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ZOOS AND AQUARIUMS COMMITTING TO INTEGRATED SPECIES CONSERVATION

Markus Gusset

Introduction

Ensuring the well-being of other species is essential if humans are to ensure their own. The quality of the land, air, and water not only affects wild populations of animals and plants but will eventually determine humanity's fate as well. Quick and effective action must be taken to deal with the profound anthropogenic issues that confront natural ecosystems, such as growing human populations, continued pollution and over-exploitation of natural resources, and climate change (Tilman et al. 2017). Human actions and lifestyle choices are threatening the planet and the life-forms that inhabit it. To preserve the diversity of the world's wildlife, humans must change how they live.

However, it has proved extremely difficult to mobilize and sustain the social and political will necessary to change behavior for the benefit of wildlife and wild places. While many believe that species and habitat conservation are innately valuable, others need to be convinced of the material importance of conserving living fauna and flora. The key strategy for achieving the required revolution in attitudes and behaviors will be reconnecting the public with nature. People must be inspired to understand that life on earth is fragile, that the species that make up life on the planet depend on each another to survive, and that human survival is reliant on the species populations in natural ecosystems. It must also be made clear that species conservation has economic value: the richer the diversity of life, the greater the opportunity for medical discoveries, economic development, and adaptive responses to the ominous impacts of global climate change.

Zoos and aquariums (accredited or otherwise designated members of the professionally recognized zoological community) are uniquely poised to contribute to the successful conservation of species and ecosystems. Many zoos and aquariums are working to make sure that the range of species they care for is supported by meaningful conservation actions linked to the survival of species in the wild (Zimmermann et al. 2007; Dick and Gusset 2010; Conde 2013). While resources may not extend to providing support for every species, conservation actions taken for the most threatened populations will have a positive impact on all species within that habitat (Conde et al. 2015; Funk et al. 2017). A global appraisal of the contribution of the world zoo and aquarium community to wildlife conservation (Gusset and Dick 2010) showed that the evaluated projects are helping to improve the conservation status of high-profile threatened species and habitats in biodiversity-rich regions of the world.

The collective social, political, and financial power of zoos and aquariums as a community, as well as the potential impact of such vast audiences, can be potent. Zoos and aquariums enjoy wide-ranging

levels of public credibility and trust and provide fun and intellectually stimulating destinations for visitors of all ages (Gusset and Chin 2016). Every year, an estimated 700 million visits are made to zoos and aquariums that are members of national or regional associations around the world (Gusset and Dick 2011a). While money and donations do not always translate into quality conservation efforts, funds are still an essential requirement for the implementation of conservation action. It is estimated that US$350 million are raised annually for direct support of wildlife conservation by zoos and aquariums in organized associations around the world (Gusset and Dick 2011a).

Instilling in all visitors a strong sense of excitement about and a desire to care for life on earth will create a solid platform for fulfilling the promise to care for and conserve wildlife (Fa et al. 2011; Rees 2011; Dick and Gusset 2013; Hosey et al. 2013). Zoological facilities are uniquely positioned to use a social-science, evidence-based approach to influence pro-environmental behavior (Gusset and Lowry 2014). A global evaluation of the educational impacts of visits to zoos and aquariums found that a significant number of people end their visit with higher biodiversity understanding and a greater knowledge of actions to help protect biodiversity (Moss et al. 2014, 2015, 2017a), with a potentially long-lasting effect (Jensen et al. 2017). The challenge, not only for zoological facilities but also for all environmental education providers, is to translate such biodiversity knowledge gains into the social and behavior change required to achieve greater biodiversity conservation (Moss et al. 2017b).

Integrated Species Conservation

To accomplish this, and to increase the effectiveness of global conservation efforts, zoos and aquariums are increasingly adopting a One Plan Approach (Figure 27.1). This conservation planning framework brings together experts from the global zoo and aquarium fraternity, local community representatives, governmental agencies, wildlife managers, conservation organizations, scientists, and others in developing conservation strategies to achieve the common goal of viable populations of the species thriving in healthy ecosystems. Through the One Plan Approach, all available resources are engaged in producing one comprehensive conservation plan for each target species. This integrated approach will result in more comprehensive actions, promote innovation in species conservation, cultivate greater collaboration between zoological facilities and with other conservation organizations, and allow for greater adaptability in the face of climate change.

