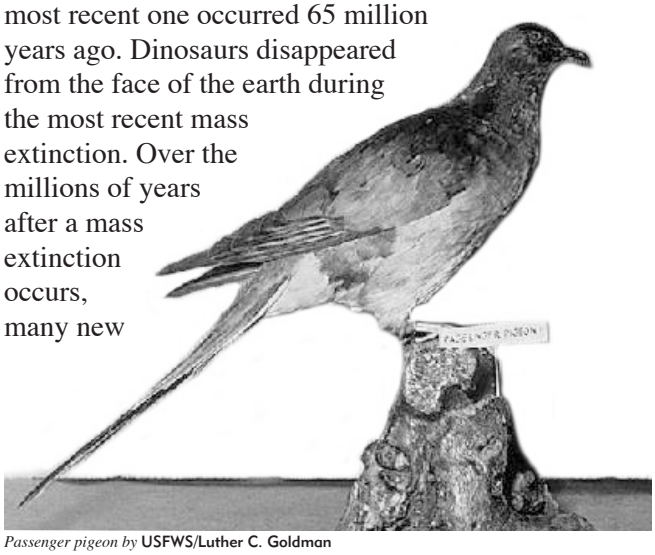
Process of Extinction

When we envision the natural **environment** of the past, one thing that may come to mind are vast herds and flocks of a great diversity of animals. In our modern world, many of these herds and flocks have been greatly diminished. Hundreds of **species** of both plants and animals have become extinct. Why?

Extinction is a natural process. A species that cannot adapt to changing environmental conditions and/or competition will not survive to reproduce. Eventually the entire species dies out. These extinctions may happen to only a few species or on a very large scale. Large scale extinctions, in which at least 65 percent of existing species become extinct over a geologically short period of time, are called **"mass extinctions"** (Leakey, 1995). Mass extinctions have occurred five times over the history of life on earth; the first one occurred approximately 440 million years ago and the most recent one occurred 65 million years ago. Dinosaurs disappeared from the face of the earth during the most recent mass extinction. Over the millions of years after a mass extinction occurs, many new varieties of species begin to inhabit **niches** that were left empty by the disappearance of other species. In 1859, in his book "The Origin of Species," Charles Darwin wrote that "the appearance of new forms and the disappearance of old forms...are bound together."



Passenger pigeon by USFWS/Luther C. Goldman

Currently, the world is facing another mass extinction. However, as opposed to the previous five events, this extinction is not caused by natural, catastrophic changes in environmental conditions. This current loss of **biodiversity** across the globe is due to one species — humans. **Wildlife**, including plants, must now compete with the expanding human **population** for **basic needs** (air, water, food, shelter and space). Human activity has had far-reaching effects on the world's **ecosystems** and the species that depend on them, including our own species.

- The population of the planet is now growing by 2.3 people per second (U.S. Census Bureau).
- In mid-2006, world population was estimated to be 6,555,000,000, with a rate of natural increase of 1.2%. (Population Reference Bureau, 2006).
- The earth is estimated to be losing up to 27,000 species of plants and animals per day (National Wildlife Federation, 2001).
- One out of every 10 plants native to the United States is in danger of extinction. (Center For Plant Conservation, 2004).
- According to **IUCN** (World Conservation Union) Red List categories, the United States is home to 935 species of animals that are listed as critically endangered, endangered, or vulnerable. This includes 41 species of mammals, 79 species of birds, 27 species of reptiles, 53 species of amphibians, 159 species of fish, and 576 species of invertebrates. (World Conservation Union, 2006).

Touch the earth...

Just inside the South Gate entrance at Woodland Park Zoo, you will find an interactive exhibit titled "Touch the earth..." This exhibit, realized through cooperation between Zero Population Growth Seattle and Woodland Park Zoo, includes a population counter, habitat loss counter, interactive computer touch screen and video clips. "Touch the earth..." emphasizes the relationships between rapidly growing human population and decreasing acreage of healthy natural habitat.

ENDANGERED SPECIES LEGISLATI0N

What do we Mean by the Word "Endangered"?

We often read statistics or quotes, similar to those listed previously, that use words like "**endangered**," "**threatened**," "**vulnerable**" and "**rare**" in reference to species of animals and plants. But what do these words actually mean? Who makes the decisions about which species are endangered?

Generally speaking:

- Species that are endangered are in immediate danger of becoming extinct over much or all of their range if no intervention occurs to halt the process.
- Species that are threatened will soon become endangered if no intervention occurs. A threatened species may be in danger of becoming extinct in parts of its range. (Also referred to as vulnerable.)
- Species that are rare are found only in small populations, not in large numbers, but are not believed to be in danger of extinction.

(The Dictionary of Ecology and Environmental Science, 1993)

However, there are many laws and treaties that determine the status of animal and plant species. When a species is referred to as endangered, threatened, vulnerable, etc., the status reference may be to one of these laws or treaties specifically. These documents, as outlined in the following paragraphs, are applicable at different levels of government from international, to national to state.

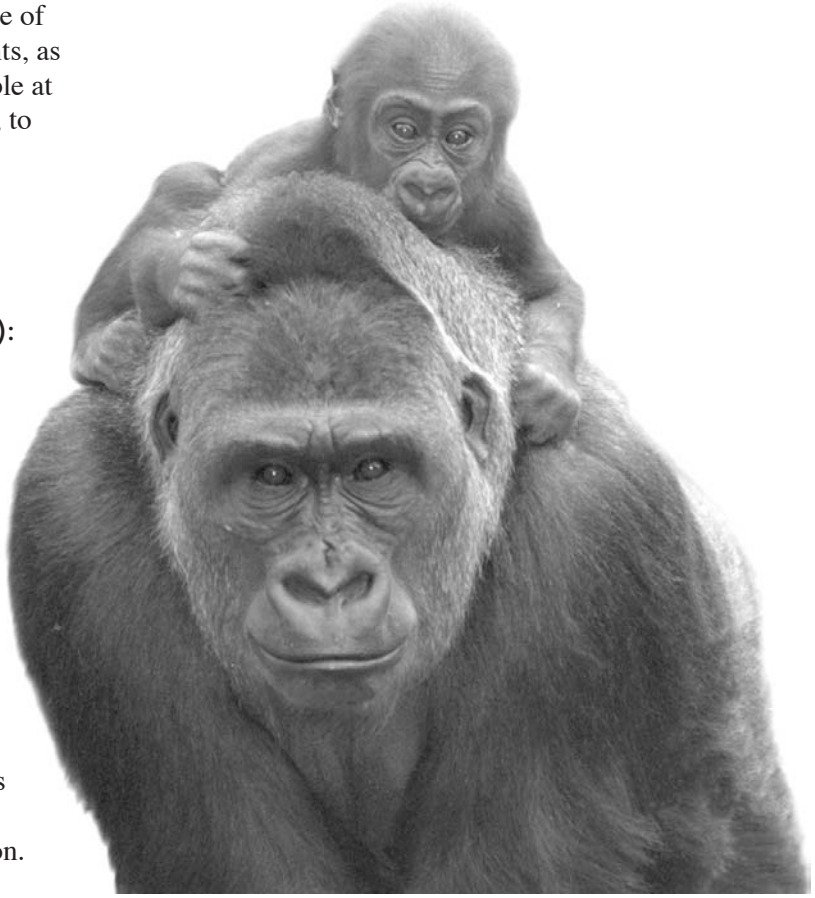
International Treaties on Endangered Species

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora):

CITES is perhaps the most effective conservation treaty in existence. It is an international agreement, drafted by IUCN (World Conservation Union), that came into force in 1975, which as of 2004) has 144 countries party to it. CITES aims specifically at regulating wildlife trade through a worldwide system of controls. The Endangered Species Act is the U.S. law that serves as legislation for the implementation of CITES.

CITES lists species of plants and animals on one of three different appendices: Appendix I lists species for which trade is absolutely prohibited because they are in immediate danger of extinction. Appendices II and III list species for which trade is allowed only if special permits are acquired. The IUCN also publishes Red Lists of data on threatened and endangered species. These lists use categories of endangerment determined by criteria developed by the IUCN. The categories, in order of decreasing threat of extinction, include "Critically Endangered," "Endangered," "Vulnerable" and "Lower Risk."

On CITES appendices and IUCN Red Lists, there are variations in how organisms are listed. Sometimes a species is listed, for example, the gorilla *(Gorilla gorilla)* is listed under Appendix I, meaning all **subspecies** of gorillas are included. Sometimes a higher taxon (such as a **family**) is listed. For example, the lemur family (Lemuridae spp.) is listed under Appendix I, meaning all **genera** and species within that family are included. Sometimes a subspecies is listed. For example, the Asiatic lion *(Panthera leo persica)* is listed under Appendix I, meaning this subspecies, but not other subspecies, is included. Sometimes a designated geographically separate population is listed. For example, the populations of the gray wolf *(Canis lupus)* in Bhutan, India, Nepal and Pakistan are listed under Appendix I, meaning only wolves in these areas and not in others are included. (These variations in listing are also used in national and state legislation.)



Renee DeMartin

Western lowland gorilla

WPZ

African elephant

CITES has been very effective in reducing declines of endangered species by banning trade in animals, plants and parts or products derived from animals or plants. One example of this is the great decline in poaching of elephants when trade in ivory was banned with the listing of African *(Loxodonta africana)* and Asian elephants *(Elephas maximus)* on Appendix I of CITES. However, only countries that have become parties to CITES are affected by CITES requirements. In addition, a country can sign the treaty but take reservations on certain species, thus excusing that country from CITES limitations on trade in those particular species (CITES, Article XV). For example, both Japan and Peru have taken reservations on the Bryde's whale *(Balaenoptera edeni)*, meaning they could hunt these whales and trade them with each other. Or, if a whale was hunted by Peru or Japan in the open ocean beyond any political boundaries, the whale could be brought back to the home country without a CITES permit because the country is not a party to CITES with respect to that species.

National Endangered Species Legislation

The Endangered Species Act (ESA) of 1973:

This act helps ensure the continued survival of endangered and threatened species by regulating United States import, export, and harming of animals and plants categorized as "endangered," "threatened," "candidate" or "species of concern." The U.S. Fish and Wildlife Service (**USFWS**), a branch of the U.S. Department of the Interior, is primarily responsible for the assignment of categories for species and for the enforcement of the ESA. The National Marine Fisheries Service (**NMFS**) is also a governing agency of the ESA and is generally responsible for the listing and protection of marine species, except for sea turtles, which are the responsibility of the USFWS.

If a plant or animal is federally listed as threatened or endangered, the Secretaries of the Interior and Commerce are responsible for developing and implementing a recovery plan for that species. (**Conservation** measures for candidate species and species of concern are recommended but voluntary.) Plants receive less protection under the ESA than do animals. For example, in most circumstances, a private landowner could legally destroy a plant species listed under the ESA found on his or her property, but it would be illegal for him or her to kill or harm a listed species of animal.

One species protected under the ESA is the American burying beetle *(Nicrophorus americanus)*, which was listed as endangered in 1989. This beetle, which has declined steadily throughout the 1900s, is an important recycler of decaying material. Burying beetles locate carcasses of small animals and after burying them, lay their eggs and rear their larvae in the buried body. The American burying beetle has declined due to a number of factors including **habitat fragmentation**, which has resulted in increased competition from other scavengers. **DDT** poisoning and **pollution** (affecting activities of nocturnal insects) have also been cited as threats to burying beetle survival.

Under the ESA, an area of "critical **habitat**" may also be designated for species on the list. Critical habitats, which are areas that are determined to be necessary for the management and conservation of listed species, are also protected from disturbance. This does not, however, dictate the activities of private landholders on their land. Unfortunately, critical habitat has not been designated for approximately 80 percent of species listed under the ESA.

One species for which critical habitat has been designated is the Indiana bat *(Myotis sodalis)*. Indiana bats are found mainly in the eastern United States where they are active during summer nights but hibernate from fall to spring in caves. Indiana bats require specific conditions when they hibernate and use only limestone caves with low, stable temperatures and high, stable humidity. The most serious threat to these bats is disturbance by humans during periods of hibernation. When bats are disturbed during winter, they use precious energy to arouse themselves from hibernation. When this occurs, they often do not have energy reserves left to make it through the duration of hibernation and can die. Due to their specific needs for caves as well as freedom from disturbance during hibernation, several caves have been listed as critical habitat for these bats and measures have been taken to protect these caves.

Between April 1995 and May 1996, a moratorium was placed on funding for the ESA, meaning that no species were added to the list during this time. Though the moratorium has been lifted, many species that are in need of protection are yet unlisted under the ESA, due to lack of funding and/or scientific research. The first species to be listed under the ESA after the moratorium was lifted was the California red-legged frog *(Rana aurora draytonni)*. This large frog, which has declined due to habitat destruction, harvesting and predation by **introduced species**, was listed as threatened in May 1996.

Several species have benefited from the protection of the Endangered Species Act. As of March 2004, over 30 species have been delisted, due in part to successful recovery: American alligator *(Alligator mississippiensis)*, Palau dove *(Gallicolumba canifrons),* arctic peregrine falcon *(Falco peregrinus tundrius)*, Palau fantail flycatcher *(Rhipidura lepida)*, Rydberg milk-vetch *(Astragalus perianus)*, eastern gray kangaroo *(Macropus giganteus)*, red kangaroo *(Macropus rufus)*, western gray kangaroo *(Macropus fuliginosus)*, Palau owl *(Pyroglaux podargina)*, Atlantic coast and eastern Gulf population of brown pelican (*Pelecanus occidentalis*), eastern North Pacific population gray whale (*Eschrichtius robustus*). A current success story is that of the Lange's metalmark butterfly *(Apodemia mormo langei)*. This insect, found in Antioch Dunes National Wildlife Refuge and adjacent lands in Costa County, CA, has benefited from preservation and restoration of its habitat under the ESA. The population of Lange's metalmark butterfly has risen from 172 in 1986, when the recovery program was implemented, to nearly 1,000 by 1998 (Defenders of Wildlife, 1998). This species has not yet been removed from the ESA, but may be a candidate for delisting in the future if it continues to recover successfully.

Lacey Act Amendments of 1981:

Another important federal law that affects trade in wildlife in the United States is the Lacey Act. One of the strongest U.S. laws designed to curb illegal wildlife trade, the Lacey Act not only prohibits interstate commerce of illegally killed animals and prevents importation of **injurious** wildlife, it also prohibits the import of animals or products that were illegally killed, collected or exported from another country. The Lacey Act covers all species protected by CITES.

Other Treaties and Acts:

There is a long list of treaties and acts, such as the Marine Mammal Protection Act of 1972, Polar Bear Treaty (1973) and the Migratory Bird Treaty Act (1918), which extend protection to some species that are not protected under other laws. Animals protected under these additional treaties and acts include seals, walruses, and migratory birds, to name a few.

State Endangered Species Legislation

Many states individually regulate wildlife and wildlife issues. In Washington state, the Washington Department of Fish and Wildlife (**WDFW**) maintains a list of "Species of Concern" in the state, which includes endangered, threatened, sensitive and candidate species. The "Species of Concern" list also includes species listed or proposed for listing by the U.S. Fish and Wildlife Service or National Marine Fisheries Service.

The Washington Fish and Wildlife Commission is made up of nine members, each serving six-year terms, who are appointed by the governor. This commission is the supervising authority for the WDFW. The Commission establishes policies and directions, including the listing procedure, for fish and wildlife species and their habitats. The WDFW implements the goals established by the Fish and Wildlife Commission. The overall goal of the program is the management, recovery and delisting of species of concern.

The Priority Habitats and Species (**PHS**) Program is one of the ways the WDFW accomplishes its goals. Through the PHS program, the WDFW gathers and disseminates information on fish, wildlife and habitat resources in Washington. This information aids government agencies, private landowners, consultants and others in identifying species and habitat types that are priorities for management and conservation. The Priority Habitats and Species List includes all species listed as endangered, threatened, sensitive or candidate in the state and provides criteria for including populations of other species as well as habitats. Eighteen habitats are covered by the PHS list (WDFW, 2004). One priority habitat is stands of aspen *(Populus tremuloides)* greater than two acres in area, which have a high density of diverse species of fish and wildlife and are very vulnerable to habitat alteration.

