

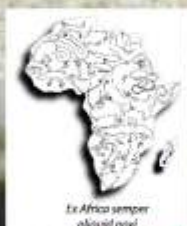


**Ensuring a future  
for  
South Africa's frogs:  
a strategy for  
conservation research**

G.J. Measey (ed.)









**SANBI Biodiversity Series 19**

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for South Africa's frogs:  
a strategy for conservation research**

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Pretoria

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## SANBI Biodiversity Series

The South African National Biodiversity Institute (SANBI) was established on 1 September 2004 through the signing into force of the National Environmental Management: Biodiversity Act (NEMBA) No. 10 of 2004 by President Thabo Mbeki. The Act expands the mandate of the former National Botanical Institute to include responsibilities relating to the full diversity of South Africa's fauna and flora, and builds on the internationally respected programmes in conservation, research, education and visitor services developed by the National Botanical Institute and its predecessors over the past century.

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# Foreword



The Global Amphibian Assessment (GAA), published in 2004, provided an IUCN assessment for every known species of amphibian, and found that nearly a third of all species were threatened with extinction. This crisis of amphibian biodiversity loss serves as an indicator of global biodiversity loss at a time when we have begun to appreciate the importance of biodiversity to our environment and the services that it provides. One of the major findings of the GAA was to highlight how little is known of the world's amphibian species, 23% of which were so little known that threat assessments could not be made (these species are listed as 'Data Deficient' by IUCN). The publishing of the GAA coincided with the publication of the Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland, a book providing comprehensive details of the amphibian fauna

of the region and their IUCN status. Both publications were landmark achievements, but IUCN Red Lists are not static in nature and require regular updates in order to maintain their relevance. Updating and maintaining the Red List is an enormous task, and with it comes the challenge to increase knowledge of each of the species such that research action might reduce their threatened status.

This document prioritises research on threatened species in South Africa so that scarce resources can be most effectively utilised to understand and reduce threats to the amazing frog diversity found in the country. The first chapter provides a general introduction on global and local amphibian decline, with the remaining chapters covering research priorities for taxonomy, conservation, monitoring and public awareness. Lastly, an appendix provides an update of the Red List with IUCN criteria for all threatened South African amphibians. Despite the large number of frog species in South Africa, and the small number of amphibian biologists, every species was evaluated (no 'Data Deficient' species remain). Now we are left with the challenge to preserve amphibian biodiversity, and herein lies the strategy that will pave the way for the next five years of conservation research.

This research strategy represents an important step forwards for conservation of amphibians in South Africa, and a model approach for other areas of the globe. It provides conservation agencies, policy makers and planners with invaluable information on what is required to make a difference to this most threatened group of vertebrates. The fulfilment of the targets presented herein would be a significant step to redress the loss of amphibian biodiversity. I join the authors in their hope that future generations of South Africans will learn to appreciate the wondrous frogs that enthralled and continue to inspire us all.



Simon N. Stuart

Chair

IUCN Species Survival Commission

# 1 Introduction: conservation assessments of the amphibians of South Africa and the world

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## Background

Amphibian declines have been an ongoing global phenomenon, first reported as such in 1990 and gathering in number with increasing quantities of studies and interpretations (e.g. Blaustein & Wake 1990; Houlahan *et al.* 2000). These reports have highlighted the complexity of the global extent of amphibian decline together with numerous factors in both pristine and disturbed habitats. 'Enigmatic declines', a term coined to refer to declines in pristine habitats (Stuart *et al.* 2004), became the focus of many studies which postulated a range of factors including increased ultraviolet radiation, climate change, infectious disease and their synergistic effects (e.g. Pounds *et al.* 2006). However, the primary cause of global biodiversity loss (including amphibians) is through habitat change (Stuart *et al.* 2008) which ultimately stems from increasing human population and per capita consumption.

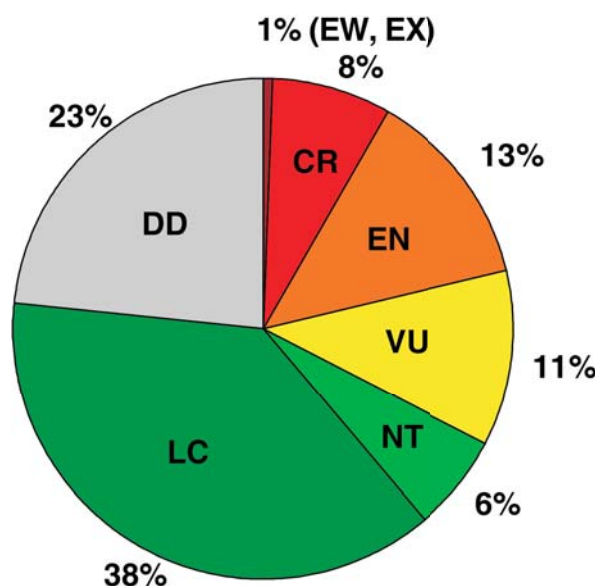
Through the 1990s there was little in the way of a class-level assessment of how widespread the phenomenon of global amphibian declines was, and of the potential factors that could be involved in amphibian declines at a global level. It is in this context that the Global Amphibian Assessment (GAA; now Amphibians on the IUCN Red List), a joint initiative led by IUCN, Conservation International and NatureServe, was completed in 2004, comprising the first ever comprehensive conservation assessment of all of the world's amphibian species known at that time (5 743 species; Stuart *et al.* 2008). The GAA's main objectives were to 1) determine the scale of the amphibian extinction crisis, 2) identify key geographical areas and habitats for amphibian conservation, 3) identify the main threats and propose priority conservation actions to address these threats, and 4) establish an amphibian-focused expert network.

Meanwhile, early in 1994 two South African herpetologists, Phil Bishop and Les Minter, pondered

the global fate of amphibians and wondered what they could achieve in South Africa. The legacy of a strong tradition in herpetological research in the region had culminated in frog distribution maps that were by then 30 years old (Poynton 1964). Red List assessments for the region were also out of date (Branch 1988). Their brainchild became known as the South African Frog Atlas Project (SAFAP), was nurtured to fruition by the Animal Demography Unit at the University of Cape Town, resulted in a collaboration of almost the entire regional herpetological community, and culminated in the publication of the first comprehensive Atlas and Red Data book for the frogs of South Africa, Lesotho and Swaziland (Minter *et al.* 2004). This publication and the updated Red List it contained coincided with the global GAA initiative and allowed this most recent regional assessment to provide one of the most comprehensive datasets into the GAA.

In order to assess the extinction risk facing each amphibian species, the GAA used the standard set by the IUCN Red List Categories and Criteria (IUCN 2001), where threat categories are determined by the application of specific criteria relating to a species' geographic distribution, population status and/or size, and threats. One of the main findings of this global assessment was that nearly one third of all known amphibians (1 856 species) were found to be in a threatened category: Critically Endangered (CR), Endangered (EN) or Vulnerable (VU; Stuart *et al.* 2004; see also Figure 1). This is considerably higher than in other vertebrate taxonomic groups that have had comprehensive global assessments, e.g. birds (12%; BirdLife International 2004) and mammals (21%; Schipper *et al.* 2008).





DD: Data Deficient  
 EW: Extinct in the Wild  
 EX: Extinct  
 CR: Critically Endangered  
 EN: Endangered  
 VU: Vulnerable  
 NT: Near Threatened  
 LC: Least Concern  
 (IUCN Red List threat categories)

Figure 1. Summary of the conservation status of the world's amphibians in 2004 (Stuart *et al.* 2008).

## The amphibians of South Africa

South Africa contains only one of the three orders in the class Amphibia; no caecilians (order Gymnophiona) or salamanders (order Caudata) can be found in the region. Salamanders do not occur in sub-Saharan Africa while caecilians are confined to the tropics with the most southerly African records in northern Mozambique. Despite amphibians in the region only being represented by frogs (order Anura), there is a spectacular variety not only of shapes and forms, but in their life histories, habitats, calls, colours and phylogenetic diversity. Frogs are very much part of South Africa's natural heritage, being a large portion of the vertebrate biodiversity, and also intriguing and beautiful creatures which continue to fascinate South Africans as well as tourists, contributing to the environment and its sights and sounds, which we so often take for granted. What is the status of amphibians in South Africa in relation to the status of amphibians around the world?

The 2004 assessment provided the first Red List categorisation of every amphibian in the country

(Minter *et al.* 2004). Prior to this, amphibian Red Lists for South Africa had only included select taxa (e.g. Branch 1988). In 2009, a workshop was convened at the South African National Biodiversity Institute (SANBI) by the South African Frog Re-assessment Group (SA-FRoG) to reassess South African amphibians (see Chapter 2). The results of this reassessment were made available in 2010 and details of the resulting accounts are detailed in Appendix 1. Table 1 provides a breakdown of amphibians of the world and South African amphibians in relation to threat category for both the 2004 comprehensive assessment and the most recent 2010 data, which also contains updates undertaken since 2004.

Data for South African amphibians is mostly comparable between the 2004 and 2010 assessments. In 2004, there were 117 (assessed) amphibian species in South Africa. Of these, 20 species were considered to be in a threatened category (CR 4; EN 8; VU 8), 5 as Near Threatened (NT), 84 as being of Least Concern (LC) and 8 as Data Deficient (DD). In terms of proportions and in comparison to global figures in 2004, 17% of South African amphibians were considered to be threatened, whereas 32% of global amphibians were considered to be in a threatened category, and nearly 7% of South African species were Data Deficient, as opposed to the global 23%, which indicated that the amphibian fauna in South Africa is comparatively well-studied when compared to the global figures. This pattern is repeated again in the 2010 assessment, as the proportion of globally threatened species is now at 30%, and the proportion of Data Deficient species has increased globally (25%, largely due to new species descriptions). If we compare the South African amphibian data with only the global anuran data, we still get similar measures as we do with the entire amphibian dataset, as 29% of all frogs are assessed in a threat category (CR – 7%, EN – 12% and VU – 10%), whereas 6% are assessed as NT, 39% as LC, and 26% as DD. Figures for the entire global dataset thus follow closely those of the anuran subset, in no small part because anurans comprise 88% of assessed amphibians. In relation to the global proportions then, South African amphibians appear to be faring relatively better, with proportionately less species in a threatened category or in the Data Deficient category. This may be due, to some extent, to the potential causes of enigmatic declines having a greater effect at the global level, e.g. chytridiomycosis and climate change (see Chapter 4).

For all 35 species reassessed during the workshop, sufficient data were available to make global assessments (for full details see Appendix 1).



**Table 1. Number of species in the different threat categories for South Africa and the world in 2004 and 2010.**

Red List Category	Number of species (Global)	% of species (Global)	Number of species (Global)	% of species (Global)	Number of species (South Africa)	% of species (South Africa)	Number of species (South Africa)	% of species (South Africa)
	2004	2004	2010	2010	2004	2004	2010	2010
Extinct (EX)	34	0.6	37	0.6	0	0	0	0
Extinct in the Wild (EW)	1	0.02	2	0.03	0	0	0	0
Critically Endangered (CR)	427	7.4	484	7.7	4	3.4	5	4.2
Endangered (EN)	761	13.3	754	12	8	6.8	7	5.9
Vulnerable (VU)	668	11.6	657	10.5	8	6.8	5	4.2
Near Threatened (NT)	359	6.3	382	6.1	5	4.3	5	4.2
Least Concern (LC)	2199	38.3	2371	37.7	84	71.8	96	81.5
Data Deficient (DD)	1294	22.5	1597	25.4	8	6.8	0	0
<b>Total Number of Species</b>	<b>5743</b>		<b>6284</b>		<b>117</b>		<b>118</b>	

The majority of species are endemic to South Africa, although some have parts of their ranges extending into Lesotho, Mozambique, Namibia and Swaziland. Only 13 were deemed to hold the same status as in the 2004 assessment. All 7 species classified as DD in 2004 had sufficient data obtained to make full assessments: 4 were proposed to be moved to LC, 1 to NT and another 2 to VU. Of threatened species, 8 were downlisted (2 CR to EN, 1 EN to VU, 2 VU to LC and 3 VU to NT) while 3 were uplisted (2 EN to CR and 1 VU to EN). Of 4 species which were listed as Near Threatened, 3 remain in this status, while another is moved to LC. A single species had been described since the 2004 assessment (*Arthroleptella rugosa*, increasing the number of South African species to 118) and this species was assessed as CR in view of its extremely small Extent of Occurrence and ongoing threats of alien vegetation and fire (see Appendix 1). The taxonomy of South African frogs is in a good state compared to the rest of the continent, although it is acknowledged there is much work that is still required (Chapter 3). Good taxonomy underlies our understanding of amphibian biology and underpins any assessment exercise.

## Distribution patterns

### Species richness

In terms of amphibian species richness, South Africa is the 27<sup>th</sup> country with the greatest known

amphibian species richness at the global level, and the fifth country at the biogeographical realm (Afrotropical) level, following Madagascar, Democratic Republic of the Congo, Cameroon and Tanzania, respectively (Stuart *et al.* 2008). It is important, however, to bear in mind the effect of sampling bias in some of these figures, as some areas and countries have been studied much more widely and intensively than others. Figure 2 depicts the known amphibian species richness of the Afrotropical realm, where darker areas indicate higher species richness (greater degree of overlap in the estimated geographical range of individual species). Within South Africa, the greatest amphibian species richness can be found in the eastern part of the country, in the Province of KwaZulu-Natal. Perhaps this is not surprising, as this area exhibits many forest patches (including relicts of montane forest at the southernmost extension of Frank White's Afro-montane phytochorion). It is also a known diversity hotspot for other taxonomic groups, such as chameleons (Tolley *et al.* 2008).

### Threatened species

The distribution of threatened species in the Afrotropical realm follows closely the greatest concentration of amphibian species (darker areas in Figure 2 match coloured areas in Figure 3), with notable exceptions of reduced threat in southern Democratic Republic of the Congo, and increased threats in the Ethiopian highlands, coastal areas

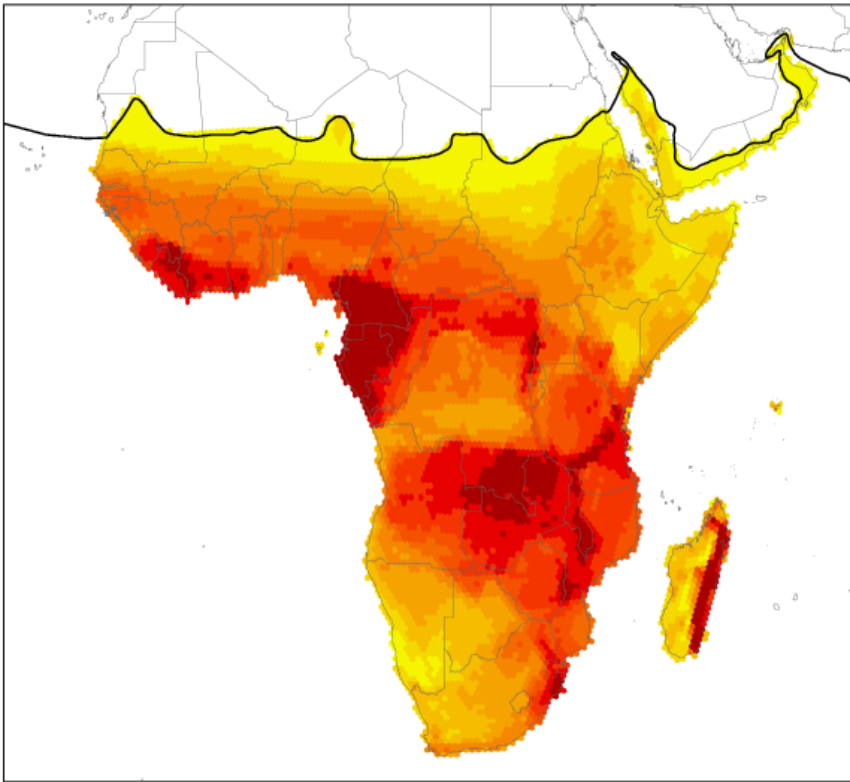


Figure 2. Amphibian species richness in the Afrotropical realm. Darker shades indicate a greater concentration of amphibian species. (Stuart *et al.* 2008).

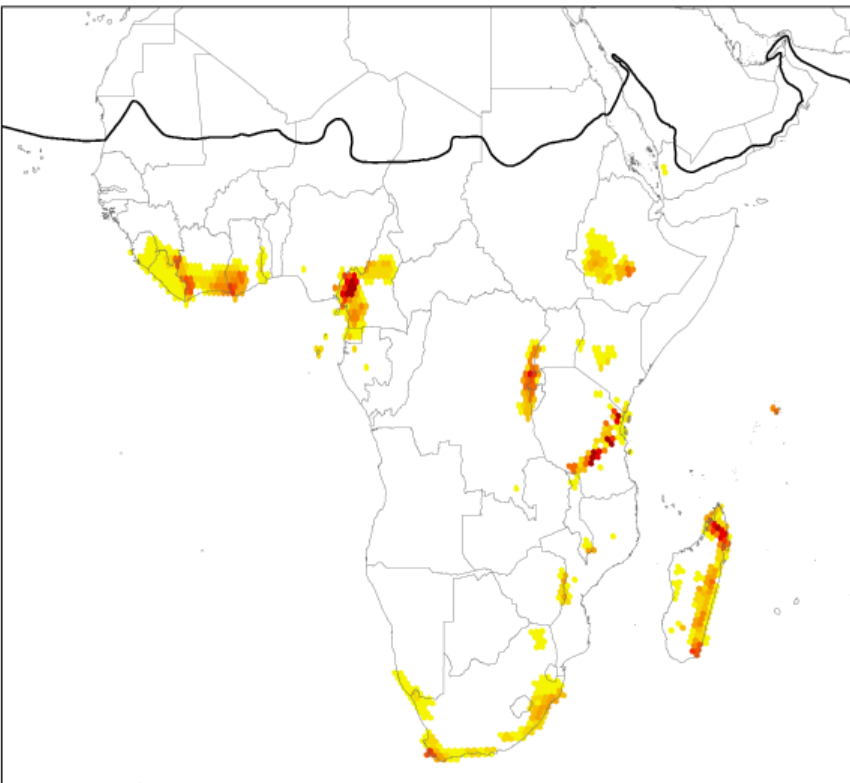


Figure 3. Distribution of threatened amphibians in the Afrotropical realm. Darker shades indicate a greater concentration of amphibian species. (Stuart *et al.* 2008).

of South Africa, and especially the southwestern Cape. Most threatened amphibians in Africa have small distributions and coincide with areas of high endemism. Within the Afrotropical realm, South Africa is the eighth country in terms of proportion of native species in a threatened category (nearly 18%), but it ranks fourth (after Madagascar, Cameroon and Tanzania) in terms of actual number of species in a threat category (N=21) (Stuart *et al.* 2008). Within South Africa, most threatened species are concentrated in southwestern South Africa (Western Cape Province), and to a lesser extent in eastern South Africa (KwaZulu-Natal Province), areas which have already been recognised as important for amphibian endemism (Minter *et al.* 2004) together with an elevated human footprint (Driver *et al.* 2005).

## Endemism

Of the 118 species currently reported in the Red List for South Africa, 51 (43%) are endemics. Of these 51 South African endemic species, 18 (35%) are in a threatened category, while 6 (12%) are considered to be Near Threatened (NT), 27 (53%) are considered to be of Least Concern (LC) and none are Data Deficient, DD (Table 2). All Critically Endangered and Endangered species in South Africa are endemics, and nearly all Vulnerable species (with the exception of one species, *Breviceps macrops*) are also endemics. Because of their endemic nature, these species will retain their threat categories at the global level. Therefore, endemic South African amphibians constitute nearly 1 (0.82%) of all globally Critically Endangered species, 1% of all globally Endangered species and 1.1% of all globally Vulnerable species.<sup>1</sup>

## Threats

There is some congruence between the patterns of major threats affecting global amphibians and those affecting South African amphibians (Table 3). The greatest threat factor

<sup>1</sup>The figures given in this chapter are those which have been submitted to the IUCN. At the time of going to press not all assessments have been reviewed and accepted and so there may be discrepancies between what is listed here and that which appears on the IUCN website. In addition, note that the figures for the global assessment also change with time as the Red List is dynamic. Figures given for 2010 come from version 2010.2 of the IUCN Red List which precede changes proposed in the December 2009 South Africa Amphibian Assessment workshop. For more information on the Red List publication process, see Appendix 1.



**Table 2. Number and proportion of endemic South African species in the different threat categories (see Appendix 1).**

Red List Category	Number of species (South Africa) 2004	% of species (South Africa) 2004	Number of species (South Africa) 2010	% of species (South Africa) 2010
Extinct (EX)	0	0	0	0
Extinct in the Wild (EW)	0	0	0	0
Critically Endangered (CR)	4	8	5	10
Endangered (EN)	8	16	8	15
Vulnerable (VU)	8	16	5	10
Near Threatened (NT)	4	8	6	12
Least Concern (LC)	20	40	27	53
Data Deficient (DD)	6	12	0	0
<b>Total Number of Species</b>	<b>50</b>		<b>51</b>	

**Table 3. Major threats to amphibians at the global and national (South Africa) levels prior to 2010 reassessment. Note that totals do not add to 100% because any one amphibian species may be threatened by more than one factor.**

Major threats	All species Global	% of all species Global	All species South Africa	% of all species South Africa
Residential and commercial development	2063	32.8	38	32.8
Agriculture and aquaculture	3125	49.7	58	50.0
Energy production and mining	229	3.6	3	2.6
Transportation and service corridors	256	4.1	3	2.6
Biological resource use	2908	46.3	6	5.2
Human intrusions and disturbance	276	4.4	1	0.9
Natural systems modifications	913	14.5	30	25.9
Invasive and other problematic species and genes	987	15.7	43	37.1
Pollution	1111	17.7	17	14.7
Geological events	63	1.0	0	0.0
Climate change and severe weather	397	6.3	3	2.6

to most amphibian species is comprised by agricultural and aquacultural activities, affecting nearly half of all assessed species, but followed closely by biological resource use (46%), which includes logging and wood harvesting and accounts for many of the records under this category, and residential and commercial development, which affects nearly one third (33%) of all amphibians. The next threat factor is pollution, with a lower percentage of amphibians apparently impacted by this threat factor (18%), followed by invasive and other problematic species and genes (affecting 16% of all amphibians) and natural system modifications (15%).

Similarly, 50% of all South African species are affected by agriculture and aquaculture. Invasive species and other problematic species and genes,

affects 37% of all South African frogs, which is considerably higher than the global average (15.7%). Of these, 40 out of 43 species are impacted by alien species, due to spreading invasive alien vegetation and afforestation. Invasive plants threaten many species in protected as well as disturbed areas. This is particularly prominent in the fire driven fynbos biome where invasive plants bring about increased fuel and therefore fire intensity from which many threatened amphibians struggle to recover (see Appendix 1). In fact, fire and fire suppression affect 24 out of 30 species impacted by system modifications.

The second major global threat factor following habitat loss, affecting 19% of all assessed amphibian species is pollution. However, in South Africa

pollution comes third, affecting 14% of amphibians, a pattern similar to that of the rest of the Afrotropical realm where pollution affects 13%. Residential and commercial development affects nearly a third of South African amphibians. A fourth threat factor affecting nearly 26% of all species is comprised of natural system modifications, including fire.

It should be stressed that in the vast majority of cases (both global and in South Africa) most threats are as perceived by Red List assessors. Very few examples of scientific studies have actually quantified the relative impact of each threat, although this should be done (see Chapter 4).

## Future directions

It is clear that global assessments play a fundamental role for the prioritisation of areas, taxa and habitats, and given the dynamic nature of the state of conservation of different taxa and areas, it is critical that assessments be kept updated as best as possible, so as to better inform conservation action and policy. The combined reassessment and prioritisation of research action for conservation of South Africa's amphibian diversity thus represents 'best practice' and something that can be held up as an example in the global arena. The prioritisation outlined in this policy document now requires the necessary funding in order to implement the recommendations contained herein. This will be a challenge for a severely under-capacitated South African amphibian research community. The need to build capacity is critical and this has been addressed in the last chapter (Chapter 6). For many of us, the fascination with these amazing creatures began when we were in our first 10 years of life. That passion that will grow into a sympathetic conservation-minded South African public needs to be nurtured in order to protect all biodiversity before its threatened components are irretrievably lost.

Much has changed since the 2004 Global Amphibian Assessment, and today we are faced with different challenges, which will affect how we conduct assessments in the future. Identifying those instances where opportunity intersects with need will be an important component of both global and regional assessments.

In the past, a Central Coordinating Team, under the auspices of the IUCN Species Survival Commission, the Centre for Applied Biodiversity Science at Conservation International and NatureServe would oversee the Global Amphibian Assessment process. Given changing priorities and demands among major partners (see Gascon *et al.* 2007),

the amphibian assessment process has changed jurisdictions and is currently under the oversight of the recently implemented Amphibian Red List Authority (Amphibian RLA). The Amphibian RLA is not a single person but a group of people from around the globe, qualified to conduct both assessments and evaluation of assessments. This means that the assessment process as a whole is more decentralised, allowing and empowering regional groups to undertake assessments where possible. Thus, channelling efforts into establishing a cohesive Southern African Amphibian specialist group that is trained in the IUCN Red List Categories and Criteria and can proactively undertake assessments may well prove an effective means to both assess and monitor the status of South African amphibians on an ongoing, regular basis, both at the global and regional levels. An added advantage of this approach is the potential to harmonise both of these processes, as shown in the approach and realisation of this book.

Based on the results from recent assessments (Table 4), priority species to monitor in future are those in threatened categories (see Chapter 5). All of the four Critically Endangered species are considered thus because of their extremely restricted Area of Occupancy (triggering criterion B2), and while most do occur in protected areas, others do not (e.g. *Heleophryne hewitti*), and even those that do occur in protected areas may not be that efficiently protected given that most of their population might fall outside of the realm of the protected area (e.g. *Anhydrophryne ngongoniensis*). In the case of those species categorised as Endangered and Vulnerable, the triggers are mostly a combination of both restricted Extent of Occurrence (EOO) (criterion B1) and Area of Occupancy (criterion B2). Either way, extinction risk is coming primarily from fragmentation and depletion of natural habitats in species that have a very circumscribed occurrence.

The small number of Data Deficient species in South Africa (N=8) was primarily because each had been recently described at the time of previous assessments, and there was very limited information to allow for a reliable assessment of their conservation status (the exception to this is *Cacosternum poyntoni*, which is regarded as a variant of *Cacosternum nanum*, so the DD status in this case was based on reservations regarding its taxonomic validity). Targeted surveys on these species allowed for their reassessment into a category other than DD, which has led to the elimination of Data Deficient species from South Africa (Figure 4). This is a very good example and model of how



Table 4. South African amphibian species assessed in the December 2009 workshop, with their previous category (2004) and new category (2010). Species in red are those that increased in threat, blue indicates species with reduced threat, and black indicates threat status that were Data Deficient and those which have remained the same.

Threatened categories: Critically Endangered (CR), Endangered (EN) and Vulnerable (VU). Other categories: Near Threatened (NT), Data Deficient (DD) and Least Concern (LC).

Family	Genus	Species	Red List Category 2004	Red List Category 2010
ARTHROLEPTIDAE	<i>Leptopelis</i>	<i>xenodactylus</i>	EN	EN
BREVICIPITIDAE	<i>Breviceps</i>	<i>bagginsi</i>	DD	VU
BREVICIPITIDAE	<i>Breviceps</i>	<i>gibbosus</i>	VU	NT
BREVICIPITIDAE	<i>Breviceps</i>	<i>macrops</i>	VU	VU
BREVICIPITIDAE	<i>Breviceps</i>	<i>sopranus</i>	DD	LC
BREVICIPITIDAE	<i>Breviceps</i>	<i>sylvestris</i>	VU	EN
BUFONIDAE	<i>Amietophrynus</i>	<i>pantherinus</i>	EN	EN
BUFONIDAE	<i>Capensibufo</i>	<i>rosei</i>	VU	VU
BUFONIDAE	<i>Vandijkophrynus</i>	<i>amatolicus</i>	EN	CR
HELEOPHYRIDAE	<i>Heleophryne</i>	<i>hewitti</i>	CR	EN
HELEOPHYRIDAE	<i>Heleophryne</i>	<i>rosei</i>	CR	CR
HEMISOTIDAE	<i>Hemisus</i>	<i>guttatus</i>	VU	VU
HYPEROLIIDAE	<i>Afrixalus</i>	<i>knysnae</i>	EN	EN
HYPEROLIIDAE	<i>Afrixalus</i>	<i>spinifrons</i>	VU	NT
HYPEROLIIDAE	<i>Hyperolius</i>	<i>horstockii</i>	VU	LC
HYPEROLIIDAE	<i>Hyperolius</i>	<i>pickersgilli</i>	EN	CR
PIPIDAE	<i>Xenopus</i>	<i>gilli</i>	VU	EN
PYXICEPHALIDAE	<i>Amietia</i>	<i>vandijki</i>	DD	LC
PYXICEPHALIDAE	<i>Amietia</i>	<i>vertebralis</i>	LC	NT
PYXICEPHALIDAE	<i>Anhydrophryne</i>	<i>ngongoniensis</i>	CR	EN
PYXICEPHALIDAE	<i>Anhydrophryne</i>	<i>ratrayi</i>	EN	VU
PYXICEPHALIDAE	<i>Arthroleptella</i>	<i>drewesii</i>	DD	NT
PYXICEPHALIDAE	<i>Arthroleptella</i>	<i>landrosia</i>	NT	NT
PYXICEPHALIDAE	<i>Arthroleptella</i>	<i>lightfooti</i>	NT	NT
PYXICEPHALIDAE	<i>Arthroleptella</i>	<i>rugosa</i>	*	CR
PYXICEPHALIDAE	<i>Arthroleptella</i>	<i>subvoce</i>	DD	VU
PYXICEPHALIDAE	<i>Cacosternum</i>	<i>capense</i>	VU	NT
PYXICEPHALIDAE	<i>Cacosternum</i>	<i>karooicum</i>	DD	LC
PYXICEPHALIDAE	<i>Cacosternum</i>	<i>striatum</i>	DD	LC
PYXICEPHALIDAE	<i>Microbatrachella</i>	<i>capensis</i>	CR	CR
PYXICEPHALIDAE	<i>Natalobatrachus</i>	<i>bonebergi</i>	EN	EN
PYXICEPHALIDAE	<i>Poyntonia</i>	<i>paludicola</i>	NT	NT
PYXICEPHALIDAE	<i>Strongylopus</i>	<i>springbokensis</i>	VU	LC
PYXICEPHALIDAE	<i>Strongylopus</i>	<i>wageri</i>	NT	LC

\* Not assessed in 2004

research policy may help to reduce the information gap with regards to DD species, and perhaps one that can be implemented elsewhere in the world.

