**Conserving Biodiversity Community and Ecosystem Ecology**

**The Sixth Extinction**

* Endangered Species Act (ESA) – law passed in 1973 to protect and encourage population growth of threatened and endangered species
* **Biodiversity** – the entire diversity of living organisms in an area
* **Extinction** – the complete loss of a species

**The Sixth Extinction – Measuring Extinction Rates**

* History of life on earth has been punctuated with five **mass extinctions**.
* Is the sixth mass extinction event occurring now?
  + Need to know the background extinction rate
  + Fossils indicate that average species exists for ~1,000,000 years
  + Estimate of **background extinction rate** is 0.0001% per year
* Current rate of extinction – three times more bird and mammal species have disappeared in the last 150 years than in the previous 200 years

**The Sixth Extinction – The Causes of Extinction**

* The most severe threats to species loss come from four general categories:
  + Loss or degradation of habitat
  + Introduction of non-native species
  + Overexploitation of species
  + Pollution

**The Sixth Extinction – Habitat Destruction and Fragmentation**

* **Habitat** is the place where a particular species lives and obtain resources for survival.
* As human population increases, pressure on natural areas increases
  + **Species area curve** measures the relationship between the size of a natural area and the number of species it can support.
* Habitat destruction affects all ecosystems.
  + If worldwide habitat destruction continues at present rate, as many as 25% of world’s species could become extinct.

**The Sixth Extinction – Habitat Destruction and Fragmentation**

* Predicting extinction caused by habitat destruction
* Usually human activity results in habitat fragmentation – large natural areas subdivided into smaller areas
  + Large predators are threatened because they require large home ranges.
* Basic rule of biological systems: energy flows in one direction along a food in chain within an ecosystem
  + The sun provides energy to the **producers** which are feed on by the **primary consumers** who are feed upon by the **secondary consumers**.

**The Sixth Extinction - Introduced Species**

* **Introduced species** – non-native species introduced to a new area either purposely or accidentally by human activity
  + Most groups of species in an area undergo **coevolution**.
  + introduction of non-native species is often destructive because they have not evolved with local species
  + Brown tree snake, introduced to Guam, caused many local bird species to go extinct

**The Sixth Extinction – Overexploitation**

* When human use of a natural resource exceeds its reproductive rate, overexploitation occurs.
  + Can occur if species is highly prized by humans, which can spur illegal hunting
  + Can also occur if species competes with humans (i.e., wolves and ranchers)

**The Sixth Extinction – Pollution**

* The release of poisons, toxins, excess nutrients, and other waste products – pollution – is another threat to biodiversity.
  + Excess fertilizer runoff leads to **eutrophication** of waterways
  + Eutrophication is the excess growth of bacteria that depletes oxygen from the water
  + Carbon dioxide is another atmospheric pollutant, associated with climate change

**The Consequences of Extinction – Loss of Resources**

* Loss of species can lead to economic impacts for humans.
  + Some biological resources harvested directly include wood (lumber and fuel), shellfish (protein), and algae (gelatin).
  + Wild species provide biological chemicals (medicines).
  + Wild species have alleles that are not present in domestic species, which can increase vigor of domesticated species.
  + Wild species can contribute other means of combating pests (biological control).

**The Consequences of Extinction – Predation, Mutualism, and Competition Derailed**

* Species interact with one another and their environment in complex ways, not just a simple food chain instead as a **food web**.

**The Consequences of Extinction – Mutualism: How Bees Feed the World**

* **Mutualism** – relationship in which both species benefit from their interaction, for example:
  + Cleaner fish
  + Fungal mycorrhizae
  + Ants and acacia trees
  + Bees are primary pollinators of many wild plants
    - Wild bees pollinate 80% of agricultural crops in U.S.
    - Bee populations are falling due to “colony collapse disorder”
    - Humans benefit from mutualism, and will lose if bees go extinct
* **Commensalism** is a relationship where one species benefits and the other is unaffected.

