

Zoo and Aquarium Conservation: Past, Present, Future

Ben A. Minter, Jane Maienschein, and James P. Collins

ZOOS AND AQUARIUMS CONFRONT THE CONSERVATION CHALLENGE

We are living, most biodiversity scientists and conservationists will tell you, in a time of profound ecological change. The mounting pressures imposed by habitat destruction and fragmentation, human population growth, overexploitation, spread of infectious diseases, and rapid climate change threaten scores of wild species around the globe (Thomas et al. 2004; Collins and Crump 2009; Hoffmann et al. 2010; Dirzo et al. 2014; Urban 2015). It's a situation so severe that the distinguished biologist E. O. Wilson recently called for setting aside no less than half the planet for biodiversity protection (Wilson 2016). Wilson's proposal no doubt sets a high-water mark for bold responses to global biodiversity loss, but it also signifies just how serious the challenge has become for many concerned about the viability of threatened species and ecosystems in the coming decades (Kolbert 2014).

Can zoos and aquariums play any role in tackling a challenge of this magnitude, let alone a significant one? Many scientists and leaders within and outside the zoo and aquarium communities believe they can, especially if they make biodiversity conservation a top institutional priority (see, e.g., Zimmermann et al. 2007; Conde et al. 2011a; Barongi et al. 2015). Although the sense of a looming global extinction crisis has clearly magnified these calls, they too are not new. Zoos and aquariums have for decades been encouraged to play a more significant role in the global effort to combat species extinction, to protect habitats, and in general to conserve biodiversity

at a range of scales, from tens of hectares, to large national parks, to immense ocean reserves (see, e.g., Bendiner 1981; Norton et al. 1995; Hancock 2002; Fa, Funk, and O'Connell 2011).

This agenda has been met with both skepticism and encouragement. Critics often argue that zoos and aquariums in fact do very little for biodiversity conservation and that any promotion as legitimate conservation organizations is a cynical appeal to justify an anachronistic and exploitative kind of institution. Supporters respond by asserting that zoos and aquariums have been serious contributors to conservation programs for more than a century, with an impressive track record of saving species that would be extinct without their efforts (see Tullis 2014 for an overview of the argument).

Such categorical views may appeal to a desire for simple and unqualified assessments, but they do not get us far in understanding zoos and aquariums as conservation actors. As the chapters in this volume will show, the story is much more complex.

ROOTS AND LEGACIES

As many zoo historians have written (including those in this volume), the early menageries from which the modern zoo emerged were anything but "centers of conservation" (see, e.g., Hoage and Deiss 1996; Reid and Moore 2014). Nevertheless, a concern with wildlife preservation, not just the protection of animals for public display in captivity, is a significant part of the history of the modern, professionally run zoo that developed in the nineteenth century. The incipient wildlife protection goals of early zoos, however, emerged at best only fitfully and partially. In European zoos in the eighteenth and early nineteenth centuries, for example, the interest lay primarily in the exotic qualities of certain animal species and in utilitarian applications of animal husbandry (Guerrini and Osborne, this volume; Ritvo, this volume). Still, by the early nineteenth century many European zoological gardens (like their later American counterparts) were viewed, especially by the scientific societies that founded them, as cultural hubs of nature study and public learning as well as recreational landscapes (Hochadel 2005).

In the United States, an identifiable concern with wildlife protection within zoos began to coalesce only in the late nineteenth century, coinciding with the early American conservation movement and the establishment of many of the nation's first zoos (see Barrow, this volume; Henson, this volume). Natural history, scientific study and education, and wildlife

preservation all became tightly linked in the original aspirational missions of many US zoological institutions during the period. Through zoological study and education, for example, early American zoos such as New York's Bronx Zoo, which opened to the public in late 1899, hoped to encourage interest in exotic and native animals and a concern for wildlife protection within a largely urban visitor base (Stott 1981, 58).

