A process for assessing and prioritizing species conservation needs: going beyond the Red List

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Abstract Conservation resources are limited, yet an increasing number of species are under threat. Assessing species for their conservation needs is, therefore, a vital first step in identifying and prioritizing species for both ex situ and in situ conservation actions. Using a transparent, logical and objective method, the Conservation Needs Assessment process developed by Amphibian Ark uses current knowledge of species in the wild to determine those with the most pressing conservation needs, and provides a foundation for the development of holistic conservation action plans that combine in situ and ex situ actions as appropriate. These assessments allow us to maximize the impact of limited conservation resources by identifying which measures could best serve those species requiring help. The Conservation Needs Assessment complements the IUCN Red List assessment, and together they provide a more holistic guide to conservation priorities and actions. Conservation Needs Assessments generate national prioritized lists of species recommended for conservation action. These can subsequently be used to assist in the development of species recovery plans and national action plans, or to inform national conservation priorities better. Additional tools that will evaluate the recommendations for ex situ rescues, to determine the best candidates for conservation breeding programmes, are currently under development.

Keywords Amphibian, assessment, conservation, Conservation Needs Assessment, prioritization, recommendations, Red List

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Introduction

The IUCN Red List process provides information and analyses on the status, trends and threats to species to inform and catalyse action for biodiversity conservation (IUCN, 2016), with the Red List criteria established to measure the relative risk of extinction among a broad array of eukaryotic taxa. This objective process identifies the extinction risk for each species. Although a limited number of Red List assessments contain data about basic conservation needs, albeit in an unstructured way, it is not the aim of Red List assessments to suggest conservation actions (Collen et al., 2016). With the number of threatened amphibian species growing, a process is required that combines the risk of extinction with other vital data to provide conservation practitioners with more concise priorities for action, based on current expert knowledge of each species.

One third to one half of all amphibian species are threatened with extinction (IUCN, 2016), with > 140 species conservatively listed as Extinct since 1900 (Ceballos et al., 2015) and hundreds more listed as Data Deficient. Available data show that of 74 Data Deficient amphibian species reassessed for the Red List during 2007–2016, 55 species (74%) were reassessed as threatened, and only 19 (26%) were categorized as Least Concern (IUCN, 2016). Parsons (2016) proposes that the Data Deficient category be renamed Assume Threatened, noting that in many cases species are Data Deficient because their abundance is low and sightings are rare, they may be cryptic, or have restricted or fragmented distribution. Such species may go extinct before scientists have a chance to document their status (Parsons, 2016).

In 2005 the IUCN Species Survival Commission Amphibian Specialist Group tasked the IUCN SSC Conservation Breeding Specialist Group (since renamed the Conservation Planning Specialist Group) with implementing the ex situ components of the Amphibian Conservation Action Plan (Gascon et al., 2007; Wren et al., 2015). Ideally, species should be saved in the wild. However, ex situ conservation is considered a necessity when it is highly unlikely that threats in the wild can be mitigated before a species becomes extinct, and all ex situ conservation programmes should be part of integrated plans including mitigation of threats and habitat protection. The Conservation Needs Assessment process was initially developed during an amphibian ex situ conservation workshop facilitated by the Conservation Breeding Specialist Group in 2006, to provide high-level guidance for the ex situ

conservation community to help determine which amphibian species are most in need of ex situ intervention to prevent extinction. In many countries the ex situ conservation community lacks sufficient expertise on the status of wild populations, and assessments based on the most recent field knowledge encourage appropriate decisions to be made. At the time the original process was developed there was no established methodology for evaluating the suitability and need for a given species to be included in an ex situ programme, and which of those species should have ex situ programmes established ahead of others. While the primary focus of the process is to prioritize species for ex situ conservation actions, the current version of the process now includes recommendations for both in situ and ex situ conservation actions.

The proliferation of conservation assessment and prioritization processes (Game et al., 2013) indicates a need for these processes by a wide range of conservation managers. However, different tools address different needs, some using qualitative data to make judgments about species vulnerability (e.g. Master, 1991), some lacking explicit links to extinction risks (e.g. Carter et al., 2000), some focusing on flagship or keystone species (e.g. Leader-Williams & Dublin, 2000) and others that focus exclusively on extinction risks (e.g. Reed, 1992). None of these approaches proved entirely appropriate for assessing amphibian species for ex situ conservation programmes at a time when a rapid response to the emerging amphibian extinction crisis was called for. Although the Conservation Needs Assessment tool we describe here was initially developed for amphibians, it is generic in nature and with modification is potentially suitable for use with other taxonomic groups. A modified version of the assessment process has already been used successfully to assess the conservation needs of native plants in Costa Rica (Cabezas et al., 2009; Cabezas et al., 2016), and it is expected that additional assessments will be made for other taxonomic groups to test and verify the wider application of the tool.

