A Winter Survey of the Herpetofauna of the uMkhuze section of the iSimangaliso Wetland Park, KwaZulu-Natal, South Africa.

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Introduction

The iSimangaliso Wetland Park (iSWP) is a UNESCO World Heritage Site located in northeastern KwaZulu-Natal, South Africa. Totalling almost 300,000 ha, the Park is an area of extraordinary species richness and home to many taxa of conservation concern. The iSWP is the largest protected area in Conservation International's Maputaland-Pondoland-Albany hotspot, and is a significant component of the Maputaland Centre of Endemism, a c.17, 000 km^2 area of unique conservation concern located between the Limpopo River and St. Lucia estuary (Smith 2001, Fig. 1).

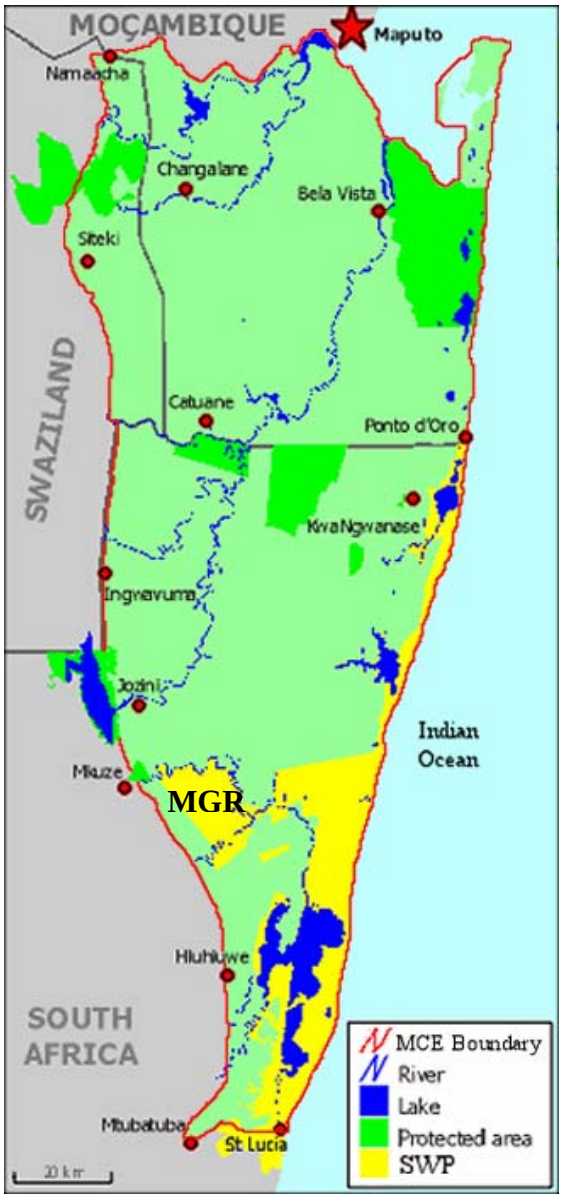


Figure 1. Map of the Maputaland Centre of Endemism (MCE) and the iSimangiliso Wetland Park (SWP). Adapted from www.mosaicconservation.org

Maputaland is an area of notable integration between tropical and subtropical biota, and also harbours numerous endemics as a consequence of *in situ* speciation on the geologically recent coastal plain (Bruton and Cooper 1980). Furthermore, well-defined climatic and geological gradients have created distinct ecological zones within the region, further contributing to high gamma diversity in this part of Africa (Smith 2006). The herpetofauna of the iSWP exemplify this diversity, with over 160 species, 16 reptiles listed in CITES appendices (Schedule 14), and many species with restricted or isolated populations (KZNNCS 1998).

