Southern African Frogs

Conservation Assessment and Management Plan
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INTRODUCTION AND BACKGROUND

Conservation efforts to protect the planet's vertebrate biodiversity have been disproportionate for the various groups and have tended to favour mammals and birds. The so-called 'lower vertebrates', i.e., fish, amphibians and reptiles, generally have a lower public appeal and are typically neglected in conservation programmes, yet these groups are of fundamental importance at an ecosystem level. In terms of species richness, amphibians outnumber mammals with more than 4700 living species currently recognised and with an expected total exceeding 5000 (Glaw & Kohler 1998). Ironically, at a time when taxonomists are unravelling and describing this richness at an unprecedented rate, alarming reports of amphibian population declines and species extinctions are being recorded around the world. Amphibia is proportionally the most threatened group of vertebrates (Branch 1994).

With the world's human population more than doubling during the second half of the 20th century to reach six billion in October 1999 (Brown et al. 1999), a concurrent increase in the rate of habitat loss and species extinction has become the greatest conservation concern. Biologists and wildlife managers realise that strategies geared to reducing the risk and rate of extinction need to be implemented to ensure viable ecosystem functioning in the long term. These strategies can be at a global as well as at a regional or national level, and include habitat preservation, intensified legislation and regulation, additional field research, investigations into the ecological roles of key species, the development of improved biological monitoring techniques and, in some cases, scientifically managed captive populations for potential restocking of wild populations. Another important strategy is the identification and highlighting of those species that are most threatened and thus in greatest need of ameliorative conservation action. Such assessments of threatened plants and animals during the past few decades have typically been presented as national or international Red Data species lists.

Conservation threats and priorities are ever changing and a dynamic system is called for to keep abreast of developments. The concept of Red Data species listing has evolved over the years and today it serves as a model for monitoring the conservation status of species. Although the methods and approaches in achieving these listings have differed over time and between countries, the principles followed were generally the same. For example, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) meets regularly to update species accounts when needed. Drawing from this resource, Seburn and Seburn (2000) took the process an important step further and compiled a document detailing conservation priorities and action plans for Canadian herpetofauna. Such details can also be obtained in the course of a Conservation Assessment and Management Plan (CAMP) for a specific region, such as was done for the amphibians of India (BCPP CAMP Report 1998).

The first assessment of threatened frogs occurring in South Africa, Swaziland and Lesotho was presented in the *South African Red Data Book – Reptiles and Amphibians* (McLachlan 1978) which listed nine species. This was updated 10 years later by Branch (1988). A total of 17 frog species, comprising four Endangered, one Vulnerable, two Rare, eight Restricted, one Peripheral and one Indeterminate species, was included. More than a decade later it again become important to re-evaluate the threatened status of frogs in this region and to this end a CAMP workshop was held in Cape Town during 24–27 July 2000. Arising from that workshop, the present report has been compiled for southern African frogs (see page 15 for details of the CAMP process). The results presented in this document should serve as the basis for compiling the next Red Data Book for this faunal group and region. It is anticipated that this will be done in conjunction with the forthcoming atlas publication which will mark the end of the Southern African Frog Atlas Project (SAFAP).

FROGS AND WETLANDS (largely excerpted from Cowan 1995, especially Channing & Van Dijk 1995).

The World Conservation Strategy (IUCN 1980) identified wetlands as the third most important life support system on Earth. In South Africa, which has relatively few wetlands, it has been estimated that more than one-third have been destroyed or lost (Breen & Begg 1989). Those that remain are in some of the most threatened areas (Zaloumis 1987; Begg 1990).

Besides amphibians, wetlands support an enormous variety of plants, invertebrates, fish, reptiles, birds and mammals, many of which can survive nowhere else. Wetlands help to regulate water quality and flow. Acting as natural filters and sponges, wetlands take up runoff, attenuate floods, reduce erosion, re-charge groundwater, trap sediments, recycle nutrients, oxygenate water and release the purified water gradually back into the system.

South Africa is an arid country in which most wetlands tend to be seasonal. Specific wetlands become biologically active at different times, depending on the seasonality and unpredictable occurrence of rain. Nevertheless, the biotic diversity of the wetlands in South Africa make them particularly important ecosystems, and they are a high priority for protection. South Africa is a signatory to the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR Convention), adopted in 1971, which provides a framework for the international conservation of wetland habitats. The conservation of these areas is essential to the long-term survival of an enormous number of species, including many species of frogs.

Frogs have soft, permeable skin and although they have many adaptations to assist in the reduction of water loss, in general they are confined to damp places when they are active. Most species of frogs, except those living in permanent wetlands, spend a large portion of the year inactive, as dictated by the risk of desiccation and/or a shortage of prey. During the dry periods in wetlands, some species may burrow into the mud or damp subsoil of places where water accumulates in the wet season. Other types of shelter used by frogs include reeds, grass tufts, under rocks, rock crevices, or the burrows of other animals such as rodents (Channing & Van Dijk 1995).

Tadpoles and adult frogs are preyed upon by their own kind and by other animals such as dragonfly nymphs, fishes, water birds, snakes and wetland mammals, such as otters. As both predators and prey, anurans are an important link in many food chains, especially those of wetland ecosystems.

Despite their importance in food chains and as ecological indicators, little attention has been paid to amphibians in the milieu of wetlands in Africa, as well as in the rest of the world. Most South African frogs are terrestrial, with an aquatic larval stage, and are associated with the interface between terrestrial and freshwater aquatic systems. The majority of frogs utilise wetlands for breeding, and many are found in or near bodies of water outside the breeding season. They occur in nearly all wetlands in South Africa: 88 of the 105 described species use wetland habitat. As such, frogs can provide important information pertinent to the ecology of these areas. In South Africa, 19 frog species are permanent residents of wetlands or surrounding areas, 60 use wetlands for breeding and feeding during the rainy season, and 17 species do not use wetlands (see Table 1 in Channing & Van Dijk 1995).

Frogs use a wide range of freshwater wetlands, from rivers, lakes and swamps, through temporary pans and puddles to seepages on mountain slopes and mossy banks. For frogs, the definition of wetlands needs to include very small bodies of water, many of which are shallow and temporary. Small wetlands are especially important for frogs and play a greater role in the metapopulation dynamics of certain taxa than the modest area of small wetlands might suggest (Gibbs 1993).

The onset of rain initiates breeding in most species, with many different breeding strategies being employed. The eggs develop rapidly into free-swimming, feeding tadpoles, with the length of larval life correlated with the stability of the wetland (Channing & Van Dijk 1995). Tadpoles in permanent ponds and streams may take two years to reach metamorphosis, while those developing in temporary pools in dry areas may complete their tadpole life in as little as three weeks (Wager 1965; Channing 1976). Many anurans choose oviposition sites in temporary waters to minimise predation and competition for their tadpoles (Van Dijk 1971b, 1972b). Tadpoles display a range of morphologies related to the phylogeny of each genus, and which enable successful occupation of widely differing habitats (Channing & Van Dijk 1995). Tadpoles generally feed on algae, other plant matter and detritus; adults feed mostly on insects and small invertebrates. Some frogs are completely terrestrial and able to complete their life cycles without using standing water at all. Such species are well represented in southern Africa.

Frog distributions can be classified into two broad categories: those restricted to relatively small areas or specialised habitats, and those with very wide distributions. Both categories are important in wetlands and merit conservation attention. This is particularly important because the viability of tadpoles determines the distribution of the various species: only in those wetlands that can support tadpoles will adult frogs occur on a sustainable basis. The eggs and embryos of anurans in wetlands are sensitive to changes in water conditions. These changes may include presence of herbicides or pesticides or other poisons that may have a deleterious effect (Channing & Van Dijk 1995).