Using a series of weighted questions, the tool both prioritizes species for conservation action and indicates broadly which type of conservation actions are needed. It has proven to be a logical, transparent, and repeatable procedure for guiding amphibian conservation activities within a country or region. The recommendations arising from the assessments, combined with data on specific threats from the Red List, can subsequently be used to inform the development of a national amphibian action plan.

Here we discuss the development and functionality of the Conservation Needs Assessment process and its use since 2007 for international amphibian assessments. We present a description of the actions that it can recommend for each species, an example of the priorities that arise from the assessment, a description of the challenges still facing the process and its use, and supplementary material giving the details of the assessment tool and an example of its use.

Assessing amphibian conservation needs

In 2004 the IUCN Global Amphibian Assessment alerted the amphibian conservation community to the fact that hundreds of species face threats that cannot be mitigated in the wild before they face extinction. There was a need for a process that objectively and consistently prioritized these species for ex situ rescue programmes. In response, during an amphibian ex situ conservation planning workshop hosted by the Conservation Breeding Specialist Group and the World Association of Zoos and Aquariums in El Valle de Anton, Panama, in 2006, a species selection working group drafted a decision tree to determine whether ex situ conservation action was appropriate for specific taxa, and a process for prioritizing species for ex situ action (Zippel et al., 2006).

The draft decision tree was subsequently refined in 2009 to include a wider range of potential conservation actions, and to capture additional information about threats and any past ex situ experience with each species. The modified decision tree was tested during several workshop-based assessments. Following these tests, and after multiple iterations, the decision tree evolved into the Conservation Needs Assessment process. This process was semi-automated using a spreadsheet-based system (Amphibian Ark, 2014) and was used in this form until early 2016 when it was migrated to an online format (Amphibian Ark, 2015). The current Conservation Needs Assessment process (Amphibian Ark, 2015) includes additional data (Supplementary material 1) and a wider range of conservation actions (Supplementary material 2), and generates prioritized recommendations for a range of species-specific ex situ and in situ conservation actions, as appropriate.

The entire assessment process, including the questions and possible responses, and the methods for prioritizing and assigning conservation actions are described in detail at Amphibian Ark (2015). Based on the feedback from 300+ assessors who have used the process, it is effective at providing an initial triage of required conservation actions, with priorities that match the expectations of the assessors. The prioritized recommendations arising from each national assessment provide a starting point for conservationists to develop more detailed action plans.

The assessment process

The current process consists of 20 questions, each with a set of pre-defined possible responses, including the IUCN Red List category and/or national Red List categories, the evolutionary distinctiveness scores from the Evolutionarily Distinct and Globally Endangered programme (EDGE, 2016), and a series of questions on topics such as status in the wild, threats and recovery, the cultural, scientific, biological or socio-economic significance of each species,

previous ex situ experience, and potential authorization for ex situ conservation action (Supplementary material 1). These questions are designed to ensure that the assessment priorities are based on diverse values and opportunities. Questions about past ex situ experience and suitability for possible conservation education programmes reflect the original orientation of the assessments towards the development of ex situ actions in the service of comprehensive conservation plans. Extensive comments are recorded to support the responses selected for each question, ensuring that sufficient detail is available within completed assessments to justify the responses and to provide further guidance and perspectives on the part of the assessors.

Some responses are assigned a numeric value (Supplementary material 1), and these are summed to provide a total score for each assessment. Higher scores indicate species with a higher priority for conservation action. The highest possible score is 95, although to date the highest priority species has a score of 69 (the mountain chicken *Leptodactylus fallax*). Responses that do not include a numeric value provide additional data to help determine appropriate conservation actions and are not factored into the prioritization score.

Using the responses selected during each assessment, the programme automatically recommends one or more conservation actions for each species, based on a series of triggers (Supplementary material 2). This automated process minimizes the risk of assessors introducing a bias towards preferred species or conservation actions. This is one of the most significant modifications to the original decision tree, in which assessors selected a single conservation role that they felt was most appropriate for each species.

