

Dung beetle conservation biogeography in southern Africa: current challenges and potential effects of climatic change

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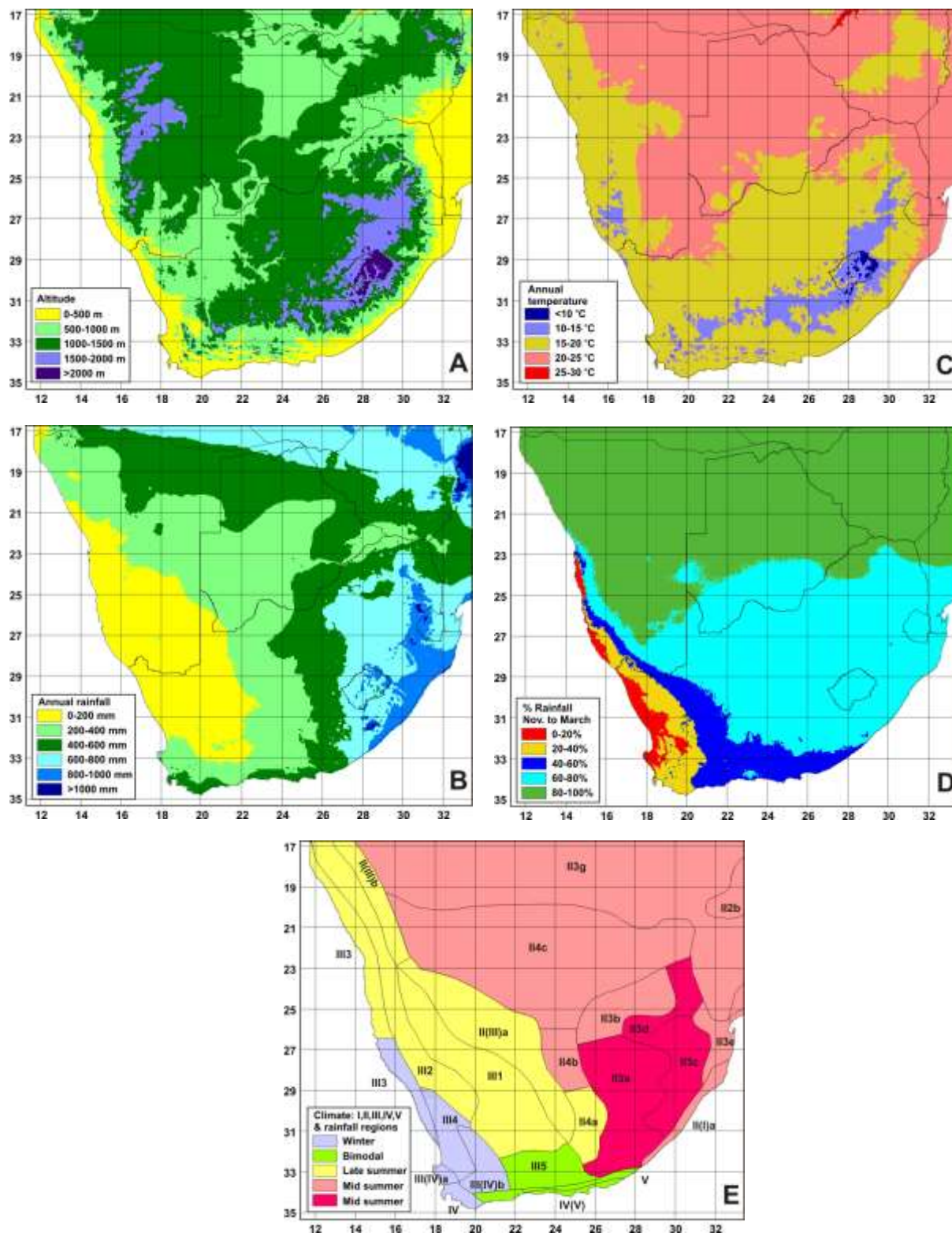
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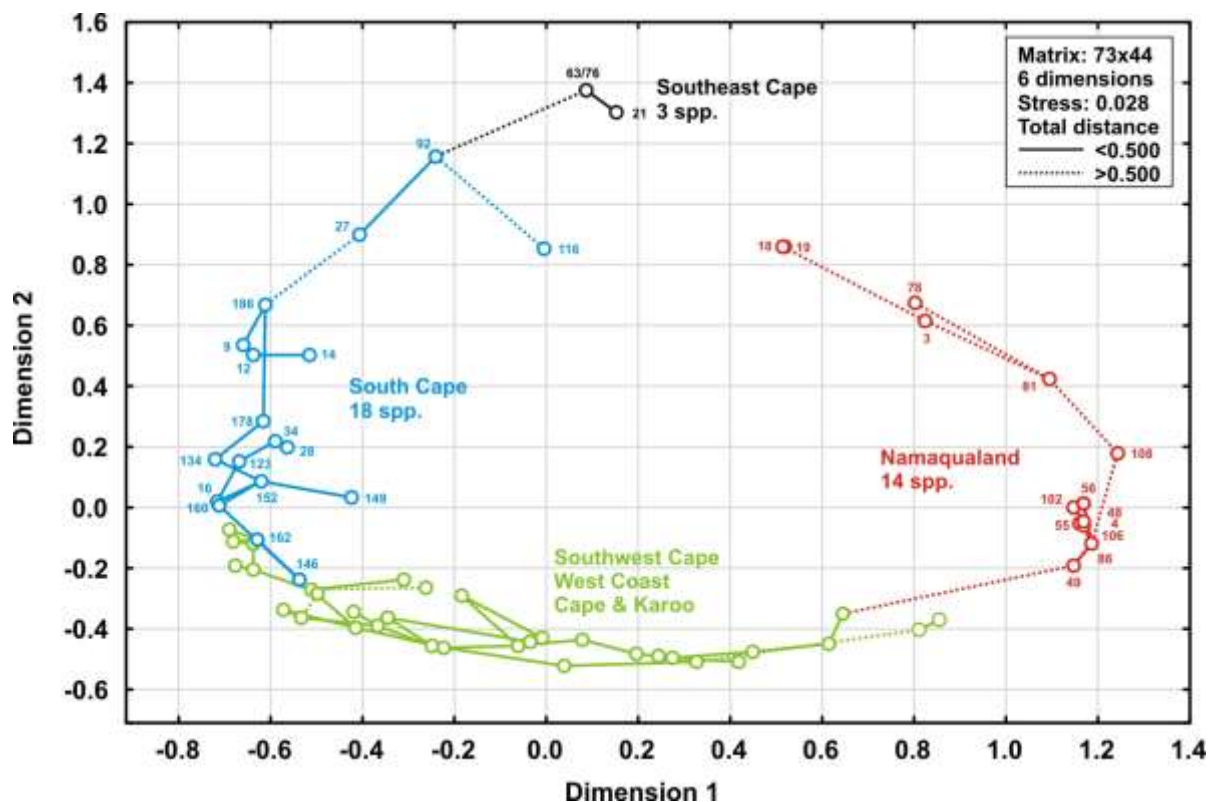
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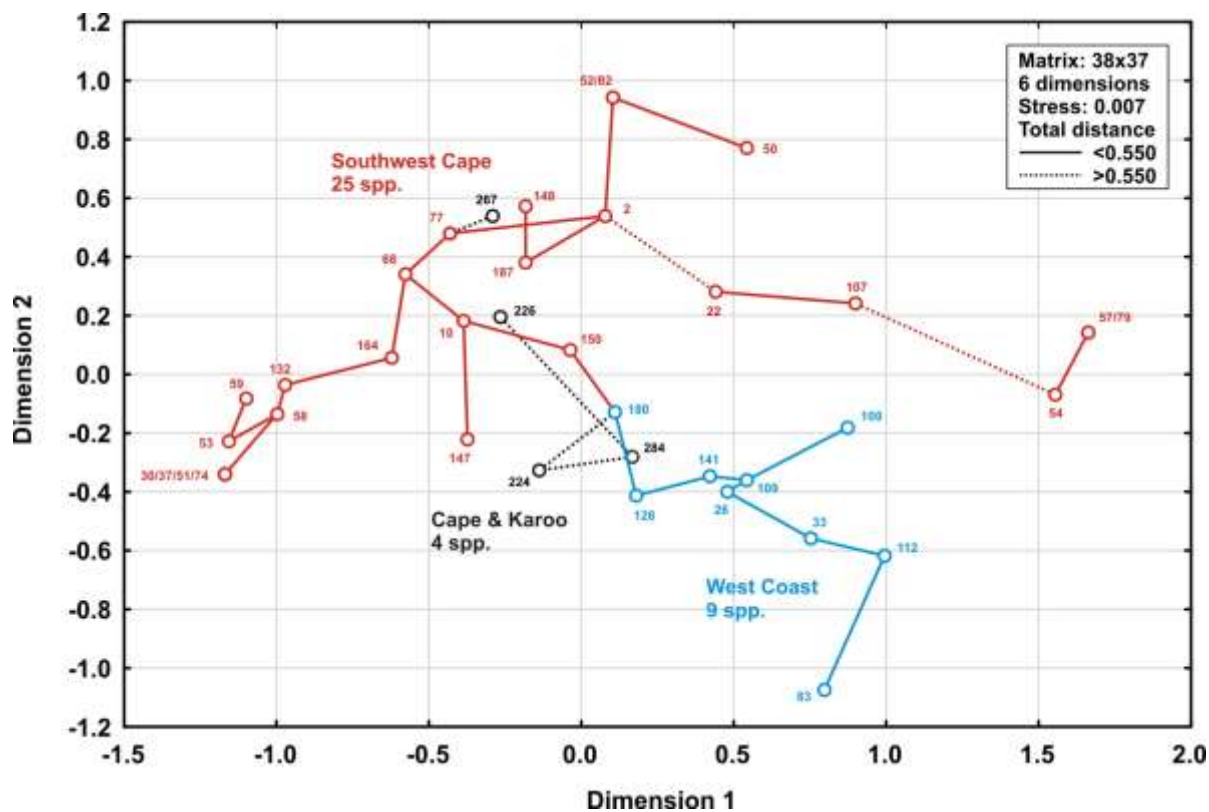
Supplementary material



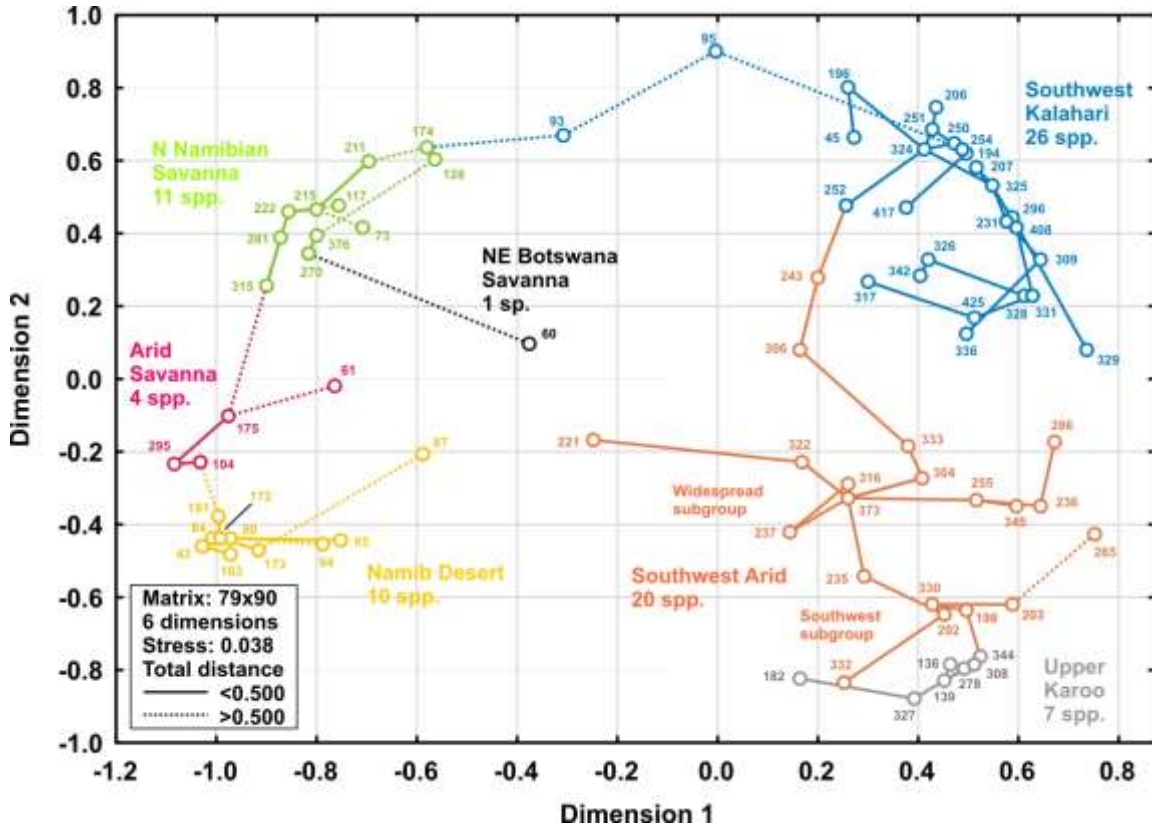
Supplementary Figure 1. Map panels showing: A. Altitude; B. Annual rainfall; C. Annual temperature; D. Rainfall seasonality (% rain in summer, November to March); E. Climatic regions after Walter & Lieth (1964) grouped into principal rainfall regions with mid-summer region divided into savanna (pink) and Highveld (magenta).



