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Revised distribution for *Otomops martiensseni* (Chiroptera: Molossidae) in southern Africa

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ABSTRACT

We provide new data on the distributional range and abundance of the giant mastiff bat, *Otomops martiensseni* for which information on distribution and ecology are sorely needed. Because this species can forage at high altitudes, it is difficult to capture and most observations have been from caves and buildings. With the advent of new sonar gathering devices and analysis software, recording of echolocation calls can give unprecedented information on evasive bat species. Previous records from South Africa were restricted to the Durban area where several colonies in buildings were documented. No published records were available for Botswana. Our data expand the range of *O. martiensseni*in South Africa about 870km northward. However, this species' relative occurrence continues to be rare, composing <0.74% of all our recorded call sequences across the region. We provide the first evidence of *O. martiensseni* in Kruger National Park (KNP) and Mapungubwe National Park (MNP) in South Africa and from Molema Bush Camp in the Tuli Block of Botswana. Of the 13,449 call sequences analyzed in our study, 91 were determined to be from *O. martiensseni* and of these, 84 occurred in KNP. Our data show that *O. martiensseni* is more widely distributed in eastern South Africa than previously thought; however, this species is rare throughout the region and thus faces an uncertain future.

1. Introduction

The giant mastiff bat (*Otomops martiensseni*) is an IUCN listed species for which ecological and distributional data are deficient. This species has been reported throughout sub-Saharan Africa with a noncontiguous distribution from Burkina Faso, eastward through Nigeria, Chad, Central African Republic, South Sudan, Ethiopia, Uganda, Kenya, Tanzania, Zambia, Angola, Zimbabwe and north-western Mozambique. In addition, a small population exists in buildings in the Durban area of South Africa (Fenton et al., 2004; Monadjem et al., 2010). Because of its patchy occurrence and the fact that major colonies have declined severely (Hutson et al., 2001), the giant mastiff bat is listed as near-threatened (Mickleburge et al., 2004; Monadjem et al., 2010). Most data suggest that *O. martiensseni* is relatively rare within its distribution, but is found locally abundant in the KwaZulu Natal Province of South Africa (Fenton et al., 2002).

In the early 20th century, Chubb (1917) described colonies of bats roosting in buildings in Durban, South Africa as the species *O. icarus*. Although, this taxonomic designation is not widely recognized (Meester et al., 1986; Koopman, 1993; Bronner et al., 2003; Simmons, 2005), genetic comparisons among populations of *O. martiensseni* lacks parsimony because

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east Africa populations show cytochrome b and D-loop mitochondrial sequences distinct from those in Durban, whereas nuclear markers showed high genetic similarities between populations in Kenya and South Africa (Lamb et al., 2006, 2008). Other than the Durban records, the southernmost record of *O. martiensseni* was in southwestern Zimbabwe where a single individual was captured in 1978 (Fenton and Bell, 1981).

Throughout most of its range, *O. martiensseni* roosts in hollow trees (Decher et al., 1997) and caves (Mutere, 1973; Kock et al., 2005) where they occured in colonies of hundreds to tens of thousands of individuals (Kock et al., 2005). However, the colonies using buildings in Durban consisted of 30 or fewer individuals (Fenton et al., 2002).

The diet of *O. martiensseni* in Ethiopia consisted of 56% Lepidoptera (moths), 14% Isoptera, 10% Coleoptera, 8% Orthoptera with a remaining composition of Hemiptera, Neuroptera, Hymenoptera, and Diptera (Rydell and Yalden, 1997). Foraging has been noted to occur at altitudes exceeding 600 m above ground level (Fenton and Griffin, 1997), making this species very difficult to catch in nets, but individuals do fly within the range of ground-based sonar detectors. In addition, *O. martiensseni* performs unique flight maneuvers involving sequences of slide-slips that alternate to the left and right when making steep descents into caves (Norberg and Rayner, 1987).

With the improvement of sonar gathering devices and analysis software, the ability to document the distributional ranges of bat species has greatly advanced, especially for difficult to capture species (Fenton et al., 2002). We hypothesized that *O. martiensseni* is more widely distributed throughout sub-Saharan Africa than is currently known from the limited observations at roost sites. In addition, we predict that through the use of sonar capture, we will find *O. martiensseni* to be more locally abundant than previously thought.

