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APPENDICES

Appendix A1 (Chapter 2) Brief description of vegetative cover at study sites across the Botswana Kalahari Basin; the percentage cover of each vegetation category (trees, shrubs and grass) are each independent measurements

Locality and site	GPS Grid Reference	Vegetation description	% Tree canopy cover	% Shrub cover	% surface cover
Chobe N P					
Chobe River site 1	S17 54 52.4	Dense canopy <i>Baikiaea</i> woodland, few shrubs and			
	E25 01 09.4	sparse grass	68.74	36.20	40
	S17 54 36.9	Open and sparse <i>Baikiaea</i>			
site 2	E25 01 08.1	woodland	49.62	34.94	42
	S17 54 57.4				
site 3	E25 03 48.4	Dense <i>Baikiaea</i> woodland	62.82	44.14	32
Savuti					
site 1	S18.53092	Shrubland and short sparse			
	E24.08378	grass tufts		58.71	27.5
site 2	S18.50264				
	E24.08978	Shrubland and short grass tufts		47.82	46.75
site 3	S18.47368	shrubland and few short sparse			
	E24.12659	grass tufts		80.87	27.5
Central Kalahari G.R.					
Nc-Kalahari site 1	S21.22689				
	E23.91247	Tall grass and sparse shrubs		27.01	65.25
	S21.33407				
site 2	E23.86986	Tall grass and sparse shrubs		36.27	75.75
	S21.40508	Open <i>Acacia</i> woodland, short			
site 3	E23.77819	sparse grass	38.23	48.86	55.5
Khutse					
site 1	S23.27663	Sparse shrubs and short grass			
	E24.40434	tufts		28.86	60.5
site 2	S23.33220	few shrub and medium height			
	E24.48308	grass tufts		41.91	83.25
	S23.44818	Shrubland, short sparse grass			
site 3	E24.39556	tufts		33.79	34
Kgalagadi					
Trans. Park					
Mabuasehube site 1	S25.06566				
	E22.03332	Grassland sparse shrubs		21.40	53.25
	S25.02857				
site 2	E21.98819	Tall grass few shrubs		19.75	57.25
	S25.03126				
site 3	E21.92641	Shrubland short grass		36.84	63.75
Sw-Kalahari					
site 1	S26 24 29.4	Dune slope grassland, very			
	E20 42 32.7	few shrubs		10.35	21.25
site 2	S26 20 34.4	Dune slope grassland, few tall			
	E20 45 02.8	herbs and shrubs		16.84	31.5
	S26 15 47.4	Dune slope, few sparse trees,			
site 3	E20 48 11.2	shrubs, herbs and no grass	17.81	14.32	14

Appendix A2 (Chapter 3) (a – e) Proportional biogeographical composition of dung beetle assemblages in each bait-type across a climatic gradient in Botswana

a) Widespread/northeast

Bait type	Chobe	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari
Carrion	16.18	0.00	19.72	0.00	0.00	0.00
Pig	44.18	20.23	3.43	0.01	0.06	0.00
Elephant	27.13	10.23	6.44	0.09	0.14	0.00
Cattle	21.24	1.21	2.88	0.00	0.00	0.00
Sheep	21.89	2.03	10.00	0.00	0.01	0.00

b) Widespread

Bait type	Chobe	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari
Carrion	25.87	12.05	0.94	29.39	0.47	0.27
Pig	29.91	5.10	6.73	32.46	0.41	0.66
Elephant	33.62	17.53	22.73	18.22	2.39	0.62
Cattle	34.75	8.54	6.85	42.80	1.00	0.73
Sheep	37.63	23.44	14.81	72.36	1.16	0.84

c) Northeast - bias

Bait type	Chobe	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari
Carrion	36.06	75.27	9.86	1.24	0.00	0.00
Pig	15.29	33.23	3.02	1.35	0.03	0.00
Elephant	28.14	27.88	3.68	1.45	0.17	0.00
Cattle	18.58	36.01	0.79	0.19	0.00	0.00
Sheep	23.69	39.27	0.37	0.60	0.08	0.00

d) Southwest - bias

Bait type	Chobe	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari
Carrion	21.78	12.05	69.01	69.01	98.43	99.73
Pig	10.62	41.15	86.73	65.96	99.36	99.34
Elephant	11.01	44.31	67.10	79.25	97.30	99.38
Cattle	25.40	53.98	89.29	55.28	99.00	99.27
Sheep	16.76	35.26	74.81	26.75	98.70	99.16

e) Poorly recorded

Bait type	Chobe	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari
Carrion	0.10	0.63	0.47	0.36	1.10	0.00
Pig	0.01	0.29	0.08	0.21	0.14	0.00
Elephant	0.09	0.06	0.05	0.99	0.00	0.00
Cattle	0.03	0.26	0.20	1.73	0.00	0.00
Sheep	0.03	0.00	0.00	0.30	0.05	0.00

Appendix A3 (Chapter 5.)

