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Challenges of Zoo Animal Welfare

Ron Kagan and Jake Veasey

INTRODUCTION

The public rarely asks questions about the “happiness” of zoo animals using a scientific framework. However, in recent years the scientific community has shown significant interest in and recognition of the cognitive abilities, emotions, and feelings (such as sadness, happiness, pleasure, joy, fear, contentment, and anxiety), even the “mental illness,” of animals (Rollin 1990, 2005; Duncan 1993, 2004; Bekoff 1994, 2005; Meyers and Diener 1995; DeGrazia 1996; Broom 1998; Fraser and Duncan 1998; Rushen, Taylor, and de Passille 1999; Hauser 2000; Kirkwood and Hubrecht 2001; Wynne 2002; Cabanac 2005; McMillan 2005b, 2005c; Balcombe 2006; Mendl et al. 2009). Some view these emotional and psychological qualities of animals as subjective, sentimental, and anthropomorphic (Mitchell, Thompson, and Miles 1997).

Animal welfare concerns are important to modern zoos and aquariums (hereafter *zoos*). Where compromised zoo animal welfare exists, it can lead to stress and boredom (Wemelsfelder 2005) as well as aberrant behaviors like swaying (Spijkerman et al. 1994; Wilson, Bloomsmith, and Maple 2004), fur plucking, and pacing (see Welfare Indicators section below; Bashaw et al. 2007; Miller, Bettinger, and Mellen 2008). As zoo professionals we need to understand and effectively address issues of animal welfare in our institutions. In this chapter, we present the primary concepts, challenges, and issues of animal welfare relevant to modern zoos. We also review methods to evaluate the welfare status of zoo mammals, and offer guidelines to advance this vital cornerstone of our profession. Since there are many different cultures, religions, values, and economics in the very human world of zoos, there are typical as well as unusual challenges for captive exotic animal welfare across the globe (Kirkwood 1996; Agoramoorthy 2002, 2004; Almazan, Rubio, and Agoramoorthy 2005; Bayvel, Rahman, and Gavinelli 2005; Jordan 2005; Fraser 2009b).

FOUNDATIONS OF ZOO ANIMAL WELFARE

Over 70 years ago, Gillespie (1934) acknowledged inadequacies in the quality of life of captive exotic animals. In the early part of the twentieth century, animal protection laws (Wild Animals in Captivity Protection Act of 1900/1911 in the UK) and advocacy efforts (Jack London Club in the USA) emerged as the public’s concern grew over the treatment of trained and caged animals in both zoos and circuses. European countries have generally led in efforts to improve animal welfare policies and legislation (Leeming 1989; Dol et al. 1997; Radford 2001; Broom and Radford 2001; Bayvel, Rahman, and Gavinelli 2005; Caporale et al. 2005; Anonymous 2006). In 1964, the United Kingdom developed the paradigm of “Five Freedoms” in order to help the agriculture industry simplify welfare concepts, recognize the importance of well-being, and facilitate the adoption of adequate welfare standards. These freedoms include (1) freedom from injury and disease; (2) freedom from hunger, thirst, and malnutrition; (3) freedom from thermal or physical distress; (4) freedom to express most “normal” behaviors; and (5) freedom from fear. By providing for these freedoms, the UK government hoped to achieve the proper care and welfare of farm animals. The UK zoo licensing legislation of 1981 and 2000 also included the Five Freedoms, which if deemed unmet can lead to the denial/revocation of a license.

While the Five Freedoms are limited, and not a framework for measuring welfare, they give structure, context, and accountability to issues of captive animal welfare. Additional freedoms proposed more recently include the freedom of an animal to exert control over its quality of life (Webster 1994) and freedom from boredom (Ryder 1998).

The U.S. Animal Welfare Act of 1970 set the stage for regulating animal care (and, to some degree, for animal welfare) in the United States, including zoos. In 1985, amendments specifically addressed the psychological well-being of captive primates.