The Washington Natural Heritage Program of the state Department of Natural Resources collects data about native ecosystems and species. This information is provided to other government agencies; private landowners and firms; and conservation organizations to use to determine protection needs for those ecosystems and species. The Natural Heritage Program produces the list "Endangered, Threatened, and Sensitive Vascular Plants of Washington with Working Lists of Rare Non-Vascular Species" with the purpose of promoting conservation of rare plant species of Washington.

To develop the list of endangered, threatened and sensitive plants, the Washington Natural Heritage Program uses the following status categories: Endangered, Threatened, Sensitive, Possibly Extinct or **Extirpated** in Washington, Review and Watch. Several of the plant species on this list are also listed on the ESA under its status categories. For example, swamp sandwort *(Arenaria paludicola)* is listed as Possibly Extinct or Extirpated by the Natural Heritage Program but as Endangered federally. Washington Department of Fish and Wildlife legislation regarding threatened and endangered species described above does not apply to plant species; however, state, federal and county agencies have consulted the Natural Heritage Program's publication for advice on creating policies to protect rare plants.

What Woodland Park Zoo Means by the Word "Endangered"

So, when we read or hear that a species is "endangered," we may not know which of the above legislative processes is being referred to or if the species is generally in danger of extinction. Sometimes, people may just say that a species is "listed," meaning it appears on either the federal or state list of threatened and endangered species.

There are several international and federal agencies that determine the endangered status of species. WPZ designates a species as endangered if it is listed as endangered on the IUCN (World Conservation Union) Red List, the U.S. Fish & Wildlife Service's Endangered Species List, or on Appendix I of CITES (Convention on the International Trade of Endangered Species of Flora and Fauna).

We may also refer to an animal or plant as "endangered in Washington state," meaning it is listed as endangered by the WDFW (animals) or by the Washington Natural Heritage Program (plants).

Why is Biological Diversity Important?

Biological diversity, or **biodiversity**, is the variety of living organisms inhabiting and interacting in an ecosystem or on the earth as a whole. Biodiversity refers not only to the variety of different species, but also the diversity of genes within a species, and the diversity of ecosystems on the planet. With the current rate of extinction, global biodiversity is decreasing daily. There are many reasons why biodiversity is important. The following are some of the reasons given by individuals or groups for the importance of biodiversity.

Aesthetic Value

Imagine walking into a forest or grassland full of different species of plants and mammals. Take a closer look, and you will find myriad species of fungi, insects, birds and other life forms. Now imagine that same area after most of the species have disappeared. Those who believe strongly in the aesthetic value of biodiversity would insist that the forest or grassland now holds less beauty, magic and appeal. This embodies the aesthetic argument for the preservation of biodiversity. Some ecosystems are more diverse than others, but in all ecosystems there is inherent splendor in the diversity found there and any loss of diversity takes away from that beauty. People who feel strongly about the aesthetic importance of species agree that "the world would somehow be diminished" if one species or another were to disappear (Lampton, 1988). The existence of areas where biodiversity is preserved plays a part in the psychological well being of many people.

Moral Responsibility

Many people would argue that all species on earth have equal rights to their existence. Each species has its niche on the planet and the intrinsic right to continue to inhabit that niche. Thus, it is the moral responsibility of humans to ensure that they do not cause the elimination of any species directly or indirectly. This does not mean that humans must sacrifice the existence of their own species, though some compromises may be necessary. A balance between human interests and those of other species must be reached in order to slow the loss of biodiversity. We share the Earth's ecosystems with a great diversity of species; all of us depend equally on a healthy planet and on each other. So any efforts to

preserve healthy ecosystems for plants and animals will also improve the world for humans.

Species Interrelationships: The Web of Life

All life forms exist in a complex web of interrelationships. The survival (or demise) of one species affects the existence of others. Each species has its role in its ecosystem. Herbivores are dependent upon plant growth for their food and are in turn preyed upon by carnivores. This energy transfer from one species to another is known as a food chain. The environmental disturbance of one species adversely affects not one link, but the entire chain. Chains interlock with other chains forming a complex web of plant and animal life. Thus, any interruption of a chain, due to natural disturbances or caused by human activity, affects the diverse web upon which all of life depends.

Researchers are just discovering that the web of life has been disturbed in the coastal system of western Alaska. Kelp forests, which are underwater nurseries and havens for hundreds of species of fish and other animals, have been decimated recently by a huge boom in the population of sea urchins, which graze on kelp. Sea urchin numbers are up because the population of their main predators, sea otters *(Enhydra lutris)*, has declined in the area. Scientists link the decline of sea otters to the greater incidence of predation on them by orca whales *(Orcinus orca)*, not usually given to preying on otters. The orcas have turned to eating otters due to the great decline of their usual prey, harbor seals *(Phoca vitulina)* and sea lions *(Eumetopias jubatus)*. Populations of seals and sea lions have been vastly reduced since the late 1980s. Nutritional problems are a possible cause of this fall in population. This could be due to overfishing of species relied upon by seals and sea lions, or a rise in ocean temperatures, or a combination of the two (Estes et al, 1998). Therefore, the depletion of kelp forests may be a result of overfishing and/or global climate change.

Medicinal Value of Genetic Diversity

There are many examples of how nature has provided humans with medicines to cure our diseases. Currently, at the end of the 20th century, over 40 percent of all prescriptions dispensed by pharmacies in the United States are derived from organisms (25 percent from plants, 13 percent from microorganisms, and 3 percent from animals) (Wilson, 1992). Surprisingly, however, the chemicals currently used in the medicines derived from plants come from only 41 species of plants! That leaves many thousands of plant species (not to mention animals and microorganisms) out there that may carry chemicals useful in curing human diseases. One new prospect is found in the blood of western fence lizards *(Sceleporus occidentalis)* which inhabit sagebrush lands of the western United States, including Washington state. Something in the blood of these lizards kills the bacteria that causes Lyme disease, which is transmitted by tick bites and can affect the joints, nerves and heart. Scientists hope that they can identify the substance in the lizards' blood that kills bacteria and use it to prevent people from contracting Lyme disease.

Traditional healers across the globe have for centuries been discovering the medicinal properties of native plants, but much of this knowledge has yet to be transferred to the global scientific community. Scientists have analyzed only a very small portion of the chemicals produced by plants for their medicinal value. If the habitats where medicinal plants grow, particularly rain forests, are not protected and taken care of, we will lose potential resources for future cures.

Agricultural Value of Genetic Diversity

The world's agricultural resources, including crops and domestic animals, were derived from wild populations of plants and animals. Over time, we have come to depend on very few species of plants and animals for our food resources. In fact, only 20 species of plants provide 90 percent of the world's food. Only three of these plants, wheat, maize (corn) and rice, account for half of the world's food (Wilson, 1992). Thus, the number of species relied upon by humans for food has decreased. Concurrently, the genetic diversity within these species has decreased due to selective breeding over the centuries. Humans have chosen specific desirable traits in animals and crops, such as quick growth or large size, and bred these species selectively for these traits. Over time, the diversity of the gene pool decreases as each member of the species becomes more and more alike. (See the "Endangered Breeds" section in this packet.)

The biodiversity of the natural world serves as a sort of genetic library to support the crops and animals we have come to rely upon so heavily. Crops and domestic animals that are not genetically diverse are susceptible to disasters such as pests and disease. Bringing new (actually old) genes from ancient, wild relatives of domestic plants and animals into the modern gene pool can strengthen and improve the resiliency of current food resources. An example of this is a species of wild grass related to corn called teosinte *(Zea diploperennis)*, which was discovered in Mexico in 1977. Teosinte is immune or resistant to several viruses that plague

domesticated corn. Genes from teosinte have been bred into domesticated corn in the hopes that the loss of crops to disease will be greatly reduced. Genetic experimenting and other tests are still being carried out, but it is likely that teosinte will prove to be of great value to modern agriculture.

Ecosystem Health

All species, however large or small, together create healthy, working ecosystems. Each species in an ecosystem, including humans, depends greatly on the proper functioning of the entire ecosystem for its own health. Ecosystems that are functioning properly help keep the right mixture of gases in the air, clean water, control floods, create soils, prevent erosion, and dispose of wastes. Vast numbers of species interact to pollinate flowers so that plants can produce fruits and seeds, from which humans and other species derive food. Many species help to decompose organic materials that might otherwise build up in the environment. In the process, valuable nutrients are returned to the soil.

Our modern cultures are, in many cases, based on short-term perspectives. It is often difficult for us to act in the best interests of future generations when we feel that our own needs are not being satisfied in the present. Conservation biologists are coming to realize that, in order to be effective, conservation must benefit people in the short term, while still providing for the future. For example, a farmer living in Haiti had one of only seven known individuals of a certain type of palm growing on his farm. For the farmer, cutting down the tree would bring the greatest benefit in the short term because he would be able to grow food where the tree once stood. To the botanists who came to visit the farmer, however, the tree was highly valuable for the preservation of global biodiversity for generations to come. To satisfy both ends, the farmer and the botanists came to an agreement: a local forester would pay the farmer for the seeds produced by the palm. The local forester could then use the seeds to propagate more palms to increase the chances of the survival of the species (Revkin, 1998). Thus, the farmer received his short-term benefit while local biodiversity was preserved for the long term.

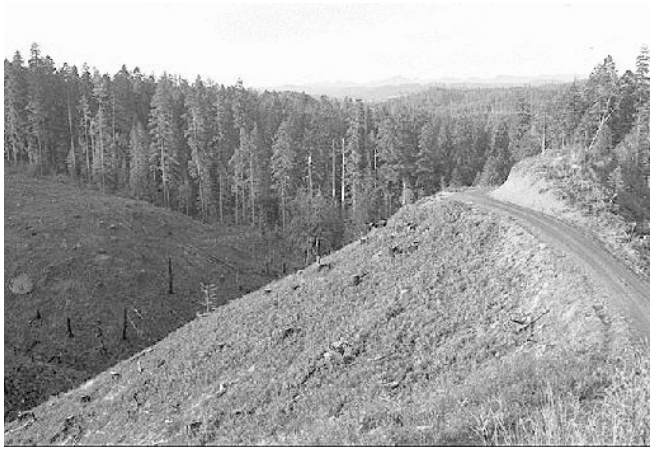
If not for the beauty and pleasure wild things provide for us; if not for their right, as fellow inhabitants, to survive on our planet; if not for the countless benefits humans derive from their presence; we should care about our endangered wildlife, both plants and animals, because there is so little time, and so much to learn.

What is Causing the Loss of Biodiversity?

When we examine the endangerment of species, it becomes clear that there are several main factors affecting the future of biodiversity on earth. **Habitat loss**; competition from introduced species; pollution of air, land and water; and overhunting and overharvesting have all played their part in causing the decline of species. Some species are mainly affected by one or another of these factors, while other species are affected by combinations of factors. Ultimately, human activities and the rapidly expanding human population are the driving forces behind each of these causes of endangerment. By better understanding these problems, we can increase our awareness of our own roles within the systems of life on earth and how to lessen our impact on the world's species.

The Primary Problem: Habitat Loss

As the human population increases, so too does our demand for land for agriculture, homes and businesses. As the land is developed, wildlife is pushed back. Millions of acres of forests and other habitats are destroyed each year to supply the human demand for land. Other threats to habitat include the building of dams for hydroelectric power, mining the land, logging for timber products, suppressing natural fires needed to preserve the prairies, and draining and filling wetlands. All these areas would otherwise support a great diversity of plant and animal species.



Spotted owl habitat loss Steve Hillebrand/USFWS

When a habitat is destroyed, species in that area may cease to exist for lack of access to basic needs. This was true for the northern aplomado falcon *(Falco femoralis septentrionalis)* of the southwestern United States and Mexico. As native grasslands were converted to farmland or overgrazed and replaced with

nonnative brush, the aplomado falcon lost the habitat it depended on for survival. By the mid-1940s aplomado falcons had all but disappeared from the southwestern United States. In 1986 the northern aplomado falcon was listed as endangered under the federal ESA. In the 1990s, aplomado falcons were bred in captivity and reintroduced into Texas where breeding pairs are now successfully raising their young.

Habitat destruction can also isolate populations, decreasing the area of habitat available to the species as well as cutting them off from other populations of their kind. When this fragmentation of habitat occurs, isolated species may be able to adequately satisfy their basic needs, but these small populations may suffer from inbreeding, which can cause harmful recessive genes to be expressed. With the loss of genetic diversity in a small population, the chance of the population being wiped out by an epidemic, a drastic change in the environment or a natural disaster is increased. Populations of species naturally isolated on islands also face similar threats, which are made even more severe by habitat loss. Populations of lion-tailed macaques *(Macaca silenus)*, primates which inhabit the Ghat mountains of southwestern India, have been isolated from one another due to drastic habitat loss resulting from hydroelectric projects, timber operations and clearing for agriculture. Lion-tailed macaques inhabit dense rain forests and are reluctant to cross open areas, such as logged or farmed land. The isolation of small populations in patches has resulted in the loss of genetic diversity and effects such as higher infant mortality have been observed.

John Farrell

Lion-tailed macaque

The loss of habitat is closely tied with global economics and international and national politics. Often, the **indigenous** people whose lives depend upon the habitat in which they live have little control over how the habitat is used or abused. (See the "Endangered Peoples" section in this packet.) As a result of consumer habits, people who live thousands of miles from regions of intense habitat destruction are often participants in that destruction.

Introduced Species

Wildlife habitats have been severely altered by the introduction of **alien**, or nonnative, species. Species have, and continue to be, introduced from one region to another by humans, both accidentally and intentionally. Some plant species first became established as garden ornamentals before they "escaped" into the wild and spread. The increase of trade across the oceans has boosted the number of species that are accidentally taken from one place to another. Aquatic species are often translocated in the ballast tanks (which are filled with or emptied of water to enhance stability depending on the load) of ships. Ships may take on ballast water in one port and discharge it in another port across the ocean, thus introducing numerous coastal marine and other aquatic species. Zebra mussels *(Dresseina polymorpha)*, native to the Baltic Sea, were introduced to the Great Lakes region of the United States in this manner in the 1990s. These mussels reproduce rapidly and have spread widely, threatening native mussel populations. Pest species, such as Asian longhorned wood-boring beetles *(Anoplophora glabripennis)* may be transported from Asia to North America in raw logs. Other species travel along with shipments of fruits and flowers or even in the wheel wells of planes!

Once introduced, species may not survive due to differences between their natural habitat and the new habitat. Some species, however, thrive in their new environments. These introduced species, whether plants or animals, can severely reduce the numbers of native species in the area. Without the natural predators or disease controls found in their native regions, introduced species can proliferate at fantastic rates. Introduced species may prey on native species, alter the natural habitats of the native species, or they may out-compete native species for basic needs.

Either way, the spread of an introduced species leads to the loss of biodiversity. In most cases, this spread is extremely difficult to stop once it has started. This is definitely true of the brown tree snake *(Boiga irregularis)*, which was accidentally introduced from its native range of northern Australia, Indonesia, New Guinea and Solomon Islands to the island of Guam after World War II. The brown tree snake, an adept predator of birds and their eggs, has caused the drastic decline of nine of the 12 species of birds native to Guam. Now dense on Guam, up to 12,000 snakes per square mile in some areas, scientists are concerned about the further spread of the snake, especially to other islands such as the Hawaiian Islands which are home to 41 percent of all endangered birds in the United States (Rillero, 1998). The brown tree snake has already been intercepted six times in association with aircraft coming from Guam to Hawaii, but has not yet established itself on the Hawaiian islands. Hopefully, it never will, or Hawaii's native bird life may become even more endangered.

