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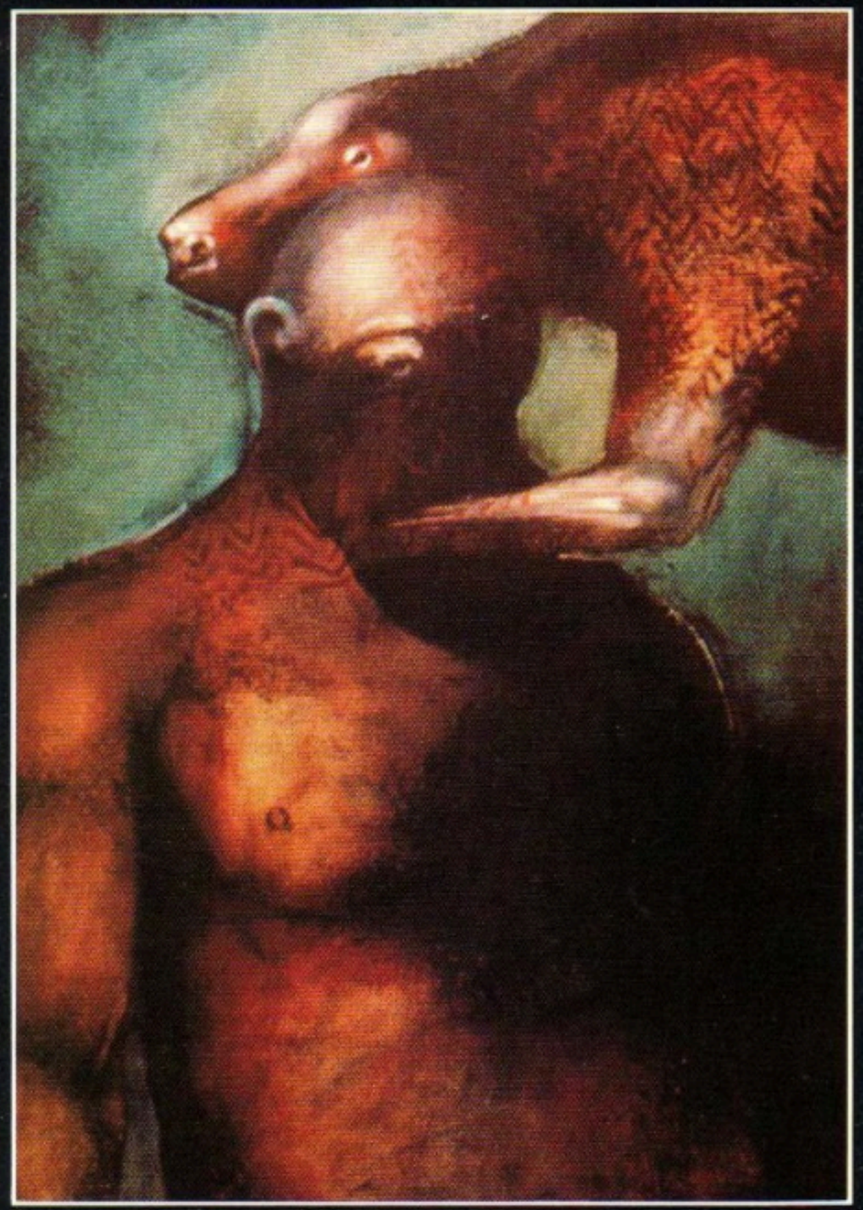
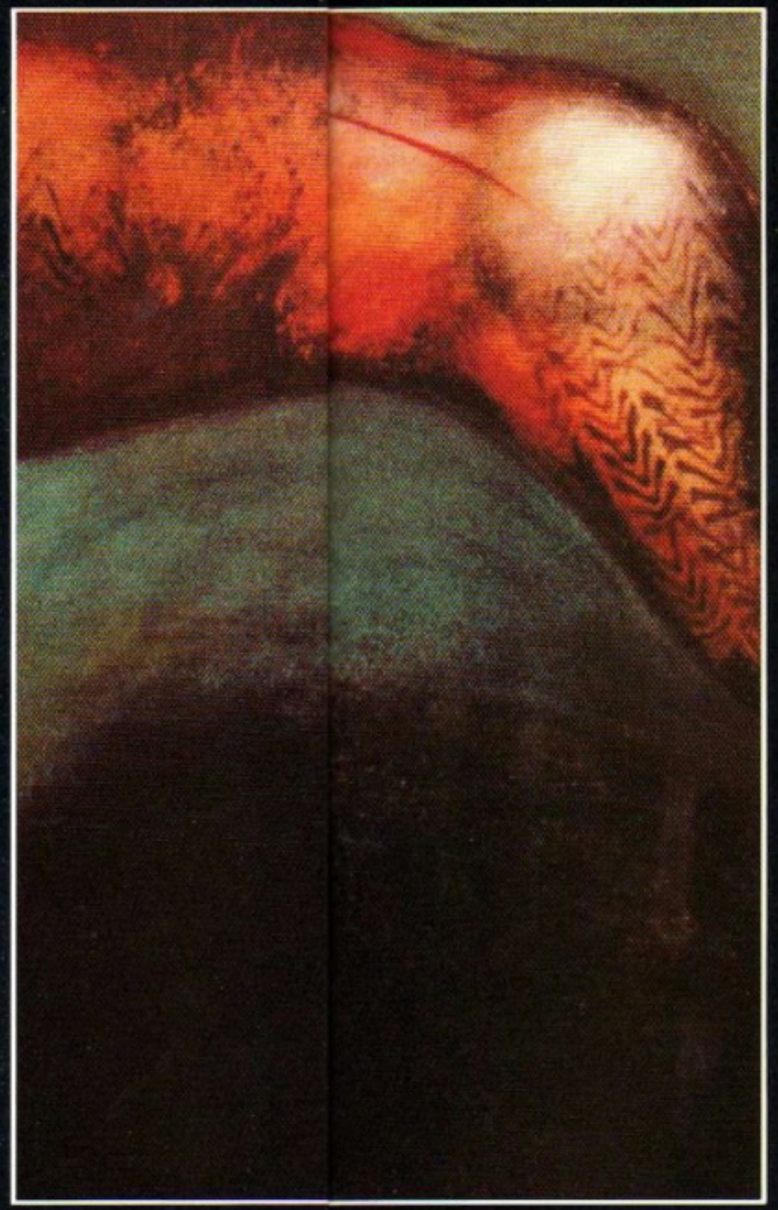
ARK DE TRIOMPHE

