

Animal Welfare Forum: The Welfare of Zoo Animals

October 11, 2002, Milwaukee, Wisconsin

The following papers were submitted by speakers at the 2002 AVMA Animal Welfare Forum, which was held at the Hyatt Regency, Milwaukee, Wisconsin. This year's Forum was presented in partnership with the American Association of Zoo Veterinarians. These papers have not undergone peer review; opinions expressed are those of the authors and not necessarily those of the American Veterinary Medical Association or the American Association of Zoo Veterinarians.

During the Forum, the 2002 Animal Welfare Award was presented to Murray E. Fowler, DVM, DACZM, DABVT, DACVIM of Davis, California.

The Animal Welfare Forum is an annual event planned by the Animal Welfare Committee, under the direction of the Executive Board. For additional information about the Forum or the Animal Welfare Award, please contact the AVMA Communications Division.

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Welcome

Jack O. Walther, DVM
AVMA President-Elect

Good morning. It is my pleasure to welcome you to the thirteenth annual Animal Welfare Forum on behalf of the more than 68,000 members of the American Veterinary Medical Association. The Animal Welfare Forum is held each year as the highlight of Animal Welfare Week, which is a public awareness program designed to promote the welfare of animals. For more than a decade, the Forum has served as a useful platform for highlighting and exploring important animal welfare concerns affecting a variety of species. This year the AVMA is pleased to present "The Welfare of Zoo Animals" in partnership with the American Association of Zoo Veterinarians.

Today's speakers will take us on a guided tour of the world of zoo animal welfare. We'll explore whether zoos are arks or archaic, why monkeys can't run in the monkey house, how an entire zoo collection can be

managed to maximize individual welfare, why it is necessary to accredit zoos and aquariums, the realities of modern wildlife conservation, and whether animals maintained humanely can serve as ambassadors for those in the wild.

Attempting to touch on all the welfare issues affecting zoo animals during a one-day Forum is incredibly ambitious. Although we don't pretend to have all the answers, the AVMA's Animal Welfare Committee has assembled an excellent panel of speakers to provide all of us with scientifically based information that we can use to understand and improve the welfare of zoo animals.

Our goal for this Forum, as it has been for all previous Forums, is to promote the well-being of animals. The AVMA is proud of the vital role veterinarians have played in advancing the welfare of animals in captivity.



In defense of zoos and aquariums: the ethical basis for keeping wild animals in captivity

Michael Hutchins, PhD; Brandie Smith, MS; Ruth Allard, MEM

America's zoos and aquariums have been the focus of recent criticism by some animal rights and welfare advocates and in print and electronic media.¹⁻⁷ These critics have characterized zoos and aquariums as animal prisons or, even worse, as exploiters and traffickers of wildlife. These accusations have fueled growing public and governmental concern about the welfare of zoo and aquarium animals and the appropriate use of these animals by public institutions.

Critics often generalize their claims to include all zoologic facilities, regardless of their quality or accomplishments. It is important to understand that there are 2 different kinds of wildlife facilities in the United States: those that are accredited by the American Zoo and Aquarium Association (AZA) and those that are not. The AZA is the only zoo and aquarium association in the world with an effective accreditation program that helps ensure quality animal care, a code of professional ethics that helps guide and regulate its members'

actions, and a dedicated conservation vision.⁸⁻¹⁰ Of the more than 2,300 animal exhibitors licensed by the USDA's Animal and Plant Health Inspection Service (APHIS), fewer than 10% are qualified to be AZA members. Our comments are restricted to zoos and aquariums accredited by the AZA.

Although critics of zoos and aquariums tend to receive plenty of media attention, their generalizations about public perceptions of accredited zoologic facilities are not supported by the facts: more than 135 million people visit AZA-accredited institutions annually,¹¹ more than 58,000 people volunteer more than 5 million hours annually at AZA facilities,¹² a 1992 Roper poll identified zoos and aquariums as the third most trusted messenger on wildlife conservation and environmental issues (trailing only National Geographic and Jacques Cousteau),¹³ and reputable print and electronic media outlets produce numerous positive reports about the conservation, scientific, and educational efforts of AZA institutions.¹⁴⁻¹⁷ Given these often disparate perspectives, how should ethically mature, caring people view accredited zoos and aquariums today? Are accredited zoos and aquariums justifiable? If so, under what conditions are they justifiable?

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Some zoo and aquarium opponents are more extreme in their criticism than others. For example, some animal rights advocates are vehemently opposed to all forms of captivity, arguing that individual sentient animals have an intrinsic right to liberty.⁷ For some people, even domestic pets are subjugated by their human owners; in their view, animals should interact with humans only as voluntary companions. It is highly unlikely that arguments presented here will change the minds of those who currently believe that zoos and aquariums are inherently wrong and should be eliminated.

More mainstream animal welfare advocates are not intrinsically opposed to zoos and aquariums; instead, they contend that the welfare of wild animals is diminished under human care and that it is impossible for zoos and aquariums to provide the richness of experience, freedom of movement, and quality of life animals would experience if left in nature.⁸ They have also challenged zoos' and aquariums' reasons for existence, contending that, by itself, recreation is not a sufficient justification for maintaining captive wild animals, especially endangered species. The basis of the argument is that zoos and aquariums and their captive breeding programs do little to support wildlife and habitat conservation. Being conservationists and animal welfare advocates, we believe these arguments provide the most valid and difficult ethical challenges to zoos and aquariums today and, as such, they will be the focus of this report.

It is not our intent to provide a final answer to these complex questions. One cannot resolve moral questions for others, as different people have different opinions, depending on their own experiences, attitudes, and vantage points. Our intent is to contribute to the continual process of critical discussion and deliberation by providing an ethical justification for the existence of accredited zoos and aquariums at the beginning of the 21st century.

Context

In assessing the strengths and weaknesses of our arguments, it is important to understand that we are not moral absolutists (ie, we believe that human concepts of right and wrong may vary with context). Consider, for example, the Biblical commandment "thou shalt not kill." This is a clear and unambiguous statement of a moral belief that is supported by the legal framework of nearly every human society. However, context is everything. What if someone is attempting to kill you or someone you care about? Most human societies consider the taking of human life in self-defense or in the defense of others morally justifiable. Thus, even our most sacrosanct moral edicts are highly context-sensitive.

Why is this relevant to an ethical justification for accredited zoos and aquariums? Once again, context is everything. Before we can evaluate ethical arguments for or against accredited zoos and aquariums, it is important to understand the realities facing wild animals and their habitats today. Here are a few facts about the status of wildlife and nature in our human-dominated world:

- The current global human population is around 6 billion. The human population continues to grow at an exponential rate. Its total is not expected to peak for 50 years, when the population may reach 8 to 11 billion or more.¹⁶
- Habitat destruction, alteration, and fragmentation to meet humans' needs continue largely unabated. As a result, wildlife is being pushed into islands of habitat surrounded by a sea of human activity. These relatively small, isolated populations have a high risk of extinction because of genetic and demographic factors, chance events, and natural catastrophes.¹⁹
- Many of the world's national parks and reserves, particularly those in developing countries, are havens for wildlife in name only. Lack of appropriate infrastructure to enforce laws or maintain park integrity renders such paper parks largely ineffective.¹⁹
- Human exploitation of wildlife for meat and other products is growing, particularly in regions where widespread poverty and lack of economic alternatives push poor people to use wild animals as a "free" source of protein and income.²⁰
- Conflict between humans and wild animals is increasing, as humans encroach on natural habitats and animals are moved out of protected areas. Scores of people are killed annually in Africa and Asia while attempting to protect their crops from elephants.^{21,22} Similarly, conflicts between people and large carnivores, such as wolves, bears, and cougars, continue to make news in the United States.²³
- The threat of bidirectional disease transmission between domestic animals and humans and wild animals is growing.²⁴ Factors responsible include increasing human encroachment on wildlife habitat, air travel, and international trade. The latter 2 have resulted in the constant movement of plants, animals, people, and pests from one continent to another. The emergence of West Nile virus in the United States is just 1 example of how diseases can cross borders, and even oceans, by natural and artificial means with devastating effects on people and wildlife.²⁵
- Exotic species (those introduced intentionally or accidentally to non-native habitats) continue to proliferate, resulting in ecologic changes that threaten native organisms.²⁶ For example, the accidental introduction of the brown tree snake to Guam resulted in the extinction of nearly every endemic forest-dwelling bird species on the island. Only 2 species, the Guam rail and Micronesian kingfisher, survive because of rescue efforts by zoos.
- The number of endangered and threatened species continues to grow. The International Union for Conservation of Nature and Natural Resources—The World Conservation Union now lists 43% of all crocodilian, 45% of all primate, 25% of all carnivore, and 38% of all turtle species as threatened with extinction.²⁷
- Burning of fossil fuels and release of other industrial air pollutants are contributing to global cli-

mate change and deterioration of the Earth's ozone layer. The resultant climatologic and ecologic shifts could have a catastrophic effect on wildlife habitats and wildlife.²⁸

- The cumulative effect of the trends previously cited is creating a need for unprecedented human intervention to stave off the most substantial loss of biological diversity since the extinction of the dinosaurs some 65 million years ago.²⁹⁻³¹
- Humans are becoming more urbanized, and fewer people have a deep personal understanding or appreciation for wildlife and nature.^{32,33} This makes it even more difficult to develop the political will to address mounting environmental problems.

We do not want to give the impression that all is lost. Conservationists must be optimists, and with the cooperation of governmental and nongovernmental organizations, academia, and industry, much can be done to reverse current trends or ameliorate their effects. We are clearly in an emergency situation, and time is of the essence. The options available in 10 years will almost certainly be more limited than the ones available to us now.

Conservation Role of Zoos and Aquariums

Zoos and aquariums that value biological diversity have a clear moral obligation to support wildlife and habitat conservation efforts worldwide. The missions of professionally managed zoos and aquariums are complex, but generally include conservation, education, research, and recreation.³⁴ Although providing wholesome recreational opportunities for the public is important, most people would likely agree that recreation (entertainment) alone is not sufficient justification for the existence of zoos and aquariums or for holding wild animals in captivity.³⁵ In fact, many animals held by zoos and aquariums are endangered in the wild, and their commercial use exclusively for entertainment purposes would be distasteful, if not illegal. Entertainment is an even less convincing justification if one assumes that the welfare of individual animals may be compromised to some degree as a result of captivity.^{1,2}

Conservation, education, and research are other matters. If zoos and aquariums demonstrate an ability to study, manage, preserve, and restore wild animals and their habitats in nature, it would provide a powerful ethical justification for their continued existence.³⁶⁻³⁸ This is particularly true given the many serious and pervasive threats facing wildlife and nature today. Wild animals in zoos and aquariums are ambassadors for their species, helping to raise public awareness and funds to support education, research, on-the-ground conservation activities in range countries, and a host of other relevant activities.³⁶⁻³⁸ Zoos and aquariums must display and sustainably breed some animals to meet their conservation goals.

The following is a brief overview of some of the numerous conservation activities in which AZA and its members are currently engaged. In 1999 and 2000, AZA and its member institutions supported more than 1,400 field conservation and related scientific research and educational initiatives in more than 80 countries worldwide.³⁹

Reintroduction

Zoos and aquariums of the 1980s and early 1990s viewed and described themselves as modern Noah's Arks and organized cooperative breeding programs to sustain populations of endangered species until they could be reintroduced to nature.⁴⁰ During the past several years, zoo and aquarium professionals have begun to question this notion, adopting a much broader definition of zoo- and aquarium-based conservation. Central to this concept is the assumption that zoos and aquariums must do more to support in situ conservation in range countries.^{36-38,41,42} There are far too many endangered species and not nearly enough space to breed them all in captivity and, in many cases, far too little habitat remaining in which to reintroduce them. In addition, reintroduction programs are difficult and expensive, and they amount to treating the symptoms of species loss rather than the causes.⁴³⁻⁴⁵ Though this shift in focus has been well documented,³⁷⁻³⁹ critics imply that zoos and aquariums are not active conservation organizations, because they are not releasing a steady stream of animals into the wild. This argument reflects an ignorance of the breadth, scope, and goals of conservation itself.

