Species Extinction: A Growing Concern

Honors Thesis (ID 499)

by

Kristin Henriksen

Thesis Director

Ball State University

Muncie, Indiana

May 1989
Floods, droughts, plagues, disease . . . all have tormented mankind throughout history. And since man's beginning, he has been forced to struggle against nature in order to survive. Yet, by the 20th century, it appears that man has begun to conquer the elements, control the forces, and rule the world. Indeed, man has prospered. Technology is expanding, the human population is increasing, knowledge is growing, and demand for natural resources is exploding. However, just at a time when man seems most in control, scientists are warning us otherwise. Biologists are insisting that the crisis we are facing today is second only to thermonuclear war (Tangley 1986). Unless drastic action is taken immediately, vital aspects of life as we know it will not exist for our children. In as few as thirty years, action will be too late.

Unlike the natural forces previously mentioned, the danger we face now is man-caused, and, because we created this problem, and, because we dominate this world, the problem is world-wide. No corner of the earth will escape the devastating effects of our dilemma. The purpose of this paper is to define and explore our plight. It will attempt to demonstrate the urgency of our predicament and will try to point out why it is of utmost importance in the minds of scientists. Finally, this paper will describe both our
situation today and the complications involved in improving our outlook.

The problem referred to above is species extinction. Just in the time it took to read the above paragraphs, one more specie may have become extinct. Scientists estimate that at least one, and perhaps two to three species per day are disappearing. At this rate, 20 to 50 percent of the world's approximately 60 million species will be extinct in 20 years. According to Norman Myers, a leading authority on species extinction, one-third to one-half of all species will be gone by the end of this century (Myers 1979). What exactly is species extinction? Where is it occurring? Why is it occurring? How will it affect us? These questions will be addressed in the following pages. Next, the moral and economic value of certain species will be explored and, finally, attempts being made to help the situation as well as the many complications involved will be examined.

What is extinction? Technically, it is defined as the extermination of an interbreeding natural population which is reproductively isolated from other groups from the face of the earth (Tangley 1986). Simply, it is the disappearance of a set of genes from this earth forever. The tragedy of this is that each set of genes is unique, separating the species and furnishing them with diverse characteristics. Each species that is lost is a storehouse of vast information. For example, Mus musculus, the common house mouse, has four strands of DNA which are tightly coiled in each of its cells.
If these four strands were enlarged to wrapping string size for study, they would extend end to end for 600 miles. Each DNA strand is a double helix and is made up of paired nitrogen bases of purines and pyrimidines. These bases are paired either as A-T (adenine-thymine) or G-C (guanine-cytosine) and are responsible for assembling our genes which determine our characteristics. If the letter for each nitrogen base from these four DNA strands were simply recorded in a book, the information obtained would be enough to fill all 15 editions of the Encyclopedia Britanica since 1768 (Wilson 1985). Imagine the information lost in a species with 92 strands of DNA as in a certain species of bird. How can we afford to lose this kind of information, especially before we are even aware of it?

We know so many details about our planet. We know its diameter and the components of its atmosphere and solar system. We know how many stars are in the Milky Way and what the mass of an electron is. We know how many genes are in a virus particle and what the surface of the moon is like. We know so much, but we have no clue about our own diversity. We do not even know to the nearest magnitude how many species live on our planet. Since the mid-1960s, the estimate has been pushed further and further upward. Just 30 years ago, the earth was considered to support three million species of which half had been identified. Scientists calculated that earth provided homes to 4100 mammal, 8700 bird, 6300 reptile, 3000 amphibian, 23,000 fish, 800,000 insect, and over 300,000
plant and fungi species. Today, some biologists claim as many as 10 million species exist, some say 30 million, while others assert that there may be 50 million species of insects alone (Tangleley 1986). Yet, since 1953, only 1.7 million species have been named. Of these, 440,000 are plants, 47,000 are vertebrates, and 751,012 are insects. The remaining are various microorganisms and invertebrate species (Wilson 1985). Even though these numbers are greater than previously expected, scientists gauge that they comprise only one-sixth of the total number of species on earth.

If a new planet were discovered, news would make front pages, money would be allotted for study, and every educated person in the world would be aware of it. This, unfortunately, is not true with biodiversity. We, as humans, tend to be more interested and fascinated with large organisms and objects. The myriads of species on earth are mainly insects, crustaceans, mites, and nematodes. Perhaps this helps to explain why so many are unaware or unconcerned with our position. However, species need our attention. Planets will still exist, probably unchanged, thirty years, but over half of our species will not.

Many argue that extinction is a natural process that should be allowed to continue. After all, we did not exterminate the dinosaurs. What extinction advocates do not realize is that this period of extinction is unlike any other in our history and cannot be compared. Mass extinctions have occurred in the history of earth every 26 to 30 million
years. According to this steady cycle, earth would be due for another mass extinction period 12 to 14 million years from now. Instead, signs of mass extinction are taking place now, breaking the cycle, and proceeding at unmatched rates (Infinite Voyage 1989). During the "great dying" of the dinosaurs, for example, approximately one species per 1000 years disappeared. Beginning in 1600, however, man became advanced enough to hunt a species to extinction, and, in the next 300 years, he was responsible for exterminating 75 known species mainly of birds and mammals. Already the extinction rate had risen to one species every four years. Between 1900 and 1960, man eliminated another 75 species, and, since 1960, extinction rates have soared. At least one species is disappearing per day and scientists estimate that the overall extinction rate may have reached 1000 species per year (Myers 1979). At this rate, we are destroying species at a rate 1000 times faster than any other extinction rate ever, and nature cannot keep up (Infinite Voyage 1989). Already enough species have been exterminated to equal the death toll of species during the dinosaur extinction period. Still, scientists are worried that in the next 25 years, extinction rates could very likely reach 100 species a day.

Another difference between extinction taking place now and previous extinctions lies in the loss of plant life. During historical mass extinctions, plant life exploded and diversified at a rate unequaled during peak periods of animal life. Today, on the other hand, we are losing plant life
just as fast, if not faster, than animal life. Whole forests
are being destroyed without hesitation. In fact, 25,000
square miles of rainforest, or an area the size of Indiana,
are being destroyed per year. In just the past minute, 50
acres of rainforest have disappeared (Tangley 1986).

This startling statistic leads to a second question:
where is species extinction occurring? Species extinction is
occurring on every continent. In the United States alone,
more than 600 plants and animals are recognized as
endangered, while 1000 more are waiting to be considered as
endangered (Kaplan 1986). According to Francis Thibodeau,
director of science for the Center for Plant Protection, more
than 10% (over 3,000 species) of wild plants alone are
threatened with extinction in the U.S. Even Canada, a
country known for its clean, fresh air and beautiful scenery
has been called an "environmental mess" by its own
environmentalists (Witt 1989).

The areas scientists are most concerned with regarding
species extinction, however, are the tropical rainforests.
Rainforests are dense growths of trees found in very wet
climates. Tropical rainforests have a constantly warm
climate with annual rainfall averaging between 60 to 100
inches. As a result of the abundance of water and the
competition for sunlight, trees in these forests often reach
a height of 100 feet or more. The largest areas of tropical
rainforests are found in the lowlands of equatorial Africa
and the Amazon River valley of South America. Other tropical
rainforests exist in Central America, in southeastern Asia, in northeastern Australia, and on the islands of Indonesia (Critchfield 1969).