Dung beetle Species		Chobe River					Savuti					NC-Kalahari				
Names	Code	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
Factor 1																
<i>Kheper lamarcki</i>	2	115	3176	985	571	479	0	139	9	5	5	0	0	0	0	0
<i>Kheper prodigiosus</i>	3	2	44	132	3	5	0	17	11	23	12	0	0	0	0	0
<i>Scarabaeus zambesianus</i>	17	8	321	253	114	384	1	8	1	19	59	0	11	1	4	2
<i>Anachalcos convexus</i>	18	51	85	42	22	83	4	5	0	0	2	0	0	0	0	0
<i>Heliocopris japetus</i>	23	0	16	23	5	7	0	5	2	6	3	0	0	0	0	0
<i>Pedaria</i> sp. (humped)	24	0	3	9	0	5	0	0	1	0	0	0	0	0	0	0
<i>Metacatharsius opacus</i>	40	176	162	100	109	141	136	161	28	106	68	1	2	0	1	0
<i>Metacatharsius troglodytes</i>	41	21	148	131	104	296	2	10	25	36	166	0	222	393	66	36
<i>Onitis granulisetosus</i>	44	0	10	15	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onitis orthopus</i>	45	0	15	76	0	1	0	0	4	0	0	0	0	0	0	0
<i>Caccobius cavatus</i> gp	46	9	693	462	376	1568	2	55	82	145	223	0	0	0	0	0
<i>Caccobius ferrugineus</i>	47	16	1020	887	109	424	2	850	248	270	427	1	104	61	6	0
<i>Caccobius nigritulus</i>	48	72	9659	1485	696	2173	0	1228	297	17	27	0	1	1	0	0

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Cleptocaccobius convexifrons</i>	49	33	820	142	281	1927	0	0	0	0	0	0	0	0	0	0
<i>Euonthophagus</i> sp. ??1	52	6	263	90	18	73	0	13	18	2	0	0	0	0	0	0
<i>Onthophagus anomalus</i>	54	7	1059	112	19	245	0	2	3	0	0	0	0	0	0	0
<i>Onthophagus plebejus</i>	59	2	71	23	0	13	0	0	2	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. nr <i>pullus</i> (horned)	63	0	15	1	0	5	0	1	0	0	0	0	0	0	0	0
<i>Onthophagus verticalis</i>	71	0	63	71	10	36	0	1	16	1	1	0	0	0	0	0
<i>Onthophagus vinctus</i>	72	15	2244	621	52	589	1	25	46	5	6	0	0	4	0	0
<i>Onthophagus virescens</i>	73	2	343	58	12	142	0	127	48	2	3	0	0	0	0	0
<i>Onthophagus</i> sp. (4 spot)	80	1	35	6	17	7	5	6	1	2	0	0	0	0	0	0
<i>Proagoderus bicallosus</i>	84	0	7	2	1	2	0	5	18	1	0	0	0	0	0	0
<i>Drepanocerus ?freyi</i>	87	0	1	11	0	5	0	1	9	0	1	0	0	0	0	0
<i>Drepanocerus laticollis</i>	88	1	20	97	4	82	0	61	383	21	102	0	0	0	0	0
<i>Euoniticellus</i> sp.	90	0	4	1	0	1	0	3	12	0	0	0	0	0	0	0
Factor 2																
<i>Pachylomerus femoralis</i>	5	23	220	63	163	583	0	0	1	0	0	0	0	0	0	1

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Scarabaeus sp. nr flavicornis</i>	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pedaria sp. IV</i>	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Copris cassius</i>	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Metacatharsius sp. (minute)</i>	42	0	2	3	1	1	1	1	0	2	0	0	0	0	1	0
<i>Cleptocaccobius viridicollis</i>	50	0	1	0	1	0	0	0	0	0	0	0	4	0	0	0
<i>Onthophagus impressicollis</i>	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Factor 3																
<i>Drepanopodus costatus</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Kheper sp. (La Grat)</i>	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pachylomerus opacus</i>	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gymnopleurus asperrimus</i>	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pycnoperus krikkeni</i>	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus flavimargo</i>	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus pallidipennis</i>	58	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus probus</i>	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dung beetle Species		Chobe River					Savuti					NC-Kalahari				
Names	Code	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Onthophagus quadraticeps</i>	64	0	9	0	4	14	0	10	1	1	1	0	1	1	1	0
<i>Onthophagus quadrinodosus</i>	65	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
<i>Onthophagus semiflavus</i>	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Phalops rufosignatus</i>	82	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0
<i>Phalops wittei</i>	83	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Factor 4																
<i>Allogymnopleurus thalassinus</i>	19	0	1	0	0	0	0	29	9	21	74	0	14	5	3	2
<i>Gymnopleurus aenescens</i>	20	0	0	0	0	0	3	247	16	117	55	2	154	35	68	0
<i>Digitonthophagus gazella</i>	51	0	1	0	0	0	0	4	19	21	48	0	1	5	0	0
<i>Onthophagus</i> sp. nr <i>pullus</i> (sp. a)	62	16	1110	238	349	543	8	2025	1215	638	270	1	2141	800	417	143
<i>Onthophagus suffusus</i>	68	0	7	1	0	0	213	842	391	153	25	0	2	4	0	0
<i>Onthophagus</i> sp. A2	75	0	0	0	0	0	3	17	1	2	0	0	0	0	1	0
<i>Phalops boschas</i>	81	0	0	0	0	0	0	15	4	9	2	0	0	0	0	0
<i>Proagoderus loricatus</i>	85	0	0	0	0	0	0	21	3	2	3	0	0	0	0	0

