



# A checklist of the reptiles and amphibians found in protected areas along the South African Wild Coast, with notes on conservation implications

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We surveyed six protected areas along the Wild Coast of the Eastern Cape, South Africa, to determine general herpetofaunal diversity as well as the representation of species of special conservation concern. Visual encounter survey methods and standard Y-shape trap arrays were used to conduct surveys from 2011 to 2013. A total of 59 species (22 amphibians and 37 reptiles) were recorded. A number of previously unknown populations of threatened species and one potential novel species were discovered in these protected areas, and the known ranges of several other species were extended. A total of 243 quarter-degree grid-cell unit records were documented, of which 90 (23% amphibians and 50% reptiles) represented the first records for the area. Amphibian and reptile diversity increased along the coast and a number of species of conservation concern were well represented in current protected areas. Our study provides a comprehensive amphibian and reptile checklist for an under-sampled region and highlights the importance of baseline data for improving conservation management.

**Conservation implications:** Small protected areas play an important role in conserving a number of threatened herpetofaunal species along the Wild Coast. The region is currently under significant and increasing pressure from anthropogenic-induced environmental degradation, which affects biodiversity and subsequently the local inhabitants. The information presented here represents an important baseline for future conservation management.

## Introduction

Amphibians and reptiles are declining globally owing to habitat loss and degradation, pressure from alien invasive species, environmental pollution, disease, unsustainable use and global climate change (Böhm *et al.* 2013). Protected areas are often useful tools for the protection of herpetofauna and contribute to the conservation of many species (Ochoa-Ochoa *et al.* 2009; Tuberville *et al.* 2005). Management actions within protected areas may, however, have a significant impact on herpetofaunal ecology in a number of ways (Measey, Armstrong & Hanekom 2009; Russell, Lear & Guynn Jr. 1999). It is therefore critical that protected area managers consider herpetofaunal diversity, abundance and distributions within a local and regional context in conservation management.

Southern Africa, the geographical region south of the Cunene and Zambezi rivers, has the richest reptile diversity in Africa (Branch 2006). Within this area, South Africa (including Lesotho and Swaziland) has the highest reptile diversity (384 indigenous species) (Branch 2014). The Wild Coast, in the former Transkei ('Transkei' refers to a former homeland in pre-democratic South Africa), is regarded as having very low reptile diversity compared with southern and north-eastern areas of South Africa (Branch 2014). Although the Pondoland region of the Wild Coast (eastern coastal region of the Eastern Cape, South Africa) is regarded as a centre of high plant diversity and endemism (Van Wyk & Smith 2001), the terrestrial faunal species of the entire Wild Coast region (coastal Transkei and Pondoland combined), in many cases, remain poorly represented compared with other areas in southern Africa (Bates *et al.* 2014; Dippenaar, Hamer & Haddad 2011; Minter *et al.* 2004; Mokhatla *et al.* 2012; Perera, Ratnayake-Perera & Proches 2011; Skead 2007). Most herpetological studies from this area date back to the early 1900s (FitzSimons 1930; Power 1935), with only a few recent ad hoc surveys added (Branch & Haagner 1999; Burger 1996; Haagner 1994). This could possibly be attributed to the remoteness of the area and unfavourable road conditions, as well as perceived safety risks, which made the logistics of field sampling challenging and, in turn, may have deterred herpetologists from working in the area. Some authors go as far as to describe the phenomenon as the 'Transkei faunal distribution gap'; that is a real gap in species distributions caused by environmental features (Botts, Erasmus & Alexander 2011; Perera *et al.* 2011; Skead 2007; C. Vernon pers. comm., 13 November 2013). This perceived distribution gap is observed for many reptile species, particularly chelonians

(Bates *et al.* 2014; Branch, Benn & Lombard 1995). There are several examples of currently known reptile species distributions (e.g. for *Trachylepis capensis*, *Bitis arietans* and *Lamprophis aurora*) extending all the way to the Kei River along the east coast, with a gap in distribution through the coastal Transkei–Pondoland region, and afterwards extending further north along the KwaZulu-Natal coastline (Bates *et al.* 2014; Minter *et al.* 2004).

The lack of herpetofaunal records along the Wild Coast is a biodiversity conservation concern. It is not clear whether the current conservation initiatives in the Wild Coast region, which forms part of the larger Maputaland–Pondoland–Albany Global Biodiversity Hotspot (Mittermeier *et al.* 2004), are sufficient for protecting herpetofauna. This relates specifically to species of special conservation concern, as well as to providing a sufficient north-east to south-west corridor for species dispersal. In addition, the resulting lack of knowledge increases the risk of negative impacts on amphibian and reptile species through poor management and development.

The objectives of this study were (1) to provide an annotated list of amphibians and reptiles occurring in protected areas along the Wild Coast and (2) to assess representation of

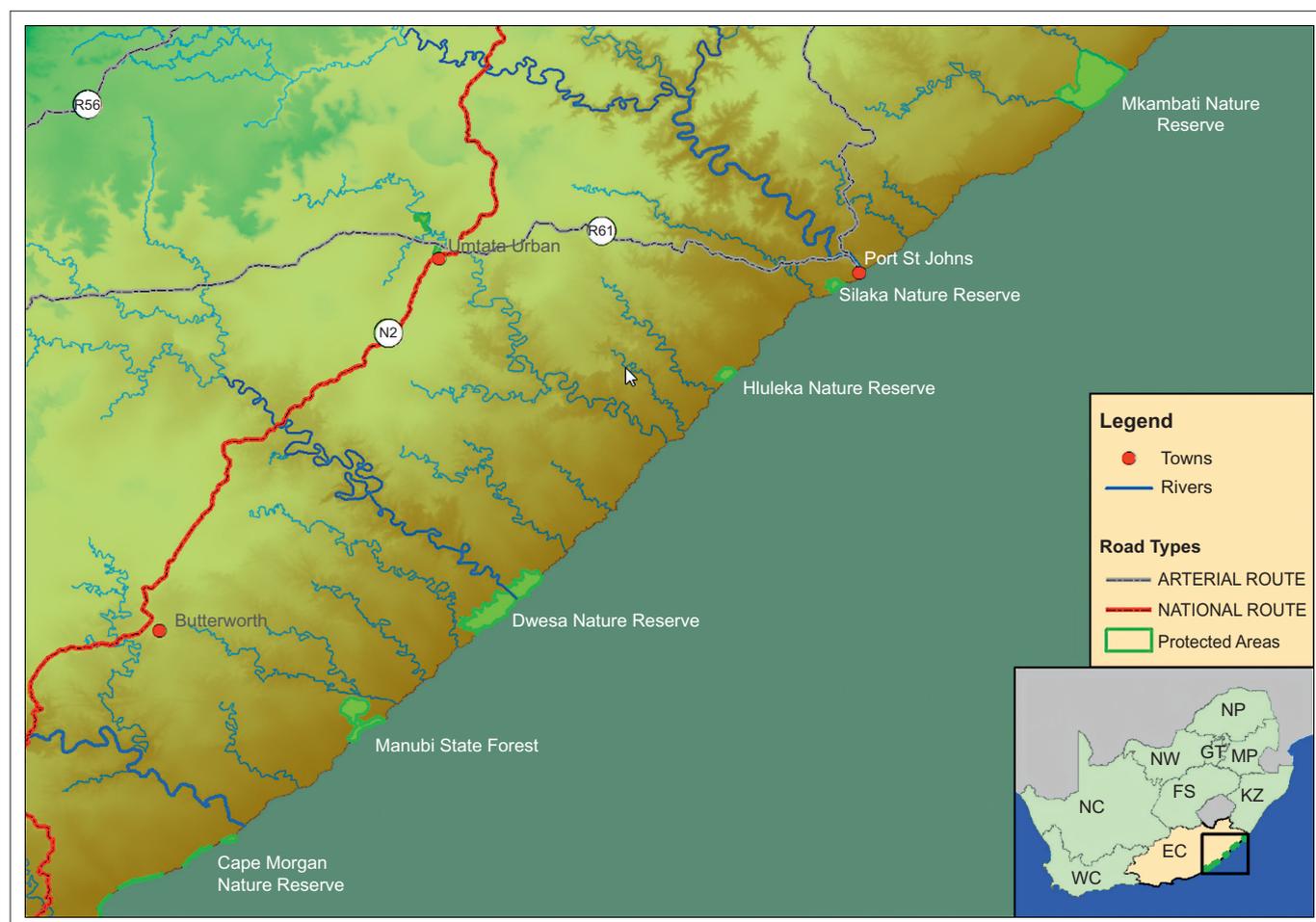
species of special conservation concern (threatened and endemic species) in relevant protected areas.

## Study areas

We surveyed a total of six protected areas along the Wild Coast in the Eastern Cape province, South Africa, from 2011 to 2013 (Figure 1). The area that constitutes the ‘Wild Coast’ stretches from north-east of East London to the KwaZulu-Natal border and includes the former Transkei and the Pondoland regions. Protected areas comprise (from south to north) the Cape Morgan Nature Reserve, Manubi State Forest, Dwesa Nature Reserve, Hluleka Nature Reserve, Silaka Nature Reserve and Mkambati Nature Reserve.

### Cape Morgan Nature Reserve

East London Coast Nature Reserves comprises a number of small nature reserves (NRs) and state forests (SFs) situated primarily along the coastline between the Great Kei River in the north and the Great Fish River in the south (Figure 1). The survey was conducted only in the Cape Morgan (214 ha) and Double-Mouth (199 ha) sections of this reserve. Vegetation types consist of southern Coastal Forest (low forests with a well-developed low tree and shrub component) (Mucina & Geldenhuys 2006) and Albany Coastal Belt Grassland



Source: Sherwyn Mack, Eastern Cape Parks and Tourism Agency

**FIGURE 1:** The location of the six protected areas along the Wild Coast, Eastern Cape, South Africa, where reptile and amphibian surveys were conducted.



(Hoare *et al.* 2006). The survey was conducted from 26 March to 02 April 2012 (Venter & Conradie 2012a).

### Manubi State Forest

The Manubi SF (with an adjacent proposed expansion area) is located in the south-western part of the Wild Coast, south-east of the town Butterworth (Figure 1). Manubi SF and the adjacent area contain small patches of subtropical dune thicket, but are dominated by Scarp forest and Transkei Coastal Belt vegetation types (Mucina & Geldenhuis 2006; Mucina *et al.* 2006). The survey was conducted from 18 to 27 February 2013 (Venter *et al.* 2013).

### Dwesa Nature Reserve

The Dwesa NR (3623 ha) is located along the western side of the Mbashe River estuary (Figure 1). The reserve occupies a narrow coastal strip of approximately 9 km in length and 1 km – 2 km in width. Dwesa NR comprises roughly 80% indigenous coastal Scarp forest and 20% Transkei Coastal Belt Grassland (Mucina & Geldenhuis 2006; Mucina *et al.* 2006). Dune forest and scrub forest are also found close to the coast and are classified as sensitive vegetation types (Mucina *et al.* 2006). The survey was conducted from 05 to 15 February 2012 (Venter & Conradie 2012b).

### Hluleka Nature Reserve

The Hluleka NR (577 ha) is situated nearly in the centre of the Wild Coast (Figure 1), south-west of Port St Johns along the coast. Scarp forest and coastal forest cover approximately 70% of the reserve, whereas the remainder of the vegetation is made up of thicket and Transkei Coastal Belt Grassland (Mucina & Geldenhuis 2006; Mucina *et al.* 2006). The survey was conducted from 20 to 28 October 2011 (Venter & Conradie 2012c).