Zoos and aquariums can and must become models of integrated conservation (Gusset and Dick 2013). As animal-care specialists, conservationists, educators, communicators, wildlife advocates and scientists, zoo and aquarium professionals must also become powerful agents of change and encourage the widespread application of the One Plan Approach, as exemplified in *Second Nature* (CBSG

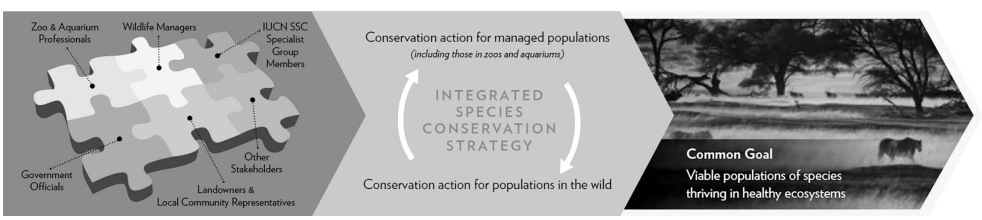

Figure 27.1 The One Plan Approach—a term coined by the IUCN SSC Conservation Breeding Specialist Group—refers to integrated species conservation planning that considers all populations of the species (inside and outside the natural range), under all conditions of management, and engages all responsible parties and resources from the start of the conservation planning initiative

Source: Illustration used with permission from Barongi et al. (2015).

2017). Their institutions must embrace the role of professional conservation organizations that operate sustainably. Fulfilling this responsibility has never been more essential.

The One Plan Approach also mandates that animals maintained in zoological facilities play a conservation role that benefits wild counterparts. The One Plan Approach links researchers in zoos and aquariums with scientists and conservationists working directly with wild populations. Likewise, education and capacity-building efforts must start with zoos and aquariums and expand to influence behavior change for conservation in society. Zoological facilities must work together, and be effective at partnering and collaborating with other conservation organizations to evaluate impacts and advocate for conserving biodiversity.

The World Association of Zoos and Aquariums (WAZA), the unifying organization for the world zoo and aquarium community (Penn et al. 2012), defines conservation in its *Committing to Conservation: The World Zoo and Aquarium Conservation Strategy* (Barongi et al. 2015: 12) as "securing populations of species in natural habitats for the long term." Therefore, this chapter focuses on direct contributions of zoos' and aquariums' core expertise in population management to species conservation within the One Plan Approach framework. "Population management" in this context refers to the human act of altering behavioral, reproductive, genetic, health-related, and welfare-related aspects of animal populations.

Sustainable Population Management

Global biodiversity targets (e.g., those by the United Nations Convention on Biological Diversity [CBD]) aim primarily to preserve biodiversity in natural habitats. However, because human impacts now affect all ecosystems, a rising number of species will benefit from, and increasingly require, intensive population management. This trend emphasizes the need for zoos and aquariums to be more directly involved in the intensive management of an increasing number of species both in zoological facilities and in the wild (Conway 2011). As zoos and aquariums engage in increased conservation breeding for the purpose of preserving biodiversity, careful species selection should be used to focus limited resources on those for which a long-term and broadly protective difference can be made.

The International Union for Conservation of Nature (IUCN), the world's largest and most diverse environmental network, has recognized that conservation breeding by zoos and aquariums has played a role in the recovery of one-quarter of the 64 vertebrate species whose threat status was reduced according to *The IUCN Red List of Threatened Species* (www.iucnredlist.org; Gusset and Dick 2012; also see Gilbert et al. 2017). Breeding animals in human care followed by reintroducing them into the wild as part of a coordinated recovery plan was one of the most frequently cited conservation actions that led to improvements in the IUCN Red List status. For birds, conservation breeding and reintroduction helped prevent the extinction of 6 out of 16 species that would probably have been lost in the absence of conservation measures. For mammals, conservation breeding and reintroduction have been more successful in improving conservation status than other conservation actions and contributed to the genuine improvement in the IUCN Red List status of at least nine species.

