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Integrating Animal Behavior and Exhibit Design

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VISITORS AND WINDS OF CHANGE IN MAMMAL EXHIBITION

Animal exhibits are the heart and soul of the zoo. As in a museum, a zoo's primary educational tool is the exhibit. The essential difference is that in the zoo, the "objects" exhibited are living, breathing, feeding, defecating, and sometimes reproducing. The maintenance of a zoo's exhibition programs is complicated by the requirements of these living "objects." While zoos have continued to seek improvements in the care of animals maintained in exhibits, more recently animal management has been driven by the animal welfare expectations of an increasingly demanding public (Holden 1988). It is not surprising, then, that zoo research programs are being driven by the requirements of the animals, especially mammals, kept in confinement on public view. In a large measure, the future of zoos as credible educational institutions for the general public will depend on the strength of this research and the successful implementation of the animal management plans that result.

The presence of visitors vastly complicates animal exhibition as compared with the management of mammals maintained in other confined environments. Visitor presence can influence the behavior of animals living in exhibit spaces (Glatston et al. 1984; Jordan and Burghardt 1986; Chamove, Hosey, and Schaetzel 1988; Thompson 1989; Baldwin 1992; Carlstead 1991). Visitors come to zoos and view animal exhibits with varied expectations; these expectations have been shaped by changes in our values and perceptions of animals and conservation since the decades following World War II.

Visitors coming to zoos today live in an increasingly urbanized society, with little direct contact with agriculture and farm animals and with shrinking opportunities to live in and experience wilderness (Conway 1969). In many urban settings and for many visitors, zoo animals are as close as they can get to the real thing. The utility of animals is not a predominant interest for these visitors. Rather, animals living in zoos can evoke strong feelings in visitors about animals they have loved and lost, including pets and backyard acquaintances; about animals they have heard about or glimpsed occasionally but do not understand (bats, for example); about familiar animals they have been able to recognize since childhood but really know little about (lions, tigers, bears, elephants); and about other wonderful animals from far-off, exotic lands. We cannot ignore the fact that, for some zoo visitors, zoo animals evoke images of themselves, friends and acquaintances, and their own life experiences (e.g., Fulghum 1989, 159–161). Their perceptions of animals come primarily from television, where most programs present animals inaccurately and often anthropomorphically. Also, most animals on television are "free" and not "imprisoned" in zoos.

Kellert's (1976) surveys of perceptions of animals in American society revealed that zoo enthusiasts were very moralistic in their attitudes toward the treatment of animals. "Zoo enthusiasts, for example, strongly objected to rodeos, killing animals for fur, and utilitarian exploitation of animals. This group also revealed strong humanistic attitudes and, somewhat surprisingly, were not particularly naturalistic or ecologistic in their attitudes toward animals . . ." (544). A humanistic attitude is distinguished by a strong personal affection for individual animals. The most striking feature of the moralistic attitude is its great concern for the welfare of animals based on ethical principles opposing exploitation and the infliction of any harm. Fifty-five percent of the United States population is estimated to be strongly oriented toward these moralistic and humanistic attitudes (Kellert 1989).

Increasing urbanization in the United States, coupled with an increase in leisure time following World War II, has propelled a rising interest in the quality of life. Interest in conventional conservation, that is, concern for the efficient and wise use of resources, has turned into a concern for and interest in the environment. Environmental quality has become an integral part of our search for better health and a higher standard of living (Hays 1987). These concerns are mirrored in the evolution of some zoo exhibits and exhibition strategies. Zoo visitors, supporters, and critics now demand better environments, better health, and higher standards of living for the animals maintained in exhibits and in confinement generally.

The new exhibition programs, with roots in the environmental movement, foster biological and conservation literacy. The concepts of natural cycles, biological diversity, carrying capacity, ecosystems, stressed ecosystems, global change, and endangered species have become central in animal exhibition themes and fuel many zoo programs.

WHAT STORIES DO EXHIBITS TELL?

Animal exhibits communicate messages or "stories" to zoo visitors, as is masterfully discussed by Coe (1985; see also Coe, chap. 16, this volume). Curators and designers can plan the message and measure the efficacy of the presentation. Or they can muddle through. Indeed, muddling through in developing exhibits has many virtues, as we describe below, as long as there is a conscious choice of a message and the objective of the exhibit's story line is formulated in advance. Unfortunately, failure to recognize what is being communicated by animals in exhibits has been an oft-repeated folly.

Zoos may have fine mammal collections and significant research and conservation programs, but if the visitor experience consists of exhibits that appear empty, or exhibited animals that appear to visitors to be uncomfortable or stressed in some way, the take-home message is just that: "We didn't see anything." "Something is wrong with that animal." "The zoo doesn't care about the animals." If this is the case, the zoo has obviously lost its opportunity to promote positive changes in knowledge, attitudes, awareness, and actions toward wildlife. Associated interpretative materials will not and cannot retrieve this lost opportunity.

The Victorian zoological garden sought to present "the animal" as a simple display of a beautiful, interesting, or unusual object to the visitor. In this respect, zoos differed little from museums. There has been, however, a revolution in zoo animal exhibition with a de-emphasis on animals as objects and an increased emphasis on *animals engaged in natural behaviors,* living in natural or naturalistic environments (table 18.1) and seeming to be at home in the exhibit space (Hediger 1970; Hutchins, Hancocks, and Crockett 1984; Forthman-Quick 1984; Greene 1987). Zoo exhibits are windows to real animals doing real things, although at a somewhat reduced scale. Exhibits that appear to place the wild animal and the zoo visitor together in the same habitat—landscape immersion—are attempts to break down the visitors' sense of security by reminding them that wild animals are really wild (Greene 1987). Robinson (1988) has taken the point further, by stressing the "inextricable links between plants and animals" (630), so that the visitor comes away with a recognition of the interdependence of biological systems.

