Flooding of the Okavango Delta influences Connectivity for Dispersing African Wild Dogs

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Abstract

Many ecosystems experience substantial changes in environmental conditions due to seasonality. While such seasonal changes may drastically alter connectivity for endangered species, most studies represent the environment by a static set of spatial layers, thus ignoring seasonal variation. Here, we address this shortcoming and employ individual-based simulations to investigate how seasonal flooding of the Okavango delta influences connectivity for dispersing African wild dogs (*Lycaon pictus*). Our results show that the Okavango delta poses a substantial dispersal barrier when the flood is at maximum extent, yet that viable dispersal corridors exist when the flood is at a minimum level. Despite a better understanding of the conservation needs for African wild dogs, our study also provides evidence that incorporating seasonality in studies of connectivity is imperative to more accurately predict the dispersal ability of endangered species.

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1 Introduction

Hello, I'm an introduction.

However, **?** and **?** used a single floodmap...

2 Methods

2.1 Study Area

As depicted in Figure 1, the study area encomassed ...

2.2 Spatial Habitat Layers

In order to generate spatial layers that depict the flood extent at different points in time, we ... Figure 2.

2.3 Dispersal Simulation

We used a previously parametrized movement model to simulate dispersal of African wild dogs. To simulate dispersing wild dogs, we employed the simulation framework presented in **?**. In this framework, a movement model that renders habitat and movement preferences of dispersing individuals is parametrized using step-selection functions. Once parametrized, the model can be employed to simulate virtual dispersers moving across the landscape.

We released virtual dispersers at random locations within the four distinct source areas depicted in Figure 1. From each source area we simulated xx individuals moving across the landscape at minimum flood and another xx individuals at maximum flood. For comparison, we also ran the simulations for a medium flood extent, yet the results for this will be presented in the appendix.

2.4 Connectivity

To gain insights into landscape connectivity from the simulated dispersal events, we prepared three complementary connectivity maps (see again (**?**)); a heatmap, indicating the absolute frequency at which each pixel in the study area was traversed by a virtual disperser, a betweenness map, highlighting pixels of particular importance to facilitate movement from one area to another, and a map of interpatch connectivity, depicting the presence and intensity of functional links between source areas. To compute the heatmap, we counted how many times each pixel in the study area was traversed by a virtual disperser. To calculate betweenness, we overlayed the study area with a regular grid and used the simulated trajectories to determine movements from one grid-cell to another. Specifically, we counted how often transitions from one grid-cell to any other occured. The centerpoint of each grid-cell then served as network node, and the number of transitions from one cell to another as weights between the respective nodes. Based on the so generated network, we then computed betweenness scores for all network nodes (i.e. for all grid-cells across the study area). Lastly, to compute interpatch connectivity, we determined the frequency at which virtual dispersers originating from one source area reached any of the other source areas. We also calculated the average dispersal duration needed until individuals reached the respective area.

3 Results

4 Discussion

5 Authors' Contributions

D.D.H., D.M.B., A.O. and G.C. conceived the study and designed methodology; D.M.B., G.C., and J.W.M. collected the data; D.D.H. and D.M.B. analysed the data; G.C. and A.O. assisted with modeling; D.D.H., D.M.B., and G.C. wrote the first draft of the manuscript and all authors contributed to the drafts at several stages and gave final approval for publication.

6 Data Availability

GPS movement data of dispersing wild dogs is available on dryad (**?**). Access to R-scripts that exemplify the application of the proposed approach using simulated data are provided through Github (`https://github.com/DavidDHofmann/DispersalSimulation`). In addition, all codes required to reproduce the African wild dog case study will be made available through an online repository at the time of publication.

