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AVMA Animal Welfare Forum: the veterinarian's role in the welfare of wildlife

November 7, 1991, Chicago, Illinois

"The purpose of the 2nd Animal Welfare Forum, sponsored by the AVMA, was to highlight the important role that veterinarians play in the ever increasing animal welfare issues. The theme addressed that part of the animal world known as wildlife.

With each passing year, we are becoming more acutely aware of the interactions of human beings with the part of their environment known as wildlife. Some species, such as grey wolves, have almost completely disappeared, whereas others, like white-tailed deer and Nutria, have proliferated to a point that is bound to be detrimental to their surroundings and the human beings with which they live.

The undomesticated animals of this world probably perceive the universe quite differently from their domesticated counterparts, and undoubtedly different from human beings, and therefore are, in themselves, a very unique and irreplacable treasure of our world.

As civilization advances, and thereby shrinks the habitat of wildlife, we must accept the responsibility of the welfare of all life forms. The onus to do so falls upon the veterinary profession: We must help develop the technology and constantly provide the tools and necessary safeguards, so this precious gift of nature will be with us and future generations forever.

The group of speakers assembled at the Forum highlighted and elucidated the wildlife welfare issues from three aspects: philosophical, political, and management.

I know you will find their papers informative and stimulating."—Dr. Sherbyn Ostrich, Chairman, Executive Board

The following papers were submitted by the speakers at the 1991 AVMA Animal Welfare Forum, held at the Palmer House Hilton in Chicago. Over 200 people participated in the 1991 Forum, which concluded with the presentation of the 1991 AVMA Animal Welfare Award to Dr. James R. Scott of Anchorage, Alaska.

The success of the 1991 Animal Welfare Forum was ensured by contributions from the following sponsors: The Hartz Mountain Corporation; Hill's Pet Products, Inc; Hoeschst-Roussel Agri-Vet Company; Hoffman-La Roche, Inc; Kal Kan Foods, Inc; MSD AGVET, Division of Merck and Co, Inc; Pfizer, Inc; Pitman-Moore, Inc; The Procter and Gamble Company; The Upjohn Company.

The AVMA Animal Welfare Forum is an annual event, planned by the AVMA Animal Welfare Committee under the direction of the AVMA Executive Board. The first Forum was held on November 9, 1990, and included presentation of the first AVMA Animal Welfare Award to Dr. Lawrence W. Bartholf of Greenfield Park, New York. The 1992 Animal Welfare Forum will be held in Chicago on November 5, and will cover the topic of pet overpopulation. For additional information on the Animal Welfare Forum or the Animal Welfare Award, please contact the AVMA Division of Scientific Activities.

Ethical responsibilities toward wildlife

Holmes Rolston III, PhD

Save the whales! —The world cheered in the fall of 1988 when we rescued 2 gray whales from the winter ice off Point Barrow Alaska. The whales were stranded for 3 weeks, several miles from open water, rising to breathe through small, and shrinking holes in the ice. Chainsaws cut pathways through the ice and a Russian icebreaker broke open a path to the sea. We spent more than a million dollars to save them; they drew the sympathy of millions of people. A polar bear, coming in to eat the whales, was chased away. Television confronted the nation with the plight of the suffering whales. Seeing them sticking their heads out of the ice and trying to breathe, everybody wanted to help. We saved the whales. People felt good about it.[1]

But was that really the right thing to do? Maybe it was too much money spent, money that could have been used better to save the whales—or to save people. Maybe money is not the only or even the principal consideration. Maybe our compassion overwhelmed us, and we let these 2 whales become a symbol of survival, but they do not really symbolize our duties in conservation and animal welfare. The whales needed help; maybe we need help thinking through our duties to wildlife. Consider a less expensive case, no big media event.

Let the bison drown!—In February of 1983, a bison fell through the ice into the Yellowstone River, and, struggling to escape, succeeded only in enlarging the hole. Toward dusk, a party of snowmobilers looped a rope around the animal's horns and, pulling, nearly saved it, but not quite. It grew dark and the rescuers abandoned their attempt. Temperatures fell to −20 F that night; in the morning the bison was dead. The ice refroze around the dead bison. Coyotes and ravens ate the exposed part of the carcass. After the spring thaw, a grizzly bear was seen feeding on the rest, a bit of rope still attached to the horns.[2]

The snowmobilers were disobeying park authorities, who had ordered them not to rescue the bison. One of the snowmobilers was troubled by the callous attitude. A drowning human being would have been saved at once; so would a drowning horse. It was as vital to the struggling bison as to any person to get out; it was freezing to death. A park ranger replied that the incident was natural and the bison should be left to its fate.

A snowmobiler protested, "If you're not going to help it, then why don't you put it out of its misery?" But mercy-killing too was contrary to the park ethic, which was, in effect: "Let it suffer!" That seems so inhumane, contrary to everything we are taught about being kind, doing to others as we would have them do to us, or respecting the right to life. Isn't it cruel to let nature take its course?

The snowmobilers thought so. But was the Yellowstone ethic too callous, inhumane? This ethic seems rather to have concluded that a simple extension of compassion from human ethics or humane society ethics to wildlife is too nondiscriminating. To treat wild animals with compassion learned in culture does not appreciate their wildness. Perhaps we are beginning to see the trouble with rescuing those whales. Or maybe we are carrying this let-nature-take-its-course ethic to extremes.

Let the lame deer suffer!—In April 1989 in Glacier National Park, a wolverine attacked a deer in deep snow but did not finish the attack, possibly interrupted by 2 workmen who saw the event from a distance, a rare sighting of an endangered species. The injured deer struggled out onto the ice of Lake McDonald, but, hamstrung, could move no further. Many visitors saw it; a photograph appeared in the local newspaper. Park officials declined to end the deer's suffering. Possibly the wolverine would return. So the lame deer suffered throughout the day, the night, and died the following morning.[3] Can this be the right ethics for a wild animal, so inhumane and indifferent? Or has ethics here somehow gone wild in the bad sense, blinded by a philosophy of false respect for cruel nature? Park officials can sometimes be compassionate. The same spring that the lame deer was left to its fate a bear was injured when hit by a truck, and Glacier Park officials mercy-killed the bear.

Leave them to the coyotes!—On Christmas Day

From the Department of Philosophy, Colorado State University, Fort Collins, CO 80523.

1987 in Theodore Roosevelt National Park in North Dakota, park visitors found 2 bucks with entangled antlers. One buck had already died and coyotes had eaten the hind parts, also nipping the rear of the live buck, emaciated from the ordeal. Taking compassion, the visitors sought the park ranger on duty, who did return to help them photograph the unusual event, but explained en route the park ethic. Wild animals should be left to their fates; human beings should not interfere. The would-be rescuers seemed to agree. But that night they sneaked back to saw off the antlers of the dead buck. The freed buck trotted away; the rescuers left, with coyotes howling nearby, thwarted from their kill. "We're glad we had the opportunity to save his life," one of them said, although he faces a park citation and a $50 to $100 fine.[4,5]

The rescue of individual animals—a couple of whales, a bison, a few deer—is humane enough and does not seem to have any detrimental effects, but that may not be the end of moral considerations, which ought to act on principles that can be universalized. It will help to consider populations, herds with hundreds of animals. Perhaps that will bring our duties toward the welfare of wild animals into clearer focus.

Let the blinded bighorns starve!—The bighorn sheep of Yellowstone caught pinkeye (infectious keratoconjunctivitis) in the winter of 1981 to 1982. On craggy slopes, partial blindness can be fatal. A sheep misses a jump, feeds poorly, and is soon injured and starving in result. More than 300 sheep (more than 60% of the herd) perished.[6,a] Wildlife veterinarians wanted to treat the disease, as they would have in any domestic herd, but the Yellowstone ethicists left the sheep to suffer, seemingly not respecting their life. The decision was based on the fact that the disease was natural, and should be left to run its course. Had they no mercy? Was this inhumane?

But perhaps mercy and humanity are not the criteria for decision here. The ethic of compassion must be set in a bigger picture of animal welfare, recognizing the function of pain in the wild. The Yellowstone ethicists knew that, although intrinsic pain is a bad thing whether in human beings or in sheep, pain in ecosystems is instrumental pain, through which the sheep are naturally selected for a more satisfactory adaptive fit. Pain in a medically skilled culture is pointless, once the alarm to health is sounded, but pain operates functionally in bighorn sheep in their niche, even after it is no longer in the interests of the pained individual. To have interfered in the interests of the blinded sheep would have weakened the species. Simply to ask whether they suffer is not enough. We must ask whether they suffer with a beneficial effect on the wild population.

[a]Meagher M. Yellowstone National Park, Wyo: Personal communication, 1984.

Of course we treat our children who catch pinkeye. We put them to bed and draw the curtains, and physicians prescribe eyedrops with sodium sulfacetamide. The *Chlamydia* organisms are destroyed and the children are back outside playing in a few days. But they are not genetically any different than before the disease, nor will the next generation be different. When the grandchildren catch pinkeye, they will be treated with eyedrops too. But that is an ethic for culture, for which human beings interrupt and relax natural selection. The welfare of the sheep still lies under the rigors of natural selection. As a result of the park ethic, only those sheep that were genetically more fit and able to cope with the disease survived; and this coping ability is now coded in the survivors. What we **ought** to do depends on what **is**. The **is** of nature differs significantly from the **is** of culture, even when similar suffering is present in both.

Wildness overrides compassion!—A human being in a frozen river would be rescued at once; a human being attacked by a wolverine would be flown by helicopter to the hospital. Bison and deer are not human beings and we cannot give them identical treatment. Still, if suffering is a bad thing for human beings, who seek to eliminate it, why is suffering not also a bad thing for bison? After all, the poor bison was struggling to get out of the ice. We cannot give medical treatment to all wild animals; we should not interrupt a predator killing its prey. But when we happen upon an opportunity to rescue an animal with the pull of a rope, or mercy-kill it lest it suffer, why not? If we can treat a herd of blinded sheep, why not? That seems to be what human nature urges, and why not let human nature take its course? That seems to be doing to others as you would have them do to you.

But compassion is not the only consideration in ethics, and in environmental ethics, it has a different role than in humanist ethics. Animals live in the wild, where they are still subject to the forces of natural selection, and the integrity of the species is a result of these selective pressures. To intervene artificially in the processes of natural selection is not to do wild animals any benefit at the level of the good of the kind, although it would benefit an individual bison or deer. Human beings, by contrast, are no longer subject to the forces of natural selection. They live in culture, where these forces are relaxed, and the integrity of *Homo sapiens* does not depend on wild nature.

In that sense, our innate compassionate feelings and the imperatives urged by our moral education are misplaced when they are transferred to wild animals. We ought not to treat the bison as we would a person, because a bison in a wild ecosystem is not a person in a culture. Pain in any culture ought to be compassionately relieved when it can be with an interest in the welfare of the sufferers. But pain in the wild ought not to be relieved if and

when it interrupts the ecosystemic processes on which the welfare of the animals involved depends.

Having said this, we must also recognize that suffering in natural systems is often contingent. We do not have any evidence that the drowning bison or the two bucks entangled were genetically inferior. We might suppose that the lame deer was weaker than others, but we do not know that. These animals could have just been unlucky. In the zigzag of chance and mischance, each zigged when a zag would have saved it, the bison crossing the river, the stags in their fight, the deer with its tendons severed by a wolverine claw. Have we any duty to respect that rotten luck? This is wildness once again, not so much the survival of the fittest, a process that we can respect, but the death of the unfortunate, whose carcasses will be exploited by opportunist scavengers. Ethics can really seem to have gone wild when it respects even this contingent element in nature and refuses to end fortuitous pain. Sometimes it seems that environmental ethics take us nearer than we wish toward a tragic view of life.

Treat the bighorn with lungworm!—Colorado wildlife veterinarians have made extensive efforts to rid the Colorado bighorn sheep of lungworm (*Protostrongylus* sp), concerned about the welfare of the sheep, respecting their right to life. We let the blinded bighorn sheep starve in Wyoming, but we fed the Colorado bighorn sheep apples laced with fenbendazole.[7,8] Were the Colorado veterinarians more moral than the Wyoming ones? We have to consider that the lungworm parasite was contracted (most think) from imported domestic sheep and that such human interruption yields a duty to promote welfare not present in the Yellowstone case. Others say that the parasite is native but that the bighorns' natural resistance to it is weakened because human settlements in the foothills deprive sheep of their winter forage and force them to winter at higher elevations. There, undernourished, they contract the lungworm first and later die of pneumonia, caused by bacteria, generally *Pasteurella* spp. Also, the lungworm is passed to the lambs, which die of pneumonia when they are a few months old.

The difference is this. The introduced parasite, the disrupted winter range, or both, mean that natural selection is not taking place. We were running the risk of human interferences, causing a species to become extinct. Letting the lungworm disease run its course really was not letting nature take its course; and, both in concern for the species and in concern for suffering individuals, treatment was required.

If we move this principle with populations back down to the individual level, we see why the lame deer should not be mercy-killed but why the bear hit by a truck was. The logic is that an encounter with a truck is no part of the forces of natural selection that have operated historically on bears. When human beings cause pain, they are under obligation to minimize it. If we had thought that the wolverine failed to kill the deer because human beings interrupted the attack, that might have been cause to dispatch it, although even here consideration for the wolverine, as an endangered species, would probably have meant that the deer should be left in case the wolverine returned.

Rescue the sow grizzly!—In the spring of 1984, a sow grizzly and her 3 cubs walked across the ice of Yellowstone Lake to Frank Island, two miles from shore. They stayed several days to feast on two elk carcasses, when the ice bridge melted. Soon afterward, they were starving on an island too small to support them. The stranded bears were left to starve, if nature took its course. The mother could swim to the mainland, but she is not going to without her cubs. This time, park authorities rescued the mother and her cubs.[6] The relevant difference was a consideration for an endangered species in an ecosystem, much interrupted by human beings who have too long persecuted the grizzlies. A breeding mother and 3 cubs was a substantial portion of the breeding population. The bears were not saved lest they suffer, but lest the species be imperiled.

It might seem now that, inconsistently, we refuse to let nature take its course. The Yellowstone ethicists let the bison drown, callous to its suffering; they let the blinded bighorn sheep die. But this time, the Yellowstone ethicists promptly rescued the grizzlies and released them on the mainland, to protect an endangered species. They were not rescuing individual bears so much as saving the species. They thought that human beings had already and elsewhere imperiled the grizzly, and that they ought to save this species.

Duties to wildlife are not simply at the level of individuals; they are also to species. Nor are they simply at the level of species; they are to these species in their ecosystems. Sometimes that means, as with the sow grizzly and her cubs, that we rescue individual animals in trouble, when they are the last tokens of a type. But sometimes it means that the good of individuals must be sacrificed for the good of the species, or for the good of other endangered species, or for the good of ecosystems.

Kill the defective tigers!—The handsome Siberian tiger, top predator in its ecosystem, is almost extinct in the wild, because of hunting for its skins. But we now have international agreements that prevent the sale of such skins, and the Chinese have expressed an interest in restoring tigers to the wild. They need animals to release. There are tigers in zoos, but there is a problem. All the Siberian tigers in zoos in North America are descendants of 7 animals; they have been through a genetic

[6]Yellowstone National Park, Wyo, Case Incident Record No. 843601, filed August 18, 1984 by Pat Ozment.

bottleneck. A few tigers are available that are genetically competent. If the defective tigers were replaced by others nearer to the wild type and with more genetic variability, bred, and released, the species could be saved in the wild. Some have asked about killing genetically inbred, inferior cats, presently held in zoos, to make space available for the cats needed to reconstruct and maintain a population genetically more likely to survive upon release.[c]

At present this is not being done, partly out of misgivings whether it ought to be done, partly because the zoos fear adverse public relations. But I argue that it ought to be done, assuming that no other alternative can be found. A top predator free in the wild is of more value than defective tigers imprisoned in zoos. A tiger is a "real" tiger only when in the wild; a tiger in a zoo is a tiger no more, and the defective tigers illustrate this. When we move to the level of species, we may kill individuals for the good of their kind.

Species are what they are because of where they are. Our human nature shapes us for culture, not a wild but an "unnatural" environment, that is, an environment in which the creative evolutionary and ecological forces are superimposed by emergent, humane forces. Conscience evolves to generate that respect for persons without which there can be no high quality of human life. But when conscience turns to address the high quality of wildlife, our human instincts and the imperatives of our ethical traditions need to be rethought. We have a duty to conserve all the wildness, species in their wild ecosystems, not just welfare of individual animals.

Shoot the feral goats!—Sensitivity to animal welfare at the level of species, however, can sometimes make an environmental ethicist seem callous. San Clemente Island is far enough off the coast of California for endemic species to have evolved in isolation there; some species of plants and animals are found there and nowhere else on Earth. The island also has a population of feral goats, introduced by the Spanish a couple of centuries ago. After the passage of the Endangered Species Act, botanists resurveyed the island and found some additional populations of endangered plants. But goats do not much care whether they are eating endangered species. So the US Fish and Wildlife Service and the US Navy, which owns the island, planned to shoot thousands of feral goats to save 3 endangered plant species, *Malacothamnus clementinus, Castilleja grisea, Delphinium kinkiense*, of which the surviving individuals numbered only a few dozens.

Some goats were shot. Then the Fund for Animals took the case to court to stop the shooting, and the court allowed the Fund to live-trap and relocate what animals they could. However, relocated animals survive poorly; most die within 6 months. Trapping is difficult; the goats reproduce about as fast as they are trapped. So the shooting has continued. Even shooting the last of them has been difficult. Altogether, about 14,000 live goats have been removed from the island and 15,000 shot. At last report, there were believed to remain only 6 feral goats on the island, 5 pregnant females and 1 billy goat.[d]

Is it inhumane to value plant species more than mammal lives, a few plants compared with thousands of goats? Veterinarians especially may incline to say that animals count but plants do not. If asked why, the reply is likely to be that the goats can enjoy life and suffer when shot, but that the plants are insentient and do not feel anything at all. But that slips back into the compassionate, humane ethic, and we have been arguing that duties to species override duties to individuals. That principle holds even when the endangered species are plants. Plants are, if we must phrase it so, wildlife too; and a population of plants, evolved as an adapted fit in an ecosystem, is of more value than a population of feral goats, which are misfits in their ecosystem.

Sterilize the mustangs!—There are about 50,000 mustangs, also some burros, on public lands in the West, a population greatly expanded from perhaps 2,000, 20 years ago. The Bureau of Land Management (BLM) has spent over $50 million rounding up the horses and offering them for adoption. But there are not enough people who want to adopt the horses, and the BLM has proposed killing 10,000 mustangs. It also has a research program to discover ways to sterilize the mustangs on the range, all with the goal of removing mustangs from the landscape.[9] These horses, of course, are not native to the West; they are feral. Nevertheless, to many they seem to belong on the western landscape.