BY CATHY SPENCER





Science's success in saving the ferret, wolf, grizzly, and cheetah could prove to be a step toward preserving Earth—and all its inhabitants

PAINTING BY MARSHALL ARISMAN

Hundreds of rivets hold an airplane together. If one of those rivets is lost, the aircraft is in little danger of crashing. As more rivets are removed, however, the chance of disaster steadily increases. Paul Ehrlich, a biologist and one of the leading spokesmen for world conservation, compares biological diversity—plants, insects, fish, and other animals—to the rivets of an airplane. One thousand species near extinction each year, and by the Nineties, the figure may rise to more than 10,000 a year—or one species every hour. "The more species lost," says Ehrlich, "the greater our chances for meeting an ecological disaster that will cause Spaceship Earth to crash."

Thirty million species are thought to populate the earth. As the tropical rain forests in Central and South America are developed, half of the world's arsenal of plants and animals literally goes up in smoke. Agricultural practices wipe out thousands of plants and animals; many species are being hunted to extinction; and land development eliminates prime habitats for a wide variety of species.

Species lost in North America in the last ten years include the dusky seaside sparrow, whose last member died in captivity on June 16, 1987; the Palos Verdes blue butterfly of California; the Louisiana vole; Sherman's pocket gopher; and the killifish, a Western species of fish. By 2000 the ruby-throated hummingbird, the rough-leaved loosestrife, the southern sea otter, and Kemp's Ridley sea turtle may also be memories.

The relationship between man and all other life forms ensures our survival, and as species begin to disappear, scientists scramble to protect them. Breakthroughs in technology and medicine that have transformed our world in the last few years now provide scientists with ways to preserve species incapable of surviving on their own. Wildlife biologists at Yellowstone National Park, for instance, are observing the effects of stress on elk by implanting heart monitors in the chests of some of these animals. New strains of vaccines, such as a genetically engineered vaccine for rabies, are being tested to protect species from deadly viruses. As the populations of such endangered species as wolves and grizzlies decrease, it may become necessary to inoculate the animals in order to protect the remaining individuals.

COMMON BONDS

Just why is the fate of these species inextricably bound up with our own? Because each and every species plays a significant role in the life cycle of others. Some species provide us with food; others supply cures for deadly diseases; and others keep our environment clean.

Before researchers can help species recover, though, they need to know how a species interrelates with the other species in its ecosystem. Scientists, for instance, once called old-growth forests biological deserts—stagnant, useless remnants of nature. Recently, however, studies have revealed how important these ancient trees are to the health of the rest of the forest.