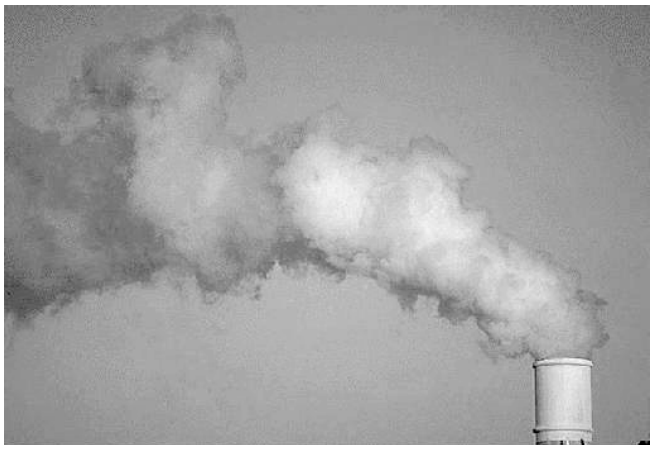
The Animal and Plant Health Inspection Service (**APHIS**), an agency of the United States Department of Agriculture, attempts to prevent the introduction of nonnative agricultural pests and diseases. The efforts of APHIS focus mainly on protecting agriculture, but also serve to prevent ecosystem damage caused by nonnative species and diseases. Other government agencies and nongovernmental organizations are also working together to distribute information and coordinate efforts to prevent the introduction of nonnative species into the United States. In February of 1999, President Clinton signed an executive order which expands federal efforts to address the threat of invasive introduced species and to prevent the future introduction of nonnative species. The Invasive Species Council, created by the order, is working to develop a management plan for invasive species.

Even domestic animals, such as cats and dogs, can have grave effects on native species of wildlife if they are left to roam unrestrained. **Feral** cats, animals that have reverted from domestication to living in a wild state, in Australia have caused the decline in great numbers of species due to predation and competition. Cats were first introduced to Australia in the 1600s and populations of feral cats were well established by the 1850s. It is estimated that Australia has a population of feral cats between 12 and 18 million (the population of feral cats in the United States is approximately 60 million). One genus of animals in Australia that has suffered from predation and competition with cats and other introduced species such as foxes, is the genus *Dasyurus*, or quolls. Quolls are weasel-like, marsupial carnivores which have declined in numbers since European settlement of Australia. The western quoll *(Dasyurus geoffroii)* is listed as an endangered species by the Australian government.

Introduced species of plants and animals have had great impacts on many native species of Washington state. Some nonnative plant species aggressively invade urban habitats and shade or choke out native plant species. Canada thistle *(Cirsium arvense)* is an invasive species that was accidentally introduced from Eurasia to Canada in the 1700s. Mixing cheap seeds in with crop seeds was a common practice prior to the 1900s and many plants, such as Canada thistle, were introduced in this way. Like many other introduced plants, Canada thistle grows aggressively and reproduces very rapidly. Thus, thistle can reduce the abundance of native plants and cause changes in the habitat to which native animals may not be able to adjust.

Pollution: Air, Water and Land

Environmental pollution, the chemical poisoning of air, land and water, poses a major threat to the survival of many plant and animal species, including humans. Carbon monoxide, a reaction product of the combustion of fuels in automobiles, approaches a hazardous level in many of our large cities. Lead, also emitted through car exhaust, ladens the air two or three feet from the ground, where it can be inhaled by small children and by wildlife.

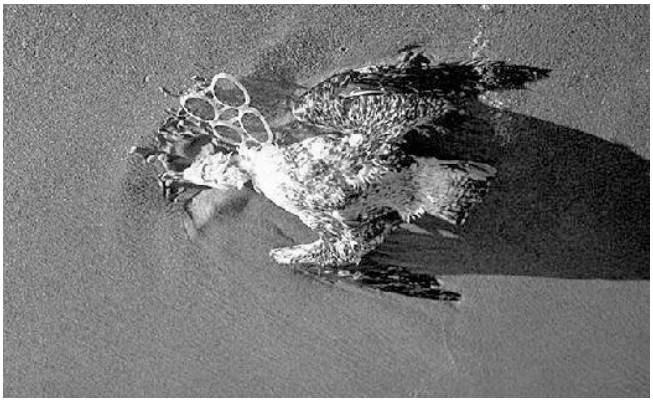


Air pollution USFWS

Coal burning factories release chemicals high into the atmosphere which cause rain falling to the earth many miles away to have a high acid content. This can cause harm to trees as well as polluting water sources relied upon by a variety of species. As various gases (CO^2, CFCs, methane, etc.) form an increasingly large blanket around the earth, sunlight reaches the earth's surface, but heat is prevented from escaping, thus causing global warming. Global warming can

result in increased global air temperatures and extreme weather patterns. The results of global warming affect many species in different ways. Marine species, such as corals, that are best adapted to certain ocean temperatures, suffer as temperatures of the ocean rise with rising air temperatures. Polar bears *(Ursus maritimus)* in Canada's Hudson Bay have already shown signs of the negative effects of global warming. Here, polar bears spend the summer on land, fasting until the water freezes over and they can go out on the ice hunting for seals. As global warming increases, the ice may take longer and longer each year to freeze over, or may melt early thereby prolonging the fasting period of the bears. Scientists have already documented declining reproductive rates in female bears in the region as well as declining survival rates of the cubs. The scientists believe that these declines may be due to global warming.

Chlorofluorocarbons **(CFCs),** halogens and other man-made chemicals are destroying the fragile, invisible layer of ozone (O^3) shielding the earth's surface against ultraviolet radiation. As ozone diminishes and more UV light penetrates the earth's atmosphere there is the potential for crop yields and wildlife populations to be reduced and for tremendous human health problems (like cancer) to occur.



Gull strangled by plastic P. Martinkovic/USFWS

Sources of water pollution include the industrial dumping of chemicals such as polychlorinated biphenyls **(PCBs),** a by-product of the manufacture of electrical equipment, paints, and plastics. PCBs are known to cause deformities in terns and other water birds and interfere with reproduction in fish. Each year, billions of gallons of liquid nitrogen fertilizer are applied to crops in this country and much of it eventually runs off into our lakes and rivers. Fertilizer causes algae and water weeds to grow rapidly. As these die and decay, they consume the oxygen in the water. This results in aquatic habitats that can no longer support fish, amphibians and reptiles. Ocean dwelling species such as fish, water birds, and sea otters are particularly vulnerable to pollution caused by major oil spills. The heavy oil slicks coat the water's surface, the feathers of water birds, and the fur of marine mammals rising to the surface to breath. Eventually, the oil washes up on shores, making the shores uninhabitable for wildlife. These oil-covered shores are unsightly and hazardous to humans as well as expensive to clean.

To maximize agricultural production and eliminate competition, farmers wage chemical warfare on insects. By the 1950s, chlorinated hydrocarbon **pesticides** such as DDT were sprayed in massive quantities, both for actual insect infestations and as a preventive measure. In the northeast, DDT was extremely effective in reducing the gypsy moth *(Lymantria dispar)* population; at the same time, however, it eradicated moth-eating birds. With no natural predators, succeeding generations of gypsy moths flourished. At the top of the food chain, predatory birds such as peregrine falcons *(Falco peregrinus)* and bald eagles *(Haliaeetus leucocephalus)* ingested highly concentrated forms of these chemical toxins. DDT affected the birds' ability to metabolize calcium, resulting in thin eggshells that broke or desiccated during incubation. These birds faced extinction until the use of DDT was banned in the United States in 1973. However, DDT is still produced and exported by the United States and still used in other countries. Many other chemicals used in agriculture pose further threats to biodiversity.

Chemicals have also been used in the elimination of predators. Predators such as eagles and coyotes, much maligned as nuisances to sheep ranchers, have been systematically poisoned. The poisons can also inadvertently harm other species. Furthermore, the predators serve an extremely useful role by regulating rodent and other herbivore populations. The elimination of these predators therefore can cause an increase in the numbers of rodents and other species, which could cause damage to agricultural resources as well as native habitats. This creates an ongoing cycle as more pesticides may then be used to combat the growing "pest" populations once their predators are eliminated.

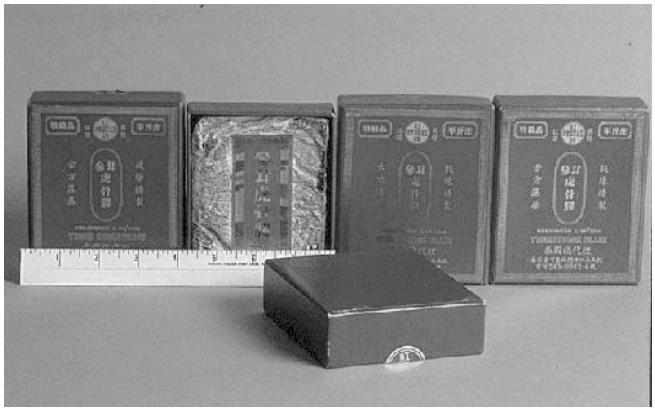
In addition to chemical pollution, excessive noise, light and heat can pollute ecosystems. For example, migratory patterns of birds and nocturnal activity of arthropods can be disrupted by excessive light generated by cities at night. Hot water released from industries into normally cold rivers can increase the temperature of the water beyond the survival range of species inhabiting the area.

Though it may seem that much of the pollution in our

world today is the result of large-scale industries, every individual contributes to some degree to the problem. By being pollution-conscious citizens and consumers we can help to decrease our own impacts on the environment.

Overhunting and Overharvesting: The Illegal Wildlife Trade

Plants and animals provide humans with necessities such as food, medicine and basic materials. Hunting and harvesting of species are both part of the natural balance of an ecosystem. However, when hunting and harvesting proceed unrestricted, especially in conjunction with rapid human population increase, these activities can become unsustainable. **Overhunting** and **overharvesting** can quickly result in the endangerment of plant and animal species.



Tiger bone glue USFWS

Animal parts and products are prized for their mystical or believed medicinal powers or as exotic souvenirs for the collector. White rhinoceroses *(Ceratotherium simum)* and black rhinoceroses *(Diceros bicornis)* have both suffered greatly from poaching due to demand for their horns. Rhinoceros horn is used as a remedy for headaches and the flu in Asian countries, as well as an aphrodisiac. Tigers and bears throughout the world also face similar problems due to poaching for use in traditional medicines. Rhino horn is also highly valued in the Persian Gulf states for making dagger handles. The demand for dagger handles once accounted for half of the illegal trade in rhino horn. However, tougher trade laws and the use of substitutes such as plastic and buffalo horn have resulted in a decline in this market (Wiese and Hutchins, 1994).

Elephants, too, have been heavily poached for their valuable ivory tusks, which were made into jewelry, artifacts and piano keys. Elephant populations decreased drastically in the 1980s. As a result an international trade ban on ivory was enacted in 1989 when African elephants *(Loxodonta africana)* were placed on Appendix I of CITES. Since the ban, poaching of elephants has greatly declined. However, there is continuing pressure to remove the ban on ivory. Some countries, such as Botswana, Namibia and Zimbabwe, have large populations of elephants. For these countries, the sale of some surplus ivory stocks would benefit conservation by raising significant funds for conservation projects. In June of 1997, the populations of elephants in these three countries were transferred from Appendix I to Appendix II of CITES. The conditions of this transfer state that, as of March 18, 1999, Botswana, Namibia and Zimbabwe are allowed to export limited amounts of raw (unworked) ivory to Japan.

Perhaps the most widespread exploitation of **exotic** animals has evolved from the human desire for adornment. In the 1800s, birds such as egrets, spoonbills, pheasants, hummingbirds, birds of paradise and herons were slaughtered by the hundreds of thousands to provide feathers for the millinery (hat) designers. This practice was banned in 1877 in Florida and Congress followed suit in 1913 by declaring the import of bird plumes illegal. The fashion trend turned to hides and furs. Tigers, leopards, cheetahs and other animals are still hunted for their beautiful fur. It takes eight leopards to fashion one coat and 20-30 pelts from a smaller spotted cat for the same garment. Although the United States banned the importation of these furs in 1972, fur coats are readily available in overseas markets. Reptile hides are much in demand for the manufacture of handbags, shoes, belts, cowboy boots, wallets and other accessories. Crocodilians are particularly threatened, as are sea turtles. Sea turtles are prized not only for their leather; their shells are made into jewelry, their meat is considered a delicacy, and their oil is used as a cosmetic base.

Some species of arthropods, such as butterflies, and plants are often collected by enthusiasts. Coupled with other threats, such as habitat loss, collecting can have significant impact on populations, especially on species with small populations. Mitchell's satyr butterfly *(Neonympha mitchellii mitchellii)*, which inhabits marshy prairie regions of southern Michigan and northern Indiana, is one species of arthropod that has become endangered in large part due to over-collecting. This species was added to the federal list of endangered species in 1992.

Eight species of whales are endangered yet they are relentlessly pursued for their oil, blubber, meat, teeth and ambergris (a product used in the cosmetic industry as a fixative for perfumes). Other popular scent fixatives include castoreum taken from beavers *(Castor canadensis)* and musk extracted from the abdomens of male musk deer *(Moschus moschiferus)*.

Effective synthetic alternatives for these products, mainly by-products of the petroleum industry, are available.

Exotic Pets and Plants...Why Not?

Exotic pets have always been popular. In fact, many zoos originated as private collections. However, the increase in the exotic pet trade is now having significant impacts on wild populations. Unfortunately, many animals do not survive the transfer from the wild to captivity. An estimated one in 10 captured birds makes it from treetop to captivity. This means that, for every wild-caught exotic bird in captivity, approximately nine others of its kind died somewhere along the way. For monkeys the figure is closer to one out of 20. In order to obtain young animals that can be sold as pets, adult animals are often killed. People who keep the animals during their transfer often cannot provide them with adequate food, shelter or space, leading to many unnecessary deaths. Live animals are often transported illegally and must be smuggled in small, oxygen-deprived spaces such as suitcases. Reptiles and amphibians captured for the pet trade face a similar plight. Many countries ban the exportation of certain wild animals, yet dealers manage to smuggle them out. Over 99 percent of the estimated 5 million marine fish traded annually are not captive-bred but are taken from the sea. In addition to fatalities related to capture and transport, millions of monkeys, parrots, coral reef fish and other animals die in captivity from inadequate care because even the most conscientious pet owners may be given misinformation or do not obtain proper care information about these exotic pets.

Seized shipment

Steve Hillebrand/USFWS

If you are considering buying a pet, it is wise to choose a traditional pet, such as a dog, cat, hamster or rabbit. If you intend to purchase an exotic pet, make sure that the animal was born in captivity in this country. Pet stores should be able to provide you with documentation showing that animals were bred in captivity. It is also advisable to research the life span and care needs of potential pets so that you fully understand the responsibility and time commitment that will be required if you obtain a pet. Many species, such as parrots and reptiles, can be extremely long-lived and the decision to obtain such a pet should be carefully considered.

Currently, over 90 percent of all mammals and 70 percent of all birds in North American zoos were captive bred (Wiese and Hutchins, 1994). Zoos have improved methods of successfully breeding animals, including reptiles and insects, in captivity, thus decreasing the need to take animals from the wild. In some situations, critically endangered animals are taken from the wild, bred in captivity, and then individuals are released back into the wild in an attempt to save the species from extinction. The Arabian oryx *(Oryx leucoryx)* and the peregrine falcon *(Falco peregrinus)* are two species for which captive breeding and then reintroduction have been successful.

Animals are not the only wildlife threatened by trade; plants, too, have entered trade in remarkable quantities. Yet we know less about the effects of trade on commercially valuable plants than we do about its effects on animals. While many species of orchids, cacti and other familiar houseplants are propagated artificially, excessive collection threatens thousands of rare and beautiful wild plants. Many plant species are in danger of extinction and receive protection under U.S. law, including many cycads, orchids and cacti.

It All Comes Down to Human Activity and Population Growth!

Look carefully at the causes of endangerment described above. You will notice that each one is intrinsically tied to human activity. Needless to say, the impacts of human activity on biodiversity increase as the human population of the world increases. If the birth rate is greater than the death rate of a population, the population increases. With the onset of agriculture and the domestication of animals approximately 10,000 years ago, the human population began to grow steadily (Tesar, 1992). Since the Industrial Revolution, which occurred between 1760 and 1830, the human population has been growing at an extremely fast and ever-faster pace. Improvements in medical care have increased human survival and life span, also contributing to the increase in human population. If we are not conscious of the relationship between human population growth, consumption patterns and the problems facing endangered species, we will not be capable of being part of the solutions.