Even as our view of zoo- and aquarium-based conservation expands, captive breeding for reintroduction will continue to play a limited, though critical, role.^{33,36,37} Populations of some species have become so small and fragmented that they cannot persist without human intervention. Well-known examples include the California condor and black-footed ferret, along with many other less publicized species, such as the Ramsey Canyon leopard frog, American burying beetle, and Oregon silverspot butterfly. State and federal wildlife agencies have often called on accredited zoos and aquariums for help with recovery efforts, including captive propagation and reintroduction. Zoos and aquariums are unique in their ability to respond to these crises, because their day-to-day care of animals allows them to conduct research on husbandry, rehabilitation, and release techniques and to construct specialized off-display breeding and holding facilities to support recovery efforts.

Endangered Species Recovery

In nature, living organisms are interconnected, and ecosystems cannot function unless they retain most of their essential parts. Endangered species must persist until essential habitat can be restored, better protected, or expanded. Because there are so many species in need of help, zoo and aquarium efforts are often focused on flagship species (those that have the ability to capture the public's attention and help preserve habitat and other taxa). Examples of the many zoo- and aquarium-sponsored efforts to recover endangered species include the Toledo Zoos for the Mona/Virgin Islands boa⁴⁶; Atlanta, National, and San Diego Zoos for the giant panda in China⁴⁷; Fort Worth Zoos for the Jamaican iguana⁴⁸; and Minnesota Zoos for the Sumatran tiger.⁴⁹

Habitat Restoration

Many of the world's natural habitats have been fragmented, altered, or lost because of human activity,

with devastating effects on wildlife. In some cases, attempts to conserve biological diversity can be aided through habitat restoration. Restoration activities by zoos and aquariums have, among other things, involved the reestablishment of native vegetation and elimination or control of invasive exotic species.⁵⁰

Member institutions of the AZA are increasing their involvement in habitat restoration. For example, the Toledo Zoo, in cooperation with the Nature Conservancy and state and federal wildlife biologists, has assisted in restoring the oak savanna habitat in Ohio⁵¹; the National Aquarium in Baltimore is collaborating with the Chesapeake Bay Foundation to restore local salt marsh habitats⁵⁰; the Florida Aquarium is helping to restore native vegetation on an island wildlife reserve in Tampa Bay⁵⁰; the Baltimore Zoo restored a native bog habitat on its grounds to serve as a refuge for endangered bog turtles⁵²; and the Vancouver Aquarium is assisting with marine shoreline restoration in the Vancouver metropolitan area.⁵³

Scientific Research

Scientific research is critical to wildlife conservation and for improving zoo and aquarium animal management. In situ and ex situ conservation efforts cannot succeed in the absence of knowledge.⁵⁴ Unfortunately, our knowledge of most wild animals and their habitats is far from complete. Contemporary zoos and aquariums are investing enormous resources in research, estimated at \$50 million annually.¹² Zoos and aquariums offer unique opportunities to study animal behavior, physiology, reproduction, growth, and development of a wide variety of taxa under semicontrolled conditions. Many of these studies would be difficult, if not impossible, to conduct in nature, because of practical or ethical limitations. For example, much of what we know about the biology of arboreal, fossorial, and wide-ranging aquatic species has come from studies⁵⁵ of captive animals.

Development of Relevant Technologies

Many technologies developed or tested by zoo and aquarium biologists are relevant to field conservation, a largely unrecognized benefit of maintaining collections of wild animals.⁵⁷ As remaining wildlife habitats become progressively smaller and more isolated, the need for active management of wildlife and their habitats grows. Consequently, technologies developed by zoos and aquariums, including those for small population management, ecologic restoration, contraception, and veterinary care, are becoming increasingly relevant to the conservation of wildlife and their habitats.^{33,36,37}

Improved veterinary technology in zoos has made important contributions.⁵⁵ For example, free-ranging animals must often be moved from 1 isolated reserve to another for conservation purposes. Capture and translocation of wild animals can be traumatic and potentially risky, often involving the use of tranquilizing drugs. Many techniques and effective dosages for safe chemical immobilization of wild animals have been developed by zoo veterinarians.⁵⁵

High-tech methods for monitoring the movements

of free-ranging animals are also becoming important in field conservation, and zoos and aquariums are on the cutting edge of these advancements. Satellite-telemetry devices were improved by testing them on Asian elephants at the Bronx Zoo before they were used to monitor the movements of forest-dwelling elephants in central Africa.⁵⁶ Radio-tracking devices have also been developed and used to monitor the movements of captive-bred Puerto Rican crested toads following their release into the wild.⁵⁷ This involved the invention of a specialized backpack to house the transmitter and battery.

Methods of individual animal identification developed by zoos and aquariums are also being used to support field conservation. The New York Aquarium assisted the Fisheries and Oceans Department of Canada in the development of a flipper band for marking free-ranging Beluga whales.⁵⁸ The Canadian Director of Fisheries and Habitat Management called this "an excellent example of how captive beluga can be studied and the knowledge gained used to directly enhance the management of free-ranging stocks."

Support of Protected Areas

Habitat loss and lack of law enforcement in and around protected areas are major factors contributing to species endangerment around the world, especially in developing countries.¹⁹ Consequently, there is a recognized need for North American zoos and aquariums to increase their support for conservation on a landscape level.^{36,38,41-45} The AZA and its member institutions are moving in this direction, both individually and collectively.

Some of the earliest examples of this approach are the support of the Wildlife Conservation Society for Amboseli National Park in Kenya,⁵⁹ the Chicago Zoological Society for Brookfield Conservation Park in South Australia,⁶⁰ and the Minnesota Zoo for Ujung Kulon National Park on the island of Java in Indonesia.⁶¹ Some more recent examples include the North Carolina Zoo's work in Kibali National Park, Uganda,⁶² and the Roger Williams Park Zoo's efforts to establish a Wildlife Management Area on the Huon Peninsula in Papua, New Guinea.⁶³ Zoos and aquariums are providing financial and logistic assistance for park personnel to buy equipment; obtain needed training; repair or build park infrastructure; survey, study, and monitor endemic fauna and flora; and develop educational and assistance programs for local communities. The ultimate goal is to empower local communities and governments to implement and manage their own programs and build international partnerships for conservation.

Conservation Education

Raising public awareness about endangered species and other environmental issues is an important aspect of conservation. If conservation efforts are to be successful, people must be interested in nature and be made aware of the problems and potential solutions facing wildlife and their habitats. With 135 million visitors each year, accredited zoos and aquariums are unique among conservation organizations, because they have a direct connection to the public.

The educational efforts of AZA members are numerous, and accredited zoos and aquariums are continually striving to evaluate their impact on visitors' behavior. Evidence indicates that zoo and aquarium educational programs are effective, at least in the short term, in building public appreciation and understanding of wildlife and wildlife conservation issues.⁶⁴ The AZA Conservation Education Committee (CEC) has initiated a major study⁶⁵ to assess the impact of zoo- and aquarium-based educational efforts on public knowledge, attitudes, and perceptions, with the goal of ensuring that critical conservation messages and concepts are reaching visitors in the most effective way.

Fundraising to Support Conservation

For conservation to succeed, it is critical that it be put on a solid financial base. The AZA and its member institutions are developing improved mechanisms to support conservation and the related scientific and educational activities of its members and collaborators. In this regard, the AZA was the first zoologic association to establish a fund dedicated to supporting wildlife and nature conservation.⁶⁶ During the past decade, the AZA Conservation Endowment Fund has provided over \$2.5 million to support 164 projects in more than 30 countries. Furthermore, 14 accredited zoos and aquariums have developed their own grant programs to support local and global conservation.

Conservation Planning and Coalition Building

The AZA and its member institutions are becoming increasingly active in conservation planning and coalition building, which are the first steps in effective conservation. Partnerships can greatly enhance organizations' abilities to take action, because expertise and expenses can be shared.

The AZA and its members have been involved in creating 2 major conservation coalitions: the Bushmeat Crisis Task Force (BCTF) and the Butterfly Conservation Initiative (BFCI). The BCTF is a coalition of 34 conservation and animal protection organizations and accredited zoos committed to curbing illegal commercial trade of wild animals for meat in Africa.⁶⁷ The coalition was created as the result of a 1998 meeting organized by the AZA. In just over 2 short years, BCTF's accomplishments have been substantial and too numerous to list here. To learn more about this project, please visit the BCTF website at www.bushmeat.org.

A similar initiative was launched in 2001 to facilitate butterfly conservation in North America.⁶⁸ Forty-two AZA member institutions, in cooperation with the United States Fish and Wildlife Service, National Wildlife Federation, Environmental Defense, the McGuire Center for Lepidoptera Research, and the Xerces Society, support the BFCI. The goal of this coalition is to support recovery of the 22 federally listed species of butterflies in the United States and to increase public awareness of and involvement in butterfly and habitat conservation. By planning cooperatively and pooling financial and human resources, zoos and aquariums can greatly enhance their conservation impact.

Animal Welfare—the Critical Caveat

The evidence presented here illustrates that zoo and aquarium contributions to wildlife and habitat conservation are substantial. However, the crux of the debate over zoos and aquariums comes down to a question of focus. Animal rights advocates believe in the intrinsic rights of individual animals, whereas conservationists focus their attention on populations, species, and ecosystems.⁶⁹ While we believe that individual animals are morally considerable, we also believe that conservation must be our highest priority. The irreversible loss of populations, species, or ecosystems will not only result in the untold suffering of many individual animals (including humans), it will also result in the loss of millions of future lives. We acknowledge that this broader perspective might appear callous to those who are strict adherents to animal rights philosophy, but zoos' and aquariums' commitment to conservation is matched by an equally strong commitment to animal welfare.^{33,38,70,71} This increased focus on animal welfare helps ensure that the collective benefits derived from wildlife conservation outweigh the costs to individual animals. No reputable zoo or aquarium professional would defend an institution that contributed to conservation, but abused or provided substandard care for its animals. A conservation-oriented mission and staunch commitment to maintaining the highest standards of animal care are the core values of accredited zoos and aquariums.^{70,71}

One of the founding fathers of animal rights, Tom Regan, refers to any attempt to usurp the rights of individual sentient animals (be they endangered or common) to preserve populations, species, or ecosystems as "environmental fascism."⁷² Several prominent environmental ethicists and conservationists have challenged this view. For example, Warren⁷³ writes, "It is less important to maintain that other animals have moral rights than to maintain that we have moral obligations to them," and Norton⁷⁴ argues, on ethical grounds, that we must balance our obligations to individual animals with our obligations to perpetuate and conserve natural processes. Because there is often a conflict between what is good for individual animals and what is good for populations, species, or ecosystems, this will sometimes mean compromising the welfare of some individuals for the greater good.^{74,75}

The following are some examples of how accredited zoos and aquariums are addressing ethical issues related to animal care and propagation.

Providing Appropriate Environments

One of the biggest criticisms from zoo and aquarium detractors is that animal welfare is diminished in captivity, simply because the wild can never be duplicated exactly. This is true. However, zoos and aquariums make up for these inadequacies by creating an environment that offers some of the accouterments of the wild while providing shelter from some of the stresses, such as predation and starvation.⁷¹ Some accredited zoos and aquariums have been criticized for having older, inadequate facilities and care programs for specific taxa. Many of these institutions are in the process of building newer and more naturalistic animal

exhibits or renovating existing ones. This is often a very time-consuming and expensive process, with new exhibits for some megamammals costing millions of dollars. In the interim, there is much being done to enhance existing enclosures and care programs so that they better meet the animals' physiologic and psychologic needs.

The comparatively new science of environmental enrichment has been embraced by accredited zoos and aquariums and provides numerous techniques for improving the lives of captive animals.⁷⁶ Enrichment is the species-appropriate enhancement of the physical and social environment. Accreditation by the AZA now requires that all member institutions develop and implement an environmental enrichment plan that improves the quality of life of captive animals by providing novel experiences and a variety of stimuli that encourage a range of natural behaviors.⁷⁰ These programs demonstrate accredited zoos' and aquariums' commitment to continually improving the welfare of animals in their care.

