Enclosing Nature:

Naturalism, Animal Welfare, and the Evolution of Zoo Design

by

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ABSTRACT

Zoos are a unique collection-based institution with deep roots in the social structure of modern society. From their beginnings as elite menageries to display power or wealth, they have evolved into public institutions committed to providing exemplary animal care, and recreational and educational opportunities for visitors. More recently, zoos have developed a series of significant conservation programs and partnerships around the globe, efforts that have proved vital to saving endangered species such as the Arabian oryx (*Oryx leucoryx*) and California condor (*Gymnogyps californianus*), among other species.

Intrinsic to the development of modern zoo designs are the interwoven concerns of naturalism and animal welfare. Animal welfare, in particular, has become the paramount responsibility for professionally run zoological institutions as they seek to become centers of conservation and education without compromising animal wellbeing. Animal welfare and naturalism (understood as a design feature in zoo exhibits) are typically harmonious objectives, but these goals have occasionally clashed in implementation. While animal welfare and naturalism are defined in various (and not always consistent) ways in the literature, in-depth interviews of leading professionals and scholars in the zoo community and multi-dimensional case studies of exemplary, accredited institutions (including the Phoenix Zoo, the San Diego Zoo, Woodland Park Zoo and Arizona-Sonora Desert Museum) provide unique insight into the shifting meaning of these terms and how welfare and naturalism have and continue to shape the development of modern zoo enclosures. This study concludes by suggesting a possible

future trajectory for innovative and alternative zoo designs that incorporate both animal welfare and naturalism without sacrificing either goal.

For my long-suffering parents

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1. INTRODUCTION

Zoos are a unique institution with deep roots in the social structure of modern society. Initially founded as private collections to demonstrate wealth or power, they have evolved into complex public organizations that seek to not only educate and entertain their visitors, but also to conserve threatened species both in their care and in the wild via a range of programs and partnerships. For accredited zoos, animal welfare is a paramount concern at all times. This seems obvious for the animals in their direct care, but they also hope to be stewards for animal welfare in the wild, as well. These efforts, to increase animal welfare and contribute more significantly to wildlife conservation, have been driving forces in the evolution of zoo enclosures. Governing bodies like the World Association of Zoos and Aquariums (WAZA) have set forth guidelines for zoos that delineate standards for animal care and wellbeing, as well as goals for increasing conservation efforts worldwide. Their comprehensive 2015 Animal Welfare Strategy carefully defines expectations for animal welfare and monitoring, as well as conservation efforts, enclosure design, breeding programs and research (Mellor et al. 2015). This document makes it clear that the professional zoo community is striving to accomplish more than to just display animals for the amusement of its guests. Rather, it is seeking to become a society of professionals using a research-based understanding of animal behavior to ensure the highest levels of animal care. With technological advances in recording and sharing information about animal behavior becoming a tool in zoos nationwide, this research is already underway. This knowledge will also enable zoos to educate their visitors more about their animals, as well as help wild populations, which

serves their conservation aims. The ultimate goal of the modern zoo is to care for their animals in the best possible way, while simultaneously educating and entertaining their visitors and helping to conserve wild populations beyond the zoo walls.

The zoo does not exist in a vacuum, however. The design of an animal enclosure is the perfect example of the many different masters a zoo must serve. First and foremost, the enclosure must be best suited for the individual animal. That is, an enclosure must serve their specific biological and physiological needs, while also providing intellectual stimulation. At the same time, the enclosure must cater to public desires and expectations, giving them what they want to see, and encouraging return visits. Ideally, there is also an educational component to the exhibit that enlightens the guests about some aspect of the animal's natural history or its current plight in the wild. Enclosures must also serve the goals of each individual institution and promote their mission statement. In addition, the enclosure must be safely accessible to keepers and janitors, as well as veterinary staff. Finally, the exhibit should have some connection to the wild, and somehow by working to effect populations ex-situ.

In this thesis, I examine the evolution of zoo enclosures by means of a pair of distinct, but interrelated research questions. First, how have the correlated but independent concerns of animal welfare and naturalism guided innovation in zoo exhibits since the early 20th century, and to what extent are these concerns mutually compatible or exclusive? It is readily apparent that both naturalism and animal welfare have been driving forces in the evolution of zoo design, and they frequently are mutually enforcing. Furthermore, when they are at odds, the tension is usually resolved by more of a

compromise in naturalism than a reduction in animal welfare.

A second key question driving this analysis concerns enclosure innovation. What innovations in zoo design does the zoo community see, or want to see, with respect to enhancing zoo animal welfare and naturalism in the coming decades? The usage of technology and monitoring software, as well as increasing the space for animals, are both innovations that are both currently underway across the professional zoo community. A third important innovation is exhibiting a smaller number of species, with a larger number of individuals. There are other models for potential trajectories of zoo design, including conservation centers, game reserves, and making the visitors "caged" within the worlds of the animals.

A historical perspective to innovation in zoo enclosures suggests the movement toward naturalism, landscape immersion and the advances in animal psychology and animal care (for both mental and physical health) have resulted in significant animal welfare improvement in zoos. In this study, I will present the results of a series of expert interviews with zoo enclosure designers, zoo managers, and zoo animal care leaders. These professionals offered their thoughts and opinions on animal welfare, enclosure design, increasing naturalism and the future of zoos, among other subjects. I will also discuss a series of case studies, undertaken at Association of Zoos and Aquariums (AZA)-accredited institutions with enclosures that represent innovations (both historical and contemporary) in animal welfare, naturalism, or both. Lastly, I will draw a number of conclusions from this examination of the evolution and philosophy of zoo enclosure design for the future of zoos more generally.

Two Key Terms: Animal Welfare and Naturalism

This discussion of zoo enclosures rests heavily on two terms that are often not well defined: naturalism and animal welfare. The fact that an enclosure is contrived by humans means that it can never be truly nature, but what, then, is meant by naturalism in the zoo context? It is often a nebulous and poorly defined concept. Historian Jeffrey Hyson, one of the country's leading experts on zoos, points out what he terms the "paradoxical relationship between design and nature" (Hyson 2000, p. 34). Although contrived, the more immersive zoo exhibits attempt to replicate natural habitats while also educating visitors about conservation and biodiversity (Hyson 2000, p. 39). At the same time, the immersive model (described in Chapter 2) still caters to entertainment, especially visitors' desires to see the animals on display.

Interviews I conducted with zoo professionals uncovered varying opinions on exhibit naturalism. Rich Sartor, Curator of Living Collections at the Phoenix Zoo, said that a naturalistic exhibit "Is a very distilled approximation of nature" (R. Sartor, personal interview, March 9, 2016). Craig Ivanyi, Director at Arizona-Sonora Desert Museum (ASDM), spoke on the same thread, saying, "it would be a fallacy to think that you ever create nature, because there are so many aspects we just don't know" (C. Ivanyi, personal interview, December 11, 2015). Yet, Ivanyi directs one of the most naturalistic zoos in existence, the Arizona-Sonora Desert Museum (ASDM). Naturalism has been embraced so thoroughly at ASDM that some no longer even consider it a zoo, as it exhibits only native creatures in a series of innovative, landscaped enclosures that artfully conceal their own contrivance. If even the director of one of the most naturalistic zoos operating today,

recognizes how short enclosures fall of recreating nature, there can be little doubt that naturalistic zoo design remains a huge challenge.

Ivanyi, though, is not the only one in zoo management to recognize the complexities of natural ecosystems, and the intrinsic difficulty in trying to recreate them. Terry Maple, Director Emeritus of ZooAtlanta, has put forth a similar sentiment, saying, "Managers of captive animals should never fool themselves with the belief that they can replicate nature in a captive setting. To expect this outcome would demonstrate an ignorance of the intricacies and complexities that characterize natural ecosystems" (Norton et al. 1996, p. 219). Gregg Mitman, a historian of science, similarly comments on zoos' "preoccupation with the re-creation of nature," saying that what they are really trying to achieve is "human invisibility within the act of creation" (Mitman 2014, p.143).

Perhaps the most accurate and insightful characterization of naturalism comes from Terry Maple. Having overseen one of the greatest overhauls of a zoological institution (the Atlanta Zoo) from one of the Humane Society's "Ten Worst Zoos in the US" to one of the premier accredited animal facilities in the world (ZooAtlanta), his insight is invaluable. He characterizes naturalism in terms of the animals, and says that for an exhibit to be "naturalistic in form and function, [they must be] designed to encourage natural behavior, breeding and normal parenting" (Maple 2013, p. 2). In the case of modern zoo enclosures, naturalism seems to mean creation of a space that mimics, as closely as possible, the habitat of animals housed within it.

But zoos must also accept that they can never fully re-create the historical homes of the animals they exhibit. What, then, should their practical goals in terms of naturalism

be? If we are to accept that the historical habitat of the animal can never be fully or truly re-created, naturalism in zoo enclosures must be defined in terms of the needs of animals, as Maple has, by ever-increasing animal wellness. In this model, naturalism becomes in service of a broader and more multi-dimensional understanding of animal welfare.

Animal welfare is also somewhat difficult to define, and varying definitions are found across the professional zoo literature. As Carlstead and Brown write, “It is important to remember that welfare is complex” (Carlstead and Brown 2015, p. 10). Markus Gusset and Gerald Dick, the Chief Conservation Officer and Executive Director for the World Association of Zoos and Aquariums, respectively, conclude that “Animal welfare is understood to vary on a continuum from very poor to very good” (Gusset and Dick 2015, p. 1). They go on to suggest that animal welfare is not as simple as minimizing the bad, but also to “promote positive welfare states” (Gusset and Dick 2015, p. 1). Terry Maple strikes a similar tone, arguing that “the concept of wellness should be synonymous with welfare... optimal animal welfare/wellness has become a major strategy driving the global zoo vision” (Maple 2010, p. 10). Maple also references WAZA's approach to delineating the terms of animal welfare. He notes that there is “no ambiguity in their message: The ethical and welfare issues involved in managing wild animals in collections need to be constantly addressed and evaluated. This is essential for the future of zoos and aquariums and for their ability to implement their core missions of conservation education and science” (Maple 2010, p. 10).

The Association of Zoos and Aquariums (AZA)-- the US-based body that accredits American zoos-- has established an Animal Welfare Committee, which created

an encompassing definition of animal welfare: “Animal welfare is the degree to which an animal can cope with challenges in its environment as determined by a combination of measures of health (including pre-clinical physiological responses) and measures of psychological well-being” (Maple 2010, p. 12). Places like Brookfield Zoo, in Chicago, have established dedicated departments to monitoring animal welfare, like their Center for the Science of Animal Welfare. They take a “holistic approach to animal welfare management... [which] involves a collaboration of many departments (animal care, veterinary services, behavioral husbandry, nutrition, animal welfare research and field research) working together to ensure that each individual... thrives” (Miller et al., 2015, p. 14). It is an increasingly influential formulation. As Orban et al. (2015) write, “Animal welfare in zoos is most often described as a combination of physical and psychological well-being. Welfare is defined as good is an animal is healthy, comfortable, well nourished, safe and able to express species-typical behaviors” (p. 18). It is therefore no secret to modern zoo professionals that animals are complex beings, and that taking care of them is a complex obligation. Zoo animal welfare requires taking care of all of an animal's needs, not just the physical. In a personal interview, the Phoenix Zoo's Rich Sartor summarized this concern well: “If you're really trying to do your best for these animals,” Sartor said, “You have to take care of the whole package. What are you doing for their minds?” (Auth. interview, 2016).

Taking all of this into consideration, the working definition of naturalism in the modern zoo community seems to mean a couple of things: a zoo enclosure is naturalistic to the degree that it a) uses natural substrates, live plants, flowing water, and the like; and

b) if it allows for natural behaviors of the animal. Animal welfare is generally defined as increasing both the quality and length of life for an animal, by caring for its physical, medical, and psychological needs. Knowing what these terms mean to the current zoo community is of paramount importance to this thesis.

For a greater understanding of the significance of these terms, however, it is important to examine the evolution of zoo enclosures that brings about the usage and importance of both naturalism and animal welfare.

Tracing the modern history of zoo enclosures, the threads of animal welfare and naturalism have continually recurred as motivations for innovation. On some occasions, they have been starkly at odds, but typically have similar goals. I will discuss these trends in the next chapter.

The pursuit of exhibit naturalism by zoos, as we shall see, reveals a number of tensions between zoos and the wild and provokes more than a few questions. If the operating definition of naturalism is increasing likeness to a place in the "wild," then it is imperative to understand that zoos are still quite far from recreating nature. There seems to be an understanding in the zoo community that they will never be able to exactly re-create nature. So what is the likely endgame of increasing zoo naturalism?

On the strictly physical level, there are a number of biological processes that occur within natural systems that are only partially understood. For example, it was only a little over a hundred years ago that the concept of nitrogen fixation was discovered, and this is now one of the most basic tenets of ecology. Scientists continue to learn about the complexities of ecological systems, and each new layer of complexity renders any hope

of perfectly recreating a natural area an impossibility. As an example, many zoos have created African plains exhibits in recent history. These exhibits usually feature large expanses of grasslands, water holes, and mixed species of varying number. However, to build an African plains exhibit that truly captures that landscape, a number of contextual questions must be answered. What part of Africa are you going to try and build a copy of? Plains and grasslands cover a vast amount of Africa, and they represent a number of different ecosystems. A place in Africa would have to be chosen that has the same physical characteristics as the analog in the US. It would need to have the same rainfall, climate, average sun, latitude, and all the other physical factors that dictate the ecology of a site. The analog site would have to account for the soil. What makes up the soil? How well does it hold water? Is it sandy or silty? What is the pH? This alone represents a chemistry problem of an unmanageable level. Just in the physical characteristics and soil, it is impossible to recreate a biome, let alone; without even considering any of the flora and fauna.

Increasing animal welfare is also a difficult concept. Zoos can assure themselves that they are meeting the physical and psychological needs of an animal, but are they really? How can we ever truly know what makes an animal "happy," or if that is an emotion they are even capable of?

The concept of "happy" is a human construct. Take a walk through any zoo, and there are ubiquitous comments from visitors about the happiness of an animal. "The tiger looks sad," they might say, or "The lion looks bored." These, however, are human emotions. It is impossible to know whether a lion prefers an enclosure, where humans

present various food items multiple times per day, or the Serengeti plain where they hunt and kill their food, and must guard it while they eat from scavengers like hyenas. Ultimately, a lion cares that its biological needs are met. There is no way to measure how valuable sprinting across a vast open plain is to a lion- perhaps they don't even care about having a vast open space. Perhaps they prefer a small, secure realm. After all, they do share over 95% of their DNA with the average housecat- who would certainly rather lay about and be waited on then have to catch their dinner. It is an ongoing task, as Maple will attest: "Good welfare is inherent in the operating philosophy of all successful zoos, but great welfare requires an extraordinary commitment throughout the organization" (Maple 2013, p. 11).

Indeed, looking at the history of zoo enclosures and the ways in which they have evolved over the last several centuries, it becomes readily apparent that both naturalism and animal welfare have played pivotal roles in each major paradigm shift for enclosure design.

2. ZOO ENCLOSURES: A HISTORY

The story of zoos and zoo enclosures is a complicated, convoluted and sometimes clumsy one. Their story, their evolution, and the themes of animal welfare and naturalism as motivators weave a tapestry that is centuries long. Even as civilization grows ever more citified and urbanized, humans still desire and seek out nature, in whatever doses they can achieve it.

Zoos are just one manifestation of this desire to be close to nature. Although their history with respect to animal welfare and naturalism is uneven, the growth and change from menageries and circuses to the modern, professionally-run zoological parks of today demonstrates significant advancements and improvements regarding animal care and the reduction of patent artificiality in enclosure design. The evolution of zoo enclosures in the modern era has been motivated by these two recurring, intertwined and occasionally opposing themes-- i.e., increasing and improving animal welfare and increasing naturalism. This evolution can be understood in a series of paradigm shifts in zoo design, beginning where human culture begins.

Animal Collections Before "Zoos": The Menagerie

The practice of keeping animals in captivity is nothing new to human culture. As animal studies historian and scholar Nigel Rothfels puts it, "...it seems that wherever and whenever there have been cities, there have been collections of unusual animals"

(Rothfels 2002, p. 35). Rothfels notes that ancient civilizations in Babylon, Greece, Egypt, and China all had examples of animal collections, as well as in South America. These collections served a number of purposes, but were largely kept as symbols of wealth or power; the way a wealthy person today might collect homes or cars (Rothfels 2002). All evidence of these enclosures shows them to be merely functional and utilitarian, consisting of little more than barriers preventing the animal from escaping. As these developing civilizations struggled to establish their own society, the likelihood that thought was cast toward the welfare of the animals is small.

Animal specimens were not only subject to the culture of the civilization to dictate the care they would receive; this relationship also determined the position they would occupy within the society. In ancient Egypt, archeological evidence suggests that a large animal collection was held at Hierakonpolis, the urban center of the civilization (Rose 2010). These animals were fed cultivated crops, and not only things that were native. There is also evidence that several of the animals had bone fractures and subsequent healing that only could have occurred in a "protected environment," demonstrating rudimentary veterinary care (Rose 2010). They were also interred in the cemetery with the elite of the society, indicating that they held a place of import for the persons they were interred beside. The appropriate care and respect that may have been afforded these animals was not without a cost, however, as it is believed that they were mostly sacrificed to either the gods or the ruler of the day, so he could take their power "as his own" (Rose 2010). So these early humans, with lives that would seem so basic by today's standards, still expended resources constructing enclosures and voluntarily cared for wild animals.

As the centuries wore on, the role of the captive animal remained relatively unchanged from ancient civilizations through the middle ages, all the way into the late eighteenth century. Animals were kept because they demonstrated elite power and wealth; acquisition and maintenance of collections were costly endeavors. The animals had little value other than their monetary worth; and the act of keeping them alive was as much about avoiding economic loss as much as anything else (Kisling 2001). These enclosures were made out of whatever materials were convenient, and created in one interest: that the animal be in plain sight. This directly reflects the purpose that they served: to be visible reminders of strength or opulence.

As the Age of the Enlightenment made scientific thought the order of the day and revolutions changed social orders around the globe, the first major paradigm shift in zoological enclosure design also took place (Stott 1981). This shift, which was actually several thousand years in the making, changed collections of animals from exclusive, private menageries to public zoological parks. Although the change to zoological parks did not happen as a result of trying to increase the naturalism of the exhibits themselves, hindsight reveals it to be the first step in naturalizing the zoo. Although scattered, these zoological parks utilized the inclusion of trees and landscaping. This brought other living elements inside the zoo with the animal inhabitants. It is notable that the shift from collections of animals in cages of pre-Enlightenment Europe to placing these cages into manicured lawns and landscaped parks was another minor paradigm shift. The Regent's Park collection of animals had long been kept as the Royal Menagerie at the Tower of London, in a predominately stone-and-bar system of enclosures, with stone walls and

floors. The shift from the dank stone hallways of the Tower of London to the richly landscaped and manicured Regent's Park demonstrates the desire to place the cages of animals in a more naturalistic setting. Here, visitors could enjoy rolling lawns, thickets of bushes, and stands of large trees. While the grounds of these new "zoological parks" contained many more natural elements, actual animal enclosures found themselves inside ornately designed buildings artfully placed on expansive lawns. Although the desire to view these animals in a more naturalistic setting had not yet extended itself all the way to the enclosures of the animals themselves, the places in which these cages were placed had become vastly more naturalistic (Ritvo 1987). So began the culture of incorporating naturalism into zoos, and an important first step in changing the ways animals in human care are presented.

The Rise of the Modern Zoo in the 18th and 19th Centuries

The change from menageries to zoological parks was driven by a number of different mechanisms and motivations. The changing political structures of the era manifested as revolutions in America and France, and democracy began to be a commonplace form of government (Ritvo 1987). As the populace became more powerful and more educated, the wonders of patrician menageries could be kept private no more. In France, a law was passed dictating that all exotic animals could no longer be privately held. These animals had to be either surrendered to the Menagerie at Marsielles, or killed and stuffed for display at Muséum National d'Histoire Naturelle (the French National

Museum of Natural History) (Howard 2011). The Menagerie at Marsielles was then quietly dissolved, and the Menagerie du Jardin des Plantes was established as a department of the museum in 1793. The Menagerie was immediately open to public viewing, citing education as a primary motivator (Howard 2011).

Figure 1: Patrons observe the Monkey house at the London Zoo in Regent's Park, 1835. The Monkey house exemplified the design aesthetic of zoo enclosures at the time: manicured, rolling lawns, large stands of trees, and landscaped gardens surrounded animals in ornate cages. The enclosures themselves had very little that could be considered naturalistic.Photo from the Museum of London's collection.