Captive breeding and reintroduction quickly emerged as the primary technique in zoos' early wildlife preservation efforts, with the notable example of the recovery of the American bison in the early twentieth century, where again the Bronx Zoo was a leader (Barrow; Rothfels; Henson; and Kisling, all this volume). Zoos' scientific and conservation ambitions and capacities became more sophisticated and extensive as the century wore on. Animal husbandry, zookeeping, and zoo biology, for example, became more professionalized in the later twentieth century, supported by the growth of scientific journals, conferences, and professional societies (Kisling 2000b). Some of the largest and best-equipped zoos, such as the one at San Diego, eventually moved to the cutting edge of research and conservation science, developing impressive new genetic and reproductive techniques (see, e.g., the chapters by Ryder; Friese; and Tubbs, all this volume). The best of these researchers contributed to advances in basic biology as they sought to conserve species using an ever-improving understanding in areas such as physiology, developmental biology, genetics, ecology, and host-pathogen interactions in zoo and aquarium species. Basic discoveries were applied to conserving animals, and also to educating the public about the importance of zoos as distinctive institutions where this sort of work could be done. Some zoos developed into "boundary institutions" using translational research to move the best ideas and most advanced techniques that modern science had to offer from laboratory or field experiments to conserving Earth's biodiversity. Although expensive, it was also the sort of discovery-based work that attracted the public's interest and donations.

Not surprisingly, this period marked the high tide of the zoo as a surrogate "Noah's ark" (see, e.g., Durrell 1976) geared to creating captive assurance populations as a hedge against extinction in the wild. The ark model was solidified in the 1980s by the creation of Species Survival Plans (SSPs) by (what is now) the Association of Zoos and Aquariums (AZA) as an overarching strategy for recovering and managing threatened and endangered species held in zoos (Grow, Luke, and Ogden, this volume; Kisling, this volume). The Amphibian Ark (Mendelson, this volume) is an excellent example of this sort of thinking. As researchers in the 1980s and 1990s began

to realize how many amphibian species were declining, some to extinction (Collins and Crump 2009), zoos, aquariums, and other conservation-related institutions created *ex situ* facilities to house and breed threatened species in the hope that at some future date the frogs can be reestablished in their natural habitats (Reid and Zippel 2008).

Breeding zoo animals to recover select threatened species and to reinforce *in situ* populations isn't the only way for zoos to contribute to species protection in the wild, however, and a suite of activities soon flourished under the general banner of "conservation." Over the past several decades, for example, many zoos expanded their capacity to protect endangered species by a range of tactics and methods, such as developing integrative species conservation programs integrating *ex situ* and *in situ* populations into a hybrid metapopulation management system (Redford, Jensen, and Breheny 2012; see also Traylor-Holzer, Leus, and Byers, this volume). Zoos also began to participate in collaborative field conservation, including significant community-based conservation initiatives (Lukas and Stoinski; Allard and Wells; and Cerezo and Kapsar, all this volume). As a result, zoos have been an important part of the institutional and intellectual context in which the science of conservation biology began to take shape in the late 1970s and early 1980s (Meine, Soulé, and Noss 2006).

Public aquariums, too, became more active participants in aquatic field conservation and science during this same period, with a growing number of calls over the past decade for them to play a more significant role in helping to sustain marine ecosystems (e.g., Penning et al. 2009; Tlustý et al. 2013; see also the chapters by Knapp and by Spring, this volume). The aquarium conservation story is less well known and documented than that of zoos, and although their conservation agenda overlaps to a considerable extent with that of zoos, aquariums' own history, as well as their technological and design requirements, also presents a distinct set of conservation challenges and opportunities deserving more research (see, e.g., Brunner 2005; also Muka, this volume; Linquist, this volume).

