African wild dog dispersal study

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Third Year Research Update
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1. Project overview and aim

As part of a collaborative effort between the Population Ecology Research Group of the University of Zurich (www.popecol.org) and the Botswana Predator Conservation Trust (BPCT, www.bpctrust.org), few candidate dispersing African wild dogs have been fitted with GPS/Satellite radio collars. The aim of the project is to follow dispersers after emigration from the natal group and to i) investigate the effect of landscape characteristics on dispersal distance, time, movement patterns and habitat selection ii) gather crucial demographic parameters such as mortality rate, settlement success, reproductive success after settlement in a new territory iii) combine this novel information on dispersing individuals with long-term demographic information on resident groups collected by the BPCT over the past 25 years to produce population viability models.

Understanding mechanism and patterns of wild dog dispersal, and its demographic consequences is fundamental for the management and conservation of the species nationally, but also across the broader landscapes of Southern Africa such as the Kavango Zambezi Transfrontier Conservation Area (KAZA/TCA). We aim to provide scientific information and advice to policy makers, resource managers, stakeholders and the public.

Results from this research will help predict population changes under changing scenarios and thus be crucial towards the management and conservation of free-living populations of the African wild dog.

2. Activities

2.1. Fieldwork

During 2019, we have continued with routine monitoring of dispersing African wild dogs collared during the previous years and we collared some more candidate dispersers. The collars used in this study (Vertex Lite, Vectronic Aerospace, Berlin) automatically record precise GPS positions several times each day and regularly send them to a base station through the Iridium satellite system. This technology allows to remotely follow the movements of collared individuals even where field conditions are prohibitive, and to more easily locate animals on the ground to collect the needed information. Collars are fitted with an independent VHF beacon that allows locating individuals in the field for routine monitoring during the dispersal events, and retrieving the collars after they detach from the animals. All collars have a drop-off mechanism timed to last 18-24 months.

Collared animals were visited regularly during the week after anesthesia to ensure no time lagged negative effects due to anesthesia or handling. We did not experience or observe any negative events (e.g. injuries, casualties) neither during anesthesia nor during the days following anesthesia. All wild dogs collared were regularly monitored. This applied to both wild dogs that had not yet dispersed and were still within the natal pack and to wild dogs that had dispersed. Monitoring was done in collaboration and coordination with BPCT activities and staff and, under normal circumstances, was at bi-monthly intervals. At each visit, information on group composition, physical condition, health status, and behaviour were collected. Dogs were monitored more frequently and closely immediately after they dispersed, to timely gain important information such as association with opposite-sex dispersing groups. We also immediately visited animals following reception of “mortality signals” (a mortality signal is sent to our computer if the collar does not record any activity for a period of 24 h). A mortality signal may be due to the collar opening (all collars are equipped with a degradable drop-off mechanism) or to the animal carrying the collar being actually dead.

2.2. National collaborations

Following upon the initiative launched in 2018, we have increased our communication channels and expanded our network with the tourism industry with the aim of obtaining information on wild dog sightings regionally, nationally and internationally. This initiative (aka "Wanted" Flyer) has the dual purpose of:

i) More precisely following the fate of dispersing wild dogs, including those individuals that are not equipped with a radio collar. Based on sightings we will be able to assess where dogs originate from and where they disperser to.

ii) Gaining a comprehensive understanding of the distribution of resident wild dogs across the Okavango-Chobe ecosystem. This will (1) help us understanding how resident individuals influence the movement patterns of dispersing individuals and, (2) provide us with a minimum estimate of abundance (given that wild dogs are individually recognizable based on their unique coat pattern).

To this end we have attached posters (Figure 1) at entrance gate of Moremi GR and Chobe NP, and at Maun International airport, and we have contacted and distributed flyers to several safari companies including: Desert and Delta, Sanctuaries, Kwando, Wilderness Safaris, Bushways Safaris, Great Exploration Limited, &Beyond, Helicopter Horizons, and Safari Services. We intend to expand collaboration with more safari companies in 2020.