Tropical rainforests occupy only seven percent of earth's land surface, yet one half to three-fourths of the earth's species inhabit these regions (Tangley 1986). Amazonia, a vast forested area in Brazil which surrounds the Amazon River and its tributaries, may be home to 30 million species alone. With its wealth of diversity, Amazonia could potentially serve as a "natural laboratory" for our study of rainforests and their valuable inhabitants. Instead, in 1987, 51 million acres of Amazonia, an area the size of Kansas, were burned for farms, cattle ranches, dams, and roads (Begley 1989). Other parts of the Amazon are being developed for hydropower, oil and mineral reserves, and farmland. Although the rainforests of Brazil may be home to more species than any other nation, they are disappearing faster than the global average. Together, Brazilian rainforests including Amazonia once comprised an impressive domain of 400,000 square miles. Today only two percent of this region has survived (Mittermeier 1987).

Brazil is not the only nation confronting immediate crisis. The forests in nearly every nation in South America are being burned for development. In a single day in September of 1988, at least 2500 separate fires were burning to clear land. An astronaut who observed South America from the space shuttle, Discovery, in October 1988 reported that
smoke from fires obscured the entire continent from his view in space (Infinite Voyage 1989). Imagine the wealth of species being destroyed as their habitats go up in flames.

Africa and Madagascar, an island east of Africa, are both fighting similar battles. The once rich forests of Madagascar now comprise only ten percent of their original domain, while the well known "African wilderness" is threatened with becoming just a string of glorified parks (Achiron 1986). Central America’s rain forests have also been victims of extreme waste.

For the past 25 years, much of the forest in Central America has been burned to create cattle pastures. Central American meat is imported as hamburger, baby food, and pet food (Uhl 1986). Because the meat produced from tropical land is leaner and is sold at a lower price than domestic meat, the demand rises. More land is cleared, more cattle are raised, and more forest is eliminated. Few people realize where their leaner, less expensive meat originates from or what kind of destruction these meat sales represent. The notion that meat on our dinner plates may originate from a steer raised on land which previously supported diverse tropical life remains abstract. Yet, what is this costing?

Studies show one acre of well-developed tropical forest can support 800,000 pounds of plants and animals. Cattle, on the other hand, gain 50 pounds per acre per year or 400 pounds in eight years which is the lifetime of a typical pasture. Total beef production from one acre of cleared land
is 200 pounds which can produce 800 hamburgers of normal size. Dividing the 800,000 pounds of possible tropical life per acre by the number of hamburgers which can be produced per acre shows that 1,000 pounds, equal to half a ton, of forest life is lost per hamburger. Also, by considering one acre equals 43,560 square feet, and by then dividing the 800 possible hamburgers into the 43,560 square feet, we see that each tropical hamburger costs us 54 square feet of forest (Uhl 1986).

Now consider this. A tropical area the size of 54 square feet commonly contains one 60 foot tree, 50 saplings and seedlings of 20-30 different species, and thousands of insects representing hundreds of species, many of which are not yet known to science. Thousands of birds, mammals, and reptiles would inhabit, use, and pass through this area, and an unimaginable wealth of mosses, fungi, and microorganisms would exist in the leaves, bark, roots, and soil. Literally, millions of diverse species would occupy a patch of tropical forest which represents a single hamburger (Uhl 1986). The short-term gain of these cattle farms comes at a high price for nature. Cattle farms do not produce for long and, once abandoned, may never contain their original abundance of forest species.

Soil in the tropics is poor and forests develop slowly, but, once developed, biodiversity in the rainforests is unprecedented. For example, according to Edward O. Wilson, Professor of Science and Curator in Entomology at the Museum
of Comparative Zoology, Harvard University, 700 separate tree species were found in a single 25 acre area in Borneo. No more than 700 native tree species can be found in all of North America (Wilson 1985). Peru, alone, contains 5000 species of trees. Several other examples of the wealth of biodiversity in the rainforests can be found in Peru. For one, forty-eight ant species have been identified on the British Isles. Forty-eight ant species have been found living in a single tropical tree in Peru (Tangley 1986). Again in Peru, a single arbitrarily chosen tree was found to support 2000 separate species of insects. Considering each tree specie contains its own ecosystem, imagine 2000 insect species existing in each of the 5000 different tree species in Peru. In North America, north of the Tropic of Cancer, 750 bird species have been identified. Central and South America contain 2780 known species. A mere 26 square kilometers of forest in Costa Rica contains at least 269 bird species. Amazonia’s rainforests contain more than two and one-half times as many vascular plants as in the three times larger area of the United States and Canada put together (Myer 1979). These examples could go on and on except for the fact that not many actual statistics are available concerning rainforest diversity. Scientists claim that not more than one-sixth of the world’s species are known to science and one-half to three-fourths of them reside in the rainforests, yet destruction continues at an accelerating rate (Stone 1986). Recall that 50 acres of rainforest are
being destroyed a minute. At this rate, we will never know what potential these forests held or what price we paid for destroying them.

Why is this occurring? Species extinction is taking place all over the world, and the primary cause of it is habitat destruction. As seen in the examples previously mentioned, destruction of the rainforests is a primary concern of scientists because it is destroying the habitat of more forms of life than anywhere else. Other biomes, although not so ecologically diverse as the rainforests, are struggling too. The United States once featured one million square kilometers of prairie. All of this, except for 16,000 square kilometers in Kansas, has become farmland. Grasslands are similarly being cultivated. Wetlands in both advanced and poorer regions are being drained, dug up, and paved over eliminating whole communities of species. Virtually every natural environment on earth is in danger of being converted to a state more "profitable" for man.

Because a United States Marine Corps Base was established in southern California in 1942, only 17 miles of beach have been left undisturbed. In this area, a unique habitat known as Chaparral exists. Chaparral is characterized by scrubby, low growing plants and trees which develop because of the effects of mild, wet winters and dry summers. Chaparral once covered most of the southwest United States but is now confined to the Marine Corps Base and fragmented islands lost in a sea of development. Chaparral
supports an array of unique plant and animal species but its plant life is being destroyed by more aggressive species introduced species by surrounding homes. Roads are cutting through the area halting the movement of animal species and limiting them to smaller and smaller spaces. As these areas decrease in size, the coyote, a key species in the chaparral ecosystem, moves on to new habitat and the balance of species is upset. Already, raccoons, opossums, and foxes, normal diet for the coyote, have severely reduced the bird population in chaparral communities.

The fundamental cause of losing biomes such as the prairies, wetlands, and communities like the Chaparral is human expansion. Today the earth’s human population is just under five billion which is twice what is was in 1950 (Levine 1986). The tide of humans is straining against the living space of plants and animals. Competition has developed between the human population and nature for places to live, to find food, and to raise young. Space is being cleared for agriculture, cattle ranches, roads, power plants, oil and mineral reserves, etc. Animals are being hunted to protect crops, disrupting nature’s delicate balance (Kaplan 1986). Poaching, illegal importing, acid rain, and pesticides, are threatening our diversity and are a result of too many people and too high a demand placed on nature and the space we allow her. By the year 2000, the population is projected to reach six billion and, by 2020, ten billion (Infinite Voyage 1989). Where can we put all the people? How can we
support them? How will nature survive? As crowded as it is today, imagine twice as many people demanding twice as much. It is a frightening thought but one that will become reality for our younger generation.

Already overpopulated areas are taking a toll on nature, especially in areas that have been previously undeveloped. Rainforests are generally located in developing geographical areas. In these areas, trees are being felled for use as fuel for cooking and heating. Nepal, a country the size of Iowa, has no roads for the delivery of chemicals for energy and fertilizer and, there, 95 percent of the trees wind up in stoves. The leaves are then used for patching, bedding, and fodder. Soon, however, nearby trees run out and human inhabitants are forced to use dried dung for fuel leaving less to nourish the fields. Erosion and loss of nutrients ruin the fields destroying the crops and causing the inhabitants to move on, leaving a wasted area behind.

In 1956, the Nepal government nationalized the forests to control deforestation. Trees continued to be cut indiscriminately, however, and, between 1965 and 1979, 25 percent of the forests in Nepal had been destroyed. Scientist estimate that in 25 years, Nepal will be bald and another whole community of species will have been wiped out (Kerasote 1987).

