Conservation Letters
A journal of the Society for Conservation Biology
Open Access

POLICY PERSPECTIVE

IUCN Guidelines for Determining When and How Ex Situ Management Should Be Used in Species Conservation

Philip J.K. McGowan[1], Kathy Traylor-Holzer[2], & Kristin Leus[3,4]

[1] School of Biology, Newcastle University, Newcastle upon Tyne NE1 7RU, UK
[2] IUCN SSC Conservation Breeding Specialist Group, 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, USA
[3] IUCN SSC Conservation Breeding Specialist Group, European Office, Copenhagen Zoo, p/a Annuntiatenstraat 6, 2170 Merksem, Belgium
[4] European Association of Zoos and Aquaria, PO Box 20164, 1000, HD Amsterdam, The Netherlands

Keywords
Captive management; conservation decision-making; ex situ management; intensive management; population management; strategic planning; threatened species.

Correspondence
Philip J.K. McGowan, School of Biology, Ridley Building 2, Newcastle University, Newcastle upon Tyne NE1 7RU, UK. Tel: 0191 208 6664 (+44 191 208 6664 if ex-UK).
E-mail: philip.mcgowan@newcastle.ac.uk

Received
22 February 2016
Accepted
13 July 2016

doi: 10.1111/conl.12285

Abstract

The Convention on Biological Diversity's target of halting extinctions by 2020 is less than a handful of years away. Captive, or ex situ, management has long been cited as having a potential role to play in the recovery of species, although this remains the subject of debate. IUCN's Species Survival Commission (IUCN SSC) produced guidelines to assist in identifying when ex situ management may contribute to species recovery in 2002. Since then, there have been considerable developments in a range of areas that may influence the design of such programs (e.g., understanding of constraints on breeding programs, development of new techniques and approaches, and strategic planning approaches to species conservation). IUCN SSC has therefore revised its guidance and proposes a five-step process: (1) compile a status review; (2) define the role(s) that ex situ management might play; (3) determine the precise nature of the ex situ population in order to meet identified role(s); (4) define resources and expertise, and appraise the feasibility and risks; and (5) make a decision that is informed based on the above analysis and transparent. These guidelines offer an objective process for considering the role of ex situ management in species conservation.

Introduction

The deterioration in status of many of the world's species is well documented (e.g., Barnosky *et al.* 2011; Dirzo *et al.* 2014). Although anthropogenic pressures are increasing (Tittensor *et al.* 2014), it is also becoming clearer that conservation action can have a positive impact (Hoffmann *et al.* 2010) and that without such interventions, more species would be threatened or even extinct (Butchart *et al.* 2006; Hoffmann *et al.* 2015) than at present. There is a wide range of pressures now facing species directly, including emerging threats from invasive species, disease, overharvest, and habitat alteration, among others. This increasingly leads to small and fragmented populations that are more vulnerable to stochastic threats (Shaffer 1981). Thus, ever more species require some form of management to maintain their status in the wild, or even avoid extinction (Redford *et al.* 2011). Strategic planning (see IUCN SSC 2008) is becoming recognized as essential in ensuring that recovery or conservation strategies address the threats facing a species and lead to effective conservation action.

There is a great range of potential conservation interventions available to help stop and then reverse species declines, one of which being ex situ management. Ex situ programs have contributed significantly to the conservation of many species, such as the California condor (*Gymnogyps californianus*), Arabian oryx (*Oryx leucoryx*), whooping crane (*Grus americana*), and black-footed ferret (*Mustela nigripes*) to name a few (Maunder & Byers 2005). Hoffman *et al.* (2010) found that captive breeding was a major factor in improved conservation status for 16 of the 68 vertebrate species that demonstrated improvement in status over the time period

examined. A variety of ex situ activities, from captive breeding and release programs to headstarting efforts and targeted research, can stave off extinction and help move populations or species closer toward recovery and sustainability (Redford *et al.* 2011). Management is occurring more frequently along a continuum of conservation states (Redford *et al.* 2011), such that it has been suggested that the boundary between ex situ and in situ management is becoming blurred (Pritchard *et al.* 2011; Redford *et al.* 2012).