Animals and their behavior are the subject of this chapter and our focus in animal exhibition. For us, the message of animals in zoos today is the experience of ecology and behavior they provide for visitors (see Lueders 1989). Animals in zoos can help visitors gain perspective on the world and their place in it. We should be trying to get the visitor to look hard at animals. As Ann Zwinger (1989) has stressed, once you really look at an animal and see it, ask questions about it, get an answer, and learn something about it, it becomes yours. "And once it becomes yours, you'll never destroy it . . ." (Zwinger 1989, 72).

TABLE 18.1. Polakowski's Definitions for "Natural" Zoo Exhibit Habitats

Exhibit Type	Definition
Realistic Natural Habitat	Reproduces the real habitat in general appearance, land formation, plant life, and animal activity.
Modified Natural Habitat	Uses the elements of the real habitat but substitutes plants and trees, uses existing or modified land forms, and integrates the habitat into the existing surroundings.
Naturalistic Habitat	Makes little or no attempt to duplicate elements of the real habitat. Involves a stylistic use of natural materials. Often the main purpose is to decorate the space.

Source: Polakowski 1987, 90.

Conway's (1968) "How to Exhibit a Bullfrog" is a metaphor of what the exhibition of animals might be and what we should be trying to accomplish with the exhibition of animals.

THE ANATOMY OF ANIMAL EXHIBITION

One of us (J.S.) recently served as an advisor for a well-known zoological park in the design of a new exhibit complex for jaguars, *Panthera onca.* The designers were working to obtain for the visitor a visual image of a jaguar lying on a log in the sun at the edge of a tropical river backwater. Think of the beautiful Coheleach (1982, 63) painting or that classic photograph of a jaguar in Perry (1970, 123). The space allotted for this was less than 300 square feet, and the designers were insistent that this was adequate; the design for the complex had also proceeded too far to allocate more space.

From studies conducted with carnivores living in exhibit spaces at the National Zoological Park (Carlstead, Seidensticker, and Baldwin 1991; Baldwin 1992; Carlstead, Brown, and Seidensticker 1993), we predicted that this exhibit, because of its small size, would produce excessive stereotypic behaviors in the jaguar maintained in that space. Visitors, rather than being thrilled, inspired, and learning something about jaguars, would take home a negative message: a big cat in a beautiful but too small cage alone, and obviously not comfortable.

The point is that exhibited animals are not objects, and they are not static. However, zoo professionals have available only a very small data base with which to make judgments concerning the welfare of animals in confined environments. This frequently puts curators in a difficult position in discussions with designers and architects of new exhibits, and creates conflict. The animal person "knows" there may be a problem, but has little in the way of empirical evidence to support those concerns.

Analyzing successful, as well as unsuccessful, mammal exhibits is an essential undertaking in building more successful exhibits. Even with the growing literature on zoo exhibit design, there is little information on exhibits that have been perceived as less than successful, or as actual failures. This complicates the analysis of those elements that have contributed to the creation of successful exhibits and those that have not worked (Petroski 1985). Indeed, there is also no well-established "industry standard" or objective criteria by which to judge an exhibit a success, a failure, or in need of help.

Animal Management Models

In our experience, there are four animal exhibition/management/research models under which zoos now operate (S. Lumpkin and J. Seidensticker, unpub.), with considerable tension among their proponents. In practice, none is purely applied.

The *zoo exhibit animal management model* is one inherited from the past and can be summarized by the phrase "Zoos are for people." For a very long time, animal management and exhibit design meant little more than holding a wild beast in an enclosure, usually a small cage or pit, and feeding it whatever it could live on that was cheap and available. Painting backdrops on cage walls, using glass rather than wire or bars, or adding cage decorations enhanced visitor perceptions, but did not change the basic model. This model is exemplified by the jaguar in the example above. The animal, not its behavior, is considered the focus.

The *ethological animal management model* can be summarized as "Zoos are for wild animal species that move and do things." Ethology is the study of whole patterns of animal behavior in natural environments, stressing evolutionary adaptations. The essential premise of this model is that zoo animals should be managed so that their lives differ as little from those of their wild conspecifics as possible. In other words, zoo managers should try to duplicate or simulate the species' spatial, social, and environmental requirements and challenges. This model's most influential early spokesperson was Hediger (1950, 1955, 1970). The ethological model does not demand that the animal's environment in confinement *look* naturalistic or that animals be allowed to manage their own affairs, only that the effects be like those in nature. For example, the replacement of the males in a lion, *Panthera leo,* pride can be a bloody affair in the wild (Schaller 1972). Introductions can be managed in a zoo setting that are not traumatic and that still result in stable social groups. The idea that the animal's environment should look naturalistic is a later innovation (Hutchins, Hancocks, and Crockett 1984).

The ethological management model is a problem-solving approach. Thus, if a species does not breed in confinement, this model assumes that changes in the captive social or physical environment to make it more like that in the wild would promote breeding. When it became apparent that inbreeding in the zoo setting was causing serious harm, breeding management plans were developed to mimic natural mating systems more closely.

The ethological model is best elucidated by comparing it with the medical model described next: the ethological model might prescribe quiet isolation for a nervous pregnant female with a history of maternal neglect that is about to give birth, since parturient females in the wild seek solitude, while the medical model might prescribe tranquilizers and prepare a plan for removing and hand-rearing the young.