We have been reciprocally exchanging information, mainly sightings and pictures, with other researcher groups active at the regional/national level including Cheetah Conservation Botswana (mainly through Leanne van der Weyde), WildCRU (Robynne Kotze), Okavango Research Institute (Emily Bennitt), Rhino Conservation Botswana (Kyle Burger).
Similar collaboration also takes place with the Painted Dog Conservation Program and Painted Dog Research Trust in Zimbabwe.

University of Zurich[UZH]
Botswana Predator Conservation Trust

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WANTED

Have you seen any African wild dog?

Please send us information on number of adults, pups, collared individuals, date and location (coordinates or a rough description). Pictures are of particular value as they allow identifying single dogs based on their unique coat pattern.

Email: wilddogdispersal@gmail.com
WhatsApp: +41 77 4352783

The project in a nutshell

The African wild dog is Africa's most endangered large carnivore. One major threat to the survival of the species is the loss and fragmentation of suitable habitats. As a result, wild dogs are forced to live in isolated and small subpopulations, which are particularly vulnerable to extinction. Through emigration and immigration, dispersing individuals lead to the formation of new groups, can rescue small subpopulations, and recolonize unoccupied areas. Understanding how and where wild dogs disperse, and assessing connectivity between subpopulations is thus fundamental for the management and conservation of the species across large wildlife landscapes such as the Kavango Zambezi Transfrontier Conservation Area (KAZA/TFCA).

We deploy GPS/Satellite radio collars on sub-adult African wild dogs that disperse from their natal pack, to collect information on dispersal movement patterns, habitat use during dispersal, survival, settlement success in a new territory, and reproductive success of newly formed packs. Finally, we will merge this novel information on dispersing individuals with existing data on resident packs to create a demographic model and assess population extinction risks under changing environmental and anthropogenic scenarios. Results from this project will be used to inform management plans to conserve this highly endangered species.

This project is a collaboration between the University of Zurich and the Botswana Predator Conservation Trust, and it is supported by the Botswana Department of Wildlife and National Parks. Please do not hesitate to visit our webpages (www.popecol.org and www.bpctrust.org) or to contact us by e-mail for more info.

Despite the newest technology implemented in the collars facilitates our work, following dispersing wild dogs over several hundred kilometers still represents a major challenge. Your help is therefore essential and much appreciated!

Your dispersal team

Figure 1: Poster/flyer distributed to collect wild dog information from tourist sightings.

2.3. International collaborations

In coordination with BPCT, at the end of 2019 we have started a collaboration with WildMe, a US-based non-profit organisation specialized in patterns recognition analysis. The scope of this collaboration is to develop algorithms capable to automatically identify individual wild dogs based on the digital photographs obtained from tourist sightings (cfr. Section 2.2.). The development of these algorithms requires processing of thousands of images and first results are supposed to be available by mid 2020. If successful, this method will allow matching any new picture of wild dogs against all pictures collected over the past 30 years and stored in the BPCT database.

3. Main findings

3.1. Patterns of emigration

Detailed results reported in this section are part of a scientific article that we will submit to a specialized journal in 2020. Tentative title of the article is: "*When to stay and when to go? Proximate causes of dispersal in an endangered social carnivore*"

Emigration is a key life history process that strongly influences population dynamics. Reliable empirical information on emigration is, however, often difficult to obtain because individuals that disappear from the study population (hereafter referred to as missing individuals) may have either dispersed or died. The aim of this part of our research is to (1) derive an empirical model reflecting proximate causes of dispersal in the African wild dog based on observed dispersal events and (2) use this information to assign a dispersal likelihood to missing individuals.

3.1.1 Data collection

For this analysis we used long term data collected since 1989 by BPCT and augmented it with novel data collected as part of the dispersal study. Overall we had information over 200 emigration events. We defined an individual as having dispersed if it was seen away from its pack either on its own, in a same-sex coalition, or in a different (unrelated) pack. Furthermore, we distinguished between *natal dispersal* (i.e. dispersal from the natal pack),

secondary dispersal (i.e. dispersal from a pack other than the natal pack), and *pack breakup* (i.e. all members of one sex left the pack)

3.1.2 Main Results and Conservation Implications

African wild dogs start dispersing at 13 months of age with females and males showing highest dispersal rates at 33 months and 37 months, respectively. For any given age, males were less likely to emigrate from the natal pack than females. Rates of secondary dispersal were overall moderate and an order of magnitude smaller than natal dispersal. Males were considerably less likely to exhibit secondary dispersal than females (Figure 2A).