Not all threatened species may require or even benefit from ex situ management (Snyder *et al.* 1996), nor do all ex situ populations provide direct conservation benefits (Lacy 2013). Factors that influence whether or not a species is managed in captivity or if ex situ management plays a role in conservation can be complex (Bowkett 2014; Martin *et al.* 2014), and careful evaluation of the benefits and costs is required to determine realistic conservation value (Balmford *et al.* 1996; Snyder *et al.* 1996). The failure to do so has fuelled criticism in the past with respect to several aspects of ex situ management, including low contribution to conservation (see Balmford *et al.* 1996; Snyder *et al.* 1996; Martin *et al.* 2014), the perceived conflict between a conservation role for zoos and the financial demands of a commercial visitor attraction (see Fa *et al.* 2014), and philosophical differences about maintaining species under captive conditions.

As the number of species requiring intensive remedial attention rises without proportional increase in resources, it is more important than ever that actions are carefully chosen to improve the status of the target species. In 2002 the International Union for Conservation of Nature (IUCN) published its *Technical Guidelines on the Management of Ex situ Populations for Conservation* to provide guidance on the strategic application of ex situ conservation (IUCN 2002). To build upon this framework, these guidelines were revised again in 2014 and expanded to incorporate the changing conservation management landscape and provide clarity to this process. Here we provide a strategic approach to making a decision about whether ex situ management is appropriate as part of a species conservation strategy in any given context, based on consideration of conservation need, role, and program requirements. This approach is outlined in more detail in the *IUCN SSC Guidelines for the Use of Ex situ Management for Species Conservation* (2014).

General considerations and scope

Both in situ and ex situ actions can have potential beneficial conservation impacts. The integration of in situ and ex situ conservation planning ensures that, whenever appropriate, ex situ conservation is used to support in situ conservation to the best effect possible. These guidelines would therefore ideally be used as an integral part of, and complementary to, existing species conservation planning processes. Ex situ activities, in this instance, are defined more broadly than traditional zoo population management and apply to any conditions under which individuals are maintained in artificial conditions under different selection pressures than those in natural conditions in a natural habitat. These guidelines can be applied across all taxonomic levels and to biosamples (e.g., genome resource banks) as well as living individuals. Finally, this approach can be applied to situations in which there is no ex situ program, as well as situations in which an existing ex situ program may be used or adapted for conservation benefit.

Ex situ management is an appropriate component in the conservation of a species if, on balance, stakeholders can be confident that the expected positive impact on the conservation of that species will outweigh the potential risks or any negative impact (which could be to the local population, species, habitat, or ecosystem), and that its use will be a wise application of the available resources. This requires an assessment of the potential net positive impact, weighted by how likely it is that this potential will be realized, given the expertise, level of difficulty or uncertainty, and available resources. It is important that any conservation activities, including ex situ management, target the causes and/or consequences of specific threats to species survival, be they primary drivers or stochastic processes. Furthermore, they need to ensure that any constraints that limit conservation effectiveness are addressed.

IUCN guidance on decision making

The following steps provide a logical decision-making process that can be applied to evaluate the appropriateness of ex situ management as a tool to support the conservation of a species and to identify the form that such management would need to take (see Figure 1). All steps of the process should be documented for transparency and clarity.

STEP 1. Compile a status review of the species, including a problem analysis.

