Robert C. Lacy[1,*], Kathy Traylor-Holzer[2] & Jonathan D. Ballou[3]

Managing for True Sustainability of Species

Summary

Despite the increasing conservation need for intensive population management, zoos are failing to maintain sustainable and diverse *ex situ* populations that contribute to species conservation. In this paper, we define the problems and identify strategies and actions for meeting this challenge.

Recognising the Problems

The "wild" of our childhood is no more. Human populations continue to expand, habitats are increasingly altered by human activities, invasive species are spreading, new diseases are emerging – and species need to adapt to these new challenges if they are to persist. Increasingly fragmented wildlife populations are at greater risk and in more need of support because they face unique threats and lack the diversity to respond. The call to action is widespread and urgent, imploring all conservation partners to use their resources and expertise effectively to advert widespread species extinctions. Zoos (including aquariums) have an expanding role and responsibility to contribute to species conservation amid this biodiversity crisis (Baker *et al.* 2011).

The increasingly necessary conservation tools of assurance populations, reintroduction and supplementation require sustainable *ex situ* populations. Unfortunately, zoos are failing to achieve this on many levels. First, currently only a small percentage of threatened species are held by zoos. Second, a small percentage of species in zoos are managed scientifically, and, finally, few of these are considered to be managed sustainably (Traylor-Holzer 2011). Moreover, our measuring stick for "sustainability" typically has been the maintenance of 90% gene diversity for 100 years, usually applied to an independent regional population. However, true sustainability is the maintenance of a resource without depletion or loss of its value. Thus, our benchmark by which "sustainability" is measured is not an indicator of true sustainability but rather acquiescence to an accepted rate of genetic decay (Ballou & Traylor-Holzer 2011; Lacy 2013). Zoos cannot serve as secure havens for averting extinction or be used as source populations for species conservation activities if we accept depletion of the adaptability that those populations will need to survive, and then often fail to meet even these inadequate goals.

Achieving Sustainability

Achieving success must start with clear goals, derived from a comprehensive conservation strategy for the species that defines what the broader community values – not just the individual zoo or zoo association or even the global zoo community, but the global conservation community. What do we mean by saving the species? Who will take responsibility for conducting each component of the conservation plan? And, perhaps most critically, who will be the species' champion to make sure that we do not just watch extinction occur? Addressing these questions is beyond the scope of this contribution, but they need to be addressed at a global level, species by species (IUCN SSC 2008).

1 Chicago Zoological Society, Brookfield, IL, USA
2 IUCN SSC Conservation Breeding Specialist Group, Apple Valley, MN, USA
3 Smithsonian Conservation Biology Institute, Washington, DC, USA
* E-mail for correspondence: rlacy@ix.netcom.com