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Oniticellus formosus</i>	91	0	0	0	0	0	0	1	16	2	3	0	0	0	0	0
Factor 5																
<i>Scarabaeus anderseni</i>	7	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0
<i>Scarabaeus flavicornis</i>	10	35	29	9	3	1	0	1	0	2	0	0	0	0	0	0
<i>Scarabaeus kochi</i>	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Catharsius melancholicus</i>	35	58	0	0	6	0	1	0	0	0	0	0	0	0	0	0
<i>Metacatharsius dentinum</i> (Karoo)	38	74	66	11	25	59	15	9	0	3	0	125	16	7	11	0
<i>Onthophagus</i> sp. A	74	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Onthophagus</i> sp. B	76	0	0	0	0	0	0	3	0	4	0	0	0	0	0	2
<i>Proagoderus sappharinus</i>	86	0	0	0	0	0	3	1	1	4	0	0	0	0	0	0
Factor 6																
<i>Scarabaeus damarensis</i>	9	0	0	0	0	0	0	9	0	16	2	0	0	0	0	0
<i>Scarabaeus proboscideus</i>	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pedaria</i> sp. (Kalahari)	27	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
<i>Metacatharsius dentinum</i>	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Metacatharsius exiguiformes</i>	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. nr <i>probus</i> (granular)	61	1	205	11	40	174	0	0	0	1	0	0	9	2	2	0
<i>Onthophagus signatus</i>	67	20	566	137	295	546	0	111	32	153	256	1	405	307	110	33
<i>Onthophagus</i> sp. k (granular)	79	3	74	11	47	86	0	0	0	0	0	3	367	59	283	21
Factor 7																
<i>Heliocopris atropos</i>	22	0	0	3	0	1	0	0	1	1	0	0	0	1	0	0
<i>Pedaria</i> sp. ?V	26	0	0	0	0	0	0	0	27	2	8	0	0	0	0	0
<i>Copris bootes</i>	29	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0
<i>Copris macer</i> or <i>vilhenai</i>	32	0	0	0	0	1	0	0	9	2	0	0	0	0	0	0
<i>Chironitis indicus</i>	43	0	0	0	0	0	0	4	23	0	0	0	0	0	0	0
<i>Milichus apicalis</i>	53	0	0	1	0	0	0	0	17	0	0	0	0	0	0	0
Factor 8																
<i>Catharsius pandion</i>	36	0	0	0	0	0	68	0	0	0	0	2	0	0	0	0
<i>Onthophagus apiciosus</i> (check)	55	5	0	0	0	0	117	0	0	0	0	19	0	0	0	0
<i>Onthophagus</i> sp. (Boek)	77	107	0	0	0	0	2	0	0	0	0	0	0	0	0	0

Dung beetle Species		Chobe River					Savuti					NC-Kalahari				
Names	Code	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Onthophagus</i> sp. (green/black)	78	35	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Factor 9																
<i>Scarabaeus goryi</i>	12	0	0	1	0	0	0	0	0	5	1	0	0	0	0	0
<i>Copris elphenor</i>	31	0	0	0	0	1	0	0	10	20	25	0	0	0	0	0
<i>Euoniticellus intermedius</i>	89	0	0	0	2	1	0	0	0	6	1	0	1	0	0	0
Factor 10																
<i>Scarabaeus bohemani</i>	8	0	0	0	0	0	0	0	0	0	0	5	6	2	1	1
<i>Scarabaeus inquisitus</i> (=sp 5)	13	0	0	0	0	0	0	0	0	0	0	9	1	1	2	0
<i>Catharsius heros</i>	34	0	1	15	0	0	0	0	0	0	0	0	1	3	0	0
<i>Onthophagus sugillatus</i>	69	82	56	35	24	123	0	0	0	0	0	42	123	118	29	27
Factor 11(unclassified)																
<i>Scarabaeus inopportunos</i>	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Catharsius calaharicus</i>	33	0	13	28	0	3	0	0	3	0	2	0	4	5	0	0
<i>Onthophagus</i> sp. <i>variegatus</i> group	70	2	16	9	3	8	46	134	182	69	32	0	1	18	0	0
Factor 1																