Suitcase for Survival

The United States is a major importer of wildlife pets and products from around the world, many of which enter the country legally. However, many wildlife shipments are imported and/or exported illegally. Wildlife products originating within the United States are also a component of domestic and international trade. Due to limited law enforcement personnel, customs officials are unable to check every single shipment or piece of luggage that enters and leaves the country. This illegal trade in wildlife pets and products is a contributing factor in the current extinction of species. There are many laws, treaties and monitoring systems, which attempt to regulate this trade, in effect. But laws and law enforcement alone cannot control the depletion of species through illegal trade. Since the demand for these products is so great, poaching and smuggling are financially worth the risk to some individuals. By becoming informed, consumers can avoid becoming (or stop being!) a part of the problem for animals and plants affected by trade.

Confiscated, illegal wildlife products often end up in storage in various USFWS facilities around the country. The wildlife items in storage include products such as mounted trophies, elephant ivory tusks, stuffed sea turtles, shoes and other leather goods made from snake, crocodile or lizard, and a wide variety of tourist souvenirs fashioned from an astounding array of wildlife. Many of these items were seized from tourists returning from abroad who purchased them without realizing it is illegal to bring them back into the United States. Others came from commercial shipments destined for places such as department stores. Still others were confiscated from people attempting to smuggle them into the United States. Some of the wildlife items kept in storage are eventually lent or donated to schools, zoos and other institutions for use in displays or for other educational purposes. However, many of the products may remain in storage or be destroyed.

In order to educate people about the product trade, the U.S. Department of the Interior, World Wildlife Fund and the American Zoo and Aquarium Association (**AZA**) collaborated to produce a wildlife trade education package, the *Suitcase for Survival*, for distribution to zoological parks in key U. S. cities. Each suitcase contains wildlife products, several examples of substitutes for the "real thing," background information, slides, and activities. *Suitcase for Survival* is targeted for grades 6 to 8 but the slide program and activities can be modified to fit the age and needs of most classes.

Suitcase for Survival provides a hands-on way to show young people that what they buy can make a difference in saving endangered species. When given proper information, people can make wise consumer decisions. We do not want students to get the impression that it is wrong to use wildlife under any circumstances. Rather, the aim is for students to understand the concept of sustainable use and learn the importance of proper management and wise use of wildlife.

Once students have the facts about wildlife trade, they can exercise their ability to choose! When considering the purchase of a wildlife item or pet, they can choose to buy it if they are sure it entered the country legally, was captive-bred, or is not harmful to wildlife populations. They can also decide to buy a substitute or they may choose not to buy anything at all.

Suitcase for Survival, including the teaching kit and slides, can be checked out from Woodland Park Zoo after completing *Suitcase for Survival* training sponsored by Woodland Park Zoo.

Confiscated endangered species products Steve Hillebrand/WSFWS

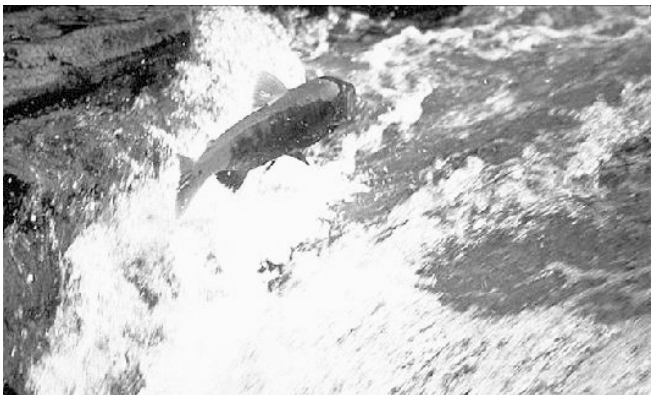
Washington State Endangered Species

The problems of habitat destruction, introduced species, pollution, hunting and harvesting, and population growth which are accompanied by the decline and extinction of animal and plant species are not limited to other parts of the world. The influx of people into the Northwest in recent years has resulted in increased pressures on habitat and wildlife. Washington state currently (2004) lists 25 species of animals as endangered and 11 species as threatened. Approximately 20 species of plants are listed as endangered and almost 50 species of plants are listed as threatened by the Washington Natural Heritage program.

The pygmy rabbit *(Brachylagus idahoensis)* of eastern Washington's shrub-steppe region in the Columbia Basin prefers areas of dense sagebrush where the soil is soft enough to dig burrows. This type of habitat has largely been converted to agricultural uses. Sagebrush removal and overgrazing by livestock have also contributed to this species' decline — pygmy rabbits are now found in only five locations within one county. The current population of pygmy rabbits is estimated to be approximately around 30 individuals (Washington Department of Fish and Wildlife, 2004). This species is listed as endangered in Washington state. Native plants of the shrub-steppe region have also suffered from habitat destruction such as Jessica's aster *(Aster jessicae)* and Umtanum desert buckwheat *(Eriogonum codium)*, which are listed as endangered by the Washington Natural Heritage Program. In fact, more plants listed as threatened or endangered by Washington state are found in the Columbia Basin region than in any other region of the state (Washington Natural Heritage Program, 1997).

The snowy plover *(Charandrius alexandrinus),* which nests only on coastal sandy or gravelly beaches and spits, is limited to only two known breeding sites in the state due to the impacts from coastal development and beach stabilization projects (Washington Department of Fish and Wildlife, 1998). This bird is listed as endangered in Washington state. The beach stabilization projects, which have been implemented since the early 1900s, involve the introduction of European beach grass *(Ammophila arenaria)*. The beach grass spreads rapidly and has altered the dune habitat in such a way that the habitat has become unsuitable for nesting plovers. Plovers are also vulnerable to disturbance from humans walking through the nesting area or vehicles driving on the beach. The birds are easily flushed from their nests exposing their eggs to predation from gulls and crows.

As of 2004, the National Marine Fisheries Service has listed five distinct groups, or Evolutionary Significant Units (**ESUs**), of Pacific salmon and steelhead found in Washington state under the Endangered Species Act. Six populations of Pacific salmon and steelhead found in Washington had already been listed under the ESA prior to 1999. The ESUs listed as threatened as of 2004, include Puget Sound chinook, Lower Columbia chinook, Hood Canal summer run chum, Columbia River chum, Middle Columbia River steelhead and Ozette Lake sockeye. Only one of the ESUs added in 1999, is listed as endangered — Upper Columbia River spring run chinook. (See the "Species of Concern in Washington" list in this packet for a full listing of threatened and endangered species of Washington state.) These new listings (and others affecting Portland, Oregon) are milestones in that this is the first time federal protection has been extended to salmon in heavily populated areas of the Pacific northwest. The primary threat to salmon in this region is habitat destruction, mainly through deforestation and the building of dams. However, the daily actions and choices of individuals living in the Pacific northwest also affect the survival of salmon. It is hoped that these listings will encourage successful salmon conservation efforts in the region.



Salmon USFWS

An endangered species success story is that of the gray wolf *(Canis lupus)* in the North Cascades. The wolf was essentially eliminated from the state by the 1920s as a result of trapping for pelts and predator control. Recently, near the end of the 1900s, adult wolves and pups have been documented moving south from British Columbia into the Selkirk mountains of northeastern Washington. The gray wolf is listed as endangered in Washington state. During the summer of 1998, researchers from Woodland Park Zoo detected the presence of wolves in the Okanogan National Forest. The presence of the wolves was verified by

analyzing **DNA** from samples of the wolves' scat, which was found by dogs specially trained to sniff out feces of wildlife (see the section "What Woodland Park Zoo Is Doing To Help Endangered Species" in this packet). If human interference can be kept to a minimum, the gray wolf may have a chance at survival in our state.

The Case of the Western Pond Turtle

(Note: This information is included in the "Endangered Species School Program," for grades 5 and up, at Woodland Park Zoo. Students play the part of environmental investigators attempting to uncover the factors that have led to the endangerment of the western pond turtle. If your class is scheduled to come to the program, please refrain from covering the information given in this section until after your students have participated in the program.)

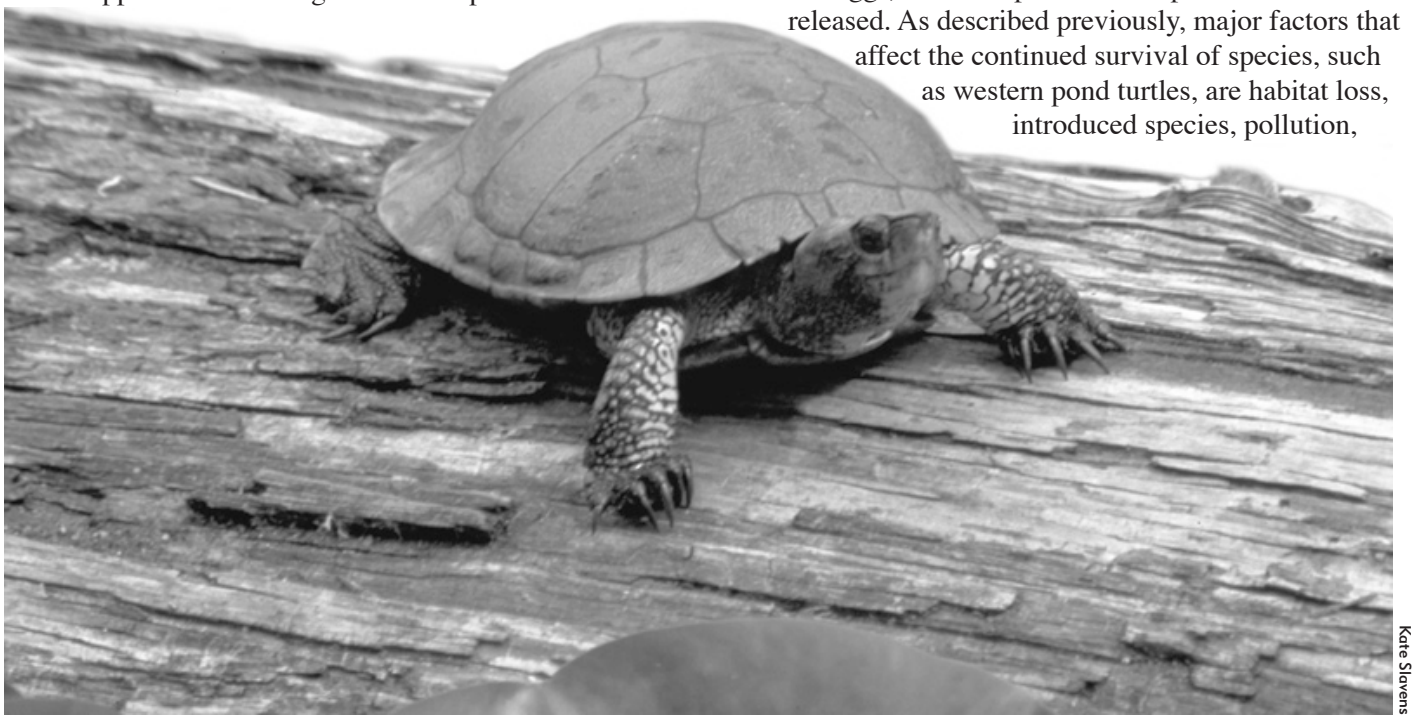
The history of the endangerment of the western pond turtle *(Clemmys marmorata)* provides examples of common threats to the survival of species of plants and animals. By examining how western pond turtles became endangered, we can come to better understand threats faced by animals and plants worldwide.

Western pond turtles have lived in slow backwaters of rivers, ponds, lakes and marshes of the Pacific northwest region for thousands of years. By the mid-1980s, the western pond turtle population in Washington had been drastically reduced. Approximately 200 western pond turtles were known to exist east of the Cascades near the Columbia River with far fewer sighted in western Washington.

What happened to Washington's native pond turtles?

Several factors have come into play over the history of western pond turtles. Wetlands have long been considered to be land of little value and were more often than not drained or filled so that they could be paved over and built on. These actions significantly reduced the healthy habitat available for pond turtles, as well as many other species. Western pond turtles have also suffered from the introduction of bullfrogs *(Rana catesbeiana)* into the region. Bullfrogs were brought to the western United States from the eastern United States in the early 1900s. Bullfrog legs were sought after for food and the introduced bullfrogs were hunted as game. Bullfrogs are large (adult frogs can be longer than 7 inches [17.5 cm]) and eat a wide variety of animals from small insects to birds as large as robins. Predation by bullfrogs has had a significant effect on the survival of baby pond turtles. Other factors affecting pond turtle populations include environmental pollution, such as oil spills, and harvesting for food (this occurred mainly during the late 1880s when gold miners in California needed easily available sources of protein).

Since 1991, biologists from Woodland Park Zoo have been working to protect baby western pond turtles from bullfrogs and to increase the size of the pond turtle population. This has been accomplished by taking newly hatched baby pond turtles from the wild and raising them in captivity. The turtles are released back into the wild after one year when they are large enough to avoid being eaten by bullfrogs. Since 1992, between over 1,000 yearling pond turtles were released back into the wild. Biologists also work to control the population of bullfrogs. One way they accomplish this is by removing bullfrog egg masses (which may contain over 10,000 eggs) from the ponds where pond turtles are released. As described previously, major factors that affect the continued survival of species, such as western pond turtles, are habitat loss, introduced species, pollution,



Kate Slavens

Western pond turtle

hunting and harvesting, all of which are directly related to human activity and human population growth.

As we examine the case of the western pond turtle, it is not difficult to see that the factors which caused western pond turtles to become endangered have also caused many other species worldwide to face extinction. For most species, a combination of factors has resulted in declining populations. But as we become aware of these common factors, we can make efforts in our own lives to have as little impact as possible.

Endangered Habitats

The survival of species is intricately intertwined with the health of their habitats. Within a habitat, each species occupies its own distinctive niche. A species' niche can be thought of as its profession, or role, in its ecosystem. This role may include, among other things, what the species eats, how it obtains its food, where it finds shelter, how much water it needs, and when it is active. Although each species has its own unique niche, every species is dependent on many biotic (living) and abiotic (nonliving) factors of its habitat. Some species are "generalists;" these species are flexible in their basic needs and can live in a variety of habitats. For example, cougars *(Puma concolor)* range widely in North America, living in habitats as disparate as the warm Florida everglades and the cold mountain slopes of Washington state. Other species are "specialists;" these animals have narrowly-defined niches and have very specific requirements for survival. An example is the Oregon silverspot butterfly *(Speyeria zerene hippolyta)* which lays its eggs only on certain species of violets that grow on dunes along the coast in Oregon and Washington. Due to the alteration of dune habitats with human development, these species of violets have become rare, leading to the listing of this butterfly as endangered in Washington state.

Because species and their habitats are so intricately intertwined, in order to prevent species from becoming extinct, we must also prevent the destruction of the world's diverse habitats and ecosystems. However, some habitats have been so drastically altered by human activity that they can be considered endangered along with some of the species which inhabit them.

Wetlands

Wetlands are integral to the survival of many species, especially migratory birds, which breed and find food in wetlands, and the young of species such as fish and amphibians. Many other animals also utilize wetlands to find food, water and shelter. Wetlands, such as freshwater or salt marshes and swamps, perform important functions that prevent the degradation of ecosystems.

Wetlands help to filter sediments and even toxins from water. Wetlands also help to prevent floods by storing water and slowly releasing it back into the ecosystem. For many years, humans have looked upon wetlands as "wastelands" because they were breeding grounds for mosquitoes and not of much use for agriculture or development. Vast areas of wetlands were drained and filled in so that homes, highways and malls could be built over them. Introduced species of plants and animals also create problems for wetlands and the species that inhabit them. One introduced plant species, purple loosestrife *(Lythrum salicaria)*, has spread rapidly and taken over large areas of wetland habitat across North America. Purple loosestrife displaces native species of plants in wetlands, so that eventually animals can no longer find adequate habitat there. Many species of plants and animals, such as the western pond turtle, have been negatively affected by the loss of wetland habitat and introduced species.

With the loss of wetlands, thousands of species are losing their homes and sources of food and water. When we lose wetlands that keep our planet healthy, we are also losing all of the important functions of wetlands, such as keeping water clean and controlling the flow of water over the land. (More information about wetlands of the Pacific northwest can be found in Woodland Park Zoo's Washington Wildlife teacher packet.)

wetlands destruction USFWS

Tropical Forests

Growing around the globe between the Tropics of Cancer and Capricorn, tropical forests encompass a variety of different habitats, ranging from dry deciduous forests to moist evergreen forests, all consisting of densely forested land. Some tropical forests experience distinct wet and dry seasons, while others are equally wet each month of the year. All tropical forests are home to an amazing amount of biological diversity. Because tropical forests have developed over longer periods of time than most other ecosystems of the earth, diverse forms of life and complex interactions between species have evolved in tropical forests.