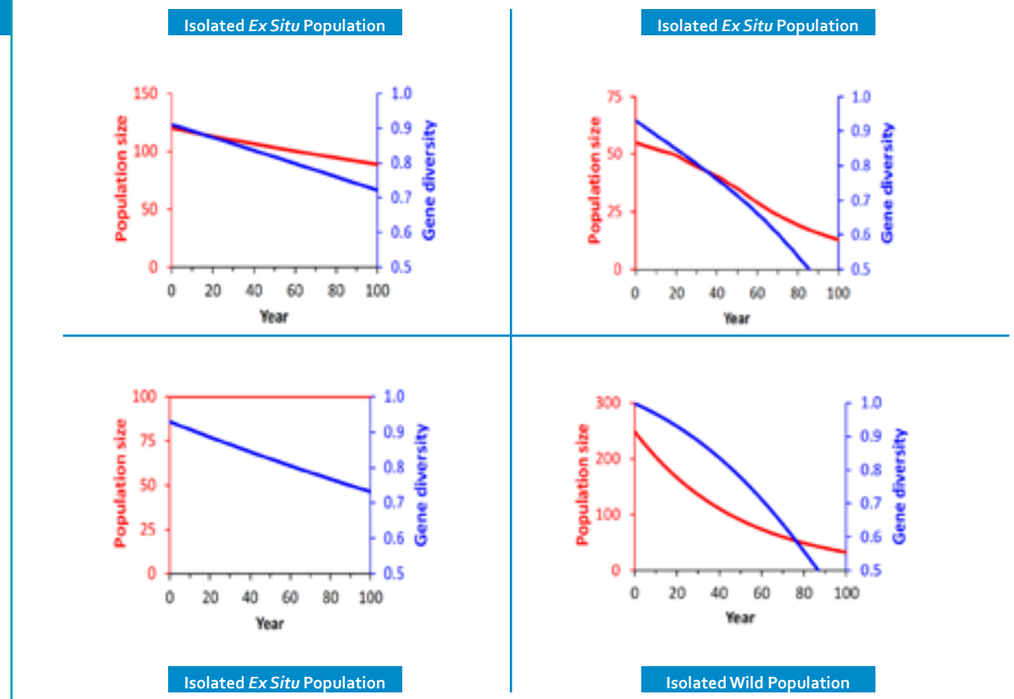

Fig. 1
Small isolated populations. Small population size with poor growth (red line) and rapid loss of gene diversity (blue line) lead to increased inbreeding and instability, resulting in decreased individual fitness, loss of genetic evolutionary potential and increased risk of population extinction.

For many species, this comprehensive species-level strategy will include the question: What are the roles of populations held at zoos? To serve as an effective source for restoring healthy wild populations, *ex situ* populations must be truly sustainable and they must contain evolutionary potential to allow adaptation to a rapidly changing global environment. True population sustainability cannot be achieved through small isolated populations managed through independent plans, but will require new and integrated management approaches among interacting populations that may transverse a broad management continuum (Redford *et al.* 2012; Lacy 2013). Collaborative management among zoos, among zoo regional programmes, between captive and wild populations, between living individuals and gametes held in a genome resource bank are all important components of integrated metapopulation management programmes that support species conservation – a One Plan approach as discussed by Byers *et al.* (this issue).

An integrated approach leads to larger and more robust populations that can maintain genetic variation through periodic, well-planned exchanges, moving from a plan for slow decay (Fig. 1) to one of sustainable maintenance (Fig. 2). In addition, the diversity of environmental conditions and management strategies across such a metapopulation better allows us to move from the narrow target of maintaining neutral genetic diversity measured through pedigree analysis to preservation of other types of variation, including behavioural, morphological, physiological and adaptive genetic variation. Through effective integration, a holistic metapopulation approach can pool "resources" in the broadest sense of the term – space, animals, genes, expertise, funds – to have the greatest conservation impact. It should also be obvious that numerous diverse, healthy, breeding animals serving to help save species will promote other purposes of zoos as well.

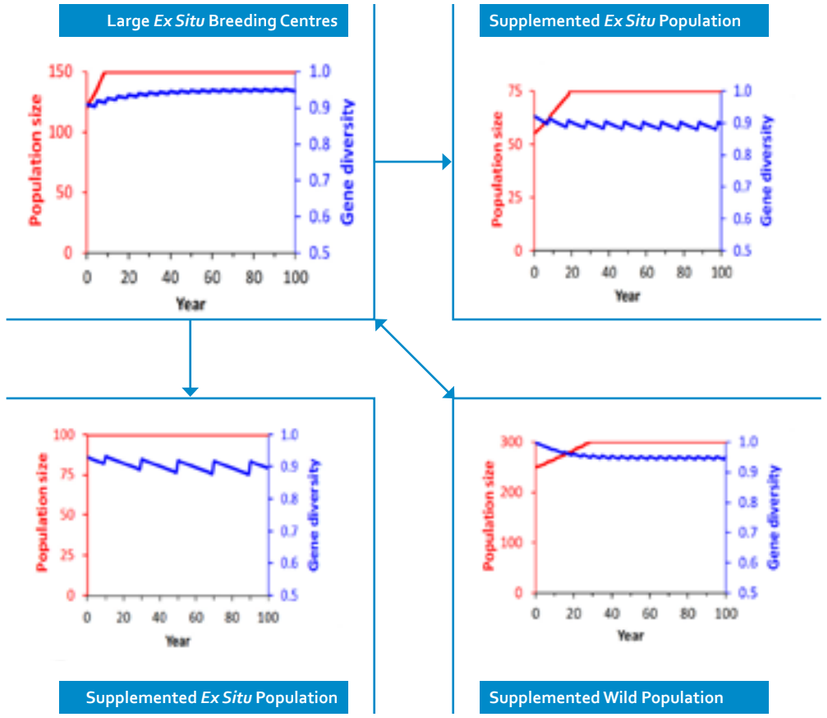

Fig. 2
Interconnected metapopulation. Improved breeding success and periodic animal exchanges promote strong population growth (red line) and maintenance of genetic potential (blue line), resulting in sustainable populations in both captivity and the wild.