### Silaka Nature Reserve

Silaka NR is a small (400 ha) protected area situated south-west of Port St Johns (Figure 1). It is made up mainly of a forested valley located between Second Beach and Sugar Loaf Rock. Vegetation types include Transkei Coastal Belt Grassland (Mucina *et al.* 2006) and Scarp forest (Mucina & Geldenhuis 2006). The survey was conducted from 29 September to 06 October 2012 (Venter, Conradie & Greeff 2012).

### Mkambati Nature Reserve

Mkambati NR (7736 ha) is situated along the north-eastern Pondoland coast (Figure 1). The vegetation types are dominated by fire-prone Pondoland Ugu Sandstone Coastal Sourveld with patches of Scarp and Swamp forest in fire refuge areas (Mucina & Geldenhuis 2006; Mucina *et al.* 2006). This reserve also contains a large population of wild ungulates (Venter *et al.* 2014). The survey was conducted from 07 to 13 February 2011 (Venter & Conradie 2011).

## Material and methods

We used a combination of visual encounter survey methods and standard Y-shape trap arrays. Each trap array consisted of three drift fences of 10 m long and 50 cm high, positioned in a Y-shape, with four pitfall traps at the ends and middle, and two one-way funnels per fence – see Appendix 4. Surveys of the six Wild Coast protected areas were conducted from 2011 to 2013. Diurnal searches were conducted by actively searching specific microhabitats, including beneath rocks and decaying logs. Nocturnal surveys were also carried out with the use of headlamps or flashlights, and advertisement calls were recorded in the field using either an Olympus VN-3500PC Voice Recorder or NAGRA ARES-ML recorder with an external Sony F-V4T microphone. All specimens other than voucher specimens were captured by hand or net (e.g. tadpoles), photographed and released back to the original capture site. Voucher specimens were humanely euthanised by injecting reptiles with and submerging amphibians in a tricaine methanesulfonate (MS222) solution (Conroy *et al.* 2009), after which they were fixed in formalin for 48 hours and transferred to 50% isopropanol for long-term storage in the herpetological collection of the Port Elizabeth Museum (PEM). Specimens were identified using field guides and publications (Branch 1998; Channing 2001; Channing & Baptista 2013; Channing *et al.* 2013; Du Preez & Curruthers 2009; Marais 2004; Petzold *et al.* 2014). Nomenclature was mainly based on Frost (2014) for amphibians and Uetz (2014) for reptiles, or updated taxonomy in recent journal publications (Channing & Baptista 2013; Petzold *et al.* 2014). Conservation status is based on the latest IUCN assessments, which use updated evaluations for amphibians (Measey 2011) and reptiles (Bates *et al.* 2014). All fieldwork was supervised by the first author, who was a staff member of the Eastern Cape Parks and Tourism Agency at the time, and formed part of the agency's operational activities as the appointed management authority of the protected areas stipulated by the *Eastern Cape Parks and Tourism Agency Act* (no. 2 of 2010). Collection and handling of specimens was according to ethical standards of Bayworld/Port Elizabeth Museum (Bayworld Ethical clearance 2013\_001).

Rating of the conservation importance of each reserve was based on the sum of the categorised scoring of the current IUCN-listed species (critically endangered = 4; endangered = 3; vulnerable = 2; near threatened = 1; least concern = 0), level of endemism based on the proposed Maputaland–Pondoland–Albany regional list of endemic to near-endemic species compiled by Perera *et al.* (2011) (endemic = 2; near endemic = 1), and the total number of species found per reserve.

Additional records were sourced from the Southern African Reptile Conservation Assessment (SARCA) (Bates *et al.* 2014), South African Frog Atlas Project (SAFAP) (Minter *et al.* 2004) and historical literature records pertaining to the study area (Appendix 3). Records with appropriate supporting evidence (identifiable photographs or voucher specimens) were



included in the final species checklist, for example Burger (1996) and the Grobler photograph (see Figure 4c).

## Results and discussion

A total of 22 amphibian species, representing 8 frog families and 15 genera (Table 1), and 37 reptile species (20 snakes, 16 lizards, 1 terrapin), representing 17 families and 33 genera (Table 2), were recorded from the six protected areas surveyed during this study (Appendix 2). This represents a near-complete list of species expected to occur along the Wild Coast (27 amphibian species were recorded by Minter *et al.* [2004] and 50 reptile species were recorded by Bates *et al.* [2014]). Although our survey excluded marine species, four species of marine turtle (*Dermochelys coriacea*, *Chelonia mydas*, *Eretmochelys imbricata* and *Caretta caretta*) and one sea snakes species (*Hydrophis platurus*) are expected to occur along the coastline (Bates *et al.* 2014). A total of three threatened amphibian and five threatened reptile species are represented in these protected areas. A total of 243 quarter-degree-unit (QDU) records were recorded, of which 37% (23% amphibians and 50% reptiles) represented first

records for the respective units (Table 3), with southerly range extensions for 11 species. These include *Arthroleptis wahlbergii*, *Breviceps* cf. *bagginsi*, *Hyperolius poweri*, *Leptopelis natalensis*, *Natalobatrachus bonebergi*, *Amblyodipsas concolor*, *Leptotyphlops sylvicolus*, *Psammophis brevirostris*, *Python natalensis*, *Thelotornis capensis capensis* and *Tropidosaura montana natalensis* (see Tables 1, 2 and Appendix 1). The most southerly distribution in Africa was also recorded for the following genera: *Amblyodipsas*, *Arthroleptis*, *Leptopelis*, *Natalobatrachus* and *Thelotornis* (Appendix 1). Furthermore, the distribution of *Bradypodion caffer* was extended northwards. Range extensions exceeding 100 km were also recorded for *A. concolor* and *P. brevirostris* (Appendix 1). The distribution range of one species, *T. montana natalensis*, was extended to the Eastern Cape herpetofaunal list. A potential new species, which is related to *Tetradactylus fitzsimonsi* from the Port Elizabeth area, was discovered in Hluleka NR (Appendix 1). Hluleka, Silaka and Mkambati NRs had the greatest numbers of amphibian species, whereas Dwesa, Hluleka and Mkambati NRs had the greatest numbers of reptile species (Table 3 and Figure 2). With regard to amphibians, Silaka NR has a higher conservation importance, which can be attributed

**TABLE 1:** Amphibian checklist for six conservation areas surveyed along the Wild Coast, Eastern Cape, South Africa.

Species	IUCN status	Survey area and map reference											
		Cape Morgan NR		Manubi SF		Dwesa NR		Hluleka NR		Silaka NR		Mkambati NR	
		3228CB	3228BC	3228BD	3228BB	3129CD	3129CB	3129DA	3129BD	3130AC			
<b>Arthroleptidae</b>													
<i>Arthroleptis wahlbergii</i> Smith, 1849								X <sup>b</sup>		X			
<i>Leptopelis natalensis</i> Smith, 1849			X <sup>a,b</sup>	X <sup>a</sup>	X		X			X	X	X	
<b>Brevicipitidae</b>													
<i>Breviceps</i> cf. <i>bagginsi</i> Minter, 2003	VU									X <sup>a,b</sup>	X	X	
<i>Breviceps verrucosus</i> Rapp, 1842								X		X	X		
<b>Bufonidae</b>													
<i>Amietophrynus gutturalis</i> Power, 1927		X	X <sup>a</sup>	X <sup>a</sup>			X		X	X	X	X	
<i>Amietophrynus rangeri</i> Hewitt, 1935		X	X	X <sup>a</sup>	X		X				X <sup>a</sup>	X <sup>a</sup>	
<b>Hyperoliidae</b>													
<i>Africalus spinifrons</i> Cope, 1862	NT							X		X			
<i>Hyperolius marmoratus verrucosus</i> Smith, 1849		X	X	X	X		X			X	X	X	
<i>Hyperolius poweri</i> Loveridge, 1938											X <sup>b</sup>	X <sup>a</sup>	
<i>Hyperolius pusillus</i> Cope, 1862			X <sup>a</sup>	X <sup>a</sup>			X			X			
<i>Hyperolius semidiscus</i> Hewitt, 1927		X		X <sup>a</sup>			X			X		X	
<i>Kassina senegalensis</i> Duméril & Bibron, 1841		X	X	X <sup>a</sup>			X			X	X	X <sup>a</sup>	
<b>Phrynobatrachidae</b>													
<i>Phrynobatrachus natalensis</i> Smith, 1849		X	X <sup>a</sup>	X <sup>a</sup>	X		X			X <sup>a</sup>	X	X	
<b>Pipidae</b>													
<i>Xenopus laevis</i> Daudin, 1802		X	X	X <sup>a</sup>	X		X			X	X <sup>a</sup>	X	
<b>Ptychadenidae</b>													
<i>Ptychadena oxyrhynchus</i> Smith, 1849		X		X <sup>a</sup>			X			X	X	X	
<i>Ptychadena porosissima</i> Steindachner, 1867											X	X	
<b>Pyxicephalidae</b>													
<i>Amietia queketti</i> Boulenger, 1895 "1894"		X	X <sup>a</sup>	X			X			X	X	X	
<i>Cacosternum nanum</i> Boulenger, 1887		X	X	X <sup>a</sup>			X			X	X	X	
<i>Cacosternum boettgeri</i> Boulenger, 1882				X							X		
<i>Natalobatrachus bonebergi</i> Hewitt & Methuen, 1912	EN		X <sup>a,b</sup>	X <sup>a</sup>	X		X		X <sup>a</sup>	X			
<i>Strongylopus fasciatus</i> Smith, 1849		X	X <sup>a</sup>	X			X			X	X	X	
<i>Strongylopus grayii</i> Smith, 1849											X		
<i>Tomopterna natalensis</i> Smith, 1849				X			X				X	X	
<b>Total</b>		<b>3</b>	<b>11</b>	<b>12</b>	<b>16</b>	<b>18</b>	<b>17</b>	<b>17</b>	<b>17</b>	<b>17</b>	<b>19</b>	<b>19</b>	

EN, endangered; NR, nature reserve; NT, near threatened; SF, state forest; VU, vulnerable.

<sup>a</sup>, Denotes a new quarter-degree-unit record; <sup>b</sup>, denotes the southern-most distribution.



TABLE 2: Reptile checklist for six conservation areas surveyed along the Wild Coast, Eastern Cape, South Africa.