The three major areas of tropical rain forest are the Neotropics (Mexico, Central and South America), Africa and Asia. Many plant and animal species living in tropical forests are **endemic** to those areas — they are found nowhere else. The majority of all insect, reptile and amphibian species live in tropical forests. There are many different species in tropical forests, but there are relatively few individuals of each species. In fact, most tropical forest species can be considered to be rare due to the low numbers of individuals. Temperate forests, on the other hand, have fewer species but greater numbers of individuals of each species. In tropical forests, the combination of rare species and threatened habitat means that many species probably die out before they are discovered!

Tropical forests play an important role in regional and global bioclimatic cycles. Intact forests maintain and conserve soils, regulate water cycles and provide habitat for more than half the species on earth. The loss of the earth's tropical forests can contribute to dramatic local and global climate changes. Carbon dioxide and other gases released into the atmosphere by the burning of tropical forests helps to trap heat reflected from the earth's surface and cause a gradual warming of the atmosphere called the "greenhouse effect." Tropical forests also provide humans with foods, medicines and other products. Many of the products we rely on today originated in tropical forests.

Unfortunately, tropical forests are fragile ecosystems that have been increasingly exploited by human activity. The causes of tropical deforestation are complex and involve governments, business interests and private citizens. Governments of developing nations, which face tremendous levels of foreign debt and burgeoning human populations, look to their forests as resources to be utilized for economic growth of their countries and to increase the living standards of their people. Multinational corporations and international lending institutions have contributed to the decline of tropical forests by financing major projects that have razed large areas of forests for timber, fruit and pulp plantations and mining operations. Logging for timber resources and clearing of land for agriculture have had drastic effects on forest ecosystems. When trees are stripped from the land, the exposed soil is often eroded away and the nutrients in any soil left behind are leached out. Soil erosion and nutrient leaching decrease the chances of the regeneration of a healthy forest. Eroded soil may also end up in nearby waterways, thereby damaging these ecosystems as well.

As human populations continue to grow, the threats to tropical forests increase. The alarming rate of tropical forest destruction has drastically affected thousands of species of plants and animals that depend on these habitats. The majority of endangered species at Woodland Park Zoo are species native to tropical forests, including western lowland gorillas *(Gorilla gorilla gorilla)* and dwarf crocodiles *(Osteolaemus tetraspis)* of Africa, Malayan sun bears *(Helarctos malayanus)* of southeast Asia, and golden lion tamarins *(Leontopithecus rosalia)* of Brazil. (More information about tropical forests can be found in Woodland Park Zoo's Tropical Rain Forest and Tropical Asia teacher packets.)

Ben McClurin

Malayan sun bear

Coral Reefs

Coral reefs are often referred to as the tropical forests of the ocean because they host more species of plants and animals than any other marine ecosystem. Coral reefs are built by invertebrate marine organisms called coral polyps. The coral polyps build hard limestone skeletons beneath them and around their bases. These limestone skeletons attach the polyps to stable surfaces, such as rocks or other corals, and help to protect the polyps. As polyps die and leave behind their limestone skeletons, new polyps grow on top of the old skeletons, building up large coral reefs over thousands of years. Microscopic algae live inside the coral polyps. The algae living within the polyps carry out photosynthesis, producing sugars and oxygen that are consumed by the polyps. In return, the polyps provide shelter for the algae and also produce carbon dioxide used by the algae in photosynthesis.

Many threats, both natural and human-caused, affect coral reefs. Corals are sensitive to environmental conditions. They grow best between 65ºF and 86ºF (18ºC and 30ºC) in shallow water (less than 164 feet [50 meters] deep) that is clear and free of sediment (MacPhee, 1996). Significant changes in water temperature or depth can negatively impact corals. Natural occurrences, such as hurricanes and extremely low tides, can kill corals, but human-caused threats have had greater impacts on coral survival. Since the 1980s the incidence of coral bleaching has been increasing. Coral bleaching occurs when the algae in the polyps die, causing the coral to lose its color. When the algae die, the polyps can also die. One possible cause of the algae die-off is global warming. As more gases are released into the atmosphere from the burning of fossil fuels, more heat from the sun is trapped in the earth's atmosphere, increasing temperatures of both air and seawater. These increased temperatures of sea water may be affecting the algae, making them more susceptible to bacterial infections.

All kinds of pollution are also affecting corals. High sediment loads, sewage and fertilizer runoff can kill or stunt the growth of coral polyps. The usage of the land near coral reefs can increase the damage. For example, heavy logging can cause more sediment to be eroded into nearby waters, smothering corals. Corals are also harmed when people harvest corals to sell in the tourist trade and when people anchor their boats over reefs the anchors catch in the coral, damaging the reef when the anchor is pulled up. When the survival of corals is threatened, the survival of the myriad species of plants and animals that depend on them is also threatened. (For more information on coral reefs and what you can do, contact your local aquarium or see the "Resources List" for organizations helping to save coral reefs.)

Endangered Peoples

Around the world, lives of indigenous peoples depend closely on their native lands. In many cases, governments have ignored the needs, and have even denied the existence, of these peoples in order to take advantage of natural resources, such as timber, mineral-bearing ores and hydroelectric power. In addition, rapidly growing human populations have increased the impacts of previously sustainable ways of life. In the process, the natural habitats that are an integral part of the lives of indigenous peoples are being destroyed, leading to the endangerment of their languages, ceremonies and other cultural traditions. With the disappearance of natural habitats that are an integral part of the religious, social and daily lives of indigenous people, their cultures are also disappearing and the world is losing an extensive knowledge base that is largely undocumented. In many of the world's traditional cultures, information is passed on from generation to generation through oral history. As people are separated from their traditional lands, either through the destruction of these lands or the movement of people to urban areas, valuable cultural knowledge based in the natural landscape is not passed on and is gradually lost.

In the late 1980s in Burma, a small country in southeast Asia, the military government, which had a long history of oppression of indigenous minorities, sold logging rights to traditional lands of the Karen and other indigenous peoples.

> 'If left unchecked, our forests will be gone forever within the next five years,' Dr. Em Marta, a Karen leader, told the United Nations in 1990. 'If our forests are gone, the Karen and other indigenous peoples will also fade away.'
>
> —Davidson, 1993

Human rights abuses, for the aim of logging and exporting hardwoods such as teak, have continued in Burma into the late 1990s.

The key to avoiding such situations is to find a balance between obtaining economic benefit through sustainable resource use and the preservation of traditional ways of life. And both of these goals must also go hand in hand with the support of healthy ecosystems.

Historically, the approach to wildlife and habitat conservation has been to completely separate people and wildlife. Many national parks and wildlife reserves of the world exclude any extraction of resources by humans, no matter how sustainable. Indigenous peoples have been cut off from their traditional food sources, medicinal sources and sacred places. One program aimed at fostering the connection between conserving natural areas and preserving indigenous cultures is the United Nations Educational, Scientific and Cultural Organization's (**UNESCO**) Man and Biosphere Program. "The [Man and Biosphere] program provides a conceptual link between the need to establish protected areas and the recognition of the lands and traditions of indigenous cultures" (Herlihy, 1997). As of 2004, there are 440 biosphere reserves in 97 countries. One biosphere reserve, the Rio Plátano Biosphere Reserve, which was established in 1980, is located in Honduras. This biosphere reserve, like others, is composed of three concentric zones. The core of the reserve is open only to use for education and tourism. The cultural zone is set aside for use by indigenous peoples for the protection of their cultures. The buffer zone is open to any use of resources that does not alter the ecosystem drastically. The Rio Platano Biosphere Reserve was established out of concern over accelerated rates of deforestation in the region, mainly by ranchers, agricultural colonists and lumbermen.

Similar pressures led to the establishment of extractive reserves in Brazil in the late 1980s. Chico Mendes gave his life for the rain forests and people of Brazil. He knew that if forests were destroyed, the people living in the rain forest would lose their livelihood. Mendes was assassinated in December of 1988 in reaction to his efforts to prevent the rain forest from being logged and cleared. But due to Mendes' dedication and ability to bring people together for a common cause, vast areas of tropical forest in Brazil have since been set aside as extractive reserves. In extractive reserves local people have subsistence rights and are permitted to extract rubber (by tapping trees), Brazil nuts, oils, medicinal plants and other sustainable products. The movement begun by Mendes has strengthened the position that intact tropical rain forests can provide sustainable economic benefit in the long term.

Endangered Domestic Breeds and Food Plants

When we think of endangered plants and animals, our thoughts often turn to places such as tropical rain forests. But on farms around the world, many breeds of domestic animals and strains of crops are in danger of vanishing.

Humans have domesticated animals and cultivated crops for thousands of years. Domestic animals live with humans and depend on them to a large degree for their survival. Modern breeds of domestic animals were derived from wild stocks of animals. Many of the original wild species originated in Asia and Europe, but many of them no longer exist. For example, the wild ancestor of domesticated cattle is the aurochs *(Bos primigenius)*, a large animal that used to roam throughout Eurasia thousands of years ago but has become extinct. The ancestors of our modern chickens, red jungle fowl *(Gallus gallus)*, however, still exist in Asia. Today's crops also originate from wild species, such as wild potatoes that grow in the highlands of South America.

Over many years of domestication, humans have selectively bred, or controlled the reproduction of, animals such as horses, dogs, cats, pigs, sheep, cattle and goats. In selective breeding, farmers identify certain traits that are desirable, such as high milk production or prolific egg-laying, select animals that exhibit those qualities and breed them with one another. Traits were also selected for their aesthetic appeal, such as lyre-shaped horns in cattle, or for their suitability to the local environment, such as drought-tolerance. Gradually, selective breeding results in different breeds within the same species that exhibit the selected traits. Domestic dogs, for example, are all the same species, yet we have breeds as different from one another as Chihuahuas and Great Danes.

With the expansion of large commercial farms, we have come to depend on only a few breeds of domestic animals for our animal products and a very small number of cultivated plants for our fruits, vegetables and grains. Domestic breeds and crops have been selectively bred for specific traits to the point where they lack any genetic diversity. In the United States, only a few breeds of pigs provide the pork, the majority of milk is produced by Holstein cows, most of our beef comes from Herefords and

Black Angus cattle, and only one or two hybrid breeds of poultry produce our broilers, fryers and eggs. These breeds are efficient at producing the desired product, however these animals require a high degree of care from humans in order to survive, including vaccinations against disease. Some breeds, such as domestic turkeys, depend on artificial means of reproduction because their body shape no longer allows them to reproduce naturally. The "perfection" of these commercial breeds has resulted in the decline in population of other breeds. In western Europe, 230 native breeds of cattle existed in the beginning of the 1900s. By 1988, only 30 native breeds of cattle were considered to be secure and 70 had become extinct (Alderson, 1994). The lack of genetic diversity among domestic animals and crops leaves them vulnerable to disasters such as disease. Our heavy dependence on a very few breeds of animals and varieties of plants for food puts us in a vulnerable position. This was exemplified in part by the Irish potato famine of the 1840s, when the single strain of potatoes growing in Ireland was wiped out by a blight to which the potatoes lacked resistance. The great loss of food crops was a factor in the resulting famine.

Minor breeds, as rare breeds of domestic animals are referred to, and wild ancestors of modern crop plants are reservoirs of genetic diversity. Minor breeds retain such traits as fertility, foraging ability, longevity, maternal instincts and resistance to disease and parasites (American Livestock Breeds Conservancy, 1993). Wild ancestors of crop plants also retain resistance to disease and other beneficial traits that have been bred out of modern varieties. Minor breeds are living history, reflecting the conditions for which they were bred.

Some small farms in North America and the United Kingdom concentrate on keeping rare breeds in hopes that they will not vanish from our earth. Scientists collect wild varieties of plants related to our modern crops and store their seeds in seed banks. Some farms focus on growing vanishing varieties of food plants, such as certain varieties of apples. In preserving and learning about these breeds and varieties, not only do we preserve gene pools that may benefit us in the future, but we preserve the history of the connection between humans, domesticated animals and cultivated crops upon which is built the civilization we know today.

Madagascar – A Unique Island Ecosystem in Trouble

The island of Madagascar, located off the southwest coast of Africa, is the fourth largest island in the world. When it became separated from the African continent by the Mozambique Channel, about 160 million years ago, the stage was set for an extraordinary experiment in evolution. A diversity of habitats, from rain forest to dry deciduous forest to deciduous thicket (also called spiny desert), combined with the long period of isolation has resulted in a unique assemblage of plant and animal species. Over the course of millions of years, plants and animals isolated on the island evolved independently from their African relatives. Today, Madagascar is home to more endemic plants and animals (species found only in Madagascar) than anywhere else in the world. Joseph-Philibert Commerson, an early naturalist best described the island's diversity in 1771, when he wrote:

I can announce to naturalists that this is the true Promised Land. Here Nature seems to have created a special sanctuary whether she seems to have withdrawn to experiment with designs different from any she has used elsewhere. At every step, one finds more remarkable and marvelous forms of life.

Madagascar is home to over 10,000 plant species, 8,000 of which are endemic. These include orchids, which are more diverse on this one island than on the entire continent of Africa, and many wild species of vanilla and coffee. Another plant found only on Madagascar is the rosy periwinkle, the source for vinblastine and vincristine, drugs used to treat Hodgkin's disease and childhood leukemia. Ninety percent of the island's reptiles and amphibians, including two-thirds of the world's chameleons, are found only on Madagascar.

Thirty-two primate species live on Madagascar and no where else in the world. These species and include the elusive aye-aye, the woolly indri and Madagascar's primate ambassadors to the world, the lemurs. All of these primates belong to the primate suborder, Prosimii, or "pre-monkey." Their ancestors are believed to have reached Madagascar on floating logs or mats of vegetation, sometime after about 50 million years ago. Woodland Park Zoo is presently (2006) home to one lemur species; red ruffed lemurs. Along the exterior walkways of the Tropical Rain Forest, you can observe the red ruffed lemurs on "lemur island."

Karen Anderson

Red ruffed lemur

Island ecosystems are very delicate because species cannot migrate to surrounding areas when natural or man-made disasters strike their environment. Although Madagascar was the last large land mass to be settled by humans, the effects of human activity on the island have been drastic. In the centuries that followed the arrival of humans on the island, many of the island's large animals became extinct; including seven of the 17 known genera of lemurs, six to 12 species of elephant birds, a pygmy hippopotamus, and two large land tortoises. Overhunting is cited for these early extinctions. Today, however, the rapidly increasing rate of extinction on the island can be attributed to habitat loss. Approximately 80 percent of the island is covered by man-made prairie; large open spaces which are the result of slash-and-burn agriculture, logging, firewood collection and cattle grazing. Other factors, like pet trade, also contribute significantly to the loss of biodiversity on the island. Many of the plant and animal species on the island, including the tomato frog *(Dyscophus antongilii)* and all known species of lemurs, are endangered. Some of these species are considered critically endangered, meaning that extinction is inevitable unless drastic measures are taken immediately.

Like many of the plant and animal colonists before them, the first humans floated to the island of Madagascar (around 500 A.D.). The people who traveled to and settled in Madagascar originated from Indonesia and Africa, primarily the former. The Malagasy language of Madagascar, of which there are several dialects, is Indonesian in origin. Today, there are approximately 20 different tribes within the Malagasy culture which are based around traditional homelands across Madagascar (Jenkins, 1987). As of mid-2006, the population of Madagascar was approximately 17.8 million, with a projected population, based on the current rate of increase, of 28.2 million by mid-2025. (Population Reference Bureau, 2006). Traditional methods of swidden, or slash and burn, agriculture which were brought with the ancestors of the Malagasy from Indonesia, are no longer sustainable with such a large human population. Fire is also used to clear land for cattle grazing and to increase runoff flowing to rice paddies. Along with the runoff of water, however, goes the precious topsoil, staining the oceans surrounding Madagascar red as the rivers deposit their loads. Madagascar has lost not only the vast majority of its forests, but also countless tons of topsoil and the nutrients contained in the soil. With this environmental destruction, crop yields have decreased as soils become poorer and tough, unpalatable grasses have replaced those which gave vital nutrients to cattle. In the mid-1980s, the government of Madagascar, in recognition of the fact that the future of Malagasy people is inextricably linked with the persistence of healthy ecosystems, created the National Environmental Action Plan. The plan, which was implemented in 1992, indicates actions to be taken over 15 years (1992-2007) in order to diminish soil erosion, preserve biodiversity, implement agroforestry (integrating the growing of crops and trees), secure land tenure for peasants, and provide environmental education.