Ensuring Quality Animal Care

Animal care is being improved and standardized through creation and distribution of husbandry manuals and thorough, scientifically based animal care standards that define appropriate management practices. The AZA Board of Directors approved management and care standards for elephants in 2001,⁷⁷ and the AZA Animal Welfare Committee is formulating standards for all remaining mammals.⁷⁰ Experts on reptile, amphibian, bird, and invertebrate husbandry have been called on to develop resources for captive management of these taxa as well. Ultimately, standards will be developed for all major taxa in AZA institutions' collections. This is not a trivial task and will take years to complete, especially since we are simultaneously working to fill the gaps in our knowledge about the biology of many species in our care. Although animal welfare is notoriously hard to define and measure,⁷⁸ zoo biologists are investigating new and practical methods to evaluate well-being in zoo and aquarium animals.⁷⁹ Such tools should help accredited facilities monitor the quality of animal care.

Training and Use of Animals in Public Education

Training and the use of animals in education pose some difficult animal care issues for zoos and aquariums. When does training compromise or enhance animal welfare? What kinds of training techniques are appropriate? When is the use of animals in entertainment (including onsite shows and television programming) educational, and when is it exploitative or harmful to public attitudes? Is putting diapers on chimps for late-night talk shows acceptable? Do animal demonstrations compromise animal welfare? Can marine mammal shows on aquarium grounds enrich the lives of performing animals while exposing visitors to quality conservation messages? The zoo and aquarium community is continually assessing the impact of professional practices on the animals under our care, and these questions are the subject of considerable debate

among the members of the AZA and its Animal Welfare Committee. The Committee is currently working on a draft policy on animals in entertainment to be considered by the AZA Board. If they are to be justified, animal shows, training programs, and exhibit design must contribute to the overall conservation and education goals of the association and not diminish animal welfare.

Surplus Animals

The zoo and aquarium profession uses the term surplus to refer to animals that are not needed to meet the population management or conservation goals of an institution or program. It is not that these animals are unwanted or neglected, and despite the penchant of certain critics for misinterpreting the word, surplus does not mean superfluous. All AZA facilities dedicate themselves to providing quality care to all animals in their custody for as long as necessary. Zoos and aquariums make known the availability of their surplus animals in case they can be of conservation or education value to another institution. The AZA also requires that all accredited facilities complete an institutional collection plan to ensure that populations stay within the captive carrying capacity (ie, the available holding space). Institutional collection plans also help zoos and aquariums define the conservation goals for all of the species in their collections.⁸⁰

Some accredited zoos and aquariums have been accused of breeding animals irresponsibly and knowingly sending them to unscrupulous dealers, animal auctions, canned hunts, and the exotic pet trade. The AZA has developed an **Animal Acquisition/Disposition (A/D)** policy that guides members' activities regarding animal transactions and for many years has banned members from sending animals to wildlife auctions and canned hunts.⁷⁰ Violation of these policies can result in ethics charges and may lead to expulsion from the AZA. Association member facilities are required to develop their own A/D policies with the caveat that such policies must meet or exceed AZA's guidelines. The AZA's Code of Professional Ethics cautions members to take great care in ensuring that animals do not end up in places that are unqualified to care for them. However, there is concern that no method currently exists to monitor transactions, so there is no effective enforcement of the full extent of the A/D process.⁶ Toward that end, AZA is working with numerous partners to develop more detailed and accurate animal records by creating a new zoologic information management system that will be international in scope.⁷⁰ In addition, AZA supports centers for population management and wildlife contraception to provide members with the best possible advice on genetic and demographic management and use of contraception to prevent unwanted births.

Beyond AZA

To demonstrate the zoo and aquarium profession's commitment to animal welfare, AZA supports legislation banning roadside animal attractions and canned hunts.⁷⁰ The AZA's Accreditation Commission has established a mentorship program for nonaccredited facilities that would like help reaching their goals of

improving animal care and qualifying for accreditation. However, for those attractions that simply will never meet its standards, the AZA has taken a more vocal stance in support of animals languishing in substandard or inappropriate roadside facilities.⁷⁰ It has also developed, and is promoting, model state legislation intended to close the worst of these facilities. The AZA continues to help train USDA-APHIS inspectors and lobby for increased funding for the agency.⁷⁰ Inspectors are responsible for evaluating animal display facilities under the United States Animal Welfare Act, so this support is for increased vigilance regarding the quality of facilities maintaining live animals in the United States.

Discussions of zoo and aquarium relevance in today's world often come down to issues of individual animal welfare versus overall species and ecosystem conservation. While we believe that conservation must be the primary mission of modern zoos and aquariums, we also contend that to be morally defensible, zoos and aquariums must demonstrate an equally unwavering commitment to maintaining high standards of animal welfare.

Conclusions

In this report, we have argued that a strong commitment to wildlife conservation and animal welfare provides a powerful ethical justification for accredited zoos and aquariums. As true ambassadors for their species, zoo and aquarium animals play an increasingly important role in securing a future for wild animals and their habitats in nature. This is particularly true given the current global context. The future of wildlife and the ecosystems on which they depend is in grave and immediate danger, and as we have documented in this report, zoos and aquariums contribute to conservation efforts in a wide variety of ways.

One question that must be resolved is how much conservation is enough, and how can these contributions be measured? What is a reasonable investment in conservation: 1, 5, or 10% or more of zoos' and aquariums' budgets? Even a 1% investment in conservation out of an estimated combined budget of over \$1 billion would mean that accredited zoos and aquariums contribute \$10 million per year to conservation. However, factoring in personnel time, facility costs, and all funds currently being spent on projects, the cumulative investment in conservation, research, and education by accredited zoos and aquariums would easily exceed that amount.¹² Regardless of their financial contribution, how do we measure the quality and impact of zoo- and aquarium-based conservation efforts? We must be committed to evaluating proposed and ongoing projects if zoos and aquariums are to spend their limited conservation resources wisely.

Also, how much should zoos and aquariums be required to improve animal welfare, short of completely replicating the wild? Zoos and aquariums are in a position to greatly increase quality of life for captive animals through improvements in exhibit design, scientifically based animal care programs, and policy. As we expand our accomplishments in these areas, the benefits of exhibiting animals in zoos and aquariums

are increasingly likely to vastly outweigh the costs, as measured in terms of individual animal welfare. There will always be a gray area where costs and benefits are arguably equal, and it is here that ethical considerations should be carefully weighed when deciding whether a captive program is necessary. This is similar to the ethical considerations used by biomedical researchers when weighing the benefits of the research against the costs to individual animal welfare,⁸¹ but in those cases, the cost to the animals is weighed against the benefit to humans and other animals. In this case, the cost to the individual animals is weighed against the benefit of the very survival of their species and the habitats on which they depend.

Like evolutionary change in any profession, the complex transformation of accredited zoos and aquariums into conservation and animal welfare organizations is being fueled in part by self-preservation, need, changing societal expectations, our increasing knowledge, and internal pressures. While external critics have certainly played a role in this process, much recent change has been generated from within. There has been a vast influx of talented, extremely well-educated people into accredited zoos and aquariums during the past decade. Some have come directly out of graduate school and others from responsible positions in academia, business, government, or the military. They have come to the zoologic profession with a love for animals and nature and a strong commitment to conservation and animal welfare. One consequence of this recent migration of new, highly trained personnel has been a growing professionalism, which has also led to an abundance of critical thinking and self-evaluation, including useful debate on the ethical basis for keeping wild animals in captivity.⁸² We hope this report will continue the growth process by spurring additional discussion and debate throughout and beyond the zoologic community.

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Strategic collection planning and individual animal welfare

Terry L. Maple, PhD

In the summer of 1984, Atlanta's city zoo was entangled in an ugly, highly visible management crisis. Indeed, it may have been the most public and visible scandal ever experienced by any American zoo. The story was zealously covered by local, regional, national, and international investigative reporters from print and electronic media. A *Parade* writer, using information gathered by the Humane Society of the United States, exposed the Atlanta Zoo and 9 other institutions in his list of the nation's 10 worst zoos. Even the *New York Times* offered an opinion: "Atlanta has given neither money nor thought to its disintegrating zoo. How a community treats animals says something about the human beings who run it. Unless Atlanta wants to commit itself to a professionally operated zoological park, would it not be better to forget about having one at all?"¹

In retrospect, the zoo crisis was neither sudden nor unexpected. It had been building for decades, fueled by neglect, mismanagement, and incompetence. At the height of the crisis, it was difficult to affix blame, because the zoo had been overwhelmed by massive

"diffusion of responsibility." Nobody was willing to be accountable. Even a local grand jury failed to find fault with a single zoo employee. But 1 contributing factor was indisputably clear. Located in Atlanta's Grant Park since 1889, the venerable institution had operated without a clear vision from its inception.² Comprising an unplanned population of animals, the Grant Park facility was more a menagerie than a zoo. With passage of time and an accumulation of depreciation and neglect, individual animals suffered the damaging effects of social deprivation, spatial restriction, sheer boredom, and inappropriate, ubiquitous, hard architecture.³ To make matters worse, the Atlanta Zoo had underachieved in conservation and education and failed (with the exception of the herpetological staff) to recruit qualified curators. A few reptile species benefited from zoo breeding efforts, but the poor condition of zoo facilities contributed to high stress, reproductive lethargy, morbidity, and mortality in primates, bears, and big cats. To take its proper place among the community of responsible, ethical zoologic parks, Atlanta's zoo required a complete restructuring, and its operating standards had to be substantially revised and upgraded.

From Zoo Atlanta, 800 Cherokee Ave, Atlanta, GA 30315.

Fortunately, the Atlanta community provided its new zoo director with a mandate for revolutionary, revitalizing changes. We achieved a great deal during the nearly 18 years of my administration. Our zoo vision was derived from an in-depth knowledge of animal behavior, guided in particular by the work of Heini Hediger.⁴ We crafted a plan in collaboration with some, I believe, of the best naturalistic architects in the business.⁵ Our exhibit philosophy was animal-centered rather than visitor-centered,⁶ and our planning process was more empirical than strategic. Given the zoo's poor reputation, we reasoned that better animal exhibits would satisfy the public as well as the animals, creating a win-win outcome. Fortunately, the modest size of our collection and a strong commitment to animal welfare prevented major errors in acquisition and disposition. In retrospect, a strategic collection plan would have served us well in 1984, but few zoos were thinking strategically at the time.

Size of collection is an important issue for modern zoos. Hancocks⁶ has argued strenuously for regionally themed zoos. A good example is the Arizona-Sonora Desert Museum, which specializes in exhibits depicting local fauna of the Sonora desert ecosystem. Many zoos have inherited a collection of a particular critical mass; indeed, zoos often feel pressured to exhibit megafauna that require considerable investments in space and night facilities. In my opinion, far too many zoos exhibit elephants, one of the most challenging of the charismatic megavertebrates to manage. As a result, elephants are living in substandard facilities throughout the nation, creating situations that are dangerous for the keepers who work with the animals on a daily basis. Also, large animal collections may create an unplanned surplus. When qualified peer institutions cannot absorb surplus animals, disposition errors can occur, and animals may be victimized by the unethical behavior of unintended, unscrupulous recipients. Careful collection planning, including attention to size, can save the institutions the grief and criticism that result from a disposition mistake.

At Zoo Atlanta we adopted the catch phrase "fewer animals living well," which guided our collection decisions (sometimes I am tempted to offer a contemporary version, such as "fewer animals living large"). Too many Zoo Atlanta cats, bears, and primates were living in substandard facilities in 1984, so we systematically reduced the size of our collection through natural attrition, selective exchanges and loans, and facility expansions and modifications to improve comfort, privacy, and well-being. My initial challenge as a new zoo director was to correct the problem of too many animals living poorly. The solution was to manage fewer animals in larger and better facilities.

Planning is important for zoos, but we are relative neophytes at this task. Our best plans are usually developed with the assistance of local business leaders or firms that specialize in planning. The American Zoo and Aquarium Association (AZA) has been engaged in a planning process for more than 2 decades, but member zoos have not always planned in synchrony. A laudable aspect of the AZA planning process has been its effort to train personnel in AZA zoos of all sizes and conditions. This training has certainly paid off. One team of experts recently defined strategic planning as

"the process by which the guiding members of an organization envision its future and develop the necessary procedures and operations to achieve that future."⁷ Strategic planning must take into account an organization's resources and limitations, but where animal welfare is concerned, a key variable is the public's expectation of careful, ethical stewardship of animal resources. In the zoo profession today, it is no longer possible to produce a strategic plan that is isolated from larger association, regional, or international conservation planning. In this regard, we have participated in 20 years of planning and negotiating the role of zoos in conservation. Our collections are now regarded as global assets and should not be managed in isolation or ignorance of total world animal populations. In this sense, our zoo collections have meaning and relevance far beyond our local communities.