The *medical animal management model* predates the ethological model and is responsible for many advances in zoo animal care and husbandry, including standards for sanitation, nutrition, and preventive medical care. The medical model stresses the reduction of environment complexity to make the captive environment cleaner and safer and to give managers greater control over the health of the animal. The medical animal management model emphasizes direct human technological intervention rather than approximating the wild condition: it fixes the animal so it can adjust to the conditions of confinement rather than fixing the conditions of confinement.

The use of techniques for "assisted" reproduction is a manifestation of the medical management model. Up to now, these techniques have generally been used when the application of ethological management, at its current state of knowledge, has not worked or has not been tried to improve captive propagation of a particular species.

The *humane animal management model* assumes that zoos are welfare states that take care of individual animals from cradle to grave. This management model is equally unconcerned with the zoo visitor and with animal populations or species as a whole. Rather, individual animals are managed like house pets, and somewhat anthropocentric assumptions are made about what animals need in order to be "happy" in confinement. This model demands intensive health care for animals, but generally is opposed to any invasive research that might cause temporary stress or pain, even in the interest of advancing medical care for the species.

This model is sympathetic to many aspects of ethological management but not to any ethologically related practices that might be perceived as potentially injurious or stressful to individual animals. This stance can lead to protectiveness of individuals that interferes with the animals' displaying behaviors required for normal social interactions or reproduction. The humane animal management model also dictates that animals can choose whether they want to be on exhibit or off, a choice that confounds exhibition strategies.

The Zoo and the Animal Exhibition System

Successful and improved exhibition of mammals, in our view, can be developed through a multifactorial perspective. This is by no means a novel idea. We present a diagram of the "animal exhibition system" in the wider zoo system in figure 18.1.

As important and central as successful animal exhibition is in zoos, it is, of course, only a part of a zoo's overall operations. There are four interdependent components that together constitute what we term "the animal exhibition system": (1) the zoo visitor looking at the exhibit; (2) the animals the zoo visitor sees in that exhibit and what those animals are doing; (3) the exhibit space, including the aesthetics of that space and how the space controls the presentation of the animals; and (4) the husbandry system that is responsible for the care of the animals. What the visitor sees

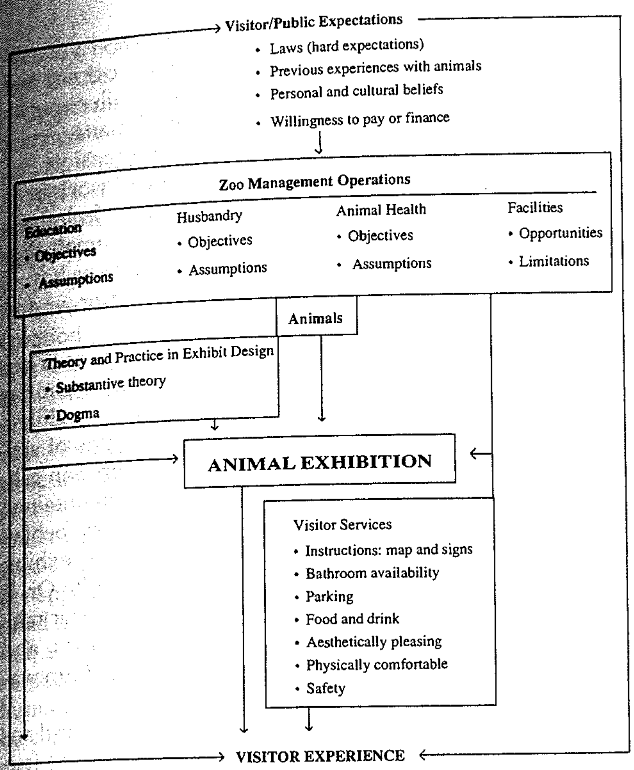

FIG. 18.1. The animal exhibition system in the context of the wider zoo. What the visitor sees in an exhibit is only part of the visitor experience. The curator's responsibility and the zoo's obligation is to enable the visitor to see animals engaged in natural behaviors.

in an exhibit is only part of the visitor experience; the zoo visitor's experience may be largely influenced by variables that are outside and beyond the control of the animal exhibition system (figure 18.1).

When someone makes a decision to visit the zoo, that person is usually already highly motivated. Once at the zoo, the visitor's expectations are strongly influenced by a hierarchy of needs: physiological needs, safety needs, social needs, and needs for self-esteem, self-actualization, and creativity. Unpleasant encounters with excessive trash, dirty bathrooms, poor directional signs, and failure to see animals that were expected can lead to great disappointment, or what can be termed "cognitive dissonance": a situation in which a person experiences something that was neither expected nor desired (Massie 1979). Curators have a very important stake in encouraging excellence in those programs that strongly influence the visitor experience.

Zoo designers can use cognitive dissonance in a positive way by devising means to "grab" zoo visitors, raise the hair on the backs of their necks, and give them a real jolt with exhibits based on landscape-immersion techniques (Coe 1985; Greene 1987).

Research and Animal Exhibition

How should research on the exhibition of mammals proceed to find the right mix of elements from the four management models so as to optimize conditions for both visitors and animals? One can begin with questions deriving from the four components of the animal exhibition system: the visitors, the animals and activities that the zoo visitor sees in the exhibit, the exhibit space, and the care of the animals on exhibit by animal keepers.

Questions about zoo visitors:
- What and how do animal exhibits communicate to the zoo visitor?
- What do zoo visitors do and want to do at the zoo?

Questions about the animals and the exhibit space:
- What is a suitable exhibit space to feature the animal's behavior?
- What are the sources of stress to animals living in exhibits, and how does this stress affect them behaviorally and physiologically?