All forests reduce soil erosion and siltation, which helps keep our water clean and protects the fish in streams, lakes, and rivers. The extensive root systems of ancient stands are better than most forests at trapping nutrients, explains Jerry Franklin, the chief plant ecologist for the USDA Forest Service. Because fewer nutrients are lost and less sediment escapes into the streams, old-growth forests (which are primarily in the Pacific Northwest) tend to produce cleaner water and support larger fish populations than do younger stands of trees.

The canopies of these trees are equally important. By adapting equipment from mountaineering and sailing, scientists have been able to climb and work in the

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300-year-old trees without harming them. "Hundreds of organisms have been found to live in the canopies," says Franklin, "from lichens, invertebrates, and arthropods to birds and mammals."

In the last 30 years, however, these ancient trees have been cut down at an average rate of up to 170 acres per day on both private and public land. As these stands of old-growth forest disappear, the population of the northern spotted owl—an "indicator" species—declines. An indicator species can be used to measure the health of plant and animal communities in the forest. By preserving an indicator species, habitat scientists preserve a whole spectrum of biological diversity. The owl's entire habitat needs to be intact for a healthy population of this species to exist. If the owl begins to die out, this indicates that something is wrong in the habitat. "If our planet isn't safe for birds, fish, and insects, then it's not safe for humankind," says Michael Bean, chairman of the wildlife program at the Environmental Defense Fund.

Alan Franklin, a research associate at Humboldt State University in Arcata, California, is studying the survival and reproduction habits of the northern spotted owl. From April 1 to August 31, Franklin and his colleagues spend ten days at a time in the forest tracking the birds and four days resting back in town. The study team works 16 to 18 hours a day and sleeps on the forest floor in the open under the stars. "The spotted owl needs thousands of acres to survive," says James Pissot, a wildlife specialist for the National Audubon Society. Old-growth forests provide a good habitat for the owl's main food sources, the northern flying squirrel, the red tree vole, and wood rats. The multilayered canopy—cooler in summer and warmer in winter—suits the owl's climatic needs as well as protecting it from becoming a meal for the great horned owl.

Creating a safe environment for all life forms is the goal of hundreds of scientists from dozens of different disciplines. And perhaps for the first time in years, man's concern for his fellow creatures is growing. This was evident in the case of the three California gray whales trapped in the ice off Point Barrow, Alaska, last October. Scientists, Eskimo, environmental activists, and the crews of two Soviet icebreakers joined together to help the whales make their journey. An Eskimo elder told his people to "think like the whales" as the escape route was cut with chain saws in the ice. Without the aid of humans all the whales would have died.

Unfortunately, not all of man's attempts to save plant and animal species end so successfully. Part of the reason: It isn't always easy to decide how man can best help preserve other species. Two different schools of thought have evolved among scientists and environmentalists. Some scientists believe it is usually best to let nature run its course, and will thus allow species on the verge of extinction to die out. Other scientists, however, feel that each species must be protected in order to preserve the delicate balance of the ecosystem. They will take extreme measures to save a species that's on the brink of extinction.

YELLOWSTONE: THE EXPERIMENT

Policies used to maintain the plants and animals in Yellowstone National Park have relied on both these schools of thought. A gigantic biological laboratory teeming with wide varieties of species, Yellowstone has, over the years, served as a window on nature. Like Alice in Wonderland, a visitor entering Yellowstone steps into a world unlike anything else on this planet. Virtually unchanged for millennia, the park contains dark crater lakes where beaches are covered with black volcanic sand. White pelicans glide like prehistoric birds over the rock formations that sculpt the terrain.

The National Park Service, responsible for the day-to-day care of Yellowstone, strives to protect and preserve the park in its natural state. The agency has

had its share of successes and failures. Had some of the natural processes been left undisturbed, severe problems might have been avoided. From the early 1900's to the late Sixties, "the function of the natural system was totally disrupted," says biologist Paul Ehrlich.

In the early 1900's, for example, the Park Service was convinced that predatory mammals were killing off the entire population of deer, antelope, and bighorn sheep in Yellowstone. As a result government agents shot 781 mountain lions, 20 wolves, and an undisclosed number of bears, as well as other species. As it turned out, the predators had not been responsible for the decline of other species in the park; the Park Service's own program to feed the elk populations with domestically grown hay had caused the problem. The hearty diet drastically increased reproduction rates, and the elk began overrunning and overgrazing Yellowstone. This forced the deer, antelope, and sheep to move to areas outside of the park where they could still find something to eat.

When Yellowstone scientists began to understand that sometimes a natural process is good for the ecosystem, one of the most controversial policies was established. In 1972 the Park Service decided to allow natural forest fires to burn (fires started by lightning are considered natural). The "let burn" policy met with a nationwide uproar when fires raged in Yellowstone last summer. Some members of Congress called for the resignation of William Mott, the director of the National Park Service; and Secretary of the Interior Donald Hodel and President Ronald Reagan were both quick to support a public outcry to stop the Park Service from letting natural fires burn. Bleak news reports fueled the fear that the entire park was being destroyed.

