SUPPORTING INFORMATION

Avian community at study site

We assessed the species composition of the bird community in TKR by conducting 62 points count along eight transects (~ 3 km each) (Ralph et al. 1993). Points were on average 500 m apart and ranged from the habitat surrounding a waterhole up to 4 km from the nearest water source. During each point count (lasting 10 minutes), we identified and estimated numbers of all species, seen or heard within a radius of ~ 200 m. We assumed that detectability did not vary with distance from the observer (as typically happens in more closed habitats such as forests) (Reynolds et al. 1980). This assumption was reasonable at TKR because of the open nature of the habitat. We estimated the overall reporting rate of each species as % number of point counts recording each species (Figure S1).

Observations of drinking

Only 20 out of 36 species drank on more than 30% of the observation days. We determined temporal drinking patterns of these species by categorising time of day into seven two-hour intervals, starting at 5h00 and ending and 19h00, and estimated mean visitation rate per hour per species for each time interval (all four waterholes pooled). Although most species were recorded drinking throughout the day, we qualitatively identified three patterns; drinking events were either concentrated around the early hours of the day, midday, later in the day or bimodal (Figure S1). Whereas sandgrouse and mousebirds typically visited the waterholes early in the day (time period A to C), a few species, such as White-browed Sparrow-weaver (*Plocepasser mahali*) and African Red-eyed Bulbul (*Pycnonotus nigricans*) visited waterholes mostly during the later hours of the day (time periods) (Figure S1).

Temperature dependency of drinking

Drinking events during the hottest time of the day (12h00 to 18h00) was not significantly related to maximum air temperature (T_{air}) in any of the 20 most commonly observed species visiting waterholes (Figure S2). Although some species visited the waterholes more on days when maximum T_{air} exceeded 35°C (Figure S2), the limited number of days where maximum T_{air} exceed 35°C could explain our lack of significant trends. However, many of the species that drank daily showed high visitation rates throughout the study, even on cooler days—giving the impression that drinking demands are not related to T_{air} in daily drinkers.

Seasonal changes in dependency in percentage of body water derived from surface water source

During the dry season, the enriched source accounted for a significantly greater proportion of the total body water pool in, Namaqua Dove () and Scaly-feathered Finch (*Sporopipes squamifrons*), although these were the only two species in which samples sizes of drinking birds were large enough for statistical analyses. During the dry season a greater proportion (6 of 17) Sociable Weavers (*Philetairus socius*) utilized the enriched waterhole, and P% was greater (~ 4 fold) than in the single individual (one out of 19 individuals) that utilized the waterhole during the wet season. Violet-eared Waxbills were trapped around the enriched waterhole during the dry season only, and 9 out of 12 individuals obtained an average of 32.8 % of their body water pool from the latter resource.

Spatial water use

Spatial variation in P5 values allowed us to establish that many some species travelled up to 2.5 km to the enriched source (Table S2). Those species that showed evidence of the enriched water source in their body water pool, showed no trends between their dependencies (P%

values) and distance from the waterhole. One of the smallest species trapped during our study, the 12-g Violet-eared Waxbill (*Uraeginthus granatinus*), showed P% values of 25-35% at all capture sites (Table S2). Only Sociable Weavers (*Philetairus socius*) and White-browed Sparrow-weavers (*Plocepasser mahali*), showed qualitatively greater P% values when trapped adjacent to the waterhole (<100 m), compared to further from the water source. These patterns contrast strongly with the majority of species showing no evidence of relying on the water source at all trapping sites, including the immediate vicinity of the waterhole (Table S2).

SUMMARY OF DRINKING PATTERNS AND WATER DEPENDENCY

Table S1: Summary of reporting rate (based on surveys), drinking dependency (% of days observed drinking), mean drinking events per day, mean maximum temperature associated with drinking event (Max T_{drink}) and birds for which body water samples were obtained for the avian community at Tswalu Kalahari Reserve. Values are presented as mean±SD. The total number of samples and number of enriched samples are presented for both wet (February 2011) and dry (October 2011) seasons. Species are categorized according to dominant dietary guild; i.e. frugivores (FRU), insectivores (INS), granivores (GRA), omnivores (OMN), nectarivores (NEC), carnivores (CAR).