A detailed review should be undertaken of all relevant information on the species, both in the wild and ex situ, with the aim of assessing the viability of the population(s) and to identify and understand threats that affect the species. This is a normal step in any conservation planning process and may, therefore, already be available for some species in existing conservation strategies or action plans. If not, this process would ideally be conducted in

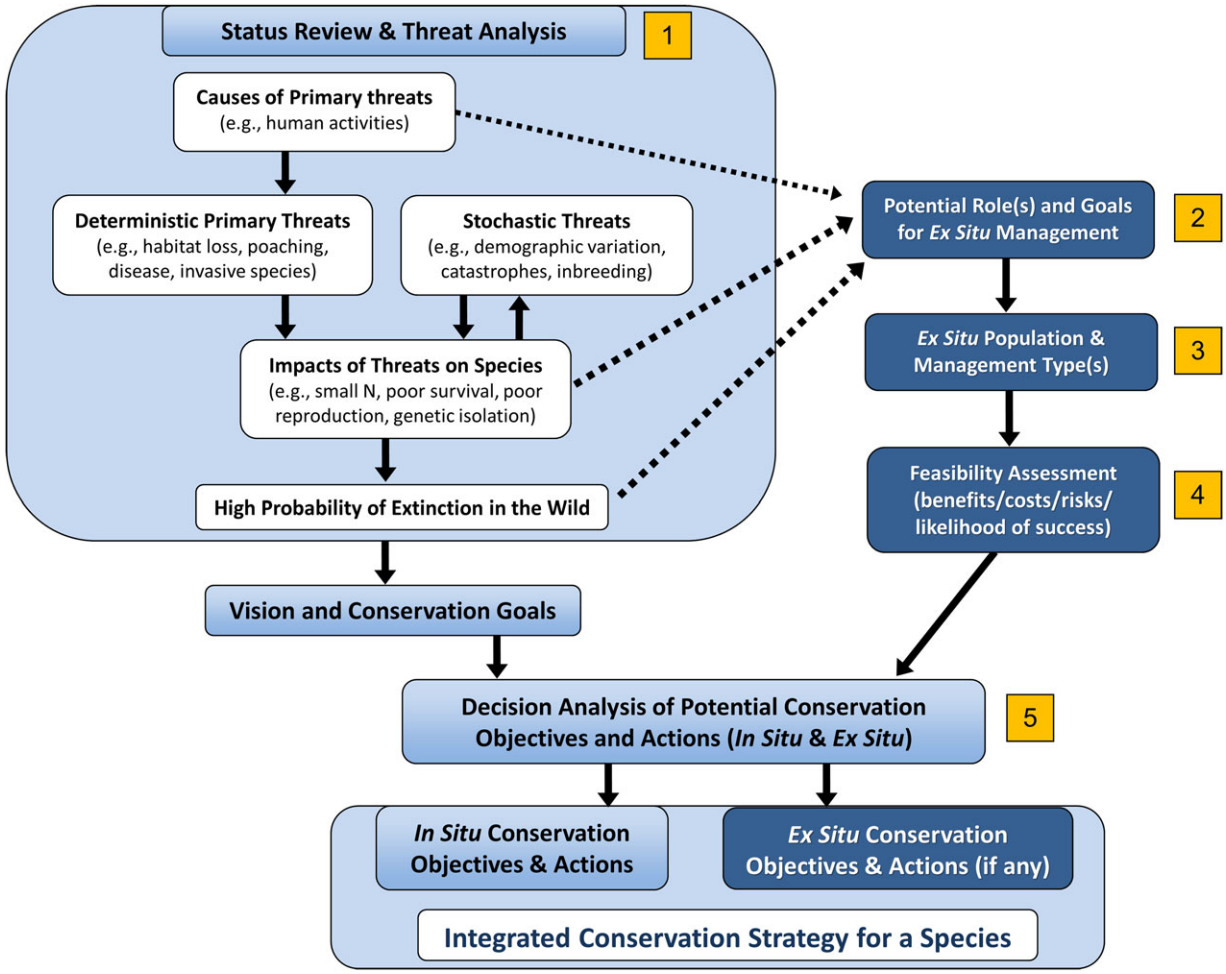

Figure 1 Incorporation of the five-step decision process described here (yellow numbers) into the species conservation planning process to develop an integrated conservation strategy for a species.

the wider framework of the creation of one integrated conservation strategy for a species (see IUCN SSC 2008).