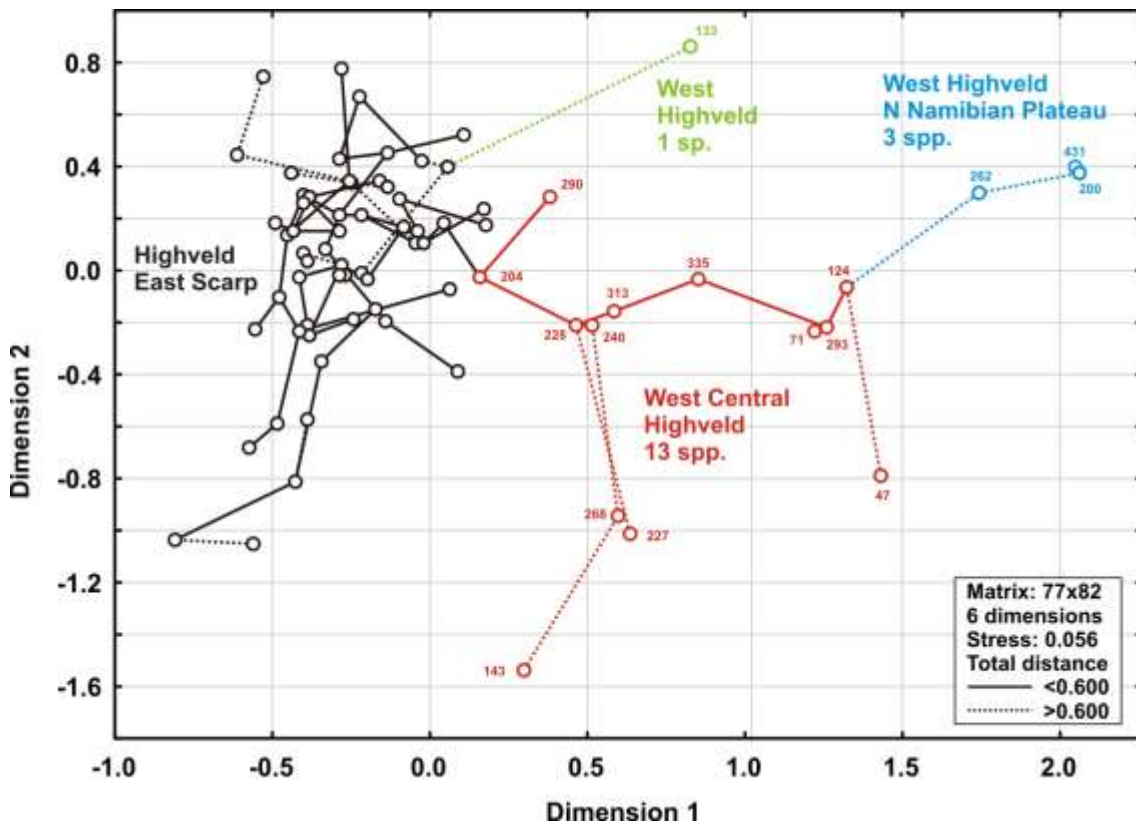
See Figure 5A1 & Table S3. Subregions in Winter & Bimodal Rainfall Region with species identity numbers.



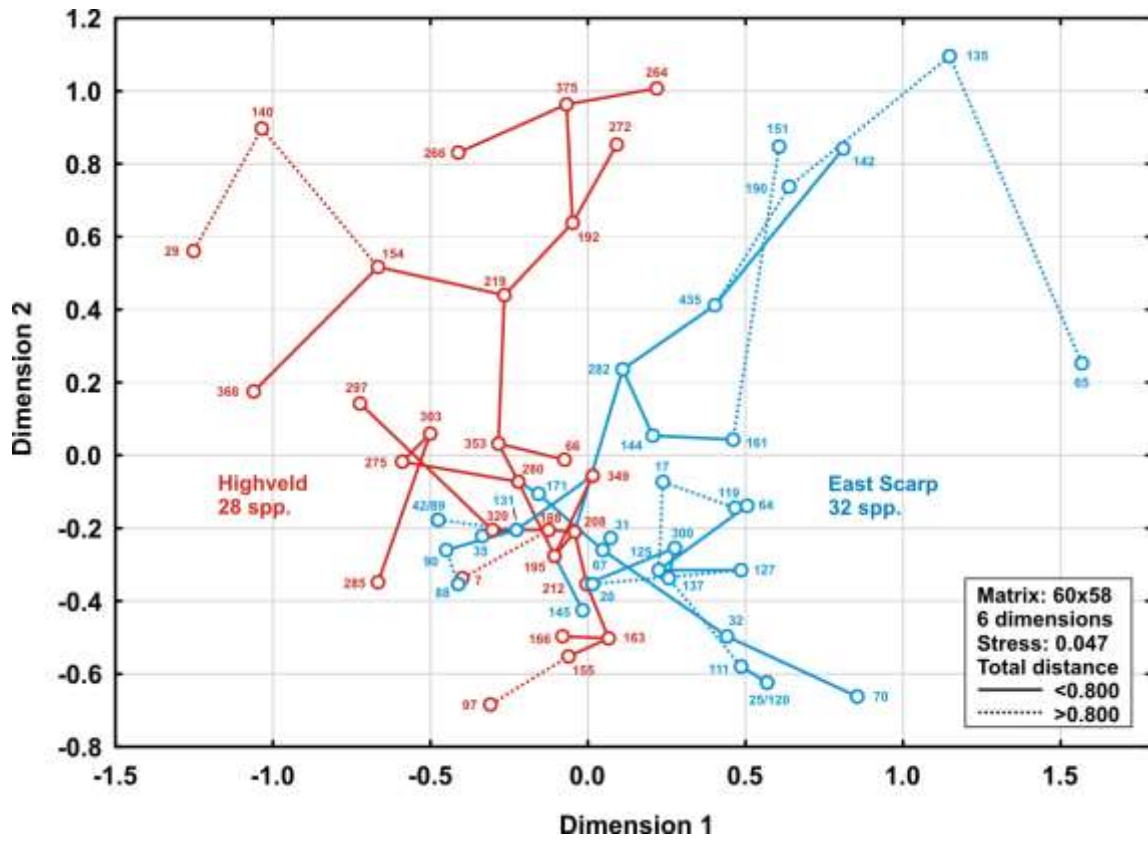
See Figure 5A2 & Table S3. West Coast, Southwest Cape plus Cape & Karoo subregions with species identity numbers.



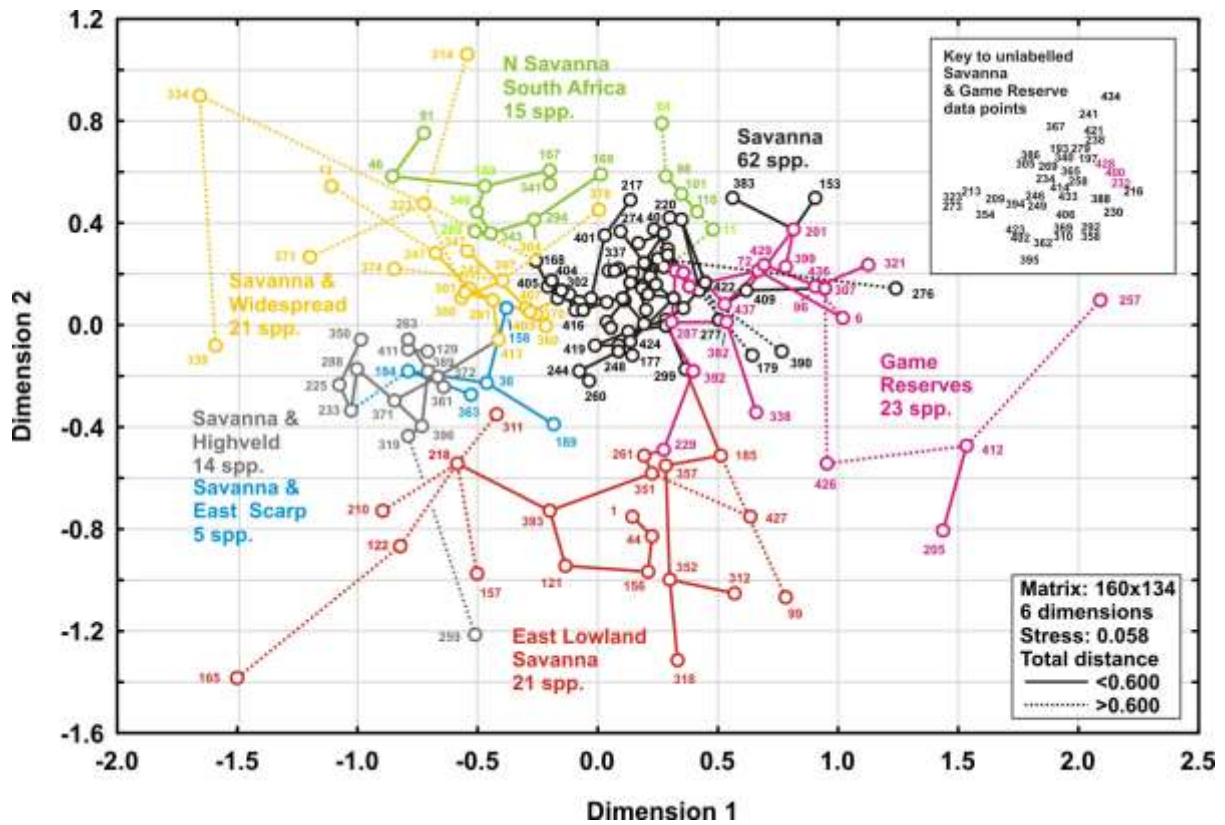
See Figure 5B & Table S3. Subregions in Southwest Arid region with species identity numbers.