Species	**Diet**	**Reporting rate (%)**	**Days observed drinking (%)**	**Mean drinking events per day**	**Mean Max T_{drink}**	**# Samples Wet/dry**	**# Enriched Wet/dry**
Acacia Pied Barbet *Tricholaema leucomelas*	OMN	16.1				3/2	0/0/
African Red-eyed Bulbul *Pycnonotus nigricans*	OMN	16.1	93.8	6.7±3.6	32.3±3.6		
Anteating Chat *Myrmecocichla formicivora*	INS	56.5	43.8	2.3±1.8	33.8±2.8	1/1	0/0
Ashy Tit *Parus cinerascens*	INS	16.1				2/2	0/0
Barn Swallow *Hirundo rustica*	INS	12.9					
Black-chested Prinia *Prinia flavicans*	INS	66.1				11/12	0/0
Black-faced Waxbill *Estrilda erythronotos*	GRA	3.2	12.5	1	34.4±1	0/1	0/1

Species	**Diet**	**Reporting rate (%)**	**Days observed drinking (%)**	**Mean drinking events per day**	**Mean Max T_{drink}**	**# Samples Wet/dry**	**# Enriched Wet/dry**
Black-throated Canary *Chrithagra atrogularis*	GRA	4.8	43.8	2.7±2.6	32.9±3.6		
Bokmakierie *Telephorus zeylonus*	INS	33.9	12.5	1±0	35.6±2.5	1/0	0/0
Brubru *Nilaus afer*	INS	4.8					
Buffy Pipit *Anthus vaalensis*	INS	1.6					
Burchell's Sandgrouse *Pterocles burchelli*	GRA		100	18.1±16.5	32.8±3.6		
Cape Glossy Starling *Lamprotornis nitens*	OMN	8.1	87.5	2.6±1.6	32.7±3.0		
Cape Penduline Tit *Anthoscopus minutus*	INS	1.6				0/1	0/0
Cape Sparrow *Passer melanurus*	GRA	17.7	93.8	10.9±5.2	32.9±3.4	0/2	0/2
Cape Turtle-Dove *Streptopelia capicola*	GRA	37.1	100	156.2±83.9	32.1±3.6	1/0	1/0
Chat Flycatcher *Bradornis infuscatus*	INS	3.2					
Chestnut-vented Tit-Babbler *Parisoma subcaeruleum*	INS	37.1				4/6	0/0/
Common Fiscal *Lanius collaris subcoronatus*	INS	46.8	25	1	35.3±1.3	4/2	0/0/
Common Ostrich *Struthio camelas*	GRA	14.5	37.5	8.0±9.4	35.1±2.6		
Common Scimitarbill *Rhinopomastus cyanomelas*	INS	6.5				2/0	0/0

Species	**Diet**	**Reporting rate (%)**	**Days observed drinking (%)**	**Mean drinking events per day**	**Mean Max T_{drink}**	**# Samples Wet/dry**	**# Enriched Wet/dry**
Common Swift *Apus apus*	INS	1.6					
Common Whitethroat *Sylvia communis*	INS	1.6					
Crimson-breasted Shrike *Laniarius atrococcineus*	INS	16.1				1/0	0/0
Crowned Lapwing *Vanellus coronatus*	INS	6.5	37.5	1.7±1.2	34.2±3.3		
Desert Cisticola *Cisticola aridulus*	INS	3.2					
Diderick Cuckoo *Chrysococyx cupreas*	INS	6.5				1/0	0/0
Dusky Sunbird *Cinnyris fuscus*	NEC	4.8					
Eastern Clapper Lark *Mirafra fasciolata*	OMN	32.3					
Eurasian Golden Oriole *Oriolus oriolus*	FRU	3.2					
Fawn-coloured Lark *Calendulauda africanoides*	OMN	64.5				6/5	0/0
Golden-breasted Bunting *Emberiza flaviventris*	GRA	1.6	6.3	1	34.9	0/1	0/1
Grey-backed Sparrowlark *Eremopterix verticalis*	GRA	3.2	6.3	3	31.5		
Jacobin Cuckoo *Clamator jacobinus*	INS	4.8					
Kalahari Scrub-Robin *Cercotrichas paena*	INS	54.8				8/8(16)	0/0/(0)

