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Lizards and landscapes: integrating field surveys and interviews to assess the impact of human disturbance on lizard assemblages and selected reptiles in a savanna in South Africa

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Abstract

Habitat degradation through over-grazing and wood collection is especially prevalent in developing countries such as South Africa. As human populations expand and the demand for land increases, the traditional idiom of setting aside protected areas for conservation is insufficient and assessment and protection of diversity outside these areas is needed. We assessed the impact of land use on lizard assemblages in communal rangelands in South Africa by comparing abundance, species richness and species diversity between degraded communal lands with a protected area. We first quantified vegetation differences between the study areas and found marked differences. Communal lands had significantly fewer large trees and less ground cover. Contrary to prediction, we found no evidence that any species of lizard was negatively affected by habitat disturbance. Some species were more common in communal lands, and species richness and diversity were also higher using certain sampling techniques. Terrestrial diversity was likely enhanced due to the preference of many terrestrial lizards for open, sparsely grassed areas. We discuss other reasons for increased diversity such as the intermediate disturbance hypothesis and/or reduced numbers of predators and competitors. We also conducted surveys of households and traditional healers to investigate the relationship between human uses of reptiles and abundance. The predominant users of reptiles were traditional healers. The most commonly used species were not encountered in our field surveys, and respondents indicated that they appeared to be declining. Our results emphasise the importance of integrating local knowledge into biodiversity assessment and conservation planning. Although we did not identify a negative impact of disturbance on lizard communities, community structure was different and this likely influenced ecosystem integrity and function in some way.

Keywords: Lizards; Ecosystems; Disturbance; Reptiles; Biodiversity; Human impact; Savanna; Traditional medicine; South Africa

1. Introduction

Unchecked human population growth and a short-term strategy to natural resource use has impacted on global biodiversity in a devastating fashion (Ehrlich, 1988; Wilson, 1988). This is particularly evident in developing countries where unemployment is high and humans are dependent on the environment for basic survival. Furthermore, unsustainable use of natural resources not only reduces species diversity, but ultimately results in a degraded ecosystem with diminished return of key environmental services (Rapport et al., 1998). Understanding the limits of ecosystem stability and resilience, particularly in relation to changes in species numbers and abundance, is a major challenge in ecology (Downing and Leibold, 2002). One measure of ecosystem perturbation is to quantify changes in assemblages of particular taxa in a given area in relation

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to environmental change. Lizards are a good candidate for these studies because they are easily observable, relatively abundant, and occupy a diversity of habitats and niches (Pianka, 1986; but see Fabricus et al., 2003). In particular, several species are arboreal and therefore dependent on trees: a key resource (firewood, curios, furniture and construction) in southern African rural communities. Arboreal lizards should therefore occur in reduced numbers in areas of high tree utilisation.

Various human land practices such as forest clearing in the Amazon, or bush encroachment due to poor land-management, can alter lizard habitat (Vitt et al., 1998; Meik et al., 2002). Anthropogenic disturbance varies in impact on reptile communities and species. For example, lizard abundance and species richness peaked at intermediate levels of urbanisation in Tucson, Arizona (Germaine and Wakeling, 2001), whereas agricultural disturbance caused a marked decrease in lizard species diversity in the Dominican Republic (Glor et al., 2000). In southeastern Spain, common chameleons (*Chamaeleo chamaeleon*) are most common in areas of intermediate disturbance, such as cultivated areas and near roads (Hodar et al., 2000). Human behaviour can also impact directly on reptiles. In Australia, a large proportion of mortality to large elapid snakes is from killing by humans, because they are highly venomous and considered a threat (Whitaker and Shine, 2000). In South Africa, reptiles are commonly killed by Xhosa and Zulu speaking people of the Eastern Cape Province for medicinal purposes, as a result of superstition, or if they pose a potential danger (Simelane and Kerley, 1997). Finally, many reptiles such as crocodiles, pythons and monitor lizards are harvested for commercial gain (e.g., Webb et al., 1987; Shine et al., 1996, 1999).