With more than 20,000 species in their care, zoos and aquariums have assumed increased leadership and responsibility for conservation-breeding programs over the years. No other group of institutions has the scientific knowledge and practical experience to keep and breed thousands of animal species, thereby offering enormous potential for contributing to wildlife conservation (Kleiman et al. 2010; Irwin et al. 2013). These zoo- and aquarium-based skills and resources are most effective for achieving conservation outcomes when applied through extensive and cross-disciplinary partnerships.

To fulfill the full suite of conservation roles required, wild-animal populations in human care must be demographically robust, the animals must be behaviorally competent and genetically representative

of wild counterparts, and the breeding program must be able to sustain these characteristics for the future (Gusset and Dick 2011b). Individuals making up viable populations should be healthy in every respect, including a positive animal-welfare state (Maple and Perdue 2013; Manteca Vilanova 2015), and be sourced legally, sustainably and ethically.

Small populations are rarely sufficient for securing long-term persistence of a species. Conservation-breeding programs at the regional or global level can help form larger populations, if needed (Conde et al. 2013). Most programs are managed at the regional level for logistical and regulatory reasons. A new way of fostering collaboration inter-regionally is being tested through Global Species Management Plans (GSMPs). A GSMP involves the management of a particular species with a globally agreed set of goals while building upon and respecting existing regional processes.

International and regional studbooks provide the data that can help facilitate the coordination of such conservation-breeding efforts across zoological institutions. Studbooks are repositories of pedigree and demographic data on animals managed internationally or regionally. ZIMS is an application of Species360 (www.species360.org) that keeps track of individual animals throughout their lives. New features have been added to ZIMS to help studbook keepers, and well-run and up-to-date studbooks will improve the animal and population data ZIMS offers within the application. As members of Species360 enter data into ZIMS, they contribute to efficient population management across the zoological community. Furthermore, applying this type of living records system to small populations in reserves could advance the One Plan Approach and make a direct contribution to sustaining wildlife in nature (Schwartz et al. 2017).

It is vital to recognize that space for holding and breeding larger populations of many species is the greatest impediment to building long-term sustainability (Lacy 2013). This issue over available space was recognized in the 1980s, yet it remains a critical need in building sustainable populations today, with a demand for caring for more species in zoos and aquariums (Gusset et al. 2014). Another crucial matter is the difficulty that zoological professionals encounter in moving animals (or gametes) for breeding purposes. Regulatory hurdles continue to make transregional movement of animals difficult (Gusset and Dick 2011b). This threatens the successful implementation of GSMPs and other collaborative interregional programs. In addition, it thwarts cooperative management of species maintained in different regions whose collective population would be sustainable, if individuals in the isolated, regional populations could be moved predictably for breeding purposes.

Continuum of Management Intensity

A clear link should be established and communicated between field conservation, and the conservation work carried out in zoos and aquariums. In line with this objective, WAZA's *Committing to Conservation: The World Zoo and Aquarium Conservation Strategy* (Barongi et al. 2015) postulates the dawning of the era of increasing focus on a more holistic approach to integrated species conservation, which works along a continuum of management intensity (Figure 27.2) (Redford et al. 2012). This new paradigm—the One Plan Approach—has been recognized in the *IUCN SSC Guidelines for Species Conservation Planning* (IUCN SSC 2017). For illustration (see Figure 27.2), Kihansi spray toads (*Nectophrynoides asperginis*) are found almost exclusively in human care as an intensively managed population and many populations of African elephants (*Loxodonta africana*) require conservation interventions in order to persist, whereas the peregrine falcon (*Falco peregrinus*) is an example of a recovered, currently self-sustaining species. Furthermore, in order to build sustainable populations, zoological facilities must commit to supporting and training the staff who implement cooperative population management.