It is important that the significant advancements that have been made at the SA-FRoG workshop and in this policy document do not become an isolated contribution to amphibian conservation in

South Africa. While they are a milestone in their own right, in order to better determine the dynamic conservation needs of the amphibians of South Africa, it will be necessary to make these efforts a regular component of the amphibian conservation landscape of the country, so conservation reassessments and reviews of this document recur every five years. We believe that this is a sound strategy

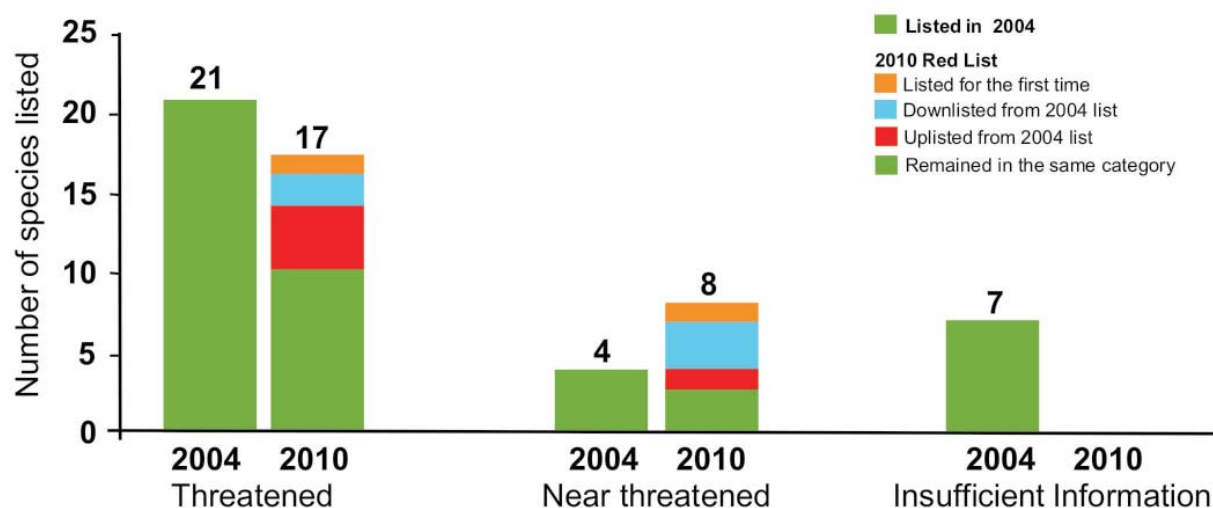


Figure 4. Changes in the number of amphibian species listed in the various broad categories of threat. Numbers reflected for 2004 represent amphibians listed in Minter *et al.* (2004) and for 2010 this document (see Appendix 1). Note that many of the changes in assessment status are classified as 'non-genuine' change as they reflect more accurate information rather than a 'genuine' increase or decline of the species concerned.

to maintain information current and to more effectively tailor conservation actions according to the needs that are identified during the course of such reviews.

## Further reading

BirdLife International. 2004. *State of the World's Birds: Indicators for our Changing World*. BirdLife International, Cambridge, UK.

BLAUSTEIN, A.R. & WAKE, D.B. 1990. Declining amphibian populations: A global phenomenon? *Trends in Ecology and Evolution* 5: 203–204.

BRANCH, W.R. (ed.) 1988. South African Red Data Book – Reptiles and Amphibians. *South African National Scientific Programmes Report* no. 151. CSIR, Pretoria.

DRIVER, A., MAZE, K., ROUGET, M., LOMBARD, A.T., NEL, J., TURPIE, J.K., COWLING, R.M., DESMET, P., GOODMAN, P., HARRIS, J., JONAS, Z., REYERS, B., SINK, K. AND STRAUSS, T. 2005. National spatial biodiversity conservation in South Africa (NSBA). *Strelitzia* 17. South African National Biodiversity Institute (SANBI), Pretoria.

GASCON, C., COLLINS, J.P., MOORE, R.D., CHURCH, D.R., MCKAY, J.E. & MENDELSON, J.R. III (eds). 2007. *Amphibian Conservation Action Plan*. IUCN/SSC Amphibian Specialist Group. Gland, Switzerland and Cambridge, UK.

HOULAHAN, J., FINDLAY, C., SCHMIDT, B., MAYER, A. & KUZMIN, S. 2000. Quantitative evidence for global amphibian declines. *Nature* 404: 752–755.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.

MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. & KNOEPFER, D. (eds) 2004. *Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland*. Smithsonian Institution Press, Washington D.C.

POUNDS, J.A., BUSTAMANTE, M.R., COLOMA, L.A., CONSUEGRA, J.A., FOGDEN, M.P.L., FOSTER, P.N., MARCA, E.L., MASTERS, K.L., MERINO-VITERI, A., PUSCHENDORF, R., RON, S.R., SÁNCHEZ-AZOFEIFA, G.A., STILL, C.J. & YOUNG, B.E. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. *Nature* 439: 161–167.

POYNTON, J. C. 1964. The Amphibia of southern Africa. *Annals of the Natal Museum* 17: 1–334.

SCHIPPER, J., CHANSON, J.S., CHIOZZA, F., COX, N.A., HOFFMANN, M., KATARIYA, V., LAMOREUX, J., RODRIGUES, A.S.L., STUART, S.N., TEMPLE, H.J., BAILLIE, J., BOITANI, L., LACHER, T.E., MITTERMEIER, R.A., SMITH, A.T., ABSOLON, D., AGUIAR, J.M., AMORI, G., BAKKOUR, N., BALDI, R., BERRIDGE, R.J., BIELBY, J., BLACK, P.A., BLANC, J.J., BROOKS, T.M., BURTON, J.A.,



- BUTYNSKI, T.M., CATULLO, G., CHAPMAN, R., COKELISS, Z., COLLEN, B., CONROY, J., COOKE, J.G., DA FONSECA, G.A.B., DEROCHER, A.E., DUBLIN, H.T., DUCKWORTH, J.W., EMMONS, L., EMSLIE, R.H., FESTA-BIANCHET, M., FOSTER, M., FOSTER, S., GARSHELIS, D.L., GATES, C., GIMENEZ-DIXON, M., GONZALEZ, S., GONZALEZ-MAYA, J.F., GOOD, T.C., HAMMERSON, G., HAMMOND, P.S., HAPPOLD, D., HAPPOLD, M., HARE, J., HARRIS, R.B., HAWKINS, C.E., HAYWOOD, M., HEANEY, L.R., HEDGES, S., HELGEN, K.M., HILTON-TAYLOR, C., HUSSAIN, S.A., ISHII, N., JEFFERSON, T.A., JENKINS, R.K.B., JOHNSTON, C.H., KEITH, M., KINGDON, J., KNOX, D.H., KOVACS, K.M., LANGHAMMER, P., LEUS, K., LEWISON, R., LICHTENSTEIN, G., LOWRY, L.F., MACAVOY, Z., MACE, G.M., MALLON, D.P., MASI, M., MCKNIGHT, M.W., MEDELLÁN, R.A., MEDICI, P., MILLS, G., MOEHLMAN, P.D., MOLUR, S., MORA, A., NOWELL, K., OATES, J.F., OLECH, W., OLIVER, W.R.L., OPREA, M., PATTERSON, B.D., PERRIN, W.F., POLIDORO, B.A., POLLOCK, C., POWEL, A., PROTAS, Y., RACEY, P., RAGLE, J., RAMANI, P., RATHBUN, G., REEVES, R.R., REILLY, S.B., REYNOLDS, J.E., RONDININI, C., ROSELL-AMBAL, R.G., RULLI, M., RYLANDS, A.B., SAVINI, S., SCHANK, C.J., SECHREST, W., SELF-SULLIVAN, C., SHOEMAKER, A., SILLERO-ZUBIRI, C., DE SILVA, N., SMITH, D.E., SRINIVASULU, C., STEPHENSON, P.J., VAN STRIEN, N., TALUKDAR, B.K., TAYLOR, B.L., TIMMINS, R., TIRIRA, D.G., TOGNETTI, M.F., TSYTSULINA, K., VEIGA, L.M., VIÉ, J.-C., WILLIAMSON, E.A., WYATT, S.A., XIE, Y. & YOUNG, B.E. 2008. The status of the world's land and marine mammals: diversity, threat, and knowledge. *Science* 322: 225–230.
- STUART, S.N., CHANSON, J.S., COX, N.A., YOUNG, B.E., RODRIGUES, A.S.L., FISCHMAN, D.L. & WALLER, R.W. 2004. Status and trends of amphibian declines and extinctions worldwide. *Science* 306: 1783–1786.
- STUART, S.N., HOFFMANN, M., CHANSON, J.S., COX, N.A., BERRIDGE, R.J., RAMANI P. & YOUNG, B.E. (eds). 2008. *Threatened Amphibians of the World*. Lynx Edicions, IUCN and Conservation International, Barcelona.
- TOLLEY, K.A., CHASE, B. & FOREST, F. 2008. Speciation and radiations track climate transitions since the Miocene Climatic Optimum: a case study of southern African chameleons. *Journal of Biogeography* 35: 1402–1414.



## 2 Building a strategy for amphibian conservation through a workshop process

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The 2004 amphibian Red List was in many respects a watershed document as it provided the first set of comprehensive IUCN assessments for every amphibian in South Africa, Lesotho and Swaziland, together with an impressive source of life history information and reference sources for each species. It was a significant achievement in the history of amphibian conservation in the region as well as being a new source of reference for amphibian conservationists and the basis for the region's 2004 IUCN Global Amphibian Assessment. However, the Red List is not static and requires regular updates, which at least should occur every five years.

Reassessment of South Africa's amphibians took place during a workshop on 2 December 2009 (see Appendix 1 for details). It was decided prior to the Red Listing workshop that gathering the regions experts into one place should result in more than the Red Listing exercise. As the 2004 amphibian Red List had provided a large number of threatened species, it was resolved that there was merit in a prioritisation exercise to enable researchers and potential funders of research to quantitatively identify which species should be prioritised for conservation research and to pinpoint exactly what that research should consist of.

To this end, a second workshop was conducted from 3–4 December 2009 at the South African National Biodiversity Institute's Kirstenbosch Research Centre, Cape Town. A list of participants and their contact details can be found in Appendix 2. Details for the 2010 update of the IUCN Red List for South Africa can be found in Appendix 1.

In order to produce the strategy documents that follow, a three stage process was initiated by a quorum of amphibian scientists. The first stage was to provide a framework of principal areas needing prioritisation for threatened species. These were:

- Understanding and documenting species diversity.
- Conservation and ecological studies.
- Assessing status and trends.
- Education, awareness and capacity building.

Each section of the framework was provided with a general target to be achieved as well as two specific aims—these are given at the beginning of each of the subsequent chapters bearing the names as above. Each subject was given half a day of workshop time with a facilitator (and eventually lead author of each section) leading the discussion to achieve the stated aims.

During each session threatened amphibian species (see Appendix 1) were evaluated and information captured relating to what research had already occurred, and what could be achieved within a five year time frame. A priority score of 1–5 for each action was included.

The scores were rated as follows:

1. The available information is sufficient. No priority for further work.
2. There is limited information, but no priority is assigned.
3. There are questions, but the priority is low.
4. Definite questions exist, and a high priority is assigned.
5. There is an urgent need for immediate work, and the highest priority is assigned.

Hence, each session aimed to produce a score together with information about exactly what should be done in the event that an action was prioritised. Where possible, specific indications about which participants were equipped and had capacity to undertake the given research were included.

The emphasis on IUCN threatened categories was given so that threatened amphibian species would receive research which would provide conservationists with sufficient information to significantly decrease threat level, as well as providing data that could be fed back into IUCN assessments in five years' time.

The third stage consisted of producing and editing the data captured during the workshop and collating this into the following strategic document. Here an emphasis was made on producing a strategy document with:

1. **Clear actions**—an attempt has been made to be precise about which actions are required. The majority of actions concern particular research priorities which are required. All actions prioritised are considered possible within the time frame of the document.
2. **Responsible agencies**—one key issue identified during the workshop is the inadequate capacity currently available in South Africa to conduct sufficient research on our threatened amphibians. In part, this has led to the need for a strategy document with priorities as well as a strategy toward increasing capacity *per se*. With this in mind, it has been difficult to assign responsible agencies to prioritised tasks within this document. However, where possible this has been done using the network of stakeholders who participated in the workshop.
3. **Time frame**—this policy document is conceived to provide researchers, funders and other workers in the field information on priorities for research on threatened amphibian species over the next five years: 2010–2015. The idea is to provide information that can be used directly in the next IUCN reassessment of South African amphibians in 2015. Following that reassessment, we suggest that another policy document is drawn up for the following five year period.

Where possible, the structure of each chapter included the following sections in order to make

sections between chapters easier for the reader to compare:

**Aims**—determined by the quorum in advance of the workshop.

**Rationale**—as laid out to the workshop attendees.

**Prioritisation tables**—results of the workshop with prioritisation given for each taxon together with notes on clear actions and responsible agencies.

**Workshop findings**—analyses of the results of the workshop together with details of issues that were raised and points discussed. Clear priorities and how these relate to taxa and research work required are given.

**Recommendations and solutions**—summaries of the prioritisation process and any matters arising with reference to the aims in each chapter.

**Hurdles and obstacles**—issues raised in the workshop regarding particular difficulties in meeting the aims expected over the next five years.

**Further reading**—an exhaustive reference list is not provided, instead further reading is included at the end of each chapter. Those interested in additional literature should consult works listed in the further reading section, or may contact the authors of chapters directly.





## 3

# Understanding and documenting species diversity

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## Aims

1. To list priorities for taxonomic research which relate to or are likely to include South African threatened amphibians.
2. To specify the methods to be used and research required in order to resolve outstanding taxonomic issues relating to South African threatened amphibians.

## Rationale

The list of threatened species of South African amphibians includes species for which taxonomic issues are outstanding. Some were listed as Data Deficient due to problems with taxonomy, while other taxa have a threatened status even though existing but unpublished research suggests that they are not taxonomically valid. In addition to known taxonomic issues, species with disjunct distributions may require taxonomic investigation in order to determine whether they represent new taxa or significant evolutionary or management units. Such investigations require a co-ordinated effort of tools and priorities so that effort is not duplicated or conflicting. These investigations rely heavily on collections of specimens (both adults and larvae for morphological analyses) and tissues (for DNA analyses). Access to available collections, both private and public, are needed for effective studies. Fieldworkers need to be directed to target taxa with adequate instruction for preservation and support for permitting.

## Background

The advent of molecular techniques has enabled taxonomists to re-evaluate the systematics of organisms worldwide. There has been a 25% increase in described species of amphibians up to 2005 (Köhler *et al.* 2005), in part as a result of advertisement call analysis and the application of molecular genetics. There are only a small number

of research groups applying molecular techniques to amphibian taxonomy based in South Africa. These are at SANBI (Cape Town), University of the Free State (Qwaqwa), and the University of the Western Cape (Bellville). Incidental molecular studies of amphibians have been published by other groups (such as the University of Pretoria) mostly working on other organisms. These studies are providing new insights into the taxonomy of African amphibians, and many have conservation implications. For example, a recently published work by Tolley *et al.* (2010) detailed the phylogeny of the genus *Capensibufo*, with two currently recognised species, and demonstrated that it contains multiple cryptic species. Another recent study by Tarrant *et al.* (2008) discovered and resolved a taxonomic error of long standing in the genus *Amietia* from the Drakensberg. Systematics itself is only one area that can be investigated using molecular tools. Where species boundaries may be in doubt, or the intraspecific genetic distribution unknown, a phylogeography can provide answers to many conservation-orientated issues. A recent review of amphibian speciation, species boundaries and phylogeography can be consulted for a more detailed understanding of the importance of genetic studies for the conservation of amphibian biodiversity (Vences & Wake 2007).

Although the molecular revolution has brought about great advancements in amphibian taxonomy, results of genetic analyses do not stand alone and taxonomy also requires the traditional skills of (preferably both) morphology and call analysis where possible in anurans. Both techniques require specialist knowledge, equipment and access to a collection of preserved specimens and/or calls. The importance of such collections is detailed later. A general priority is for sufficient funding to allow thorough reviews of all South African amphibian taxa. This could be applied through higher degree training, resulting in the parallel development of a new generation of amphibian systematists (see

Chapter 6). Simultaneously, we acknowledge the need for setting priorities for taxonomic work and this document attempts to set priorities as appropriate for those amphibians considered threatened under IUCN (2001) criteria.

## Target

**To determine which of South Africa's threatened amphibians require taxonomic work, and to ascertain which aspects of their taxonomy are outstanding as well as the most appropriate methods that can be used to correct this deficiency.**

## Approach

The amphibian species on the Red List were evaluated during the workshop. Both threatened and Data Deficient species were included. For each species an assessment was made of the need for descriptive studies, advertisement calls, traditional morphology (including tadpoles), systematics, and phylogeographic work. The panel prioritised the needs in terms of funding required, and noted ongoing projects. The generalised levels of priority from 1 (low) to 5 (high) were defined as set out in Chapter 2.

## Summary

Of categories considered necessary to understand and document the species diversity of amphibians in South Africa, by far the highest priority lies with conducting phylogeographical studies. The low score for priority in descriptions suggests that there are not a great many recognised species which are only awaiting description. Undescribed species do exist but require more research prior to descriptions being made. The highest priority was given to phylogeographic studies, which involves determining species boundaries and cryptic species where these are suspected and/or remain to be discovered and require a phylogeographic and/or systematic approach (see Vences & Wake 2007). Like descriptions, morphology also appears to have a low priority while calls clearly require much more attention.

The species with the highest consistent priority for taxonomic work is an as yet undescribed species of *Poyntonophrynus*, with an emphasis on phylogeography to determine species delimitations. Likewise, a high priority for phylogeography and other systematic work was given to species of *Anhadrophryne*, *Capensibufo*, *Xenopus* and *Microbatrachella*.

## Descriptions and morphology of threatened amphibians

The panel determined that there were high priorities to describe new species of the genus *Anhydrophryne* from the Drakensberg and *Xenopus* from the Cape lowlands. There was no priority perceived for detailed morphological studies, although many tadpoles remain undescribed. However, there are many known and expected cryptic species still to be described, and these may be threatened and will require work (see Table 1).

## Advertisement call studies

Male frogs use vocalisations, referred to as advertisement calls, in order to attract females. Surveys of calls provide rapid data that can be used to identify unnamed species, as well as map distributions. Many species do not require any further studies, although others are not well-documented, and call studies may lead to the recognition of cryptic species (see Table 1). Two species require high priority for call analysis: *Afrixalus knysnae* and *Vandijkophrynus nubicolus*. Of all the taxa considered, 35% were recognised as having outstanding questions.

## Systematics

The phylogenetic relationships of the threatened species are important when determining the history of the taxa. Conservation efforts can be better directed with knowledge of the origin of species concerned. For example, the relationships of the genus *Breviceps* were examined by Loader *et al.* (2004) and Van der Meijden *et al.* (2004). African ranid radiations (now assigned to a number of other families) were studied by molecular techniques (Bossuyt *et al.* 2006). Questions concerning phylogenetic relationships were recognised for nearly half of all the taxa assessed, but no high priority was recognised for any threatened species.

## Phylogeography

Molecular biogeography has been used successfully to study ecoregion biogeographic history (Moodley & Bruford 2007). Many of the threatened species show a pattern of disjunct distribution. This may indicate genetic isolation or rapid dispersal. Phylogeographic studies will enable gene flow to be estimated between geographically isolated populations, which links to the conservation of the species listed in Table 1. A quarter of all species assessed were considered to have a high priority for phylogeographic studies and this section scored highest overall for priorities on taxonomic research for South African threatened amphibians.

Table 1. Threatened species of South African amphibians identified as needing some level of taxonomic investigation, levels 3 to 5 (see explanations in text).

Priority rank	Species name	Description	Call	Morphology	Systematics	Phylogeography	Funding required	Comments	Total	Monitoring rank	Conservation rank
1	<i>Poyntonophrynus</i> spp.	3	3	3	3	4	4	Highest overall priority, work on phylogeography must be completed in the next five years.	16	N/A	N/A
2	<i>Anhydrophryne</i> sp. ( <i>Drakensberg</i> )	4	3	1	3	4	3	Specimens are awaiting description but more data on phylogeography is required first.	15	N/A	N/A
2	<i>Xenopus gilli</i>	4	3	3	1	4	3	Two taxa are present and a priority to describe the <i>Agulhus</i> population is recognised.	15	8	4
3	<i>Capensibufo</i> cf. <i>tradouwi</i>	1	3	1	3	4	3	Cryptic taxa are known and phylogeographic work and descriptive work prioritised. Populations from the eastern part of the range are lacking samples. Taxonomic revision required.	12	N/A	N/A
3	<i>Microbatrachella capensis</i>	1	3	1	3	4	3	There are disjunct populations which require phylogeographic investigations.	12	8	3
3	<i>Afrivalus knysnae</i>	1	4	1	3	3	2	Species boundaries in this complex are uncertain. A clear priority on call analysis with phylogeography and systematics.	12	2	1
3	<i>Capensibufo</i> cf. <i>rosei</i>	3	1	1	3	4	2	Cryptic taxa are known, but phylogeographic work and descriptive work prioritised. Taxonomic revision required.	12	2	1
4	<i>Afrivalus spinifrons</i>	1	3	1	3	3	3	The status of taxa currently treated as subspecies is uncertain, with a priority on calls, phylogeography and systematics.	11	8	N/A
4	<i>Breviceps sylvestris</i>	1	3	1	3	3	4	Prioritised phylogeographic work requires mtDNA markers. Proposal to sequence mitochondrial genome to aid search for primers has highest priority.	11	5	N/A
4	<i>Breviceps bagginsi</i>	1	3	1	3	3	1	Cryptic species may be included in this taxon with a priority on calls, phylogeography and systematics.	11	5	3
4	<i>Cacosternum striatum</i>	1	3	1	3	3	1	This is apparently a widespread species, but phylogeography, systematics and work on calls are required.	11	N/A	N/A
5	<i>Amietophrynus pantherinus</i>	1	3	1	1	4	3	Evaluating populations of this species and <i>A. pardalis</i> is prioritised.	10	5	7
5	<i>Breviceps gibbosus</i>	1	3	1	1	4	2	The priority to determine the status of disjunct populations will be investigated using calls and phylogeography.	10	N/A	N/A
5	<i>Hadromophryne natalensis</i>	1	2	1	3	3	3	Phylogeographic and systematic work has priority for this species.	10	N/A	N/A
5	<i>Breviceps macrops</i>	1	2	1	3	3	2	The relationships of this species are not established. The genetic population structure should be prioritised.	10	10	N/A



5	<i>Leptopelis xenodactylus</i>	1	2	1	3	3	1	The relationships between this and other species without toe discs are prioritised.	10	5	4		
5	<i>Strongylopus springbokensis</i>	1	2	1	3	3	1	Phylogeographic and systematic work has priority for this species.	10	N/A	N/A		
5	<i>Amietia vandijki</i>	1	3	1	2	3	2	Priority on collection of calls away from the type locality.	10	N/A	N/A		
5	<i>Vandijkophrynus nubicolus</i>	1	4	1	2	2	2	Clarification of taxonomic status relative to nominate <i>V. gariepensis</i> required.	10	N/A	N/A		
6	<i>Strongylopus wageri</i>	1	2	1	1	4	1	There are several disjunct populations which require phylogenetic investigations.	9	N/A	N/A		
6	<i>Hemisus guttatus</i>	1	1	1	3	3	2	Phylogeographic and systematic work has priority for this species.	9	8	N/A		
6	<i>Arthroleptella drewesii</i>	1	1	1	3	3	1	Phylogeographic and systematic work has priority for this species.	9	N/A	N/A		
6	<i>Arthroleptella landdrosia</i>	1	1	1	3	3	1	Phylogeographic and systematic work has priority for this species.	9	N/A	N/A		
6	<i>Hyperolius pickersgilli</i>	1	2	1	2	3	3	The priority on phylogeography requires collections of tissues during other studies.	9	1	3		
6	<i>Cacosternum karoaicum</i>	1	3	1	2	2	1	Obtaining more calls is a priority for this species.	9	N/A	N/A		
7	<i>Arthroleptella lightfooti</i>	1	1	1	2	3	1	Phylogeographic work has priority for this species.	8	N/A	N/A		
7	<i>Poyntonia paludicola</i>	1	1	1	1	4	3	There is evidence of disjunct populations with possible cryptic species. Loss of some habitats increases the priority for this study.	8	N/A	N/A		
7	<i>Heleophryne hewitti</i>	1	3	1	2	1	3	Systematics in need of revision, most data available but in need of analysis.	8	8	1		
7	<i>Anhydrophryne ngongoniensis</i>	1	2	1	1	3	3	Important to understand distribution in Eastern Cape. Cryptic taxa suspected in this genus.	8	9	3		
8	<i>Vandijkophrynus amatolicus</i>	1	1	1	1	3	1	Phylogeographic work dependent on finding specimens.	7	3	1		
8	<i>Cacosternum capense</i>	1	2	1	1	2	1	Calls are available, but require analysis.	7	10	N/A		
8	<i>Ptychadena taenioscelis</i>	1	1	1	3	1	2	Taxonomy is in need of revision.	7	N/A	N/A		
9	<i>Breviceps sopranus</i>	1	1	1	2	1	3	No priority, current work is sufficient.	6	N/A	N/A		
10	<i>Anhydrophryne rattrayi</i>	1	1	1	1	1	1	No priority, current work is sufficient.	5	N/A	N/A		
10	<i>Arthroleptella rugosa</i>	1	1	1	1	1	1	No priority, current work is sufficient.	5	7	2		
10	<i>Arthroleptella subvoce</i>	1	1	1	1	1	1	No priority, current work is sufficient.	5	10	2		
10	<i>Heleophryne rosei</i>	1	1	1	1	1	1	No priority, current work is sufficient.	5	6	3		
10	<i>Hyperolius horstockii</i>	1	1	1	1	1	1	No priority, current work is sufficient.	5	N/A	N/A		
10	<i>Natalobatrachus bonebergi</i>	1	1	1	1	1	1	No priority, current work is sufficient.	5	4	3		
<b>Totals out of 100</b>									<b>22</b>	<b>38</b>	<b>22</b>	<b>41</b>	<b>56</b>

## Undescribed species

Undescribed species are likely to be of conservation concern as they will be limited in their distribution (i.e. smaller than those with which they are currently in synonymy). Studies should be initiated as soon as possible in those not already under investigation. Cryptic species in need of conservation may be present in other genera: *Amietia*, *Amietophrynus*, *Anhydrophryne*, *Breviceps*, *Caco sternum*, *Capensibufo*, *Poyntonophrynus*, *Strongylopus*, *Vandijkophrynus* and *Xenopus*.

## Amphibian collections

There are many South African institutions with amphibian collections (excluding teaching collections). Many of these collections were assembled in the days when herpetologists were still widely employed by museums, but now they are 'orphan' collections without professional support.

Collections should meet a number of criteria. These include:

1. The specimens need to be accessible to scientists, both as searchable electronic databases, and as loans.
2. The collection needs to be supported by the institution for the foreseeable future, in terms of long-term personnel and financial resources.

It is recommended that voucher collections be deposited in the South African Institute of Aquatic Biodiversity (SAIAB) collection in Grahamstown, the National Museum collection in Bloemfontein, and the Port Elizabeth Museum (Bayworld). Tissue collections should be deposited with SAIAB in Grahamstown, SANBI in Cape Town, and Biobank in Pretoria. In addition, it is advised that the long term viability of 'orphan' collections be revised and where necessary, those that are considered to be in danger of deterioration or destruction are moved to one of the three institutions listed above.

Within the time frame of this strategy document (the next five years), the highest priority is to consolidate any 'orphan' collections into those with long term viability. All recommended institutions must provide online searchable electronic databases within the next five years. Funding to instigate these facilities exists from the National Research Foundation South African Biosystematics Initiative (NRF-SABI) funding initiative. All databases should be linked with ongoing national initiatives such as the South African Tree of Life project ([www.tolweb.org](http://www.tolweb.org)).

## Funding priorities for taxonomy

Funding is required for three primary areas: student training, phylogenetic and phylogeographic research on threatened species, and basic biodiversity research, including surveys and collection of tissues and vouchers.

Student training is critical to rebuild taxonomic expertise in the country (see Chapter 6). For amphibian work, bursaries and running expenses to cover both fieldwork and molecular investigations are needed. We estimate that six MSc and six PhD level students should be accommodated per year for the next five years. This funding should complement that from other sources, such as the NRF-SABI program.

Funding for research into phylogenetics and phylogeographic problems is both critically important and expensive. Sufficient funding should be made available to groups involved in these aspects that will cover fieldwork and laboratory investigations. We recommend that at least one workshop should be organised to teach new analytical methods for those studying amphibian phylogeography within the next five years.

The importance of basic biodiversity research cannot be overemphasized. Without this documentation, it will not be possible to recognise, conserve, or utilise the country's biodiversity. Funding for basic biodiversity research should be made available on a long-term basis.

## Recommendations and solutions

1. Clear taxonomic priorities are to conduct morphological, call and molecular studies within genera which are considered to contain cryptic species with restricted distributions: *Poyntonophrynus*, *Anhydrophryne*, *Xenopus* and *Capensibufo*. Of the known species which are currently threatened, taxonomic work is still required on both species of *Afrivalus*: *A. knysnae* and *A. spinifrons*.
2. The priorities for most taxonomic research (and hence funding) are for phylogeographic studies and secondarily higher level phylogenies. Phylogeographic studies provide powerful insights both into species boundaries and natural disjunctions, however very few laboratories in South Africa regularly carry out such studies on amphibians. A workshop on the latest phylogeographical techniques is to be organised within the next five years.
3. Issues to be considered by both amphibian researchers and the bodies concerned with funding and permitting the work include: that

## Box 1: Ethical considerations

Collectors need to be aware of the ethical issues involved in the collection of amphibian calls, tissue and specimens. Ethics clearance is normally required before permits are issued. The issues to be considered are:

1. The number of specimens collected should not adversely affect the viability of the population, especially when these collections are made at breeding ponds early in the season. Sample size should be commensurate with, and not less than, that required by the scientific needs of the study.
2. Collateral damage to the environment should be avoided and steps should be taken to prevent spread of disease.
3. The animals should not be stressed in the short- or long-term. Animals that will be collected for voucher specimens should be humanely euthanized using appropriate methods.
4. Collectors must be aware of the legal issues of both collecting and transporting specimens, which vary from Province to Province.
5. The data associated with every specimen should be publicly available. An embargo may be placed on tissues, calls and vouchers that are part of an ongoing study.

research should be ethical, collections should be placed in appropriate and publicly available collections, and that there is a real need to fund both the primary work and research by students who will help to build future capacity in South African amphibian systematics. Consolidation of museum specimens and the availability of online catalogues should be achieved within the next five years.