The traditional approach to conserving biodiversity is to set aside protected areas (Bibby, 1998). Human populations continue to grow however, and the amount of land available for protection in reserves is nearing its limit, hence an assessment of biodiversity outside protected areas is needed (Shackleton, 2000). Traditional agro-ecosystems may harbour high levels of diversity, sometimes comparable to protected areas (McNeely, 1995). Sustainable use of resources so they persist into the future is therefore key to ensuring conservation of biodiversity outside of protected areas.

Habitat disturbance is dependent on land practice. Legally, there is equal access to resources under communal tenure. If institutional or social control over resources is weak or non-existent, or if human densities are above carrying capacity, overexploitation can result (Shackleton, 1998). Livestock grazing is the primary land use in African savanna communal rangelands, with additional natural resource harvesting, particularly that of firewood (Cousins, 1999). Together, intensive livestock grazing and wood collection results in a decrease in grass and woody biomass respectively.

We studied the impact of human-driven disturbance on lizard assemblages in a savanna biome in South Africa. Our approach was twofold: we conducted field surveys to assess species richness, abundance and diversity of lizards in undisturbed and disturbed habitats, and we conducted interviews of households and traditional leaders to measure direct impacts (e.g., use and/or killing) on lizards and selected reptiles. Because of logistical constraints, we restricted our field surveys to lizards. However, our interviews focussed on commonly used reptiles such as pythons, monitor lizards, and tortoises, all of which are traditionally used by local communities in South Africa (Simelane and Kerley, 1997).

2. Methods

2.1. Study area

Fieldwork was conducted at Wits Rural Facility (WRF) (Bohlabela district, Limpopo Province, 24° 31′S; 31° 6′E; low disturbance study area), and in neighbouring communal rangelands (CL), around the Sigagula community (high disturbance study area). WRF is a protected area used as a research station. CL (Sigagula) is also in the Bohlabela district, which has land-uses typical of African savanna rangelands, and was characterised by high population density, poverty, cattle overstocking, and intensive harvesting of firewood, placing high pressure on natural resources (Shackleton, 2000). In the late 1990s the mean population density was 176 people per km^2 (Pollard et al., 1999), while the cattle stocking rate was 0.88 livestock units (LSU) per hectare (four times the recommended stocking rate) (Parsons et al., 1997). The two study areas were ±10 km apart to ensure similar environmental variables, making land management regime the major difference (soil type and general topography were the same). We sampled three replicate sites per study area, 1–2 km apart within each study area.

2.2. Vegetation structure

We assessed woody plant density using 10 belt transects per site, 100 × 10 m in length and 50 m apart. Woody plants with circumference >5 cm were recorded using the following physical characteristics: circumference (5–50, 50–100, >100 cm); dead; alive with no leaves; or alive with leaves; height (>2, 2–4, >4 m); and presence of holes and/or loose bark. We only considered holes and loose bark that had sufficient space for a lizard to take refuge. Every 2 m along each transect, distance, circumference and height of the nearest grass tuft was recorded. Density was calculated using $D = 1/(2d)^2$, where D = density and d = mean distance to nearest tuft. We calculated basal cover (m^{-2}) by converting mean grass tuft circumference to mean basal area, and multiplying by density. Basal cover was converted to % basal cover. Mean grass tuft height was also recorded. We used χ^2 contingency tables to test for an interaction between study area and distribution of trees among categories. One-way ANOVAs tested for differences between study areas for each category. Density of woody plants, grass cover and grass height were compared between study areas using ANOVA.

2.3. Lizard assemblages

Terrestrial and arboreal lizards were sampled using visual encounter surveys of plots (Crump and Scott, 1994). For arboreal lizards, we sampled 25 trees per circumference category within a 600×300 m plot, one plot per site. Two measures were used: number of individuals per sampling episode (counts); and density, calculated from tree density (number of lizards per tree). By using lizard species densities for arboreal samples, we eliminated the influence of different tree densities between study areas. We assessed terrestrial lizards using 100×10 m transects, 10 transects per site. We also used time-constrained searches (TCS) to complement transects and arboreal sampling. TCS consisted of sampling a site within a fixed time period, but unconstrained by area. A single individual (RS) spent 1.5 h performing the arboreal sampling and transects for each site (combined). For counts and density, Mann–Whitney *U* tests compared study areas (transects combined), and Kruskal–Wallis one-way ANOVAs for the six replicate sites. Two variables were used to analyse communities: species richness and diversity. Species richness was simply the total number of species per site. Diversity ($\propto$) was calculated using Fisher's index of diversity (Fisher et al., 1943). We used the program LOGSERIE (Krebs, 1989) to calculate indeces of diversity based on two variables: the number of species (*S*) in the sample, and the number of individuals (*N*), using the formula:

$$S = \propto \log_e(1 + N/\propto).$$

Species richness and diversity were compared between study areas using Mann–Whitney *U* tests.