How is this continuous destruction going to affect us? Basically, we do not know. The question what good is a species can be compared to the question what good is a
newborn child; both hold unknown potentials. The remainder of this paper will focus on the value of species and their role in our everyday lives. It will examine their overall contributions to agriculture, medicine, and industry, will note specific endangered species, and, finally, will take a look at what is being done to save our plant and animal species and some of the complications involved.

First, however, let's examine some of the moral issues at hand. Norman Levine, professor emeritus at the College of Veterinary Medicine at the University of Illinois, argues that certain species are expendable: that extinction "is not evil;" and that the process of extinction "is normal and necessary" and should not cause anxiety. He asks "would the world really be a better place if dinosaurs and trilobites and dodos still existed?" And "do we really need snail darters and condors and black lion tamarins?" Levine’s point is that unless a species provides us with something useful, or, unless it can be "cultivated appreciably," it is not worth saving. He implies that species must benefit us, as the dominant creature on earth, before we expend time, energy, and money trying to save them (Levine 1986).

On the other hand, do we, as the dominant creatures on earth, have the right to decide which species are of value? Some species are going to disappear, but those that are exterminated by humans raise some ethical and moral questions. We are a late-coming species which solely has developed a mind for attempted control of this world. We,
alone, have been given the power to foresee and alter the future. We, as a species, have also developed morals. With these and our power, can we not do something less self-interested than saving a species simply for its resource value? Do we have the right to deny living space from the species that share our home? The majority of those of decent character will refrain from needless destruction. Is it not offensive to senselessly kill forms of life? Contrary to what Levine implies, this is not a period of natural extinction. This is man-caused, artificial extinction and is as different as death by natural causes is from death by murder. Natural extinction opens doors to newer species; forced extinction does not. Man-caused extinction is an unnatural end and creates unpredictable circumstances. Each death of a species disrupts the world's delicate balance and may cause the end for other species. In fact, with the loss of just one plant species, scientists estimate 10 to 30 other species disappear. With the loss of just one key species, a whole ecosystem can be destroyed. Myers compares the destroying of species to removing rivets from an airplane. There are tens of thousands of rivets on an airplane, but, even if just a few were removed, one would not want to ride on that airplane. How do we know when too many rivets have been extracted? (Infinite Voyage 1989)

Taking the ethical argument a step further involves the process of extinction. By disrupting natural environments and destroying species, we are intervening in natural
evolution. New species do not develop from previous species as they would do if left alone, so the evolutionary process is discontinued. By the same token, if we continue to homogenize environments for our use, few areas will be left with enough ecological diversity to encourage new species to emerge. This, again, impedes natural evolution. And, finally, ethically speaking, do we have the right to deny individuals living in the year 2000, a chance to enjoy the diversity that we now enjoy? Species are simply disappearing, and new ones are not developing. At this rate, humans living in the year 2000 will not have a chance to appreciate at least one million species that exist today.

Levine asks if the world would really be a better place if dinosaurs, trilobites, or dodos still existed? Comparing the loss of the dinosaur and trilobites to the loss of the dodo bird is like comparing the moon to a fish. We could not have saved the trilobites or dinosaurs as theirs was a natural end. The dodo bird was not. The dodo was a large land bird often weighing 50 pounds and owning small, useless wings. It evolved on the island of Mauritius in the Indian Ocean where it had no natural enemies. However, in 1598, Dutch merchant ships began to stop at the island to kill the birds for food. The birds were easy prey and, by the late 17th century, were completely extinct.

Was the world affected by the extinction of the dodo bird? Before long, following the extinction of the dodo, a change took place on the island. The Calvaria trees, trees
native to the island and all over 300 years old, were producing fertile seeds but the seeds were not germinating. The trees were dying and no younger trees existed to replace them. Apparently, while the dodos lived, they ingested seeds from the Calvaria trees. As the seeds moved through the dodo's digestive system, the shells were worn off, and, when the seeds were regurgitated or expelled, they were able to germinate. Due, then, to the loss of the dodo bird, a tree species was destroyed also. Who knows how many insects, rodents, or other forms of life depended on the Calvaria tree for survival. Who can say if we really need the snail darters, condors, and lion tamarins? Stability in ecosystems is provided by diversity, and as we lessen diversity we will be weakening stability.

Some people could rightfully point out that we have tried to eliminate smallpox, polio, whooping cough, measles, etc. We have attempted for centuries to rid ourselves of mosquitoes, fleas, moths, dandelions, and even crab grass. Obviously, species do not represent absolute values to be saved, and some tradeoffs must be made, but neither do humans represent absolute values. The only absolute value is the survival of life on earth, and to this all species contribute.

Others argue that most endangered species including the snail darter, condors, and lion tamarins have no resource value. They would be correct in saying that only 20 plants make up 90 percent of our diet and that only 150 are
cultivated appreciably, so why spend time and money on the rest?

Many human beings derive pleasure from our diversity, and, although most will never actually see a wild cheetah or a blue whale, knowing they exist provides a certain satisfaction. But besides the sentimental aspect, scientists are finding that future human beings will need the species of today to survive. Most of mankind will agree we have duties to other people. Definitely we should not harm another human being and, possibly, we should try to help other human beings. Many, such as Levine, feel that we do not have a direct duty to save a species merely for the sake of the species, but for the benefit of mankind. Even so, if losing species is endangering mankind, then we need to save the species. We do not know what plight we are creating so we must end our destruction. It is not endangered species we are discussing then but an endangered human future. Still, more and more people are demanding that species be saved only if they provide us with a tangible benefit today, not thirty years down the road. Altruistic ethics in saving the species are, in themselves, not enough to convince society and must be reinforced with self-interest. Although it seems insensitive, self-sustaining ecosystems are the only ones that are going to survive. It appears that at the present state of human intellectual development, wildlife must prove that it can pay for itself before it will be given a chance.

One way wildlife helps to support itself in dollar value
is simply to exist. The diversity of wildlife is fascinating and beautiful. Bird watchers from the United States alone spend more than half a million dollars annually on their hobby. Individuals from North America, Europe, and Japan spend billions of dollars every year traveling in search of a wild tiger, rhino, or elephant. In 1976, the World Bank loaned Kenya $36 million to improve its parks and wildlife refuges. The bank's objective was to develop wildlife-based tourism. The project now earns a 16 percent rate of return proving economically successful, while, at the same time, preserving wildlife (Fitzgerald 1986). Television, films, and books concerning wildlife also generate vast amounts of money for those unable to travel extensively (Myers 1979). Obviously, however, this is not enough. In order to save species, we must convince everyone that species are an indispensable part of our world.

Dr. Tom Lovejoy of the World Wildlife Fund sums up the feelings of many scientists concerning the value of wildlife and our study of it in his following comments:

If we were preparing for a new Dark Age, and could take only a limited number of books into the monasteries for the duration, we might have to determine which single branch of knowledge would have the greatest survival value for us. The outstanding candidate would be biology, including its applied forms such as medicine, agriculture, forestry, and fisheries. Yet, we are doing just the
contrary by throwing out the biology books before they have been written. (Myers 1979)

Species can prove to be valuable both individually and as a whole not only aesthetically, but agriculturally, medicinally, and industrially. As a whole, species maintain a balance in nature that cannot be achieved by man but that must be maintained for our survival. Individually, even uninteresting, wild species, especially plant species, can have enormous worth when genetically transferred into a commercial crop. For example, more than 7000 kinds of plants are grown or collected, yet, of these, only 20 species provide 90 percent of the world's food. Just three, wheat, corn, and rice, supply 50 percent of our food.