Species	IUCN status	Survey area and map reference										
		Cape Morgan NR		Manubi SF		Dwesa NR		Hluleka NR	Silaka NR		Mkambati NR	
		3228CB	3228BC	3228 BD	3129BD	3129CD	3129CB	3129DA	3129BD	3130AC	3130AA	
<b>Pelomedusidae</b>												
<i>Pelomedusa galeata</i> Schoepff, 1972			X <sup>a</sup>	X <sup>a</sup>		X <sup>a</sup>		X <sup>a</sup>		X <sup>a</sup>		
<b>Crocodylidae</b>												
<i>Crocodylus niloticus</i> Laurenti, 1768	VU			X								
<b>Gekkonidae</b>												
<i>Afroedura pondolia</i> Hewitt, 1925				X <sup>b</sup>	X	X		X	X <sup>a</sup>	X		
<i>Hemidactylus mabouia</i> Moreau de Jonnés, 1818		X	X	X <sup>a</sup>		X		X	X	X <sup>a</sup>		
<i>Lygodactylus capensis</i> Smith, 1848		X	X					X				
<i>Pachydactylus maculatus</i> Gray, 1845		X	X									
<b>Lacertidae</b>												
<i>Tropidosaura montana natalensis</i> FitzSimons, 1947										X <sup>a,b</sup>		
<b>Cordylidae</b>												
<i>Chamaesaura anguina</i> Linnaeus, 1758				X		X <sup>a</sup>						
<b>Gerrhosauridae</b>												
<i>Gerrhosaurus flavigularis</i> Wiegmann, 1828		X <sup>a</sup>		X <sup>a</sup>				X				
<i>Tetradactylus cf. fitzsimonsi</i> Hewitt, 1915	VU					X <sup>a,*</sup>						
<b>Scincidae</b>												
<i>Acontias plumbeus</i> Bianconii, 1849			X	X								
<i>Trachylepis homalocephala</i> Wiegmann, 1828		X <sup>a</sup>	X <sup>a</sup>		X <sup>a</sup>	X <sup>a</sup>	X <sup>a</sup>	X <sup>a</sup>		X <sup>a</sup>		
<i>Trachylepis varia</i> Peters, 1867		X <sup>a</sup>	X <sup>a</sup>	X	X <sup>a</sup>	X <sup>a</sup>	X <sup>a</sup>	X	X	X <sup>a</sup>		
<b>Varanidae</b>												
<i>Varanus niloticus</i> Linnaeus, 1758		X	X	X		X <sup>a</sup>		X	X <sup>a</sup>	X <sup>a</sup>		
<b>Chamaeleonidae</b>												
<i>Bradypodion caffer</i> Boettger, 1889	ED					X	X		X	X <sup>a,c</sup>		
<i>Bradypodion ketanicum</i> Hewitt, 1935	VU		X	X	X							
<b>Agamidae</b>												
<i>Agama atra</i> Daudin, 1802		X	X					X	X	X		
<b>Typhlopidae</b>												
<i>Afrotyphlops bibronii</i> Smith, 1846			X <sup>a</sup>	X	X	X		X				
<b>Leptotyphlopidae</b>												
<i>Leptotyphlops sylvicolus</i> Broadley & Wallach, 1997						X <sup>a,b</sup>			X <sup>a</sup>			
<b>Pythonidae</b>												
<i>Python natalensis</i> Smith, 1840										X <sup>a,b</sup>		
<b>Viperidae</b>												
<i>Bitis arietans</i> Merrem, 1820								X				
<i>Causus rhombeatus</i> Lichtenstein, 1823		X	X	X <sup>a</sup>		X		X	X <sup>a</sup>	X <sup>a</sup>		
<b>Lamprophiidae</b>												
<i>Amblyodipsas concolor</i> Smith, 1849			X <sup>a,b</sup>	X <sup>a</sup>		X <sup>a</sup>						
<i>Boaedon capensis</i> Dumeril, 1854				X <sup>a</sup>		X	X <sup>a</sup>	X		X		
<i>Duberria lutrix lutrix</i> Lunnaeus, 1758		X <sup>a</sup>	X <sup>a</sup>	X		X <sup>a</sup>		X				
<i>Lycodonomorphus inornatus</i> Duméril & Bibron, 1854			X <sup>a</sup>	X <sup>a</sup>								
<i>Lycodonomorphus rufulus</i> Lichtenstein, 1823						X						
<i>Lycophidion capense</i> Smith, 1831				X <sup>a</sup>					X	X <sup>a</sup>		

Table 2 continues →

**TABLE 2 (continues...):** Reptile checklist for six conservation areas surveyed along the Wild Coast, Eastern Cape, South Africa.

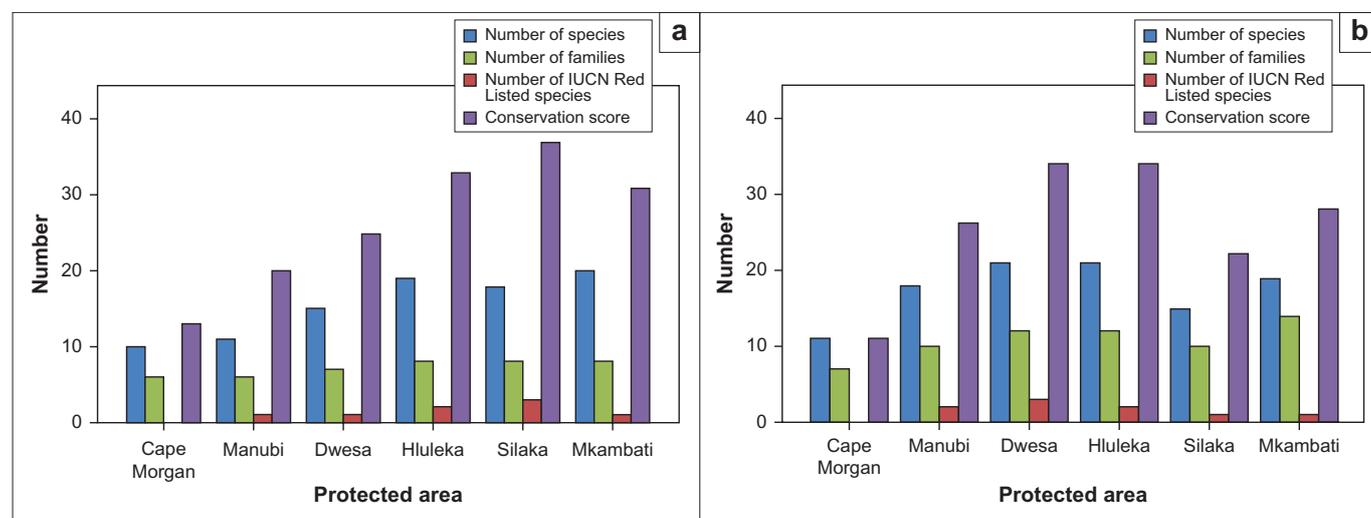
Species	IUCN status	Survey area and map reference									
		Cape Morgan NR		Manubi SF		Dwesa NR		Hluleka NR		Mkambati NR	
		3130AC	3129 CD	3228 BD	3129BD	3129CD	3129CB	3129DA	3129BD	3130AC	3130AA
<i>Macrelaps microlepidotus</i> Günther, 1863	NT		X <sup>a</sup>	X							
<i>Psammaphis brevirostris</i> Peters, 1881			X <sup>a,b</sup>			X			X <sup>a</sup>	X <sup>a</sup>	
<b>Elapidae</b>											
<i>Dendroaspis polylepis</i> Günther, 1864									X		
<b>Colubridae</b>											
<i>Crotaphopeltis hotamboeia</i> Laurenti, 1768			X <sup>a</sup>	X <sup>a</sup>		X					X <sup>a</sup>
<i>Dasypeltis inornata</i> Smith, 1849				X		X					
<i>Dispholidus typus</i> Smith, 1828				X		X					
<i>Philothamnus haplogaster</i> Günther, 1863						X					
<i>Philothamnus natalensis</i> Broadley, 1966		X <sup>a</sup>						X <sup>a</sup>	X	X <sup>a</sup>	X <sup>a</sup>
<i>Thelotornis capensis capensis</i> Smith, 1849									X <sup>a,b</sup>		
<b>Total</b>	<b>5</b>	<b>11</b>	<b>18</b>	<b>21</b>	<b>21</b>	<b>16</b>	<b>19</b>	<b>19</b>	<b>19</b>	<b>19</b>	<b>19</b>

EN, endangered; NR, nature reserve; NT, near threatened; SF, state forest; VU, vulnerable. <sup>a</sup>Denotes a new quarter-degree-unit record. <sup>b</sup>, Denotes the southern-most distribution; <sup>c</sup>, denotes the northern-most distribution.

**TABLE 3:** New quarter-degree-unit records for South Africa and conservation importance score of six conservation areas studied along the Wild Coast, Eastern Cape, South Africa.

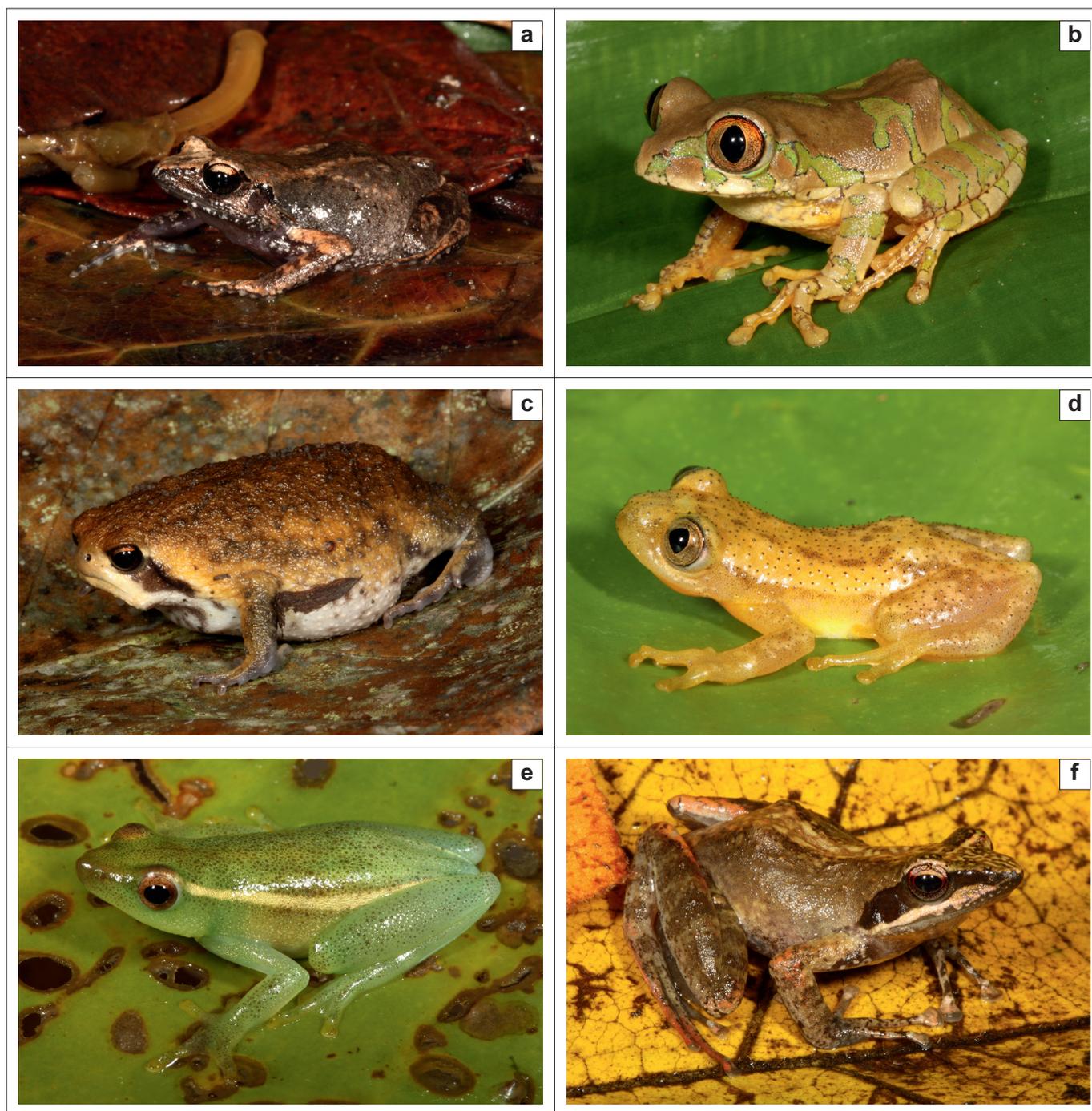
Records	Conservation area					
	Cape Morgan NR	Manubi SF	Dwesa NR	Hluleka NR	Silaka NR	Mkambati NR
<b>Reptiles</b>						
Number of reptile species	11	18	21	21	16	19
Number of QDU records	11	18	26	21	20	30
Number of new QDU records	6	11	11	9	6	20
Percentage new QDU records (%)	55	61	42	43	30	67
Reptile conservation importance score	11	26	34	34	22	28
<b>Amphibians</b>						
Number of amphibian species	11	12	16	18	17	19
Number of QDU records	11	12	22	18	21	33
Number of new QDU records	0	7	11	1	3	5
Percentage new QDU records (%)	0	58	50	6	14	15
Amphibian conservation importance score	13	20	25	33	37	31
<b>Overall conservation importance score</b>	<b>24</b>	<b>46</b>	<b>59</b>	<b>67</b>	<b>59</b>	<b>56</b>

NR, nature reserve; QDU, quarter-degree unit; SF, state forest.