2.4. Human use and perceptions of reptiles

We assessed the potential impacts of rural communities on reptiles using interviews from a set questionnaire. Interviewees were asked to identify 12 reptile species using photographs from Branch (1998b). Reptiles were selected largely based on traditional use (Simelane and Kerley, 1997); however, we decided to include representatives of all the major reptile groups: snakes, lizards and tortoises. Crocodiles were excluded because there were no known populations in close proximity to the villages. Questions pertained to frequency of encounter, change in encounter rate, location of encounter, uses for the informant or others, and reaction upon encounter (Appendix 1). The interview sample was randomly selected, but consisted of households and traditional healers (considered key informants). We were constrained by the number of traditional healers living in the area. Our interview sample resulted in 32 households and 14 traditional healers. The questionnaire was always administered by RS, with the assistance of a translator.

All means are reported ±1 SD. We set $\alpha = 0.05$ for statistical significance.

3. Results

3.1. Vegetation structure

Mean density of woody plants >5 cm circumference (undisturbed: 192.4 ± 99.1 trees/ha^{-1}; disturbed: 204.3 ± 118.4 trees/ha^{-1}) did not differ significantly between study areas ($F_1 = 0.176$; $P = 0.676$). This is likely due to the inclusion of woody plants of relatively small circumference. However, a highly significant interaction existed between categories and study areas for all characteristics except presence of holes (Table 1). Significant results were: more trees in larger circumference categories and higher height categories; dead trees; trees without leaves; and trees with loose bark in undisturbed than in disturbed areas.

Basal grass cover (%) was significantly higher in the disturbed ($12.5\% \pm 8.2\%$) than undisturbed area ($4.7\% \pm 3.0\%$) ($F_1 = 23.58$; $P < 0.001$). Grass height was significantly higher in the undisturbed (353 ± 288.69 mm) than disturbed area (97.44 ± 95.62 mm) ($F_1 = 182.06$; $P < 0.001$).

3.2. Lizard assemblages

We recorded 536 observations of lizards representing 10 species and seven families. Cape dwarf geckos (*Lygodactylus capensis*) were the most abundant species in both study areas, irrespective of sampling technique (arboreal sampling, transects and TCS) and appeared to do equally well in both disturbed and undisturbed areas (Table 2). Other species were encountered much less frequently, precluding statistical analysis, although the general trend was higher counts in the disturbed areas (Table 2). This was particularly true for the girdled lizard *Cordylus t. jonesi*, the gecko *Homopholis wahlbergi*, and the tree agama *Acanthocercus atricollis*. We also observed tree agamas living on large trees in several villages, including trees close to houses, suggesting some resilience to anthropogenic disturbance.

Although overall tree density between the two areas did not differ significantly, there were more trees with

Table 1
Comparison of the proportion of trees in each category of the five physical characteristics measured, and significance tests comparing the distribution of each characteristic between the disturbed and the undisturbed areas

	Circumference			Alive/dead			Height			Holes		Loose bark	
	5–50	50–100	>100	AL	ANL	D	>2	2–4	>4	Pres.	Abs.	Pres.	Abs.
Undisturbed	97.0	2.3	0.7	76.2	20.4[a]	3.4[a]	40.1	45.3[a]	14.6[a]	0.6	99.4	4.5	95.5
Disturbed	98.8	0.7	0.5	95.1	4.7	0.2	93.3[a]	6.2	0.5	0.4	99.6	0.3	99.7
χ^2, df	55.90	2		905.16	2		3856.25	2		2.81	1	231.70	1
P	<0.0001			<0.0001			<0.0001			0.0937		<0.0001	

AL = alive with leaves; ANL = alive with no leaves; D = dead, Pres. = presence; Abs. = absence.
[a] Indicates a significant ($P < 0.05$) difference between categories using one-way ANOVA. Circumference in cm, height in m.