2. Methods and materials

We deployed one or two Pettersson D240x bat detectors (Pettersson Elektronik, Uppsala, Sweden) positioned on tripods or hand-held, 1 m above the ground and angled 45° to the horizontal for two hours past the time of published sunset. On some occasions, when recording within the safety of research or tourists camps, we were able to deploy detectors unattended throughout the night (sunset to dawn). Also, on certain nights we sampled from 1 to 3 h after sunset while driving and pausing along road transects in order to briefly sample larger numbers of localities. Real-time sonar call sequences were recorded onto a PC laptop or onto a Samson H2 Zoom digital recorder (Samson Technologies, Hauppauge, New York, USA) from the D240x detectors and analyzed for call parameters using Sonobat 3.1 (SonoBat Inc., Arcata, Oregon, USA). SonoBat 3.1 uses FFT with 2048 frequency bins, Hanning window, and a 0.025 msec time interval (high precision) to calculate frequency data. To identify call sequences of *O. martiensseni*, we compared call duration, high frequency, and low frequency with published data from Fenton et al. (2004). We also calculated band-width and Fc (characteristic call frequency determined by finding the point in the final 40% of the call having the lowest slope or exhibiting the end of the main trend of the body of the call).

3. Results

3.1. Survey sites

We surveyed for *O. martiensseni* across 32 sites in KNP in both the dry (May and June, 2008 and 2009) and wet seasons (December, January or February 2010 and 2011). We also surveyed along the Limpopo River at two sites in MNP, South Africa and at the MBC in Botswana during the wet season in December 2011.

3.2. Vocalizations

The sonar calls of *O. martiensseni* consist of a frequency modulated sweep beginning and ending at relatively low frequencies audible to the human ear, with a narrow band width and long duration (Fig. 1), unique among African echolocating bats (Fenton et al., 2004). Some sonar calls gathered from KNP, MNP and MBC matched the call structure published for *O. martiensseni* (Fenton et al., 2004).

A total of 13,449 analyzable call sequences were recorded throughout our study. Of these, 91 were distinguished to be those of *O. martiensseni*. Means and standard deviations as well as maximum and minimum values for five call structure variables are provided in Table 1 and call data for all 91 call sequences are presented in Appendix.

3.3. Relative abundance and new localities

In KNP we surveyed 32 sites (Table 2) and recorded 11,655 sequences of which 86 (0.74%) were confirmed as *O. martiensseni* from 11 of the 32 sites. In MNP, we recorded 1284 sequences of which two (0.16%) were from *O. martiensseni* and for MBC, 510 sequences led to three calls (0.59%) distinguished as *O. martiensseni*. Thus, calls recorded of this species foraging in any of our survey areas were rare. In MNP, we were restricted to collecting data from the private tourist camp where we censused at two sites. At our camp, we were able to keep the detector running all night and we captured two sonar passes by *O. martiensseni*. We also sampled for sonar calls near a swimming pool about 0.5 km from our camp. Although bat activity was high, no sonar sequences were recorded from *O. martiensseni* (Table 2).