In actuality many benefits were reaped from the fires. According to park superintendent Robert Barbee, fires help renew life in lodgepole pine forests, the predominant species of pine tree throughout Yellowstone. Without fire the trees cannot repopulate. The pine cones release their seeds only after being exposed to the high temperatures of a fire. "Some of the cones had laid dormant waiting for fire since the late 1500's," Barbee explains.

Furthermore, few animals were known to have been killed by the fires. In fact, the fires helped create new wildlife habitat. Green shoots of grass appeared over the blackened forest floor three weeks after some areas had burned. The ash left by the fire puts rich nutrients back in the ground, which then promotes succulent new growth.

"The fires didn't burn as much forest as the news reports indicated," says David Vales, a doctoral candidate in wildlife biology at the University of Idaho. "The figures indicating the number of acres burned refer to the perimeter of the fire. Within that fire perimeter by early September, only about forty or fifty percent of the forest actually burned." Since then, prolonged dry periods have caused additional areas to burn. When fire moves through a forested area, a patchwork is created. Driven by wind, the fire pushes forward, igniting only about one third to one half of each section of forest.

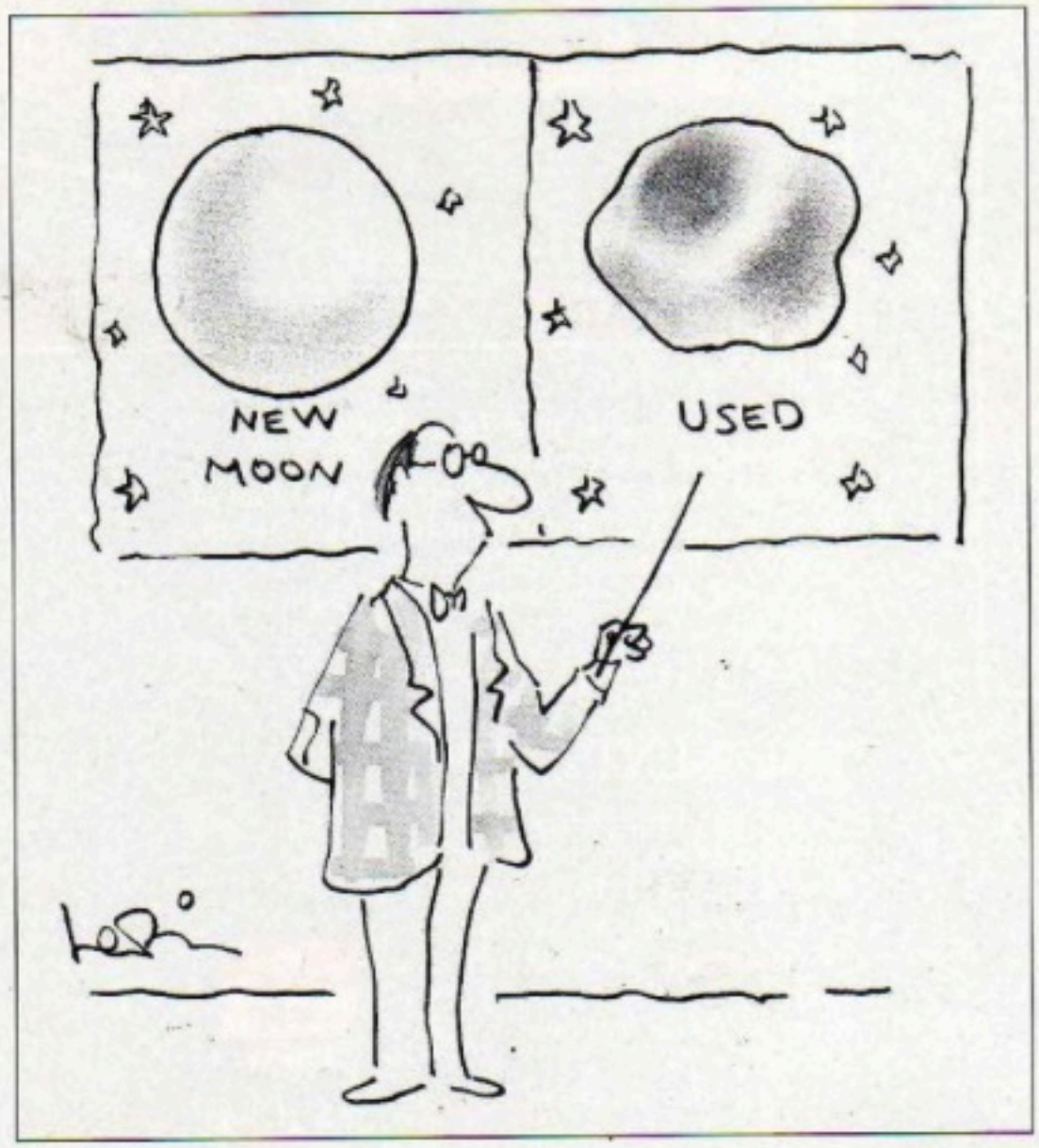
Vales, who is studying a small number of mature bull elk to learn about their winter survival strategies, tried to stay in the field during the fires to watch his subjects. Some days the smoke loomed too thick to fly over the summer grazing areas, and at one point Vales, threatened by fire, had to move out of his living quarters. But this was the opportunity of a lifetime for a wildlife biologist. Rarely do such extensive fires affect a large wildlife refuge, and scientists are unsure how much human intervention should be applied in such a situation. Park Service managers now must decide if the policy to let fires burn naturally in Yellowstone will continue through this year. This decision, however, may already be greatly influenced by strong public opinion.