The danger is that, through cross breeding, scientists have developed genetically superior strains of these essential crops. Basically, then, we have a monoculture of each crop which leaves them wide open to insect attacks and diseases. Just one type of disease or destructive insect could potentially wipe specific crops throughout whole nations. The Irish Potato Famine provides a perfect example of the vulnerability of a monoculture. The famine began in 1845 when a fungus attacked the potato crop and wiped out the food supply for more than half the people in Ireland. None of the potato crops could resist the fungus, and it singly reduced the Irish population by 2,500,000 in four years. About 1,500,000 people are believed to have died of disease and hunger, and the remainder emigrated to the United States
and other countries to escape starvation.

Tragedies such as the Irish Potato Famine can be avoided with the introduction of genetic variety. Wild species of corn, for example, can be crossbred with commercial corn to add genes that may be less susceptible to the insects and diseases to which the crops of today are vulnerable. Unless fresh genes are introduced to commercial crops every five to fifteen years, they cannot maintain their productivity, and they become susceptible to new diseases. One blight among a single commercial crop today could have far worse effects than the famine had in Ireland. Tens of thousands of new strains of commercial crops exist in the wild, but they, again, are being destroyed before we have a chance to test them. Some of these new strains are demonstratably better than the strains we use now for commercial crops. An example is perennial corn. Strains of corn that automatically germinate each year have been discovered. It would become unnecessary to replant corn each year saving farmers billions of dollars if this wild strain of corn could be successfully crossed with our commercial corn crop. However, only one thousand individual perennial corn plants have been located in the wild, and all of these are in a single location - a location scheduled for development. These plants can and will be saved, but this situation demonstrates the problem. So many potentially beneficial plants are being destroyed before we can discover their usefulness.

Plant geneticists, not fertilizers and pesticides, have
produced record crops. Yields in both temperate and tropical zones have been increased by the skills of plant geneticists. For example, a strain of barley has been developed that can grow in sand and can be irrigated with seawater (Myers 1979). An entirely new crop, triticale, was produced in the late 1970s by crossing strains of wheat and rye. Finally, geneticists have increased the cultivation of sorghum, a plant rich in amino acids, by analyzing 9000 forms and producing two highly productive breeds. All this could not have been done without geneticists or genetic reservoirs existing in the wild. The following problem, however, illustrates the complexity of preserving gene pools in the wild.

In the mid-1970s, a "miracle strain" of rice called IR-8 was developed for farmers in the Philippines. The strain was highly productive but was hit by tungro disease. Farmers switched to another hybrid, IR-20, which proved to be vulnerable to grassy stunt virus and brown hopper insects. Farmers switched again to IR-26, a super hybrid, which was resistant to almost all Philippine diseases and insects. However, this strain was blown over by the strong winds characteristic of the island. Geneticists decided to breed the IR-26 with an island original which had an unusual capacity to stand up under strong winds. Ironically, breeders could not locate the island strain because farmers had eliminated it by planting virtually all of their fields with the original IR-8.
The U.S. Department of Agriculture estimates the value of improvement made in commercial crops by plant breeders equals one percent annually or $52 billion per year (Myers 1979). A wild strain of wheat from Turkey with high resistance to known United State's wheat diseases has singularly saved the United States $50 million per year. A fresh strain of onion introduced from Persia into the United States has saved us a minimum of $3.5 million per year. Columbia introduced two new strains of dwarf rice which, by 1975, were responsible for a two and one-half times increase in previous rice output, accounting for a $350 million profit. Conversely, if global warming caused by increased carbon dioxide accumulating in the air actually increases earth's temperatures two to three degrees Celsius and decreases rainfall as it is expected to, genetically adapted strains of all commercial crops may be desperately needed.

So, not only do we need wild plants for a continuous supply of fresh genes, but we need time to discover their individual value. Potential benefits for agriculture are being discovered every day. In West Africa a plant known as katemfe has been discovered to produce a substance 1600 times sweeter than sucrose; another, known as serendipity berry, produces a substance 3000 times sweeter than sucrose (Wilson 1985). A plant found in the Amazon called an aguaje palm produces a fruit much like a cross between a peach and a tomato which is packed with iron, niacin, vitamin A, and vitamin C. Its fruit also serves excellently as a flavoring
for sherbet. Another plant in the Amazon called camu camu yields fruits that have 30 times the vitamin C content of an orange has (Begley 1989). All these recent plant discoveries can be agriculturally useful to humans, but more must not be destroyed before we can discover their value.

The earth contains at least 80,000 edible plants only 3000 of which have ever been used for food. Only 150 are cultivated on a large scale, and only 20 produce 90 percent of our food. Essentially, we are using the same harvestable plants that have provided humans with food for centuries. Obviously, food possibilities are grossly underexploited and could provide answers to world hunger problems. Skillfully harvesting food sources from natural areas, particularly the tropics, could serve as another way nature and natural ecosystems can help pay for their protection.

Since tropical areas of the world are constantly warm, insects are continuously a threat. In order to combat these unrelenting pests, plants in the tropics tend to produce strong chemicals. These chemicals have been used as natural pesticides since the 1950s because they are biodegradable and do not accumulate in organisms so have little or no effect on higher birds and mammals. Insects can overcome pesticides in three to ten years, however, so new genetic combinations need to be derived constantly to stay ahead. Few plants, unfortunately, have been screened for this use so we know virtually nothing about their potential value in controlling insects in commercial crops except that it must be great.
The chemicals found in these plants often have medicinal properties. In fact, one in ten of these tropical plants contains some kind of anticancer substance of variable potency (Begley 1989). Twenty percent of all plants contain alkaloids which belong to an exceptionally valuable group of drugs. Forty percent of the drugs we use today are derived from plants, and more plants are being tested for medicinal use every day. Recently, the bark from a previously unknown tree in Peru has been discovered to act as an effective agent against cancer in lab rodents. In addition, a flowering plant in preliminary tests at the University of Illinois at the Chicago College of Pharmacy has been shown to weaken the AIDS virus (Begley 1989). A Peruvian vine root has been found to combat conjunctivitis and other eye disorders, and plants exist that Indians have used for years to treat snakebites, diarrhea, and fever. Still, less than two percent of Amazonia's plants alone have been analyzed, and less than two percent of all flowering plants which commonly produce alkaloids have been tested. These plants alone have produced thousands of useful alkaloids with a wide range of medicinal value already, but so much more is waiting to be discovered. The rainforests show extraordinary promise, but are still disappearing at a rate of 50 acres per minute.

Two particular species of exceptional value are the Purple Foxglove and the Rosy Periwinkle. The Purple Foxglove is native to western Europe and Morocco and yields digitalis, a drug which aids in the treatment of congestive heart
failure. Grecian Foxglove, a close relative of Purple Foxglove, produces digoxin which is 300 times more powerful than digitalis and which saves the lives of at least three million Americans per year. Digoxin is commercially sold in the United States for a profit of over $14 million annually.

The Rosy Periwinkle, originally found in Madagascar, grows in many parts of the tropics. Used in combination with other substances, the plant’s vincristine and vinblastine extracted from the stems and leaves have achieved remission in several forms of cancer. Before 1960, a person suffering from Hodgkin’s Disease had only a 19 percent chance of remission. Today, the Rosy Periwinkle has prompted remission in 80 percent of persons with Hodgkin’s Disease, 99 percent for those with lymphocytic leukemia, and 50 to 80 percent for individuals suffering from several other types of cancer (Myers 1979).