Dispersing coalition size was larger for natal dispersers compared with secondary dispersers. We did not observe differences in coalition size between the two sexes, neither in natal nor in secondary dispersing groups. For natal dispersal, coalition size increased with number of same-sex candidate dispersers and decreased with increasing numbers of pups. Of all natal dispersing groups, 50% of male and 35% of female groups included individuals born in multiple litters. Multi-litter dispersal groups were overall larger than single-litter groups. For secondary dispersal, coalition size increased with number of same-sex adults present in the pack (Figure 2B).

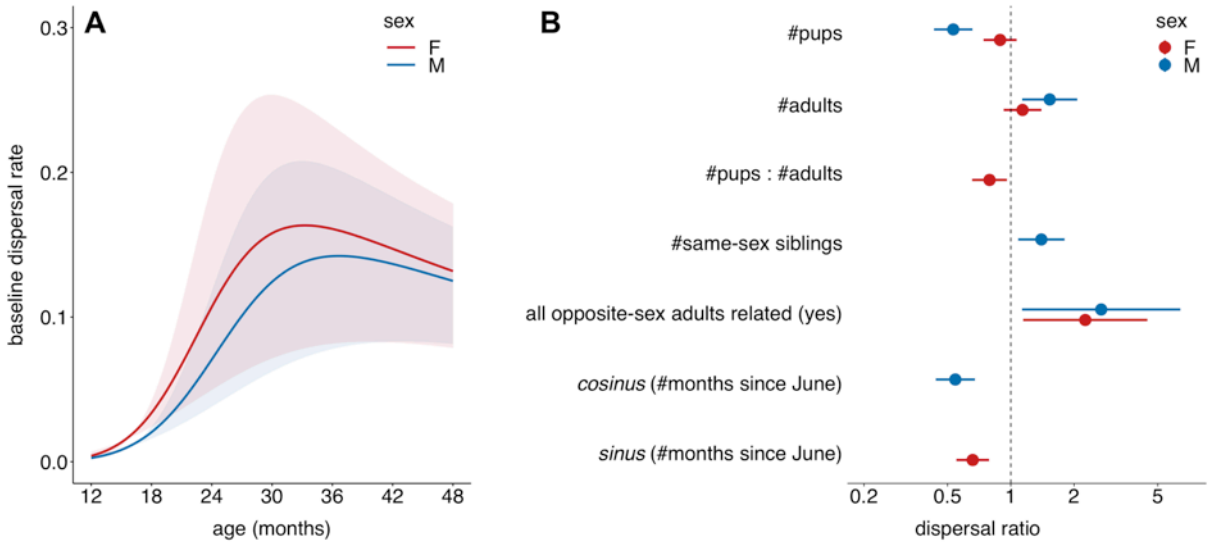


Figure 2: (A) Baseline function showing the rate of natal dispersal for male (blue) and female (red) wild dogs as a function of age. (B) Dispersal ratios showing effects of predictors and interactions on rates of natal dispersal.

Dispersal ratios >1 shifts the baseline function upwards, which results in higher dispersal rates compared to the "baseline" (for a given age and by holding all other predictors equal). The opposite applies for dispersal ratios <1.

We used the gained knowledge on factors affecting dispersal to assign a dispersal probability to missing individuals that permanently disappeared from the focal population and whose fate was unknown. We found that 18 % of missing females and 25% of missing males likely dispersed from the natal pack within one month of disappearance. In our sample of 226 missing adults, these percentages correspond to 47 natal dispersers (17 females and 33 males). Based on an average dispersing coalition size of 3 individuals, these figures translate to 17 dispersing coalitions and thus potentially 7/8 newly formed packs (assuming any two independent dispersing units formed a pack). With an expected per-pack litter size of ten pups of which about five survive to one year of age, these new packs can add approximately 35-40 adult wild dogs to the global population in one year. Given the order of magnitude of these numbers, failure to assign the correct fate to missing individuals would result in a misrepresentation of overall population dynamics, and consequently wrong management plans.

