Prey selection by African wild dogs (*Lycaon pictus*) in northern Botswana

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INTRODUCTION

Prey selection varies among large carnivores in different ecosystems. Factors influencing prey selection include availability (Fanshawe & Fitzgibbon, 1993), sex, age, body condition, body size (Hayward, O'Brien, Hofmeyr & Kerley, 2006), the prey's anti-predatory mechanisms such as vigilance and speed (Schoener, 1971), and habitat selection (Mills & Mills, 2017).

Studies in East (Fanshawe & Fitzgibbon, 1993) and southern Africa (*e.g.*, Mills & Biggs, 1993; Hayward *et al*., 2006; Hayward, O'Brien & Kerley, 2007) have demonstrated that African wild dogs (*Lycaon pictus*) primarily select medium-sized antelope. In southern Africa, impala (*Aepyceros melampus*) and, to a lesser extent, greater kudu (*Strepsiceros strepsiceros*) have been recorded as the most common prey species for wild dogs (Hayward *et al*., 2006). However, published data on the diet of wild dogs in Botswana are scarce, except for anecdotal notes by Hubel *et al*., (2016) from northern Botswana. To address this knowledge gap, we investigated seasonal prey selection by wild dogs in the northeastern Okavango Delta region.

MATERIALS AND METHODS

We conducted our study in the Vumbura Plains (S18°58', E22°57′ and S18°49′, E22°56′) and nearby Linyanti-Selinda areas (S18°37′, E23°30′ and S18°20′, E23°52′) in the northeastern Okavango Delta, Botswana, between 2010 and 2011. The two study sites share similarities in floral and mega-faunal (Sianga 2013) composition, as well as ecosystem functioning (Thomas & Shaw, 1991); therefore, we pooled our data from the two sites. The area receives an average rainfall of approximately 450 mm per annum and is characterized by several habitat types (Hensman, Owen-Smith, Parrini & Erasmus, 2012; Havemann, 2014). Permanent swamps and floodplain grasslands dominate the surroundings of many waterways. Mixed woodlands of predominantly mopane (*Colophospermum mopane*), *Terminalia* spp. and *Vachellia* spp. (Sianga, 2013) grow adjacent to these mesic vegetation types.

Prey availability

We used Distance sampling (Buckland *et al*., 2001) to estimate the population densities of ungulates. We surveyed a total of 22, four-kilometre transects in each of the two study sites during the dry (April–October) and wet seasons (November–March) in 2010 and 2011, giving a total of 88 km of survey transects for each study site every season. We selected the starting locations for each transect at random and repeated the surveys for subsequent seasons, but did not resurvey a transect more than once in a single season. We conducted surveys between sunrise and 10:00 and between 16:00 and sunset to control for the effects of temperature on foraging activity of herbivores to enhance our ability to detect them before they retreated into shade. We drove a vehicle ≤20 km/h with two observers sitting on raised seats (~1.80 m above the ground). Observers independently recorded animal sightings on either side of each transect. For each sighting we recorded species, cluster size, global position system (GPS) coordinates, and perpendicular distance to the middle of each cluster using a range finder (Nikon Rifle hunter 550). We also

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recorded the sex of the individuals at each sighting, where possible (mostly adults). We measured transect lengths using the trip odometer in a GPS unit.

Wild dog diet

We determined the diet of wild dogs at our two study sites through direct observations of wild dog packs. To facilitate our observations, we fitted two mature individuals in each of three packs of wild dogs (the Vumbura pack (n = 15 animals), the Zibadianja pack, (n = 11 animals) and the Linyanti pack, (n = 12 animals) with a very high frequency (VHF) collar or a GPS collars (GPS PLUS Globalstar-3 VECTRONICS). To fit collars, a Botswana registered veterinarian tranquilized wild dogs using a dart gun (Dan-Inject JM Standard model) fired from a research vehicle with darts containing a combination of medetomidine and ketamine. The reversal agent (atipamezole) was hand-injected to reverse the anaesthesia.