Source: Jan A. Venter

**FIGURE 2:** A comparison of the number of (a) amphibian and (b) reptile species and families and number of IUCN Red Listed species, as well as the conservation importance scores recorded in the six protected areas during the study.



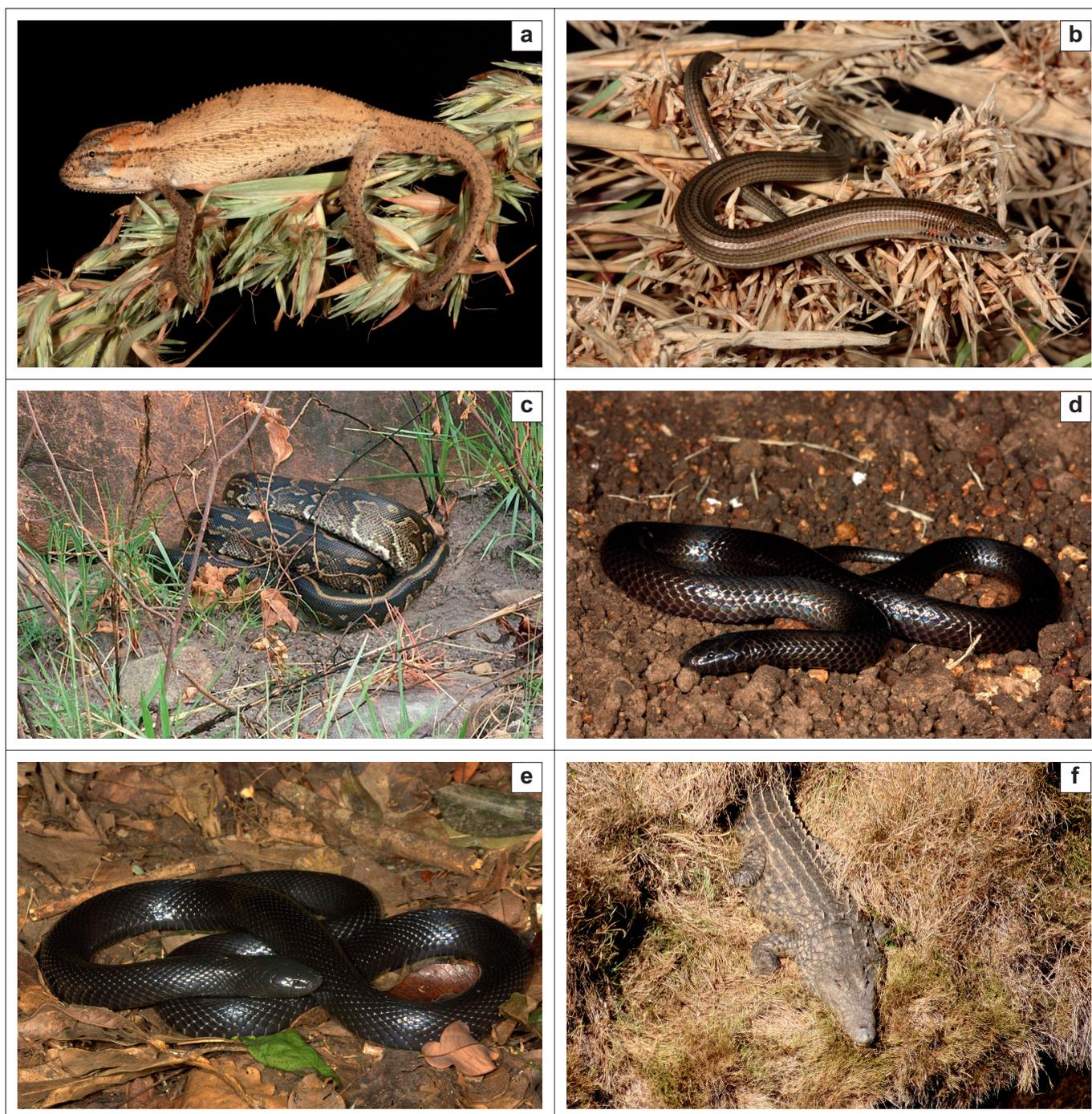
Source: Werner Conradie

**FIGURE 3:** Amphibian species of special or conservation concern recorded in protected areas along the Wild Coast, including (a) *Arthroleptis wahlbergii* (Hluleka NR), (b) *Leptopelis natalensis* (Silaka NR), (c) *Breviceps cf. bagginsi* (Silaka NR), (d) *Afrixalus spinifrons* (Hluleka NR), (e) *Hyperolius poweri* (Mkambati NR) and (f) *Natalobatrachus bonebergi* (Manubi SF).

to the presence of three threatened, five endemic and three near-endemic species. Both Dwesa and Hluleka NRs are important for reptile conservation, as they are home to at least two threatened, three endemic and two near-endemic species each. Regarding overall conservation importance, Hluleka NR scored the highest, followed by, in descending order, Dwesa NR, Mkambati NR, Silaka NR, Manubi SF and Cape Morgan NR (Table 3 and Figure 2). Species of special conservation concern or noteworthy records are illustrated in Figures 3 and 4.

## Conclusion

We provide valuable data on amphibian and reptilian species presence and distribution for a fairly under-sampled region in South Africa. Our study further highlights the importance of baseline survey work to inform conservation management planning for protected areas and species of special conservation concern. The discovery of several healthy and thriving populations of threatened species, such as *B. cf. bagginsi*, *N. bonebergi*, *Afrixalus spinifrons*, *Macrelaps*



Source: Werner Conradie (a, b, d, e); Quartus Grobler (c); Jan A. Venter (f).

**FIGURE 4:** Reptile species of special or conservation concern recorded in protected areas along the Wild Coast, including (a) *Bradypodion caffer* (Mkambati NR), (b) *Tetradactylus cf. fitzsimonsi* (Hluleka NR), (c) *Python natalensis* (Mkambati NR), (d) *Amblyodipsas concolor* (Hluleka NR), (e) *Macrelaps microlepidotus* (Manubi SF) and (f) *Crocodylus niloticus* (Dwesa NR).

*microlepidotus* and *Bradypodion* spp., is very encouraging. It further indicates that even small protected areas, as is the case with Silaka NR, Hluleka NR and Manubi SF, play an important role in conserving a number of threatened species, considering the development pressure many of these species face in KwaZulu-Natal (Minter *et al.* 2004). Future research should focus on investigating the impact of current land-use activities (communal subsistence farming) on species conservation along the Wild Coast

compared with that of commercial agriculture, forestry and high-density development in areas such as south-western KwaZulu-Natal. This is especially important because of the significant and increasing pressure placed on the Wild Coast region owing to slash-and-burn agriculture, illegal activities such as sand mining, road construction and logging, as well as water pollution from neglected or non-functional municipal sewage treatment works (De Villiers & Costello 2013). Significant portions of land



north-east of Mkambati NR (Xolobeni area) are currently being considered for mining, which, together with the construction of the proposed national (N2) toll road, will result in additional habitat loss and fragmentation for several important herpetofaunal species. It is therefore critical that the current protected areas in the region remain secure and that opportunities are sought to increase the size of the protected areas in the region to form corridors for dispersal. In addition, it is crucial that local, provincial and national government agencies take note of the potential negative consequences of increased land degradation in the region, the effect on biodiversity and the subsequent impact on local communities.

Our study provides the first checklist for amphibians and reptiles from the Wild Coast protected areas, but gaps remain owing to factors related to spatial and temporal under-sampling. The results reported here represent only one sampling trip per protected area, conducted during either early or late summer, which may have led to species being missed owing to non-breeding or inactivity. It is important that further surveys and monitoring are conducted to increase sampling effort and to capture seasonal differences in species assemblages and densities. Monitoring at regular intervals, in order to measure the effect of land use or climate change on the populations of threatened species especially, is recommended. Our surveys focused on the coastal areas of the Wild Coast, with the inland area of the Transkei remaining under-sampled. A rich source of undiscovered herpetofaunal diversity is likely to still be uncovered.

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## Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

## Authors' contributions

J.A.V. (Nelson Mandela Metropolitan University) was the project leader. He was responsible for experimental design, conducted fieldwork and performed data analysis. W.C. (Port Elizabeth Museum) assisted in experimental design, conducted fieldwork, handled all preservation and lodging of specimens and performed data analysis.

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Appendix 1 starts on the next page→



## Appendix 1

### Species accounts

This section provides selective species accounts (excluding common and widespread species, marine turtles and sea snakes) to highlight special records for the region. Species account information was sourced from the individual species account sections in Minter *et al.* (2004) and Bates *et al.* (2014), and updated with our new records unless stated otherwise. Families are organised according to Frost (2014) for Amphibia and Bates *et al.* (2014) for Reptilia. Species of special conservation concern or noteworthy records are illustrated in Figures 3 and 4 in the main text. All additional PEM holdings collected and used in this study are listed in Appendix 2 and additional records derived from other sources are listed in Appendix 3. Records labelled as PEM A refer to amphibian records from the Port Elizabeth Museum, those labelled PEM T refer to tadpole records from this collection and those labelled PEM R refer to reptilian records from the collection.

### Amphibia

#### ARTHROLEPTIDAE

##### *Arthroleptis wahlbergii* Smith, 1849 (Bush squeaker)

This species is endemic to the coastal forest patches of the east coast of South Africa, from the border of Mozambique to just south of Port St Johns. Because of this restriction, the species is under encroachment pressure owing to agricultural and urban development. The Hluleka NR (3129CD) specimens represent the most southern distribution of the species, as well as for the genus in Africa. Two additional inland records from Mqanduli (PEM A7368, PEM A7369) are included in the PEM collection. FitzSimons (1930) considered the population around Port St Johns as a new species, namely *Arthroleptis wageri*, citing a broader head, shorter hind limbs and larger general size. This arrangement was also followed by Laurent (1941). However, Poynton (1964) synonymised this species with the more common *A. wahlbergii*. Genetic studies currently underway on this species show substantial genetic differentiation for this Eastern Cape population, pointing to the possibility that *A. wageri* might be a valid species (K. Tolley pers. comm., 14 July 2014). The species was recorded only from Hluleka and Silaka NRs during this study.

#### BREVICIPITIDAE

##### *Breviceps* cf. *bagginsi* Minter, 2003 (Bilbo's rain frog)

A series of specimens collected from Silaka NR (3129CB, -DA) during this study and one additional PEM specimen (PEM A11122) previously collected 15 km west of Mkambati NR (3129BB, new QDU record) have temporarily been assigned to *Breviceps bagginsi*, based on the call and morphology. In Silaka NR, specimens were captured in traps associated with grassland habitat (see 'Study area'). These new records potentially expand the known distribution of this species southwards to the Port St Johns area. Burger (1996) reported an unidentified *Breviceps* species from Mkambati NR (3129BD), recorded as *Breviceps mossambicus* by Minter

(2004b) and later identified as *B. bagginsi* (Measey 2011). The specific specimen is not available in any museum collection and thus could not be verified. This species belongs to the *B. mossambicus* complex and further studies are needed in the northern coastal Eastern Cape to determine whether the applicable records of *B. mossambicus* in Minter (2004b) can be assigned to *B. bagginsi*. Minter (2004b) mistakenly reported *B. mossambicus* as occurring as far south as Mkambati NR, but the provided QDU actually represents Port St Johns. *B. bagginsi* is a recently described species known only from four KwaZulu-Natal QDU records (Minter 2004a) and is believed to be endemic to KwaZulu-Natal. Thus, the new distribution records for the Eastern Cape and the presence in a protected area will contribute to protecting the species. The species is currently rated as vulnerable (Measey 2011). The species was recorded only from Silaka NR during this study.