Contemporary zoos (some would rename them bioparks or conservation parks) are dedicated to 5 basic purposes: conservation, education, science, entertainment, and animal welfare. Although AZA members voted in 1980 to establish conservation as the Association's first priority, the others have not been officially prioritized or ranked. My ranking would place animal welfare first, followed by conservation, education, science, and entertainment. Although Hediger himself proclaimed that "science is always last in the zoological garden,"⁴ it looms large as the foundation of zoo management and therefore is worthy of higher standing in any reasonable sequence of priorities. During my tenure at Zoo Atlanta, science contributed mightily to our reputation. By virtue of our achievements in conservation, education, animal welfare, and science, the zoo was transformed from an industry pariah in 1984 to an industry leader a decade later. Regardless of their order of prioritization, it is important for a zoo to achieve balance among the 5 basic purposes. It is certainly possible to succeed in all areas, but when funds are scarce, it is inevitable that the science side of the house will be the first component to suffer budget cuts. Professor Hediger was correct in identifying a strong bias against science in the zoologic garden. Today, science is regarded as a luxury rather than a necessity. In my opinion, a modern zoo cannot be called truly great unless it finds a way to cultivate a rational, scientific culture. Sadly, by this criterion, very few zoos have reached true greatness.

One issue that requires a great deal more attention is lifespan planning. Because of improved medical care, better husbandry practices, and more appropriate living quarters and social groupings, animals are living longer and better in the zoo. Apes are capable of living 50 years or longer and require some of the most expensive and expansive quarters of any zoo animal. We must plan for long lives and be prepared to retire older animals that can no longer be safely or effectively exhibited. It is not sufficient to relocate them into abandoned cages with inadequate space. Creative thought must be put into designing retirement space just as we devote it to exhibit space. Aesthetics are not as important, but functionality is essential. As for exhibit space, quality will be more important than quantity.

Zoo Atlanta once retired an old male lion with 1 eye. After acquiring females, we reasoned that the older lion would not be able to spar effectively with the younger cats and would be vulnerable to serious injury. Fortunately, in rebuilding the zoo, we had retained housing options for this animal, and he lived out his days quietly with plenty of attention from his keepers. Like old lions in the wild, he led a solitary life, although I would have liked for him to periodically mate with familiar females as old lions persist in doing. As always, familiarity with established behavioral and ecologic norms in the wild is the appropriate guideline for designers.

Although common chimpanzees (*Pan troglodytes*) live long and may suffer a decline in social status with age, behavioral scientists recognize that the older animal plays an important role in chimpanzee society. If a facility is large and complex, an older animal can move to protected, peripheral space and interact at its preferred pace and schedule. Complexity and privacy are important design elements for any species that lives in groups, particularly highly intelligent, social, and manipulative creatures like the chimpanzee.

Because collection plans will soon be required for AZA accreditation, longevity will be a factor subject to inspection by our peers. Has the institution seriously considered the future needs of long-lived individuals in its collection? Collectively, AZA may have to consider sanctuaries engineered and operated by AZA institutions. Already, we are faced with sanctuary options that may not meet our stringent operating standards. To retain our public credibility, we need to be proactive on this issue. When an animal no longer fits the profile for public exhibition, euthanasia is not an appropriate option.⁸ Given the service that zoo animals provide to their devoted community, we owe them a lifetime of high quality care. Understandably, humane euthanasia may be required for medical reasons. However, old age is not a justification for warehousing or sacrificing an individual who has spent its life educating, entertaining, and inspiring humanity. We owe them, it seems to me, a long and happy life in the zoo.

Zoo biologists have been criticized for putting populations above individual animal welfare. I recall a media debate on the efficacy of Timmy, a male gorilla whose monogamous relationship at a midwestern zoo was interrupted so that he could join 4 fecund females in New York. I entered the discussion as a representative of the gorilla committee of AZA's Species Survival Plan (SSP). Animal rights adversaries hired their own behaviorist, Dr. Roger Fouts. The debate was spirited but not winnable, since neither side capitulated. The SSP position did establish that the breeding opportunity in New York took priority over Timmy's unproductive friendship with a single female. However, because gorillas are not normally monogamous, and a harem social system is the norm for gorillas, it was reasonable to conclude that the change was beneficial to him as an individual. It is possible, and certainly desirable, to craft solutions that benefit the individual and the population. During the 20 years in which I closely participated in SSP translocations of gorillas and orangutans, with very few exceptions, changes

implemented were beneficial to the recipients. One reason that translocations tend to work is the thoughtful and diligent planning of cooperative curators, scientists, and keepers. In every case that I have reviewed for the AZA, these individuals always considered the welfare, personality, and history of and risks to the individual animals involved.

Zoo veterinarians often serve as the officer in charge of humane and ethical animal management, and they take this role very seriously. Veterinarians' skills are greatly strengthened when integrated with an active, highly professional, behavioral research program. Psychologists, anthropologists, and zoologists (ethologists) who are actively engaged in studies of the zoo's animal collection can provide information on the state of psychologic well-being of each and every animal under direct observation. Working with keepers and curators, behavioral scientists in the zoo can monitor changes in animals that result from stress or other events. Changes in behavior may also be indicators of disease. These experts can be employed by the zoo or brought into the zoo from nearby colleges and universities. Psychologists are particularly valuable for providing expertise in animal training and enrichment programs. Unfortunately, many zoos do not use behavioral scientists in their management programs and miss an opportunity to institute best practices on behalf of their animals.

Anyone who works closely with zoo animals recognizes their individuality. Individual apes, cats, bears, crocodiles, and whales have distinct personalities and unique developmental histories that influence their behavior.¹¹ Some are more likable and easily managed; both are functions of temperament and intellect. I have raised dozens of Oscar cichlids (*Astronotus ocellatus*), and each fish was uniquely different from the others. Oscars are interesting in another way, because they recognize individuality in the humans who care for them. Oscar fish are capable of knowing their owner. Indeed, I have yet to find a species of bird, mammal, fish, or reptile that does not demonstrate individual differences and distinctly different personalities within a group. As research⁹ has demonstrated, personality is a hypothetical construct that applies to many species. Because animals so clearly reveal their individuality to their keepers, it is essential that we provide for their individual welfare in the zoo. The challenge to our SSP units is to discover ways to balance the welfare of the population and the individual. I am reminded of my debate with the philosopher Dale Jamison.¹⁰ He made the following key point: "Species diversity is one kind of diversity, but so is diversity of populations and individuals. We should be concerned with preserving species, but we should also be concerned with preserving populations and individuals in order to preserve diversity."

Our critics have stated that zoo professionals systematically disregard the welfare of individual animals. I disagree with that assessment, as I have witnessed a high degree of concern for individual animals in my 30 years of work in zoos. This concern is manifest during population planning sessions whenever SSP management committees meet to struggle with their priorities and goals

for a species. If we continue to draw upon a broad base of disciplines within zoo biology (ie, behavior as well as population biology), I am confident that we will arrive at decisions that will benefit populations and individuals. Careful, scholarly, strategic planning is the key to optimal, ethical, and humane operating standards in every principled zoo.

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Positive reinforcement training and environmental enrichment: enhancing animal well-being

Gail Ellen Laule, MA

It has been 18 years since the Animal Welfare Act mandated that facilities housing nonhuman primates provide for their psychologic well-being, triggering a concerted effort by scientists and professionals to enhance the welfare of all captive animals. Today, it is difficult to assess the progress made or whether, overall, captive animals are substantially better off. In general, zoos are good at providing animals with the basics: quality food and medical care, a safe and secure place to live, a naturalistic environment, and appropriate social contacts. Increasing longevity and reproduction of many species are indicators of the success of this pursuit. Despite these efforts, some observations about a wild animal's life in captivity can be made.

These animals are spatially limited in an environment that is sterile and unchanging, in comparison to the wild. There are no predators or prey. Social group size and configuration are limited and, in most cases, there is no diversity of species present. They must eat a fixed diet when and where it is offered, even if the feeding method is unnatural. And most zoo animals still spend most of their time in holding areas that are smaller and more barren than the exhibit spaces zoo visitors see. The net result is that captive animals have little control over their lives. Negative consequences ranging from boredom to stereotypic behavior often result.

Given these realities of zoo life, addressing animal welfare is a daunting task. Most will agree that welfare

is not something that an animal either has or does not have. Rather, it lies on a continuum from poor to good. Petto et al¹ suggest that psychologic well-being be generally defined as "the ability to adapt—to respond and adjust to changing situations." To assess well-being, they recommend using a combination of variables, including behavior, health, reproduction, and longevity. Desmond² suggests that in pursuing enhanced animal welfare, the behavior of the animal "should be the lens through which we focus our efforts."

Shepherdson³ provides a detailed framework using observable behavior as an indicator of well-being. He notes that most animal welfare researchers would agree that enhanced well-being requires that animals have a reasonable measure of choice and control in their lives and that they are "behaviorally competent and empowered to act on their own behalf." He suggests that animals experiencing enhanced welfare should be free of behaviors that are abnormal or indicative of fear and frustration. They should actively explore and interact with their environment and demonstrate a diversity of behavior similar to that typically observed in the wild. Finally, they should demonstrate behavioral flexibility and appropriate responses to changing circumstances.

With these behavioral objectives in mind, this paper will explore how positive reinforcement training and environmental enrichment can address 2 broad aspects of captive animal welfare: helping animals to cope and prosper in an "artificial" zoological system and maintaining as much "naturalness" in this new context as possible.

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Define Your Training System

In assessing the benefits of training to animals, particularly in regard to welfare, it is important to distinguish the type of training being used and specific techniques employed. The training recommended in this paper is based on the use of positive reinforcement; animals are rewarded with something they like for the desired behavioral response. Operationally, it means that the positive alternatives are exhausted before any kind of negative reinforcement is used. On the rare occasions when an escape-avoidance technique is necessary, it is kept to a minimum and balanced by positive reinforcement the vast majority of the time. Physical punishment is not appropriate as a training technique, and no food deprivation is required. Animals are fed their daily diet, and rewards for training include portions of that diet or extra treats. Finally, this training relies on the voluntary cooperation of the animal.

Unfortunately, captive animal management practices have traditionally included a large measure of negative reinforcement. Although this training works, there is an inherent cost to the animal's welfare when it is forced to cooperate through the threat of a negative event that elicits fear or anxiety.⁴ Consider a primate that must receive an injection for its health. If negative reinforcement is used, training the animal to present a leg for the injection requires the threat of an even more negative stimulus, thus exposing the animal to stress from both stimuli. Using positive reinforcement, the animal is trained through shaping and rewards to voluntarily present the leg and is concurrently desensitized to the procedure to reduce the associated fear or anxiety. It seems reasonable to say that positive reinforcement training is consistent with efforts to contribute to that animal's welfare.

Basics of Environmental Enrichment

There have been different names used to refer to the process we call environmental enrichment. In this paper, I am using the term and definition developed by the Behavior Husbandry Advisory Group for the American Zoological and Aquarium Association: "Environmental enrichment is a process for improving or enhancing zoo animal environments and care within the context of their inhabitant's behavioral biology and natural history. It is a dynamic process in which changes to structures and husbandry practices are made with the goal of increasing behavioral choices available to animals and drawing out their species-appropriate behaviors and abilities, thus enhancing animal welfare."

Research has shown that the key to successful enrichment is in its complexity and variability.⁵⁻⁷ These features keep enrichment interesting and novel and encourage animals to interact with their environment. Enrichment is divided into the following categories:

- Physical enrichment, including natural features (eg, logs, rocks, water, and substrate) and artificial items (eg, culverts, ropes, cargo nets, and platforms) used to create useful elements (eg, perches, dens, climbing structures, and lookouts). It also includes temperature, light, sound, and space use, as well as artificial and natural manipulable objects and toys.