**The Consequences of Extinction – Predation: How Songbirds May Save Forests**

* **Predator** – species that survives by eating other species
  + Songbirds consume many insects
  + Most insects eaten by songbirds consume plants
  + Songbirds help to sustain forests
  + As songbird numbers decline, damage to forests increases

**The Consequences of Extinction – Competition: How a Deliberately Infected Chicken Could Save a Life**

* A leading cause of food illness in the U.S. is caused by *Salmonella enteritidis*.
  + About 2 million Americans infected each year
  + About 400 die each year as a result of infection
  + Most common source of infection is eggs
  + *S. enteritidis* contaminates egg when it forms in the hen
* **Competitive exclusion** is the use of food and space resources, making it impossible for another species to establish itself.
  + On this principle, chickens are deliberately infected with harmless bacteria.
  + Harmless bacteria establish and prevent *S. enteritidis* from living in chicken’s gut thus decreasing the number of eggs infected with *S. enteritidis*.
* Competition between species can have consequences for humans as well.
  + Mosquitos, snails and tadpoles compete for same resources in ponds
  + When populations of snails and tadpoles decrease, mosquitoes increase
  + Potentially serious because mosquitoes can spread malaria, West Nile virus, and yellow fever

**The Consequences of Extinction – Keystone Species: How Wolves Feed Beavers**

* Keystone species are key figures in determining the food web of an ecosystem.
  + Wolves were eradicated from Yellowstone Park in 1920s
  + With wolves gone, biologists noted declines in aspen, cottonwood, and willow trees
  + Trees declined due to predation by elk
  + Trees are crucial for beavers, songbirds, and fish
  + With reintroduction of wolves, trees and other species rebounded

**The Consequences of Extinction – Disrupted Energy and Chemical Flows**

* An ecosystem is defined as all of the organisms in a given area, along with their non-biological enivornment.
* Energy flow - only a small portion (~10%) of the energy in one level of a trophic pyramid can be converted to biomass at the next level
* Diversity also affects energy flow, such as in more diverse grasslands, more biomass is produced
* Nutrient cycling – nutrients that pass through a food web rarely leave the system
* The soil community has an important role in nutrient cycling.
  + **Decomposers** return nutrients back in to the soil for use by plants
  + Introduction of non-native earthworms in NE U.S. had dramatic impact on forest plants
  + Non-native worms changed the soil community

**The Consequences of Extinction – Psychological Effects**

* Our experience with nature has strong psychological effects
* Dental patients viewing landscapes showed a decrease in blood pressure
* Hospital patients who could view trees recovered from surgery more quickly
* Instinctive desire to commune with nature is called **biophilia**
* Loss of biodiversity could make human experience less pleasant

**Saving Species – Protecting Habitat**

* Less than 2% of the earth’s surface contain up to 50% of the earth’s mammal, bird, reptile, and plant species. These areas are biodiversity hotspots.
* Converting wild areas to agricultural production is a major cause of habitat destruction.
* Ways to decrease the rate of habitat destruction
  + Altering our consumption patterns can help decrease habitat destruction
  + Eating low on the food chain (less meat and dairy) makes a difference
  + Increased financial aid to developing countries can also help
  + So can slowing human population growth rate

**Saving Species – Protection From Environmental Disasters**

* A large population provides group protection from environmental disaster.
  + A species with a slow growth rate is at greater risk if its numbers diminish.
  + The longer a population remains small, the greater its risk.

**Saving Species – An Overview of Conservation Genetics**

* **Genetic variability** is the sum of all of the alleles and their distribution within the species.
* Loss of genetic variability is a two-fold problem.
  + Low genetic variability leads to low fitness, and is more likely to express harmful mutant alleles.
  + Rapid loss of genetic variability can lead to extinction due to the low fitness of individuals.

**Saving Species – A Closer Look: Conservation Genetics**

* The importance of genetic variability
* When individuals are heterozygotic for many genes, the overall effect is greater fitness.
* Heterozygotes can avoid deleterious effects of recessive alleles.
* In a small population, individuals are more likely to be related to their mates.
  + Result can be **inbreeding depression**, a decline in heterzygotes
  + Because of this, cheetahs have poor quality sperm and low rate of cub survival
  + In humans, children of first cousins have lower rates of heterozygosity and higher rates of infant mortality
* Small populations lose their genetic variability due to genetic drift.
* The consequences of low genetic variability in a population
  + A small population can become stuck in a cycle that leads to extinction.
  + This is called the extinction vortex
* Irish potato is a human example of the potentially disastrous effects of low genetic diversity
  + In 1850s, Irish potato crop had very low genetic diversity
  + Fungus that causes potato blight arrived in Ireland; plants rotted in fields
  + Because of crop failure, nearly 1 million Irish died of starvation and disease

**Protecting Biodiversity Versus Meeting Human Needs**

* The protection of endangered species sometimes has effects on human livelihood.
  + Farmers were unable to use water for irrigation because diversion of water would have disrupted fish populations.
  + Endangered Species Act has helped save American alligators, peregrine falcons, and bald eagles.