3.2. Movement, habitat preference, and connectivity

Detailed results reported in this section are part of two scientific articles that we will submit to a specialized journal in 2020. Tentative titles of the articles are: "*African wild dog dispersal and implications for management*" and "*Ranging wide: Movement corridors of dispersing African wild dogs in the Kavango-Zambesi Transfrontier Conservation Area*".

Long-term viability of the species requires the identification and preservation of key dispersal corridors that connect subpopulations. This part of our research aims at understanding the movement behaviour of dispersing wild dogs and identifying their dispersal corridors. Our analysis relies on the collection of reliable GPS relocation data and underlying environmental covariates that characterize the landscape matrix through which dispersers move.

3.2.1 GPS Data and Spatial Covariates

Since resident individuals and dispersing individuals face different pressures and motivations, we strictly distinguish between GPS data recorded during *residence* and GPS data recorded during *dispersal*. For the present analysis we only used GPS data of individuals that dispersed from the natal pack (Figure 3A). We obtained geo-referenced raster layers from freely available online services. The layers were intended to be used as covariates to help explaining the observed movement trajectories. We were able to prepare the following layers: Water-cover, Tree-cover: layer that, shrub-cover, Protection status, Human presence, Roads.

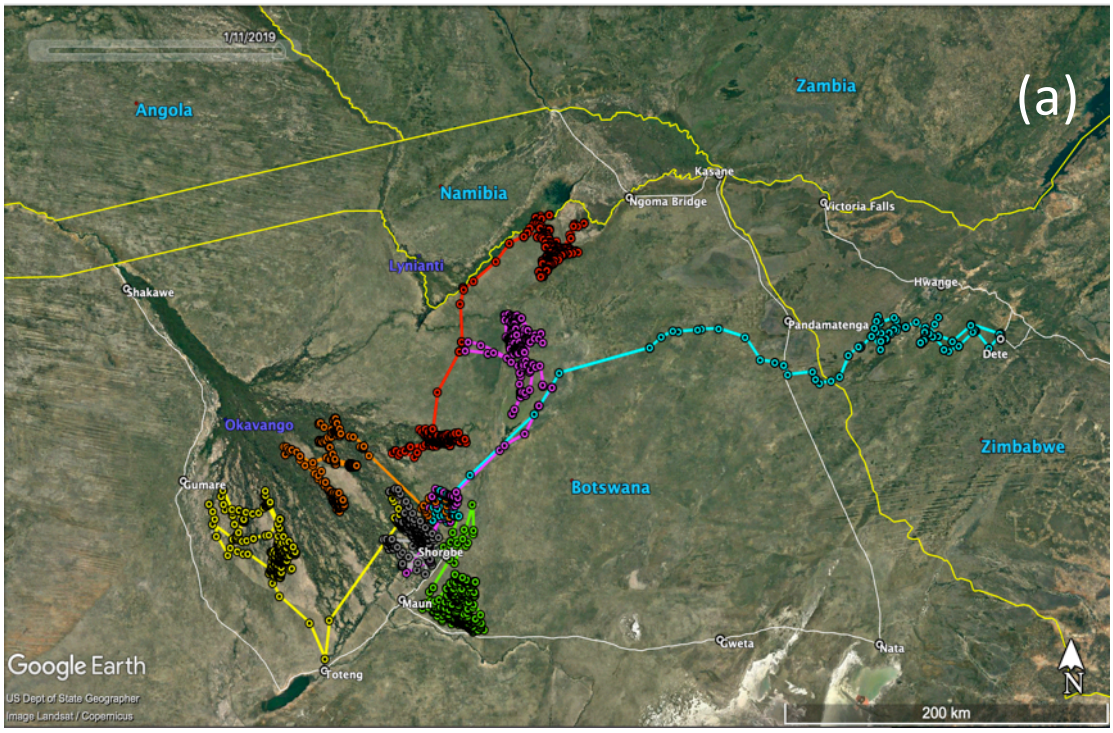
3.2.2 Habitat Selection Model and Permeability Surface