While animal care techniques have been improving in zoos for decades, it is only relatively recently that animal welfare has been a significant, separate topic of discussion in the United States (Norton et al. 1995; Rowan 1995; Burghardt et al. 1996; Hutchins 2002; Maple 2007). The Association of Zoos and Aquariums (AZA) created an Animal Welfare Committee in 2000, though in contrast with European zoo associations, there are still no AZA professional awards in North America for animal welfare excellence. In fact, many have published criticisms of zoo animal welfare policies and conditions (Batten 1976; Jordan and Ormrod 1978; McKenna, Travers, and Wray 1987; Malamud 1998; Mullen and Marvin 1999; Margodt 2001; Donahue and Trump 2006).

Public pressure has encouraged much of the current attention on animal welfare, while science has focused on the need to improve the conditions of farm and research animals (Dodds and Orlans 1983; Novak and Petto 1991; van Zutphen and Balls 1997; Ewing, Lay, and von Borell 1998; Rollin 2003; Benson and Rollin 2004; Duncan 2004). Zoo-sponsored research efforts focusing on animal welfare are recent and predominate in the United Kingdom and Europe. The existing challenge for all zoos is to develop both a robust and a rigorous evaluative system to measure well-being, along with a strategy that ensures a good quality of life for each animal (Hosey, Melfi, and Pankhurst 2009).

Zoos have invested in improved exhibit design over the past several decades (see Hancocks, chap. 11, this volume; Coe and Dykstra, chap. 18, this volume), yet exhibit design often attends disproportionately to human needs and wishes, e.g. aesthetics, visitor flow, and ease of cleaning. Since the design of an exhibit can play a critical role in affecting animal welfare, some new exhibits incorporate important elements that address this concern (see Cipreste, Schetini de Azevedo, and Young, chap. 15, this volume). Zoos need to ensure that old and new exhibits meet more than the basic needs of animals.

WHAT IS ANIMAL WELFARE?

The term *welfare* is generally considered synonymous with *well-being*, which is essentially the state of feeling “well-off” (Varner 1996). *Welfare* is not a simply defined term in either philosophy or science (Fraser 1995; Wuichet and Norton 1995; Appleby and Sandoe 2002; Taylor 2003; Haynes 2008; Mellow, Patterson-Kane, and Stafford 2009). It encompasses the condition of good mental, physical, and emotional health (Appleby and Hughes 1997; Bekoff 1998; Dolins 1999; Ryder 1998; Spedding 2000; Nordenfelt 2006). Well-being is a condition that is self-determined by the individual (human or animal) and not by an observer or caretaker—a central challenge for its evaluation.

To provide a good quality of life for captive mammals, we need to understand the main determinants of well-being for each species and, just as important, each individual (Gosling 2001). For example, while the need for food is obviously critical to all organisms for survival, the control over choice of food items, mealtimes, and dining style may be important to some species and/or some individuals, but less so to others (Young 1997; Owen et al. 2005; Videan et al. 2005; Ross 2006).

How can we know if an animal’s welfare or state of well-being is good? An understanding of a species’ behavioral ecology and natural history is fundamental to identifying those factors likely to be linked with the individual’s well-being. Welfare is also dependent on an individual’s ability to perform certain species-specific behaviors that it is highly motivated to perform, e.g. nest building or avoiding predators (Gregory 2005; see McPhee and Carlstead, chap. 25, this volume). There should be an absence of signs of distress or severe discomfort and of acute or prolonged stress that results in a reduction in physical and/or mental health (Broom and Johnson 1993; Balm 1999; Moberg and Mench 2000). Thus, good welfare can be demonstrated by the absence of “problems” along with the presence of normal, natural behaviors and good physical condition (Archer 1979; Stoskopf 1983; Wiepkema and Koolhaas 1993; von Holst 1998; Sapolsky 2004; Morgan and Tromborg 2007).