Questions about care and the animal keepers:
- What changes in animal management procedures can be implemented to promote excellence in animal exhibition?

These questions emphasize action on two levels: (1) increased research to understand the animal exhibition system, and (2) increased use of opportunities to implement improvements in the animal exhibition system. It is no surprise to zoo researchers that so often their findings are only slowly or never implemented, as this gap between research findings and practice exists in the management of most natural resources.

Difficulty in applying new substantive findings comes from the lack of a linkage between those who make the discoveries and those who care for the animals daily or who design exhibits. This linkage can be forged by developing husbandry protocols that are jointly authored by researcher and animal management and keeper staff, protocols that seek to meet articulated and agreed-upon objectives. Performance plans for researchers, managers, and keeper staff can contain statements to this effect. In our view, the essential linkage lies in establishing exhibition objectives.

Setting Exhibition Objectives

"It was Fauna's conviction, born out of long experience, that most people, one, did not know what they wanted; two, did not know how to go about getting it; and three, didn't know when they had it . . ." (Steinbeck 1954, 116). So it is with opportunities and constraints in establishing and meeting objectives for animal exhibits.

Should animal exhibition objectives be framed largely as an exercise in consumer (visitor) satisfaction, as visitor education, or in terms of the activity of the animals themselves? While obviously related, these questions address different dimensions of the zoo management system.

Consumer or visitor satisfaction objectives have their origins in economics. We can think of the yield of an exhibit, or a cluster of exhibits (or even the entire zoo experience) in terms of social benefits and aesthetic value, which can be measured in dollars. Most zoo visitors, as do most opera audiences, partake of an aesthetic experience and are willing to pay for it. Persons who dislike crowds, for example, or who are not satisfied with exhibit styles, or with the animals they see or do not see, simply would not be willing to pay again for that experience. Other visitors, however, might not care about crowding and might return again and again.

The aesthetic experience the former visitors have might not be less, but might differ qualitatively.

Managers establishing objectives usually seek to balance the total number of visitors in attendance, or rate of visitor attendance per day or per hour, or to maintain a sustained flow of visitation throughout the day or through the seasons. Value from a group of exhibits might be better maximized by providing opportunities to satisfy visitors of both low and high tolerance to visitor crowding. The consumer or economic perspective can also be used when seeking financial support from an expanded constituency, for example, by comparing zoos with professional sporting events or other forms of outdoor recreation and informal education.

Objectives concerning the effect of an exhibit on knowledge acquisition, attitude change, and subsequent visitor behavior originate from an expansion of zoos' concerns from entertainment to education and conservation. A good recent example of setting objectives and follow-up monitoring involves the African Rock Kopje exhibit at the San Diego Zoo. As Derwin and Piper (1988) explain, "The broad goal of the exhibit was to communicate the concept and beauty of the interdependent ecosystem and to increase the knowledge and appreciation of wildlife in people of all ages" (438).

An exhibit complex may have both cognitive (intellectual) and affective objectives (Shettel 1989). Among the cognitive objectives for the African Rock Kopje exhibit were that visitors be able to describe the kopje as an ecosystem, identify the secret life that makes the kopje a viable environment, and describe the physical or behavioral adaptations to the kopje of the hyrax, *Procavia capensis,* klipspringer, *Oreotragus oreotragus,* and pancake tortoise, *Malacochersus tornieri,* and explain these adaptations' survival value. "Affective objectives included requirements that visitors speak of and behave toward plants and animals with respect, express appreciation for nature and wildlife, and support conservation efforts when given the opportunity . . ." (Derwin and Piper 1988, 439).

Monitoring of visitors leaving the kopje exhibit revealed that they were unable to answer the cognitive questions if they had not read the interpretive signs. Interactive elements significantly helped cognitive recall. Younger visitors were more likely to use interpretive elements than to read panels; older visitors were more likely to read panels (Derwin and Piper 1988).

A major problem in defining objectives for informal learning in zoos is how little we know about what actually happens in zoos in terms of knowledge acquisition, or how that is influenced by levels of exhibit naturalism, conservation information, and interactive learning opportunities (S. Kellert, pers. comm., 1987). We cannot yet measure progress or the effect of zoo programs on informal learning. However, this is presently a major area of research in zoos (and other informal learning centers): we seek to understand learning styles in different people, how these change with age, and how to utilize this understanding in the presentation of animals and ancillary materials. We suspect that there are many lessons for us in the world of advertising. Morgan and Gramann (1989) provide a useful introduction to this topic.

The third dimension in establishing objectives in the exhibition of animals is the animals. What they are doing and how they are presented to the visitor are often influenced by the tensions generated among the four animal management models described above. To move beyond these tensions, we need to establish the following propositions and work from them: (1) what zoo visitors learn and how they feel about their visit to the zoo are strongly related to the animals they see and what these animals are doing, and (2) zoos have a vital concern and obligation to seek ways to improve zoo visitors' animal-viewing experience.

Such propositions may seem trivial, self-evident. They are not. Rather, they establish a base for evaluating and for proposing improvements in exhibits. Objectives for exhibits and exhibit operations can be formulated in terms of animals and what those animals are doing. Curators can ask, for example: Can visitors always see the animals maintained on exhibit? What are those animals doing? Are they behaving in the ways we want and expect them to in exhibit spaces? If not, what is wrong, and how can we fix it? Or, if an exhibit works, why does it work, and what does it take to keep it working? These are operational questions, and from these objectives, routines, improvements, and innovations can be established.