The status review should contain information on all factors that are appropriate to the life history and taxonomy, current population status, demographic and genetic viability, and ecosystem function of the species being considered. IUCN provides a structure for a status review that may be helpful (see IUCN SSC 2008) and that builds on the IUCN Red List process (see Mace *et al.* 2008; IUCN Standards and Petitions Subcommittee 2014). The character and scale of the status review will vary depending on the precise circumstances, including data availability and relevance. Important information gaps concerning the status should be noted. A problem analysis should be undertaken to identify the specific threats (direct, indirect, and stochastic) facing the species in the wild and the constraints limiting its viability and conservation. This provides the framework for evaluating specifically how ex situ management of the species may contribute to its conservation. Genetic and demographic modeling should, where possible, be used to assess the viability of the wild population. Any free-living populations living outside the species' indigenous range, as well as the status of existing ex situ population(s) (if any), should be included.

STEP 2. Define the role(s) that ex situ management might play in the overall conservation of the species.

The potential ex situ management strategies proposed should address the causes or consequences of one or more specific threats or constraints to the species' viability and conservation as identified in the status review and problem analysis, and target improvement of its conservation status. There should be a clear statement on how the proposed ex situ program will address certain

specific threat(s) and/or constraints and, thereby contribute quantifiable benefits to the conservation of the species. This should state how progress will be measured. Population modeling can be effective in assessing the potential impact of the ex situ program on the viability of the wild population.

Potential roles (purpose/function) that an ex situ program might serve must be identified clearly. These include, but are not restricted to:

- insurance population, preserving options for future conservation strategies;
- temporary rescue, protecting against catastrophes or predicted imminent threats;
- demographic manipulation;
- source for population restoration, either to re-establish the species in part of its former range or to reinforce an existing population (demographically and/or genetically);
- source for ecological replacement to re-establish a lost ecological function and/or modify habitats, or for assisted colonization to introduce the species outside of its indigenous range to avoid extinction;
- research and/or training that will directly benefit conservation of the species; and
- education and awareness program that addresses specific threats or constraints to the conservation of the species or its habitat.

One ex situ program may serve several conservation roles, either simultaneously or consecutively, and these should be made explicit.

STEP 3. Determine the characteristics and dimensions of the ex situ population needed to fulfill the identified conservation role(s).

The conservation purpose and function that has been identified for the ex situ program will determine its nature, scale, and duration.

The biological factors that are important to achieve the program's aim and objectives include, but are not limited to: number of founders required; number of individuals or bio-samples to be maintained ex situ; whether reproduction is required; expected length of ex situ program; relative risk of artificial selection or adaptation; and the conditions in which the individuals should be maintained. Population models may be used to determine the necessary population size, composition and level of management needed to meet the conservation role(s) of the population.

Once these biological characteristics have been considered, the practical features of the program should be evaluated. These include: geographic location and scale for the ex situ activities; housing requirements; inclusion or not of any existing ex situ populations; the intensity of genetic and demographic management required to achieve the program goals; degree of exposure to humans; and estimated ongoing commitment to the program.

STEP 4. Define the resources and expertise needed for the ex situ management program to meet its role(s) and appraise the feasibility and risks.

It is not sufficient to know the potential role and value of an ex situ program designed to meet a specific conservation role—it is also critical to evaluate the resources needed, the feasibility of successfully managing such a program, the likelihood of success at all steps of the program, including, where relevant, any subsequent return to the wild, and the risks, including those to the species in the wild and to other conservation activities. These should be balanced against the risks of failing to take appropriate conservation action.