The uMhkuze Game Reserve (MGR) is the westernmost constituent of the iSWP. MGR harbours an inordinate number of reptile and amphibian species, and is an ideal place to study the unique herpetofauna of Maputaland. Although herpetofauna are often neglected in research initiatives and management plans, this trend is reversing in MGR thanks to an ongoing survey of the reserve

initiated in 2006 by the iSWP Threatened Species Project with Operation Wallacea volunteers. This survey aims to mine distributional, habitat-usage, and ecological data from varied taxa in MGR by conducting biodiversity surveys within two 5 km^2 grid squares each year. The winter survey of reptiles and amphibians detailed here is an extension of this continuing research effort, and our data are presented with a goal of advancing the knowledge of the herpetofauna of MGR while further refining the atlasing methodology, toward a more comprehensive understanding of the biodiversity of the reserve and region.

Study Area

MGR is located 40 km from the coast of the Indian Ocean, lies between 27° 32′ 30″ S and 27° 48′ 30″ S and between 32° 06′ 00″ E and 32° 26′ 00″ E, and is 370 km² in size. Altitude ranges from 30 to 480 metres above sea level. The reserve boundaries are the Mkhuze River at the north and east, the Msunduzi River to the south, with the Lebombo Mountain Range constituting the western edge. Formed during the break up of Gondwanaland 140 million years ago, the Lebombos represent the continental rift line in southern Africa and contribute to the diverse physiography exhibited within the reserve (Goodman 1990, Fig. 2). Although completely fenced, MGR forms part of the iSWP (formerly known as the Greater St Lucia Wetland Park) and is linked to the Ozabeni section of the iSWP on its eastern side.

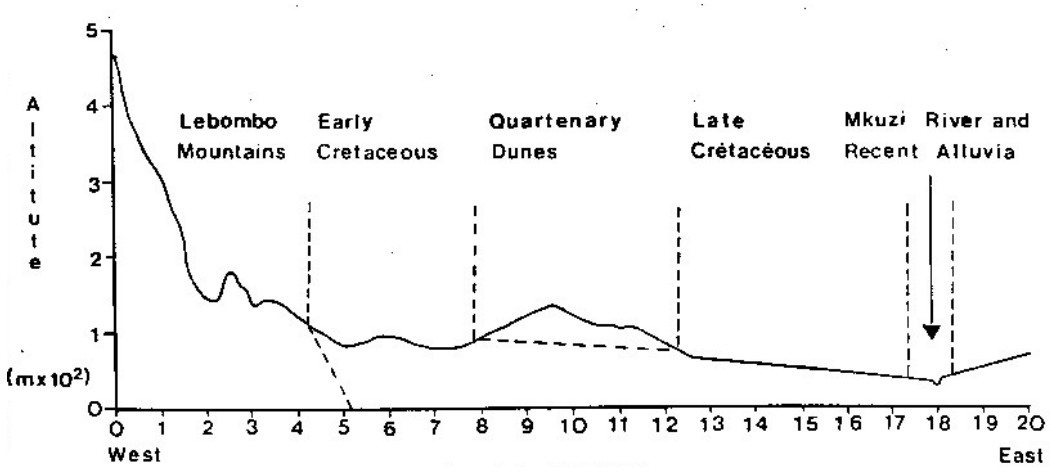


Figure 2. Topographic scheme of Mkhuze Game Reserve. Adapted from Goodman 1990.

The climate of MGR is sub-tropical, consisting of hot, humid summers (southern hemisphere; mid-September – late March) and mild, arid winters (April-mid September). Mean annual temperature is 23.2º C. Rainfall in MGR averages 700 mm annually, with most precipitation occurring during the summer months. Goodman (1990) divides MGR into eight major vegetation types, which overlap along complex environmental and edaphic gradients. The reserve is notable for its unique fig and sand forests, and diversity of bushveld types.

