Zoos: Their Changing Roles

As urban refuges of wildlife, zoos have opportunities for education, conservation, and research.

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The expansion of urban populations now makes it necessary for zoos to educate the generations growing up without any natural contact with wild creatures. Except at the zoo, the opportunities to know or even to become interested in wild creatures are largely vicarious for most city dwellers. Yet, the opinions of these urbanites may ultimately shape the future policies of conservation in this country. Seen in this light, the educational challenges to the zoo naturalist and the conservationist are identical.

The educational functions and methods of zoos (as of museums) are not those of the classroom, although zoos do collaborate with schools to supplement classroom education. Departments of education at several zoos, such as those in London, San Diego, and New York, supply programs, lectures, and tours for the local schools. The education departments of the San Diego and Bronx zoos now send lecturers with living animals to nearby elementary and secondary schools, operate an in-service teachers' course on the use of the zoo, conduct special summer courses, give tours, and manage an educational film program. In Philadelphia and Chicago, "zoo mobiles," each containing animal exhibits and a lecturer, visit schools and playgrounds. Zoos and universities located close to each other often establish joint programs.

Subjects that might be taught in zoos include geography, evolution, and an appreciation of the term "renewable resoruces." At the 1967 annual conference of the American Association of Zoological Parks and Aquariums, in a symposium entitled "The use of zoos and aquaria in teaching animal behavior," A. W. Stokes remarked that

> Over 100 colleges now offer graduate training in this [animal behavior] field. The increase in courses in animal behavior is meteoric. For these courses to be really effective they should expose students to actual observation of animal behavior. . . . Such places [zoos and aquaria] offer a variety of animals exhibited in far more spacious quarters that one could never attain in a laboratory, thus allowing opportunity to observe behavior patterns not possible indoors.

Education at the zoo has always seemed like recreation. Adults and children come to the zoo without urging, and many educators are convinced that this fact points the way to use of the zoo as a motivational stimulus for inner-city children, although there are as yet no conclusive programs to explore this possibility. Since the zoo presents unusual variety amid the homogeneous municipal habitat, its excitement and mystery would seem to be an effective way of interesting children in reading and thus in education—a way of arousing curiosity.

Satisfying curiosity about kinds of animals and what they look like has always been an important function at the zoo; through new techniques, exhibits at the zoo are broadening the visitors' basic scientific knowledge. Habitat exhibits, as opposed to cages in which pairs of animals are confined, are being constructed as fast as funds permit. New group displays of social animals and increasing birth rates at zoos enable city dwellers to begin to understand animal behavior.

The promise of more leisure time in the future will help to change the zoo's role. As a recreational resource for the family, zoos seem beyond compare. More than 85 million visits were recorded by American zoological collections last year, more than the combined attendance of all botanical gardens and natural history museums, and also more than the combined attendance of all national football and baseball games. In short, the zoo can successfully compete in the amusement field while educating the public.

Exhibits

It was not until recently that any major zoo had a department of exhibition comparable to those of most museums. In 1964, the New York Zoological Society established a department of exhibition and graphic arts patterned, in some ways, after that of the American Museum of Natural History. Prior to this time, the Arizona-Sonora Desert Museum, which in many aspects is like a zoo, had established a curator of exhibits, and, since 1964, exhibition departments have been initiated in Chicago's Brookfield Zoo and the Philadelphia Zoo. This development reflects not only an increasing concern with the problem of presenting animals in exhibits that appear more natural and introducing more information about them but also the availability of new exhibit materials and techniques from other fields. In natural history museums habitat groups and interpretive graphics do not have to be designed for animals' eating, digging, climbing, chewing, and so forth. With new synthetic materials such as fiber glass and polyethylene, the appearance of animal environments, even under conditions of close confinement, can be simulated. A better understanding of animals' needs and behavior enables the visitor to the zoo to have a less obstructed view of the animals. Open-fronted exhibits, the use of moats rather than bars, and habitat settings are being used widely (Fig. 1).

The desire to keep wild animals, which may harbor persistent parasites, in areas that can be quickly and efficiently cleaned, is usually in conflict with the need to exhibit them in a display simulating some part of their natural habitat. For this reason, a tile wall or "lavatory" type of display has its supporters, particularly for the exhibition of primates. However, as the new techniques become less expensive, the need for this type of housing will disappear. The addition of exhibition departments to zoos will also release the curatorial staffs from many specialized aspects of exhibit preparation, and the zoo should be able to proceed more rapidly toward the goal of displaying all of its animals within the ecological and evolutionary context implied by a "natural" background rather than as disenfranchised creatures in steel, tile, or concrete confinement.