Some of the practical factors that will determine the overall scale of resources required include: the facilities, infrastructure, space, and staffing (numbers, skills, and continuity) required; disease risk; the risk of catastrophes; and the finances required for all essential activities over an adequate period of time. Factors related to feasibility include: the probability of obtaining the required resources; taxonomic stability; options for genetic management; probability of successful collaboration; ability to maintain and/or breed the species as required; and legal and regulatory requirements. Where relevant, it is important to assess the impact of the removal of individuals from the wild on the remaining wild source population. Other risks to be considered include ecological risks; health and safety risks; and potential political, social, or public conflicts of interest.

STEP 5. Make a decision that is informed (i.e., uses the information gathered in STEPS 1–4) and transparent (i.e., demonstrates how and why the decision was taken).

The decision whether or not to include ex situ management in the conservation strategy for a species should be determined by weighing the potential conservation benefit to the species against the likelihood of success and overall costs and risks of not only the proposed ex situ program, but also alternative conservation actions or inaction.

In general, including ex situ management in a conservation management strategy is warranted when potential conservation benefit is both high and likely to be achieved. Similarly, ex situ management is not warranted if there is little conservation benefit, feasibility is low, and costs and risks (especially to the wild population) are high. Within these two extremes, the relative

importance (weight) of potential conservation benefit versus likelihood of success, costs, and risks will vary for each species and situation. Some of the factors that may affect relative weights and priorities include, but are not limited to: the severity of threats and/or risk of extinction of the wild population; the significance of the species (ecological, cultural, sociological, economic or evolutionary distinctness, value of the species in leveraging large scale habitat conservation, etc.); and legal and political mandates.

Documentary evidence of information gathered and decisions made for Steps 1 through 5 is highly important, *regardless of whether the decision to proceed with the ex situ management is positive or negative*. It is valuable to document that a logical and thorough analysis has been made and a decision concluded, even if that decision is not to pursue ex situ conservation activities, as a reference point for future discussion of the same issues. Archiving of documents with the relevant taxon-based IUCN specialist group as well as the IUCN Conservation Breeding Specialist Group (CBSG) is recommended to inform future conservation planning. A central repository of submitted assessments will be maintained and accessible on the CBSG website (www.cbsg.org) to inform ex situ managers and provide examples of ex situ evaluations for species conservation.

Discussion

Ex situ activities provide a tool for those striving to conserve threatened species in the wild. Just like other conservation management options such as anti-poaching patrols or habitat corridors, ex situ management may or may not be an appropriate or feasible conservation strategy. Also, like other options (e.g., translocation, IUCN SSC 2013), ex situ management should be considered as a potential tool, evaluated for its relative benefit and feasibility, and recommended or rejected after a thorough assessment. This assessment should identify those cases where there is a clear and explicitly stated role for ex situ management. This is increasingly important given the urgency of action to address the Convention on Biological Diversity's Target 12 of avoiding extinctions by 2020 and improving the status of the most threatened species. Without objective guidelines, the role of ex situ management is likely to remain contested as to its value, viability, and scope. For example, the ability of zoos to successfully deliver the establishment of long-term self-sustaining insurance populations for a large number of threatened species in their care, and the potential significance of such a population for the conservation of the species involved, remains under discussion (e.g., Bowkett, 2009; Lees & Wilcken, 2009; Balmford *et al.* 2011; Conde *et al.* 2011). Also, the impact of generations spent in captivity has been the subject of much debate (e.g., Williams & Hoffman, 2009). This framework should help guide practitioners through the choices that need to be made so that limited resources, including individual animals and plants (or other biotic material) and goodwill, are used to best effect.

A danger exists in waiting too long before considering ex situ management. If the decision to implement ex situ management of a species is left until extinction is imminent, it is frequently too late to implement effectively, thus increasing the chance of failure and risking permanent extinction of the species (Martin *et al.* 2012). If individuals need to be removed from the wild, this is best undertaken when the wild population is still relatively large, holds significant genetic diversity, and is less impacted by such removals. This reinforces the need for comprehensive strategic planning for species to be undertaken as early as possible.