- Feeding enrichment, including the type of foods provided and the frequency and method of delivery, with emphasis on novelty and variety. Examples include feeding whole, frozen, chopped, and live food items that are dispersed, hidden, buried, or hung in the environment.
- Sensory enrichment, entailing stimulating the senses by introducing music or nature sounds; perfumes, spices, and urine or fecal scents of other species; edible plantings; varied bedding materials, such as straw and shavings; varied light and dark spaces; and temperature variations created by hot rocks, misters, ice shavings, and heated or cooled spaces.
- Social enrichment, referring to group size, composition, and changes within groups caused by births and the introduction of new animals, as well as compatible mixed-species situations.
- Occupational enrichment, including introducing items that encourage problem solving and physical manipulation by the animal and activities like positive reinforcement training.
- Human-animal interactions, including play, grooming, brushing, and training for husbandry purposes and other behaviors like painting, retrieval, and A to B's to encourage exercise.

Living in the Zoo—Helping Animals to Cope

To help animals cope and prosper in an "artificial" zoologic system, we must consider the routine events animals are exposed to that may be in conflict with natural behavior, and a source of short-term stress and, in some cases, long-term distress. Among these events are:

- Daily routine husbandry activities, including shifting animals between enclosures; brief physical examinations; short-term separations from conspecifics; noninvasive procedures, such as skin care, hoof or claw trims, urine collection, and minor wound treatment; and short-term restraint.
- Veterinary procedures that are uncomfortable, invasive, require special equipment or greater restraint, including blood draws, injections, more thorough physical examinations, TB testing, serious wound treatment, radiography, and ultrasonography.
- Social housing and resultant behavioral problems, including aggression and excessive dominance, which threaten the safety and welfare of individual animals because of a lack of sufficient physical space and alternative social grouping options.

Although husbandry routines, veterinary procedures, and social living are all important components of captive animal care and welfare, each comes with a substantial cost to the animal. Positive reinforcement training is an effective technique to minimize these costs and maximize benefits. The training process rewards animals with something they like for voluntarily cooperating in necessary behaviors, from shifting on and off exhibit to having a blood sample taken. This voluntary cooperation provides animals the opportunity to work for food,^{8,9} achieve greater choice and control over daily events,¹⁰ and experience greater mental stimulation.¹¹

A more tangible benefit of voluntary cooperation is reduced use of physical restraint and anesthesia.¹²

Trained animals also maintain a high degree of reliability in participating in these procedures and appear less stressed while doing so.¹³⁻¹⁵ Many husbandry and veterinary procedures can be carried out with less disruption to all animals by reducing the need to separate animals from their social groups.¹⁶

This training relies on a technique called desensitization to help animals overcome the fear or discomfort associated with a particular experience or event. By pairing positive rewards with any action or object that elicits fear, the fearful entity slowly becomes less scary and, presumably, less stressful. Using this technique, animals have been desensitized to a wide array of husbandry activities, veterinary procedures, new enclosures, restraint devices, negatively perceived people (eg, veterinarians), novel objects, strange noises, and so on. In fact, we have found that animals desensitized to specific stimuli can, over time, become generally desensitized to any novel or unexpected event.¹⁷ Observations indicate that they will react less fearfully to new stimuli and, if they do react, are quicker to recover and continue working.¹⁸ It seems fair to say that animals that are less fearful experience a higher level of welfare.

Environmental enrichment can also be used in conjunction with training to maximize voluntary cooperation. Animals are more likely to shift reliably into areas that are physically enriched. This is especially important when asking animals to shift into holding areas where they will remain for a substantial length of time (eg, overnight). Enrichment can also be used to acclimate animals to new environments or to squeeze cages and restraint chutes by placing preferred foods in those areas and giving animals free access to explore on their own. This acclimation process is an effective initial step before moving on to formal desensitization.

It is most desirable to house naturally social animals in groups.^{19,20} However, because of the constraints captivity imposes upon animals and their ability to avoid or escape negative behavior, social housing must be carefully implemented and monitored or it can become a stressful, negative experience for subordinate animals.²¹ Positive reinforcement training has proven to be effective in addressing social issues in a variety of species. Using a training technique called "cooperative feeding," it is possible to enhance introductions, mitigate dominance-related problems, increase affiliative behaviors, and reduce aggression in socially housed animals.²² Operationally, this entails reinforcing 2 events within the group simultaneously: dominant animals are reinforced for allowing subordinate animals to receive food or attention, while subordinate animals are reinforced for being "brave" enough to accept food or attention in the presence of these more aggressive animals. Cooperative feeding can help ensure that all individuals enjoy a better quality of life, not just the strongest or more dominant ones.

One study²³ documented the reduction in aggressive behavior of a male chimpanzee (*Pan troglodytes*) toward other group members during feeding time through the use of cooperative feeding. Other studies^{24,25} with drills (*Papio leucophaeus*) documented an increase in all forms of affiliative behavior during and following the project.

Environmental enrichment has also proven useful in providing safer and more flexible spaces for socially housed animals. Items like logs, rocks, brush piles, and hanging fire hose strips can be used to create visual barriers, which allow subdominant animals the opportunity to avoid contact with dominant group members. Providing multiple resting areas, wallowing holes, and climbing structures also decreases pressure on subdominant animals. Finally, food is a frequent stimulus for aggressive behavior in social groups. By using feeding and occupational enrichment techniques to deliver food items, tension can be diffused by increasing the amount of time and energy required to search for, process, and consume food.^{26,27}

Living in the Zoo—Maximizing Species Typical Behavior

Heine Hediger,²⁸ former director of the Zoological Gardens in Zurich, wrote in the 1940s and 50s on the care and treatment of wild animals in captivity. Hediger's main contention was that imitating nature in captivity is a mistake that can have serious repercussions: "What cannot be avoided in keeping animals in captivity, is isolation from the cycle of life; therefore a fresh artificial cycle must be created. Naturalness in the treatment of wild animals does not consist, therefore, of a pedantic imitation of 1 model section of nature. It means that a substitute for it must be found suitable for animals taking into account the new conditions of life in captivity."²⁸

Hediger is right. The captive environment is not the natural environment, no matter how similar it may look. The environment in the wild is a reactive one. Under each rock is a potential food item, behind each bush a potential predator, high in each tree a potential refuge. However accurately this environment may be reproduced in a zoo, it is a passive environment. Therefore, strategies for increasing species typical behaviors must be overlaid onto even the most naturalistic exhibit to be successful.²⁹

When using environmental enrichment techniques to increase species typical behavior, we are interested in how animals use objects, rather than how "naturalistic" looking they appear. As Mench and Kreger³⁰ put it, "We must place emphasis on designing zoo environments that meet needs that animals themselves perceive to be important." If we want a primate to brachiate from 1 location to another, we must provide a suitable means for that behavior to occur. A hanging vine might be the natural option, but a rope of similar diameter and flexibility placed at an appropriate height and angle is equally effective in eliciting brachiation. Similarly, a sloth bear may not have access to rotten logs filled with termites, but a capped PVC pipe with holes drilled in it and filled with raisins provides the same opportunity for the bear to use its unique "vacuum cleaner" action to obtain food. A supply of sticks and a yogurt cup filled with applesauce just out of arms reach of a chimpanzee stimulates a species typical tool-use behavior similar to termite feeding in the wild. With ungulates, 1 zoo found that placing several large piles of maple branches in a sika deer yard stimulated a variety of species-typical behaviors;

"They became the focus of activity for the herd, which spent several weeks stripping the bark. Newborn fawns bedded in these brush piles. The stag used them to remove the velvet from his antlers."³¹

Inglis and Fergusson³² suggest that information-gathering is the primary activity of all animals, subsumed only by specific motivations like seeking food. Many studies^{33,34} point to the importance of exploratory behavior as an indicator of well-being. A good enrichment program uses all categories of enrichment to build complexity, change, and sensory stimulation into the environment, which in turn triggers desirable behaviors.³⁵

Another important objective is to reduce abnormal or stereotypic behavior.^{36,37} In studies³⁸⁻⁴⁰ with primates and marine mammals, positive reinforcement training proved effective in reducing abnormal behavior in a number of ways. We can train an incompatible behavior to replace the undesirable one. If fear is the underlying cause of negative behavior, we can address this through desensitization or we can simply increase the behavioral repertoire of an animal, providing greater alternatives to the undesirable behavior. Enrichment can be used to reduce stereotypic behavior by increasing sensory stimulation and overall activity or by providing the opportunity to perform more species-appropriate behaviors.^{41,42}

Conclusions

Optimal care and management of zoo animals requires recognition of what each captive animal has gained and what they have lost in the artificial world of the zoo. Only by recognizing the price animals pay for their loss of freedom, naturalness, choice, and control in many aspects of their lives can we effectively mitigate those losses. To that end, positive reinforcement training and environmental enrichment offer specific tools and techniques to enhance the lives of captive animals and achieve a higher degree of well-being.

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Stress and distress: evaluating their impact for the well-being of zoo animals

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Are "well-being" and "stress" 2 mutually exclusive terms? Let us consider the bungee jumper who leaps willingly off a 100-foot bridge or the popularity of roller coaster rides at one of the many amusement parks around the nation. Drastically different experiences, such as the thrill and excitement of a roller coaster ride and the much less desirable stress of a daily commute during rush hour or giving a public speech, can elicit very similar physiologic and hormonal reactions that have been summarized under the term "stress response." The wide range of occurrences that can evoke such a response highlights the complexity surrounding the term "stress" and its assessment. Across mammals and, more generally, across vertebrates, the neuroendocrine and physiologic responses to stressful stimuli appear to be quite similar and have been preserved through evolutionary history. What, then, is stress, how does it impact the well-being of animals, and how can we measure it?

Stress and Distress—Concept and Definition

Since the early 1970s, stress has become an increasingly popular and widely applied term in our everyday language and usually conjures up negative images. Disagreements about a clear definition of the term have caused some researchers to doubt the general usefulness of the stress concept,^{1,2} while others struggle with changing the original definition and meaning.^{3,4}

The term "stress" originated in the engineering field to describe certain properties of metals and glass and was introduced into the biological field in the late 1930s by Canadian physician and stress researcher Hans Selye.^{5,6} Selye defined stress as a general syndrome occurring in response to any stimulus that

threatens or appears to threaten the homeostasis (or the physiologic and physical integrity) of an individual.⁷ He called such stimuli "stressors" and the syndrome "stress" or "general adaptation syndrome."⁸ A very general concept of the stress response had already been described almost a decade earlier as the "fight or flight" syndrome by Walter B. Cannon.⁹ This general physiologic stress response appears to have evolved as an adaptive mechanism that allows organisms to adjust to and cope with less predictable circumstances in their environment and to respond rapidly to a wide variety of stimuli. Thus, stress represents an important part of life and should not be considered as inherently bad.¹ Some researchers have recently argued that the term stress should only be used for events that are considered detrimental to an individual.⁴ However, we are still in the process of establishing what distinguishes the normal and adaptive response from the one that leads to negative effects. Although we can clearly identify some of the negative effects, we are not yet able to distinguish positive and negative stressors and associated responses reliably. The term "distress," applied by some³ to label the already identified detrimental effects of stress responses and certain stressors on animal health and well-being, appears to represent a more appropriate subcategory of stress. As we continue to expand our knowledge in the area of stress research and gain a better understanding of its mechanisms and consequences, we may be able to establish more appropriate definitions in the future.

The Stress Response and Its Consequences

Once a stressor has been perceived by an organism, the hypothalamus is stimulated and responds by synthesizing and releasing corticotropin-releasing factor, among other hormones. Corticotropin-releasing factor is one of the primary factors activating the pitu-

From the Chicago Zoological Society, Brookfield Zoo, 3300 Golf Rd, Brookfield, IL 60513.

itary gland, which in turn secretes ACTH, thus activating the adrenal gland. However, several other hormones, including catecholamines, have also been found to regulate ACTH secretion.^{8,9} Once activated, the adrenal cortex secretes glucocorticoid hormones, cortisol, and corticosterone (also termed "stress hormones" by some).⁶ The brain region and various glands involved in this neuroendocrine chain reaction have been termed the **hypothalamic-pituitary-adrenal (HPA) axis**. Activation of the HPA axis can be triggered by a wide variety of circumstances.¹⁰ Selye³ envisioned this stress response to be rather unspecific, showing the same physiologic reactions regardless of the type and intensity of the stressor. We now know that the process that regulates secretion of glucocorticoids is more complex and may respond in a graded fashion rather than an "all or none" response.¹⁰ Sapolsky et al.¹¹ suggest that glucocorticoids permit, stimulate, or suppress an ongoing stress response and prepare the brain for a subsequent stressor. Responses of the HPA axis may be activated peripherally (by various environmental factors) or centrally (through perception of a threat). Further research will hopefully elucidate more specifically how physiologic responses and mechanisms may differ with varying stressors and the perception of stressors.