Materials and Methods

From 14 July - 4 September 2007, two 5 km^2 grid squares inside MGR were surveyed simultaneously for herpetofauna by continuous trapping. Each trap array consisted of three, 30 metre plastic drift fence lines that converged at a central point, with individual lines angled roughly 120º from each other. The bottom third of each fence was folded and covered with substrate, and the remaining portion (approx. 30 cm) was then stabilized upright with steel dropper poles and plastic cable ties. Along each fence line, seven 20 litre buckets were placed flush with the ground into holes dug directly beneath the drift fence. A bucket was also placed at the middle point of the trap where the fence lines joined, for a total of 25 buckets per array. Additionally, 3-4 funnel traps were staggered along each line (Fig 3). Funnel traps were made by cutting PVC pipe to lengths of 80 – 100 cm and then fitting each end with an inward-facing funnel, constructed from the top third of a 2-litre plastic soda bottle.

To determine trap array locations, each pre-selected grid square was divided into twenty-five 1 km^2 squares. Five of these squares were then chosen for trap placement localities based on maximum habitat heterogeneity. A total of 10 trap arrays were constructed (5 per 5 km^2 grid square). Grid Square One contained primarily Mixed Bushveld, Thicket, and *Microphyllous* Thorny Plains Bushveld veld types, whereas the predominant vegetation in Grid Square Two was Sand Forest and Red Sand Bushveld (Goodman 1990). Because sufficient numbers of individuals and species were not captured for strong statistical habitat analysis involving multiple vegetation types in each grid square, for habitat comparisons we demarcated habitat type for Grid Square One as “Mixed Bushveld” and Grid Square Two as “Sand Forest.” Although the true veld type of some trap site locations may not have conformed to Goodman’s (1990) strict definition of Mixed Bushveld and

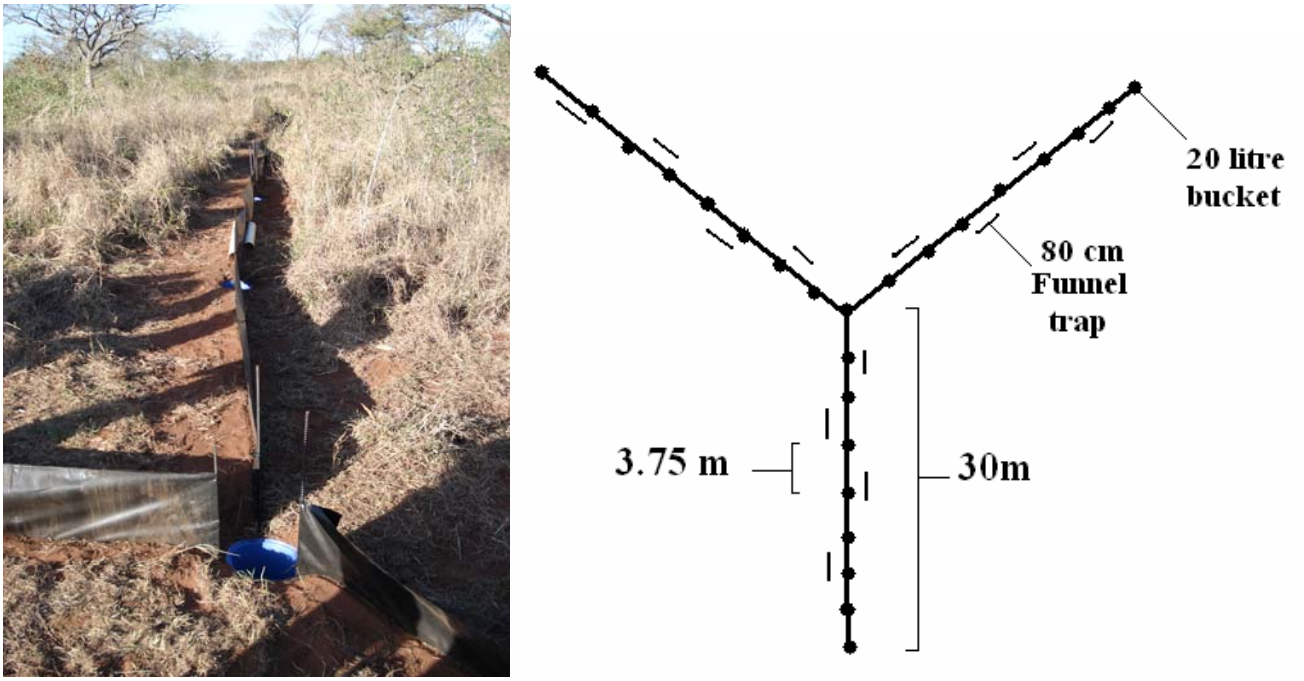


Figure 3. Trap design and specifics

Sand Forest (e.g. site locations at the forest ecotone), the two 5 km^2 grid squares overarchingly corresponded to these definitions, physiognomically and vegetatively.