## Further reading

- BOSSUYT, F., BROWN, R.M., HILLIS, D.M., CANNATELLA, D.G., MILINKOVITCH, M.C. 2006. Phylogeny and biogeography of a cosmopolitan frog radiation: Late cretaceous diversification resulted in continent-scale endemism in the Family Ranidae. *Systematic Biology* 55: 579–594.
- IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.
- KÖHLER, J., VEITES, D.R., BONETT, R.M., GARCIA, F.H., GLAW, F., STEINKE, D. & VENCES, M. 2005. New amphibians and global conservation: A boost in species discoveries in a highly endangered vertebrate group. *Bioscience* 55: 693–696.
- LOADER, S.P., GOWER, D.J., HOWELL, K.M., DOGGART, N., RÖDEL, M.-O., CLARKE, B.T., DE SÁ R.O., COHEN, B.L. & WILKINSON, M. 2004.

Phylogenetic relationships of African microhylid frogs inferred from DNA sequences of mitochondrial 12S and 16S rRNA genes. *Organisms, Diversity and Evolution* 4: 227–235.

MOODLEY, Y. & BRUFORD, M.W. 2007. Molecular biogeography: Towards an integrated framework for conserving Pan-African biodiversity. *PLoS ONE* 2(5): e454.

TARRANT, J., CUNNINGHAM, M.J. & DU PREEZ, L.H. 2008. Maluti mystery: a systematic review of *Amietia vertebralis* (Hewitt, 1927) and *Strongylopus hymenopus* (Boulenger, 1920) (Anura: Pyxicephalidae). *Zootaxa* 1962: 33–48.

TOLLEY, K.A., DE VILLIERS, A.L., CHERRY, M.J. & MEASEY, G.J. 2010. Isolation and high genetic diversity in dwarf mountain toads (*Capensibufo*) from South Africa. *Biological Journal of the Linnean Society* 100: 822–834.

VAN DER MEIJDEN, A., VENCES, M., MEYER, A. 2004. Novel phylogenetic relationships of the enigmatic brevicepitine and scaphiophryne toads as revealed by sequences from the nuclear Rag-1 gene. *Proceedings of the Royal Society of London, B (Supplement)* 271: S378–S381.

VENCES, M. & WAKE, D.B. 2007. Speciation, species boundaries and phylogeography of amphibians. In H.H. Heatwole & M. Tyler (eds), *Amphibian Biology* (6): 2613–2669. Surrey Beatty & Sons, Chipping Norton, Australia.



## 4

## Conservation and ecological studies

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## Aims

The aims of this chapter are to:

1. Document conservation research on threatened South African amphibians and to highlight deficiencies.
2. Identify key areas of research required in order to make future assessments of South African threatened amphibians more accurate with quantitative evidence.

## Rationale

Conservation of any threatened species is reliant on a minimum knowledge of the species' distribution, biology, and behaviour before a meaningful assessment of direct threats and impacts can be made. Given the large number of amphibian species in South Africa, efforts in understanding these basic aspects of each species have not been distributed evenly resulting in a patchy knowledge base on which to draw for threatened species.

There have only been two published Red Data books of South Africa's amphibians: Branch (1988) and Minter *et al.* (2004). Only the latter publication had comprehensive distribution maps based on a compilation of known occurrences with an active frog atlas project that spanned a decade.

However, deficiencies in knowledge highlighted by Minter *et al.* (2004) remain, to a large extent, in the majority of species. This is due to numerous reasons, including the remote distributions of many species over inaccessible terrain, a dearth in the quantity of South African based herpetologists and an acute shortage of funding for baseline field surveys. Although the ideal situation would provide adequate funding and personnel to gather the missing data for all South African amphibians,

the reality is that there are a limited number of herpetologists. These herpetologists are compelled to target those species and areas most in need of research and conservation interventions. A clear way to achieve this is to acquire funding to research those species which are threatened under IUCN criteria. However, the proportion of threatened species in South Africa is quite large (15%), thus within these species clear priorities are needed.

This document aims to give a synopsis of the current state of research into South Africa's threatened amphibian taxa and help highlight those species which are not currently receiving the necessary research needed in order to make informed decisions about threats to their conservation. It should be stressed that the work stipulated as required here represents only a fraction (only threatened species) of the full body of work that is required on South African amphibians. This document aims to highlight the most urgent work required if South Africa is to avoid losing elements of its unique amphibian fauna.

## Prioritisation process

To date, Red Listing of South African frogs has been made on Category B criteria, that is determining where species occur (Extent of Occurrence and Area of Occupancy: EOO and AOO) in order to assess their threat status. Determining the EOO and AOO is of vital importance but it is recognised that it is in many cases a crude means of assessment and does not afford sufficient knowledge to conserve the most threatened species. In some cases, EOO and AOO are not well known, even for threatened taxa, and this information becomes an immediate priority. In other cases, it is necessary to plan the next step such as population level studies, so that there is baseline data available for future

monitoring, threat determination or even basic studies of biology in order to determine appropriate conservation actions.

In the prioritisation process exercise, we examined each of the threatened taxa to determine what work was realistic (in terms of funding and capacity) in order to:

- a. Complete minimum Red List category criteria for Category B (EOO and AOO).
- b. Assess whether threats have been adequately identified:
  - i. Whether these represent direct threats.
  - ii. Prioritise work which is required to quantify identified threats.
- c. State additional work that would provide sufficient data to assess each species on quantitative population data for Category A criteria.
- d. Whether or not formalisation of agreements between stakeholders (e.g. Biodiversity Management Plan, Stewardship agreement or Memorandum of Understanding) are necessary for the conservation of the threatened species.

For each of these criteria, each threatened species was given a priority score (from 1–5, see Chapter 2) and these scores were then added together to achieve the overall conservation research score.

## Conservation research explained

*Identify management units*—in practice, the conservation of species is normally achieved according to management units. This is because it is seldom that entire species fall into an area that can be managed as a unit and because of practical constraints on conservation staff and budgets that preclude comprehensive species management. Many species, especially habitat specialists, have patchy distributions and phylogeographic studies have shown that these populations often show disjunctions in gene flow (see Chapter 3). Despite these studies, very little work has been conducted on South African amphibians to show the locations and extent of populations that constitute management units based on population genetics and geographic coherence.

The IUCN (2001) currently defines a 'location' as 'a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present.' While this

definition of 'location' is useful in terms of assessing threat status, it may also be applied as a first estimation of management units.

Management units as defined by population genetic considerations may in some cases actually be equivalent to 'locations' whilst in others there may be many more (or less) management units than locations. Recognising separate management units often requires effective communication between different stakeholders.

In order to identify management units, a satisfactory understanding of a species' EOO and AOO is a prerequisite. Major threats should have been assessed and relevant stakeholders identified. Should formalisation of agreements between several stakeholders on threats to conserve a threatened species be deemed necessary, this suggests drawing up a species specific Biodiversity Management Plan (BMP-S) in terms of the National Environmental Management Biodiversity Act (NEMBA). Interim agreements or Memoranda of Understanding should be entered into wherever possible. In addition to surveys, molecular methods can be applied to determine whether identified management units represent isolated populations, have limited connectivity through dispersal or act as source-sink populations. More details of these applications are given in Chapter 3.

*Basic biology, ecology and behaviour*—many aspects of the biology of South African amphibians have yet to be determined and without knowing important facts about the life-history of each threatened species, it will be difficult to draft plans to conserve them. For example, knowing how far individuals travel may determine the physical area of a meta-population. Phenology is often important in amphibians as some species only appear for very limited periods to breed, or certain life-history stages (e.g. eggs, tadpoles) may have very brief durations which require well-timed conservation actions.

Investigating basic biology, ecology and behaviour can be expensive and lengthy, but is often critical to producing effective conservation plans. A combined approach using a number of techniques (e.g. genetics, radio-telemetry, Capture-Mark-Recapture (CMR), niche modelling and ecological characterisations) is likely to provide a secure basis for interpretation. Basic biology includes estimating population size, although this is treated in its own right below as it is important in assessing extinction threat and is considered an essential tool in conservation management, and is also the basis for population monitoring (see Chapter 5).

*Dispersal*—knowledge about how far individuals can move between sites is very important in determining whether or not subpopulations are isolated and therefore helps to determine the viability of subpopulations of a threatened species. Many species of amphibians live in metapopulations (see below) where several breeding sites appear discreet but are effectively acting as a single subpopulation. Some amphibians rely on the dispersal inherent in metapopulation dynamics to counter stochastic fluctuations in breeding habitat viability. Dispersal can be measured directly, by attempting to identify individuals that have dispersed (via CMR studies or radio-telemetry), or inferred by genetic techniques. Direct methods are relatively simple to conduct, but require extensive time in the field and have a low probability of finding what is normally a low proportion of dispersing animals. Genetic techniques are expensive and require significant development of primers per species (see Chapter 3). Ideally, a combination of these methods should be used.

*Habitat requirements*—within the distribution (EOO) of some South African amphibians, the occurrence is sporadic and unpredictable. Conducting research into the precise habitat requirements (environmental variables) are required. Such studies would help predict occurrence throughout the distribution and highlight areas which are already protected or in need of conservation efforts.

*Distribution*—despite the best efforts of a decade-long frog atlas project in South Africa (Minter *et al.* 2004) there are still several species for which we do not have comprehensive distribution data. This impinges on our ability to make informed threat assessments due to the primacy of this information in assessments (as mentioned above, this is largely due to the fact that distribution data are normally the first data gathered).

*Estimation of population size*—in order to make accurate IUCN Red-Listing categories (under Criteria A, C or D), data on fluctuations in population size are required. The number of mature individuals in a population is defined as ‘the number of individuals known, estimated or inferred to be capable of reproduction’ (IUCN 2001).

There are very few published population size estimates adhering to this definition available for South African amphibians. Furthermore, there are also very little data available on how population numbers fluctuate over time (see Chapter 5 for further discussion). Aquatic-breeding species appear to fluctuate more than terrestrial-breeding species (Marsh 2001; Alford & Richards 1999). For ‘explosive’ breeding amphibians, it has been

estimated that 10–15 years of data is required in order to detect trends in some populations (Marsh 2000). However, there are many species for which trend data can be acquired in far shorter periods. As many aquatic breeding amphibians are prone to boom and bust variations, this must also be taken into account when estimating population size. Often, population data from a single year are not appropriate and the estimation of population size and this information should rather form part of a structured monitoring strategy (see Chapter 5).

As amphibians have highly structured populations (individuals differ substantially in age, size, developmental stage and other attributes that affect their relative contributions to population growth), population estimates are preferentially made of breeding adults, or more specifically breeding females. In some cases (such as ghost frogs, genus *Heleophryne*), however desirable, this type of population estimate may not be possible as females do not spend a lot of time at the breeding sites and are generally difficult to detect so other forms of population assessment need to be made.

There are many appropriate methods to accumulate data on population sizes. Most make use of CMR models which are based on making permanent marks on a proportion of the population (either larvae or adults), allowing them to mix freely with unmarked animals, and making repeated ‘recapture’ events to estimate total population size. It should be emphasised that the more animals that are marked (and hence recaptured) and the more frequent the capture events, the better the estimates become.

The primary limitation to the estimation of population size by the various CMR methods is marking a sufficiently large sample of individuals. This is particularly difficult with those species that are sparsely scattered through the environment and do not gather at specific sites for the purposes of breeding. For some of the species (see Table 1) there are very few recent observations of any kind and capture for the purposes of marking may not be feasible or desirable as it could be a potentially threatening activity itself.

An alternative means of estimating population size that has wide application among vocalising anurans is the use of auditory surveys of calling frogs. Although these methods do not deliver actual counts as they normally yield categorical estimates, they are useful in that they also give an indication of the number of individuals engaged in breeding activity. Unfortunately, it is almost exclusively male frogs that call and so these numbers do not give a direct estimation of the numbers of breeding

females. This method becomes the only practical method for estimating numbers of anurans that are not easily captured or are difficult or impossible to observe. Many South African frogs, particularly those from the fynbos biome, fall into this category. Developing a method which combined CMR and acoustic surveys would be a major achievement in the conservation of these cryptic species.

## Identification of 'direct threats'

Direct threats are defined as '*The proximate human activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets*' (Salafsky *et al.* 2008).

Concentrating on direct threats (*sensu* Salafsky *et al.* 2008) focuses researchers into identifying those actions which, if reversed, are most likely to conserve threatened species. Direct threats are different from other stresses and contributing factors (indirect threats) which may predispose or make certain species more vulnerable.

Aside from the obvious and most pervasive direct threat, habitat loss (see Chapter 1), there are many other more cryptic threats to amphibian populations which need research in order to qualify whether threats are direct, and quantify the relative importance of the threat and which life-history stage they impact upon. Obvious threats, such as cars hitting frogs on roads, may be relatively less important than hidden threats such as alien fish eliminating all reproductive output in breeding sites. However, reduced population size (stressor), non-lethal disease (stressor), or occurring outside of a conservation area (contributing factors) are not themselves direct threats.

We suggest that identification of threats should be ongoing throughout any research into threatened amphibians. Determination and differentiation between direct threats, stressors and contributing factors should be based, wherever feasible, upon quantitative research.

Quantification of threats is vital and should go together with estimating population sizes. Threats have been categorised by Semlitch (2003) into:

1. Habitat destruction and alteration
2. Global climate change
3. Chemical contamination
4. Disease and pathogens
5. Invasive species
6. Commercial exploitation

It is worth noting that some of the categories are not considered direct threats (e.g. climate change, non-lethal disease, non-toxic pollution, benign invasive species *cf.* Salafsky *et al.* 2008). However each may be important as a stressor or contributing factor, and therefore worthy of research and (especially) monitoring (see Chapter 5).

## Biodiversity Management Plans for Species (BMP-S)

A Biodiversity Management Plans for Species (BMP-S) is a new tool for biodiversity conservation provided for by the National Environmental Management Biodiversity Act (NEMBA) to ensure long-term survival of threatened species. The plan is expected to be especially useful when multiple stakeholders are required to work together in a strategic conservation action. The BMP-S should document this strategy with all such persons, organisations or organs of state together, copies of agreements and how these actions will ultimately reduce the threatened status of each species.

For South African threatened amphibians, species which involve multiple stakeholders and require a co-ordinated, strategic approach to conservation are judged as requiring a BMP-S. Priorities are set for those species where work on the BMP-S can begin within the next five years. In the case that other agreements, such as memoranda of understanding, are considered sufficient to meet the objective of reduction of threat status, only these are listed.

## Summary of findings

Of all the categories considered, the need to assess direct threats for the majority of species was considered highest. Details of perceived threats are given in a separate table (Table 2). Basic biology, population size and Biodiversity Management Plans had near equal weighting with identifying management units relatively low as many species appear to have this information already available.

Clear priorities can be seen for several taxa including *Capensibufo rosei* (VU), which may be made up of several cryptic species (see Chapter 3) of which one of these is extremely range-restricted so urgency is required in identification of management units and high priorities for determining the as yet unknown basic biology and population size. *Breviceps sylvestris* (EN) has very little information relating to its AOO and this is reflected in the need to establish management units. Some CR species ranked relatively low in the prioritisation as they have already been the subject of conservation studies (e.g. *Anhydrophryne ngongoniensis*, *Arthro-leptella rugosa*).



Table 1. Research for conservation of threatened South African amphibian species: five year strategic plan. See text for details.

Priority rank	Species name	Urgency	Survey needed	Practical implications	Monitoring priority	Monitoring prioritised	Current status	Taxonomy priority rank	Conservation priority rank
1	<i>Vandijkophrynus amatolicus</i>	3	3	3	9	Distribution surveys, Pres/Abs of known sites.	Ongoing: MJC, WC (UFS, PEM).	8	3
1	<i>Heleophryne hewitti</i>	3	3	3	9	Pres/Abs, population counts of tadpoles.	Ongoing: WC (PEM).	7	8
1	<i>Afrixalus knysnae</i>	3	3	3	9	Tadpole Pres/Abs.	LM and WC.	3	2
1	<i>Capensibufo rosei</i>	3	3	3	9	Pres/Abs, population counts of adults, batch marking.	Ongoing (GJM, KAT: SANBI).	3	2
2	<i>Arthroleptella rugosa</i>	3	2	3	8	AOO, call-based, population.	Ongoing (Adv, AAT: CapeNature).	10	7
2	<i>Arthroleptella subvoce</i>	3	2	3	8	Pres/Abs (calls-based), population counts.	Ongoing (Adv, AAT: CapeNature).		10
3	<i>Hyperolius pickersgilli</i>	3	3	1	7	EOO, Pres/Abs (call-based), habitat quality.	To be initiated (Ezemvelo KZN Wildlife, eThekweni Municipality, PAAZAB).	6	1
3	<i>Microbatrachella capensis</i>	3	1	3	7	AOO (call-based), threats, population.	Ongoing (Adv: CapeNature).	3	8
3	<i>Heleophryne rosei</i>	3	1	3	7	Analyse current data, regular population estimates, threats.	Ongoing (Adv: CapeNature).	10	8
3	<i>Anhydrophryne ngongoniensis</i>	2	2	3	7	Pres/Abs and population monitoring at Ngele forestry site if possible. Weather and habitat monitoring.	Proposed (Ezemvelo KZN Wildlife, JH).	7	9

Pres/Abs = Presence/Absence

CMR = Capture-Mark-Recapture

3	<i>Natalobatrachus bonebergi</i>	2	2	3	7	Clutch counts, Pres/Abs.	Proposed (eThekweni Municipality).	10	4
3	<i>Breviceps bagginsi</i>	2	3	2	7	Pres/Abs (calls-based).	Proposed (Ezemvelo KZN Wildlife, LM, JH).	4	5
4	<i>Leptopelis xenodactylus</i>	2	3	1	6	Distribution surveys only, test local Pres/Abs monitoring.	Proposed (JH).	5	5
4	<i>Amietophrynus pantherinus</i>	2	1	3	6	CMR at breeding times.	Ongoing: (SANBI, WLICC).	5	7
4	<i>Amietia vertebralis</i>	2	1	3	6	Occupancy, tadpole counts, disease surveys.	Ongoing (NWU: LdP).	NA	NA
4	<i>Xenopus gilli</i>	2	1	3	6	Trapping – CMR and removal of <i>X. laevis</i> .	Proposed (SANBI, SANParks).	2	8

## People

MJC—Michael Cunningham  
 WC—Werner Conradie  
 JH—James Harvey  
 GJM—G. John Measey  
 LM—Les Minter  
 LdP—Louis du Preez  
 KAT—Krystal A. Tolley  
 AAT—Andrew A. Turner  
 AdV—Atherton de Villiers

## Institutions

UFS—University of the Free State  
 PEM—Port Elizabeth Museum  
 SANBI—South African National Biodiversity Institute  
 CapeNature  
 Ezemvelo KZN Wildlife  
 eThekweni Municipality  
 PAAZAB—African Association of Zoos and Aquaria  
 WLICC—Western Leopard Toad Conservation Committee  
 NWU—North-West University  
 SANParks—South African National Parks

## Other

CMR—Capture Mark Recapture  
 Pres/Abs—Present/Absent

Table 2. Details of perceived threats are given according to the classification by Semelitch (2003).

Species name	Tadpoles	Capture of adults	Calls of adults	Adult movements to and from breeding sites
<i>Leptopelis xenodactylus</i>	N/A		Quantification of calls across several sites is needed for these frogs which spend a lot of time underground.	
<i>Breviceps macrops</i>	N/A	CMR of adults probably the best way of monitoring populations of this species.	Pres/Abs based on calls across several sites probably the best way of monitoring this species. Transect, point or total counts of calling males may provide an index of population size.	
<i>Breviceps sylvestris</i>	N/A	CMR of adults probably the best way of monitoring populations of this species.	It may also be possible to obtain estimates of male population size from calls as this species does often form choruses.	
<i>Amietophrynus pantherinus</i>	N/A			This species undergoes spectacular migrations which lend themselves to monitoring numbers over these periods. CMR can be used through photographic identities.
<i>Capensibufo rosei</i>	N/A	This species does not call and is extremely cryptic when not breeding. Counting adults at the breeding sites may be the only way of monitoring populations.		
<i>Vandijkophrynus amatolicus</i>	N/A			This species is a poor caller but the difficulty in locating this species when not calling probably precludes all other methods.
<i>Heleophryne hewitti</i>	CMR of tadpoles might be the only way of realistically monitoring a population. Baseline data is already available for this species and monitoring is ongoing at several streams.			
<i>Heleophryne rosei</i>	CMR of tadpoles might be the only way of realistically monitoring a population. No baseline data is available, but this is desirable in order to go beyond current simple Pres/Abs data.			

<i>Arixalus knysnae</i>	N/A	Information on where and when this species calls is required before aural surveys can be conducted.
<i>Arixalus spinifrons</i>	N/A	Counts of calling males are a suitable method to estimate population size.
<i>Hyperolius horstockii</i>	N/A	Counts of calling males are a suitable method to estimate population size.
<i>Hyperolius pickersgilli</i>	N/A	Best monitored through assessment of calls.  Could use CMR of adults.
<i>Xenopus gilli</i>	N/A	As this species occurs in acid blackwater pools, the only way of monitoring or assessing trends is to capture adults. Seine nets and funnel traps are effective. Should we seine net ponds, mark all individuals and then set up monitoring? Try this at one or two ponds after the platanna trap method to obtain estimate of trap sampling effectivity or just monitor by mark-recapture. This species is an ideal for long-term CMR models. Adults may be 'marked' by images of individual ventral and dorsal patterns.
<i>Anhydrophryne rattrayi</i>	N/A	Counts of calling males are a suitable method to estimate population size.
<i>Arthroleptella ngongoniensis</i>	N/A	Probably best monitored through assessment of calls.
<i>Microbatrachella capensis</i>	N/A	Best monitored through assessment of calls.
<i>Natalobatrachus bonebergi</i>	N/A	Can either be monitored by numbers of calling males along stream transect or by counting adult and nest mass presence.
<i>Strongylopus springbokensis</i>	N/A	A difficult frog to monitor due to the short breeding period and scattered nature of the populations. However, numbers of calling males is the only practical method.



## Recommendations and solutions

### 1. Prioritisation of conservation research on threatened amphibians

Conservation research is prioritised for *Capensibufo rosei*, *Hyperolius pickersgilli*, *Afrivalus knysnae*, *Vandijkophrynus amatolicus* and *Natalobatrachus bonebergi*. Moreover research is required on each threatened taxon and our process has revealed the interesting finding that our conservation research is most deficient in the need to assess

and distinguish between threats, their magnitude and our ability to reverse or mitigate against them.

### 2. Research on aspects of basic biology

Basic biology of many of our threatened amphibians remains unknown and requires investment in terms of research time and capital. Population demographics are unknown for the majority of species, and these are a prerequisite of monitoring (see Chapter 5). Determining the limits of dispersal of many species will have direct implications on

### Box 1: Preventing the introduction and spread of amphibian disease in South Africa

The past twenty years has taught us that amphibians are the most threatened group of vertebrates and disease has emerged as one of the most important stressors that can escalate with other direct threats to extinction of threatened amphibian species. With an ever increasing influence of direct threats on amphibians in South Africa, we must remain vigilant, not only for existing amphibian diseases (such as the amphibian chytrid *Batrachochytrium dendrobatidis*), but also actively prevent the introduction or spread of any other potentially damaging disease. This requires epidemiological evidence to determine whether the disease has been recently introduced, is still spreading, or is an established disease causing a renewed epidemic due to factors such as increased virulence or environmental changes. Scale of inference is also very important when dealing with disease spread and the control thereof, because it will determine the geographical areas affected including geographical boundaries. The level of prevention of disease spread can be expressed in a geo-political sense.

Only two amphibian diseases are currently listed as notifiable to the World Animal Health Organization (OIE), thus requiring regulation of the amphibian trade aimed at the prevention of disease spread. These diseases are ranavirus and amphibian chytridiomycosis. Details on specific quarantine and disease testing conditions can be found at the OIE website ([www.oie.int](http://www.oie.int)). These protocols are rigorous enough to be followed for amphibian diseases in general and should be adhered to before veterinary health certificates are issued.

Within South Africa the responsibility for disease prevention resides with Veterinary Services (Department of Agriculture). The Veterinary Health Act (2002) makes provision for the control of all animal diseases, domestic and wildlife, including the regulation of the importation and exportation of animals. A shortcoming at this level is the lack of basic training in the diagnosis and treatment of key threatening amphibian diseases. Diagnostic testing and quarantine must be performed by a competent authority at a nationally appointed biosecure facility. Various internet sites exist that contain relevant and up to date information on the subject (e.g. [www.amphibianark.org](http://www.amphibianark.org)). Part of the national disease prevention strategy is the development of a surveillance system that will allow the rapid detection of outbreaks and response to outbreaks. Protocols for surveillance and response have not been determined for South Africa.

The last level of disease prevention takes place on a community level and may involve industry, researchers and the public. The method of prevention is community-based education and involvement. Industry-specific material should be disseminated to those industries that may be involved in the translocation of amphibians, such as tourism, fresh produce, horticulture and animal trade. Without consistent and stringent adherence to disease hygiene protocols, the transmission of disease in amphibian populations is highly likely through researchers' activities. Amphibian researchers appear to be aware of the risks and prevention protocols of amphibian diseases in the field and in the laboratory. However, other researchers involved with aquatic studies (fish biologists, entomologists, botanists, hydrologists, limnologists) have not been educated about amphibian diseases. All forms of communication/media should be utilised to spearhead education to the general public as opportunities prevail.

the fragmented nature of their distribution and their ability to use altered habitats for movement between breeding sites.

### 3. Prevention of the spread of disease

Different stakeholders with a mandate to protect animals from disease need to work together in order to prevent introduction, spread and transmission of existing and new amphibian diseases. Researchers bear an important responsibility in not being the disseminators of potentially harmful diseases.

### 4. Emergency Amphibian Conservation Task Team (EAC-TT) to respond to crises for threatened amphibians

In the case that declines are detected, there may be an immediate need for action starting with an

EAC-TT made up of relevant amphibian specialists (drawn from the workshop) and important stakeholders. The Task Team must be enabled financially and given appropriate powers to resort to *ex situ* conservation with partners in the African Association of Zoos and Aquariums (PAAZAB). In return, PAAZAB partners need to establish husbandry skills to take on amphibians in emergency cases.

## Further reading

BRANCH, W.R. 1988. South African Red Data Book—Reptiles and Amphibians. *S.A.N.C.P. Report* No. 151.

MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. & KNOEPFER, D. 2004. *Atlas and red data book of the frogs of*

### Box 2: A Task Team to respond to crises for threatened amphibians

Despite our best efforts in conservation planning, there are sometimes circumstances and situations which arise beyond our control which may escalate the threat of extinction to an already threatened amphibian species. Making a link between monitoring, conservation and threatened status is crucial, but this also means that we need to be prepared to respond to situations that monitoring or conservation research suggests are an emergency. There is no fix-all response to any crises that may emerge. Each must be handled on a case by case basis.

In order to tackle potential emergency situations which may arise, we propose an Emergency Amphibian Conservation Task Team (EAC-TT) made up of appropriate members drawn from this workshop (see Appendix 2) and other appropriate persons co-opted by the EAC-TT. Establishment of such emergency groups is recognised as international best-practice.

Any such task team will require funds in order to meet and carry out EAC-TT emergency measures. Such funding needs to be sourced so that it is available at short notice in order to make a meaningful response to a disaster scenario.

In such situations, the EAC-TT may need to consider the option of *ex situ* conservation. Article 9 of the Convention on Biological Diversity (1992) of which South Africa is a signatory, mandates the pro-active adoption of measures for the *ex situ* conservation of biological components, and recommends the establishment of facilities for *ex situ* conservation. The IUCN further endorses the potential need for *ex situ* measures for threatened taxa. To this end the African Association of Zoos and Aquaria (PAAZAB) conducted a species prioritisation workshop in 2008 to identify those species of southern African amphibian to which *ex situ* options are best applied (see [www.amphibianark.org](http://www.amphibianark.org) for workshop results). PAAZAB, through its member zoos, has capacity in amphibian propagation for conservation purposes. Tools for the demographic and genetic management of *ex situ* populations for conservation are well developed and specific guidelines for amphibian management to these ends are available on the Amphibian Ark website mentioned above. Tenhumberg *et al.* (2004) discuss optimal models for combined *in situ/ex situ* populations to ensure persistence in the wild.

PAAZAB is in the process of dialogue with Provincial conservation authorities for the establishment of *ex situ* populations of certain threatened South African amphibians in order to refine the know-how of propagation techniques specific to South African taxa. Without prior knowledge of appropriate propagation techniques, we cannot ensure the success of any EAC-TT emergency *ex situ* measures.

*South Africa, Lesotho and Swaziland*. Smithsonian Institution Press, Washington DC.

IUCN 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.

MARSH, D.M. 2001. Fluctuations in amphibian populations: a meta-analysis. *Biological Conservation* 101: 327–335.

SEMLITSCH, R.D. 2003. *Amphibian conservation*. Smithsonian Books, Washington.

SALAFSKY, N., SALZER, D., STATTERSFIELD, A.J., HILTON-TAYLOR, C., NEUGARTEN, R., BUTCHART, S.H., COLLEN, B., COX, N., MASTER, L.L., O'CONNOR, S. & WILKIE, D. 2008. A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. *Conservation Biology* 22: 897–911.

TENHUMBERG, B., TYRE, A.J., SHEA, K. & POSSINGHAM, H.P. 2004. Linking wild and captive populations to maximize species persistence: optimal translocation strategies. *Conservation Biology* 18: 1304–1314.