Species	Diet	Reporting rate (%)	Days observed drinking (%)	Mean drinking events per day	Mean Max T_{drink}	# Samples Wet/dry	# Enriched Wet/dry
Kori Bustard *Ardeotis kori*	INS	1.6					
Kurrichane Buttonquail *Turnix sylvacticus*	INS	6.5					
Lappet-faced Vulture *Aegypius tracheliotos*	CAR		25.0	3	33.7±1.9		
Lark-like Bunting *Emberiza impetuani*	GRA	19.4	62.5	6.3±4.4	34.2±3.3		
Laughing Dove *Streptopelia senegalensis*	GRA	33.9	100	36.7±37.6	32.6±3.5	1/0	0/0
Lesser Grey Shrike *Lanius minor*	INS	24.2					
Long-billed Crombec *Sylvietta rufescens*	INS	3.2					
Marico Flycatcher *Bradornis mariquensis*	INS	22.6				0/5	0/0
Namaqua Dove *Oena capensis*	GRA	59.7	100	387.3±131.8	32.2±3.6	7/6	5/6
Namaqua Sandgrouse *Pterocles namaqua*	GRA		100	31.6±19.9	31.6±3.5		
Northern Black Korhaan *Afrotis afraoides*	INS	19.4					
Pearl-spotted Owlet *Glaucidium perlatum*	CAR					1/0	0/0
Pririt Batis *Batis pririt*	INS	6.5					
Pygmy Falcon *Polihierax semitorquatus*	CAR	1.6				1/0	0/0

Species	Diet	Reporting rate (%)	Days observed drinking (%)	Mean drinking events per day	Mean Max T_{drink}	# Samples Wet/dry	# Enriched Wet/dry
Red-backed Shrike *Lanius collurio*	INS	4.8	18.8	2±1	33.3±2.0		
Red-billed Quelea *Quelea quelea*	GRA	1.6					
Red-crested Korhaan *Lophotis ruficrista*	INS	30.6					
Red-faced Mousebird *Urocolius indicus*	FRU	8.1	18.8	5±5	32.8±1.9		
Red-headed Finch *Amadina erythrocephala*	GRA	17.7	31.3	2.2±1.1	33.3±1.8		
Red-necked Falcon *Falco chicquera*	CAR	1.6					
Cinnamon-breasted Bunting *Emberiza tahapisi*	GRA					0/1	0/0
Rufous-cheecked Nightjar *Caprimulgus rufigena*	INS					1/0	0/0
Rufous-eared Warbler *Malcorus pectoralis*	INS	3.2				1/2	0/0
Scaly-feathered Finch *Sporopipes squamifrons*	GRA	62.9				29/19	4/4
Secretarybird *Sagittarius serpentarius*	CAR	3.2	18.8	1.3±0.6	32.4±4.1		
Shaft-tailed Whydah *Vidua regia*	GRA	3.2	6.3	1	37.4		
Sociable Weaver *Philetairus socius*	OMN	25.8	87.5	69.3±110.7	34.6±2.4	19/17	1/6
Southern Grey-headed Sparrow *Passer diffusus*	GRA	6.5	6.3	1	34.9		