We combined the collected GPS data of dispersing wild dog coalitions with corresponding spatial covariates (e.g. vegetation type, human presence) and estimated habitat preferences of dispersing wild dogs. These habitat preferences indicated the strength at which covariates were selected or avoided during dispersal. Using the estimated habitat preferences, we then predicted a permeability surface spanning over the entire KAZA. The permeability surface indicated through which areas dispersers found it easy or difficult to move. The ultimate purpose of the permeability surface was to use it as input to calculate the expected "costs" of moving from one point in the study area to another and to identify corridors between pre-defined source points (Figure 3B).

3.2.3 Main Results and Management Considerations

Disperser strictly avoided areas characterized by a high human presence, which is mostly pronounced along major paved roads. Despite we observed a few dispersal events crossing major water bodies associated with the Okavango Delta, dispersers avoided moving through water and preferably traversed dry land when available. In particular they appeared to mainly move across areas covered by shrubs and grasslands in the vicinity of water and avoided areas densely covered by trees.

Our connectivity analysis revealed three major corridors (Figure 1B): One runs SE-NW and connects the Okavango-Linyanti ecosystem in Botswana with Luengue-Luiana NP in Angola. One runs W-E between Chobe NP in Botswana and Zimbabwe's Hwange NP. One runs NE-SW, completely across unprotected areas, and connects Kafue NP in Zambia with more central regions of the KAZA-TFCA. The Linyanti-Okavango region is the highest frequented corridor. Several minor routes branch off these three major corridors, including a southward connection between the Okavango-Linyanti and the Central Kalahari Game Reserve. According to our model there is only a very limited W-E direct connection between the Okavango region and Namibia's Kaudom NP.



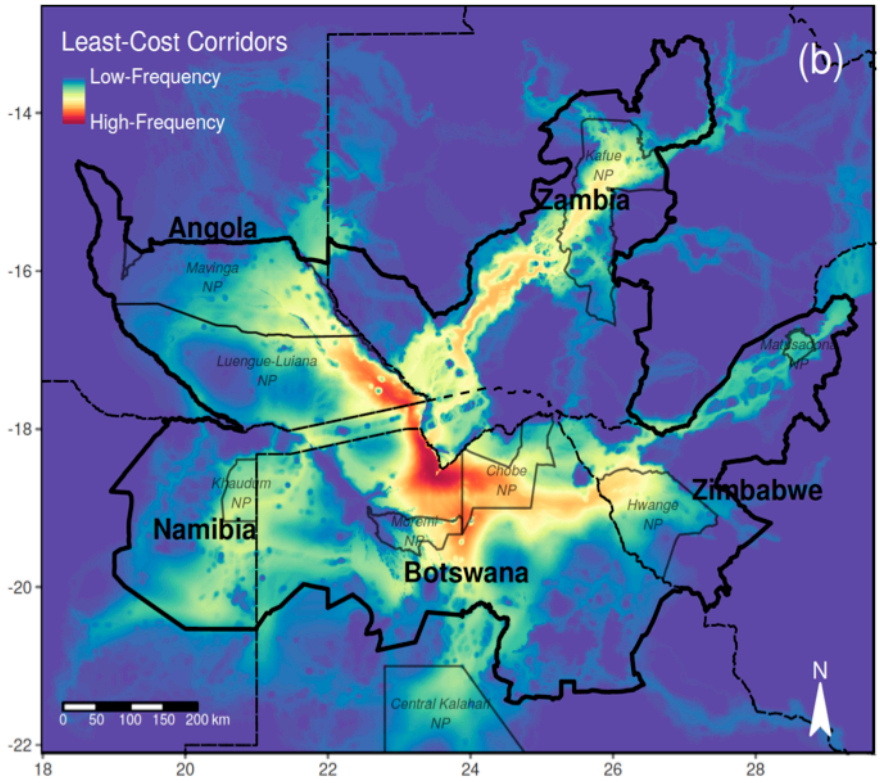


Figure 3: (A) Examples of observed African wild dog dispersal trajectories. Each color represents a single dispersing coalition, dots represent single GPS locations. White lines represent major roads and yellow thin lines international boundaries. (B) Heat map showing potential dispersal corridors (connectivity) connecting protected areas within the KAZA landscape. Red colors represent high connectivity, blue colors reduced connectivity.

