multiple levels.
C. Island biogeography theory is a key component of conservation biology.
   1. Much of modern conservation biology is based on the **equilibrium theory of island biogeography.**
   2. Island biogeography is best understood at the landscape level. Species richness is explained by size (of the island or patch of habitat) and immigration and emigration affect total number of species in an area.
   3. The number of species is expected to double as the island (or patch) size increases ten times.
D. Should endangered species be the focus of conservation efforts?
   1. Currently, the primary legislation for protecting biodiversity in the United States is the **Endangered Species Act (ESA).**

E. Single-species approaches include **captive breeding,** reintroduction efforts, and cloning.
    1. Zoos and botanical gardens have become centers for the captive breeding of endangered species, so that large numbers of individuals can be raised and then reintroduced into the wild.
    2. Examples of successful reintroduction programs include wolves in Yellowstone National Park and Siberian tigers in China.

F. Some species act as "umbrellas" for protecting habitat and communities.

G. International conservation efforts include widely signed treaties.
    1. The 1973 **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** protects endangered species by banning the international transport of their body parts.
    2. In 1992, the leaders of many nations agreed to the **Convention on Biological Diversity,** a treaty outlining the importance of conserving biodiversity, using it sustainably, fairly distributing its benefits, and committing signatory nations to conserving this diversity.

H. **Biodiversity hotspots** pinpoint areas of high diversity.
    1. Biodiversity hotspots are areas that support an especially great diversity of species, particularly species that are **endemic** to the area.

I. **Community-based conservation** is increasingly popular.
    1. Many conservation biologists actively engage local people in efforts to protect the land and wildlife in their own backyards, in an approach called community-based conservation.

J. Innovative economic strategies are being employed.

VI. Conclusion

A. The erosion of biological diversity threatens to result in a mass extinction event equivalent to the major ones of the geological past.

B. The primary causes of biodiversity loss include habitat alteration, invasive species, pollution, overharvesting, and global climate change.

C. Many conservation biologists are rising to the challenge with traditional and innovative strategies to save endangered species and their habitats.

D. Earth's biologically diverse communities of plants and animals are part of the natural capital of the planet. From natural capital, flow ecosystem services. We need ecosystem services for our own good. It is in the best interests of humans and all other life to protect biological diversity.