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Kheper lamarcki</i>	2	0	21	2	0	0	0	0	0	0	0	0	0	0	0	0
<i>Kheper prodigiosus</i>	3	0	1	1	0	0	0	0	0	0	1	0	0	0	0	
<i>Scarabaeus zambesianus</i>	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Anachalcos convexus</i>	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Heliocoprps japetus</i>	23	0	7	2	0	0	0	0	0	0	0	0	0	0	0	
<i>Pedaria</i> sp. (humped)	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Metacatharsius opacus</i>	40	10	2	3	0	0	0	1	0	0	4	0	0	0	0	
<i>Metacatharsius troglodytes</i>	41	2	66	87	0	6	0	0	0	0	0	0	0	0	0	
<i>Onitis granulisetosus</i>	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Onitis orthopus</i>	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Caccobius cavatus</i> gp	46	3	147	50	0	4	0	0	0	0	0	0	0	0	0	
<i>Caccobius ferrugineus</i>	47	3	58	10	0	0	0	1	5	0	2	0	0	0	0	
<i>Caccobius nigrifulus</i>	48	0	1	3	0	0	0	4	4	0	0	0	0	0	0	
<i>Cleptocaccobius convexifrons</i>	49	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
<i>Euonthophagus</i> sp. ??1	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Onthophagus anomalus</i>	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus plebejus</i>	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. nr pullus (horned)	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus verticalis</i>	71	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus vinctus</i>	72	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus virescens</i>	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. (4 spot)	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Proagoderus bicallosus</i>	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Drepanocerus ?freyi</i>	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Drepanocerus laticollis</i>	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Euoniticellus</i> sp.	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Factor 2																
<i>Pachylomerus femoralis</i>	5	1126	4911	705	444	718	0	0	0	0	0	0	0	0	0	1
<i>Scarabaeus</i> sp. nr <i>flavicornis</i>	11	0	10	1	0	0	0	0	0	0	1	0	0	0	0	0
<i>Pedaria</i> sp. IV	25	0	17	4	0	0	0	0	0	0	0	0	0	0	0	0

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Copris cassius</i>	30	0	2	24	2	0	0	0	0	0	0	0	0	0	0	0
<i>Metacatharsius</i> sp. (minute)	42	14	21	42	17	3	0	0	0	0	0	0	0	0	0	
<i>Cleptocaccobius viridicollis</i>	50	0	4	2	0	0	0	0	0	0	0	0	0	0	0	
<i>Onthophagus impressicollis</i>	57	1	4	3	2	0	0	0	0	0	0	0	0	0	0	
Factor 3																
<i>Drepanopodus costatus</i>	1	0	0	0	0	0	0	0	0	0	0	0	42	0	19	4
<i>Kheper</i> sp. (<i>La Grat</i>)	4	0	0	0	0	0	0	0	0	0	0	0	31	1	3	8
<i>Pachylomerus opacus</i>	6	0	1	0	0	0	0	0	0	0	0	0	27	3	1	6
<i>Gymnopleurus asperrimus</i>	21	0	0	0	0	0	0	0	0	0	0	0	55	16	8	52
<i>Pycnoperus krikkeni</i>	28	0	0	0	0	0	0	5	0	0	1	0	2	2	5	1
<i>Onthophagus flavimargo</i>	56	0	13	3	0	0	0	0	0	0	1	0	58	52	11	25
<i>Onthophagus pallidipennis</i>	58	0	10	1	0	0	0	0	0	0	1	0	5	2	1	2
<i>Onthophagus probus</i>	60	0	0	0	0	0	0	40	22	7	65	2	504	206	192	274
<i>Onthophagus quadraticeps</i>	64	3	582	142	35	8	0	10	5	1	23	0	182	65	55	138
<i>Onthophagus quadrinodosus</i>	65	0	3	0	0	0	0	0	0	0	1	0	4	0	3	0

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Onthophagus semiflavus</i>	66	0	0	0	0	0	2	155	65	49	126	8	2372	935	764	1002
<i>Phalops rufosignatus</i>	82	0	0	0	0	0	0	2	0	0	0	0	92	34	9	74
<i>Phalops wittei</i>	83	0	1	0	0	0	0	4	3	1	2	0	182	74	7	101
Factor 4																
<i>Allogymnopleurus thalassinus</i>	19	0	3	9	1	0	0	0	0	0	0	0	0	0	0	0
<i>Gymnopleurus aenescens</i>	20	54	222	38	23	5	4	195	79	45	229	0	0	0	0	0
<i>Digitonthophagus gazella</i>	51	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. nr pullus (sp. a)	62	5	455	319	75	46	0	117	212	102	525	0	64	111	170	404
<i>Onthophagus suffusus</i>	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. A2	75	0	1	0	1	0	0	9	0	0	0	0	0	0	0	0
<i>Phalops boschas</i>	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Proagoderus loricatus</i>	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Oniticellus formosus</i>	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Factor 5																