The pitfall in animal exhibition is that exhibition and ancillary activities such as interpretive programs are too often viewed *as an activity and not as a result.* The "consumer" is the visitor, not the animals, or the exhibit, or the interpretive programs themselves. The challenge is to define aggressively the results desired, and then monitor to see that they are achieved.

"DADDY, WHERE ARE THE ELEPHANTS?"

There are probably no more than a dozen of the approximately 4,000 mammal species that are recognized by the vast majority of people no matter where they live or what languages they speak. Most people, if ever exposed to them, remember to name elephants, lions, tigers, bears, giant pandas, and "monkeys." Indeed, the first exposition of a large exotic animal in North America was a lion in 1720; the first dromedary camel, *Camelus dromedarius,* was exhibited in 1721, the first orangutan, *Pongo pygmaeus,* in 1789, and the first Indian elephant, *Elephas maximus,* in 1796 (Vail 1934). These animals are nearly always included in zoo exhibition programs. Why are some animals favorites of zoo visitors and others ignored?

Public Preference and Perception

Kellert (1989), in a national (United States) survey, found the most-liked animals to be the dog, horse, swan, robin, butterfly, trout, salmon, eagle, elephant, turtle, cat, ladybug, and raccoon; the least-liked included the cockroach, mosquito, rat, wasp, rattlesnake, bat, vulture, shark, lizard, crow, coyote, and wolf. Note that the most preferred species were the dog and horse; the most preferred wild mammal was the elephant. Morris and Morris (1966, 200), based on a mail survey solicited over British television, found the top ten animal favorites among children to be the chimpanzee, monkey, horse, bushbaby, panda, bear, elephant, lion, dog, and giraffe.

Important factors in these human preferences have been investigated by Morris and Morris (1966), Kellert (1989), and Kaplan and Kaplan (1989), among others (see Hoage 1989). Kellert (1989, 22) found the following factors to be important in public preferences for different species: "size (usually, the larger the animal, the more preferred); aesthetics (considered 'attractive'); intelligence (thought not only to have the capacity for reason but also for feelings and emotion); danger to humans; likelihood of inflicting property damage; phylogenetic relatedness to humans; cultural and historical relationship to humans; relationship to human society (pet, domestic farm animals, game, pest, native wildlife, exotic wildlife); texture (body appearance and structure; generally, the more unfamiliar to humans, the less preferred); mode of locomotion (generally, the more unfamiliar to humans, the less preferred); economic value of the species to humans." Morris and Morris (1966) examined the appeal that giant pandas have for zoo visitors and identified the following elements: flat face; large eyes; little or no tail; sits up vertically; can manipulate small objects; killer turned nonkiller; apparently harmless and friendly toward human beings; sexless; playful; appears clumsy; appears to be very soft; outline is rounded; is black-and-white; is a giant; has an easy name; has a historical precursor (teddy bear); is rare; comes from a remote and mysterious habitat; has a strange history of discovery; and is immensely valuable.

"Perhaps the greatest challenge confronting a wildlife educator is to encourage people to see animals 'as animals'—that is, without prejudice or preconceived notions or anthropomorphic projections . . ." (Hoage 1989, xiii). In our view, this is the major educational goal for zoos.

Active Animals and Visitor Viewing Opportunities

Like the management of all natural resource systems, the management of the animal exhibition system operates within biological, socioeconomic, and technological constraints. The manager's constant challenge is to understand these constraints and, within them, identify opportunities for change and improvement. For example, a common exhibition strategy in North America is to feature local, medium-sized mammals such as raccoons, *Procyon lotor,* or Virginia opossums, *Didelphis virginiana.* These animals are readily available and are usually inexpensive to obtain and maintain. We know that visitors value that with which they are familiar. The technology of producing exhibit spaces for these animals usually is not complicated. However, most medium-sized North American mammals are nocturnal and/or crepuscular in their activity and, when not active, retire to the protection of burrows. That is a biological constraint, and no amount of ancillary interpretative material will fix it. Nor can one design an exhibit to rectify this fact of life.

It is not surprising that large or active or "social" animals engage zoo visitors' attention longer than small or inactive animals. Bitgood, Patterson, and Benefield (1986) have defined eight factors that influence visitor behavior at zoo exhibits in terms of "attracting power"—the percentage of passersby who stop to view an exhibit—and "holding power"—the length of time that visitors stop and look at the exhibit. Holding power is correlated with animal motion, animal size, visitor participation, the presence of an animal infant, and ease of viewability. Attracting power is directly related to visitors' perceptions of the species' characteristics—perceived dangerousness and attractiveness are examples—and inversely related to the number of visually competing stimuli. Attracting and holding power both depend on visitor fatigue, satiation, and placement of exits.

An understanding of visitor perception and behavior at zoos is beginning to be included in exhibit design. Beautiful exhibits without animals are not what zoos are about. In our view, a reasonable objective is that visitors have a 90–95% chance of seeing an animal in an exhibit space engaged in natural behaviors. To accomplish this there must be a correct match between the animal's characteristics, the animal's needs, the exhibit space, and animal management procedures.

WONDERFUL ANIMALS DOING INTERESTING THINGS

Grant Jones (1982) has set out the principles for getting it right for the visitor, particularly as this can be accomplished through landscape immersion techniques (appendix 18.1). The curator's responsibility is selecting and getting it right for the animal. There are six variables (modified from Burghardt 1975) that are directly linked to wonderful animals doing interesting things in animal exhibits: (1) the animal keepers and their presentation to and interaction with the exhibit animals, (2) animal management procedures, (3) the actual physical characteristics of the exhibit space, (4) the environment (temperature, sun/shade, wind, etc.) in the exhibit space, (5) visitor numbers and their presentation to the animals, and (6) the animal species selected for exhibition and the characteristics of those species.