Zoo-based visitor education, a more indirect approach to conservation than breeding and reintroduction or participation in field projects, has long been a staple of zoo and aquarium programs (as the chapters in this volume by Henson and by Palmer, Kasperbauer, and Sandøe illustrate). The education-conservation link rests on the expectation that the better visitors understand the behavior, natural history, and status of threatened wildlife, the more likely they will be to engage in pro-conservation/environmental behavior. Although the evidence supporting this claim for the link's effective-

ness is mixed and often hotly contested (e.g., Falk et al. 2007; Marino et al. 2010; Jensen 2014), many within and outside the zoo and aquarium community suggest that under the right conditions these institutions can have an appreciable impact on biodiversity knowledge and conservation actions, especially if such programs foster a sense of connection between visitors and animals (Rabb and Saunders 2005; Moss, Jensen, and Gusset 2015; also Grajal, Luebke, and Kelly, this volume; Clayton and Le Nguyen, this volume).

Finally, scores of zoos and aquariums have increasingly become patrons of field conservation, devoting part of their operating budgets to funding in situ wildlife programs. According to the AZA, its accredited zoos and aquariums “fund over 2500 conservation projects in more than 100 countries and spend on average \$160 million on conservation initiatives annually” (<https://www.aza.org/conservation-funding>; also Grow, Luke and Ogden, this volume; Allard and Wells, this volume). Even though these numbers sound impressive—especially for a field (conservation) notorious for feeling cash-strapped—as Grazian (2015) points out, this effort is largely carried by a small set of larger and comparatively more resource-rich zoos. Furthermore, conservation expenditures currently account for only a very small percentage of most zoological institutions’ budgets. The most recent conservation vision of WAZA, for example called for a minimum of 3 percent of zoos’ and aquariums’ annual operating budgets to be devoted to conservation, which would mark a considerable increase for some (Barongi et al. 2015). Many within the zoo and aquarium communities are therefore pressing for even more investment and for these institutions to contribute even more of their budgets to conservation in the future (see, e.g., the chapters by Barongi and by Lukas and Stoinski, this volume).

TENSIONS AND TRADE-OFFS

To the degree that zoos and aquariums become more seriously engaged in conservation in their visions, programs, and budgets, they will have to contend with the constraints of their own institutional histories and capacities (as noted by Henson, this volume, and by Monfort and Christen, this volume). But they will also have to come to grips with a complex and rapidly evolving ethical and social context (see, e.g., the contributions in this volume by Palmer, Kasperbauer, and Sandøe; Norton; Clay; and Maple and Segura). Of course, zoological institutions have for decades prompted discussions about a range of animal welfare and animal rights issues, from the basic question of the moral acceptability of keeping animals in captivity

(e.g., Jamieson 1985, 1995; Regan 1995; Gruen 2014) to more specific ethical arguments and debates over practices such as captive breeding, manipulative zoo- and aquarium-based research, wild animal acquisition, habitat enrichment, and commercialization of wildlife (see, e.g., Norton et al. 1995; Kreger and Hutchins 2010; Maple and Perdue 2013).

In the past several years purported ethical violations by zoos and aquariums have been litigated in the news and popular media as a series of controversial cases have reignited a debate about the place of zoological parks in modern society, from the breeding and keeping of orcas at SeaWorld to the culling of captive animals for population management (e.g., Greene, this volume). As we write this introduction in summer 2016, the decision by the Cincinnati Zoo to shoot Harambe the Gorilla after a child entered his enclosure has provoked an international uproar (e.g., McPhate 2016; Walters 2016), yet it remains unclear what lessons we have learned from that unfortunate episode. Collectively, these recent cases have energized a growing chorus of critics calling for the end of what they believe to be an unethical and unnecessary form of animal exploitation in the twenty-first century (e.g., Wallace-Wells 2014; Zimmermann 2015; Bekoff 2016).