This theme of education and natural history was one that underpinned much of the movement from menagerie to zoological garden. Collections also went from being owned by a single person to governed by a zoological society, as in the Zoological Society of London. Founded by Sir Stamford Raffles in 1826, it sought to create a new zoological park for public consumption in Regent's Park, which is now known as the London Zoo (Ritvo 1987). A number of important discoveries regarding animal behavior were revealed by these new, scientifically-based zoos, and the London Zoo was no exception. Not only were things like rearing of joeys by kangaroos investigated on live animals at

Regent's Park, but Darwin also used the live monkeys there for his study on evolution (Hochadel 2005).

The Enlightenment caused a shift toward knowledge and education, and people sought to organize and understand the natural world around them. This increased thirst for knowledge also meant there was an increased interest in natural history, an interest zoos sought to fulfill. The understanding of the inter-relatedness of species was the basis for arrangement of animals within the modern zoo. In Regent's Park, a single route directed visitors past a series of side-by-side cages within buildings, only bars separating specimen from viewer. The contemporary understanding about the inter-relatedness of species dictated their taxonomic arrangement. This meant that zoos had animals grouped by similarity; with aviaries, monkey or reptile houses, and large cats grouped together. Examples of these taxonomic arrangements are ubiquitous in early zoological parks (Ritvo 1987). Because of the biological arrangement of species, the dedication to "education," and the labeling of specimens, The London Zoo is regarded as the world's first "scientific zoo" (Ritvo 1987).

The system of organization for the London Zoo was mirrored in zoos worldwide, as the desire for intellect and an understanding of the natural world spread around the globe. In the United States, the first zoo (Philadelphia) was chartered in 1859; although it wouldn't open until 1874 due to the turmoil of the American Civil War. Many more zoos would open in the ensuing decades, including the National Zoo in Washington, D.C. In 1889 and the New York Zoological Park (Bronx Zoo) in 1899.

In Europe, zoos all shared the commonality of lovely, manicured grounds;

assuring that the patron felt they were in a managed and cultivated version of nature. The animals remained in intricately-designed buildings, where they were readily viewable, as yet separated from that nature. This ornamentalism in design was not as popular in the United States. For one thing, zoos in the US had more acreage to work with and smaller budgets than their European counterparts. Even if designers had desired a large, ornate building, they could not have afforded it. For this, if no other reason, some animals in the new American zoos found themselves in more naturalistic settings (Ritvo 1987). Some who have studied zoo history extensively, like Jeffrey Hyson, don't feel this was entirely accidental. In his studies, he has found the inclusion of elements that harken back to the natural history of the animal to be deliberate; even if limited in scope. “For all their 'artificiality', as modern landscape architects have alleged,” Hyson writes, “the earliest American zoos attempted to replicate at least some elements of the natural environments their inhabitants had once known” (Hyson 2000, p. 27).

These new zoos, with their scientific basis, demonstrated the completion of the shift in zoo culture from ad hoc animal menageries to orderly zoological parks. As Elizabeth Hanson, a historian of science and author of an influential study on the evolution of the modern zoo, succinctly states: “The new zoos set themselves apart from menageries and traveling animal shows by stating their mission as education, the advancement of science, and in some cases conservation, in addition to entertainment” (Hanson 2002, p. 3). Especially in America, this new generation of zoos sought to increase interest in the natural world and subsequently encourage the protection of species and natural lands by interesting their patrons in nature, via the animals on display

(Stott 1981).

The "Hagenbeck Revolution" in Zoo Design

These incremental inclusions of naturalism in 19th century zoos set the stage for what is arguably one of the most major shifts in the design of zoo enclosures. "Hagenbeckization," or what is also often referred to as the "Hagenbeck revolution" in zoo design, was the start of the modern era of zoo enclosures (Stott 1981).

After the success of the London Zoo in Regent's Park, zoos soon opened all across Europe. The growth of zoological parks called for a steady and reliable source of animals to supply them; as the lifespan for many creatures in human care was not extensive. Although animal collection, trade and exhibition had long been a business, this created a boom and demand for order in what was a hit-or-miss industry. Carl Hagenbeck streamlined this industry, and became world-known as an animal collector, supplier and exhibitioner (Ritvo 1987).

Hagenbeck was the son of a German fishmonger who had accidentally fallen into animal exhibition in 1848, with six seals that had found their way into sturgeon nets. Carl's father exhibited these seals and made a profit; and soon became a collector and purveyor of animals other than aquatic. When Carl graduated school, he was given a choice: take over the family's fish business or the animal collection. Hagenbeck chose the animals (Hyson 2000).

With the collection he had inherited, Hagenbeck opened his menagerie in 1866. By the 1880s, it was a sound investment, with large groups of visitors each year

(Hancocks 2001). Even with a move to a larger site, he still dreamed of exhibiting animals in open air, as delineated in his autobiography:

> "I desired, above all things, to give the animals the maximum of liberty. I wished to exhibit them not as captives, confined within narrow spaces, and looked at between iron bars, but as free to wander from place to place within as large a limit as possible, and with no bars to obstruct the view and serve as a reminder of captivity" (Hagenbeck 1912 p. 20).

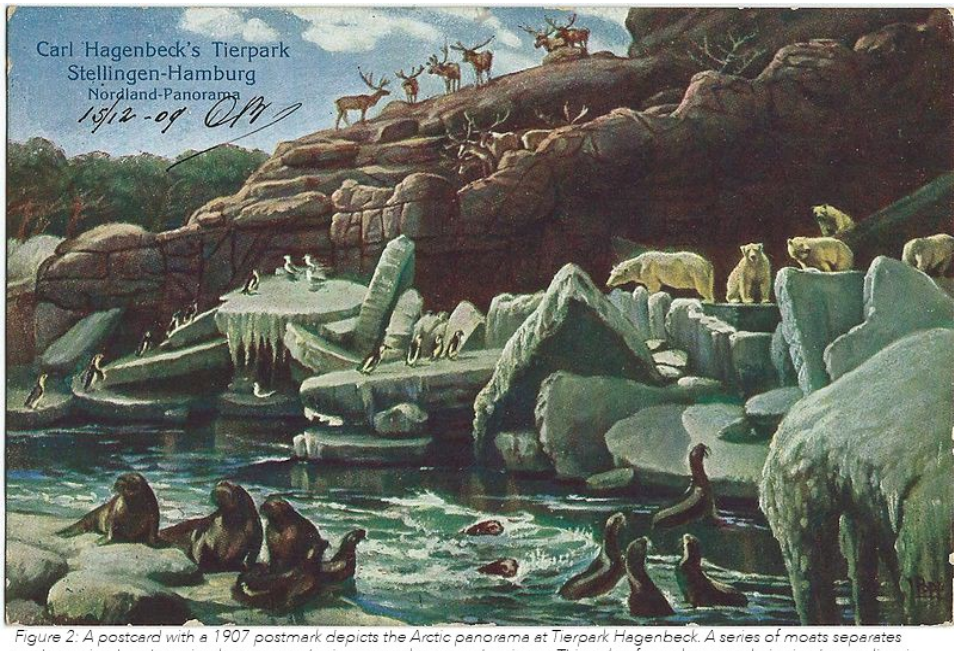

Figure 2: A postcard with a 1907 postmark depicts the Arctic panorama at Tierpark Hagenbeck. A series of moats separates each species, but the animals appear to be in one enclosure to the viewer. This style of encolsure revolutionized naturalism in zoo enclosures, as well as bringing about some incidental animal welfare increases. This enclosure does not, however, differentiate between different arctic climates, and penguins mingle with polar bears. Photo from a vintage postcard collection (wikimedia commons).

For the first time in the design of zoo enclosures, an innovator had articulated an explicit desire for a marriage of animal welfare and naturalism, giving his visitors an experience in animals that seemed uncaged. Hagenbeck set about designing his new zoo in Hamburg, Germany. It would open in 1907 (Hyson 2000). The major innovation of his design was to utilize spatial separation in place of bars. Using a system of tiers in progressively increasing elevation and separating them with moats, he could segregate animals without the viewer being able to perceive the barriers. He called these elaborate

enclosures “panoramas.” When his new zoo opened, it had two complete panoramas: Africa and the Arctic. The zoo was an “immediate and great success” and patrons came in droves to see lions and bears “unobscured by bars” (Hancocks 2001, p. 64-65). His was the first zoo in the world “to combine naturalistic exhibition landscapes, barless enclosures and regional groups of mixed species” (Kleiman et al. 2013, p. 124).

In addition to reducing the appearance of captivity, Hagenbeck had made another wide departure from traditional zoo design by his grouping of species on exhibit. He did not organize the zoo phylogenetically but rather sought to group animals according to climate. In this way, lions would be with giraffes and zebras rather than with tigers and panthers. This rearrangement, as it turns out, was partly accidental. He sought to incorporate different types of animals into one habitat, and because these species came from the same type of locations, they would logically share the same environment. The “accidental” nature was emphasized in the arctic panorama, where seals, penguins and polar bears all shared space. Although the climate of their natural habitats is similar, it is obviously not an accurate depiction of the actual distribution of these species in situ. Hagenbeck would go on to receive criticism at the time for the mixing of species of ungulates from all over the world in his Africa panorama (Hanson 2002). Although not geographically accurate, these panoramas were the largest scale undertaking of any zoo up to this time, and certainly set the bar for the enclosures that were to come. Hagenbeck had made it clear that animals belonged in a more naturalistic setting, one that more directly reflected the lives they had lived prior to being in human care. The responses of the visitors were also very positive, and it seemed clear that not only were

these types of enclosures better for the animals, but for the patrons, as well.

The American Response

The popularity of this new type of exhibit did not go unnoticed. American Zoo directors always visited Tierpark Hagenbeck when they would tour Europe's zoos, and recognized the awe these enclosures inspired.

A new director at the Denver Zoo, along with the landscape architect for the city of Denver, began plans for a large-scale habitat exhibit in 1912. This exhibit was to be the first in a series of exhibits that would make Denver a “habitat zoo,” as Hagenbeck's Tierpark had come to be known (Etter and Etter 1995). The panorama that they sought to replicate was a scene from the Colorado Rockies; both because of their ability to plant and maintain vegetation that belonged in their scene, and to bolster local pride. Painstaking effort was taken to recreate exact rock faces from places in the Rockies, including expeditions making their way up the mountains to take casts of the actual rocks and re-create actual places. The commitment to naturalism in the design of this new enclosure was extensive (Mills 1918). Unfortunately, this commitment to naturalism did not extend to the animals within the scene, but merely to the setting of the stage for exotic creatures to be exhibited.

The zoo touted their new exhibit as an improvement in animal welfare, especially for the bears in the new enclosure. Bears had historically suffered particularly dour conditions at zoos; usually housed in “bear pits” with steel poles in the center for them to

climb. When they climbed to the top of the pole, visitors could feed them (Hancocks 1971). Saco R. DeBoer, the landscape architect for the exhibit, wrote an article for the journal *Parks and Recreation* in 1918, saying that this new exhibit was a vast improvement upon the "damp pits, in which the sunlight could penetrate only to a little spot on the back wall" (DeBoer 1918, p. 4). He goes on to directly say that the exhibit is "trying to give back to them, be it in a limited way only, some of the surroundings they were removed from" (DeBoer 1918, p. 6). Clearly, improving animal welfare and increasing the naturalism were significant motivations for the exhibit; although these were not necessarily in harmony. Polar bears and monkeys, obviously not native to the region, would each inhabit this Colorado Rockies scene.

Following this, St. Louis would go on to build an elaborate African veldt exhibit in the same style, modeled after another Missouri landscape. The chosen landscape: granite boulders near Granitesville, Missouri. The painstaking replica of a local place housed lions, zebra and antelope; all native to lands far distant from the Midwest. The Cincinnati Zoo did something similar, placing their African animals in an exhibit modeled after on the shores of the Kentucky river (Stott 1981). There are numerous other examples of such exhibits in this era: modeled after local ecosystems, populated with exotic creatures.

While naturalism had vastly increased, these exhibits demonstrate an intrinsic disconnect between the naturalism of place and the species within them. "Naturalism" was present in these landscape panorama exhibits, but it was largely an aesthetic rather than an ecological understanding of landscape features that were considered striking or

interesting. The animals who would actually inhabit these exhibits were not housed in enclosures that reflected their natural or ecological history. In this way, naturalism in a certain aesthetic sense was increased, and there were incidental increases in animal welfare; but it was not yet the case that the animals were understood to be part of the ecosystem that was being re-created in the zoo.

Although some zoos sought to mimic the design of Hagenbeck's panoramas, it is important to note that this design aesthetic was not accepted wholly in the American zoo community. Some, like influential conservationist and founding director of the New York Zoological Park (Bronx Zoo) William T. Hornaday, were "dead set against" Hagenbeck-like exhibits. He felt that the size of these types of habitats made the space between the viewer and the subject too great; and said that those studying animals "always desire to get as close to them as possible" (Hanson 2002, p. 143). These exhibits also sought to improve animal welfare as Hornaday saw it, by increasing the areas the animals had to roam (Hancocks 2001).

The Bronx Zoo did have one major departure, however, which was a step forward in paying homage to the natural history of the animal. Rather than arranging animals taxonomically, the Bronx Zoo arranged their specimens according to continent. This allowed for animals of Africa to be in one area, rather than all the large cats together- a much more "naturalistic" arrangement of species (in that it paid homage to their natural history) than arranging them according to man-made taxa (Mitman 1996).

The "Bathroom" Model of Zoo Design

Although enclosures had been making strides forward for over a century, the early twentieth century brought about the next paradigm shift in exhibit design which was a definitive step backwards, both in naturalism and in animal welfare. Although intended to increase antiseptic conditions and improve animal health, exhibits ceased to have any natural elements and lost any intellectual interest to their inhabitants. These changes had incidental reductions in the mental well-being of the animals.

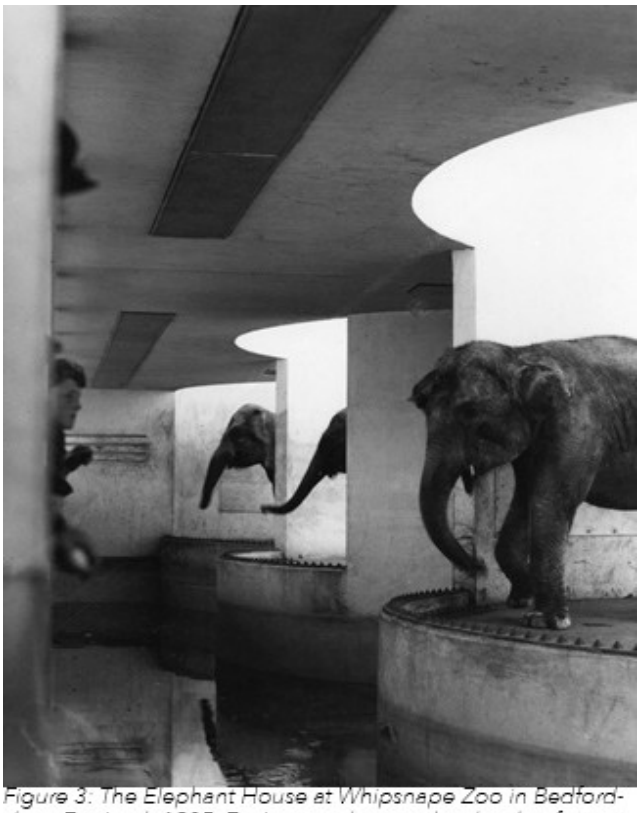

Figure 3: The Elephant House at Whipsnape Zoo in Bedfordshire, England; 1935. Enclosures designed in the disinfectant era were devoid of anything that could not be sterilized, and were a major step backward for naturalism. While the paramount concern was animal welfare, even that suffered as little was done to engage the minds of the animals or allow them to exhibit natural behaviors. Photo from the Architectural Press Archive.

In this era, germ theory had become the accepted method of disease transmission, antibiotics were discovered, and vaccination had proved effective in thwarting many

diseases of the time. David Hancocks, a former director of the Woodland Park Zoo, comments on this shift, noting that “The modern age began to associate progress with everything that was clean, open, bright, and streamlined,” and that “Architects sought functional expression in their buildings, uncluttered by ornament” (Hancocks 2001, p. 74).

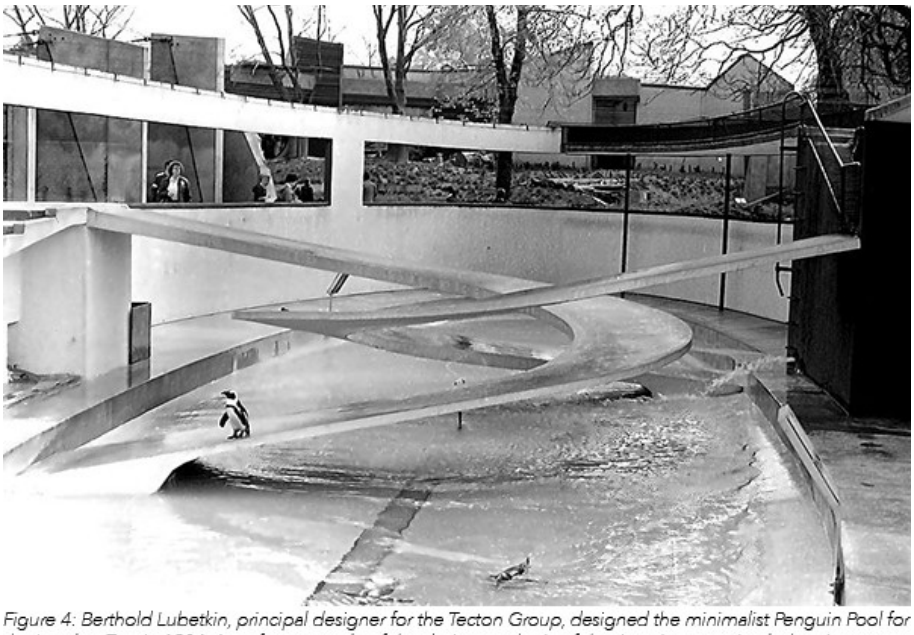

Figure 4: Berthold Lubetkin, principal designer for the Tecton Group, designed the minimalist Penguin Pool for the London Zoo in 1934. A perfect example of the design aesthetic of the time, it was praised when it was unveiled. Photo Credit: Gillphoto (Wikimedia commons).

He went on to say that, “This manifestation of scientific enlightenment as architecture heralded a depressing phase of zoo history. It was the start of the Disinfectant Era. 'Modern' meant efficient and hygienic. Thus animals from forests and deserts, evolved over millennia for life in complex and environmentally dense habitats, were now to live in zoo exhibits designed principally for water hoses” (Hancocks 2001, p. 76). Critics often refer to this phase as the “bathroom phase” of zoo design (Hyson 2000).

This movement toward sterility, in which many zoos adopted scientific purity,

meant that many zoo animals found themselves in “clinically sterile cages with walls lined in glazed tiles, usually white or pale green, smooth concrete floors, and cage furnishings reduced to a stainless steel pole and a cantilevered slab... plate glass denied even audio contact with the public” (Hancocks 2001, p. 77). The intentions of the designers were good: the ability to sterilize an exhibit would decrease the chances of disease transmission and perhaps illness. However, the toll that these exhibits, devoid of interest, took on the animal's psychological well-being negated any positive effects of reducing infectious agents. It is also of note that little was known about zoonotic diseases at the time, and even modern zoological medicine works with a number of unknowns about the etiology of afflictions of their patients; and it is entirely possible that there was no benefit to sterilization. With the small amount that was known about husbandry in this era, poor nutrition or lacking medical care likely were the cause of death for most zoo-kept species, and not the bacteria they sought to abolish.

Technology and progress were not always detrimental, however, and also began to be utilized in a number of beneficial ways in this era. When the National Zoo, in Washington DC, hired a new director in 1925, William M. Mann immediately set about re-vamping the zoo. He sought inspiration touring European zoos, and returned wanting to build a new reptile house modeled after the new one at the London Zoo. The Reptile house at the London Zoo was “the most technologically advanced building of its type in the world, incorporating electric heating with separate thermostatic controls for each individual cage and artificial ultraviolet lights as a substitute for sunshine” (Hancocks 2001, p. 98). Many of these technologies were state-of-the-art; both thermal controls and

ultraviolet light were invented less than a century before. The plans for the Reptile House at the National Zoo utilized these technologies. The mimicked other aspect;s of the London design, as well, utilizing skylights to allow in natural UV light, and detailed environmental controls for each display. The backgrounds of each enclosure were painted by well-known artists, and carefully placed foliage sought to complete the scene (Hanson 2002).

These exhibits, although well-meaning, did not serve the best interests of their animal occupants, and represented a stark reduction in naturalism, as well. While disease is a major concern among modern zoo professionals, building enclosures to allow solely for the control of bacteria is now recognized as incomplete animal welfare. These sterile enclosures, devoid of intellectual stimulation, also did nothing for the mental well-being of their occupants. Other practices of zoos in this era included controlling diets of their animals, utilizing nutritionally-sound, scientifically-designed biscuits as food sources. While this was a method of delivering all the biologically-required nutrients to the animal, it allowed for none of the foraging pleasure or interaction with natural food items. These biscuits also likely lost much of the flavor or texture of natural food items. Keepers were also prevented from changing the enclosures, adding intellectually-stimulating items, or changing the daily routines of their specimens (Hancocks 2001).