The basic concepts of exhibition are

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changing too. Exhibits based on taxonomic affinities—the big cats, the bears, the ungulates—are being supplemented by thematic presentations founded on zoogeography, ecology, and behavior. The Munich Zoo was arranging its exhibits by continent as early as 1932, and the same concept was important in the development of the Detroit Zoo. The new Milwaukee Zoo has combined predator-prey presentations, first developed by Hagenbeck at Stellingen in Hamburg, with zoogeography to show lions in juxtaposition with zebras, jaguars with tapirs, and tigers with deer. Exhibits of nocturnal animals relying upon activity-reversal systems are the first substantial behavioral displays, but sophisticated smaller exhibits developed at Chicago's Brookfield Zoo by Rabb to demonstrate dominance hierarchies and territorial marking are additional examples. The Aquatic Birds Building at the Bronx Zoo houses a contrasting series of exaggerated views of wetland habitats subtly emphasizing the waterbirds' dependence on the preservation of swamps, marshes, and beaches.

However, European zoos have enjoyed one unsought advantage over their sister institutions in the United States. They were bombed. Many are no longer plagued with unsuitable buildings constructed before the recent renaissance in thought and design of zoological parks. Furthermore, buildings for zoos are extraordinarily expensive to construct because they are specialized in almost every detail. Structures designed to exhibit elephants, hummingbirds, gorillas, cobras, storks, crocodiles, pack-rats, and flamingos have to incorporate innumerable requirements. The need for new physical facilities is urgent in American zoos, all the more because their facilities are so sorely tried by reason of their very popularity.

Zoos and Conservation

One of the reasons for the exhibition of live animals is to encourage those visitors who can to become more deeply concerned with their surroundings and to take advantage of local wildlife and the out-of-doors. It is customary for biologists to urge those who can to seek animals in the wild, to hike, and to visit national parks, but it is now evident that such visits in great quantity will finally destroy these wild areas. The fragility of many animal and plant communities subjected to human pressures in some of our national parks has become all too evident (*1*), and the real value of the zoo's role in this context is to act as a partial substitute for visits to natural areas and to fulfill certain functions of parks in the field of environmental education and conservation.

Conservation of wild animals would seem to find a natural base in zoological parks. Where better can the plight of a vanishing species arouse widespread public sentiment and support than in presentations of the animal itself located in human population centers? It seems strange that more conservationists have not sought to make zoos headquarters for efforts in conservation education. The wildlife protection work of Hornaday (*2*), who was the first director of the New York Zoological Park, stands almost alone in the early days of this century. He was a moving force in the development of the Migratory Bird Act, which stopped the po-