THE DIVERSITY AND ENDEMISM OF FROGS IN SOUTH AFRICA, LESOTHO AND SWAZILAND

The exceptional biodiversity of South Africa, Lesotho and Swaziland (hereafter referred to as “the region”) is apparent in the unusually large number of biomes or distinctive broad vegetation types which are present (Cowling et al. 1997). Seven biomes can be recognized: Succulent Karoo (arid shrublands dominated by succulent plants), Nama Karoo (arid shrublands with a large grassy component), Evergreen Forest, Thicket (inclusive of “Valley Bushveld”), Fynbos (montane and lowland forms), Savannah (woodlands, of various types), and Grasslands (including the sour grasslands and alpine heaths of the Afromontane highlands, and the highveld sweet and mixed grasslands of the plains). This schema is based on those of White (1983), Huntley (1984), Rutherford & Westfall (1986), Low & Rebelo (1996). The biomes are made up of many vegetation types: 70 described by Acocks (1988) and 68 by Low & Rebelo (1996). In a sense, the biomes "summarise" the variation in the many physical factors which have gradients across the region, e.g., precipitation, temperature, altitude, topography and geological substrate, as well as the evolutionary history of the region.

As a group, the frogs of the region are relatively diverse. There are 108 described species, and at least one additional known species awaits description (L.R. Minter in prep.; see Table 1). If the recent trend in taxonomic research is sustained, it is anticipated that several further species will be discovered and described in years to come (Channing 1999). This level of species richness places the region above the global average in relation to land area and is in line with the high species richness in other groups (Siegfried 1989).

The species richness, coupled with the diversity of habitats in the region, is reflected in a diversity of life history traits. For example, there are completely aquatic species (e.g., *Xenopus* spp.) and completely terrestrial species (e.g., *Breviceps* spp.), and a number of groups with intermediate levels of dependence on water for reproduction (e.g., *Arthroleptella* spp. and *Hemisus* spp.). There is also a broad spectrum of reproductive strategies with respect to K and r selection, and rate of tadpole development, depending mainly on the type of oviposition site used (Wager 1986; Harrison 1998). Although there is a marked drop in species richness in the arid west, in comparison with the relatively mesic east, there are species which are adapted to even the most arid parts of the region (Bates 1998).

Given that all the biomes of the region are populated with frogs, a relatively high diversity of species could be predicted. If one also takes into account that the Fynbos and Thicket biomes are restricted to South Africa, that the two Karoo biomes are restricted to the southern African subcontinent (i.e., south of the Kunene and Zambezi rivers), and that the Grassland Biome is completely isolated from other such areas in Africa, it could be further predicted that high levels of endemism may be present amongst the region's frogs.

Endemism with respect to the region (South Africa, Lesotho and Swaziland), and the subcontinent (south of the Kunene and Zambezi rivers) was checked using the interim distribution maps of the Southern African Frog Atlas Project (Minter et al. 2000) as well as the distribution maps of Poynton (1964), Poynton & Broadley (1991) and Channing & Griffin (1993). Species were deemed endemic if at least 90% of their distribution range fell within the region. As predicted, the level of endemism is high (Tables 2 and 3) with 60 of the 109 listed species (55%) being endemic to the region, and a further 12 (11%) being endemic to the southern African subcontinent, i.e., a total of 72 (66%).

Table 2. Species list for the region spanning South Africa, Lesotho and Swaziland. Endemic status: 0 indicates no endemism to southern Africa; 1 indicates endemism to southern Africa; 2 indicates endemism to the region (South Africa, Lesotho and Swaziland). Two species whose status in the region is unclear, and which probably occur only marginally, are indicated as "marginal". The relevant IUCN status categories are Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Data Deficient (DD) and Least Concern (LC). All species without a category shown are Not Evaluated (NE).

SPECIES	**FAMILY**	**Endemic Status**	**Revised Status**
Arthroleptis stenodactylus	Arthroleptidae	0	
Arthroleptis wahlbergi	Arthroleptidae	2	

SPECIES	FAMILY	Endemic Status	Revised Status
Bufo amatolicus	Bufonidae	2	NT
Bufo angusticeps	Bufonidae	2	LC
Bufo fenoulheti	Bufonidae	1	
Bufo gariepensis	Bufonidae	2	
Bufo garmani	Bufonidae	0	
Bufo gutturalis	Bufonidae	0	
Bufo maculatus	Bufonidae	0	
Bufo pantherinus	Bufonidae	2	EN
Bufo pardalis	Bufonidae	2	LC
Bufo poweri	Bufonidae	1	
Bufo rangeri	Bufonidae	2	
Bufo robinsoni	Bufonidae	2	DD
Bufo vertebralis	Bufonidae	2	
Capensibufo rosei	Bufonidae	2	VU
Capensibufo tradouwi	Bufonidae	2	
Schismaderma carens	Bufonidae	0	
Heleophryne hewitti	Heleophrynidae	2	CR
Heleophryne natalensis	Heleophrynidae	2	
Heleophryne purcelli	Heleophrynidae	2	
Heleophryne regis	Heleophrynidae	2	
Heleophryne rosei	Heleophrynidae	2	CR
Hemisus guineensis	Hemisotidae	0	
Hemisus guttatus	Hemisotidae	2	NT
Hemisus marmoratus	Hemisotidae	0	
Afrixalus aureus	Hyperoliidae	1	
Afrixalus delicatus	Hyperoliidae	1	
Afrixalus fornasinii	Hyperoliidae	0	
Afrixalus knysnae	Hyperoliidae	2	DD
Afrixalus spinifrons	Hyperoliidae	2	
Hyperolius argus	Hyperoliidae	0	
Hyperolius horstockii	Hyperoliidae	2	
Hyperolius marmoratus	Hyperoliidae	0	
Hyperolius nasutus	Hyperoliidae	0	
Hyperolius pickersgilli	Hyperoliidae	2	EN
Hyperolius pusillus	Hyperoliidae	0	
Hyperolius semidiscus	Hyperoliidae	2	
Hyperolius tuberilinguis	Hyperoliidae	0	
Kassina maculata	Hyperoliidae	0	
Kassina senegalensis	Hyperoliidae	0	
Leptopelis mossambicus	Hyperoliidae	1	
Leptopelis natalensis	Hyperoliidae	2	
Leptopelis xenodactylus	Hyperoliidae	2	EN
Semnodactylus wealii	Hyperoliidae	2	
Breviceps acutirostris	Microhylidae	2	
Breviceps adspersus	Microhylidae	0	
Breviceps fuscus	Microhylidae	2	
Breviceps gibbosus	Microhylidae	2	NT
Breviceps macrops	Microhylidae	1	NT