Tailoring Solutions to the Problem

With a clear understanding of the goals for sustaining a species and the roles to be filled by zoo populations, the methodologies necessary to successfully fill those roles can be determined. This analysis must start with specifying what trajectory (in terms of population size, growth, stability, variability and resilience, and in terms of impacts on audiences) we desire for each population – with constant reference back to the overall species' conservation plan, rather than relying on *ad hoc* justifications or a generic template, as is the case for many of the current breeding programmes. Current and expected trajectories must be compared, the reasons for any gaps between the two identified and plans put in place to correct the deficiencies. Listed below are several types of deficiencies not uncommon in managed populations, along with some strategies for resolution.

If managed populations for a species are too small to be demographically and genetically robust, then a choice must be made as to whether or not *ex situ* populations will serve a conservation role for that species. If it is affirmed that they should, then:

- recruit additional zoos to manage the species;
- have each zoo maintaining the species commit to keeping a larger number of individuals;
- institute exchanges to link formerly disconnected *ex situ* populations through joint management and mutual support;
- create new specialised breeding facilities;
- establish a programme of managed and mutually beneficial exchanges between *ex situ* and *in situ* populations; and/or
- use gamete banks to increase the genetically effective size of a population.

If the source population that founded the existing *ex situ* population was too small or otherwise of limited genetic diversity, of unknown history or of uncertain taxonomy, then:

- determine the taxonomy, history and diversity of the source on which the managed population is based;
- combine programmes for subspecies that are not reproductively isolated or strongly differentiated, especially if sub-specific identity of animals is uncertain or already mixed;
- obtain new founders from other breeding programmes; and/or
- obtain new founders from wild populations able to sustain such removals.

If exhibit practices and husbandry protocols do not result in sufficient reproduction and survival to meet population goals, then:

- transfer animals to facilities that can achieve those levels;
- develop new or redesigned facilities, such as specialised breeding centres; and/or
- change the social management (e.g. natural social groupings, mate choice).

If the species biology or husbandry requirements are not sufficiently known to identify which actions are needed, then:

- implement research programmes in the field or in zoos to provide the needed data.

If the *ex situ* population is being sustained biologically, but the positive conservation effect is not being achieved, then:

- improve integration with efforts for wild populations;
- communicate effectively to audiences to change behaviours that are counter to conservation; and/or
- reallocate resources towards methods that successfully counter threats to the species.

Acting Locally

Many of the above are obvious options, many have been suggested before and almost all either require or are more easily achieved by institutions working in collaborative partnerships – both within the zoo community and with other conservation organisations. However, there are many things that each institution can do by itself and to promote the needed partnerships.

First, develop institutional animal collections based on identified conservation needs and opportunities. If comprehensive conservation plans (or Regional Collection Plans based on broader input) exist for species you are considering, use these plans to identify where your efforts are most needed. If such plans do not yet exist, contact IUCN SSC specialist groups, governmental agencies and others to offer to host or support such an assessment and planning.

Let it be known that your zoo has resources for species conservation – such as expertise, access to audiences, breeding facilities, funding – but that you need help to make sure that the resources are used where and how they are most needed. If you do not know where to begin to make the right contacts, ask WAZA or the IUCN SSC Conservation Breeding Specialist Group for help.

For programmes that need coordination, identify who at your zoo can serve as the species manager, support their position and then hold them accountable for success. The species manager should develop a realistic long-term management plan for ensuring that the population can serve the identified goals. If the population serves as insurance against loss of the species, be certain that the number of founders, breeding population size and space for population growth are adequate to sustain a genetically diverse and demographically robust population. If calculations show that this need is not being met, determine from where and how many new founders, additional breeding spaces, new breeding consortium partner or other resources are needed. Do not accept an explanation that although a population is not projected to meet goals, there is no clear solution and therefore management will continue as before. If the husbandry and technologies for managing the species well are not yet known, determine what research needs to be supported by your institution to answer the critical questions. Do not assume that someone will develop the techniques that you will need to succeed with the species; be proactive in pushing for a solution.

For each species that is in your collection because it needs protection, make sure that your institution has a clearly stated conservation goal. These goals should be documented, understood by all involved and specific regarding what purposes those animals are serving in the broader conservation strategy for the species (not just vaguely defined as "display" or "education" or "breeding").