No endangered species is at stake here; the danger is to range ecosystems. The mustangs are mostly in the arid lands of Nevada and Utah, and BLM ecologists and environmentalists agree that the quality of public lands is in serious decline because of overgrazing. When the overgrazing is attributable to the mustangs, environmental ethics prefers the integrity of ecosystems to the welfare of feral animals. The mustangs ought to be removed, preferably by sterilizing, if necessary by killing. But we also have to notice that the overgrazing problem is often more a result of too many cattle, sheep, and goats, which outnumber the mustangs 98 to one on public lands. Remember also that this is subsidized grazing, much below comparable costs on private land. Surely it would be better to reduce cattle grazing on these public lands, which might be done simply by charging market costs. That would give the mustangs enough space in which to

[c]Hargrove E, in consultation with officials at the Chicago Zoological Park, University of North Texas, Denton, Tex: Personal communication, 1988.

[d]Larson J, Winchell C, Natural Resources Office, Naval Air Station, North Island, San Diego, Calif: Personal communication, 1984, 1989, 1991.

live, while we continue to perfect the sterilizing techniques. Perhaps there is not enough need for a little more cheap beef to justify the killing of these mustangs. But both cows and mustangs ought to yield to the integrity of ecosystems.

Restore the wolves!—The top carnivore is missing from most of our American landscapes, and we are wondering whether we can, and whether we ought to restore that majestic animal, the grey wolf. One place the wolf does remain is in Minnesota, where there are about 1,200 wolves. That respects the integrity of this species in that ecosystem, which is what we ought to do. But there is a problem. There are also 12,000 livestock ranches scattered through the wolves' territory, or, to phrase it the other way, the wolves are scattered through the properties of thousands of ranchers. That works unexpectedly well, but each year, wolves begin to kill livestock on forty to fifty of these ranches. A controller inspects the carcass, and if a wolf is guilty, it is trapped and killed. About thirty to forty wolves each year are killed in this mitigation.[c]

In the mix of nature and culture on our landscape, if we are to have wolves, we must kill wolves. We ought to do both. This time the problem is cattle again, now on private lands, and we have to consider the interests of the ranchers. But the integrity of the wolf population too is served by removing those animals that turn from their natural prey to domestic animals. Aldo Leopold wrote that in his trigger-happy youth he thought that the only good wolf was a dead wolf, until he shot one once and reached it in time "to watch a fierce green fire dying in her eyes."[10] But here, to keep that fire going in the species, we have, sadly, to put it out in individuals that lose that wildness and turn to killing cattle. We ought to restore that fierce green gaze on our landscape, where and as we can, even if in the resulting confrontation of people and wildlife, we sometimes have to kill. Sometimes in environmental ethics, there are no easy choices.

Respect wild life!—We have direct encounters with life that has eyes, at least when our gaze is returned by something that itself has a concerned outlook. The relation is two place: I-thou, subject to subject. When we meet higher animals, there is somebody there behind the fur and feathers. They live as species, historical lines, fitted into ecosystems, and their welfare is entwined with that of their biotic communities. We ought not, with misguided compassion, to sever them from their wild worlds. These wild animals defend their own lives because they have a good of their own. Animals hunt and howl, seek shelter, care for their young, flee from threats, grow hungry, thirsty, hot, tired, excited, sleepy, seek out their habitats and mates. They suffer injury and lick their wounds. They can know security and fear, endurance and fatigue, comfort and pain. When they figure out their helps and hurts in the environment, they do not make people the measure of things at all. More, man is not the only measurer of things, and there is no better evidence of this than spontaneous wild life, born free.

Still, people are the only moral measurers, and how should we count these wild, nonmoral things? Only in human beings does conscience arise; perhaps such a conscience ought not to be used simply to defend our human interests, those of the species *Homo sapiens*, any more than it ought to be used to defend our individual self-interests. We ought to be conscious of other consciousness. Whatever matters to animals, matters morally.

Life in the wild is not, as we have insisted, life in culture, and different moral rules can apply. Something about treating whales, bison, deer, or even feral goats and mustangs with the compassion we ought to give other human beings seems to elevate them unnaturally, unable to value them for what they are. There is something insufficiently discriminating in such judgments—species blind in a bad sense, blind to the real differences between species, valuational differences that do count morally.

But neither should we forget that, in other ways, recent scientific progress has increasingly smeared the human/nonhuman boundary line. Animal anatomy, biochemistry, perception, cognition, experience, behavior, and evolutionary history are kin to our own. Animals have no immortal souls, but then persons may not either, or beings with souls may not be the only kind that count morally. Ethical progress has further smeared the boundary. Sensual pleasures are a good thing, ethics should be egalitarian, nonarbitrary, nondiscriminatory. There are ample scientific grounds that animals enjoy pleasures and suffer pains; and ethically no grounds to value these in human beings and not in animals. Once we can discriminate the differences between wild nature and human culture, the *is* in nature and the *ought* in ethics are not so far apart after all.

[c]Mech LD. North Central Forest and Range Experiment Station, St Paul, Minn: Personal communication, 1991.

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An eagle's eye view of wildlife legislation

Leslie A. Dierauf, VMD

In the United States, the eagle is the symbol of our national pride. The eagle can be found in 43 of our 50 states, but in many of those states, the eagle is listed as a threatened or endangered species over part or all of its range.

As a professional staff member on the US House of Representatives, Merchant Marine and Fisheries Committee, I work on a team that oversees and drafts legislation concerned with fisheries, wildlife, conservation, and the environment. So I must have a keen eye, and an acute ear with regard to specific legislation and legal language within legislation. On the other hand, I also must have a bird's eye view of the Congressional landscape, a full overview of legislation passing through other Congressional Committees to ensure that fisheries, wildlife, conservation, and environmental issues will not be compromised in any way.

The 102nd Congress, a Bird's Eye View

To date, in the 102nd Congress, which is just about at its halfway point, 151 bills related to wildlife have been introduced by members of Congress. These 151 bills come both from the House of Representatives and the Senate, and include duplicate measures.

This list of 151 bills includes large omnibus issues, such as National Energy Policy (and protection of wildlife within the context of oil and gas drilling), Reclamation Projects (particularly Western States' measures to protect and enhance fisheries practices on dammed or diverted rivers, including endangered salmon in the Northwest), and the Clean Water Act Reauthorization (including protection of wetlands).

More species- or population-specific examples within this list of 151 bills include 4 bills on the conservation of exotic wild birds (2 from the House of Representatives, 2 from the Senate), 3 bills on the promotion of biological diversity, 2 bills amending the Marine Mammal Protection Act, 1 bill dealing with the Florida panther, and 1 bill amending the National Environmental Policy Act. There are multiple bills dealing with the spotted owl, ranging from those related to human economic degradation to those related to ancient forest degradation. Almost every bill introduced attempts to promote consensus between industry and environment, because these 2 factions are the ones that affect almost every constituent almost every day.

As Aldo Leopold said in his 1946 treatise, *Adventures of a Conservationist:* "An issue may be so clear in outline, so inevitable in logic, so imperative in need, and so universal in importance as to command immediate support from any reasonable person. Yet that collective person, the public, may take a decade to see the argument and another to acquiesce in an effective program." Our Founding Fathers were clever. They made it much easier to block the passage of a bill than to promote its passage. So, what will be the demise of the 151 bills already introduced this year?

If the legislative process works as it generally does during the course of a 2-year Congress, the 102nd Congress will do the following.

- Introduce approximately 150 additional bills related to wildlife between fall of 1991 and fall of 1992.
- Deem approximately one-third of all the bills as substantive and of immediate importance (ie, to be dealt with in the 102nd Congress).
- Admit that approximately one-third of all the bills have substance and importance, but may not be adequately evolved to be passable in this Congress.
- Reject approximately one-third of the bills, because they are inadequate, of little substance, or simply because they are unconstitutionally sound.

In the 101st Congress, a total of 11,824 bills were introduced on all issues. At any one time, Congress and Congressional staffers are juggling two-thirds of all the bills introduced. Approximately 2% of the 11,824 bills dealt in some way with wildlife, 1% were considered of importance, and less than 0.5% of the 11,824 bills dealing with wildlife were passed by both House and Senate and signed into law by the President. Or to phrase it

From the US House of Representatives Committee on Merchant Marine and Fisheries, 545 House Annex 2, Washington, DC 20515.

differently, of the 11,824 bills introduced in the 2 years of the 101st Congress, 324 dealt with wildlife in some manner, 6 passed in the House, but not the Senate, 3 passed in the Senate but not the House, and 93 passed both houses. The President vetoed 1 of those and signed 92 into law, that is, approximately 28% of all the wildlife legislation introduced became law.

The Politics of Science or the Science of Politics?

Congressional staffers are conduits; we take information in, turn it, churn it, digest it, add more to it, and are expected to spit out a succinct and understandable product (but not a waste product), from which the Members can vote their minds. I attempt to bridge the gap between science and the public.

At this point of factual succinctness, politics come into play. To understand the politics of science, think of a matrix with science across the top and politics down the side, where we can have any one of four scenarios:

Good Science, Good Politics
Good Science, Bad Politics
Bad Science, Good Politics, and
Bad Science, Bad Politics.

So I tell myself that if I win an argument (ie, win acceptance of a bill I recommend to my Congressional Member) 25% of the time, I must be doing all right. Because in Congress, what Members do best is cut deals. Congressional Members cut deals 24 hours a day. But the trade-off in the end, is that they truly are thinking of their constituents, and it might be better to cut a not-so-good deal today, in trade off for a much better deal tomorrow. One thing is certain—you learn to dislike the issue and not the Member, because you may find that the Member against you today is with you tomorrow!

Existing Wildlife/Animal Welfare Laws

Congress has charged the Secretary of the Interior, through the Director of the US Fish and Wildlife Service, with responsibilities for the management of certain wildlife resources, including endangered and threatened species, migratory birds, certain marine mammals, and freshwater and some anadromous fish. Congress has charged the Secretary of Commerce through the Office of Protected Resources in the National Marine Fisheries Service with responsibilities for certain marine mammals, and anadromous or marine fish. Some of the laws these Agency Departments implement and enforce are:

The Endangered Species Act
(16 USC 1531ff et seq)
The Convention on International Trade in Endangered Species
(27 UST 108)
The Marine Mammal Protection Act
(16 USC 1361 et seq)
The National Wildlife Refuge Administration Act
(16 USC 668 et seq)

Two other laws not within the jurisdiction of the Secretaries of Interior or Commerce, but laws related to wildlife animal welfare are:

The National Environmental Policy Act
(42 USC 4321 et seq)
The Animal Welfare Act
(7 USC 2131 et seq)

The Endangered Species Act (ESA; 1973)—The ESA is authorized through 1992 and has been amended 7 times since its passage. The ESA protects threatened and endangered species and their habitats in the United States, as well as prohibiting importation and exportation of species listed as endangered or threatened.

The Convention on International Trade in Endangered Species (CITES; 1975)—Under the ESA, this Convention, signed by 112 member countries, regulates, and in many cases prohibits, domestic imports and exports of wild animal and plant species threatened by trade. Appendix-I species are those that are endangered and on the brink of extinction, including such animals as bald eagles, great apes, rhinoceros, sea turtles, the great whales, giant pandas, Asian and African elephants, and many of the large wild cats. Appendix-II species are those that are threatened and on the brink of being endangered, including many of the monkeys, flamingos, lizards, golden eagles, land tortoises, crocodiles, and corals.

A 1982 amendment to the ESA made it the implementing legislation for CITES. Within the United States there are 11 import/export ports for wildlife and wildlife product entry and exit.

The Marine Mammal Protection Act (MMPA; 1972)—The MMPA is authorized through 1993, and has been amended 4 times since its initial passage. The MMPA is a moratorium on the taking or importing of marine mammals or their products. The term "take" under the MMPA means to hunt, capture, kill, harass, or attempt to hunt, capture, kill, or harass. Exceptions to the MMPA law of taking include scientific research, public display, subsistence hunting, and incidental taking in commercial activities, such as fishing.

The National Wildlife Refuge Administration Act (NWRAA; 1966)—The NWRAA consolidates various wildlife conservation areas, such as game ranges, waterfowl production areas, and wildlife refuges into the National Wildlife Refuge System, and establishes administrative standards for managing the system. The act dictates that the management activities within the NWR units are to be orchestrated by the Director of the US Fish and Wildlife Service (FWS). The NWRAA also sets out

uses that it deems compatible with the major purposes of each refuge.

The National Environmental Policy Act (NEPA; 1969)—Until 1970, environmental quality was considered primarily as incorporated within public policy, and encompassed only water, soil, and wildlife. The NEPA changed all that by requiring that environmental concerns be totally integrated into federal decision making. The purpose of NEPA was to implant within a federal agency's consciousness, an awareness and concern for all environmental impacts that any action or proposed action of theirs would have. Within NEPA, environmental impact statements are required prior to each step of a development activity.

The Animal Welfare Act (AWA; 1970)—The AWA is overseen by the Agriculture Committees and is implemented by the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS). The APHIS has the primary responsibility for implementing legislation pertaining to animals; with regard to wildlife, the AWA states only that beyond the definition of "animal," wildlife is any such other warm-blooded animal. As the Animal Welfare Act presently stands, nowhere are wild animals specifically mentioned. The law merely implies that it applies to them.

Current Actions Attributable to Existing Wildlife Laws

During 1990, just a few of the actions taken by Federal, state, and local governments were attributable to 1 or more of the aforementioned laws:

- The Desert Tortoise: Emergency Endangered in Southern California, Utah, and Nevada; recovery plans involve state agencies, livestock industry representatives, and wildlife organizations.
- The Spotted Owl: Threatened in Washington, Oregon, California, and British Columbia; recovery plans revise federal practices to balance job protection with owl preservation. Designated critical habitat equals 6.9 million acres of old growth forest.
- The Florida Panther: Endangered in Florida; the Federal government has acquired 25,000 acres of habitat in southern Florida for this endangered species.
- Three United States zoos (San Diego, Cleveland, and The National Zoo in Washington, DC) began collection of frozen stocks of semen and embryos from endangered species for use in experimental propagation.
- Species survival plans were ongoing at 128 US zoos; these computerized population management plans offer intensive care for endangered wildlife.
- Two hundred FWS law enforcement agents around the country, as well as 60 wildlife inspectors within the FWS and at ports of entry were on duty.
- Because of the MMPA amendments in 1988 (Pub L 100-711), nations now exporting tuna to the United States must employ more stringent dolphin protection measures.

Let's look at the ESA in depth. The ESA insists that any or all of the 5 following situations must exist for a species to be listed as threatened or endangered. The species must be substantially reduced in numbers by: 1) modification of habitat/conversion, fragmentation, construction; 2) overuse; 3) disease or predation; 4) inadequacy of existing regulatory mechanisms; or 5) natural or man-made factors.

The rationale for listing must be based on the best available scientific information without regard for economics (or value). Once listed, a species' critical habitat may be designated, economics can be considered, and a recovery plan for that species within its habitat must be drafted and finalized.

The ESA does not consider value, because the value of a species is not concrete. The ESA is cold-blooded, cut, and dried. If a species meets any of the 5 criteria, then its definition is threatened or endangered. There are exemption possibilities within the ESA, but historically they have few precedents. The ESA measures science on its merits, species, populations, and habitat only, and incorporates no anthropomorphic or value criteria.

Because of issues revolving around endangered species and economics, certain realizations have been incorporated into decision-making, such as by the Portland panel ("The Gang of Four") relative to old growth forests. This panel was selected by Congress, not by the environmental or timber industries, and was a panel composed of hand-picked scientists. The panel's conclusions essentially stated that if species such as the spotted owl, the marbled murrulet, the Pacific yew tree, and other old-growth dependent species are to survive, logging practices in the ancient forests (of the Pacific Northwest in this panel's particular case) must be updated and logging acreage must be reduced to save ecosystem and species alike. The report catalogued 14 options available to each of the various sides of the issue and actually calculated relative costs and benefits for each option. The options as they now stand range from cutting timber harvests in half, community assistance, and economic diversification, to worker retraining, use of new timber products and new timber harvesting techniques.[1]

Since the turn of the century, the US population has grown from 76 million people in 1900 to 133 million in 1940 to 250 million in 1990, more than tripling its size.[2] This in itself is threatening wildlife, because of conversion, fragmentation, and loss of essential habitat. These physical and chemical stresses of public encroachment on wildlife habitat have also led to increased disease and pre-

dation problems, because wildlife populations are becoming hemmed in. Overpopulation of human beings is in some cases causing exploitation of wildlife through overhunting and overfishing as well. Introduction of exotic, non-indigenous species, such as zebra mussels into the Great Lakes, where this species has no known predators, can cause havoc with natural ecosystems. In fact, it has been stated that human population growth has been identified as one of the greatest long-term threats to the environment.[3]

Just a few of the probable causes of wildlife loss are: physical alteration on land, on coasts, or in near-shore areas; chemical stresses, acid rain, ozone, sediments, and pesticides; direct takings, such as overharvesting of fish; introduction of exotic species, which invade natural communities and displace native species; and plastics in the environment that trap or are ingested by fish, birds and mammals.[4]

Human destruction of habitat includes industrial growth, pollution, agriculture, erosion, pesticides, collecting, hunting, and the desire for exotic pets. The constituents, all of us, are part of the problem when it comes to wildlife welfare.

Specific Examples of Pending Wildlife Legislation

Various bills concerning wildlife legislation are pending in the 102nd Congress.

Biodiversity—According to the World Health Organization, approximately 80% of the people in developing nations rely on traditional medicine, wild plants and animals, for their primary health care. In developing countries, nearly 40% of all prescription drugs are derived from natural sources. Yet to date only one-fifth of all living species have been analyzed for potential pharmacologic attributes.[5]

Since 1492, approximately 500 species of plants and animals, including the California grizzly bear and the great auk, have become extinct.

In the last 10 years, 34 vertebrate species or populations have become extinct while awaiting federal protection.

Presently, the Fish and Wildlife Service and the National Marine Fisheries Service list 600 plants and animals within the United States as threatened or endangered.

After analyzing State Natural Heritage Programs, the Nature Conservancy has estimated that there may be a total of 9,000 plant and animal species at risk within the 50 states.

Hawaii, Californnia, Texas, and Florida are the most biologically diverse states in the United States. Yet in looking at the natural communities in these states, half of the species in Hawaii and Florida are at risk, one-third of the species in Texas are at risk, and one-fifth of the species in California are at risk.[6]

Biodiversity provides genetic, species, and ecosystem diversity. Besides pragmatic reasons for maintaining biodiversity, ethical and aesthetic reasons are as compelling. The objectives in maintaining biodiversity are viable native populations, natural genetic variation, natural biological communities, structural diversity, non-native species control, human resource needs, scientific understanding, public awareness, conservation incentives, and regional ecosystem conservation.

Bills establishing a federal strategy for biodiversity (essentially a "pre-endangered species" act) have been introduced in both the House and the Senate (HR 585, HR 2082, and S 58), each has had hearings, and each is moving through Committee (Science, Space and Technology [H.R. 585], Merchant Marine and Fisheries [H.R. 2082], and Environment and Public Works [S. 58]) process. Terrestrial, as well as marine species, are addressed in the bills, along with the potential costs for protecting such diversity.