It is too early to tell how this newly emboldened critique of zoological parks will play out. As the discussions in this volume remind us, zoos and aquariums have weathered many storms over the decades while managing to remain incredibly popular among the public. Nevertheless, as they strive to become more serious partners in the study, recovery, management, and preservation of wildlife “outside the enclosure,” they will have to make difficult decisions and consider complex trade-offs regarding the values and interests that have traditionally shaped their mission, including decisions that will affect not only their identity, but also their bottom line (Cohen 2013). This means that the fuller ethical evaluation of zoo and aquarium conservation requires more than navigating and balancing animal welfare concerns (as important as these are). It also requires understanding and managing an emerging set of value-laden and ethical questions about our responsibility to conserve biodiversity, preserve wildness, and achieve sustainability across a spectrum of rapidly changing *ex situ* and *in situ* contexts (Minteer and Collins 2013; also Norton; Monfort and Christen; Cerezo and Kapsar; and Linquist, all this volume).

The SeaWorld orca case in particular has underscored perhaps the most difficult and controversial of these value-driven challenges: balancing zoological parks’ long-standing entertainment and recreation interests with the growing commitment to animal welfare, scientific research, and biodiversity conservation (Conway 2011; Grazian 2015).¹ Again, this chal-

lenge to balance the entertainment and scientific aims of zoological parks is far from new. As Henson (this volume) writes, zoos have been struggling with the task of harmonizing their public and scientific goals since the late nineteenth century. As far back as the early nineteenth century (when the modern version of the institution emerged in Europe), zoos were forced to realize that they could not survive as purely scientific institutions for research and education. They had to build and sustain their popularity with an often fickle public, typically more interested in seeing new and exhilarating animal attractions than in learning about natural history or about wildlife conservation (Hochadel 2005, 39–40).

It's a pragmatic concession, however, that has made some trouble, reflected in the widely voiced criticism that philistine entertainment values, more than "higher" educational, scientific, or conservation goals, define the zoo and aquarium today. Yet at the same time some zoological parks are embracing rather than fleeing from their public entertainment function, arguing that more ambitious, immersive, and challenging designs can lure more visitors *and* display a more respectable animal and environmental ethic (see, e.g., Minter, this volume). Regardless, as Ivanyi and Colodner (this volume) remind us (by their example of the Arizona-Sonora Desert Museum), public popularity and a strong zoo conservation identity are by no means mutually exclusive.

THE ARK AND BEYOND

It's clear that zoos and aquariums continue to evolve and mature in complex ways as modern conservation actors, all while being buffeted by the shifting winds of institutional, scientific, and societal change. As a result, the expanding conservation role for zoological parks raises a set of intriguing and difficult questions and challenges as we think more deeply about the history of zoos and aquariums, what they are today, and where they might—and perhaps should—be going. This book wrestles with these questions and challenges.

The questions and challenges concern the trajectory of zoological parks themselves, but they also concern zoo- and aquarium-centered scholarship, especially a set of important discussions in conservation history, the history and philosophy of the life sciences, environmental and animal ethics/studies, and conservation biology. For example:

- How and why did the conservation mission emerge and evolve in modern zoos and aquariums, and how does its development situate these

institutions in the wider history, philosophy, and practice of science and conservation?

- “Conservation” has been used to describe a wide array of practices within and by zoos and aquariums, from breeding to release in situ and conserving species (and habitats) in the field, to conducting ex situ animal research that may inform field conservation, to promoting pro-conservation attitudes and behavior through education. How have these different practices developed at various times and in various places? Are all these interpretations of conservation equally compatible? Which, in the end, are the most important?
- What do we mean by “animal welfare” and “animal wellness,” and how do these commitments and responsibilities relate to the conservation values and goals of zoos and aquariums today as well as to a wider set of conservation values applied to animals in their natural habitats? Can zoos make good on their promise to be leaders in both conservation and animal care while also catering to public entertainment and recreation interests?
- What is “wild” or “natural”—and how do we know? Can zoos ever be wild in any meaningful sense? To what extent does it matter whether zoos or aquariums replicate natural conditions (which they cannot do without qualifications)? How do narratives about acclimatization, husbandry, “enculturation” of both animals and humans, and wildlife protection all fit into this mix?
- What are the implications for conservation philosophy, science, and policy when zoos and aquariums become more engaged in field conservation projects—and as they take on an enhanced role as breeding centers and as “conservation arks” for threatened wild populations? Is the ark metaphor even useful today given the practical limitations of zoos and aquariums (space, resources)—limitations that become more glaring in the face of a global biodiversity crisis?