SPECIES	FAMILY	Endemic Status	Revised Status
Breviceps montanus	Microhylidae	2	
Breviceps mossambicus	Microhylidae	0	
Breviceps namaquensis	Microhylidae	2	
Breviceps rosei	Microhylidae	2	
Breviceps sp. (sopranus)	Microhylidae	2	
Breviceps sylvestris	Microhylidae	2	NT
Breviceps verrucosus	Microhylidae	2	
Phrynomantis annectens	Microhylidae	1	
Phrynomantis bifasciatus	Microhylidae	0	
Xenopus gilli	Pipidae	2	EN
Xenopus laevis	Pipidae	0	
Xenopus muelleri	Pipidae	0	
Anhydrophryne rattrayi	Petropedetidae	2	NT
Arthroleptella bicolor	Petropedetidae	2	
Arthroleptella drewesii	Petropedetidae	2	NT
Arthroleptella hewitti	Petropedetidae	2	
Arthroleptella lightfooti	Petropedetidae	2	NT
Arthroleptella ngongoniensis	Petropedetidae	2	CR
Arthroleptella landdrosia	Petropedetidae	2	NT
Arthroleptella villiersi	Petropedetidae	2	
Cacosternum boettgeri	Petropedetidae	1	
Cacosternum capense	Petropedetidae	2	VU
Cacosternum namaquense	Petropedetidae	2	
Cacosternum nanum	Petropedetidae	2	
Cacosternum striatum	Petropedetidae	2	DD
Microbatrachella capensis	Petropedetidae	2	CR
Natalobatrachus bonebergi	Petropedetidae	2	EN
Phrynobatrachus acridoides	Petropedetidae	0	
Phrynobatrachus mababiensis	Petropedetidae	0	
Phrynobatrachus natalensis	Petropedetidae	0	
Poyntonia paludicola	Petropedetidae	2	NT
Afrana angolensis	Ranidae	0	
Afrana dracomontana	Ranidae	2	
Afrana fuscigula	Ranidae	1	
Afrana vandijki	Ranidae	2	DD
Amietia vertebralis	Ranidae	2	
Hildebrandtia ornata	Ranidae	0	
Ptychadena anchietae	Ranidae	0	
Ptychadena mascareniensis	Ranidae	0	
Ptychadena mossambica	Ranidae	0	
Ptychadena oxyrhynchus	Ranidae	0	
Ptychadena porosissima	Ranidae	0	
Ptychadena taenioscelis	Ranidae	0	
Ptychadena uzungwensis	Ranidae	0	
Pyxicephalus adspersus	Ranidae	0	NT
Pyxicephalus edulis	Ranidae	0	
Strongylopus bonaespei	Ranidae	2	
Strongylopus fasciatus	Ranidae	1	

SPECIES	FAMILY	Endemic Status	Revised Status
Strongylopus grayii	Ranidae	2	
Strongylopus hymenopus	Ranidae	2	
Strongylopus springbokensis	Ranidae	2	DD
Strongylopus wageri	Ranidae	2	NT
Tomopterna cryptotis	Ranidae	0	
Tomopterna delalandii	Ranidae	2	
Tomopterna krugerensis	Ranidae	1	
Tomopterna marmorata	Ranidae	1	
Tomopterna natalensis	Ranidae	2	
Tomopterna tandyi	Ranidae	0	
Chiromantis xerampelina	Rhacophoridae	0	

Species richness and endemism are summarised in Table 3. Ten families occur within the region, of which five families, Ranidae (27 spp.), Petropedetidae (19 spp.), Hyperoliidae (19 spp.), Bufonidae (16 spp.) and Microhylidae (14 spp.), are dominant in terms of numbers of species (Table 3). Proportionately speaking, regional endemism is approximately evenly spread over the families, except in the cases of the family Rhacophoridae which has no endemic species, and the family Heleophrynidae (5 spp.) which is entirely endemic to the region. Threatened and near-threatened taxa are spread across most of the families, but the Petropedetidae with 9 (47%) threatened and near-threatened species, and the endemic family Heleophrynidae with 2 (40%), must be singled out as being of special concern (Table 3). The largest number of widespread species is found in the family Ranidae, which also has the lowest percentage of threatened and near-threatened species, apart from the Arthroleptidae and Rhacophoridae which have no threatened or near-threatened species (Table 3).

Table 3. Summary of endemism and threatened taxa by family. Abbreviations and codes for endemism (column 2), and categories of threat, are the same as in Table 2. Note that regional endemism (column 2) is based on national boundaries. The totals (column 3) apply to the sum of regional endemism codes (column 2). Percentages in columns 2 and 4 are based on the species totals in column 3, and the percentages in column 3 are based on the overall species total of 109.

1. Family	2. Regional endemism: codes 2 + 1 + 0	3. Total species richness	4. Threatened taxa CR+EN+ VU+NT
Arthroleptidae	1 (50%) + 0 + 1 (50%)	2 (2%)	0+0+0+0=0
Bufonidae	10 (63%) +2 (13%) + 4 (25%)	16 (15%)	0+1+1+1=3 (19%)
Heleophrynidae	5 (100%) + 0 + 0	5 (5%)	2+0+0+0=2 (40%)
Hemisotidae	1 (33%) + 0 + 2 (67%)	3 (3%)	0+0+0+1=1 (33%)
Hyperoliidae	8 (42%) + 3 (16%) + 8 (42%)	19 (17%)	0+2+0+0=2 (11%)
Microhylidae	9 (64%) + 2 (14%) + 3 (21%)	14 (13%)	0+0+0+3=3 (21%)
Pipidae	1 (33%) + 0 + 2 (67%)	3 (3%)	0+1+0+0=1 (33%)
Petropedetidae	15 (79%) +1 (5%) +3 (16%)	19 (17%)	2+1+1+5=9 (47%)
Ranidae	10 (37%) + 4 (15%) +13 (48%)	27 (25%)	0+0+0+2=2 (7%)
Rhacophoridae	0 + 0 + 1 (100%)	1 (1%)	0+0+0+0=0
TOTALS	**60(55%) + 12(11%) + 37(34%)**	**109 spp. (100%)**	**4+5+2+12=23 (21%)**

The biogeographic patterning of endemism within the region has been extensively analysed and described (Poynton 1960, 1964, 1990, 1992, 1995, 2000; Poynton & Boycott 1996; Poynton & Broadley 1978, 1991; Van Dijk 1972a, 1982).

Focussing on the relevance of our findings for conservation, if one tallies the species which do not occur in the region, i.e., are not amongst the 109 species listed for South Africa, Lesotho and Swaziland in Table 1, but which do occur in subcontinental southern Africa, not more than 20 species can be added to the category of southern African endemics, despite the fact that the land area is more than doubled by the addition of Namibia, Botswana, Zimbabwe and Mozambique south of the Zambezi (Poynton & Broadley 1991; Channing & Griffin 1993). This clearly indicates that South Africa, together with the enclaves of Lesotho and Swaziland, is an important centre of endemism for African anurans. Not only that, but of the 23 threatened and near-threatened species on the Red List (Tables 2 & 3), all but two are endemic to the region, and one of those two is endemic to subcontinental southern Africa. Of the 23, no less than 20 (87%) occur in the winter-rainfall region in the south western corner of South Africa, and in the Grassland Biome (cf. Drinkrow & Cherry 1995). Thus we see that the relevant provinces of South Africa, and Lesotho, undoubtedly have an important responsibility to conserve anuran biodiversity in Africa.

GLOBALLY DECLINING AMPHIBIAN POPULATIONS

At the First World Congress of Herpetology in 1989, many of the participants expressed concern regarding the marked declines in amphibian populations observed in many parts of the world over the previous several decades. This led to a series of scientific meetings and workshops and to the establishment, in 1991, of the Declining Amphibian Populations Task Force (DAPTF) by the Species Survival Commission (SSC) of the International Union for the Conservation of Nature (IUCN). For early reports and reviews of this phenomenon, see Blaustein & Wake (1990, 1995), Bradford (1991), Pechmann et al. (1991), Tyler (1991), Crump et al. 1992, Blaustein et al. (1994). An extensive record of the literature on declining amphibians may be found in the issues of *Froglog*, newsletter of the DAPTF. The current DAPTF Working Group Chair for Southern Africa is Dr Les Minter, University of the North, P/Bag X1106, Sovenga 0727, South Africa.