This era of sterility and technology demonstrated a serious problem within the zoo community. There was precious little literature and governance of zoos, their occupants, and their keepers. In the 1910s, the journal *Parks and Recreation* began publishing a periodical with anecdotes and tips from various zoo personnel, to share knowledge of

animal husbandry and enclosure design, in an attempt to rectify the dearth of literature on the subject. This periodical, the official communique of the American Institute of Park Executives, was just the beginning of professionalizing zoo care. The American Institute of Park Executives would create the first professional associate of zoo managers in 1924, called the American Association of Zoological Parks and Aquariums (AAZPA) (Hanson 2002).

Organizing zoo directors and sharing expertise were good steps in standardizing animal care and zoo management, but real guidelines of best practices for animal husbandry were still decades away. It wasn't until 1950 that the first comprehensive manual of animal husbandry for zoo animals was published by the Swiss zoologist Heini Hediger. His book, *Wild Animals in Captivity: An Outline of the Biology of Zoological Gardens* (1950), and the subsequent tome *Studies of the Psychology and Behaviour of Animals in Zoos and Circuses* (1955) outlined the best practices for maintaining wild animals in human care. He argued that the quality of the space occupied by the animals was every bit, or more, important than the quantity of space. Hediger relayed the concepts that animals live in widely varied habitats, and that monotonous day-to-day care routines do nothing to mimic the natural lives of these animals, leaving them intellectually un-stimulated. *Wild Animals in Captivity* stated that there were two main ways that the environment of a captive animal could be enriched: spatially or temporally. Spatially, the exhibit itself could be augmented with additional items of curiosity of play; such as logs or branches. Temporally, the schedule of that animal's life should be changed from time to time, to avoid monotony of timing. It was noted that one of the

causes for pacing was the knowledge that feeding would happen in a specific place at a specific time, and changes to an animal's schedule helped alleviate this. Hediger was ahead of his time, however, and his instructions would be given little credence until decades later (Hyson 2000).

1960s and 1970s: Animal Rights, Environmentalism, and the Woodland Park Model

As the 20th century wore on, animal welfare concerns became even more salient for the public and the zoo community. This was especially true in the 1960's, when movements of social and political change sought to make society more equal in all ways. The Animal Welfare Act of 1966 (AWA) was the first legislative act governing the care of animals used in experimentation, commerce and exhibition. The AWA set forth specific guidelines limiting the pain and suffering an animal can be put through, as well as minimum standards of space and care. There are a number of limitations to this legislation, however, as the definition of what is to be considered an "animal" are somewhat narrow: anything that is cold-blooded or hollow-boned is not included (reptiles [Reptilia] and birds [Aves]). This meant that zoos had to start meeting some standards of care that were now mandated and checked by government. Although other guidelines now exist, such as those governing endangered species of for accreditation by the Association of Zoos and Aquariums (AZA) or the International Union for Conservation of Nature (IUCN), the AWA remains the sole piece of legislation that governs the welfare of zoo animals, even today.

As the animal welfare reforms of the 1960s gave way to the increased animal

activism of the 1970s, efforts that were in turn spurred by the appearance of key texts like Peter Singer's widely read book, *Animal Liberation* (Singer 1975), "Animal welfare science" soon also became a tenet of zoo governance. As behavioral biologist Georgia Mason writes, animal welfare science "evaluates the wellbeing of animals controlled by humans... [and] includes the welfare impacts of enclosure sizes and housing conditions that prevent species-typical natural behaviors" (Mason, 2010, p. 713). Improving the health and well-being of animals in human care became paramount to zoo keepers and directors (Maple 2015).

In addition to the animal welfare movement, another important factor in the increase of interest in animal welfare within the zoological community was simple supply-and-demand. Three separate laws were passed in the late 1960s and early 1970s (Animal Welfare Act, Endangered Species Act and Convention on International Trade of Endangered Species of Wild Flora and Fauna) that governed the trade and import of endangered species, making the acquisition of these species ever more difficult for zoos. In addition, increasing deterioration of natural habitats and human pressures continued the decline of wild populations, adding more and more species to the endangered list. Animal welfare had to become a matter of utmost importance; if for no other reason than to lose an animal was a serious financial loss that could not be easily re-couped. The loss of an animal also created a hole in a collection that could not be easily replaced. The health, well-being and longevity of zoo animal specimens was now more important than ever (Hanson 2002). This time period also saw a wider understanding of animals as beings, and that they had intellectual needs as well as physical. Zoos began to try and

cater to the knowledge that animals were at least relatively sentient beings who could suffer from things like boredom and monotony.

Equipped with empirical knowledge about the psychological needs of animals, the intuitive belief that animals needed to be in more naturalistic enclosures, and new laws governing their care; the zoo community was poised for the last major paradigm shift. "Landscape immersion," a movement born at the Woodland Park Zoo in the 1970s, continues to be the standard of enclosure design into the current era.

A new veterinarian was hired at Woodland Park Zoo, in Seattle, in 1972. James Foster was influenced by Hediger's texts about caring for animals in captivity, and firmly believed that the mental well-being of the animals in his care was every bit as important as their physical health. With almost no funding for their efforts, Foster and the animal care staff set about making as many changes within the enclosures as they could, creatively altering the environments of their charges (Hancocks 2001). Addition of branches and trees to the primate house gave the occupants hours of swinging and climbing in an enclosure that had nothing inside it but two bars (one vertical and one horizontal) for nearly seven decades. This was a vast departure from the preceding sterile era- sticks could not be cleaned or sanitized and required replacement. A natural cover of hay was also added to the floor of the primate house, and snacks were hidden within it so the primates could forage for them. Doing these relatively simple things allowed for the primates to exhibit a whole slew of natural behaviors they had not been able to in their sterile enclosure, embodying the hope that the minds of the animals could be cared for as well as the basic physiological needs (Hyson 2000).

This time period at Woodland Park demonstrated over and over again that even simple alterations can change the life of a captive animal. For many of these exhibits, the ways in which the animals responded was clearly indicative of a greater ability to behave more naturally. When shrubs were planted in the enclosure for Snowy Owls, a mother owl laid eggs and raised young; something that had never happened before. In the caracal lynx enclosure, an effort was made to replicate the substrate of the cat's natural desert habitat by adding sand, rocks, sagebrush, tree branches and gravel to the otherwise sterile environment. The caracal still had access to part of their enclosure that was not improved, and this is where they were fed. It was found that the cats spent more than 80% of their free time in the more naturalistic environment, when given the chance. When they were fed, they would even drag their food into the more natural setting to eat it (Hancocks 2001).

With empirical evidence that animals could flourish in environments that were more akin to their historical ecosystems, the Woodland Park Zoo decided to take this success one step further. When zoo administration decided to implement a new long-range plan, their first step was to declare that their main client was the animals, rather than the guests. This alone was a major departure from the historical governance of zoos; wherein the animal was a mechanism to get the viewers to visit. This shift, to catering to the animals rather than the people, would become a tenet of zoo management dogma that has carried through to today (Hyson 2000). The notion is simply that a happier, healthier animal is more likely to engage in natural behaviors within their enclosure, and that this is ultimately what people want to see. Social psychology research suggests that visitors

walk through the gates of a zoo with pre-determined ideas of what they expect each animal should be doing: monkeys swinging from trees, tigers stalking, otters frolicking. When their enclosures encourage greater health and well-being, and allow for the manifestation of these behaviors, not only are the animals are better off, but the visitors leave with a better attitude toward the animals they have just seen, as well (Kellert 1989).

Figure 5. The entrance to the Gorilla Forest exhibit at Woodland Park Zoo demonstrates their dogma of landscape immersion, where the guest feels as though they are in the same landscape with the animals. Photo Credit: K. Boyle.

Placing the needs of the animals above all else, Woodland Park went outside of the norm and hired landscape architects to help design new enclosures. Grant Jones, one of the principals of the Jones & Jones design firm, had already committed to an "Nature-first" design aesthetic; catering to animals in a zoo seemed a natural next step. Jones & Jones also had a groundbreaking method of determining the topography of a landscape, allowing them to most accurately determine what could and would thrive there. It was this method that they used to map the whole of the Woodland Park Zoo grounds, and to

determine which areas of the zoo would best lend themselves to re-creating different ecosystems around the globe. This was the first instance that a zoo used a landscape architect to guide the future of the grounds and their animal enclosures. David Hancocks, former director of Woodland Park, notes that this was important because "landscape architects work with landforms, natural systems, climate, micro-habitats and vegetation" (Hancocks 2001, p. 138). Woodland Park hoped to harness all these aspects to create exhibits that would benefit the planet, their animals, and guests.

Rather than arranging animals in traditional phylogenetic or geographical groups, exhibits were planned based on bio-climactic zones. This was a throwback to what Hagenbeck had accidentally stumbled upon, i.e., that housing animals in naturalistic exhibits makes the most sense when this is done based on climate rather than strict evolutionary relatedness or geographic origin. Woodland Park was so committed to creation of bioclimatic zones that logically flowed into one another that they created a tundra zone between the arctic and temperate forest, that would house musk ox and caribou; neither of which were species owned by the zoo at that time (Hancocks 2001).

The first exhibit that Woodland Park sought to overhaul was that of the lowland gorilla. John Coe, a renowned landscape architect who wrote his master's thesis on animal environments, was also tapped to join forces with Jones & Jones for this exhibit. Coe based his design largely around field research by Jane Goodall and others, desiring to create a space that allowed for as many of their natural behaviors as possible (Coe 1996). The gorilla exhibit was to mimic upland forests of West Africa, with hills, vegetation, natural substrate, and even flowing water. Functional design aspects included

areas to retreat from sight, heated rocks on which the gorillas could lounge (located conveniently where visitors could see them), as well as full size trees. The proposal for this exhibit, when presented to other zoo professionals, was met with skepticism and criticism. Zoo directors and animal welfare activists cited examples of gorillas destroying any vegetation within their exhibits, ingesting inappropriate plant matter, or falling from heights as obstacles to such an exhibit-- and said that these design features would actually endanger the gorillas they were meant to delight (Coe 1996). Coe and Woodland Park were undeterred.

Design and implementation of the exhibit moved forward, in a style that Coe would come to call “landscape immersion.” While the idea of naturalistic exhibits had been utilized in different ways throughout the history of zoos, even Hagenbeck's elaborate panoramas made the viewer woefully aware that they were outside the habitat, looking in. Woodland Park sought to do away with all of that. Visitors would enter an ecosystem and be wandering through the landscape long before they would see an animal, almost as if seeing them by chance (Coe 1989).

When the gorillas were first released into their habitat, the design team, zoo management and keepers all held their collective breath. They were uniform in their belief that this was what was best for these animals, but there was little or no concrete data gathered within a zoo to support this belief. When the first gorilla was allowed into the new habitat, it was the male leader of the troupe. He entered with some trepidation-- he had spent his life on concrete and stone, and seemed confused by the natural substrate. It didn't take long, however. Soon all the gorillas were freely roaming in their new

habitat. The group seemed more at ease, tensions and fights no longer broke out among them, and overall, it seemed it was a success. The small, nondescript area that once housed the gorillas full-time now served as their private quarters, away from human eyes (Hancocks 2001).

The success of this exhibit was watched warily by other zoos; many of whom were convinced that the gorillas would either destroy the habitat, not take to it, or that the public would have a great outcry. None of these things happened. David Hancocks summarizes the transition, likening it to Hagenbeck's panoramas:

'Landscape immersion' has now become a byword in the zoo profession

Figure 6: A view into the expanisive Gorilla Forest at Woodland Park. Barriers are disguised in whatever way possible, and natural substrates and foliage abound. Photo: K. Boyle.

since its 1976 introduction at Woodland Park Zoo... In many ways, the

> breakthrough of landscape immersion at Seattle in the 1970's mirrors the events at Stellingen in 1907, when Hagenbeck introduced his panoramas. There was initial rejection and bitter denunciation by many zoo professionals in both instances, followed by wholesale duplication (Hancocks 2001 p. 139).

True to his words, landscape immersion became the standard for zoo enclosures in the 1980s. Although not every exhibit was a resounding success; it seemed clear that the way to exhibit and house animals in captivity, at least for zoos, was intelligently designed naturalistic enclosures that allowed for a maximum number of natural behaviors to be exhibited. These represented the ultimate marriage of naturalism and animal welfare.

Figure 7. A steel cage and the surrounding guardrail of the previous gorilla exhibit are nearly obscured by over-growing plants at Woodland Park Zoo . This space is hidden behind gates marked "Employees Only,' a few dozen yards from the current immersion enclosure. This space is now an extra playroom for the gorillas to visit. This cage was once their sole home, and demonstrates how far enclosure design has come. Photo: K. Boyle.

Conclusion

In less than two centuries, definitions for both naturalism and animal welfare had

changed drastically in the zoo community. Naturalism has come to mean what is essentially a recreation of the native habitat of the animal, harkening back to the natural history of their species. Although still not explicitly defined, naturalism in the zoo setting means that substrates should be things found in nature- dirt, sawdust, hay, grass. It also means that the exhibit itself should incorporate design features that can be found in those ecosystems, like water features or large trees, when appropriate. Animal welfare has also had a dramatic shift in interpretation by the professional zoo community. While the earliest collections of animals sought to do little else than to care for the physical needs of the animal by being sure they were fed, given water, and kept out of the elements; there was little or no attention paid to the "higher needs" of the various species. Animal welfare has come to be understood as the well-being of the animal as a whole, including engaging their intellect and natural skills. An exhibit in which a monkey cannot climb or swing or a zebra cannot graze is no longer considered to be an exhibit which cares for all the needs of the animal.

These two tenets of design find their stories intricately interwoven in the century and a half of zoo history, and often are mutually enforcing. Increasing naturalism by placing trees and branches in gorilla exhibits also increases animal welfare, although the goal was initially to increase naturalism. Other times, as in the disinfectant era, the desire to increase animal welfare (by preventing disease) essentially gutted the exhibits of anything that could be even remotely considered naturalistic. Even now, in the modern era, if there is a conflict of animal welfare versus naturalism, most zoos will relax their standards of naturalism to ensure the highest level of care for their animals.

These two pillars of enclosure design are not the only ones that govern, however. Somewhere in this equation has to be the major player of visitor experience. The modern immersive exhibit has every bit as much to do with visitors and education as it does naturalism and animal welfare; taking people to the place in the world where the animal could be found historically. The immersive exhibit hopes to show the visitor this place, tell them about this place, and ultimately get them to care about this place; although it is somewhere they may have never been and may never hope to be. It is at this convergence of many masters that modern zoos make their home; trying to engage and educate their visitors, while being faithful to the natural world and providing the highest standard of care for their animal charges.

The history of the evolution of zoo enclosures is one that continually finds itself propelled by animal welfare, naturalism, or both. In retrospect, some of the paradigm shifts, like the "bathroom model" of enclosure design can seem misguided. However, when one looks more closely at the motivations of the time, even this seemingly-backwards model had the best intentions-- improving animal health-- at its origin. This desire, to make the lives of their charges as full as possible, is one that will come up again and again in interviews with zoo professionals, as we shall see in the next chapter.

3. MODERN ZOO DESIGN: A VIEW FROM THE FIELD

Without a doubt, stepping into a modern, accredited zoo is a much different experience from a century ago. This is, by no means, accidental. Following the Woodland Park model, naturalistic immersion exhibits are now the norm, and zoos have clearly become much more than a postage-stamp collection of animals. Speaking with zoo directors, architects, keepers, and other professionals in the field paints a picture of a complex institution that must serve a number of interests. Zoos have developed their own terminology, missions, legislating bodies, and scientific institutions-- and have conservation partners around the globe. These new goals, however, do not release them of their need to remain financially viable. This means that while animal welfare is paramount, the needs and preferences of the visitors are also a primary consideration. It is also important to note that there are plenty of zoos that are not accredited, do not answer to any governing body, and who seek to do little more than draw in as many visitors as possible. For these zoos, neither animal welfare nor naturalism are primary (or often even significant) concerns; visitor experience (and sales) are valued above all else. But even at accredited zoos, there are varying definitions and models of naturalism, and a range of ways that design principle interacts with animal welfare.

All of these factors (animal welfare, naturalism, visitor experience, education) contribute to what the zoo community views as a "good" zoo exhibit. Differences aside, there is a resounding belief across the field that, as Terry Maple, director emeritus for Zoo Atlanta and founding editor of the journal *Zoo Biology*, puts it, "Zoos have been

transformed" (Hanson 2002).

To gain a better understanding of the diversity of current views regarding the evolution of zoos and especially the design improvements facilitating the enhancement of animal welfare and naturalism, I interviewed a number of zoo professionals and scholars. Over the course of two years, I visited six different AZA-accredited zoos and met with animal care directors, architects, and administrators. These facilities ranged from massive zoos, with huge operating budgets (like the San Diego Zoo and the San Diego Zoo Safari Park) to relatively small zoos, like Arizona-Sonora Desert Museum. Additionally, I attended a zoo symposium regarding the future of zoos and conservation, and spoke with a number of experts in the fields of animal care, visitor experience, and zoo management. These professionals answered questions, took me on guided tours of their exhibits and animal care facilities, and allowed me to photo-document their institutions.

A number of themes arose in these interviews with the zoo community, including an emphasis on conservation and education, increasing naturalism, the benefits of accreditation and oversight, and visitor experience. I identify these themes, all of which exemplify the intersection of animal welfare, naturalism and entertainment where the modern zoo exists.

In the next chapter, three case studies are presented as examples of navigating this tenuous crossroads. These specific institutions, Woodland Park Zoo, the Arizona-Sonora Desert Museum and the San Diego Zoo Safari Park, each house at least one exhibit that has been awarded the top prize by the AZA for enclosure design. Each of these zoos also represents some type of innovation, or departure from the norm, that makes them

exceptional in terms of modern zoo development. This chapter focuses on a more general discussion of the changing nature of zoos and zoo exhibit design based on my conversations with zoo professionals and zoo scholars.

The Evolution of Zoos: Reflections from the Zoo Community

The view that zoos have changed drastically over the last hundred years resonates across the entire zoological community. For example, Monica Lake, a Projects supervisor at Woodland Park Zoo, underscored that, "What we called a zoo in the early 1900s and what we call a zoo now are two very different things" (M. Lake, personal interview, July 13, 2016). Even those who are skeptical about the necessity of zoos, like historian Nigel Rothfels, concede that, "Quality of life for animals in zoos has improved" (N. Rothfels, personal interview, November 7, 2015). Still, the uneven and incomplete paradigm shift from the older menagerie model to the more naturalistic/ecological vision is acknowledged by many zoo leaders today, including Rick Barongi, the former director of the Houston Zoo and one of the masterminds behind Disney's Animal Kingdom. "Zoos were designed to be recreation and entertainment facilities and now we're trying to be conservation organizations," Barongi has observed, concluding that, "It's [going to] be a long journey" (R. Barongi, personal interview, November 6, 2015).

The definition of what it means to be a zoo is obviously very different from the times of the 19th century zoological garden. But what exactly, according to the zoo community, has changed? Nancy Hawkes, the General Curator at Woodland Park Zoo (WPZ), points out that many people don't spend the time outdoors that older generations

did. “The audience is mostly urban; people who don't get out into nature as much. Our job is to provide a window to that nature” (N. Hawkes, personal interview, July 13, 2016). Craig Ivanyi, the director of the Arizona-Sonora Desert Museum (ASDM), a hybrid zoo-natural history museum-biopark located outside of Tucson, echoes the sentiment: “Our educational role is being a window to the natural world,” and “What matters to me is that you've had an impact on biodiversity and that you've connected people with nature” (Auth. interview, 2015).

The notion that education is the most important role of the modern zoo came up again and again in my discussions with zoo leadership at the institutions I visited. Hawkes said the most important role of the modern zoo was “educating people” (Auth. interview, 2016), as did Lake, who said that having guests learning and caring “on behalf of wild animals” (Auth. interview, 2016). Robyn Badger, the architect for the Zoological Society of San Diego, also highlighted the themes of education and nature; saying that the role of modern zoos “has to be making people more aware of their environment” (R. Badger, personal interview, July 18, 2016). Interestingly, zoos can also use their position to educate the public about conservation partnerships, as Rick Barongi points out, “Our main justification for having zoos nowadays is to get the public to understand and appreciate that by coming to see those animals you are helping to save the animal in the wild. We have to connect to the wild” (Auth. Interview, 2015). This same sentiment, that people could be made to care about the wild by visiting a zoo, was one that has a historical analog with Hornaday's vision for the Bronx Zoo. It's a view that draws the partial assent of Rich Sartor, the Director of Living Collections at the Phoenix Zoo.

