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RESEARCH NOTE

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Long-distance African wild dog dispersal within the Kavango-Zambezi transfrontier conservation area

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1 | INTRODUCTION

For spatially separated populations, dispersal is essential to facilitate gene flow and colonisation (Creel et al., 2019; Woodroffe et al., 2019). This is especially true for the wide-ranging African wild dog (*Lycaon pictus*), an endangered species, whose global population currently consists of ca. 6600 adults, scattered across 39 sub-populations and is vulnerable to habitat loss and fragmentation, infectious diseases and anthropogenic mortality (Woodroffe & Sillero-Zubiri, 2012).

Wild dogs are cooperative breeders living in packs of up to 30 individuals (Creel & Creel, 2002). Both sexes disperse from their natal pack, over distances of 2 (Woodroffe et al., 2019) to 476 km (Davies-Mostert et al., 2012), to find unrelated mates or packs, and colonise new territories (Creel & Creel, 2002; McNutt, 1996). Observations of long distance dispersals (>80 km straight linear distance) of wild dogs are rarely recorded, despite their high value for conservation management (Cozzi et al., 2020; Davies-Mostert et al., 2012). Here, we describe a long-distance cross-boundary dispersal of an African wild dog female (FEMALE146.02) within the Kavango–Zambezi Transfrontier Conservation Area (KAZA-TFCA).

2 | METHODS

2.1 | Study Area

The KAZA-TFCA covers 520,000 km^2 across five African countries (PPF, 2018) and is home to ca. 25% of the global African wild dog population (Woodroffe, 2013). FEMALE146.02's natal pack (which dissolved) lived in Hwange National Park (HNP), Zimbabwe: a 14,651 km^2 unfenced protected area with woodland, bushland and open grassland (Valeix et al., 2010). She settled in the unfenced 1200 km^2 Wildlife Management Area Linyanti NG15 (Linyanti), Botswana, which consists of riparian woodland, sandveld and grassland (Fynn, 2017; Figure 1).

2.2 | Fieldwork

FEMALE146.02 (a 3-year-old subordinate female in a pack of 16 individuals) was fitted with a GPS collar (Tellus/Followit, Sweden). From 12 June to 25 September 2021, this collar provided fixes at 08:20,