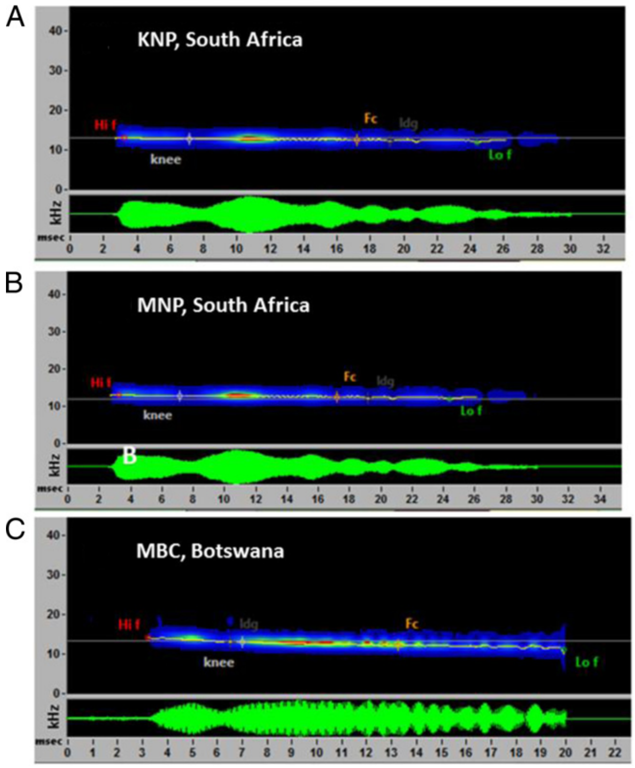

Fig. 1. Sonograms of calls recorded from *O. martiensseni* in (A) near Shingwedzi in northern Kruger National Park (KNP) and (B) Leokwe Camp, Mapungubwe National Park (MNP), South Africa, and (C) Molema Bush Camp (MBC) in Botswana located about 30 km west of MNP adjacent to the Limpopo River (see Table 1 for GPS units of all sites).

Table 1
Mean values, standard deviations, and maximum and minimum values for 91 calls of *O. martiensseni* recorded during the study. Fc = characteristic call frequency (see methods for definition), SD = standard deviation, ms = milliseconds, kHz = kilohertz. SonoBat 3.1 uses FFT with 2048 frequency bins, Hanning window, and a 0.025 ms time interval (high precision) to calculate frequency data. Also provided are means and standard deviations of call structure variables provided by Fenton et al. (2004) for *O. martiensseni* calls recorded in Durban, South Africa.

	Mean value (SD)	Maximum value	Minimum value	Mean (SD) from Fenton et al. (2004)
Duration (ms)	21.18 (3.61)	27.81	11.79	22 (3.96)
Fc (kHz)	11.70 (0.71)	13.54	10.51	NA
High frequency (kHz)	13.19 (1.08)	15.67	11.01	14.7 (1.68)
Low frequency (kHz)	10.82 (0.65)	12.23	9.11	8.9 (0.91)
Band width (kHz)	2.40 (0.90)	5.64	0.65	NA
Maximum power (kHz)	12.41 (0.90)	14.55	10.76	9.9 (1.11)

3.4. Mapping new distributional records

The 86 call sequences recorded in KNP were distributed mostly in the Skukuza and Shingwedzi areas (Fig. 2(A)). However, these areas were also where most of our survey efforts took place (Shingwedzi, $n = 38$ nights; Skukuza, $n = 17$ nights). No recording of *O. martiensseni* were gathered near Orpen or Punda Maria that we sampled for two nights each in December of 2011. The MNP and MBC, both adjacent to the Limpopo River, but separated by about 30 km east to west, were sampled for two nights each in December 2011 with a total of five *O. martiensseni* calls recorded (Fig. 2(B)).

3.5. Seasonality

We detected *O. martiensseni* in KNP in both the dry and wet seasons. However, of 1740 call sequences gathered in December, January or February, only three (0.17%) were from *O. martiensseni,* whereas, of the 9915 sonar calls gathered in May and June, 92 were from *O. martiensseni* (0.93%), indicating that this species may be more prevalent in KNP during the dry season. Because we only sampled MNP and the MBC in December, we do not know if *O. martiensseni* is present at these sites during the dry season.

Table 2
Locality and presence/absence data for all locality points censused for sonar calls in KNP, MNP (South Africa), and MBC (Botswana).