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Scarabaeus anderseni</i>	7	299	34	3	7	0	17	6	2	0	15	6	1	0	0	0
<i>Scarabaeus flavicornis</i>	10	494	214	11	9	0	329	1404	28	0	23	214	225	0	18	2
<i>Scarabaeus kochi</i>	15	134	61	22	21	1	11	10	4	7	17	3	3	0	0	1
<i>Catharsius melancholicus</i>	35	215	31	6	0	0	14	7	0	0	1	9	0	0	0	0
<i>Metacatharsius dentinum</i> (Karoo)	38	505	36	68	37	24	42	15	11	1	9	103	9	0	11	1
<i>Onthophagus</i> sp. A	74	307	110	7	1	1	7	50	3	2	17	4	0	0	0	0
<i>Onthophagus</i> sp. B	76	421	513	41	12	4	132	483	60	7	35	10	24	0	2	0
<i>Proagoderus sappharinus</i>	86	6	31	8	4	2	5	16	3	1	5	0	0	0	0	0
Factor 6																
<i>Scarabaeus damarensis</i>	9	55	111	11	16	0	8	221	10	144	295	0	0	0	1	0
<i>Scarabaeus proboscideus</i>	16	0	180	34	3	5	1	43	60	30	471	0	29	21	130	706
<i>Pedaria</i> sp. (Kalahari)	27	2	112	13	1	0	3	24	69	11	86	1	21	11	11	29
<i>Metacatharsius dentinum</i>	37	27	1167	897	65	35	2	110	122	26	874	0	90	337	299	527
<i>Metacatharsius exiguiiformes</i>	39	0	11	11	0	5	0	3	20	5	137	0	0	2	3	2
<i>Onthophagus</i> sp. nr <i>probus</i> (granular)	61	74	2756	804	145	41	6	1084	790	393	1793	0	6	0	4	3

Dung beetle Species	Code	Chobe River					Savuti					NC-Kalahari				
		Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
<i>Onthophagus signatus</i>	67	17	1870	616	107	65	7	632	520	142	1095	1	143	119	153	226
<i>Onthophagus</i> sp. k (granular)	79	25	1812	433	10	24	2	1602	812	92	1766	1	197	61	118	282
Factor 7																
<i>Helicopriss atropos</i>	22	0	2	2	0	0	0	0	0	0	0	1	0	0	0	0
<i>Pedaria</i> sp. ?V	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Copris bootes</i>	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Copris macer or vilhenai</i>	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Chironitis indicus</i>	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Milichus apicalis</i>	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Factor 8																
<i>Catharsius pandion</i>	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus apiciosus</i> (check)	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. (Boek)	77	32	0	1	2	2	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus</i> sp. (green/black)	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dung beetle Species		Chobe River					Savuti					NC-Kalahari				
Names	Code	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She	Car	Pig	Ele	Cat	She
Factor 9																
<i>Scarabaeus goryi</i>	12	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Copris elphenor</i>	31	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Euoniticellus intermedius</i>	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Factor 10																
<i>Scarabaeus bohemani</i>	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Scarabaeus inquisitus</i> (=sp 5)	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Catharsius heros</i>	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onthophagus sugillatus</i>	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Factor 11(unclassified)																
<i>Scarabaeus inopportunos</i>	14	0	0	0	0	0	38	99	12	30	160	3	48	1	34	51
<i>Catharsius calaharicus</i>	33	0	48	13	0	0	0	12	6	0	1	0	7	7	0	1
<i>Onthophagus sp. variegatus</i> group	70	19	177	87	0	1	0	0	1	0	0	5	106	27	12	7

Appendix A4 (All chapters): Abundances of 139 dung beetles species recorded in Chobe National Park, Central Kalahari Game Reserve and Kalahari Transfrontier Park.