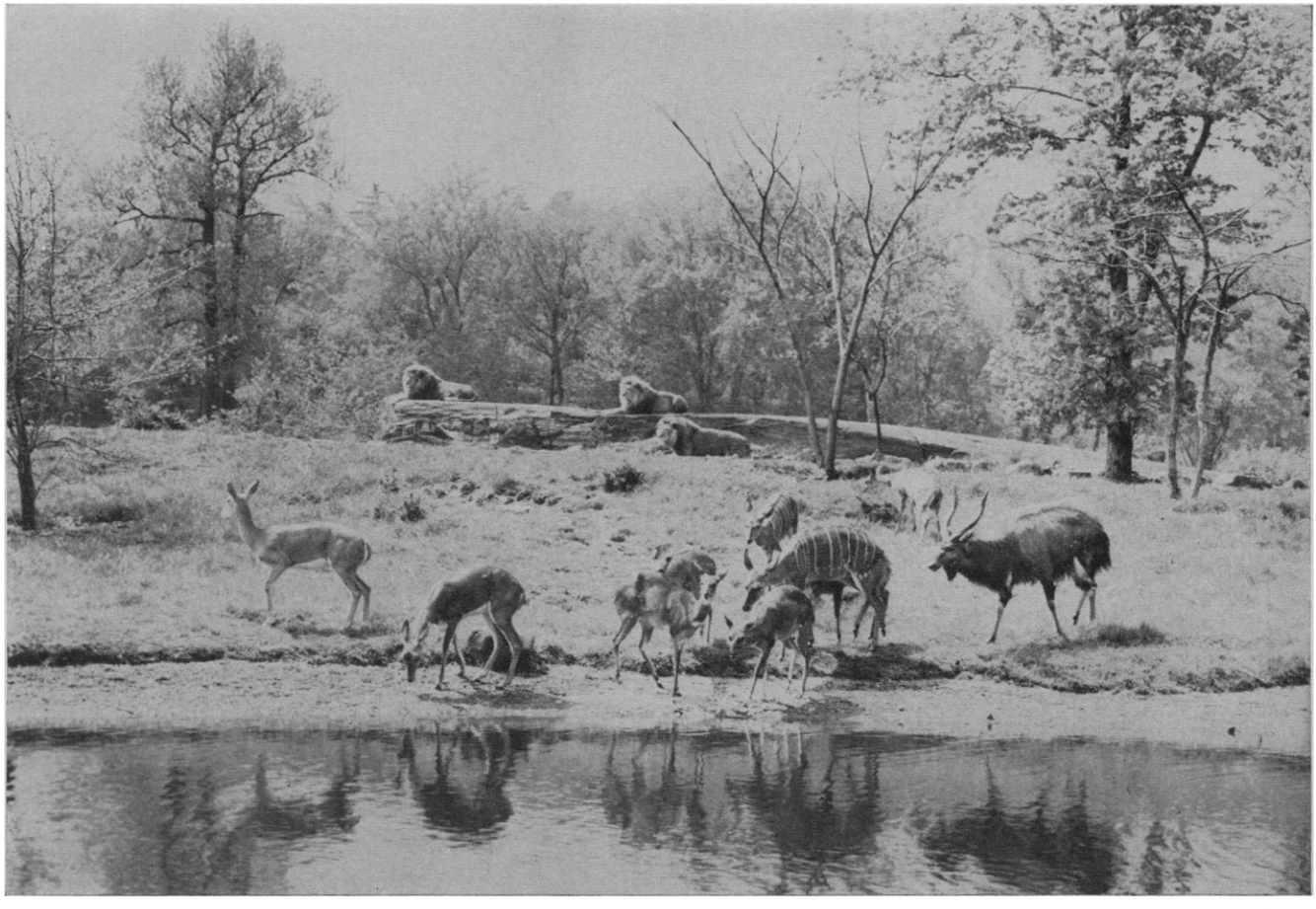

Fig. 1. A modern moated exhibit of African antelopes and lions in adjacent enclosures at the New York Zoological Park.

tentially disastrous trade in bird plumage, and in the establishment of the American Bison Society, which eventually won protection for the bison and led to stocked bison refuges. But recently, and especially within the last decade, conservationists associated with zoos and captive collections have included some of the most prominent wildlife protectionists—men like Osborn of the New York Zoological Society, Grzimek of the Frankfurt Zoo, and the well-known aviculturists and ornithologists Delacour, Scott, and Ripley.

Nevertheless, zoos are frequently and inaccurately accused of depleting wildlife populations. Until the zoos' boycotts of orangutans (*Pongo pygmaeus*), first initiated in the United States in 1962, zoos did contribute to the precarious status of this species, but evidence is lacking to show that collecting by zoos has been of major importance to any other animal population, although zoos have also restricted their importations of giant tortoises and monkey-eating eagles. The problem lies elsewhere. The U.S. Department of the Interior reported importations for 1967 totaling 74,304 mammals (62,526 of which were primates largely for laboratory study), 203,189 birds, 405,134 reptiles, 137,697 amphibians, and 27,759,332 fish (*3*). Zoos required not more than a fraction of 1 percent of this number, and, most alarmingly, the total number of live mammals and reptiles imported for the laboratory, pet, and zoo trade are but a fraction of the number represented by the trade in hides and animal products (*4*).