GPS	Year sampled	Date sampled	*Otomops* presence	Number of calls
Skukuza area, Kruger National Park, South Africa				
[36] **357933**, **723519**	2008	25 June	Yes	3
[36] **3357798**, **723527**	2008	26 June	No	
[36] **3358014**, **725152**	2009	31 May	No	
[36] **3358006**, **7235145**	2009	02 June	No	
[36] **3358014**, **725152**	2009	21 June	No	
[36] **3356568**, **7236022**	2009	3 June	No	
[36] **3356664**, **7235940**	2009	20 June	Yes	1
[36] **3356568**, **7236022**	2010	21 January	No	
[36] **3355280**, **7236358**	2009	03 June	No	
[36] **3355244**, **7236361**	2009	03 June	No	
[36] **3357142**, **7235174**	2008	28 June	Yes	3
[36] **3357142**, **7235174**	2008	29 June	Yes	2
[36] **3357079**, **7235127**	2009	19 June	Yes	1
[36] **3377098**, **7235151**	2011	11 December	No	
[36] **3370510**, **7239315**	2009	21 June	No	
[36] **3375446**, **7234855**	2009	21 June	No	
[36] **3378238**, **7235255**	2009	21 June	No	
[36] **3347909**, **7221057**	2009	4 June	No	
[36] **3347902**, **7221047**	2009	18 June	Yes	1
[36] **3347866**, **720648**	2009	18 June	No	
[36] **3350086**, **7223016**	2009	17 June	No	
[36] **3349753**, **7228826**	2009	17 June	No	
[36] **3350086**, **7223016**	2010	19 January	No	
[36] **3350086**, **7223016**	2010	20 January	No	
Orpen area, Kruger National Park, South Africa				
[36] **337685**, **7293640**	2011	12 December	No	
Shingwedzi area, Kruger National Park, South Africa				
[36] **339994**, **7443771**	2008	10 June	Yes	2
[36] **339994**, **7443771**	2008	11 June	Yes	3
[36] **339994**, **7443771**	2008	13 June	Yes	5
[36] **339994**, **7443771**	2008	15 June	Yes	4
[36] **339994**, **7443771**	2009	8 June	Yes	1
[36] **339994**, **7443771**	2009	12 June	Yes	2
[36] **339994**, **7443771**	2010	23 January	No	
[36] **339994**, **7443771**	2010	24 January	Yes	1
[36] **339994**, **7443771**	2010	3 February	No	
[36] **339994**, **7443771**	2010	4 February	Yes	2
[36] **328642**, **7435764**	2009	9 June	No	
[36] **341735**, **7441912**	2009	10 June	No	
[36] **338045**, **7445252**	2008	12 June	No	
[36] **338045**, **7445252**	2008	14 June	No	
[36] **338045**, **7445252**	2008	20 June	Yes	11
[36] **338045**, **7445252**	2008	21 June	Yes	9
[36] **338045**, **7445252**	2009	24 June	No	
[36] **338045**, **7445252**	2010	24 January	No	
[36] **338045**, **7445252**	2010	25 January	No	
[36] **338045**, **7445252**	2010	26 January	No	
[36] **338045**, **7445252**	2010	3 February	No	
[36] **338045**, **7445252**	2010	4 February	No	
[36] **334604**, **7444928**	2008	19 June	Yes	2
[36] **334604**, **7444928**	2008	20 June	Yes	6
[36] **334604**, **7444928**	2008	21 June	Yes	1
[36] **334604**, **7444928**	2009	12 June	No	
[36] **337947**, **7440113**	2009	13 June	Yes	1
[36] **338311**, **7440692**	2009	13 June	Yes	1
[36] **339267**, **7442687**	2008	5 June	No	
[36] **339267**, **7442687**	2008	9 June	Yes	1
[36] **339267**, **7442687**	2008	22 June	No	
[36] **339267**, **7442687**	2008	28 June	Yes	3
[36] **339267**, **7442687**	2008	29 June	Yes	2
[36] **339267**, **7442687**	2009	6 June	Yes	1
[36] **339267**, **7442687**	2009	11 June	No	
[36] **339267**, **7442687**	2010	6 February	No	
[36] **339267**, **7442687**	2011	13 December	No	
[36] **339813**, **7443676**	2008	4 June	No	
[36] **339908**, **7443584**	2009	7 June	Yes	2

(continued on next page)

Table 2 (*continued*)

GPS	Year sampled	Date sampled	*Otomops* presence	Number of calls
[36] **341711**, **7441758**	2008	16 June	Yes	3
[36] **341711**, **7441758**	2008	17 June	Yes	1
[36] **341711**, **7441758**	2009	8 June	No	
[36] **341711**, **7441758**	2009	9 June	No	
[36] **341711**, **7441758**	2010	23 January	No	
[36] **341711**, **7441758**	2010	25 January	Yes	1
[36] **319135**, **7432195**	2008	19 June	No	
[36] **349753**, **7228826**	2009	14 June	Yes	1
[36] **350086**, **7230161**	2009	14 June	No	
[36] **335136**, **7451014**	2010	28 January	No	
[36] **335136**, **7451014**	2010	30 January	No	
[36] **337129**, **7445862**	2009	15 June	No	
Letaba area, Kruger National Park, South Africa				
[36] **354941**, **7361349**	2010	4 February	No	
Punda Maria area, Kruger National Park, South Africa				
[36] **296265**, **7489265**	2010	15 December	No	
[36] **296281**, **7489200**	2010	15 December	No	
[36] **296239**, **7489241**	2010	15 December	No	
Leokwe Camp area, Mapungubwe National Park, South Africa				
[35] **743496**, **7541094**	2011	21 December	Yes	2
[35] **743780**, **7541148**	2011	22 December	No	
Molema Bush Camp, Northern Tuli Game Reserve, Botswana				
[35] **703666**, **7533004**	2011	18 December	No	
[35] **703604**, **7532896**	2011	18 December	Yes	2