The term *distress* has been suggested as central to characterizing the impact of negative stress (Wielebnowski 2003; McMillan 2005b; NRC 2008). Prolonged distress or severe discomfort will compromise well-being and is measurable behaviorally and/or physiologically. While we are sure that animals deprived of food and water for a prolonged period will ultimately be distressed, we still do not know if (or how much) distress occurs when other, less obvious physical or social needs are not met. If an anteater lives in a zoo without a deep substrate in which to dig, will it be distressed? Do captive polar bears and other marine mammals experience distress when maintained in freshwater as opposed to seawater? We need far more research on hundreds of exotic species to answer these questions.

Individual physical problems, e.g. from disease-related decline, may neither result from poor welfare nor cause a reduction in welfare. For example, an animal’s arthritis may not be caused by poor management, but by effective husbandry and care that allow the individual to live longer than is typical in the wild. However, arthritic animals may not only experience chronic pain but also be unable to perform species-specific behaviors, e.g. avoid the aggression of conspecifics, in which case their well-being is likely compromised.

An animal’s survival in the wild depends on its successfully reacting and responding to its environment (Poole 1992; Stafleur, Grommers, and Vorstenbosch 1996; Broom 1998; Dawkins 1998). If a zoo animal cannot react appropriately to stimuli in its captive environment, behaviors indicative of “frustration” may result. In addition, the “design” of mammals includes the need to initiate activity (e.g. play, exploration, information gathering) based on changes in motivation, and not just to react to events or circumstances (Mench 1998; Carlstead 1999). Although conditions that compromise well-being do occur in the wild, the animal management staff is responsible for ensuring adequate well-being once an animal enters the care of the zoo. Zoos need to address how they can meet the complete needs of all their mammals, regardless of an animal’s age, popularity, or value (Föllmi et al. 2007).

Both the physical and the social environments (Rees 2009) profoundly affect quality of life and therefore state of welfare and sense of well-being. Quality of life and suffering are subjective and relative challenges for animals as they are for

humans (Sandoe 1999; Wemelsfelder 1999; Dawkins 1980, 2005; Gregory 2005).

WELFARE INDICATORS

In a very real and literal way, humans are somewhat “blind” to how most other species perceive and experience the world. Our ability to understand the needs of most mammals may also be quite limited. A greater research focus on “soft” psychological characteristics (e.g. animal awareness, consciousness, sentience, emotions, individuality, feelings, and thoughts) may help us better understand the complete needs and complexity of other mammals and therefore how to improve their welfare in captivity (Dawkins 1993, 2001; Capitano 1999; Griffin 2001; Kirkwood 2003; Turner and D’Silva 2006; Powell and Svoke 2008; Fraser 2009a).

Since the thoughts and feelings of animals are largely inaccessible to us, we rely on indirect indicators of an animal’s mental state and physical condition to determine its state of well-being. Historically, indicators of zoo animal well-being have included longevity and reproductive success. However, mammals can survive and reproduce over many years, even in the most stressful circumstances. Thus, we need to establish more sensitive indicators.

The challenges scientists face in assessing animal welfare are considerable (Sandoe and Simonsen 1992; Mason and Mendl 1993; Mench 1993; Gonder, Smeby, and Wolfe 2001; Dawkins 2003, 2006; Jordan 2005; Webster 2005). The great number of species, small sample size, limited resources (financial and staff), multiple variables (including individual animal variation), and the unique circumstances of each facility all create additional obstacles when working in zoos. Assessing welfare generally involves measuring behavioral and physiological responses to stressors (Morgan and Tromborg 2007; McPhee and Carlstead, chap. 25, this volume; Hodges, Brown, and Heistermann, chap. 33, this volume). The behavioral and physiological responses of mammals to environmental variables, e.g. insufficient space, that typically have a negative impact on welfare are thought to be their attempts to cope with or eliminate stressors.