Wetlands—To date, 5 bills have been introduced dealing with the protection and/or preservation of wetlands. The bills are being driven by President Bush's "no-net-loss" of wetlands policy, his alteration of the regulatory definition of wetlands, and Congress' strong intention to make the wetlands issue part of the Clean Water Act reauthorization. The 5 bills range from industry/development-friendly to absolute environmentally-friendly. The 2 bills on most common ground, HR 404 and HR 2400, attempt to bring consensus to the factions on either side of the center. In each bill, the issues of private property rights, endangered species, public policy, and state's rights come into play.

The loss of all types of wetlands is great, and this loss appears to be progressing under the system presently in place.

Aldo Leopold said in his *Sand County almanac*, referring to the Wisconsin marshes: "Man and beast, plant and soil lived on and with each other in mutual toleration, to the mutual benefit of all. The marsh might have kept on producing hay and prairie chickens, deer and muskrat, crane music and cranberries forever. But the next wave of settlers began to drain and fill the marshes, they did not include soil, plants or birds in their ideas of mutuality. The dividends of such a balanced economy were too modest. They envisioned farms not only around, but in the marsh. The Sand County farms failed, the prairie chickens died out, and the cranes are today endangered."

Since 1776, in the contiguous 48 states, more than 50% of our wetlands have been lost to conversion and construction; even though wetlands support commercial fisheries, provide recreation, flood control, filtering of polluted waters, and serve as habitat for 1/3 of the nation's endangered species. Waterfowl populations have de-

creased 30% in the last 22 years, and as of 1990, Florida's wetland-dependent dusky seaside sparrow is listed as extinct.[7]

On the bright side, in 1950, there were 182 National Parks (24.6 million acres); by 1990 there were 358 (80.1 million acres). In 1950, there were 17.1 million acres devoted to National Wildlife Refuges; today there are 89.1 million acres. The National Wilderness Preservation System has grown from 10.4 million acres in 1970 to 95.0 million acres in 1990. In 1970, there were 868 miles of National Wild and Scenic Rivers in the United States; today there are 9,318 miles. And finally, in 1975 there was only one National Estuary (composed of 4,700 acres), and two National Marine Reserves (covering 65,000 acres); today there are 18 National Estuaries (250,000 acres) and 9 National Marine Sanctuaries (9,338,000 acres).[8]

Water policy—Much of the western United States is a desert. The purpose of water policy in the west has been to cure a condition of drought. However, despite the policy, there has been a 5-year drought in California. The fault of policy has been to favor agriculture and other development at the expense of the environment. Because of the drought, so little water is left for fish and wildlife as to threaten entire species with extinction, and to threaten California with application of the Endangered Species Act.[9]

Western water legislation, embodied within HR 429, and including the Central Utah Project, has been passed in the House and is being considered by the Senate. The bill gives the Bureau of Land Management the power to move water where it is needed during droughts, closes loopholes for farms receiving subsidized water rates, and establishes a special fund to offset and pay for damages that reclamation projects may have on fish, wildlife, and recreational activities. It also specifically requires an investigative project to monitor drainage water for selenium and to design methods to correct potential problems with contaminants, which can be devastating to migratory waterfowl and bird populations.[10]

Exotic birds—Approximately 12 organizations including groups such as the National Audubon Society, the World Wildlife Fund, the Humane Society of the United States, the Fish and Wildlife Service, and the Association of Avian Veterinarians have been working for over 3 years to draft legislation that regulates the importation of exotic birds.

There are 54 bird species, such as parrots and cockatoos, worldwide that are "species of concern" because of their popularity and decreasing numbers. Of these, 13 species are considered the "worst-off", such as the blue-fronted Amazon parrot and the sulfur-crested cockatoo. The "worst-off" species include those that are popular because they can talk, because they are exceptionally colorful, or because they are so rare as to be considered endangered, and thus of great "value."

The legislative goals of the exotic bird working groups are to discourage the desire for the most threatened of the species, to promote captive breeding of those species for which set-up pairs already exist and whose breeding successes have been documented, and to prohibit trade of all other species. These are laudable goals, but within the last year, the working group who had been so highly praised for coming to so many consensus decisions has been split, and the fate of the birds hangs in political infighting and organizational turf-battles, over HR 2541 and HR 2540.

National wildlife refuge oil and gas activities—The bills HR 1320 and S 1220 contain portions that would open the Arctic National Wildlife Refuge to oil and gas exploration, development, and production activities. Two other bills, HR 39 and S 39, would set aside the 1.5 million of the 19.1 million acres of Arctic National Wildlife Refuge as wilderness, and in so doing ban oil and gas activities completely and unconditionally.

Bills relating to the Arctic National Wildlife Refuge have been introduced repeatedly over the last 12 years in Congress. But only in the 102nd Congress has the issue evolved to a point where a decision might actually come about. The difference is two-fold: 1) there presumably will be a National Energy Policy, which will include provisions for energy conservation and alternative energy sources, and 2) the bills presently pending would protect national security, decrease oil imports, and promote conservation efforts while allowing oil and gas activities to go forward, yet stringently protecting wildlife and the habitat they live on in the process.

The confusion and indecision with this issue lies in misperceptions concerning the comparative acreage involved, the pristineness of the area, and how exactly to protect the wildlife and environment of the coastal plain of the Arctic National Wildlife Refuge, while allowing oil and gas activities to proceed.

What Can We Do?

What I am seeing as I work with wildlife and conservation issues on Capitol Hill is that, in general, every group advocates responsible and sustainable use of our natural resources. For a balanced ecosystem approach to sustaining wildlife populations, all species must be considered part of the interactive community. This is where we come in as scientists.

Our responsibility as veterinarians and scientists is to ensure that all animals receive humane and conscientious care and treatment. When dealing with wildlife, a broader view is required. Wildlife veterinarians do not normally consider individual animals per se, but rather populations,

habitats, ecosystems, and the management of each of these.

How do we become more responsible legislatively? We do this by publishing and making scientific data and results clear and accessible, by advising conservation organizations, by reviewing and responding to *Federal Register* and *Congressional Record* publications, and by providing our own written and oral comments on issues of importance to the welfare of wildlife.

The Legislative Horizon

There are several wildlife issues that potentially could be considered legislatively.

- Should wolves be reintroduced to Yellowstone?
- Should sea otters be translocated to new, but historically old, habitat?
- How can we control the introduction of exotic, non-native species into environments where those species have no known predators?
- Should we consider the consumptive use of farm-raised wildlife or hatchery fish as opposed to wild species? What are the pros and cons?
- Should contingency plans be in place for terrestrial and marine wildlife emergencies and unusual die-offs?
- Do the animal welfare laws for wildlife need to be more clearly spelled out? Why or why not?
- How can we develop a law that protects wildlife from illegal trade, when we know that smuggling will probably continue, as it has in all its forms for centuries?
- How can development, industry, wildlife, and environmentalism coexist in a union of greatest benefit to all?

These are just a few of the issues that Congress deals with on a daily basis in Washington, DC. Only with your help, factual input, scientific perceptions, and concern for the animals we care for in the environment we all live in, will safe and sane decisions be made that are in the best interest of wildlife and animal welfare.

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Mountain gorilla conservation: A study in human values

James W. Foster, DVM

Recently I heard economics defined as "the study of how people make choices." In using this broad definition and if choices are based on human values, economics then becomes applicable to more than management of dollars and cents, but can also be used in addressing ethical issues such as animal welfare and wildlife conservation. For instance, when planning a long-term conservation project involving an endangered species, we must consider human values, both positive and negative, while developing our objectives. If the endangered species is found in an underdeveloped country, we may not only be dealing with the dollars and cents that this species provides the country's economy, but the traditional cultural values of the host country, such as the value of a species as a religious symbol or a food source. We often find that international conservation projects are based on aesthetic values that are poorly understood and seem overly idealistic to the host country. When this occurs, conflicts in management goals arise and the project is often doomed from a lack of cooperation.

Preservation of the mountain gorilla (*Gorilla gorilla beringei*) of Rwanda has had its share of these misunderstandings, and from time to time through the years, the survival of this magnificent species has been in doubt. My intent here is to review some of the history of mountain gorilla conservation and how recently veterinary medicine has become involved in efforts being made for its long-term survival.

Zoo and Wildlife Medicine

Historically, wildlife veterinarians have dealt primarily with large populations of free-ranging animals. Their time being devoted to monitoring the health of the population, obtaining samples from animals to determine their health status, translocating animals to suitable habitat, and researching the physiology and diseases of a selected species.

Zoo veterinarians, on the other hand, have devoted their time to clinical medicine, diagnosing disease and treating the individual animal. Major emphasis is also placed on preventive medicine programs in zoo health programs, including routine deworming, vaccination, quarantine, and periodic testing such as annual tuberculosis testing in primates. Pathologic examination, nutrition, reproduction, and research are also included in zoo health programs.

During the last few decades, human pressures have reduced habitat of many free-ranging species into island populations. In those species that are rare and endangered, it is no longer feasible to accept mortality from disease because each animal provides an important contribution to the gene pool. A more intensive management plan is required, placing heavy emphasis on treating the individual to preserve as much genetic diversity as possible. A model for such a plan can be patterned after a typical zoo health program.

Not all rare and endangered species lend themselves to intensive health management. First, the animals must be accessible so that they may be approached at close proximity to evaluate signs of disease and health status. Therefore, habitat and terrain are important factors. Second, the natural behavior of the species must be considered. Does the animal live in social groups or is it a solitary species? If it is solitary, it may not be economically feasible to monitor individual animals scattered over a vast habitat. Last, but equally important, is it possible to approach the animals so that medication can be administered after arriving at the diagnosis?

The endangered mountain gorilla meets all of the aforementioned criteria. Although it lives in the tropical rainforests of equatorial Africa at elevations above 8,000 feet, the habitat is difficult, but possible, to penetrate. It is a social species living in groups of 2 to 32, and seldom travels great distances from one day to the next, making it possible to locate a given group on a daily basis. But most important from a veterinarian's point of view

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is that 8 groups have been habituated or tamed through the years so that they may be studied by researchers and visited by groups of tourists each day. Habituation makes it possible to get within close proximity of the animals for health evaluations and to administer medications by nontraumatic delivery systems, such as blow gun darts commonly used in zoos.

History of Gorilla Conservation

Although it is one of man's closest relatives, the mountain gorilla has had a difficult time surviving man's pressures through the years. First, it was considered to be a prime food item for the pygmoid tribes sharing its habitat. As travel between continents became easier, trophy hunting the gorilla for sport became a short-term problem. Zoos soon found the gorilla to be an attractive exhibit animal and encouraged collecting. As the number of tourists and expatriates visited and moved to the region, a market for gorilla parts such as skulls and hands developed, placing new pressures on gorilla survival. Then later, pressures from agriculture reduced the mountain gorilla range to the Virunga Volcano region found along the borders of Rwanda, Zaire, and Uganda, and to a second small area of Uganda known as the Impenetrable Forest.

It is doubtful that there would be any remaining habitat today had not Carl Akeley, who had become enamored with the species while collecting skins for a diorama at the American Museum of Natural History, persuaded the king of Belgium to set aside the Virunga Volcano area as a mountain gorilla preserve in the late 1920s. The gorilla preserve was to become the first national park in all Africa. Agricultural encroachment around the boundaries of the park, however, has continued through the years in spite of its preserve status.

In 1959, George Schaller, an American field researcher, spent a year studying the mountain gorilla. Schaller's approach was to habituate the animals so that they could be approached at close proximity so their behavior could be more closely observed. This was an innovative idea that led to a wealth of data that had not previously been reported. It was especially bold in that until that time, the gorilla was still thought of as an animal dangerous to people and was considered by many to be a ferocious beast. Schaller later published 2 books on his study that became very popular, thus attracting new international attention to the gorilla.[1,2]

Dian Fossey began a long-term study of the mountain gorilla in 1967, using Schaller's approach of habituating the animals to human presence. After commencing her studies in Zaire at Akeley and Schaller's former camp, a revolution forced her to move to the other side of the Virunga Mountains to Rwanda. Although this was only a few miles from her first study area, she soon encountered a whole new set of problems. She found that illegal grazing of cattle was common in the park, gorillas were being killed for profit, and the gorillas would frequently become caught in snares illegally set for small antelope species. The park staff seemed to be unwilling or unable to control these activities, so as the years went by, she became more and more involved in what she referred to as "active conservation," such as anti-poaching patrols and evicting cattle graziers from the park.[3]

International conservationists were appalled in 1978 when Fossey reported that one of her study groups had been attacked by poachers and an adult male was killed apparently for his skull and hands to be sold as souvenirs to tourists. As a result of this adverse publicity, public support and financing were used to increase anti-poaching patrols within the park and new conservation techniques were applied to mountain gorilla conservation, most important being the Mountain Gorilla Project.

The Mountain Gorilla Project was implemented in the Parc National des Volcans in 1979. The purpose of the project was to increase anti-poaching patrols in the park, to educate the people of Rwanda regarding this national treasure, and to habituate gorilla groups so they could be visited on a daily basis by tourists. The conservation goal of this project was to increase foreign capitol through tourism and in turn provide an economic reason for Rwanda to protect the mountain gorilla. During the past ten years, the tourist visit program has become extremely successful in that tourism has become Rwanda's major industry and the gorilla has become a source of local pride for its citizens.

Animal Health Project

Although an increase in anti-poaching patrols had eliminated the direct poaching of gorillas (no gorillas have been killed in Rwanda since 1983), thousands of snares set for antelope species were still being destroyed each year within the park. The gorillas would, by accident, step into these snares, resulting in loss of limb or occasionally loss of life. In 1984, I received a request from Fossey to come to Rwanda and develop a health program. Fossey recognized that veterinary assistance would be valuable in immobilizing animals for snare removal and in providing emergency treatment. It wasn't until 1986, however, that I received funding through the Morris Animal Foundation to develop a veterinary program at the Park National des Volcans. Regrettably, Dian Fossey did not live to see her request for veterinary assistance fulfilled. She was murdered just a few months prior to my arrival in Rwanda.

Program development and objectives—In addition to Fossey's request for assistance in snare removal and emergency treatment, there was a need to determine the long-term requirements for health care for the mountain gorilla and to provide veterinary training and consultation to the behavioral

researchers at Karisoke Research Center and the Mountain Gorilla Project.

Having had the experience of developing the veterinary program for Seattle's Woodland Park Zoo, it seemed natural to me to use this experience in planning a program for the gorillas. The elements of the zoo program consisted of preventive medicine, medicine and surgery, pathologic examination, nutrition, reproduction and nursery care, and research. It was apparent that some of these elements, such as nutrition and reproduction, would require less emphasis while working with free-ranging gorillas, but zoo experience and data would provide the initial outline for the program until field data became available.

In reviewing the literature published on gorilla medical problems, I found that there were scant field data available. So other sources of information needed to be explored. The first possibility was the vast amount of information collected through the years by Fossey and other field researchers observing the research groups. The second was to solicit information from members of the Mountain Gorilla Project who had been working on a regular basis with the tourist groups.

Additional information was to be collected by personal observation. Regular visits were to be made to the gorilla groups monitoring signs of disease and evidence of trauma. Since the animals were habituated, it was usually possible to approach them close enough to make a reasonable visual examination. If the animal was shy, binoculars could be used.

A final objective was to collect biological data that would be of future value in long-term gorilla management. These research goals were to be attained without disrupting the natural behavior of the animals. Therefore, physiologic data were to be collected opportunistically, while the animals were immobilized for emergency health care or limited to non-invasive studies such as parasitologic studies.

Prior to leaving for Africa, it was necessary to acquire drugs and equipment necessary to support the goals of the project. The pharmaceutical inventory was developed by using the zoo inventory and recommendations made by the medical team at the University of Washington Primate Center. Pathology instruments, laboratory equipment, immobilization equipment, and medical supplies had to be closely inventoried because most could not be acquired in Rwanda and mail service was unpredictable, expensive, and slow. At that time, turnaround time for mail averaged six weeks and a telephone call to the United States required a two-day commitment, including driving time, waiting for connection, and an overnight stay in a hotel. Fortunately with the aid of my computer, the inventories were complete.

The Field Program

Examples of medical treatment—I had hardly arrived in Rwanda and was still in the process of getting equipment and supplies through customs when a member of the Mountain Gorilla Project summoned me to make a medical observation on an adult male gorilla named Tiger that had been in a serious fight with the dominant male from another group. A few hours later, I found myself at Karisoke Research Center, with only a handful of medical supplies, and awaiting the return of David Watts who had graciously volunteered to run the camp following Dian Fossey's death.

That evening, David and I and a Swiss researcher discussed the severity of Tiger's wounds and how antibiotics might be administered to prevent infection. I was impressed with their sensitivity and judgment, and after several options were considered and rejected, we decided to try oral treatment because it would be the least traumatic and disruptive method of administration.

The following morning, we located Tiger a short distance from where he had been left the day before. His wounds were as severe as David had described the night before and warranted treatment, so we proceeded with our plan of oral treatment. Doxycycline capsules were emptied into the hollow core of wild celery and David handed them to Tiger one stalk at a time. After several hours and frequent rejection, the full dose was finally administered. We patiently continued the treatment for 7 days, finding almost a daily improvement in Tiger's condition. A few months later, all of the wounds had healed. A slightly stiff forefinger remained as the only result of the fight.

Two gorillas were immobilized during the 2-year project, both adult males. Immobilizations were performed with a compressed air darting system.[a] This system is quiet and non-traumatic, causing a minimum of discomfort to the animal and no noticeable disruption of the group. A combination[b] of tiletamine HCl and zolazepam HCl was used as the immobilizing agent because of its proven safety in primates and low volume, permitting the use of a small and therefore lightweight dart.

The first immobilization was performed on an adult male gorilla for snare removal in a group that had been frequently followed, but was not habituated. The fact that it was the first attempt to immobilize an adult male gorilla provided some apprehension as to the conduct of the animal after darting and the resulting behavior of the remainder of the group. Fortunately no problems were encountered, but it was necessary to track the animal in difficult terrain for almost 2 hours prior to darting. It was in the middle of the rainy season and rain was coming down in torrents, so this likely explained the disinterest of other members of the group. The cable-type snare had embedded itself into the ankle, so after removal, a physical examination, and blood collection, the gorilla was

[a]Telinject, Telinject USA, Newhall, Calif.
[b]Telezol, AH Robins Co, Richmond, Va.

heavily dosed with antibiotics and left to recover from anesthesia. It was reported by the trackers that the gorilla had recovered full use of the leg within a week after treatment.

The second immobilization was also performed on an adult male. It was Tiger (mentioned earlier). In contrast to the first male, Tiger was easy to approach because he was well habituated and had extreme toxemia from a large abscess on the neck, resulting from an infection in the laryngeal sac. The same aforementioned equipment and drugs were used. The wound was debrided and the animal was heavily dosed with antibiotics. Thirty six hours after the immobilization and a slow recovery from the immobilizing drug, Tiger died. It is unlikely that this infection was related to his earlier injuries because at least 2 other animals have been observed with laryngeal sac infections.