Nevertheless, it has been found that such disparate events as mating, fighting, hunting, and being hunted can all evoke the stress response³ and activate the adrenal cortex. For example, Colborn et al.¹² found that stallions secreted similar amounts of glucocorticoids whether they were restrained, exercised, or permitted to mate. When such stressors are short-term, the response is called acute, and the associated physiologic processes are usually beneficial. Rapid changes in heart rate, blood pressure, and gastrointestinal activity are all designed to allow the organism to quickly respond to the situation at hand. However, it is when acute stress occurs repeatedly without allowing for coping responses or recovery or when the stress response is chronically activated that stress becomes distress.³ An accumulation of biological costs through a series of acute stressors or a consistent chronic stressor has been shown to lead to various pathologic conditions and thus distress.³ Some of the pathologic symptoms found to be linked to chronically elevated glucocorticoid concentrations are immune deficiency, reproductive suppression, growth reduction, muscle wasting, gastrointestinal dysfunction, and impaired brain function.^{9,13} For example, acute stress has been found to have a stimulatory or facilitatory effect on aspects of reproduction, whereas chronic stress can lead to an overall inhibition of reproduction.¹⁴ Thus, identifying early symptoms of distress and pinpointing chronic as well as repetitive acute stressors are essential for evaluating animal well-being.

Stress, Distress and Animal Well-being in Zoo Animals

Defining animal well-being and welfare has been fraught with much difficulty, and no clear consensus has been reached.¹⁵ One problem is that welfare cannot be seen solely as a scientific concept,¹⁶ since it also

reflects political and ethical views of societies.¹⁷⁻¹⁹ In assessing welfare, we are not only concerned with the physical needs but also with psychologic and emotional aspects of well-being. However, defining psychologic well-being and assessing mental states of animals are clearly very difficult. It requires us to view the world from the animal's perspective rather than our own, usually anthropocentric, viewpoint guided by our limited sensory capacities. Even though we may never be able to establish what constitutes perfect well-being for individual animals, we most certainly can establish what leads to a lack of well-being. It is via the process of elimination that we can identify the prerequisites necessary for both physical and psychologic well-being of species and individuals to the best of our abilities.

The following basic "freedoms" were established as minimum standards for the welfare of farm animals in the UK after much political controversy: "Freedom to display most normal behavior patterns, freedom from thirst, hunger and malnutrition, freedom from physical and thermal discomfort, injury and disease, and freedom from fear."²⁰ Although quite vague, these freedoms can offer a starting point for identifying some of the prerequisites necessary for improved well-being.

Minimum requirements have already been established for many zoo-held species and are being improved upon or newly established for others (eg, under the supervision of the American Zoo and Aquarium Associations [AZA] Animal Welfare Committee, AZA members are working on compiling and revising mammal and avian standards based on currently available scientific information). Successful reproduction, lack of disease and pain, absence of abnormal or detrimental behaviors, normal weight range and blood values, food consumption, and longevity have all been used as indicators of well-being. Zoos have made tremendous progress over the past decades in the areas of veterinary care, nutrition, population genetics and management, animal husbandry, and exhibit design and have greatly contributed to our understanding of individual animal and species-specific needs. Recent advances in stress research have now lead to the realization that certain preclinical and clinical symptoms may be resulting from physical and psychologic distress experienced in the captive environment. Freedom from distress thus represents another essential component for the establishment of overall well-being.

Free-ranging animals may often experience stress and distress on a daily basis; for example, hunting, being hunted, mating, fighting, establishing and maintaining social hierarchies, finding shelter, diseases, parasites, sudden changes in weather, and anthropogenic influences can all represent significant stressors. However, stress reactivity can vary greatly across species and individuals according to sex, age, genetics, nutritional status, overall health, and early rearing environment (including prenatal experiences).^{21,22} Therefore, animals born and raised in captivity may react very differently compared with their wild counterparts, even when faced with the same stressors. In captivity, many of these original stressors have been removed, and the lack of stimulation can itself present a source of distress due to animal boredom.²³ Environmental enrichment, now car-

ried out by many zoos for a wide variety of species, can provide necessary and beneficial stimulation. Depending on an animal's temperament, some individuals may require more stimulation than others. Several studies²⁴ on animal temperament have shown that, similar to humans, some individuals may seek novelty and excitement, whereas others prefer routines. A variety of studies^{25,26} employing quantitative behavioral observations or measures of reproductive success already indicate the beneficial effects of environmental enrichment, exhibit changes, and provision of behavioral choices. However, very little research has yet examined physiologic stress responses and preclinical and clinical signs of distress in combination with changes in captive management and environment of zoo animals. The challenge is to identify appropriate measures that can be applied to zoo animals for the assessment of distress and well-being.

Measuring Stress and Distress

No single biochemical or behavioral measure can be used to assess animal well-being or stress.^{18,27,28} While behavioral observations may frequently provide a first indicator of distress, they can also be misleading. Individual variation in stress reactivity, variation in coping styles,^{29,30} and our lack of understanding of the causal mechanisms underlying observed behavioral changes do not make them a reliable indicator of distress.³¹ Similarly, measures of reproductive success, growth rate, and general health, although important for examining certain aspects of animal well-being, usually cannot provide reliable early indicators of distress when examined by themselves. Only through a combination of factors, including physiologic measures, can we begin to examine the influence of stress and distress on animal well-being.

The recent development of fecal hormone monitoring has provided us with a new tool for such investigations.^{28,32,33} Measuring glucocorticoid concentrations in blood samples has long been used as an indicator of stress in mammals^{25,28}; however, the invasive nature and inherent stress of collecting blood samples³⁴ have limited its usefulness for studies on many captive and wild animals. Fecal corticoid monitoring can be used in combination with behavioral observations and other measures of overall health in longitudinal studies without additional stress to the animal.²⁸ One has to be aware, though, that careful biochemical and physiologic validation is necessary for the application of this technique, and resulting measures cannot provide a litmus test for distress. Increases in fecal glucocorticoids may be a result of negative (ie, nonadaptive) or positive (ie, adaptive) stress responses. Furthermore, glucocorticoid concentrations may decline because of intrinsic hormonal control and negative feedback mechanisms, rather than elimination or decrease of the external stressor.³⁵ In addition, although a wide variety of stressors stimulate the HPA axis, not all types of stressors will affect an increase in glucocorticoids.³⁶ Nevertheless, the combined use of all available measures can help us better understand the impact of various stressors on animal well-being and make significant advances in our assessment of distress.

Examples of Zoo Studies on Animal Stress

Recent studies^{37,44} on wild and captive animals are beginning to investigate the effects of various environmental and social variables on stress responses using non-invasive physiologic measures in combination with behavioral and other measures. Application of such measures to zoo animals has already shown promising results. A study⁴⁵ on urinary cortisol in leopard cats found that concentrations were significantly reduced and pacing behavior decreased when additional hiding spaces were added to the enclosure and enrichment was provided. A study⁴⁶ on capuchin monkeys using fecal cortisol and behavioral measures indicated a positive effect of enrichment on stress responses with a decline in cortisol. Another study⁴⁷ employing the use of salivary corticosterone measures and behavioral observations on several mammal species, including rhinos, found no significant effect of zoo visitors on corticoid levels. An ongoing study on cheetahs combines a health measure, the development and severity of gastroenteritis, with fecal corticoid concentrations and environmental and husbandry factors.^{48,49}

In a recent study on clouded leopards, Wielebnowski et al⁴⁹ examined 74 individuals at 12 North American zoos and correlated fecal corticoid concentrations with extensive behavioral and husbandry information. Results showed significant correlations between observed behavioral problems (eg, fur plucking, extensive pacing, and hiding) and mean fecal corticoid concentrations, potentially indicating chronic stress. Furthermore, several husbandry variables, including enclosure height, number of keepers, and keeper-time spent with animals, also correlated significantly with mean fecal corticoid concentrations. For example, the higher the enclosure, the lower the corticoid concentrations. Also, animals on display or visibly exposed to other large cats appeared to have increased corticoid concentrations. These results can provide us with first indicators of potential problems. However, further experimental manipulation of enclosure features and husbandry variables is needed to establish causality. Therefore, an ongoing follow-up study is currently investigating the impact of enclosure height and hiding spaces on a subset of the study population by experimentally manipulating enclosure features. Longitudinal behavioral and hormone monitoring, together with keeper and health records of individual clouded leopards, are used to assess the effect of these environmental changes on animal well-being.

Several similar studies on a variety of species, including okapi, black rhinos, elephants, and polar bears, are currently being conducted. These types of longitudinal and multidisciplinary studies, carried out on a representative sample of various captive populations at multiple facilities, will allow us to significantly increase our understanding of the impact of stress on zoo animals. Ultimately, these concerted efforts can provide us with scientific evidence and quantitative evaluation for management and husbandry adjustments to improve the well-being of the animals in our care.

Future Research

Integration of measures from a wide variety of disciplines, including (but not limited to) veterinary med-

icine, nutrition, genetics, reproductive physiology, behavior, and psychology, will be required to address issues of stress and distress in captive and wild animals. More cross-disciplinary research is urgently needed to address these topics. Furthermore, the development and use of innovative and noninvasive measures of stress responses and assessment of animal psychologic status are needed in combination with the already existing techniques to further improve our understanding. Remote sensing technology, various radiotelemetry devices, and other advances in sampling technology will hopefully provide us with new avenues for these endeavors in the near future.

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Steering the ark toward Eden: design for animal well-being

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Whatever one thinks of capturing wild animals for pets, zoos, aquariums, or research, one may also think of their descendants as refugees of our own species' global war for dominion over nature. This paper will review the development of zoo design as we seek to improve the well-being of these zoologic refugees.

Stage 1—Physical Survival

During the era of barred cages, there were few long-term survivors. Advances in diet and veterinary care brought in the era of green-tile enclosures and, for many species, greatly increased longevity. In 1950, this success encouraged Edward Hindle, Scientific Director of the London Zoo, to say, "...the vast majority of zoo animals are far healthier...than those in the wild, and also have a longer average life."¹ Massa, the popular Philadelphia Zoo gorilla, set the species longevity record of 54 years in such an environment and was well supported by human caregivers.

Stage 2—Emotional Survival and Reproduction

While Massa had close human friends, he usually lived alone. Willie B, Zoo Atlanta's gorilla patriarch, led a similarly isolated life for his first 27 years. Then in 1988, Willie was joined by 13 gorillas from the Yerkes Regional Primate Research Center. Formed into 3 troops, they soon acclimated to their spacious naturalistic outdoor enclosures. Within this complex social and natural environment that was managed by Dr. Terry Maple,² the previously solitary Willie B sired 5 offspring. A total of 13 gorillas have been born at Zoo Atlanta since 1988. Similar breeding successes have been achieved by many zoos for many species when appropriate social grouping is combined with advanced veterinary care. During this same period, zoos in Lincoln Park, Illinois and Howletts, England had great success with gorillas in highly artificial, albeit enriched environments. In Europe, laws were putting building preservation above animal well-being.³

From CLRdesign Incorporated, 121 N Broad St, Philadelphia, PA 19107.

Larger, lushly landscaped displays modeled on natural habitats emerged in the United States in the 1970s. My recollection of the period was that the same sentiment, which favored nature as the model in display design, favored a more hands-off policy in husbandry. Gone were chimpanzee tea parties. Gone also were mechanical mice as enrichment stimuli. Naturalistic displays were thought by some to be sufficiently stimulating that additional stimulation was unnecessary.³ While this approach worked well, it did not always prevent problems, such as loss of occupation. Could we do more?

Green Space is Not Always Enough

As before, some behavioral problems were treated with medication, and physical and behavioral health problems were often seen as unrelated.⁴ Training and behavioral enrichment activities were remedial. Hediger⁵ identified problems related to boredom; lack of activity and exercise could lead to loss of physical fitness and long-term health problems. Even highly naturalistic artificial habitats may not meet all animal needs. Stoinski⁶ found gorillas at Zoo Atlanta eschewed open spaces, preferring shady retreats near large solid objects. Carlstead⁷ suggested some black rhinoceroses suffered chronic stress resulting in diminished longevity and reproduction when kept in small or walled enclosures, however naturalistic they appeared.