In addition to providing agriculture and medicine with myriads of uses, plants can also benefit industry. Industry’s ever increasing demand for new raw materials will only continue to escalate. Already, plants produce, to name a few, latex products, resins, cleoresins, gums, essential oils for flavors and juices, vegetable dyes and tannins, vegetable fats and waxes, insecticides, growth regulators, and lubricants. Lubricants are exceptionally important products in our society, and alternate materials are in demand. Many, many plants produce oils and waxes, but the Jojoba shrub is the only plant found so far that produces
liquid wax for lubricants. Besides generating lubricants, liquid wax can assist in the manufacture of textiles, leather, electrical insulation, paper coatings, polishes, carbon paper, pet foods, pharmaceuticals, and cosmetics. Alcohol and acid derivatives from liquid wax in the Jojoba plant can be used for disinfectants, detergents, emulsifiers, protective coatings, corrosion inhibitors, and bases for creams and ointments. Obviously, the value of Jojoba in our economy cannot be underestimated, and future discovery of other sources of natural liquid wax would surely help.

Rubber is another product that is indispensable to our economy. Synthetic rubber is very expensive and is in such high demand that it must be supplemented, if not replaced, by natural sources of rubber. Natural rubber has great elasticity and resistance to heat and is, therefore, in high demand for all kinds of tires. Bus and automobile tires use 40 percent natural rubber, while aircraft tires must be almost entirely made of natural rubber (Myers 1979). Demand for natural rubber is expected to exceed supply soon, so new plants which can yield rubber must also be found.

The single most widely used raw material in industry is petroleum. Petroleum, like natural gas, is plant material that has been transformed by time and weather into compressed energy. Yet, petroleum, from this origin, is a limited and nonrenewable source. Scientists have devised a way to grow energy, however, by heating vegetable matter in air-free containers. This technique yields 75 percent oil, residues
of char, and trace gases. The oil is not unlike crude petroleum and shows promise, but a steady supply of vegetable matter in large amounts is needed to "grow gasoline" in this way. Tropical legumes such as the ipilipil from Central America can provide this supply. The ipilipil can grow four meters in six months yielding two to three times more fuelwood than most other fast growing plant species. Legumes such as the ipilipil are also perhaps the most versatile plants in the world. When cattle are fed a mixture of grass and leaves from young ipilipil tees, they fatten equally as well as cattle fed from the best pastures anywhere. In addition, the ipilipil leaves can also be used in green manure for extra rich nutrient supply. Biomass energy for fuel production such as petroleum can also be obtained from plant species which produce hydrocarbons like oil, and from water plants such as algae and kelp.

Each of the previous examples shows how plant species can provide tangible benefits for man. Innumerable plant species still exist that can provide many times more benefits than we can imagine. Each beneficial specie can be harvested safely from its natural environment without disrupting the ecosystem that depends on it. Natural areas can then more than pay for their protection by providing species of such overwhelming value.

Up to this point, utilitarian benefits of plant species in agriculture, medicine, and industry have been discussed. Animals, too, can serve humans in these three categories. In
agriculture, for example, insects can be utilized to control insect pests. Because insects tend to be highly specific in their choice of prey, introducing insect predators and parasites is typically a safe way of annihilating unwanted pests. As more and more insect species are becoming resistant to chemical insecticides, and, as we see what persistent toxic chemicals are doing to our environment, the introduction of insects as a pest control seems a preferable strategy. Records show that partial or complete control of insect pests and weed problems has been accomplished in hundreds of cases. A dramatic example occurred fifteen years ago when the winter moth threatened to ruin all the hardwood forests of Nova Scotia and possibly the United States. Two parasites were introduced which controlled the moths and saved Nova Scotia alone over $12 million.

California has used biological control of pests for half a century reducing crop losses and decreasing the need for chemicals. Some cases can be cited with a gain on investment of up to 25,000 percent (Myers 1979).

Saving animal species in the wild can also benefit agriculture in some of the same ways as wild plant species do. Like plants, genetic diversity must be continuously introduced to commercial breeds of livestock. Special strains of cattle, pigs, sheep, horses, and poultry have been developed for optimum production and so are susceptible to disease and eventual decline of productivity. In many developed countries, livestock are considered to be at an
emergency level of homogenization. Related species from the wild could be used to hybridize with domestic species improving the breed's resistance and productivity. For example, crossing domestic cattle with wild bison has resulted in an animal that attains maximum weight in half the time commercial cattle take with less expensive food input. In this case, however, the problem of fertile offspring has not been overcome. Domestic geese, too, could be improved by cross-breeding them with Arctic species that feature short incubation periods or tropical species that produce eggs year round (Myers 1979).

A third way wild animal species can benefit agriculture is as food sources. Snakes and lizards have been consumed for centuries as a delicacy. Grasshoppers, locusts, termites, and grubs are widely eaten and enjoyed by individuals in arid regions. Ant species produce 25 generations in a year, and one pair can create 564 million offspring, thereby proving to be a potential harvestable food supply and already eaten by many in Mexico. Quiche made with insects may not sound appetizing to Americans, but, for many lesser developed regions, any kind of food sounds good. In addition, insects are extremely nutritious containing high amounts of protein.

Animals, either directly or indirectly, have also served medicine for centuries. Bee venom is used for arthritis, snake venom serves as a nonaddictive pain killer and aids in treatment of thrombotic disorders, and larvae from a blowfly
secrete a substance which accelerates healing of deep wounds, decaying tissues, and osteomyelitis. Indirectly, animals serve as useful biological models from which we can study and learn. The Devil's Hole pupfish, an endangered species, can withstand extreme temperatures and salinity which may help us to redesign our kidney machines (Kaplan 1986). A fish which was found in the Amazon called a black ghost knife can regenerate its nerves and spinal cord within a year. By studying the chemicals and hormones involved, the black ghost knife may offer hope to individuals suffering from multiple sclerosis (Begley 1989). Examining the physiology of long-flying birds has led to an understanding of cardiomyopathy. The armadillo may hold the key to curing leprosy as it is the only other creature besides humans to develop the disease. The Florida manatee has provided insights to research on hemophilia because of its poorly clotting blood, and elephants have helped to shed light on atherosclerosis and fatty acid problems (Myers 1979). Primates have served as especially valuable tools in medicine because of their close relationship to humans. Half of all primates, however, are endangered (Infinite Voyage 1989).

In industry, animals supply glues, fibers, leather goods, furs, and many other products. The sperm whale was pushed to near extinction in 1970 by an ever increasing demand for its oil for lubricant production. The whale is still being hunted in order to make dog food, lipstick, and fertilizer, all of which can be produced from other sources
(Kaplan 1986).

In addition to providing benefits in agriculture, medicine and industry, plants and animals can serve many other purposes. For years, aquatic weeds have caused damage and complications in many waterways, and Florida manatees may provide a welcome relief. Manatees can eat one quarter of their weight in vegetable matter per day. A canal in Georgetown became clogged requiring four men to work ten days to clear the weed, then they had to maintain the canal for several hours every week. Finally, two manatees were introduced to the area, and the canal has been kept clear with no problem (Myers 1979).

Aquatic weeds such as the water hyacinth can, in themselves, prove useful. Because they thrive on domestic sewage and can double themselves in eight to ten days, they offer potential as animal feed, fertilizer, and control for water pollution. One third a hectare of water hyacinth can purify 2000 tons of sewage daily and can also produce biogas in amounts that can be economically exploitable (Myers 1979).

Examples of the utilitarian benefits of plant and animal species such as the ones mentioned above could fill volumes, and their potential is beyond imagination. Compared to the vast amount of knowledge waiting to be discovered, we know next to nothing. Only one percent of our world's species has been thoroughly screened for utilitarian possibilities. Yet, keeping in mind the incredible array of uses that have been discovered to date, does it not seem ridiculous to
destroy species before learning about their existence? The utilitarian benefits that plant and animal species provide will most definitely repay many times over the cost of preserving and studying them while they are still alive.