The ten trap stations were checked daily between 6:00 – 11:30 a.m. (Because of survey logistics and the distance between grid squares, only one check per day was feasible.) Specimens were removed from the traps and released immediately after identification, although unidentifiable specimens and "species of interest" were taken back to the lab for photographs, tissue collection (ventral scales or blood), and/or voucher preparation. Each specimen encountered in a trap was assigned a GPS waypoint according to the trap station where it was captured.

Surveying of herpetofauna was also conducted through active searching, which consisted of timed expeditions in the field where teams would look under rocks, lift logs, scrape ground litter and search suitable habitat for reptiles and amphibians. Recordings of specimens were also made during night drives on tar roads (although these were limited due to cold evenings). Incidental daytime encounters were similarly recorded. Specimens recorded during opportunistic searches are included in this report, but this data was not subjected to comparative habitat analysis to due to biased search effort

in areas of rocky habitat. All statistical analyses were conducted using Statistica ver 6 (StatSoft Inc., 2002).

Results

Sixty species of reptiles and amphibians were recorded during the survey period (Appendix A). Trap stations were open for a total of 11,352 trap nights (# buckets *x* survey nights), during which 430 specimens (trap success = 3.8%) representing 30 species were captured (Fig. 6). Reptiles constituted 22 of those species (Lizards – 12, Snakes – 8, Land Tortoises – 1, Amphisbaenia - l), and amphibians the remaining 8 (all Anurans). The most frequently captured amphibian was the Rain Frog (*Breviceps adspersus* or *mossambicus* - awaiting molecular verification; 32.3% of all captured individuals), and the most common reptile was the Variable Skink (*Trachylepis varia*, 24.2%). Ten species (33.3% of the total number trapped) were represented by only one captured specimen. Combining the yields of all trap stations, thirty-six individuals was the highest capture total in a single day (Aug. 26th). The most species recorded during a daily check was 10, on August

Figure 4. OpWall volunteers remove a Brown House Snake (*Lamprophis capensis*) from a funnel trap.

