Importance of Conservation
Why Is Population Conservation Important?

• Species have an inherent right to exist.

• Future generations of humans should be able to enjoy all species.

• Preserve potential medicines and other products that might benefit humans.

• Preserve genetic variation in populations.

• Preserve food webs and community structure.

• Preserve ecosystem services: nutrient recycling, waste decomposition, water purification.
Conservation biologists argue that all species are the products of unique evolutionary trajectories and have the right to exist without human interference that would cause the extinction of those species. Once these species are gone, evolution might never replace a species—evolutionary trajectory might never be duplicated.
Enjoyment of Future Generations

“In our every deliberation, we must consider the impact of our decisions on the next seven generations.”

– Iroquois Federation of Native Americans

“We must consider our planet to be on loan from our children rather than being a gift from our ancestors.”

– G. H. Brundtland, former prime minister of Norway

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Taq polymerase, an enzyme, was isolated from the bacterium *Thermus aquaticus*, found in geothermal pools of Yellowstone National Park. This enzyme is used in the polymerase chain reaction (PCR), which allows humans to produce multiple copies of a gene for research.

One of the current leading drugs in the fight against cancer was isolated from the rosy periwinkle, which is found only in Madagascar.

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Preserve Genetic Variation in Populations

Courtship of the Blue-Footed Booby

Genetic variation in populations ensures that some individuals will have the genetic makeup to survive stochastic (unpredictable) events, thus preserving the population. Genetic variation also prevents the emergence of deleterious recessive alleles that might emerge from close relatives mating with each other. Preservation of many genetically varied populations ensures species survival if one population suffers a catastrophic event that destroys the entire population.

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Preserve Genetic Variation in Populations: Ensure Disease Resistance

Pepper Mild Mottle Virus (PMMV)

Plant viruses cause an estimated $60 billion loss in crop yields worldwide each year. This threatens our food security. Having genetic variation ensures that some individuals will be resistant and will survive.

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Preserve Genetic Variation in Populations: Ensure Disease Resistance

Populations of the Tasmanian devil, an Australian marsupial, are currently facing extinction from maxillofacial tumor disease, a type of cancer. Affected devils develop lesions on their mouths and can transfer cancerous cells to other devils during communal feeding. The tumors eventually erode the chewing muscles, and the devil starves to death. Researchers studying the devil predicted extinction within 20 years, but recently, a population of devils resistant to the disease was discovered on the island. Individuals from this population are now being introduced into all devil populations in the hope that interbreeding will transfer the genes, conferring resistance, and the species can be saved from extinction.

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Preserve Food Webs

The loss of any species from a food web disrupts the entire web. Preserving as many species in the web as possible ensures that every species will have another food resource to fall back on if one food resource suffers a population decline. Having an alternative food source also allows a declining population the opportunity to rebound.
Preserve Community Structure

• All species in a community are interconnected—not only in food webs but also in resource partitioning and filling available niches.

• Certain species play profound roles in the community. The loss of these species might significantly alter the habitat, causing other species to also suffer extinction:
  - Dominant species
  - Keystone species
  - Foundation species

• Preserving multiple populations across an ecosystem ensures replacement if one population is extirpated.
Dominant species often affect what other species can succeed in the community. The maple tree—the dominant species in the northeastern United States—provides shade and thereby excludes undergrowth species that would compete with other trees for nutrients.
Keystone species play such a pivotal role in their communities that removal of the keystone species results in the destruction of the community. Keystone species identified by biologists include the starfish of the Philippines coral reef, the sea otter of the northern California kelp forest (pictured at the left), the kangaroo rat of the California desert, and the flying fox of Samoa. These species do not have to be the largest nor the most numerous in the environment.
Preserve Community Structure: Keystone Species

The starfish *Pisaster*: keystone species of the Philippines coral reef. They predate on sea urchins that graze the coral reef, thereby keeping their population size in check.

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Preserve Community Structure: Keystone Species

Flying fox of Samoa: pollinator of 70% of all Samoan plants

Kangaroo rat of southwest United States: excludes other seed-eating rodents

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Preserve Community Structure: Foundation Species

Foundation species are the engineers of ecosystems. Beavers build and maintain dams, thereby maintaining a wetland ecosystem that in turn favors the establishment and maintenance of numerous wetland species.
Preserve Ecosystem Services:
Nutrient Recycling, Waste Decomposition, Water Purification

• Ecosystem services depend on proper ecosystem functioning.