Species	Diet	Reporting rate (%)	Days observed drinking (%)	Mean drinking events per day	Mean Max T_{drink}	# Samples Wet/dry	# Enriched Wet/dry
Southern Masked-Weaver *Ploceus velatus*	OMN	29	100	16.6±19.2	31.9±3.3	6/3	1/0
Southern Pale Chanting Goshawk *Melierax canorus*	CAR	1.6	18.8	1	36.6±2.5		
Southern Yellow-billed Hornbill *Tockus leucomelas*	OMN	1.6					
Spike-heeled Lark *Chersomanes albofasciata*	OMN	6.5				1/0	0/0
Tinkling Cisticola *Cisticola rufilatus*	INS					1/0	0/0
[i]Violet-eared Waxbill *Uraeginthus granatinus*	GRA	8.1	50	2.5±1.3	34.1±2.6	0/12	0/9
[i]Wattled Starling *Creatophora cinerea*	OMN	6.5	6.3	9	31.5		
White-backed Mousebird *Colius colius*	FRU	14.5	56.3	5.3±4.6	33.7±3.9	4/6	0/0
White-backed Vulture *Gyps africanus*	CAR		6.3	41	34.8		
White-browed Sparrow-Weaver *Plocepasser mahali*	OMN	81	43.8	4.3±3.3	35.4±2.7	11/14	1/1
Yellow Canary *Crithagra flaviventris*	GRA	26.6	93.8	18.2±14.4	33.5±3.4	0/4	0/1
Yellow-bellied Eremomela *Eremomela icteropygialis*	INS	10.8				0/3	0/0

Table S2: Mean % body water pool (P% ±SD) derived from the enriched source at different distances from the sources in species that drank frequently and in a number of species not observed to drink.

	Mean ± SD P% (number enriched/total sampled)					
Species	**100 m**	**500 m**	**1000 m**	**1500 m**	**2000 m**	**2500 m**
Namaqua Dove *Oena capensis*	45.3±34.9 (7/8)	53.6 (1/1)	62.1 (1/1)	24.72 (1/2)	91.04 (1/1)	
Violet-eared Waxbill *Uraeginthus granatinus*	34.5±23.0 (4/5)		25.0±8.9 (2/2)		35.7±15.6 (3/5)	
Sociable Weaver *Philetairus socius*	17.1±9.1 (5/9)	N/A (0/4)	N/A (0/5)	9.5 (1/4)	1.99 (1/10)	N/A (0/4)
Southern Masked-Weaver *Ploceus velatus*	N/A (0/4)		7.7 (1/2)			N/A (0/3)
Scaly-feathered Finch *Sporopipes squamifrons*	10.6±2.4 (2/7)	2.9 (1/6)	5.5±2.1 (3/17)	2.2 (1/7)	N/A (0/9)	7.6 (1/2)
White-browed Sparrow-Weaver *Plocepasser mahali*	92.9 (1/3)	N/A (0/4)	5.1 (1/4)		N/A (0/10)	N/A (0/4)
Yellow Canary *Crithagra flaviventris*	63.4 (1/4)					
Fawn-coloured Lark *Calendulauda africanoides*	N/A (0/4)	N/A (0/2)	N/A (0/2)	N/A (0/1)	N/A (0/2)	
Black-chested Prinia *Prinia flavicans*	N/A (0/5)	N/A (0/3)	N/A (0/6)	N/A (0/3)	N/A (0/4)	
Common Fiscal *Lanius collaris subcoronatus*	N/A (0/1)	N/A (0/2)	N/A (0/1)		N/A (0/2)	
Marico Flycatcher *Bradornis mariquensis*	N/A (0/3)		N/A (0/1)			N/A (0/1)
Acacia Pied Barbet *Tricholaema leucomelas*	N/A (0/1)	N/A (0/1)			N/A (0/1)	N/A (0/1)
Chestnut-vented Tit-Babbler *Parisoma subcaeruleum*	N/A (0/2)		N/A (0/1)	N/A (0/2)	N/A (0/1)	