#### HYPEROLIIDAE

##### *Afrixalus spinifrons* Cope, 1862 (Natal leaf-folding frog)

An endemic South African species distributed from St. Lucia Village in the north to Cintsa Bay and Kei Road in the south. Pickersgill (1996) assigned the Eastern Cape populations to *A. spinifrons spinifrons*, but Tarrant (2012) showed that, according to molecular description, Eastern Cape populations should be referred to *Afrixalus spinifrons intermedius*. The species is currently rated as near threatened (Measey 2011). Whilst documenting and photographing freshly laid eggs *in situ* at Silaka NR, an adult ran up the stem of the leaf to the clutch and assumed a threatening posture. This behaviour can possibly be attributed to a form of parental care or protection, which has never been reported for the species. The species was found in both Silaka and Hluleka NRs during the study.

##### *Hyperolius poweri* Loveridge, 1938

Channing *et al.* (2013a) assigned the KwaZulu-Natal and Eastern Cape populations of the *Hyperolius nasutus* complex (for which Mkambati NR is the most southern distribution) to *H. poweri* based on genetics and calls. Because of the recent taxonomical change, the species' threatened status has not been assessed. However, owing to its patchy distribution along the east coast of South Africa and loss of habitat due to agricultural and urban development, the species may in the future be considered threatened and treated as a separate conservation unit. The species was found in Mkambati NR during the study, which is the only known occurrence of the species in the Eastern Cape.

#### PYXICEPHALIDAE

##### *Cacosternum boettgeri* Boulenger, 1882 (Boettger's caco)

Recent revision of the genus by Channing *et al.* (2013b) indicated the presence of cryptic diversity and led to the description of four new species (*Cacosternum aggestum*, *Cacosternum australis*, *Cacosternum nanogularum* and *Cacosternum rhythmum*), with Conradie (2014) describing another species within the *C. boettgeri* complex (*Cacosternum thorini*). In both studies, no material from coastal Eastern Cape or KwaZulu-Natal was used. Populations from these areas may hold further cryptic diversity. Burger (1996)



reported this species to be present in Mkambati NR based on the call only, and the SAFAP database lists a voucher specimen collected from Dwesa NR in late 1991. The specimen is unaccounted for in any of the South African museums; thus, its identification cannot be verified. Owing to its possible distribution, we tentatively include this species in our records. However, no new material has been collected from any of the reserves surveyed during the current study. Further surveys in optimal conditions are needed to confirm the presence of this species from coastal Eastern Cape.

#### ***Natalobatrachus bonebergi* Hewitt & Methuen, 1912 (Kloof frog)**

The species is currently known from only nine localities in KwaZulu-Natal and the Eastern Cape (Measey 2011). Historically, it has been recorded from 18 QDUs (Du Preez 2004), of which three are in the Eastern Cape. During the frog atlas period (1996–2002), only two of the historical sites were confirmed and one new QDU was added (Dwesa NR, 3228BB), which represented its most southern distribution (Du Preez 2004). We report three new QDU records (3228BD, 3129CB and 3228BC), which now represent the most southern distribution, and confirm the two historical QDU sites (3129DA and 3129CD) previously recorded. This increases the existing distribution to seven QDU sites within the Eastern Cape, including 3228BB and the historical record (3229CC). The habitat of *N. bonebergi* is currently being heavily affected by agricultural clearing (especially for sugar cane) and urbanisation, particularly in KwaZulu-Natal (Measey 2011). As a result, populations of this species are becoming severely fragmented and are thus regarded as endangered (Measey 2011).

## **Reptilia**

### **CROCODYLIDAE**

#### ***Crocodylus niloticus* Laurenti, 1768 (Nile crocodile)**

Crocodiles are restricted to the northern and eastern parts of South Africa. They were re-introduced to Dwesa NR in 1979 (Pooley 1980), which has been criticised as ‘ill-advised’ by Marais (2014a). This criticism may be unwarranted because good evidence exists that the species historically (during the 19th and early 20th centuries) occurred even further south than the current location in Dwesa NR, with the last record of a crocodile killed in the former Transkei recorded in the Mendwana river, Dwesa Forest in 1903 (Feely 2010). Evidence also exists that the re-introduced Dwesa NR population did successfully breed (Feely 2010; Venter & Conradie 2012), but the survival rate of young crocodiles is still to be determined. Only two adults were recorded in the latest game census (Peinke & Gibisela 2013). This species is rated as vulnerable (Bates *et al.* 2014).

### **GEKKONIDAE**

#### ***Afroedura pondolia* Hewitt, 1925 (Pondo flat gecko)**

This species is endemic to the Eastern Cape and KwaZulu-Natal coast and associated with scattered inland records. It reaches its southern distribution limit around the coastal

Dwesa NR (3228BD) and inland Butterworth (3228AD) area. It is present in Mkambati, Silaka (TM 76520), Hluleka and Dwesa NRs.

#### ***Lygodactylus capensis* Smith, 1848 (Common dwarf gecko)**

This is a common and widespread diurnal gecko species, which is not native to the Eastern Cape (Branch 2014). Populations at Silaka and Cape Morgan NRs were most likely accidentally introduced by tourists visiting the reserves. All specimens collected or observed were limited to buildings and other human-made structures.

### **LACERTIDAE**

#### ***Tropidosaura montana natalensis* FitzSimons, 1947 (Common mountain lizard)**

This subspecies is restricted to southern KwaZulu-Natal, where it is found in both coastal and montane grassland. A single record from Mkambati NR was recorded during this study, its remains being regurgitated by a *Lycophidion capense*. This is the first record for this species in the Eastern Cape.

### **GERRHOSAURIDAE**

#### ***Gerrhosaurus flavigularis* Wiegmann, 1828 (Yellow-throated plated lizard)**

This species occurs mostly in north-eastern parts of South Africa, with an apparently isolated southern population. In a recent revision of the entire genus, three well-structured clades were formed (i.e. eastern South Africa, northern South Africa and East Africa) and current research may split these populations (Bates *et al.* 2013). If this is the case, the southern population will keep the name *G. flavigularis*, which will make the Silaka NR material the most northern record. The species was observed at three of the six reserves surveyed.

#### ***Tetradactylus cf. fitzsimonsi* (FitzSimons' long-tailed seps)**

*Tetradactylus fitzsimonsi* is restricted to only four QDUs in the Port Elizabeth area and one near George. The new records from Hluleka NR were found 600 km to the north-east of the *T. fitzsimonsi* distribution range. Identification of these specimens is based on FitzSimons (1943), with the main identifying characteristic being the lack of front limbs. Current genetic and morphometric work indicates that the Hluleka specimens might be a novel species related to *T. fitzsimonsi* (K. Tolley pers. comm., 14 July 2014). More than a century of herpetological studies in the Eastern Cape have failed to find any additional *T. fitzsimonsi* records from the coastal Eastern Cape or the former Transkei. Furthermore, overlap of the distribution for *T. fitzsimonsi* and the congener, *Tetradactylus africanus*, is not clear. FitzSimons (1943) gives the distribution of *T. africanus* as Pondoland and northwards (i.e. northern Eastern Cape), but no recent records have been collected from this area (Bates 2014a, 2014b). The Ditsong National Museum of Natural History (TM 69067) houses a specimen of *T. africanus* from Msikaba River, near Mkambati NR (Bates 2014c). Additional surveys in coastal grassland along the Eastern Cape coastline will improve information on this species' distribution. For the purpose of this species inventory we consider the species as *T. fitzsimonsi*.



## SCINCIDAE

### *Acontias plumbeus* Bianconii, 1849 (Giant legless skink)

This species represents the world's largest species of legless skink, with a maximum size recorded at 490 mm, and is restricted to well-forested areas (Branch 1998). An isolated Eastern Cape population around East London shows a number of subtle morphological differences from northern populations (Bourquin & Lambiris 1996), and possibly represents a new species (Branch 2002). Genetic studies are currently underway to determine the relationship of this population to northern populations (Daniels, in preparation). Its sister species, *Acontias poecilus*, is known from only five specimens in south-eastern KwaZulu-Natal (Bourquin & Lambiris 1996) and only a single record from the Eastern Cape (Branch & Haagner 1999), but may be present in Mkambati NR (Bauer 2014). Dwesa NR has a selection of preserved specimens on display for educational purposes, which includes a preserved *A. plumbeus* from the reserve (M. Burger pers. comm., 23 April 2014). This forms the basis of the present record in SARCA. We confirmed this distribution during the recent survey of Dwesa NR and reported a new distribution record for the Manubi SF area.

### *Trachylepis homalocephala* Wiegmann, 1828 (Red-sided skink)

This species is found mostly in the Eastern Cape and Western Cape, with scattered populations in KwaZulu-Natal, Lesotho, the Free State, Mpumalanga and Limpopo. In the recent reptile atlas (Bates *et al.* 2014) there is a noticeable gap in the distribution from East London to the closest KwaZulu-Natal populations. This gap has been described as a biodiversity-poor gap due to negative environmental conditions (see main text). We recorded this species from all the reserves, indicating a sampling gap rather than a natural distribution gap. More surveys need to be conducted outside the reserves to determine the full extent of this species' distribution.

## CHAMAELEONIDAE

### *Bradypodion caffer* Boettger, 1889 (Pondo dwarf chameleon)

Dwarf chameleons from Mkambati NR have been assigned to *Bradypodion melanocephalum* (Raw 2001; Tolley & Burger 2007), given their morphological similarity to the species. They were therefore regarded as the population with the most southern distribution limit of the species (Tolley 2014a). In contrast, Raw (2001) regarded the Mkambati population as a new species. Recent molecular work on this population shows a close relationship to *B. caffer*, which may represent a grassland ecomorph (K. Tolley pers. comm., 14 July 2014). *B. caffer* is a forest-adapted species, whereas the Mkambati population was found only in natural grassland. Although morphological similarity might be expected within a species (i.e. amongst populations), structure is a known driver of morphological variation in dwarf chameleons habitat (Da Silva & Tolley 2013; Hopkins & Tolley 2011; Tolley 2014a). The grassland population of Mkambati most likely represents an ecomorph of *B. caffer* and is another example of ecological adaptation due to differences in habitat

structure in this group. The forest and grassland ecomorphs should be considered as separate management units with regard to conservation and management. Despite a close genetic relationship, the two ecomorphs are distinct with regard to the morphological adaptations that allow them to persist in the different environments. Additional molecular and morphological work is required to better place the Mkambati population. *B. caffer* was also recorded from the forests at Silaka and Hluleka NRs (K. Tolley pers. comm., 14 July 2014) and has been classified as endangered (Tolley 2014b).

### *Bradypodion kentanicum* Hewitt, 1935 (Kentani dwarf chameleon)

This species is restricted to coastal Scarp forest from Kentani in the south to Coffee Bay in the north (Tolley & Burger 2007). It was represented in Dwesa NR and Manubi SF and has been assessed as vulnerable (Tolley 2014c).

## LEPTOTYPHLOPIDAE

### *Leptotyphlops sylvicolus* Broadley & Wallach, 1997 (Forest thread snake)

The species is restricted to coastal moist forest (except for the Matatiele area, where they were found in grassland). Eastern Cape specimens differ morphologically from the main type and genetic differences indicate that a number of cryptic species exist. This is specifically the case with *L. sylvicolus* (Adalsteinsson *et al.* 2009). Further investigations of the isolated Eastern Cape specimens are needed and the populations may warrant special conservation concern. The species is currently regarded as data deficient (Alexander 2014a). It was collected from only two of the reserves surveyed and both represented new records for this species. At Mkambati NR, specimens were collected under rocks in gardens, but the surrounding vegetation type is grassland. In Hluleka NR, specimens were collected amongst the chalets, which are surrounded by coastal forest.