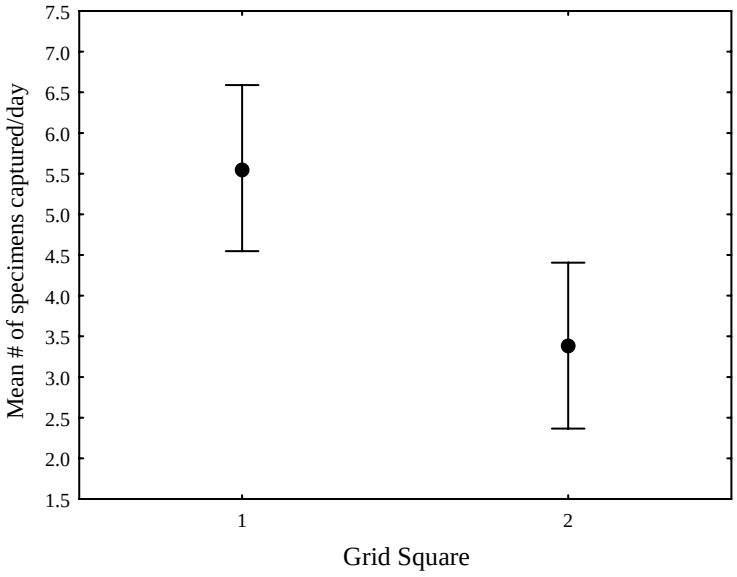
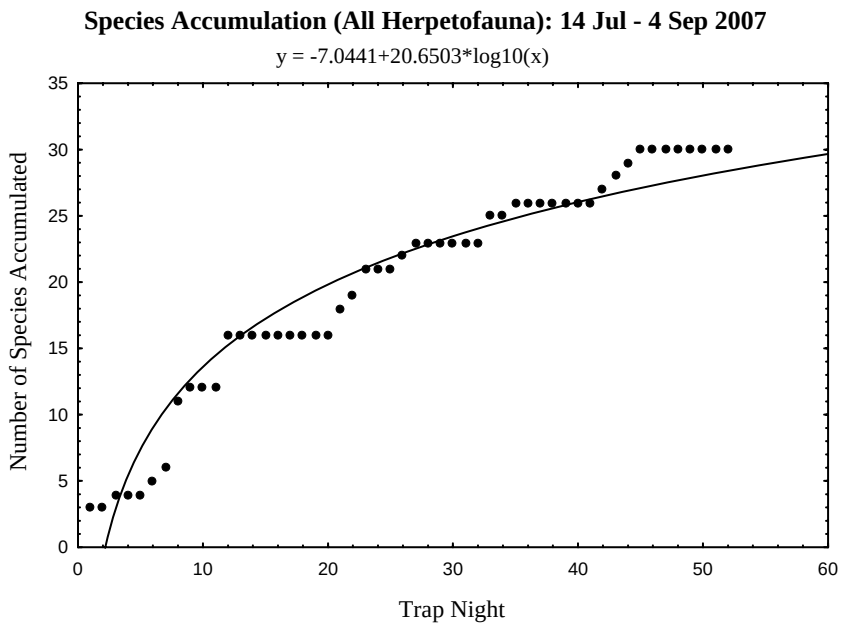
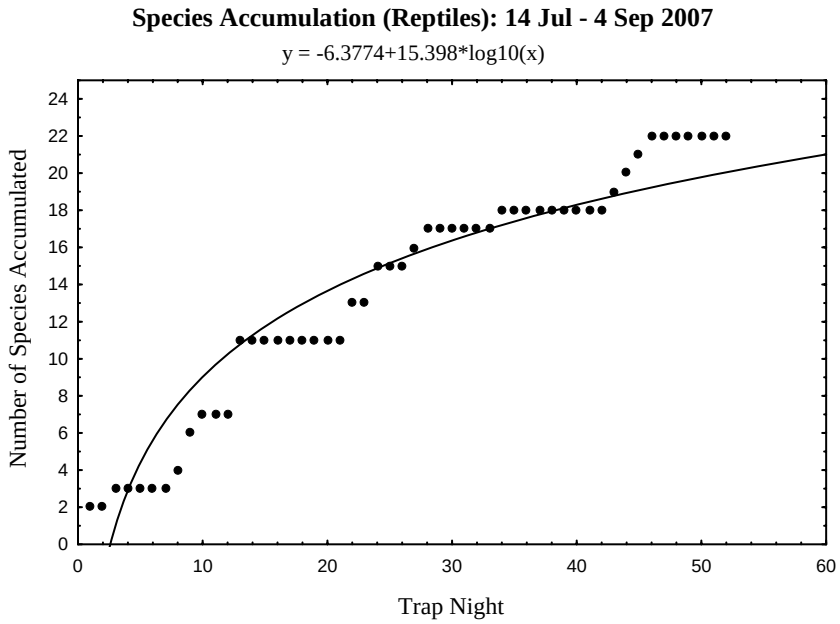


Figure 5. Capture averages for trap arrays in two 5 km grid squares in MGR. ANOVA: F(1, 86)=9.0316, p=.00348. Vertical bars denote 95% confidence intervals.