Sartor agrees that education is of utmost importance, but for a slightly different reason: "Education is our most significant contribution. We try and do what we can with the conservation part, but we're not gonna save the world just with conservation efforts. We have to indoctrinate as many people as possible to know and care about the environment" (Auth. Interview, 2016). Badger agrees, and thinks exhibits should inspire visitors. She

Figure 10: The walkways at Woodland Park are as much a part of the immersion as the enclosures themselves. Here, in the rainforest biome, overhead support is designed to look like a fallen tree, and surrounded by actual foliage, drawing the visitor in. Photo: K. Boyle.

wants guests to leave "fired up to make a change" (Auth. Interview, 2016). This does, however, create another crossroads where zoos have to negotiate their position carefully. How can they educate their visitors without overwhelming them about complex and still often polarizing environmental issues like climate change? It seems that too much information about environmental issues overwhelms the average visitor, and leaves them with a feeling of powerlessness (which can lead to a complete lack of action on their part). Zoos have to try and find the perfect amount of information for guests to feel they

can take action, rather than feeling overwhelmed or alienated (Kaufman 2012).

As we've seen, enclosures have obviously been a major point of change within the zoo community, and have come a great distance from the bars and concrete floors of the past. The increasing embrace of naturalism was noted by many zoo professionals. Badger, for example, pointed out that "Moving away from the sterility of exhibits is a huge change" (Auth. interview, 2016). Sartor, who has been in the zoo industry for nearly 30 years, has seen firsthand the change from sterile exhibits to the more naturalistic ones of today. Indeed, when you ask him what has changed in zoo exhibits, he responds: "Leaving he bars and concrete behind for more naturalism" (Auth. interview, 2015). When he began working as a keeper, "fears of germs were a governing

Figure 8: Zoos consider education of their guests to be of the utmost importance. Signage like this, at Woodland Park, educates about current problems facing the Humboldt penguin. Hopefully, visitors will see and interacgt with the animal on exhibit, and take away knowledge about the animal from the interpretive materials. Photo: K. Boyle.

principle" in enclosure design (Auth. interview, 2015). Enclosures had to be designed such that everything could be sterilized, and it was widely accepted that a natural substrate would lead to health complications for animals in zoos. This is no longer the accepted norm.

On the subject of animal welfare, one of the most unilateral, and thus striking, things about speaking to those employed by zoos is their careful word choice. Indeed, the nomenclature of the industry is one of the things that an outsider will immediately pick up on when speaking to a series of zoo professionals. Whichever institution they work for, how they speak about what they do is uncannily uniform. "Captivity" is no longer used, the preferred form being "in human care" or "managed care." The places where animals spend time is their "exhibit", "habitat", or "day room," not their "cage." What were once "holding areas" are now their "bedrooms." Even the names of the institutions themselves have changed to reflect their changing motivations. What were originally called menageries, then zoological gardens, then just zoos, have morphed into much more highly complex names, such as the Phoenix Zoo, which recently changed the name of its supporting organization from the Arizona Zoological Society to the Arizona Center for Nature Conservation. The change in terminology reflects the different missions that modern zoos have; many of which were not even a consideration in the time of their predecessors.

Several professionals commented on this; i.e., that the mission of zoos has changed, and that has had a large influence in the changing definition of zoos over the last century. Hawkes puts this simply: "The mission of zoos has moved from

entertainment to centers of conservation and education" (Auth. interview, 2016). This change in mission is reflected in a number of ways, not the least of which is answering to governing bodies, like the Association of Zoos and Aquariums (AZA). The AZA was founded in 1924, and today, holds its member institutions to the highest standards of zoos. It is worth noting that it is not required that a zoo be a member to function as a business, but zoos not accredited by AZA cannot participate in species survival plans, animal loans, and other programs governed by AZA. There are currently approximately 230 facilities approved by AZA in the United States; but even Shelly Grow, the Director of Conservation programs for the AZA, will admit that "this does represent fewer than 10% of the animal facilities in the United States" (Grow 2015). For this reason, it is important to realize that AZA zoos are the top tier of zoos in the US, and house the rarest species, give the most to conservation, and work the hardest at being centers of education.

That being said, it is worth noting that most zoos tend to emphasize their education and conservation aims, although these projects may constitute only a small percent of their annual operating budget. Conservation is one of the many aspects of zoo management that the AZA requires participation in. This is left very broad, however. The language of the AZA's accreditation standards does not require a minimum percent of the annual operating budget for any of their institutions has to be devoted to ex-situ conservation activities, but only that criteria are met for types of conservation activities the zoo engages in (AZA.org 2017).

Rich Sartor explained that accreditation, "Is a big deal," and that, "Every year the

bar is raised" (Auth. interview, 2015). This means that the standards AZA requires are more exhaustive every year. He also commented on the four pillars of AZA accreditation, "Conservation, science, education and recreation," which are widely embraced (Auth. interview, 2015). Rick Barongi echoed his sentiment about the importance of AZA recognition, saying that the design standards they set forth are a "big consideration" in any new project. Being an AZA zoo is an ongoing project, as well, as he went on to say that, "Knowing that every five years you are going to get inspected [by AZA], keeps everyone honest" (Auth. interview, 2015). The AZA also works to ensure that zoos are abiding by their mission statements, and keeping them at the "forefront of everyone's minds," as Badger put it, adding, "Mission statements are becoming more and more important all the time" (Auth. interview, 2016). As an example, the mission statement of her institution, San Diego Zoo Global (SDZG), is "San Diego Zoo Global is committed to saving species worldwide by uniting our expertise in animal care and conservation science with our dedication to inspiring passion for nature" (San Diego Zoo Global). To embody their mission statement, SDZG has employed a number of scorecards that can be used by zoo staff and visitors to grade exhibits and features on a number of scales, including animal welfare and visitor impression. Their scores of animal welfare include lack of stereotypical behaviors and time spent engaging in natural behaviors, as well as where the animals spend their time in the exhibit.

Nancy Hawkes said that they use their institution's mission statement, "Woodland Park Zoo saves animals and their habitats through conservation leadership and engaging experiences, inspiring people to learn, care and act" (Woodland Park Zoo) in "everything

we do" (Auth. interview, 2016). Sartor voiced a similar sentiment: "Hopefully it [our mission statement] governs everything we do" (Auth. interview, 2015). This represents one of the major paradigm shifts for modern zoos. Prior to the modern era, there were few, if any, standards that zoos sought to maintain. AZA governance, and granting of accreditation, means that AZA zoos can interact with one another and know that any animal that moves between them will be given the same standard of care across the board, as well as a number of other requirements. It is also only AZA zoos that participate in population-level species management, governed by Taxon Advisory Groups (TAGs) and Species Survival Plans (SSPs), diligently working to secure genetic variability and species viability for generations to come.

But AZA accreditation also has other benefits. The modern consumer is much savvier than those of generations past, due largely to the accessibility of information. The ASDM's Craig Ivanyi noted this trend: "People these days are much more in tune with animal welfare." Zoo visitors can easily look up whether their local zoo has AZA approval. The availability of information also means that anytime there is a tragedy in a zoo, such as an animal death or human injury, the story is quickly spread across the internet and social media.

One such instance recently took place at the Cincinnati Zoo and Botanical Garden. In May of 2016, a young boy got away from his mother and snuck into an animal enclosure where lowland gorillas were housed. A wide moat separated visitors from the gorilla, and the boy made his way under a three-foot fence, through four feet of brush, and fell into the moat. While the two females in the enclosure made their way inside

when directed to by keepers, the adult male, Harambe, went to investigate. Eventually, with Harambe in possession of the young boy, the zoo made the decision that they would have to shoot him to save the boy (Streithorst 2016). A video taken of the incident went viral on the internet, and sparked a worldwide debate over animals in captivity. This is just one example of a zoo story becoming worldwide news, and creating debate about the ethics of zoos. Even before the Harambe incident, Barongi said, "An accident in your exhibit is horrible" (Auth. interview, 2015).

In addition to the readily available nature of information and news in the modern era, there also plenty of groups seeking acknowledgement both on the web, in print media and on television. Well-known and vocal animal rights groups such as People for the Ethical Treatment of Animals (PeTA) make their ethical opposition to zoos quite clear:

> PETA opposes zoos because cages and cramped enclosures at zoos deprive animals of the opportunity to satisfy their most basic needs. The zoo community regards the animals it keeps as commodities, and animals are regularly bought, sold, borrowed, and traded without any regard for established relationships. Zoos breed animals because the presence of babies draws zoo visitors and boosts revenue. But the animals' fate is often bleak once they outgrow their "cuteness." And some zoos still import animals from the wild (People for the Ethical Treatment of Animals).

Captive Animals' Protection Society (CAPS), another group deeply critical of zoos, puts it directly, "We believe that wild animals belong in their natural habitat and should not be caged for our entertainment" (Captive Animals' Protection Society). With so many voices in the debate about animal welfare, accreditation from the AZA lends credence to the mission statements of the zoos they approve, and gives visitors a sense that they are supporting a zoo with a wider mission, that is working to make a difference.

Moving away from an institution that is focused primarily on entertainment to one that is a center of conservation and education is certainly not without obstacles; not the least of which is making sure that visitors get what they want. Sartor puts it very simply: "If the zoo's [going to] exist, it has to be a successful business" (Auth. interview, 2015). Without visitors coming through the gates, there is no funding for all of the zoo's other work. It is sometimes a difficult line to walk, and compromises have to be made. In the words of Rick Barongi: "If we take the fun out of it, we're not going to have the money to do the conservation. There's going to be trade-offs here" (Barongi 2015).

His statement gives a tiny sliver of insight into the world of zoo enclosure design; which is riddled with compromise, trade-offs, and reconciling myriad tensions between seemingly opposite camps.

Keeping visitors happy is clearly a major source of tension in designing a zoo enclosure. Barongi, Badger and Hawkes all talked about making emotional connections between the visitors and the animals. Barongi talked about teaching his interpretive staff to "Tell stories," and not to "...just regurgitate facts they can read." He also talked about personalizing the animal to the public, and encouraging staff to share stores specific to a particular animal: "...they [visitors] want to know about *that* gorilla" (Auth. Interview, 2015). Badger had a slightly different take. She wants to design zoo enclosures that allow the public to interact with the animal in some way. "If guests can interact with the animal," she says, "There is a more emotional connection" (Auth. interview, 2016). Hawkes said, "Making an emotional connection" was the second most important contribution of modern zoos (Auth. interview, 2016).

No matter their stance on emotionally engaging their guests, the zoo community is in relative agreement about what the public wants to see: animals that are active. Hawkes told me, “Visitors want to see a big, active animal” (Auth. Interview, 2016). Likewise, Robyn Badger said that visitors want to “See the animal is active” (Auth. Interview, 2016). And at the Phoenix Zoo, Rich Sartor also agreed, saying that visitors want “Big, active animals... or something with a high 'cool' factor” (Auth. Interview, 2015). While this seems like it should be a relatively easy goal to accomplish; the fact is that many animals exist on far different circadian rhythms than humans do. Hawkes commented on visitor expectation of animal behavior, saying that sometimes it is difficult because visitors sometimes “Put a human measurement on a very different animal” (Auth. Interview, 2016). In the case of an animal like the Koala, they sleep up to 20 hours a day (San Diego Zoo Global)-- and trying to convince a wild animal that these four hours of activity should be during peak visitor times is not something the average marsupial (or any other wild animal, for that matter) seems to respond to. The next best thing? “Proximity,” states Barongi simply, “We have to get the public as close as possible.” He goes on to say that “Visitors want to get as close as they can,” and that a major challenge when designing a zoo enclosure is “Getting the people as close to the animal as possible, without sacrificing safety” (Auth. interview, 2015).

The theme of safety was another source of tension that arose several times in many of my interviews. One obvious group of interviewees who listed safety among their top concerns were the zoo administrators. As mentioned above, some, like Barongi, listed safety as his top consideration when designing a new enclosure: “The number one

consideration is safety- of the public, of the animal, and the keeper" (Auth. interview, 2015). He also brought up safety again, when talking about design challenges, telling me that the biggest challenge is "making barriers invisible without sacrificing security" (Auth. interview, 2015). Others, like architect Robyn Badger, said her designs are assessed by a Risk/Safety Manager, and that she always has to include things like safety rails and accessible walkways.

Badger's biggest design obstacle, however, was another that was felt at other zoos- "reconciling the budget" (Auth. interview, 2016). At Woodland Park, Hawkes said the biggest challenge in exhibit design was simply "cost" (Auth. interview, 2016). Badger went on to point out that there is the added layer of complexity in design that the budget is a dynamic factor-- she won't design something that is likely to break, or will be expensive to fix if it does break. "If something breaks down, that requires funds to fix, too," she says (Auth. interview, 2016).

Because of the sizable footprint of the San Diego Zoo's two campuses (San Diego Zoo and San Diego Zoo Safari Park), Badger has the luxury of large spaces in which to design her enclosures. This is not the case for most zoos; many of which are land-locked in the midst of cities, national parks or suburban sprawl, and cannot increase their borders. "Having adequate space is always an issue," according to Sartor (Auth. interview, 2015). Rick Barongi also talked about the space of the enclosure, understanding that space is typically limited. "You can reduce the size [of the enclosure]," he says, "But don't reduce the quality." Especially when reconciling a budget, he has noticed that there is a tendency to build bigger exhibits that don't have the

quality of enrichment or design. “Don't be obsessed with 'bigger is better,'” he warned (Auth. interview, 2015).

Advances in technology have certainly assisted in increasing the quality of the space allotted for enclosures. In the case of aquatic exhibits, it used to be nearly impossible to do underwater viewing for many species, because of the lack of water clarity. Nigel Rothfels said he had seen a major improvement in aquatic systems, which allows for better filtration of the water, allowing visitors to see below the surface: “You used to never be able to see a hippo underwater, and now it's [the water] perfectly clear” (Auth. interview, 2015). Sartor talked at length about technological advances in enrichment; including devices that allow the public and the animal to interact, if even indirectly. Other advances include a vast increase in the knowledge about animal behavior, especially those in human care. Badger has used this to her advantage. When she was designing her award-winning Tull Family Tiger Trail exhibit, she took into account the recorded behavior of the tigers in their old enclosure. In that enclosure, the tigers tended to spend much of their time near the entrances to their bedrooms; particularly around mealtimes. In her new exhibit, the entrances to the tiger's bedrooms are disguised within the main part of the exhibit, so that when the tigers choose to spend their time there, they are in excellent position for the visitors to see them.

Given that actually re-creating nature in all its intricacy and diversity is an impossibility, the relationship between naturalistic exhibits and animal welfare is a complex one. As both animal welfare and naturalism are multi-dimensional, getting these many facets to align is daunting. It is inevitably where the design process must start,

however. “They evolved in a natural setting, so, for me, that's your standard to shoot for. As best you can approximate that, the better,” says Sartor (Auth. interview, 2015). Hawkes says that one must “Start the design process with the animal's natural history in mind,” because doing so will allow an animal to engage in the widest array of natural behaviors (Auth. interview, 2016). This is how she defined naturalism, in terms of an exhibit- “A tiger being able to act like a tiger, or a monkey being able to act like a monkey” (Auth. interview, 2016). For her colleague, Monica Lake, naturalism means that visitors “don't really know where the edges are” (Auth. interview, 2016).

Hawkes brought up another interesting point when she was talking about naturalism. She feels that naturalism in zoos is two sided, and should include the visitor as well as the animal. She was talking about Woodland Park's landscape immersion model, and having the visitor in the same landscape as the animal; but this is one more point of contradiction in the zoo world. How natural is too natural? Visitors want to see active animals, engaging in natural behaviors, but what about predation? Most visitors would feel very uncomfortable watching a tiger stalk, kill and devour a prey animal in their enclosure, or having their children witness it. So as naturalism in enclosure design is a distilled approximation of nature, it would also seem that the public wants an animal to behave in a way that is also an edited version of reality; another limitation that zoos must cater to.

Although naturalism may have differing definitions, there is very little disagreement about whether or not naturalistic exhibits are better for animals. When Robyn Badger was asked how important animal welfare was in planning a new exhibit,

she laughed a little. “First and foremost, we have to be looking after the animals.” She conceded that animal welfare and naturalism “may be at odds,” but also agreed that more naturalistic exhibits are “definitely” more promoting of animal welfare (Auth. interview, 2016). She gave specific examples of times making compromises between these two tenets, as we will see. Her sentiment was one shared by Sartor, who said he does find naturalistic exhibits to be more promoting of animal welfare. He also said that he “found it to be wholly true” that naturalistic exhibits were “just better” (Auth. interview, 2015). While these exhibits are better for animal welfare, it was also noted that caring for an animal does not end with designing an amazing exhibit. Hawkes points out: “Animal welfare is more complex than just the naturalistic exhibit” (Auth. interview, 2016).

The welfare of the animals in their care is of utmost importance to those who work in zoos, a theme that arose over and over again. “The animal needs have to trump everything else,” according to Sartor (Auth. interview, 2015). In his mind, to make sure an animal welfare is the best it can be, comparing the behavior of an animal in a zoo to that of one in the wild is ideal. Behavioral ethograms of wild animals, dictating how much time they spend doing various activities, can be compared with those animals in human care, to assure that the animal is acting like it would in the wild. “We provide, in a human managed space, the best quality of life we can, knowing that they've traded off a wild existence” (Auth. interview, 2015). Much of the responsibility of monitoring animal welfare falls to the keepers, who spend the most time around the animals. “Keepers are the best judge of this [animal welfare],” Hawkes says (Auth. interview, 2016). Barongi agreed: “The quality of care is non-negotiable. You have to have good keepers” (Auth.

interview, 2015).

This is another major change in the zoo industry in the modern era: “there is a new generation of zoo keepers,” according to Barongi (Auth. interview, 2015). These professionals are both highly educated and well trained. Whereas animal care used to fall to a staff member who was also responsible for cutting lawns and cleaning bathrooms, keepers are now scientists and biologists. “Being a keeper has become a bona fide profession,” in the words of Sartor (Auth. interview, 2015).

Modern zoos operate at a complicated crossroads. This means they are always struggling to reconcile various positions, many of which are seemingly at odds. “It is a marriage of multiple things,” Ivanyi points out, “There's an age old tension of form versus function” (Auth. interview, 2015). Badger, as an architect, feels the pressure to please all of the interested parties. “We're conducting everything,” she says; “It is hard to reconcile a lot of things. That's the challenge of it, really” (Auth. interview, 2016). Managing the various strands of the modern zoo mission was a recurring theme among the professionals I spoke with. “The challenge is balancing everything,” Barongi noted (Auth. interview, 2015). In Phoenix, Sartor feels both the tension and the dilemma: “Trying to satisfy the multiple constituents... it's part of our challenge. There's always a tension there” (Auth. interview, 2015). Usually, this tension is eased with through a process of give-and-take. “A group of people-- directors, keepers, curators, wildlife experts-- sit down and fight it out... You have to compromise,” according to Barongi (Auth. interview, 2015). Indeed, the theme of compromise is woven deeply into the process of enclosure design and zoo management. It's a situation that demands that

everyone has to give up something. As Craig Ivanyi put it, “Most likely, nobody gets *exactly* what they want” (Auth. interview, 2015).

Much has changed from the menageries of old to the modern zoos of today, but that does not mean that animal welfare, naturalism, and the business of the zoo co-exist without tension. Zoos still have to keep visitors happy, which means that they are ultimately responsible to tame, contain, and present nature in a way that is not always completely authentic. A continuing struggle for the administration of these parks is how much naturalism is too much? What will offend visitors? In addition, these institutions have substantial overhead costs to keep the zoo functioning, and this leaves little money for devotion to conservation and education, although these are the reasons for the existence of zoos most widely touted by the professional zoo community.

Today, zoos occupy every biome in the United States, and welcome 175 million guests each year, to create a five billion dollar-a-year industry (Gusset and Dick 2011). In touring these zoos, a guest quickly becomes keenly aware of their surroundings. Zoos are no longer rows of barred cages where animals sit on a neat row, as they once were, but are now dynamic, with goals that extend far beyond entertainment. In today's exhibits, malleability and intelligence of design are paramount to allow for the unpredictability of what are, ultimately, still wild creatures. The complex management of zoos is perhaps best summarized by Ivanyi, who has spent 32 years at the Arizona Sonora Desert Museum: “We have to balance the needs of the animals with the needs of the

visitors with the needs of the people that are taking care of them" (Auth. interview, 2015).

What Makes a "Good" Zoo Exhibit?

Having explored the many considerations that go into the planning and execution of a new zoo exhibit, it is important to consider what exactly defines the success of that exhibit. The opinions of zoo professionals and academics are important, but perhaps not as concrete as the definitions provided by the Association of Zoos and Aquariums.