## 5

## Assessing status and trends

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## Aims

1. To determine which threatened South African amphibian species need to be monitored, for what purposes and how this should best be done.
2. To recommend which species assemblages should be monitored to assess the effects of climate change, and how and where this should be done.

## Rationale

Regular monitoring of amphibian populations is the best way of determining population trends within species. This may be the only way of assessing conservation actions for many amphibians. Some amphibians undergo large natural fluctuations in their population numbers and so long-term data-sets are required in order to determine the direction of trends over time. Monitoring data can be used to assess the effects of conservation and other land management practices. Where possible, all monitoring techniques should be quantitative (i.e. estimating abundance with confidence intervals so that comparisons can be made). Monitoring sites and methods need to be chosen with care so that they can be realistically continued over long periods with consistent methods.

Climate change is known to have had strong effects on amphibian distributions in the past, and rapid future changes in climate can therefore be expected to affect both distributions and densities of South African frogs. Monitoring can play a vital role in determining whether effects of climate change are reflected in amphibian populations. Models can be used to decide where best to target species or communities of frogs for monitoring of climate change. Monitoring should be enacted across a range of habitats and altitudes to account for local spatial environmental effects. Monitoring entire amphibian communities rather than only threatened species will also enable estimates of the generality of these effects.

## Individual species monitoring

During the workshop, each threatened species was assessed according to its Red List status, relative perceived urgency for monitoring within the time frame of the next five years, whether initial surveys are needed and the practical implication of monitoring (see Table 1). Each of these scores was added to produce a priority listing for monitoring of threatened South African amphibian species. The type of monitoring activity was then stipulated as well as the presence of existing capacity to carry out monitoring.

The results of this exercise indicated top priority for *Vandijkophrynus amatolicus* which requires extensive monitoring for presence/absence at known and potential sites. This species has not been located for more than 11 years, and requires regular monitoring of known breeding sites for any sign of activity of adults, juveniles and larvae. *Arthroleptella rugosa*, *Heleophryne hewitti* and *Afrixalus knysnae* were each judged to have high priority for monitoring with differing methods and objectives. The need to monitor threatened amphibian species from grassland was highlighted, due to extensive habitat change undertaken in that area and the highly threatened status of this biome.

It is noteworthy that none of the threatened species investigated could be monitored together, as they are either spatially separated or require different monitoring techniques. However, monitoring of many threatened species could be part of community assemblage monitoring programs.

## Amphibian community assemblage monitoring

When considering an amphibian community assemblage monitoring site, there are many issues worth considering and building into the monitoring design. There is a growing global literature on this subject and we encourage those interested in setting up such monitoring sites to read as much of it as possible before they choose a site and com-



**Table 1. Each threatened species to be assessed according to its Red List status, relative perceived urgency for monitoring within the time frame of the next five years, whether initial surveys are needed and the practical implication of monitoring.**

Rank	Species name	ID management units	Basic biology and ecology	Estimating population size	Threats	BMP-S	Comments	Conservation priority total	Monitoring priority rank	Taxonomy priority rank
1	<i>Hyperolius pickersgilli</i>	4	4	4	5	4	Highest priority for identifying threats, but identification of management units, basic biology, population size and stakeholder agreements are also high priorities.	21	3	6
2	<i>Capensibufo rosei</i>	5	4	4	3	3	Highest priority for identifying management units, basic biology and population size are also priorities.	19	1	3
2	<i>Afrivalus knysnae</i>	4	5	4	4	2	Some subpopulations require locating as priority before determining phenology, estimating population size and evaluating perceived threats.	19	1	3
3	<i>Vandijkophrynus amatolicus</i>	4	5	3	4	2	Assessing whether this species is already extinct is the highest priority. If a population can be located, other priorities on management units and identification of threats follow.	18	1	8
4	<i>Natalobatrachus bonebergi</i>	3	3	4	3	4	Priority is given to assessment of population size and initiation of stakeholder agreements.	17	3	10
5	<i>Leptopelis xenodactylus</i>	3	4	2	4	3	Determination of dispersal and distribution receives high priority together with categorising threats.	16	4	5
5	<i>Breviceps bagginsi</i>	3	4	2	4	3	Investigations of habitat preference and distribution are prioritised together with quantifying threats for this species.	16	3	4
5	<i>Breviceps sylvestris</i>	4	3	2	3	4	Priority on identification of management units and building interim agreements with stakeholders.	16	N/A	4
6	<i>Heleophryne rosei</i>	1	3	4	4	3	Estimating population size and determining the nature of perceived threats rank highest for this species.	15	3	10
7	<i>Amietophrynus pantherinus</i>	1	1	4	4	4	Completion of BMP-S is a priority together with quantifying perceived threats and estimating population size.	14	4	5
7	<i>Arthroleptella rugosa</i>	1	2	3	4	4	Priority is given to assessment of perceived threats and initiation of stakeholder agreements.	14	2	10
8	<i>Hemius guttatus</i>	2	4	2	3	2	Determining dispersal capabilities are prioritised for this species.	13	N/A	6
8	<i>Heleophryne hewitti</i>	1	2	3	4	3	An assessment of perceived threats has highest priority.	13	1	7
8	<i>Afrivalus spinifrons</i>	3	3	2	3	2	No high priority actions were assigned.	13	N/A	4
8	<i>Xenopus gilli</i>	2	3	3	2	3	No high priority actions were assigned.	13	4	2
8	<i>Microbatrachella capensis</i>	2	3	3	2	3	No high priority actions were assigned.	13	3	3
9	<i>Anhydrophryne ngongoniensis</i>	1	3	1	3	4	Priority is given to initiation of stakeholder agreements.	12	3	7
10	<i>Breviceps macrops</i>	2	2	2	4	1	Priority on quantifying threats to this species.	11	N/A	5
10	<i>Arthroleptella subvoce</i>	1	2	3	3	2	No high priority actions were assigned.	11	2	10
10	<i>Cacosternum capense</i>	1	3	3	2	2	No high priority actions were assigned.	11	N/A	8
	<b>Totals</b>	<b>48</b>	<b>63</b>	<b>58</b>	<b>68</b>	<b>58</b>				

mence the monitoring protocol. Here some of the most important considerations are briefly listed:

- Importance of using diverse sampling techniques, temporal and seasonal sampling.
- Reduction of sampling error by consistency of recorders—worth training multiple recorders who go out in (at least) pairs to keep consistency. For long-term monitoring it is important to plan for replacement of personnel as they move jobs or retire.
- Importance of flexibility in sampling as diverse range of life-history stages as possible and identification and measurements thereof.
- Detectability may vary with weather, moon brightness, precipitation and prey availability. Locating monitoring sites near national weather stations is strongly encouraged wherever possible or installing a weather monitoring station alongside the monitoring site.
- Accessibility is of key importance as sites must be visited during inclement weather when vehicular access is likely to be at its poorest.
- Communication of monitoring results to the wider research community and the general public.

### Going back to study sites with good community assemblage data

Increasingly, studies are going back to areas which were well-studied in the past with historical records of species assemblage and relative abundance (e.g. Dodd *et al.* 2007). Such studies can be very informative with respect to long-term changes and emphasise the importance of publication of survey data for long-term comparisons. While these data may not be able to derive the same quality of data for population trends, data on changes in community assemblages are still of great importance.

### Designing monitoring studies for future analyses of trends

Monitoring is in itself not an end product. Monitoring of amphibians needs to produce data which can then be analysed meaningfully in terms of trends over time. For most species, units of time will be in years, requiring significant investment in human capital and resources. Therefore, monitoring programmes need to be initially designed to produce data which can be used in analyses.

Estimating the size of the population of breeding adults is the first step in producing a population vi-

ability analysis (PVA). The PVA is a process which determines the probability that a species will go extinct in a given period of time. As a quantitative analysis it can be used under Criterion E for Red Listing (IUCN 2001). Most PVAs are based on demographic models of populations over a number of years (annual Capture-Mark-Recapture [CMR] studies), but they draw on a great deal of data types and can reveal far more about populations than growth trends. There are many books that review this topic and calculations and data required, and we urge those interested to consult these together with the current literature (e.g. Morris & Doak 2002). The technique extrapolates from trends in this data to predict increases, stability or decline to extinction. The more unstable the populations (like pond-breeding amphibians), the longer the period of data required (see Chapter 4). An alternative to demographic data is to use direct head counts, for example the total number of adults breeding at a site every year. This data can also be used to calculate long-term trends, but will clearly be of less value than a full demographic (CMR) study.

Occupancy modelling uses presence/absence data from a large number of small sites which are used over time to predict viability of a collective population. Even in complex metapopulations, the rate of site recruitment must be greater than the rate at which they disappear, and so viability can be calculated. Once again, this data is second in quality to full demographic (CMR) data, but can be more easily obtained, especially from volunteer groups.

Careful designs are needed for studies for which data is expected to reveal long-term trends. Data from volunteers (so-called 'citizen scientists') can be valuable if the ultimate goal is planned and the analysis known. In the time frame of this policy document (the next five years) it is doubtful that a PVA will be achieved for any threatened amphibian in South Africa. However, it should be possible to determine what type of study and long-term data set can be realistically accrued in order to make PVAs a possibility for future use. Moreover, a pilot citizen science scheme should be drawn up with the aim of building occupancy models within the next five years. The South African Environmental Observatory Network (SAEON) is interested in aiding with logistics given that there are champions who can pilot such a scheme on a regional basis.

### Potential to add research onto monitoring

A large part of any study on population genetics is the cost of field work to produce tissue samples. Temporal studies, which deal with genetic varia-

Table 2. Methods of monitoring South African threatened frogs.

Species name	Habitat destruction and alteration	Global climate change	Chemical contamination	Disease and pathogens	Invasive species	Prioritisation score
<i>Hyperolius pickersgilli</i>	Habitat loss, fragmentation from agriculture, urbanisation and afforestation. Changes in hydrology from urbanisation, industrialisation, pollution (pesticide run-off from agriculture).		Possibly herbicides.	Known to be positive for chytrid.		5
<i>Capensibufo rosei</i>	Change in Park use.	Change in rainfall and temperature regimes.			Alien invasive vegetation.	3
<i>Afrivalus knysnae</i>	Encroachment by urban development on habitat.	Rainfall regimes changes.			Alien invasive vegetation.	4
<i>Vandijkophrynus amatolicus</i>	Grazing, afforestation, inappropriate fire regimes.		Possibly herbicides.		Alien invasive vegetation.	4
<i>Natalobatrachus bonebergi</i>	Severe habitat loss and degradation especially to sugar cane plantations, deforestation, siltation, pollution (mine waste).				Alien invasive vegetation.	3
<i>Leptopelis xenodactylus</i>	Habitat loss due to agriculture and forestry, cattle in vleis trampling and eutrophication, overgrazing, inappropriate fire regimes, urban development, fire regime in matrix, dam construction.		Possibly herbicides.		Alien invasive vegetation.	4
<i>Breviceps bagginsi</i>	Afforestation, road maintenance, inappropriate fire regimes, overgrazing.		Possibly herbicides.			4
<i>Breviceps sylvestris</i>	Forestry, clearing of indigenous forest, management of ecotones.				Alien invasive vegetation (especially black wattle).	3
<i>Heleophryne rosei</i>	Visitor pressure by hikers in the Park.			Known to be positive for chytrid.	Alien invasive vegetation.	4
<i>Amietophrynus pantherinus</i>	Urbanisation, swimming pools, urban design, vehicles.			Known to be positive for chytrid.	Alien plants, alien fish.	4
<i>Arthroleptella rugosa</i>	Fire regimes.				Alien invasive vegetation.	4
<i>Hemisus guttatus</i>	Agriculture, afforestation, urban development, temporary wetland infilling.		Possibly herbicides.			3
<i>Heleophryne hewitti</i>	Forestry, habitat destruction, fires and floods, degradation/soil erosion, reducing stream flow, road building, siltation.			Known to be positive for chytrid.	Alien invasive vegetation.	4

<i>Afrivalus spinifrons</i>	Agriculture, draining of wetlands, afforestation, urban development encroaching into wetlands.	Possibly herbicides.	3
<i>Xenopus gilli</i>	Water quality, habitat transformation.	Alien invasive vegetation and hybridisation with <i>Xenopus laevis</i> .	3
<i>Microbatrachella capensis</i>	Habitat transformation, water quality.	Known to be positive for chytrid.	2
<i>Anhydrophrayne ngongoniensis</i>	Inappropriate fire regimes, overgrazing, encroachment/planting of plantations.	Change in rainfall and temperature regimes.	3
<i>Breviceps macrops</i>	Property development (holiday homes), diamond mining, quad biking.		4
<i>Arthroleptella subvoce</i>	Fire regimes.		3
<i>Cacosternum capense</i>	Habitat loss due to agriculture and urban development.		2

tion and composition over several years or decades are not possible in the current short-term scientific funding procedure. Monitoring programmes are therefore strongly encouraged to take tissue samples of amphibian communities for future research. These samples can be deposited in current tissue banking facilities for future use (see Chapter 3).

Monitoring for the chytrid fungus has produced initiatives for monitoring of several of South Africa's amphibian species, but the opportunity also exists for monitoring disease during other monitoring events. A number of different methods can be used to collect samples for processing for presence/absence and prevalence of disease including swabs, larval collections and opportunistic collection of mortalities for forensic investigation (see below).

Many observations made during monitoring events considerably add to the natural history information base of South African frogs for which records of most species are very slim. These observations, together with any trends in data, range extensions, etc. should be published as natural history notes. The Herpetological Association of Africa (HAA; visit [www.africanherpetology.org](http://www.africanherpetology.org)) has a dedicated publication for such notes (*African Herp News*).

Samples for studies can often be collected opportunistically without affecting the population under study. For example, road kill can be collected, frozen or preserved, and then used for studies of parasitology, disease, tissue (for DNA analyses), bones for ageing (skeletochronology) or simply accessioned into museum collections for future use and reference. Similarly, opportunities to make collections of tadpoles in drying puddles and other miscellaneous mortality events should not be passed up. Those conducting monitoring should therefore be equipped to make appropriate collections whenever such opportunities arise.

Collaborating with researchers is strongly encouraged for any amphibian monitoring program and it is therefore also encouraged to present monitoring data at national meetings with zoological or particularly herpetological themes. The HAA holds biannual meetings where such presentations are welcomed.

## Recommendations and solutions

### 1. Individual threatened species monitoring

The results of our workshop suggest that regular monitoring should be set up for at least four of South Africa's threatened amphibian species:



### Box 1: The amphibian monitoring site at Hans Merensky Nature Reserve, Limpopo Province

Frog activity associated with a temporary impoundment in mopane woodland at Hans Merensky Nature Reserve, Limpopo Province, South Africa, was monitored continuously from September 2000 to 2005. Data were collected every night, two hours after sunset, by means of an aural survey and strip transect while weather variables, were measured at 30 minute intervals by means of a computerised, Davis Weather Station. Eighteen frog species have used this site for breeding during the study period and the study is currently being written up by its co-ordinator, Les Minter.

This study exemplifies a good choice of sites recording the phenology of many amphibian species including the collection of weather data. The cessation of this monitoring site also highlights the issue of failing capacity to maintain monitoring sites. The data collected from the Hans Merensky site will however produce a solid baseline study on which to build future comparisons including the resumption of long-term community amphibian assemblage monitoring.

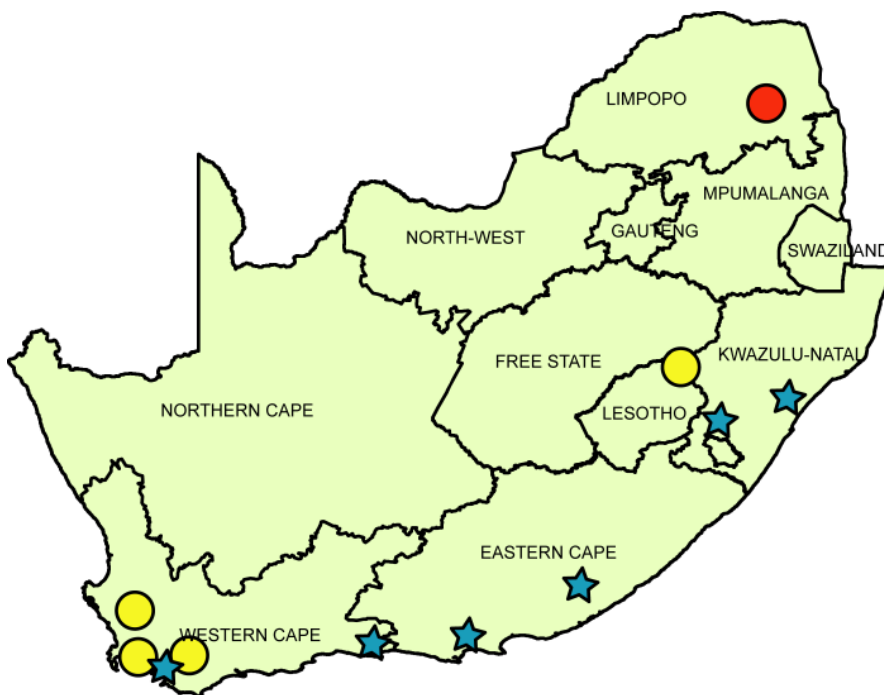


Figure 1. Map of South Africa with location of amphibian monitoring sites. Current monitoring sites (yellow circles), old monitoring site (red circle), and prioritised threatened species monitoring sites (blue stars).

*Vandijkophrynus amatolicus*, *Arthroleptella rugosa*, *Heleophryne hewitti* and *Afrivalus knysnae* (see Figure 1 for locations). The methods for these monitoring activities are identified, but we recognise that funding is not currently available for any of these activities and capacity will rely on already overstretched staff at higher education facilities, museums and provincial nature conservation organisations. Special attention is warranted to monitor threatened amphibian species from the highly threatened grassland biome (e.g. *Leptopelis xenodactylus* and *Breviceps bagginsi*; Figure 1).

We strongly encourage the continuation of existing monitoring initiatives (e.g. Table Mountain Ghost Frog, Micro Frog, Western Leopard Toad) and advise those involved to quantify all data collected for long-term population viability analysis. Population viability analysis is an important aspect of Red Listing species and any current or future monitoring studies must ensure that any data collected can be meaningfully analysed using this technique for inclusion in future Red List assessments.

#### 2. Amphibian community monitoring

Ongoing community monitoring is taking place at three localities in the Western Cape, one in the

Free State and data exists for one site in Limpopo. We recommend those wishing to start long-term amphibian monitoring to research the subject widely and consider many aspects of sampling, data analysis and logistics before they decide on a site. Many potential sites exist and we recommend inclusion with individual threatened species monitoring (above), or including amphibians in a wider monitoring program. Sites for which historical community assemblage data exist (see Figure 1) should be prioritised for new surveys or as monitoring sites.

#### 3. Encourage research and reporting

Whenever possible, monitoring should complement research into South African amphibians and results

## Box 2: Choice of long-term monitoring sites in the Western Cape

The only current long-term monitoring sites of amphibians in South Africa are in the Western Cape and are carried out under the auspices of CapeNature.

The CapeNature long-term frog monitoring project uses amphibian presence and abundance to monitor amphibian responses to long-term climate change and other factors in the Western Cape Province. Climate change has been implicated in amphibian species declines and as weather is known to be an important driver of amphibian behaviour it was considered important to measure climatic variables so that they could be examined for causal effects when analysing species presence and abundances. There are automatic weather stations at the Landdrooskop and Swartboskloof sites which record temperature, relative humidity, atmospheric pressure, solar radiation, UV-B radiation, wind speed, wind direction and rainfall.

Data has been collected continuously at two sites (Landdrooskop and Swartboskloof in the Hottentots-Holland Mountains) since the austral winter of 2002 and from a third site (Veepos in the Groot Winterhoek Mountains) since 2008. The Landdrooskop and Veepos sites are at high altitude (~1 000 m) and the Swartboskloof site at mid-altitude (~400 m asl). The sites were chosen to cover a range of altitudes in protected environments and are situated in areas that accommodate a broad set of the local frog species. The Swartboskloof site was also chosen on the basis of an apparent decline of *Poyntonia paludicola* at this site. The Veepos site was chosen in particular for the presence of *Arthroleptella subvoce*. This is the most northerly known population of *Arthroleptella* which is a genus that depend on the presence of permanently wet habitats. The general trend of increasing aridity with decreasing latitude means that this population should be the closest to the limits of suitably wet habitat and can be expected to be the first area to show the effects of local climate warming and/or drying.

The sampling schedule for the Landdrooskop and Swartboskloof sites consists of four site visits in winter (June–September) and two visits in summer (December and February) to the Swartboskloof and Landdrooskop sites. The Veepos site is visited twice a year in July and September (mid- and late-winter) as the monitoring is focussed on one species that is known to breed over these monitoring periods.

A visit consists of a 30 minute daytime period of listening for the advertisement calls of male frogs followed by a walk through the site to obtain visual records. The presence of each species is noted and an estimate of abundance is made. There are five abundance categories: <10, 10–20, 21–50, 51–100, >100. An estimate of calling density is also made in three simple classes: not calling, calls discrete in time, and calls overlapping in time. Evidence of breeding behaviour such as calling, egg laying, eggs and tadpoles are also recorded.

CapeNature will monitor these sites as long as budget and human capacity exist to continue this research.

of monitoring disseminated to the scientific community and the general public. Failure to analyse trends on a regular basis could result in long-term declines going unnoticed by those carrying out monitoring. We recommend that all monitoring data is analysed and assessed prior to the Red Listing update every five years.

### Hurdles and obstacles

Capacity in national and provincial reserves is severely limited in South Africa with no indication of future investment in amphibian monitoring above that already underway by CapeNature. There is no dedicated funding for commencing and maintaining new long-term monitoring sites. Monitoring that is

already ongoing of threatened species is limited to short-term funding cycles of academic funding institutions, or funded by the researchers themselves.

Further research is required into the efficacy of current monitoring techniques. This requires investment in infrastructure (such as linking recording equipment to weather stations at existing sites), as well as investment in research to bring about techniques for our more unique species (e.g. those that do not call or breed by nesting).

Bringing amphibians into the remit of existing biodiversity monitoring sites (e.g. SAEON) would rely on investment in capacity building of those individuals undertaking monitoring as well as the

### BOX 3: Chytrid monitoring of *Amietia vertebralis* and *A. umbraculata*

A site in the northwestern Drakensberg Mountains in the Royal Natal National Park and neighbouring Lesotho is being monitored by a group from the University of the North-West. The site was chosen following reports of amphibian die-offs in the area. Ten monitoring stations are arranged over 15 km and between 3 000 and 3 200 m asl. Four seasonal visits per year have been taking place since 2006 and are designed to follow the infection of *Amietia vertebralis* and *A. umbraculata* larvae with *Batrachochytrium dendrobatidis*, a chytrid fungal infection which can be detected on the chitinous larval mouthparts (see Chapter 4). In addition to monitoring *B. dendrobatidis*, the group collect data on the entire amphibian assemblage (adults, larvae and eggs), phenology, air and water temperature.

relevant support for regular analysis of data to assess trends. The most feasible option within the time frame of this document would be to train staff of national or provincial reserves in areas identified as priorities for monitoring.

In the event that monitoring detects trends that are catastrophic to threatened species, a Task Team to respond to crises for threatened amphibians is recommended (see Chapter 4).

### Further reading

DODD, C.K. 2009. *Amphibian ecology and conservation: a handbook of techniques*. Oxford University Press, USA.

MORRIS, W.F. & DOAK, D.F. 2002. *Quantitative conservation biology: the theory and practice of population viability analysis*. Sinauer Associates, Sunderland.



# 6 Education, awareness and capacity building

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## Aims

1. To build capacity in professionals practising conservation and taxonomy of amphibians in South Africa.
2. To promote awareness and appreciation among the general public as to the inherent value of biodiversity, of which amphibians are an integral part.

## Rationale

South Africa has an extremely rich amphibian fauna, and is recognised as a globally important area of biodiversity, but has very low numbers of professional herpetologists to carry out the work required to ensure conservation of amphibians. The general public is unaware of the global significance of the biodiversity of endemic frogs and has a low level of appreciation to the point that frogs are despised or feared in some sections of South African society. Key areas are therefore to raise awareness and build capacity within South Africa's population all the way from educating the general public and encouraging citizen scientists, through to producing and supporting academic scholars and conservation professionals. Both non-professionals and professionals at all levels are targeted: audiences include school children, academics, biodiversity professionals, and members of the general public. Indicators will be set for each target audience type, which are focused on mainstreaming biodiversity issues related to amphibians.

## Training, capacity building and awareness

### 1. School children

- a. School programmes can greatly assist in creating interest in amphibians at a young age. Even if young students do not form a research-related interest in amphibians, they can learn to appreciate and respect amphibians and their environments. This would require relevant information on amphibians to be built into school programmes and curricula and/or incorporation of amphibian curricula into extra-mural pro-

grammes.

### 2. Young researchers

- a. The university level is a key point at which to recruit new scientists to the field of herpetology. Some opportunities exist for post-graduate students to study amphibians, although the majority of universities do not have active programmes. Strengthening these programmes through networks would be essential to build this target group.
- b. The Herpetological Association of Africa (HAA) is a member-run association which promotes amphibian research in Africa. As such, it is uniquely placed to encourage young researchers to become involved. Through the HAA website, which is being set up to provide an interactive forum, young people could be made aware of study and volunteer opportunities.

### 3. Provincial and national conservation organisations

Both South African National Parks and the provincial reserves are responsible for protecting the biodiversity within their boundaries. However, for most of these organisations there are very few individuals with experience and training to generate any sort of data or information (even basic species lists) for amphibians. Building a stronger network of conservation authorities on the ground and researchers is essential to increase capacity in this target group.

### 4. General public

- a. The general public can also contribute to specific projects through citizen science. Simple citizen science projects can provide important data for amphibian conservation (see Chapter 5). More importantly, their contribution will afford them a greater understanding and appreciation of the environment.
- b. Education programmes at zoos and aquaria which incorporate components of amphibian research, and publicise how individuals can be-



come involved in citizen science would greatly enhance the profile of amphibians. Networking between the zoo and aquaria associations and researchers would be a vital part of ensuring that the general public becomes involved.

## Recommendations and solutions

### 1. School programmes: the following educational resources are currently missing for mainstream South African learners. The production of this material is encouraged and is a strategic priority.

- a. A basic teaching pack that is based on South African frogs (rather than textbook material that covers frogs from elsewhere) could be produced and distributed free to schools across the country. This would allow for incorporation of local information into school programmes, and raise awareness regarding local frogs and their diverse life-histories.
- b. Books written for South African school learners raising awareness on the importance of local amphibian diversity and conservation would allow for those interested to learn more. Similarly, websites with accessible information on local amphibians would provide more material for teachers and learners.
- c. Class science projects that are based on amphibians would raise awareness to a higher level and perhaps allow students to become citizen scientists. A special teaching pack should be created that provides the basic ideas and know-how for science projects that could be conducted at the school. The better resourced schools could link in their observations using digital cameras and keep databases of amphibian observations.

### 2. Young researchers

- a. The HAA website is the logical venue to promote all amphibian research possibilities in South Africa, and to increase the number of students that choose to study in this field. If this website is maintained in a vibrant and attractive style, with forums, advertisements regarding opportunities, and examples of the types of research that are ongoing, it will be the best forum to attract new researchers.

### 3. Provincial and national conservation organisations

- a. When working on provincial or national reserves, researchers and environmental impact assessment (EIA) consultants must invite field rangers to accompany them during sampling. In this way, researchers obtain extra help, but also

informally train the field rangers. Even if that training is not taken to full capacity, generating some interest in amphibians will increase the capacity of the conservation organisations.

### 4. General public

- a. The digital revolution in photography makes it relatively easy to provide images of amphibians together with locality data from anywhere in South Africa to a central data storage and processing facility. These 'virtual museums' have been a great success in national and international programmes (e.g. SARCA, SABCA, iSpot). In addition to providing valuable locality data, records on disease, range expansions and invasions might also be recorded. Such schemes are dependent on the general public getting feedback from websites, including identifications and range maps. This, in turn, is dependent on the small current capacity of amphibian professionals and informed volunteers that could assist. Examples are given in Box 1.
- b. Citizen scientists can also conduct amphibian monitoring in their own back gardens. These types of data would greatly assist amphibian conservation efforts.
- c. Although the number of professionals is small, there are many organisations which engage in education for the general public on a regular basis, and by building a network between these potential partners and researchers, the aims could be achieved. Working with partners also requires co-ordination so that messages that go out to the public are not mixed and do not contain spurious or unhelpful information. PAZAAB is an existing group which may facilitate this process.

## Hurdles and obstacles

Our present ability in South Africa to carry out capacity building, especially for the general public, must grow extensively in order to reach the short-term objectives set out in this document as well as future strategies. The minimal number of researchers (see Table 1) who are focused on either research issues or environmental impact assessments requires a boost from the bottom up with more employed conservationists with herpetofauna as a top priority as well as a concomitant increase in public interest and participation. Although the herpetological community currently lacks the human capital to carry out further capacity building required, there is the potential to seed such initiatives strategically in schools and universities to build future human capital in herpetology. While there is no dedicated funding for producing new materials for schools, or for carrying out recommendations listed above, we hope that setting

## Box 1: Examples of how citizen scientists can become involved in anuran research

### Example 1: Monitoring

Obtaining data on population demographics and movement can be assisted by citizens through a website that has been set up for people to upload photos of Western Leopard Toads. Images are uploaded together with their locality, date and contact details to Upload Your Toad at <http://bgis.sanbi.org/uploadyourtoad/>.

A second phase is planned whereby users will be provided with mapping information about where their toad is in relation to others, and ultimately running the image through automated identification software to give feedback about where the toad was last seen.



A Western Leopard Toad is photographed dorsally with a scale (ruler). The dorsal patterning of the toad is unique enabling automated identification to search hundreds of images for a match. Building up a database of such images over many years will enable Capture-Mark-Recapture information to be used for population demographic estimates.

### Example 2: Development of tadpoles in ponds

This is a simple protocol for monitoring development of tadpoles at a diverse number of localities. Being able to predict the development of tadpoles at many different sites can be very useful in urban situations. For example, with the Western Leopard Toad the City of Cape Town has a Memorandum of Agreement with the Western Leopard Toad Conservation Committee to cease mowing activities when toadlets emerge from ponds. Predicting emergence times is currently difficult, but with enough data and monitoring by citizen scientists, this task can become relatively easy at a large number of sites.