Species	Species abbreviation.	Chobe National Park		Central Kalahari Game Reserve		Kgalagadi Transfrontier Park		Functional Group
		Chobe River	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari	
<i>Drepanopodus costatus</i>								
Wiedeman	Dco	0	0	0	0	0	65	R
<i>Kheper cupreus</i> Castelnau	Kcu	0	0	2	0	0	0	R
<i>Kheper lamarcki</i> M ^l Leay	Kla	5326	158	0	23	0	0	R
<i>Kheper prodigiosus</i> Erichson	Kpr	186	63	0	2	1	0	R
<i>Kheper sp. 1 = kalaharicus</i>	KLag	0	0	0	0	0	43	R
<i>Pachylomera femoralis</i> Kirby	Pfe	1052	1	1	7904	0	1	R
<i>Pachylomera opacus</i> Lansberge	Pop	0	0	0	1	0	37	R
<i>Scarabaeus ambiguus</i>								
Boheman	Sam	0	0	1	0	0	0	R
<i>Scarabaeus ?lucidulus</i>	San	2	0	1	343	40	7	R
<i>Scarabaeus sp. nr anderseni</i>	Sanl	0	0	0	0	9	0	R
<i>Scarabaeus bohemani</i> Harold	Sbo	0	0	15	0	0	0	R
<i>Scarabaeus damarensis</i>								
Janssens	Sda	0	27	0	193	678	1	R
<i>Scarabaeus ebenus</i> Klug	Seb	0	4	0	0	0	0	R
<i>Scarabaeus flavicornis</i>								
Boheman	Sfl	77	3	0	728	1784	459	R
<i>Scarabaeus sp. nr flavicornis</i>	Sflr	0	0	0	11	1	0	R
<i>Scarabaeus galenus</i> Westwood	Sga	0	0	0	2	0	0	R
<i>Scarabaeus goryi</i> Harold	Sgo	1	6	0	14	0	0	R
<i>Scarabaeus inquisitus</i>								
Péringuey	Sin	0	0	13	0	0	0	R
<i>Scarabaeus inopportunos</i>								
Ferreira	Sio	0	0	0	0	339	137	R
<i>Scarabaeus kochi</i> Ferreira	Sko	0	0	0	239	49	7	R
<i>Scarabaeus parvulus</i> Boheman	Spar	0	0	0	0	0	6	R
<i>Scarabaeus proboscideus</i>								
Guérin	Spr	0	0	0	222	605	886	R
<i>Scarabaeus satyrus</i> Boheman	Ssa	0	0	3	1	0	4	R
<i>Scarabaeus zambesianus</i>	Sza	1080	88	18	0	0	0	R



Species	Species abbreviation.	Chobe National Park		Central Kalahari Game Reserve		Kgalagadi Transfrontier Park		Functional Group
		Chobe River	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari	
<i>Péringuey</i>								
<i>Anachalcos convexus</i> Boheman	Aco	283	11	0	0	0	0	R
<i>Allogymnopleurus thalassinus</i> Klug	Ath	1	133	24	13	0	0	R
<i>Gymnopleurus aenescens</i> Wiedemann	Gae	0	438	259	342	552	0	R
<i>Gymnopleurus asperrimus</i> Felsche	Gas	0	0	0	0	0	131	R
<i>Gymnopleurus ignitus</i> Klug	Gig	1	0	0	0	0	0	R
<i>Sisyphus goryi</i> Harold	Sgr	0	3	0	0	0	0	R
<i>Coptorhina</i> sp.	Csp1	0	2	0	0	0	0	T
<i>Heliocopris atropos</i> Boheman	Hat	4	2	1	4	1	0	T
<i>Heliocopris japedus</i> Klug	Hja	51	16	0	9	0	0	T
<i>Pedaria</i> sp. VIII	Psp8	17	1	0	0	0	0	K
<i>Pedaria</i> sp. IV	Psp4	0	0	0	21	0	0	K
<i>Pedaria</i> sp. V	Psp5	0	37	0	0	0	0	K
<i>Pedaria</i> sp. VI	Psp6	1	1	0	0	0	0	K
<i>Pedaria</i> sp. XI	Psp11	4	0	0	128	193	73	K
<i>Pycnopanelus krikkeni</i> Cambefort	Pkr	0	0	0	0	6	10	K
<i>Copris bootes</i> Klug	Cbo	0	17	0	0	0	0	T
<i>Copris cassius</i> Péringuey	Cca	0	0	0	28	0	0	T
<i>Copris cornifrons</i> Boheman	Cco	0	0	0	0	0	1	T
<i>Copris elphenor</i> Klug	Cel	1	55	0	2	0	0	T
<i>Copris evanidus</i> Klug	Cev	0	0	5	3	0	0	T
<i>Copris vilhenai</i> Ferreira	Cma	1	11	0	0	0	0	T
<i>Catharsius calaharicus</i> Kolbe	Ccl	44	5	9	61	19	15	T
<i>Catharsius heros</i> Boheman	Che	16	0	4	0	0	0	T
<i>Catharsius melancholicus</i> Boheman	Cme	64	1	0	252	22	9	T
<i>Catharsius pandion</i> Harold	Cpa	0	68	2	0	0	0	T
<i>Catharsius</i> sp. nr <i>tricornutus</i>	Ctrr	0	6	0	0	0	0	T
<i>Metacatharsius exiguiformis</i> Ferreira	Mde	0	0	0	2191	1134	1253	T