Every day the Park Service is forced to make decisions for or against nature taking its course. And the right decision is often unclear. In the spring of 1984, for instance, the Park Service let nature decide the fate of four bears. A female grizzly and her three cubs accidentally became stranded on an island in the middle of Yellowstone Lake. After much deliberation, the agency chose not to intervene. All four bears, unable to help themselves, slowly died of starvation.

When man must intervene, he is armed with high technology. Recent medical breakthroughs in reproductive biology and genetics have already been adapted to save other species. In an effort to increase the populations of some species, reproductive biologists are implanting the embryos of zebras into horses, for example, and geneticists are breeding animals of the same species but from different zoos to produce offspring with more varied genetic makeups. The desire and need to preserve other life forms have become so urgent that soon after a scientific breakthrough occurs, it is applied in the field as part of programs to assist wildlife biologists.

Through the technique of observation, scientists including Jane Goodall, George Schaller, and Mark and Delia Owens are making the most valuable (and probably the best-known) contributions to the preservation of other species. Most biologists in the wild observe all day or all night, while the rest of their time is spent huddled in a tent in the windswept Kalahari Desert or in subtropical climates.

Researchers in Yellowstone also make observations and collect data. In 1986,



for example, Maurice Hornocker, director of the Wildlife Research Institute at the University of Idaho, began a five-year study on the mountain lion. The study team captures, tranquilizes, and tags each lion, then attaches radio transmitters to each animal to monitor its behavior and habitat requirements. Researchers hope to determine how the lion fits into the overall scheme of the Yellowstone ecosystem and what action, if any, man should take to help this species.

The mountain lion recovery program reflects man's changing attitude toward his fellow creatures. The mountain lion is one of the three big North American predators; the other two are the grizzly and the wolf. Hated and feared by man, predators were either killed or forced to flee to remote areas when humans tamed the wilderness in this country. Now, however, we've come to realize that predators, like all species, play a significant role in the overall balance of nature.

"The predator control program in the early part of this century wiped out the entire population of lions in Yellowstone," says Hornocker. When he began his study three years ago, he didn't believe a single lion would be found in the park. Preliminary reports showed, however, that perhaps 20 lions resided full-time in the park. Hornocker feels that most of these mountain lions migrated from Montana.

Other findings suggest that the Yellowstone lions appear to have developed characteristics unlike those of other lion in the country. According to John Varley, director of research at Yellowstone, these lions weigh up to 25 pounds more than other mountain lions, which may indicate an evolutionary trait developed to overcome a 700-pound elk.

The researchers tracking the lions are also trying to determine if the lions follow the elk herds into their summer ranges. Even though most of the big game animals—deer, elk, bison—stay in the park year-round, during the winter they migrate to lower elevations where there is less snowfall. If the lions follow their prey into summer ranges, then they are evolving according to the availability of their food source. All other mountain lions set up a home territory and never migrate. The Yellowstone lions would have to set up a summer and a winter range—an unusual trait, says Varley.

"The mountain lion is a real success story," says Hornocker. "It can adapt to many different situations and has been able to cope with modern times as long as its habitat requirements are met." All the mountain lion requires from man is a minimum amount of protection.

The wolf and the grizzly, on the other hand, have experienced much more difficulty in coping with changes and have survived in only a few isolated pockets.

The eerie cry of the wolf has been absent from Yellowstone National Park and its environs for more than half a century.