It is evident that the declines cannot be attributed to a single cause but are the result of a variety of factors acting in isolation or in combination. The principal and most widespread local cause appears to be habitat loss, degradation and fragmentation, while other local factors include pollution by agricultural and industrial chemicals, the introduction of exotic predators and road kills. Examples of more widespread or global causes of declines are: an increase in UV radiation due to ozone depletion in the upper atmosphere, acid precipitation and global warming. The discovery that a novel frog pathogen, a chytrid fungus, is responsible for mass mortalities and extinctions of numerous frog species in Australia and Central America (Berger et al. 1998; Longcore et al. 1999), has created even more consternation in herpetological and conservation circles. This fungus is now known to have caused amphibian declines in several countries in Europe and South America, as well as the USA, Canada and New Zealand, i.e. the spread of this disease has reached pandemic proportions. Iridoviral infections are similarly implicated in mass amphibian mortalities (Daszak et al. 1999).

THREATS TO SOUTHERN AFRICAN FROGS

Evidence for amphibian declines in southern Africa

Channing and Van Dijk (1995) found no evidence for a “country-wide decline in frog populations” in South Africa, and attributed observed local declines to habitat destruction, pollution and other factors, such as a general disregard for amphibians by the public.

In the Western Cape province, the Western Cape Nature Conservation Board has an ongoing monitoring programme for threatened species of frog. Unfortunately this is not replicated in other provinces although there is a clear need, especially in KwaZulu-Natal and Eastern Cape provinces.

Monitoring in the Western Cape includes annual visits by conservation officials to key localities during the breeding seasons of the species concerned (De Villiers 1997; Baard et al. 1999). The most threatened montane frog in this region is *Heleophryne rosei*. Despite the discovery of a new, but small, breeding site of this species in recent years, the number of breeding localities has declined from a total of eight streams to six. The most threatened lowland frog is *Microbatrachella capensis*, followed by *Xenopus gilli* and *Bufo pantherinus*. In particular, *M. capensis* and *X. gilli* have suffered dramatic habitat loss. On the Cape Flats, *X. gilli* is probably now extinct and only one *M. capensis* breeding site remains, surrounded by a sea of urban development. This site supports a healthy population of *M. capensis* but it must still be confirmed whether there is a population of the often sympatric *X. gilli* present there. Further population declines in both of these species have been recorded near Kleinmond, mainly as a result of sand mining activities, alien vegetation encroachment (De Villiers 1997b) and, in the Betty's Bay area, development and general habitat degradation. Although *B. pantherinus* can tolerate a certain amount of habitat modification, urban expansion has lead to dramatic declines in population densities in some places. The above four frogs include two Critically Endangered and two Endangered species. Population declines have also been documented for the two Vulnerable frogs in this region, *Cacosternum capense* and, to a lesser extent, *Capensibufo rosei.*

In Gauteng, a severe decline in the number of breeding sites and adult individuals of *Pyxicephalus adspersus* has occurred over the last two decades, owing to the spread of housing developments, shopping malls and industries (Cook 1996).

A continuous, long-term frog monitoring project, initiated by Dr Les Minter, University of the North, was established at Hans Merensky Provincial Nature Reserve in October 2000, and currently represents the only project of this kind in southern Africa. In order to effectively monitor frog population fluctuations, it is essential that additional frog monitoring stations be established, particularly in areas where threatened species occur.

There are, to date, no published records of chytridiomycosis in southern Africa, but this possibility is presently being investigated (R. Speare & L. du Preez pers. comm.). Local herpetologists and conservationists should be provided with information and materials that will enable them to react quickly and effectively to reports of mass mortalities (eg. *Amietia vertebralis*) which occur from time to time, so that these events can be properly documented and investigated.

Threats identified by CAMP participants

An analysis of the perceived (present or predicted) threats to the 30 species reviewed in this workshop (taxon data sheets, Item 7A), shows that loss of habitat is by far the most significant (26/30). Habitat loss may be a consequence of wetland drainage and infilling, habitat fragmentation (23/30), afforestation, crop farming, and invasive alien vegetation (19/30). Activities associated with afforestation often result in the siltation of streams, reduction of surface water, and altered fire regimes. Alien plant growth also increases the frequency and intensity of fires, which were cited as a threat to 11/30 species.

Other threats included pesticides (9/30), pollution (9/30), damming (7/30), road kills (6/30), introduced predators (4/30), grazing (3/30) and disease (2/30). Altered drainage patterns were cited as additional threats for several species.

Climatic change was also cited as a probable future threat for several species, but this threat was not included in the taxon data sheets because it is believed to be potentially relevant to all species and it is not yet clear which species are at higher risk from climatic changes than others. Climate change is likely to take the form of global warming, altered rainfall patterns, longer periods of drought, and the drying out of frog habitats.

Management recommendations

Since habitat loss, fragmentation and degradation are perceived to be the greatest threats facing southern African frogs, it is obvious that habitat management is of paramount importance, and was recommended for 28 of the 30 species assessed. However, we know very little about the specific ecological requirements of most species, hence limiting factor research was deemed necessary in 26/30 species, in order to identify factors critical to the survival of the species.

A distinct problem is that most, if not all of the habitat of some species, falls outside protected areas and cannot be managed effectively. For these species, it is important that statutory conservation areas be established to encompass as much of their respective areas of habitat as possible. Failing this, attempts should be made to create conservancies, Natural Heritage Sites and similar partnerships of understanding with the relevant landowners and managers and thus ensure appropriate habitat management.

Monitoring allows one to track changes in population size; this is especially important in the case of species with small distributions, because disease or some other catastrophic event could cause extinction of the species within a relatively short period of time. Monitoring was recommended for 27/30 species.

In 11/30 cases, it was felt that community-based environmental education programmes could be useful in raising public awareness of problems such as pollution and habitat loss and encourage the public to be more supportive of conservation initiatives.

Translocation was recommended as a management option for two species and sustainable utilization, for one species.

Population and Habitat Viability Assessment (PHVA) workshops were recommended for most of the threatened species, in order to develop comprehensive and achievable management plans. PHVA workshops provide a means of assembling available detailed biological information on the respective taxa, evaluating the threats to their habitat, the development of management scenarios with immediate and 100-year time-scales, and the formulation of specific management plans with the aid of simulation models. For those species that were indicated as being in need of a PHVA workshop in the near future, we wish to urge immediate planning for those evaluations.

With only partial understanding of the underlying causes of population declines in some species, it is often difficult to clearly define specific management actions needed for conservation. In such cases, research should precede management action, followed by surveys to evaluate the effectiveness of the actions taken. This information should then be fed back to researchers for modification of the management action, if necessary.

Captive breeding recommendations

A captive breeding programme was not recommended for any of the species assessed in this workshop.

THE SOUTHERN AFRICAN FROG ATLAS PROJECT (SAFAP)

With broad support from the herpetological community, the Southern African Frog Atlas Project (SAFAP) was launched in November 1995. Since then, SAFAP has gained the monetary backing of the South African Department of Environmental Affairs and Tourism, WWF-SA, the Mazda Wildlife

Fund, Total South Africa, the Declining Amphibian Populations Task Force and the South African National Research Foundation, putting the project on a firm financial footing. The project is co-ordinated from the Avian Demography Unit (ADU) at the University of Cape Town, assisted by regional organisers in the various provinces of South Africa, and in Lesotho and Swaziland.