Data collection during gorilla visits—The gorilla visits for health evaluation were the most rewarding part of the project. As planned, I visited the habituated groups on a regular basis to monitor for disease indicators and evidence of previous health problems. Because of their long-term habituation, I was able to approach the gorillas close enough to make observations without binoculars. Some of the younger animals seemed to crave human contact and would frequently perform attention-getting behavior, attempting to solicit play. Perhaps the strangest encounters were when a gorilla would approach within inches of my face and stare calmly into my eyes. Other gorilla researchers had observed this behavior through the years, but were at a loss as to its motivation. Nevertheless, each time, it had a profound effect on my emotions, ranging from fear, then embarrassment, and finally to a profound feeling of deep communication.

Examples of observations made during these visits were ophthalmitis, possible malar abscess, syndactyly, and numerous evidences of trauma such as loss of digits, wounds, cuts, and scrapes.

Historical data—I had found during my previous zoo experience that observers collecting behavioral data frequently record signs of disease and trauma. I expected that Dian Fossey and others would have also noted such observations and that this would be useful in developing a health management plan. Reviewing these documents proved to be more difficult than at first supposed because the Fossey cabin, where the research data was archived, was still closed and guarded pending further investigation of the murder. Also, the Mountain Gorilla Project personnel were at first reluctant to share information for obscure political reasons. Eventually these problems were resolved and a rich source of data emerged, especially from the research files.

These data suggested that the major gorilla health concerns (n = 356) were trauma (76%), respiratory tract illness (10%), diarrhea (5%), human-caused trauma, from snares and spears (3%), and a variety of miscellaneous problems (6%). This supported my field observations, but because the reports were subjective, it was impossible to qualify most health notations as to severity.

Parasitologic examinations—Because the gorillas build a nest each night for sleeping and regularly defecate in this nest, fecal specimens were readily available for parasite evaluation. Experienced gorilla trackers are usually able to determine the former occupant of the nest by using nest size, size of the feces, location of the nest in reference to other members of the group, and hair length, color, and texture for criteria. The predominant ova found on these routine examinations was the nodular worm *Oesophagostomum stephanostomum*. This ova was found in almost all of the fecal specimens examined.

Postmortem examinations—Necropsies were performed on 6 gorillas, the adult male (Tiger) that had died of a laryngeal sac infection and 5 infants. In other studies, it was found that there is a 38% mortality in infants younger than 3 years (n = 50 infants).[4] Thirty-eight percent of these mortalities were attributable to infanticide by adult males from other groups, whereas the remainder was caused by disease, usually pneumonia. Four of the 5 infants that I necropsied had died of pneumonia, the fifth from trauma possibly resulting from infanticide.

Eleven skulls were examined for dental pathologic findings, shedding some light on dental problems of free-ranging gorillas. The following problems were found: no abnormalities (27%), slight to extreme dental wear (46%), periodontal disease (10%), loss of teeth from disease or trauma (10%), and fractured teeth (10%).

Laboratory constructed—Midway through the 2-year project, it became apparent that continual veterinary presence was needed in the Park National des Volcans. The Morris Animal Foundation agreed to take on the funding and administrative responsibilities for a long-term program. A laboratory and housing were needed to support the veterinary activities. With funding provided by the Morris Animal Foundation, The Digit Fund, and World Wildlife Fund International, my wife Jane and I selected a site, and designed and coordinated construction of the new facility at the park headquarters in the small village of Kinigi.

Conclusion

Undertaking a veterinary project in a developing country like Rwanda has its disappointments as well as rewards. Because there is a limited amount of money donated to wildlife conservation, competition among funding agencies is intense, often resulting in political infighting for control of the management of an endangered species. This not only distracts from the conservation goals of the project, but often places the responsibility for

wildlife management decisions in the hands of organizations staffed only with fund-raisers. The science of wildlife conservation is complicated and requires input from a large variety of scientific disciplines.

Many of the personnel involved in gorilla conservation were highly motivated but had no formal training in the disciplines of conservation biology. It seemed that the criteria for hiring was based entirely on language skills and earlier experience dealing with the African mystique. I believe the candidates for these positions should be selected first on scientific training and experience.

What is the future of the mountain gorilla? The short-term prospects are good. The last census taken in 1990 suggests an increase in the population from 279 in 1986 to 310 animals. A recent survey in the Impenetrable Forest in Uganda revealed this population to be over 300 animals; much larger than previous estimates of around 150. Direct poaching of gorillas has not been reported since 1983, cattle grazing within the park has been discontinued and agricultural encroachment has been limited with the construction of stone and bamboo fences, and moats.

The long-term prospects for the gorilla, however, look far more difficult. Rwanda's population is expected to double by the turn of the century. Almost all tillable soil is now under cultivation and each year, 23,000 families are looking for land to farm. Unfortunately, it is predictable that pressures will soon be put on the government to release protected land, such as the gorilla habitat, for farming. The decision to preserve this land will again be determined by human values: the priorities of the western world and the value of the gorilla to the people of Rwanda.

The Morris Animal Foundation has continued to provide funding and administration of the mountain gorilla veterinary project, now called the Volcano Veterinary Center, through the past few years and plans to continue in the future. A veterinarian has been on site providing health care for the gorillas since the project's inception in 1986. It has become a unique and valuable veterinary contribution to wildlife conservation.

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Role of the veterinarian in wildlife rehabilitation

Stuart L. Porter, VMD

The purpose of this article is to educate veterinarians about the basics of wildlife rehabilitation so that they may have a better idea of how to proceed when injured or orphaned wildlife is brought to them for care. I believe that veterinarians need to be more involved than they currently are with the diagnosis and management of these animals in captivity. I believe there is need for much improvement and that our responsibility for these animals and humane considerations dictate that we strive to improve the situation.

Wildlife rehabilitation involves the medical treatment and captive management of injured and orphaned native wildlife, with the ultimate goal of returning an animal that will be able to survive to a suitable environment. Several thousand self-taught people are attempting to do this in this country, but unfortunately many of them have limited facilities and little veterinary support. There are 2 national organizations, the National Wildlife Rehabilitators Association and the International Wildlife Rehabilitation Council, striving to improve the professionalism in this field through publications and national meetings, but they have no official authority. The government agencies given responsibility for native wildlife have done little to create standards for the proper care of these animals as exist in the Animal Welfare Act, which does not cover most of these species. No veterinarian working for the Fish and Wildlife Service or any State Wildlife Agency has the responsibility to provide care to injured wild animals. In fact, there are few veterinarians working in the wildlife field at all, in spite of zoonotic and domestic livestock disease considerations. Organized veterinary medicine apparently has little interest in the care of wild animals. Although there appears to be a good deal of student interest in this area, many veterinary schools offer little, if any, teaching in this area.

After working in this field for 17 years, I have come to learn two indisputable facts concerning wild animals. Wild animals do get into trouble by getting hit by cars, gunshot, poisoned, caught in fences, flying into windows, being knocked out of nests, and getting attacked by dogs and cats. Most of the causes of their injuries are human related. The second fact is that people often find these animals and call or take them to their local practicing veterinarian. A 1986 national survey of wildlife rehabilitators indicated that over half million wild animals were examined by them.[1] Considering the increase in the numbers of wildlife rehabilitators and the heightened environmental awareness of the public, that number is probably 2 or 3 times as high today. There are many rehabilitation centers that receive 2,000 to 6,000 animals yearly. There is one facility in California at which more than 10,000 animals are treated annually. Unfortunately there are fewer than 6 veterinarians working in this field full time. Most of these rehabilitation facilities use the services of busy local practioners who only see what they are brought and have little input as to the level of care the animals receive.

Figure 1—Deer fawns trained to suckle from a bottle rack. The less exposure to human beings while in captivity, the greater their chance of surviving after release.

So what does all this mean to the average practicing veterinarian? First of all, every veterinary hospital needs to have a policy towards wildlife. The policy needs to be well thought out and include staff input. Many factors need to be taken into account, including the fact that these animals do not belong to the people who find them and these "rescuers" may not be inclined to pay for

From the Wildlife Center of Virginia, PO Box 98, Weyers Cave, VA 24486.

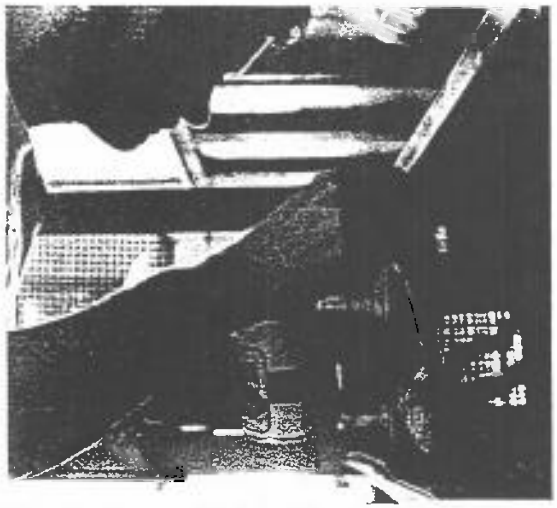

Figure 2—A young robin being fed canned dog food. Orphan songbirds need to be fed every 15 to 30 minutes from sunrise to sunset.

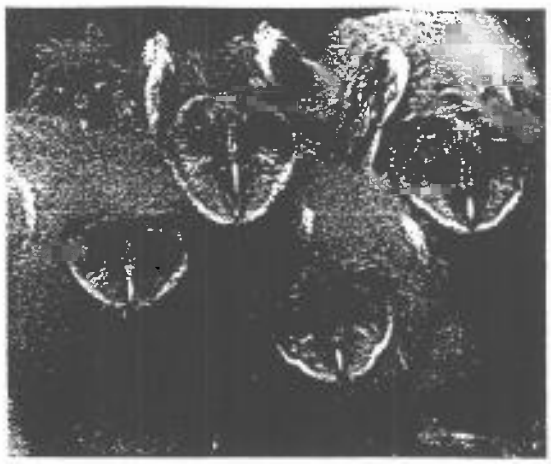

Figure 3—A clutch of immature barn owls.

services rendered. Although these animals may not be particularly expensive to treat, the treatment takes time and space. There is nothing wrong with a "no wildlife treated here" policy, but you should then be prepared to refer people to a place where they will get help, either another practice, rehabilitation center, SPCA, or private citizen with a permit. The people who find these helpless animals and contact you are disappointed and offended when they are turned away, and the credibility of your practice and the profession suffers. Practitioners need to be careful that they or their staff don't give advice that is biologically or medically unsound such as "feed the orphan bird bread and milk," or "leave the hawk with the drooping wing out in the field."

If the practice chooses to accept wildlife, then there needs to be an equally well thought out wildlife plan. The plan needs to include how involved the hospital will become with the animal and what type of remuneration will be expected. Some practices work out a financial arrangement with permitted rehabilitators who will pick up animals at the veterinary hospital. Other practices may raise, treat, and rehabilitate the animals on site. A busy veterinary practice is often not the ideal place to house wildlife and this may result in behavioral problems for wild animals or an animal injuring itself because of all the activity around it. Also, if a practice does take on this responsibility, everybody needs to be involved.

Practices that accept wildlife should maintain a log, which at a minimum includes the species admitted, the date it arrived, diagnosis, ultimate disposition, and date. I have found medical records useful for these animals and case numbers could be assigned if needed. The information in these logs is often required to be submitted as an annual report to state or federal wildlife agencies. Many veterinarians worry about treating wildlife without having the proper permits. It is unlikely that a practice would be cited for providing care to a wild animal. However, those practices actively engaged in caring for and rehabilitating these animals should apply to their state wildlife agency and the US Fish and Wildlife Service to obtain the necessary permits.

During spring and summer, many people find immature birds and mammals that appear to be orphaned. Those that are brought to veterinary hospitals need to be examined for congenital defects or other injuries, stabilized, and placed on a proper diet (Fig 1). There are several and varied references on proper diets for orphaned animals, and most of the formulas used are readily available.[2-7] Although most of these species are not difficult to raise, they are time consuming, with immature passerines requiring feeding every fifteen minutes from sunrise to sunset (Fig 2). Another major consideration must be trying not to interfere with the normal behavior of the species. A wild animal that "thinks" it is human should not be released; there have been numerous reports of people being injured by deer and owls that have been improperly hand raised. There are ways to avoid these problems but they are beyond the resources of the typical veterinary practice. In addition, predatory animals should only be handled by experienced professionals because they must be allowed to practice prey-killing prior to release or they are likely to starve in the wild (Fig 3).

Most of the wild animals found by the public are injured and not sick. They tend to get injured by several of the aforementioned common mechanisms, and as such, treatment protocols are easy to formulate. The processes involved in arriving at a diagnosis and then a treatment plan are similar to those used for domestic animals.

A history as complete as possible is important. This should include the name, address, and phone number of the person that found the animal. Even if the diagnosis is obvious, there may be other animals at risk, or there may be legal implications,

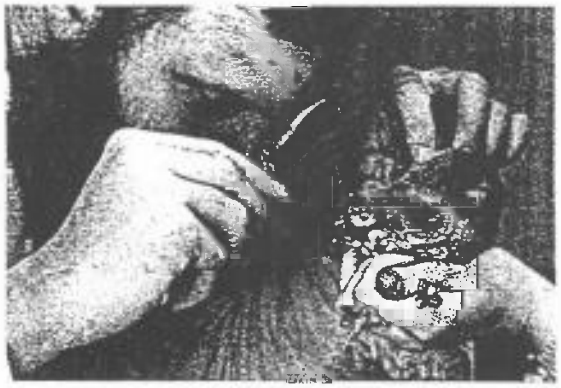

Figure 4—A screech owl that had been hit by a car. The eye is being examined because frequently there are lesions in the back of the eye that are not evident on superficial examination.

Figure 5—Bobcat that had been hit by a car and had a fractured pelvis. The tape on its right rear limb is all that remains of the fluid line.

such as in the case of gunshot or intentional pesticide poisoning. Although it may be easy to determine the organ system affected, there may be a variety of causes, which would each require a different treatment (Fig 4).

A complete physical examination is essential and will require either physical or chemical restraint. Most of the commonly seen wild animals are easily handled if one pays attention to their offensive and defensive weapons such as teeth, claws, antlers, and hooves (Fig 5 and 6). Only vicious animals such as carnivores and some rodents will need to be chemically restrained. The clinician must evaluate mental attitude, physical condition, hydration, and skeletal integrity among other things, using the same techniques that are used with domestic animals. This cannot be done without handling the animal because emaciation and

Figure 6—Golden eagle being restrained on its way back to an outdoor enclosure.

other injuries are often not apparent from a distance. Because most of these animals are trauma victims, multiple injuries are common.

The concept of releaseability is one factor of which the average practitioner may be unaware. The goal of wildlife rehabilitation is to ultimately release the animal, with the ability to survive, back to the wild. A wild bird with 1 functional wing, or 1 limb, or any totally blind animal should not be released, and thus, unless it is a threatened or endangered species, it should be humanely euthanatized. There are other factors that may also make an animal unreleaseable and veterinarians working with these animals need to decide with which they agree. At the Wildlife Center of Virginia (WCV), approximately 20% of our patients are euthanatized on first examination. Veterinarians should not amputate part of any wild animal without having a firm idea of what will ultimately become of that animal. The legal placement of unreleaseable animals is difficult, time consuming and best left to larger rehabilitation centers. The responsible government agencies will not give permits to people to keep unreleaseable wildlife, including handraised orphans in their homes.

After a physical examination, the veterinarian may perform a CBC, blood chemical analysis, radiography, examination of feces, or toxicologic screenings. These procedures are similar to those done on domestic animals. Many of the wild animals found are severely anemic, dehydrated, hypoproteinemic, and hypothermic. Knowing these things should affect the treatment and prognosis. It may be obvious that a bird has a fractured wing, but radiography will reveal to the clinician the severity of the fracture, the best type of fixation, and the

Figure 7—A red-tailed hawk with a fractured humerus, which is being treated by taping the wing in flexion and wrapping it with a stockinette.

prognosis as to regaining flight (Fig 7). A fracture through a joint will probably heal, but the bird will probably never be able to fly again and is thus unreleaseable. In some cases more elaborate diagnostic tests such as electrocardiography, magnetic resonance imaging, ultrasonography, endoscopy, and laparoscopy may be performed and give valuable information about the extent of the animal's problems.

The treatment of these animals often involves administration of fluids by a variety of routes depending on the size and the severity of the condition. I use multiple electrolyte solutions or lactated Ringer's for oral rehydration most often. The diagnostic tests may indicate that the animal is severely anemic and hypoproteinemic to the point that more extreme measures are necessary, such as intravenous, intra-osseous, or intraperitoneal administration of blood, plasma, or fluids. This is commonly done at the WCV when the bird's total solid concentration is less than 1 g/dl and the PCV is 15% or lower. Hypothermia is best treated by providing supplemental heat with a heat lamp, heating pad, incubator, or some other means. Supplemental oxygen may be indicated in animals that are dyspneic. Antibiotics, corticosteroids, and other drugs may also be indicated depending on physical findings.

Because many of these animals are injured and fractures are not uncommon, surgical intervention may be necessary. It is important not to subject a severely compromised animal to anesthesia and surgery. Veterinarians often will immediately anesthetize and perform surgery on a wild animal with a fracture prior to correcting the dehydration and hypoproteinemia and are upset that these animals do not survive. Many fractures are readily treated by only external immobilization with masking tape, aluminum splints, or some other material. Anesthesia can be performed by use of many different drugs. At the WCV, in any animal that can be physically restrained, anesthesia is induced by inhalation of isoflurane via mask, and the animal's condition is monitored. The more vicious animals are given an injection of ketamine/acepromazine, which may then be supplemented with an inhalant anesthetic if necessary.

Diagnosis and treatment is often the easy part, whereas getting the animal to eat in captivity may be more of a challenge depending on the species and the veterinarian's resources. The animal may become debilitated and even starve to death in a veterinary hospital while refusing to eat. The animals may not be eating for a variety of reasons, some relating to the active environment of a busy practice or to an inappropriate diet. Some species will not eat in a small cage, but readily accept the same food in a quiet larger pen. If the animal will not eat on its own, then you must provide nourishment for it. At the WCV, we use various hyperalimentation formulas that we administer by stomach tube. Many of these products are the same ones used in pet birds, dogs, and even people. Some veterinarians merely purée canned dog food and administer that by tube. Some animals under my care have survived for 2 months on liquid diets. Because hundreds of predatory animals are treated at the WCV, small rodents are a mainstay of the food supply and tend to be readily accepted even by some fish- and bird-eating predators.