The problem of species extinction was first realized during the 1950s. Governments tried to nationalize forests, but, as in Nepal, trees were felled indiscriminately, and destruction continued at accelerating rates. During the 1960s and 1970s, reforestation programs were instated in many tropical villages with the intent to educate and include locals. In Nepal, programs were inaugurated by the Australian Development Assistant Bureau in which villagers were hired as watchkeepers and storeholders. The Australia Forestry Project provided firewood, forage, and timber for communities at affordable prices. The money collected was then put towards replanting and salaries. The Australia Forestry Project provided a framework for the Community Forest Development Project which began in 1980 through a combined effort of the World Bank, the United Nations Development Program, and the U.N. Food and Agriculture Organization (Freeman 1986).

To date, these programs have really had little effect. Implemented programs do not have enough trained help and population growth demands are burning the forests faster than they can be replaced. Deforestation rates are still accelerating, but at least programs are a beginning point and are making some people aware of our plight. Programs found
to work best are those in which no dramatic goals are set and no instant cures are promised. Most importantly, successful programs are those endorsed by area residents where local opinion is respected. Program leaders need to educate by explaining reasons, describing problems, and addressing complications involved in the project. It is a complicated process which will take dedication and support by many. And, unfortunately, not enough is being done fast enough. Japan is already planning to fund the first road that will extend from the Pacific to the Amazon in order to facilitate intensive lumbering. According to scientists and stated by Senator Albert Gore, this action is simply "a catastrophe waiting to happen" (Begley 1989).

On the other hand, Brazil has established two reserves to show how native products can be safely and profitably harvested. Native species have taken eons to adapt to poor tropical soils, and, by harvesting natural species, the land can be used more effectively for longer periods of time. For example, less valuable trees can be burned or cut for sale as charcoal or timber. Commercial varieties such as the Brazilian nut tree can be left to harvest. Annuals and semiperennials can then be planted. The annuals are eventually phased out and replaced with fruit bearing trees which can also be harvested. Production can continue for 50 years before the whole cycle begins again (Begley 1989).

Unfortunately, this practice is uncommon and natural areas all over the world are being threatened. Even
protected areas such as national parks and refuges are endangered. The World Heritage Program classifies a few parks each year as so valuable that protection is imperative, not only for the country in which they exist, but for the whole world. Three of these appear on a list developed by the International Union for Conservation of Nature and Natural Resources (IUCN) of "Threatened Protected Natural Areas of the World" (Cahn 1985). These three include Garamba National Park in Zaire, Yugoslavia's Durmitor National Park and Tara Canyon, and Nigorongom Conservation Area in Tanzania. Garamba National Park is suffering because of poaching and inadequate managing. In this park, the white rhino count which was estimated at 1300 in 1963 has been depleted to a mere ten. Durmitor National Park and Tara Canyon is being threatened by pollutants from a lead processing factory upstream. Also, a proposed hydroelectric project will flood the Tara, one of Europe's last wild rivers. The Tara River is known for its diversity of flora and fauna but developers cannot be convinced of its biotic value.

Also in the top ten on the IUCN's list of "Threatened Protected Natural Areas of the World" is North America's John Pennekamp Coral Reef State Park and Key Largo National Marine Sanctuary in Florida. The park is suffering because of land development, filling, dredging, and pollution. Many scientists feel the Everglades National Park, also in Florida, should have been included on the list because the
bird population has been decreased by 90 percent in the past
50 years due to reduced water supply and pollution (Cahn
1985).

Another complaint involving the IUCN’s list was the
IUCN’s decision to remove from the list Cape Tribulation
National Park, an area containing three biomes including a
mangrove swamp, a tropical rainforest, and a coral reef. The
park was originally included on the list but was removed
because of pressure from the Australian government which
wanted a road built through the area. The park was removed
from the list and the road was built. The road was washed
out and is now closed, but it continues to harm the
ecosystem’s delicate balance.

Other parks that are included in the top 43 of the
IUCN’s list are Wrangell St. Elias National Park and St.
Matthew Island of Alaska Maritime National Wildlife Refuge in
Alaska, Canada’s Wood Buffalo National Park, the Indiana Dune
National Lakeshore, Peru’s Manu National Park, and
Indonesia’s Kutai Game Reserve. Both Alaskan parks are being
threatened because of oil development projects. The Indiana
dunes are endangered because of water pollution, acid rain,
and commercial and residential activities. Canada’s Wood
Buffalo National Park will suffer if a proposed hydroelectric
dam is built. Eight hundred species of birds are threatened
in Peru’s National Park due to forestry, agriculture, oil and
mineral exploration, canal projects, and road development.
One hundred and fifty bird species are endangered in
Indonesia's Game Reserve also due to timber and oil exploitation (Cahn 1985).

As hopeless as statistics make the situation appear, many are still trying to stop the onslaught. In Canada, Mulroney has devoted hundreds of millions of dollars to clean up the St. Lawrence River and Great Lakes. He is committed to cutting Canada's acid rain causing emission by 50 percent by 1994. President Bush, in the United States, has also promised early acid rain action in Congress (Witt 1989).

Also in the United States, the Center for Plant Conservation is attempting to build a living genetic library. Previously, the U.S. Fish and Wildlife Service has only been able to protect 60 endangered plant varieties under the Endangered Species Act. The Center for Plant Conservation is established in 17 U.S. facilities already, and it is pushing to collect and preserve all endangered plants in the United States. Similarly, the National Plant Germplasm, a organization funded by the U.S. Department of Agriculture, will concentrate on gathering information on agriculturally useful species. State organizations have been established by the Nature Conservancy to compile inventories of rare plants and animals to recommend which are in most urgent need of protection (Gilbert 1985). European plant species are also being documented by the Kew Botanical Gardens (Fox 1985).

Zoos, gardens, and genetic libraries can protect individuals and can save specific genetic combinations, but they cannot entirely replace natural areas. The ongoing
dynamism of gene flow under the selection pressure in a wild biome is natural evolution (Rolston 1985). By destroying generative processes in the wild, we are tampering with evolution and are, in the long run, changing the natural course of our world.

Parks provide a better answer, but nations are going to have to protect much larger areas if ecosystems and their wild species are going to survive. Fragmented habitats cause rapid extinction of species in most ecosystems. Even if an area is reduced by one-tenth, the number of species will be reduced by one-half (Myers 1979). The American bald eagle, an endangered species, needs large areas in which to hunt food. If its natural habitat is disturbed, it will stop reproducing. Cranes, too, need large areas in order to mate. Unless a pair of cranes can live in a 1000 acre area of undisturbed marsh, they, too, will not reproduce (Kaplan 1986).

The biggest complication in saving species other than over population of humans is money. The United States and other developed nations will have to decide what value species hold for them. They need to decide which species to protect and which to leave alone. In poorer, lesser developed countries, protected areas are too inadequately funded. Stronger nations are going to have to help. Amazonian countries owe an international debt of $200 billion, and, if the world values the Amazon, the world will have to pay for it (Begley 1989). It is only going to cost
more in the future if nations procrastinate.

Another complication is attitude. People need to be informed about what we are doing to our world, then care about the devastation. Developed countries are the only countries with the power to abate continued destruction, yet developed countries have agricultural and industrial needs that encourage continued deforestation. Companies from Japan and the United States, for example, are leading the destruction of old-growth forests in the United States. Both the United States and Japan recognize the need to take care of species but both balk at saving habitat for species. The Japanese have spent large amounts of money to feed cranes in their country but are unable to protect enough land for them all. The government in Japan has also refused to illegalize whale hunting even though most other countries have. They claim that whale consumption is a cultural tradition. A poll taken in Japan concerning whale consumption revealed that 54 percent of Japanese had not eaten whale at all in the last five years, and only 26 percent had eaten it more than four times in the last five years (Di Silvestro 1987). Ironically, they insist on upholding a tradition that will eventually ensure that no more whales will exist to eat.