Two different formats currently exist for completing Conservation Needs Assessments: assessors and other stakeholders working in face-to-face workshops, and individual assessors (or rarely small groups) working online. In both the workshop and online formats, assessors from a wide variety of backgrounds are identified, often with the help of Amphibian Specialist Group Regional Chairs. Assessors may include specialist group members, academics, field biologists and researchers, university students, animal husbandry experts, and members of national, local, or regional wildlife agencies.

Workshop format

Up to 20 assessors are brought together for each national workshop. Generally all amphibian species in the country are assessed, although when the total number of species is high, only threatened species are assessed, to reduce the length of each workshop. Draft recommendations and priorities are reviewed during and are circulated immediately after each workshop for final review and endorsement by all workshop participants.

At the end of each assessment workshop the prioritized lists of species recommended for each conservation action are reviewed by the assessors, to check for any anomalies in the results and as a quality control measure to ensure the accuracy of the assessments. Assessors check that species included in the various conservation action lists, and their priority order, reflects their intuition based on their knowledge of the wild status of each species. A workshop facilitator with a thorough understanding of the process is essential in these workshops: experience has shown there are sometimes misunderstandings about the questions, particularly with regards to language; there can be inconsistent interpretation of the questions; and not all questions can be answered quantitatively or objectively. This might result in a species being recommended for a conservation action that seems to the assessors to be inappropriate, or an anticipated action that has not been recommended. In these cases the process and data are reviewed by the facilitator and assessors to ensure that the questions have been understood correctly and the data have been captured accurately, and to further discuss any data that might be controversial. Assessment data are changed only if there is consensus amongst the assessors that a misunderstanding of the questions has occurred or that a different answer to a question is more accurate. If the priority order of species within each conservation action is questionable, the assessments for any species that appear to have been wrongly prioritized are also reviewed. Of 2,350 assessments made in a workshop situation, < 20 have been changed during the review period and of those, the majority required only a simple correction to the data recorded. Further discussion of any perceived data errors generally results in agreement.

An invaluable benefit of the workshop-based assessments comes from bringing together a wide range of stakeholders who share a common interest in amphibian conservation; in some countries this has been the first time that many of the participants have met and shared their expertise. This gathering of experts provides an opportunity for detailed discussions about each assessment and is a national networking opportunity for participants from many different areas of conservation practice.

The online process

The online process follows the same format as the workshop process, the difference being that each assessor is usually working independently, online, and in his or her own time. One of the challenges of moving to an online assessment process is that assessors are often working in isolation, with the resulting assessments containing data from each assessor's own research or expertise, but potentially lacking other expert knowledge. As a partial solution to this issue, some online assessments have been made by small groups

of experts working together simultaneously, using online communication software. Comprehensive help pages in both English and Spanish are available within the online application, and a series of tutorial videos explains the background of the assessments, and use of the assessment data and recommendations, and how to add new assessments.

In the case that multiple assessments for the same species in the same country are made by different assessors, all assessments for that species can be viewed as a single consolidated assessment, with the individual assessments also being accessible. The responses and comments made by all the assessors for each question are included in consolidated assessments, with the percentage of assessors who made each response in parentheses. All of the conservation actions recommended by each individual assessment are included. For each conservation action, the number of assessments for the species is shown in parentheses, along with the percentage of those assessments that recommended each conservation action. Consolidated assessments are not included in conservation action reports, and therefore a consolidated priority score is not calculated. They provide a means for all data and recommendations from individual assessments to be compiled into a single assessment; however, they do not attempt to resolve any differences between individual assessments. Assessors are encouraged to review assessments for the same species made by other assessors, and if disagreements are found these can be discussed with the person who made the original assessment.

Since 2015, when the online format was first used, 317 assessments have been completed online, with an additional 110 assessments awaiting review and approval. Review of the completed assessments shows that, despite the availability of the online help system and training videos, misunderstanding of some questions and responses prevails, presumably because new assessors are not taking the time to review the help pages fully before adding their data. Using the online programme during face-to-face workshops, and with an experienced facilitator, is the preferable method for producing well-considered and accurate assessments, rather than individual assessors working in isolation.