The Malagasy people have a saying that originates from the chameleon's ability to move its eyes independently of one another;

Behave like the chameleon:
Look forward and observe behind.

The chameleon teaches us to learn from the past, while looking ahead to the future. The rapid loss of habitat and the number of endemic species on the island of Madagascar make it one of the most endangered "hot spots" on the planet. If we wish to save not only the animals, plants and human cultures of Madagascar, but all the world's biological and cultural diversity, we must learn to recognize the results of our past actions and, most importantly, take steps to change the future.

Conservation: What Is Being Done for Endangered Species?

Conservation of endangered species is multifaceted and is constantly being expanded in new directions. Intrepid researchers spend long hours in the field gathering data on diets, reproductive habits and other aspects of the lives of endangered species. They may also spend long hours with local people working on conservation plans that meet the needs of both people and wildlife. Dedicated staff at zoos provide for the needs of captive animals and promote the successful breeding of endangered species as well as carrying out research which can help conservationists in the field. Scientists at botanical gardens work to nurture rare species of plants and to preserve their seeds for future use. Educators in schools, in zoos, at nature centers and in the field bring the awareness of endangered species of plants, animals and their habitats to students of all ages. Many nonprofit groups and political activists are working to ensure that legislators are well-informed about conservation issues affecting our world. And citizens of the world, by becoming educated about endangered species and practicing conservation-conscious habits at work, school and home, are all doing their part to save species from extinction. The following paragraphs describe some of the efforts that are being made by conservation institutions.

Conservation Programs in Zoos, Aquariums and Botanical Gardens

Zoos have been instrumental in establishing captive breeding populations of endangered animals, in the hope of one day returning them to the wild, and so there is no longer the need to remove species from their natural habitats. As a result, there have been a number of successes in restoring endangered species to their former ranges. In 1907, when the New York Zoological Park began breeding bison *(Bison bison)*, there were fewer than 1,000 animals remaining in the wild. Today, more than 20,000 bison, descendants of captive species, are now living on wildlife preserves. The Arabian oryx *(Oryx leucoryx)* became extinct in the wild in the early 1970s. However, several animals were living in captivity at the time, and a "world herd" was established in North American zoos, starting with Phoenix Zoo and San Diego Wild Animal Park. The population in captivity grew, and in 1982 the first oryx were released into a reserve in Oman. With the cooperation and employment of the local people, the reintroduction has been a success. These breeding and release programs are very important, but their success depends on habitat preservation — there must be intact habitats into which we can safely reintroduce animals.

Taxon Advisory Groups (TAGs) and Conservation Action Partnerships (CAPs)

The American Association of Zoos & Aquariums (AZA), established in 1972, is a group that aids the advancement of North American zoos and aquariums in their efforts towards conservation, education, scientific study and recreation. By accrediting zoos to ensure that institutions meet certain standards and by helping member institutions to disseminate information, AZA promotes the conservation of the world's wildlife and habitats. The AZA has developed Taxon Advisory Groups (TAGs) in order to identify species that will benefit most from captive management programs. TAGs consider certain criteria pertaining to all species in a taxon (organisms in the same taxonomic grouping such as canids [dogs] or felids [cats]) and assess which species should be recommended for captive management programs. Through this program, zoos and aquariums are able to devote their limited space and capabilities to species which have been deemed to be most in need of support.

One of the criteria used in evaluations by TAGs is whether a captive population of a species can strengthen conservation projects in their country of origin. To meet this end, AZA has also developed Conservation Action Partnerships (CAPs), which serve to increase awareness of and support conservation needs in specific geographic regions of the world. Regions for which CAPs have been developed are areas rich in biodiversity with large numbers of endemic (unique to that region) wildlife, such as Madagascar and Brazil.

An aspect of both TAGs and CAPs is conservation education both in countries from which endangered species originate and other countries around the world. Conservation education programs may include teacher training opportunities at zoos, environmental education in communities living in proximity to endangered species, and school or community programs on and off zoo grounds which enhance the public's knowledge of wildlife conservation. These education programs foster respect, stewardship and an understanding of the endangerment of species and habitats.

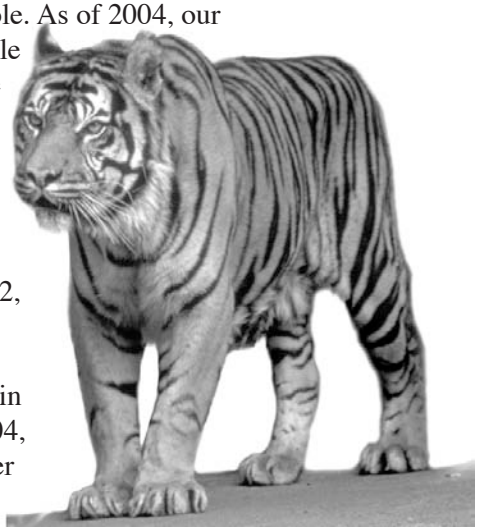
Species Survival Plans (SSPs)

Species Survival Plan

Many consider today's zoos to be the modern Noah's Ark, providing animals refuge against extinction. Realistically, zoos are not able to provide protection to each existing animal species, however as habitat destruction continues to be the biggest threat to an animal's survival in the wild, zoos may be the only hope of maintaining active breeding populations with assured genetic diversity. Without genetic variation, all species are doomed to extinction. Although habitat is rapidly disappearing, it continues to be important to save species teetering on the brink of extinction, if for no other reason than to keep genetic options open as we struggle to protect wild habitats.

Woodland Park Zoo houses approximately 50 species of endangered mammals, birds, reptiles and amphibians. As an institution accredited by the AZA, our zoo is one of many participants involved in the propagation of captive endangered species through a program developed by the Association of Zoos & Aquariums (AZA) known as the Species Survival Plan (SSP). The Species Survival Plan is a strategy based on scientific analysis which provides genetic information helpful in the successful breeding of rare and endangered species. Because genetically sound populations are needed to assure continued successful breeding, we join other zoos and private breeding institutions in assuming this animal management responsibility. In order to save as many threatened species as possible, the SSPs focus on habitat preservation, maintenance of healthy captive populations, scientific research and public education. When and where necessary and appropriate, SSPs also support the reintroduction of species back into their native habitats.

Zoo visitors are often unaware of what captive management strategies involve. Curators and zoo keepers are involved in projects as diverse as gorilla *(Gorilla gorilla)* demographic studies and the development of better diets for red pandas *(Ailurus fulgens)*. Zoos share expenses and information to improve reproduction and maintenance of species. A program involving Humboldt penguins *(Spheniscus humboldti)* has been beneficial in increased parent-reared breeding successes at the zoo, and many keepers are involved in ground work SSP planning that will impact some of the world's most endangered species. Sometimes, an SSP coordinator will advise that animals be moved from one zoo to another, called a "breeding loan," in order to increase the genetic diversity of subsequent offspring. For instance, in 1998 Woodland Park Zoo received a new young male Sumatran tiger (*Panthera tigris sumatrae*) as a mate for an elderly, female Sumatran tiger. The SSP coordinator then recommended that the older female Sumatran tiger be relocated to another facility, and a younger female Sumatran tiger, which was a better genetic match with the new male, move in. Although this transfer was difficult for the keepers involved who had worked with the elderly female for many years, the move benefited the captive population of Sumatran tigers as a whole. As of 2004, our male and female adult pair have successfully bred and produced two litters of cubs. Born in December 2002, the first litter comprised two females. Born in September 2004, the second litter comprised two males.



Sumatran tiger Richard Birchfield

The zoo receives limited private funding for SSP research projects. A strong commitment to conservation provides inspiration for continued work with the belief that our efforts will positively impact future generations of endangered species. Similar programs in other areas of the world serve to coordinate population management of endangered species in captivity in those regions.

Rare Plant Conservation

According to the Center for Plant Conservation (**CPC**), one out of every 10 plant species native to the United States (meaning the species was growing in the United States before European settlement) is in danger of extinction. Many other plant species worldwide face similar circumstances. Plants are primary producers, meaning they capture energy from the sun and transfer that energy to other inhabitants of their ecosystems. Thus, in order to have healthy ecosystems with stable populations of animals, it is important to keep native plant communities intact. Botanical gardens and arboreta throughout the world play a major role in the conservation of rare plants.

The Center for Plant Conservation is a network of 33 botanical gardens and arboreta from across the United

States with a national coordinating office in St. Louis, Missouri. The CPC works to identify and promote the conservation of rare plants. The CPC coordinates the growth and maintenance of the National Collection of Endangered Plants. At the various participating institutions, more than 600 species (as of 2004) of endangered plants are housed as a living collection. The focus of the CPC is conservation and research on rare plants as well as public education about plant conservation and endangerment. Restoration of native plant communities is also an effort taken on by CPC participating institutions.

Another aspect of plant conservation is the long-term storage of seeds of rare plants in order to preserve the genetic representation of these species. With proper storage, which in some cases means cryogenic storage in liquid nitrogen, seeds can remain viable for decades. If need be, the seeds can be propagated and fresh seeds can then be collected from the plants for continued storage. With the storage of these seeds, rare plants could be propagated and restored to their native habitats if this becomes necessary.

On St. Helena island in the South Atlantic, 1,200 miles off the shores of southwestern Africa, plant conservation in the field is actively being pursued. The native vegetation of this small island, the majority of it endemic, has been largely destroyed since humans discovered and settled on the island during the last 500 years. Endemic plants have been pushed to extinction due to the introduction of goats and a variety of nonnative plants. In addition, human settlers cleared much of the vegetation and harvested a great quantity of timber. Now, the Environmental Conservation Section of the Agriculture and Forestry Department of St. Helena propagates several species of endemic plants and reintroduces them into the recently established Diana's Peak National Park. Goats have been eliminated from the island and efforts are being made to control exotic plants. Some endemic species that are being reintroduced to Diana's Peak and other areas include she cabbage *(Lachanodes arborea)*, he cabbage *(Pladaroxylon leucodendron)* and false gumwood *(Commidendrum spurium)*, all listed as Critically Endangered by the IUCN.

Although Woodland Park Zoo is considered to be a "zoological garden," the zoo grounds and exhibits encompass an extensive botanical collection. Similar to the Association of Zoos & Aquariums, the Association of Zoological Horticulture (**AZH**) supports and coordinates efforts by zoos to preserve endangered species in zoos, aquariums, arboretums and botanical gardens. The botanical collection at Woodland Park Zoo includes rare and endangered plants such as orchids and pitcher plants. By providing visitors with an immersion experience in different habitats such as a tropical rain forest and the African savanna, the plants at the zoo increase the public's understanding of the vital connection between wildlife and habitat.

Conservation in the Field

Research in the Field

The key to survival of wildlife, including plants, is the existence of healthy habitats throughout the world. Zoos, aquariums and botanical gardens work to preserve the genetic lines of species of plants and animals out of their natural environments *(ex situ)* while also helping to raise funds for conservation projects for species in their natural environments *(in situ)*. Field conservation projects serve to identify species that are in need of protection; determine how they satisfy their basic needs which must be met in order for these species to survive; and discover any interactions between species or between animals, plants and the environment that are necessary for the lasting integrity of the ecosystem. Research in the field on reproductive, social and dietary habits is particularly useful to institutions working to care for and breed animals in captivity. Likewise, research on species in captivity benefits conservation work in the field (see the paragraph on research in the section "What Woodland Park Zoo is Doing to Help Endangered Species" in this packet). The ultimate outcome of many conservation research projects is to identify priority species and areas for management and conservation. The information gained in the field, along with cooperative efforts of off-site conservation and breeding facilities, can lead to the successful protection of species and habitats.

A prime example of the interplay between field research and *ex situ* conservation is the story of the golden lion tamarin *(Leontopithecus rosalia)*, a small South American monkey. In 1974, out of concern for

Carol Beach

golden lion tamarin

the dwindling populations of golden lion tamarins in Brazil, the Pocos das Antas Biological Reserve was created. Field research showed that by 1980, the population of golden lion tamarins in the reserve had decreased to only 100 individuals and outside the reserve there existed only small pockets of tamarins (Tudge, 1991). In an effort to save golden lion tamarins from extinction, a comprehensive plan was developed. The plan included field research on the wild population; restoration, management and protection of the habitat; management of and research on the captive population; public education; and reintroduction. All of these factors have worked together to create a brighter future for golden lion tamarins in the forests of Brazil. New methods of pre-release and post-release training have increased the success of reintroduced tamarins. By 2002, reintroductions had added 359 animals to the population. Two of the golden lion tamarins involved in the project were born at Woodland Park Zoo. Biologists continue to train and release captive-born tamarins into the wild. After the tamarins are reintroduced, field researchers gather data to track the success of the released tamarins. Although the rain forest habitat of golden lion tamarins is still severely threatened, the reintroduced tamarins have been surviving well and even producing offspring with wild tamarins.

Community Involvement on Field Conservation

The examples of many field conservation projects have shown that without the involvement and support of the local community, a conservation project has little chance of success. Generally, the local people who live together with species that are the targets of conservation are most affected by the actions taken to protect the species. When an area is protected to save a species, people of the region may be cut off from sources of employment, income and/or traditional sources of medicines or foods. In the past, money from tourism generated by the existence of rare species never reached the people who were denied parts of their life-style for the benefit of the protected species. People were rarely offered alternatives for jobs or other sources of income nor were they provided with opportunities to be retrained in other fields of work. Examples of this lack of concern for the needs of local populations come from across the globe, from the old growth forests of the Pacific northwest to the savannas of east Africa. In many regions, the alienation of local communities from their traditional lands has often led to a lack of respect and support for conservation efforts.

Many current conservationists consider the local community to be an integral part of any conservation plan. Actually, these considerations are not new, but have only been widely incorporated into field conservation planning since the beginning of the 1980s. One of the reasons that the golden lion tamarin project mentioned previously has been so successful is the continued interest and support of the local communities. Conservation projects now involve community environmental education, employment of local people by the project or protected area, direction of funds generated by tourism to local communities, permission to access and use subsistence resources (such as nontimber, sustainable forest products) within protected areas, and significant input from local people in the planning process for conservation.

Starting with Kakadu National Park in 1979, Australia has developed a system of Aborigine-inhabited, joint-managed national parks. Parts of Kakadu were established on Aboriginal owned lands which were leased to the government for use as a national park. The terms of the leases provide for the respect of Aboriginal land use rights, cultural traditions and participation in park management. With the strong involvement of Aborigines in the management of the park, Kakadu protects the diverse habitats, animals and vegetation of the region as well as the traditional values and cultures of the Aboriginal people of the area.

What Woodland Park Zoo is Doing to Help Endangered Species

Captive Breeding Programs

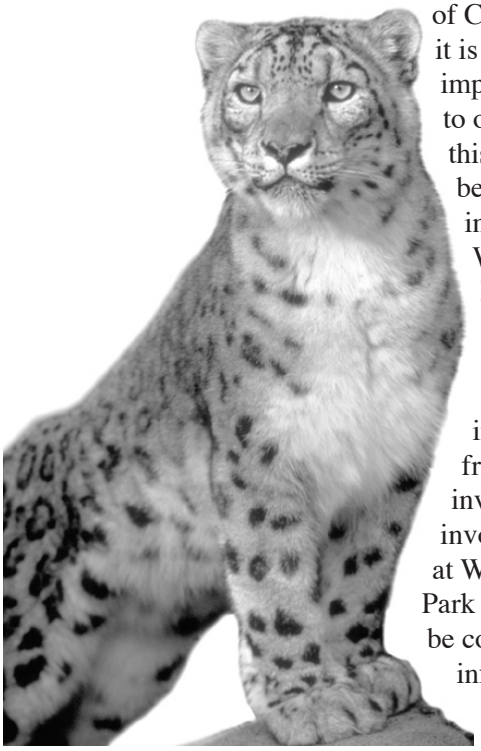
Many of Woodland Park Zoo's endangered species are part of international captive management programs. The successful breeding of lion-tailed macaques *(Macaca silenus)*, snow leopards *(Uncia uncia)*, ocelots *(Leopardis pardalis)*, Humboldt penguins *(Spheniscus humboldti)*, golden lion tamarins *(Leontopithecus rosalia)*, Malayan sun bears *(Helarctos malayanus)* and other threatened animals helps increase their population numbers, making them less likely to become extinct. Furthermore, it means that zoos no longer need to capture animals from the wild, but can trade with one another to exhibit and breed rare wildlife and to maintain genetic variability of captive animal groups. According to the Association of Zoos & Aquariums, by the 1990s, 90 percent of mammals and 70 percent of birds in North American, AZA accredited zoos were bred in captivity.