In another poll, both Japanese and Americans were tested. Sixty nine percent of Americans polled responded that they would be willing to pay higher prices for tuna if nets were developed in which fewer porpoises would become entangled. Only 34 percent of Japanese agreed. In response
to a question on whether or not society should fill a wetland for development even if it endangered a species, 54 percent of Japanese said they would, while only 38 percent of Americans agreed. These examples illustrate the Japanese's lack of understanding of the broader concept. After studying Japanese culture, Di Silvestro concludes that Japanese seem to regard themselves as being taken care of by nature. They do not, as a society, feel responsible for nature, and they place greatest value on wildlife when "restricted, formal, and idealized" as depicted in Japanese gardens and in their careful construction of the Bonsai trees (Di Silvestro 1987).

On the other hand, the formalized view of nature in Japan can be regarded not as a restriction of nature, but as a celebration of forms from natural environments. The Japanese have kept their landscape much cleaner than have Americans and their idealizations of natural forms serves as worship to nature and calls attention to its beauty. In Japan, litter is not a problem as it is in the United States. The Japanese also have very little soil erosion take place in their country in comparison to that in America.

The point is that developed countries must take the responsibility to improve overall attitudes. Education must help us all to finally realize that nature can only take care of us if we take care of her. There must be a give and take relationship in order for both sides to survive. The Endangered Species Act, funded by the U.S. Fish and Wildlife Service, is a program that is designed to return to nature
some of what has been given to us.

The purpose of the Endangered Species Act is to protect "species, subspecies, or population which are interbreeding natural populations that are reproductively isolated from other groups" (Steinhart 1986). Problems enter when trying to decide whether an endangered population is reproductively isolated or not. For example, the dusky seaside sparrow is the world’s rarest bird. At one time, over 6000 lived in the Cape Canaveral area but, since 1968, due to land development and marsh drainage, the number declined to 1800. They were then placed on the Endangered Species list and a small refuge was set aside for their protection. Further development, however, pushed the bird to the brink of extinction. In 1980, six birds were found, all male. They were captured and have been bred in captivity with the Scott’s seaside sparrow. Five have now died, and the last one is ten years old. He is spending his last days perched in a cage at Walt Disney’s Resort in Florida. For the past nine years, genes from the dusky seaside sparrow have been ladled into the Scott’s seaside sparrow, and breeders now have a bird that is 92 percent dusky. However, the Fish and Wildlife Service has labeled the hybrid bird a "synthetic species" and will not recognize it for protection. The Service regarded the bird as biologically extinct as soon as only males were found in the wild and no money has been spent on them since.

Red wolves are facing a similar situation. Of 65 that were tested, only 14 passed tests screening for hybridization
with wild coyotes. The Mexican duck has been taken from the endangered species list because evidence has shown that it interbreeds with the Texas mallard. Evidence has also been recorded that the Louisiana black bear and the Florida panther may be tainted with other genes. The Florida panther lives in the Everglades and due to real estate which is disturbing the natural water flow, its domain is shrinking. Only 11 to 25 cats are known to exist today, and its future looks bleak (Mishara 1986).

The Endangered Species Act prepares a list of identified species that are threatened with extinction. Once a species is listed, the Act develops a program for recovery and then funds and monitors the recovery. According to the Act, federal projects can be halted if they threaten the habitat of an endangered species. The Act also states that it is illegal to damage or dig up endangered plants (Byrne 1988).

Attaining a position on the list is an extremely long wait for a species, and it does not always mean rescue. It can take more than two years to make the list and, even now, only half of the species on the list have recovery plans in place (Gilbert 1985). Only 430 species have been added to the list in the past twelve years, and thousand of species are waiting to be added. While waiting, a possible 170 have become extinct (Byrne 1988). Even finally making the list does not ensure salvation. The last habitat of the endangered Palos Verdes blue butterfly was bulldozed after it had made the list (NPCA Report 1985).
The Act has succeeded in some cases though. Because of it, the whooping crane population has recovered from 15 in 1941 to over 150 today (NPCA Report 1985). The Act is also responsible for bringing the Florida alligator back from the brink of extinction.

Other animals that are being protected under the Endangered Species Act include the Muriqui, a large ape-like monkey of South America; the golden lion tamarin, a beautiful squirrel sized monkey of Rio de Janeiro; and Africa's black rhino and elephant. Some endangered animals included in the top twelve on the list are Africa's white rhino; the kouprey, a primitive wild ox; and the 20 foot long Orinoco crocodile found in Venezuela along the Orinoco River (Cahn 1985).

Most of these animals are not especially useful to mankind and are, perhaps, not key species in their ecosystems. But they do represent our plight and many have become symbols for the need of a conservation movement. Larger, exotic animals serve to gain attention for the rest of our endangered species.

In Brazil, 21 species and subspecies of primates exist. Sixteen are found nowhere else and fourteen are endangered. The muriqui has served as a symbol for the plight of endangered species for years. The population of this large, ape-like monkey has been separated into ten widely isolated pockets of forest surrounded by development and continued deforestation. Only 350 to 400 of these monkeys still exist in less than five percent of their original home. This
animal has never bred in captivity, and because there is no gene flow between the isolated pockets in the wild, it will not be long before this symbol becomes just another extinction.

In Africa, poaching is the big cause of extinction. The white rhino, the black rhino, and the African elephant all have rapidly depleting populations because of illegal hunting. In 1970 65,000 black rhino’s existed in Africa. Today they are extinct in most parts of the continent with only scattered groups enduring. The rhino’s horn, which is used to make dagger handles and which has medicinal value, is the chief object of the illegal killing. During the 1970s, the horn rose in value from $17 a pound to $300 per pound. It is no wonder armed gangs overpower park guards in search of the black rhino (Achiron 1986).

Elephants have also been illegally slaughtered for years. Ivory obtained from elephant tusks is a $500 million industry (Achiron 1986). Just last year, 60,000 African elephants were illegally slaughtered, and, although nearly a million remain, they are already extirpated and reduced by 80 percent in most areas (Infinite Voyage 1989).

The death of a species is not a dramatic event. The curators will report the death of the last dusky seaside sparrow to the Florida Division of Wildlife, to the U.S. Fish and Wildlife Service, and to the National Audobon Society. Remorse may be expressed in some newspapers, and the corpse will be frozen in hopes of some day cloning surviving cells.
Finally, a last search in the wild may take place before the species is removed from the endangered list.

To many, the death of a species will go unnoticed. Some will neither know nor care that a dusky seaside sparrow ever existed. But, will the world be the same place environmentally? One more species exterminated. Biologists were aware of the dusky seaside sparrow, but what of the hundreds, thousands, even millions of species we being killed unknowingly? Every species depends on still other species and each plays a role in keeping the world going. Each species that dies removes the potential for finding a lifesaving drug, a gene for breeding more highly productive crops, and, if nothing else, a part of our natural history. "Destroying species is like tearing pages from an unread book written in a language humans hardly know how to read" (Rolston 1985). We are only one in a world of perhaps 60 million species. We all share this planet, and, with each extinction, our home loses some of it beauty and wonder. It does not have to be species or humans. Hopefully, through increasing awareness, thoughtful consideration to development decisions, and continuing educational programs, our grim outlook can be reversed. The longer the delay, the greater the cost of future reclamation.
Species on the Edge: A Case Study

On Easter Sunday, April 19, 1987, a lone California condor glided gracefully through the California skies with hardly a flap of its wings. Five biologists lying in wait below caught their breath at the sight of the gigantic, jet black bird soaring so easily above them. The California condor is the largest flying land bird in North America with a wing span measuring just under ten feet. It is coal black except for a fleshy red head and long, white feathers on the underside of each wing. Condors are a living link to prehistoric history as they have roots beginning in the Pleistocene Epoch. At one time, they ranged over most of western North America feeding on dead saber tooth tigers and woolly mammoths. Today, due to the loss of habitat, collecting of eggs, collisions with power lines, hunting, pesticides, and lead poisoning, the condor seen soaring above the biologists waiting in the Bitter Creek National Refuge below is the last free flying California condor.