To try to understand these questions better, and to do our best to answer them, we created a “thinking community” (as the great conservationist Aldo Leopold might have put it) around the story of zoo and aquarium conservation, a community that would itself grow and evolve as we moved through the various stages of our project. The first event was held at the Marine Biological Laboratory (MBL) in Woods Hole, Massachusetts, in May 2014 as part of the MBL-Arizona State University (ASU) History of Biology seminar series. That meeting focused primarily on the *historical* foundations

of zoo and aquarium conservation, with some consideration of contemporary management and scientific issues. In fall 2015 we held a companion zoo and aquarium conservation symposium at ASU in Tempe and the Phoenix Zoo that effectively “flipped” the earlier gathering, emphasizing the participation of zoo and aquarium leaders while bringing along many of the historians from the earlier Woods Hole seminar and expanding the group to include ethicists, biologists, and social scientists. By the time we began compiling the chapters collected in this volume, our “thinking community” had swelled to four dozen contributors representing an impressive breadth of zoological and academic institutions (and an equally wide array of scholarly and professional fields and traditions).

The overarching theme of the project, the theme that bound us all together, was the meaning and significance of zoo and aquarium conservation as an idea and as a set of practices, and how an understanding of its complex traditions, challenges, and opportunities could be absorbed into broader narratives and discussions in conservation history, environmental ethics, the history of the life sciences, and conservation biology. The primary focus was on the US story, though the international context figures prominently in several of the contributions.

An early model for the present volume was the groundbreaking collection *Ethics on the Ark* (Norton et al. 1995), which drew together an eclectic group of zoo professionals, philosophers, activists, and biologists to consider a range of ethical, scientific, and management issues confronting the modern zoo (see the chapters in this volume by Norton and by Maple and Segura). A lot of water has flowed under the conservation bridge since the mid-1990s; the time therefore seemed right for a new assembly of voices. We also sought to expand the discussion by emphasizing the historical dimension, especially because zoos and aquariums have been nearly invisible in the standard conservation narratives.² And we wanted *The Ark and Beyond* to incorporate key perspectives from the social sciences (especially psychology and sociology), as well as a set of questions about zoo ethics and values that acknowledged, but also went beyond, the usual animal welfare debates.

THE ROAD AHEAD

We’ve arranged the chapters that follow into six clusters. The first two parts focus on the historical dimension of zoo and aquarium conservation, beginning with the rise of the modern zoo in Europe, which had only a tenuous link to what we would consider conservation today (though the roots

of later conceptual and practical tensions in zoo conservation are clearly visible). Chapters in part 2 explore the emergence of an identifiable conservation agenda in the early American zoos and aquariums of the late nineteenth and early twentieth centuries, concluding with the growth and maturation of this agenda late in the twentieth century. One of the more intriguing conclusions that emerges from these discussions is that there is no single, unified narrative of zoo and aquarium conservation, but rather a tangle of converging and diverging ideas and practices surrounding the circulation, breeding, reintroduction, and preservation of wildlife in and by zoological parks. As a result, although there is historical evidence supporting the claims that zoos have been championing conservation since the late nineteenth century, with a few notable exceptions this commitment was neither consistent nor all that significant for species protection until the later part of the twentieth century.

The next part moves to a consideration of today's zoo and aquarium conservation landscape, including emerging agendas motivating major zoo and aquarium bodies such as the World Association of Zoos and Aquariums (WAZA), the US-based Association of Zoos and Aquariums (AZA), and the Conservation Planning Specialist Group of the International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC). This third part also includes a series of in-depth accounts of particular programs at zoological parks known for their conservation programs and their influence on species survival and environmental sustainability more generally. Taken together, the chapters in this part demonstrate the diversity and scope of the contemporary zoo and aquarium conservation vision while emphasizing the importance of integrating zoological parks into a larger network of institutions working to recover, protect, and manage biodiversity across the landscape.