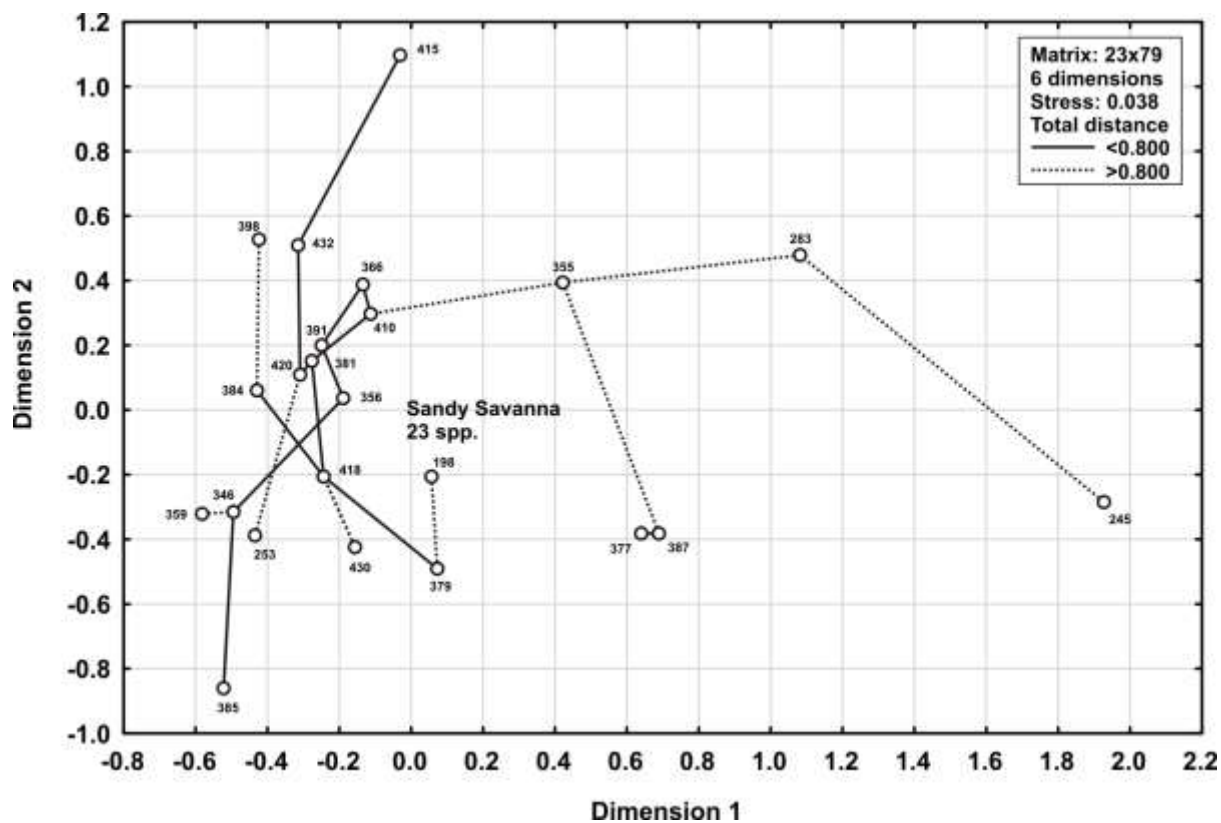
See Figure 5C1 & Table S3. Subregions on Highveld with species identity numbers.



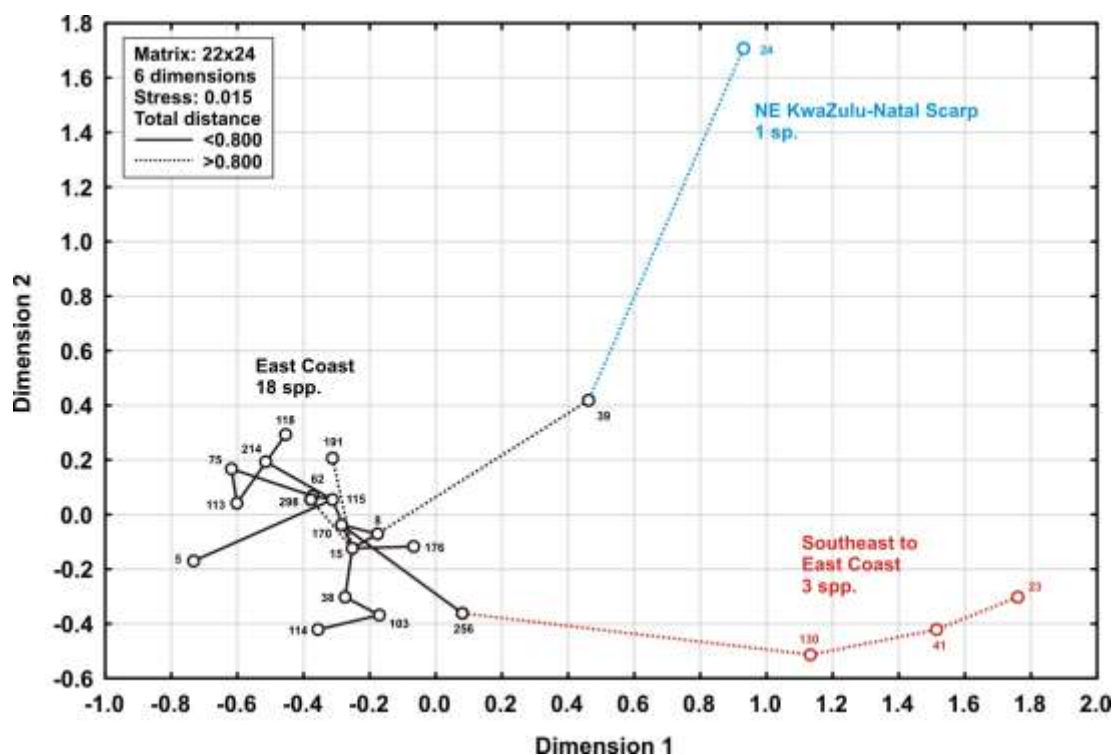
See Figure 5C2 & Table S3. Highveld and East Scarp subregions with species identity numbers.



See Figure 5D & Table S3. Subregions in Savanna region with species identity numbers.

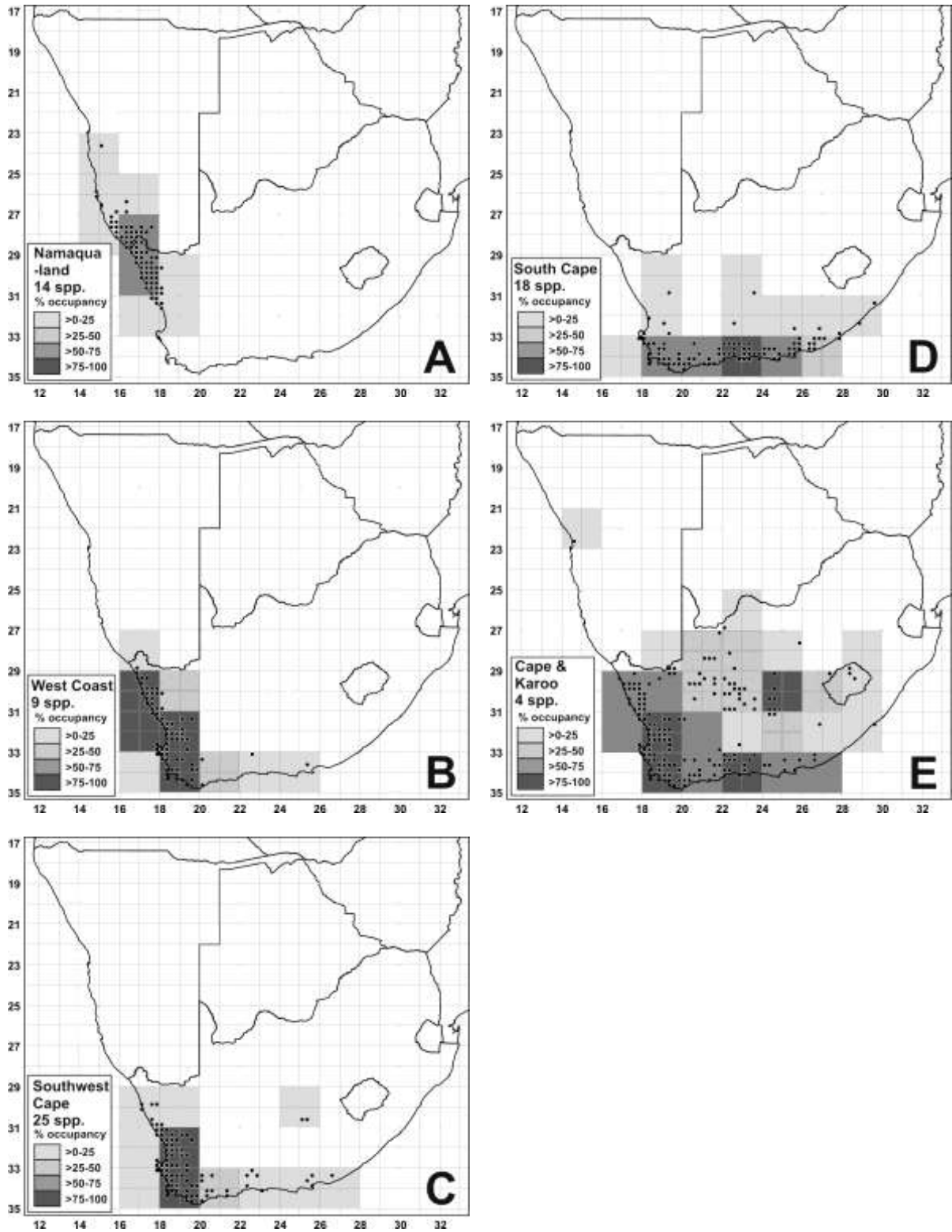


See Table S3. Sandy Savanna region with species identity numbers.

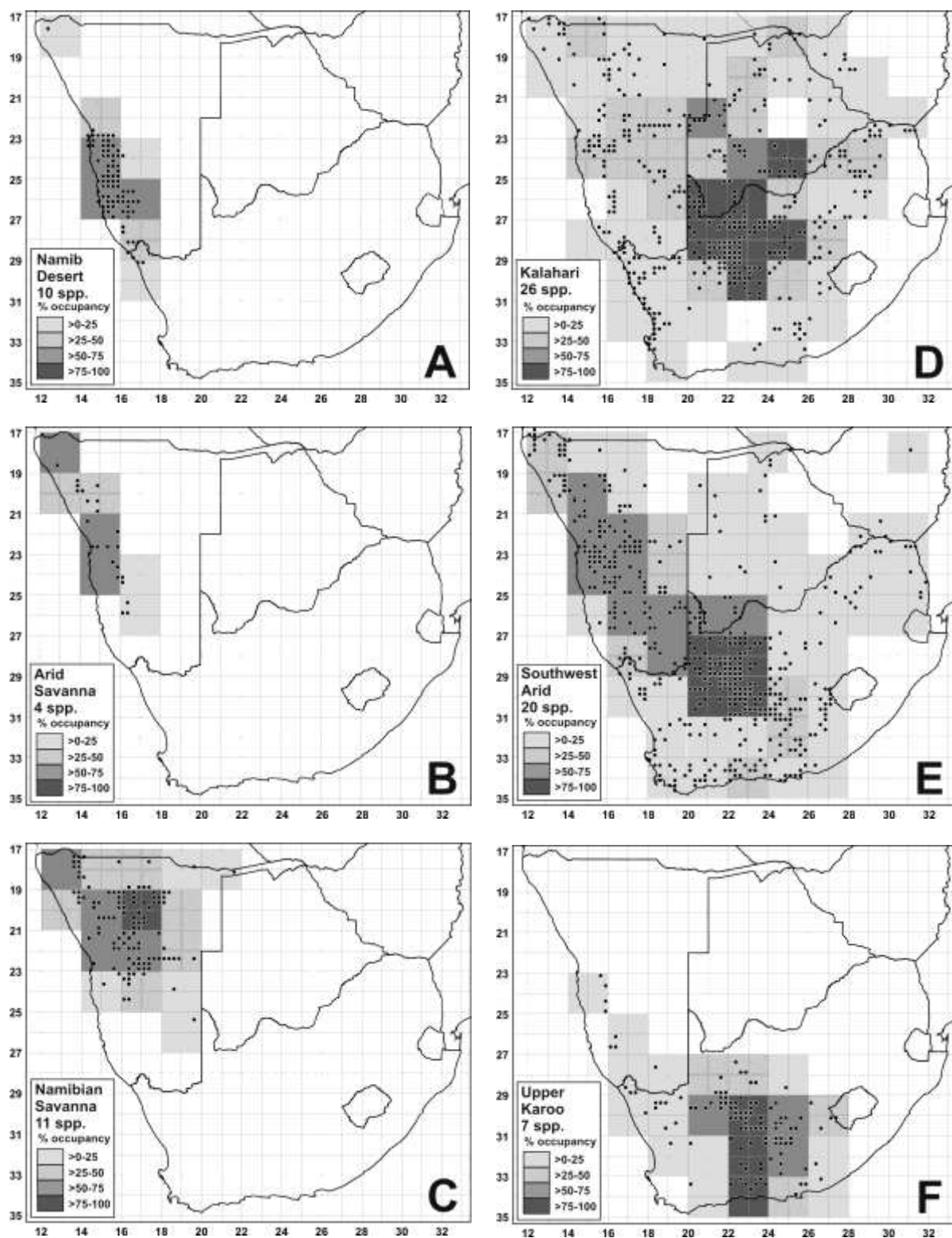


See Table S3. Subregions in East Coast region with species identity numbers.