What is a good zoo exhibit? It depends on who you ask. On one end of the spectrum, you have animal rights groups. According to them, there is no such thing as a good zoo exhibit. On the other extreme end are unaccredited zoos or other animal facilities that think any space at all is perfectly fine for an animal. Somewhere in the middle lie groups like the Association of Zoos and Aquariums, who feel that there *is* such a thing as a good zoo exhibit (and a bad exhibit), and that a high-quality zoo exhibit must meet a comprehensive set of standards in a number of categories to be considered as such. This middle group, also includes the members of AZA-accredited zoo staff, who similarly believe that there are good exhibits and bad exhibits, and that all possible measures must be taken to assure they do not have any of the latter. Beyond simple accreditation, the AZA also gives awards each year for outstanding exhibits. These exhibits are educational, exciting, engaging, and earn approval for the highest standards in animal care.

As with most any topic posed to a number of zoo professionals, consistent themes

emerge when they are posed with the question of what constitutes a good zoo exhibit. One such theme that emerged was that a good exhibit gives animals choices. They can be given choices about what substrate to stand or sit on, to be in view or not, to be warm or cool, wet or dry, inside or outside. Rich Sartor, Zoological Curator at Phoenix Zoo, classifies a good exhibit as one that "satisfies animals' needs, and is not torture for the animal care staff to maintain" (Auth. interview, 2015). He goes on to say that animals should be given opportunities for choice about their environment. The exhibit itself should be "challenging, interesting, they [the animals] engage with it," in his mind, and "engage their minds as well as the physical needs they have" (Auth. interview, 2015). The theme of engagement also came up with Nigel Rothfels, who said a good exhibit should be "Intellectually, socially and ecologically significant and interesting for the animal and public" (Auth. interview, 2015). Terry Maple states it very simply: "The goal... should be to provide every animal in the collection with an environment that optimizes health and welfare" (Maple 2013, p. 2).

As far as what the AZA considers to be a good exhibit, Rick Barongi, who was a longtime chair of the Honors and Awards Committee at the AZA, is an excellent person to ask. He spent years reviewing applications for outstanding exhibits in AZA zoos, and deciding upon each year's winners. What is a good exhibit to the chairperson of the AZA Honors and Awards Committee? According to Barongi, a good exhibit has three major pillars: it is good for the animal, good for the keepers, and good for the public. As far as what that means, he defines what is good for the animal as something that "elicits natural behaviors," a place that is "habitat" and not just an "enclosure," as well as making sure

that where the animal is spending time behind the scenes is up to the same standards (Auth. interview, 2015). In the case of the keepers, he wants their safety to be paramount. As far as what is good for the visitors, he wants the exhibit to be one where people can see the animal. He wants to get the public as close to the animal as possible. He wants the animal at eye-level of the visitor or above, helping "leaving people in awe." He poses the questions, "Does that exhibit connect back to the wild?" and "How is that exhibit helping to save animals in the wild?" (Auth. interview, 2015).

Across the zoo industry, there are themes that emerge in the categories of animal welfare, naturalism, and visitor experience. Most of the zoo professionals I interviewed emphasized the conservation and educational aspects of their institutions, although these aspects reflect relatively little of an annual operating budget. If education and ex-situ conservation activities are truly to become the main aims of a modern zoo, the amount of funding devoted to them will have to increase. Ultimately, modern zoos, and the professionals who are spending their lives working in them, are working to innovate the juxtaposition of entertainment, animal welfare and naturalism; while doing what they can to help the wider natural world.

As we will see in the next chapter, three zoos (Woodland Park, Arizona-Sonora Desert Museum, and San Diego Zoo Safari Park) have managed to find new ways to improve the lives of their animals and their visitors, making them of particular interest as case studies in progressive enclosure design.

4. EXHIBIT NATURALISM AND ANIMAL WELFARE: THREE CASE STUDIES

Introduction

This chapter explores animal exhibits at three AZA-accredited institutions, Woodland Park Zoo, the Arizona-Sonora Desert Museum, and San Diego Zoo Safari Park, zoos that have been recognized over the years for their outstanding enclosure designs. Each of these three zoos has made a departure from what is the norm, which makes them particularly enlightening as case studies for this project. As mentioned earlier, Woodland Park Zoo was the birthplace of the model of landscape immersion, and the first institution to put the visitor in the same habitat as the animal they were encountering. The Arizona-Sonora Desert Museum has decided to fully embrace exhibit naturalism, and only display animals native to this high desert in the American Southwest. In San Diego, the Safari Park is the first off-site facility to increase the footprint for it's parent zoo, and has now become a destination unto itself.

For this project I conducted site visits of each zoo (often more than once), and I conducted interviews with key members of the staff, many of which have already been referenced. I also created photographic images of their award-winning exhibits, highlighting specific design features of relevance to this study. This chapter will therefore document three distinctive examples of what the professional zoo community considers to be a “good” exhibit with respect to naturalism, animal welfare, and visitor experience.

Birthplace of Immersive Landscapes: Woodland Park Zoo

By any standards, Woodland Park Zoo is a wonderful place to visit. From the moment you pull onto the grounds, in North Seattle's Phinney Ridge neighborhood, you feel like you are in the wilderness. Although some of the city's tiniest, most narrow streets can be found in this part of the city, a single turn into the parking lot at Woodland Park takes you into a coniferous oasis, where huge firs shield you from the city beyond, in what they call a "landscape buffer." The ticket booths and entrances are further ensconced in trees, and passing through the gates takes you into an open pavilion, where you immediately are greeted with an immersive exhibit. This was no accident, according to Monica Lake, the Projects Supervisor at Woodland Park: "Immediately, as soon as you come in the gate, you have an animal experience" (Auth. interview, 2016).

Figure 11: Immediately upon entering the park, visitors are greeted by the Humboldt Penguin exhibit. This view, from above, embodies the Zoo's design tenet of "One visitor, one exhibit," meaning that sightlines are manipulated so that no visitor is looking across the exhibit at another. Photo: K. Boyle.

This shouldn't take anyone by surprise. As we've seen, Woodland Park was the birthplace of the landscape immersion movement in enclosure design, and set a new bar for naturalism of a zoo in the late 1970s and 1980s. Even today, Woodland Park continues to earn accolades for their efforts in enclosure design, sustainability and conservation efforts. The zoo's 93-acre campus was purchased by the city of Seattle in the late 1800's, and has been open to the public ever since. The work of Jones and Jones, a Seattle landscape design firm, on the Gorilla Forest exhibit "married architecture and landscape architecture" (Hanson 2002). Since then, nearly every one of the seven Woodland Park zones has won an exhibit award from the AZA (six in total). Unlike other naturalistic exhibits before them (such as the Hagenbeck style), landscape immersion included the guest, the walkways, the entrances-- the whole zoo. "The difference between Hagenbeck and immersive landscapes," Lake says, "is that the guest and the animal are in the *same* landscape." This is the major departure from the norm that makes Woodland Park exceptional. They were not the first zoo to have naturalistic exhibits, but they were the first to make the whole zoo an immersive experience.

After you make your way through the park's West Entrance, the animal experience you are greeted with isn't just any animal experience- it is the AZA Exhibit Award Top Honor-winning Humboldt Penguin Experience. "Crystal clear waters" lap against rocky shorelines with numerous small dens and hiding places. A downward sloping visitor path leads to plexiglass domes below the surface of the water, oriented sideways so guests can get into them, sit, and look around. These allow visitors to feel as though they are underwater with the penguins, where they swim past and interact with

your fingers. “The goal is that you are in the landscape with nature,” says Lakes. A study in immersion, it is just a first experience of one of the major tenet's of WPZ's enclosure design philosophy- one visitor, one exhibit.

But what does “one visitor-one exhibit” mean? At Woodland Park, it means that visitors are supposed to feel like their viewpoint is the only one looking into an exhibit. This is accomplished by the careful manipulation of sight lines. They call these “protected views,” and examples are all over the zoo. From one side of the African savannah, it is impossible to see the visitors on the other side. The same is true of the grizzly bear enclosure, on the Northern Trail (also an AZA award winner)- where views from three different points never allow you to see another visitor peering into the exhibit. Even when seated in one of the underwater half-bubbles at the Humboldt penguin exhibit, the angling of them makes it such that you can't see a guest seated in the other one- even though it is only a foot and a half away. Similarly, when viewing the avian species from the above-water vantage point, boulders block the view of the underwater bubbles and lower viewing areas.

If you ask Nancy Hawkes, Woodland Park's General Curator, what makes a good exhibit, she has a very specific idea about what that looks like. “The most important thing is that the animals have an opportunity to express a repertoire of natural behaviors; like species-appropriate mating, territoriality, hunting, etcetera.” She also stresses the importance of holding areas, saying they need to “be as positive an area as an exhibit” (Auth. interview, 2016). This reflects another trend other zoo professionals mentioned, that anywhere an animal spends time must be of equal quality; even if it is never

viewable to the public.

As with other zoo professionals, Hawkes wants animals to have choices in their exhibits-- about where they are, what they are doing, and whether they are in view or not. Lake calls this allowing the animals to have “prospect and refuge opportunities,” also espousing the importance of giving the animals choices (Auth. interview, 2016). She subscribes to the landscape immersion model, and sees the whole zoo as a cohesive unit. There is a “need to put the animals in context” (Auth. interview, 2016). Hawkes' statements demonstrate that Woodland Park knows what a “good” zoo exhibit is. Their model for enclosure design, immersion, has neatly married naturalism and animal welfare, while including and educating their visitors.

When the Woodland Park team began trying to enrich the spaces of animals in the 1960's, despite budgetary restrictions, they essentially invented both the terminology and

Figure 12: The lower viewing areas for the Humbolt Penguin exhibit include underwater viewing, with three-dimensional portholes that allow guests to feel like they are under water, as well. Photo: K. Boyle.

practice of enrichment for captive animals. “Enrichment” is a blanket term that that refers to any variety of activities that can occupy an animal within their enclosure. Although the US Congress wouldn't pass amendments to the Animal Welfare Act that would require

Figure 12: Penguins swim and play in their enclosure at WSoodland Park. Photo: K. Boyle.

animals in captivity to receive intellectual stimuli as well as caring for their basic needs until 1985, Woodland Park staff had begun trying to improve the quality of the spaces for animals for almost 20 years, with the installation of a new director in the 1960s (Young 2003). Delivering food in an interesting or unusual way is one type of enrichment. Adding a toy or object to an enclosure is another way of changing the space for an animal. Hawkes also likes the idea of using enrichment items to draw the animals into the view of visitors; a positive experience for everyone.

Interestingly, enrichment doesn't only benefit the animal, and improve the quality of their space, it also benefits the public. Knowing that what visitors want to see are active animals, giving them toys is an effective way to not only engage their minds; it allows visitors to see them in action. Hawkes points out that there is research supporting the idea that visitors do not mind the break in naturalism of an exhibit by the addition of a toy or man-made object- as long as it is an object of interest to the animal. Keepers at

Figure 13: A polar bear plays in the water, chasing treats frozen in a block of ice at Point Defiance Zoo. This enrichment, with so many interpretive opportunities and highly enjoyed by the animal, is ideal. Photo: Mike Baehr (Flikr)

Point Defiance Zoo and Aquarium, just south of Woodland Park in Tacoma, freeze whole salmon in the middle of large barrels, making giant ice cubes. These "cubes" are incredibly buoyant, in addition to housing a tasty treat, and the bears at Point Defiance play for hours with them, knocking them around, pouncing on them in the water and trying to hold them under the surface. These ice treats, sometimes also containing produce, are a good example of a way in which naturalism is at times relaxed in the face of animal welfare. While a polar bear eating an apple is not perhaps the most natural

thing in the world, there are other benefits of these enrichments. By referencing the natural region of the animal and their omnivorous dietary requirements, there are numerous opportunities for interpreters to educate the public about the animal while the latter are amused by the spectacle. This little bit of frozen water not only entertains the bear and enchants the public, but offers a nod to the historical, native habitat of the animal, as well as their dietary needs and lifestyle. It thus opensthe door for educational and interpretive opportunities with guests about melting sea ice and global warming. This makes this an ideal enrichment. This innovation of using enrichments to "trick" the public into learning about their animals seems so simple, and is now a major tenet of zoo animal care that found its birthplace in Phinney Ridge.

Leaving the exemplary Humboldt Penguin Exhibit, a short walk takes you to the biome of the tropical forest, which is divided into African and South American forests. The Asian forest is to the right, and the first enclosure is that of the Jaguar. The overhead barrier is designed to look like a giant fallen tree, and is a rather convincing replica. "Wow, that's cool!" says one visitor as he points out the tree to his companion. Nothing but glass divides the visitor from the prowling felid, sleek and dangerous. Children stand at the glass, eye-to-eye with an animal that could eat them if given appropriate motivation and opportunity.

Venturing into the African tropical forest takes you to where landscape immersion began: the 1976 Gorilla Forest exhibit by Jones and Jones. Although now more than 40 years old, and certainly no longer the most cutting edge or advanced exhibit of its kind, the Gorilla Forest is still awe-inspiring. Walking into a wooden building that feels

something like a deck or lean-to, you come to a series of windows that open onto an upward sweeping expanse of forest. A stream flows down the hillside, and full-size fir trees dot the landscape. Boulders form the upper edge of the hill, but there is no obvious barrier to the forest. Just beyond the glass, rifling through some hay, is a full-size female gorilla. She moves pieces of straw this way and that, occasionally picking things up and placing them in her mouth. This female gorilla, foraging for tidbits of food in her hay, was demonstrating the effectiveness of an original enrichment created at WPZ. Although separated from visitors by glass, she can't be more than three feet away. She is busy with her own goals, and hardly takes notice of visitors passing by. Wooden slats create the roof, from which hang roots and leaves; as well as vines that are growing overhead. The edge of the walkway looks as though it was dug in; contributing to the lean-to feeling. Interpretive signs convey educational materials about gorilla news, welfare and conservation, all framed with logs and in neutral colors of browns and greens. This is landscape immersion at work.

Walking on, a second set of windows opens on another swath of forest. The first hillside is nowhere in view, although only a short distance has been traveled. This section of forest is completely separate from the first, and Lake explains gorillas are alternated between the two areas. This is one more way of creating variety in the animal's lives; they do not go to the same exhibit every day. Just past the viewing areas for guests, where the principle of one-visitor, one-exhibit is absolutely employed, lies a gate created by screwing real branches and sticks to a metal frame. The gate, with its weathered wood, blends seamlessly into the temperate Northwest forest; with the exception of the white

sign emblazoned in red with “Employees Only.” Lake comments on the privileges that being a zoo professional can afford, like entering such areas. Behind the gate, a short trip through northwest forest leads to a concrete plaza. A hexagonal metal and mesh structure is nearly obscured by the trees that grow around it. It can only be defined as a cage; and the thickness of the wires makes looking into it difficult. A thick metal structure winds around the cage, and it becomes apparent that this was a guard rail at some point. Bushes and grasses have now almost completely overgrown it, but it slowly becomes clear that

Figure 14: Guests enjoy the Gorilla Forest exhibit at Woodland Park Zoo, experiencing landscape immersion at work. Photo: K. Boyle.

this is what was the gorilla exhibit prior to 1976. This area now serves as a playroom for the gorillas- an extra space they can wander to, out of sight of the visitors. It is a tangible reminder of how far zoos have come in enclosure design in a very short time. No more than a hundred feet away from the intelligently designed forest, full of environmental complexity and enrichments, is a steel cage with a concrete floor.

Back out through the gate, to where the visitors are, a baby gorilla toddles through

the exhibit and picks up a branch. She swings it over her head and begins pulling the branch apart, flinging leaves this way and that. The branch was a cut piece of fresh browse, not a permanent fixture in the enclosure; just another nod to the constant efforts of zoo staff to give their animals things to do and choices in their lives.

Walking away from the gorillas, toward the next award-winning exhibit, the African Savannah, you are definitely left with a sense of awe. “Wow,” you think to yourself, “that was cool.”

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Walking the grounds of Woodland Park's campus, it is obvious that it benefits from the ecosystem in which it is constructed. Rich soil and plentiful Northwest rain allow for plants to grow into very large backdrops, and spaces that are not cleared and manicured quickly fill with vegetation. As visitors travel from exhibit to exhibit, the pathways are lined with lush green bushes, towering trees, and birdsong. The zoo has made itself so hospitable, numerous animals that are actually wild call the zoo their home- heron, wild rabbits and other native birds all mingle with the zoo's chosen inhabitants, of their own free will.

At Woodland Park, a good zoo exhibit must engage the visitor in the same landscape as the animal. This immersion model creates the illusion of an effortless harmony between naturalism, animal welfare, visitor experience and education. Like any zoo, however, Woodland Park still has challenges. As is the case for most zoos with long

histories, WPZ was established within a city and is now land-locked by its borders, which cannot be expanded. As they move forward, the WPZ creative design and management teams will have to find new and clever ways to continue evolving without increasing their footprint.

Eschewing the Exotic: Arizona-Sonora Desert Museum

Not every zoo has the benefit of a welcoming climate. While many may have balked at the arid expanse of desert just northwest of Tucson, the Arizona-Sonora Desert Museum has certainly embraced the unique, sometimes harsh, desert climate it finds itself in.

Arriving at ASDM is similar to arriving at Woodland Park, in that there is also a landscape buffer. This landscape buffer, however, is 91,000-acre Saguaro National Park. Fourteen miles from Tucson, ASDM is not in the middle of a city. Driving in to the "museum" (a term that masks the hybrid nature of ASDM as zoo, botanical garden, natural history museum, art gallery and, most recently, aquarium) gives you sprawling views of hillsides covered in native saguaro cactus, found only in Arizona. Craig Ivanyi, a three-decade veteran of ASDM and the current director, characterizes this setting: "Your experience starts long before you get to our gates" (Auth. interview, 2015). David Hancocks, a former director of both Woodland Park and ASDM, puts it eloquently:

> To arrive at the museum, visitors travel through several miles of desert, immersed, even before they begin their tour, in a world of rocky mountain peaks and gorges and a marvelously rich variety of cholla, prickly pear, ocotillo, palo verde, and other unusual plant forms, most notably the giant saguaro cactus. There is no requirement for visitors to suspend their belief and try to imagine that they are in a natural habitat. The crisp light, the susurrant sounds, the characteristic scents of sage and creosote and the constant chattering of cactus wrens, the wide and dramatic vistas- all combine to make a powerful sense of a special place (Hancocks 2001, p. 202).

Ivanyi sees this immediate immersion as both "a blessing and a curse." "There's no question that you're immersed in the desert," he says (Auth. interview, 2015). His woe is also this immersion: those "dramatic vistas" that Hancocks loves so much mean the

nearest population center is also fourteen miles away, and lack of public transportation means getting visitors through those gates is a constant challenge.

The complete immersion, though, has obvious benefits. When it comes to naturalism, it's no secret that Ivanyi and ASDM have a distinct advantage: all of the animals in the zoo are native to the Sonoran Desert biome. This makes ASDM the

Figure 15: Driving in to the Arizona-Sonora Desert Museum takes you through the majestic landscape buffer of Saguaro National Park, involving the visitor in the ecosystem long before they enter the gates themselves. Photo: K. Boyle.

ultimate in landscape immersion, and a clear departure from most zoos that seek to exhibit the exotic. If the belief is that an animal's natural habitat is the most promoting of animal welfare, and thus the best possible enclosure space for that animal, then ASDM also boasts some of the most animal-friendly enclosures around. Furthermore, housing and exhibiting only native species means there is little or no alteration necessary to the existing terrain to make an extremely naturalistic habitat. For some species, like the river

otter, significant modifications are necessary, because a river may not run through the zoo grounds at the right place, and certainly wouldn't have underwater viewing opportunities if it did. For most animals, however, there should be little modification necessary to the actual substrate to accommodate their lifestyles. Theoretically, these enclosures should also be more than adequate for the animal's welfare needs, because this is their historically native habitat. At ASDM, this also means that 85% of the zoo's exhibits are outdoors. “It's easier to have more things outside year-round,” Ivanyi says (Auth. interview, 2015). Walking the paths between exhibits, the visitor never has to imagine traveling between ecosystems, they remain immersed in the same ecosystem as the animals. This also means that designing an enclosure at ASDM doesn't always mean trying to replicate nature, nor building a facsimile of contrived nature, but typically containing actual nature. No one has to struggle to carefully design every aspect of the landscape, because the zoo is the landscape, and the landscape is the zoo.

The marriage of nature and zoo at ASDM makes the starting point for enclosure

Figure 16: Craig Ivanyi, the director of the ASDM and an employee of more than thirty years, leads the way down Desert Loop Trail. Boundaries are particularly difficult to discern at ASDM, where the edges of exhibits just give way to more vast expanses of desert. Photo: K. Boyle.

creation somewhat beyond other zoos, with design features on a level many zoos can only imagine. One example of this is the way in which things that are human-created within the museum have been designed with careful and deliberate contemplation. This sort of technical innovation in enclosure design has even led to inventions that are now used in other zoos, like the ASDM's nearly invisible fencing. Ken Stockton, an ASDM Director of Design and Planning for some fifteen years, invented the sheer mesh, and called it Invisinet. This fencing is so sheer, it is almost imperceptible to the naked eye. To suspend it at ASDM, fenceposts are cleverly designed to look like cholla cacti, ocotillo branches, or saguaro skeletons. Where obviously human accents are necessary, like railings or signposts, metals are allowed to rust just as they would in the desert, dampening the effect of human intrusion on nature.