Extraordinary animals, wolves share food with the old that can no longer hunt, give one another gifts, remain monogamous, and watch over their pups. According to recorded history, a wolf has never killed a human, and it will move out of an area if more than three humans occupy a square mile. In the next decade, thanks to radio tracking and studies done on the behavior of other populations of wolves, the wolf may again take up its role as one of the three dominant predators in the park. The Park Service plans to bring the wolves back, but unlike their predecessors, these wolves will be manipulated by man. Radio collars will monitor and control their activities as they move about the park and into outlying areas. If researchers want to examine or move a wolf, particularly one that has strayed, the team will locate the animal from the air and push a button connected to a radio signal transmitter. That, in turn, will activate a needle in the animal's collar, injecting a tranquilizer into its neck. Otherwise, the wolf's strong homing instinct may compel the animal to return to its home range.

Scientists will establish three management zones for the wolf recovery program. There are no fences or gates to keep the wolves inside the park boundaries, so outlying areas of public and private land are part of the zoned areas. In the first zone wolves will be allowed to roam freely. They will share the second zone with other users, such as ranchers, hunters, and farmers. In the third zone wolves will be relocated or killed if they interfere with other land users.

"Restoring the wolves in Yellowstone will have a major impact all over the country and probably all over the world," says Hank Fischer, the northern Rockies representative for Defenders of Wildlife, a nonprofit educational organization. "The world will see that we respect the wolf's right to exist." The return of the wolf may also encourage other parks to start reintroducing predators that have been lost from their original habitat. A survey of park visitors indicates that they are in favor of reintroducing the wolf by five to one.

Unlike the wolf, the grizzly managed to hang on to its place in Yellowstone. Still threatened with extinction, the grizzly is vulnerable to any change in its environment and must be watched closely if it is going to survive. DNA fingerprinting—a method used to study each individual chromosome—is now helping park scientists develop an acute understanding of the grizzlies in Yellowstone. The DNA imprinting will help distinguish the differences between the Yellowstone grizzly and the Glacier Park grizzly and will also reveal the distinct characteristics of each individual bear.

Park scientists are most interested in the population dynamics of the grizzly—in other words, charting a family tree. Female grizzlies may mate with two or three male bears during each breeding season. If this is true, scientists speculate that it's possible for separate ova to be fertilized by each male, and if so, each cub in a litter may have a different father. DNA analysis should determine which bears have fathered which cubs in a litter. One half of the DNA fingerprinting of a mother and daughter will be identical, and the other half of the daughter's DNA will match one half of her father's. The researchers hope to find out which males are doing the mating in the park and how the bears are related. This will provide insight into how the bears from different parts of the park and outlying areas interact. Scientists can then predict where bears reside at certain times of the year and how far they'll roam to mate.

Counting a population of bears is no easy task: Elusive animals, they run away from approaching humans. Yet the Park Service needs to ascertain the number of bears so scientists can intervene if the population begins to drop. An elaborate system has been devised to determine the approximate size of the grizzly population. Characteristics such as birth rates, death rates, number of young per animal, and size of litters are all fed into a computer program that estimates the overall life span, breeding age, and other idiosyncrasies of a future population. These numbers are then compared with a number determined by counting the females with newborn cubs.

Female bears have cubs every three years. In any given year (year one) there are at least so many females with newborn cubs. In the following year (year two) a different group of females will have newborns. In year three those females with new cubs represent yet another group of females. This process determines the approximate number of breeding females in the Yellowstone grizzly population. The computer figures, plus the female–cub ratio, show a yearly increase of 1.5 percent since 1983 (three times greater than the increase in the world's human population).

Duplication in the count, however, is bound to occur, says Frank Craighead, who, with his brother John, conducted the first scientific research on the grizzlies in Yellowstone. In 1988 they counted 19 sows with newborn cubs, which is a good indicator of the population recovery. "But what is important is how many yearlings show up in the spring," Frank Craighead points out. "If only a fourth of the yearlings live through the winter, then that is not a recovering population."

During a study from 1959 to 1970 the Craigheads focused primarily on the grizzlies that came to the park garbage dumps. The brothers pioneered tagging, radio tracking, and identification techniques that have become a part of every wildlife field study. The Craigheads tracked grizzlies to their dens and col-

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"Leon's done it! He's discovered this year's disease!"

thing backward, and get mechanical power—with great efficiency. But this is something I *don't* have confidence in, unlike the other ideas I've discussed.

And here's an off-the-wall idea, something where the calculations that say either you can or can't do it haven't been worked out yet: First, nanotechnology will make it possible to build enormous reflecting telescopes using thin film materials in deep space. I mean telescopes on the scale of planets and solar systems. If you look in just one direction, you can make a telescope that'll work just fine. Then these telescopes might peer at light bent by a black hole. So you might see what our solar system looked like hundreds or thousands of years ago, using the black hole, in effect, as a mirror.