• Ecosystem functioning depends on biodiversity in the ecosystem.

• Therefore, ecosystem services depend on biodiversity in the ecosystem.

• Conservation of biodiversity is critical to the maintenance of ecosystem services (such as pollination by bees).

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Biodiversity: Species Diversity

Biodiversity means many species surviving in an ecosystem. Intact ecosystems are incredibly diverse—so diverse that new species, such as this smoky honeyeater, never before described, are discovered every day by field biologists. However, the rate of species loss caused by human activity greatly exceeds the rate of species loss caused by natural extinction. Species that could provide potential benefits to humans might be lost before scientists even discover the species or discover those benefits.
Threats to Biodiversity

1. Loss of suitable habitat

2. Alteration of suitable habitat

3. Introduction of nonnative species

4. Overharvesting of species by humans
Conservation Problems

• Habitat conservation vs. resource extraction
  - timber and mining

• Habitat conservation vs. human economic gain
  - job and cattle losses

• Habitat conservation vs. human convenience
  - highways and bridges

• Species reintroduction vs. human safety
  - cougar, timberwolf, and grizzly
How Do We Conserve Populations?

In order to conserve populations, years of field research are required to determine critical information about a species:

1. Suitable habitat: Type and area of habitat needed

2. Population size: How many individuals ensure the population’s survival and the maintenance of genetic variation within the population?
   a. minimum viable population
   b. effective population size

3. Reproductive rate and reproductive habits
Population Conservation: Three Approaches

• Small population approach:
  - Focus: Loss of genetic variation among individuals in the population (genetic bottleneck)
  - Extinction vortex
  - Example: Grizzly bears of Yellowstone National Park

• Declining population approach:
  - Focus: Environmental factors that cause population decline
  - Example: Red-cockaded woodpeckers of South Carolina

• Captive breeding/reintroduction into the wild programs:
  - Focus: Raise individuals in captivity and return them to the wild
  - Example: Operation Migration
The concern for small populations is the probability of genetic inbreeding, which leaves the population vulnerable to extinction by stochastic events, such as disease: Few individuals have the genetic makeup to resist the disease. With little genetic variation in the population, the probability is great that all individuals will perish. Continued inbreeding of the surviving individuals leads to less and less genetic variation in each generation, leading to reduced fitness and higher mortality. Eventually, the population is extirpated—if not by a stochastic event, then by its own reduced fitness (deleterious recessives) emerging through inbreeding.
Declining Population Approach Example:
Red-Cockaded Woodpecker, Southeast United States

The red-cockaded woodpecker plays a vital role in the intricate web of life of the southern pine forests.
Declining Population Approach Example: Red-Cockaded Woodpecker – North Carolina

Carole Copeyon, Jeffrey Walters, and Jay Carter of North Carolina State University conducted experiments on populations of the endangered red-cockaded woodpecker to identify factors responsible for the decline in woodpecker populations. This research discovered that the red-cockaded woodpecker has specific habitat requirements and a social structure that strongly impacts successful reproduction.

Habitat requirements: The red cockaded woodpecker nests in mature pine forests. Unlike other woodpeckers, which build their breeding cavities in dead trees, the red-cockaded woodpecker builds its nest in living pine trees, drilling small holes around a central breeding cavity. Pine sap seeps from the smaller holes and repels predators that might otherwise eat the woodpecker eggs. Additionally, the red-cockaded woodpecker requires a habitat with low undergrowth, facilitating its flight to and from the breeding cavity. When young woodpeckers disperse to a new suitable habitat, they require several years to excavate new breeding cavities before they can produce their first clutch.
Declining Population Approach Example: Red-Cockaded Woodpecker – Southeast United States

A rare bird, the red-cockaded woodpecker lives only in mature pine forests in the American southeast. Like most woodpeckers, it pecks on wood, but its tastes are somewhat more specific than most varieties. It seeks out only living pines with red heart disease, a fungus that affects the tree’s heartwood, in which it excavates nesting holes, drilling smaller holes to drain pitch. Groups usually breed in loose colonies in stands of tall pines, reusing their nests from year to year.