	Mean ± SD P% (number enriched/total sampled)					
Species	**100 m**	**500 m**	**1000 m**	**1500 m**	**2000 m**	**2500 m**
White-backed Mousebird *Colius colius*	N/A (0/5)		N/A (0/1)	N/A (0/1)		

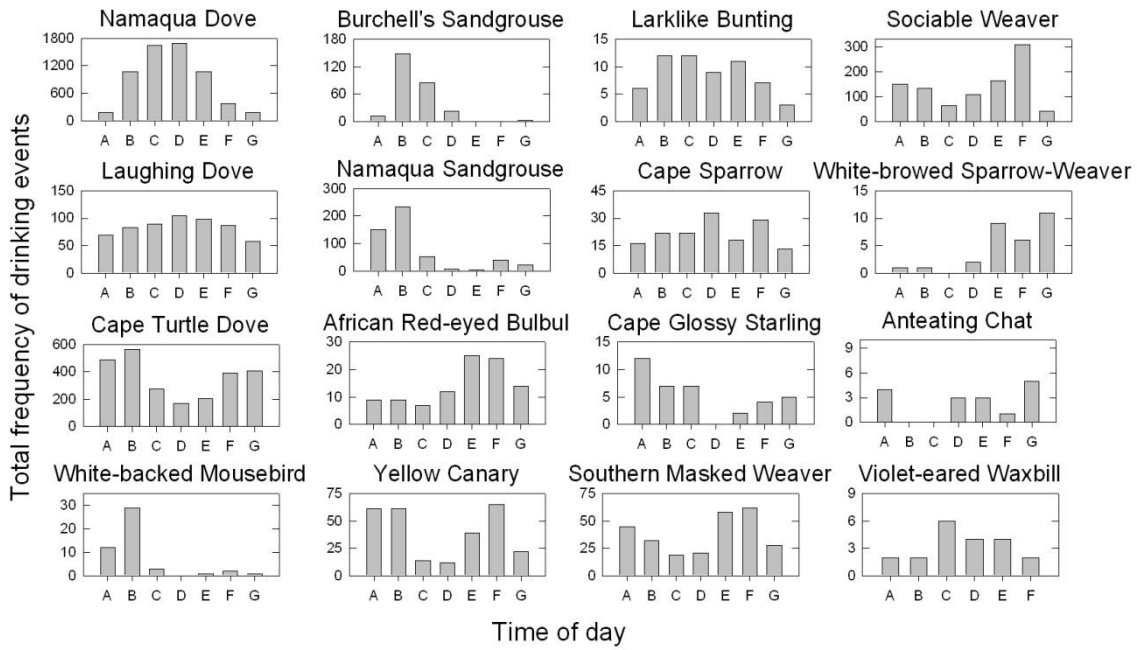

Figure S1: Frequency of drinking events pooled across all four waterholes as a function of time of day in 16 species that drank more than 40% of days during summer in Tswalu Kalahari Reserve (November to December 2009). Times are categorized as A = 05h00 – 07h00; B = 07h00 – 9h00; C = 9h00 –11h00; D = 11h00 – 13h00; E = 13h00 – 15h00, F = 15h00 – 17h00, G = 17h00 – 19h00. Sunrise and sunset times averaged 05:40 and 18:40 respectively during the study period.