Omni: Could you zero in and see, for example, Columbus crossing the Atlantic?

Drexler: It depends on the size of the black hole, unfortunately. The resolution you can get on objects is proportional to the size of your mirror—the larger the better. In this case it would be the diameter of the zone in which light is turned one hundred and eighty degrees by the black hole. That's not much larger than the diameter of a black hole. And stellar black holes are not all that large. The really large ones tend to be in the middle of a thick mass of matter in the center of galaxies, which may be too opaque to do the trick with them.

It's pretty clear that you can do this trick, at least for nonrotating black holes with everything lined up right, but the question is, How much light are you capturing and how much resolution do you have? In principle, you could recover light emitted in the past and therefore see into the past. But it may be that your view is very dim and blurry, so that you can't see any kind of human-interest stuff.

Omni: You used to be heavily involved in the space-settlement movement. Why have you changed your focus?

Drexler: At present my suspicion is that we will have assemblers and nanotechnology before we have large-scale space development using more conventional technologies. With replicator-based production, we'll get superior materials for spacecraft and so forth, all at trivial costs. As a result, large-scale opening up of the space frontier will be easier.

Omni: So you think we should develop nanotechnology before we go into space?

Drexler: It's not that I think that's the way it *should* be. I think that it's the way it probably will be. Not too long after we learn to apply nanotechnology to produce a space system, we'll build domed museums over whatever small, struggling installations we've previously built on the moon or Mars. These will be declared branches of the Smithsonian Museum, and theme parks will be built next to them. Regular tourist traffic will begin, with the tickets being extraordinarily cheap. And we'll go on from there. ∞

ARK DE TRIOMPHE

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lected data on age, sex, death rate, range, and social interaction among animals. They grew to know and understand the grizzly's needs and behavior.

In 1967 the Craigheads' census showed that the grizzly population consisted of 202 animals. Around that time the Park Service decided to close the garbage dumps. The agency felt that feeding bears was unnatural and was "creating an environment overpopulated with bears." The Craigheads warned that the grizzlies were a fragile species and that a slight change in their habits could cause their numbers to plummet.

Between 1969 and 1970 all the dumps were closed, and by 1973, 189 grizzlies were killed. Their crime was entering campgrounds in search of the garbage they were accustomed to eating. In 1980 only 46 bears were counted in the park. Did the Park Service make the right decision to reestablish a population of bears independent from man? Today "there isn't a single bear alive that was alive when the dumps were here," admits Superintendent Barbee.

Frank Craighead still believes that the grizzly should be lured away from populated areas by placing carcasses in remote areas. He feels a constant source of high-quality food would also increase reproduction and decrease mortality of the grizzlies. In the meantime the Park Service will continue to protect the grizzly by closely monitoring its population. As long as its numbers are not in jeopardy, the bear will remain free roaming.

SCIENCE AND THE FERRET

Some creatures need more help from humans than others. Sometimes the fate of an entire population requires complete human control to prevent a species from vanishing. The most endangered mammal in North America—the black-footed ferret—was nearly lost. Science enabled the species to recover.

Fundamental to any species' survival is its ability to produce offspring. With the help of two wildlife veterinarians deep in the hills of Sybille, Wyoming, the ferret is doing this. Don Kwiatkowski and Tom Thorne do everything from monitoring breeding sessions to collecting and freezing male sperm.

To help the male ferrets become good breeders, they "practice" with semidomesticated Siberian polecats. Male ferrets are fertile about four weeks before the females, and according to Kwiatkowski, "The more the males are bred, the better breeders they become." Kwiatkowski, who lives in a small trailer less than 100 yards away from the ferret compound, is guardian of the ferrets 24 hours a day, seven days [illegible]

When the female ferrets are in heat, the marathon begins. Ferrets can injure one another during sex (the females are especially aggressive), so Kwiatkowski and Thorne have hooked up video cameras and microphones to each cage in the long, narrow rooms where the ferrets mate. Thorne and Kwiatkowski keep a 24-hour watch on the animals during the mating season. The researchers also observe the ferrets to study their behavior during mating and make sure breeding occurs. While Thorne sleeps on a small cot in an environment as sterile as an operating room, Kwiatkowski keeps a vigil on the ferrets. While Kwiatkowski sleeps, Thorne keeps watch.