A series of digital images of tadpoles on a scaled background (1 cm squares) can be used to measure development of tadpoles over time.

### Example 3: North American Amphibian Monitoring Programme

<http://www.pwrc.usgs.gov/naamp/>

This encourages the keen members of the public (citizen scientists) to sign up for three years of frog monitoring via identification of calls on known stretches of roads. The programme is organised by State and relies on accurate identification of calls by volunteers to be entered into an online database.

This model could be set up in South Africa on a Provincial basis with minimal expenditure, producing important presence absence data for a wide network of areas.

these priorities will enable partner institutions to aid with these targets.

Setting up a web portal for observations by citizen scientists is a high priority that should be implemented within the next two years. This should take the form of a virtual museum in which digital observations can be archived and verified by specialist user groups.

At the university level, few institutions have active programs on amphibians (due to a scarcity of researchers placed at academic institutions), and the result is that young researchers are not exposed to this possibility. This could change given appropriate appointments and we use this opportunity to appeal to these institutions to redress the national deficiency in one of the most diverse groups of vertebrates in the region.

Table 1. Summary of current human capital for South Africa in the field of herpetology in relation to geographic region and threatened taxa. The number of active herpetologist are given per category (P—Provincial, A—Academic, M—Museum, I—Independent/NGO/other).

Province	Threatened taxa	Present outreach					Total
		P	A	M	I		
Eastern Cape	<i>Heleophryne hewitti</i>	0	0	2	0	2	
	<i>Vandijkophryne amatolicus</i>						
	<i>Afrixalus knysnae</i>						
	<i>Anhydrophryne rattrayi</i>						
	<i>Natalobatrachus bonebergi</i>						
	<i>Afrixalus spinifrons</i>						
	<i>Hyperolius horstockii</i>						
	<i>Cacosternum striatum</i>						
KwaZulu-Natal	<i>Anhydrophryne ngongoniensis</i>	1	1	0	1	3	
		Monitoring program at Giba Gorge being set up with upper Highway schools—to include <i>Natalobatrachus bonebergi</i> and non-threatened taxa.					
	<i>Afrixalus spinifrons</i>						
	<i>Amietia vertebralis</i>						
	<i>Hyperolius pickersgilli</i>						
		Young researcher (North-West University honours student) to take up monitoring project at Mt. Moreland of <i>H. pickersgilli</i> .					
	<i>Leptopelis xenodactylus</i>						
	<i>Natalobatrachus bonebergi</i>						
	<i>Hemisus guttatus</i>						
		Regular talks to schools and citizens around the Province on amphibian crisis and threatened frogs of KwaZulu-Natal.					
<i>Breviceps bagginsi</i>							
	Potential to improve frog displays at uShaka.						

Limpopo	<i>Breviceps sylvestris</i>	None.	0	0	0	0	0	0	0
Northern Cape	<i>Breviceps macrops</i>	None.	0	0	0	0	0	0	0
Western Cape	<i>Heleophryne rosei</i>	Year of the Frog display at Two Oceans Aquarium.	2	3	0	0	0	0	5
	<i>Microbatrachella capensis</i>								
	<i>Xenopus gilli</i>								
	<i>Cacosternum capense</i>								
	<i>Capensibufo rosei</i>								
	<i>Breviceps gibbosus</i>								
	<i>Poyntonia paludicola</i>								
	<i>Afraxalus knysnae</i>								
	<i>Arthroleptella landdrosia</i>								
	<i>Arthroleptella lightfooti</i>								
	<i>Arthroleptella subvoce</i>								
	<i>Arthroleptella rugosa</i>								
	<i>Arthroleptella drewesii</i>								
	<i>Amietophrynus pantherinus</i>	Leopard Toad monitoring and research with public participation and steering committee.							
Mpumalanga	<i>Hemisis guttatus</i>		0	0	0	0	0	0	0
	<i>Strongylopus wageri</i>	None.							
	<i>Breviceps sopranus</i>								
North-West	None.	None.	0	2	0	0	0	0	2
Free State	<i>Breviceps sylvestris</i>	None.	0	1	0	0	0	0	1
Gauteng	None.	Overall unknown. Free Bullfrog pamphlet available. Publicity on Giant Bullfrog through Endangered Wildlife Trust website.	0	1	0	0	0	0	1



# Appendix 1

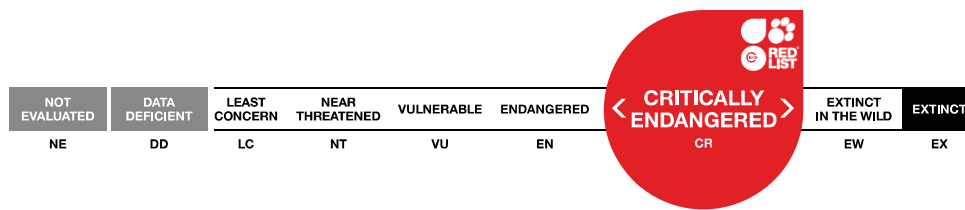
## A workshop to reassess the IUCN Red List status of South African amphibians

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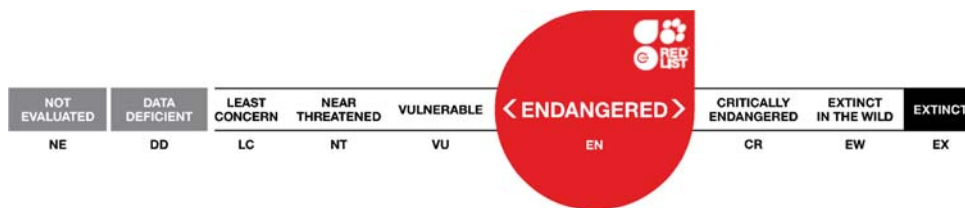
The most recent Red List assessment workshop of South African amphibians took place at SANBI, Cape Town, on 2 December 2009, when the South African Frog Reassessment Group (SA-FRoG) was formed. Prior to the workshop, taxonomic leaders were charged with investigating all South African taxa to assess all recent data. Only those considered to be threatened (CR, EN or VU), Data Deficient (DD) or species which had previously been listed as threatened were discussed at the workshop, all others having already been considered by leaders as continuing to be of Least Concern (LC). IUCN guidelines were used (IUCN Standards and Petitions Working Group 2008) together with criteria (IUCN 2001) in order to conduct Red List assessments. Data was captured at the workshop by Sarah Davies (to whom thanks are extended), including noting points which required additional information.

Below follows a summary of the Red List categories used in this assessment. For full details of the categories and their criteria, visit [www.iucnredlist.org](http://www.iucnredlist.org)



### CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the Criteria (A to E; IUCN 2001), and it is therefore considered to be facing an extremely high risk of extinction in the wild.



### ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the Criteria (A to E; IUCN 2001), and it is therefore considered to be facing a very high risk of extinction in the wild.



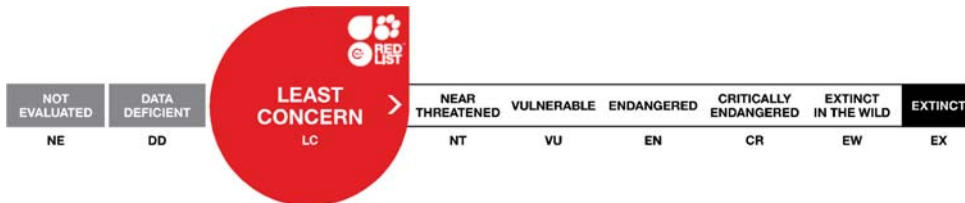
### VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the Criteria (A to E; IUCN 2001), and it is therefore considered to be facing a high risk of extinction in the wild.



### NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.



### LEAST CONCERN (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

Note that as no frogs in South Africa are considered Extinct (EX) or Extinct in the Wild (EW), these categories have not been used. Also, there are no longer any Data Deficient (DD) amphibians in South Africa.

Following the workshop, the region's Red List Authority for amphibians entered the collated data into the IUCN online Species Information Service (SIS; thanks are extended to Ariadne Angulo (IUCN) for facilitating this process). Existing accounts (from the 2004 assessment) were used as a draft for the updated accounts, and a grateful acknowledgement is made to all those who participated in the 2004 assessment of South African frogs, and who have laid the foundation of this and all future Red Listing of the region's amphibians.

Given the above selection criteria, the number of species reassessed was 35 or around a third of all frogs occurring in South Africa. Although all of the other species are considered to be LC, their assessments need to be updated with a priority on South African endemics.

## Threatened frogs of South Africa

The following section contains IUCN species accounts for all amphibians that were reassessed during the December 2009 workshop. Each account contains information as it has been submitted to the IUCN at the time of going to press. Most accounts have already been evaluated by a review process (co-ordinated by Ariadne Angulo and members of the Amphibian Red List Authority) and have been published on the official IUCN Red List site ([www.iucnredlist.org](http://www.iucnredlist.org)).

The IUCN Red List is not a static register and any readers wishing to know the current status of any of South Africa's amphibians should consult [www.iucnredlist.org](http://www.iucnredlist.org).

Credit for the assessments is given to the assessors, the South African Frog Reassessment Group (SA-FRoG) and the IUCN SSC Amphibian Specialist Group.

SA-FRoG is made up of the participants of the December 2009 workshop (in alphabetical order): Marius Burger, Alan Channing, Michael Cunningham, Sarah Davies, Atherton de Villiers, Louis du Preez, James Harvey, John Measey, Les Minter, Jeanne Tarrant, Krystal Tolley and Andrew Turner.

Special thanks are extended to Ariadne Angulo (IUCN, Amphibian Red List Authority), and other assessors who reviewed species accounts. Information on the members of the Amphibian Red List Authority can be found at [amphibianrla.pbworks.com](http://amphibianrla.pbworks.com)

Each species account contains a summary of the data present on the IUCN Red List in the following sections:

**Family:** species are arranged alphabetically according to the taxonomic family to which they belong.

**Common name:** the most common English name is provided. For other common names, see Du Preez and Carruthers (2009).

**Scientific name Authority:** the genus name and specific epithet as well as its authority, according to Frost (2010), are given.

**Taxonomic notes:** where applicable, notes on the species' classification are provided.



**Red List status:** the IUCN threat status is followed by the specific criteria on which the assessment was made. For more details consult documentation available at [www.iucnredlist.org](http://www.iucnredlist.org). This is followed by a paragraph giving a verbal justification of the status enclosed within a coloured box and the historical Red List status shaded according to the historical Red List status.

**History:** if available, the status of this species in the 2004 assessment (Minter *et al.* 2004) is provided.

**Geographic Range:** political regions (Provinces) where the species occurs is provided followed by a paragraph with a description of the range (including the Extent of Occurrence and Area of Occupancy, EOO and AOO respectively). A map of the EOO shaded according to the Red List status is displayed on a topographical background—dark areas indicate higher altitudes with major rivers in blue. An inset window displays the position of the map within the political borders of South Africa (black) and its Provinces (green).

**Population:** a detailed description of the population size and trends is included. See Chapters 4 and 5 for a discussion on how better descriptions of population may be made in future.

**Habitat and Ecology:** this includes a description of the pertinent aspects of known habitat and ecology. Where these aspects are unknown, a generalisation is given for the genus. For the most comprehensive ecological information and literature on most species, consult Minter *et al.* (2004).

**Major Threats:** detailed descriptions of the major perceived threats to the species are given. See Chapter 4 for a discussion on how threats for each species were evaluated.

**Conservation Actions:** The description of conservation research required and how this will improve future assessments is provided here. For a more detailed discussion on these aspects, see Chapter 4. Where applicable, this is followed by a list of protected areas in which the species occurs.

## Further reading

DU PREEZ, L.H. & CARRUTHERS, V. 2009. *Complete guide to the frogs of southern Africa*. Struik Nature, Cape Town.

FROST, D.R., GRANT, T., FAIVOVICH, J., BAIN, R.H., HAAS, A., HADDAD, C.F.B., DE SA, R.O., CHANNING, A., WILKINSON, M., DONNELLAN, S.C., RAXWORTHY, C.J., CAMPBELL, J.A., BLOTTO, B.L., MOLER, P., DREWES, R.C., NUSSBAUM, R.A., LYNCH, J.D., GREEN, D.M. & WHEELER, W.C. 2006. The amphibian tree of life. *Bulletin of the American Museum of Natural History* 297: 1–370.

IUCN 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.

IUCN Standards and Petitions Working Group. 2008. *Guidelines for Using the IUCN Red List Categories and Criteria. Version 7.0*. Prepared by the Standards and Petitions Working Group of the IUCN SSC Biodiversity Assessments Sub-Committee in August 2008.


MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. & KNOEPFER, D. (eds) 2004. *Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland*. Smithsonian Institution Press, Washington DC.

NB: The full references of documents cited in the species accounts are listed on the IUCN Red List site ([www.iucnredlist.org](http://www.iucnredlist.org)).

## Family: ARTHROLEPTIDAE

### Long-toed Tree Frog:

*Leptopelis xenodactylus* Poynton, 1963



**Endangered,  
B2ab(ii,iii,iv)**

Listed as Endangered, in view of its very small AOO (50 km<sup>2</sup>), severely fragmented nature of the subpopulations, and a continuing decline in the quality of its habitat and AOO.

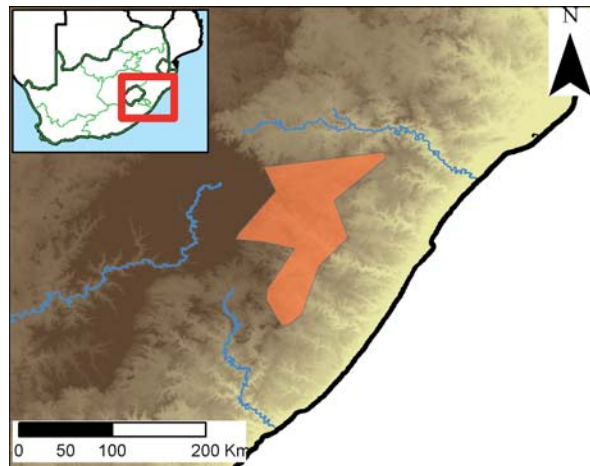
History: 2004 – Endangered



### Geographic Range:

South Africa (KwaZulu-Natal)

This species is endemic to southeastern South Africa in the southern KwaZulu-Natal highlands, and marginally in the Eastern Cape. It is not found on the steep slopes of the escarpment, and is usually found between 1 000 and 1 830 m asl. Known from 11 localities, with an EOO of 10 567 km<sup>2</sup> and an AOO estimated at 0.5% of the EOO (50 km<sup>2</sup>). This AOO estimate is based on known breeding sites and the expectation that more will be discovered (see Armstrong 2001). However, there is a continuing decline in AOO as the temporary wetlands this species inhabits are being drained for agriculture and construction.



### Population:

This species is cryptic and not commonly encountered. It is considered severely fragmented as over 50% of individuals are in isolated patches, and the distances between subpopulations are considered to be too great for dispersal within one generation.

### Habitat and Ecology:

It occurs in grassland, keeping to areas away from trees, and breeds in upland bogs, grassy wetlands and marshes, generally using semi-permanent water. Eggs are presumably laid in a nest on the ground near water.

### Major Threats:

It has a small range, and lives in a habitat that is threatened by afforestation, inappropriate fire

regimes, cattle trampling vleis and eutrophication, overgrazing, and the spread of alien plants that lower the water table (leading to drying out of breeding sites).

### Conservation Actions:


Priority for conservation work is given over to determination of dispersal and distribution together with categorising threats. The relationships between this and other species without toe discs require study. This species would make a good candidate for monitoring. Areas in which it occurs require stakeholder agreements for sensitive management. It is found in the uKhahlamba-Drakensberg Park, which is at least well-managed for biodiversity conservation.



## Family: BREVICIPITIDAE

### Bilbo's Rain Frog:

*Breviceps bagginsi* Minter, 2003



**Vulnerable**  
B1ab(ii,iii)+  
2ab(ii,iii)

Listed as Vulnerable due to its small and declining AOO (around 1 100 km<sup>2</sup>), and small EOO (11 000 km<sup>2</sup>), the severely fragmented nature of subpopulations, and ongoing decline in habitat quality.

History: 2004 – Data Deficient

### Geographic Range:

South Africa (KwaZulu-Natal)

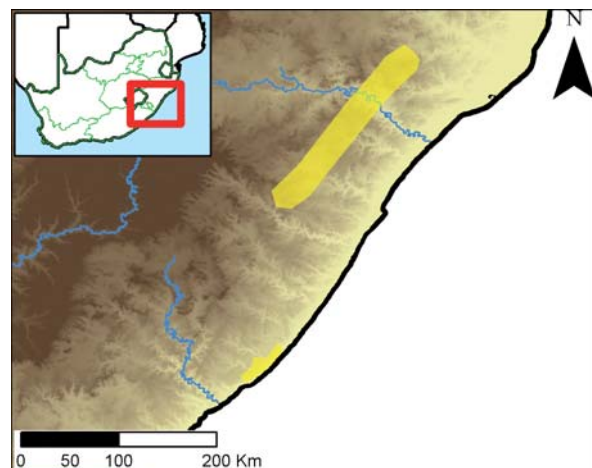
This recently described species occurs from 25 to 1 400 m asl in the KwaZulu-Natal midlands of southeastern South Africa along the mist belt from Boston in the west to Melmoth in the northeast and down to the coast at Mkambati. Its AOO is declining and is currently approximated to be 10% of the measured EOO, 11 000 km<sup>2</sup>.

### Population:

It is an uncommon species that occurs in congregations of 20–30 individuals. No one site holds >50% of individuals and the distances between subpopulations are considered to be too great for dispersal within one generation.

### Habitat and Ecology:

It is most often found on the edges of wood plantations in grasslands, and it presumably breeds by development occurring directly in subterranean nests. Ongoing silviculture over most of its AOO threatens the habitat of this species. At Mkambati it occurs in undisturbed grassland.



### Major Threats:

The main threats to this species are believed to be continued afforestation in the region and the construction and maintenance of roads.

### Conservation Actions:

Determining the basic biology including habitat choice and dispersal is seen as being a high priority for this species together with the identification of direct threats. Interim conservation agreements need to be made with land owners. Once population estimates have been made, monitoring of populations and habitat is required. The Mkambati population is in a protected area.

## Family: BREVICIPITIDAE

### Cape Rain Frog:

*Breviceps gibbosus* (Linnaeus, 1758)

This species, originally named *Rana gibbosa*, was the first African frog species to be entered into the Linnean system of nomenclature in 1758.



**Near Threatened**

Listed as Near Threatened because even though its distribution is not considered to be severely fragmented and it occurs in >10 locations, it has a limited EOO and continuing decline in the extent and quality of its habitat.

History: 2004 – Vulnerable

### Geographic Range:

South Africa (Western Cape)

This species is endemic to the southwestern Western Cape, where it ranges from the central Cape Peninsula in the south, to west of Citrusdal in the north. There is a distribution gap in the Swartland. It ranges from sea level up to 1 000 m asl. Its EOO is 6 700 km<sup>2</sup>, with an AOO estimated to be 10% of its EOO.

### Population:

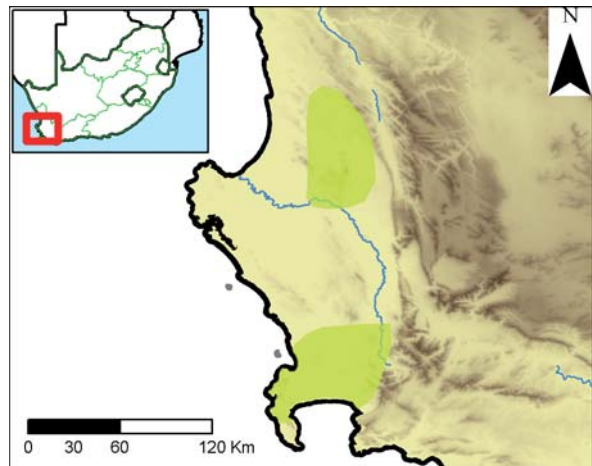
It can be relatively common in parts of its range. Its distribution is not considered to be severely fragmented (as less than half of the individuals can be found in isolated patches) and it is estimated to occur in over 10 locations.

### Habitat and Ecology:

It is a burrowing frog of renosterveld fynbos heathland. It also occurs in disturbed habitats, such as pine plantations and gardens and there is ongoing decline in its habitat over much of its range. It breeds by development occurring directly in subterranean nests with up to 22 froglets recorded for this species (Minter *et al.* 2004), and is not associated with water.

### Major Threats:

Although it is somewhat adaptable, its habitat has been severely reduced and fragmented by agricultural expansion in much of its range and urban



development in parts of its range. It is possibly impacted by the use of pesticides, and herbicides, and this might account for the apparent absence of the species from most renosterveld fragments in the Swartland, north of Cape Town.


### Conservation Actions:

No research or conservation actions are currently prioritised for this species. However, it would be important to discover the influence of pollution from pesticides on this and other species in the genus. Population estimates are required in order to conduct monitoring, especially in areas of land transformation. It occurs in several protected areas, including Table Mountain National Park, Helderberg Nature Reserve, and Paarl Mountain Nature Reserve.

## Family: BREVICIPITIDAE

### Desert Rain Frog:

*Breviceps macrops* Boulenger, 1907



< VULNERABLE >  
VU

**Vulnerable**  
B1ab(ii,iii,iv)+  
2ab(ii,iii,iv)

The major threat to this species (mining) has recently ceased and together with restoration of large areas of habitat could mean that in future this species may no longer be threatened. However, current estimates suggest that there are less than 10 000 individuals and that there has been a decline of 10% within three generations. In addition, there is ongoing reduction to quality of its habitat and given it is not yet known from restored habitat, it is still considered to be Vulnerable.

History: 2004 – Vulnerable

### Geographic Range:

Namibia, South Africa (Northern Cape)

This species occurs on the Namaqualand coast of South Africa, north to Lüderitz in coastal south-western Namibia, with an EOO of 4 900 km<sup>2</sup>. It ranges from close to the high-water mark to 10 km from the coast, within 50 m asl, giving it an AOO of 270 km<sup>2</sup>.

### Population:

It is a locally common species but estimates (Channing & Bell pers. comm.) suggest that there are less than 10 000 individuals and that this may decline by 10% in three generations. Its distribution is not considered to be severely fragmented.

### Habitat and Ecology:

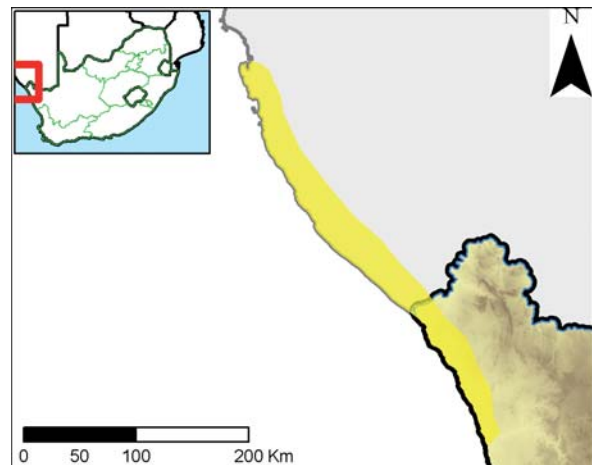
It burrows into sand dunes vegetated with low, succulent shrubs and other xerophytic vegetation in the fog belt during the day and emerges at night to feed when weather conditions are right. It presumably breeds by development occurring directly in subterranean nests and it is not associated with water.

### Major Threats:

The past main threat to the species is loss of its habitat as a result of coastal opencast diamond



J. Marais



mining but this is ceasing in many areas. The recovery of this species relies on habitat restoration by mine agencies to restore degraded habitat. Currently there is no evidence to suggest that this species occurs in restored areas (Channing & Bell pers. comm.). Development of roads, increasing pressure from human settlement, and changing land-use (e.g. increased grazing) pose additional ongoing threats.

### Conservation Actions:

It needs to be established whether this species can utilise regenerated land following past negative impacts of mining, and studies to this end are ongoing. Ongoing threats including those from recreation should be assessed. Population trends should be researched and monitored. It is not known from any protected areas. There is a need to establish conservation areas within the range of this species.



## Family: BREVICIPITIDAE

Whistling Rain Frog:  
*Breviceps sopranus* Minter, 2003



History: 2004 – Data Deficient



### Geographic Range:

Mozambique (presence uncertain), South Africa (KwaZulu-Natal, Mpumalanga), Swaziland

This species is known from Mtunzini in KwaZulu-Natal, southeastern South Africa, north through Swaziland along the Lebombo Mountains to Komatiport in Mpumalanga, eastern South Africa. It has a relatively large EOO (12 700 km<sup>2</sup>) and AOO estimated at 3% of its EOO (381 km<sup>2</sup>). It is a lowland species (0–350 m asl) occurring in flat and hilly areas.

### Population:

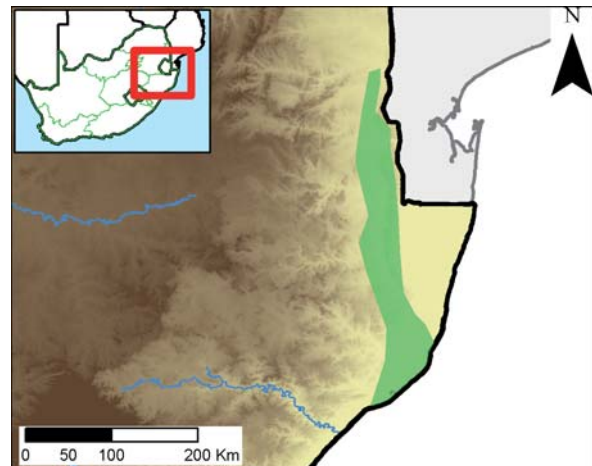
It appears to be a fairly common species.

### Habitat and Ecology:

This is a species of coastal and dune forest, and dry woodland savanna, which is not found in altered habitats. It presumably breeds by development occurring directly in subterranean nests.

### Major Threats:

Afforestation, sugar farming and subsistence agriculture are localised threats in parts of its large range.



### Conservation Actions:

Despite threats, including sugar cane farming, afforestation and agriculture, this species is not seen as having a high priority for conservation research or other actions in view of its large EOO. It also occurs in Mlawula Nature Reserve in Swaziland, and in iSimangaliso Wetland Park, Hluhluwe Game Reserve and Mkuze Game Reserve in South Africa.




## Family: BREVICIPITIDAE

### Northern Rain Frog:

*Breviceps sylvestris* FitzSimons, 1930

There are questions regarding the validity of the subspecies: *Breviceps sylvestris sylvestris* and *B. s. taeniatus*.



**Endangered**  
B2ab(ii,iii)

Listed as Endangered as its AOO is estimated at 101 km<sup>2</sup>, it is considered to have a severely fragmented distribution, and there is a continuing decline in the extent and quality of its habitat.

History: 2004 – Vulnerable

### Geographic Range:

South Africa (Limpopo)

This species is endemic to Limpopo, northeastern South Africa, where it occurs in two disjunct subpopulations: *Breviceps s. sylvestris* occurs along the eastern escarpment and *B. s. taeniatus* occurs in the Soutpansberg Mountains. The EOO is 11 700 km<sup>2</sup>, but the AOO of the two subpopulations is thought to be only 101 km<sup>2</sup>. The two subspecies are thought to be isolated by about 80 km of unsuitable habitat. It is a highland species, occurring between 800 and 1 800 m asl.

### Population:

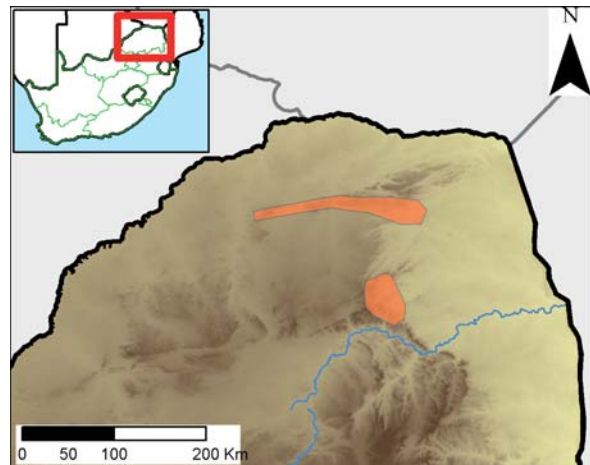
It is locally common to abundant. Its distribution is considered to be severely fragmented as more than half of the total number of individuals are in isolated patches.

### Habitat and Ecology:

It breeds in natural forests, grassy forest fringes, and adjacent open grassland and gardens, but never far from forest. Individuals have also been found in plantations. Nests have been found under stones with the female in attendance. It breeds by development occurring directly in subterranean nests.



A. Turner



### Major Threats:

The main threats are loss of habitat due to afforestation, fire, fruit plantations, and subsistence agriculture, and to a lesser extent housing.


### Conservation Actions:

Resolving taxonomic issues, identifying management units, biology and threats are seen as key priority research areas for this species. Additional policy is required in terms of agreements with commercial land owners. Of the threats, it is important to invest effort into how this species can best co-occur with developing agriculture. Once population sizes have been established, monitoring of populations and habitat should be put in place. It occurs in several protected areas, including Blouberg Nature Reserve, Thabina Nature Reserve and the Wolkberg Wilderness Area.

## Family: BUFONIDAE

Western Leopard Toad:  
*Amietophrynus pantherinus* (Smith,  
1828)

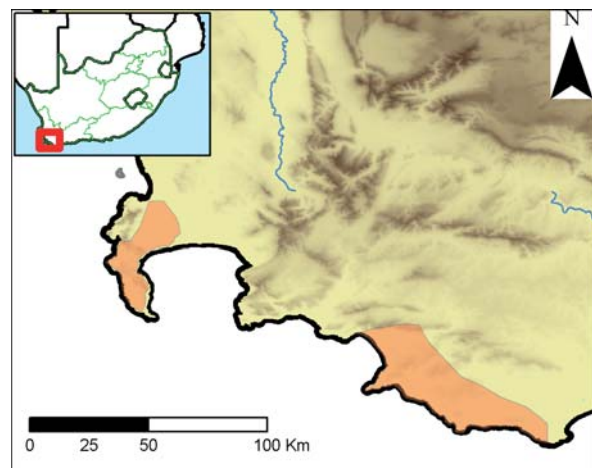
Reports of this species occurring between Agulhas and Wilderness, the westernmost record of *Amietophrynus pardalis* (Minter *et al.* 2004) remain unconfirmed.