However, some critics feel that to cage any animal is immoral, and this strong antagonism against captivity, from well-intentioned persons who may give little thought to hunting or destruction of habitats, probably delayed the union of zoo-naturalists and the conservationists. The bond was inevitable, not only because of the zoos' obligatory interest in conservation, but also because several species have become so rare that they would not exist were it not for zoos. The zoos and other captive collections can act as reservoirs for the preservation of certain species which may even be reintroduced in newly protected parks in their native lands at some time in the future. The Pere David deer (*Elaphurus davidianus*), the Przewalski horse (*Equus przewalski*), the wisent (*Bison bonasus*), the Hawaiian goose (*Branta sandvicensis*), the Laysan teal (*Anas platyrhynchos laysanensis*), and the Swinhoe pheasant (*Lophura swinhoei*) are prominent among endangered species which have benefited from captive management.

The Pere David deer is thought to have been a resident of the plains of northeastern China; however, the last of the species in China died in 1921 leaving its fate with a single captive herd which the Duke of Bedford had gathered from European zoos and placed on his estate, Woburn Abbey, in 1898. Bedford obtained only 18 of these great ungainly deer but, by World War I, his herd had increased to 88. Only 50 survived the privations of the war (*5*) but by 1948 the herd numbered 300 (*6*). The 1967 census of the *International Zoo Yearbook* (*7*) lists 452 animals in 46 collections. Two hundred sixty-five of this number were still at Woburn Abbey, and four represent animals returned to China as a gift from the London Zoological Society to the Peking Zoo.

The last of the true wild horses, the Przewalski horse, once ranged through southwestern Mongolia and northeastern Sinkiang. In 1966 a sighting raised hopes for the survival of a few of these extremely rare and believed possibly extinct animals in the wild. Captive stocks in 33 zoos totaled 149 (*8*), and 14 colts were bred in that year. In this case, the surviving captive herd owes its existence to Carl Hagenbeck and to the zoological gardens in Prague and Munich. Hagenbeck sent an expedition to Mongolia that returned in 1901, after surmounting almost incredible difficulties, with 28 Przewalski horses. About 24 of the progeny of these animals survived World War II in the Prague and Munich zoos. From these two herds the present stock was established, and it is heartening to reflect that the number of horses has more than doubled during the past 7 years.

Still another dramatic instance of the successful captive breeding of an endangered species is the story of the wisent or European bison. Once widespread in European forests and perhaps in Siberia, this tall, rangy relative of the American bison was gradually diminished by destruction of forests and by hunting, until by 1900 it was largely confined to the Bialowieza Forest in eastern Poland and to the foothills of the Caucasus. World War I and its aftermath put an end to the wild populations which finally disappeared in the early 1920's. Fortunately, enough animals had been sent to zoos and bred so that the Bialowieza Forest could be restocked in 1929, and remnants of this reintroduced herd and scattered groups in zoos were still extant after World War II. Today the world stock numbers more than 300 in 64 zoos and in the forest reserve.

No significant captive stocks of endangered fish or amphibians are being bred in zoological parks, but the San Diego zoo has been notably successful with one famous reptile, the Galapagos tortoise (*Testudo elephantopus*), and successfully hatched 17 young tortoises from 1961 through 1965 (*9*). Birds have received less care than mammals, but important captive stocks of a surprising number of rare waterfowl and pheasants are being maintained in zoos and private collections. The Hawaiian goose has been bred in sufficient numbers to permit birds bred in captivity to be reintroduced with the wild population, and the Laysan teal, so rare 30 years ago that it was doubted whether more than 24 birds survived, has become common in collections. During 1967 and 1968, the Bureau of Sports Fisheries and Wildlife successfully reared whooping cranes from eggs taken in the wild and thereby raised new hopes for the captive propagation of this bird.

Current successes arouse curiosity about lost opportunities, and a review of the responsibilities that the last four centuries of extinction would have posed to modern collections of birds is instructive (*10*). I examined (*11*) the 162 extinct birds with captive propagation potentials in mind. Fifty-eight forms had characteristics or living relatives with characteristics which suggest that the possibility of breeding them in captivity, with modern methods, would be a good one. Species included in this list are among the most spectacular of vanished birds, for example, the elephant bird (*Aepyornis maximus*), the lesser moa (*Megalapteryx didinus*), and the dodo (*Raphus cucullatus*). Thirteen species, including the Carolina parakeet (*Conuropsis carolinensis*) and the passenger pigeon, both of which were bred in captivity, could readily be propagated at the present stage of avicultural technology. Twenty-seven forms had characteristics of groups which have not yielded to aviculture, and 64 species belonged to groups for which information is so scanty as to make any evaluation impractical. Of the 307 existing birds listed as rare by

the International Union for the Conservation of Nature and Natural Resources in 1965, useful information was available for 241. Of these, 101 are unsuited for captive management at this stage of propagation science. In this group, I include such species as the ivory-billed woodpecker (*Campephilus principalis*), the Atitlan grebe (*Podilymbus gigas*), the monkey-eating eagle (*Pithecophaga jefferyi*), and the pygmy swift (*Micropanyptila furcata*). A further 84 species show characteristics suggesting that they may have propagation potential, and 47 more are already being propagated or most certainly could be.