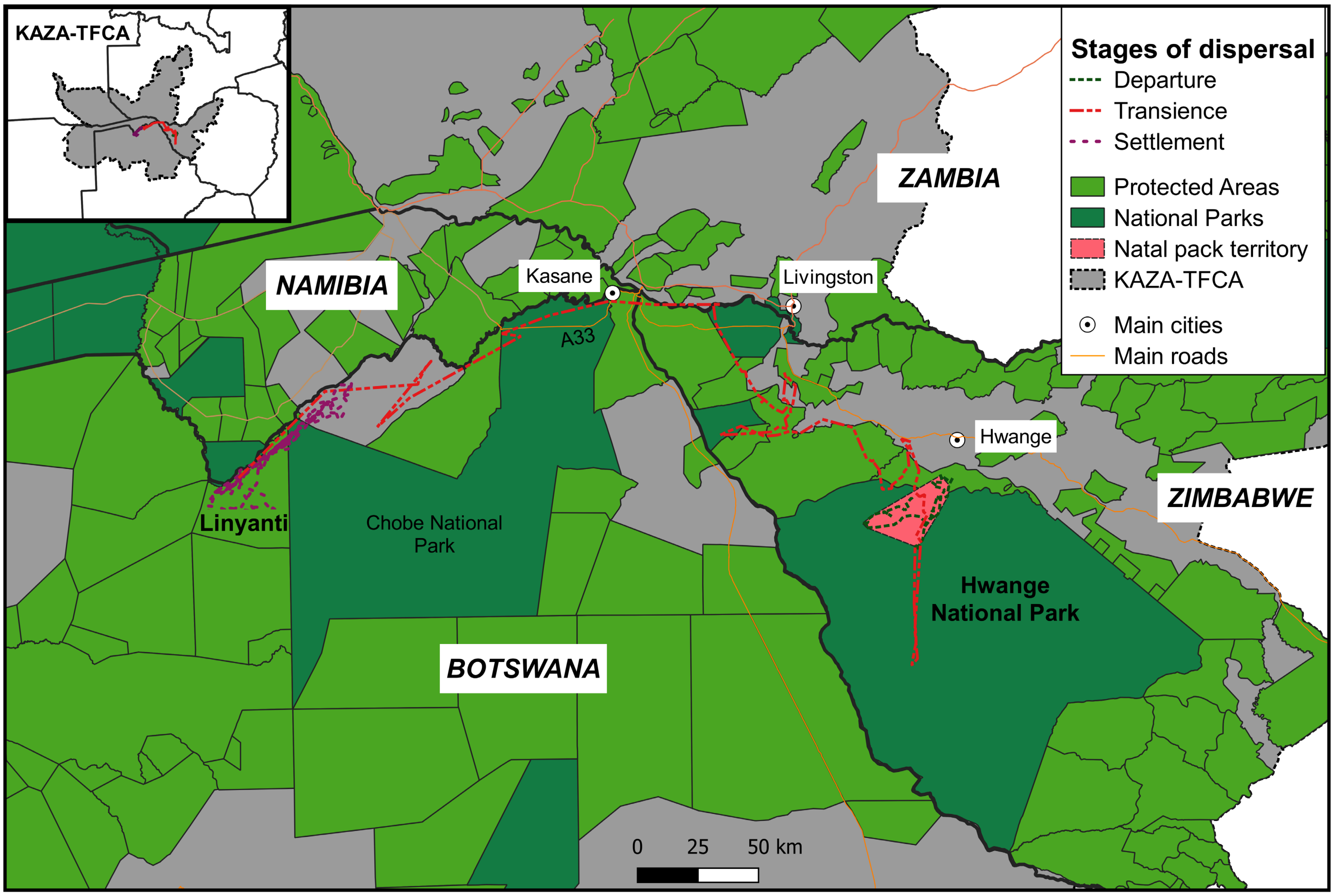

FIGURE 1 Dispersal movement of African wild dog female FEMALE146.02, which dispersed from Hwange National Park (Zimbabwe) to Linyanti (Botswana), situated within the Kavango–Zambezi Transfrontier Conservation Area (KAZA-TFCA). (Natal pack territory using 100% Minimum Convex Polygon in QGIS)

16:20 and 00:20 h. FEMALE146.02 was immobilised by qualified veterinarians using butorphanol/medetomidine, reversed with atipamezole. Independently, our Trans-Kalahari Predator Programme deployed a camera trap survey at Linyanti (October–December 2021, 63 stations, 4 × 4 km grid).

2.3 | Analyses

To identify departure, transience and settlement phases of dispersal, we calculated the net squared displacement (NSD), which is the square of the Euclidian distance (dE) (Börger & Fryxell, 2012). For each phase, we calculated the mean, maximum and minimum dE between 8 and 24 h fixes; the total dE (from first to last fix per phase), total path length (L) (cumulative distance), straightness index (ST = total dE/L, 1 = straight line, 0 = tortuous path - Almeida et al., 2010); plus the straight line between the furthest two dispersal locations (maximum straight distance). Using QGIS 3.8.2 (2019, qgis.org) we calculated, per phase, the percentage of time FEMALE146.02 spent in each land use type (PPF; https://www.peaceparks.org/) and land cover (ESA-CCI-LC 2016; http://2016africalandcover20m.esrin.esa.int/). We performed Fisher's exact tests to compare land cover proportions from random proportions (Table 1).

3 | RESULTS AND DISCUSSION

Based on NSD (Figure A1) and field observations, FEMALE146.02's transience phase lasted from 27 June to 29 July in which she travelled 430 km in 32 days with a straight linear distance of 252 km (Table 1; Figure 1). This is comparable to a previously recorded dispersal from the Okavango Delta, Botswana, to HNP (Cozzi et al., 2020) but shorter than the dispersal from southwest Botswana to HNP reported by Davies-Mostert et al. (2012) (Table 2). Throughout Africa, dispersal distances of wild dogs vary widely (Table 2), possibly due to terrain and overall wild dog densities (potential of locating mates) (Cozzi et al., 2020).

In accordance with observations by Woodroffe et al. (2019) and Cozzi et al. (2020), FEMALE146.02 travelled in a straighter line during transience than departure and settlement. FEMALE146.02's mean daily distance travelled (DDT) during departure and settlement in HNP and Linyanti, respectively, was comparable to DDT

TABLE 1 Summary of the African wild dog female trajectory from Hwange National Park (HNP), Zimbabwe, to Linyanti, Botswana

	Departure from HNP	Transience	Settlement at Linyanti
Dates	12th June 2021	27th June 2021	29th July 2021
Days	15	32	58
In 24 h window			
Mean dE	7.47 (SE = 0.96)	17.95 (SE = 2.89)	8.72 (SE = 0.95)
Maximum dE	13.31	52.64	29.85
Minimum dE	3.21	2.83	0.003
In 8 h window			
Mean dE	3.08 (SE = 0.37)	6.17 (SE = 1.01)	4.06 (SE = 0.26)
Maximum dE	11.44	39.17	14.62
Minimum dE	0.067	0.002	0.026
Total dE	20.00	252.62	51.95
L in 24 h window for the total number of days	97.10	430.84	479.51
ST = total dE/L	0.21	0.59	0.11
Land cover[NS]			
Woodland	7%	7%	0%
Bushland	50%	33%	68%
Grassland	36%	41%	30%
Cropland	7%	19%	2%
Land use			
National Parks	86%	30%	16%
Protected areas[a]	14%	41%	61%
Not protected[b]	0%	30%	23%

Abbreviations: dE, Euclidian distance in km between first and last position; L, total path length in km; SE, Standard error; ST, straightness index (where 1 indicates a straight line and 0 a tortuous path).NS: all land cover proportions of the three phases were not significantly different from random proportions (*p*-value > 0.05 in Fisher's exact test). Random proportions were calculated from 1000 random points per phase inside a buffer with an equivalent distance to the mean dE in a 24-window of each phase.