**Endangered**  
**B1ab(ii,iii,iv)+**  
**2ab(ii,iii,iv)**

Listed as Endangered in view of its EOO being 1,750 km<sup>2</sup> and with an AOO of 440 km<sup>2</sup>, with a severely fragmented distribution, and a continuing decline in the extent and quality of its habitat and AOO.

History: 2004 – Endangered



### Geographic Range:

South Africa (Western Cape)

This species is known only from a very small area (EOO 1 750 km<sup>2</sup>) of the Western Cape, ranging from the Cape Peninsula eastward to the westernmost part of Agulhas National Park. Its AOO (440 km<sup>2</sup>) is continually being reduced by ongoing development and habitat change within the City of Cape Town and Overstrand. It is only known to breed at low elevations, within 25 km of the sea, but adults have been found ranging in the mountains up to 500 m asl. Subpopulations from the City of Cape Town have been shown to be genetically distinct from those in the eastern area of this species' distribution and their disjunction is not believed to have been caused by anthropogenic effects. Subpopulations in Kleinmond, Betty's Bay and Pringle Bay are now thought to be extinct.

### Population:

It is locally common and easily seen during breeding in August. Within the last 20 years it has undergone drastic declines from urban areas where it was once abundant, although no quantitative data are available. Collection of quantitative data is on-

going with which it is hoped to provide population data in the future. The spatial distribution of this species is considered to be severely fragmented as more than half of the occupied habitat area is in small and isolated patches and >50% of subpopulations are considered non-viable.

### Habitat and Ecology:

It breeds in large wetlands, vleis, dams, and sluggish water in lowland fynbos heathland, as well as in altered habitats with permanent waterbodies, and occasionally temporary waterbodies that retain water well into summer, and has a preference for deep water with floating plants. Females have been reported to lay nearly 25 000 eggs. It forages in fynbos heathland, farmland, suburban gardens, and urban open areas, although always in close proximity to freshwater habitats. There is an ongoing decline in the quantity and quality of suitable habitat for both foraging and breeding.

### Major Threats:

Although it is tolerant of habitat alteration, it is being negatively impacted by increased urbanisation and agricultural expansion in its entire range.



Road kills, urban design, alien vegetation and introduced fish are all thought to be important factors. A recent introduction and rapid expansion of *Amietophrynus gutturalis* into the City of Cape Town poses threats of competition and possible hybridisation.

### Conservation Actions:

Research is needed to determine population trends and the importance of perceived threats. A Biodiversity Management Plan (under NEMBA) is required to underpin Memoranda of Understand-

ing between multiple stakeholders. Monitoring is required at known breeding sites to determine their efficacy, especially in the eastern range. There is great potential to significantly improve the status of this species through conservation planning and control of threats posed by alien species (including fish, Guttural toads and plants). It occurs on the western fringe of Agulhas National Park, Table Mountain National Park as well as in various City of Cape Town Reserves. However, much of its remaining habitat is made up of urban gardens, is unprotected, and requires significant public education to make any conservation measure a success.




A rural breeding site (a) is lined with reeds and has deep water with floating vegetation. Radio tracking Western Leopard Toads at a rural breeding site (b) and a typical hiding place is revealed in a suburban garden (c). A suburban area with similar vegetation is immediately next to a road and housing estate with vibracrete walls preventing dispersal (d). Signs alert drivers to the possibility of finding toads on roads (e). An important suburban breeding area contains many breeding sites and many hazards (f). Photographs: J. Measey.

## Family: BUFONIDAE

### Rose's Mountain Toadlet: *Capensibufo rosei* (Hewitt, 1926)

A recent phylogeny of this genus suggests that there may be more than two species, and that *Capensibufo rosei* on the Cape Peninsula may be substantially different from subpopulations from other sites (Tolley *et al.* 2010). Resolving the taxonomy of the genus is a conservation priority for this taxon.



**Vulnerable**  
B1ab(ii,iii,iv)+  
2ab(ii,iii,iv)

Listed as Vulnerable in view of its EOO of 6 526 km<sup>2</sup> and AOO of 130 km<sup>2</sup>, with all individuals in eight locations, and a continuing decline in the AOO, quality of its habitat and the number of subpopulations.

History: 2004 – Vulnerable

### Geographic Range:

South Africa (Western Cape)

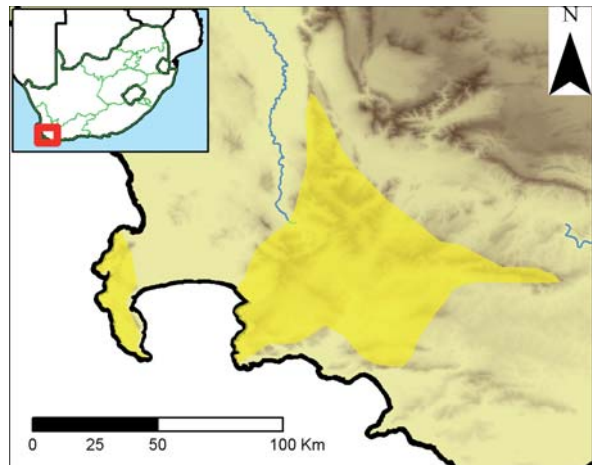
This species occurs only in southwestern South Africa, where it is restricted to the mountains southwest of the Breede River, including the Cape Peninsula (an EOO of 6 526 km<sup>2</sup> with and AOO estimated to be 2% of its EOO). Its altitudinal range is 60 to 1 600 m asl, with more than 80% of localities being above 400 m asl.

### Population:

It is locally common at breeding sites, and large breeding aggregations can sometimes be found. However, it is absent from some apparently suitable sites and can no longer be found at some historically recorded sites on the Cape Peninsula.

### Habitat and Ecology:

It is a species of mountain fynbos heathland, and does not survive in altered habitats. Adults congre-



gate to breed in temporary pools, where they lay around 100 eggs in long strings of amber jelly.

### Major Threats:

The main threat to this species is the loss of its fynbos habitat, mainly because of the spread of alien vegetation and frequent burning. No explanation or threat has been deduced for historical populations now missing from the Cape Peninsula.

### Conservation Actions:


Taxonomy, understanding ecology, threats and population size and trends are all high priority areas for research in conserving this species. Known sites need active management to reduce influence by alien vegetation. Much of the range of this species is within protected areas.



## Family: BUFONIDAE

### Amatola Toad:

*Vandijkophrynus amatolicus* (Hewitt, 1925)



**Critically Endangered A2a**

Listed as Critically Endangered due to a past population decline inferred to be close to 100%, as despite targeted searches, this species has not been seen at all from 1998 to 2009.

History: 2004 – Endangered

### Geographic Range:

South Africa (Eastern Cape)

This species is known only from the Winterberg and Amatola Mountains, between Katberg and Keiskammahoek, in the Eastern Cape at 1 400–1 800 m asl.

### Population:

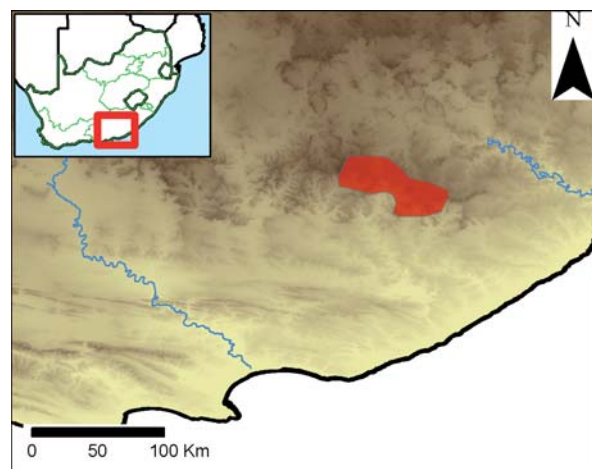
About ten visits to suitable sites over 11 years (1998–2009) have not turned up any frogs of this species and it is possible that this species is already extinct. Prior to the disappearance, it was known to congregate in large numbers to breed. The spatial distribution of this species is considered to be severely fragmented based on historical data as no one site holds >50% of individuals and the distances between subpopulations are considered to be too great for dispersal within one generation.

### Habitat and Ecology:

It lays strings of eggs in shallow temporary pools and seepages in high-altitude moist grasslands, and is absent from forests and plantations. Tadpoles are free living and metamorphose before leaving the aquatic environment.

### Major Threats:

The main threats are loss of grassland through afforestation affecting the majority of the distribution,



overgrazing, and fires; over the last 20 years about 20% of its habitat has been lost to plantations. Overgrazing and frequent fires may be responsible for disappearance from remaining appropriate sites in the last 11 years.

### Conservation Actions:


The key research action required is to relocate this species and determine its phenology. There is a possibility that after 11 years without being seen, this species may already be extinct. Other priorities are to identify Management units and assess perceived threats. If populations can be located, the population size should be determined and the site protected. If the specific requirements of this species can be determined, this may lead to restoration of appropriate habitat.

## Family: HELEOPHYRIDAE

### Hewitt's Ghost Frog:

*Heleophryne hewitti* Boycott, 1988

The taxonomy of this genus is in need of revision.



< ENDANGERED >  
EN

**Endangered**  
B1ab(iii)

Listed as Endangered because its EOO is considerably below 5 000 km<sup>2</sup>, all individuals are in two locations, and there is a continuing decline in the quality and extent of its habitat.

History: 2004 – Critically Endangered

### Geographic Range:

South Africa (Eastern Cape)

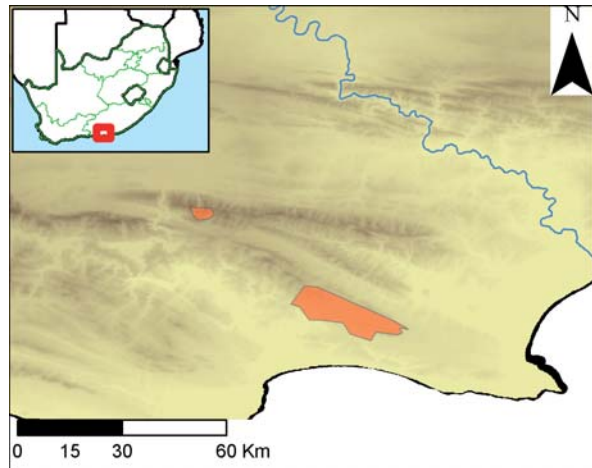
This species appears to be restricted to four perennial rivers (Geelhoutboom, Martin's, Klein and Diepkloof) with their headwaters in the Elandsberg Mountains, and a fifth site in the Cockscomb Mountains, all in the Eastern Cape. Its altitudinal range is 400–550 m asl.

### Population:

No numerical population information is currently available for this species. Tadpoles are seen regularly and adults rarely, fitting their cryptic life history. The spatial distribution of this species is not considered to be severely fragmented as one site (Elandsberg) holds >50% of individuals although 30 km distance between subpopulations is considered to be too great for dispersal within one generation.

### Habitat and Ecology:

It is a species of fynbos heathland and grassy fynbos. Only very small remnants of fynbos survive within its range so very little non-breeding habitat survives. It breeds in fast-flowing perennial rivers and streams with rocky beds in the upper reaches of the Elandsberg and Cockscomb Mountains. Females lay up to 200 eggs. Adults and tadpoles are found beneath submerged and partly submerged rocks in these streams, and occasionally at the edge of small waterfalls and cascades. The tadpoles take two years to develop.



### Major Threats:


The main threats are loss of suitable non-breeding and breeding habitat as a result of afforestation with exotic pine plantations, fires, erosion, siltation of streams, dams, and road building. Introduced predatory fish are probably also a threat.

### Conservation Actions:

Understanding and quantifying threats scored the highest priority for conservation research on this species. In addition, any information on demography of adults or tadpoles would be very valuable. Taxonomic revision of the whole genus is necessary. The species is not known to occur in any protected areas, and the maintenance of its remaining breeding and non-breeding habitat is essential. There is also a need for continued monitoring of known populations, survey work for other populations and invasive species control. Agreements need to be drawn up with private land owners for the management and long-term protection of sites.

## Family: HELEOPHYRNIDAE

### Table Mountain Ghost Frog: *Heleophryne rosei* Hewitt, 1925



**Critically Endangered**  
B1ab(ii,iii)+2ab(ii,iii)

Listed as Critically Endangered because its EOO and AOO are less than 9 km<sup>2</sup>, all individuals are in a single location, and there is a continuing decline in the quality of its habitat.

History: 2004 – Critically Endangered

#### Geographic Range:

South Africa (Western Cape)

This species has a very restricted range (EOO is 9 km<sup>2</sup>) being endemic to the southern and eastern slopes of Table Mountain, in the Western Cape, extreme southwestern South Africa. Within this, the AOO (around 4.5 km<sup>2</sup>) is believed to be suffering ongoing decline. It occurs between 240 and 1 060 m asl.

#### Population:

It is a rare and elusive species that survives in low population densities. The number of tadpoles in Skeleton Gorge decreased by around 50% from 1980 to 2000, but monitoring of tadpoles suggest that this subpopulation is stable.

#### Habitat and Ecology:

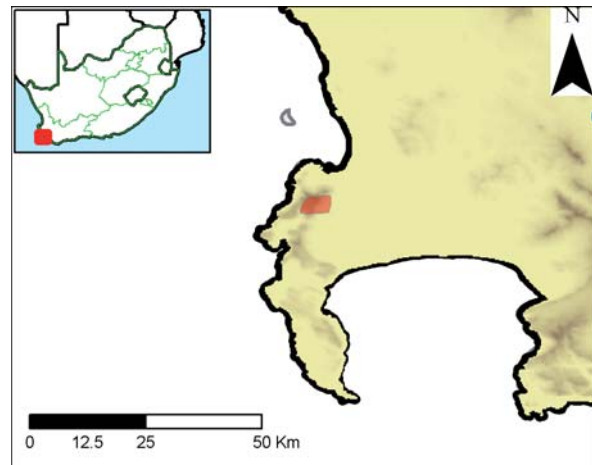
It lives in forest and fynbos heathland, breeding in clear perennial streams in gorges, valleys and ravines on Table Mountain. Non-breeding adults have been found in damp, sheltered habitat well away from streams, including in caves. The tadpoles require longer than 12 months to complete metamorphosis, and so it is important that there is perennial water to allow the larvae to develop. The habitat on some of these streams is deteriorating due to abstraction and soil erosion.

#### Major Threats:

The main threats are the spread of alien vegetation, frequent fires, and water storage reservoirs



V. Carruthers



on the mountain which can affect the consistency of stream-flow. Intensification of tourism is also a threat through soil erosion around some of the streams. Water abstraction from streams has resulted in habitat loss and may limit the vertical movement of tadpoles in summer.


#### Conservation Actions:

The whole of this species' range is incorporated in the Table Mountain National Park, part of the Cape Floristic Region World Heritage Site, and Kirstenbosch National Botanical Garden. High priorities for conservation research were set to determine the dispersal of this species and the highest priority to estimate population size. Perceived threats need to be evaluated and management plans need to be properly implemented and integrated between properties. Current monitoring of tadpoles could be expanded to make population estimates.



## Family: HEMISOTIDAE

Spotted Shovel-nosed Frog:  
*Hemisus guttatus* (Rapp, 1842)



< VULNERABLE >  
vu

**Vulnerable**  
B2ab(ii,iii,iv)

Listed as Vulnerable because its AOO is estimated to be 510 km<sup>2</sup>, its distribution is severely fragmented, and there is continuing decline in its AOO and the extent and quality of its habitat. The estimate of the AOO provided is conservative in nature; if additional surveys suggest it is more circumscribed, then a higher threat category should be considered.

History: 2004 – Vulnerable

### Geographic Range:

South Africa (KwaZulu-Natal, Mpumalanga)

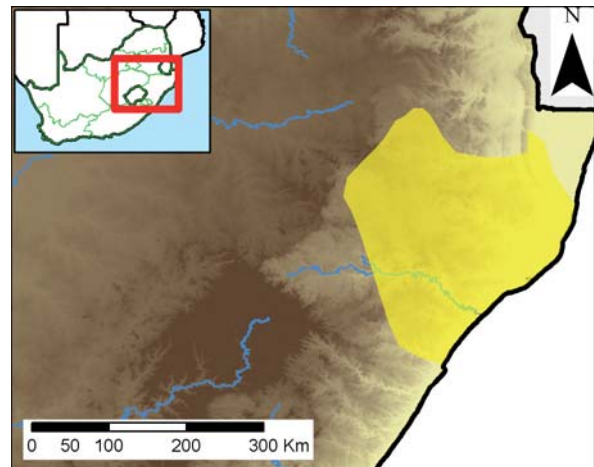
This species, which is known only from South Africa, occurs in southern Mpumalanga, and central and eastern KwaZulu-Natal, south to Durban on the coast (EOO of 51 000 km<sup>2</sup> and AOO conservatively estimated to be 1%). The northernmost coastal record is from Hluhluwe. It ranges from sea level up to over 1 000 m asl on the summit of the Lebombo Mountains. It has not been recorded from Swaziland, but it presumably occurs in this country.

### Population:

Breeding congregations of this species appear to be relatively small and widely dispersed. This species is considered to be severely fragmented as no sub-population has >50% of individuals and >50% of subpopulations are considered non-viable.

### Habitat and Ecology:

It inhabits grassland and savanna. It breeds in seasonal pans, swampy areas, and in pools near



rivers. It nests in burrows in wet soil by temporary water and tadpoles move to water to develop.

### Major Threats:

The main threats include habitat loss due to afforestation, sugar cane cultivation, urbanisation and invasive alien plants lowering the water table.

### Conservation Actions:

The highest priority for conservation research of this species is to assess its ability to disperse. Understanding the impact of perceived threats and population size and trends is also required. This species occurs in the iSimangaliso Wetlands Park, the Hluhluwe-Imfolozi Game Reserve, and other protected areas.




## Family: HYPEROLIIDAE

### Knysna Leaf-folding Frog:

#### *Afrivalus knysnae* (Loveridge, 1954)

This species is closely related to *Afrivalus spinifrons* (Cope 1862). Species boundaries in this complex are uncertain and taxonomic studies using calls, morphology and genetics are necessary.



**Endangered**  
**B1ab(ii,iii,iv,v)**

Listed as Endangered, in view of its EOO being 1 756 km<sup>2</sup>, its distribution being severely fragmented (no one site holds >50% of individuals and the distances between subpopulations are considered to be too great for dispersal within one generation) with all individuals in seven locations, and a continuing decline in the quality of its habitat, AOO, number of locations and number of mature individuals.

History: 2004 – Endangered

### Geographic Range:

South Africa (Eastern Cape, Western Cape)

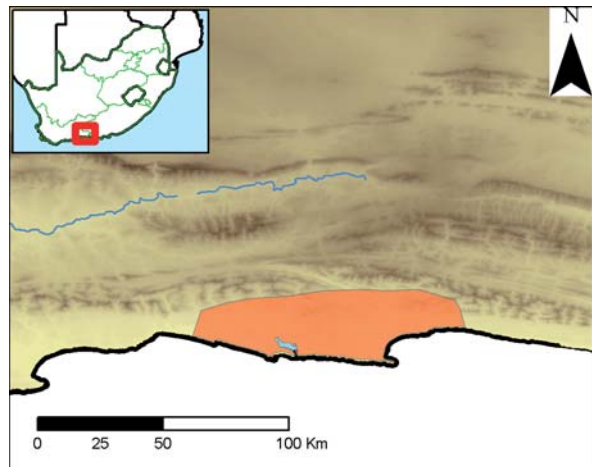
This species is known from around seven locations at low altitude (< 250 m asl) on the south coast of South Africa on either side of the border between the Eastern Cape and Western Cape. EOO is 1 756 km<sup>2</sup> and the AOO has not been formally calculated but is known to be declining as some sites are presumed lost as no adults or tadpoles have been found there for at least three years. Although some sites are pristine, others are threatened by alien vegetation.

### Population:

The spatial distribution of this species is considered to be severely fragmented as no one site holds >50% of individuals and the distances between subpopulations are considered to be too great for dispersal within one generation. Visits to one site have not produced any individuals (adults or tadpoles) for three years. It seems likely that this subpopulation has become extinct, but further visits are required to substantiate this. The cause for this disappearance is as yet unknown, but change in water quality is suspected as a possible reason.



V. Carruthers



### Habitat and Ecology:

It lives in a coastal mosaic of vegetation types, including mountain fynbos heathland, and forest. It breeds in small dams and shallow semi-permanent water with much emergent vegetation and even in well-vegetated ornamental garden ponds. It is suspected that this species requires high water quality for breeding. Habitat is declining due to encroachment by urban development, alien invasive vegetation and chemical pollution. Species in this genus deposit between 20 and 50 eggs on vegetation above the water. Tadpoles emerge, drop into the water and remain there until metamorphosis.

### Major Threats:

The main threat is habitat loss due to urban and recreational development, afforestation, invasive vegetation, agricultural expansion and chemical pollution. These threats are likely to act locally on breeding sites. Drought may cause additional stresses for this species.



### Conservation Actions:

This species ranks amongst the highest in need of conservation-orientated research of South African threatened frogs. The taxonomy of the species complex is in need of comprehensive review. Important questions are still unanswered concerning the call and tadpole of this species. There is a definite need to identify management areas,

describe breeding phenology, and to identify direct threats, in particular, the effects of changes in water quality at sites with this species need to be documented. The AOO needs to be calculated as well as an assessment of the health of all known sites. Once this has been achieved, monitoring at known breeding sites should be instigated. It occurs in Tsitsikamma National Park, Goukamma Nature Reserve and Diepwalle Forestry Area.



The breeding habitat of the Knysna Leaf-folding Frog (*Afrivalus knysnae*) at Covie (a, b) which is the eastern most known locality for the species. These frogs often share habitats and lay their egg clutches out of water, folded in a grass leaf (c). Photographs: L. du Preez.

## Family: HYPEROLIIDAE

### Natal Leaf-folding Frog:

*Afrixalus spinifrons* (Cope, 1862)

We follow Pickersgill (1996) in considering what were formerly regarded as the eastern populations of *Afrixalus knysnae* to be a subspecies of *A. spinifrons* (*A. s. intermedius*). Species boundaries in this complex are uncertain and taxonomic studies using calls, morphology and genetics are necessary.



#### Near Threatened

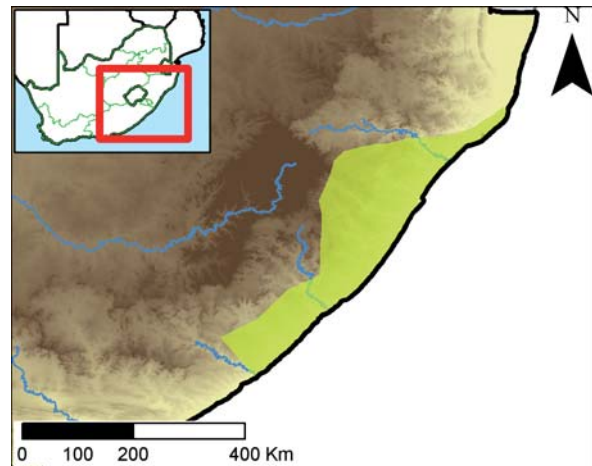
Listed as Near Threatened as although its EOO is 19 000 km<sup>2</sup>, its AOO is less than 1 900 km<sup>2</sup>, and there is continuing decline in the quality of its habitat, there are 11 locations and the spatial distribution of this species is not considered to be severely fragmented. However, certain sites where this species occurs do have a large number of different threats which may seriously impact on population viability in future. Loss of certain sites could easily result in less than 10 locations triggering the criteria for Vulnerable status.

Loss of certain sites could easily result in less than 10 locations triggering the criteria for Vulnerable status.

History: 2004 – Vulnerable



M. Burger



### Geographic Range:

South Africa (Eastern Cape, KwaZulu-Natal), Lesotho (presence uncertain).

This species, which is endemic to South Africa, occurs as two subspecies: *A. s. spinifrons* occurs in the KwaZulu-Natal lowlands, and the Eastern Cape coast of South Africa at low to intermediate altitudes; *A. s. intermedius* occurs at altitudes above 1 000 to around 1 500 m asl in western KwaZulu-Natal between the midlands and foothills of the Drakensberg. The EOO is around 19 000 km<sup>2</sup>, and the AOO is estimated to be 10% of this.

### Population:

This species is hard to detect but it is known to be doing well at some sites where it appears abundant.

### Habitat and Ecology:

It is associated with low vegetation in shrubland and dry forest. It breeds in vleis (including dams)

and temporary pools and pans (including roadside pools) and uses emergent vegetation to create egg nests. Species in this genus deposit between 20 and 50 eggs on vegetation above the water. Tadpoles emerge, drop into the water and remain there until metamorphosis.

### Major Threats:

Certain subpopulations are affected by loss of wetlands through urban and recreational development, afforestation, agricultural expansion, pesticides, and overgrazing by livestock. Coastal populations (i.e. *A. s. spinifrons*) may be at higher risk than those inland due to heavier development pressure along the KwaZulu-Natal coastline.

### Conservation Actions:

Determining whether the two subspecies are separate species is a high conservation research priority for this species, and the entire genus in South



Africa is in need of taxonomic attention. Insufficient information exists on life history of the subspecies, and monitoring of breeding sites is recommended at the extremes of the distribution. Although there are many threats to individual sites, the species as

a whole is not considered to require conservation effort at this time. *Afrixalus s. intermedius* occurs in the uKhahlamba-Drakensberg National Park. *Afrixalus s. spinifrons* occurs in a number of coastal protected areas.



The breeding area of the Natal Leaf-folding Frog (*Afrixalus spinifrons*) at Isipingo (a) is lush and very close to high density habitation. Near Fort Nottingham, this image, taken in winter (b), shows a rural breeding habitat. Lastly, breeding habitat for the Natal Leaf-folding Frog and the Spotted Shovel-nosed Frog (*Hemisus guttatus*, see page 57), with a national highway only 100 m to the back (c). Photographs: (a) J. Tarrant (b) J. Harvey (c) J. Harvey.



## Family: HYPEROLIIDAE

### Arum Lily Frog:

*Hyperolius horstockii* (Schlegel, 1837)

LEAST  
CONCERN  
LC

**Least Concern**

Listed as Least Concern as although it has a relatively restricted EOO (18 000 km<sup>2</sup>), its AOO (900 km<sup>2</sup>) is large. It is not considered to be severely fragmented, and despite some impact on a limited number of subpopulations, it is known to adapt to disturbed environments.

History: 2004 – Vulnerable

### Geographic Range:

South Africa (Western Cape)

This is a coastal species occurring at low elevations (<500 m asl) along the southern coast of the Western Cape (including the Cape Peninsula), and east into the western part of the Eastern Cape. Its EOO is 18 000 km<sup>2</sup> with an estimated AOO of 5%.

### Population:

This species is relatively abundant in many wetland areas and can tolerate disturbance. This species is not considered to be severely fragmented.

### Habitat and Ecology:

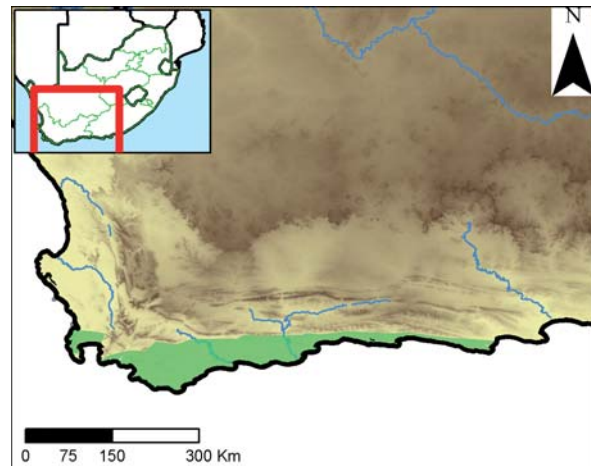
It lives in wetlands in coastal fynbos heathland. It breeds in large and small pans, dams, vleis, and even slow-flowing streams. It needs emergent vegetation, and therefore requires relatively permanent water, though it seems to avoid very deep water.

### Major Threats:

Spreading alien vegetation can lead to drying out of its breeding habitats. It is probably also adversely affected by fires. Several populations have disap-



A. Turner




peared due to the impacts of agricultural and urban expansion on its native habitat. No evidence exists that collection of Arum Lily flowers affects this species in any way whatsoever.

### Conservation Actions:

No conservation actions are currently prioritised for this species. It occurs in several protected areas, including Table Mountain National Park and De Hoop Nature Reserve.

## Family: HYPEROLIIDAE

Pickersgill's Reed Frog:  
*Hyperolius pickersgilli* Raw, 1982



**Critically Endangered** B2ab(ii,iii)

Listed as Critically Endangered in view of its small AOO of 9 km<sup>2</sup>, with its distribution being severely fragmented, and a continuing decline in the quality of its habitat and AOO.

History: 2004 – Endangered

### Geographic Range:

South Africa (KwaZulu-Natal)

This species is endemic to the coast of KwaZulu-Natal, ranging from Warner Beach in the south to St. Lucia village in the north. It is found within 20 km of the coast up to 380 m asl. Although the EOO is 2 303 km<sup>2</sup>, the AOO has been calculated to be only 9 km<sup>2</sup>.

### Population:

The spatial distribution of this species is considered to be severely fragmented as >50% of individuals are in small and isolated patches and >50% of subpopulations are considered non-viable. It is secretive and so is under-recorded, but appears to be a rare species.

### Habitat and Ecology:

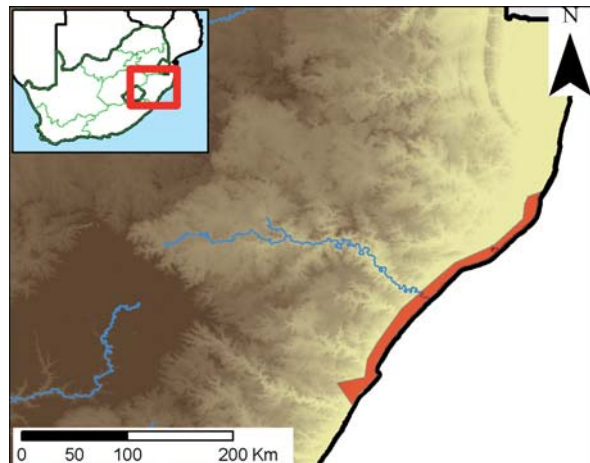
It is a species of coastal mosaic bushland and grassland, breeding in stagnant, usually temporary to semi-permanent water, rarely exceeding 50 cm in depth, surrounded by dense sedges. It is seldom found at the same breeding sites as the abundant *Hyperolius marmoratus*.