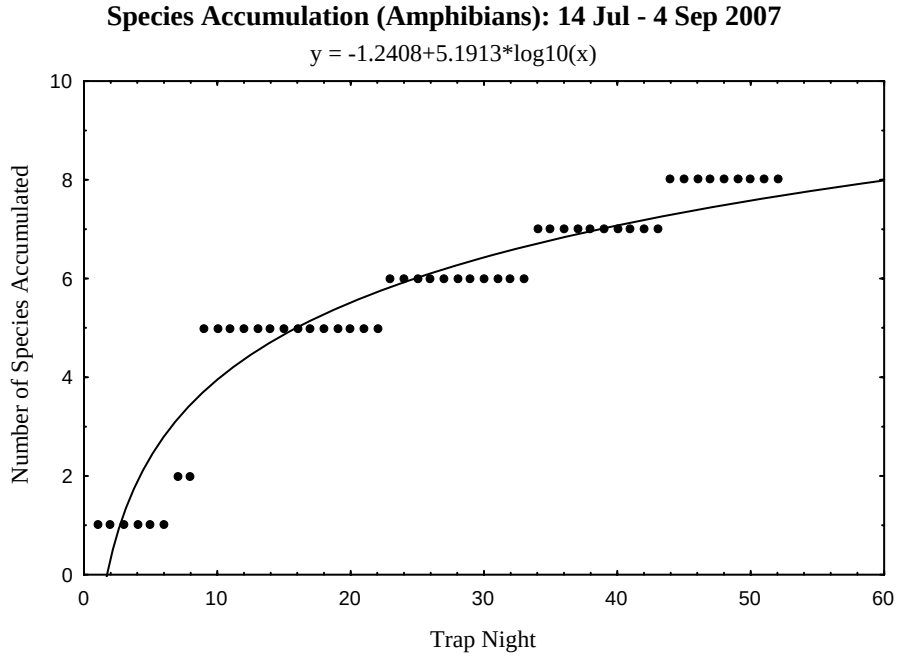


Figure 6. Species accumulation curves of herpetofauna from winter trapping in MGR

16th. Overall, a higher total number of reptile individuals were captured in traps than amphibians for the trapping period (Mann-Whitney U test, $Z = -2.89$, $p = 0.004$).

The five trap stations in Grid Square One (Mixed Bushveld) produced a higher total of individual captures ($n = 245$) than the traps in Grid Square Two (Sand Forest, $n = 185$). ANOVA applied to daily capture rate data (specimen abundance) for all traps in each of the two grid squares determined a significant difference ($p < .05$) between the capture success of Mixed Bushveld and Sand Forest traps (Fig. 5). The most productive trap station (83 individuals captured) was in Mixed Bushveld, and the least productive in Sand Forest (18 individuals).

Discussion

There are several probable reasons why trap arrays in Mixed Bushveld yielded higher abundances of reptiles and amphibians than traps in Sand Forest. In terms of both plant structure and composition, Mixed Bushveld habitat in MGR is exceptionally heterogeneous and mostly open-canopied (Goodman 1990). Areas of open-canopy and sparse vegetation allow for suitable basking sites (necessary for reptiles because thermoregulation is a high priority for many species in winter, Branch 1998), while dense shrubs and grasses in close approximation provide shade and optimal retreats from predators. In contrast, Sand Forest is primarily a closed canopy habitat with a poorly developed herbaceous layer; unsuitable for active herpetofauna during winter. Additionally, soils in Mixed Bushveld are more compact than the loose, sandy soils of Sand Forest, which allows for a higher abundance of refugium (tunnels, burrows, etc.) available to reptiles and frogs.

While we cannot definitively conclude that there are fewer reptiles and amphibians in Sand Forest during winter because of our trapping bias towards smaller species, our data show that Mixed Bushveld is definitely an area of intense use for many species during cooler months. Data from a replicate trapping survey conducted during summer in MGR show similar capture rates for traps in both habitats (unpub. data); indicating herpetofaunal activity levels within different habitat types fluctuate seasonally, but not necessarily to the same degree. Future research is needed to determine whether species composition among habitats also changes seasonally.

Figure 7. OpWall volunteers prepare to measure a large female Southern African Python (*Python natalensis*) captured in MGR.