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		Chobe River	Savuti	NC-Kalahari	Khutse	Mabuasehube	Sw-Kalahari	
<i>Metacatharsius dentinum</i> Ferreira	Mdk	235	27	159	670	78	124	T
<i>Metacatharsius exiguus</i> Boheman	Mex	1	0	0	2	1	0	T
<i>Metacatharsius sp.</i> Mei	Mei	0	0	0	27	165	7	T
<i>Metacatharsius latifrons</i> Harold	Mla	0	0	0	1	2	4	T
<i>Metacatharsius marani</i> Balthasar	Mma	0	3	0	0	0	6	T
<i>Metacatharsius opacus</i> Waterhouse	Mop	688	499	4	15	5	0	T
<i>Metacatharsius troglodytes</i> Boheman	Mtr	700	239	717	161	0	0	T
<i>Metacatharsius sp.2</i> Msp2	Msp2	7	4	1	97	0	0	T
<i>Metacatharsius pumilioniformis</i> Ferreira	Msp3	0	0	0	0	1	5	T
<i>Cheironitis hoplosternus</i> Harold	Cho	0	0	1	1	0	0	T
<i>Cheironitis indicus</i> Lansberge	Cin	0	27	0	0	0	0	T
<i>Onitis alexis</i> Klug	Oal	0	0	4	0	2	0	T
<i>Onitis deceptor</i> Péringuey	Ode	7	0	0	0	0	0	T
<i>Onitis granulisetosus</i> Ferreira	Ogr	25	0	0	0	0	0	T
<i>Onitis inversidens</i> Lansberge	Oin	5	0	0	0	0	0	T
<i>Onitis orthopus</i> Lansberge	Oor	92	4	0	0	0	0	T
<i>Onitis viridulus</i> Boheman	Ovi	1	0	0	0	0	0	T
<i>Caccobius cavatus</i> d'Orbigny	Ccv	3108	507	0	204	0	0	K
<i>Caccobius ferrugineus</i> Fahraeus	Cfe	2456	1797	172	71	8	0	K
<i>Caccobius nigrutilus</i> Klug	Cni	14085	1569	2	4	8	0	K
<i>Caccobius sp. 1</i>	Cspl	2	0	0	0	0	0	K
<i>Cleptocaccobius convexifrons</i> Raffray	Ccn	3203	0	0	0	1	0	K
<i>Cleptocaccobius viridicollis</i> Fahraeus	Cvr	2	0	4	6	0	0	K
<i>Digitonthophagus gazella</i>	Dga	1	92	6	1	1	0	T



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Fabricius								
<i>Euonthophagus</i> sp.1	Esp1	450	33	0	0	0	0	T
<i>Hyalonthophagus alcyon</i> d'Orbigny	Hal	1	2	0	0	0	0	T
<i>Milichus apicalis</i> Fahraeus	Map	1	17	0	0	0	0	T
<i>Mimonthophagus anomalus</i> Klug	Oan	1442	5	0	0	0	0	K
<i>Mimonthophagus flavimargo</i> d'Orbigny	Ofl	0	0	0	16	1	146	T
<i>Onthophagus bicavifrons</i> d'Orbigny	Obi	1	0	1	0	0	0	T
<i>Onthophagus</i> sp. nr <i>bicavifrons</i>	Obir	0	0	0	6	0	0	T
<i>Onthophagus fimetarius</i> Roth	Ofi	0	6	0	0	0	0	T
<i>Onthophagus flavolimbatus</i> Klug	Ofa	0	2	0	0	0	0	K
<i>Onthophagus impressicollis</i> Boheman	Oim	0	0	0	10	0	0	K
<i>Onthophagus juvenicus</i> Klug	Oju	2	0	0	0	0	0	T
<i>Onthophagus</i> sp.	Ooc	0	0	0	1	0	0	?
<i>Onthophagus pallidipennis</i> Fahraeus	Opa	1	0	0	11	1	10	K
<i>Onthophagus plebejus</i> Klug	Opl	109	2	0	0	0	0	T
<i>Onthophagus probus</i> Péringuey	Opr	0	0	0	0	134	1178	K
<i>Onthophagus</i> sp. nr <i>probus</i>	Oprr	431	1	13	3820	4066	13	K
<i>Onthophagus</i> sp. nr <i>pullus</i> (sp. a)	Opur	2256	4156	3502	900	956	749	K
<i>Onthophagus</i> sp. nr <i>pullus</i> (horned)	Ophr	21	1	0	0	0	0	K
<i>Onthophagus quadraticeps</i> Harold	Oqu	27	13	3	770	39	440	T
<i>Onthophagus quadrinodosus</i> Fahraeus	Oqa	0	2	0	3	1	7	T
<i>Onthophagus rugulipennis</i> Fairmaire	Oru	0	0	1	0	0	0	K