We identified the Okavango-Linyanti region as a dispersal hub through which dispersers gain access to more peripheral regions of the KAZA-TFCA. On the one side this is certainly due to its central position within the KAZA-TFCA, and on the other side to its environmental characteristics, to the absence of human activities, and to the presence of the impermeable Okavango and Linyanti water bodies that likely funnel dispersal movements. The region is also instrumental for the connectivity of the subpopulations in Zambia's Kafue and Zimbabwe's Hwange NPs, which are separated by the Zambesi River and therefore forced to a detour via northern Botswana. The key role of the Okavango-Linyanti region for the overall connectivity of the KATA-TFCA calls for actions to secure its protection status in the future.

Our results also highlighted a southwards potential dispersal corridor(s) between the Okavango-Linyanti ecosystem and the Central Kalahari Game Reserve. Some areas through which such corridors run are neither part of KAZA-TFCA nor under protected status. Human presence and activities along the national road that longitudinally traverses the corridor(s) and the related increased mortality due to direct persecution and collisions may limit realized connectivity. In fact, despite having dispersed south of the Okavango Delta, no one of the monitored dispersing coalitions had crossed the national road and reached the Central Kalahari Game Reserve.

3.3. Wanted Flyer

Since beginning of this initiative, we have received information on 248 single sightings. Each sighting may contain a few to over hundred pictures, together with information on date and rough location (Figure 4). In 60 % of the cases, tourists who contacted us were made aware of our project through the poster located at Maun Airport, 27 % through the posters at the main gates of Moremi GR and Chobe NP and only 13 % through information that they received at the lodges.

Given the large number of photographs received and the time required to sort them manually, we were not yet able to match all pictures against our database (this process will speed up when the algorithm developed by WildMe will be available; cfr. Section 2.3.). Nonetheless, during 2019 we were able to obtain regular composition updates and rough

locations on 7 packs bordering the BPCT historic main study area without the need of deploying any additional radio collars. These 7 uncollared packs add to the 11 collared packs (resident packs regularly followed by BPCT plus dispersal packs) that we have been following during 2019 and constitute an important part of the data collected during the year.