Matching Exhibit Spaces and Animal Needs

Hediger (1970, 524) characterized facilities for keeping animals in zoos as either "kennels" or "territories." By kennels he meant "a jail-like narrow cage in which an animal, most frequently a single one, is kept by force and viewed in this situation as a living specimen. 'Territory' on the other hand means the natural division of space, with species-specific habitat organization for the use of an animal or of a social unit of animals." A reading of Hediger (1950) is a necessary start for anyone trying to move the exhibition of animals beyond a kennel mode into a territorial mode. Since Hediger proposed the use of the word "territory" in this way, the term has taken on a more restricted meaning as "an area occupied more or less exclusively by an animal or group of animals by means of repulsion through overt defense or advertisement" (Wilson 1975, 597). Hediger's point is that the old-style cages, or kennels—even if they had glass or wire fronts for public viewing and painted backdrops—were very little different from museum displays, "a kind of solid box in which the animal was housed as a living specimen until its death and it became ready for the museum. The

TABLE 18.2. Eisenberg's Feeding and Substrate Matrix for Mammals

	Fossorial	Semifossorial	Aquatic	Semiaquatic	Volant	Terrestrial	Scansorial	Arboreal
Piscivore and squid-eater	−	+	+	+	+	−	−	−
Carnivore	+	+	+	+	+	+	+	+
Nectarivore	−	−	−	−	+	−	+	+
Gummivore	−	−	−	−	−	−	+	+
Crustacivore and clam-eater	−	−	+	+	−	−	−	−
Myrmecophage	+	+	−	−	−	+	+	+
Aerial insectivore	−	−	−	−	+	−	−	−
Foliage-gleaning insectivore	−	−	−	−	+	−	−	−
Insectivore/omnivore	+	+	−	+	−	+	+	+
Frugivore/omnivore	+	+	−	+	+	+	+	+
Frugivore/grainivore	+	+	−	+	−	+	+	+
Frugivore/herbivore	+	+	−	+	−	+	+	+
Herbivore/browser	+	+	−	+	−	+	+	+
Herbivore/grazer	+	+	+	+	−	+	+	−
Planktivore	−	−	+	−	−	−	−	−
Sanguivore	−	−	−	−	+	−	−	−

Source: Eisenberg 1981, 248.
Note: +, species adapted for this substrate and dietary specialization exist in the class Mammalia; −, no mammals are adapted for this substrate and dietary specialization. (See Eisenberg 1981 for definitions of terms utilized here.)

death chambers of the menageries were, in a way, the anterooms or waiting rooms of the museums. . . . There really was not much difference in the manner of presentation: the living animal in its narrow cage was provided with food, the stuffed one with preservative" (Hediger 1970, 521).

Moving the exhibition of zoo mammals beyond the "anteroom" mode has become more viable and exciting with our expanding experience of animals living in the wild through field studies. Significant exhibit improvements cannot be achieved without reference to natural history studies of the species in the wild (Maple 1981; Hutchins, Hancocks, and Crockett 1984). We must give consideration to the following variables as outlined in *The Mammalian Radiations* (Eisenberg 1981): (1) body size of adults, (2) relative brain weight, (3) basic metabolic rate, (4) geographic range, (5) diet type, (6) prey size, (7) diversity of foods eaten, (8) food-finding strategy, (9) activity patterns, (10) substrate utilization, (11) vegetation or habitat type(s) utilized, (12) mating system, (13) rearing system, (14) foraging system, (15) refuging system, and (16) antipredator system. The usefulness of behavioral studies in the maintenance of wild mammals in confinement and in developing captive breeding programs cannot be overemphasized (Eisenberg and Kleiman 1977).

Eisenberg's concepts of the "macroniche" and the "behavioral system" are central to the process of selecting mammal species to exhibit and establishing environmentally appropriate exhibit spaces. In seeking modal strategies among mammals, Eisenberg (1981, 247) devised a means of classifying living mammals into categories according to their utilization of certain environmental substrates and dietary preferences. His resulting matrix includes 8 categories of adaptations for substrate utilization and 16 categories of modal tendencies in dietary specialization. Of 128 possible modal strategies that result from this matrix, Eisenberg concluded that mammals utilize 64, or half, of them (table 18.2). Activity cycles and fluctuations in body temperature that derive from energy conservation needs and antipredatory strategies are affected by these modal strategies.

In captivity, daily feeding schedules can synchronize many rhythmic behaviors in mammals and can also result in circadian rhythms similar to those of light-dark cycles (cited in Zielinski 1986). Food-entrained rhythms have been demonstrated for herbivorous and omnivorous species. Some carnivores hunt for foods that have daily rhythms of availability. While learning to anticipate food delivery time in the zoo, they remain nocturnally active and spend most of the day resting and sleeping (Zielinski 1986; Baldwin 1992).

The restricted daily feedings experienced by many zoo mammals can result in activity cycles consisting of active periods that anticipate food delivery followed by subsequent long rest periods. The adaptive significance or theory of entrainment matters little when one is attempting to improve a mammal exhibit. Food delivery schedules that improve visitor viewing opportunities are preferable. (We discuss other aspects of foraging behavior below.) For some species, changing nocturnal cycles to diurnal ones can never be achieved, and it may be best to reconsider the species selected for exhibition in the first place. Or in some cases, especially when there is a conservation commitment to a species, an exhibit strategy can be chosen that will balance an exhibit with high holding power (diurnally active, social animals) with one in which the mammals predictably will be less active.