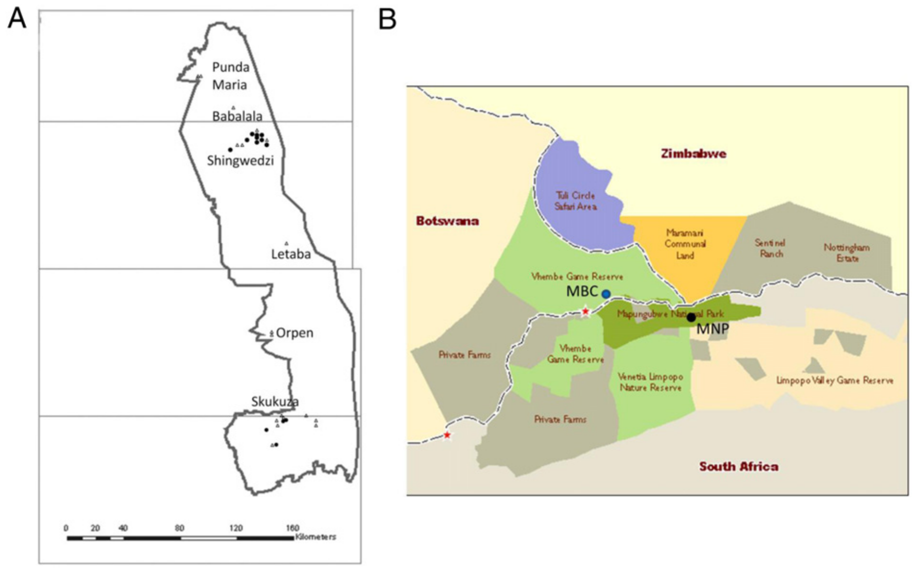

Fig. 2. Maps of sampling area localities. (A) Kruger National Park (KNP), filled circles indicate localities where sonar calls of *O. martiensseni* were recorded, whereas open triangles indicate sampling localities where no calls of *O. martiensseni* occurred. (B) Mapungubwe National Park (MNP, black dot), South Africa and Molema Bush Camp (MBC, blue dot), Botswana, both are areas where *O. martiensseni* was recorded during our survey. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

4. Discussion

In this paper we provide new locality data for extending the range of *O. martiensseni* by approximately 870 km northward from published records of colonies in Durban, South Africa. We also provide the first evidence of this species in Kruger National Park (KNP) and Mapungubwe National Park (MNP), South Africa as well as provide first records of *O. martiensseni* in Botswana at Molema Bush Camp (MBC) adjacent to the Limpopo River. Our first hypothesis that this species would be more widely distributed than previously thought was supported. However, our second hypothesis that this species would be more common in areas where detected was not supported by our data.

Until now, the only records of *O. martiensseni* in South Africa were from buildings in the city of Durban (Chubb, 1917, Fenton et al., 2002, Fenton et al., 2004) and no records were available for Botswana. We found *O. martiensseni* to be relatively