PHYSIOLOGICAL INDICATORS

Physiological responses to stress are complex and multifaceted, and they vary according to the species of the animal and the nature of the stressor (Moberg 1985; Touma and Palme 2005; see also Hodges, Brown, and Heistermann, chap. 33, this volume; McPhee and Carlstead, chap. 25, this volume). Exposure to stress generally results in an elevation in glucocorticoids secreted by the hypothalamic-pituitary-adrenal (HPA) axis (Matteri, Carroll, and Dyer 2000; Shepherdson, Carlstead, and Wielebnowski 2004; Carlstead and Brown 2005; Lane 2006). The secretion of these steroid hormones facilitates the mobilization of energy reserves and enhanced cardiovascular tone to prepare the animal for a coping response, such as fight or flight.

Physiological indicators of welfare primarily involve measuring compounds released by the animal in its blood, and/or in excreta and saliva, as well as short-term changes in body temperature and heart and respiration rates (Dathe, Kuck-

elkorn, and Minnemann 1992; Bauman 2002; Von der Ohe and Servheen 2002; Peel et al. 2005; Stewart et al. 2005; Touma and Palme 2005; Pedernera-Romano et al. 2006; Hodges, Brown, and Heistermann, chap. 33, this volume). However, an elevation in glucocorticoids comparable to that during a stress response can occur seasonally or when an animal is simply excited or has exerted itself. Indeed, the sampling procedure alone, particularly if this involves capture and taking blood, may activate a stress response, potentially invalidating any worthwhile conclusions about other stressors. Further complicating our understanding of the physiological indicators of stress is the finding that in some situations of chronic stress, the HPA response will be depressed (Wielebnowski 2003).

Chronic stress, with a prolonged activation of short-term coping responses, can ultimately harm the health of an individual. The more the animal is required to cope—and the less an animal is able to cope—the more its welfare is likely to be compromised. Chronic physiological stress responses can also be measured, and include immunosuppression, reduced fecundity, reduction in protein synthesis, weight loss, elevated blood pressure, ulceration, thickening of the arteries, and premature death (Coe and Scheffler 1989; Blecha 2000; Elsasser et al. 2000; Shepherdson, Carlstead, and Wielebnowski 2004). Chronic stress reactions may be particularly significant in assessing the level of everyday welfare of zoo animals, because they should reflect welfare status under the prevailing conditions, rather than at the moment of measurement. However, chronic stress indicators are often difficult to measure in live animals. Finally, these measures only result from highly acute or prolonged stressors, and so while they can tell us that the animal is coping poorly, they may be slow to do so.

BEHAVIORAL MEASURES

Since the collection and interpretation of physiological indicators may be difficult, behavioral studies are often a practical approach to evaluating welfare status, particularly in such nonexperimental conditions as are found in zoos. Comparing the behavior of zoo mammals with their wild counterparts can reveal the effects of captive conditions on exotic mammals as we attempt to improve zoo mammal well-being (see also McPhee and Carlstead, chap. 25, this volume).

Time budgets and comparisons with the wild. Time budgets essentially measure how animals allocate their time. Animal care staff can use time budgets of captive mammals as a baseline to assess the impact on behavior caused by changes in management practices or other changes in the animal’s physical and social environment. Knowledge of the time-budget differences between wild animals and captive animals can indicate possible problems with captive management (Mallapur and Chellam 2002; Melfi and Feistner 2002), although changes in the frequencies of certain behaviors need not—e.g. it is unlikely that a reduction in vigilance behavior by prey animals would mean that their welfare was compromised.

Preference tests and behavioral needs. Animals can provide insight into their motivations by expressing preferences for

certain environmental variables (Fraser, Phillips, and Thompson 1993; Duncan 2004). Thus, preference tests can indicate what animals are motivated to obtain or to avoid. For example, chickens prefer larger cages with a substrate to smaller cages with a wire floor (Dawkins 1983), presumably because the former provide more opportunities to perform species-appropriate behaviors such as dust bathing. However, preference tests only indicate a relative preference. Preferences may vary based on age, season, temperature, social environment, previous experiences, and the availability of different resources. Also, because an animal expresses a preference for a certain variable does not mean that it will inevitably experience reduced well-being in its absence. Finally, animals do not always make choices that are in their individual best interests: e.g. adult male mammals may fight during the breeding season.