In the United States, accelerated interest in breeding of endangered forms in zoos resulted in the incorporation of the Wild Animal Propagation Trust under the aegis of the American Association of Zoological Parks and Aquariums in 1963. Formed to coordinate and promote the breeding of endangered animlas in captivity, the Wild Animal Propagation Trust is developing national breeding programs with especially important species and is receiving such remarkable cooperation in the case of the orangutan that it virtually controls all movement and pairing of these animals in zoos in the United States. However, obtaining animals—even those scheduled for propagation — sometimes poses technical problems.

The zoo is often dealing with creatures subject to stringent regulations by the United States Public Health Service and the Department of Agriculture. In order to import an ungulate, such as an antelope or a giraffe, it is necessary for the zoo to obtain special permits and to reserve quarantine space, usually at the Quarantine Station of the Department of Agriculture in Clifton, New Jersey, and at certain approved quarantine stations abroad. The prospective exhibit must be confined 60 days in a foreign quarantine station and then must spend 30 days in Clifton as a precaution against introducing such diseases as rinderpest and foot-and-mouth disease. Gallinaceous birds, waterfowl, doves, pigeons, and parrots are also subject to various quarantine regulations, but, in the case of the hoofed animal, the specimen must remain in a state of "permanent post-entry quarantine" throughout its life, and upon death the body must be disposed of in an approved manner. Fewer than 50 American zoos have been approved for the importation of ungulates. Because the United States Department of Agriculture adheres to a policy of eradicating disease by slaughtering animals, in American zoos there is a constant fear of an outbreak of foot-and-mouth disease that might mean the destruction of major herds of vanishing animals.

Potential for Research

To zoologists unfamiliar with animal keeping and heavily attended zoos, the zoological park may seem a natural research facility; however, there are serious problems to be overcome. Recent developments suggest that obstacles to research at zoos are now being solved.

Although many European zoological parks have conducted regular, if modest, scientific programs since their inception, in the United States only the New York and Philadelphia zoological societies have a long history of scientific inquiry. Jarvis (*12*) once suggested that it was " . . . quite extraordinary that, whereas collections of dead animals should be generally accepted as scientifically valuable, so few people have ever realized the huge scientific potential of a collection of living animals." One obstacle to research in zoos has been inadequate scientific staffs.

Usually, American zoos cannot afford to hire scientific curators without primary duties in the maintenance and exhibition of the collection. Modern labor practices have further complicated the curator's job. The 5-day week combined with ever more generous leave policies make it difficult to provide 7-day-a-week care for animals, and zoos are situated in a city environment where it is especially difficult to find potential keepers with experience in caring for animals. There is little likelihood that machines will replace human caretakers in zoos, because the care of complex living exhibits requires responsive unprogrammed maintenance from intelligent people. Because the management of wild animals is often poorly understood, the zoo curator finds himself committed professionally and morally to applying his skills to the development programs for the care of animals. Indeed, the successful acclimatization and breeding of a difficult species comprise a major professional goal. The need to improve the exhibition and health of the living collections, combined with substantial administrative and public educational responsibilities, leaves the curator with little time for basic research.