## PYTHONIDAE

### *Python natalensis* Smith, 1840 (Southern African python)

Southern African pythons once extended to Port Alfred (Eastern Cape), but the last known specimen from this area was killed in Bathurst in 1927 (Broadley 1990; C. Vernon pers. comm. 13 November 2013). There are unconfirmed historical records of pythons killed in the Manubi or Dwesa Forest region (records seem to be unclear which forest) in 1845 (C. Vernon pers. comm., 13 November 2013). In the early 1980s, specimens were re-introduced in the Andries Vosloo NR outside Grahamstown, but no follow-up work has been done on this population (Alexander 2014b; C. Vernon pers. comm., 13 November 2013). Anecdotal records exist for Mkambati NR (Burger 1996; De Villiers & Costello 2013), as well as a single photographic record by ECPTA staff (see Figure 4C). The occurrence of *P. natalensis* in Mkambati NR is noteworthy, given that almost nothing has been recorded regarding python distribution in the former Transkei region and this is the only recent record for the Eastern Cape.



## LAMPROPHIIDAE

### *Amblyodipsas concolor* Smith, 1849 (KwaZulu-Natal purple-glossed snake)

This is a fossorial species restricted to moist forested areas in the eastern and northern parts of southern Africa, feeding mostly on other snakes and lizards. This cryptic species can easily be confused with sympatric *Amblyodipsas polylepis*, *Macrelaps microlepidotus* and *Atractaspis bibronii*, which occur further north. They differ from the latter two as they do not have preocular scales, but do have paired subcaudals and divided anal scales (Broadley 1990; Marais 2004). They are also differentiated from *A. polylepis* by having lower mid-body scale counts (17 vs 19) (Broadley 1990; Marais 2004). Previously the only record for the Eastern Cape was based on a specimen from Mtumbane, Port St Johns area (Haagner 1994: TM 69016). We extend the species' distribution 120 km southwards to Manubi SF and add two additional new records south of Port St Johns (Hluleka and Dwesa NRs). No records of either *A. polylepis* or *A. bibronii* exist for the Eastern Cape and more surveys are needed in the most north-eastern parts of the Eastern Cape to confirm the presence of this species.

### *Macrelaps microlepidotus* Günther, 1863 (KwaZulu-Natal black snake)

*Macrelaps microlepidotus* is a semi-fossorial snake that inhabits moist forest and feeds on frogs, lizards and other snakes (Marais 2004). Its distribution is restricted mainly to the coastal eastern parts of South Africa, with an inland expansion into the Amatole region (Eastern Cape) and the Escourt area (KwaZulu-Natal). It has previously been known from only seven QDUs in the Eastern Cape. Recently, the most inland Eastern Cape record was confirmed from the Katberg area and two new QDUs (one based on the collection from Dwesa NR during this study) were added in the Eastern Cape (Conradie, Venter & Nicolau 2012). We provide another new locality (Manubi SF), further indicating continuous distribution along the east coast of the Transkei. Owing to habitat destruction this species is rated as near threatened (Bates *et al.* 2014).

### *Psammodon brevirostris* Peters, 1881 (Short-snouted grass snake)

This species occurs mostly in the northern and eastern parts of South Africa, inhabiting grassland and savannah. It has previously been found only in three localities in the Eastern Cape (Bates *et al.* 2014; Branch & Haagner 1999), with its southern distribution limit around Mpande Beach (3129CD: PEM R13694). We extend the distribution 100 km south to Manubi SF and add two additional new records for the Eastern Cape (Mkambati and Hluleka NRs). A recently donated specimen to the PEM collection expands the distribution of this species even further south to the Kei River mouth (PEM 20166).

## ELAPIDAE

### *Dendroaspis polylepis* Günther, 1864 (Black mamba)

Only two records exist for this species in the Eastern Cape, namely from Port St Johns (TM 21455) and Mkambati NR. The latter is based only on observational data (Burger 1996;

De Villiers & Costello 2013). It is likely that this species will occur more widely in the north-eastern parts of the Eastern Cape. We found none during this study.

## COLUBRIDAE

### *Thelotornis capensis capensis* Smith, 1849 (south-eastern savannah vine-snake)

*T. capensis capensis* is an arboreal species that occurs in coastal thicket and savannah. The only record for the Eastern Cape is an anecdotal sighting by D. de Villiers (pers. comm., 23 April 2014). The specimen was sighted and photographed (photo could not be found) near the Msikaba River vulture colony in Mkambati NR (D. de Villiers pers. comm., 23 April 2014). This forms the basis of the SARCA record for the Eastern Cape (Marais 2014b) and has been listed in De Villiers and Costello (2013). The record needs to be confirmed and voucher specimens need to be collected.

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Appendix 2 starts on the next page→



## Appendix 2

### List of all amphibian material from the Port Elizabeth Museum examined for the study

#### Amphibians

*Arthroleptis wahlbergii*: Silaka NR (PEM A10548–10554), Hluleka NR (PEM A9967, 10001). *Leptopelis natalensis*: Mkambati NR (PEM A9565; PEM T434), Silaka NR (PEM A10588–10591), Hluleka NR (PEM A9979, 9980; PEM T497, 505), Dwesa NR (PEM T535, 541, 542), Manubi (PEM T640). *Breviceps* cf. *bagginsi*: Silaka NR (PEM A10565–10569). *Breviceps verrucosus*: Silaka NR (PEM A10570). *Amietophrynus gutturalis*: Mkambati NR (PEM A6908, 9553–9556), Silaka NR (PEM A10563, 10564; PEM T592), Hluleka NR (PEM A2141, 2142, 6942, 9970, 9971, 9978), Dwesa NR (PEM A10115, 10130; PEM T536, 545), Cape Morgan NR (PEM A10164, 10172). *Amietophrynus rangeri*: Mkambati NR (PEM A9557–9559), Hluleka NR (PEM A6936), Dwesa NR (PEM A3460, 6751, 10126, 10155), Manubi SF (PEM A10723, 10727, 10728), Cape Morgan NR (PEM A10165, 10175, 10177, 10178). *Afrixalus spinifrons*: Silaka NR (PEM A10555–10560; PEM T593, 632), Hluleka NR (PEM A9984, 9986). *Hyperolius marmoratus verrucosus*: Mkambati NR (PEM A6903, 6909, 6910, 9560–9563; PEM T428–431, 669), Silaka NR (PEM A10577–10580), Hluleka NR (PEM A2147–2151, 6924–6927, 9963, 9964, 9982, 9983, 9990, 9991), Dwesa NR (PEM A6753, 10116, 10120, 10124, 10125, 10136, 10141; PEM T539, 543), Manubi SF (PEM A10730, 10734, 10735; PEM T636, 637), Cape Morgan NR (PEM A10184, 10185; PEM T549). *Hyperolius poweri*: Mkambati NR (PEM A6911–6914, 9545, 9546, 11106, 11107; PEM T426, 427). *Hyperolius pusillus*: Silaka NR (PEM A10581, 10582), Hluleka NR (PEM A6928–6930, 9985, 9987–9989), Dwesa NR (PEM A10122, 10135, 10140, 10142, 10148, 10153; PEM T538), Manubi SF (PEM T638). *Hyperolius semidiscus*: Silaka NR (PEM A10583–10586), Hluleka NR (PEM A6939–6941, 9995–9997), Dwesa NR (PEM A10111–11014, 10117–10119, 10121, 10137). *Kassina senegalensis*: Mkambati NR (PEM A9564; PEM T432, 433, 665, 667), Silaka NR (PEM A10587), Hluleka NR (PEM A9962, 9969, 9973, 9974, 9977), Dwesa NR (PEM T537, 546), Manubi SF (PEM T639), Cape Morgan NR (PEM A10170, 10174, 10186, 10187). *Phrynobatrachus natalensis*: Mkambati NR (PEM A6917, 9566; PEM T440, 441, 669), Silaka NR (PEM A10595–10597; PEM T594), Hluleka NR (PEM A9959–9961, 9965, 9968; PEM T506, 507), Dwesa NR (PEM A8194–8196, 10127, 10129, 10145, 10151; PEM T540), Manubi SF (PEM A10733), Cape Morgan NR (PEM A10166–10168). *Xenopus laevis*: Mkambati NR (PEM A9573, 9574; PEM T737), Silaka NR (PEM T599), Hluleka NR (PEM A9975, 9976), Dwesa NR (PEM 10138), Manubi SF (PEM A10731, 10736), Cape Morgan NR (PEM A10179). *Ptychadena oxyrhynchus*: Mkambati NR (PEM A9567; PEM T443–446), Silaka NR (PEM A10598–10601), Hluleka NR (PEM A2143, 9981, 9994), Dwesa NR (PEM A10139; PEM T544), Cape Morgan NR (PEM A10182). *Ptychadena porosissima*: Mkambati NR (PEM A9568–9570; PEM T442). *Amietia queketti*: Mkambati NR (PEM A7049–7053, 9547–9552; PEM T438, 439), Silaka NR (PEM A10561, 10562), Hluleka NR (PEM A2144–2146, 7062, 9966, 9998; PEM T509), Dwesa NR (PEM A3953–3955, 10108,

10123, 10128, 10132–10134, 10147; PEM T588), Manubi SF (PEM A10729, 10732; PEM T633), Cape Morgan NR (PEM A10180, 10181, 10183). *Cacosternum nanum*: Silaka NR (PEM A10571–10576; PEM T595, 596), Hluleka NR (PEM A9999, 10000; PEM T495, 496, 499, 503, 508), Dwesa NR (PEM A10143, 10144, 10146, 10149, 10150, 10152, 10154), Manubi SF (PEM T634, 635), Cape Morgan NR (PEM A10109, 10110, 10163). *Natalobatrachus bonebergi*: Silaka NR (PEM A10592–10594; PEM T597), Hluleka NR (PEM A9992, 9993; PEM T502, 504, 510), Manubi SF (PEM A10724, 10725; PEM T641). *Strongylopus fasciatus*: Mkambati NR (PEM A6918), Silaka NR (PEM A10602; PEM T598), Dwesa NR (PEM A4091, 10131), Manubi SF (PEM A10726), Cape Morgan NR (PEM A10169, 10171, 10173, 10176, 10188). *Strongylopus grayii*: Mkambati NR (PEM A6922). *Tomopterna natalensis*: Mkambati NR (PEM A6915, 6916, 9571, 9572; PEM T435, 436), Hluleka NR (PEM A9972, 10002).