Understanding these major niche dimensions—substrate, diet, and activity cycle—is the first step in moving mammal exhibition beyond the kennel. This knowledge can be used to select species for exhibition that will not spend their days in burrows or otherwise out of view. A review of the mammals will demonstrate that this is not an easy task for many groups.

Eisenberg (1981, 441) emphasizes that an animal's social life may be divided into behavioral phases, which should be identified and targeted in the exhibition of mammals. He also suggests that it is useful to treat the social organizations of the two sexes differently. It is usually not possible to optimize an exhibit space for all behavioral phases for both sexes except for mammals that live in stable mixed-sex social groups.

The exhibition of coatis, *Nasua narica,* can be used as an example. There is nothing natural or constructive in the exhibition of a pair of coatis. Males are mainly solitary and can pose a danger to young coatis. Females live in small bands consisting of females and offspring, joined only during the breeding season by males (see Russell 1981, 1983a, 1983b). Targeting of the behavioral system of the coati would focus on the foraging system, refuging system, and antipredator strategy of a female band or bands. (At the National Zoological Park we have been able to maintain two bands together in one exhibit space equipped with two dens.) The exhibit would not include mating or rearing unless the male was held in a separate area and seasonally introduced to the group.

A surprising number of "solitary" carnivores are maintained in zoo exhibits as male-female or same-sex pairs. For some species, this is simply wrong behaviorally: adults are never found together except briefly for mating. In others, siblings remain together for extended periods of time after dispersal, or resident adults might utilize the same refuging or foraging areas if they are restricted by limited or highly clumped resources. We must ask, What social group is being presented in the exhibit space? Is that grouping correct for the species? At what phase in its life cycle? How long does this social grouping endure? Have the visitors been so informed?

The refuging phase in the life of a mammal is extremely important as it relates to mammalian exhibits because many mammals spend a considerable time sleeping, hibernating or estivating, or overwintering. Eisenberg points out that refuging may be strongly phasic. For example, the rearing requirements for young may be unlike the conditions necessary for adult survival, and male and female refuging areas may be radically different. Even in species with a more or less permanent social life, a single refuging area may be spatially subdivided by the age and sex classes (Eisenberg 1981, 419).

Unfortunately, the natural history literature on refuging is nonexistent for most species or lacking in the details that might be useful. We have benefited by asking field-workers to describe the characteristics of the lay-up places where they find their radio-tagged animals and encouraging them to include this information in their published accounts. A reasonable objective and a real challenge in animal exhibition is that the animal be comfortable staying in the exhibit on public view.

There is a very small body of literature available on just what mammals do in their exhibit spaces (e.g., Byers 1977; Mahler 1984; Forthman-Quick and Pappas 1986; Blasetti et al. 1988; Baldwin 1992). The improvement of existing exhibits requires an attempt to understand how animals adapt to the confines in which they live. In other words, we must seek to analyze behavior patterns as phenotypic adaptations to local conditions: the conditions of the exhibit space. The first step is to document what animals do in their exhibits and where and when they do it. Second, we must seek to understand how proximate conditions influence their behavior in their exhibits. And third, we must understand how the characteristics (morphological and physiological) of the species themselves are manifested in the behavior the visitor sees. We can then begin to understand why some exhibits work and other do not and, with this understanding, what animals' needs are and what we can do to fix exhibits that do not work.

Using these ideas for exhibit design and improvement is not as difficult as it may seem. A useful starting point is to fold the sixteen factors listed above into five primary design considerations:

1. Select species that are "exhibitable" in the facility available. An asocial, nocturnal, burrow-using mammal, for example, is not exhibitable in an outdoor enclosure open for daytime viewing.
2. Ensure that the macroniche of the species is considered in the exhibit design and that the exhibit is environmentally appropriate for the species.
3. Establish and explicitly state which behavioral system or systems are to be featured while the animal is in the exhibit space. Optimize the opportunity for animals to engage in nonaggressive social interactions during public viewing hours.
4. Provide appropriate species-specific resting or refuging sites for the mammals in the exhibit space.
5. Manipulate food type, amount, and distribution and timing of deliveries to optimize vigilance, food-seeking behavior, and with some species, feeding behavior (see below).

Animal Management Procedures and Environmental Enrichment

The kennel approach to zoo mammal management required only ensuring that the animals were fed and cleaned; animal keepers usually had their experience in custodial or farm work. This approach to husbandry did not recognize the effects that confinement had on the animals or the considerable effects that animal keepers have on the lives of the animals in their care. We present three recent examples of how modifications in animal management routines have significantly improved the behavior of confined mammals and likely visitor experience.

Mellen (1991) found a positive correlation between reproductive success in small nondomestic cats, *Felis* spp., and husbandry style. The more time keepers spent interacting with cats they cared for, the more likely the cats were to reproduce successfully. This result of increased "socialization" characterized by daily human-animal interactions beyond routine cleaning, feeding, and weighing—so that cats learned to feel "comfortable" with the inevitable presence of their keepers—was counterintuitive and contrary to what has been a noninteraction policy of actively minimizing contact between keepers and animals in many zoos. Mellen recommended that keepers not make pets out of the cats under their care, but encourage positive, "friendly" behavior from the cats; these interactions can be developed through cage mesh.