### Major Threats:

It is confined to a small area subject to urbanisation, habitat fragmentation, afforestation, and drainage for agricultural and urban development. Some breeding sites are being polluted by DDT, which is used for controlling malarial mosquitoes. The spread of alien vegetation, in particular *Eucalyptus* species, is responsible for the drying out of some breeding sites.



J. Harvey



### Conservation Actions:


Obtaining accurate information on threats was given the highest priority on conservation research for this species. Determining the status of all sites and estimating population size also receive high research priorities. Research is still required to determine population sizes, life history and ecology (in particular dispersal potential), followed by appropriate monitoring of both population and habitat. In addition, land owner agreements need to be drawn up for protection and management of all sites for conservation management. This species occurs in the iSimangaliso Wetland Park, the Umlalazi Nature Reserve, and the Twinstreams-Mtunzini Natural Heritage Site.

## Family: PIPIDAE

### Cape Platanna:

#### *Xenopus gilli* Rose & Hewitt, 1927

A deep genetic split characterises the disjunct distribution of this species



**Endangered**  
B1ab(i,iii)+  
2ab(i,iii)

Listed as Endangered in view of its declining EOO currently being 1 450 km<sup>2</sup>, and AOO of 14.5 km<sup>2</sup>, with all individuals in four locations, and a continuing decline in the extent and quality of its habitat.

History: 2004 – Endangered

### Geographic Range:

South Africa (Western Cape)

This species is endemic to extreme southwestern South Africa, occurring on the Cape Peninsula and the southwestern Cape coast. It is a low-altitude species occurring at 10–140 m asl; currently known populations occur within 10 km of the coast. Its EOO is estimated to be 1 450 km<sup>2</sup>, is considered to be declining, and its AOO is estimated to be 1% of the EOO.

### Population:

The spatial distribution of this species is not considered to be severely fragmented as one subpopulation/location holds >50% of individuals, however the distances between subpopulations of around 100 km is considered to be too great for dispersal within one generation. It appears to be relatively abundant in some of the known localities.

### Habitat and Ecology:

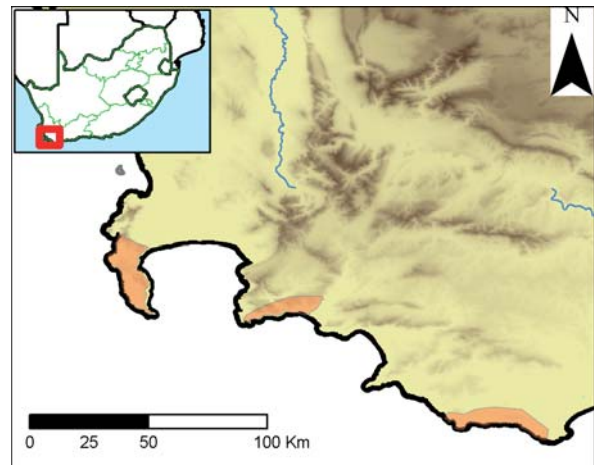
It is found only in black, acid water in Cape fynbos heathland. It is a winter breeder (July–October). It aestivates if waterbodies dry up. It does not tolerate alteration of its habitat, and the larvae are very sensitive to changes in water quality.

### Major Threats:

The main threats are habitat loss due to urbanisation, agricultural run-off, and the effects of spread-



J. Measey



ing alien plants. It may be threatened by hybridisation with *X. laevis*, and there have been concerns about how many populations of this species represent pure *X. gilli*. *X. laevis* does not favour the acid water that *X. gilli* requires.

### Conservation Actions:

Research priorities for this species include estimating dispersal capabilities, identification of management units and monitoring population size. The threat of hybridisation needs to be clarified, as *X. laevis* now occurs throughout the range. Habitat management and restoration are needed. It occurs in Table Mountain National Park and Agulhas National Park, both of which are relatively well-managed, although there is a need to control the spread of invasive plants within these areas.



## Family: PYXICEPHALIDAE

### Drakensberg River Frog: *Amietia dracomontana* (Channing, 1978)

Tarrant *et al.* (2008) note that there are still taxonomic difficulties associated with this genus and good delimitation of species still requires further taxonomic work.

LEAST  
CONCERN  
LC

**Least Concern**

Listed as Least Concern since it is common and adaptable with a presumed large population and because it is unlikely to be declining to qualify for listing in a more threatened category.

History: 2004 – not listed

### Geographic Range:

Lesotho; South Africa (Free State)

This species is endemic to the highlands of southern and eastern Lesotho above 2 000 m asl. It presumably occurs in nearby South Africa, but so far there have not been any records. The EOO has not been formally approximated.

### Population:

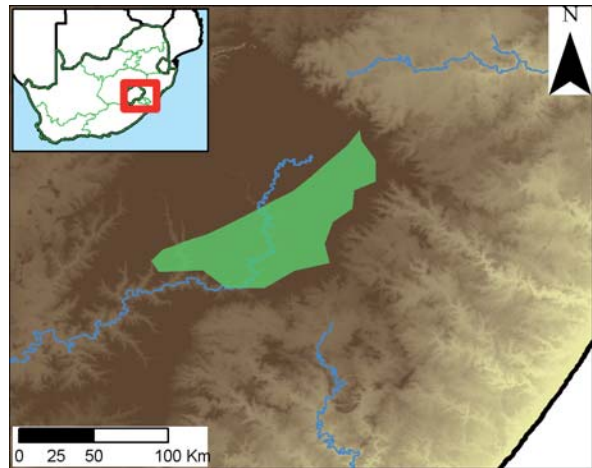
This species appears to be common and adaptable.

### Habitat and Ecology:

It is a species of montane grassland (including pastureland), living in the vicinity of permanent streams. It breeds in shallow streams, and on the edges of rivers with well-vegetated banks.

### Major Threats:

Apart from the local effects of dams, this species does not appear to be seriously threatened, despite its relatively small range. However it has



the ecological characteristics of a species that is potentially at risk from chytridiomycosis, and so its populations should be regularly monitored.


### Conservation Actions:

This species has been identified as potentially being vulnerable to chytrid fungus (high altitude stream breeder) and as such should undergo monitoring once basic life-history, threats and population trends have been assessed. There are still taxonomic issues within this group which require more work. It presumably occurs in one or two protected areas, such as Sehlabathebe National Park.



## Family: PYXICEPHALIDAE

Van Dijk's River Frog:  
*Amietia vandijki* Visser & Channing,  
1997



**Least Concern**

Listed as Least Concern as it occurs throughout three protected mountain ranges, is common in all three, and threats are not considered to be sufficiently intense at this time to merit assessment in a threatened category.

History: 2004 – Data Deficient

### Geographic Range:

South Africa (Western Cape)

This species is known from the Swartberg, Langeberg and Hottentots-Holland Mountain ranges in the eastern part of the Western Cape. It occurs at medium to high altitudes, up to at least 1 800 m asl.

### Population:

It is considered to be a common species in all three mountain ranges.

### Habitat and Ecology:

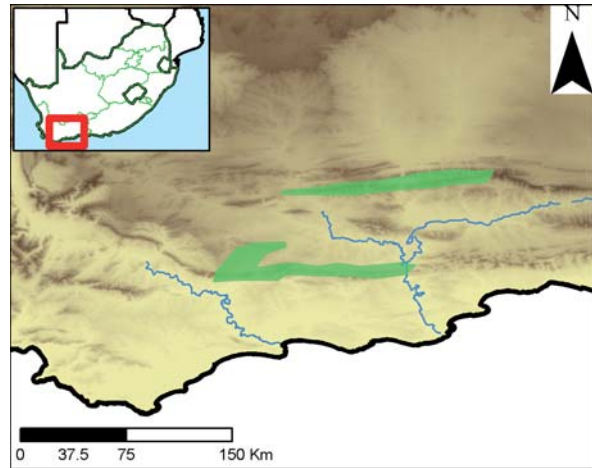
It inhabits mountain fynbos heathland, and is associated with rocky streams on steep, well-vegetated slopes, and forest gorges. It breeds in pools at the sides of streams, and in deeper, slow-flowing water.

### Major Threats:

Much of its habitat is protected, but even within the protected areas this species may be threatened by the damming of streams, the spread of invasive



A. Turner



alien plants, and by too frequent fires. However, these threats are currently thought not to be sufficiently intense and are being well-managed within the protected areas.

### Conservation Actions:

No conservation actions are currently prioritised for this species, although further research on population trends would be useful and required for a sound basis for future monitoring. Taxonomic investigations of disjunct distributions require attention. It is currently known from four protected areas: Grootvadersbos Nature Reserve, Boosmansbos Wilderness Area, Swartberg Nature Reserve and Garcia State Forest.

## Family: PYXICEPHALIDAE

### Phofung River Frog:

*Amietia vertebralis* (Hewitt, 1927)

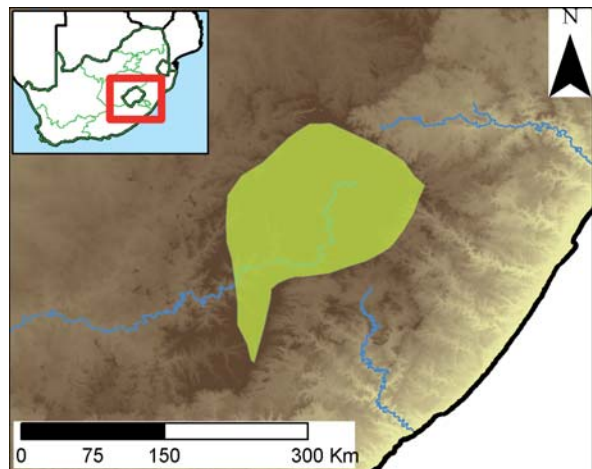
This species has a confusing taxonomic history which has recently been reviewed (Tarrant *et al.* 2008). The last Red List assessment of populations now associated with this species was made under the name *Strongylopus hymenopus* and likely included other taxa (see Minter *et al.* 2004; Tarrant *et al.* 2008).



#### Near Threatened

This species has been assessed as Near Threatened as the recent change in its taxonomic status means that it is not as widespread as

previously thought (Tarrant *et al.* 2008), and threats do not appear to be as severe. However, it may be vulnerable to invasive predatory fish, overgrazing with subsequent siltation and several die-offs associated with the chytrid fungus have already been observed. As this is a high-altitude species dependent on pristine habitat, it may also be vulnerable to small changes in climate.



### Geographic Range:

Lesotho; South Africa (KwaZulu Natal, Free State)

This species is endemic to the cold and wet north-eastern Drakensberg, restricted mainly to the South African side (KwaZulu-Natal and Free State), at altitudes between 1 800 and 3 200 m asl. It is commonly found in streams and rivers flowing eastward into South Africa rather than those flowing west into Lesotho. Although some subpopulations are noted to have declined, no reduction in EOO of 4 000 km<sup>2</sup> has yet been noted.

### Population:

Concerns have been raised over recorded pathogen-related mortalities (Smith *et al.* 2007), although the effect on populations is as yet unknown. It is locally abundant in its restricted range.

### Habitat and Ecology:

It is a water-dependent species in montane grassland. It is found only in pristine habitats, and it is not present in agricultural areas. It is not known to move over land. It breeds in cold clear streams with associated pools with rocky substrates.

### Major Threats:

It is not significantly threatened because of the remoteness of its habitat. Local populations may be affected by overgrazing by livestock (causing erosion and subsequent siltation) and dams on rivers. An additional observed risk is the threat of predation and competition posed by the introduction of trout and other alien fish for recreational fishing into the main rivers of Lesotho (Swartz 2005). There are several undocumented chytrid-related die-off events recorded for this species at several sites (Du Preez & Weldon pers. comm. 2009), and chytrid infection rate is up to 38.6% in tadpoles (Smith *et al.* 2007), although these subpopulations at these same sites still appear healthy (Du Preez & Weldon pers. comm. 2009).

### Conservation Actions:


This species would benefit from monitoring of subpopulations with particular reference to the spread and effect of chytrid. Baseline data on life-history, ecology, population trends and threats are all required before monitoring can begin. It occurs in the uKhahlamba-Drakensberg Park.

## Family: PYXICEPHALIDAE

### Mistbelt Chirping Frog:

*Anhydrophryne ngongoniensis* (Bishop & Passmore, 1993)

This species was recently found to belong in the genus *Anhydrophryne* rather than *Arthroleptella* (Dawood & Stam 2006).



**< ENDANGERED >**  
EN

**Endangered,  
B1ab(i,ii,iii,iv)+  
2ab(i,ii,iii,iv)**

Listed as Endangered because its EOO is estimated to be 1 525 km<sup>2</sup>, its AOO is estimated to be ca. 992 ha (just below 10 km<sup>2</sup>), and both are experiencing a continuing decline. Its distribution is restricted to four locations and there is a continuing decline in the number of subpopulations and in the extent and quality of its habitat.

History: 2004 – Critically Endangered

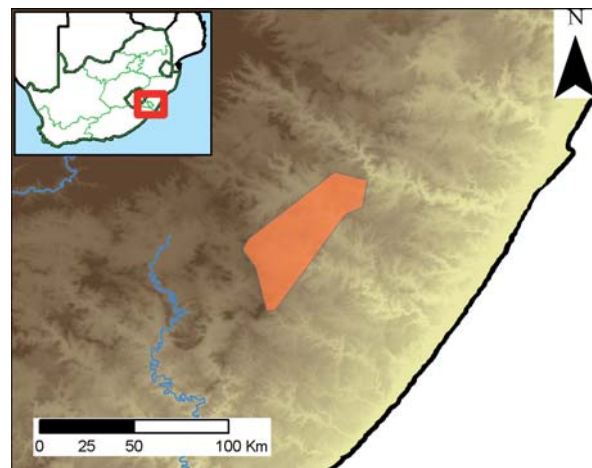
### Geographic Range:

South Africa (KwaZulu-Natal)

This species is restricted to a small area of mist belt on the eastern escarpment of KwaZulu-Natal (which includes the former enclave of Eastern Cape, recently incorporated into KwaZulu-Natal), South Africa. Six fragmented and isolated subpopulations were known until 2004 (Minter *et al.* 2004). Recent surveys indicate that the species is extant at four of the six known sites, but it is possibly extinct at two of these sites (Harvey pers. comm. 2009). In addition, it has been found to occur more extensively in Ngele Forest than previously known, in the Mpur forestry area, and a new population within the Ixopo region (Roelton Dam) was also discovered (Harvey pers. comm. 2009). Within the Mpur forestry area, *A. ngongoniensis* was recorded at several new sites (Harvey pers. comm. 2009). In total, 12 subpopulations are now known, although these are aggregated in only four locations. It is known to occur between 1 020 and 1 720 m asl, and its total AOO is estimated to be 9 km<sup>2</sup> (Harvey pers. comm. 2009), while its EOO is estimated to be 1 525 km<sup>2</sup>.



V. Carruthers



### Population:

Based on surveys conducted from 2003–2005, the global adult population size of *A. ngongoniensis* is estimated to lie between 2 495 and 3 350 individuals (Harvey pers. comm. 2009). It is uncertain how many discrete subpopulations are involved, but for the purposes of this assessment we are provisionally considering twelve subpopulations, two of which may be extinct, based on the results of recent field work (Harvey pers. comm. 2009). The largest single subpopulation would appear to occur in Ngele Forest, and while 'Poortje Forest' may also hold a large subpopulation, this still needs to be confirmed (Harvey pers. comm. 2009). Although the Mpur forestry sites are separated, various sites may be connected as part of a larger subpopulation (Harvey pers. comm. 2009). The spatial distribution of this species is not considered to be severely fragmented as one subpopulation/location holds >50% of individuals. Other subpopulations are small and scattered and distances are considered to be too great for dispersal within one generation.



### Habitat and Ecology:

It is known from montane forest and, to a lesser extent, high-altitude grassland (Harvey pers. comm. 2009). It appears to be strongly associated with riparian zones, and in grassland sites, with very dense vegetation (Harvey pers. comm. 2006). Most sites from which it has been recorded are surrounded by exotic tree plantations (Harvey pers. comm. 2009). It generally prefers steep slopes, close to seepages. It breeds in decaying vegetation at the base of grass and sedge tussocks on grassy slopes in the mist belt of the escarpment. Males call from well-concealed positions at the bases of grass tussocks by day, while at night they climb to calling positions about 20 cm below the tips of grass stems. The eggs are laid on damp soil or vegetation and develop directly, without a larval stage.

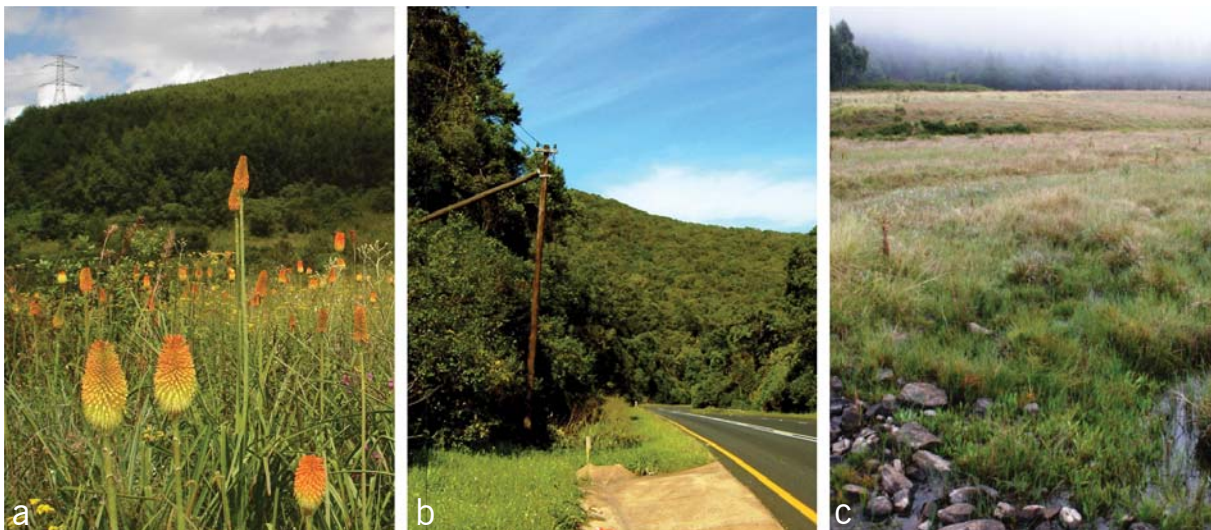
### Major Threats:

The habitat of this species is experiencing a rapid rate of loss, due to afforestation, the spread of invasive wattle trees (lowering the water table), and the impact of inappropriate fire regimes. Additional threats include timber plantations, overgrazing, fragmentation, dust and habitat damage due to harvest activities (Harvey pers. comm. 2006, 2009). The greatest threats are fires, invasive plants and habitat fragmentation resulting in population isolation (Harvey pers. comm. 2009). Forest populations appear to be less threatened given that their habitat patches are typically larger and not as exposed to many of the identified threats, including burning (Harvey pers. comm. 2006). Inappropriate use of agrochemicals for alien plant control could also potentially impact upon a population, although

this has not been investigated (Harvey pers. comm. 2009). Climate change could also be a potential threat given predictions of loss of grassland biome and species range shifts and contractions due to changes in climatic conditions. This species has a small range and has less than half the population distributed in subpopulations that are within a transformed land matrix and it is not likely that there is additional appropriate habitat to colonise, although this requires further investigation (Harvey pers. comm. 2009).

### Conservation Actions:

Although it occurs in the Ngele Forest Reserve, most of the habitat of this species is not protected, so improved protection and maintenance of the remaining habitat is a priority. The relative impact of perceived threats needs to be researched and populations together with habitat require monitoring. Recent surveys have found that the majority of populations occur on land belonging to two private forestry companies (Harvey pers. comm. 2006). These companies initially responded positively towards the species' conservation, and management guidelines were developed and provided to both companies, with one company implementing a long-term monitoring programme for this species (Harvey pers. comm. 2006). However, there has been a recent change in environmental management staff and no further monitoring efforts have taken place since. It is unknown whether these companies have implemented the suggested management recommendations (Harvey pers. comm. 2009).




Lynford Valley, Ixopo (a) is the type locality of the Mistbelt Chirping Frog (*Anhydrophryne ngongoniensis*) with encroaching pine plantations in the background. Ngele Forest (b) supports the largest known population of Mistbelt Chirping Frogs, bisected by a highway. Poortje Wetland (c), with hummock marsh in the foreground supporting Long-toed Tree Frogs (*Leptopelis xenodactylus*, see page 45) and grassy upland slopes in the background, the habitat of the Mistbelt Chirping Frog, in which encroaching pine plantations are just visible through the mist. Photographs: (a) J. Tarrant (b) J. Harvey (c) L. du Preez.



## Family: PYXICEPHALIDAE

### Hogsback Chirping Frog: *Anhydrophryne rattrayi* (Hewitt, 1919)



< VULNERABLE >  
v.u.

**Vulnerable,  
B1ab(iii)+2ab(iii)**

Listed as Vulnerable, as this species has a small EOO and AOO, and there is a continuing decline in the quality of habitat. Although this species qualifies as Endangered, it appears to be plentiful where it occurs and the decline in habitat quality is not thought to be particularly severe. It may occur in more locations than currently known as there are unsurveyed areas with suitable habitat.

History: 2004
–
Endangered

#### Geographic Range:

South Africa (Eastern Cape)

This species is known only from the Amatola, Katberg and Keiskammahoek Mountains (three locations) in the Eastern Cape. It has a small EOO of 3 705 km<sup>2</sup>, and an AOO estimated at 10%, although there is a possibility that this species occurs in several more locations but these have not yet been surveyed. There is a record from near Patensie, some 200 km southwest of the main range, but it has not been found in this area since it was discovered in 1961 and has not been included in this assessment. This species occurs above 1 100 m asl.

#### Population:

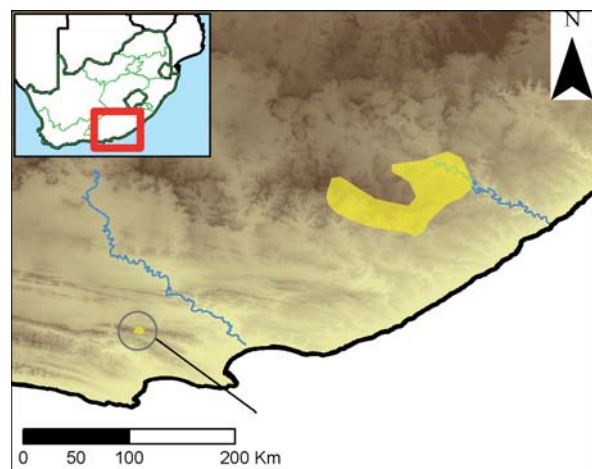
It can be common in suitable places. The distribution of this species is not thought to be severely fragmented as less than half of the animals are in isolated patches. Although it is recorded from three localities it is expected to be found elsewhere.

#### Habitat and Ecology:

It inhabits the leaf litter of montane forest and lives on the forest edge, being particularly associated with the grassland-forest ecotone, and with small patches of grass and wetland inside forest. However, it is not found outside forest. It makes a ter-



M. Burger



restrial nest, and lays 11–20 eggs, which develop directly, without a larval stage.

#### Major Threats:

The main threat is habitat loss due to human settlement, small scale agriculture, afforestation, invasive plants and fire. Pines are often planted right up to the natural forests, destroying the grassland-forest ecotone. Its remaining habitat is very restricted and patchy.

#### Conservation Actions:

More information about the phenology of this species would be useful, as well as trends in populations and assessments about the magnitude of each threat. Grassland-forest ecotone protection might benefit this species and may be an undervalued habitat for conservation. It occurs in several state forests and nature reserves, including Hogsback Indigenous Forest, Katberg Forest and Stutterheim Nature Reserve.

## Family: PYXICEPHALIDAE

Drewes' Moss Frog:

*Arthroleptella drewesii* Channing,  
Hendricks & Dawood, 1994



### Near Threatened

Listed as Near Threatened as although it would meet requirements for Endangered under criterion B1b(iv,v)

c(iii,iv)+2b(iv,v)c(iii,iv) the threats are currently not considered to be sufficiently severe or intense, are not considered likely to occur within two generations, and are being controlled by Provincial and local authorities as well as a private nature reserve.

History: 2004 – Data Deficient

### Geographic Range:

South Africa (Western Cape)

This species is known only from two locations on the slopes of the lower Kleinrivier and Babilonstoring Mountains near Hermanus in the Western Cape, above 200 m asl and up to 1 100 m asl. Most of its very restricted EOO (17 km<sup>2</sup> with AOO estimated at 10% of EOO) falls within protected areas.

### Population:

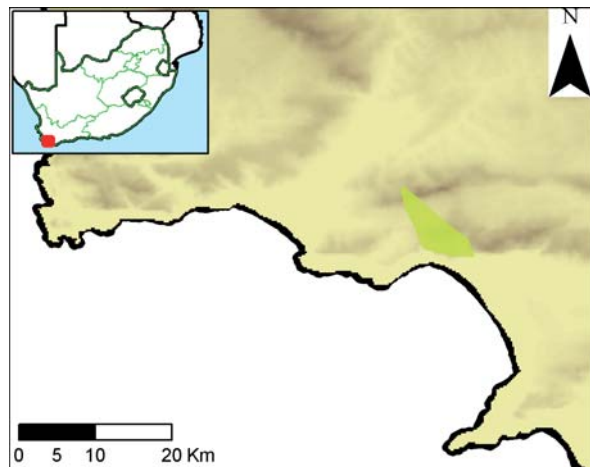
It occurs in small, widely scattered subpopulations associated with seepages within two locations, one a large mountain range and the other a small mountain range. Fire and post-fire impacts on number of mature individuals are expected to cause large fluctuations in subpopulation sizes (as in other members of this genus) but the species as a whole should be buffered against these fluctuations by the relatively large number of subpopulations within each location if the fires are not severe enough to extirpate the entire location.

### Habitat and Ecology:

This is a species of fynbos heathland, which does not survive in degraded areas. It breeds in wet mossy areas near densely vegetated streams and hillside seepages. It presumably lays its small direct-developing eggs (expected to be 10, like



A. Turner



other members of the genus) in moss or similar vegetation.

### Major Threats:

Its habitat is largely protected, although one threat to it is the spread of alien species (in particular pines and hakeas) and too frequent and intense fires which are expected to cause large fluctuations in subpopulation sizes (as in other members of this genus). However, these threats are not considered to be severe or intense but require active management as they will act synergistically.

### Conservation Actions:


This species requires monitoring of habitat and populations to achieve ecologically sound fire management once basic information concerning population size and phenology is collected. Removal of alien invasive plant species, already being implemented in some protected areas, should continue across the entire range of this species. It occurs in Babilonstoring, Fernkloof, Maanschynkop and Vogelgat Nature Reserves. The effects of fire on this and other species of *Arthroleptella* require research.

## Family: PYXICEPHALIDAE

### Landdroskop Moss Frog:

*Arthroleptella landdrosia* Dawood & Channing, 2000

The taxonomy of *A. landdrosia* is under revision and is presently best considered complex. The current assessment will be an evaluation of the entire complex.



**Near Threatened**

Listed as Near Threatened as, although it qualifies for Endangered under B1ab(ii,iii)c(iv)+2ab(ii,iii)c(iv), it is relatively abundant within its small EOO (283 km<sup>2</sup>), and the current threats are not perceived to be severe. However, the extent and quality of its habitat are probably declining a little, thus making the species close to qualifying for threatened status.

History: 2004 – Near Threatened

### Geographic Range:

South Africa (Western Cape)

This species is endemic to the Hottentots-Holland and Kogelberg Mountain (up to 1 200 m asl) complexes, South Africa. It has a small EOO of 283 km<sup>2</sup> with an AOO estimated at 10%.

### Population:

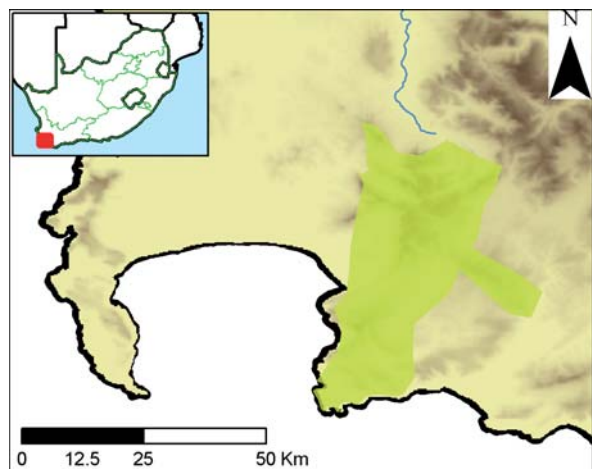
This species occurs in small, widely scattered subpopulations (these are currently estimated to be 12). Fire and post-fire impacts on number of mature individuals are expected to cause large fluctuations in subpopulation sizes (as in other members of this genus) but the species as a whole should be buffered against these fluctuations by the relatively large number of locations.

### Habitat and Ecology:

It inhabits fynbos heathland and does not survive in degraded areas. Breeding is by direct development, and eggs (average expected to be 10 like other members of the genus) are laid in wet vegetation in fynbos seeps and marginally in forest habitats.



A. Turner



### Major Threats:

Even though its habitat is largely protected, the major threats to this species are the spread of alien species (in particular pines) and too frequent and intense fires. Coastal populations are likely to be affected by urban development. However, these threats are believed to be relatively minor.

### Conservation Actions:

Although urban spread, invasive plants and fire are threats, no conservation actions are currently prioritised for this species. Much of this species' range is protected in the well-managed Hottentots-Holland and Kogelberg Nature Reserves. Taxonomic revision is still in progress and more work on population status is required in order to begin monitoring population trends (and the effect of threats such as fire frequency). Results from research need to feed into conservation management plans in affected areas.



## Family: PYXICEPHALIDAE

Cape Peninsula Moss Frog:  
*Arthroleptella lightfooti* (Boulenger,  
1910)



### Near Threatened

Although this species qualifies for Endangered under B1ab(ii,iii,v) c(iv)+2ab(ii,iii,v)c(iv), it has been listed as Near

Threatened because it is relatively abundant within its small EOO (134 km<sup>2</sup>) and the current threats are not considered to be severe. However, the extent and quality of its habitat are probably declining a little suggesting that it may become threatened.