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<i>Onthophagus semiflavus</i>								
Boheman	Ose	0	0	0	0	397	5081	K
<i>Onthophagus signatus</i> Fahraeus	Osi	1564	552	856	2675	2396	642	K
<i>Onthophagus suffusus</i> Klug	Osu	8	1624	6	0	0	0	T
<i>Onthophagus sugillatus</i> Klug	Osg	320	0	339	0	0	0	T
<i>Onthophagus</i> sp. nr <i>variegatus</i>	Ovar	38	463	19	284	1	157	T
<i>Onthophagus verticalis</i>								
Fahraeus	Ove	180	19	0	3	0	0	K
<i>Onthophagus vinctus</i> Erichson	Ovi	3521	83	4	3	0	0	T
<i>Onthophagus virescens</i> Harold	Ovr	557	180	0	0	0	0	K
<i>Onthophagus</i> sp. 2	Osp2	0	0	1	426	79	4	K
<i>Onthophagus</i> sp. 3	Osp3	0	23	1	2	9	0	K
<i>Onthophagus</i> sp. 4	Osp4	0	7	2	991	717	36	K
<i>Onthophagus</i> sp. 5	Osp5	107	2	0	37	0	0	?K
<i>Onthophagus</i> sp. 6	Osp6	35	1	0	0	0	0	?K
<i>Onthophagus</i> sp. 7	Osp7	221	0	733	2304	4274	659	?K
<i>Onthophagus</i> sp. 8	Osp8	66	14	0	0	0	0	?K
<i>Onthophagus</i> sp. 9	Osp9	0	0	0	5	1	0	?K
<i>Onthophagus</i> sp. 10	Osp10	2	0	0	0	0	0	?K
<i>Onthophagus</i> sp. 12	Osp12	2	0	0	0	0	0	?K
<i>Onthophagus</i> sp. 13	Osp13	0	0	1	0	0	0	?K
<i>Onthophagus</i> sp. 14	Osp14	0	0	1	0	0	0	?K
<i>Onthophagus</i> sp. 15	Osp15	0	1	0	0	0	0	?K
<i>Onthophagus</i> sp. 16	Osp16	0	1	0	0	0	0	?K
<i>Phalops boschas</i> Klug	Pbo	0	30	0	0	0	0	T
<i>Phalops dregei</i> Harold	Pdr	0	0	2	0	0	0	T
<i>Phalops rufosignatus</i>								
Lansberge	Pru	0	0	8	0	2	209	T
<i>Phalops wittei</i> Harold	Pwi	0	0	3	1	10	364	T
<i>Proagoderus bicallosus</i> Klug	Pbi	12	24	0	0	0	0	T
<i>Proagoderus loricatus</i> Klug	Plo	0	29	0	0	0	0	T
<i>Proagoderus sappharinus</i>								
Péringuey	Psa	0	9	0	51	30	0	T
<i>Stiptopodius</i> sp. (A)	Ssp1	0	1	0	0	0	0	?



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<i>Tomogonus</i> sp.	Tcr	1	0	1	0	0	0	<i>K</i>
<i>Eodrepanus fastiditus</i> (Péringuey)	Dfa	4	1	0	0	0	0	<i>T</i>
<i>Ixodina freyi</i> (Janssens)	Dfr	17	11	0	0	0	0	<i>T</i>
<i>Drepanocerus kirbyi</i> (Kirby)	Dki	1	2	0	0	0	0	<i>T</i>
<i>Latodrepanus laticollis</i> (Fahraeus)	Dla	204	567	0	0	0	0	<i>T</i>
<i>Euoniticellus intermedius</i> Reiche	Ein	3	7	1	0	0	1	<i>T</i>
<i>Euoniticellus kawanus</i> Janssens	Eka	0	3	0	0	0	0	<i>T</i>
<i>Euoniticellus</i> sp.	Euol	6	15	0	0	0	0	<i>K</i>
<i>Liatongus militaris</i> (Castelnau)	Lmi	0	1	0	0	0	0	<i>T</i>
<i>Oniticellus egregius</i> Klug	Oeg	0	0	4	0	0	0	<i>E</i>
<i>Oniticellus formosus</i> Chevrolat	Ofo	0	22	0	0	0	0	<i>E</i>
<i>Oniticellus planatus</i> Castelnau	Opn	0	5	0	0	0	0	<i>E</i>
<i>Tragiscus dimidiatus</i> Klug	Tdi	0	1	0	0	0	0	<i>E</i>
Species richness		71	78	45	59	48	40	
Total individuals		44512	13941	6975	26375	18867	13027	
Shannon-Weiner diversity		2.52	2.522	1.72	2.46	2.353	2.274	
Total traps: N x 2 days exposure		60 x 2	60 x 2	60x 2	60 x 2	60 x 2	60 x 2	

Functional Groups; R = roller; T= tunneller; K = kleptocoprids; E = endocoprids/dwellers