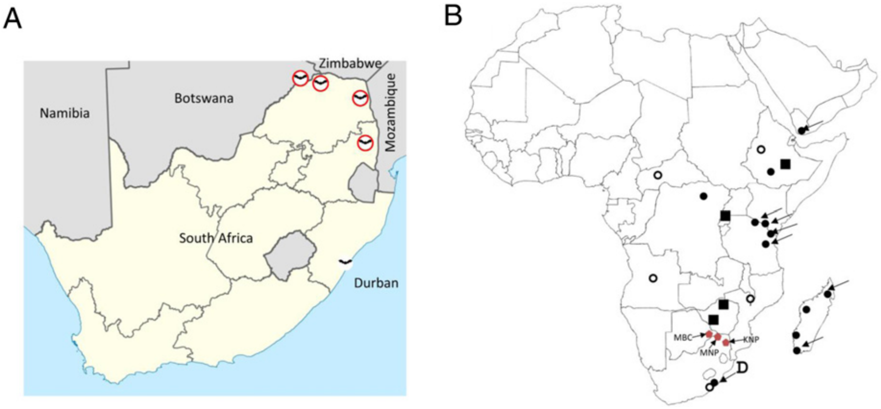

Fig. 3. A. Regional map showing only known previous records of *O. martiensseni* in Durban, South Africa (Chubb, 1917; Fenton et al., 2004) with the additions of our records (red circles) based upon sonar data from Kruger National Park (KNP), Mapungubwe National Park (MNP), South Africa and Molema Bush Camp (MBC), Botswana. B. Map of Africa (modified from Fenton et al., 2002) showing previously documented records with the addition of our new records (red dots). D = the location of sites near Durban, solid black dots designate areas where bats were taken in roosts and solid rectangles indicate where bats were netted (from Fenton et al., 2002). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

rare based on calls gathered from our near-ground level recording stations, but present at many localities in KNP. However, this species accounted for only a very small portion (<1%) of all recorded calls, indicating that it is one of the more rarely observed species in the region. We should point out however that call sequence data can be misleading when used to calculate abundance of any bat species. This is because some species may be predispose to circle an area while foraging causing them to be recorded more than once thereby artificially inflating the number of individuals active in a given area (Miller, 2001). That being said, we feel that the very limited calls gathered from *O. martiensseni* during our survey does indicate that this species is relatively rare. This is further corroborated by the fact that we only recorded sonar from *O. martiensseni* at 11 of the 32 sites we sampled in KNP where our most extensive surveys took place. In addition, repeated sampling at some of the sites near Skukuza and Shingwedzi in KNP showed similar results in number of calls recorded and none of these were within one minute of each other, a standard suggested by Miller (2001).

We anticipate that gaps in distribution of *O. martiensseni* will be filled as more localities are sampled. The occurrence of *O. martiensseni* in MNP and MBC followed the same pattern found in KNP with seemingly only a few individuals present at any given locality. Based on these records we propose a new distribution map for *O. martiensseni* to include our sampling areas (Fig. 3).

We also found *O. martiensseni* to be more active in KNP during the dry season than in the wet season and this pattern fits with data suggesting that foraging distances may be longer during the dry season (Kingdon (1974), Long, 1995). In addition, sonar recordings gathered >600 m above the ground (Fenton and Griffin, 1997) indicates that our estimates of abundance of this species probably are conservative as activity at such altitudes would be outside the recording range of ground-based sonar detectors. For example, McCracken et al. (2008) used radio-microphone bat detectors strung from free-floating balloons and helium kites to record Brazilian free-tailed bats (Molossidae: *Tadarida brasiliensis*) foraging 1118 m above the ground. Therefore, we suggest that the use of elevated microphones may be beneficial in determining this species status. Because *O. martiensseni* is listed as a near-threatened species (Mickleburge et al., 2004; Monadjem et al., 2010), more data on its distribution and abundance are of critical importance in considering future conservation efforts. Our censusing data from KNP, MNP, and MBC show this species to be more widely distributed than previously noted in South Africa and Botswana, occurring in the largest protected game park (KNP) and also one of the relatively smaller parks (MNP) in South Africa. Although we have yet to locate any roost sites for *O. martiensseni* in our study areas, it seems plausible that the presence of human buildings and other infrastructure would provide roosting opportunities for colonies. On a continental scale (Fig. 3(B)) our data bridge the most southern locality for this species in Durban, South Africa with that of the capture of one individual in southwestern Zimbabwe in 1978 at the Sengwa Wildlife Research Area (Fenton and Bell, 1981). More research is necessary to better understand the natural history of *O. martiensseni* and this species' relationship to human development and other landscape changes throughout sub-Saharan Africa in order to build a comprehensive and effective conservation plan.

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Appendix

Parameter data for each sonar call recorded for *O. martiensseni* by site. Ms = milliseconds, kHz = kilohertz, Fc = characteristic call frequency (see methods for explanation).