The strength of preferences can be measured by making the animal choose to give up resources or perform work for its preference (Consumer Demand Theory: Dawkins 1983, 1990). An individual's unwillingness to sacrifice food, comfort, or social contact, or its willingness to perform "work" such as pressing levers, swimming through cold water, or pushing open heavy doors, is measurable (Van der Harst and Spruijt 2007; Watters, Margulis, and Atsalis 2009) and can demonstrate the strength of its preference. The harder the animal works or the more it is willing to sacrifice, the greater its preference, and hence the greater the likely welfare deficit if the individual is denied access to that resource or opportunity. Such an approach can inform facility design, especially with regard to indoor areas (Ewing, Lay, and von Borell 1998). Species differences are important considerations; a lack of social interaction is likely to be more significant for a social primate such as a chimpanzee than for a solitary predator such as a tiger. Similarly, the compression of an elephant's extensive daily walking routine into 2 or 3 hours in captivity is likely to pose a greater welfare challenge than altering a captive snake's mobility or feeding ecology.

There are certain behaviors (termed behavioral needs) that we believe animals must perform for satisfactory well-being. Such behaviors may be of a long duration, energetically demanding, and internally stimulated (i.e. not reliant on external stimuli). For example, if members of a species typically forage for 14 to 20 hours per day in the wild, limited foraging opportunities in a captive environment may lead to reduced well-being. Zoo professionals should develop creative ways to compensate for such a large discrepancy in the time budget (McPhee and Carlstead, chap. 25, this volume).

Animals usually exhibit escape behavior in the presence of the appropriate external stimuli, e.g. a predator. Nevertheless, many zoo exhibits house animals in close visual, auditory, and olfactory proximity to machinery, visitors, and other species, including their natural predators (Hosey 2000; Birke 2002; Davey and Henzi 2004; Davey 2006; Owen et al. 2004; Davis, Schaffner, and Smith 2005; Powell et al. 2006; Sellinger and Ha 2006; Davey 2007; Kuhar 2008). While the actual risk of being attacked is low (though there are risks of predation in zoos), an animal may exhibit predator avoidance behaviors, e.g. hiding. This important behavioral need can collide with the zoo's wish to have animals in full view during visitor hours.

Abnormal behaviors. We can also document the frequency and duration of "abnormal" behaviors, the most obvious of which are stereotypic behaviors (Meyer-Holzappel 1968; Dantzer 1986, 1991; Mason 1991a, 1991b, 2006; Mason and Latham 2004; Wechsler 1991; Lawrence and Rushen 1993; Gruber et al. 2000; Rees 2004; Wilson, Bloomsmith, and Maple 2004; Montaudouin and Le Page 2005; Shyne 2005; Tarou, Bloomsmith, and Maple 2005; Swaisgood and Shepherdson 2005; Renner and Kelly 2006; Ross 2006; Elzanowski and Sergiel 2006; Soriano et al. 2006; see also MCPhee and Carlstead, chap. 25, this volume). High levels of stereotypy may indicate that an individual has experienced a welfare challenge and has been coping for a prolonged period (Wilson, Bloomsmith, and Maple 2004). These unvarying behaviors have been correlated with poor welfare, as they are typically seen in animals housed in small enclosures. However, stereotypies, like physiological changes, can also occur when an animal is simply excited (Veasey 1993). It has been suggested that stereotypic behaviors may be satisfying or soothing to perform in that they provide a controllable (albeit high) level of stimulation that helps the individual animal cope with unpleasant or uncontrollable conditions (Rushen 1993). Thus, some animals exhibiting stereotypies may actually have lower heart rates, higher levels of circulating endogenous opioids, and reduced cortisol levels in comparison with animals in similar conditions not exhibiting stereotypies (Dantzer 1986; Mason 1991a).