Coe and Scheffler⁸ demonstrated a relationship between high levels of stress and depressed immune response. Snowdon⁹ found that giving captive animals choices lowered stress levels. Larger, more naturalistic enclosures offer more choices but still fall far short of the diversity of the wild, and most important choices are made for animals by caregivers. To borrow a computer analogy, large, passive exhibit areas (hardware) also need active husbandry programs (software) to reach their full potential. Nearly 20 years ago, Fortham-Quick¹⁰ summarized the debate between the naturalistic method¹¹ and the more interventionist approach of Markowitz,¹² who argued for integration of behavioral enrichment and training into the basic design of naturalistic animal displays. Yet, I have found

that until recently, training and enrichment specialists were not involved in facility design, although they are increasingly requested to solve behavioral problems later.

Stage 3—Activity-based Design and Husbandry

In attempting to create a framework for the proactive integration of design, behavioral enrichment, training, and husbandry, I proposed the following definition:

"Activity-based design begins with the premise that the animals' long term well-being is paramount and that environments, programs and procedures which advance this goal are frequently of great interest to the visiting public. Healthy animals with stimulating behavioral choices tend to be more active. Therefore, opportunity-rich animal environments, enlightened animal care and caretaker devotion should all be made visible to the public within a setting which demonstrates the animals' innate competence."¹³

Several popular zoo exhibits of the last decade have incorporated many of these features, providing substitute occupations for animals, such as searching for and catching food (Woodland Park Zoo "Northern Trail" and Sea World Florida's "Arctic Wild"). The Wildlife Conservation Park/Bronx Zoo's "Congo" exhibit includes built-in gorilla foraging features and habitat choices within a stunningly realistic recreation of the Congo rainforest. However, this behavior-based concept may be most useful for zoo facilities lacking the space or funds for high levels of habitat verisimilitude or those choosing a more economic and flexible approach. Orangutans at National Zoological Park's "Think Tank" chose to travel overhead across the zoo to visit friends and potential mates.¹⁴ At the Philadelphia Zoo's "PECO Primate Reserve,"¹⁵ the indoor guest experience is more like visiting a large, complex behavioral enrichment laboratory than visiting a traditional zoo. One result has been the birth of 18 young of 6 species in the first 4 years.

Rotation Exhibits

A recent example of this activity-based approach in primate facilities is the just-opened "Gorilla Forest" at the Louisville Zoo. Troops of gorillas can choose between large naturalistic outdoor habitats or a circular arrangement of indoor day rooms surrounding a public gallery. This "gorillas in the round" concept was developed at the Apenheul Zoo in Holland and was used more recently at the Columbus Zoo.

In traditional displays, the animal spends its life in the same space. In a rotation concept, the animal may visit 4 areas each day, for example, typically accessing 4 times the space made up of 4 different settings. Behaviorally, it is a simulation of Hediger's description of a territory made up of pathways linking activity or use areas.⁵ Adjacent spaces in the system are occupied by other animals, simulating overlapping territories in nature. Alternatively, some areas could be bypassed,

allowing recovery from overuse or renovation to introduce novelty. This animal rotation concept should be thought of as a circuit of consecutive or serial mixed-species exhibits. Measures for controlling contagious diseases are the same as in the more common, concurrent mixed-species displays.

The gorilla exhibit complex at Zoo Atlanta was planned in 1983 with the potential to rotate 4 or more gorilla troops through 4 outdoor yards on a daily basis, simulating the movement of mountain gorillas through their home range in Rwanda.¹⁶ While this rotation option was never used on a permanent basis, it was tested. Lukas¹⁷ found that activity levels and exploratory behavior increased when 2 troops were gradually transitioned to daily rotation in adjacent habitats.

The most ambitious rotation exhibit in use today is the Louisville Zoo's "Island" display. Here, orangutans, siamang, tapir, babirusa, and a Sumatran tiger rotate daily among 3 naturalistic outdoor displays and a large indoor dayroom.¹⁸ The order, sequence, duration, and timing of their movements are randomized by care staff on a daily basis to optimize novelty. A 3-year behavioral analysis by White et al¹⁹ provided the following summary:

"Moving animals among the exhibits affected activity levels and/or space utilization in all animals in the activity-based management system... The results support the conclusion that exposure to varying exhibits produces variation in the behavior of the animals and elicits natural behaviors that would be unlikely to occur in a traditional single exhibit. Activity-based management provides unique opportunities for the behavioral enrichment of captive animals."

Ambitious rotation exhibits are now being planned for the California Science Center, Los Angeles; Point Defiance Park Zoo and Aquarium, Tacoma, Wash; and Taronga Zoo, Sydney, Australia. Predicted benefits to animal well-being include increased stimulation and activity resulting in improved physical fitness. Staff benefits include greater responsibility and creativity in daily operations and more training. Important considerations include cost of additional staff and greater staff expertise in operant conditioning and behavioral enrichment. Construction cost is increased as well, because barriers must be designed to contain the most demanding species. Another concern is increased risk of error or mechanical failure in the operation of a greatly increased number of animal transfer gates. Louisville Zoo has developed procedural safeguards against this eventuality.²⁰ Do benefits in animal well-being, staff development and morale, and visitor approval outweigh concerns over increased construction and operational cost and risks of disease contamination or accident? This new approach is strongly supported by Louisville Zoo staff.^b

Affiliative Design

Can we provide physical and social settings conducive to affiliative behavior among and between species while avoiding settings that encourage aggres-

sive behavior?²¹ Critical resources, such as feeding areas, shelters, and basking locations, can be provided in widely dispersed abundance to minimize competition while ensuring opportunities for exercise and positive social interaction. The chimpanzee display at the Los Angeles Zoo was designed to eliminate previously high levels of aggression between chimpanzees and zoo visitors by reducing the amount of open-moated frontier socially defended by both species. A variety of dispersed small-scale viewing opportunities was provided. Behavioral analysis⁶ showed affiliative interaction between chimpanzees and the public replaced aggressive behavior. However, aggression within the ape group also increased, perhaps because the larger area increased opportunities for group fragmentation.

Increasing Animal Physical Fitness

Cynthia Moss noted that wild elephants, which often travel many miles each day, rarely have foot problems.⁴ Foot infections, sometimes life-threatening, are a common development in zoo elephants kept on hard surfaces with little exercise. A well-conceived program of vigorous exercise may be the key to elephant health and longevity.⁶ New elephant facilities planned for Honolulu Zoo and Taronga Zoo in Australia will provide large pool systems where elephants can participate in low impact aquatic aerobic exercise. Sea World Florida's "Arctic Wild" encourages polar bears to dive to depths of 25 feet in attempts to catch fish. National Zoo and San Diego Zoo's Center for Research in Endangered Species have coursing areas where cheetahs enthusiastically pursue automated prey using equipment developed for coursing dogs. Fitness may also be evaluated by observing dexterity and balance. When zoo-raised golden lion tamarins were first reintroduced into their native forests of Brazil, some initially fell out of their trees. Having been raised on rigid climbing structures, they were apparently unprepared for life in a mobile environment.¹ Today many zoo tamarin groups are housed in natural trees, and zoos in Atlanta, Los Angeles, and Denver have artificial sway branches that move realistically when primates climb on them.

Putting Animal Well-being First

Advances in diet and veterinary care from stage 1 and multi-individual, multigroup, and multispecies facilities and larger, more naturalistic exhibits from stage 2 have been integrated with advances in behavioral management. In stage 3, specialties traditionally considered separate, such as veterinary care, animal maintenance, behavioral enrichment, animal training, architecture, and landscape architecture, are collaborating to a remarkable degree in the interest of improving animal well-being. However, these examples are by no means common. Concepts such as animal rotation are met with skepticism, reminding me of the response received 25 years ago to the introduction of the highly naturalistic immersion habitats, which have become today's standard in the United States and Australia. Building on the research of White et al¹⁹ and Lukas et al,²² we need far more evaluation of these new activity-based zoo facilities. For example, White et al¹⁹ found

that the stimulative effect of rotation exhibits was reduced by time and habituation. Perhaps this also occurred in earlier naturalistic exhibits. No single approach is sufficient. We must continually advance to maintain high levels of animal well-being.

Stage 4—Towards Greater Self-determination for Zoo Animals

Just as each stage built on the advances of previous stages, the future will continue to build on the present and past while finding new paradigms. Stage 2 animal displays used images of animal habitats in nature and reports from field biologists as their inspiration, briefly breaking the tendency of some zoos to copy other zoos. Stage 3 advanced by including training and behavioral enrichment in daily husbandry. What new paradigm will continue this advancement?

Perhaps the most persistent feature of the relationship between a zoo's staff and its animals is the implicit assumption that captive animals must be entirely dependent on their human caregivers. Indeed, present facilities and programs depend on this condition. But what if we relaxed this assumption? What if monkeys really did run the monkey house?²³ Let us look at some of the opportunities implicit in this radical paradigm.

Over 50 years ago, Hediger⁷ showed that even wild animals are not free of strict physical and behavioral limitations on their actions. Yet it may be said that the organism with the most control over its environment has the most freedom. Snowden⁹ showed captive primates can lower stress by taking control of the stressful situation. Much of the work of the behavioral enrichment movement developed to remedy behavioral anomalies resulting from lack of stimulation and choice. Operant conditioning training in zoos, while an enormously valuable tool, rarely encourages animals to take the lead in choosing the interaction. Most types of behavioral enrichment encourage free choice for animals but are usually more dependent on keeper initiative than animal initiative.

It is time to evaluate our own perceptions of animals' competence to manage their own lives. For millions of years, the antecessors of today's captive species prospered, adapted, and evolved in a world full of opportunity, risk, and intense competition. There were no humans to dice their fruit or call them in. We cannot return these refugees to earlier times, but we can respect their ability to proactively satisfy more of their own behavioral and environmental needs. In the wild, they learned from conspecifics or experience; today we can train them to use appropriately designed facilities. Perhaps they could acquire much of their own diet through active foraging, browsing, or simulated hunting, regaining an important natural occupation and increasing physical fitness. Perhaps there are ways for dolphins to manipulate the acoustic signature of their tanks or for bears or elephants to turn on a cooling shower on a hot day without human intermediaries. Motion-activated switches could turn on heaters, coolers, fans, audio-visual displays, or food dispensers, allowing individual animals, from penguins to polar bears, to customize their living facilities.²⁴ Animal choices need not be limited by wild precedents.

Orangutans at the National Zoo's "Think Tank," trained to use electronic intermediaries, communicate with staff using symbolic language.¹⁴ Rather than living passively in uniform environments mandated by regulation or standard, animals in indoor environments could move through gradients of light, temperature, humidity, color, or smell to select their preferred microenvironments.

Stage 4 thinking may find its greatest opportunity in wildlife sanctuaries, including those from which animals will eventually be reintroduced into the wild. Here, the animal's adaptive competence must be honed. In 1928, Edward Beston²⁵ wrote:

"For the animal shall not be measured by man. In a world older and more complete than ours they moved finished and complete, gifted with extensions of the senses we have lost or never attained, living by voices we shall never hear. They are not brethren, they are not underlings; they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendor and travail of earth."

Most of the wild animals in our zoos, aquariums, sanctuaries, and laboratories are refugees, the captive descendants of earlier generations. We cannot return them to wild habitats that no longer exist, nor can we humanely turn them loose on our streets or parks. But until the time comes, if it ever does, to recreate lost native habitat, we can take the next step by developing facilities and programs respecting the competence of even insects or crustaceans to choose among viable options, giving them greater control of their lives. In so doing, we will be rethinking our basic relationship to nature, redefining captive species not as unfortunate dependents but, as Beston suggests, "other nations" to be respected for what they are as well as what they were. It is this realization, I believe, that will lead us to stage 4, creating zoo habitats in which animals more freely engage their lives and ours.