Recommended conservation actions

As each assessment is completed, recommended conservation actions for each species are automatically generated, based on a series of triggers from the responses in the assessment data (Supplementary material 2). Potential actions include Ex Situ Rescue, In Situ Conservation, In Situ Research, Ex Situ Research, Supplementation, Biobanking, Mass Production in Captivity, and Conservation Education (Supplementary material 2), with none, one, or more actions being recommended for each species. These high-level actions, in combination with the extensive notes recorded during the assessment process, can subsequently be used by national or regional amphibian conservation groups as a guide to develop new, or update existing, amphibian action plans within each country or region or as a prioritized guide to inform future conservation programme development. Supplementary material 3 provides an example assessment showing the triggers for each conservation action.

Although the tool was developed initially to identify those species for which ex situ conservation actions would be needed, and this remains its emphasis, the assessment process identifies species for which some aspects of their status in the wild are unknown, and these species are recommended for additional in situ research. Some of these species are ideal candidates for further survey or research work by students, others will be more appropriate for experienced field practitioners, so that eventually the data currently missing from the assessments can be included, and more accurate recommendations can be generated. Some species are identified as most suitable for in situ conservation: species for which mitigation of threats in the wild is possible and may still bring about their successful conservation within a timeframe that will prevent their further decline or extinction, perhaps without the need to resort to ex situ conservation actions. The more detailed nature of in situ actions, where obvious or proposed, is recorded in the notes field of the assessment. More than one conservation action is often recommended: thus a species might be recommended for in situ research and in situ conservation simultaneously.

Priorities

Within each country, the lists of species recommended for each conservation action are presented, with those species that are the highest priority (according to the weighted questions; Supplementary material 1) at the top of each list. An example assessment showing how priorities are calculated is included in Supplementary material 3.

Although conservation resources should generally be applied to the highest priority species, this is not always practical. Some species may be facing serious threats that are unlikely to be mitigated, or have such low numbers in the wild that the chance of recovery is extremely low. Likewise, some species have not been seen in the wild for many years, despite regular surveys. Thus the potential benefit of any conservation actions directed toward an individual species must be weighed against the likelihood of success, with resources directed to those that are most likely to show the most promise of benefitting from those resources. Some of the questions, particularly those that do not include scores, have been included in the process to provide additional relevant detail, ensuring that consideration is given to those species for which the recommended conservation action(s) will most likely succeed.

Many other assessment processes include the cost of specific conservation actions such as recovery programmes, threat mitigation, and habitat restoration and protection (e.g. Balmford et al., 2000; Naidoo et al., 2006; Szabo et al., 2009). The Conservation Needs Assessment process, however, does not consider the cost of recommended conservation actions: it acts as an initial triage mechanism. After a national assessment has been completed the resulting recommendations and priorities can then be used as a guide for national governments and conservation organizations to develop more detailed action plans. During the development of these action plans, the costs associated with required conservation actions can be estimated, with a further level of prioritization being made based on the potential availability of funding and other resources.

Assessments completed

The current version of the Conservation Needs Assessment process has been used to generate almost 2,700 assessments for more than 2,300 species of amphibians (31% of the 7,530 currently known species; AmphibiaWeb, 2016) in 28 countries (Table 1). The selection of species for assessment with this tool has been country-focussed, with 282 assessments for species in Eastern Africa, 213 in the Caribbean, 143 in Central America, 334 in North America, 861 in South America, 62 in Eastern Asia, 703 in South East Asia, 81 in Southern Asia, 18 in Eastern Europe, and one in Southern Europe. Anurans account for 2,371 assessments, newts and salamanders for 295 and caecilians for 33. Of these assessments, 2,382 have been completed during workshops, with the remaining 317 completed online. A further 220 assessments have been started and are not included in the figures presented here, nor yet in online reports. Several more country-wide assessments are currently underway and it is hoped that all amphibian species will eventually be assessed.

During the past 9 years c. 350 amphibian experts have contributed their knowledge as assessors, either during national or regional Conservation Needs Assessment workshops, or using the online programme. Assessors include Amphibian Specialist Group members, scientists, field biologists and researchers, university students, animal husbandry experts, and other appropriate stakeholders. Combining and sharing the expertise and experiences of such a broad representation of stakeholders is vital to enhance the assessments, ensuring that appropriate recommendations for priority national and global conservation actions are delivered. Representatives of both local and national government wildlife departments have been invited to all assessment workshops to ensure that the assessment process and recommendations are transparent, and to encourage buy-in among those who need to authorize or implement actions. Assessments can and should be updated as new data are collected, or if existing data change significantly.