Duration (ms)	Fc (kHz)	High freq. (kHz)	Low freq. (kHz)	Band width (kHz)	Freq. of max. power (kHz)
Kruger National Park, South Africa					
24.26	10.78	11.05	10.06	1.45	11.10
19.82	11.04	12.11	10.21	1.90	11.78
17.81	13.13	14.46	11.75	2.71	13.60
19.88	11.6	12.00	10.8	1.2	12.00
19.75	11.05	12.99	10.44	2.55	11.98
21.25	11.18	13.20	9.87	3.33	11.76
17.33	11.79	13.42	10.68	2.74	12.62
20.81	10.76	12.52	10.19	2.32	11.55
19.34	11.71	13.43	11.01	2.49	12.14
27.20	11.29	13.55	10.45	3.09	11.18
21.66	10.86	11.41	9.80	1.16	10.99
19.34	11.71	13.43	11.01	2.42	12.14
14.62	12.40	15.67	11.97	3.71	12.45
23.17	10.51	11.01	9.42	1.59	10.76
26.49	11.43	13.53	10.48	3.05	11.98
13.18	11.44	12.56	10.90	1.66	12.05
21.01	11.84	13.50	10.71	2.78	12.62
26.53	12.05	13.91	11.34	2.57	12.85
16.70	11.33	11.72	11.07	0.65	11.60
23.03	11.16	12.89	10.09	2.80	11.76
20.23	11.70	13.03	11.00	2.03	12.41
26.14	10.80	13.32	9.923	3.40	11.14
18.12	13.20	14.75	11.85	2.90	14.14
19.34	11.71	13.43	11.01	2.42	12.14
14.92	11.42	12.05	11.23	0.81	11.57
21.04	10.59	11.33	10.25	1.08	11.02
23.50	10.56	11.33	10.25	2.37	11.32
22.76	10.90	12.44	9.97	2.47	11.53
20.57	12.02	13.85	10.86	2.99	12.42
18.04	13.54	14.88	10.82	4.06	14.55
22.64	11.47	11.95	10.29	1.66	11.63
22.44	11.23	13.48	10.48	3.00	11.40
22.58	10.14	13.62	9.57	4.04	10.91
23.28	11.84	13.20	11.26	1.94	12.39
22.89	11.82	13.27	11.06	2.21	13.03
21.18	12.46	13.69	11.23	2.45	13.24
15.84	12.41	14.30	11.78	2.53	13.13
25.92	12.95	13.18	11.45	1.73	12.84
24.51	10.78	11.90	10.33	1.57	11.32
22.02	10.95	12.33	10.43	1.89	11.75
25.87	11.24	12.38	10.36	2.02	11.80
22.91	11.56	12.65	10.99	1.65	12.20
18.61	11.56	12.74	11.00	1.74	12.20
22.28	11.99	12.94	11.18	1.76	12.60
14.07	11.63	12.98	11.18	1.80	12.02
23.28	11.56	13.14	10.95	2.19	12.85
24.17	12.08	13.50	11.66	1.83	12.82
20.51	11.28	13.63	10.89	2.73	12.84
21.49	12.06	13.97	10.97	3.00	13.04
17.40	12.73	14.26	12.23	2.03	13.25
15.93	12.37	14.29	10.87	3.41	13.27
18.56	12.25	14.35	10.81	3.53	12.90
22.04	11.97	14.37	11.35	3.02	13.35

(*continued on next page*)

Duration (ms)	Fc (kHz)	High freq. (kHz)	Low freq. (kHz)	Band width (kHz)	Freq. of max. power (kHz)
22.50	12.57	14.47	11.43	3.03	14.13
19.45	12.01	14.80	10.99	3.80	13.69
27.81	10.91	12.17	10.17	1.99	11.36
11.79	11.58	14.14	10.09	4.04	12.68
24.87	11.73	14.75	9.11	5.64	14.22
22.60	10.58	11.46	9.97	1.50	10.94
18.46	12.91	14.90	11.93	3.00	13.33
20.81	10.76	12.52	10.20	2.32	12.32
19.76	11.04	12.99	10.43	2.55	11.98
21.25	11.18	13.20	9.86	3.33	11.76
17.33	11.79	13.42	10.68	2.74	12.62
23.25	10.64	11.75	10.11	1.64	11.46
20.97	11.10	12.11	10.35	1.76	11.42
27.20	11.29	13.55	10.45	3.09	11.18
24.70	12.68	14.52	11.66	2.85	13.61
Mapungubwe National Park, South Africa					
21.17	11.67	13.12	10.94	2.18	11.13
Tuli Block, Botswana					
24.26	10.37	13.48	9.95	3.54	10.36
24.77	11.62	13.63	10.70	2.93	12.70
21.55	11.31	13.05	10.18	2.87	12.25

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