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Surplus animals: the price of success

Albert H. Lewandowski, DVM

Zoologic parks have worked diligently for more than 100 years to attain consistent results in breeding the wide variety of species in their collections. Success brings public attention and acclaim, professional accolades, and an unspoken authority and status on the committees of the American Zoo and Aquarium Association (AZA), which help manage threatened and endangered animals in participating institutions.

With considerable emphasis and financial resources focused on providing optimum conditions for reproduction and on scientific advances in medicine, nutrition, and animal psychology, a substantial number of institutions have been successful in reproducing the animals in their care. The regularity with which some species, even rare and endangered species, are now reproducing leads us to a problem fraught with moral and ethical turmoil. We have been too successful. We have more animals than we can adequately take care of. We have a surplus.

With limited space in our institutions, minimal funds in times of economic crisis, and spiraling costs, maintaining animals not essential to the immediate purpose of sustaining an adequate gene pool strains resources. Compounding the problem are the concern for animal welfare, the ethics of responsible management, and the highly charged emotions that develop whenever issues concerning animals are brought to the table.

The word "surplus" does not necessarily imply that an animal is unwanted or unneeded. Surplus animals are surplus for myriad reasons.¹ An unpaired male or female may be temporarily surplus and need only be placed in an appropriate breeding situation. Keeping a normal social animal in a solitary environment or an unnatural grouping for an extended period of time creates a situation that can be corrected. Maintaining optimum group size and sex ratios creates opportunities for enhancing the psychologic well-being of the animals, and improves prospects of continued successful reproduction and group survival. Animals whose life span averages 12 to 15 years cannot be permitted to languish for 2 to 3 years in a holding cage. The most responsible animal managers work overtime to obtain suitable matches for their charges, keeping unpaired time down to a bare minimum. These animals pose a fairly easily remedied surplus problem.

Some unpaired animals have served an indispensable function as a focus for public awareness. The elephant Ziggy of the Brookfield Zoo, the gorilla Massa of Philadelphia, and Smokey the Bear of the National Zoo have been symbols of their institutions—recognized worldwide superstars of the animal kingdom during their lifetimes. Their role as ambassadors superseded other functions they might have had within the gene

pool of their time. They provided a focal point for media attention, attracting the general public and providing needed revenues. The use of individuals, however, is a double-edged sword.

One success story was the transfer of the gorilla, Timmy, from Cleveland to the Bronx Zoo in October 1991. Animal rights activists tried to block the nonreproductive but popular animal's move.² A federal judge allowed the transfer, and Timmy has sired 13 offspring since his arrival in New York. The focus on an individual animal in this case could easily have doomed the AZA Species Survival Plan (SSP) recommended breeding. Hopefully, more enlightened marketing will redirect education about conservation programs, with less emphasis on individual animals and greater emphasis on the importance of animal populations and biodiversity.

Excess male offspring also pose a surplus problem. With a 50% chance of producing either sex at each birth, a most uncomfortable situation is created when only 1 or 2 males are adequate to provide for an entire herd of females. Bachelor groups are not particularly popular with zoo curators because of management problems; multi-male groups are prone to fighting and injury, often requiring that individuals be isolated for their own safety, which in turn creates its own set of problems. Every zoo director wants a baby gorilla or baby elephant on display to bring patrons into the park. Male baby gorillas and elephants come with "surplus" built in. Most zoo professionals have little desire to deal with the issue of what to do when the animal becomes sexually mature and is no longer a cute little baby.

In 1999, Will Meikle, general manager of the Taronga Zoo, broached the subject of aborting a male gorilla fetus to avoid creating another surplus male gorilla. In a bold and revealing statement, he said that the zoo industry would have to decide what to do with surplus males in the global population. He noted that we are able to absorb the surplus today, but that it "will be a management problem for someone else in 10 years." Unfortunately, some managers are more concerned with preserving the status quo than with the long-term effects on animal populations.

Nonreproductive animals, whether because of advanced age or infirmity, are frequently in the ranks of surplus. These animals are often long-term residents of the zoo and public favorites as well. They serve no practical purpose and contribute nothing at this point in their lives to the global gene pool, but even the most objective animal manager has a soft spot in his heart for an old timer in retirement.

Notable exceptions to this class of nonreproductive animals are those that may serve as an integral part of a group, such as gorilla "aunts." These surplus animals can provide structure and stability, promoting a healthy social environment for a troupe. Their impact

From the Cleveland Metroparks Zoo, 3900 Wildlife Way, Cleveland, OH 44109.

in this role exceeds the need for them to reproduce and must be addressed in long-term species planning.

The SSP, in attempting to manage the gene pool for threatened and endangered species of AZA zoos and their affiliates, may single out animals that are over-represented and recommend that they not be bred or rebred. They are no longer needed to maintain the gene pool, having contributed multiple offspring, and now create another class of surplus animals, which are past their prime but not old and infirm.

Hybrid animals pose another class of surplus. In an attempt to maintain pure genetic lines, animals of mixed subspecific heritage are undesirable for further propagation and contribute nothing to the legitimate gene pool for their species. A glaring example is orangutans that karyotype as Sumatran \times Bornean hybrids. In 1990, almost a third of the orangutans in North American zoos were of mixed subspecies. Maintaining these animals over their 30-year plus lifespan puts an enormous burden on the institutions that hold them.¹ What does fate hold in store for them?

Genetic anomalies, bred for their unusual colors or pelage pattern, are interesting but represent an evolutionary dead end. White tigers have generated much interest and a great deal of press but contribute little to conservation of important genes, no matter how beautiful they may be. Severe medical problems as a result of intensive inbreeding to preserve this color variation render these mutants no legitimate place in an institution managing for the conservation of a species.² Unless the more important message of sound animal genetics can be accepted for zoo animals as it is in the livestock industry, long-term survival of many species is imperiled.

Imperfect or aged animals, animals with medical conditions that we cannot cure but are capable of maintaining indefinitely because of our advances in medicine, and animals with conditions that medicine can (possibly) improve at high cost and untold man-hours represent still another class of surplus. Do we maintain these animals for their good or for our own impotent reasons?¹ As responsible animal managers and institutions dedicated to the advancement of science and the conservation of nature, what options are open for placing these animals?

In most institutions, surplus animals are frequently maintained within the primary exhibit or warehoused in an off-exhibit area. If housed in the main group, multiple problems result. The surplus animal is frequently low in the social structure and is subject to injury, or worse, may injure a valuable breeding animal. Animals that would, in the wild, be driven from the group are confined to a limited area, interfering with the social structure and reproductive success and decreasing the survivability of neonates that are genetically more valuable to the species. Each exhibit has a carrying capacity, a limited number of animals that can live comfortably in a given space because of the territorial requirements of each species. Exceeding the carrying capacity carries a grave price, paid for by the animals involved.

If a surplus animal is housed in an off-exhibit area, its quarters are usually less desirable and not as suit-

able as the main exhibit area. Temporarily keeping an animal in a less-than-ideal area until it can be permanently placed is justifiable. A moral and ethical question arises when the "temporary" placement drags on for years. Quality of life for that animal now comes into question. Is this moral? Is this ethical? Can zoologic parks responsibly place these animals? To not take up precious funds, time, and space; to not divert curators, keepers, and veterinarians from animals and species that require intensive management; to make optimum use of the resources at hand; and to maximize contributions to serious conservation efforts, these animals must be placed in suitable situations.

Based on current costs, a large carnivore (eg, a tiger) will require at least \$25,000 to maintain it under minimally acceptable conditions for its lifetime. The costs of food, shelter, utilities, keeper time, and veterinary care add up rapidly. Primates generally are more expensive to maintain, and hoofed stock are generally less expensive to maintain. Extraneous animals, even 1 extraneous animal, can rapidly become an economic burden. What responsible institution would not rather focus its attention on progressive, fruitful programs than on maintaining the status quo? How many surplus animals can continue to be supported without regard to cost and lost funds for legitimate conservation?

What Options are Available?

Optimally, another party desires the surplus animal. The first institution of choice would be another zoologic park. Professional care by an institution involved in a cooperative breeding program is most desirable. Knowing that an animal is going to a place where friends and colleagues have a need for it and will be caring for it gives peace of mind. The curators, keepers, and veterinarians who work in the zoologic community do so because they want to make a difference in the lives of the animals under their care, not because they'll get rich doing so. Securing good placement for an animal is its own reward.

When a direct zoo-to-zoo transfer is not possible, another option is using registered animal suppliers. With their ear to the ground, licensed brokers and dealers are often able to put together transfers to overseas contacts or other institutions that may not be aware of a surplus animal. Zoos often go to considerable effort to limit second party transactions in an attempt to keep unqualified persons and hunting ranches from obtaining surplus animals.^{4,5} Occasionally, these precautions fail, but sensationalizing these failures undermines the many positive changes that professionals in the USDA and AZA have made during the past 30 years.

A third alternative is transfer to a private breeder. Many fine institutions with high professional standards and impeccable records breed and raise unusual species. Often these individuals are motivated more by dedication and interest than by profit. The use of profile sheets by zoos to document the experience and care afforded by these private breeders helps to ensure proper care and the ability to track genetic lines if required. Though not a perfect system, sincere efforts

by curators and animal care managers to place these animals with a responsible breeder expand the available gene pool and make good use of outside expertise.

Private individuals constitute another resource for some species. While the placement of lions or tigers with a private individual to maintain as a pet is blatantly irresponsible, judicious placement of neonates, injured animals, and animals needing long-term care might be reasonable. Small, private menageries stocked with creatures of questionable parentage, cast-off pets, and zoologic oddities contribute nothing to the efforts of conservation. These situations only hamper serious efforts by reputable individuals. Distinguishing between acceptable and unacceptable is not always easy.⁵

No responsible zoologic park can justify disposing of surplus stock to the highest bidder at a public animal auction. The AZA Code of Ethics condemns this practice, and AZA members pledge to "make every effort to assure that exotic animals do not find their way into the hands of those not qualified to care for them."⁶ Weak or nonexistent state and local laws regarding the private ownership of exotic animals compound this problem.

An often-maligned outlet for surplus animals is legitimate medical research.⁷ An option more suited to primates than deer and politically incorrect in many circles, animals transferred to medical research provide an invaluable service to mankind. Veterinary colleagues in laboratory animal medicine provide no less concern and care for their charges than veterinarians working at zoologic parks. Allowing surplus animals to be used in medical research is a public relations nightmare, but perhaps the zoo community needs to voice an opinion in support of sound medical research that has improved the lives of humans and animals. Again, education regarding the difficult ethical choices faced when placing surplus animals may shift public perception.

The last option for a surplus animal that is not suited to medical research, too dangerous to place with a private individual, too old for a dealer to place, too common for placement with any zoo, tying up valuable exhibit or off-exhibit space, costing thousands of dollars to maintain, not a high profile animal, does not have a life-threatening medical condition, or not "perfect" is culling.^{1,3,7} An animal that has heretofore lived a useful, productive life deserves better than to be relegated to a holding area for the remainder of its days. Morally and ethically, quality of life for these animals becomes suspect at best, nonexistent at worst.

Animal managers have a responsibility and obligation to advertise that an animal is available. A sincere

effort must be made to place surplus animals. Sometimes, however, an animal may be surplus for several years before it becomes obvious even to the most optimistic caregiver that there will be no takers. As a responsible steward, a difficult choice and a plan to manage for the future must be made.

To rush out and eliminate all surplus animals in zoologic collections today would not be responsible management. Much soul searching needs to be done. As maximum use of space becomes more important, resources continue to be stretched, and education regarding animal management takes hold, perhaps the surplus animals in our care need to make way for more endangered animals, important breeding stock, and SSP animals—not on a whim, but as part of a carefully considered long-term plan for each animal collection.

The principles of animal management are taught to every farm child who shows animals in 4-H classes at the county fair. As our population becomes increasingly more urban, the realities of responsible animal husbandry and management become more alien to the general public. Perhaps the time has come to voice the basic principles of Animal Science 101 for an urban audience. Zoologic park collections are not exempt from these principles, but we have moved away from their use. As professional managers, we need to get back to basics.

"...I have moral responsibilities...to the animals under my care... (to) display the highest integrity, the best judgment or ethics possible, and use my professional skills to the best interests of all."⁶ The animals in my care are not mine, but are left to me in trust. I will make hard decisions, invest wisely, manage carefully, perform morally and ethically and, hopefully, leave things better for my having been here. I must be a responsible steward.

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