During the 1987 breeding season the two veterinarians spent 100 days and nights watchdogging the ferrets' lovemaking. The vigil was reduced to 25 days and nights during the 1988 breeding season, and this year's monitored sessions are expected to be even shorter. Thirty-four kits have survived from 44 babies born to 13 litters in 1988, and seven of eight kits survived in 1987. The veterinarians believe that the 1989 breeding season will produce even more kits. Thorne and Kwiatkowski are just two of the hundreds of people who've contributed to the ferret's survival. Their supporters include nutritionists, fertility specialists, chemists, geneticists, field biologists, and concerned citizens.

No black-footed ferrets are known to exist in the wild, though researchers are still hoping a colony will turn up in Montana. Many sightings have been reported in Wyoming, but all have turned out to be false alarms—prairie dogs whose faces have been accidentally blackened by coal deposits in their burrows. "Tracking down reported sightings of black-footed ferrets is worse than trying to find the Tasmanian tiger," admits Tim Clark, a wildlife biologist at Idaho State University, who often responds to the reports himself. Clark has spent 15 years in the field looking for black-footed ferrets.

The chance of finding another colony of ferrets is less than 1 percent—yet the New York Zoological Society has offered a $5,000 reward to anyone who happens upon a black-footed ferret. If a new colony of ferrets is discovered, it will have been isolated from any other ferrets for 30 to 50 years. The genetic makeup of a new colony would be very different from that of the Sybille colony. A chance to introduce a varied gene pool would obviously help ensure the species' future.

THE CHEETAH AND EVOLUTION

The black-footed ferret could not have survived without the aid of man and science: Nature could no longer sustain the species. In some instances, however, nature has been able to heal itself. Like the black-footed ferret, the African cheetah suffers from a limited gene pool. Yet [illegible]

years with ten to 100 times less variation in its genes than most big cats.

The cheetah apparently suffered a dramatic reduction in its population hundreds of years ago. "As the cheetah went through this population crisis, its defective genes were wiped out. The species came through the crisis genetically homogenous, with far less genetic variability but with the defective genes so reduced in numbers that inbreeding could proceed without substantial loss to the species," says E. O. Wilson, the renowned evolutionary biologist.

Stephen J. O'Brien, a geneticist at the National Cancer Institute in Frederick, Maryland, and other geneticists agree that even when a population is reduced to just seven individuals, the species can still retain 95 percent of its genetic variability. The cheetah was reduced to a few individuals by one or more events such as a drastic climate change, a viral or bacterial plague, or loss of habitat.

In addition to reducing the cheetah's numbers, the squeeze on the gene pool also resulted in a high infant mortality rate and left the species more vulnerable to disease. And even though the cheetah is the world's fastest animal, reaching speeds of up to 70 miles per hour, today's cheetah can run only a few hundred yards before collapsing from exhaustion, says O'Brien. This weakness has developed over hundreds of years.

In an experiment conducted by O'Brien, dime-size patches of skin were exchanged among 12 unrelated African cheetahs. In cats domesticated as pets such grafts are rejected within seven to ten days. The patches exchanged among the cheetahs grew together and healed, as if the cheetahs were identical twins. The genetic makeup of the grafted animals was identical and likely represented the entire population.

This proves that even though some animal populations have been reduced to very small numbers, which drastically limits their gene pool and makes the species more vulnerable to environmental changes, the species may still be restored to an adequate population. Furthermore, the species may exist for hundreds or even thousands of years.

Since the cheetah's first population crisis is estimated to have occurred 10,000 to 12,000 years ago, natural selection—the evolutionary process by which the least adaptable individuals fail to survive—has surely by now eliminated the most defective genes in the population.

Unlike the cheetah, man cannot run 70 miles per hour, but the automobile can easily surpass this speed. Unlike the mountain lion, the wolf, and the grizzly, man cannot hunt with his bare hands, but we have developed ways to manipulate livestock through farming and ranching. Unlike the northern spotted owl, we cannot fly freely, but we have devised technology that allows us to soar in contraptions far faster than any bird. Unlike the black-footed ferret, we cannot wiggle our bodies into underground colonies, but our homes are built above and below ground with some of nature's finest products. Unlike any other creature on Earth, man has an intellect. Nonetheless, there is a bond that ties all life forms together. The relationship between man, the forests, the northern spotted owl, the black-footed ferret, the cheetah, the many species of butterflies, the plankton in the oceans, the grizzly, the wolf, and the mountain lion—all plants and animals—is a delicate balance of interrelationships critical to every species' survival.

"Not only do we need the resources that nature provides for our daily needs, but our state of mind requires the presence of the natural world to live up to our fullest capacity," says Wilson. "Our connection with nature runs deeper than most members of the human race appreciate, acknowledge, or understand."

Man is in a unique situation. We are the first thinking species that has evolved on Earth, and we literally dominate the world. We have the opportunity to mold the future of all life forms—by taking the present into our own hands.