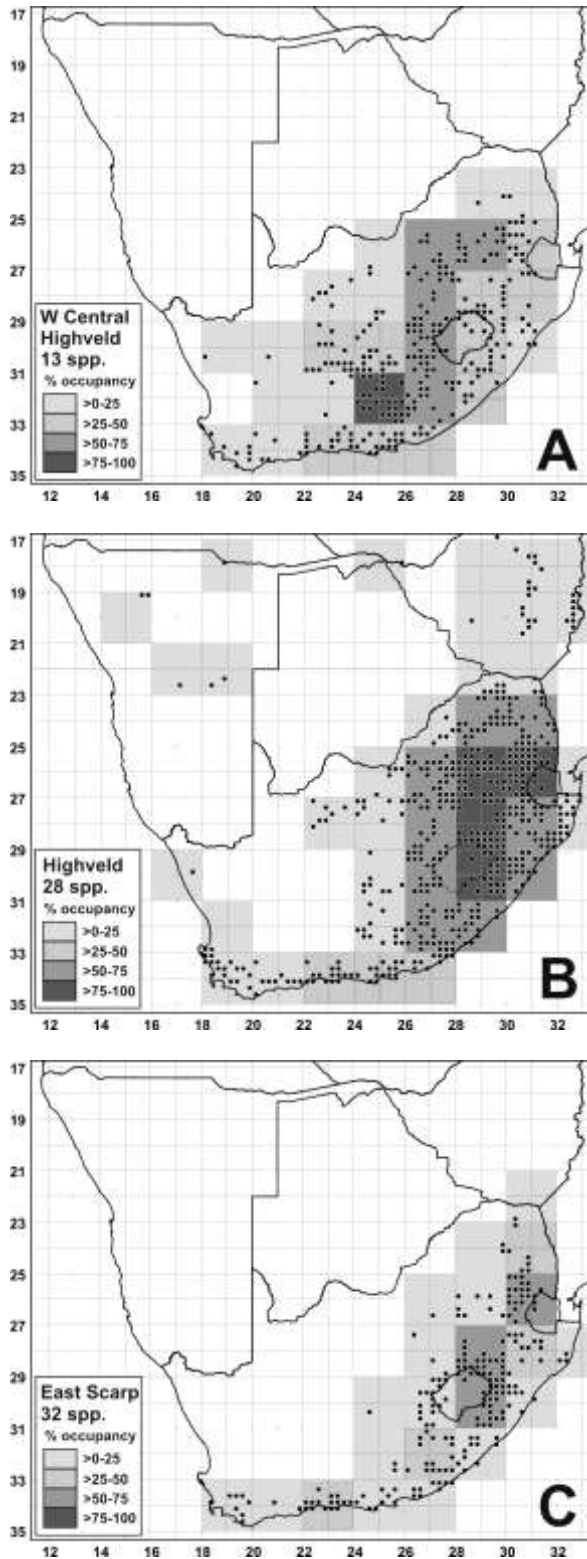
Supplementary Figure 2. NMDS ordination biplots (see Fig. 5) with species identity numbers added to data points (see Supplementary Table S3 for key).



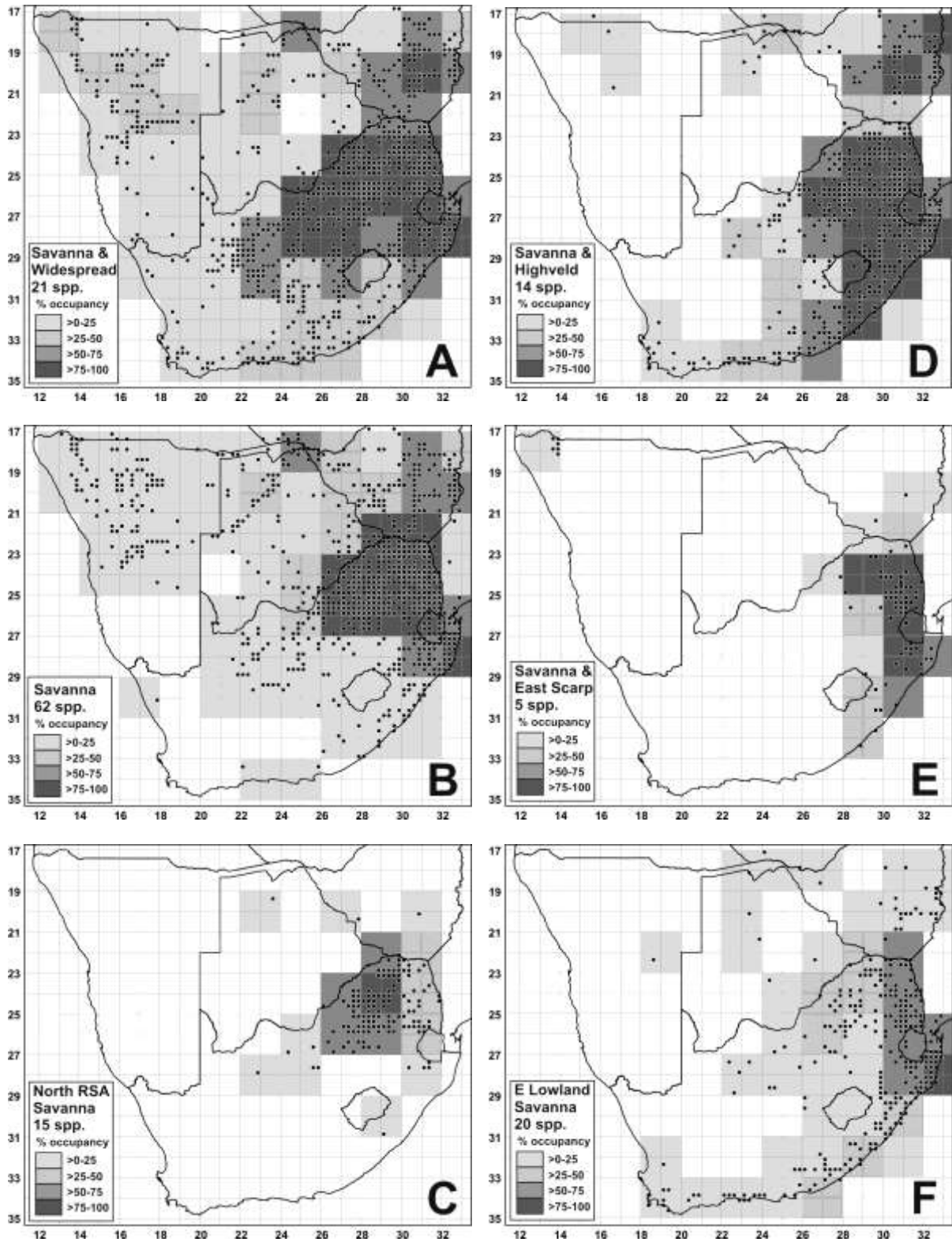
Supplementary Figure 3. Range and distribution centres of dung beetle species in five of six subregions defined for the Winter & Bimodal rainfall region.



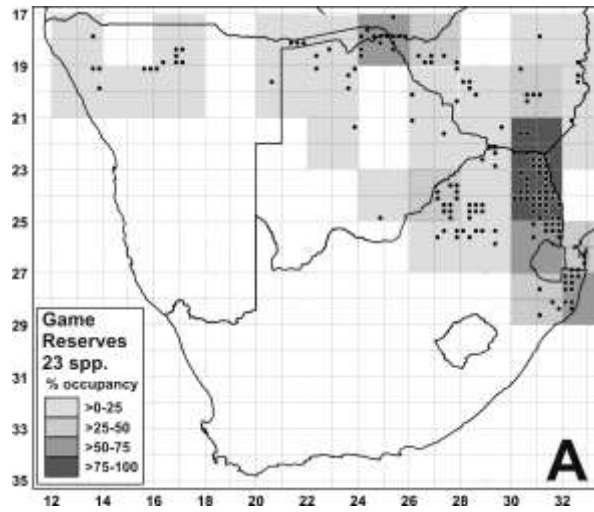
Supplementary Figure 4. Range and distribution centres of dung beetle species in six of seven subregions defined for the Southwest Arid region.



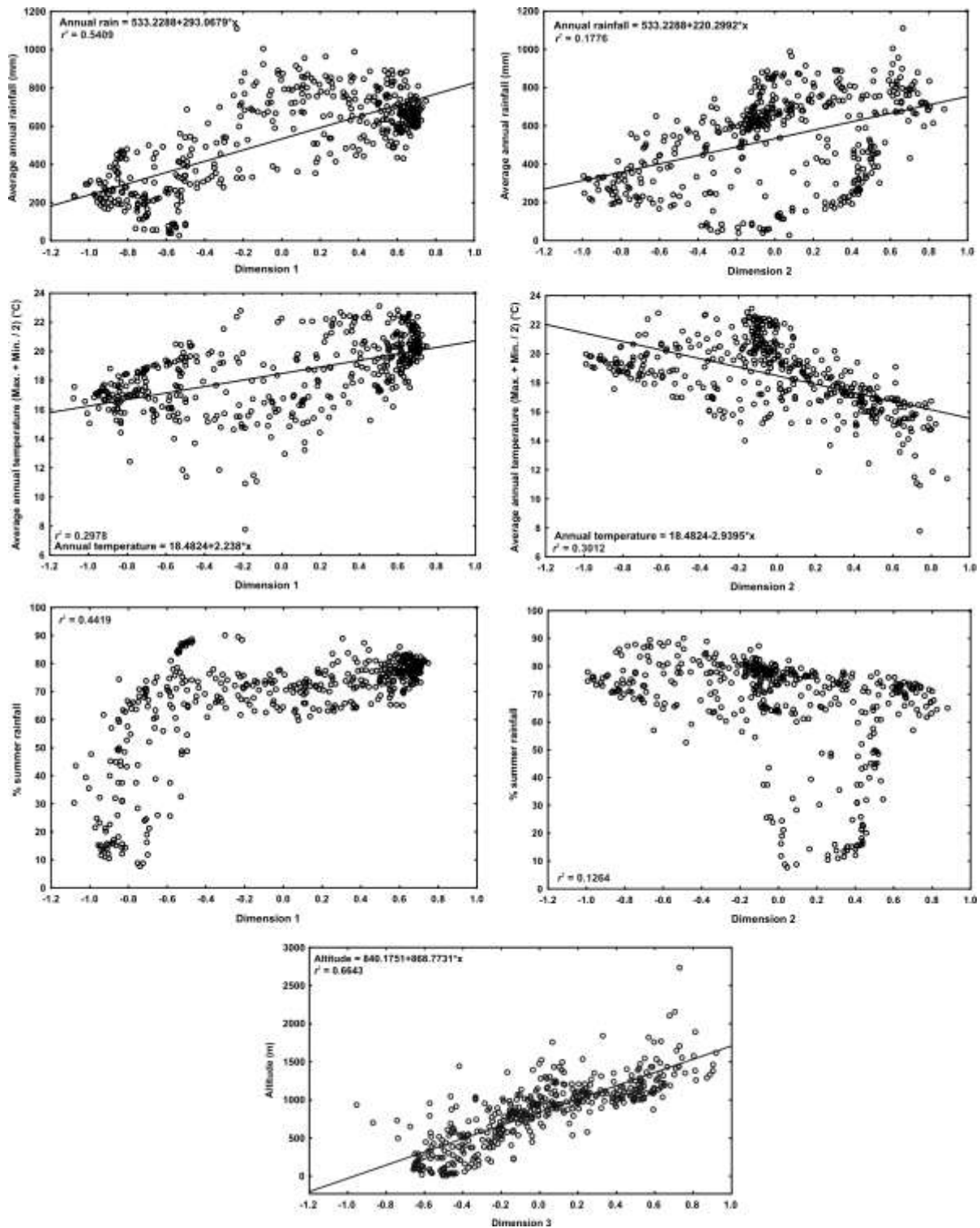
Supplementary Figure 5. Range and distribution centres of dung beetle species in three of five subregions defined for the Southeast Highland region.