Attention must also be paid to how these species are housed. In addition to the stress of strange smells and sounds in a veterinary hospital, wild animals may injure themselves on slippery cage bottoms or on the cage doors. It is better to keep them in quiet locations on a non-slip substrate like carpeting or towels and to provide perches for birds, or logs to hide in for small mammals. Ultimately they need to be acclimated to the outdoors prior to release.

Another major consideration is to determine when the animal is ready for release. Criteria used must be aimed at ensuring the survival of the animal in the wild. Animals kept inside should be ac-

climated to outside temperatures. Depending on the initial injury, the animal's recuperation period may last days to months. Animals that were hit by car and had no fractures usually take 2 weeks before they are back to normal, even though they may fly weakly in a day or 2. All predators with head trauma must demonstrate the ability to find and kill live prey in an outside pen prior to release from the WCV. Blind birds can often still fly. Periodically we will find owls that appear normal, but are unable to pass this test and are then judged unreleaseable. Some animals may require a year or longer before they are flying well enough to be returned to the wild. The actual rehabilitation process begins once the animal's wounds have healed. Birds especially need time to build up their flight muscles and stamina and this requires flight pens or exercise by other means. In some cases, physical therapy involving massage and range of motion exercises will be necessary for the return of normal joint mobility. Some facilities measure stamina by determining respiratory recovery rates after exercise, whereas others measure blood lactate concentration. The larger the bird, the more important this becomes.

Once the animal has been judged ready for release, thought needs to be given to proper release sites. In many cases, it is best to release the animal where it was found; however, this may be contraindicated in some cases, such as an animal found on an interstate highway. Animals should be released in a suitable habitat, but away from people, pets, and cars. Consideration should also be given to the weather, time of year and even time of day. Animals should not be released during or just preceding inclement weather. Releasing reptiles and adolescent mammals in winter is also not a good idea. Migrating birds should not be released after the migration has finished. These species may be shipped by airline to the wintering location and released there. Many people prefer to release nocturnal species at dusk and diurnal species early in the day. Raptors may be mobbed by crows and smaller birds, but this doesn't seem to cause any injuries.

Some wildlife biologists and veterinarians question the value of trying to treat and release these species and suggest that those that are not threatened or endangered should be humanely euthanatized. However, there are points in support of rehabilitation efforts worldwide. Wildlife rehabilitation is a humane activity. These animals have a biological right to survive. Because most of the reasons wild animals are injured are related to human interference, it cannot be said that we are interfering with the natural order of things by rehabilitating the animals. They deserve to be humanely and correctly treated just as do our pets and to be given a second chance back in the wild. Some have even received third chances.

There are other benefits to the rehabilitation of wild animals. These animals serve as sentinels of our environment. Unless there are large "die-offs", no one is usually paying close attention to causes of wildlife morbidity and mortality. Toxicologic and some infectious diagnoses may indicate an environmental problem prior to massive population decreases. The WCV has been involved in avian pesticide monitoring after receiving an endangered bald eagle with granular carbofuran-induced intoxication in 1986 (Fig 8). Fortunately, the bird was treated successfully and ultimately released, but this case raised many questions about the safety of organophosphates and carbamates in the environment and indicated how little was known about normal blood values, diagnostic testing, and treatment of these animals. We began working with Virginia and Federal wildlife officials to gather as much data as possible. We also started collecting blood samples to determine normal blood cholinesterase values. We have discovered that a substantial number of the eagles and hawks with injuries related to trauma also have depressed values of this enzyme, which may have contributed to their being injured. Another consequence of this work is that Virginia ultimately established a Pesticide Monitoring Board and in 1991 became the first state to ban the sale of granular carbofuran because of its danger to wildlife. The Environmental Protection Agency (EPA) had this product under special review for over five years and finally after Virginia's action settled with the company out of court to phase out its use nationwide, except for a few minor uses. The WCV provided clinical evidence of a potential environmental problem. The EPA is now looking into a number of granular cholinesterase inhibitors to evaluate their safety in the environment.

Figure 8—Bald eagle with the effects of carbamate toxicosis.

Wildlife rehabilitators were prominently involved in the controversy over lead shot and its effects on wildlife. The lead shot still in the environment has been responsible for the poisoning of many bald eagles and trumpeter swans seen at the Raptor Center of the University of Minnesota in addition to hundreds of other affected species seen around the country. Wildlife rehabilitators with the proper veterinary support could have a major role in this and other efforts.

Although most species treated by wildlife

rehabilitators are not endangered, the diagnostic and treatment protocols developed for these common species can then be used on those that are or do become threatened or endangered. Little is known about normal blood values in most wild species. A tremendous amount of data is or could be accumulated by wildlife rehabilitators. These data are often shared with others at national meetings and in journals that are out of the scientific mainstream. By increasing veterinary participation, these data collecting and analysis efforts could be enhanced. At the WCV, diagnostic tests such as CBC, fecal analysis, blood chemical analyses, determination of lead and cholinesterase concentrations, and histologic examinations are routinely run. Other procedures such as computerized axial tomography, magnetic resonance imaging, electromyography, and electrocardiography are occasionally used with the support of other members of the medical and veterinary community. Treatment procedures such as intraosseous blood transfusions, proper drug dosages, orthopedic procedures, hyperalimentation formulas, and captive animal diets are being developed and can be used on common and endangered species. Necropsies often reveal important information about infectious, parasitic, and toxic diseases in addition to the evaluation of treatment protocols.

Population management is important, but populations are made up of individuals. In the early 1800's, billions of passenger pigeons were reported in this country. The last passenger pigeon died in the Cincinatti Zoo in 1916. A similar fate befell the once numerous Carolina parakeet. Our destructive technology has improved immeasurably since the turn of the century and species that are considered common today could easily disappear within a decade. As human populations grow and habitat continues to decrease, the interactions between people and native species must increase. The time to worry about populations is while they are healthy, not once they have declined to several dozen specimens.

Much has been written in the last 2 years about wildlife rehabilitation efforts during disasters such as oil spills and obviously thousands of animals are impacted during these. Much publicity is focused on the heroic efforts of the wildlife rehabilitators working against the clock to save these animals. Fortunately, these disasters are not every-day events, but hundreds of wild animals are injured and found every day and more publicity needs to be focused on what is being done to help these animals.

If any of us working with wildlife are going to have a lasting impact, the existence and quality of suitable habitat is essential. Habitat preservation is basically a political decision affected by the attitudes and knowledge of the public. Wildlife rehabilitators use injured animals and their experiences to educate the general public and especially school children about the value of wildlife and the importance of a healthy environment. If our environment is going to survive the pressures being placed on it, we must affect people's attitudes about the value of wildlife and its role in the ecosystem.

The WCV serves as a training center for senior veterinary students to gain experience in working with wildlife. Unfortunately there are too few opportunities for gaining veterinary experience with wild animals.

The general public is supportive of wildlife rehabilitation. Most wildlife rehabilitation centers are private, nonprofit organizations which need to raise their own operating funds. These are raised primarily by individual donations. A survey commissioned by the Virginia Game Department indicated that 85% of the people questioned wanted to see nongame monies raised by tax check-offs used for wildlife rehabilitation. The general public believes and expects the responsible government agencies to come to the aid of these animals and they are usually surprised and annoyed when told that this is not the case. If the veterinary profession wanted, they could use this support to increase and improve professional wildlife rehabilitation efforts and create many more job opportunities for veterinarians interested in this field.

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Veterinary service in postwar Kuwait

Philip F. Alm, DVM, MS

It is a rare occasion when a veterinarian is asked to go overseas and become the Command Veterinarian for a large scale military operation. The United States encountered such an operation in late 1990 and early 1991 in the Persian Gulf. Considering the US military had never had a presence in the Gulf region, the prospect of such a command led me to assess my veterinary education, training and experience, as well as my physical stamina before I postponed retirement and accepted the challenge. I was given full support of our veterinarians in the active Army, the Reserves, and the National Guard throughout the world. They all proved their value on a daily basis and made my multifaceted job very gratifying.

My basic responsibility from late August until the end of February was to provide safe and wholesome food sources for more than half a million Department of Defense personnel in the Theater of Operations and to provide veterinary medical care to all military working dogs in the five Gulf countries. Those were the ABC's of Veterinary public health and practical veterinary medicine.

My greatest challenge and most rewarding experience was during the first week in March when I entered Kuwait as a part of the US Army Medical Damage Assessment Team. Our purpose was to provide humanitarian assistance to postwar Kuwait during the initial days after the Iraqi soldiers had been pushed northward out of their country.

While driving from Saudi Arabia into Kuwait, the smoke, the stench, the abandoned war machines, and the devestation of war were everywhere. Upon arriving in Kuwait City, the population was in total chaos, but celebrations were ongoing everywhere. It soon became apparent that this was truly a city in great need. The city was without electricity, water, and sewage systems; lacked medical care facilities and health care providers; but the city was "liberated."

My job was to make the initial assessment of the food and water requirements of the Kuwaiti people. Within the first day, it became apparent to me that food and water for human survival was a problem that needed some attention, but was not critical. As I drove around the city I noticed a dead Holstein cow in a corner parking lot and then another and another. I knew immediately that we needed to find out the cause of these deaths because they could soon become a severe public health hazard, particularly if there was an infectious disease involved.

The neighborhood people led us to several homes, schoolyards, playgrounds, and even a closed in soccer stadium where we found 10 to 50 head of dairy cattle in each place, totally hidden from the site of any passing vehicles. These cattle had been brought into the city in early September when Iraqi soldiers had began to slaughter all dairy herds to feed their hungry troops. For some reason, once the cattle were brought into the city in small numbers, the soldiers had left them alone.

Once I had located the first group of cattle, it was obvious that there was no infectious disease problem as the immediate cause of the deaths I had

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observed. These cattle were totally emaciated and starving to death. Most of them had had no feed or water for the 5 to 7 days since the beginning of the ground offensive when the Iraqi's had blown up all the water pumping stations and power plants in the city. The cattle were virtually dying in front of me, basically because of complete dehydration. I knew I had to make an attempt to get some water to these cattle, locate all sites in the city that had animals, and get a water brigade of some kind going or these animals would all be dead within a day or 2. This was not a small undertaking in a city approximately the size of San Francisco, with 2,000 dairy cattle spread throughout the city in some 150 locations.

I returned to my base headquarters and commandered the first water tanker truck I could find; which turned out to be the Commanding General's shower water for that evening! We gave water to some 500 cattle before midnight that day. I was able to get 4 more water tankers into Kuwait within the next 48 hours, replaced the General's shower water, and the Army continued to water these cattle for around 3 weeks until water supplies were restored to the city. We also eventually were able to get some resources for supplying some grain supplements and hay.

This was by far the greatest animal humanitarian effort with which I have ever been involved and it would not have been possible without the tremendous backing and support of the Veterinary Service received from BG Frix of the 22nd Support Command, active duty veterinarians such as CPT Tim Adams of the 483rd Medical Detachment out of Dahran and reserve component veterinarians such as MAJ Kirk Skeeles and LTC Dale Thurman.

However, the worst was yet to come. On March 2nd, as I drove past the Kuwait City zoo, I decided to enter the zoo and assess the situation. The scene was rubble, smoke, stench, and death.

Near the entrance, Asian macaques wandered about freely, one of them clumsily trailing the others on the remains of a foot that had been shot. A thirsty and hungry Indian elephant stood in its cage, barely moving, wounded in the shoulder from an Iraqi bullet, and obviously close to death from lack of food and water. Two emaciated hippopatamuses layed in the grass and would not move, water buffalo cowered in dehydration in their cages. Large cats lay thirsty and starving. The worst sight was in the animal feeding area where we saw the heads and bullet-riddled remains of animals the Iraqi soldiers had used for target practice: monkeys, gazelles, oryxes, antelope, birds, and even anteaters.

We quickly diverted a water truck to the zoo and provided water as soon as we possibly could. After 5 to 7 days without water, the 3,000-pound elephant drank a tankful of water. Eventually we were able to provide food and water to all the zoo animals. Our veterinary personnel disposed of animal remains, cleaned the pools and ponds and filled them with clean, fresh water. The elephant's wounds were treated as were those of other animals. The basics of veterinary medicine were again put to use.

As of my last communication, the animals of the Kuwait zoo are alive and well. Before the war, the zoo's collection included more than 400 animals, representing 134 species. Approximately 2 dozen animals survived.

Zoo veterinarians—doctors on the ark?

R. Eric Miller, DVM

In a corner of the Cincinnati Zoological and Botanical Gardens stands a small, restored pavilion. Its displays contain no living animals, but rather the preserved bodies of the last passenger pigeon and the last Carolina parakeet. Both died there during World War I, the last representatives of species driven to extinction by human interference outside of the zoo's boundaries. Next door, "living" exhibits feature Cincinnati's large breeding group of gorillas and a feline house specializing in small, endangered exotic cats. As wild habitats and animals become increasingly threatened, the juxtaposition of facilities is appropriate. Many of the more than 104,000,000 annual visitors to North American zoological institutions[a] fail to realize that numerous zoo "favorites", such as Siberian tigers *(Panthera tigris altaica)*, Asian elephants *(Elephas maximus)*, and orangutans *(Pongo pygmaeus)*, are endangered in the wild and are subjects of intensive captive breeding programs.[1] Yet other species, such as California condors *(Gymnogyps californianus)* and black- footed ferrets *(Mustela nigripes)*, have depended on captive breeding programs for their very survival.

As zoological parks remain centers for public entertainment and pleasure, via education, research, and breeding, they have also become conservation centers. In this role, fulfilling basic animal welfare needs lays the cornerstone for the ultimate animal welfare issue, that of preventing the extinction of species.

As medical personnel and as part of a larger team of zoo professionals, veterinarians have a key role in animal welfare at zoological institutions. As recently as 1982, Robert Bendiner wrote, "until the last decade, a resident veterinarian was the rarest animal to be found in the zoo."[2] Today, the situation has changed greatly, because nearly every major zoological facility has a full-time veterinarian. Many have staffs that include several clinical veterinarians along with nutritionists, pathologists, behavioralists, and reproductive researchers (Fig 1). Indeed, Dr. David Wildt, a reproductive researcher at the National Zoological Park, has suggested that advances in veterinary medicine (especially capture, restraint, anesthesia, and medical management) have had key roles in changing and expanding the direction of (zoo) research programs.[3]

Figure 1—Quarter Horse mare and newborn zebra delivered by the mare as a result of an embryo transfer procedure. Reprinted with permission from the Courier-Journal *May 17, 1984;A-12. Photograph by Paul Schuhmann.*

Veterinary concerns in animal welfare are wide-ranging. Historically, the identification and treatment of disease in individual animals and species in each institution were central to the veterinarian's role in animal welfare. Catastrophic epizootics of infectious disease, such as rhinotracheitis in clouded leopards *(Neofelis nebulosa)* and parvovirus in South American canids, reinforced

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[a]For this paper, the terms "zoological park (zoo)" and "aquarium" will refer to the 160 accredited members of the American Association of Zoological Parks and Aquariums. Nearly all major public and private zoological institutions are members.

the importance of these activities.[4,5] But zoo veterinarians' interest has expanded beyond diagnosis and treatment of individual animals, and includes the evaluation of populations and preventive medicine, a situation more similar to the orientation of wildlife veterinarians.[6]

In zoological institutions, prevention of disease is critical because the untamed nature of the patients makes intensive treatment of many species difficult if not impossible. Preventive medicine programs include vaccinations (eg, lions and tigers for feline respiratory viruses), parasite surveillance (monitoring gorillas for *Balantidium coli* or orangutans for *Strongyloides* sp), testing for tuberculosis and the communicable diseases, and routine quarantine of new arrivals to prevent introduction of disease into an established animal collection. Preventive medicine in zoological parks also includes identification of environmental factors that may make captive species more susceptible to opportunistic pathogens.[7]

Animal welfare in zoological institutions is regulated by several government agencies. The Animal Welfare Act, which covers animal food, housing, health and safety, is central to this regulation. Since 1970, its enforcement in zoological parks has been carried out by USDA inspections of the more than 1400 facilities that have a USDA license to exhibit animals.[8] The USDA provisions include exotic animals, but exclude birds, reptiles, amphibians, fish, and certain domestic and laboratory-bred mammals.[8,9] The Animal Welfare Act also regulates animal transport and its most recent amendment addresses the psychological well-being of primates.

Veterinarians are central to the inspection process at zoological institutions, both as inspectors and as supervisors. In fact, for the psychologic well-being of primates, the attending veterinarian at the institution is responsible for overseeing application of the Animal Welfare Act standards. Additionally, at institutions with active research programs, veterinarians are integral in the function of Institutional Animal Care and Use Committees. Besides the standards of the Animal Welfare Act, zoos and aquariums have other federal regulations to meet as well. They are subject to the Department of Commerce's Marine Mammal Protection Act of 1972, which specifies housing and water conditions for marine mammals, and the Interior Department's Endangered Species and Migratory Bird Acts that require permits for the maintenance of covered species.[10]

In 1980, the zoological community developed a second, rigorous system of regulation through the accreditation process of the American Association of Zoological Parks and Aquariums (AAZPA). By 1985, all AAZPA institutions had complied or lost membership. Today, 160 North American zoological institutions are accredited members of AAZPA.[1]

The scope of the AAZPA inspections is broader than that of the federal government, for example, all animal species are covered. In addition to food, water, and housing, further attention is given to the social needs of the animals, record keeping, research, and captive propagation of endangered species. By their Code of Ethics, zoos are bound to see that the animals in their care receive humane care. In addition, animals may only be transferred to other institutions that are capable of providing professional care, and if they are euthanatized, it must be done so humanely. The accreditation process also requires cooperation in local, national, and international conservation programs, and the provision of educational programs for the public. Member institutions must file detailed financial statements to demonstrate their ability to provide for the sustained care of the animals in their charge.

Table 1—Comparative rates of species extinctions

Time	Rate of extinction
70,000,000 years ago (disappearance of the dinosaurs)	1 species/1000 years
1 AD to 1650	1 species mammal or bird/82 years
1650 to 1850	1 species mammal or bird/5 years
1850 to 1900	1 species mammal or bird/9.5 months
1900 to 1950	1 species mammal or bird/8 months
Present	All plant and animal life, 1 to 6 species/day?
2000 (projected)	All plant and animal life, 1 species/hour

These regulations reflect the concern of zoo professionals, governmental agencies, and the public in the humane and improved care of captive animals. Simply stated by Dr. Morton Silberman, "husbandry that promotes well-being is synonymous with humane treatment."[11] Nutritious feedstuffs, appropriate social groups, and adequate housing all seem obvious requirements. Yet, for animals in zoos, the provision of each is often the result of years of research. For example, many species have evolved complex and specialized feeding strategies, but often these are diets that zoos are still studying and refining.[12]

Increasing knowledge of animal behavior has advanced our concepts of animal welfare and housing.[13] "Postage stamp" exhibits that featured few individuals and large numbers of species have been replaced by more naturalistic displays featuring groups, troops, and other arrangements that parallel a species' natural social structure.[14] Gorillas are an example. They rarely reproduced in pairs, but have been much more fecund when placed in larger troops that mimic their wild society.