Where possible, ex situ management should be undertaken within the range states and under similar climatic regimes to the wild population (Maunder & Byers 2005). At present this is a challenge, because the current distribution of ex situ facilities and professional capacity generally does not match with the geographic areas of greatest species loss (Conde *et al.* 2011; Traylor-Holzer 2011). There is a need, therefore, to intensify efforts to build increased capacity for skills in ex situ conservation (including species conservation assessment and population management) in such regions.

The most effective use of all populations and all existing expertise to promote the conservation of a species is achieved when all stakeholders collaborate to develop one integrated species plan (Byers *et al.* 2013). A strategic approach that includes a review of all of the factors mentioned above and an informed and transparent decision-making process will result in a more objective analysis of whether, and how, any ex situ activity should be recommended for conservation benefit.

Acknowledgments

We thank the following colleagues from across the Species Survival Commission who played key roles in engaging the diverse community of species specialists: Mike Maunder (SSC Plant Conservation Subcommittee), Paul Pearce-Kelly (SSC Invertebrate Conservation Subcommittee), Yvonne Sadovy (SSC Marine Conservation Subcommittee), Topiltzin Contreras MacBeath (SSC Freshwater Conservation Subcommittee), Mark Stanley Price (SSC Species Conservation Planning Subcommittee), Mike Jordan (SSC Reintroduction Specialist Group), Onnie Byers (Conservation Breeding Specialist Group),

and Mike Hoffmann (SSC Steering Committee). We would also like to acknowledge those from across the SSC and beyond who took part in developing early drafts and/or who provided helpful comments during open consultations on draft text. This ensured a very diverse range of taxonomic and institutional contexts were considered. We also acknowledge the support of the home institutions and organizations of all contributors, and, in particular, those of the authors (Newcastle University, the Conservation Breeding Specialist Group and Copenhagen Zoo).

References

Balmford, A., Kroshko, J., Leader-Williams, N. & Mason, G. (2011). Zoos and captive breeding. *Science*, **332**, 1149-1150.

Balmford, A., Mace, G.M. & Leader-Williams, N. (1996). Designing the Ark: setting priorities for captive breeding. *Conserv. Biol.*, **10**, 719-727.

Barnosky, A.D., Matzke, N., Tomiya, S. *et al.* (2011). Has the Earth's sixth mass extinction already arrived? *Nature*, **471**, 51-57.

Bowkett, A.E. (2009). Recent captive breeding proposals and the return of the ark concept to global species conservation. *Conserv. Biol.*, **23**, 773-776.

Bowkett, A.E. (2014). *Ex situ* conservation planning is more complicated than prioritizing the keeping of threatened species in zoos. *Anim. Conserv.*, **17**, 101-103.

Butchart, S., Stattersfield, A. & Collar, N. (2006). How many bird extinctions have we prevented? *Oryx*, **40**, 266-278.

Byers, O., Lees, C., Wilcken, J. & Schwitzer, C. (2013). The One Plan approach: the philosophy and implementation of CBSG's approach to integrated species conservation planning. *WAZA Mag.*, **14**, 2-5.

Conde, D.A., Flesness, N., Colchero, F., Jones, O.R. & Scheuerlein, A. (2011). An emerging role of zoos to conserve biodiversity. *Science*, **331**, 1390-1391.

Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J.B. & Collen, B. (2014). Defaunation in the anthropocene. *Science*, **345**, 401-406.

Fa, J.E., Gusset, M., Flesness, N & Conde, D.A. (2014). Zoos have yet to unveil their full conservation potential. *Anim. Conserv.*, **17**, 97-100.

Hoffmann, M., Duckworth, J.W., Holmes, K., Mallon, D.P., Rodrigues, A.S. & Stuart, S.N. (2015). The difference conservation makes to extinction risk of the world's ungulates. *Conserv. Biol.* **29**, 1303-1313.