A factor complicating the relationship between stereotypies and animal welfare is that even after conditions improve, stereotypies often persist (Mason 1991b). Therefore the presence of stereotypies may not always reflect the prevailing conditions experienced by the individual. Assessing and addressing the welfare (and especially stereotypies) of primates, elephants, bears, and marine mammals, with their complex behavioral needs, is especially challenging (Novak and Suomi 1988; Kiley-Worthington 1990; Schmid 1995; Galhardo et al. 1996; Baker 1997; McBain 1999; Waples and Gales 2002; Clubb and Mason 2003; Swaisgood et al. 2003; Hosey 2005; Cheyne 2006; Hutchins 2006; Meller, Coney, and Shepherdson 2007; Wemmer and Christen 2008; Forthman, Kane, and Waldau 2009). Instances of apparent stereotypic behaviors have been described in wild animals (Veasey, Waran, and Young 1996).

Behavioral indicators of poor welfare or distress can also include vocalizing, extreme timidity, aggression, escape behaviors, self-mutilation, fur plucking, pacing (Boinski, Gross, and Davis 1999; Wielebnowski et al. 2002; Peel et al. 2005), and decreased performance of behaviors critical to survival and reproduction, e.g. grooming, mating, and foraging/feeding. The context is important when attempting to attribute a cause to the behaviors.

COMPENSATING FOR STRESS

Enrichment is one method of compensating for compromised conditions in captivity. Environmental enrichment programs (Markowitz 1981; Markowitz and Aday 1998; Maple 1996; Robinson 1997; Young 2003; Shyne 2005; Shepherdson, chap. 6, this volume; Cipreste, Schetini de Azevedo, and Young, chap. 15, this volume) continue to evolve as an important way to address challenges created by captive environments.

For zoos, environmental enrichment has traditionally not been as rigorously and consistently applied as has “basic” management, i.e. husbandry, nutrition, and preventive medicine. “Basic” animal care (e.g. feeding, housing, and transport) has tended to be separated from animal welfare (i.e. *how* an animal is fed, housed, and transported) (Dembiec, Snider, and Zanella 2004; Broom 2005; Iossa, Soulsbury, and Harris 2009). Zoos need to allocate more staff time and expertise to enrichment and engage welfare professionals who have been scientifically trained (see Shepherdson, chap. 6, this volume; Cipreste, Schetini de Azevedo, and Young, chap. 15, this volume).

Although counterintuitive to some degree, exposure to a certain amount of stress, even in captivity, may be good for animal well-being (McEwan 2002), since stress in nature helps individuals build a healthy capacity to cope with dynamic physical and social environments. Some of the stress in captivity is similar in frequency, quality, and magnitude to the stress of living in the wild; but captive animals face many additional artificial stressors, e.g. confined space, close proximity to conspecifics, constant human presence, unnatural diets, and exposure to chemicals for cleaning enclosures, among others (Morris 1964; Hosey 2008).

Providing zoo mammals with choice in addition to the Five Freedoms discussed earlier is an enormous challenge (Laule 2003; Owen et al. 2005; Videan et al. 2005; Schapiro and Lambeth 2007) and requires significant rethinking and reengineering of space and other resources for many mammalian species. Control, choice, and decision making represent important biological needs, since they are characteristics that animals exhibit regularly in the wild (Meyers and Diener 1995).