Data are collected by volunteer members of the public and by professional herpetologists. Data are submitted mainly in the form of audio recordings of calling frogs. Being species specific and stereotyped, calls are a reliable form of evidence on which to base taxon identification. (Frogs are generally cryptic and hard to find, but even when in the hand, they tend to be difficult to identify because of variability in skin colour, markings and size.) All identifications are handled by experts – usually the regional organisers – unless a particular observer has proven ability. This approach ensures a high degree of reliability of the data. Supplementary sources of data are photographs and specimens of eggs, tadpoles and frogs. The tadpoles of most species can be reliably identified using features of gross morphology and mouth parts. Collection of adult specimens is generally discouraged for obvious conservation reasons.

SAFAP aims to comprehensively cover all 109 species of frogs in South Africa, Lesotho and Swaziland, on a quarter-degree (15'X15') grid; there are c. 2000 grid cells in the region. Because exact locations are often recorded using GPS technology, much of the data has good spatial accuracy. Where reliable pre-atlas data are available, e.g. from the literature and museum records, these are included in the SAFAP database; for some areas this may provide a useful historical dimension.

Frogs are neither popular nor easy to observe, with the result that relatively few volunteers contribute records of frogs; this places a heavy burden on the professional herpetologists to achieve adequate coverage of all areas and species. These fundamental problems are greatly exacerbated by the need to do most of the fieldwork at night when frogs are calling, and the fact that frogs cannot be found calling at all times of the year. The unpredictability of rain, and of the various species' responses to rain, are major stumbling blocks because a meticulously planned and expensive expedition can turn out to be a dismal failure if conditions are not right.

Despite the difficulties, to date (July 2000), c. 23 650 records, including c. 9000 pre-atlas records, have been entered for 75% of the grid cells, although many of these cells will require further visits to record additional species (Fig. 1). The greatest need is for more data from the arid western parts of South Africa where rainfall is both scarce and unpredictable, but where, nevertheless, several interesting species of frogs occur, and also from inaccessible montane areas. The quantity of records accumulated thus far already far exceeds anything compiled previously for frogs in southern Africa (e.g., Poynton 1964). From 2000 to 2002, gaps must be filled to achieve near-complete coverage of all grid cells, thereby creating one of the most detailed, comprehensive and large-scale distributional databases for amphibians in the world.

As should be the case in all modern biodiversity surveys, the aim is to survey all grid cells, thereby creating information in which negative data, i.e., the absence of records of species, is nearly as reliable as positive data, i.e., the recorded presence of species. Such completeness is an essential element of modern methodology because it allows one to interpret the data and reach conclusions which are of direct relevance to the conservation and macro-ecology of species. Other *ad hoc* data sets, which are often used to describe distribution, are bedevilled by the uncertainty surrounding the issues of how much missing information to interpolate and what the gaps in information might mean, if anything.

CONSERVATION ASSESSMENT AND MANAGEMENT PLANS (CAMPs)

Within the Species Survival Commission (SSC) of IUCN, The World Conservation Union, the primary goal of the Conservation Breeding Specialist Group (CBSG) is to contribute to the development of holistic and viable conservation strategies and management action plans. Toward this goal, CBSG is collaborating with agencies and other Specialist Groups worldwide in the development of scientifically based processes, on both a global and regional basis, with the goal of facilitating an integrated approach to species management for conservation. One of these tools is called the Conservation Assessment and Management Plan (CAMP).

CAMPs provide strategic guidance for the conservation of threatened taxa. This may include recommendations for field investigations and improved data-gathering methods, and the application of intensive management techniques that increasingly are required for survival and recovery of threatened taxa. The CAMP process ensures an objective overall view of the status of the taxa in question with the intent of improving the effectiveness and synergy of conservation efforts. CAMPs also are one means of testing the applicability of the new IUCN Red List criteria for threat (IUCN 2000) as well as the scope of their applicability. Additionally, CAMPs are an attempt to produce ongoing summaries of current data for groups of taxa, providing a mechanism for recording and tracking of species' status.

CAMP recommendations are broad-based: of paramount importance are those recommendations related to field surveys, applied investigations and *in situ* conservation and management programs. Ultimately, the survival of taxa in the wild will depend on the availability of field data regarding the status of natural populations, the ecological role of the species (and its interdependence on other taxa), life history parameters, and applied investigations related to management and conservation. Where such data are lacking, a primary recommendation of the CAMP will be to stimulate their collection.

In addition to management of taxa in their natural habitat, conservation programs leading to viable populations of threatened species may sometimes need a captive component. In general, captive populations and programs can serve several roles in holistic conservation: (1) as genetic and demographic reservoirs that can be used to reinforce wild populations either by revitalising populations that are languishing in natural habitats or by re-establishing by translocation populations that have become depleted or extinct; (2) by providing scientific resources for information and technology that can be used to protect and manage wild populations; and (3) as living ambassadors that can educate the public as well as generate interest in and funds for *in situ* conservation. Additionally, non-threatened taxa can serve as "surrogate" species, which can be used to develop husbandry and propagation techniques that later can be applied to threatened species.

Captive management programs should only be developed in conjunction with ongoing field investigations and holistic conservation initiatives. It should be emphasised that captive breeding is not the answer to the extinction crisis and should not be viewed as a complete solution. It is one option along a continuum of strategic options for population recovery. If implemented, these programs should be part of an integrated species management plan that includes habitat management, limiting factors management, field research, and public education. A recovery effort that is not part of a holistic population management program in the wild does not have a high probability of making a meaningful contribution to conservation.

THE SOUTHERN AFRICAN FROG CAMP PROCESS

CAMP workshop goals

The goals of the CAMP workshop were:

- To review the population status and demographic trends for the selected Southern African frog species and to apply the newest IUCN Red List criteria for threat (IUCN 2000; see Appendix II).
- To provide recommendations for *in situ* management, research and information-gathering for all reviewed taxa, including: field investigations; surveys, population monitoring and investigation of limiting factors; taxonomic studies; recommendations for PHVA workshops; more intensive management in the wild; or other specific research.
- To provide recommendations for *ex situ* management and research for the taxa, including husbandry, maintenance of viable captive populations of the more threatened species (where appropriate, feasible, and desirable) and the development of collaborative captive/field programs.
- Produce a review draft Conservation Assessment and Management Plan, presenting the assessments and recommendations from the workshop for distribution to and review by workshop participants and all parties interested in frog conservation.

Scope of the CAMP

Although only 30 species were discussed in detail during the workshop, the whole species assemblage (109 species) was considered in a selection process prior to the workshop. All the workshop participants were involved in the selection process, and the 30 selected species were those deemed to require a detailed assessment. By implication, therefore, the other 79 species are considered to be of Least Concern, although this cannot be stated categorically because they were not subjected to the assessment process of the CAMP, and therefore have to be categorized as Not Evaluated.

Of the 30 species assessed, 29 are endemic to the region comprising South Africa, Lesotho and Swaziland, i.e., the region covered by SAFAP and the CAMP. For those 29 species, therefore, the assessment of status in terms of the IUCN criteria was a *global assessment*. The single exception is the Giant Bullfrog *Pyxicephalus adspersus* which is not endemic to the region, and was therefore given a *regional assessment*.

CAMP procedure

The CAMP process assembles expertise on wild and captive management for the taxonomic group under review in an intensive and interactive workshop format. The purpose of the Southern African Frog Conservation Assessment and Management Plan (CAMP) workshop was to assist in the development of a database for 30 selected southern African frog species, and to assist in the further development of a conservation strategy for these species. This process was designed to be complementary to SAFAP. Twenty-two people (see Appendix I) participated in the 4-day event, which was hosted by SAFAP and the Avian Demography Unit (ADU), University of Cape Town. The ADU, SAFAP and Sea World Inc., generously sponsored the workshop.