Peter Bloom, one of the five biologists in waiting, knows this bird well. He has been tracking him for months, and, in the process, has learned that condors are capable of traveling 150 miles a day at speeds of up to 80 miles an hour. They can
ride a thermal wind for ten miles without seeming to move their wings. At times, they appear to hang in flight before suddenly diving to earth for a meal. Throughout these months, Peter Bloom says that the bird above them known as AC-9 has been "very methodical. You get the feeling he knows something's up" (Nielson 1987).

AC-9 is seven years old. He was born in 1980 at the base of a cliff in the Angeles National Forest. When he was 45 days old, biologists from the Condor Research Center carefully picked him out of his nest and measured and weighed him. In 1984, he was tagged IC-9 for "immature condor." In the fall of 1985, he met his first mate, AC-8 and earned the name AC-9 for "adult condor." AC-8 was older and more experienced and had recently been widowed. She chose AC-9 over two older males, AC-2 and AC-5, and they became the only breeding pair of condors left. Condors mate for life, and the breeding of AC-9 with AC-8 was the first time biologists had ever known of a condor replacing a dead mate (Di Silvestro 1986).

Controversy concerning the safety of the California condors has been raging for years. In the 1930s, the Audobon Society studied 100 condors. Since then, two condors have disappeared per year due to man related causes. Condors lay only one egg every other year, and many of the laid eggs were not hatching because of the pesticide known as DDT which caused the female to lay eggs with shells that were too thin and broke before a hatchling developed. By the 1950s, it was evident that the condor population was declining faster than it was
being replaced. Two opposing viewpoints then developed: the hands off view felt that humans should not be involved in saving the bird except in protecting its habitat; the hands on view argued that the bird would surely die if it was not taken into captivity to study. Those with the second view insisted that unless biologists could better understand the condor, it could never be saved.

The hands on side seemed to be winning when the San Diego Zoo in California was granted permission by the U.S. fish and Wildlife Service to obtain a captive breeding permit. However, the National Audubon Society, at that time a strong believer in hands off treatment of the condors, went to court in a successful effort to revoke this license. By 1980, continued decline of the condor population caused the Audubon society to switch camps. It joined the efforts of the United States Fish and Wildlife Service in forming the Condor Research Center (CRC). The CRC began tagging condors, visiting their nests, and tracking the birds with radio devises in order to learn more about them. However, the same year, a chick died while being measured. A two year freeze was placed on the program, but, in 1982, the CRC regained its permit. Biologists from the program discovered that female condors would replace broken or stolen eggs, so they began collecting laid eggs to take to zoos to hatch (Nielson 1987).

David Brower, president of Friends of Earth and a leading spokesman against the hands on viewpoint, was furious and declared that the CRC was "destroying the condor in order to
save it" (Nielson 1987). Like many, Brower felt the condor could never be the same bird as without human intervention.

An end to the argument finally came when six California condors died in a single winter. In the fall of 1984, twelve condors existed in the wild. By spring, only six remained, only one of which had ever successfully bred (Murphy 1985). The U.S. Fish and Wildlife Service decided to capture the last six birds, but the Audobon Society once again switched sides and sued the work of the CRC in capturing the wild condors. The Audobon Society argued: one, of the 21 birds held in captivity, none had ever bred; two, capture of the wild condors would make it harder to resist developers trying to build in their protected habitat; and, three, that by this action, the CRC would be "ending a culture in the wild and [would not] be able to get it back" (Murphy 1985). The Audobon Society felt that condors displayed in zoos would become used to people and could then never roam wild again.

While the case was being held in court, AC-3, the last breeding female, was found in a field. AC-3 held special status among biologists because she was known to be unusually fertile and had already produced five eggs which had successfully hatched in captivity. Veterinarians found that AC-3 was suffering from lead poisoning from a gunshot wound. They also discovered that she had ingested a bullet from a carcass she had eaten which resulted in lead poisoning in her digestive tract paralyzing it. She died on the operating table one month after she was found (Murphy 1985).
After AC-3's death, hope was diminishing. An article described the California condor as one of the "most breathtaking sights" but a "sight this generation may be the last to see" (U.S. News and World Report 1986). Facts were building supporting the hands on treatment. First, wild condors were disappearing much faster than anticipated. Second, although zoos owned 21 condors, none had been displayed to the public and human intervention had been kept to a minimum. Third, eggs were hatching successfully in captivity, and, lastly, seven Andean condors, a close relative to the California condor, which had been raised in captivity had successfully joined a wild flock (Nielson 1987). In 1985, the U.S. Fish and Wildlife Service was granted permission to capture all wild California condors until their "reason for decline was better understood and arrangements could be made to reintroduce them to the wild" (Di Silvestro 1986).

Before capture, AC-9 mated with AC-8. AC-8 laid their first egg which subsequently broke because of DDT induced egg shell thinning. A month later, she laid a second egg which biologists moved to the San Diego Wildlife Zoo where, on June 6, 1985, it hatched successfully. The day little Nojoqui hatched, its mother was captured. Only three male condors were left in the wild (Raloff 1986).

Dead carcasses were set out with biologists in waiting. Mesh nets were shot over the bird as soon as it landed to feed. AC-2 was caught and only two remained. AC-9 watched as AC-5 was captured. He rested on a tree branch with the biologists'
truck below him and never moved. Bloom said that he seemed almost friendly and watched the capture of AC-5 as if fascinated. In his experience, Bloom recalls that he has "never seen a condor so curious" (Nielson 1987).

Peter Bloom waited again Easter morning. At 10:15AM AC-9 drifted down from the sky, awkwardly landed by a stillborn goat, and began feeding. Within minutes, cannons fired and a mesh net surrounded him. AC-9 was hurried off to the San Diego Wildlife Zoo where he is contained in an 80 foot long cage with 13 other condors (Lang 1987). The skies have been cleared of the California condor. Nature will survive because other birds of prey can clean up the carrion, but does it matter that the condor does not exist in the wild?

The condor is telling us that something is going wrong with our environment. By saving the condor, we are proving that we care what is happening to the earth. By studying the condor's habits, we can learn how to improve conditions that caused their extermination in the wild. It is about time we show that we care what is happening to our world. To date $20 million has been spent to save the condors, as much as the cost of a single F-16 fighter (People Weekly 1988). Yet, this money has been well spent. The California condor is helping us understand our environment and the condition of this rare feathered family is improving.

UN-1 and AC-4, two captive California condors laid an egg March 3, 1988 signaling the first conception to ever take place in captivity. The 28th member of the condor family was hatched
after 61 hours of struggle. Veterinarians aided in the process fearing the chick would become exhausted and die. The newborn named Molloko, an Indian name for condor, was supported throughout by a tape of grunts, chirps, and claw rustling imitating noises which would be made by its parents. Molloko is fed chopped mouse from a puppet which looks like a condor's head (People Weekly 1988). In six months, it will make a lumbering takeoff and will begin to fly. This bird, however, will never fly free skies. 

Geographers Frank Davis and Joseph Scepan, of the University of California at Santa Barbara, and Linda L. Blum, of the National Audubon Society, are working to ensure that future chicks will survive in the wild. They are studying environmental factors affecting the condor by utilizing a computerized mapping system. By comparing the 15,000 sightings of the condor in the last 15 years along with environmental variables, geological and ecological information is being gathered which will be used to reintroduce the condor to the wild. Many of the cow and game range previously frequented by the condor, for example, will be converted to agricultural and residential areas by the time the California condor is ready to be released, so new sites must be found (Science News 1987). Hopefully, through a combined effort of scientists, the California condor, a bird zookeepers claim has a "Labrador retriever personality" and which seem more related to storks than birds of prey, will someday fly free again.
WORKS CITED