Supplementary Figure 6. Range and distribution centres of dung beetle species in six of nine subregions defined for the Savanna region.



Supplementary Figure 7. Range and distribution centres of dung beetle species in the game reserve subregion of the Savanna region.



Supplementary Figure 8. Scatter plots and results for regression of significant environmental variables (Spearman $r > 0.4$ in Table 1) on values for the first three dimensions yielded by NMDS ordination of subcontinental distribution data for 437 dung beetle species.

Supplementary Table S1 Number of validated species in nine tribes of dung beetles (*polyphyletic) recorded in South Africa, Botswana and Namibia, proportions in four categories of range size and number of species deleted from the NMDS analysis of distribution patterns due to doubtful taxonomic status[^] or limited data^{^^}.

Tribe	% species showing range (km ²)				Total N	Pattern bias based on values >30%
	0-2x10 ⁴	2x10 ⁴ -10 ⁵	10 ⁵ -10 ⁶	>10 ⁶		
Ateuchini*	42.9	14.3	32.1	10.7	28	Bimodal small & large ranges
Canthonini*	76.8	15.9	4.9	2.4	82	Unimodal very small ranges
Coprini*	33.3	10.7	39.3	16.7	84	Bimodal small & large ranges
Gymnopleurini	5.6	5.6	66.7	22.2	18	Unimodal large ranges
Onitini	20.5	11.4	47.7	20.5	44	Unimodal large ranges
Oniticellini	0.0	3.8	38.5	57.7	26	Unimodal very large ranges
Onthophagini	4.4	18.5	47.4	29.6	135	Unimodal large ranges
Scarabaeini	41.1	16.7	33.3	18.9	90	Bimodal small & large ranges
Sisyphini	16.0	28.0	40.0	16.0	25	Unimodal large ranges
Total N spp.	160	80	193	99	532 [^]	[^] 9 of original 541 spp. deleted
Deleted NMDS	40	10	29	16	95 ^{^^}	^{^^} 95 of 532 spp. deleted = 437 spp. retained for NMDS analysis

Supplementary Table S2 Key to genera in Figure 3 (*^NGenera in groups 8-12 with Winter Rainfall spp.;
^N = number of species).

Tribe	ID No.	Genus	Total spp.	Tribe	ID No.	Genus	Total spp.
Group 1				Group 10			
Scarabaeini	62	<i>Pachysoma</i>	13	Scarabaeini	65	<i>Sceliages</i> * ¹	4
Group 2				Group 11			
Canthonini	6	<i>Aphengoecus</i>	1	Gymnopleurini	28	<i>Garreta</i>	4
Canthonini	7	<i>Bohepilissus</i>	1	Onthophagini	55	<i>Mimonthophagus</i>	3
Canthonini	8	<i>Byrrhidium</i>	2				
Canthonini	10	<i>Circellium</i>	1	Group 12			
Canthonini	11	<i>Dicranocara</i>	2	Canthonini	17	<i>Hammondantus</i>	1
Coprini	23	<i>Macroderes</i>	13	Canthonini	18	<i>Namaphilus</i>	1
				Canthonini	19	<i>Pycnpanelus</i>	1
Group 3				Coprini	25	<i>Metacatharsius</i>	7
Canthonini	13	<i>Epirinus</i>	25	Gymnopleurini	29	<i>Gymnopleurus</i>	9
Canthonini	15	<i>Odontoloma</i>	12	Onitini	30	<i>Cheironitis</i>	5
				Onthophagini	49	<i>Digitonthophagus</i>	3
Group 4				Onthophagini	50	<i>Euonthophagus</i>	4
Ateuchini	3	<i>Frankenbergerius</i>	4	Onthophagini	51	<i>Hamonthophagus</i>	2
				Onthophagini	53	<i>Kurtops</i>	2
Group 5				Onthophagini	57	<i>Phalops</i>	12
Canthonini	12	<i>Endroedyolus</i>	1	Scarabaeini	59	<i>Escarabaeus</i>	2
Canthonini	16	<i>Peckolus</i>	2	Scarabaeini	61	<i>Pachylomera</i>	2
Coprini	24	<i>Litocoprini</i>	1	Scarabaeini	63	<i>Scarabaeolus</i> * ²	24
Coprini	26	<i>Xinidium</i>	3				
Onitini	32	<i>Kolbellus</i>	1				
Oniticellini	36	<i>Cyptochirus</i>	1				
Oniticellini	44	<i>Tibiodrepanus</i>	1				
Group 6							
Canthonini	14	<i>Gyronotus</i>	4				
Group 7							
Onitini	34	<i>Tropidonitis</i>	1				
Group 8							
Ateuchini	5	<i>Sarophorus</i> * ²	5				
Group 9							
Ateuchini	1	<i>Coptorhina</i>	3				
Ateuchini	2	<i>Delopleurus</i>	1				
Ateuchini	4	<i>Pedaria</i>	3				
Canthonini	9	<i>Chalconotus</i>	1				
Coprini	22	<i>Heliocoprini</i>	7				
Gymnopleurini	27	<i>Allogymnopleurus</i>	2				
Onitini	31	<i>Heteronitis</i>	1				
Oniticellini	35	<i>Afrodrepanus</i>	1				
Oniticellini	37	<i>Drepanocerus</i>	2				
Oniticellini	38	<i>Eodrepanus</i>	1				
Oniticellini	39	<i>Epidrepanus</i>	1				
Oniticellini	41	<i>Latodrepanus</i>	1				
Oniticellini	42	<i>Liatongus</i>	1				
Oniticellini	45	<i>Tiniocellus</i>	2				
Oniticellini	46	<i>Tragiscus</i>	1				
Onthophagini	48	<i>Cleptocaccobius</i>	2				
Onthophagini	52	<i>Hyalonthophagus</i>	1				
Onthophagini	54	<i>Milichus</i>	1				
Coprini	20	<i>Catharsius</i>	14				
Coprini	21	<i>Copris</i> * ⁵	31				

Onitini	33	<i>Onitis</i> *2	24				
Oniticellini	40	<i>Euoniticellus</i>	4				
Oniticellini	43	<i>Oniticellus</i>	4				
Onthophagini	47	<i>Caccobius</i>	5				
Onthophagini	56	<i>Onthophagus</i> *6	70				
Onthophagini	58	<i>Proagoderus</i>	11				
Scarabaeini	60	<i>Kheper</i> *1	9				
Scarabaeini	64	<i>Scarabaeus</i> *7	29				
Sisyphini	66	<i>Neosisyphus</i> *1	11				
Sisyphini	67	<i>Sisyphus</i> *1	13				

Supplementary Table S3 Identity number, EOO and range in species groups defined by ordination analyses.

Identity Number	Extent Of Occurrence (EOO) km ²	N 1/16th Degree Squares	NMDS ordination analyses Species groups distribution centres Region: Subregion
			Southwest Arid: Namib Desert
43	13,600	6	<i>Hammondantus psammophilus</i> Cambefort, 1978
80	8,250	9	<i>Pachysoma fitzsimonsi</i> Ferreira, 1953
84	9,500	14	<i>Pachysoma rotundigena</i> Felsche, 1907
85	1,400	5	<i>Pachysoma schinzi</i> Fairmaire, 1888
87	200	2	<i>Pachysoma valeflorae</i> Ferreira, 1953
94	910	2	<i>Scarabaeolus canaliculatus</i> (Fairmaire, 1888)
172	40,000	40	<i>Pachysoma denticolle</i> Péringuey, 1888
173	24,000	23	<i>Pachysoma rodriguesi</i> (Ferreira, 1953)
181	27,000	9	<i>Scarabaeolus namibensis</i> (Zidek & Pokorný, 2018)
183	55,500	27	<i>Scarabaeolus rubripennis</i> (Boheman, 1860)
			Southwest Arid: Northeast Botswana Savanna
60	2,790	3	<i>Mimonthophagus limbibasis</i> (d'Orbigny, 1905)
			Southwest Arid: North Namibian Savanna
73	10,885	8	<i>Onthophagus bayeri</i> Balthasar, 1942
117	18,600	2	<i>Sisyphus splendidus</i> Montreuil, 2015
128	49,485	15	<i>Copris laioides</i> Boucomont, 1832
174	66,480	11	<i>Phalops pauliani</i> Barbero, Palestrini & Roggero, 2003
211	168,350	42	<i>Copris gracilis</i> Waterhouse, 1891
215	105,070	45	<i>Copris subsidens</i> Péringuey, 1901
222	419,910	27	<i>Digitonthophagus viridicollis</i> Génier, 2017
270	157,030	17	<i>Onitis obscurus</i> van Lansberge, 1886
281	393,675	14	<i>Onthophagus axillaris</i> Boheman, 1860
315	115,340	27	<i>Phalops prasinus</i> (Erichson, 1843)
376	4,761,275	18	<i>Garreta nitens</i> (Olivier, 1789)
			Southwest Arid: Southwest Kalahari
45	6,000	5	<i>Kheper kalaharicus</i> (Davis, Deschodt & Scholtz, 2011)
93	9,250	3	<i>Scarabaeolus afronitidus</i> Davis, Stals & Deschodt, 2015
95	4,285	3	<i>Scarabaeolus carniphilus</i> (Davis & Deschodt, 2015)
194	639,850	92	<i>Catharsius calaharicus</i> Kolbe, 1893
196	970,820	29	<i>Catharsius melancholicus</i> Boheman, 1860
206	547,290	64	<i>Copris cassius</i> Péringuey, 1901
207	286,300	32	<i>Copris cornifrons</i> Boheman, 1860
231	211,965	56	<i>Euonthophagus flavimargo</i> (d'Orbigny, 1902)
250	799,195	68	<i>Kurtops quadraticeps</i> (Harold, 1867)
251	255,955	25	<i>Metacatharsius anderseni</i> (Waterhouse, 1891)
252	471,130	96	<i>Metacatharsius exiguiformis</i> (Ferreira, 1964)
254	322,620	59	<i>Metacatharsius latifrons</i> (Harold, 1868)
296	587,600	27	<i>Onthophagus leucopygus</i> Harold, 1867
309	800,000	48	<i>Pachylomera opaca</i> van Lansberge, 1874
317	591,895	64	<i>Phalops rufosignatus</i> van Lansberge, 1885
324	627,900	44	<i>Scarabaeolus anderseni</i> (Waterhouse, 1890))
325	952,000	62	<i>Scarabaeolus damarensis</i> (Janssens, 1940)
326	844,500	113	<i>Scarabaeolus flavicornis</i> (Boheman, 1860)
328	510,500	43	<i>Scarabaeolus inoportunus</i> (Ferreira, 1953)
329	446,500	21	<i>Scarabaeolus inquisitus</i> (Péringuey, 1908)
331	430,000	34	<i>Scarabaeolus kochi</i> (Ferreira, 1952)
336	298,810	44	<i>Scarabaeus costatus</i> (Wiedemann, 1823)
342	502,100	129	<i>Scarabaeus proboscideus</i> (Guérin-Meneville, 1844)
408	1,080,205	71	<i>Onthophagus granulifer</i> Harold, 1886
417	1,414,010	113	<i>Onthophagus venustus</i> Erichson, 1843
425	1,562,330	154	<i>Phalops wittei</i> (Harold, 1867)