Wild dogs were followed at dusk and dawn (*i.e.* during their crepuscular active periods) in an attempt to cover all hunting sessions. Follows began by searching for each pack using telemetry (VHF collar signal) until we got a visual on them and then following them during the hunt. We found dogs 25–40% of the time when searching with telemetry equipment (n = 252 field days). However, as chance would have it, they were often found already hunting or after they had completed a hunt, leading to unequal sampling. In addition, some individual wild dogs either died, dispersed and pups were born in the second year of the study. Individuals that did not remain with the pack for at least 12 months of the study period were not included in averaging our wild dog pack sizes. This includes pups that were born in 2011 and mortalities and immigrants that occurred before December 2010, as the field study concluded in February 2012. During follows, we recorded all kills found noting species, sex, and age.

Data analysis

We categorized potential prey into three groups: 1) small ungulates (<40 kg), 2) medium-sized ungulates (40–250 kg), and 3) large ungulates (>250 kg) (Stuart & Stuart, 2007). We grouped all ungulates by size class to provide a sufficient sample size for the Distance Program (recommended at >40 observations per analysis). Small ungulates included common duiker (*Sylvicapra grimmia*) and steenbok (*Raphicerus campestris*); medium-sized ungulates were impala, common warthog (*Phacochoerus africanus*), red lechwe (*Kobus leche*), common reedbuck (*Redunca arundinum*), common tsessebe (*Damaliscus lunatus*), and bushbuck (*Tragelapus scriptus*); and large ungulates included greater kudu, plains zebra (*Equus burchellii*), blue wildebeest (*Connochaetus taurinus*), waterbuck (*Kobus ellipsiprymnus*), giraffe (*Giraffa camelopardalis angolensis*) and buffalo (*Syncerus cafer*). We included wildebeest, zebra, giraffe, and buffalo as potential wild dog prey because there are published and unpublished records of their calves being killed by wild dogs (Creel & Creel, 2002; McNutt & Woodroffe, 2013).

We set the Distance Program to select the best model based on the highest P-value and lowest Akaike Information Criterion (AIC). We also set significance at non-overlapping 95% confidence limits. We used Jacob's index (Jacobs, 1974) to determine prey selection. We calculated the index using ungulate densities and actual wild dog kill composition.

RESULTS

Prey selection by age and sex

We recorded 128 wild dog kills comprising eight species. Overall, wild dogs killed more adults than subadults and lambs. The proportion of impala (74.1%) exceeded that of all other prey species combined. Kudu and warthog were the second and third most killed species and the rest constituted <10% of total kills (Table 1). Interestingly, when wild dogs preyed upon warthogs, they mostly killed young animals (Table 1). Wild dogs preyed on impala significantly more frequently than any other ungulate (χ^2 = 61.4, d.f. = 1, P < 0.01).

Prey availability and selection

Proportions of medium-sized prey in the overall prey guild across wet and dry seasons were higher than for the other prey groups (Table 2). However, wild dogs optimally preyed on medium-sized ungulates only in the 2010 dry season (Table 2). Despite medium-sized prey, especially impala, dominating the prey consumed (Table 1), wild dogs actually avoided medium-sized prey and selected large prey in both the 2010/11 wet and 2011 dry seasons (Table 2). Wild dogs avoided small ungulates in the 2010 dry season and 2010/11 wet season, but selected them in the

Table 1. Combined African wild dog (*Lycaon pictus*) kills in our study sites in northern Botswana.

Prey species	Adults		Subadults	Lambs	Unknown	Total	% of total kills
	Males	Females					
Impala	14	22	10	22	23	91	71.1
Greater kudu	2	7	2	3	3	17	13.3
Warthog	1	1	4	4	1	11	8.6
Red lechwe	1	0	0	0	2	4	3.1
Steenbok	1	0	0	0	1	2	1.6
Common duiker	0	1	0	0	0	1	0.8
Reedbuck	0	1	0	0	0	1	0.8
Tsesebe	0	1	0	0	0	1	0.8
Total	19	33	16	29	33	128	100

Table 2. Wild dog (*Lycaon pictus*) prey selection calculated using Jacob's index (*D*) for wet and dry seasons. For males and females, we examined selection within a species (*i.e.* rows add up to 100%), while for all prey we examined across species (*i.e.* columns add up to 100%). Values close to –1 indicate high avoidance (highlighted in red), while values those close to +1 indicate strong selection (highlighted in green). Values between –0.25 and 0.25 indicate a food resource reflect optimal utilization of prey (highlighted in orange). Proportion in % kills data derived from Table 1. * = insufficient data to perform the calculation.