This commitment to immersion in the desert means that ASDM is "deeply tied to a sense of place," as Ivanyi puts it (Auth. interview, 2015). His animals are from the desert, and still live in the desert. If you ask him what a good zoo exhibit is, he emphasizes the importance of animal welfare. As a herpetologist, he has spent his life studying some of the less charismatic, and therefore occasionally overlooked, species. This makes his understanding of animal welfare much broader than that of some. He feels that animal welfare is dynamic, and something that is not always well understood for all animals. "Take a rattlesnake, for instance. We had no idea about their complex social structure not that long ago" he says (Auth. interview, 2015). This means that the norm for such creatures used to be immediate removal from their mother at birth, and a solitary existence in a tank. He points out that now it is well known that that rattlesnakes

recognize and interact within familial units. Learning as much as possible about a species' natural history and behavior is therefore a major tenet of animal welfare. In the past, “A lack of understanding of husbandry led to an over-simplification of what an animal needs,” he said (Auth. interview, 2015). He is a huge proponent of education, not only for the guests, but as keepers.

Ivanyi's description of animal welfare, as with so many other zoo professionals, extends way beyond the basic physical needs of the animal. He believes that caring for the mental well-being of the animal is every bit as important as making sure the animal is fed the appropriate diet or living in the right climate. According to Ivanyi, and as with Hawkes and Sartor, there are two major parts to this: enrichment and providing opportunities for animal choice. “A really important thing is choices,” he says, “Giving animals choices” (Auth. interview, 2015). He is not alone in this thought. Research in applied animal behavior science supports this as well, suggesting that allowing animals to “control their own access to increased variability” improves captive environments (Clubb and Mason, 2002, p. 323). Any number of ASDM's exhibits demonstrate this tenet. There, choices mean that animals can decide to be in hiding or in view, that they can choose the type of substrate they are standing or laying on, or whether they are in direct sunlight or shade. In the black bear enclosure, there is bedrock, hay bedding, loose gravel or soil substrates that the animal can be resting on. These choices are given to the animals even when it can limit viewing the animal. At ASDM, animal welfare and comfort are valued above being in sight to visitors at all times. Several exhibits throughout the grounds have signage explaining that the animals in that enclosure may not be visible for

Figure 18: At the entrace to ASDM, the desert sprawls before you. Guests never have to imagine they are anywhere, because they actually are in the ecosystem being exhibited. Photo: K. Boyle.

months at a time, because of seasonal hibernation or torpor.

Another way to care for the mental well-being of an animal is the practice of enrichment that has strong roots at Woodland Park. “When you have an animal in captivity,” Ivanyi says, “enrichment is a huge thing” (Auth. interview, 2015). When walking through his aviary, small bits of fruit and vegetables are placed around the enclosure, and birds mill about and peck at it. The river otter has a small island floating on the water of his enclosure, that appears to have some small treat on it, allowing him to climb out of the water and clamber on the floatation device. Around the grounds, there are interpretive materials telling visitors about enrichments in general, as well as explaining specific ones.

Zoos exist on a number of different scales. The AZA has recognized this, and gives

yearly exhibit awards in two categories: those with an annual operating budget over five million dollars, and those with a yearly operating budget under that. This was not always the case, however. ASDM, a zoo with an operating budget well under five million dollars, won the exhibit award for their Javelina exhibit before the AZA had begun making the distinction between zoos based on budgets. This means that ASDM was competing against zoos who are spending much more money than they do; and ASDM still managed to bring home top honors.

When you set off on Desert Loop Trail, it is easy to see why they earned this recognition. The smaller world of the museum welcomes 400,000 annual visitors, compared to the nearly 5 million that visit the San Diego Zoos each year. The scaling has many advantages. Smaller daily crowds provide a more intimate feeling, and Desert Loop Trail boasts design features that would be destroyed by huge numbers of visitors. A completely dirt trail, lined with short metal posts with metal cable hanging between them, is not made to withstand the footprints of 5 million people a year. As you set off down the trail, you wind through several switchbacks of towering saguaro, prickly pipe organ cactus, and numerous other desert plants. It certainly is another advantage for the desert museum that this landscape is so unusual for people from anywhere else. Ivanyi has heard visitors exclaim, when taking in the scenery, "It's like an alien landscape!" "For him," he says, "this *is* exotic" (Auth. interview, 2015).

After wandering through closely planted, beautifully maintained desert plants for a short time, you come across a fork in the path. As you stand there, contemplating which direction to go, a slight movement catches your eye, and you realize you are looking right

at a coyote. The Invisinet that surrounds his enclosure is aptly named, and is indeed nearly invisible to the naked eye. Saguaro skeletons hide fence posts, and supports built to look like ocotillo branches and cholla cactus all blend seamlessly into the desert scape. It is an ideal example of landscape immersion. The visitor is surrounded by the landscape of the animal long before they see them, and then, when you first see the animal, it feels almost accidental. In the case of the coyote enclosure, the barriers are so difficult to perceive that there is almost an instinctual adrenaline rush as you try to find the barrier separating you from the wild animal. The illusion is enhanced by the small fence that is highly visible at the edges of the path, the same two-foot tall metal post and cable fence that has lined the whole path. It makes your mind race-- *is it possible that this little fence is the only thing between me and a coyote*?

It is not a perfect illusion, of course. Invisinet is still a tangible object, and strong enough to contain wild animals, and thus does have to have some type of girth. It is definitely visible when up close, even though it is a very minor interruption to the view. The imperceptibility at distances does make it an interesting item for use in zoos. The initial moments of seeing the coyote, when it feels as if there is almost nothing between you and the animal, causes a visceral reaction that should not be devalued.

Desert Loop Trail continues down past the coyotes, sloping downward into a natural valley of the Museum. The edge of the zoo lies just beyond the path, but there is no way to discern where this might be. The hillside sprawls downward and onward for an expansive distance, plants maintained by the zoo blending into and giving way to their native counterparts with no visible boundary. This is one of the many advantages of the

landscape buffer of a national park. The visitors aren't aware yet, but they are making their way down toward the Javelina Exhibit, recipient of AZA's exhibit award in 1998.

Javelina are a unique animal, found only in three states of the Southwest US. There are only a couple species of wild pigs that have a historically natural home in the United States, making these a somewhat rare creature. The javelina exhibit takes into account the natural history of the javelina, and their natural behaviors. They keep cool in the desert heat by wallowing in mud, or in trickling riverbeds, and like the dense vegetation that

Figure 19. As guest stroll Desert Loop Trail, a coyote comes into view. The aptly named Invisinet is hardly a barrier at all, and it seems as though there is nothing but a cable fence between guests and the animal. Carefully designed saguaro skeletons, like the one at center, support the nearly invisible fencing, and blend seamlessly into the landscape. Photo: K. Boyle.

typically lines these beds as providers of shade. The design of the enclosure lies within a natural valley of the grounds, in what likely was a river bed at some point in its natural history. The enclosure uses stone bridges to take visitors over shady wallows, where the animals like to spend the summer days. Signs advise visitors that there is a “Javvy Hot

Spot!" under the bridge, and directs their attention to where the animals like to spend their time. These signs are at other points around the enclosure, helping guests find the animals in the incredibly naturalistic space if there doesn't happen to be a guide present. A social species, they typically live in groups of 2-20, and their single, larger enclosure allows for engaging in this natural behavior, as well. In three visits to the Javelina exhibit, they were always in a group of two, at minimum. They also spent much time in the shady places beneath the bridges. Their exhibit clearly allows them to make choices and to engage in a number of natural behaviors: wallowing in dry river beds, living as a social group, and finding shade beneath vegetation. The exhibit also makes it possible for the visitors to get a good view of them while they are engaging in these natural behaviors--an excellent marriage of animal welfare, naturalism, visitor experience and education.

Of the three institutions explored in this chapter, the ASDM welcomes the smallest number of visitors. This has both benefits and drawbacks. The major drawback is that budgetary concerns are always very real for the desert museum. This opposite side of this, however, is one that has already been briefly touched on: that the desert museum can do things that many other zoos cannot. For instance, the smaller number of visitors means that the ratio of visitors to interpretational guides is much smaller. This makes the amount of personal attention each visitor receives from ASDM staff versus other zoos much greater, and allows for lots of interpretation opportunities all across the grounds; a valuable weapon in education. While staff was also seen at Woodland Park, and there were certainly volunteers and staff on the grounds, there was a much greater interaction at ASDM. In addition to this benefit, there are physical advantages to welcoming fewer

guests. The museum has any number of small nooks and crannies that visitors can find

Figure 20: Javelina slumber in a dry riverbed, as they would in the wild. The clever design of their enclosure, and the knowledge of their natural history, makes them right at home. Just out of frame is signage that alerts visitors this is a "Javvy Hot Spot!" so visitors won't miss the animals, who blend rather seamlessly into their environment. Photo: K. Boyle.

their way in and out of. These viewpoints allow animals to have natural lives where guests can still observe them, unbeknownst to them. At the beaver enclosure, a den for the animals to hide away in is only visible to guests if they climb onto a small platform and push a button to slightly illuminate their activity. This platform is around the corner from the main viewing window, it is an area only one or two people can fit at any given time. Huge numbers of people would make features like this an accessibility nightmare at other zoos. There are also other design advantages. For instance, Desert Loop trail would not be a possibility at many other zoos, because of their sheer numbers. Imagine the damage that three or five times as many people would inflict on a dusty desert trail. Whereas a steady but somewhat modest annual attendance means that the number of people trekking along Desert Loop will not erode away so much of the soil as to destroy it; this would not be the case everywhere.

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At ASDM, a “good” zoo exhibit is one that allows an animal to have choices within their historically native habitat. Their commitment to allowing an animal to have choices is so comprehensive that they embody another notable departure from other zoo models: they are not so committed to guaranteeing their visitors an eyeful of the animal that they will infringe upon their behaviors and natural life cycles. This commitment to naturalism not only makes their exhibits outstanding, but makes them a highly regarded (and very unique) zoo within the professional zoo community. They still have battles to fight: getting visitors through the gates and convincing the public that native species are as interesting as exotic ones. The ASDM is has taken would could be construed as an inhospitable climate and embraced the ecosystem, making the exhibition of these native creatures their hallmark -- something that might be more difficult to accomplish in a place like Topeka. Some of their struggles result in amusing anecdotes, like the occasional confused visitor who misunderstands their name. “I have seen women arrive in evening gowns and high heels, saying 'Where's the museum?'” Ivanyi recalled. “When 85% of the exhibits are outside and its 100 degrees out, you're thinking to yourself, 'That's gonna hurt'” (Auth. interview, 2015). These obstacles aside, ASDM has found their marriage of naturalism and animal welfare in embodying the extreme of naturalism.

By housing native species evolutionarily designed for life in their desert ecosystem, they are exhibiting exemplary animal welfare, as well.

Room To Grow: San Diego Zoo Safari Park

At places like San Diego Zoo's Safari Park, Desert Loop Trail would be quickly destroyed by the sheer magnitude of the two million people that pass through their gates every year. Safari Park is not a stand-alone facility, either, and is a secondary site to the San Diego Zoo itself, which greets more than three million guests annually. With total attendance of over five million visitors between the two facilities, there is a huge opportunity for visitor education, outreach and conservation. It also means that the Safari Park was a major departure from traditional zoos, in that an off-site facility opened to support the main zoo.

The Safari Park, situated in Escondido, California, is thirty-two miles northeast of San Diego itself. It opened in 1972 as an off-site facility for San Diego Zoo proper, as a breeding and housing facility for many large mammals. The Safari Park battled some initial confusion, as it was the first park of its kind. In the early 1970's when the park opened, many zoos still had bars and concrete enclosures. This meant visitors were accustomed to small spaces where animals were very close and readily visible. The Safari Park initially found it difficult to draw the crowds the Zoo itself did; because visitors expected to see more animals in a much smaller area. For the Safari Park, which boasts an 1,800-acre campus (compared to the just 99 acres of the San Diego Zoo), this created a unique solution to a pervasive animal welfare debate. Animal welfare science has studied what makes some animals thrive in human care while some seem to struggle, and determined that animals with naturally large ranges, like a tiger or polar bear, tend to fare worse in enclosures than some of their counterparts (Mason, 2010; Clubb et al., 2006).

The larger space meant that these animals could have much larger enclosures, with more room to engage in natural behaviors like roaming.

A zoo on this magnitude means there are other unique challenges that have to be tackled, as well. Robyn Badger, the architect for the Zoological Society of San Diego, has spent the last twenty-nine years navigating the complex interplay of forces in enclosure design. As the architect for a number of enclosures, including the AZA award-winning Tull Family Tiger Trail, she has experienced the tension between these forces. “We're [architects] conducting everything -- it is hard to reconcile a lot of things,” she says, “That's the challenge of it, really.” It's a dynamic process. Even once plans have been approved and building is underway, things don't always fall into three-dimensional space exactly as planned and have to be modified on-the-fly.

For Badger, her vast area has provided a much greater space for creativity in design. To speak with her about enclosure design, she almost skips right past animal welfare; perhaps because that is such a given for her. “Well, first and foremost, we have to be looking after the animals,” she says. The elaborate “bedrooms” for the tigers, as she refers to them, required almost as much attention to design as her visitor areas. She also subscribes to the general consensus among zoo professionals that a good exhibit gives animals choices. Because of the massive acreage of the Safari Park, this means that there are three separate enclosures designed for tigers on her Tull Family Tiger Trail. Although the visitors follow a single path, they are actually looking at three different spaces, with different tigers, with different design features. Like the gorillas at Woodland Park, the tigers are not in the same space day after day, they rotate through multiple enclosures.

She also focuses on the educational role of zoos in her designs, because of how she feels about the role of zoos. She wants visitors to leave more connected to the environment then they were when they arrived, and motivated to make an actual change that helps that environment. She does comment that when "reconciling the budget," what she considers to be the biggest obstacle in enclosure design, additions that serve primarily educational or visitor experience-purposes are usually the first on the chopping block; something that should be amended if zoos want to increase their roles as places of education.

Badger says that although more naturalistic exhibits are "definitely" more likely to enhance animal welfare, the two tenets "may be at odds." She gives an example from the planning for Tiger Trail. There are a number of towering, mature trees within the exhibit; this posed both an advantage and a problem. The mature trees allow for the tigers to engage in a number of natural behaviors, like sitting or rubbing against the trees. The animals couldn't be given free reign, however, because the trees are also part of the zoo's collection, and have to be protected, as well. Unfortunately, another natural behavior of tigers is to stand on their hind legs and scratch the trees with their mighty claws, sometimes destroying or damaging them. The original plan was to wrap the trees in "hot wire," a type of electrical fencing that would not allow the tigers to interact with the trees at all, in interest of protecting them. Keepers campaigned for the hot wire to start four or five feet up the tree so tigers could still lean or lay against the thick trunks, but not stand on their hind legs and claw the trees.

This sort of give-and-take is a theme that Badger repeated several times in our discussion. Her insight makes it seem as though there isn't so much as a trade-off

between animal welfare and naturalism in her zoo work, but usually more of a compromise between the two. The compromise doesn't end at the design stage, either. In the case of her mature trees, careful attention was paid to construction crews throughout

Figure 21: The entrance to the Tull Family Tiger Trail welcomes visitors with the sounds of the jungle, as well as the plants and animals. Misters placed along this walkway make the entrace somewhat humid, as well, giving visitors a sense of the climate of Southern Asia, where these Sumatran tigers histrically call home. Photo: K. Boyle.

the building process to assure no damage was done to the root balls of the trees. “It was a process,” Badger summarizes.

Badger doesn't have the ability to assure protected views like Woodland Park, because the sheer number of visitors makes that all but an impossibility. She also can't utilize a rocky, dirt trail for effect, because of the lack of accessibility and structural

integrity. One dirt path is a feature of the Tiger Trail, and rope handrails lead you through brush one person wide, along boulders. Even this trail is not really dirt, though, and utilizes a layer of dirt over rock work. A unique glimpse into the enclosure rewards visitors for taking the path, and does have the effect of making one feel like they are more in nature, if only briefly.

These obstacles, however, did not deter Badger from creating an “all-five senses” approach to immersion for Tiger Trail. She wants her guests to cross “a rickety bridge,” and be able to clamber over a boulder to engage touch. The dirt trail adventure, with leaves brushing the skin of visitors, is another attempt at the same. Perhaps one of the most impressive innovations is a computer-driven sound system that runs throughout the exhibit, that Badger says “lives and breathes as its own environment.” The sounds are not recorded on a loop, but rather a dynamic program that randomly generates different sounds at different times.

Even listening to the recording of Badger's interview, entering Tiger Trail is readily apparent. The local background noise fades away and is replaced by bird calls, insects, branches and leaves rustling, and other sounds indicative of being in Southeast Asia; the natural historical home of tigers. Misters along the path dampen the skin of her visitors as the humid air in tropical Asia would. As an experience in what Badger calls “auditory landscape immersion,” guests hear and feel the jungle long before they ever see an animal. Just inside the entrance to the trail, a small play areas gives kids a chance to run around and adults a chance to rest. This doesn't mean that there wasn't a great deal of design involved; a number of educational outreach features play a major role in this area,

themed like an illegal logging camp. Guests can manipulate a model chainsaw that sets off logging noises, and signage explains the large-scale destruction of tiger habitats due

Figure 22: A tiger slumbers in perfect view of guest seating at San Diego Zoo Safari Park's Tiger Trail. Architect Robyn Badger cleverly designed the entreces to bedrooms in sight of visitors, so if tigers are waiting to be fed, her guests don't miss a minute. Photo: K. Boyle.

to deforestation, linking the exhibit to the wild. A camera trap also snaps a photo of guests as they pass through, and super-imposes a tiger into the image; a reminder that you are in the habitat of the tiger, and they can be anywhere.

Further along the trail, guests find themselves situated between two of the three tiger enclosures. Uphill, forested areas with the mature trees allow tigers to stalk through brush and stay completely out of sight if they wish. Downhill, a less forested area overlooks a Sambutan Longhouse, another beautiful architectural design aspect of the enclosure. Trees in both enclosures have the hotwire around the trunk, five or six feet

high- evidence of the compromises of design. Badger utilized the knowledge that tigers tend to hang out near the entrances to their bedrooms, particularly as the afternoon wanes toward closing time for the zoo (and feeding time for the obligate carnivores), and placed these entrances strategically in prime locations to be visible to guests.

As visitors wander the trail and into the longhouse, painstaking effort has been taken to never stray from the theme of the Asian wilderness. The incredible attention to detail extends from the open log rafters to the light fixtures, the tables and chairs, the floors, even the bathrooms. Badger recounts stories of trips to flea markets to acquire lights that would be regionally and period specific. When she finally found one that she liked, she commissioned replicas to look like the real thing. The difference between her original and the replicas is difficult to discern, even when she points it out. Food service regulations required a wall treatment that could be sterilized behind the small concessions counter. Rather than standard stainless steel, Badger employed bamboo matting beneath clear plastic, so the wall blends. Such careful attention to detail is readily apparent throughout the enclosure.

Beyond the longhouse, visitors find their way beneath a full-scale waterfall, through an intricate mock-cave walkway. This waterfall comes from the upper tiger exhibit, flows over the edge of the cave, and plunges some twenty or thirty feet to the rest of the enclosure below, where a third tiger enclosure lies. This is an exceptional experience for the guests, who marvel at the spectacle as they pass through. “Is this a real waterfall?” one guest muses to her group as they wander through the fine spray. Her question encompasses the spirit of landscape immersion- *is it real*? The waterfall is also a

design feature that is excellent for animal welfare, as tigers are one of the few cat species who enjoy being in the water, and are known to bathe in it to cool themselves off on a hot day. Their webbed feet also make them excellent swimmers, another reason to enjoy the water. The presence of such a large water feature obviously allows the tigers to exhibit a number of natural behaviors.

Beyond the waterfall, guests are the ones presented with a choice, as they can wander a wooden walkway down around the lower enclosure, where a dead-end will one day connect across Elephant Valley to The Grove. Guests can also take a loop that leads them around the backside of the uphill forested exhibit, and eventually past Condor Ridge and back to the beginning of the trail.

The San Diego Zoo Safari Park has a challenge most zoos would dream of: millions of visitors a year. While this does increase their budget, it also creates design obstacles. For them, a "good" zoo exhibit is one that engages all five senses, including sound. The utilization of a high-tech sound environment is a brilliant innovation when you have so many visitors, and a way of really bringing them into the same place as the animal. Their massive footprint allows them spatial freedom of design, a distinct advantage.