At a time when zoos are focusing on breeding endangered species, the preservation of species becomes the paramount animal welfare issue. Arguably, extinctions are part of the natural process of Darwinian evolution, but the current number of extinctions is compounded exponentially by man-made environmental changes and destruction (Table 1).[2,15,16] In this maelstrom of endangerment, zoos are a potential means of survival for some

critically endangered species. However, the numbers of endangered species are too overwhelming for zoological institutions to become "arks" for all species (it has been estimated that zoos could manage 2000 vertebrate species).[17]

Responsible zoo professionals readily acknowledge that the first priority is to maintain a species in its native, intact environment. Michael Hutchins, AAZPA Director of Conservation and Science observes, "captive propagation cannot be considered as a panacea for the endangered species problem and should be implemented as part of a more holistic effort to preserve species in their natural habitats."[18] But for many species, political instability (the kouprey, *Bos sauveli* in Cambodia); introduced predators (the Micronesian kingfisher on Guam); introduced disease (the gaur, *Bos gaurus*, in Southeast Asia); poaching for commercially valuable products (the black rhinoceros, *Diceros bicornis*, across sub-Saharan African); and most commonly, massive habitat destruction (all the prosimian primates on Madagascar) create a future threatened by the risk of unnatural extinction. For these and other species, captive breeding may serve as an alternative to extinction until current political and environmental instabilities resolve.[19]

Some captive-bred animals have already been returned to their native habitats. As early as 1907, American bison (*Bison bison*) from the New York Zoological Society were used to reestablish several bison herds in the American West.[20] Today, golden lion tamarins (*Leontopithecus rosalia*) are being reintroduced into Brazilian rain forests, and after being hunted to extinction in the 1960s, captive-bred Arabian oryx (*Oryx leucoryx*) from the San Diego and Phoenix Zoos have returned to Jordan and Oman. But for many captive-bred species, reintroduction remains a distant goal because of continued habitat destruction or political instability in their native areas.[19]

The success of captive breeding programs should not be based solely on reintroductions. Many intensive genetic and nutritional analyses, telemetry trials, and behavioral and disease studies are more readily performed in zoological parks because of the greater accessibility of captive animals. Almost invariably, research in zoos focuses on projects that benefit the animals and their species, producing results that are often applicable to the conservation of captive as well as wild individuals still afield. The scope of zoo-based research is growing; a recent survey reported 388 conservation research projects in zoos of 63 countries.[21] From 1990 to 1991, more than 400 technical articles on wildlife biology and conservation research were published in North America by AAZPA institutions.

Vital to the maintenance of endangered species in captivity is the development of programs that preserve their genetic variability over the long term. The clear challenge is to preserve an animal most like its wild relatives in appearance, fertility, resistance to disease; a product of natural selection, not an artificial subspecies produced by the selection of man. Although 90% of the mammals currently exhibited in North American zoos are captive born,[19] the Asian wild horse (*Equus przewalskii*), the last truly wild (not feral) horse, illustrates the inbreeding predicament. Bred from captive stock since the turn of the century, in the intervening decades, the head shape of the animals has changed. Thus we question whether we have saved the Asian wild horse, or a semi-domesticated version of it.

To avoid this dilemma, a definition of what constitutes saving a species is necessary. Genetic modeling provides us with one definition, saving a species requires the maintenance of 90% of its genetic variability over the next 200 years or 50 generations.[17] To achieve that goal, on the basis of mathematical models, 250 breeding animals would be needed for most species (for some slower breeding species [eg, Asian elephants], 50 might be enough, for some faster breeding species [eg, elephant shrews], 1000 or more might be required).[17] Because only a relative few individuals of each species are housed in each zoo, cooperation without coordination is insufficient to preserve wild animals in captivity over long periods of time.[19,22]

In North America, coordination has been provided by the Species Survival Plans (SSP) of the AAZPA. Currently the management of more than 60 threatened species is done by a committee (Appendix). The AAZPA has set a goal of 200 SSP committees by the year 2000. Similar programs have been organized in Europe, Japan, Australia/New Zealand, Brazil, Southeast Asia, and Africa. The Captive Breeding Specialist Group, a more than 300-member international committee of the World Conservation Union, oversees the global coordination of these regional programs. Worldwide, animals may be identified and located through another organization, the International Species Information System.

Perhaps the Siberian tiger (*Panthera tigris altaica*) best illustrates the function of a SSP. Today more Siberian tigers live in zoos (600 to 700) than in the wild (estimated 300 to 400). Yet, all of the world's captive Siberian tigers descend from 44 "founder" tigers (wild individuals that were presumably unrelated). In Siberian tigers, as in many species, the founders are not equally represented; some have had more breeding success than others.[19] The St. Louis Zoological Park's Siberian tigers were genetically over-represented and the tiger SSP determined that they should not be bred (a progesterone implant was placed in the female). When space became available, new, genetically underrepresented lineages were located (a male tiger from San Diego and a female tiger from the Denver Zoo) and placed together at St. Louis. The match was a success in that breeding took place and 2

cubs resulted (whose future placement will be at the direction of the SSP).

However, problems quickly arise. Space limitations are illustrated by the 1750 spaces for large cats in North American zoos, which is space for SSP programs for 7 species if we accept the assumption of a necessary 250 breeding individuals/species (in reality, such a number usually requires a population at least twice that size).[23] Thus, zoos must select 7 species of large cats in which to invest their finite resources (all the world's zoos would fit within an area the size of Washington, DC).[19,24]

This selection requires wisdom. A form of conservation triage exists, a protocol for selecting species for captive breeding.[25] Priority is given to animals that may be in immediate danger of extinction or that may represent the last living member of genus or taxonomic family. If there is not a reasonable chance of success for captive breeding (eg, has the maintenance of related, non-endangered species been successful?), priority is reduced.

The medical management of these small, captive populations offers unique opportunities for veterinarians. The deleterious effects of inbreeding include the potential for altered resistance to disease.[26] According to Dr. Linda Munson, a veterinary pathologist, diseases could prove to be greater modifiers of small populations in the future than the past because of greater habitat and genetic restrictions.[27]

In part, Dr. Munson's observation is illustrated by the prevalence and high morbidity of feline infectious peritonitis in cheetahs.[28] It is a situation likely compounded by their genetic impoverishment.[26] It is a disease, like several others, that markedly complicates the movement of animals between institutions for genetic purposes. The cheetah SSP Committee has been a leader in the interdisciplinary approach to solving these problems. Its research advisory group contains a nutritionist, geneticist, clinical veterinarian, veterinary pathologist, reproductive physiologist, and behavioralist.

As advisors to SSP and related committees, veterinarians are in a central position to monitor vital statistics and disease trends that affect the growth and survival of a captive population. Their role includes the cataloguing of each species' diseases, establishment of preventive medicine programs, and determining veterinary research needs.

Of vital importance to the future maintenance of genetic diversity is research into the reproduction of endangered species.[29-32] With reproductive physiologists and many others, veterinarians have had an active role in the development of cycle determination, artificial insemination, and embryo transfer, which are steps that will aid in the transfer of genetic material between zoos (and the first step in transferring genetic material from the wild to captivity and vice versa or between parks).

Even at necropsy, SSP veterinarians attempt to establish disease patterns and collect tissues for comparative studies vital to the survival of many endangered species.[27] Species Survival plan veterinarians are one source for central tissue/sera repositories vital for future research. And the demand for veterinary participation is a growing one; one estimate suggests a need for 240 veterinary advisors to SSP and related committees by the year 2000 (presently, there are approximately 100 full-time zoo veterinarians).[6]

As members of some captive populations are being prepared for return to the wild, close attention must be paid to the potential for disease spread (the same is true when wild animals are brought into captivity, or if wild animals are translocated between habitats). As golden lion tamarins are being prepared for reintroduction into the coastal rain forests of Brazil, the problems of infectious diseases and genetic defects (eg, coronaviral hepatitis and diaphragmatic hernias) take on critical importance.[33,34] The issues may be more mundane, but no less important (eg, it is critical that Arabian oryx returning to the Middle East be free of tuberculosis or viral diseases such as bluetongue that reside in the United States). Evaluating such risks is vital to the future success of reintroduction programs. In recognition of this, the Captive Breeding Specialist Group is organizing a seminar that will address these issues (November 1992, Oakland, Calif.).

As wildlife habitats continue to shrink, zoological institutions are extending their view beyond those endangered animals that they maintain within their perimeters. An enviable record of funding field programs (more than $4,000,000 annually[21]) has been achieved by Wildlife Conservation International, a division of the New York Zoological Society. It is being joined by a growing cadre of zoos funding habitat protection and field research (eg, the San Diego Zoo's support for the Darwin Research Station in Ecuador helps breed endangered subspecies of the Galapagos tortoise *[Geochelone elephantopus]*, the Minnesota Zoo's "adoption" of Ujon Kulong National Park in Indonesia protects a reserve that is home to the largest remaining population of Javan rhinoceroses *[Rhinoceros sondaicus]*). In such ways, zoological parks can offer unique opportunities for locally supported institutions to contribute to global conservation.[24]

In a similar manner, zoo veterinarians have a growing role in international conservation. In a forward-looking program, the New York Zoological Society employs a full-time veterinarian to service its field projects. Additionally, Dr. Christen Wemmer has established a zoo school that employs a team of zoo professionals to disseminate zoo management and conservation biology techniques to zoological parks in the underdeveloped world.[35] Zoo veterinarians have been active participants in that program and in Zoo Conservation Outreach

Group, a cooperative organization of 32 North American zoological parks and 15 Central American zoos.

As the wild grows smaller, and zoological institutions expand their horizons, the line between captivity and the wild is often blurred. The plight of black rhinoceroses in their native Africa illustrates the point. After a 90% decrease in black rhinoceros numbers (primarily attributable to poaching), the Kenyan government designed a successful sanctuary program that translocated animals from vast, poorly protected parks to smaller, fenced parks and ranches, areas more readily monitored and defended. In the sanctuaries at Lake Nakuru, Solio Ranch, and elsewhere, black rhinoceros numbers have been growing, but only in areas that have carrying capacities between 15 and 100 animals. The situation is similar for elephants, "the distribution of human and elephant populations has changed from one characterized by human islands in a sea of elephants to increasingly small islands of elephants in a sea of people."[36] In reality, the protective fencing for the rhinoceroses or the isolation created by a sea of people has created "megazoos," complete with the specter of inbreeding. Moving rhinoceroses from zoo to zoo is a large enough task in itself; moving them from sanctuary to sanctuary is even more herculean. Thus the genetic management and reproductive studies in zoological institutions have impact on these populations as well,[37] and new opportunities are presented for the zoological and wildlife communities to share interests on common ground.

Through continued research, health monitoring, animal movement and the prevention of disease, veterinarians have vital roles in the preservation of endangered species. Captive propagation programs provide hope to some of the threatened species alive in a world rife with environmental danger. The sheer scale of the present ecological crisis precludes zoological institutions from becoming "arks" to all endangered species, but through careful selection and design, they can be "lifeboats" for many.

Captive propagation cannot be an end unto itself, but rather an integral part of the larger mosaic that is education, research, and field conservation. All seek preservation. To prevent losses of animal species should be the ultimate goal in animal welfare, for the species involved and for ourselves.

Appendix

Species presently included in species survival plans of the American Association of Zoological Parks and Aquariums

Mammals

addax (*Addax nasoma culatus*)
African elephant (*Loxodonta africana*)
Arabian oryx (*Oryx leucoryx*)
Asian elephant (*Elephas maximus*)
Asian lion (*Panthera leo persica*)
Asian small-clawed otter (*Aonyx cinerea*)
Asian wild horse (*Equus przewalskii*)
Baird's tapir (*Tapiris bairdii*)
barasingha deer (*Cervus duvauceli*)
black-footed ferret (*Mustela nigripes*)
black lemur (*Lemur macaco*)
black rhinoceros (*Diceros bicornis*)
bonobo (pigmy chimpanzee—*Pan paniscus*)
Chacoan peccary (*Tayassu wagneri*)
cheetah (*Acinonyx jubatus*)
chimpanzee (*Pan troglodytes*)
clouded leopard (*Neofelis nebulosa*)
drill baboon (*Papio leucophaeus*)
gaur (*Bos gaurus*)
gibbons (*Hylobates* sp)
golden lion tamarin (*Leontopithecus rosalia*)
greater one-horned rhinoceros (*Rhinoceros unicornis*)
Grevys' zebra (*Equus grevyi*)
lion-tailed macaque (*Macaca silenus*)
lowland gorilla (*Gorilla gorilla*)
lowland tapir (*Tapiris terrestrus*)
Malayan tapir (*Tapiris indicus*)
maned wolf (*Chrysosyon brachyurus*)
okapi (*Okapia johnstoni*)
orangutan (*Pongo pygmaeus*)
red panda (*Ailurus fulgens*)
red wolf (*Canis rufus*)
ruffed lemurs (*Lemur variegatus*)
scimitar-horned oryx (*Oryx tao*)
snow leopard (*Panthera uncia*)
spectacled bear (*Tremarctos ornatus*)
Sumatran rhinoceros (*Didermocerus sumatrensis*)
tiger (*Panthera tigris* sp)
white rhinoceros (*Ceratotherium simum*)

Birds

Andean condor (*Vultur gryphus*)
Bali mynah (*Leucospar rothschildi*)
California condor (*Gymnogyps californianus*)
Guam rail (*Rallus owentoni*)
hooded crane (*Grus monacha*)
Humboldt penguin (*Spheniscus humboldti*)
Micronesian kingfisher (*Halcyon c cinnamomina*)
palm cockatoo (*Probosciger atterimus*)
red-crowned crane (*Grus japonensis*)
St. Vincent parrot (*Amazonia guildingii*)
thick-billed parrot (*Rhynchopsitta p pachyrhyncha*)
wattled crane (*Bugeranus carunculatus*)
white-naped crane (*Grus vipio*)

Reptiles and Amphibians

Aruba Island rattlesnake (*Crotalus unicolor*)
Chinese alligator (*Alligator sinensis*)
Dumeril's ground boa (*Acrantophis dumerili*)
Puerto Rican crested toad (*Peltophryne lemur*)
radiated tortoise (*Geochelone radiata*)
Virgin Island boa (*Epicrates monensis*)

Fish

Lake Victoria cichlids (*Haplochromus* sp and others)

INVERTEBRATES

Partula snails (*Partula* sp)

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Wildlife diseases and population medicine

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The public image of a wildlife veterinarian is a person who takes care of a sick or injured wild animal or an animal in a zoo. It takes considerable discussion to broaden that stereotypic viewpoint.

The purpose of this report is to explain the activities of a small cadre of wildlife veterinarians who are devoting their efforts to the welfare of free-ranging wildlife through the practice of population medicine. These veterinarians are not numerous; perhaps 30 are working full time and another 50 to 100 practice wildlife population medicine as part of their other job functions. The American Association of Wildlife Veterinarians has approximately 330 members, including students and nonveterinarian subscribing members. Although wildlife veterinarians are few in number, their practice covers an immense number of animals. Most wildlife populations are unmeasured, but there are some impressive estimates for a few groups. For example, there are approximately 32.4 million deer, elk, antelope, and other wild ruminants in North America, and migratory mallards number about 10.2 million. These are but a few of the animals we treat.

Certain elementary facts must be accepted if one is to apply veterinary skills that will benefit an entire wildlife population. Every wildlife population has a natality rate and a mortality rate. When the 2 rates are equal, the population is stable. More births than deaths yield an increase, and the opposite yields a decrease. Baby birds and squirrels are born to replace ancestors that have died or will die, and young wild animals are purposefully overproduced to allow for losses of immature animals and reproductive failures.

Therefore, death is a necessary component of the natural scheme. Every wild animal will some day develop a medical problem that will cause its demise. Types of death range from quick and painless to slow and agonizing. Although wildlife veterinarians can help determine what types of death occur in wildlife populations, no one makes a substantial difference by attending to each animal on an individual basis. The sheer number of animals makes us focus our attention on the health of a herd, flock, or group of wild animals to make certain that most of the animals in a wildlife population are healthy and that the species in question is able to reproduce in adequate numbers. When appropriate, the wildlife veterinarian must concentrate on finding ways to prevent health problems that threaten wildlife by breaking disease or parasite transmission cycles in nature and eliminating toxic chemicals.

Before proceeding, it is important to adequately recognize the profession of wildlife management as a field of endeavor equivalent to that of wildlife veterinarians. The parent professional association for wildlife managers is The Wildlife Society, which has over 8,800 members, 2 refereed periodicals, and an accreditation process for its members. Over 90 colleges and universities teach wildlife conservation and wildlife management at the BS, MS, or PhD level.[1] Therefore, wildlife veterinarians are only a small part of the conservation team that is responsible for the welfare of wild animals. The wildlife veterinarian serves as a specialist/advisor to the wildlife management team in regard to health matters; however, the veterinarian's efforts are finally achieved through acceptance and actions of wildlife administrators, biologists, and law enforcement officers. Animal welfare, when defined in terms of healthy, sustained wildlife populations, is the common goal among wildlife managers and wildlife veterinarians.

Duties of Wildlife Veterinarians

Wildlife veterinarians practice population medicine by applying a wide variety of veterinary skills. Diagnostic skills are needed to determine the causes of sickness and death in wild animals. As diseases and parasites are identified in wildlife, their impact upon the population must be determined through research and surveillance. Epidemiologic skills are used to define the disease interrelationships between wildlife and domestic livestock and the role of wildlife in transmission of human diseases. Finally, the wildlife veterinarians must use their knowledge to devise ways to pre-

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vent, control, or eliminate major disease problems in free-ranging wildlife. These tasks are confounded by the fact that there are 467 mammalian, 1,100 avian, 394 reptilian, and 226 amphibian species in the United States and Canada,[2] and the list of potentially harmful viruses, bacteria, protozoa, helminths, arthropods, and toxins is nearly endless. All veterinary specialities, such as pathology, parasitology, entomology, microbiology and toxicology are used by wildlife veterinarians.

Wildlife Diagnosticians

The diagnostic process is an important first step in defining disease problems in wildlife. Without this process, the cause of sickness or death in wildlife is often the subject of wild speculation. Once the cause of the problem is identified, a course of action can be drawn when needed.

Many veterinarians involved with free-ranging wildlife have additional training in pathology, and a few are board-certified. Most wildlife specimens are submitted for examination after they are dead, and necropsy procedures often are followed by laboratory tests such as bacterial cultures, virus isolations, histologic examination and toxicologic analyses. Occasionally a sick animal is submitted for examination when it is still alive. The diagnostic strategy is to examine the animal in depth to gather any possible information and then euthanatize the animal for further study through necropsy. Clinical treatment is rarely initiated because it is more important to obtain data that can be used to help maintain the health of the free-ranging population than it is to save the individual animal.