INDIVIDUAL VERSUS SPECIES WELFARE

Conway (1976) suggested that focus on the welfare of individuals is antithetical to the conservation of species, and creates a conflict between the welfare of individuals and that of populations. Thus, the argument implies that consideration for the welfare of many, including future individuals, should outweigh consideration for the welfare of an individual (Lacy 1991, 1995). Animal welfare groups, the media, and the general public often focus their attention on individual animals. And some in the conservation community (including zoos) may essentially contribute to welfare “speciesism” in that the charismatic megavertebrates often benefit more from attention and investment than other species (e.g. giant pandas [*Ailuropoda melanoleuca*] and gorillas [*Gorilla gorilla*]). Zoos’ conservation education programs that encourage a greater focus on species survival and habitat preservation may not overcome the great value the public places on individual animals, especially large mammals (Conway 1976; Lewandowski 2003). Zoos can, however, take on this challenge and engage the public in a discovery of, and dialogue about, the relationship between individual animal welfare and conservation, including the complicated choices and significant costs of achieving well-being for all individuals.

Conway (1976), Lacy (1991), and Lindburg (1991) argue that an aesthetic appreciation of individual animals can lead to enhanced appreciation of and support for species. This may be a major contribution of zoos, and the foundation for

much support for wildlife conservation and animal welfare (see Routman, Ogden, and Winsten, chap. 12, this volume). Ideally, we should develop solutions that benefit both individuals and populations, although strategies and practices that fully embrace both animal conservation and animal welfare can be difficult to achieve (Kagan 2001; Maple 2003). For instance, consider the dilemma faced by a zoo asked to provide space and resources for a rescued pet tiger of uncertain ancestry. By accommodating this animal, the zoo now may have less space available for captive breeding of genetically valuable tigers capable of making substantial contributions to conservation.

ZOO ENVIRONMENTS FOR IMPROVED ANIMAL WELFARE

The design of exhibits and the interaction of keepers with the animals in their care are central determinants of the quality of a captive animal’s life (Shepherdson, Mellen, and Hutchins 1998). For some exhibits, an important distinction between captivity and confinement can be made (Wemelsfelder 2005). Some zoo mammals may be so limited and restricted by their physical environment that they are indeed confined, and not simply captive (Bostock 1993).

Decisions of animal care staff essentially replace many important decisions the animal would have made in the wild. For example, choosing a mate or when and what to eat are important life experiences that we, not the captive animal, determine. Providing significant choice and control to the animal may improve its situation quite dramatically. Current management protocols for elephants, including maintaining them in chains—though banned in the United Kingdom by elephant management guidelines established by the British and Irish Association of Zoos and Aquariums—and the use/threat of physical discipline including electric shock—current AZA elephant standards—are vivid examples of how intensive our control is over some zoo animals (Schmid 1998; Friend and Parker 1999; Gruber et al. 2000; Elzanowski and Sergiel 2006).

Greater knowledge of and sensitivity to how animals (not humans) perceive and experience life in a captive environment could help prevent a host of stressors from dramatically compromising the well-being of zoo animals (Wemelsfelder 1999). For example, while humans’ sensory abilities include detecting certain air pollutants, we may not detect many odors (or their relative intensity) or realize that prolonged, even chronic, exposure to fumes from cleaning solutions, urine, dust, and excreta in a holding barn could be extremely challenging for many animals. Moreover, captive animals are often subjected to loud noises (Birke 2002; Owen et al. 2004; Coppola, Enns, and Grandin 2006; Patterson-Kane and Farnworth 2006; Powell et al. 2006), inappropriate temperatures (Lindburg 1998; Rees 2004), unnatural light cycles and/or artificial lighting, and forced human proximity (Rushen, Taylor, and de Passille 1999; Fernandez et al. 2009). Since we humans are usually only temporarily exposed to these stimuli within exhibits, we may not perceive the stimuli as strong, offensive, or even detect them at all.