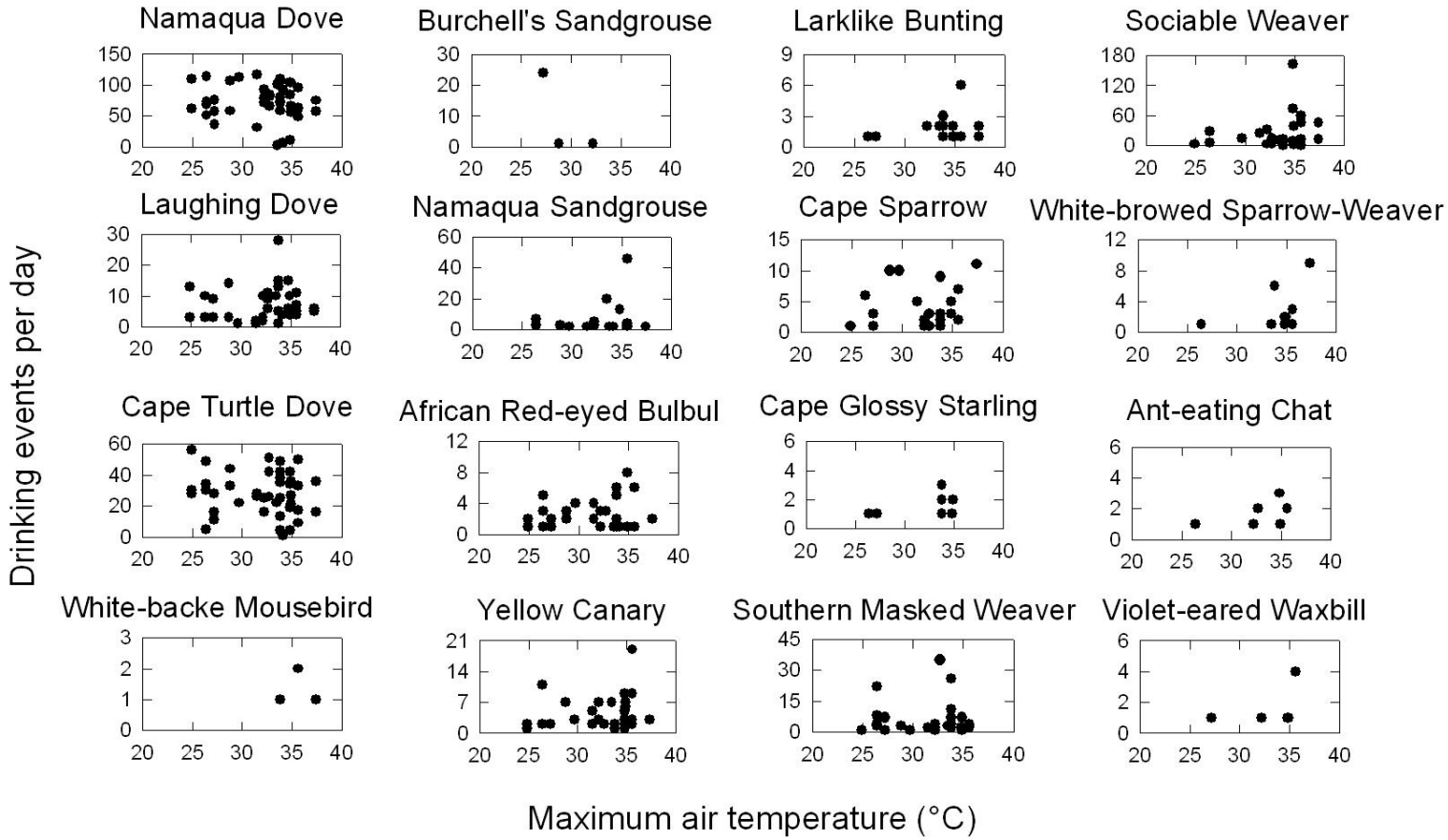

Figure S2: Drinking events pooled across all four waterholes as a function of maximum daily temperature in the 16 species that drank on more than 40% of days during summer in Tswalu Kalahari Reserve (November to December 2009).

References

Ralph, C. J., G. G. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. USDA Forest Service General Technical Report PSW-GTR-144.

Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor **82**:309-313.

SUMMARY OF DRINKING PATTERNS AND WATER DEPENDENCY

Associated data of stable isotope ratios are available at:

Figshare

doi: 10.6084/m9.figshare.5313910

https://doi.org/10.6084/m9.figshare.5313910.v1