The fact that we captured more reptile species and individuals than amphibians was not surprising considering that this survey was conducted during the middle of winter, when frog activity is depressed. Based on trapping abundances, *Breviceps* spp. appears to be the most active frog during winter, and *Trachylepis varia* the most abundant reptile within the two 5 km² areas surveyed. Most lizard species captured in traps were small, diurnal, habitat generalists that bask and actively forage on sunny days, using burrows and grass tussocks as refugia (Alexander and Marais 2007). Active year-round, these species (i.e. *Trachylepis* spp. and *Lygodactylus capensis*) occur at high densities in MGR and thus were well represented in the traps. The majority of trap-captured snakes were small, fossorial or semi-fossorial species (e.g. *Aparallactus capensis*).

Larger diurnal reptiles (i.e. *Naja* spp. and *Varanus* spp.) were infrequently captured in traps (probably because they either avoided or escaped from the buckets) therefore most recordings of

these species came from active searches. However, nocturnal reptile species were noticeably underrepresented in trapping and active search efforts. For example, two common snakes in MGR, the Brown House Snake (*Lamprophis capensis*) and Herald Snake (*Crotaphopeltis hotamboeia*), although frequently observed during active searches in warmer months, were represented in this survey by only one individual for each respective species. Similarly, the Rhombic Egg-eater (*Dasypeltis scabra*), regularly encountered on roads at night during the summer, was not captured at all during this expedition. These observations support our hypothesis that some nocturnal snakes in the region, most notably feeding specialists (e.g. the batrachophagous *C. hotamboeia* and egg-eating *D. scabra*), undergo longer periods of inactivity relative to other reptiles during unsuitable climatic episodes because of fundamentally different ecological strategies related to foraging.

While the cool, exceptionally dry surveying climate certainly stunted our species list (46 reptiles, 14 frogs), the tally was higher than expected. Thirteen more species were recorded during the 2007 survey compared to the 2006 survey. Recordings of Delalande's Beaked Blind Snake (*Rhinotyphlops lalandei*) and Holub's Sandveld Lizard (*Nucras holubi*) represent new additions to the herpetofauna species list for the iSWP. *R. lalandei* is also a KwaZulu-Natal provincial record, and the capture of three individuals in the Lebombo foothills during this survey significantly extends the species' distribution in southern Africa. Additionally, three juvenile Two-striped Shovel-snout snakes (*Prosymna bivittata*) captured during active searches augment a lone adult record from 2006 and verify a viable population of the species within the reserve.

In total, 42 specimens were taken from MGR as voucher specimens and have been accessioned by the Port Elizabeth Museum. Tissue samples from several of these specimens have already been analyzed and contributed to recent molecular studies on African viperids and fossorial snake genera. Species recorded during this survey that are listed in the South African Red Data Book (Branch 1988) include the Nile Crocodile (*Crocodylus niloticus* - vulnerable), Forest Cobra (*Naja melanoleuca* - peripheral), Southern African Python (*Python natalensis* - vulnerable), and Transvaal Quill-snouted Snake (*Xenocalamus transvaalensis* - rare).

Conclusions

In addition to recording two new reptile species for the region, ecological insight was garnered for a variety of taxa, and further understanding of winter behaviour and habitat use of reptiles and amphibians in MGR was acquired during OpWall 2007. Thanks to increased research attention in recent years, the herpetofauna species list for the iSWP has noticeably expanded, yet more surprises undoubtedly await future "herpers" in the region. Because of Maputaland's unique geography and climate, co-association with the Lebombo Mountains and coastal plain, and wide breadth of habitat types, there is a strong possibility that additional reptile and frog species will be discovered in MGR. Furthermore, several species that have been recorded during the past two years are represented by lone specimens (e.g. *Lycophidion pygmaeum* and *Homoroselaps dorsalis*) and large portions of the reserve still await formal sampling. Incredibly, the number of reptile and amphibian species recorded within MGR exceeds 115 specimens, and genetic analyses and voucher specimen verification will probably place the total closer to 130. This means greater than 70% of the herpetofaunal diversity of the iSWP occurs within an area less than 20% of its total size; ranking MGR as one of the most species-rich areas in southern Africa, and underscoring the need for long-term protection and beneficial management practices in the reserve for these underappreciated and often overlooked animals.