Table 2
Lizard species documented during visual encounter surveys in the disturbed (communal lands; CL) and undisturbed (WRF) areas

Species	Disturbed	Undisturbed	Total	Arboreal	Transects	TCS	Chance
Scincidae							
Mabuya striata	8	3	11	6	0	5	
M. varia	9	6	15	6	2	7	
Scelotes bidigittatus	0	1	1	0	1	0	
Lacertidae							
Nucras intertexta	5	0	5	0	3	2	WRF
Pedioplanis lineoocellata	4	0	4	1	2	1	WRF
Heliobolus lugubris	1	0	1	0	0	1	
Gerrhosauridae							
Gerrhosaurus flavigularis	3	1	4	0	2	2	
Cordylidae							
Cordylus tropidosternum jonesi	18	2	20	7	5	8	
Agamidae							
Acanthocercus atricollis	28	12	40	30	0	10	
Agama aculeata	0	0	0	0	0	0	WRF,CL
Chamaeleonidae							
Chamaeleo dilepis	3	0	3	2	1	0	WRF
Gekkonidae							
Hemidactylus mabouia	1	1	2	0	0	2	
Homopholis wahlbergii	11	0	11	9	0	2	WRF
Lygodactylus capensis	222	198	420	260	11	149	
Pachydactylus punctatus	1	0	1	0	1	0	
Varanidae							
Varanus albigularis	0	0	0	0	0	0	WRF

Three sampling methods were used: arboreal, transects, and time constrained searches (TCS) (see text for details). Lizards encountered at a site by chance only, and not during sampling, are also indicated, but not included in total counts.

circumference >50 cm in the undisturbed area (Table 1). Because more arboreal lizards were found using these trees (>50 cm circumference), we predicted higher arboreal lizard density in the undisturbed area. However, this only held true for *Lygodactylus capensis*, although the mean density was not significant. The overall pattern was that arboreal lizard density was higher in the disturbed area, and this was significant for the gecko *H. wahlbergii* ($P < 0.005$; Table 3).

Species richness and species diversity were dependent on sampling method. TCS values for species richness and species diversity were significantly higher for the disturbed area, although the values for the disturbed area were higher than the undisturbed site in all remaining instances (Table 4).

3.3. Human use and perceptions of reptiles

Similar proportions of traditional healers and households reported seeing the listed reptiles (Tables 5 and 6);

Table 3
Mean (±SD) arboreal lizard density for the disturbed and undisturbed areas

Species	Undisturbed	Disturbed
Lygodactylus capensis	35.56 ± 55.42	26.42 ± 39.43
Acanthocercus atricollis	0.24 ± 0.36	0.42 ± 0.55
Mabuya varia	0.10 ± 0.44	0.17 ± 0.30
M. striata	0.09 ± 0.21	0.07 ± 0.23
Homopholis wahlbergii	0.00	0.19 ± 0.34
Chamaeleo dilepis	0.00	6.60 ± 28.02
Cordylus tropidosternum jonesi	0.06 ± 0.20	0.10 ± 0.22

Table 4
A comparison of mean (±SD) species richness and diversity for all sampling methods, using Mann–Whitney *U* tests

		Transects	Arboreal	TCS	
Species richness	Undisturbed	1.67 ± 1.53	4.00 ± 1.00	3.00 ± 0.00	
	Disturbed	3.67 ± 1.53	5.67 ± 0.58	7.00 ± 0.00	
	U, df	1.50, 1	0.50, 1		0.00, 1
	P	0.184	0.072	0.025	
Species diversity	Undisturbed	2.21 ± 2.03	0.97 ± 0.30	0.79 ± 0.02	
	Disturbed	3.49 ± 0.76	1.43 ± 0.15	2.35 ± 0.41	
	U, df	3.50, 1	1.00, 1		0.00, 1
	P	0.658	0.127	0.050	

TCS = time constrained searches. See text for details of computational methods.