#### Reptiles

*Crocodylus niloticus*: Dwesa NR (ECPTA). *Pelomedusa galeata*: Mkambati NR (PEM R19172), Silaka NR (ECPTA), Hluleka NR (ECPTA), Dwesa NR (PEM R19787, 19790), Manubi SF (PEM R20297). *Afroedura pondolia*: Mkambati NR (PEM R9711, 12031, 19152), Hluleka NR (PEM R13377–13379, 19427, 19435, 19436), Dwesa NR (PEM R13327, 13328, 13448, 13842, 13857, 19783, 19799, 19803). *Hemidactylus mabouia*: Mkambati NR (PEM R9710, 13367, 19155, 19156), Silaka NR (PEM R20140–20144), Hluleka NR (PEM R13375, 13376, 19426, 19440), Dwesa NR (PEM R19798, 19804), Manubi SF (PEM R20290), Cape Morgan NR (PEM R19863, 19864, 19873). *Pachydactylus maculatus*: Silaka NR (PEM R20145, 20146), Manubi SF (PEM R20291), Cape Morgan NR (PEM A19870). *Agama atra*: Manubi ST (PEM R13008, 20296), Cape Morgan NR (PEM R19872). Material: Mkambati NR (PEM R13370, 19153, 19154, 20686), Silaka NR (PEM R20133), Manubi ST (PEM R20282, 20283), Cape Morgan NR (PEM R19874, 19877). *Bradypodion caffer*: Mkambati NR (PEM R20685, 20687–20689). *Bradypodion ketanicum*: Dwesa NR (PEM R5503, 5505, 17101, 17102, 19789, 19800), Manubi SF (PEM R16616, 16711). *Acontias plumbeus*: Dwesa NR (PEM R19811), Manubi SF (PEM R20279). *Trachylepis homalocephala*: Mkambati NR (PEM R19157), Silaka NR (PEM R20151), Hluleka NR (PEM R19433), Dwesa NR (PEM R19807), Manubi SF (PEM R20299, 20300), Cape Morgan NR (PEM R19868, 19871). *Trachylepis varia*: Mkambati NR (PEM R13368, 19158–19161), Silaka NR (PEM R20149, 20150), Hluleka NR (PEM R19428, 19434, 19452), Dwesa NR (PEM R13779, 19788, 19801), Manubi SF (PEM R20301, 20302), Cape Morgan NR (PEM R19875, 19876). *Tropidosaura montana natalensis*: Mkambati NR (PEM R19173). *Chamaesaura anguina anguina*: Hluleka NR (PEM R19443), Dwesa NR (PEM R19802). *Gerrhosaurus flavigularis*: Silaka NR (PEM R20138, 20139), Dwesa NR (PEM R19797, 19809, 19810), Cape Morgan NR (PEM R19869). *Tetradactylus* cf. *fitszimonsi*: Hluleka NR (PEM R19424, 19425, 19453, 19456). *Varanus niloticus*: Mkambati NR (PEM R20864), Silaka NR (ECPTA), Hluleka NR (PEM R19451), Dwesa NR (PEM R13329, 19808), Cape Morgan NR (ECPTA). *Leptotyphlops sylvicolus*: Mkambati NR (PEM R18079, 19164, 19165),



Hluleka NR (PEM R19439). *Afrotyphlops bibronii*: Silaka NR (PEM R20130–20132), Hluleka NR (PEM R19429, 19430, 19438), Dwesa NR (PEM R13693, 13836, 19805), Manubi SF (PEM R20280, 20281). *Crotaphopeltis hotamboeia*: Mkambati NR (PEM R19163), Hluleka NR (PEM R19444), Dwesa NR (PEM R19796), Manubi SF (PEM R20287) *Dasypeltis inornata*: Hluleka NR (PEM R19445), Dwesa NR (PEM R13692). *Dispholidus typus typus*: Hluleka NR (PEM R19447, 19448), Dwesa NR (PEM R13725, 19785). *Philothamnus hoplogaster*: Hluleka NR (PEM R13690). *Philothamnus natalensis occidentalis*: Mkambati NR (PEM R19167, 19168), Silaka NR (PEM R20147, 20148), Cape Morgan NR (PEM A19878). *Python natalensis*: Mkambati NR (ECPTA). *Amblyodipsas concolor*: Hluleka NR (PEM R19437), Dwesa NR (PEM R19795), Manubi SF (PEM R20284, 20285). *Boaedon capensis*:

Mkambati NR (PEM R13369), Silaka NR (PEM R20135), Hluleka NR (PEM R19454, 19455). *Duberria lutrix lutrix*: Silaka NR (PEM R20137), Hluleka NR (PEM R19431, 19432), Dwesa NR (PEM R13724), Manubi SF (PEM R20288, 20289), Cape Morgan NR (PEM R19866). *Lycodonomorphus rufulus*: Dwesa NR (PEM R19792, 19793), Manubi SF (PEM R20292, 20295). *Lycophidion capense*: Mkambati NR (PEM R19166), Dwesa NR (PEM R19794). *Macrelaps microlepidotus*: Dwesa NR (PEM R19786, 19791), Manubi SF (PEM R20294, 20295). *Psammophis brevirostris*: Mkambati NR (PEM R19169–19171), Hluleka NR (PEM R19446), Manubi SF (PEM R20298). *Bitis arietans*: Silaka NR (PEM R20134). *Causus rhombeatus*: Mkambati NR (PEM R19162), Silaka NR (PEM R20136), Hluleka NR (PEM R19449, 19450), Dwesa NR (PEM R19806), Manubi SF (PEM R20286), Cape Morgan NR (PEM R13714, 19865, 19867).

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## Appendix 3

### Additional records used in compiling the final checklist of amphibians and reptiles of the Wild Coast reserves

TM, Ditsong National Museum of Natural History (formerly Transvaal Museum); CAS, California Academy of Science; DMR, Durban Natural Science Museum.

#### Amphibians

*Arthroleptis wahlbergii*: Hluleka NR (SAFAP 116500, 141009), Silaka NR (SAFAP 14100). *Leptopelis natalensis*: Dwesa NR (SAFAP 116240), Hluleka NR (SAFAP 141006), Mkambati NR (SAFAP 116162, 116226), Silaka NR (SAFAP 116243; CAS 11606, 211607). *Breviceps bagginsi*: Mkambati NR (SAFAP 116148, 116742, 117408), Silaka NR (SAFAP 116147). *Breviceps verrucosus*: Mkambati NR (SAFAP 116743, 117409), Silaka NR (SAFAP 116146). *Amietophrynus gutturalis*: Hluleka NR (SAFAP 141004), Mkambati NR (SAFAP 116154, 116161, 116223, 116744), Silaka NR (SAFAP 116247, 140996). *Amietophrynus rangeri*: Cape Morgan NR (SAFAP 115819, 115821), Dwesa NR (SAFAP 117285). *Hyperolius marmoratus verrucosus*: Cape Morgan NR (SAFAP 115817, 115822), Dwesa NR (SAFAP 117289, 116238), Hluleka NR (CAS 21162, CAS 211611), Manubi SF (SAFAP 115772), Mkambati NR (SAFAP 116157, 116164, 116224, 116745), Silaka NR (SAFAP 116244, 140998). *Hyperolius poweri*: Mkambati NR (SAFAP 116158, 116746). *Hyperolius semidiscus*: Cape Morgan NR (SAFAP 115823), Hluleka NR (CAS 211609, 211610), Mkambati NR (SAFAP 116165), Silaka NR (SAFAP 115618, 116245).

*Kassina senegalensis*: Cape Morgan NR (SAFAP 115825), Manubi SF (SAFAP 115774), Mkambati NR (SAFAP 116155). *Phrynobatrachus natalensis*: Cape Morgan NR (SAFAP 115818), Mkambati NR (SAFAP 116160, 116163, 116227), Silaka NR (CAS 211604, 211605). *Xenopus laevis*: Dwesa NR (SAFAP 116219, 117460). *Ptychadena oxyrhynchus*: Mkambati NR (SAFAP 116156, 116220, 117415), Silaka NR (SAFAP 116242). *Ptychadena porosissima*: Mkambati NR (SAFAP 116221, 117416). *Amietia queketti*: Cape Morgan NR (SAFAP 115740), Dwesa NR (SAFAP 127053), Hluleka NR (SAFAP 141005), Mkambati NR (SAFAP 116748, 117417, 117418, 117458, 117459), Silaka NR (SAFAP 115616, 140999). *Cacosternum boettgeri*: Mkambati NR (SAFAP 11652). *Cacosternum nanum*: Cape Morgan NR (SAFAP 115820, 115824), Hluleka NR (SAFAP 117439), Manubi SF (SAFAP 115773), Mkambati NR (SAFAP 116149, 116152, 116166). *Natalobatrachus bonebergi*: Silaka NR (SAFAP 116246), Dwesa NR (SAFAP 116239). *Strongylopus fasciatus*: Dwesa NR (SAFAP 127052), Hluleka NR (SAFAP 141007), Mkambati NR (SAFAP 116153, 116222). *Tomopterna natalensis*: Mkambati NR (SAFAP 116150, 116159, 116217, 116225).

#### Reptiles

*Afroedura pondolia*: Silaka NR (TM 76520), Dwesa NR (TM 69607–69621). *Hemidactylus mabouia*: Manubi SF (TM 69605, 69606). *Agama atra*: Mkambati NR (DMR1124). *Bradypodion caffer*: Silaka NR (SARCA 100520, 100521). *Bradypodion ketanicum*: Dwesa NR (SARCA 100721). *Acontias plumbeus*: Dwesa NR (SARCA 129704). *Dasypeltis inornata*: Hluleka NR (SARCA 1576). *Dispholidus typus*: Dwesa NR (SARCA 4373). *Lycophidion capense*: Mkambati NR (DMR1107).

Appendix 4 starts on the next page→



## Appendix 4

**TABLE 1-A4:** A summary of the locations, habitats and trapping dates where drift fence with pitfall or funnel combinations were set in the six protected areas along the Wild Coast, Eastern Cape, South Africa.