Veterinarians in many universities and diagnostic laboratories throughout the United States occasionally do necropsies on wildlife. There also are a number of nonveterinarians with excellent diagnostic skills. Two organizations, the Southeastern Cooperative Wildlife Disease Study (SCWDS) in Athens, Georgia, and the National Wildlife Health Research Center (NWHRC) have wildlife diagnostic services as a specific mission. The SCWDS investigates 150 to 250 mortality events/year in the southeast region. Although their work is largely with resident mammals, 34% of the animals examined are birds and 38% are nongame wildlife. The NWHRC investigates 700 to 800 episodes of wildlife mortality annually; waterfowl and endangered species are involved in about 80% of those episodes.

One advantage of the diagnostic process is that repeated observations of a specific problem can give some indication of its importance to the wildlife population at large. For example, 31% of the diagnostic accessions for deer submitted to SCWDS were attributed to hemorrhagic disease viruses.[3] On the basis of similar SCWDS data, canine distemper afflicted 62% and 78% of raccoons and grey foxes, respectively. In contrast, canine distemper does not appear to be a problem in red foxes, but sarcoptic mange was the major problem in over 60% of accessions. Avian pox is the most common (25%) diagnostic problem in wild turkeys in the Southeast.[4] Obviously, reducing losses to the primary disease factor for any given species should receive high priority in disease management.

Prescriptions for Wildlife Health

Wildlife veterinarians and wildlife disease biologists identify, study, and attempt to resolve wildlife disease problems in various ways. In many cases, wildlife veterinarians helped make changes similar to prescriptions filled by wildlife managers, animal health authorities, and the general public.

Poultry litter . . . . good or bad?—The nationwide inventory for chickens of all types is approximately 37.2 billion.[5] Inherent to these birds is a tremendous amount of poultry manure, much of which is spread back onto fields as fertilizer. The potential for disease transmission to wild birds from domestic poultry via manure has not been well studied although there are legitimate concerns.

A good focal point for potential disease dissemination by manure spreading is the protozoan parasite, *Histomonas meleagridis*. The life cycle of this 1-celled pathogen is complex and involves the poultry cecal nematode, *Heterakis gallinarum*, as a transport host. The protozoan is carried by the cecal worm and can cause severe, fatal disease, often termed "blackhead," in wild turkeys, ruffed grouse, chukars, and sometimes, bobwhite quail.

Chickens and pheasants are resistant to disease and are reservoirs of the parasites. Because thousands of tons of chicken manure are placed into wildlife habitat, the risk of *Histomonas* transmission to wild turkeys and other birds currently is being assessed. We have found that manure from broiler chickens was essentially free of the parasites because these chickens had a life span that was too short to promote internal parasite problems. In contrast, breeder birds that were kept for several months on litter had a high prevalence of infection. Egg-laying hens kept in cages had an intermediate prevalence. These data support the prescription that litter from broilers can be used to increase soil fertility in wild turkey, grouse, or quail habitat, but layer or breeder manure should be avoided.

Lead shot—Ingestion of lead shotgun pellets, and even lead fishing weights, by waterfowl can result in lead poisoning. Waterfowl mistakenly consume the shot as grit material and become poisoned when the base metal is absorbed as lead salts in the gizzard. Estimated annual losses of waterfowl to lead poisoning may exceed 1 million birds.[6] Secondary losses also can occur in raptors that ingest lead pellets while consuming lead-poisoned birds or unretrieved waterfowl killed with lead.

Although this problem was readily identified in individual birds, it took a substantial effort to assess

its impact on the waterfowl population because the losses of birds were gradual and covert. In addition, a substitute for lead shotgun pellets was difficult to develop because the density of lead gives it ballistic superiority over lighter metals. A substitute, steel shot (actually iron), has been developed and today its use is prescribed by law for use in waterfowl hunting. Losses of waterfowl attributable to lead pellet ingestion are expected to subside.

Dirty bird feeders—According to the 1985 National Survey of Fishing, Hunting, and Wildlife Associated Recreation, 85.8 million Americans feed birds and other wildlife around their homes.[7] This represents 47% of the United States population. Backyard feeders provide literally tons of food and may have a positive impact on songbirds and other animals. However, as veterinarians, we must consider the disease implications of concentrating numerous animals at a point feeding source. Indeed, avian salmonellosis has been linked with dirty bird feeders.[8-10] Trichomoniasis, a protozoan disease of doves and other columbiformes, also has been associated with concentration of birds at feeding and watering stations.[11] A recent example was a trichomoniasis epornitic in mourning doves in 26 counties in North Carolina in March to July, 1991. Over 500 birds were found dead and virtually all of the dead birds were discovered near feeders.

Greater effort is needed by wildlife veterinarians to assess the disease ramifications of artificial feeding for songbirds. More problems, including bacterial and protozoan agents as well as mycotoxins, would probably be identified. Of course, the prescription would be greater public education towards feeder sanitation, site rotation, and avoidance of excessive concentration of birds. Undoubtedly, manufacturers of bird feeding products would help publicize these recommendations if encouraged.

Brucellosis in bison and elk—The Greater Yellowstone Area of Wyoming, Idaho, and Montana is the largest and most remote wilderness ecosystem in the contiguous United States. It harbors approximately 90,000 elk and 4,000 bison, which are regarded by many people as wildlife resources that are national treasures. Unfortunately, many of these animals are infected with bovine brucellosis. As the nationwide eradication program approaches its goal for domestic cattle, political conflicts over the brucellosis-infected wildlife in the Greater Yellowstone Area will become more common and contentious. Opposing mandates and policies of the numerous state and federal agencies responsible for managing wildlife and agriculture will present obstacles to eliminating the disease.[12]

Wildlife veterinarians, in cooperation with biologists, researchers, state and federal regulatory veterinarians, and agency administrators, are working to solve the problem while protecting the integrity of the area's elk, bison, and cattle populations. In Wyoming, most of the brucellosis-infected elk reside during winter months on artificial feedgrounds. Winter feeding helps transmit infection by keeping the elk in unnaturally crowded conditions. However, use of feedgrounds during winter also provides access to these elk, and wildlife veterinarians and biologists are developing a ballistic vaccination program designed to immunize all feedground elk populations against brucellosis.[13] Habitat enhancements and feedground management practices also are being evaluated to find ways to reduce the length of time and number of elk that use feedgrounds.

Domestic sheep/bighorn sheep—Bighorn sheep populations have suffered a number of sudden die-offs in various western states. These losses are startling and have frustrated restoration attempts for this species. Observers usually identify pneumonia as the problem, and several wildlife disease authorities have speculated that domestic sheep are carriers of bacterial and viral disease organisms fatal to bighorns.[14,15] This possibility has been given serious consideration by federal land management agencies in grazing allotment programs, and a few leases were denied on the grounds of disease risk to wild sheep. Both cattle and sheep ranchers are extremely concerned that this concept will lead to a precedent that will deny them access to federal lands. Thus, a controversy has developed, and wildlife and livestock interests are in opposition.

Wildlife veterinarians and wildlife disease specialists are putting increased effort into the study of domestic sheep/bighorn sheep disease relationships. Their goals are to continue to expand disease prevalence data on healthy bighorn populations, to accumulate more disease data on other western wildlife species, to conduct complete epidemiologic investigations of bighorn sheep die-offs, and to continue to manage bighorn sheep populations.[16] New diagnostic tools are becoming available to characterize the *Pasteurella* organisms suspected as primary agents through DNA fingerprinting. This information should lead to some answers on the cross-transmissibility of these agents among sheep. In the interim, wildlife and livestock veterinarians are able to make only general recommendations about the importance of domestic sheep on bighorn range.

Relocation of the biological package—Wildlife relocation has proved to be one of the most effective tools for restoration of once depleted wildlife species. Notable successes include the return of white-tailed deer and wild turkey populations from threatened levels. Current efforts to restore endangered species such as black-footed ferrets, red wolves, and Puerto Rican parrots hinge upon relocation from captivity to the wild.

Wildlife veterinarians are aware that each wild animal is actually a biological package that encompasses the microbiologic flora, viruses, and endo-

and ectoparasites of the animal. Therefore, the moving of wild animals always holds the potential for relocation of a disease agent as well. Thorough veterinary inspection must be given to ensure that the animals being moved are free of important diseases and parasites.

Good examples of the disease ramifications of relocating wildlife are provided by the commercial traffic of wild animals such as raccoons, foxes, coyotes, wild swine, and game farm cervids. Raccoons that were being relocated by private hunting clubs have been found to have rabies,[17] and public health epidemiologists speculate that raccoon relocation was responsible for the introduction of rabies into terrestrial mammals in the mid-Atlantic states in 1977.[18,19] More recently, interstate traffic in live red foxes and coyotes has increased substantially to meet the demand for animals to stock foxhound chasing pens. This commercially based activity by the private sector has important disease ramifications as evidenced by the discovery of the zoonotic parasite, *Echinococcus multilocularis*, in red foxes illegally imported into South Carolina in 1989.[16]

Wild swine are present in at least 18 states, and their numbers are estimated between 0.5 and 2 million animals nationwide.[20,21] Disease surveys have revealed that substantial numbers of wild swine are infected with swine brucellosis, pseudorabies or both.[22] These diseases are of importance to our domestic pork industry, and in the case of swine brucellosis, a threat to human health. Because the distinction between a wild pig and a domestic pig is not clear cut, it is difficult to regulate interstate movement of wild swine or to keep these animals out of domestic marketing channels. Thus, transport of infected wild swine to stock new hunting areas represents a continuous threat to control and eradication of swine brucellosis and pseudorabies in domestic swine.

Another example of wildlife relocation having disease potential is the increased popularity of game ranching. The most common species for game ranching are fallow deer, red deer, elk, and axis deer, but a number of other species also are involved. Most of the estimated 300,000 to 500,000 head of these animals are kept under fence, although approximately 74,000 are unconfined in Texas.[23] Recently, bovine tuberculosis was discovered in game ranch elk in Montana. Tracebacks from the index herd revealed infection in elk in 10 states and a number of additional suspect herds.[a] Current data suggest that this is a long-standing problem that could be a severe setback to the nationwide bovine tuberculosis effort.

These are a few examples of unwanted pathogens that traveled within biologic packages during relocation. Wildlife veterinarians are helping to resolve these threats in numerous ways including disease testing of imported animals, development of regulations, surveillance of adjacent native wildlife populations, and public education.

[a]Essey MA, Veterinary Services, APHIS, USDA, Hyattsville, Md: Personal communication, 1991.

Taking Medicines to the Woods

The concept of treating entire wildlife populations with vaccines or drugs is receiving greater consideration and use. The most notable example is the success that is being achieved with oral rabies vaccination of wild red foxes in Europe.[24] Experimental trials are now being done on a large-scale basis in Canada with oral modified-live virus rabies vaccine for foxes,[25,26] and 2 preliminary studies have been done in the United States with raccoons. The US trials are being conducted with a unique vaccinia-rabies glycoprotein vaccine (V-RG) produced by genetic engineering.[27,28] This V-RG vaccine is thermostable and effective orally in raccoons.[29] Introduction of rabies infection via V-RG vaccine is not possible, because the vaccine only contains the rabies virus surface protein.

What is being done with raccoons and foxes may become possible in a variety of other wildlife species. For example, pilot studies with placebo baits containing biologic markers have shown that oral baits can be delivered to wild swine,[30] small rodents, and mongooses at rates of 95%, 79%, and 91%, respectively. Biotechnology may soon produce a variety of useful vaccines for wildlife diseases including brucellosis in elk and bison, bluetongue and epizootic hemorrhagic disease viruses in deer, canine distemper in furbearers (including the black-footed ferret), swine brucellosis and pseudorabies in wild swine, avian cholera in waterfowl, and many others. These possibilities could have tremendous health benefits for wildlife.

Future Wildlife Veterinarians

There has been a slow but steady increase in jobs available for veterinarians in the specialty of wildlife population medicine. Many veterinary students and young veterinarians aspire to work with wildlife. It may seem that there is an oversupply of veterinarians for the jobs available; however, many aspirants are poorly prepared for the work they desire. Their experiences are in clinical work with zoo animals and rehabilitation, and they lack background in veterinary diagnostics, epidemiology, wildlife biology, and wildlife management.

Greater job opportunities are on the horizon for veterinarians in wildlife management because our profession has something of value to bring to the conservation team. Traditional veterinary course work provides the much-needed baseline education for wildlife veterinarians, but additional pre- or postgraduate training is required to qualify a person for the work. Veterinary educators are examining the training needs for producing wildlife veterinarians who are true specialists in this field. The entire veterinary community should

support this new speciality and work collectively to keep its focus on population health if we are to achieve animal welfare goals for our free-living wildlife.

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Veterinary contributions toward improving capture, medical management, and anesthesia of free-ranging wildlife

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Mankind has been capturing wild animals for many thousands of years, primarily as a means to feed ourselves. Many of the techniques used to capture wild animals today are only recent adaptations of poison-tipped blow-gun darts, drive nets, snares or gin traps. From a historical perspective, tremendous progress has been made recently in improving the way wild animals are captured and handled, and veterinarians have had a role in this. It was only 30 years ago that commercial models of dart guns came into common use, and it has only been 20 years since anesthetic alternatives to nicotine and succinylcholine, which could be delivered by dart, have become available. In the last 20 to 30 years, drop-nets, drive-nets, bow-nets, jump-nets, net-guns, and corrals, bomas, and chutes have made capture of large numbers of wild animals, including endangered species, feasible. Veterinarians have had a large role in the development of wildlife capture methods, in testing and refining sedative and anesthetic drugs, and in improving the way wild animals are medically treated and managed during and after capture. In this way, veterinarians have contributed greatly to the welfare of wild animals and to the conservation of wildlife populations.

Wildlife are captured for a variety of reasons. Problem animals like skunks in backyards, particularly in rabies endemic areas, or non-native carnivores preying on endangered species are good examples of wild animals most people would agree need to be caught. Capture of nuisance bears, or coyote and other native carnivores in agricultural areas are examples of wild animals that people have diverse opinions as to whether they should be captured, removed, or killed. Large-scale killing of wildlife, using indiscriminate trapping and poisoning, are examples of wildlife control actions to which most people object.

Biologists and researchers capture wildlife and mark and release them to study their ecology, behavior, or movements. As long as these types of wildlife capture efforts are carried out professionally, with low injury and minimal stress and mortality, most people support them. Veterinarians can work with other wildlife professionals as part of a research team and can specifically improve techniques and efficiency of procedures like blood collection and reduce stress. Veterinarians can also train biologists, much as they train technicians, to sedate and immobilize wild animals.

Wildlife health studies are conducted by universities and by state and federal agencies. These usually require capture to obtain samples and most often directly involve a veterinarian. In some circumstances, diseased wild animals, often threatened or endangered species, are captured for treatment and may be released or taken into captivity. Depending on the goals and outcome of these actions, the public generally supports these types of interventions as well.

Capture of surplus wildlife for relocation to new habitats, to save them from impending habitat destruction, or to establish new populations of threatened or endangered species is probably the most recognized and popular reason for wildlife capture. Many examples of this type of activity are shown on educational television and frequently veterinarians have a prominent role.

Four specific ways in which veterinarians have contributed to the welfare of wild animals are: by improving actual methods of capture; by understanding and reducing the stresses of capture, and handling; by rapidly and effectively treating stress and capture-associated injuries and metabolic disturbances; and by developing better anesthetic drugs and delivery systems. A fifth way veterinarians have helped improve the health of wildlife is by assisting with the development of ways to medicate and treat wildlife remotely so that capture is not necessary at all.

As an example of improvements in the methods used to capture wild animals, we should look at the evolution of methods used to trap wild carnivores. The leghold or gin trap is an old, and some would argue cruel, device used to capture a variety

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of wild animals. Some older models even had spikes on the jaws to better hold the leg of the trapped animal. If set indiscriminately or baited with meat or other foods, raptors, pets, and other "non-target" animals may be caught. One of the only advantages of the leghold trap is that "non-target" animals, although they may be injured, can be released.

Such is not the case for alternative methods such as "Conibear" or killing types of traps, "coyote getters," and poisons. But, for many years trappers have known that they could reduce trap injuries by weakening the springs to reduce jaw impact, by padding the jaws, and by shortening and putting shock absorbers in the chain. New commercial padded jaw leghold traps considerably reduce the amount of laceration and the rate of fracture for most species while being comparable in capture effectiveness. Veterinarians helped develop and test this trap. Most trapping agencies are replacing all old traps with padded traps. Better box traps, leghold snares, as well as the use of tranquilizer tabs to calm captured carnivores, are additional humane improvements in trapping methods. The AVMA has set aside funding to help find and develop alternative and humane means of wildlife control. In this manner too we veterinarians have become part of the solution, not just part of the problem.

Even while society is struggling with when or whether problem wildlife should be trapped, we as a profession can encourage federal and state agencies to make trapper training mandatory, to make 24-hour trap checks mandatory for federal and state agencies as well as for private citizens, and to require that all agents who trap wildlife are appropriately trained in the best capture methodology to reduce injury and stress, and in humane euthanasia techniques. Animal Damage Control is considering training its agents to anesthetize trapped wildlife, and we may see the day when government trappers use more ketamine than strychnine or euthanasia solution.

Wildlife veterinarians have taken advantage of the introduction of new anesthetics and have found ways to apply them to the capture of wild carnivores. Only 20 years ago biologists would try to hold black bears in a head squeeze to ear tag them or use IM administration of succinycholine or barbiturates to immobilize the bears, with poor results. Phencyclidine HCl, then ketamine HCl, and now tiletamine HCl have made anesthesia of bears rather easy. Combinations of ketamine and xylazine seldom cause seizures and their effects can be partially reversed with yohimbine. In the early 1980s, we tested these combinations on a wide variety of wild carnivores and found them to be reliable and safe, if somewhat volume restrictive.

In larger species such as brown bear and polar bear, a formulation[a] of tiletamine HCl and zolazepam HCl has proven to be extremely safe and effective for field anesthesia, even under the harshest conditions, and it is safe to use for the biologist/veterinarian. In some other species, narcotic/tranquilizer combinations offer safe and rapid anesthesia and are more compatible with physiologic and behavioral needs. Dr. Tom Williams showed that fentanyl citrate and azaperone were the best available anesthetics for sea otters,[1] which made safe handling of hundreds of oiled sea otters in Alaska possible. Dr. Terry Kreeger and others have field tested collars that can be remotely triggered to deliver anesthetics to wolves and allow them to be captured without pursuit or darting.[2] In that species too, the formulation[a] of tiletamine HCl and zolazepam HCl is the best drug.

Table 1–Weight comparison of water-filled commercial darts used to deliver medication and drugs to wild animals

Dart	Weight 2 ml	Weight 3 ml
Dart 1 = Telinject*	5.72 g	7.9 g
Dart 2 = PneuDart†	9.5 g	11.0 g
Dart 3 = Paxarms‡	ND	13.95 g
Dart 4 = Aerojects§	12.7 g	15.7 g
Dart 5 = CapChur‖	17.2 g	19.6 g

*Telinject, USA, Newhall, Calif; †PneuDart Inc, Williamsport, Pa; ‡Telonics Inc, Mesa, Ariz. §Ballisti Vet Inc, Minneapolis, Minn; ‖ Palmer Equipment Co, Douglasville, Ga.