Increasingly, as a result of habitat loss, and habitat and population fragmentation, many wild populations have similarities to populations in human care—small in size, fragmented, and with limited gene flow between them. For example, animals reintroduced into relatively small, fenced reserves

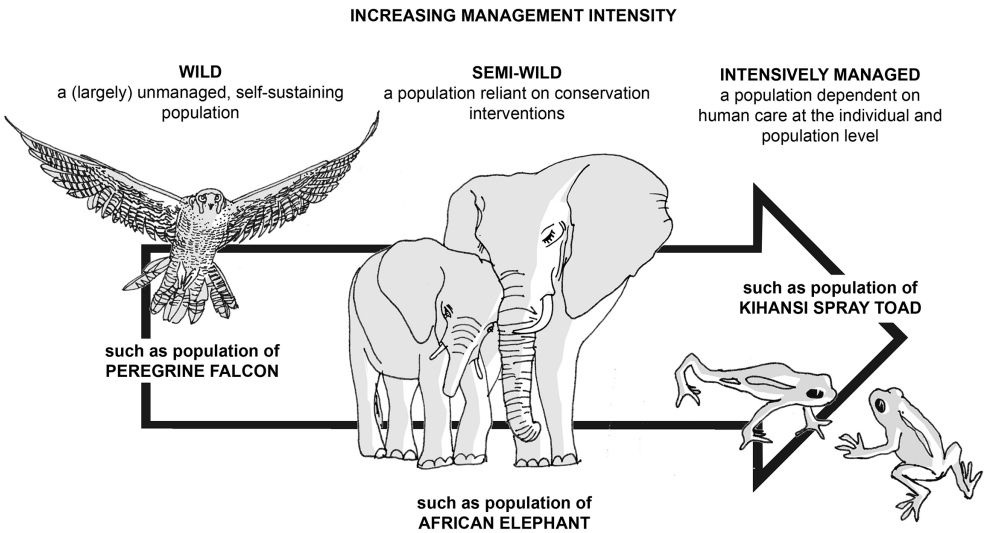

Figure 27.2 Integrated species conservation works along a continuum of management intensity, including little, if any, human intervention in wild populations all the way to intensively managed populations in some reserves and in zoos and aquariums

Source: Illustration by Júlia Hanuliaková/Zoo Design Inc.

have necessitated periodic translocation of individuals to mimic natural dispersal and maintain gene flow. This model is referred to as a managed metapopulation (Figure 27.3), as natural metapopulation processes such as dispersal are subject to human intervention.

Genome resource banks, as an additional component of metapopulation management (see Figure 27.3), serve to cryopreserve genetic material of animals (e.g., blood, gametes, embryos, tissues). Long-term population viability often requires transfers of animals (or gametes) for breeding. Traditionally, this included the exchange of animals between holders of the population in human care, import of animals from the wild to either bolster existing or establish new populations in human care, and export of animals from populations in human care to the wild. These transfers can be combined under one umbrella of interactive exchanges of animals (or gametes) between populations in the wild and in human care for achieving coincident conservation outcomes (Gusset and Dick 2013), as illustrated in Figure 27.3 by the various types of transfers. This greatly enhances the capacity to sustain viable populations both in zoological facilities and in the wild. For the sake of effective population management, legislation at national and international levels (including regulations by the Convention on International Trade in Endangered Species of Wild Fauna and Flora [CITES]) should be adapted and enforced to provide opportunities for such interactive exchanges.