Table 5
Percentage of questionnaire respondents who responded affirmatively to a selection of the most important questions and species (vernacular name under species name)

Reptile	TH: seen	HH: seen	TH: use	HH: use	TH: kill to use	HH: kill to use	TH: kill and leave	HH: kill and leave
Geochelone pardalis								
Leopard tortoise	100	100	100	9	29	0	0	0
Bitis arietans								
Puffadder (snake)	93	88	79	9	21	0	0	16
Python natalensis								
African python (snake)	79	39	79	12	7	0	0	3
Varanus albigularis								
Rock monitor (lizard)	93	91	79	6	36	0	0	0

The first answer (seen) was in response to encounter. The second refers to uses. The third and the fourth were options in response to reaction upon encounter. TH = traditional healer sample ($N = 14$), HH = household sample ($N = 32$).

Table 6
Percentage of respondents who had either seen a species less often; or not at all, compared to 10 years previously

Species	TH: seen less often	HH: seen less often	TH: not seen anymore	HH: not seen anymore
Geochelone pardalis	61	65	8	3
Pelomedusa subrufa	46	51	8	0
Bitis arietans	63	77	0	0
Python natalensis	67	68	16	16
Naja mossambica	54	59	9	13
Lamprophis fuliginosus	67	43	11	20
Dendroaspis polylepis	58	42	0	24
Mabuya striata	0	3	0	0
Acanthocercus atricollis	54	38	9	0
Varanus albigularis	8	6	0	0
Homopholis wahlbergii	37	23	9	0
Chamaeleo dilepis	7	3	0	0

TH = traditional healers ($N = 14$), HH = households ($N = 32$).

however, traditional healers used reptiles far more frequently. The most frequently used reptiles are listed in Table 5. Reptiles often had multiple medicinal purposes, being used to treat more than one ailment (personal observation). Fewer respondents killed reptiles compared to those that used them, and the number of respondents that killed reptiles and discarded them upon encounter was very low (Table 5).

Most species had been seen by respondents (Table 5), although identification ability varied. For example, *Lamprophis fuliginosus*, a common non-descript harmless snake was generally confused with venomous species. Other snake species were misidentified fairly often, such as *P. natalensis* and *B. arietans.*

Species encountered by us during field sampling were seen frequently by respondents. The percentage respondents who had seen specific species daily were as follows: *M. striata*, TH: 100%, HH: 97%; *A. atricollis*, TH: 57%, HH: 72%; *H. wahlbergii*, TH: 0%, HH: 3%; *C. dilepis*, TH: 14%, HH: 28%.

If we compare frequency of encounter presently (time of study) and 10 years previously, several species were seen less often by both traditional healers and households (>50%; Table 6). These include *G. pardalis, B. arietans, P. natalensis* and *Naja mossambica*. Several species were reported seen less frequently by >50% of one group, but not the other (Table 6).

4. Discussion

4.1. Vegetation structure

Current land practices have significantly impacted on vegetation structure in communal lands in our study area. Although woody plant density did not differ significantly between the undisturbed and communal lands, structural characteristics were different. Woody plants in the larger circumference and height categories were significantly less common in the communal lands, and this can be attributed to firewood chopping (Shackleton et al., 1994). There were also fewer dead trees in the disturbed area, because of their suitability for firewood (Du Plessis, 1995). Furthermore, dead trees are more likely to have exfoliating bark, holes, and broken-off limbs, all used as refugia by many lizard species. Finally, grasses in the communal lands were more low-growing and creeper-like (McNaughton, 1984), typical of heavily grazed areas. The plant communities in the undisturbed and communal lands were therefore quite different, all as a result of human activity.