Hoffmann, M., Hilton-Taylor, C., Angulo, A. *et al.* (2010). The impact of conservation on the status of the world's vertebrates. *Science*, **330**, 1503-1509.

IUCN (2002). *IUCN technical guidelines on the management of ex situ populations for conservation*. IUCN, Gland, Switzerland.

IUCN/SSC (2008). *Strategic planning for species conservation: a handbook. Version 1.0*. IUCN Species Survival Commission, Gland, Switzerland. 104 pp.

IUCN/SSC (2013). *Guidelines for reintroductions and other conservation translocations. Version 1.0*. IUCN Species Survival Commission, Gland, Switzerland. viiii + 57 pp.

IUCN/SSC (2014). *Guidelines on the use of ex situ management for species conservation. Version 2.0*. IUCN Species Survival Commission, Gland, Switzerland.

IUCN Standards and Petitions Subcommittee (2014). *Guidelines for using the IUCN Red List categories and criteria*. Version 11. Prepared by the Standards and Petitions Subcommittee. Downloadable from http://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Lacy, R.C. (2013). Achieving true sustainability of zoo populations. *Zoo Biol.* **32**, 19-26.

Lees C & Wilcken J. (2009). Sustaining the Ark: the challenges faced by zoos in maintaining viable populations. *Int. Zoo Yearbook*, **43**, 6-18.

Mace, G.M., Collar, N.J., Gaston, K.J. *et al.* (2008) Quantification of extinction risk: IUCN's system for classifying threatened species. *Conserv. Biol.*, **22**, 1424–1442.

Martin, T.E., Lurbiecki, H, Joy, J.B. & Mooers, A.O. (2014). Mammal and bird species held in zoos are less endemic than their close relatives not held in zoos. *Anim. Conserv.*, **17**, 89-96.

Martin, T.G., Nally, S., Burbidge, A.A. *et al.* (2012). Acting fast helps avoid extinction. *Conserv. Lett.*, **5**, 274-280.

Maunder, M & Byers, O. (2005). The IUCN technical guidelines on the management of *ex situ* populations for conservation: reflecting major changes in the application of *ex situ* conservation. *Oryx*, **39**, 95-98.

Pritchard, D.J., Fa, J.E., Oldfield, S. & Harrop, S.R. (2011). Bringing the captive closer to the wild: redefining the role of *ex situ* conservation. *Oryx*, **46**, 18-23.

Redford, K.H., Amato, G., Baillie, J. *et al.* (2011). What does it mean to successfully conserve a (vertebrate) species? *Bioscience*, **61**, 39-48.

Redford, K.H., Jensen, D.B. & Breheny, J.J. (2012). Integrating the captive and the wild. *Science*, **338**, 1157-1158.

Shaffer, M.L. (1981). Minimum population sizes for species conservation. *Bioscience*, **31**, 131-134.

Snyder, N.F.R., Derrickson, S.R., Beissinger, S.R. *et al.* (1996). Limitations of captive breeding in endangered species recovery. *Conserv. Biol.*, **10**, 338-348.

Tittensor, D.P., Walpole, M., Hill, S.L.L. *et al.* (2014). A mid-term analysis of progress towards international biodiversity targets. *Science*, **346**, 241-244.

Traylor-Holzer, K. (2011). Identifying gaps and opportunities for inter-regional *ex situ* species management. *WAZA Mag.*, **12**, 30-33.

Traylor-Holzer, K., Leus, K., & McGowan P.J.K. (2013). Integrating assessment of *ex situ* management options into species conservation planning. *WAZA Mag.*, **14**, 6-9.

Williams, S.E. & Hoffman, E.A. (2009). Minimizing genetic adaptation in captive breeding programs: a review. *Biol. Conserv.*, **142**, 2388-2400.