Periodically confirm that you are meeting your institution's goals for each species and contributing to its overall conservation. If you did not meet targets, decide what further efforts are needed. If the species status is not improving in the wild, ask the broader community for a reassessment of threats and the needed responses. Explain to your public, staff, members and trustees or local authorities what you are doing for conservation of the threatened species. Document and then explain proudly how the programmes at your institution helped to save species for which you have accepted responsibility.

Invest in the Future, Not in the Past

True sustainability of the wildlife populations under the care of zoos is necessary for the future of zoos and the future of many species, but success will require new investments in new ideas with new partners. Our current species management programmes are mostly focused on holding on to remnants of the animal resources we once had, and in many cases we are not even meeting short-term goals. Instead of continuing to use only resources and methods that have been insufficient to date, we need to decide what animals, research, facilities, people and approaches will be needed to achieve species conservation goals.

There are a number of programmes in which zoos are already working closely with many partners to achieve success for species – such as the Amphibian Ark, the international golden lion tamarin programme, a consortium working for Humboldt penguins in Peru, efforts to prevent the loss of the Tasmanian devil to disease, restoration of the fire-bellied toad in Denmark and Germany, and the Sumatran tiger Global Species Management Plan. We need many more such programmes – so that the One Plan approach becomes the norm for species conservation by zoos rather than exceptional models. The precarious future for so many species demands such an affirmative response.

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John E. Fa[1,*], Stuart Harrop[2], Sara Oldfield[3] & Diana Pritchard[4]

The Need to Balance *Ex Situ* and *In Situ* Conservation

Summary

In situ conservation is central to contemporary global biodiversity protection and is the predominant emphasis of international regulation and funding strategies. *Ex situ* approaches, in contrast, have been relegated to a subsidiary role and their direct contributions to conservation have been limited. Evidence exists for the conservation community to make a strong case for an enhanced role for *ex situ* conservation. We note the advances occurring within institutions specialising in *ex situ* conservation and stress that, although much remains to be done, many constraints are being addressed. The evidence of increasing extinction rates, exacerbated by climate change, challenges the wisdom of a heavy dependence on *in situ* strategies and necessitates increased development of *ex situ* approaches. A number of different techniques that enable species and their habitats to survive should now be explored. Moreover, the relentless loss of "the wild" may soon render the *in situ*–*ex situ* distinction misleading, or even obsolete.

1 Durrell Wildlife Conservation Trust, Trinity, Jersey, Channel Islands & Department of Life Sciences, Imperial College London, Ascot, UK
2 Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, University of Kent, Canterbury, UK
3 Botanic Gardens Conservation International, Richmond, UK
4 School of Global Studies, University of Sussex, Brighton, UK
* E-mail for correspondence: john.fa@durrell.org

Introduction

In situ and *ex situ* conservation are seen as two distinct approaches to the protection of wild species. *In situ* conservation, defined by the Convention on Biological Diversity (CBD) with reference to the protection of species in their natural surroundings, derives primarily from scientific considerations concerning the conservation benefits that accrue from the protection of integrated habitats and ecosystems. Since the 1992 Earth Summit in Rio de Janeiro, Brazil, *in situ* conservation has been designated, expressly, as the legal and institutional priority. CBD and other global instruments and funding strategies address a range of practices relating to *in situ* measures for conservation and relegate *ex situ* approaches to a subordinated supply role, as seen in CBD Articles 8 and 9.

We wish to stimulate discussions about the need to revise the contributions that *ex situ* approaches can make to conservation. We consider that *ex situ* conservation has a more important role to play, especially in the face of the evidence of increasing extinction rates, exacerbated by climate change. Integrated conservation management approaches hold much potential, but we must recognise the significance of institutional factors, not just the science, that have hitherto constrained the development of direct conservation contributions from *ex situ* and integrated techniques. We also question the continued validity of the *in situ*–*ex situ* distinction.

Ex Situ Institutions

The vehicles of *ex situ* conservation are those organisations that hold wild plants and animals and genetic material: zoos, aquariums, botanic gardens, arboreta and seed banks. Although these already lay claim to support conservation through a range of education, research and funding activities, their potential to contribute in more direct ways to the conservation of species has increased with recent developments. Specifically, these organisations and their networks have proliferated across the globe, such as Botanic Gardens Conservation International (BGCI) and the World Association of Zoos and Aquariums (WAZA). For example, the International Species Information System (ISIS) is an international non-profit organisation serving zoos and aquariums worldwide, and manages a comprehensive database of animal species and their environments for animal management and conservation goals. It records over 2 million captive animals of almost 15,000 taxa and 10,000 species.