As we mentioned above, the ethical and societal context of the modern zoological park has figured prominently in discussions of the value of zoos and aquariums today, especially in light of significant concerns about animal welfare. Chapters in part 4 explore the welfare-conservation relation across a number of dimensions, revealing the complexity and ongoing challenges of running an ethically accountable institution premised on the public display of animals for human enjoyment. Contributions examine the nuances of the human connection to zoo animals and reflect on evolving ethical responsibilities surrounding animal wellness and the intricacies of the animal welfare-conservation interface. The part closes with an argument for zoological parks to promote a wider environmental ethic of ecological resilience and sustainability.

The scientific dimension of zoo and aquarium conservation is the subject of the penultimate part of the volume, which draws together a series of chapters examining one of the more fascinating and innovative frontiers of zoo biology: the use of advanced genetic and reproductive technologies to help recover and conserve threatened animal populations—and perhaps even to “revive and restore” species through genetic engineering and synthetic biology (aka “de-extinction”). The role of zoological parks in the “genetic rescue” of species, especially at the more interventionist end of the spectrum, raises a host of intriguing issues, including ethical and philosophical questions about the appropriate use of these technologies and what they might have in store both for zoo and aquarium animals and for the future of endangered species in the wild. Zoological research supporting critical conservation efforts is also highlighted, as well as the myriad scientific and institutional questions confronting zoos and aquariums as they address one of the more urgent and formidable biodiversity challenges today: the amphibian extinction crisis.

The final part of the book considers several alternative pathways and models for zoos and aquariums moving forward, starting with a cautionary argument for zoos to solidify what they historically do well (caring for and managing zoo animal populations) rather than overcommitting themselves as “full service” conservation organizations. It offers defenses of place-based zoological institutions rooted in natural history and regional culture as well as arguments to rethink the societal role and ecological footprint of zoos and aquariums in the age of sustainability. The discussion closes with a pair of chapters probing the biological, aesthetic, and cultural implications of enhancing wildness and naturalness in the zoo environment, including whether we really want zoos to be red in tooth and claw—and whether radical efforts to make zoos more immersive offer a more naturalistic alternative to the traditional visitor experience or just a more ingeniously designed one.

No single volume on a subject as complex and context-dependent as zoo and aquarium conservation, even one as expansive as ours, could persuasively claim to be complete or exhaustive. Still, in *The Ark and Beyond* we’ve worked hard to provide as informed and as rich a treatment of the story of zoo and aquarium conservation as possible. We believe the book captures some of the very best thinking about zoos and conservation available today.

If we were asked (in closing this introduction) to condense a long list of project goals into a single ambition for this book, we’d say it is to show

how a carefully chosen set of critical and diverse perspectives on the evolution and character of zoological parks can help us better understand them as conservation actors in a time of rapid ecological change, rising expectations, and deepening societal skepticism. We also hope to demonstrate the great value of assembling a diverse and thoughtful group of academics and practitioners to engage in a challenging, and not always easy, conversation about the legacy, limitations, and hopes of one of our more popular public institutions as it continues to change and transform in this century. That involves two goals rather than one, we realize. But you need to have pairs on the ark.

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I am delighted to serve as editor for the new University of Chicago Press series Convening Science: Discovery at the Marine Biological Laboratory. These books will “highlight the ongoing role the Marine Biological Laboratory plays in the creation and dissemination of science, in its broader historical context, as well as current practice and future potential.” Each volume is anchored at the MBL, including work about the MBL and MBL science and scientists, work by those scientists, work that begins with workshops or research or courses at the MBL, collaborations made possible by the MBL, and so on. Books by, about, with, for, inspired by, and otherwise related to the MBL will capture the spirit of discovery by the community of MBL scientists and students. Some will be monographic, while others are collaborative coherent collections.

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The Ark and Beyond

The Evolution of Zoo and Aquarium Conservation

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