History: 2004 – Near Threatened

### Geographic Range:

South Africa (Western Cape)

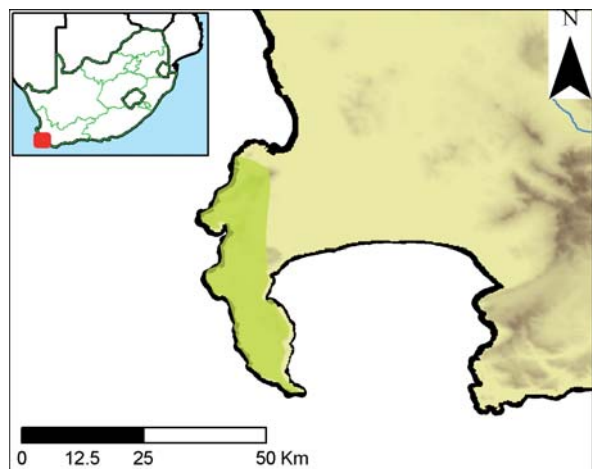
This species is endemic to Table Mountain and to the other mountains of the Cape Peninsula, where it occurs from sea level up to 1 000 m asl. It is very restricted with a small EOO (134 km<sup>2</sup>) and an AOO estimated to be 10%.

### Population:

This species appears to be relatively abundant on the Cape Peninsula. Fire and post-fire impacts on number of mature individuals are expected to cause large fluctuations in subpopulation sizes (as in other members of this genus) but the species as a whole should be buffered against these fluctuations by the relatively large number of locations (currently estimated to be 10).

### Habitat and Ecology:

It is a species of fynbos heathland and forest that does not survive in developed areas. Breeding is by direct development, with 5–12 eggs being laid in moss or similar vegetation in wet mossy areas near rivers, hillside or roadside seepages, and heavily vegetated streams.



### Major Threats:

Even though its habitat is largely protected, the major threats to this species are the spread of alien species (in particular pines) and too frequent or intense fires which cause extreme population fluctuations. Increased tourism in the area needs to be properly managed to minimise impact. There has probably been some loss of habitat in the past due to urban development and pine plantations on parts of the mountains.

### Conservation Actions:

No conservation actions are currently prioritised for this species, however, monitoring programs are required to determine population trends. Most of this species' range is in Table Mountain National Park and Kirstenbosch National Botanical Garden and thus potential impacts from tourism need to be properly managed. Results from research need to be placed into a management framework for active conservation measures, inclusive of invasive species control.




## Family: PYXICEPHALIDAE

### Rough Moss Frog:

*Arthroleptella rugosa* Turner & Channing, 2008

This species was recently described by Turner & Channing (2008).



**Critically Endangered**  
 $B1ab(i,ii,iii,v)$   
 $c(iv) + 2ab(i,ii,iii,v)$   
 $c(iv)$

This species is classified as Critically Endangered in view of its very small EOO (2.3 km<sup>2</sup>) and AOO (0.9 km<sup>2</sup>) and the ongoing threats of fire and invasive vegetation causing large population fluctuations to a very small population of adult individuals.

History: 2004 – Not Listed

### Geographic Range:

South Africa (Western Cape)

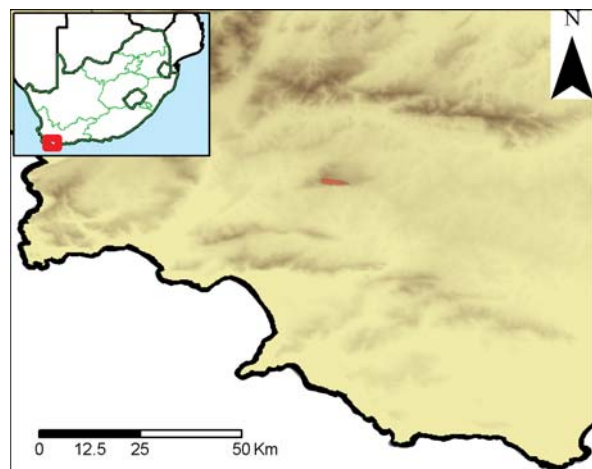
This species is confined to a very small area (between 500 and 800 m asl) of the Klein Swartberg near Caledon, Western Cape. Reduction of the very small AOO (0.9 km<sup>2</sup>) and EOO (2.3 km<sup>2</sup>) is ongoing.

### Population:

Extensive survey work has been conducted and the number of mature individuals is estimated to be around 1 000. Fire and post-fire impacts on number of mature individuals are expected to cause large fluctuations in subpopulation sizes (as in other members of this genus) and the species as a whole is threatened due to the single location.

### Habitat and Ecology:

This species occupies indigenous fynbos heathland vegetation and can be found in dense restio stands in close proximity to seepages. The area it occupies is under threat from alien vegetation and too frequent fires and has an ongoing decline in quality.



It is a direct developing species laying around 10 eggs like other members of the genus.

### Major Threats:


The main threats to this species are fires which cause extreme population fluctuations and have a synergistic effect on alien invasive plants which are degrading and drying seepages. Both threats are extensive and severe on the entire distribution of this species.

### Conservation Actions:

Identification of impact of threats and their management is seen as a key area of research for the conservation of this species. An invasive alien plant clearing plan for the site is a priority and is being developed by CapeNature and private land owners. This and other members of the genus require more information on life history, dispersal and population size to be followed by monitoring.

## Family: PYXICEPHALIDAE

Northern Moss Frog:  
*Arthroleptella subvoce* Turner, de  
Villiers, Dawood & Channing, 2004



**Endangered B1ab(ii)  
c(iv)+2ab(ii)c(iv)**

Listed as Endangered as, although it qualifies for Critically Endangered under B2c(iv) (extreme fluctuations in the number of adult individuals), the intensity of the threats are currently low. Therefore this factor was downweighted in the assessment.

History: 2004 – Data Deficient

### Geographic Range:

South Africa (Western Cape)

This species is currently known only from three locations in the mountains of the Groot Winterhoek Wilderness Area, Western Cape. The known EOO is about 3.3 km<sup>2</sup> and the estimated AOO is 10% of this. It has been recorded at altitudes above 900 m asl.

### Population:

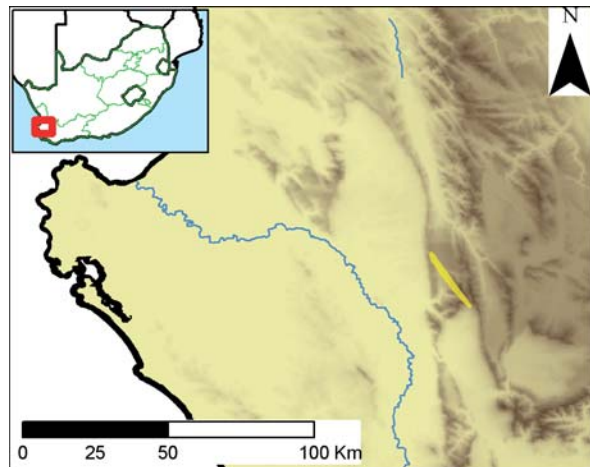
One of the three known populations is monitored twice a year. This is the second largest of the three populations and the largest number of calling males is estimated to be less than 50 individuals. Fire and post-fire impacts on number of mature individuals are expected to cause large fluctuations in subpopulation sizes (as in other members of this genus) and species as a whole is threatened due to the small number of locations.

### Habitat and Ecology:

This species is known from thickly vegetated seeps dominated by restioid vegetation, on gentle mountain slopes within montane fynbos. It breeds by direct development laying between 6 to 12 eggs annually.

### Major Threats:

The main threat to this species is damage to its habitat which is dependent on permanently avail-



able surface water. This habitat is primarily threatened by excessively short fire-return intervals and invasion by alien plants. Although the area has low densities of alien plant species and an acceptable fire-return interval currently, these are ever present threats. The invasion of alien invasive woody vegetation increases the impact of fires which may lead to more dramatic population fluctuations. An additional threat to this species is the proximity of one population to human residences which may result in water contamination. Active management is required in order to prevent threats escalating.

### Conservation Actions:

Most of the known range of this species falls within a protected area, the Groot Winterhoek Wilderness Area. A monitoring programme has been set up to monitor the population near human habitation. Perceived threats and the effects of fire on this and other species of *Arthroleptella* require research. More research is required on life-history and dispersal of this species. Active management is required, especially with regard to alien invading plants.

## Family: PYXICEPHALIDAE

Cape Caco:

*Cacosternum capense* Hewitt, 1925



### Near Threatened

Listed as Near Threatened because, while it occurs in about fifteen different locations and its distribution is not considered to be severely fragmented, its EOO is less than 20 000 km<sup>2</sup>, its AOO is probably less than 2 000 km<sup>2</sup> and the quality of its habitat in the southwestern Cape is declining.

Listed as Near Threatened because, while it occurs in about fifteen different locations and its distribution is not considered to be severely fragmented, its EOO is less than 20 000 km<sup>2</sup>, its AOO is probably less than 2 000 km<sup>2</sup> and the quality of its habitat in the southwestern Cape is declining.

History: 2004 – Vulnerable

### Geographic Range:

South Africa (Western Cape)

This species is endemic to the Cape lowlands (below 280 m asl) west of the Cape Fold Mountains, in the Western Cape. It occurs from the Cape Flats, through the wheat-growing region known as the Swartland, northwards for approximately 200 km to Graafwater, with two relictual populations occurring in the Olifants and Breede River valleys. Its EOO (19 500 km<sup>2</sup> with an AOO of around 1%) appears to have contracted over the last few decades in tandem with increased urbanisation. It is now extirpated from the urban areas and immediate surrounds of Cape Town. However, this process has slowed in recent years.

### Population:

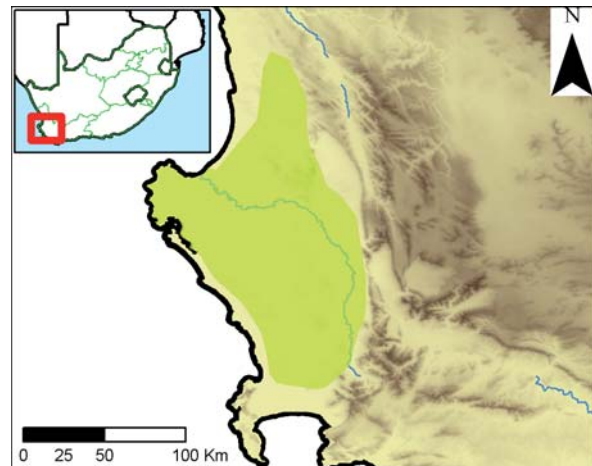
Subpopulations are widely scattered and densities (as assessed by chorus intensity) can be high but do not normally reach historical levels. Most of the populations that were close to regions of heavy urbanisation have been lost.

### Habitat and Ecology:

It lives in undulating low-lying areas with poorly drained loamy to clay soils, although it is known from some shallow sand habitats. The dominant vegetation in which it historically occurred was Renosterveld heathland, which can leach and acidify the surface water. However, its contemporary presence in disturbed agricultural land indicates that acidic water is not a prerequisite for this species. It breeds in vleis and depressions in flat low-lying areas. The eggs are laid in numerous small clusters (20–50) attached to submerged vegetation in temporary water, with up to 400 eggs from a



L. du Preez



single female. It can tolerate some disturbance and survives in many regularly ploughed wheat fields, possibly due to its burrowing to depths below the reach of conventional ploughs (they aestivate in burrows during the dry season).

### Major Threats:

This species occurs in a habitat that is in high demand for urbanisation and agriculture and over 90% of its former habitat has been transformed by agriculture or urbanisation. These same areas are under pressure from alien invasive plants which threaten to dry the breeding habitats. The long-term viability of populations living in disturbed agricultural fields, which contain high levels of agrochemicals, is uncertain.

### Conservation Actions:

No research or conservation priorities are assigned to this species. Knowledge of the biology and ecology of the species, together with how these are affected by habitat changes and different land uses, and in particular agrochemicals, are needed to better evaluate its status. It is known to occur in three protected areas: J.N. Briers-Louw Provincial Nature Reserve (near Paarl), Elandsberg Private Nature Reserve (near Hermon) and the adjoining Voëlvlei Provincial Nature Reserve.



## Family: PYXICEPHALIDAE

Karoo Caco:

*Cacosternum karooicum* Boycott, de Villiers & Scott, 2002



**Least Concern**

This species is listed as Least Concern as it has a large distribution, is presumed to have a large population, and appears to have no known major threats.

History: 2004 – Data Deficient

### Geographic Range:

South Africa (Western Cape, Northern Cape)

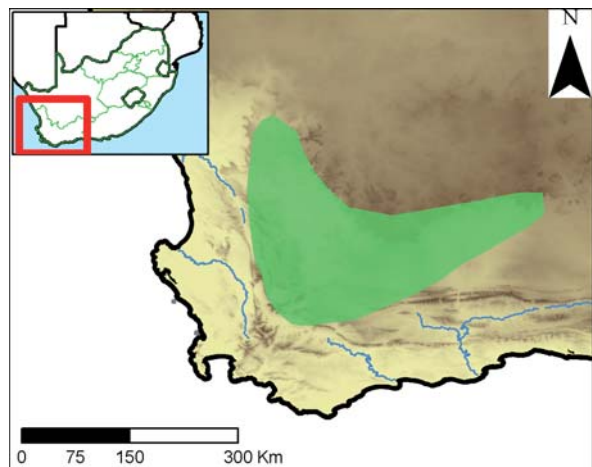
This species is endemic to the Karoo (between 750 and 1 500 m asl) in the Western Cape and Northern Cape. It has a large EOO (23 575 km<sup>2</sup>) and an AOO of 1 746 km<sup>2</sup>.

### Population:

Where it is known it appears to be locally abundant.

### Habitat and Ecology:

It lives in dry shrubland, semi-deserts, and rocky areas. It is probably associated with stony substrates, aestivating in rock cracks and crevices during harsher conditions. It is an opportunistic breeder, taking advantage of rainfall of sufficient magnitude regardless of the season in which it occurs. It breeds in temporary natural stream-side pools, but is also able to utilise man-made water sources.



### Major Threats:

There is no information on threats to this species, but given that it is probably fairly adaptable, and that it occurs in an area of low human impact, it is probably not particularly threatened.

### Conservation Actions:

No research or conservation priorities are listed for this species. It is known from Karoo National Park, Vrolijkheid Nature Reserve and Boesmansklouf Private Nature Reserve.



## Family: PYXICEPHALIDAE

### Striped Caco:

*Cacosternum striatum* FitzSimons, 1947

LEAST  
CONCERN
LC



Least Concern

Listed as Least Concern as this is a wide-ranging common species. Threats are localised and therefore negligible to the species as a whole.

History: 2004 – Data Deficient

### Geographic Range:

Lesotho, South Africa (KwaZulu-Natal)

This species occurs in South Africa and Lesotho, where it has been recorded from the midlands of KwaZulu-Natal and coastal regions (0 m asl) from Durban north to Charter's Creek. It is also known from the southern Drakensberg Mountains, South Africa, up to at least 1 800 m asl, perhaps higher. Its distribution is large (EOO is 25 650 km<sup>2</sup>), and AOO (estimated at 2% of EOO) is incompletely known at present.

### Population:

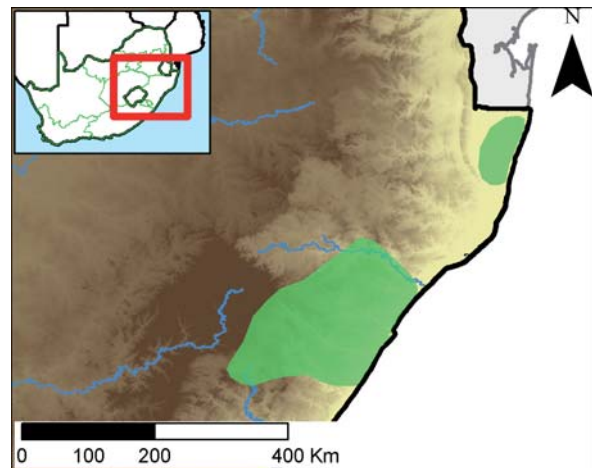
It appears to be relatively abundant in places where it is found.

### Habitat and Ecology:

It is generally associated with grassland areas, and breeding takes place in dense grass tussocks in inundated wetlands, marshy areas, or adjacent to slow-flowing side waters of highland streams. It is found in both low- and high-altitude habitats.



M. Burger



### Major Threats:

There are no major threats known to the species at this time. Potential future threats are small scale farming and pollution associated with fertiliser and pesticides.


### Conservation Actions:

No conservation actions are prioritised for this species. It is known from Sehlabathebe National Park in Lesotho, and iSimangaliso National Park and Vernon Crookes Nature Reserve in South Africa.

## Family: PYXICEPHALIDAE

Micro Frog:

*Microbatrachella capensis* (Boulenger, 1910)



CRITICALLY  
ENDANGERED  
CR

**Critically Endangered, B2ab(ii,iii)**

Listed as Critically Endangered because its AOO is 7 km<sup>2</sup>, its distribution is severely fragmented, and there is a continuing decline in its AOO, and in the extent and quality of its habitat.

History: 2004 – Critically Endangered

### Geographic Range:

South Africa (Western Cape)

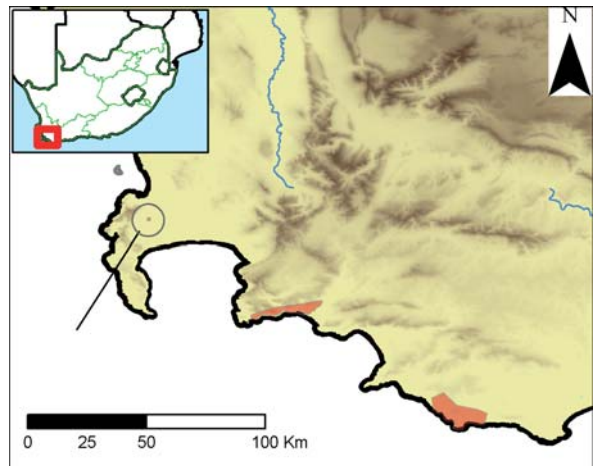
This species occurs only in the coastal lowlands (from 15 m up to 80 m asl) in the southwestern part of the Western Cape, where it formerly ranged from Cape Town east to the Agulhas Plain (with an EOO of 1 399 km<sup>2</sup>). However, it is now extinct on the Cape Flats near Cape Town, except at one locality at Kenilworth Race Course. Its eastern distribution is much more fragmented than is shown on the map (four locations), since it occurs only in very isolated localities (AOO 7.36 km<sup>2</sup>, which is considered to be declining).

### Population:

It occurs in high densities at breeding sites, which are few and far between. The spatial distribution of this species is considered to be severely fragmented as over 50% of individuals are in isolated patches, and the distances between subpopulations are considered to be too great for dispersal within one generation.

### Habitat and Ecology:

This species lives in sandy, coastal fynbos heathland, and it is not generally found in anthropogenic habitats. It is associated with seepage pools and seasonal vleis, and depends on black, acidic waters for breeding. Providing that the water remains of this quality, it can tolerate very limited habitat disturbance. When their wetland habitat dries up, they bury themselves and aestivate through the dry



season. Eggs are attached to submerged vegetation, and larval development is slow.

### Major Threats:

It has a very restricted range in an area that is subject to the impacts of urbanisation, agricultural expansion, the spread of alien vegetation (leading to drying out of breeding pools), and drainage of breeding habitats. Three of the four locations in which it occurs are under constant pressure from development.


### Conservation Actions:

High priority should be given to resolution of the taxonomic status of disjunct populations. A further priority for research conservation action is to obtain accurate monitoring through calls of males for this species. As its name implies, it is a very small frog and this research will be challenging. Agulhas National Park is the only statutory protected area in which it occurs, although it is also present in various other local authority and private nature reserves. However, additional habitat protection is needed in view of the species' fragmented distribution.

## Family: PYXICEPHALIDAE

### Kloof Frog:

*Natalobatrachus bonebergi* Hewitt & Methuen, 1912



**Endangered,  
B2ab(ii,iii)**

Listed as Endangered, in view that its AOO is around 150 km<sup>2</sup>, its distribution is severely fragmented, and there is a continuing decline in the extent and quality of its habitat and AOO.

History: 2004 – Endangered

### Geographic Range:

South Africa (Eastern Cape, KwaZulu-Natal)

This species is restricted to southeastern South Africa, where it ranges from Dwesa Nature Reserve in the Eastern Cape east to southern and central KwaZulu-Natal. Its EOO has been estimated as 15 000 km<sup>2</sup>, with an AOO of approximately 1% of the EOO (150 km<sup>2</sup> and declining). It occurs in nine locations, all between 50 and 900 m asl.

### Population:

Little population information is available for this species. It is considered to be severely fragmented as >50% of individuals are in isolated patches and the distances between subpopulations are considered to be too great for dispersal within one generation.

### Habitat and Ecology:

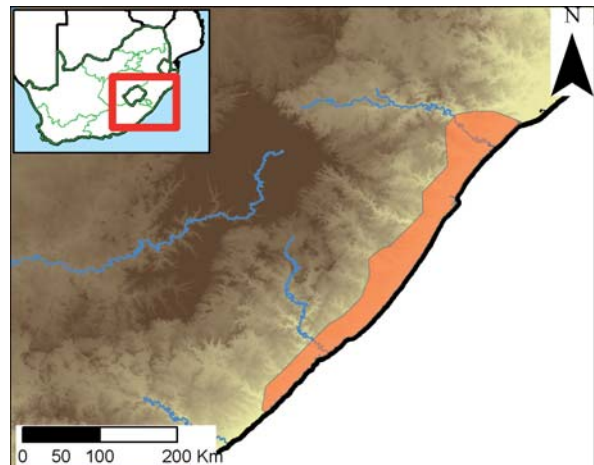
It lives in coastal forests and gallery forests, where it is usually found along streams and does not survive in open areas. It breeds in streams, hanging its eggs above water on branches, and sometimes on rock faces. The larvae fall into the water where they develop.

### Major Threats:

Much of the forest habitat of this species has been lost to sugar cane cultivation and other agricul-



L. du Preez



ture, woodcutting, afforestation and urbanisation. It is also threatened by pollution and siltation of streams.

### Conservation Actions:

A priority for conservation research is to estimate the population size of adults in subpopulations, as well as determining the cause of direct threats. Obtaining a memorandum of understanding with land owners is also of high priority. It occurs in several protected areas, including Umtamvuna Nature Reserve and Oribi Gorge Nature Reserve. However, additional habitat and waterway protection is required.



## Family: PYXICEPHALIDAE

Montane Marsh Frog:  
*Poyntonia paludicola* Channing &  
Boycott, 1989



### Near Threatened

Although this species has a small EOO (5 000 km<sup>2</sup>), it is relatively abundant, has a stable population and occurs almost entirely within protected areas, so it does not qualify for a threatened status. However, there are ongoing threats (such as alien vegetation) which are not currently severe, but that make the species close to qualifying for threatened status and hence it is listed as Near Threatened.

History: 2004 – Near Threatened

### Geographic Range:

South Africa (Western Cape)

This species occurs only in the Hottentots-Holland, Kogelberg Mountain complex, and the Klein River Mountains, in the southwestern part of Western Cape, from 200–1 800 m asl. It occurs in four locations and the EOO is estimated at 5 000 km<sup>2</sup> with an AOO of approximately 5% of the EOO.

### Population:

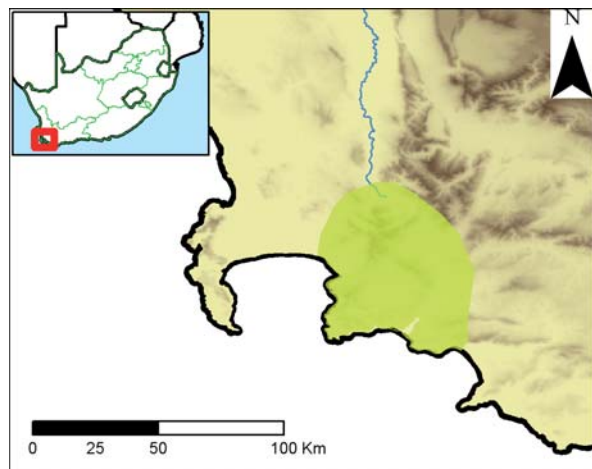
This species is relatively abundant within areas where it occurs. The population is believed to be stable.

### Habitat and Ecology:

It inhabits mountain fynbos heathland, and is restricted to areas with high rainfall (2 000–3 000 mm of rain per year). It breeds in shallow streams and seepages.



A. Turner



### Major Threats:

The main threats to this species are the spread of alien species (pines in particular), afforestation, construction of dams, and too frequent fires. However, these threats are currently believed to be relatively minor due to sound reserve management.

### Conservation Actions:

Taxonomic studies should be prioritised to establish the status of disjunct distributions. No conservation actions are currently prioritised for this species. All populations recorded to date have been found in protected areas, Kogelberg Biosphere Nature Reserve, Hottentots-Holland Nature Reserve and Fernkloof Nature Reserve.



## Family: PYXICEPHALIDAE

Namaqua Stream Frog:  
*Strongylopus springbokensis* Channing,  
1986



**Least Concern**

Previously listed as Vulnerable, this species has been found in a larger area between what were previously considered to be fragmented subpopulations. It is now listed as Least Concern in view of its wide EOO and stable population.

History: 2004 – Vulnerable

### Geographic Range:

Namibia (presence uncertain), South Africa (Northern Cape)

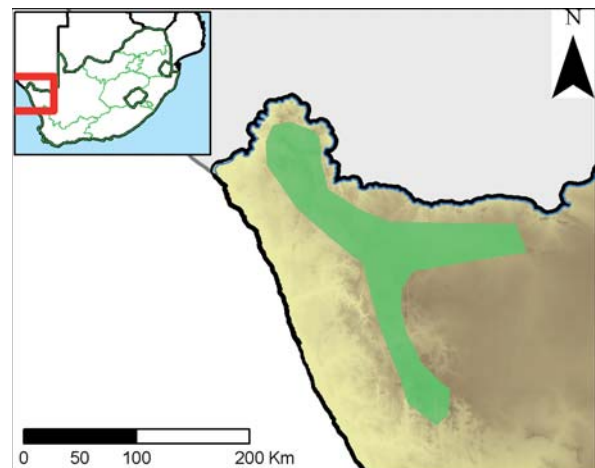
This species lives in mountainous areas of Namaqualand north of the Knersvlakte and south of the Orange River in the Northern Cape. It has not so far been recorded from Namibia, although it is likely to occur there. It is found at 200–1 600 m asl. Its EOO is estimated as 9 000 km<sup>2</sup> with an AOO of approximately 5% of the EOO and it is known from around 15 locations.

### Population:

This species is not uncommon in proximity to water sources in its habitat.

### Habitat and Ecology:

It lives in springs and streams in rocky hills and mountains in the succulent karoo and fynbos (heathland) biomes. It breeds in springs and streams, small permanent and temporary ponds, as well as small artificial dams. It lays its eggs out of water under rocks or in rock crevices, tunnels in vegetation, or rodent burrows. Development is arrested after the tadpoles' eyes and tails are formed,



and await the rains that hatch the eggs and sweep the tadpoles into water.

### Major Threats:

Although its habitat is degraded by grazing pressure (including trampling at watering points), and siltation and pollution of the streams, these threats are acting on a minority of subpopulations and so are not currently considered to be very severe.

### Conservation Actions:

No conservation actions are currently prioritised for this species. It occurs in the Richtersveld National Park.

## Family: PYXICEPHALIDAE

### Plain Stream Frog:

*Strongylopus wageri* (Wager, 1961)

LEAST  
CONCERN
LC

**Least Concern**

Listed as Least Concern as it is widespread and common and has good populations in the Drakensberg. Known breeding sites are all active

History: 2004 – Near Threatened



L. du Preez

### Geographic Range:

Lesotho (presence uncertain), South Africa (Free State, KwaZulu-Natal, Mpumalanga), Swaziland (presence uncertain)

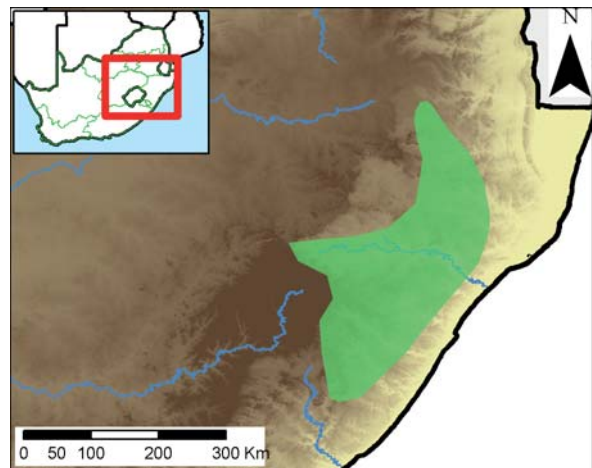
This species ranges from the Wesa Forest in KwaZulu-Natal northwards along the foothills of the Drakensberg Mountain range in South Africa. Isolated populations exist further to the east in Qudeni Forest, Entumeni Nature Reserve, and Ngome Forest Reserve, and along the southern boundary of Mpumalanga. It occurs from low altitudes up to 2 000 m asl. It might occur in Lesotho and Swaziland, but it has not so far been found there.

### Population:

This species can be abundant at sites where it occurs.

### Habitat and Ecology:

At lower altitudes it inhabits mist-belt forest, and at higher altitudes up to 2 000 m asl it occurs in montane grassland. This species appears to be quite sensitive to habitat degradation. It breeds in quiet pools in clear streams. The eggs are laid on vegetation dangling into the water or on rocks, and the larvae develop in the water.



### Major Threats:

This species is threatened by afforestation, and by the introduction of exotic trout that prey on the larvae. However, these threats are currently thought not to be sufficiently intense and are being well-managed within the protected areas in which this species occurs.

### Conservation Actions:

No conservation actions are currently prioritised for this species. This species occurs in a few protected areas (such as Entumeni Nature Reserve and Ngome Forest Reserve).

## Appendix 2

### List of participants and their e-mail addresses



Standing (left to right): Dave Morgan, John Measey, Solly Nkoane, James Harvey, Atherton de Villiers, Ché Weldon, Marius Burger, Alan Channing, Andrew Turner, Sarah Davies and Adrian Armstrong.

Sitting (left to right): Jeanne Tarrant, Louis du Preez, Werner Conradie, Zishan Ebrahim, Krystal Tolley, Les Minter and Michael Cunningham.

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