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Appendix A: Herpetofauna species list for the 2007 OpWall expedition in uMkhuze Game Reserve
*captured in trap array

REPTILES

*Acanthocerus atricollis**	Southern Tree Agama
Acontias plumbeus	Giant Legless Skink
*Aparallactus capensis**	Black-headed Centipede-eater
*Bitis arietans**	Puff Adder
Crocodylus niloticus	Nile Crocodile
Crotaphopeltis hotamboeia	Herald Snake
Dipsadaboa aulica	Marlbed Tree Snake
Dispholidus typus	Boomslang
*Gerrhosaurus flavigularis**	Yellow-throated Plated Lizard
*Hemidactylus mabouia**	Moreau's Tropical House Gecko
*Ichnotropis squamulosa**	Common Rough-scaled Lizard
*Kinixys belliana**	Bell's Hinged Tortoise
*Lamprophis capensis**	Brown House Snake
*Leptotyphlops incognitus**	Incognito Worm Snake
Leptotyphlops scutifrons conjunctus	Eastern Cape Worm Snake
Lycophidion capense	Common Wolf Snake
*Lygodactylus capensis**	Cape Dwarf Gecko
Naja melanoleuca	Forest Cobra
Naja mossambica	Mozambique Spitting Cobra
*Nucras holubi**	Holub's Sandveld Lizard
*Nucras intertexta**	Spotted Sandveld Lizard
Pachydactylus maculatus	Spotted Thick-toed Gecko
*Pachydactylus vansoni**	Van Son's Gecko
*Panaspis wahlbergii**	Wahlberg's Snake-eyed Skink
Pelusios sinuatus	Serrated Hinged Terrapin
Philothamnus semivariegatus	Spotted Bush Snake
Platysaurus lebomboensis	Lebombo Flat Lizard
*Prosymna bivittata**	Two-striped Shovel-snout
Prosymna stuhlmannii	East African Shovel-snout
Psammophis brevirostris	Short-snouted Sand Snake
*Psammophis mossambicus**	Olive Grass Snake
Psammophis subtaeniatus	Western Stripe-bellied Sand Snake
Python natalensis	Southern African Python
*Rhinotyphlops lalandei**	Delalande's Beaked Blind Snake
*Scelotes mossambicus**	Mozambique Dwarf Burrowing Skink
Stigmochelys pardalis	Leopard Tortoise
Telescopus semiannulatus	Eastern Tiger Snake
Thelotornis capensis	Vine Snake
Trachylepis margaritifer	Rainbow Skink
*Trachylepis striata**	Striped Skink
*Trachylepis varia**	Variable Skink
Typhlops bibronii	Bibron's Blind Snake
Varanus albigularis	Rock Monitor
Varanus niloticus	Water Monitor
*Xenocalamus transvaalensis**	Transvaal Quill-snouted Snake
*Zygaspis vandami arenicola**	Vandam's Round-headed Worm Lizard

AMPHIBIANS

*Amietophrynus garmani**	Eastern Olive Toad
Amietophrynus gutturalis	Guttural Toad
Breviceps sp. (*adspersus* or *mossambicus*)*	Rain Frog
*Cacosternum boettgeri**	Common Caco
*Chiromantis xerampelina**	Foam Nest Frog
*Kassina senegalensis**	Bubbling Kassina
*Leptopelis mossambicus**	Brown-backed Tree Frog
Phrynobatrachus mababiensis	Dwarf Puddle Frog
*Phynomantis bifasciatus**	Banded Rubber Frog
Ptychadena anchietae	Plain Grass Frog
Ptychadena mossambica	Broad-banded Grass Frog
Pyxicephalus edulus	African Bullfrog
*Schismaderma carens**	Red Toad
Xenopus meulleri	Tropical Platanna