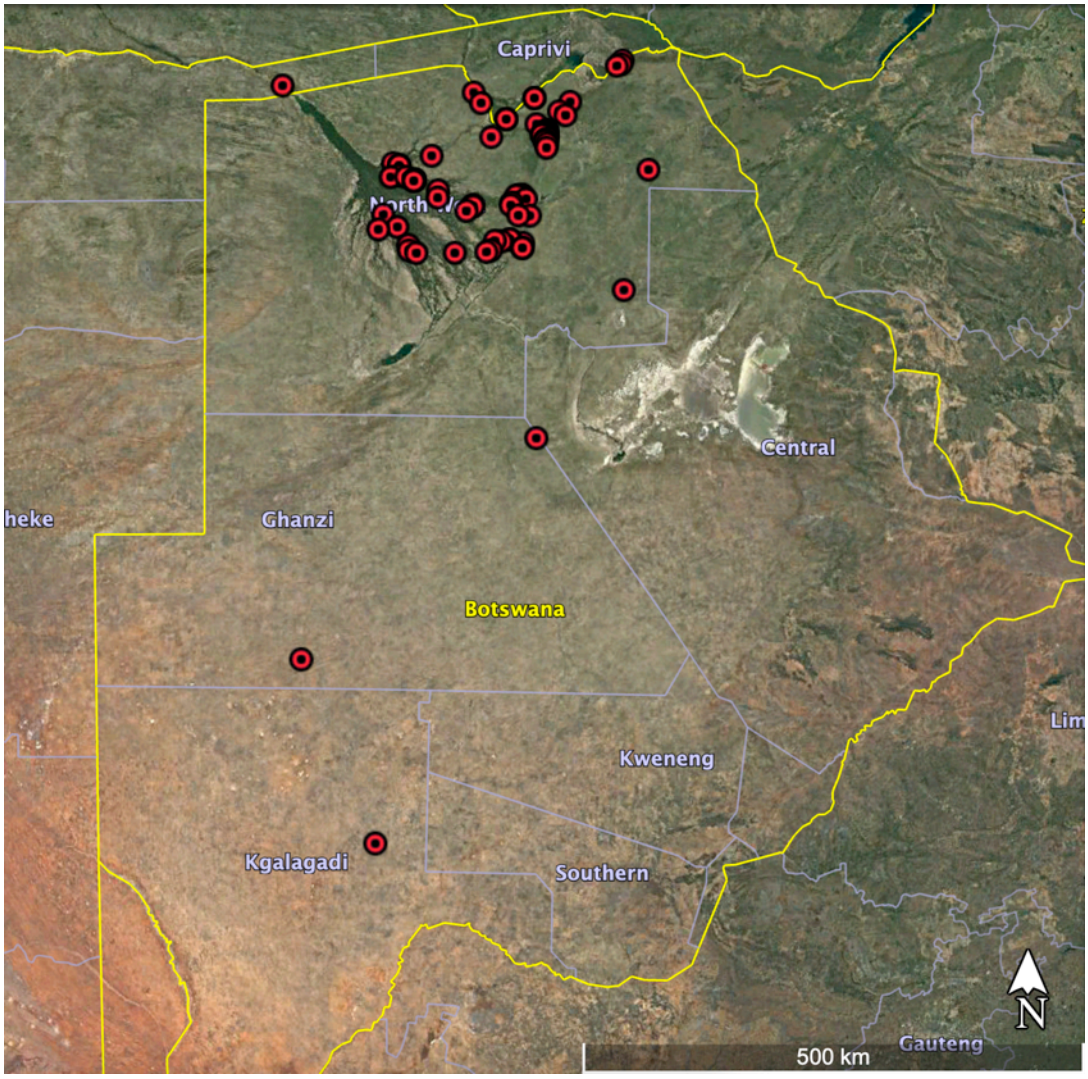


Figure 4: Spatial representation (red dots) of a subset (80 out of 248) of the sightings (pictures) received from tourists.

7. Future perspectives and directions

Our project is a complementary project to the long-term wild dog research and monitoring program at BPCT. We therefore see the dispersal project as a long-term project to be

developed and integrated in other wild dog-related activities at BPCT. The novelty of the dispersal project is that it adds a new spatial and population dynamic dimension to BPCT wild dog research. However, the core of the dispersal project is and remains the wild dog population resident in the Okavango Delta, which acts as source for the dispersing wild dogs that are the focus of this study.

In the short term, we plan to continue our research, which focuses at understanding the fate of individuals that disperse from the main BPCT study area across northern Botswana and use this information to assess population viability under changing environmental and anthropogenic scenarios.
We would like to strengthen our collaboration with the tourism industry and increase the flow of information transfer (sightings and pictures) from tourists to us and from us back to tourists and tour operators. In particular, we aim at increasing the moderate number of reports (only 13 %; cfr. Section 3.3.) that we receive directly from lodges.

In the medium to long term, we can foresee expansion of activities to a larger national (and international) extent, and this will be much dependent on the movement trajectories of the dispersing wild dogs. We would also welcome a collaborative effort with other researchers working in other areas of the country to gather information on dispersing wild dogs across different ecosystems. This information will be invaluable given the mosaic of ecosystems that characterize Botswana and the KAZA/TFCA landscape.

In accordance with the National Wildlife Conservation Research Action Plan, through our wild dog dispersal project we aim to provide scientific information and advice to policy makers, resource managers, stakeholders and the public. The information gathered through the wild dog dispersal project will provide evidence-based information for the conservation and management of the African wild dog, nationally and internationally. In this respect, the spatial extent of the dispersal project can help support research and conservation across transboundary ecosystems such as the KAZA/TFCA, for which we identified Botswana as a key wild dog conservation and dispersal hub.