The science of managing small populations in human care is of direct relevance to field-conservation programs that require intensive wildlife-management techniques. For example, fencing can be highly effective for preventing human—wildlife conflicts in wild-animal populations adjacent to settled areas. However, fenced populations will require human intervention to be viable in the long term. Similarly, fragmented and small populations may require translocation of animals among the few remaining sites to restore gene flow. As land-use change and, increasingly, climate change progress habitat fragmentation, deterioration, and destruction, translocation is likely to become an increasingly important conservation tool, as illustrated in Figure 27.3 by the transfer of animals between semi-wild populations. Strategic guidance is provided in the revised *IUCN SSC Guidelines for Reintroductions and Other Conservation Translocations* (IUCN SSC 2013). An example of an

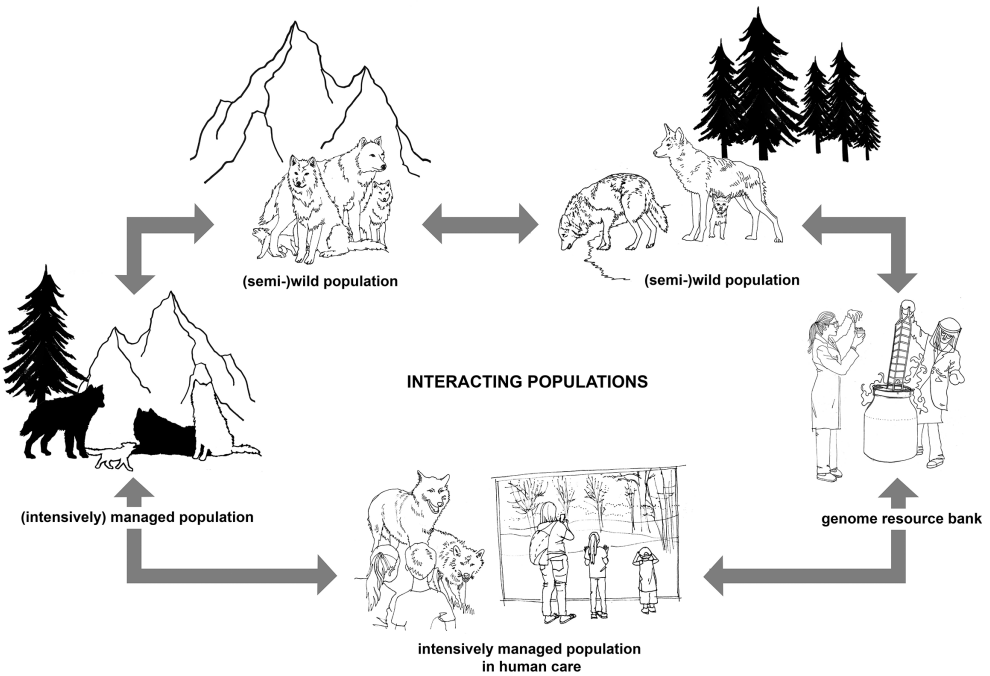

Figure 27.3 Metapopulation management involves managing a set of interacting populations under a common conservation goal. Its components may include multiple regional populations managed in human care (including range-country breeding programs), multiple (semi-)wild populations (including reintroduced populations) and genome resource banks. Arrows indicate transfers of animals (or gametes)

Source: Illustration by Júlia Hanuliaková/Zoo Design Inc.

integrated species conservation strategy, which involves conservation interventions along the continuum of management intensity and applies a metapopulation management approach, is provided in Box 27.1.

Box 27.1 Integrated Conservation of the Red Wolf in the United States

The red wolf (*Canis rufus*) is one of the world's most threatened canids (Figure 27.4). Once common throughout the eastern and south-central United States, the species was decimated by the early part of the 20th century as a result of predator control and habitat destruction. The red wolf was designated an endangered species in 1967. The establishment of a managed zoo population in the early 1970s allowed persistence of the species and a dedicated conservation-breeding program (split among multiple zoological facilities) facilitated a reintroduction program (initiated in the mid-1980s) that supported two wild populations, one of which persists today in North Carolina. This restoration effort was the first time in US history that a federally listed species was reintroduced to its historical range from which it had been extirpated. The US Fish and Wildlife Service set the explicit objective of managing red wolves via the interactive exchange of animals between populations in human care and in the wild. As of 2017, about 200 red wolves live in zoological facilities, and about 50 roam freely. The red wolf thus provides

Figure 27.4 Red wolf at Point Defiance Zoo & Aquarium
Source: Photograph by John Froschauer.

an example where a species once extinct in the wild benefits from an integrated conservation strategy (Figure 27.1) that contains conservation actions for both the managed zoo population and the (small, reintroduced) wild population. This strategy involves conservation interventions along the continuum of management intensity (Figure 27.2) and applies a metapopulation management approach (Figure 27.3). Nevertheless, anthropogenic mortality continues to threaten the persistence of the red wolf in its historical range, highlighting the need for intensive population management (human intervention) both in zoological facilities and in the wild (for more information, see www.fws.gov/redwolf/index.html).