Prior to the workshop, the taxon data forms were distributed to the participants so that each could assemble appropriate data for the species to be evaluated. Using that material as background, the workshop focused on compiling all available information concerning the status of the 30 species. The completed Taxon Data Sheets can be found in Section 2 of this report.

Participants in the CAMP worked in three groups to make the assessments and recommendations contained within this document. These assessments and the recommendations of the working groups were discussed in plenary sessions during which the group reached consensus on the data. Subsequently, a draft report was produced and distributed to the editors. The editors refined the wording and added missing information to the Taxon Data Sheets for the final report. Although the criteria were modified in a number of cases, in only one case, that of *Strongylopus wageri*, was the original classification changed, namely from Least Concern to Near Threatened.

The classification of frogs as presented in the Taxon Data Sheets follows Frost (2000) in respect of family, genus and species, the only exceptions being our acceptance of the genera *Afrana, Amietia* and *Strongylopus* being separated from the cosmopolitan genus *Rana* (see Dubois 1992). Synonyms were selected from those listed by Frost (2000).

Maps

Distribution maps for the species considered by this workshop can be found with the Taxon Data Sheets. These are interim maps, provided by SAFAP, and will be updated when SAFAP publishes an atlas of the frogs of the region in 2003. The maps use a quarter-degree grid (15 minutes of latitude by 15 minutes of longitude) which yields approximately 2000 grid cells for the region. The maps show the presence/absence of species per grid cell.

Most of the data in the database has been collected specifically for SAFAP since 1995. The SAFAP database includes data obtained from museum and other collections and most of these records pre-date SAFAP. To distinguish between recent and older records, the distribution maps use a cross (X) for all pre-1990 records, and a filled circle for all post-1989 records. Interim (July 2000) atlas maps are presented in this report, except for three species, *Athroleptella ngongoniensis, Hemisus guttatus Hyperolius pickersgilli* and *Strongylopus wageri*, which have more recent (June 2001) interim maps.

Camp document review

The preliminary CAMP document generated at the workshop was reviewed by a group of volunteer editors who participated in the CAMP workshop. IUCN Red List Assessments were forwarded to the SSC Red Listing Authority in Cambridge, U.K. Additional review and comment may take place after the distribution of the final report from this workshop to a broader audience, which includes amphibian biologists, wildlife managers, Specialist Group members, academic scientists, regional captive programs, and other interested parties worldwide. This document may be revised and updated as necessary. As with all CAMPs, this should be considered a “living” document to be updated as situations change.

THE NEW IUCN RED LIST CATEGORIES

The threatened species categories now used in IUCN Red Data Books and Red Lists have been in place, with some modification, for almost 30 years (Mace et al. 1992). The Mace-Lande criteria (Mace and Lande 1991) were an early developmental step in an attempt to make those categories more explicit. These criteria subsequently have been revised and formulated several times into the current IUCN Red List Categories (IUCN 2000).

During the workshop, the 30 frog taxa were evaluated on a taxon-by-taxon basis, in terms of their current and projected status in the wild, in order to assign priorities for conservation action or information-gathering activities. Data used in this evaluation were based primarily on a best-estimate basis as gathered by workshop participants, and may be subject to further review by other experts in the field.

The New IUCN Red List Categories provide a system that facilitates comparisons across widely different taxa, and is based both on population and distribution criteria. These criteria can be applied to any taxonomic unit at or below the species level, with sufficient range among the different criteria to enable the appropriate listing of taxa from the complete spectrum of taxa, with the exception of micro-organisms (Mace et al. 1994).

The complete reference for the new IUCN Red List Categories of Threat can be found in Appendix II. The New IUCN Red List Categories are: Extinct (EX); Extinct in the Wild (EW); Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Near Threatened (NT); Least Concern (LC); Data Deficient (DD); and Not Evaluated (NE). Definitions of these categories are based on population viability theory. In assessing threat according to the New IUCN Red List criteria, workshop participants also used information on the status and interaction of habitat and other characteristics. Information about population trends, fragmentation, range, threats, stochastic environmental events, real and potential, were also considered.

To assist in making recommendations, participants in the workshop were encouraged to be as quantitative or numerate as possible for two reasons: (1) CAMPs ultimately must establish numerical objectives for viable population sizes and distributions; (2) numbers provide for more objectivity, less ambiguity, more comparability, better communication, and, hence, co-operation. During the workshop, there often were attempts to estimate if the total population of each taxon was greater or less than the numerical thresholds for the numeric criteria for the IUCN Categories of Threat, where applicable. In most cases, current population estimates for taxa were unavailable or available for species/subspecies within a limited part of their distribution. In all cases, if presented, conservative numerical estimates were used. **When population numbers were estimated or inferred from data present at the workshop, these estimates generally represented first-attempt, order-of-magnitude, educated guesses that can serve as hypotheses for falsification. As such, the workshop participants emphasised that these estimates should not be regarded as authoritative for any purpose other than the CAMP process.**

The new IUCN Red List status classifications for the 30 taxa examined during this CAMP exercise are presented in Table 1. Several of these assessments represent changes from the assessments reported in the national Red Data book (Branch 1988), the 1996 IUCN Red List, and the 2000 IUCN Red List.

Table 1. Selected southern African frog species assessed during the CAMP workshop, and their newly assigned IUCN Red List Categories of Threat.

SPECIES	IUCN CATEGORY ASSIGNED	IUCN CRITERIA MET
Arthroleptella ngongoniensis	CR	B2ab(ii,iii,iv,v)
Heleophryne hewitti	CR	B1ab(ii,iii,iv,v)
Heleophryne rosei	CR	B1ab(ii,iii,v)+2ab(ii,iii,v)
Microbatrachella capensis	CR	B2ab(i,ii,iii,iv,v)
Bufo pantherinus	EN	B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)
Hyperolius pickersgilli	EN	B2ab(ii,iii,iv)
Leptopelis xenodactylus	EN	B2ab(ii,iii,iv)
Natalobatrachus bonebergi	EN	B2ab(ii,iii,iv)
Xenopus gilli	EN	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)
Cacosternum capense	VU	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)
Capensibufo rosei	VU	B1ab(ii,iii,iv)+2ab(ii,iii,iv)
Anhydrophryne rattrayi	NT	
Arthroleptella drewesii	NT	
Arthroleptella landdrosia	NT	
Arthroleptella lightfooti	NT	
Breviceps gibbosus	NT	
Breviceps macrops	NT	
Breviceps sylvestris	NT	
Bufo amatolicus	NT	
Hemisus guttatus	NT	
Poyntonia paludicola	NT	
Pyxicephalus adspersus	NT	
Strongylopus wageri	NT	
Afrana vandijki	DD	
Afrixalus knysnae	DD	
Bufo robinsoni	DD	
Cacosternum striatum	DD	
Strongylopus springbokensis	DD	
Bufo angusticeps	LC	
Bufo pardalis	LC	

30 SPECIES EVALUATED	**see Taxon Data Sheets on pages**
4 Critically Endangered (CR)	**31-51**
5 Endangered (EN)	**52-78**
2 Vulnerable (VU)	**79-90**
12 Near Threatened (NT)	**91-152**
5 Data Deficient (DD)	**153-177**
2 Least Concern (LC)	**178-187**

DEVELOPING A PLAN OF ACTION FOR SOUTHERN AFRICAN FROGS

After CAMP assessments were completed, participants used the remaining time to work together to identify the broad issues and problems affecting the conservation of southern African frogs. Three working groups were set up: Conservation Planning and Implementation, Monitoring, and Research. Each group was asked to examine the issues identified under its topic and to group issues under common themes, and to prioritise and describe each issue in more detail.