Most captive management programs at Woodland Park Zoo are directed by Species Survival Plans (SSPs) (see the section on "Species Survival Plans" in this packet). Funds raised by the zoo often go to support

components of Species Survival Plans at other zoos or even in the field. In 1998, Woodland Park Zoo donated money to a keeper training workshop focused on red pandas *(Ailurus fulgens)*, an SSP species. Woodland Park Zoo also works closely with the International Snow Leopard Trust, an organization based in Seattle which has been instrumental in establishing and expanding parks and reserves for snow leopards *(Uncia uncia)* and bringing the numerous countries where these cats are found together in conservation efforts. In fact, this effort has become truly international with the coordination of exchanges of animals between zoos around the globe. The aim of these exchanges is to preserve genetic diversity within the captive population of snow leopards. Woodland Park Zoo has had great success with breeding snow leopards and has contributed a number of animals to the captive population.

Research

Woodland Park Zoo supports scientific investigation in zoos and in the field. Just as field research can contribute to the management of captive animals, research in zoos can provide information that can be useful in the management of wild populations. Observations of species in captivity provide information that would be extremely difficult to obtain in the wild. For example, studies of snow leopards at Woodland Park Zoo have indicated that males may contribute to the rearing of cubs. This has not been seen with other large cats. Some male snow leopards at Woodland Park Zoo have successfully remained part of the family group after the young are born. Since wild snow leopards live high in the mountains of Central Asia, it is practically impossible to observe this paternal behavior except in zoos. Woodland Park Zoo researchers are able to obtain information from scientific investigation involving animals at Woodland Park Zoo that can be compared to information obtained from animals in the wild. For example, researchers at Woodland Park Zoo developed noninvasive methods of obtaining stress hormone levels of many species of animals at the zoo by analyzing their feces. This method was applied with a wild population in assessing stress levels of northern spotted owls (*Strix occidentalis caurina*) nesting near logging roads in Washington's forests. In order to verify that the method was accurate, the scientists were able to use blood and fecal samples from a northern spotted owl housed at the zoo.



Snow leopard Gerry Ellis

Research in zoos can also provide valuable information for field research on wild populations of animals. For example, researchers studying Matschie's tree kangaroos (*Dendrolagus matschiei*) needed to find out what size and type of radio collar would fit on tree kangaroos and not disrupt their daily movements. To find out, zookeepers at Woodland Park Zoo tested the radio collars on the zoo's tree kangaroos. With the knowledge that the radio collars fit and were not disruptive to the tree kangaroos, the researchers were able to radio collar wild tree kangaroos and learn more about their movements and feeding habits in their native forests of Papua New Guinea.

Returning Animals to the Wild

In a number of cases where some natural habitat remains, zoos can return captive endangered animals to the wild. Woodland Park Zoo has participated in programs to return captive-born golden lion tamarins to the tropical rain forest in Brazil and Bali mynahs *(Leucopsar rothschildi)* to their native habitat on Bali. Bred and raised in captivity, these animals represent the hope for a future wild population (see "Research in the Field" in this packet). In 1999, Woodland Park Zoo helped to fund a project, run by the Madagascar Conservation Action Partnership, (see "Taxon Advisory Groups" in this packet) to reintroduce captive black and white ruffed lemurs *(Varecia variegata variegata)* into the Betampona Natural Reserve in Madagascar. After a free-ranging training period in primate facilities in the United States, the lemurs were released into the reserve. Other species within the reserve have benefited from the reintroduction project, which has resulted in increased protection of the reserve and education of local populations about the rich biodiversity in their backyards. Poaching of ebony trees in the reserve has nearly ceased and local teachers are learning how to integrate environmental education into their curricula, which was recently mandated by the Malagasy government.

In addition to supporting reintroduction of captive-

born animals into the wild, Woodland Park Zoo has also played a role in returning rehabilitated animals to their natural homes. Woodland Park Zoo's long-term program to rehabilitate and release injured bald eagles *(Haliaeetus leucocephalus)* and golden eagles *(Aquila chrysaetos)* has met with great success. Over 80 bald and golden eagles have been rehabilitated and released back into the wild since the beginning of the program in the 1970s. Woodland Park Zoo has also been instrumental in increasing the numbers of endangered western pond turtles in the wild. Newly hatched pond turtles are raised for one year at Woodland Park Zoo and then released back into wetlands (see "The Case of the Western Pond Turtle" in this packet).

On the other side of the globe, Woodland Park Zoo staff lend their expertise and the zoo donates funds to projects aimed at rehabilitating and re-releasing orphaned orangutans *(Pongo pygmaeus)* into the tropical forests of Borneo. With forest fires, continued human-encroachment on habitat, and the confiscation of orangutans kept as pets, there has been increasing incidences of orphaned orangutans in need of care in Borneo. When devastating fires hit the region in 1997, emergency funds were allocated to Wanariset Orangutan Rehabilitation Center for fire fighting equipment and personnel. In spring of 1998, a veterinary staff person from Woodland Park Zoo took additional materials needed to care for orphaned orangutans to Wanariset. These materials were donated by local Seattle companies and by Woodland Park Zoo docents. A continuing relationship between Woodland Park Zoo and Wanariset will ensure the survival and return to the wild of many orangutans.

Professional Training and Public Education

The Conservation Department at Woodland Park Zoo provides professional training in wildlife medicine and scientific investigation for university and graduate students. Every year up to six veterinary students, from second year students to senior veterinary technicians, each spend several months at the zoo and acquire skills in wildlife medicine. In addition, veterinarians from Woodland Park Zoo travel to Indonesia to conduct annual training sessions for veterinarians across Indonesia. The training the Indonesian veterinarians receive is applicable for both exotic animal care in zoos and for the care of wild animals. Some of the Indonesian students who are trained through this program apply their skills in wildlife rehabilitation facilities such as Wanariset Orangutan Rehabilitation Center.

Two facets of public education are vital to the conservation of endangered species. First, education of people living in proximity to endangered species helps to increase their awareness of the important role people play in the lives of plants and animals and also the important roles plants and animals play in our lives. With this awareness, people are inspired to take responsibility for the integrity of their local environments. Second, it is important to educate people around the world about earth's ecosystems and species that are in danger of extinction. This knowledge can illuminate the fact that our daily personal choices affect not only species and habitats in our own backyards but also those in every part of the world.

Working together with conservation groups, zoos and zoo visitors can make a positive contribution to wildlife preservation both in captivity and in the wild. Education about endangered species in the countries in which they are found is also a focus of the efforts of zoos in public education. Woodland Park Zoo is currently helping to fund the production of educational materials on western lowland gorillas *(Gorilla gorilla gorilla)* in the Ndoki forest of the Democratic Republic of the Congo. The educational materials are distributed in local communities with the aim of bringing an appreciation and awareness of the wildlife with which they live.

Endangered species living in zoos are ambassadors of their wild counterparts. The opportunity to observe endangered animals in naturalistic habitats helps zoo visitors to understand and appreciate wildlife. In turn, visitors are then more likely to be concerned about the survival of wildlife and their native habitats. Education programs help people to understand the significance of plants and animals as an integral part of life on planet earth.

Endangered Species and You

When we learn about endangered species, we come to understand the importance of healthy habitats and functioning ecosystems. We also learn how our own actions are interconnected with the survival of species and habitats. If we keep this awareness at the forefront of our minds, we can conduct our lives in ways that contribute to the survival of all the earth's species: we can conserve natural resources, limit our use of chemicals, respect the lives of animals and plants, be conservation-minded consumers, reuse everything that can be reused and recycle the rest, inform our legislators of our concerns, and help to educate those around us. If we care about endangered species of plants and animals, we must try to share our planet's land and resources with them so that we all can survive. Through our actions to save endangered species, we also help to secure the future of all species of plants and animals before they reach the brink of extinction.

A Short History of Conservation in Zoos

Humans have built and run zoos, in some form or another, for more than 3,000 years, in places such as Egypt and China (Koebner, 1994). Until relatively recently, however, the main focus of zoos did not include conservation. For thousands of years, rulers and royalty kept exotic animals primarily as symbols of power and wealth. From the beginning of the eighteenth century on, these menageries became more accessible to all classes of people, but the menageries still served principally as entertainment, satisfying people's curiosity about exotic and unfamiliar species. Animals were extensively collected in the wild and few efforts were made to breed them in captivity. In many cases, the animals did not fare well in captivity and menageries were consistently obtaining new animals from the wild.

Throughout the 1800s there grew a strong interest in natural history and wildlife. Zoological gardens in Britain aimed to increase the understanding of wildlife throughout their expanding empire by studying animals in captivity. The role of zoos in conservation began to develop in the early 1900s. At that time, for example, fewer than a thousand bison were left on the plains of the United States after decades of unrestricted hunting. However, the Bronx Zoo in New York had successfully bred bison in captivity and in 1907 the zoo, along with the New York Zoological Society (now the Wildlife Conservation Society), launched a successful campaign to reintroduce zoo-bred bison back to the plains. In zoos across North America, efforts to keep animals healthy and breed them in captivity were stepped-up as wild populations of animals desired by zoological gardens declined. In the early 1900s in Germany, Carl Hagenbeck pioneered the concept of naturalistic exhibits, with animals displayed in open areas surrounded by moats instead of bars. Throughout the rest of the century, Hagenbeck's ideas were applied and further developed in North American zoos.

Jaguars

Agnes Overbaugh

©Woodland Park Zoo

In 1899, the City of Seattle purchased "Woodland Park," the estate of the late Guy Phinney, which included some animals. The city incorporated the land into its system of parks and, with the help of park planners, developed Woodland Park Zoo. During the first several decades of the 1900s, Woodland Park Zoo had a motley collection of animals and limited funding for staff and physical development. Federal aid and a bond issue during the 1930s resulted in some improvement of zoo facilities. The bear grottoes, completed in 1951 as a part of the bond issue, were at the time considered to be among the best naturalistic exhibits in the country because the exhibits were open, unbarred and offered the bears physical features that mimicked their natural habitat. These exhibits were a far cry, however, from the naturalistic exhibits developed at Woodland Park Zoo during recent years.

In the 1970s, paralleling developments in zoos worldwide, Woodland Park Zoo began to design and construct naturalistic exhibits, which not only provided the animals with natural features, but also gave visitors the feeling of being immersed in habitats. This feeling of immersion enhanced the visitors' understanding of the relationship between animals and their habitats and highlighted the importance of preserving habitat in order to save species from extinction. Woodland Park Zoo pioneered new techniques in naturalistic exhibit design with the construction of the western lowland gorilla exhibit in 1979, setting new standards for zoo exhibits. This exhibit immersed visitors in the African rain forest habitat of western lowland gorillas through the use of large outdoor exhibit areas, extensive plantings and natural social groupings. When the African Savanna opened in 1980, visitors were given yet another perspective on

the animals. The savanna exhibits were designed to allow the visitors to look up at the animals rather than down on them. This helped to instill in visitors a sense of respect for the animals. The long-range plan of the zoo, which was adopted in 1976, grouped zoo exhibits, as animals and plants are grouped in nature, according to **bioclimatic zone**, as opposed to taxonomic group (e.g. all birds together, all bears together). In nature, the climate patterns of a region, including average temperature range and precipitation, is the primary feature that differentiates bioclimatic zones. The climate patterns determine the types of plant communities and animal life found in the bioclimatic zone. Bioclimatic zones recreated at Woodland Park Zoo through clever exhibit design and horticulture techniques include African savanna; tropical rain forest; Asian tropical forest; tundra, taiga and montane zones of northern latitudes; temperate forest; and the isolated landmasses of Australasia.

Humboldt penguins Richard Birchfield

As zoo exhibits have evolved through the late 1900s, the participation of zoos in conservation efforts has grown. The Association of Zoos and Aquariums (AZA) coordinates some of these efforts through programs such as Species Survival Plans (see "Conservation in Zoos, Aquariums and Botanical Gardens" in this packet). Concurrently, many North American zoos have adopted missions that emphasize conservation, education and research. Woodland Park Zoo has been a leader in many efforts to save endangered species, such as snow leopards, golden lion tamarins and western pond turtles, through captive breeding, habitat preservation, reintroduction, scientific investigation and public education. Now, at the beginning of the 21st century, the role of Woodland Park Zoo in the conservation of endangered species continues to develop and expand.

Since 1995, Woodland Park Zoo has supported innovative and effective field conservation work through small grants and staff directed field projects. Since 1998, the Zoo has funded 95 different projects in 41 countries for a total of over 2 million dollars going directly to the field to support species and habitat conservation efforts. In 2003, recognizing the critical need for long-term support and investment in achieving lasting results in key ecosystems and communities around the world, Woodland Park Zoo started the Partners for Wildlife program. The zoo made multi-year financial commitments to four projects with which the zoo had already been involved: the Snow Leopard Trust, the Asian Crane Conservation Program, the Botswana Wild Dog Project and the Tree Kangaroo Conservation Program.

In 1999, Woodland Park Zoo celebrated its centennial. As we look back on how zoos and the conservation of species have changed over time, we look forward into the 21st century and our further development as a conservation, education and research institution.

WOODLAND PARK ZOO

Our mission:

Woodland Park Zoo saves animals and their habitats through conservation leadership and engaging experiences, inspiring people to learn, care and act.

Endangered Species at Woodland Park Zoo

These species are listed on CITES Appendix I or as endangered under the federal Endangered Species Act, except * = listed as endangered in Washington state but not by CITES or the ESA.