4.2. Lizard assemblages

Lizard communities in the communal lands did not appear to have been negatively affected by local land practices in any obvious way. Lizards were often more abundant in the disturbed area, and these communal lands had higher species richness and diversity. A recent study in South African xeric succulent thicket under different land-use regimes produced similar findings: lizards were almost twice as abundant in communally grazed areas than protected areas, although diversity was similar among sites (Fabricus et al., 2003). Previous studies in the same geographic area as our study, show that responses to habitat alteration in communal lands appear to be taxon specific. Grasshopper diversity was similar between a protected area and neighbouring communal lands, although communities differed in guild structure (Prendini et al., 1996). Bird diversity in the same area was higher in the protected area compared to communal lands (Lewis, 1997), while plant diversity was higher in the communal lands (Shackleton, 1998, 2000). Species within a taxon may also vary in response to disturbance. For example, in communal lands a few plant species increased in abundance along a gradient of increasing disturbance, whereas others decreased, and some did not change (Shackleton et al., 1994).

Using the lizard assemblage in the undisturbed area as a baseline, we found no evidence that lizards in the communal area were negatively impacted by habitat disturbance. Eight lizard species were recorded only from the disturbed area, although four were represented by only one specimen, and five were found in the undisturbed area through chance encounters. *Varanus albigularis* and the tortoise *G. pardalis* were found by chance only in the undisturbed area, and both are eaten and used in traditional medicine. *Lygodactylus capensis* was by far the most common species at all sites, irrespective of sampling techniques. *Lygodactylus capensis* is a generalist species far smaller than any of the other arboreal lizards in the study area, and therefore may not experience any significant competition from other lizard taxa; it also used refuge sites inaccessible to other species. Other species encountered during surveys, including *M. striata* and *H. wahlbergii*, are also habitat generalists and have been anecdotally reported to use human structural features (Branch, 1998b). All were more common in the disturbed area, and significantly more so for *H. wahlbergii*. Surprisingly, tree agamas, that normally prefer large trees (Reaney and Whiting, 2003), occurred in similar numbers in both study areas. They were also observed on large trees in villages, where human traffic is high. However, although they appear to do well in and close to human habitation, they are likely to be negatively impacted by further tree harvesting.

4.3. Intermediate disturbance hypothesis

The intermediate disturbance hypothesis states that diversity is highest under an intermediate disturbance regime, and lower at sites with very high or very low levels of disturbance (Grime, 1973; Huston, 1994). Previous studies of lizard populations experiencing intermediate levels of disturbance have provided some support for this idea. For example, lizard abundance and species richness peaked at intermediate levels of urbanisation in Tucson, Arizona (Germaine and Wakeling, 2001). And in southeastern Spain, common chameleons (*C. chamaeleon*) were most common in areas of intermediate disturbance, such as cultivated areas and near roads (Hodar et al., 2000). Although the definition of 'intermediate disturbance' is subjective and therefore problematic, our study suggests that some taxa may benefit from an intermediate disturbance. In particular, terrestrial lizards (lacertids in particular) become more abundant as ground cover becomes sparser (personal observation). Disturbance generally affects discrete areas, resulting in a patchy landscape and increased habitat heterogeneity. In Australia, high lizard diversity in chenopod shrublands has been attributed to high levels of microhabitat variability (Read, 1995). The current land-use practices in the communal lands are typical of communities in many areas of South Africa. The net result may be that lizard diversity could be changing over a broad geographic area.

4.4. Human use and perceptions of reptiles

Average households rarely used reptiles, while traditional healers made extensive use of reptiles for medicinal purposes. Nine of 12 species were used by more than 50% of traditional healers. The most heavily used species were also perceived to have declined, including a tortoise (*G. pardalis*) and two snakes (*B. arietans* and *P. natalensis*). Fortunately all these species have relatively broad geographic ranges and are not of conservation concern (Branch, 1988a). Response to questions about reptile use were not consistent, as different treatments (reptiles) were used for the same illnesses. And compared to members of households, traditional healers were more likely to kill reptiles for use upon encounter. Some uses by traditional healers did not result in death. For example, traditional healers were able to remove a small piece of a tortoise shell and release the animal. Interestingly, 71% of users buy animal products, suggesting there is a market for the sale of reptile products (see Simelane and Kerley, 1997). The impact of indiscriminate killing on reptile populations is likely low, because respondents who killed reptiles upon encounter, but not for use, were few (highest: 25% of a household). This also depended on place of encounter – reptiles close to homesteads were more likely to be killed. Species most often killed were snakes.