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Woodland Park, Arizona-Sonora Desert Museum, and San Diego Zoo Safari Park have become institutions within the zoo community that are seen as innovators and leaders. It is no wonder that their exhibits have won awards, because they are so clearly

dedicated to promoting animal welfare and environmental stewardship, while engaging the guests with an enjoyable experience. Each of these three institutions has also made some departure from the zoo norm, making them even more interesting as case studies in enclosure design. For Woodland Park, they began enrichment and landscape immersion. At ASDM, they stopped trying to exhibit only exotic to focus on what is native. And at San Diego Zoo, they opened the Safari Park to increase the space they had for animal enclosures, breeding, and roaming.

Regardless of whether the discussion is about AZA exhibit standards or the feelings of those working in the industry, there are a few things that the zoo community is unanimous on. First and foremost, animal welfare is paramount. Basic physical needs must be met, but even more than that, an animal's mind must be engaged in a number of different ways, including giving them choices and enrichments. For an exhibit to be called a good exhibit, by any of these parties, animal care standards have to be met.

At the Phoenix Zoo, Rich Sartor had a very interesting view on this challenge. He commented that in general, professional zoo enclosures are good, and that there are constant efforts to improve them even further. He said this must become the norm; and that it must always be a goal to not only have outstanding enclosures, but to continually work to make them better. “The actual world of a wild animal may be really, really narrow and defined by their territoriality, available food, all kinds of competition. There's a certain trade-off of, 'I have you in captivity now... you can't do a lot of things you could do in the wild, because we have defined your world for you.' We never can rest at trying to do better” (Auth. interview, 2015). With a community so dedicated to always

improving, it is almost unavoidable that enclosures will continue to evolve with increasing knowledge about animal welfare and ecosystems, as will zoos more generally.

When it comes to naturalism, it is clear that ASDM has made a departure few other zoos have attempted: they have harnessed the exotic nature of their ecosystem rather than importing exotic creatures from afar. Insofar as creating nature, or recreating nature within a zoo, the way in which ASDM has managed to simply utilize the nature

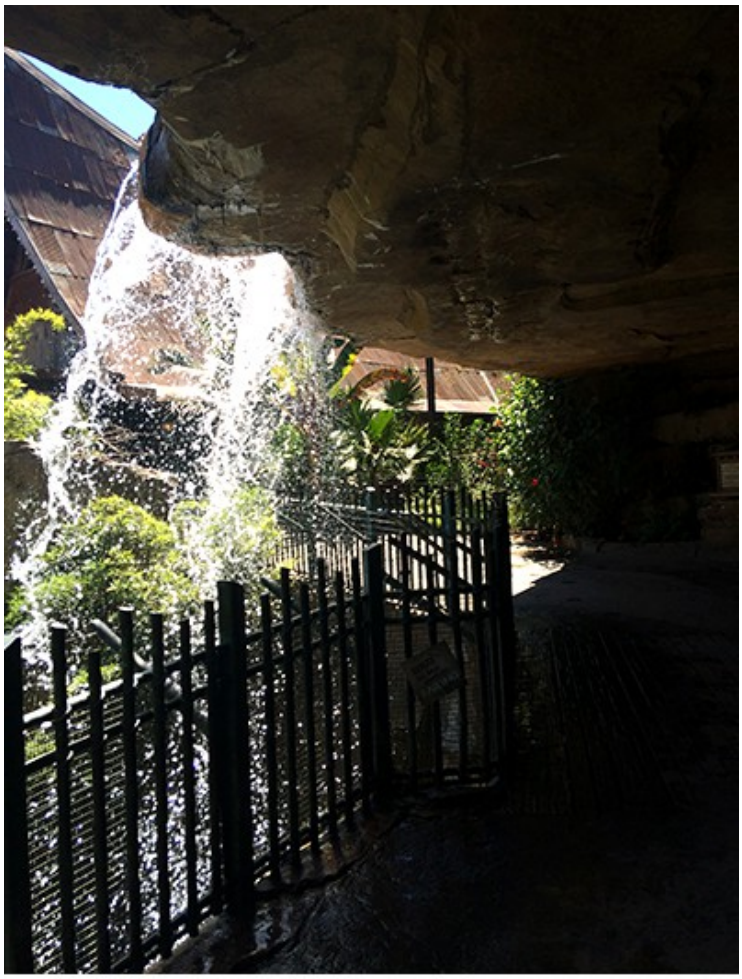

Figure 23: Guest walk beneath a flowing waterfall as they navigate Tiger Trail, and can look over the railing to see tigers playing in the water below. Photo: K. Boyle.

they exist within is a novel concept, indeed. At Woodland Park, they have utilized the natural layout of their campus and the microclimates that are found there to best dictate

the type of enclosure and foliage that can be supported, also allowing the land itself to play a part in the design of their enclosures. For the Safari Park, naturalism has evolved as well, to include things like fully mature trees that have stood where they are for decades, and building their enclosures around them. They have also allowed for much wider spaces to become enclosures, giving their charges a greater amount of space to roam.

These institutions serve as guideposts for the professional zoo community as they find their way into the future. These award-winning enclosures are a snapshot in time of what we presently view as the best models for zoo enclosure design, and offer a starting point for possible trajectories of zoo design in the future.

5. THE FUTURE OF ZOOS

Zoos have undeniably come far from their beginnings. Although their roots were not particularly noble, modern zoos do have strong beliefs in and commitments to environmental stewardship and the aims of conservation and education. In the beginning, menageries did little more than collect species like Pokemon; there was frequently competition to have the greatest number of varieties in possession. Neither animal welfare nor naturalism were considered at this time. With Hagenbeck's panoramas, naturalism was vastly increased with the inclusion of more natural elements, but not necessarily a deliberate nor consistent naturalism that was true to in-situ conditions and that matched the needs of the animal in the enclosure. With the antiseptic model of the mid-20th century, animal welfare was the paramount concern; albeit in a narrow sense (driven primarily by a concern with hygienic conditions). Unfortunately for animal welfare, the belief was that animals in human care could not possibly exist in a world that could not be sterilized to protect their health, and all natural substrates were removed from enclosures. It wasn't until a middle ground was reached between caring for naturalism and caring for animal welfare that a balance that emerged in the later part of the 20th century in the form of landscape immersion. Even if this marriage of naturalism and welfare was not always perfect, over time it improved the wellness of animals in human care and enhanced the experience of the visitor. The landscape immersion model takes visitors on a journey beyond the naturalistic enclosure, and tries to place them into the historically native ecosystem of the animal. Although this model was reached as

something of an accidental convergence of increasing animal welfare and reducing obvious captivity, it has become the predominant model today.

Having come so far from where they began, in a relatively short time, we might now ask where do zoos go from here, what is the future of zoo enclosure design?

In fact, there is probably not a single future for enclosure design, or for zoos (Minteer 2018). There are a number of ways zoo exhibits can continue to evolve into the future. Fencing large, protected areas, is one method of rethinking what a zoo is – by increasing naturalism so much that it becomes actual nature. Increasing the space that is used to enclose animals is another possible change, and using off-site facilities as a sort of managed, protected "wild" for conservation and propagation of species. Another way is by making the visitors rather than the animals enclosed.

The Regional "Biopark"

Figure 9: A bobcat stares down visitors at the Arizona-Sonora Desert Museum. Photo: K. Boyle.

As far as increasing naturalism in zoo exhibits, there seem to be several evolving models. One approach is to follow the example of the Arizona-Sonora Desert Museum. If zoos in each different climate of the US sought only to house animals that were native to that climate, then essentially every climate in the world could be mimicked in different places. It would mean that to see an animal from the rainforest, you would have to travel somewhere tropical that could support that ecosystem; to see an animal that spends its life in the cold, you would have to venture to a zoo in one of the northernmost states. It seems natural to try and put an animal in its natural habitat, at least to Ivanyi at the ASDM: "You're not trying to put Galapagos tortoises in the snow, and you're not putting polar bears in the desert" (Auth. interview, 2015).

Numerous zoo professionals talked about the future of zoos as "[exhibiting] fewer species better," like Hawkes at Woodland Park. "And having fewer species, but more individuals," she adds (Auth. interview, 2016). Ivanyi agreed that the days of the "postage-stamp collection" (Auth. interview, 2015) are gone. It seems like a marriage of this idea and the unabashed embracement of the natural ecosystem at ASDM could lead to a zoo that not only has naturalism at the highest level, but increases animal welfare as a byproduct.

There is, however, the question of just how generalizable the ASDM model is. Craig Ivanyi mused, "Could you do the Desert Museum in the middle of Oklahoma?" He tends to feel like the Sonoran Desert is an exotic ecosystem unto itself, and thus lends itself well to being the subject of a whole zoo. "This is an exotic, compelling location that draws people. Just doing what's right here, for people from outside this region, it is

exotic" (Auth. interview, 2015).

Ivanyi's thought, however, suggests an interesting path that zoos could take; namely, changing what they view as "exotic." Zoos might need to try harder to make themselves attractive to those that are visiting, and tie themselves closer to eco-tourism. It is also possible that if people were more educated about animal welfare, they would encourage and support their local zoo shifting toward native species.

Although these are interesting questions, the bottom line is that while ASDM seems like an ideal model for a zoo, visitors love to see the exotic; and changing their view of what they want to see would be the real challenge of adopting this model. Research also suggests that many zoo visitors are local to the area of the zoo, and it is their repeat visits that increase annual attendance (Davey 2007). Many of these visitors might not be motivated to witness a collection of things native to their backyard.

Blurring the Boundaries

Another interesting idea in increasing naturalism is presented by a model like that of Amakhala Game Reserve in the Eastern Cape of South Africa. Amakhala was founded in 1999, by a group of local farmers. Economics of the time had made it difficult for the small farm to make ends meet financially, and an idea was born to create a nature reserve. By putting their land and funds together, they could not only increase the area for the animals, but could increase the number of species the land was capable of supporting.

Amakhala is certainly not the first of its type; in fact, two lanes of roadway is all that separates Amakhala from Shamwari Game Reserve, a similar facility that was

founded seven years earlier, with similar aims and motivations. These game reserves represent an interesting idea in the evolving nature of animal enclosures: what if animal exhibits were just one huge area?

In the case of Amakhala, the grounds encompass an area of 18,500 acres. To compare this to the grounds at San Diego Zoo Safari Park, Amakhala is fully a ten-fold larger facility than what is considered to be a huge zoo facility in the US. These types of facilities are obviously managing their animals on a much greater land scale than a traditional zoo.

This encompasses what some zoo professionals talked about as an important change in enclosure design. “Mixed species exhibits are compelling,” concludes animal and zoo scholar Nigel Rothfels (Auth. interview, 2015). Many zoos have built enclosures like Woodland Park's African Savannah, where species that co-exist peacefully share the same enclosure. Typically ungulates like zebra, giraffe, and various antelope are inhabitants of such an exhibit, as well as ostrich and monkeys. It would seem that taking this “compelling” concept to the extreme of naturalism, where things exist as they do in the wild, is manifest in Amakhala.

Indeed, all the peaceful ungulates do wander the low grasslands of Amakhala; on any given morning, groups of zebra, wildebeest, red hartebeest and impala can be observed wandering the expansive veldt. Ostriches are also a common sight, as are elephants and giraffes. The major difference between zoos and this type of management system is easily spotted when herds of prey animals begin to scatter. It is not random: unlike the “freedom from fear” that life in a zoo offers, this animal management facility

is so naturalistic that the animals feed themselves, and apex predators like lions, cheetah and hyenas stalk and kill prey species. To witness the scattering of prey animals is to see a response to the impending danger of a predator.

This does present a unique set of problems. Amakhala employs a staff ecologist, who has a number of responsibilities. As with zoos, the first concern is always the animals. He conducts surveys and counts of some animals, to determine their numbers. Other animals, especially those that are highly endangered, like the Southern White Rhinoceros, have GPS-trackers on at all times. Ultimately, management of this ecosystem comes down to mathematical equations of carrying capacity, and making sure the land is never trying to support more life than is sustainable for a long time to come.

Like any proposed model, this one is not without its drawbacks. Occasionally, the behavior of wild animals cannot be predicted or controlled, and this can cause unforeseen

Figure 24. At game reserves like Amakhala, guests board vehicles and travel around the ecosystem of the animals to view them. Here, a group watches a pair of giraffe as they graze on leaves. Photo. K. Boyle.

problems. When the lions were first introduced to the controlled ecosystem of Amakhala,

they nearly decimated the springbok population, leaving only six individuals. Allowing the animals to be as wild as possible, and eating whatever they like, means that they will occasionally eat something you don't want them to. Luckily, when the springbok became more difficult to find, the lions made the warthogs their favorite prey. It just so happened that Amakhala was suffering from an over-population problem of warthogs; and the lions essentially solved it.

The furthest extent of natural reserves like Amakhala are places like Kruger National Park, which covers nearly five million acres of South Africa. The park specializes in tourism, and welcomes over 1.6 million visitors annually. Visitors can take guided tours in hopes of seeing some of the more elusive species, but seeing any particular animal is never guaranteed on any given day. The whole five million acres is still fenced, however, and even this "wildness" is one that is contained and managed, on some scale.

Other ways of increasing space are establishing more places like SDZG Safari Park, as an off-site facility with larger, more naturalistic spaces for animals to roam. Safari Park manages to see a huge number of visitors each year, and still provides high-quality space for their animals. Several members of the zoo community said that more ex-situ facilities would become popular as zoos began focusing more specifically on smaller number of species. These off-site facilities can welcome visitors if they wish, but it would not be specifically necessary for them to worry as much about making animals visible if the main zoo can provide visitor experiences.

In terms of how this can benefit the animals, the Animal Behavior Research

Group, within the Zoology Department of Oxford University says simply: “Perhaps the most obvious suggestion [to increase animal wellness] is that zoo enclosures should be made larger” (Clubb and Mason, 207, p. 322).

The Technological Zoo

There are other efforts to increase conservation in zoos, in the hopes of maintaining sufficient genetic variability to support sustainable populations. San Diego Zoo Global's Frozen Zoo is just one such facility. On the grounds with the Safari Park, the Frozen Zoo seeks to preserve the genetic variability from as many species as they can. They have banked 10,000 cellular samples from over 1,000 taxa, including at least one extinct species. The hope is that technology will eventually allow for inclusion of these genetics into existing populations, or creation of populations via surrogacy. The use of closely-related species as surrogates for embryos of extinct animals would theoretically allow populations that have dwindled to be revitalized with banked genetic information. The husbandry for these practices has been lacking, however, and has resulted in the death of at least one animal that was created by in vitro fertilization and surrogacy (Friese 2013). That aside, there have been instances of endangered animals being created by in vitro fertilization, then gestated by another species successfully. This technology has yet to be perfected; as such, the Frozen Zoo exists as almost a doomsday-esque respite of genetic information. For those species that already are or soon will be extinct, the hope is that this genetic material can somehow assist in propagation or revitalization of their species.

For animals who are not yet extinct, increasing animal welfare is one way of changing what it means to be a zoo in the future. By removing the visitors, Conservation Centers for Species Survival (C2S2) represent an emphasis on animal welfare, and a de-emphasis on visitor experience. At these centers, the consideration of whether or not a visitor can see the animal is not given much if any weight; in fact, in some cases visitors are welcomed only to a small portion of the facility. C2S2 are fully accredited by the AZA, and boast a unique mission: "to cooperatively apply its unique resources for the survival of threatened species with special needs—large areas, natural group sizes, minimal public disturbance and research" (Sawyer, 2012, p. 1). The goal of these centers is to have protected lands where animals can breed and engage in as many of their natural behaviors as possible. Some species, like the cheetah (*Acinonyx jubatus*) have been closely studied and are known to fare poorly (defined as having poor reproductive rates and increased infant mortality) in situations where they are readily viewable to humans (Caro 1993). Conservation centers take this knowledge and remove the role of visitor experience, valuing the comfort of the animal. Since the goal of these breeding centers is to increase populations of endangered animals increased animal welfare happens as a by-product. Animals that are stressed or unhealthy are less likely to breed, and so taking conscientious care of the animals helps achieve their population-bolstering aims.

There are other shifts on the horizon that aim to improve animal welfare. One of the many criticisms of the zoo industry, as voiced by Rothfels, is that there are "inconsistencies in animal care across the industry" (Auth. interview, 2015). It comes as no surprise that welfare leaders like Chicago's Brookfield Zoo are seeking to streamline

care. As the technology becomes more readily available, many zoos will begin utilizing welfare monitoring software that will help track animal behaviors and norms, and hopefully standardize animal welfare. Brookfield Zoo launched a software program, WelfareTrak®, that allows keepers to easily monitor important factors in animal behavior. This software is web-based, and currently in testing mode. As such, it is offered free to institutions that want to utilize it and help test the program. A set of short, species-specific questions is created by a "panel of international experts," and is answered weekly by keepers for each animal. This has a number of benefits. First, for individual animals, it will be helpful to have a lifelong log of how much that animal eats and when, as well as what its normal activity level and body condition are. Since baselines are different even among individuals in a species, having individual data would be highly valuable. On a wider scale, the hope is to have all animal facilities participating in using some type of software like this. This would mean they can share results and create accurate behavioral ethograms for animals in human care, based on gathered data. These data could all be stored in the database that would be available to animal care institutions worldwide, theoretically improving welfare for animals in human care everywhere, by increasing the base of knowledge of animal needs and husbandry (Whitham 2016).

A similar project is underway at Lincoln Park Zoo, a short sixteen miles away, in Chicago. ZooMonitor operates on many of the same principles as WelfareTrak, with a few important differences (Altimari 2016). The major difference is reporting. Lincoln Park Zoo has a team of nearly 50 people monitoring 25 species in 25 exhibits and recording data in real time with iPads. Rather than the WefareTrak system, in which

keepers check in once a week, ZooMonitor utilizes volunteers to constantly input data about a group or individual animal's behavior. This means that there are a great many more data points recorded and processed with the ZooMonitor system. In the future, applications could be created for phones that would allow zoo visitors to report their observations as well. This could have a few implications. First, guests would be more informed about some given aspect of animal behavior, because they are tuned in to observing and reporting it. This would help accomplish educational objectives of zoos. It would also exponentially increase the number of data points for behavioral ethograms, expediting the process of compiling information on animal behavior.

In the case of ZooMonitor and WelfareTrak, the goals are the same of either system-- to create a reliable database of animal behavior information, and share it across all zoos. Either application seeks to standardize, and thus improve, animal welfare. Ideally, a model could be created that marries both types of software. This would allow for observations from volunteers and possibly visitors to be compiled with more educated observations and reports from keepers and animal care staff, for the most comprehensive collection of knowledge.

Radical Immersion

Another emerging model for re-thinking the future of zoos is a shift in who is being contained. In these models, the design is such that the visitors find themselves in an enclosure, rather than the animals. At some historic zoos, buildings that once housed taxonomic groups are now historical landmarks, and cannot be torn down to make way

for new exhibits. At places like Tiergarten Schonbrunn, the landmark building that once housed the big cats now houses the visitors, who peer out windows at the animals in an open, outdoor area. All of the old furnishings from the days as an exhibit remain as they were, and visitors can experience a sense of the cages and bars that used to contain the majestic animals they can see prowling the outdoor enclosure.

At places like Parque Safari, in Chile, zoo designers have embraced other unique ways of enclosing their visitors while animals roam free. For their zoo, visitors have multiple options for being enclosed while animals can move about. One experience has open vehicles that take visitors into areas with herbivores, where visitors can observe animals like on a safari. In herbivore areas, visitors can also kayak through, observing the animals from the water. For the carnivore experience, however, vehicles are modified to cages on wheels, and guests stay seated within them as they drive into the lion area. Lions can jump on top of the vehicles, looking down at guests, or sink their claws into the sides of the cages. Guests are also given food scraps to fling out of the cages to encourage the cats to interact with them. This safari park-like experience is certainly one way of changing who is contained, and allowing the animals some modicum of being free-range to roam. It also leaves visitors with a unique experience; having a lion alight onto your vehicle can be reliably counted on to cause a spike in adrenaline. While this perhaps does not exemplify naturalism, it does allow the animals more freedom, and to engage in natural behaviors such as stalking and hunting.

Another example of this same type of re-imagining of the visitor experience is currently under construction in Denmark. The Bjarke Ingels Group (BIG) is designing

Zootopia; a radical rethinking of the traditional zoo concept at the Givskud Zoo in Denmark. The new addition will be a combination safari and immersive zoological park, where visitors can ride bikes or float down the river through biomes arranged by continent. For carnivorous or dangerous species, BIG has designed mirrored pods to transport visitors, while theoretically causing minimal human impact on the animals (Minteer 2016). Whether or not this will be a successful endeavor remains to be seen; the first phases of the park are slated to open in 2019.

Regardless of the ethics of zoos as institutions, there can be no debate that zoos have evolved away from their roots as curiosities. They continue moving toward places of animal welfare, research, environmental stewardship, and conservation. Just how zoos will continue to evolve in the future is not yet known, but it is undeniable that, just like it always has, change will come to the world of zoo enclosures and quickly redefine what the norm is.