Each group then identified promising solutions that could address each issue, prioritised the solution(s) and indicated a timeline for when the solution(s) should be begun and completed, and a group or individual to take on the role of a "champion", whether it is to carry out the task personally or to recruit others to help.

WORKING GROUP ON CONSERVATION PLANNING AND IMPLEMENTATION

Issue 1: Legislation

There is currently a process underway to consolidate national policy on the conservation and utilisation of reptiles and amphibians. Participation in policy review and drafting is recommended. The following issues are considered to be important:

- trade in amphibians
- commercial utilisation
- herpetological collecting
- Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) reports should include amphibians. Relevant results from these studies should feed back to conservation planning agencies.
- Water Reserve Determinations must be done to maintain amphibian habitat.

Solution 1:
Participation by all provincial and other conservation agencies in the process of consolidation and review of national policy on the conservation and utilization of reptiles and amphibians in South Africa. National legislative strategy must be adopted by the provincial authorities.
Champion: Ernst Baard of the Western Cape Nature Conservation Board.
Time Line: from 2001, ongoing.

Issue 2: Conservation planning

1 Additional data are needed for conservation. For example,
   a) What taxa do we have?
   b) Where do these taxa occur?
   c) Which taxa are threatened?
   d) What are the threats? Where do these threats operate?
   e) What areas are especially important for frog conservation?
   f) What is the conservation status of those areas?
   g) Where are the conservation gaps?
   h) How do the frog distributions relate to the spatial arrangement of other environmental factors?
2 A new Red Data book for South African frogs is needed.
3 Population and Habitat Viability Assessments (PHVAs) are needed for several species.

Solution 2.1a:
Undertake a taxonomic review of this group.
Champions: Alan Channing and Bill Branch.
Time Line: 2000 to end of 2001.

Solution 2.1b:
Continue data collection for the Southern African Frog Atlas Project and publish the atlas.
Champions: James Harrison, Marius Burger and Les Minter
Time Line: 2000 to end of 2002.

Solution 2.1c&d:
Publish the CAMP report.
Champions: James Harrison, Marius Burger, Les Minter, Susie Ellis.
Time Line: 2000 to mid-2001.

Solution 2.1e, f, g & h:
Undertake an analysis of distribution to identify patterns of distribution, endemism "hotspots", "Important Frog Areas", etc., as part of the atlas publication.
Champions: James Harrison, Marius Burger, Graham Alexander and Les Underhill.
Time Line: 2000 to end of 2002.

Solution 2.2:
Publish a new Red Data book. Explore the potential for doing this as part of the atlas publication. Further data may be needed for certain taxa.
Champions: James Harrison, Marius Burger, Les Minter and Bill Branch.
Time Line: 2000 to end of 2002.

Solution 2.3:
Organize PHVAs for selected species.
Champions: James Harrison, Andrew Turner, Atherton de Villiers and Ernst Baard, and Bill Branch, with assistance from IUCN.
Time Line: 2001 and beyond.

Issue 3: Funding for conservation action

Actions which need funding include:

- research into taxonomy, life histories, limiting factors
- surveys of taxa
- populations monitoring
- education and awareness programmes
- enlargement and establishment of protected areas
- management of existing protected areas
- control of trade and utilisation
- herpetological capacity building in conservation agencies.

Solution 3:

- Cape Action Plan for the Environment (CAPE) is a probable source of funding for the Cape Floristic kingdom (biodiversity research, baseline surveys, planning, monitoring).
- International donor funding (via Department of Environmental Affairs and Tourism).
- Paper companies for sponsorship of Red Data book and atlas.

Champion: Ernst Baard (for CAPE), Geoff Cowan (foreign donors), James Harrison to send proposal to Cowan.

Time Line: 2000 to the end of 2003.

Issue 4: Frogs as a resource

The conservation of frogs can be promoted by highlighting their value as a resource, in the following areas:

- indicator species, especially for wetland health
- ecological value as predators and prey
- commercial value, derived from their ecological value, but also as a food resource for human consumption, medical use, etc.
- educational resource
- ecotourism attractions.

Sustainable levels of utlilsation need to be ascertained.

Issue 5: Education and awareness

The conservation of frogs is promoted by education and greater awareness. Aspects to focus on include:

- ecological value of frogs as predators and prey
- the diversity of the South African amphibian fauna
- the biological interest of the fauna (e.g., habitats, life cycles, etc.)
- frogs and tadpoles as examples of biological and environmental concepts
- myths about frogs
- potential for urban conservation of amphibians
- ecotourism value (e.g. Giant Bullfrog).

WORKING GROUP ON MONITORING

Why monitor frogs in South Africa?

- In general we lack baseline data for population studies, especially for potentially endangered species.
- We have no idea how the well-documented global decline in amphibians is affecting Africa, and thus cannot make informed statements about South African frog populations.
- South Africa has a high level of endemism, especially in the south-western Cape, and this warrants special attention be paid to the conservation status of endemics.
- As changes in climate have been predicted, we need to start or intensify monitoring so we can detect change, especially in the endemic species of the winter-rainfall region, as they may be especially vulnerable to change.
- We have a growing human population with a high rate of urbanisation and are thus losing natural habitat rapidly.
- We lack data on environmental quality and habitat viability, especially in agricultural and forestry areas.
- We need to determine how stable populations are, including metapopulation dynamics, and distinguish source from sink populations, etc.
- We lack long-term ecological data sets which are essential to sound conservation planning.

Two basic issues were identified:
1. surveying distributions,

2. monitoring the populations and habitats of threatened and sensitive species.

1. Issues in distribution surveys

- Past distribution surveys have been erratic and scarce, with SAFAP being the first comprehensive effort to assess the distributions of southern African frogs on the basis of recently collected data.
- Accurate distribution maps are essential to initiate conservation planning for individual species.
- In southern Africa, we have a large frog fauna, but a small population of herpetologists, and the fauna remains largely understudied, unlike the situation in America and Europe. We are seriously behind in basic studies, with Anura being one of the least studied vertebrate groups in Africa. In addition, we have lost 50% of the herpetological posts in South Africa in the last 5 years.

Accurate patterns of distribution and macro-ecology of frogs need to be documented and studied so that we can
a) accurately detemine range contraction and expansion;
b) identify habitat requirements;
c) identify declining and threatened populations which need monitoring;
d) plan conservation and management;
e) identify patterns of endemism.

Solutions:
SAFAP will solve most of the distribution problems.
Champions: Marius Burger, James Harrison, Les Minter.
Timeline: 2000 to end of 2002.

2. Issues in populations monitoring

1. Habitat loss to development necessitates that Environmental Impact Assessments (EIAs) include wetlands and that relevant species of frogs be highlighted.
2. Endemic species should enjoy special attention.
3. Long term ecological data sets need to be established as a basis for future research.
4. The success of rehabilitation attempts, e.g., quarry sites at Kleinmond, needs to be evaluated. (Funding for this should be the responsibility of the company and be written into the “resource consent” document.)