Challenges

The reliability of the process depends on assembling a knowledgeable group of assessors with a broad range of expertise. Assessment workshops that lack sufficient expertise may result in many incomplete assessments, or species not being assessed at all as a result of lack of knowledge. Politics of science or governance may sometimes influence the attendance, or individual participation or expression of the assessors assembled for a workshop. The resulting recommendations from such compromised workshops may not be accurate, and it is problematic to generate prioritized species and action lists when not all species have been assessed equivalently.

Challenges and benefits exist with both the workshop-based format and online assessments. There are three primary benefits of online assessments: (1) considerable financial savings compared to the costs of holding workshops, (2) assessors are able to complete assessments in their own time, and without needing to commit to multiple-day workshops, and (3) availability to a greater number of expert assessors. Together these benefits make the online format an efficient and effective way to develop recommendations for conservation actions.

Disagreements about data provided by other assessors may be a challenge in the online environment. In a workshop situation differences of opinion can be discussed within the group, with agreed or combined opinions being included in each assessment. However, when assessments are completed in isolation from other experts, this discussion and subsequent collective information is less easy, potentially resulting in conflicting assessments. To date this has not yet occurred, but if and when it does, discussions using online communications software could alleviate this potential problem.

After the assessments

The Conservation Needs Assessment is one step in a series of processes that begin with the identification of threatened species by the IUCN Red List. Following on from the Red List, the Conservation Needs Assessment prioritizes amphibian species within a country or region in terms of need for conservation action and identifies those types of conservation actions most appropriate for each species. As such it can form the basis for the development of national or regional Amphibian Conservation Action Plans that identify specific conservation actions and the resources needed to support those actions. National groups of relevant stakeholders should make use of the recommendations to

TABLE 1 The number of species recommended for each conservation action by country as of November 2016. Because each assessment can result in multiple different recommended conservation actions for each species, the total number of recommendations for each country generally exceeds the number of species in each country.

Country	Ark[1]	Rescue[2]	In situ conservation[3]	In situ research[4]	Ex situ research/ analog[5]	Mass production[6]	Conservation education	Supplementation	Biobanking	None	Assessment date
Argentina*	0	6	18	40	19	0	34	0	6	12	26 Oct. 2010
Bahamas*	0	0	0	0	1	0	1	0	0	0	26 Mar. 2011
Bolivia	0	29	40	111	15	2	74	0	29	86	5 June 2014
Brazil*	0	14	24	142	19	0	58	0	14	23	12 Aug. 2009
Cambodia	0	0	22	57	1	0	30	0	0	5	30 Mar. 2012
Canada	0	0	3	3	9	0	21	0	0	20	26 Oct. 2012
Chile	0	9	24	33	16	1	21	0	9	4	4 Dec. 2009
Cuba	0	0	41	41	38	0	26	0	0	1	26 Mar. 2011
Dominica*	0	1	2	2	0	0	1	0	1	0	26 Mar. 2011
Dominican Republic	0	4	28	11	20	0	22	0	4	1	26 Mar. 2011
Ecuador*	0	55	202	185	10	0	61	0	55	17	11 June 2012
Grenada*	0	0	1	0	1	0	1	0	0	0	26 Mar. 2011
Guatemala	0	34	42	83	11	0	12	0	34	36	6 Feb. 2010
Haiti	0	10	41	21	19	0	20	0	10	2	26 Mar. 2011
Hungary	0	0	1	18	0	0	9	0	0	0	24 May 2016
India*	0	1	4	7	3	1	7	0	1	0	1 Nov. 2016
Indonesia*	0	1	1	63	0	1	82	0	1	88	2 Aug. 2009
Jamaica	0	1	4	10	6	0	6	0	1	7	26 Mar. 2011
Japan	0	0	61	1	12	0	59	0	0	0	22 Jan. 2011
Laos	0	0	35	92	2	0	45	0	0	6	30 Mar. 2012
Madagascar	0	20	167	203	78	4	62	0	20	12	Feb.–Sep. 2015
Philippines	0	2	36	47	40	1	42	0	2	19	3 July 2014
Puerto Rico	0	7	6	8	6	0	22	0	7	0	26 Mar. 2011
Singapore	0	1	8	25	2	0	12	0	1	2	2 Nov. 2011
St. Vincent and the Grenadines	0	0	1	0	0	0	1	0	0	0	26 Mar. 2011
Sri Lanka*	0	11	22	18	31	0	27	0	11	13	19 Nov. 2009
Trinidad and Tobago*	0	0	0	5	3	0	2	0	0	0	21 July 2015
United States	1	6	58	61	36	0	90	0	7	118	26 Oct. 2012
Vietnam	0	0	80	155	4	0	73	0	0	6	30 Mar. 2012

*Not all species have been assessed.