ID no.	EOO km ²	N 1/16th	NMDS groups
			Southwest Arid: Arid Savanna
61	280	2	<i>Namaphilus endroedyi</i> (Deschodt, Davis & Scholtz, 2011)
104	18,345	5	<i>Scarabaeus cognatus</i> Péringuey, 1901
175	39,635	14	<i>Phalops plancus</i> Erichson, 1843
295	102,535	15	<i>Onthophagus gonopygus</i> d'Orbigny, 1902
			Southwest Arid: Southwest Arid
199	208,930	57	<i>Cheironitis audens</i> (Péringuey, 1901)
202	113,785	33	<i>Cheironitis indicus</i> van Lansberge, 1875
203	478,375	118	<i>Cheironitis scabrosus</i> (Fabricius, 1776)
221	795,870	54	<i>Digitonthophagus namaquensis</i> Génier, 2017
235	263,705	74	<i>Gymnopleurus andreaei</i> Ferreira, 1954
236	223,500	80	<i>Gymnopleurus asperrimus</i> Felsche, 1909
237	587,750	192	<i>Gymnopleurus humanus</i> Macleay, 1821
243	390,575	40	<i>Hamonthophagus acutus</i> (d'Orbigny, 1908)
255	312,390	112	<i>Metacatharsius marani</i> (Balthasar, 1940)
265	756,700	119	<i>Onitis aygulus</i> (Fabricius, 1781)
286	988,530	86	<i>Onthophagus convexus</i> d'Orbigny, 1908
304	830,525	100	<i>Onthophagus probus</i> Péringuey, 1901
306	226,630	71	<i>Onthophagus semiflavus</i> Boheman, 1860
316	122,540	35	<i>Phalops pyroides</i> (d'Orbigny, 1908)
322	264,500	61	<i>Pycnopanelus krikkeni</i> Cambefort, 1978
330	359,300	25	<i>Scarabaeolus karrooensis</i> (zur Strassen, 1961)
332	247,150	26	<i>Scarabaeolus pabulator</i> (Péringuey, 1908)
333	398,100	67	<i>Scarabaeolus parvulus</i> (Boheman, 1860)
345	791,785	53	<i>Scarabaeus vicinus</i> Janssens, 1940
373	1,491,750	206	<i>Escarabaeus satyrus</i> (Boheman, 1860)
			Southwest Arid: Upper Karoo
136	98,000	33	<i>Epirinus striatus</i> Scholtz & Howden, 1987
139	97,405	36	<i>Euonthophagus vicarius</i> (Péringuey, 1901)
182	59,650	26	<i>Scarabaeolus megaparvulus</i> (Davis & Deschodt, 2015)
278	126,235	47	<i>Onthophagus albipennis</i> Péringuey, 1908
308	219,865	58	<i>Onthophagus peringueyi</i> Shipp, 1895
327	110,000	36	<i>Scarabaeolus fritschi</i> (Harold, 1868)
344	288,635	69	<i>Scarabaeus viator</i> Péringuey, 1901
			Winter & Bimodal Rainfall Region: Namaqualand
3	163	3	<i>Byrrhidium convexum</i> Scholtz & Howden, 1987
4	2,370	5	<i>Byrrhidium ovale</i> Harold, 1869
18	190	2	<i>Dicranocara deschodti</i> Frolov & Scholtz, 2003
19	300	2	<i>Dicranocara vandermisseni</i> Moretto, 2016
48	1,170	3	<i>Macroderes amplior</i> Frolov & Scholtz, 2004
49	2,605	4	<i>Macroderes cornutus</i> Frolov & Scholtz, 2004
55	1,501	4	<i>Macroderes mutilans</i> Kolbe, 1908
56	53	4	<i>Macroderes namakwanus</i> Frolov & Scholtz, 2004
78	8,500	18	<i>Pachysoma bennigseni</i> Felsche, 1907
81	17,650	32	<i>Pachysoma gariepinum</i> Ferreira, 1953
86	6,000	23	<i>Pachysoma striatum</i> Castelnau, 1840
102	18,000	3	<i>Scarabaeus alienus</i> Péringuey, 1901
106	3,335	4	<i>Scarabaeus hottentorum</i> Péringuey, 1901
108	16,030	16	<i>Scarabaeus proximus</i> Péringuey, 1901
			Winter & Bimodal Rainfall Region: West Coast
26	3,400	8	<i>Epirinus granulatus</i> Scholtz & Howden, 1987
33	15,275	17	<i>Epirinus scrobiculatus</i> Harold, 1880
83	8,500	29	<i>Pachysoma hippocrates</i> Macleay, 1821
100	12,500	24	<i>Scarabaeolus reichei</i> (Waterhouse, 1890)
109	11,000	33	<i>Scarabaeus rugosus</i> (Hausmann, 1807)

112	6,180	12	<i>Sceliages brittoni</i> zur Strassen, 1965
126	45,395	31	<i>Copris capensis</i> Waterhouse, 1891
141	25,000	23	<i>Kheper bonellii</i> (Macleay, 1821)
180	48,000	42	<i>Scarabaeolus intricatus</i> (Fabricius, 1801)
ID no.	EOO km²	N 1/16th	NMDS groups
			Winter & Bimodal Rainfall Region: Southwest Cape
2	3,700	10	<i>Aphengoecus multiserratus</i> Scholtz & Howden, 1987
10	7,625	21	<i>Copris anceus</i> (Olivier, 1789)
22	2,700	7	<i>Epirinus bento</i> Ferreira, 1964
30	230	2	<i>Epirinus pseudorugosus</i> Medina & Scholtz, 2005
37	2,995	4	<i>Frankenbergerius nanus</i> (Péringuey, 1888)
50	2,775	7	<i>Macroderes endroedyi</i> Frolov & Scholtz, 2004
51	535	2	<i>Macroderes fornicatus</i> Sharp, 1880
52	105	2	<i>Macroderes foveatus</i> Frolov & Scholtz, 2004
53	1,535	4	<i>Macroderes greeni</i> (Kirby, 1818)
54	5,045	8	<i>Macroderes minutus</i> Frolov & Scholtz, 2004
57	80	2	<i>Macroderes nitidus</i> Harold, 1877
58	7,940	6	<i>Macroderes politulus</i> Preudhomme de Borre, 1880
59	2,300	4	<i>Macroderes undulatus</i> Preudhomme de Borre, 1880
68	1,685	4	<i>Odontoloma pusillum</i> Howden & Scholtz, 1987
74	180	2	<i>Onthophagus cineraceus</i> d'Orbigny, 1902
77	10,750	15	<i>Pachysoma aesculapius</i> (Olivier, 1789)
79	130	2	<i>Pachysoma endroedyi</i> (Harrison, Scholtz & Chown, 2003)
82	700	3	<i>Pachysoma glentoni</i> (Harrison, Scholtz & Chown, 2003)
107	3,305	5	<i>Scarabaeus piliventris</i> zur Strassen, 1962
132	27,500	12	<i>Epirinus comosus</i> Péringuey, 1901
147	52,460	16	<i>Odontoloma dentinum</i> (Harold, 1868)
148	43,165	9	<i>Odontoloma disalatum</i> Howden & Scholtz, 1987
150	71,165	33	<i>Odontoloma pygidiale</i> Péringuey, 1901
164	44,485	30	<i>Onthophagus minutus</i> (Hausmann, 1807)
187	23,250	24	<i>Scarabaeus suri</i> (Hausmann, 1807)
			Winter & Bimodal Rainfall Region: Cape & Karoo
224	258,000	73	<i>Epirinus flagellatus</i> (Fabricius, 1775)
226	335,500	82	<i>Epirinus aeneus</i> (Wiedemann, 1823)
267	529,675	25	<i>Onitis confusus</i> Boheman, 1860
284	241,800	70	<i>Onthophagus camelooides</i> d'Orbigny, 1898
			Winter & Bimodal Rainfall Region: South Cape
9	11,950	20	<i>Circellium bacchus</i> (Fabricius, 1781)
12	9,990	5	<i>Copris jacchus</i> Fabricius, 1775
14	3,945	3	<i>Copris sexdentatus</i> Thunberg, 1818
16	2,100	4	<i>Copris victorini</i> Boheman, 1857
27	1,130	2	<i>Epirinus minimus</i> Medina & Scholtz, 2005
28	1,750	3	<i>Epirinus montanus</i> Scholtz & Howden, 1987
34	1,175	8	<i>Epirinus silvestris</i> (Cambefort, 1978)
92	6,740	8	<i>Sarophorus striatus</i> Frolov & Scholtz, 2003
116	9,685	4	<i>Sisyphus perissinottoi</i> Montreuil, 2015
123	38,100	15	<i>Bohepilissus subtilis</i> (Boheman, 1857)
134	29,550	14	<i>Epirinus hilaris</i> Péringuey, 1901
146	25,800	7	<i>Neosisyphus quadricollis</i> (Gory, 1833)
149	45,810	10	<i>Odontoloma endroedyi</i> Howden & Scholtz, 1987
152	70,125	11	<i>Onitis minutus</i> van Lansberge, 1875
160	59,495	35	<i>Onthophagus giraffa</i> (Hausmann, 1807)
162	26,615	10	<i>Onthophagus immundus</i> Boheman, 1858
178	46,695	14	<i>Sarophorus tuberculatus</i> (Castelnau, 1840)
186	31,775	7	<i>Scarabaeus savignyi</i> Macleay, 1821
			Winter & Bimodal Rainfall Region: Southeast Cape
21	130	2	<i>Epirinus aquilus</i> Medina & Scholtz, 2005
63	905	2	<i>Odontoloma apiculum</i> Howden & Scholtz, 1987
76	1,725	2	<i>Onthophagus scapularis</i> d'Orbigny, 1902