The specificity of the bird’s breeding habitat makes it extremely vulnerable to habitat loss. Red heart fungus was once common in trees at least 70 years old, but most pines are cut before they reach that age, resulting in a shortage of nesting sites. Fire prevention and suppression policies have also negatively impacted the species, allowing underbrush to clog the open forests it prefers. Consequently, conservation efforts have focused on the installation of artificial cavities for nesting and controlled burns.
Red-Cockaded Woodpeckers: Vulnerable to Habitat Loss

Social structure: The reproduction of red-cockaded woodpeckers is limited by the number of available breeding cavities. Only those mated pairs that acquire an appropriate tree and successfully excavate a breeding cavity will reproduce. Adult birds without breeding cavities of their own assist their parents in feeding the offspring. These nonbreeding older siblings are called “helpers at the nest,” and raising the young successfully depends on having several helpers at the nest. Eventually, a helper will inherit the breeding cavity when its parents die and then be able to breed on its own.

Suspecting the importance of this social structure in reproduction, the North Carolina State University researchers constructed breeding cavities in unoccupied suitable habitat at 20 sites. Woodpeckers colonized 18 of the 20 sites, supporting the hypothesis that breeding cavity availability limits the reproduction of this species.

For more information go to: http://www.nature.org/newsfeatures/specialfeatures/animals/birds/red-cockaded-woodpecker.xml
Declining Population Approach Example: Red-Cockaded Woodpecker

Conclusion: A management program combining excavation of breeding cavities and periodic burning to control undergrowth resulted in the successful re-establishment of red-cockaded woodpecker populations in unoccupied suitable habitat. The populations rebounded to the point where the species is no longer endangered.
Captive Breeding/Reintroduction into the Wild Example: Operation Migration

Operation Migration is a joint Canadian/U.S. program that reintroduces populations of endangered migratory birds into the wild in new locations. Beginning with the nonendangered Canada geese, ultralight pilots trained captive-raised birds to follow an ultralight, leading the birds on their first autumn migration to reserves in the southern United States. After success with the Canada geese, the team moved on to train sandhill cranes. Also not an endangered species but a close relative of the team’s primary target is the highly endangered whooping crane.

Only one breeding population of whooping cranes existed in the wild when this program began. Operation Migration has successfully established additional breeding populations of migratory whooping cranes in new locations, thus helping the species avoid extinction. Operation Migration was profiled on the TV news program 60 Minutes and was dramatized in the movie Fly Away Home. Learn more about Operation Migration on its website: http://operationmigration.org.
Captive Breeding—A Success Story: The Cheetah

In the early 20th century, the cheetah population declined to only 35 individuals. Through the captive breeding program of the San Diego Zoo, cheetahs were successfully raised in captivity and reintroduced into the wild. Because of the genetic bottleneck the population suffered, all cheetahs alive today are virtually identical genetically.
Sumatran Tiger: *Panthera tigris sumatrae*

- Smallest subspecies of tiger
- Critically endangered, with maybe less than 500 left in the wild
- Difficult to study
- Elusive
- Live in dense jungles
- Avoid people

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Borneo Rhino

• Only 25–50 Borneo rhinos, a subspecies of the critically endangered Sumatran rhino, are thought to exist. They are found in the interior Heart of Borneo forests of Sabah, Malaysia.

• Rhino monitoring and protection efforts are aimed at conserving and boosting the number of Sumatran rhinos in Sabah through the prevention of poaching, securing habitat from further degradation, and illegal encroachment.

• Two still photographs have been taken of this endangered species.

• One video image was captured: http://www.youtube.com/user/wwf#p/u/1/td-VIaKTwZk.
• Grizzly bears (*Ursus arctos horribilis*) once roamed most of the North American continent.

• Habitat destruction and direct conflicts with humans have reduced their range by 99% in the lower 48 states. In 1975, grizzly bears were listed as threatened under the Endangered Species Act.

• Researchers wanted to collect DNA to have an accurate census.

For more information: http://www.nrmsc.usgs.gov/research/NCDEbeardna.htm
How Do You Collect Grizzly Bear DNA Without Harming Them?

Bear hair sampling can yield enough DNA to identify individuals and gender. To collect bear hair, the researchers set up hair snags and identified trees the bears used for scratching.

See a video of the grizzly bear DNA study: http://www.youtube.com/watch?v=3XJnCe73o28
Researchers believe there are about 765 bears in northwestern Montana.

The result was the most accurate and precise census of a bear population to date, bear experts said.

Researchers also found evidence that the population has been growing in size and expanding its range.