[1]A species that is extinct in the wild (locally or globally) and that would become completely extinct without ex situ management.

[2]A species that is in imminent danger of extinction (locally or globally) and requires ex situ management, as part of an integrated programme, to ensure its survival.

[3]A species for which mitigation of threats in the wild may still bring about its successful conservation.

[4]A species that for one or more reasons requires further in situ research to be carried out as part of the conservation action for the species.

[5]A species currently undergoing, or proposed for specific applied research that directly contributes to the conservation of that species, or a related species, in the wild (this includes clearly defined analog species for husbandry research).

[6]A species threatened through wild collection (e.g. as a food resource), which could be or is currently being bred in captivity (normally in-country, ex situ) to replace a demand for specimens collected from the wild.

develop a national action plan, followed by holistic species-level action plans for the highest priority species that detail species actions, responsible parties and a timeline for achieving the goals outlined in the plan. Many ex situ rescue programmes have been implemented as a result of recommendations from Conservation Needs Assessments (e.g. for *Telmatobius culeus* in Bolivia, *Lithobates vibicarius* in Costa Rica, *Telmatobius pisanoi* and *T. stephani* in Argentina, *Alsodes vanzolinii* in Chile, *Eleutherodactylus portoricensis* in Puerto Rico and *Scinax alcatraz* in Brazil).

As an example of this process, on the last day of the Conservation Needs Assessment in the Philippines, assessors drafted the outline of an Amphibian Action Plan for the Philippines, with authors being assigned to various chapters. At a subsequent workshop the authors met to consolidate and review the content, with additional work on the document continuing. Action plans for individual species follow from the national action plans and integrate all of the necessary conservation actions for those species (Byers et al., 2013), explicitly stating the short-, medium-, and long-term goals of each component of the conservation initiative. At a different level, the Association of Zoos and Aquariums Amphibian Taxon Advisory Group relied heavily on the Conservation Needs Assessment process in identifying the seven priority species for ex situ management in Association of Zoos and Aquariums facilities (Barber & Poole, 2014).

Summary

Conservation managers are faced with a multitude of competing issues that generally require significant resources. The Conservation Needs Assessment process helps to prioritize species for conservation actions, ensuring that limited resources can be assigned to species and actions that can most benefit from those resources. This assessment process was first developed in 2006, and has evolved into a transparent and respected method for determining high level priorities for both ex situ and in situ conservation action to help save threatened amphibians. Almost 2,700 assessments have been completed to date, with many of the ex situ actions recommended by those assessments being implemented. In conjunction with data from recent Red List assessments and other amphibian databases, the Conservation Needs Assessments are a valuable resource for directing and prioritizing amphibian conservation planning and action at the national level. We suggest that although the process was developed for amphibians, it can be modified to be equally useful for other taxonomic groups.

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Author contributions

KJ is the primary author. He was responsible for developing the current version of the assessment process, and has facilitated 13 assessment workshops. LC and RG have facilitated 14 assessments workshops, and contributed their experiences with the assessment process. KB, RG, GG, RL and KZ were all part of the group that developed the original assessment process, and have contributed their expertise to subsequent revisions of the process. AB is the Executive Director of the Amphibian Ark, which administers the assessments. All co-authors reviewed and contributed to this article.

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Biographical sketches

Kevin Johnson's principal interest is supporting ex situ conservation programmes for threatened amphibians. Anne Baker's research interests include understanding the barriers to effective conservation planning and what motivates people to engage in conservation action. Luis Carrillo trained as a wildlife veterinarian working in zoos and related ex situ facilities, his main research interests are conservation medicine and amphibian medicine. Graeme Gillespie has been undertaking research and management of threatened herpetofauna in Australia for 30 years. He has also undertaken ecological research on herpetofauna diversity and conservation in Sulawesi and Borneo. Richard Gibson works with New Zealand endemic ectotherms and birds and is exploring the interface between in situ and ex situ conservation through reintroduction, research and educational projects. Robert Lacy studies processes that threaten population viability, develops software for species risk assessments, and assists agencies and NGOs with conservation planning. Kevin Zippel is no longer involved with conservation research.