ID no.	EOO km ²	N 1/16th	NMDS groups
Southeast Highlands: West Highveld, Upper Karoo, North Namibia			
200	651,685	85	<i>Cheironitis hoplosternus</i> (Harold, 1868)
262	239,965	70	<i>Neosisyphus macrorubrus</i> (Paschalidis, 1974)
431	1,063,280	160	<i>Scarabaeolus bohemani</i> (Harold, 1868)
Southeast Highlands: Highveld			
7	6,130	9	<i>Catharsius longiceps</i> Gillet, 1907
29	170	2	<i>Epirinus mucrodentatus</i> Scholtz & Howden, 1987
66	19,885	12	<i>Odontoloma peckorum</i> (Howden & Scholtz, 1987)
97	3,080	3	<i>Scarabaeus karae</i> Davis & Deschodt, 2017
140	65,575	26	<i>Frankenbergerius armatus</i> (Boheman, 1857)
154	96,210	47	<i>Onitis perpunctatus</i> Balthasar, 1963
155	65,350	11	<i>Onthophagus absyrtus</i> Balthasar, 1946
163	96,245	29	<i>Onthophagus lamnifer</i> d'Orbigny, 1902
166	89,365	29	<i>Onthophagus obtutus</i> Péringuey, 1901
188	31,865	60	<i>Sisyphus caffer</i> Boheman, 1857
192	781,120	58	<i>Caccobius obtusus</i> (Fahraeus, 1857)
195	126,300	32	<i>Catharsius marcellus</i> Kolbe, 1893
208	318,935	79	<i>Copris corniger</i> Sahlberg, 1823
212	258,970	42	<i>Copris jacchoides</i> Nguyen-Phung & Cambefort, 1987
219	323,350	84	<i>Cyptochirus ambiguus</i> (Kirby, 1828)
264	131,510	33	<i>Oniticellus pictus</i> (Hausmann, 1807)
266	576,190	212	<i>Onitis caffer</i> Boheman, 1857
272	198,180	85	<i>Onitis pecuarius</i> van Lansberge, 1875
275	348,320	152	<i>Onitis tortuosus</i> Houston, 1983
280	170,285	89	<i>Onthophagus asperulus</i> d'Orbigny, 1905
285	217,320	29	<i>Onthophagus cinctipennis</i> Quedenfeldt, 1884
297	251,810	69	<i>Onthophagus interstitialis</i> Fahraeus, 1857
303	156,440	36	<i>Onthophagus pilosus</i> Fahraeus, 1857
320	300,285	56	<i>Proagoderus lanista</i> (Castelnau, 1840)
349	142,520	37	<i>Sisyphus costatus</i> (Thunberg, 1818)
353	107,815	67	<i>Xinidium dentilabris</i> Harold, 1869
368	1,252,590	99	<i>Copris obesus</i> Boheman, 1857
375	2,234,985	134	<i>Euoniticellus triangulatus</i> (Harold, 1873)
Southeast Highlands: East Scarp			
17	5,085	4	<i>Copris vrydaghi</i> Ferreira, 1962
20	80	2	<i>Endroedyolus paradoxus</i> Scholtz & Howden, 1987
25	80	2	<i>Epirinus drakomontanus</i> Scholtz & Howden, 1987
31	17,500	5	<i>Epirinus punctatus</i> Scholtz & Howden, 1987
32	7,810	3	<i>Epirinus pygidialis</i> Scholtz & Howden, 1987
35	16,485	7	<i>Frankenbergerius barratti</i> (Waterhouse, 1876)
42	83	2	<i>Gyronotus schuelei</i> Morett, 2013
64	13,375	6	<i>Odontoloma doubei</i> Howden & Scholtz, 1987
65	8,020	4	<i>Odontoloma obscurum</i> Howden & Scholtz, 1987
67	14,615	6	<i>Odontoloma planatum</i> Howden & Scholtz, 1987
70	265	3	<i>Onitis cribratus</i> van Lansberge, 1875
88	15	2	<i>Peckolus alpinus</i> Howden & Scholtz, 1988
89	85	2	<i>Peckolus poenskopius</i> Deschodt & Scholtz, 2008
90	755	2	<i>Sarophorus carinatus</i> Frolov & Scholtz, 2003
111	18,000	6	<i>Scarabaeus westwoodi</i> Harold, 1869
119	5,990	4	<i>Xinidium dewitzi</i> (Harold, 1878)
120	20	2	<i>Xinidium howdeni</i> Cambefort, 1993
125	91,950	34	<i>Copris caelatus</i> (Fabricius, 1794)
127	41,240	8	<i>Copris crassus</i> Deschodt & Davis, 2015
131	40,500	16	<i>Epirinus asper</i> Péringuey, 1901
135	50,250	9	<i>Epirinus relictus</i> Scholtz & Howden, 1987
137	52,550	21	<i>Epirinus validus</i> Péringuey, 1901
142	85,760	32	<i>Litocopris simplex</i> (Harold, 1868)
144	27,150	20	<i>Neosisyphus barbarossa</i> (Wiedemann, 1823)
145	30,620	7	<i>Neosisyphus kuehni</i> (Haaf, 1955)

151	64,415	7	<i>Odontoloma sculpturatum</i> (Harold, 1868)
161	38,760	31	<i>Onthophagus hyaena</i> (Fabricius, 1801)
171	61,695	31	<i>Onthophagus vigens</i> Péringuey, 1901
190	24,500	23	<i>Sisyphus muricatus</i> (Olivier, 1789)
282	274,485	115	<i>Onthophagus binodis</i> (Thunberg, 1818)
300	180,110	40	<i>Onthophagus lugubris</i> Fahraeus, 1857
435	5,683,200	29	<i>Tibiodrepanus sulcicollis</i> (Castelnau, 1840)
ID no.	EOO km²	N 1/16th	NMDS groups
			Southeast Highlands: West Central Highveld
47	1,395	2	<i>Kolbeellus ateuchoides</i> (van Lansberge, 1875)
71	105	2	<i>Onitis licitus</i> Péringuey, 1901
124	92,235	26	<i>Catharsius vitulus</i> Boheman, 1857
143	40,815	9	<i>Macroderes bias</i> (Olivier 1789)
204	269,985	53	<i>Copris antares</i> Ferreira, 1958
227	106,900	23	<i>Epirinus obtusus</i> Boheman, 1857
228	677,390	156	<i>Euoniticellus africanus</i> (Harold, 1873)
240	256,000	49	<i>Gymnopleurus leei</i> (Fabricius, 1792)
268	150,365	14	<i>Onitis curvipes</i> van Lansberge, 1875
290	181,630	28	<i>Onthophagus cyaneoniger</i> d'Orbigny, 1902
293	174,610	58	<i>Onthophagus fritschi</i> d'Orbigny, 1902
313	355,495	79	<i>Phalops bubalus</i> (Harold, 1867)
335	134,360	42	<i>Scarabaeus basuto</i> zur Strassen, 1962
			Southeast Highlands: West Highveld
133	74,300	17	<i>Epirinus gratus</i> Péringuey, 1901
			Savanna: Savanna & East Scarp
36	18,695	12	<i>Frankenbergerius gomesi</i> (Ferreira, 1954)
158	26,645	10	<i>Onthophagus cupricollis</i> Péringuey, 1888
184	70,500	22	<i>Scarabaeus caffer</i> (Boheman, 1857)
189	50,820	24	<i>Sisyphus fasciculatus</i> Boheman, 1857
363	1,295,810	37	<i>Cleptocaccobius postlutatus</i> (d'Orbigny, 1905)
			Savanna: Savanna & Highveld
129	65,380	27	<i>Copris macer</i> Péringuey, 1901
225	160,840	20	<i>Epidrepanus caelatus</i> (Gerstaecker, 1871)
233	209,670	77	<i>Garreta unicolor</i> (Fahraeus, 1857)
259	118,955	34	<i>Neosisyphus confrater</i> (Kolbe, 1914)
263	720,705	214	<i>Neosisyphus rubrus</i> (Paschalidis, 1974)
288	206,820	94	<i>Onthophagus cribripennis</i> d'Orbigny, 1902
319	232,570	93	<i>Proagoderus chalcostolus</i> (d'Orbigny, 1902)
350	124,410	37	<i>Sisyphus manni</i> Montreuil, 2015
361	1,064,120	150	<i>Catharsius tricornutus</i> (DeGeer, 1778)
371	3,526,325	84	<i>Drepanocerus kirbyi</i> Kirby, 1828
372	1,517,320	50	<i>Eodrepanus fastiditus</i> (Péringuey, 1901)
389	3,632,435	228	<i>Liatongus militaris</i> (Castelnau, 1840)
396	4,837,160	138	<i>Oniticellus planatus</i> Castelnau, 1840
411	2,391,165	72	<i>Onthophagus parumnotatus</i> Fahraeus, 1857
			Savanna: Savanna & Widespread
13	18,840	9	<i>Copris ritsemiae</i> Harold, 1875
223	503,040	36	<i>Drepanocerus patrizii</i> (Boucomont, 1923)
242	267,770	79	<i>Gymnopleurus virens</i> Erichson, 1843
247	236,025	52	<i>Heliocopris pirmal</i> (Fabricius, 1798)
271	116,085	12	<i>Onitis parainflaticollis</i> Ferreira, 1977
291	847,490	78	<i>Tiaronthophagus ebenus</i> (Péringuey, 1888)
301	418,675	126	<i>Onthophagus obtusicornis</i> Fahraeus, 1857
314	500,430	111	<i>Phalops dregei</i> (Harold, 1867)
334	371,530	78	<i>Scarabaeus ambiguus</i> (Boheman, 1857)
339	104,390	18	<i>Scarabaeus funebris</i> (Boheman, 1857)
347	214,130	35	<i>Sceliages difficilis</i> zur Strassen, 1965
360	5,293,770	72	<i>Catharsius sesostris</i> Waterhouse, 1888

364	1,627,025	99	<i>Cleptocaccobius viridicollis</i> (Fahraeus, 1857)
370	3,711,400	278	<i>Digitonthophagus gazella</i> (Fabricius, 1787) <i>auctorum</i>
374	9,060,360	381	<i>Euoniticellus intermedius</i> (Reiche, 1849)
378	3,715,845	84	<i>Heliocopris andersoni</i> Bates, 1868
380	3,416,220	117	<i>Heliocopris hamadryas</i> (Fabricius, 1775)
397	9,990,325	382	<i>Onitis alexis</i> Klug, 1835
403	4,968,210	154	<i>Onthophagus aeruginosus</i> Roth, 1851
407	5,546,895	142	<i>Onthophagus fimetarius</i> Roth, 1851
413	4,391,285	81	<i>Onthophagus pugionatus</i> Fahraeus, 1857
ID no.	EOO km²	N 1/16th	NMDS groups
			Savanna: Savanna
40	1,270	6	<i>Gyronotus glabrosus</i> Scholtz & Howden, 1987
153	59,050	20	<i>Onitis obenbergeri</i> Balthasar, 1942
168	85,445	16	<i>Onthophagus producticollis</i> d'Orbigny, 1908
177	85,690	50	<i>Proagoderus tersidorsis</i> (d'Orbigny, 1902)
179	20,500	9	<i>Scarabaeolus clanceyi</i> (Ferreira, 1954)
193	812,345	43	<i>Catharsius aegaeus</i> Génier, 2017
197	774,500	75	<i>Catharsius philus</i> Kolbe, 1893
209	940,275	138	<i>Copris denticulatus</i> Nguyen-Phung, 1988
213	601,700	123	<i>Copris mesacanthus</i> Harold, 1878
217	898,960	48	<i>Coptorhina auspicata</i> Péringuey, 1901
220	186,855	21	<i>Delopleurus pullus</i> Boheman, 1857
230	946,605	84	<i>Euonthophagus carbonarius</i> (Klug, 1855)
234	737,635	133	<i>Garreta wahlbergi</i> (Fahraeus, 1856)
238	534,260	86	<i>Gymnopleurus humeralis</i> Klug, 1855
241	451,400	96	<i>Gymnopleurus pumilus</i> Reiche, 1850
244	669,355	100	<i>Hamonthophagus depressus</i> (Harold, 1871)
246	328,720	68	<i>Heliocopris neptunus</i> Boheman, 1857
248	232,385	45	<i>Hyalonthophagus alcyonides</i> (d'Orbigny, 1913)
249	662,125	131	<i>Kheper nigroaeneus</i> (Boheman, 1857)
258	712,200	66	<i>Neosisyphus calcaratus</i> (Klug, 1855)
260	154,350	48	<i>Neosisyphus fortuitus</i> (Péringuey, 1901)
269	366,000	82	<i>Onitis fulgidus</i> Klug, 1855
273	327,800	49	<i>Onitis picticollis</i> Boheman, 1857
274	191,355	13	<i>Onitis pseudosetosus</i> Ferreira, 1976
276	944,160	31	<i>Onitis westermanni</i> van Lansberge, 1886
277	245,690	22	<i>Onthophagus aequipubens</i> d'Orbigny, 1905
279	324,950	28	<i>Onthophagus albipodex</i> d'Orbigny, 1902
292	860,785	49	<i>Onthophagus flavolimbatus</i> Klug, 1855
299	228,595	20	<i>Onthophagus leroyi</i> d'Orbigny, 1902
302	316,415	49	<i>Onthophagus pauxillus</i> d'Orbigny, 1902
305	230,805	57	<i>Onthophagus rasipennis</i> d'Orbigny, 1908
310	127,365	18	<i>Pedaria cylindrica</i> Fahraeus, 1857
323	283,960	106	<i>Sarophorus costatus</i> (Fahraeus, 1857)
337	186,900	36	<i>Scarabaeus deludens</i> zur Strassen, 1961
340	699,090	36	<i>Scarabaeus galenus</i> Westwood, 1847
354	123,625	49	<i>Tiniocellus eurypygus</i> Branco, 2010
358	2,013,940	66	<i>Caccobius nigrutilus</i> (Klug, 1855)
362	6,750,790	201	<i>Chalconotus convexus</i> Boheman, 1857
365	1,016,860	159	<i>Copris amyntor</i> Klug, 1855
367	2,357,905	153	<i>Copris evanidus</i> Klug, 1855
369	4,106,325	33	<i>Coptorhina nitidipennis</i> Boheman, 1857
383	1,865,025	50	<i>Kheper cupreus</i> (Castelnau, 1840)
386	1,257,850	53	<i>Kheper subaeneus</i> (Harold, 1869)
388	4,469,700	57	<i>Latodrepanus laticollis</i> (Fahraeus, 1857)
390	3,129,685	134	<i>Metacatharsius opacus</i> (Waterhouse, 1891)
394	2,407,180	30	<i>Oniticellus egregius</i> Klug, 1855
395	4,827,535	69	<i>Oniticellus formosus</i> Chevrolat, 1830
401	4,665,140	228	<i>Onitis uncinatus</i> Klug, 1855
402	4,084,025	125	<i>Onitis viridulus</i> Boheman, 1857
404	2,057,540	23	<i>Onthophagus apiciosus</i> d'Orbigny, 1902
405	4,290,470	110	<i>Onthophagus bicavifrons</i> d'Orbigny, 1902