[a]Protected areas: all natural areas with legal protection other than National Parks.

[b]Not protected: all areas without any category of protection, including communal land with livestock and settlements.

of established packs (Pomilia et al., 2015). However, compared to departure and settlement, FEMALE146.02's maximum DDT was larger during transience. Although not different from random proportions (*p*-value >0.05), FEMALE146.02 travelled in grassland more during transience (Table 1), possibly because it presents less resistance to movement. This is in line with Klarevas-Irby et al. (2021), who showed that transient individuals travel farther, faster and straighter to reduce energetic costs of long-distance dispersals.

FEMALE146.02's dispersal followed the disappearance of the natal pack's alpha female, resulting in a pack of related members with no pups, which is a known cause of pack dissolution through dispersal (Behr et al., 2020; Masenga et al., 2015). Wild dogs usually disperse in same sex aggregations (McNutt, 1996; Somers et al., 2008; Woodroffe et al., 2019) and occasionally in mixed sex coalitions (Masenga et al., 2015). As two females and three males disappeared on the same date as FEMALE146.02, both options are possible. However, only FEMALE146.02 was detected during the camera trap survey at Linyanti, along with an unrelated male detected 4 days later and 4 km away from where FEMALE146.02 had appeared. It therefore seems that, despite the high anthropogenic mortality risk related to dispersal (Cozzi et al., 2020; Woodroffe et al., 2019), 5 months after dispersing, FEMALE146.02 was still alive and could potentially breed in Linyanti.

During dispersal, FEMALE146.02 did not cross the Zambezi River and crossed one highway three times (Botswana's A33) (Figure 1). Dispersing wild dogs avoid large water bodies and human infrastructures (Cozzi et al., 2020; Hofmann et al., 2021), which may be dispersal barriers. During transience, the majority of FEMALE146.02 fixes were in wildlife-designated areas, while 30% were in non-protected areas (Table 1). This is testament to the high permeability of the KAZA-TFCA to wildlife movements,

TABLE 2 African wild dogs' dispersal trajectories from different studies (distances in km)

Starting location	Final location	Sample size	Days	Straight linear distance to settlement	Cumulative distance	Max. straight distance during the whole trajectory	Max. DDT in 24h during transience	Study
HNP, Zimbabwe	Linyanti, Botswana	One female	32	252	430	307	52	Our study
Okavango delta, Botswana	HNP, Zimbabwe	One coalition of four females	9	311	614	345	54	Cozzi et al. (2020)
HNP, Zimbabwe	southeast Zimbabwe	One coalition of two males	-	-	-	199	-	Davies-Mostert et al. (2012).
Southwest Botswana	HNP, Zimbabwe	One coalition of three males	-	-	-	476	-	Davies-Mostert et al. (2012)
Okavango delta, Botswana	Okavango delta, Botswana	Average data of 16 coalitions	48	54	597	103	35	Cozzi et al. (2020); Hofmann et al. (2021)
Okavango delta, Botswana	Long-distance[a] dispersal within KAZA-TFCA	Average data of 7 coalitions	32	110	465	137	43	Cozzi et al. (2020).
Laikipia, Kenya	Laikipia, Kenya	Average data of 44 coalitions	19	37	487	-	-	Woodroffe et al. (2019)
Serengeti, Tanzania	Border of Tanzania and Kenya	Average data of 2 coalitions	250	361	4713	-	-	Masenga et al. (2015)

Abbreviations: DDT, Daily distance travelled; HNP, Hwange National Park; KAZA-TFCA, Kavango–Zambezi Transfrontier Conservation Area.
[a]Long distance: outside Okavango Delta study area: 3000 km^2 (Cozzi et al., 2020).

which consists of ~70% intact protected natural habitat (Hofmann et al., 2021; KAZA TFCA, 2015), and the area's importance in facilitating dispersal, and therewith gene flow, between wildlife populations (Brennan et al., 2020; Elliot et al., 2014; Hofmann et al., 2021). Wild dogs are a strong indicator species for connectivity across the KAZA-TFCA (Brennan et al., 2020), as such, the dispersal described here can assist in locating and protecting more wildlife dispersal areas within the KAZA-TFCA (Munthali et al., 2018), and confirms the significance of international transboundary conservation efforts.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data is available from the authors upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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