As the biodiversity crisis intensifies, an increasing number of species will likely require some form of intensive population management in order to avoid extinction. Guidance on if and when activities in zoos and aquariums can be a beneficial component of an overall species-conservation strategy is provided in the revised *IUCN SSC Guidelines on the Use of* Ex Situ *Management for Species Conservation* (IUCN SSC 2014; McGowan et al. 2017). These guidelines outline a five-step decision-making process that defines potential conservation roles that populations in human care may play, the type of activities needed to fulfill those roles, and the feasibility, risks, and likelihood of success. Population management can be used more effectively as a conservation tool if the specific ways in which it can improve population viability or prevent extinction are identified and critically evaluated as part of an integrated approach to species-conservation planning.

In addition to advancing tools for the behavioral, reproductive, genetic, health-related, and welfare-related management of intensively managed populations, innovative approaches are needed to enhance the capacity to sustain viable populations both in human care and in the wild (Gusset et al. 2014). There are existing challenges that also need attention, such as the management of group-living species, low reproductive success, metapopulation management and adaptation to being kept in human care. Research and new technological advances (e.g., genomics) are emerging that have the potential to significantly change and improve how populations are managed. There will be the need to develop new ways and software tools to incorporate these findings and technologies into population management. Developing sustainable, genetically diverse populations is an obligation that serves field conservation and conservation work carried out in zoological facilities and animal-welfare goals.

Conclusion

Animals in zoos and aquariums act as ambassadors that, if leveraged effectively, can provide impact and reach to the support accredited zoo and aquarium communities give to wildlife conservation. It is essential to provide visitors with clear explanations about the conservation impact their everyday behavior is having on wild populations, both locally and globally, and to focus behavioral-change campaigns on the behavior changes that will be most positive for biodiversity conservation (Gusset and Lowry 2014).

It is imperative that all zoos and aquariums increase their contribution to and impact on saving species in the wild, including the provision of skills and technical and financial resources (Fa et al. 2014). Creating a clear connection between a live animal in a zoological facility and a conservation project in the field should be integrated into every master-planning process to make certain that adequate support is generated for saving species in the wild.

Zoological institutions are already playing a major role in the global conservation of species (Conde et al. 2011), and this will grow as their conservation missions are integrated into every aspect of operations. The One Plan Approach builds on the strengths and motivations to link all the skill sets and experience of zoo and aquarium staff to individuals and organizations working in the field (Figure 27.1). Advances in animal care and research with intensively managed small populations in zoological facilities are being applied to larger global issues.

Sustainable population management is one of the most critical issues for modern zoos and aquariums (Gusset and Dick 2011b; Gusset et al. 2014), and visitors may find it difficult to differentiate between the needs of an individual animal (animal welfare) and the conservation needs of a species (population management). Population management within zoological facilities regularly requires animal transfers, mate selection, social-group composition, euthanasia or contraception (Hildebrandt et al. 2017), and these requirements should be clearly explained to all stakeholders in conservation and welfare terms.

Excellent animal welfare is fundamental to achieving a shared wildlife-conservation goal. While conservation of wildlife is the core purpose of zoological facilities, positive animal welfare is their

core activity (Gusset and Dick 2015). To that end, a commitment statement has been adopted as a part of WAZA's *Caring for Wildlife: The World Zoo and Aquarium Animal Welfare Strategy* (Mellor et al. 2015: 15): "Zoos and aquariums have a responsibility to achieve high standards of animal welfare in support of their goals as modern conservation organizations."

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