COMMON NAME	SCIENTIFIC NAME
MAMMALS	
African elephant	*Loxodonta africana*
African wild dog	*Lycaon pictus*
Asian elephant	*Elephas maximus*
Chinese goral	*Nemorhaedus caudatus arnouxianus*
Clouded leopard	*Neofelis nebulosa*
Fat-tailed dwarf lemur	*Cheirogaleus medius*
Goeldi's monkey	*Callimico goeldii*
Golden lion tamarin	*Leontopithecus rosalia*
Jaguar	*Panthera onca*
Lion-tailed macaque	*Macaca silenus*
Lowland anoa	*Bubalus depressicornis*
Malayan sun bear	*Helarctos malayanus*
Malayan tapir	*Tapirus indicus*
Matschie's tree kangaroo	*Dendrolagus matschiei*
Ocelot	*Leopardus (Felis) pardalis*
Orangutan	*Pongo pygmaeus*
Red panda	*Ailurus fulgens styani*
Red ruffed lemur	*Varecia variegata rubra*
Rodrigues fruit bat	*Pteropus rodricensis*
Siamang	*Symphalangus syndactylus*
Sloth bear	*Melursus ursinus*
Snow leopard	*Uncia uncia*
Southern pudu	*Pudu pudu*
Sumatran tiger	*Panthera tigris sumatrae*
Western lowland gorilla	*Gorilla gorilla gorilla*
BIRDS	
Northern bald eagle	*Haliaeetus leucocephalus*
Bali mynah	*Leucopsar rothschildi*
Cabot's tragopan	*Tragopan caboti*
Gyrfalcon	*Falco rusticolus*
Himalayan Impeyan pheasant	*Lophophorus impeyans*
Humboldt penguin	*Spheniscus humboldti*
Palawan peacock pheasant	*Polyplectron emphanum*
Peregrine falcon	*Falco peregrinus*
Red-crowned crane	*Grus japonensis*
White-eared pheasant	*Crossoptilon crossoptilon*
White-naped crane	*Grus vipio*
PLANTS	
2 species of pitcher plants	*Nepenthes* spp.
2 species of orchids	*Orchidaceae*

COMMON NAME	SCIENTIFIC NAME
REPTILES	
Egyptian tortoise	*Testudo kleinmanni*
Dumeril's ground boa	*Acrantophis dumerili*
Indian rock python	*Python molurus molurus*
Komodo dragon	*Varanus komodensis*
Madagascan tree boa	*Sanzinia madagascariensis*
Radiated tortoise	*Geochelone radiata*
Rhinoceros iguana	*Cyclura cornuta*
West African dwarf crocodile	*Osteolaemus tetraspis tetraspis*
Yellow-spotted side-necked turtle	*Podocnemis unifilis*
INVERTEBRATES	
Partula snail	*Partula nodosa*

Ocelot Milt Huffman

Species Survival Programs at Woodland Park Zoo

Species Survival Plan

COMMON NAME	SCIENTIFIC NAME
MAMMALS	
African elephant	*Loxodonta africana*
African wild dog	*Lycaon pictus*
Asian elephant	*Elephas maximus*
Black-and-white colobus	*Colobus guereza*
Clouded leopard	*Neofelis nebulosa*
DeBrazza's guenon	*Cercopithecus neglectus*
Goeldi's monkey	*Callimico goeldii*
Golden lion tamarin	*Leontopithecus rosalia*
Fennec fox	*Fennecus zerda*
Jaguar	*Panthera onca*
Lion	*Panthera leo*
Lion-tailed macaque	*Macaca silenus*
Malayan sun bear	*Melarctos malayanus*
Matschie's tree kangaroo	*Dendrolagus matschii*
North American river otter	*Lontra canadensis*
Ocelot	*Leopardus pardalis*
Orangutan	*Pongo pygmaeus*
Pallas cat	*Otocolobus manul*
Pygmy loris	*Nycticebus pygmaeus*
Red panda	*Ailurus fulgens styani*
Red ruffed lemur	*Varecia variegata rubra*
Reticulated giraffe	*Giraffa camelopardalis reticulata*
Rodrigues fruit bat	*Pteropus rodricensis*
Siamang	*Hylobates syndactylus*
Sloth bear	*Melursus ursinus*
Snow leopard	*Uncia uncia*
Sumatran tiger	*Panthera tigris sumatrae*
Western lowland gorilla	*Gorilla gorilla gorilla*
BIRDS	
Bali mynah	*Leucopsar rothschildi*
Humboldt penguin	*Speniscus humboldti*
Keel-billed toucan	*Ramphastos sulfuratus*
Red-crowned crane	*Grus japonensis*
Victoria crowned pigeon	*Goura victoria*
White-naped crane	*Grus vipio*
REPTILES	
Aruba Island rattlesnake	*Crotalus durissus unicolor*
Dumeril's boa	*Acrantophis dumerili*
Komodo dragon	*Varanus komodensis*
Louisiana pine snake	*Pituophis ruthveni*
Radiated tortoise	*Geochelone radiata*
INVERTEBRATES	
Partula snail	*Partula nodosa*

Karen Anderson

White-naped crane

Species of Concern in Washington State

(Including species listed by the U.S. Fish and Wildlife Service and National Marine Fisheries Service)

State Status
E = Endangered
T = Threatened
C = Candidate
S = Sensitive

Federal Status
E = Endangered
T = Threatened
C = Candidate
SC = Species of Concern

COMMON NAME	SCIENTIFIC NAME	STATE STATUS	FEDERAL STATUS
MAMMALS			
Black right whale	*Balaena glacialis*	E	E
Sei whale	*Balaenoptera borealis*	E	E
Blue whale	*Balaenoptera musculus*	E	E
Fin whale	*Balaenoptera physalus*	E	E
Pygmy rabbit	*Brachylagus idahoensis*	E	E
Gray wolf	*Canis lupus*	E	E
Pallid townsend's big-eared bat	*Coryhorhinus townsendii pallescens*	C	SC
Pacific townsend's big-eared bat	*Coryhorhinus townsendii townsendii*	C	SC
Townsend's big-eared bat	*Coryhorhinus townsendii*	C	SC
Alaskan sea otter	*Enhydra lutris lutris*	E	none
Sea otter	*Enhydra lutris*	E	SC
Gray whale	*Eschrichtius robustus*	S	none
Steller sea lion	*Eumetopias jubatus*	T	T
Wolverine	*Gulo gulo*	C	SC
Black-tailed jack rabbit	*Lepus californicus*	C	none
White-tailed jack rabbit	*Lepus townsendii*	C	none
Lynx	*Lynx canadensis*	T	T
Fisher	*Martes pennanti*	E	SC
Humpback whale	*Megaptera novaeangliae*	E	E
Gray-tailed vole	*Microtus canicaudus*	C	none
Kincaid's meadow vole	*Microtus pennsylvanicus kincaidi*	none	SC
Small-footed myotis	*Myotis ciliolabrum*	none	SC
Long-eared myotis	*Myotis evotis*	none	SC
Keen's myotis	*Myotis keenii*	C	none
Fringed myotis	*Myotis thysanodes*	none	SC
Long-legged myotis	*Myotis volans*	none	SC
Yuma myotis	*Myotis yumanensis*	none	SC
Columbian white-tailed deer	*Odocoileus virginianus leucurus*	E	E
Killer whale	*Orcinus orca*	E	none
California bighorn sheep	*Ovis canadensis californiana*	none	SC
Pacific harbor porpoise	*Phocoena phocoena*	C	none
Sperm whale	*Physeter macrocephalus*	E	E
Woodland caribou	*Rangifer tarandus*	E	E
Western gray squirrel	*Sciurus griseus*	T	SC
Merriam's shrew	*Sorex merriami*	C	none
Preble's shrew	*Sorex preblei*	none	SC
Destruction island shrew	*Sorex trowbridgii destructioni*	none	SC
Townsend's ground squirrel	*Spermophilus townsendii*	C	none
Washington ground squirrel	*Spermophilus washingtoni*	C	C
Shelton pocket gopher	*Thomomys mazama couchi*	C	C
Cathlamet pocket gopher	*Thomomys mazama louiei*	C	C
Olympic pocket gopher	*Thomomys mazama melanops*	C	C

Yelm pocket gopher	*Thomomys mazama yelmensis*	C	C
Mazama (western) pocket gopher	*Thomomys mazama*	T	C
Brush prairie pocket gopher	*Thomomys talpoides douglasi*	C	none
Grizzly bear	*Ursus arctos*	E	T
BIRDS			
Northern goshawk	*Accipiter gentilis*	C	SC
Western grebe	*Aechmophorus occidentalis*	C	none
Sage sparrow	*Amphispiza belli*	C	none
Golden eagle	*Aquila chrysaetos*	C	none
Burrowing owl	*Athene cunicularia*	C	SC
Upland sandpiper	*Bartramia longicauda*	E	none
Marbled murrelet	*Brachyramphus marmoratus*	T	T
Aleutian canada goose	*Branta canadensis leucopareia*	none	SC
Ferruginous hawk	*Buteo regalis*	T	SC
Sage-grouse	*Centrocercus urophasianus*	T	C
Vaux's swift	*Chaetura vauxi*	C	none
Snowy plover	*Charadrius alexandrinus*	E	T
Black tern	*Chlidonias niger*	none	SC
Yellow-billed cuckoo	*Coccyzus americanus*	C	C
Olive-sided flycatcher	*Contopus borealis*	none	SC
Pileated woodpecker	*Dryocopus pileatus*	C	none
Willow flycatcher	*Empidonax traillii*	none	SC
Streaked horned lark	*Eremophila alpestris strigata*	E	C
Merlin	*Falco columbarius*	C	none
American peregrine falcon	*Falco peregrinus anatum*	S	SC
Peale's peregrine falcon	*Falco peregrinus pealei*	S	SC
Arctic peregrine falcon	*Falco peregrinus tundrius*	S	SC
Peregrine falcon	*Falco peregrinus*	S	SC
Tufted puffin	*Fratercula cirrhata*	C	SC
Common loon	*Gavia immer*	S	none
Sandhill crane	*Grus canadensis*	E	none
Bald eagle	*Haliaeetus leucocephalus*	T	T
Loggerhead shrike	*Lanius ludovicianus*	C	SC
Lewis' woodpecker	*Melanerpes lewis*	C	none
Sage thrasher	*Oreoscoptes montanus*	C	none
Flammulated owl	*Otus flammeolus*	C	none
American white pelican	*Pelecanus erythrorhynchos*	E	none
Brown pelican	*Pelecanus occidentalis*	E	E
Brandt's cormorant	*Phalacrocorax penicillatus*	C	none
Short-tailed albatross	*Phoebastria albatrus*	C	E
White-headed woodpecker	*Picoides albolarvatus*	C	none
Black-backed woodpecker	*Picoides arcticus*	C	none
Oregon vesper sparrow	*Pooecetes gramineus affinis*	C	SC
Purple martin	*Progne subis*	C	none
Cassin's auklet	*Ptychoramphus aleuticus*	C	SC
Slender-billed white-breasted nuthatch	*Sitta carolinensis aculeata*	C	SC
Spotted owl	*Strix occidentalis*	E	T
Sharp-tailed grouse	*Tympanuchus phasianellus*	T	SC
Common murre	*Uria aalge*	C	none
REPTILES			
Loggerhead sea turtle	*Caretta caretta*	T	T
Green sea turtle	*Chelonia mydas*	T	T
Western pond turtle	*Clemmys marmorata*	E	SC

Sharptail snake	*Contia tenuis*	C	none
Leatherback sea turtle	*Dermochelys coriacea*	E	E
California mountain kingsnake	*Lampropeltis zonata*	C	none
Striped whipsnake	*Masticophis taeniatus*	C	none
Sagebrush lizard	*Sceloporus graciosus*	C	SC
AMPHIBIANS			
Rocky mountain tailed frog	*Ascaphus montanus*	C	none
Tailed frog	*Ascaphus truei*	none	SC
Western toad	*Bufo boreas*	C	SC
Dunn's salamander	*Plethodon dunni*	C	none
Larch mountain salamander	*Plethodon larselli*	S	SC
Van dyke's salamander	*Plethodon vandykei*	C	SC
Red-legged frog	*Rana aurora*	none	SC
Cascades frog	*Rana cascadae*	none	SC
Columbia spotted frog	*Rana luteiventris*	C	SC
Northern leopard frog	*Rana pipiens*	E	SC
Oregon spotted frog	*Rana pretiosa*	E	C
Cascade torrent salamander	*Rhyacotriton cascadae*	C	none
Columbia torrent salamander	*Rhyacotriton kezeri*	C	SC
Olympic torrent salamander	*Rhyacotriton olympicus*	none	SC
FISH			
Mountain sucker	*Catostomus platyrhynchus*	C	none
Pacific herring (Cherry Point)	*Clupea pallasi*	C	C
Pacific herring (Discovery Bay)	*Clupea pallasi*	C	C
Margined sculpin	*Cottus marginatus*	S	SC
Lake chub	*Couesius plumbeus*	C	none
Pacific cod (S&C Puget Sound)	*Gadus macrocephalus*	C	SC
River lamprey	*Lampetra ayresi*	C	SC
Pacific lamprey	*Lampetra tridentata*	none	SC
Pacific hake (C. Puget Sound)	*Merluccius productus*	C	SC
Olympic mudminnow	*Novumbra hubbsi*	S	none
Coastal cutthroat	*Oncorhynchus clarki clarki*	none	SC
Westslope cutthroat	*Oncorhynchus clarki lewisi*	none	SC
Chum salmon (Hood Canal SU)	*Oncorhynchus keta*	C	T
Chum salmon (Lower Columbia)	*Oncorhynchus keta*	C	T
Coho salmon (Puget Sound)	*Oncorhynchus kisutch*	none	SC
Coho salmon (Lower Columbia/SW WA)	*Oncorhynchus kisutch*	none	C
Steelhead (Snake River)	*Oncorhynchus mykiss*	C	T
Steelhead (Middle Columbia)	*Oncorhynchus mykiss*	C	T
Steelhead (Upper Columbia)	*Oncorhynchus mykiss*	C	T
Steelhead (Lower Columbia)	*Oncorhynchus mykiss*	C	T
Sockeye salmon (Snake R.)	*Oncorhynchus nerka*	C	E
Sockeye salmon (Ozette Lake)	*Oncorhynchus nerka*	C	T
Chinook salmon (Puget Sound)	*Oncorhynchus tshawytscha*	C	T
Chinook salmon (Upper Columbia SP)	*Oncorhynchus tshawytscha*	C	E
Chinook salmon (Lower Columbia)	*Oncorhynchus tshawytscha*	C	T
Chinook salmon (Snake R. SP/SU)	*Oncorhynchus tshawytscha*	C	T
Chinook salmon (Snake R. Fall)	*Oncorhynchus tshawytscha*	C	T
Pygmy whitefish	*Prosopium coulteri*	S	none
Leopard dace	*Rhinichthys falcatus*	C	none
Umatilla dace	*Rhinichthys umatilla*	C	none
Bull trout	*Salvelinus confluentus*	C	T
Bull trout (Columbia Basin)	*Salvelinus confluentus*	C	T

Bull trout (Coastal/Puget Sound)	*Salvelinus confluentus*	C	T
Brown rockfish	*Sebastes auriculatus*	C	SC
Copper rockfish	*Sebastes caurinus*	C	SC
Greenstriped rockfish	*Sebastes elongatus*	C	none
Widow rockfish	*Sebastes entomelas*	C	none
Yellowtail rockfish	*Sebastes flavidus*	C	none
Quillback rockfish	*Sebastes maliger*	C	SC
Black rockfish	*Sebastes melanops*	C	none
China rockfish	*Sebastes nebulosus*	C	none
Tiger rockfish	*Sebastes nigrocinctus*	C	none
Bocaccio rockfish	*Sebastes paucispinis*	C	none
Canary rockfish	*Sebastes pinniger*	C	none
Redstripe rockfish	*Sebastes proriger*	C	none
Yelloweye rockfish	*Sebastes ruberrimus*	C	none
Eulachon	*Thaleichthys pacificus*	C	C
Walleye pollock (S. Puget Sound)	*Theragra chalcogramma*	C	SC
MOLLUSKS			
Newcomb's littorine snail	*Algamorda subrotundata*	C	SC
California floater	*Anodonta californiensis*	C	SC
Columbian oregonian	*Cryptomastix hendersoni*	C	none
Popular oregonian	*Cryptomastix populi*	C	none
Giant columbia river limpet	*Fisherola nuttalli*	C	none
Giant columbia spire snail	*Fluminicola columbiana*	C	SC
Dalles sideband	*Monadenia fidelis minor*	C	none
Olympia oyster	*Ostrea lurida*	C	none
Blue-gray taildropper	*Prophysaon coeruleum*	C	none
BEETLES			
Beller's ground beetle	*Agonum belleri*	C	SC
Columbia river tiger beetle	*Cicindela columbica*	C	none
Sand-verbena moth	*Copablepharon fuscum*	C	none
Long-horned leaf beetle	*Donacia idola*	C	none
Hatch's click beetle	*Eanus hatchii*	C	SC
Mann's mollusk-eating ground beetle	*Scaphinotus mannii*	C	none
BUTTERFLIES			
Silver-bordered fritillary	*Boloria selene atrocostalis*	C	none
Island marble	*Euchloe ausonides insulanus*	C	SC
Taylor's (whulge) checkerspot	*Euphydryas editha taylori*	E	C
Chinquapin hairstreak	*Habrodais grunus herri*	C	none
Makah (Queen Charlotte) copper	*Lycaena mariposa charlottensis*	C	SC
Juniper hairstreak	*Mitoura grynea barryi*	C	none
Johnson's hairstreak	*Mitoura johnsoni*	C	none
Yuma skipper	*Ochlodes yuma*	C	none
Great arctic	*Oeneis nevadensis gigas*	C	none
Shepard's parnassian	*Parnassius clodius shepardi*	C	none
Puget blue	*Plebejus icarioides blackmorei*	C	none
Mardon skipper	*Polites mardon*	E	C
Valley silverspot	*Speyeria zerene bremnerii*	C	SC
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	E	T
OTHER INSECTS			
Columbia clubtail	*Gomphus lynnae*	C	none
Fender's soliperlan stonefly	*Soliperla fenderi*	none	SC