Values in Balance

It seems like it should be simple: if what is best for an animal is to be in its natural habitat, then shouldn't every zoo be like the Arizona-Sonora Desert Museum? In theory, this is ideal. Ecologically-minded scientists could establish what species belonged in that ecosystem, and animals could take up residence in enclosures that are the ultimate in naturalism; just a protected area of where they are found naturally. This seems like it should then be the ultimate in animal welfare also, doesn't it?

Unfortunately, even if it is universally accepted that the natural historical habitat

of the animal is the best one in which it should live (which is not something easily proven), the chances of implementing such a dogma are slim to none. Zoos are not yet willing to wholesale abandon their roles as places of entertainment, and what visitors want to see is what they have been conditioned to expect: the exotic. Additionally, the obstacles to the institution of such a practice would be staggering.

For instance, what would be done with those animals that do not have a native habitat in the US? For an animal like a cheetah, which roams the savannahs of Africa, would we choose the most reasonable facsimile in the US, and put them somewhere in the grasslands of the Midwest? Do we find somewhere with similar temperature, annual rainfall, and vegetation as their natural habitat, and say that is as close as we can get? Proponents of Pleistocene Rewilding would argue that if a long-extinct ancestor once lived in that ecosystem, their extant relative could thrive there, as well (Donlan et al. 2006). If there is no acceptable analog, do they all get shipped back to Africa, to live in the natural habitat they came from? None of these answers are satisfactory. Moreover, many endangered animals come from countries that lack appropriate infrastructure to provide the level of staffing, medical care and facilities that more established systems in the US provide. If the best possible care is in the US, shipping an animal where it will not get the same standards of care cannot be considered in the best interest of the animal.

So what about nature reserves, like Amakhala? They provide plenty of space for animals to roam, and within historically native habitats. But how much of the wild are we supposed to protect animals from if they are in human care? The fact of the matter is that life in the wild is dangerous for most animals, and the fear of being eaten is a daily

experience. Is it important for an animal who is naturally a prey species to experience the possibility of being eaten? In zoos, animals experience "freedom from fear," as Sartor puts it (Auth. interview, 2015). In the wild, many species are under constant threat of being chased or eaten, and zoos provide a sanctuary from that. If what is best for animals is increasing naturalism, however, then it has to be that predators would be part of that equation. Corticosteriods are stress hormones that are natural in animal systems, and have an effect on basically every system in the body. These are typically released in times of stress, such as being hunted, or fleeing. It is well known that a deficiency in these hormones can cause a number of physiologically-based health problems, like Cushing's disease or an over-sensitivity to insulin, causing dangerously low blood-sugar levels. It is possible that prey and predator animals have evolved with a dependence on these stressful situations of fight-or-flight for regulation of body systems (de Kloet 1992). If this was the case, then increasing naturalism would actually be increasing animal welfare, although it seems counter-intuitive.

The other side of this particular facet of keeping captive animals is the third master that the zoo must serve- entertainment. If it was scientifically proven that prey animals were healthier if they were hunted, could zoos convince the public that witnessing one animal kill another was fine? Most visitors would not be able to stomach such a spectacle, and zoos may find, in the future, that their ability to cater to ultimate wellness of their animals is limited by what the public will allow (Greene 2018).

As mentioned earlier, for some, like animal advocacy groups CAP and PeTA, there is no such thing as a "good" zoo exhibit. PeTA is primarily an animal rights group,

and takes a hard stance that no animal should be held in captivity. “PeTA opposes zoos because cages and cramped enclosures at zoos deprive animals of the opportunity to satisfy their most basic needs,” according to their website (PeTA.org 2015). There is never a justification to have an animal in an enclosure, according to their standards. (It is worth noting that comparatively more moderate animal welfare groups, like the Humane Society of the United States, have worked with zoos to help improve welfare rather than taking a strictly abolitionist stance [Maple 2012]).

Ethical dismissals of zoos, though, run up against some difficult questions. For example, what about the case of South America's amphibians and the chytrid fungus? For these animals, entire species, and indeed the vast majority of their entire class of Amphibia, was in danger of eradication because of this fungus. Chytrid is known to cause mass death because of a hyperkeratinization of the skin; one that makes the other layer of skin difficult to permeate. This is deadly to amphibians, who use their skin as the site of water and electrolyte balance. This ultimately causes cardiac arrest and death of the animals. If it was not for the efforts of wildlife biologists and dedicated herpetologists beginning in the late 1990s, when the chytrid fungus began wiping out populations, there might not be many of these species left today. Biologists captured and rescued as many amphibians as possible, bringing them safely into human care where they can be protected from the fungi in sterile labs. While the virulence factors and potential causes of immunity are investigated, the amphibians that are susceptible to it remain safely in human care (Rowley and Alford 2013). Would PeTA or CAP prefer these animals were free, to potentially become infected and succumb to the disease? Is it so bad to have an

animal in human care that it is better to die and go extinct than be in an enclosure? It depends, ultimately, on what you value (Mendelson 2018).

In the worst-case scenario, what if something like this happened to all species? What if bacteria or a virus threatened to eradicate all of the big cats of the world, unless they were in human care? Could we justify keeping them in our care then?

We don't need to imagine a world where there is impending doom for wild animal species. Climate change is happening at a record pace, altering biomes and ecosystems around the world. The acidification of the oceans, for instance, is swiftly making it impossible for some marine life to calcify their shells, and may soon eradicate coral reefs and other types of marine life altogether (Doney et al. 2009). Perhaps zoos need to position themselves to become safe havens for wildlife, providing protected ecosystems where they can persist even as the destruction of their natural environments proceeds. It is possible that human destruction of natural lands will get to such an extent that there will be no such thing as the wild, and all animals will have to exist in some form of human care. Even in South Africa, a place many think of as “the wild,” there is no such thing. The “wild” is the protected and highly managed (and fenced) areas of Kruger National Park and small game reserves like Amakhala; the rest of the countryside is owned, farmed, or fenced by humans- or some combination of the three. Terry Maple says, “For those who believe that zoos should not exhibit elephants and for other critics who oppose captive breeding programs, it is quite possible that zoos will be the last refuge for a species on the verge of extinction in the wild” (Maple, 2013, pp. 15-16).

Institutions like the Frozen Zoo are already preparing for the eventuality that there

will be more extinctions to come, and that zoos must be braced with back-up genomes to potentially repopulate decimated species with appropriate genetic variability.

It seems that in the compromise between animal welfare and naturalism, models like Amakhala or C2S2 centers best capture the spirit of both. Animals can roam relatively freely, interact as they would naturally, with careful management and monitoring by watchful human eyes. These types of locations, however, leave out a very important part of what zoos are; namely, places for *people* as well as animals.

Zoos represent a unique place in society. They are places where people who live in typically urban settings can experience something outside of their city, and perhaps go away with a wider understanding of the natural world. This understanding may also lead to caring for nature-- a shift in values and behaviors that conservation psychologists argue is necessary for any large-scale change to take place in the issues currently facing the biome (Clayton and Meyers 2015). In a culture where climate change is up for debate, and political voices espouse beliefs in "alternative facts," reaching the public and educating them about the environment may become the most important role for zoos.

But what is the best way to do this? How can the masses be inspired to make a change, to fight for the planet, to reduce their carbon footprint? Excellent examples can be found at AZA-accredited zoos, where real, emotional experiences take visitors out of their daily lives to interact with animals in a real way. Whether it is a penguin trying to nibble at your fingers through the glass bubble at Woodland Park, passing beneath a waterfall where a tiger frolics below at San Diego Zoo Safari Park, or feeling like you have stumbled upon a coyote at Arizona-Sonora Desert Museum -- making people *feel*

something toward the natural world they might never have otherwise felt is invaluable. If visitors can feel something toward the environment, perhaps they will also develop a sense of responsibility toward it, as well. Using the combined tools of naturalism, immersion and increasing welfare to evoke positive feeling in visitors, zoos can inspire their guests to become stewards of the environment. Perhaps an increased understanding of the natural world and the countless non-human species that inhabit it can inspire a movement of stewardship that will lead to preventing the further decimation of natural ecosystems.

Zoos have come a great distance in improving both animal welfare and naturalism in the last century. It seems that now, with these goals fairly well in hand, their roles as centers of education and conservation must become the primary concern in the interest of educating as many people as possible to the plights zoo animals' wild counterparts.

It is no longer the case that zoos are singular institutions aimed purely at entertainment, or demonstrations of wealth and power, although that is where their roots lie. Zoos have evolved into complex organizations that serve a number of different purposes and goals. They have several obstacles they must continue to try and overcome in the future, not the least of which is standardizing animal care across all facilities. In addition to this, facilities that aren't accredited and that house animals in sub-standard enclosures or have poor animal care drag down the entire zoo community, especially in the eyes of those members of the public who don't realize there is a difference between an accredited zoo and all the others. Zoos must continue to strive to learn all they can about the species they house, and be tireless at improving their quality of life, mentally and

physically. They also must continue to engage and educate visitors, to ensure their funding and existence into the future.

Going forward, it will be important for zoos to continue to expand their roles as educators, as their entertainment appeal draws a unique crowd that may not be reached by other, more traditional methods. Zoos welcome visitors from every economic background and every age group, and the utilization of their power to engage this diverse audience should not be underestimated. Their potential in this role, as environmental educators, could represent a future for zoos in which humans change how they view and interact with the natural world around them.

The design of zoo enclosures is an embodiment of the many masters a zoo must serve. Enclosures must serve the zoo's mission statement, animal welfare, naturalism, education, the keepers, the visitors, safety, enrichment, environmental protection and conservation, as well as others. The complex relationship between naturalism and animal welfare is one that can be followed through the history of zoo enclosure design, from their earliest evolution into zoological parks to the landscape immersion exhibits of today.

In a perfect world, this last paradigm shift -- from the current levels of ecosystem destruction to a protected world of tomorrow -- will help promote the ultimate conservation goal of zoos: reintroduction of populations of animals, raised in zoos, to be released back into the newly protected wild and live as they have historically. Until then, the dedicated staff of zoos will continue educating people, and will do their best to increase the naturalism and welfare of the species in their care. Without the stars of the

show, after all, there is no zoo.

References

Altimari E. Lincoln Park Zoo [internet]. Lincoln Park Zoo Launches ZooMonitor, a Free and Accessible Web App That Monitors Animal Behavior to Improve Welfare. 2016. Available from: http://www.lpzoo.org/pressroom/lincoln-park-zoo-launches-zoomonitor-free-and-accessible-web-app-monitors-animal-behavior

Barongi R. Conservation in Zoos and Aquariums: Programs and Visions [presentation]. At: The Ark and Beyond: The Evolution of Zoo and Aquarium Conservation, A Symposium. 2015 November 5-6; Tempe.

Barongi R, FA Fisken, M Parker and M Gusset. (eds). Committing to Conservation: The World Zoo and Aquarium Conservation Strategy. Gland: WAZA Executive Office. 2015.

Bean R. Barless Enclosures: Progress of the Idea in the Zoos of the World. *Parks & Recreation*. 1925; 8(4): 347-351.

Captive Animals' Protection Society (CAPS). Captive Animals' Protection Society [internet]. Our Work: Zoos. 2017. Available from: http://www.captiveanimals.org/our-work/zoos.

Caro TM. Behavioral solutions to breeding cheetahs in captivity: Insights from the wild. *Zoo Biology.* 1993. 12, 1, 19-30.

Carlstead K and J Brown. Using science to understand zoo elephant welfare: evolution of ovarian cyclicity and keeper-elephant relationships. *World Association of Zoos and Aquariums Magazine.* 2015. 10-13.

Clayton SD and G Myers. *Conservation Psychology: Understanding and Promoting Human Care for Nature*. John Wiley & Sons Ltd, 2015.

Clubb R and GJ Mason. "Natural behavioral biology as a risk factor in carnivore welfare: How analyzing species differences could help zoos improve enclosures." *Applied Animal Behavior Science.* 2007; 102, 303-328.

Coe JC. The Genesis of Habitat Immersion in Gorilla Exhibits, Woodland Park Zoological Garden & Zoo Atlanta, 1978-88, (unpublished). 1989. Published 2006 at http://www.joncoedesign.com.

Coe, Jon C. 1996, "One Hundred Years of Evolution In Great Ape Facilities in American Zoos." Proceedings of The AZA 1995 Western Regional Conference, American Zoo and Aquarium Association. 1995, Bethesda, MD.

Davey G. An analysis of country, socio-economic and time factors on worldwide zoo attendance during a 40-year period. *International Zoo Yearbook* [internet]. 41 (1); 2007. 217–225.

de Kloet RE. Corticosteroids, Stress and Aging. *Annals of the New York Academy of Sciences.* 1992; 663(1): 357-371.

Doney S, V Fabry, R Feely, and J Kleypas. Ocean Acidification: The Other CO2 Problem. *Annual Review of Marine Science.* 2009; 1: 169-192.

Donlan CJ, Berger J, Bock CE, Bock JH, Burney DA, Estes JA, Foreman D, Martin PS, Roemer GW, Smith FA, Soulé ME, and Greene HW. Pleistocene Rewilding: An Optimistic Agenda for Twenty- First Century Conservation. *The American Naturalist*. 2006; 168 (5): 660-681.

Hochadel S. Science in the 19th-century zoo. *Endeavour.* 2005; 29(1): 38-42.

Etter C, and DD Etter. *The Denver Zoo: A Centennial History.* Boulder, CO: Roberts Rinehart Pub., 1995. Print.

Friese C. *Cloning Wild Life: Zoos, Captivity, and the Future of Endangered Animals.* New York: NYU Press, 2013.

Greene H. "Rewilding the Lifeboats." In *The Ark and Beyond: The Evolution of Zoo and Aquarium Conservation*, ed. Ben A. Minteer, Jane Maienschein, and James P. Collins (Chicago: University of Chicago Press). 2018.

Grow S. Conservation in Zoos and Aquariums: Programs and Visions [presentation]. At: The Ark and Beyond: The Evolution of Zoo and Aquarium Conservation, A Symposium. 2015 November 5-6; Tempe.

Gusset M and Dick G. Editorial. *World Association of Zoos and Aquariums Magazine.* 2015. 1.

Gusset M and Dick G. The global reach of zoos and aquariums in visitor numbers and conservation expenditures. *Zoo Biology*. 2011; 30: 566–569.

Hagenbeck C. *Beasts and men, being Carl Hagenbeck's experiences for half a century among wild animals*. New York, New York: Ulan Press, 2012. Originally printed 1910. 322.

Hancocks D. *A Different Nature: The Paradoxical World of Zoos and Their Uncertain*

Future. Berkeley, California: University of California Press; 2001. 280.

Hancocks D. *Animals and Architecture*. New York, New York: Praeger Press; 1971. 200.

Hanson E. *Animal Attractions: Nature on Display in American Zoos*. Princeton, New Jersey: Princeton University Press; 2002. 243.

Howard R. Medical Politics and the founding of the Jardin des Plantes in Paris. *Journal of the Society for the Bibliography of Natural History.* 2011; 9(4): 395-402.

Hyson J. Jungles of Eden: The Design of American Zoos. *Environmentalism in Landscape Architecture.*Washington, DC: Dumbarton Oaks Research Library and Collection, 2000.

Kaufman L. "Zoos and Aquariums Struggle With Ways to Discuss Climate Change." *The New York Times.* Web, 26 Aug. 2012.

Kellert SR, Dunlap J. Informal learning at the zoo: A study of attitude and knowledge impacts. A report to the Zoological Society of Philadelphia. 1989.

Kisling Jr. V. Zoo and Aquarium History: Ancient Animal Collections to Zoological Gardens. United States: CBC Press; 2001. 440 p.

Kleiman, DG, KV Thompson, and C Baer. *Wild Mammals in Captivity: Principles and Techniques for Zoo Management*. Chicago, IL: U of Chicago, 2013. Print.

Maple TL and BM Perdue. Zoo Animal Welfare. *Animal Welfare*. Springer-Verlag, Heidelberg, 2013.

Maple, TL. Four decades of psychological research on zoo animal welfare. *World Association of Zoos and Aquariums Magazine.* 2015. 41-44.

Mason GJ. "Species differences in responses to captivity: stress, welfare and the comparative method." *Trends in Ecology and Evolution*, 25(12), 2010.

Mason GJ. "Using species differences in health and well-being to identify intrinsic risk and protective factors. *World Association of Zoos and Aquariums Magazine.* 2015. 2-5.

Mellor DJ, S Hunt, and M Gusset, eds. 2015. Caring for Wildlife: The World Zoo and Aquarium Animal Welfare Strategy. Gland, Switzerland: World Association of Zoos and Aquariums.

Mendelson, III JR. "Frogs in Glass Boxes: Responses of Zoos to Global Amphibian

Extinctions." In *The Ark and Beyond: The Evolution of Zoo and Aquarium Conservation*, ed. Ben A. Minteer, Jane Maienschein, and James P. Collins (Chicago: University of Chicago Press). 2018.

Miller LJ, RS Wells, R Stacey, FW Ziegler, JC Whitham and M Adkesson. Animal welfare management of bottlenose dolphins at the Chicago Zoological Society's Brookfield Zoo. *World Association of Zoos and Aquariums Magazine.* 2015. 14-17.

Mills WFR. Moving a Mountain to the City for Denver's New Habitat Zoo. *The American City.* 1918; 19(6); 474.

Minteer BA. Is the Real Zootopia the Future of Zoos or Just Another Spectacle? *Slate Magazine,* 2016. Web.

Mitman G. When Nature is the Zoo: Vision and Power in the Art and Science of Natural History. *Osirius: Science in the Field.* 1996; 2(11): 117-143.

Merkel, Hermann W. "Beautifying the Zoological Park." *Bulletin*. 51-60 ed. Vol. 16. New York: New York Zoological Society, 1912. 901-10. Print.

Muskopf HC. "Barless Bear Dens: Bruin's Habitation in St. Louis a Triumph in Construction," *Parks and Recreation*, 1921, 5(1):55-58.

Norton B, Maple T, Hutchins M and E Stevens. *ETHICS on the ARK (Zoo & Aquarium Biology & Conservation)*. Washington DC: Smithsomian Books; 1996. 360p.

Orban D, H Freeman, C Wheaton, J Mellen, J Soltis and K Leighty. Use of science to to enhance animal welfare at Disney's Animal Kingdom. *World Association of Zoos and Aquariums Magazine.* 2015. 18-21.

People for the Ethical Treatment of Animals (PeTA). c2017. People for the Ethical Treatment of Animals [internet]. Animal Rights Uncompromised: Zoos. [Cited 13 January 2017]. Available from: http://www.peta.org/about-peta/why-peta/zoos/.

Ritvo H. *The Animal Estate: The English and Other Creatures in the Victorian Era.* Cambridge, Massachusetts: Harvard University Press; 1987. 347 p.

Rose M. World's First Zoo - Hierakonpolis, Egypt. Archeology 2010; 63 (1). Available: http://archive.archaeology.org/1001/topten/egypt.html via the INTERNET. Accessed 2015 February 10.

Rothfels N. *Savages and Beasts: The Birth of the Modern Zoo.* Baltimore: The Johns Hopkins University Press; 2002. 268 p.

Rowley J and R Alford. Hot bodies protect amphibians against chytrid infection in nature. *Nature*. 2013; 1515(3): 10-38.

San Diego Zoo Global. c2017. San Diego Zoo [internet]. Animals and Plants. [Cited 12 January 2017]. Available from http://animals.sandiegozoo.org/animals/koala.

San Diego Zoo Global Mission Statement. c2017. San Diego Zoo Global [internet]. San Diego (CA): San Diego Zoo Global Mission and Vision. [Cited 15 January 2017]. Available from: http://zoo.sandiegozoo.org/content/san-diego-zoo-global-mission-and-vision.

Sawyer R. 2012 [cited 19 January 2017]. Conservation Centers for Species Survival: A Growing Resource for Species Recovery. *US Fish & Wildlife Service: Endangered Species Program Bulletin* [internet]. January- March 2012. Available from: https://www.fws.gov/Endangered/news/episodes/bu-01-2012/c2s2/index.html.

Stott RJ. The Historical Origins of the of the Zoological Park in American Thought. *Environmental Review: ER*. 1981; 5(2), 52-65.

Streithorst R. Harambe and the Cincinnati Zoo. CBS News. 13 January 2017. Available from: http://www.cbsnews.com/harambe-gorilla-cincinnati-zoo/.

Whitham J. Chicago Zoological Society Center for the Science of Animal Welfare [internet]. Monitoring the welfare of individual animals. 2016. [Cited 19 January 2017]. Available from: https://www.czs.org/AnimalWelfareTrak

Woodland Park Zoo Mission Statement. Woodland Park Zoo [internet]. Seattle (WA): Woodland Park Zoo: Our Mission. 2017. [Cited 15 January 2017]. Available from: http://www.zoo.org/mission#.WHslOGWJl01.

Young R. *Environmental Enrichment for Captive Animals*. Oxford, UK: Blackwell Publishing; 2003. 240.