Protected area	Trap ID	Coordinates		Habitat description	Plate	Trapping dates	Trap days
Cape Morgan	CM1/12	32.70232 S	28.35091 E	Swamp forest/wetland: dense ferns, sedges and reeds; soil very wet	A	26 Mar. – 02 Apr. 2012	6 ( $P = 24$ ; $F = 36$ )
Cape Morgan	CM2/12	32.70141 S	28.34971 E	Coastal grassland with bushclumps: grazed, recently burned coastal grassland next to bushclump with palms and <i>Acacia</i> sp. trees	B	26 Mar. – 02 Apr. 2012	6 ( $P = 24$ ; $F = 36$ )
Cape Morgan	CM3/12	32.69476 S	28.36074 E	Thicket drainage line with deep and muddy black soils	C	26 Mar. – 02 Apr. 2012	6 ( $P = 24$ ; $F = 36$ )
Cape Morgan	CM4/12	32.69953 S	28.35802 E	Dune forest and tall tree forest close to office complex	D	26 Mar. – 02 Apr. 2012	6 ( $P = 24$ ; $F = 36$ )9
Cape Morgan	CM5/12	32.69156 S	28.34887 E	Coastal grassland with <i>Acacia</i> sp. thicket edge in Morgans Bay commonage	E	27 Mar. – 02 Apr. 2012	5 ( $P = 20$ ; $F = 30$ )
Cape Morgan	CM6/12	32.70753 S	28.34679 E	Dune forest on sea side of secondary dune	F	27 Mar. – 02 Apr. 2012	5 ( $P = 20$ ; $F = 30$ )
Manubi	MA01/13	32.44096 S	28.604466 E	Wetland with some small <i>Eucalyptus</i> sp. trees, many old <i>Eucalyptus</i> tree (died from ring barking); Scarp forest	G	18–27 Feb. 2013	9 ( $P = 36$ ; $F = 54$ )
Manubi	MA02/13	32.44416 S	28.59796 E	Old, tall forest, minimal undergrowth; Scarp forest	H	18–27 Feb. 2013	9 ( $P = 36$ ; $F = 54$ )
Manubi	MA03/13	32.44853 S	28.59672 E	Old, tall forest, slightly more open canopy, many small <i>Pittosporum viridiflorum</i> in undergrowth; Scarp forest	I	18–27 Feb. 2013	9 ( $P = 36$ ; $F = 54$ )
Manubi	MA04/13	31.65949 S	29.29955 E	Palm mosaic, short, overgrazed grassland; Transkei coastal belt	J	18–27 Feb. 2013	9 ( $P = 36$ ; $F = 54$ )
Manubi	MA04/13	31.65103 S	29.51192 E	Dune forest; low, fairly open canopy – Subtropical dune thicket	K	18–27 Feb. 2013	9 ( $P = 36$ ; $F = 54$ )
Manubi	MA04/13	31.65531 S	29.50457 E	Ecotone – coastal scrub/grassland. P4 arm in grass, P3 arm on boundary and P1 arm in <i>Acacia</i> sp. scrub; Subtropical dune thicket/ subtropical seashore vegetation	L	18–27 Feb. 2013	9 ( $P = 36$ ; $F = 54$ )
Dwesa	D1/12	32.30278 S	28.83614 E	Coastal dune forest, on vegetated secondary dune; Indian ocean coastal belt	M	05–15 Feb. 2012	10 ( $P = 39$ ; $F = 59$ )
Dwesa	D2/12	32.28365 S	28.83591 E	Riverine forest, on Kobofo river; Scarp forest	N	05–15 Feb. 2012	10 ( $P = 38$ ; $F = 58$ )
Dwesa	D3/12	32.28792 S	28.86794 E	Short coastal grassland with scattered <i>Cyprus</i> sp. and a small pond; Indian ocean coastal belt	O	06–15 Feb. 2012	9 ( $P = 36$ ; $F = 54$ )
Dwesa	D4/12	32.28304 S	28.86469 E	<i>Cymbopogon</i> sp. tall and wet grassland on edge of wetland and riparian forest; Indian ocean coastal belt	P	06–15 Feb. 2012	9 ( $P = 36$ ; $F = 54$ )
Dwesa	D5/12	32.28584 S	28.85278 E	Dry, recently burned (< 12 months) grassland; Indian ocean coastal belt	Q	06–15 Feb. 2012	9 ( $P = 35$ ; $F = 53$ )
Dwesa	D6/12	32.27626 S	28.84885 E	Mature Scarp forest	R	06–15 Feb. 2012	9 ( $P = 34$ ; $F = 51$ )
Hluleka	HH01/10/11	31.82097 S	29.29845 E	Tall, wet <i>Cymbopogon plurinodus</i> and <i>Cyprus</i> sp. grassland adjacent to <i>Acacia karoo</i> bushclump; edge of Scarp forest in Transkei coastal belt vegetation type	S	20–28 Oct. 2011	8 ( $P = 31$ ; $F = 46$ )
Hluleka	HH02/10/11	31.81784 S	29.29799 E	Riverine forest infested with <i>Cestrum laevigatum</i> ; Scarp forest in Transkei coastal belt vegetation type	T	21–28 Oct. 2011	7 ( $P = 29$ ; $F = 43$ )
Hluleka	HH03/10/11	31.81806 S	29.30017 E	Tall, mature Scarp forest	U	21–28 Oct. 2011	7 ( $P = 28$ ; $F = 42$ )
Hluleka	HH04/10/11	31.82822 S	29.29682 E	Short coastal grassland; Transkei coastal belt vegetation type	V	21–28 Oct. 2011	7 ( $P = 28$ ; $F = 42$ )
Hluleka	HH05/10/11	31.83141 S	29.29762 E	Tall, dry <i>Cymbopogon plurinodus</i> grassland adjacent to dune forest in Transkei coastal belt vegetation type	W	21–28 Oct. 2011	7 ( $P = 28$ ; $F = 41$ )
Hluleka	HH06/10/11	31.82822 S	29.29682 E	In <i>Millettia grandis</i> forest stand with <i>Acacia</i> sp. and <i>Gymnosporia buxifolia</i> ; Transkei coastal belt vegetation type	X	21–28 Oct. 2011	7 ( $P = 27$ ; $F = 41$ )
Silaka	SIL 01/12	31.6501 S	29.505013 E	Old forest; tall canopy with minimal ground cover. Adjacent to large stream	Y	29 Sept. – 06 Oct. 2012	8 ( $P = 32$ ; $F = 48$ )
Silaka	SIL 02/12	31.6501 S	29.505013 E	Coastal grassland, tall grass; predominantly <i>Hiperenia</i>	Z	29 Sep–06 Oct 2012	8 ( $P = 32$ ; $F = 48$ )
Silaka	SIL 03/12	31.65779 S	29.50323 E	Floodplain, very thick grass component; mainly <i>Kikuyu</i> . Adjacent to small stream, not permanently flowing	AA	29 Sept. – 06 Oct. 2012	8 ( $P = 32$ ; $F = 48$ )
Silaka	SIL 04/12	31.65895 S	29.50165 E	Short grassland; dry, warm, north-east-facing slope. Gravelly soil	AB	29 Sept. – 06 Oct. 2012	8 ( $P = 32$ ; $F = 48$ )
Silaka	SIL 05/12	31.65103 S	29.51192 E	Dry forest, low canopy and minimal ground cover	AC	29 Sept. – 06 Oct. 2012	7 ( $P = 28$ ; $F = 42$ )
Silaka	SIL 06/12	31.65531 S	29.50457 E	Ecotone – Forest/grassland; P4 arm in grass, P3 arm on forest boundary and P2 arm in forest	AD	29 Sept. – 06 Oct. 2012	7 ( $P = 28$ ; $F = 42$ )

Table 1-A4 continues →



**TABLE 1-A4 (Continues...):** A summary of the locations, habitats and trapping dates where drift fence with pitfall or funnel combinations were set in the six protected areas along the Wild Coast, Eastern Cape, South Africa.

Protected area	Trap ID	Coordinates		Habitat description	Plate	Trapping dates	Trap days
Mkambati	MKFT 1	31.28984 S	29.98994 E	Gwe-gwe forest: Scarp forest vegetation type patch of $\pm 7.76$ ha	AE	07–13 Feb. 2011	6 ( $P = 25$ ; $F = 37$ )
Mkambati	MKFT 2	31.27716 S	29.98765 E	Forest patch: Very small Scarp forest clump surrounded by <i>Cymbopogon validus</i> – <i>Digitaria natalensis</i> medium grassland community	AF	08–13 Feb. 2011	5 ( $P = 20$ ; $F = 31$ )
Mkambati	MKFT 3	31.27783 S	30.00504 E	Burned grassland: Recently burned <i>Tristachya leucothrix</i> – <i>Loudetia simplex</i> short grassland community. Between wetland and sandstone outcrops. Pondoland-Ugu Sandstone Coastal Sourveld vegetation type	AG	07–13 Feb. 2011	6.00 ( $P = 24$ ; $F = 36$ )
Mkambati	MKFT 4	31.27613 S	30.02296 E	Coastal grassland: <i>Themeda triandra</i> – <i>Centella asiatica</i> dwarf grassland community. Pondoland-Ugu Sandstone Coastal Sourveld vegetation type	AH	07–13 Feb. 2011	6 ( $P = 24$ ; $F = 36$ )
Mkambati	MKFT 5	31.26084 S	30.03824 E	Mosquito beach: <i>Cymbopogon validus</i> and <i>Digitaria natalensis</i> medium grassland community. Pondoland-Ugu Sandstone Coastal Sourveld vegetation type	AI	08–13 Feb. 2011	5 ( $P = 20$ ; $F = 30$ )

The number of trap days as well as pitfall trap days and funnel trap days are indicated per site. Photographs of each trap site provide a visual representation of habitat type and trap layout (Figure 1-A4, plates a–ai).  
F, funnel traps; P, pitfall traps.



Source: Jan A. Venter

**FIGURE 1-A4:** (a–ai) Habitat type and trap layout of the respective trap sites surveyed during this study.

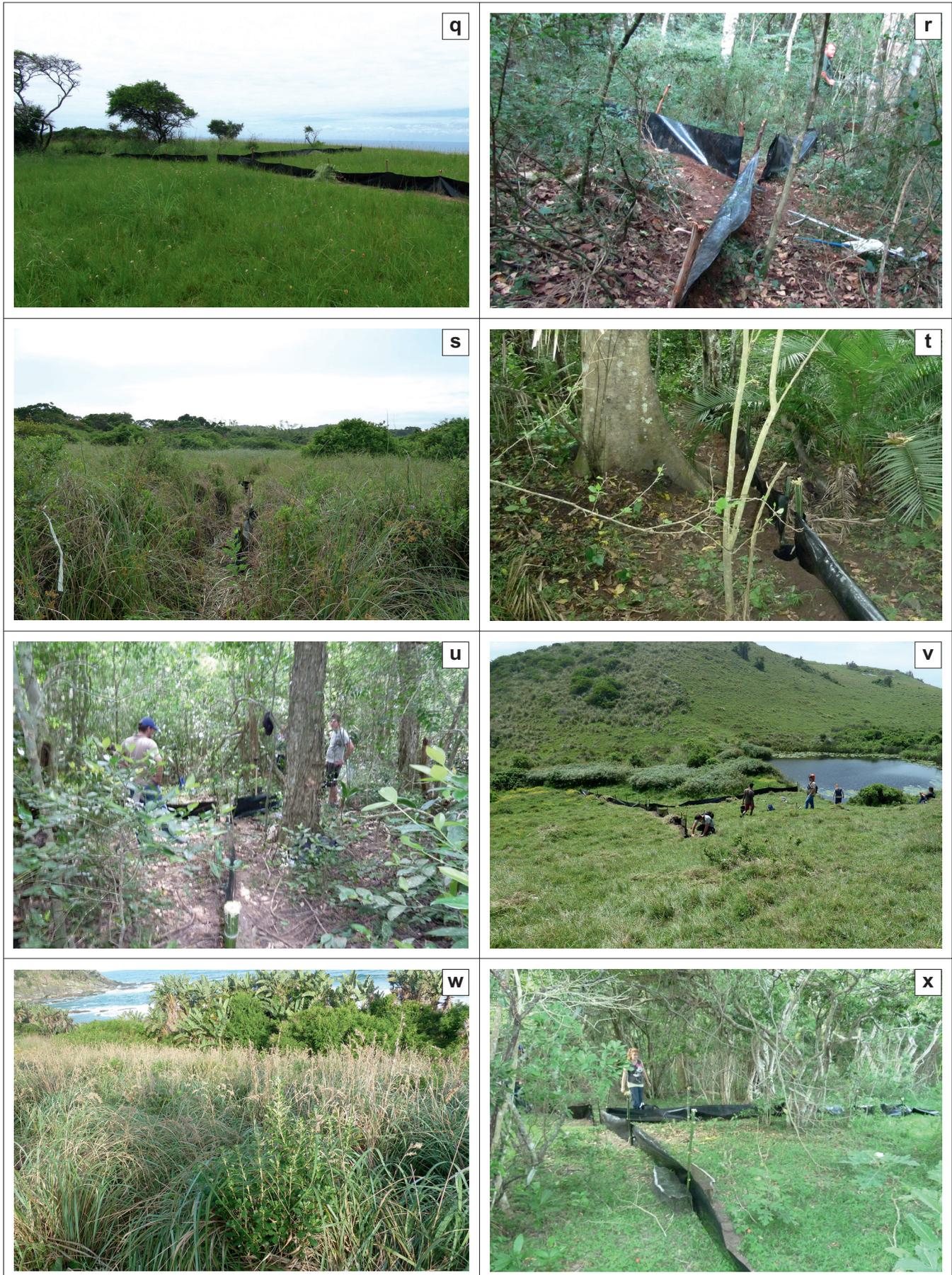
Figure 1-A4 continues on next page →



Source: Jan A. Venter

FIGURE 1-A4 (Continues...): (a–ai) Habitat type and trap layout of the respective trap sites surveyed during this study.

Figure 1-A4 continues on next page →



Source: Jan A. Venter

FIGURE 1-A4 (Continues...): (a–ai) Habitat type and trap layout of the respective trap sites surveyed during this study.

Figure 1-A4 continues on next page →



Source: Jan A. Venter

FIGURE 1-A4 (Continues...): (a–ai) Habitat type and trap layout of the respective trap sites surveyed during this study.

Figure 1-A4 continues on next page →



Source: Jan A. Venter

**FIGURE 1-A4 (Continues...):** (a–ai) Habitat type and trap layout of the respective trap sites surveyed during this study.