7 Acknowledgements

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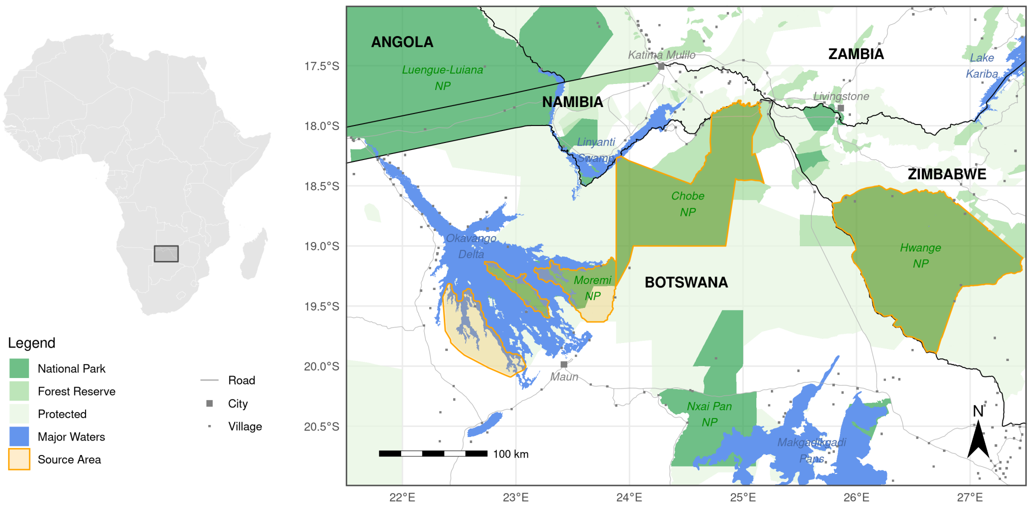
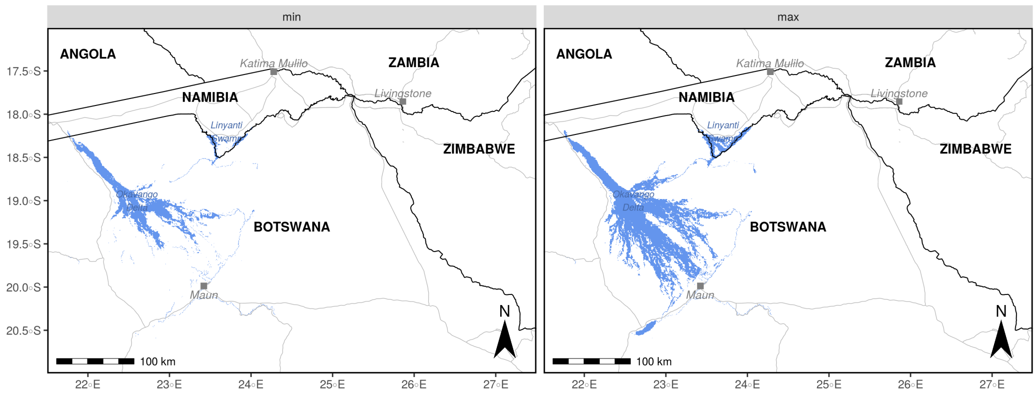
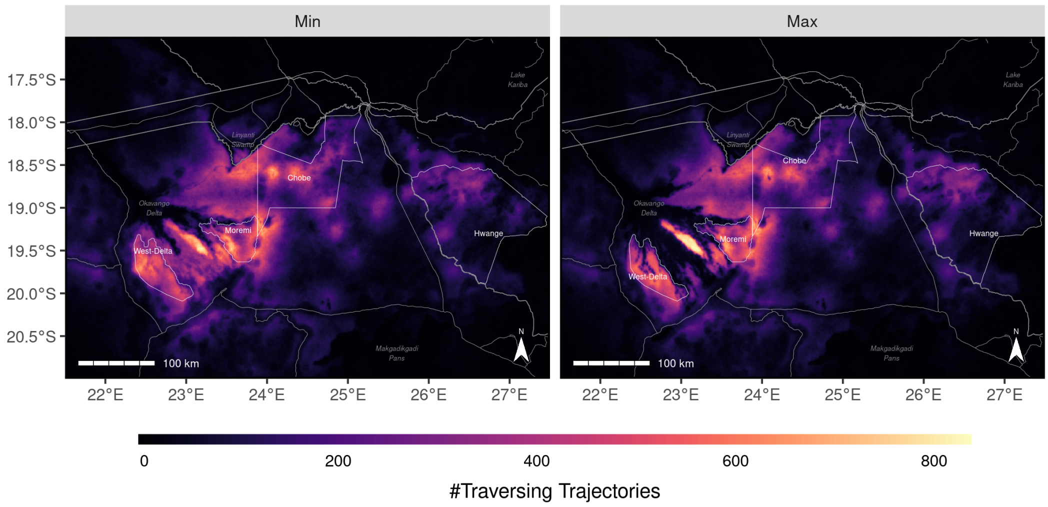


Figure 1: Study area across which we simulated dispersal events. Virtual dispersers were released at random locations within the orange source areas.



min
max
ANGOLA
ZAMBIA
NAMIBIA
ZIMBABWE
BOTSWANA
Katima Mulilo
Livingstone
Linyanti
Maun
N
100 km
17.5°S
18.0°S
18.5°S
19.0°S
19.5°S
20.0°S
20.5°S
22°E
23°E
24°E
25°E
26°E
27°E

Figure 2



Min
Max
17.5°S
18.0°S
18.5°S
19.0°S
19.5°S
20.0°S
20.5°S
22°E
23°E
24°E
25°E
26°E
27°E
Chobe
Moremi
West-Delta
Hwange
100 km
N
0
200
400
600
800
#Traversing Trajectories

Figure 3

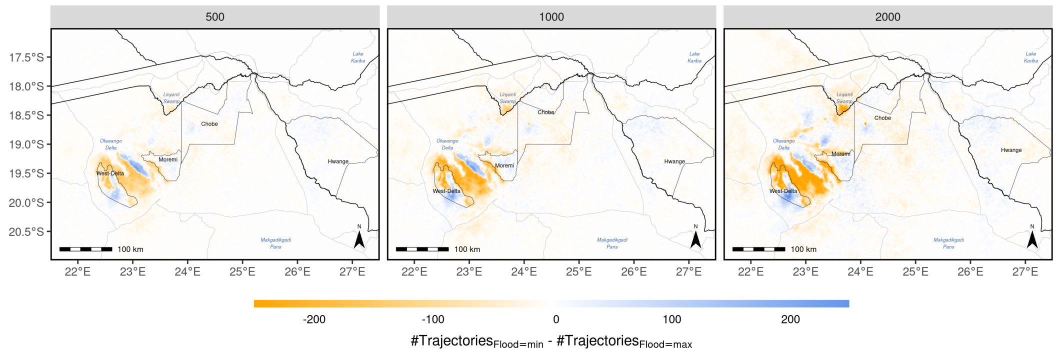

500
1000
2000
17.5°S
18.0°S
18.5°S
19.0°S
19.5°S
20.0°S
20.5°S
22°E
23°E
24°E
25°E
26°E
27°E
Chobe
Moremi
West Delta
Hwange
100 km
N
-200
-100
0
100
200
#Trajectories$_{Flood=min}$ - #Trajectories$_{Flood=max}$

Figure 4