406	1,691,195	52	<i>Onthophagus ebenicolor</i> d'Orbigny, 1902
409	1,440,975	79	<i>Onthophagus lamelliger</i> Gerstaecker, 1871
414	2,692,290	36	<i>Onthophagus pullus</i> Roth, 1851
416	2,016,665	40	<i>Onthophagus quadrinodosus</i> Fahraeus, 1857
419	8,771,775	216	<i>Onthophagus vinctus</i> Erichson, 1843
421	1,179,470	57	<i>Phalops ardea</i> (Klug, 1855)
422	2,069,530	94	<i>Phalops boschas</i> (Klug, 1855)
423	1,564,855	103	<i>Phalops flavocinctus</i> (Klug, 1855)
424	1,479,555	78	<i>Phalops smaragdinus</i> (Harold, 1875)
433	5,042,590	152	<i>Sisyphus goryi</i> (Castelnau, 1840)
434	2,175,705	46	<i>Sisyphus impressipennis</i> van Lansberge, 1886
ID no.	EOO km²	N 1/16th	NMDS groups
			Savanna: Game Reserves
6	15,750	4	<i>Catharsius laticeps</i> Boheman, 1857 (name incorrect)
72	1,950	2	<i>Onitis paraconfusus</i> Ferreira, 1976
96	3,040	2	<i>Scarabaeolus gracai</i> (Ferreira, 1952)
201	669,950	15	<i>Cheironitis imitator</i> Balthasar, 1963
205	959,800	12	<i>Copris bootes</i> Klug, 1855
216	677,310	33	<i>Copris vilhenai</i> Ferreira, 1962
229	547,830	16	<i>Euoniticellus zumpti</i> Janssens, 1953
232	409,200	12	<i>Euonthophagus jeanneli</i> (d'Orbigny, 1913)
257	658,380	12	<i>Mimonthophagus anomalus</i> (Klug, 1855)
287	145,035	12	<i>Onthophagus corniculiger</i> d'Orbigny, 1913
307	962,255	23	<i>Onthophagus suffusus</i> Klug, 1855
321	847,660	12	<i>Proagoderus rectefurcatus</i> (Fairmaire, 1891)
338	422,865	14	<i>Scarabaeus ebenus</i> (Klug, 1855)
382	3,997,830	54	<i>Heteronitis castelnau</i> (Harold, 1862)
392	7,382,875	22	<i>Milichus apicalis</i> (Fahraeus, 1857)
399	1,704,640	19	<i>Onitis inversidens</i> van Lansberge, 1875
400	2,759,790	30	<i>Onitis mendax</i> Gillet, 1918
412	1,949,910	21	<i>Onthophagus plebejus</i> Klug, 1855
426	3,227,420	40	<i>Proagoderus bicallosus</i> (Klug, 1855)
428	1,895,725	33	<i>Proagoderus loricatus</i> (Klug, 1855)
429	1,303,445	26	<i>Proagoderus rangifer</i> (Klug, 1855)
436	2,951,525	17	<i>Tiniocellus spinipes</i> (Roth, 1851)
437	2,192,230	17	<i>Tragiscus dimidiatus</i> Klug, 1855
			Savanna: North RSA Savanna
11	540	2	<i>Copris cambeforti</i> Nguyen-Phung, 1988
46	1,450	3	<i>Kheper zurstrasseni</i> Davis, 1986
69	15,205	3	<i>Odontoloma quadridens</i> (d'Orbigny, 1908)
91	12,270	4	<i>Sarophorus latus</i> Frolov & Scholtz, 2003
98	4,395	4	<i>Scarabaeolus niemandi</i> (Deschodt & Davis, 2015)
101	5,100	8	<i>Scarabaeolus soutpansbergensis</i> (Deschodt & Davis, 2015)
110	2,500	8	<i>Scarabaeus schulzeae</i> Ferreira, 1969
159	42,255	11	<i>Onthophagus discretus</i> Péringuey, 1901
167	40,975	15	<i>Onthophagus pallax</i> Péringuey, 1901
169	32,470	12	<i>Onthophagus trinodosus</i> Fahraeus, 1857
289	128,590	12	<i>Onthophagus croesus</i> Bates, 1888
294	118,900	16	<i>Onthophagus fugitivus</i> Péringuey, 1901
341	119,975	16	<i>Scarabaeus interstitialis</i> (Boheman, 1857)
343	105,335	86	<i>Scarabaeus rusticus</i> (Boheman, 1857)
348	103,400	31	<i>Sceliages hippias</i> Westwood, 1844
			Savanna: East Lowland Savanna
1	960	2	<i>Anonychonitis freyi</i> Janssens, 1950
44	750	4	<i>Kheper clericus</i> (Boheman, 1857)
99	4,900	7	<i>Scarabaeolus planipennis</i> (Davis & Deschodt, 2015)
121	27,860	20	<i>Afrodrepanus impressicollis</i> (Fahraeus, 1857)
122	35,250	9	<i>Allogymnopleurus consocius</i> (Péringuey, 1901)
156	98,720	24	<i>Onthophagus beiranus</i> Péringuey, 1908
157	44,150	15	<i>Onthophagus cretus</i> Péringuey, 1901

165	70,340	16	<i>Onthophagus naso</i> Fahraeus, 1857
185	40,770	14	<i>Scarabaeus geminogalenus</i> Davis & Deschodt, 2017
210	116,200	80	<i>Copris fidius</i> (Olivier, 1789)
218	681,450	57	<i>Coptorhina klugii</i> Hope, 1833
261	900,785	41	<i>Neosisyphus infuscatus</i> (Klug, 1855)
311	388,675	53	<i>Pedaria picea</i> Fahraeus, 1857
312	730,030	23	<i>Pedaria segregis</i> Péringuey, 1901
318	192,750	32	<i>Proagoderus aureiceps</i> (d'Orbigny, 1902)
351	919,450	57	<i>Sisyphus nanniscus</i> Péringuey, 1901
352	326,650	34	<i>Sisyphus sordidus</i> Boheman, 1857
357	1,133,180	31	<i>Caccobius histerinus</i> Fahraeus, 1857
393	1,156,170	87	<i>Neosisyphus spinipes</i> (Thunberg, 1818)
427	1,444,830	32	<i>Proagoderus dives</i> (Harold, 1877)
ID no.	EOO km²	N 1/16th	NMDS groups
			Savanna: North Botswana Savanna
138	74,550	7	<i>Escarabaeus remii</i> Davis & Deschodt, 2017
239	659,605	14	<i>Gymnopleurus ignitus</i> Klug, 1855
			Savanna: Savanna to Highveld sand
105	305	3	<i>Scarabaeus heqvisti</i> zur Strassen, 1962
			Sandy Savanna
198	367,200	63	<i>Catharsius ulysses</i> Boheman, 1857
245	391,450	59	<i>Heliocopris faunus</i> Boheman, 1857
253	680,625	36	<i>Metacatharsius exiguus</i> (Boheman, 1860)
283	642,681	31	<i>Onthophagus bovinus</i> Péringuey, 1892
346	579,415	65	<i>Scarabaeus zambesianus</i> Péringuey, 1901
355	1,523,140	241	<i>Allogymnopleurus splendidus</i> (Bertolini, 1849)
356	4,823,540	87	<i>Caccobius ferrugineus</i> (Fahraeus, 1857)
359	3,687,200	27	<i>Catharsius heros</i> Boheman, 1860
366	3,968,365	292	<i>Copris elphenor</i> Klug, 1855
377	1,407,890	112	<i>Gymnopleurus aenescens</i> Wiedemann, 1821
379	1,602,870	38	<i>Heliocopris atropos</i> Boheman, 1860
381	3,260,895	108	<i>Heliocopris japeus</i> Klug, 1855
384	2,173,065	103	<i>Kheper lamarcki</i> (Macleay, 1821)
385	2,045,625	62	<i>Kheper prodigiosus</i> (Erichson, 1843)
387	1,133,835	154	<i>Kurtops signatus</i> (Fahraeus, 1857)
391	1,228,465	130	<i>Metacatharsius troglodytes</i> (Boheman, 1857)
398	1,264,130	45	<i>Onitis deceptor</i> Péringuey, 1901
410	1,056,735	72	<i>Onthophagus pallidipennis</i> Fahraeus, 1857
415	1,875,455	27	<i>Onthophagus quadrimaculatus</i> Raffray, 1877
418	1,288,690	51	<i>Onthophagus verticalis</i> Fahraeus, 1857
420	2,663,660	128	<i>Pachylomera femoralis</i> (Kirby, 1828)
430	1,117,105	79	<i>Proagoderus sapphirinus</i> (Fahraeus, 1857)
432	2,990,240	106	<i>Scarabaeus goryi</i> (Castelnau, 1840)
			East coast: East Coast
5	8,250	9	<i>Catharsius harpagus</i> Harold, 1877
8	18,650	24	<i>Catharsius pandion</i> Harold, 1877
15	8,690	17	<i>Copris urus</i> Boheman, 1857
38	8,394	14	<i>Garreta caffer</i> (Fahraeus, 1857)
39	2,900	5	<i>Gyronotus carinatus</i> Felsche, 1911
62	14,150	14	<i>Neosisyphus mirabilis</i> (Arrow, 1927)
75	8,945	11	<i>Onthophagus giuseppicarpenetoi</i> Tagliaferri & Moretto, 2013
103	3,250	11	<i>Scarabaeus bornemisszai</i> zur Strassen, 1980
113	13,335	7	<i>Sceliages gagates</i> Shipp, 1895
114	4,500	8	<i>Sisyphus neobornemisszanus</i> Daniel & Davis, 2016
115	18,105	15	<i>Sisyphus oralensis</i> Daniel & Davis, 2016
118	2,455	5	<i>Tropidonitis paradoxus</i> (Boheman, 1857)
170	38,715	12	<i>Onthophagus ursinus</i> d'Orbigny, 1902
176	33,450	28	<i>Proagoderus aciculatus</i> (Fahraeus, 1857)
191	861,245	20	<i>Caccobius cavatus</i> d'Orbigny, 1908

214	211,185	30	<i>Copris puncticollis</i> Boheman, 1857
256	298,230	13	<i>Mimonthophagus ambiguus</i> (Péringuey, 1901)
298	874,260	15	<i>Onthophagus lacustris</i> Harold, 1877
East coast: Southeast to East Coast			
23	2,300	4	<i>Epirinus convexus</i> Scholtz & Howden, 1987
41	6,350	13	<i>Gyronotus pumilus</i> (Boheman, 1857)
130	31,800	20	<i>Copris orion caffer</i> Gillet, 1908
East coast: Northeast KwaZulu-Natal Scarp			
24	81	2	<i>Epirinus davisii</i> Scholtz & Howden, 1987