Its diversity resembled that of grizzly bear populations in pristine habitats.

“All the things people have been doing are making a difference,” said Chris Servheen, the service’s grizzly bear recovery coordinator. “This gives us some feedback that the bears are doing really well. This was an investment in the recovery of an icon of the American West, which is the grizzly bear.”
Yellowstone National Park

Yellowstone National Park, established by the U.S. Congress and signed into law by President Ulysses S. Grant on March 1, 1872, is a national park located primarily in the U.S. state of Wyoming, although it also extends into Montana and Idaho. Yellowstone was the first national park in the world and is known for its wildlife and its many geothermal features, especially Old Faithful Geyser, one of the most popular features in the park. It has many types of ecosystems, but the subalpine forest is dominant. This is one of the most studied places in the world and offers many examples of wildlife conservation.
Top Predators at Yellowstone National Park

The top predators were mountain lions (top right), bears (bottom left), and wolves (bottom right). Through predator control by 1930, there were *no* more gray wolves or mountain lions (they left the bears alone).
In the absence of a top predator, a dramatic increase in the number of herbivores was observed, which led to the overgrazing of cottonwood and willow. This led to a loss of habitat for other species, such as beavers. Coyotes tried to fill the niche but are too small to take down elk. Coyote predation/competition led to a major decline in the red fox.

Implications: Gray wolves were a keystone predator in Yellowstone National Park.
Wolf Restoration at Yellowstone National Park

• The idea of wolf reintroduction was first brought to Congress in 1966 by biologists who were concerned with the critically high elk populations in Yellowstone.

• A major controversy ensued over whether to bring back wolves to Yellowstone—ranchers feared that wolves would eat their livestock.

The Wolf Restoration Project:
• 1995: 14 wolves reintroduced from Canada
• 1996: 17 more wolves reintroduced (to ensure enough genetic diversity to survive)
Radio Collars on Wolves

- The reintroduced wolves were fitted with radio collars to track their movements in and out of Yellowstone.

- This was necessary for monitoring the population and determining if the project was successful.

- Today, park biologist only radio-collar half the pups born and the alpha (dominant) males and females within a pack.
Goals of the Recovery Program

- The minimum recovery goal was 30 breeding pairs and at least 300 wolves for three consecutive years.

- This was attained in 2002 and has been exceeded every year since.
Problems for Wolves

• In the summer of 2005, about 40% of the northern Yellowstone Park–area wolf population died from canine parvovirus.

• Currently, the wolf populations in the lower 48 states is about 5,500 individuals (Montana, Idaho, Wyoming, and Wisconsin).

• Interpack conflict has lead to the death of some wolves:
  - via ranchers outside Yellowstone
  - illegal shooting of wolves by people outside Yellowstone
    (in October 1995, one alpha male was shot)
Overgrazing by Elk

• Without the wolves, the elk dramatically increased in number and saw a decease in abundance and distribution of aspen, cottonwood, and willows in the winter range of elk.

• After the reintroduction of wolves, researchers had a rare opportunity to study the responses in the food chain.

• For scientific articles, go to: http://www.cof.orst.edu/cascades/articles.php.
Implications of Wolf Reintroduction

• The project was considered successful because the wolves thrived and kept the herbivore population down, and there was a re-establishment of vegetation, such as cottonwood and willow, in high predation risk sites.

• Researchers are now starting to view predators as part of a naturally functioning ecosystem.

Wolf Reintroduction on Yellowstone Biodiversity

The reintroduction of wolves has increased biodiversity within Yellowstone National Park:

• An increase in new-growth vegetation, such as aspen and willow trees, has occurred.

• The beaver and red fox have also recovered—probably due to the wolves keeping coyote populations under control.

• Scavengers have also benefitted.
Gray Wolves: Off Endangered Species List

• Gray wolves were removed from the list of threatened and endangered species in the western Great Lakes, including Wisconsin, and portions of the northern Rocky Mountain states.

• An estimated 1,500 wolves now roam Idaho, Montana, and Wyoming.

• Plans submitted by Idaho, Montana, and Wyoming indicate that the states will likely maintain between 900 and 1,250 wolves for the foreseeable future.
The Wisdom of Stewardship

• Reforming policies that lead to declines in biodiversity

• Addressing the needs of people whose livelihood is derived from exploiting wild species

• Promoting more research on biodiversity