Similarly, zoos with relatively spacious natural and complex outdoor exhibits may not allow their animals to remain

outdoors 24 hours a day for reasons of visibility, security, weather, and ease of maintenance. Some zoos “rotate” individuals within exhibits several times during the day to ensure that the animals that are on display are always active. Thus, some individual animals may spend the vast majority of their lives, by design, off exhibit in small, sterile holding cages (Sommer 1973; Coe 2003), not significantly different from what was provided 50 years ago. We need to provide mammals that climb, dig, fly, run, hide, swim, and burrow with ample and appropriate opportunities to express their behavioral needs. For convenience, we feed some zoo animals at set times in specific locations, not the way most animals feed in the wild. As a consequence, we increase predictability and the passive time in the animals’ daily time budget, and we may facilitate aggression in group-dwelling species.

Finally, the impact of weather and climate on captive exotic animal welfare needs significant scientific attention.

THE FUTURE

The environments of zoo animals have improved over the years and, it is hoped, not only appear better to visitors, but also are better for the animals. But, as Mench and Kreger (1996, 10) so poignantly wrote in the first edition of this book, “The natural habitat created in a zoo environment is an illusion . . . real to the visitor but to the animal . . . restrictive, monotonous, lacking most of the niches in nature.” While hard to admit, zoo professionals’ assumptions, best intentions, expertise, and great affection for animals do not necessarily mean that all individual captive animals are thriving. Our challenge is to develop and utilize accurate measurements of well-being and to provide conditions that will promote welfare for all animals in our care.

Today, while exhibits are larger and more cosmetically appealing to humans, they still may not be fully relevant to their residents. A mowed grassy area may be enticing to humans, but does not offer a natural home to most animals (see Hancocks, chap. 11, this volume). We believe that if each zoo maintained fewer species in truly appropriate physical and social conditions, captive animals would experience better well-being.

Our own sensory limitations as well as the costs of change retard progress in developing new approaches. Providing a full, 24-hour, enriched, stimulating, and relatively uncontrolled life experience for zoo mammals mandates sophisticated, complex environmental design and significantly different animal management practices, developed from extensive, professionwide collaborative research efforts and evaluations (Smith 2004; Wells and Irwin 2008; Wells 2009). Our goal should be to establish institutional policies and professional standards that provide animals with a full range of opportunities, choice, and control.

Of course, we need to avoid creating exhibit features that can pose serious risks for our animals. For example, water moats may be more attractive and less expensive to build than dry moats, and they are effective at containing almost all primates. But, they led to drownings in half of all U.S. water-coated chimpanzee exhibits during the 1990s, even where compensatory safeguards such as underwater nets were installed (data from Chimpanzee SSP). While costly and logisti-

cally challenging, we also need to provide mammals with opportunities to be rough on their environments, e.g. to destroy trees (Maki and Bloomsmith 1989). Hot-wired trees and other inaccessible naturalistic exhibit features afford little value to the nonhuman primates.

Our focus should be on optimum, not minimum, conditions. We need to consider that even a successful record of increasing investment in *ex situ* and *in situ* conservation (improving the welfare of a species) does not necessarily mean that individual zoo animals have been adequately provided for (Kirkpatrick 1996). Saving a species may be a hollow conservation success, and ethically questionable, if we harm individual captive animals in the process. We need to advance both the science and the policy of zoo animal welfare (Jordan 2005; Defra 2005, 2006); otherwise, our public standing as “the” animal experts, advocates, and preservers is vulnerable.

ASSOCIATIONS/WEB SITES FOCUSING ON ANIMAL WELFARE

Important associations/Web sites that focus on animal welfare research and issues include the Scientists Center for Animal Welfare (SCAW—www.scaw.com), Universities Federation for Animal Welfare (UFAW—www.ufaw.org.uk), Society and Animals Forum (formerly Psychologists for the Ethical Treatment of Animals, www.psyeta.org), and the International Society for Applied Ethology (ISAE—www.applied-ethology.org). Related journals that regularly publish captive animal welfare studies include *Applied Animal Behaviour Science*, *Animal Welfare*, *Journal of Applied Animal Welfare*, and *Zoo Biology*.

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