Respondents exhibited poor snake identification skills. Snake species were often not differentiated, and all were considered venomous, including harmless house snakes (*L. fuliginosus*). Overall, information from questionnaires corresponded relatively well with field sampling data. That is, species most familiar to respondents were species most commonly encountered in field samples. However, the relationship between species commonly used in traditional medicine and their abundance and conservation status in communal areas, remains poorly understood. This is perhaps compounded by the fact that many users of reptiles buy their products from markets. Some of these specimens may have been collected in other areas. Intensive sampling of markets selling animal products may shed light on place of collection, the extent of collection, and use of threatened or endangered taxa. Future field surveys could be directed at these areas to obtain a measure of sustainability.

4.5. Predator and/or competitor suppression

A lack of predators can cause a species to increase in abundance (Case et al., 1998). Large mammal species numbers are seriously depleted in communal lands (personal observation) and many smaller mammals appear to have declined. Also, bird diversity is higher in the protected area than neighbouring communal lands (Lewis, 1997). Both taxa contain numerous species that exert considerable predation pressure on reptiles. In addition, both taxa contain species that could compete with lizards through use of cavities in trees for roosting and/or breeding, as well as their food source, which is predominantly insects (Du Plessis, 1995; Lewis, 1997). We did not evaluate these effects directly, but given the major changes in species composition (of numerous vertebrate and invertebrate groups) from the same study area, there is a real likelihood of an affect. Therefore, although we did not document any obvious negative affect of human disturbance on the lizard community, it is probable that on a larger spatial scale, ecosystem structure and function has been altered in some way. Such alteration could be in the composition of food webs and tropic interactions, and resulting energy flow. One obvious interaction is between lizards and their insect prey. If predation on certain insects by lizards is either magnified or reduced, this could alter levels of interspecific competition between insects and have cascading effects at the community and ecosystem levels. Furthermore, it is possible that some species not encountered in field surveys, which naturally occur in low numbers, may have been extirpated or have been negatively affected by land-use in communal lands. All these factors are likely to influence ecosystem structure and function. Finally, investigation of reptile use by traditional healers is needed over a broad geographic area to determine intensity of use and the conservation implications. Sustainable harvesting levels must be sought to ensure these species continue to play important ecological roles.

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Appendix A

Questionnaire used during interviews of traditional healers and households to establish recognition, level of use, and reaction to, reptiles. In the interests of space, we have omitted boxes and spaces for scoring responses.

A.1. Biographical information

Name
Age
Gender
Occupation/livelihood
Cultural group
Place of birth
When did you move here?
Education
Religion/beliefs

A.2. Reptile identification, perceptions and use

1. Have you seen this animal before?
2. Do you have a name for this animal?
3. How often do you see this animal?
   (a) Every day
   (b) 1 week/2 weeks
   (c) A few times
   (d) Once
4. Where do you see this animal?
   (i) In relation to where you stay:
      (a) Around your homestead/neighbours homestead
      (b) Far from villages.
   (ii) Habitat
      (a) Around or in water
      (b) Little or no grass
      (c) Long grass
      (d) Many trees
      (e) Few trees
      (f) Other
5. (i) If you were to compare how often you see the animal now to the past (10 years) would you say:
      (a) More often
      (b) The same
      (c) Less often
      (d) Not any more
   (ii) Unless (c), why do you think this is so, and when did this change come about?
6. Do you personally have any uses for this animal? If so, explain what these uses are.
7. Do you know of anyone who has a use for this animal? If so explain what these uses are.
8. When you encounter this animal, how do you react?
   (a) Kill it instantly and leave it
   (b) Kill it to use it
   (c) Catch it to use it alive
   (d) Try to chase it away
   (e) Ignore it
   (f) Run away
   (g) Pick it up arid place it in a different place
   (h) Call someone else to kill the animal
   (i) Catch it for someone else to use.
9. Is this animal harmful? If so, explain how it is harmful.
10. Have you personally been harmed by this animal? If so, explain.
11. Do you know anyone who has been harmed by this animal? If so explain.
12. Are there any benefits of the animal known to you? If so, how?
13. Is there any use of this animal for rituals, ceremonies or other cultural purposes such as myths, legends or totems?

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