A more direct obstacle to research is that zoos rarely have sufficient numbers of any one species to constitute a scientific sample. Because animals may require years to become acclimatized, and because of possible public indignation, programs involving surgical manipulation of captive animals have been eschewed at zoos. Only certain kinds of behavior are available to the scientist working at a zoo, even in the best planned captive exhibits. Nevertheless, captive animals have too much to tell about man's evolution, behavior, and disease for large living collections in the heart of our urban educational and research centers to be ignored. Conditons at the zoo lend an intimacy and consistency to animal observation usually unparalleled in the field. While not all of a species normal behavior can be observed in captivity (or is likely to be observed in the wild), the captive's reduction of flight distance (*13*), and inurement to observers outside his enclosure are partial compensations. Subjects from a zoo can be of known age, weight, sex, and parentage yet available within a far less restricting confinement than is usually practical in the laboratory. At the zoo an animal may be studied conveniently and can be tested in ways and with equipment impossible to use in the wild; even the animal's parasites and food intake may be measured without endangering other observations. Although surgical manipulation of wild animals has not yet won wide acceptability, advances in techniques for restraining wild animals and in anesthesiology promise to open unique opportunities for experimentation that will be less traumatic.

Naturally, a major attraction of the zoo for scientists is the availability of unusual subjects. Elephants, hummingbirds, hellbenders, and monitors may each offer an as yet unrealized opportunity for species-specific research. The zoo staff's experience with little-known creatures and their care is an especial lure for the scientist who knows little of animal care, but the good health and adjustment of the acclimated zoo animal in its captive environment are even more important.

Today, there are promising scientific developments at several large zoos in the form of more or less independent research institutes. The biologists in an institue connected with a zoo may have

few, if any, responsibilities for exhibits, yet they can benefit from the stimulus of the living collection and from association with experienced curators. The curators and, ultimately, the collection can be benefited as well, for the investigator who concentrates on one or two species, or on a particular aspect of the biology of several species, is likely to develop information on management of captives that the diffuse curatorial efforts might never reveal. There are several pace-setting examples of such semiautonomous institutes in the United States and in Great Britain.

The Penrose Institute, in the Philadelphia Zoo, was established in 1901. Directed by H. L. Ratcliffe, the institute is generally concerned with studies in pathology and has been especially concerned with tuberculosis and nutrition. While the zoo has provided much material for the institute's work, the institute has aided the zoo's programs in animal care and nutrition. Two comparable efforts at the London Zoo are the Nuffield Institute of Comparative Medicine, started in 1962, and the Wellcome Institute of Comparative Physiology, which began in 1965. At these organizations, housed in impressively modern zoo laboratories, but including associates at various universities, infectious diseases, pharmacology, radiology, biochemistry, surgery, and reproductive physiology are being studied. In California, the Zoological Society of San Diego recently established an Institute for Comparative Biology under the direction of C. York, and work is proceeding in several fields including comparative primate behavior, general physiology and pathology, comparative neurophysiology, toxicology, biochemistry, and hematology (*14*). The New York Zoological Society is developing a still different kind of research institute. The society and the Rockefeller University joined forces to create an Institute for Research in Animal Behavior under the direction of D. R. Griffin. This cooperative effort, which may well be a model for future relations between zoos and universities includes facilities at both zoo and university and includes the New York Zoological Society William Beebe Tropical Research Station in Trinidad. Staff appointments carry appropriate titles within society and university and there is a cost-sharing plan. The work and goals of the institute were described by Penney (*15*). Additional cooperative programs exist in several cities including Oklahoma City, St. Louis, Chicago, and Portland, Oregon, and a promising program in behavioral biology has been started by J. Eisenberg at the National Zoo in Washington.

The zoo, perhaps, is most easily utilized for comparative studies on a broad spectrum of species; its special facilities can provide an important supplement for intensive field investigations of a particular species and can suggest new approaches to old problems. The biologist familiar with marsupial reproduction finds mammals available for observation at an extraordinarily early stage. The giraffe watcher may wonder how this walking scaffold avoids a stroke when he lowers his head 18 feet in one swift movement. The viewer of the vulture may be moved to determine why his subjects do not die of food poisoning, while the geneticist may learn of the opportunities presented by the armadillo's polyembryony or the parthenogenetic success of certain *Lacerta* and *Cnemidophorus* lizards. Navigation may be studied in experiments with birds which migrate over trackless oceans at night, echolocation with bats, and learning and transmission of song patterns in birds can compete for the investigators' attention with the problem of animal play and the evolution of facial expression. Unfortunately, it seems probable that investigation of a number of species will only be possible in the zoo for they will exist nowhere else.

Summary

The zoo's urban location, recent changes in concepts, and improvements in technology have come at a time when environmental education requires much attention. As an urban institution and a resource of diminishing wild creatures, the zoo seems destined to fulfill an increasingly important role in education, conservation, and research.

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