A second focus in improving management and housing for confined mammals has been "environmental enrichment": the provisioning of confined mammals with more things to do in their environment. In what has become a classic study, Chamove and colleagues (1982) added deep woodchip litter to otherwise unexciting primate cages: "The presence of woodchips as a direct-contact litter decreased inactivity and fighting, and increased time spent on the ground. Placing food in the deep litter led to further behavioral improvements. The use of frozen foods improved food distribution and reduced fighting in most situations, especially when the food was buried in the litter. With time, the litter became increasingly inhibitory to bacteria . . ." (Chamove et al. 1982, 308).

At the National Zoological Park, "Smokey Bear" *(Ursus americanus)* engaged in a high incidence of stereotypic pacing behavior. Hiding food in the exhibit as an alternative to his once- or twice-a-day standard feeding regimen was a very successful means of reducing the stereotypic pacing and inducing him to spend time searching for and finding food (Carlstead, Seidensticker, and Baldwin 1991). The total additional keeper time needed for this change in husbandry procedure was 20 minutes each day. In contrast, an automatic feeder in the bear's exhibit was ineffective in reducing stereotypic pacing.

Experimental evidence from sloth bears, *Melursus ursinus,* brown bears, *Ursus arctos,* and American black bears suggests that environmental stimuli that elicit manipulative behaviors are essential for guiding feeding-motivated behaviors into functional foraging sequences. Food that is hidden in manipulable objects, or that requires some complex activity to acquire (e.g., fishing or scanning an area while walking), requires the animal to constantly modify its behavior based on the stimuli it encounters, and thus to develop contingencies between behavior and its consequences (Carlstead, Seidensticker, and Baldwin 1991; Shepherdson et al. 1993). (Contingencies = "learning or more broadly, any process whereby the favorable results of some pattern of behavior produces changes in the animal that cause this behavior to be repeated or to increase in frequency" [Griffin 1984, 21]). Attempts to stimulate normal bear behavior by outfitting enclosures with feeding devices that dispense snacks at unpredictable intervals demonstrate an understanding of the high motivation of bears to feed, but they fail to allow bears to develop behavioral contingencies. The dispensed food is merely retrieved from highly predictable locations and requires no complex behaviors to obtain (Carlstead, Seidensticker, and Baldwin 1991).

A captive environment usually presents conditions to which all species must adapt, such as the presence of humans, imposed feeding regimes and a lack of foraging opportunities, veterinary medical procedures, space limitations, forced social groupings, and unchanging surroundings. Compared with the wild, confinement offers few opportunities for an animal to learn to cope with aversive conditions. Enrichment provides animals with behavioral options for responding to the environment. Data indicate that rearing in a socially or physically enriched environment, as well as experience with complex environments as an adult, promotes normal species-specific behavior, increases activity and exploration, reduces emotionality, and facilitates coping ability (research reviewed in Carlstead and Seidensticker 1989).

The behavioral benefits of enriching the environment of zoo animals by providing enclosure furnishings, toys, feeding devices, and scatter feeding have been extolled and are resulting in a general trend toward "occupational therapy" for confined mammals (Holden 1988). In our own experience, for example, the conflicting results of scatter feeding and a feeding device for bears have shown there is no one panacea. Each species or functional husbandry group (a group of species that are essentially treated the same from a husbandry point of view) should be examined to determine what is best for that group or species.

CONCLUSION

In seeking integrated principles for exhibiting mammals, we have examined those factors that affect what mammals do or do not do in exhibit spaces. Throughout this chapter we have sought to identify the dimensions that influence the mammal-zoo visitor interaction.

Exhibits fail when the life history characteristics of the mammals exhibited have not been carefully evaluated in relation to the objective of the exhibit, and when animal requirements have not been fully identified and included in the design of the exhibit space. Unfortunately, there are a multitude of examples of these shortcomings in most zoos. We have described an approach for identifying and fixing exhibits that are not working.

Improvements in animal management and in the exhibit space should be based on the characteristics and needs of the animal and the zoo's obligation to the visitor. Ask these simple questions: Can the visitor see the animals, and are they engaged in natural behavior?

APPENDIX 18.1 JONES'S PRINCIPLES FOR THE PRESENTATION OF ANIMALS AND NATURE IN ZOOS

1. Have animals at or above eye-level of viewers.
2. Don't surround animals with viewers; provide a number of smaller overlooks without overlapping lines of sight; avoid single overlooks; place overlooks on secondary pathways.
3. Allow the animal to remove itself from situations it finds stressful; allow the animal to choose between hot and cool, high and low, dry and wet, and off/on exhibit.
4. Don't display social animals in solitary confinement; display social animals in social groups.
5. Don't display deformed or disfigured animals.
6. Don't display animals using human artifacts; provide abundant occupational alternatives using features that are found in the animal's natural habitat that are suitable for the animals' physical and mental capabilities.
7. Don't exhibit the animal in a setting totally unrelated to its origins or adaptations; recreate or replicate a landscape typical of the animal's natural habitat(s) without distortion, or exaggeration, faithful in all possible details.
8. Make it impossible for the viewer to determine what contains the animal.
9. Immerse the viewer in the replicated landscape even before seeing the animal; make overlooks and adjacent circulation areas appear to be extensions of the animal's habitat; don't build perceptual barriers by placing the humans in a familiar man-made setting and the animals in a naturalistic setting.

10. Don't display animals from different habitats together in a natural habitat setting; combine compatible animals from the same habitat and use this opportunity to demonstrate and interpret inter-relationships between these species. An exception to this is when it is useful to point out adaptive characteristics the two species share.
11. Relate adjacent exhibits into habitat complexes and thus, form transitional or ecotonal areas between exhibits of adjacent habitat zones.
12. Don't design the buildings first and animal exhibits and holding areas second; plan all these elements concurrently as interrelated parts.

Source: Jones 1982, 189-90.

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