Problems:
a. In South Africa there is a lack of funding to support monitoring efforts, even for species where we know it is imperative, e.g., *Arthroleptella ngongoniensis*.
b. There is a lack of local expertise in standard monitoring techniques used in other countries.
c. There is a lack of baseline information.
d. Lack of equipment for monitoring, e.g., automatic data loggers.
e. Concerns about safety in the field, and theft of equipment left out in the field.

Solutions:
First priority: long-term ecological monitoring stations. Four initial sites suggested, but more sites recommended:
Mtunzini, in the coastal dune forest in northern KwaZulu-Natal (resuscitate existing set-up)
Champion: Phil Bishop
Timeline: Underway, initiated in 1994.
Hans Merensky, savannah
Champion: Les Minter
Timeline: In place.
Royal Natal National Park, sour grasslands
Champion: Angelo Lambiris and/or KwaZulu-Natal Conservation Service
Timeline: Unknown, perhaps 5 years.
Western Cape (low to high altitude gradient)
Champion: Atherton de Villiers
Timeline: Unknown, perhaps 3 years.

Funding and manpower are limiting factors, but overseas funding could be sought after detailed proposals have been written.

The South African Long Term Ecological Research (LTER) committee is considering a network of LTER sites, e.g., grassland, savannah, fynbos, as part of the international LTER. Selection is based on global issues such as climatic change. National Research Foundation (NRF) was identified as the primary funder and driver for South Africa (Chairperson: Albert Van Jaarsveld, University of Pretoria). A herpetologist(s) should join this effort.

Bill Branch suggested that monitoring studies be initiated in National Parks throughout the country, and an attempt be made to get the National Parks Board to become involved and eventually take over responsibility. Provincial nature conservation agencies have the responsibility to study their biota in the same manner as the Western Cape Nature Conservation Board, both inside and outside protected areas; the NRF should be approached for support.

Partnerships between interested parties need to be established, e.g., university or technicon students (zoology, nature conservation) could be used in the annual surveys of nature conservation agencies, as part of their coursework component.

Starting a long-term Anuran monitoring programme may require a national coordinator with three to five full-time employed workers at different stations. The latter individuals will do most of the monitoring and also liaise with universities, etc. to compliment these efforts. Methods as per Heyer et al. (1993). Information from diverse institutions, e.g., the Weather Bureau, needs to be assimilated.

Individual herpetologists and/or zoology/nature conservation departments of universities/technicons, and/or natural history museums, could monitor populations at specific sites, using standardized procedures, in collaboration with the national long-term monitoring coordinator. Previously unsurveyed areas should be identified and prioritized for initial, exploratory surveys, especially by museums. Surveys and monitoring could be relatively easy to do with minimal costs, as volunteer students can easily be found for data collection. Overseas funding may be needed as the government has cut budgets and frozen posts dramatically.

WORKING GROUP ON RESEARCH

An analysis of the taxon data sheets (Item 14. Supporting research recommended for the taxon), shows that little basic information is available for most of the 30 frog species reviewed in this workshop. Participants felt that field surveys were need for all species in order to clarify distribution patterns, population densities etc., limiting factor research i.e., ecological studies, were recommended for 18, life history studies for 16, genetic studies for 9 and taxonomic research for 8 species. Information on the life history and ecology of most other frog species in the region is also incomplete or totally unknown.

The Working Group on Research identified and prioritised the following issues:

Issue 1. Life history & ecology

The lack of knowledge of the life histories and ecology of most of our frog species, and the importance of this information for planning conservation strategies, places this category of research high on the priority list. Of the 30 frog species assessed during the workshop, supporting research into life histories was recommended for 16 species and limiting factor research (ecological study) for 18. A specific concern was the effect of stocking dams and rivers with exotic predatory fish which pose a potential threat to indigenous species of frogs at all stages of their life cycles. This threat needs to be investigated to determine the extent and effect of this predation on local frog populations.

Solution 1.1:
The CAMP report and recommendations identify specific research needs for species dealt with in the CAMP workshop and could inform the planning of new, or revision of existing research projects.
Champions: authors & editors of the CAMP Report
Timeline: 2001

Solution 1.2:
The Southern African Frog Atlas and Red Data Book will identify certain research needs for all southern African frog species.
Champions: SAFAP authors & editors.
Time line: 2003.

Issue 2. Taxonomy

An established, stable classification is a basic prerequisite in all areas of biological research. This stage has not yet been reached in southern Africa as new frog species are still being discovered and described at a steady rate (alpha taxonomy) and their inter-relationships at generic and family levels have not been satisfactorily resolved (beta taxonomy). Taxonomic research was recommended for 8 of the frog species assessed during the workshop. Without increased funding for taxonomic research and the creation of posts for taxonomists, the potential for tapping the rich biodiversity of this country will not be fully realised.

Solution 2.1:
The opportunity should be taken, whenever possible, to highlight the importance of taxonomic research, in order to inform and influence research facilitators at research institutions, and funding bodies. Also see 4.1, 5.1 & 5.2 below.
Champions: all workshop participants.
Timeline: ongoing.

Issue 3. Applied research

Areas of applied research such as the use of adult frogs and tadpoles as bio-indicators of habitat quality, the pharmacological properties of frog skin secretions, and the potential for sustainable utilization of certain species, have received too little attention in southern Africa.

Solution 3.1:
Applied research attracts more funding than pure research because of its more obvious short-term benefits. This fact sould be used to advantage by combining both pure and applied aspects within one research project.
Champions: researchers and research facilitators.
Timeline: ongoing.

Solution 3.2:
Local herpetologists should familiarise themselves with the current use of amphibians in applied research and establish linkages with the appropriate scientific disciplines to investigate the potential of our local fauna.
Champions: researchers and research facilitators.
Timeline: ongoing.

Issue 4. Funding

Increased levels of funding are required from the National Research Foundation (NRF), the Department of Environmental Affairs & Tourism (DEAT), universities & NGOs to address the research needs identified in this workshop.

Solution 4.1:
Efforts should be made to raise the level of funding and seek new sources. Progress in this respect should be communicated to researchers.
Champions: G. Cowan and J. Dini (DEAT), Les Minter, James Harrison.
Time line: As and when projects are identified.

Solution 4.2:
Improve the image of herpetology through articles, public lectures, posters, books, contributions to textbooks, articles in teaching journals, etc.
Champions: All CAMP delegates, also with the aid of the communications sections of the conservation agencies.

Issue 5. National research capacity and output

A scarcity of local herpetologists seriously limits research output. This is due to, and exacerbated by staff reductions at museums, universities, national and provincial conservation departments and other governmental research institutes. With such poor prospects for finding employment it is not surprising that few young scientists are attracted to, or remain in this area of research. The number of active herpetologists can therefore be expected to dwindle with the passage of time.

Solution 5.1:
Letters of concern should be sent to people in positions of authority, such as the Minister of Environment and Tourism (Valli Moosa), the chairperson of the Portfolio Committee for the Environment (Gwen Mahlangu) and Provincial MECs (Environment). The importance of maintaining and utilizing local biodiversity, and our commitments in respect of international agreements pertaining to the environment should be stressed.

Champions: James Harrison, Bill Branch.
Time line: To coincide with the publication of the CAMP document.

Solution 5.2:
The establishment of an African Amphibian Research Centre would stimulate interest in the study of amphibians, facilitate research on amphibians here and in other African countries, focus effort on high priority research projects and provide employment for local herpetologists and facilities for visiting herpetologists. The Centre could also co-ordinate monitoring projects at various sites throughout the country, maintain an atlas database, a reference collection of preserved specimens and tissues, a tape library of calls, and a collection of published works on African amphibians.
Champion: Les Minter
Timeline: ongoing.

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