Season	Prey	All			Males			Females		
		% Prey	% Diet	Jacob's index	% Prey	% Diet	Jacob's index	% Prey	% Diet	Jacob's index
Dry 2010	Small	9.49	0.0	**–1.00**	*	*	*	*	*	*
	Medium	76.20	80.0	**0.11**	50	50	**0.00**	50	50	**0.00**
	Large	14.30	20.0	**0.20**	12	0	**–1.00**	88	100	**1.00**
Wet 2010/11	Small	0.50	0.0	**–1.00**	*	*	*	*	*	*
	Medium	96.50	84.2	**–0.91**	15	38	**0.55**	85	62	**–0.55**
	Large	3.00	15.8	**0.72**	41	33	**–0.17**	59	67	**0.17**
Dry 2011	Small	0.55	2.1	**0.59**	*	50	*	*	50	*
	Medium	93.80	87.2	**–0.38**	16	38	**0.85**	84	62	**–0.53**
	Large	5.61	10.6	**0.33**	29	20	**–0.24**	71	80	**0.24**

2011 dry season (Table 2). We rarely sighted small ungulates during prey surveys and only occasionally found them at wild dog kills (n = 2, Table 1), so the latter results should be viewed with caution. Wild dogs generally selected or at least optimally preyed on males of medium-sized prey, and avoided or optimally preyed on females of medium-sized prey (Table 2). In the 2010/11 wet and 2011 dry seasons, wild dogs consumed males and females of large prey optimally, but strongly selected females over males in the 2010 dry season (Table 2).

DISCUSSION

We found a high proportion of medium-sized prey in the diet of wild dogs in our study area. Hayward *et al*. (2006, 2007) also pointed out that medium-sized prey, particularly impala, are important components of wild dog diets in southern Africa. However, we found greater dietary selection for large ungulates by wild dogs in our study area. Our study therefore suggests that while medium-sized ungulates sustain the wild dog population in northern Botswana, large ungulates, particularly kudu, are also important. These results are in line with the findings of Pole, Gordon, Gorman & MacAskill (2004) who reported that wild dogs selected female impala and kudu at the end of the dry season (March–October) when their body conditions were compromised by lactation.

We found that wild dogs tended to kill more females than males of medium-sized prey, but generally selected males. Davies-Mostert, Mills & Macdonald (2013) also found that wild dogs killed more female impala and kudu than males. In addition, as in our study, Fitzgibbon & Fanshawe (1989) found that wild dogs preferred male Thompson's gazelles (*Gazella thompsonii*) in poor condition just after the rutting season. Since kudu is the only large ungulate we recorded in the diet of wild dogs in our study area, this shows the species' critical importance in wild dog diet in northern Botswana.

Our wild dog kill records contained more adults than lambs and subadults. Although this result might have been due to us missing some kills, as wild dogs fed quickly and left their kill sites as soon as possible as a strategy to minimize kleptoparasitic encounters with other carnivores, it is more likely that this reflects the true state as there are more adults than young in most ungulate populations. Alternatively, other factors such as pack size (Gusset & Macdonald, 2010) and energy budget dynamics (Hubel *et al*., 2016) could have also contributed to adults being selected over younger animals. For example, wild dogs probably avoided adult warthogs because of their ability to fight back and cause serious injuries and even death (pers. obs.). With regard to their avoidance of small ungulates, wild dog prey choice was probably determined by the very low density and the small energetic trade-off benefits of pursing such small prey. Males of very large ungulates were probably avoided because of the risks associated with prey capture (Creel & Christianson, 2008). We conclude that medium-sized and some large ungulates, particularly young warthogs, kudu, and male impala, represent critical staple foods of wild dogs in northern Botswana.

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