Few people today remember that a veterinarian was one of the patent holders on the first dart guns sold in the United States. Now, 30 years later, there are at least 7 major makers of darting equipment, and small, light darts have greatly reduced the injuries associated with remote drug delivery. The bottom line on dart impact and effectiveness is expressed in the equation $KE = M \times V^2$, where KE = impact energy, M = mass of the dart, and V = velocity of the dart. The impact energy of a 2- or 3 ml-dart can be reduced simply by using lighter darts (Table 1). Concentrated and potent drugs allow the use of smaller lighter darts that cause less excitement, less tissue trauma, allow more rapid drug absorption, and smoother induction of anesthesia. Plastic darts that weigh half what the original darts weighed and that have gelatin barbs that melt so they need not be cut out and side-ported needles for less traumatic drug injection are today taken for granted.

Until modern anesthetics and anesthetic combinations were available, it was extremely difficult to safely capture wild ungulates in an efficient manner. Combinations of ketamine and xylazine have largely replaced the use of succinylcholine on deer, but the combination was not as useful for elk, moose, and caribou. Medetomidine[b] and ketamine, whose effects can be reversed with atipamizole,[c] may be the combination of the 1990's and appears to have potential for all North American

[a]Telezol, AH Robins Co, 1407 Cummings Dr, Richmond, Va.

[b]Zalopine, Wildlife Pharmaceuticals, Fort Collins, Colo.
[c]Antipin, Wildlife Pharmaceuticals, Fort Collins, Colo.

cervids. Carfentanil citrate[d] has begun to replace etorphine HCl for capture and anesthesia of a variety of native and exotic hoofstock. It is twice as potent and three times as concentrated as 1 mg/ml, etorphine giving more rapid induction times and allowing the use of small darts. Also, we are now seeing development of a new generation of rapid but short-acting narcotics, the first of which is A-3080. In the summer of 1990, A-3080 was tested and found to be extremely effective on free-ranging wild impala, kudu, eland, waterbuck, cape buffalo, warthog, white rhinoceros, and elephant in Kruger National Park.[3]

Drug darting of individual animals is inherently expensive, is time-consuming, and carries the risk of anesthetic complications. Improvements in physical capture techniques in the last 20 years have allowed the roundup and physical capture of herds of wild ungulates. Drive-nets and drop-nets, which had been used to capture a variety of game in Africa, and historically by North American Indians, were introduced to the United States in the early 1970s. They became the preferred methods for capturing large numbers of deer and bighorn sheep where they could be baited or driven to nets. Net-guns of the type used for large-scale red deer capture in New Zealand are now in wide use in North America for capture of selected bighorn sheep, deer, elk, and caribou. These species can be captured in almost any location without reliance on heavy awkward nets or acceptance of bait.

Another New Zealand idea that has great promise for capturing a variety of North American species is the pop-up trap. Counter weights are remotely triggered to pull up reinforced plastic sheeting around wild ungulates attracted to bait. The large-scale farming of red deer has also led to improvements in the design of chutes and alley ways, crushes or squeeze chutes, round abouts, and other means of yarding or moving wild hoofstock. Hundreds of elk and tens of thousands of wild horses have been driven into wing traps of corrals. Most of these animals are handled without any drugs and with few injuries and complications.

The need to relocate or dehorn large numbers of rhinoceros from areas where poaching is difficult or impossible to control has forced a number of advances in their capture and handling. Using the old method of vehicular pursuit and neck snaring of rhinoceros, it was not uncommon for 50% of the rhinoceros captured in this way to die. Veterinarians in Africa have continually improved mixtures of narcotics and tranquilizers, and by combining them with hyaluronidase can often achieve immobilization and safe anesthesia of rhinoceros in 4 minutes. Close monitoring and supportive treatment allow the veterinarians to keep rhinoceros anesthetized for several hours while they are transported out of the bush and to central bomas for reversal of anesthesia. At the bomas, just before reversal and arousal, the rhinoceros are often given short- and long-acting tranquilizers to calm them, thus reducing stress and self-inflicted trauma and to speed acceptance of food and water. In Namibia, trucks and crates that can be taken to the animal and mechanically manipulated allow even more rapid handling and shorter anesthesia of rhinoceros. Drs. Mike Kock in Zimbabwe and Pete Morkel in Namibia have recently begun large-scale rhinoceros capture for dehorning. Few if any complications appear to result, and subsequent loss or poaching of dehorned rhinoceros is thus far minimal.

One way to improve the health and welfare of wildlife during capture is to better define and manage the stresses of capture. This can be done first by preventing stress by the design and conduct of a capture. The unique susceptibility of each species must be taken into account and its threshold and response to stress understood. Rapid, efficient, and quiet handling of unanesthetized or partially sedated wild animals is a basic and important rule. Padded and smooth walls and darkened chutes and rooms will often reduce fear and trauma. Monitoring of basic vital signs, pulse, respiration, and temperature will show trends that predict eventual outcome of a capture and suggest when emergency treatment is needed. Just as the most severe injuries should be treated first, so should be the most severe case of capture stress/myopathy. When possible, pH, blood gas values, and oxygen saturation should be monitored. Some portable units are now becoming available. The field use of oximeters has allowed researchers to determine the percentage of oxygen saturated hemoglobin in the blood of anesthetized wild animals in the field and to determine which animals had respiratory problems long before changes in perfusion or respiratory rate or volume signaled danger.[4] Dr. Jack Allen adapted an oximeter[e] to animals as diverse as impala, kudu, elephant, and wart hog during tests of the narcotic A-3080.[3,4]

Portable gas anesthetic machines allow isoflourane and halothane to be used in the field. California sea lions that are notoriously difficult to safely anesthetize were held under gas anesthesia on their rookeries for up to an hour for minor surgery and blood sample collection by Dr. Thierry Work et al.[5] Both females and pups were anesthetized, and rapid recovery from gas anesthesia did not cause orphaning or animals to seek water before they were sufficiently recovered.

Allometric scaling, a means in matching anesthetic doses to the metabolic rate and other factors, rather than just the weight of an animal has been proposed by Dr. Charles Sedgwick.[6] Although it is complicated, allometric scaling does allow closer tailoring of anesthesia to the animal.

Xylazine, phencyclidine HCl, and etorphine

[d]Wildnil. Wildlife Pharmaceuticals, Fort Collins, Colo.

[e]N-10, Nellcor, Inc, Hayward, Calif.

became available for use in the United States about 20 years ago. Before that, wildlife capture was limited to now-believed-inappropriate drugs. Pharmacologists and veterinarians have greatly improved the variety of anesthetics available for wild animals and have thus contributed to their welfare. Tranquilizers can now be matched to species in which they are most effective and to the specific need. Phenothiazines are still quite useful on wild equids, and as mentioned, they are being used in longer-acting forms to help a variety of wild animals adapt to captivity. Butyrophenones are more effective on other species and cause fewer side effects. Thus azaperone is the best tranquilizer to balance fentanyl anesthesia of sea otters. Benzodiazepines also have relatively fewer side effects than major tranquilizers and are being increasingly used to balance the effects of narcotics and cyclohexamines. Promazines and xylazine seem to have little calming effect on pronghorn antelope, but diazepam is fairly effective. A reversal for benzodiazepines is also now in the testing stages. Antiserotonin drugs that are specifically tailored to obtund fear are being developed and have shown some promise in some species. These "taming drugs" allow wild animals to be closely handled and manipulated without much of a fear response but do not cause deep sedation of recumbency.

The use and variety of alpha adrenergics appears to be increasing. Reversal of xylazine sedation with yohimbine was reported in the mid 1980s and greatly extended the uses of that drug. Detomidine[f] appears to offer somewhat improved receptor specificity as does the new reversal agent idozoxan. But the next-generation drug, medetomidine,[b] has 100 times the receptor specificity of xylazine and is effective in microgram per kilogram doses. Its reversal agent, antipamizole,[c] is the most pure and selective of the alpha adrenergic reversal agents and is effective in many species that were unresponsive to yohimbine.

Phencyclidine is unavailable, but ketamine and the combination[a] of tiletamine and zolazepam have replaced it and seem to offer fewer side effects. Concentrated forms of ketamine are now available or can be made easily. The formulation[a] of tiletamine HCl and zolazepam HCl can be reconstituted in high concentrations, allowing the use of low liquid volumes.

The dilute (1 mg/ml) forms of etorphine that have been available in the United States have always been of limited value. The British and South Africans have found formulations of 2.4 and 9.8 mg of etorphine/ml, usually combined with a tranquilizer, to be quite effective in a variety of species. Carfentanyl citrate[d] and other fentanyl derivatives appear to offer more rapid immobilization with a higher therapeutic index than etorphine. The real progress in narcotics in the last 10 years has been the development of pure antagonists. Diprenorphine and nalorphine HCl[g] were only partial narcotic antagonists, retaining some agonistic properties. Naloxone HCl[h] was the first pure antagonist available. Because it has a relatively short half life, it had to be given at high doses and recycling often occurred. Naltrexone and nalmaphene appear to be as effective as naloxone but much longer lasting in most species, greatly improving the usefulness of narcotic immobilizing drugs.

Wild animals by their very nature will flee and resist capture and so suffer considerable stress, associated physiologic changes, and a variety of injuries, and they are sometimes killed in the process of capture. It follows that methods of remotely treating wildlife or capturing them without pursuit could substantially improve the health and welfare of the animals. Because treatment of health problems has traditionally required capture of the animals, wildlife biologists, curators, and game ranchers have often opted not to treat health problems that might be responsive to early treatment, or that eventually shorten the animal's life or reduce its reproductive potential. Although some problems do resolve on their own, the application of many advances in veterinary medicine to wild animals has been retarded by the difficulty of delivering treatments.

A system was devised for use in the livestock industry to allow vaccination and treatment of cattle without having to catch them in corrals or squeeze chutes. The system[i] uses a biobullet, which is hollow and made of hydroxypropylcellulose, which melts and absorbs into tissue at body temperture, and which may be filled with freeze-dried vaccines or treatment drugs. The light biobullet (an empty 25-caliber biobullet weighs 350 mg) has little impact energy, thus limited penetration power. It penetrates skin and subcutaneous tissues and buries in muscle to a depth of approximately 2 to 4 cm. There are now 3 sizes of biobullets (20 caliber, 25 caliber, and long 25 caliber). However, animals weighing less than 20 kg should probably not be implanted with biobullets.

Because of their low weight, biobullets can be fired at fairly high velocity, thus achieving good accuracy, without substantial increase in impact energy and penetration. The 2 major limitations of this system are that biobullet payloads are limited to about 250 mg, and that the low weight of the biobullet does not allow skin penetration of many species beyond about 25 to 30 yards. Such thick-skinned species as Cape buffalo elephant and rhinoceros may have penetration problems depending on the amount of elasticity and thickness of the skin in the target area and the weight of the biobullet. When used from a blind, from a tower near a food or water source, or from a helicopter, this system can be a safe and cost-effective method to remotely treat free-ranging and captive wildlife.

[f]Dormosedan, Norden Laboratories, Lincoln, Neb.

[g]Nalline HCl, MSD Agvet, Division of Merck & Co, Rahway, NJ.

[h]PM Naloxone, Pitman Moore, Washington Cross, NJ.

[i]BallistiVet Inc, 8990 Springbrook Dr, Minneapolis, Minn.

Probably the best known application of this system is its use to deliver reduced dose strain 19 brucellosis vaccine to wapiti in Wyoming. Wild wapiti, when their populations are concentrated on winter feed grounds, are vaccinated via biobullet as they move past a narrow point or stand along a line of feed. Although early use of this system included a paint ball to mark vaccinated animals, the trajectories of paint ball and biobullet were very different and the complexity proved cumbersome. Thousands of wapiti have been vaccinated, and although it may assist in the control of brucellosis, it does not appear that brucellosis in wapiti will be eradicated by this program.

Twelve captive and 73 free-ranging peninsular desert bighorn sheep have been vaccinated with modified-live parainfluenza 3 virus vaccine in biobullets.[7] Blood was collected from the captive animals before vaccination and they were monitored for 6 months. A 6-fold increase in mean titer was seen in 2 weeks and a 10-fold increase in titer was seen within 1 month.[7] When vaccinating free-ranging bighorn sheep, the pilot and gunner could usually see the biobullet hit, and hemorrhage from the penetration site often marked the vaccinated animals. Only adult bighorn sheep were vaccinated. Even in the face of widely dispersed populations in rugged terrain, biobullet vaccination of bighorn sheep proved to be more cost-effective and safer than capture.

Periodic outbreaks of anthrax, which have severely impacted roan antelope populations in and around Kruger National Park in South Africa, have been managed by large-scale aerial biobullet vaccination of a variety of large ungulates. A Sterne vaccine strain of *Bacillus anthracis* was custom packed into 25-caliber biobullets. Impala, roan antelope, waterbuck, kudu, wildebeest, zebra, and eland were successfully vaccinated. Observations of the biobullet striking the animal, the animal's reaction, and hemorrhage from the implant site served to mark vaccinated animals. An excellent correlation (95%) was found between observed and actual hits, as verified by examination of carcasses of harvested animals. Problems in achieving penetration of Cape buffalo skin required increasing the weight of the biobullet.

A collar[J] that may be fitted to an animal for radio tracking has 2 optional syringe injectors. These have been successfully tested on white-tailed deer and wolves and are now commercially available. The radio collar itself has some unique features, such as being able to compile activity data and send it back to a computer in the receiver. A device may also be incorporated to release the collar on radio command or when the collar's batteries get low.

If both injectors contain immobilizing drugs, repeated remote immobilization to obtain samples may be achieved. One injector may be used for a treatment drug and the second for an immobilizing drug. The system allows the operator to select which injector will be triggered. Both injectors may be filled with treatment drugs and the collar remotely released after treatment. The first injectors available in 1990 had a maximal capacity of 1.5 ml; this capacity was expanded to 4 ml in 1991.

The collar was successful in recapturing white-tailed deer 28 of 31 times that it was used in Minnesota at temperatures from −37 to 22 C.[8] In the 3 failures, the collar was remotely released. Communication with the collars was achieved at distances of 3 km on the ground and 26.5 km from the air.[8] In a smaller separate set of trials, white-tailed deer captured with the collar had substantially lower serum cortisol concentrations than deer captured in Clover traps or by rocket net.[9] Reduction of stress-related physiologic changes may have advantages for wildlife research and management of individual animals.

Feed supplements have been used to improve condition and to deliver vitamins and minerals and other compounds to livestock for many years. Wild animals in game parks and zoos have been similarly supplemented. Wildlife managers have resisted routine supplementation as a solution to winter starvation problems, believing that this would encourage improved survival and reproductive success that would lead to worse overpopulation problems in the future. However, with the loss of prime wildlife habitats to agriculture and development, refuges for which the primary purpose is to provide improved availability of food, water, and cover and reduce foraging on adjacent lands, have been established for waterfowl and wild ungulates. In years of extremely severe and unusual weather and when food has been cut off by highways, fences, and other human activities, wildlife may be supplemented. However, wildlife populations on ranches and in game parks, just as free-ranging wildlife, cannot be sustained at levels exceeding the carrying capacity of the land without eventual health and ecologic consequences.

Tule elk introduced to Point Reyes National Seashore, California, had signs of severe copper deficiency after one year, including antler anomalies, fractures, light hair coats, pica, and other signs of nutritional deficiency.[10] Inherently, marginal copper concentrations in soil, high concentrations of molybdenum in the soil of specific meadows frequented by the elk, prexisting overgrazing by livestock, and brush encroachment were believed to be exacerbating the problem. A temporary addition of copper sulfate to a molasses-grain feed supplement, dispersal of the elk, removal of cattle, and burning of the range to regenerate optimal browse species proved to be successful in managing this problem.[10]

Lungworms (protostronglyus spp), which are transplacentally transmitted to fetal bighorn sheep, have been managed by adding anthelmintics to fermented apple pomace for over 10 years.[11] Cambendazole was most effective against stored infective larvae, but fenbendazole was most effec-

[J]Wildlink Inc, 2924 98th North, Brooklyn Park, Minn.

tive against adult nematodes and was less toxic.[11] When lamb mortality caused by verminous pneumonia was a major problem, cambendazole was given to ewes on winter ranges.[11] Measuring the average amounts of apple pomace consumed daily allowed calculation of safe and effective dosages.

Foreyt et al[12] report that a pelleted alfalfa feed containing a calculated dosage of 10 mg of fenbendazole/kg of body weight was fed to approximately 200 Rocky Mountain bighorn sheep daily for 3 consecutive days in Washington (n = 65), Idaho (n = 75), and Oregon (n = 75). This was repeated a second year in Washington. Before treatment, lungworm larvae were detected in the feces of 84%, 93%, and 97% of the bighorn sheep from Washington, Idaho, and Oregon respectively.[12] After treatment, larvae were detected in feces of 3, 0, and 67% of sheep, respectively, and the number of larvae per gram of feces was reduced by 50 to 95%.[12] Numbers of other paresites were also reduced and the reproductive rate of the herd improved substantially. This same formulation was fed to 6 captive pregnant female bighorn sheep at 3 to 5 times the field dose for 6 days. Toxic effects were not observed and all 6 ewes bore healthy lambs.

Anthelmintics have been added to feed blocks to control internal roundworm parasite problems on game ranches and in zoos. It has proven more difficult to persuade wild animals to routinely accept a feed block and to consistently consume quantities with sufficient anthelminthic to be effective.

The manipulation of natural endemic parasites in free-ranging wildlife is controversial. Traditionally, wildlife managers have believed that parasites that evolve with a species may serve as a check on populations, just as diminishing forage quality and quantity help maintain wildlife within the carrying capacity of their range. The justification for routinely deworming free-ranging wild animals must take the ecologic role of the parasite into account. However, introduced parasites and ranges degraded by brush encroachment, fire suppression, overgrazing, or other human activities may justify treatment.

It will probably remain necessary to capture wild animals to evaluate, mark, and treat them. In some situations, however, new technologies allowing the obtainment of samples and delivery of treatments without the stress and trauma of capture are available. Animal welfare concerns and costs will likely continue to encourage these developments.

As we move toward the 21st century, human population increases and development are a threat to the survival of large numbers of wild animals, but current improvements in technology also hold the promise of better ways to capture, transport, treat, and care for our wildlife. It is on this two-edged sword that wildlife veterinary medicine is balanced. As wild animals grow rarer, we put more effort and money into their care, but often only after we have effectively appropriated most of their habitat. Hopefully, we will be as clever and aggressive in preserving wildlife populations in healthy environments as we have been in developing technologies we can use to treat them.

'The white man must treat the beasts of this land as his brothers. I'm a savage and I do not understand any other way. What is man without the beasts? If all the beasts were gone, man would die of a great loneliness of the spirit.'—Chief Seattle, 1850.

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