Buffalo, cattle and their interactions at the edge of transfrontier conservation areas

de Garine-Wichatitsky, M., Caron, A., Valls, H., Perroton, A., Moyo, V. A., Miguel, E., Zengeya, F., Gomo, C., Cornélis, D., Grosbois, V., Hoffmeyr, M. D., Mukamuri, B., Guerbois, C., Pfukenyi, D., Murwira, A., Chamaillé-Jammes, S., Fynn, R., Le Page, C., Figuié M., Fritz, H.

Research platform
Production and conservation in partnership

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AGRICULTURAL RESEARCH FOR DEVELOPMENT

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THUTO KE THEBE
UNIVERSITY OF BOTSWANA

South African NATIONAL PARKS

Introduction

- *Material and methods*

Multi-disciplinary wildlife-livestock surveys 2008-16

- Ecological surveys: monitoring movements of sympatric cattle/buffalo/(herders) with GPS; camera traps; remote sensing and ground surveys for monitoring grazing and water resources

- Disease surveys: samples collection from immobilized buffalos, longitudinal livestock surveys, serology or other appropriate diagnostic methods

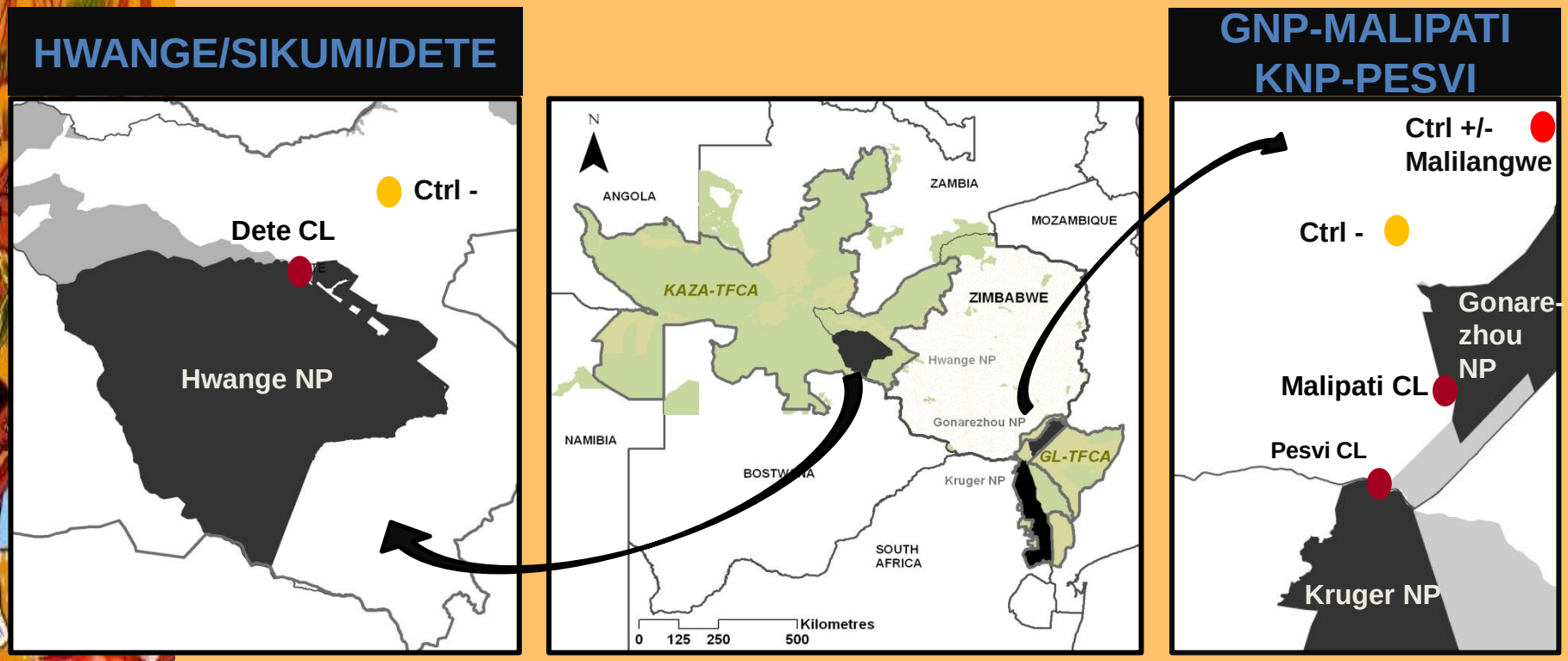
- Socio-anthropological surveys: interviews, focus group discussions, participatory research, companion modelling

Introduction

- *Material and methods:*

KAZA and GLTFCA/peripheries

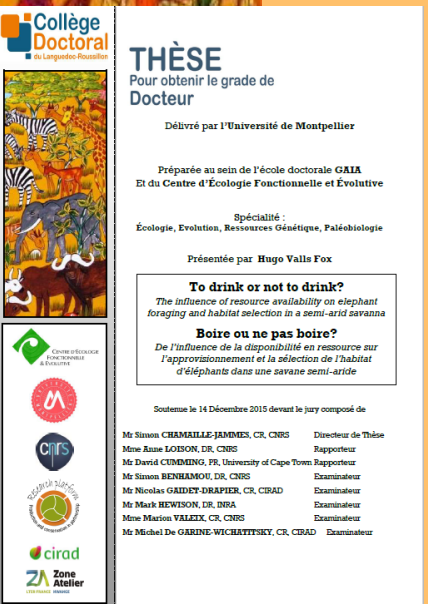
Comparison of different (buffalo/cattle) interfaces



Material and methods

List of main references with details at the end of this ppt

de Garine-Wichatitsky et al., 2010;Guerbois, 2012;Miguel, 2012;Caron et al., 2013;de Garine-Wichatitksy et al., 2013;de Garine-Wichatitsky et al., 2013a;de Garine-Wichatitsky et al., 2013b;de Garine-Wichatitsky et al., 2013c;Guerbois et al., 2013;Miguel et al., 2013;Kock et al., 2014;Zengeya, 2014; Fynn et al., 2015;Perroton, 2015;Valls-Fox, 2015; Zengeya et al., 2015;Caron et al., 2016…


Collège Doctoral du Languedoc-Roussillon

THÈSE
Pour obtenir le grade de
Docteur

Délivré par l'Université de Montpellier

Préparée au sein de l'école doctorale GAIA
Et du Centre d'Écologie Fonctionnelle et Évolutive

Spécialité :
Écologie, Evolution, Ressources Génétique, Paléobiologie

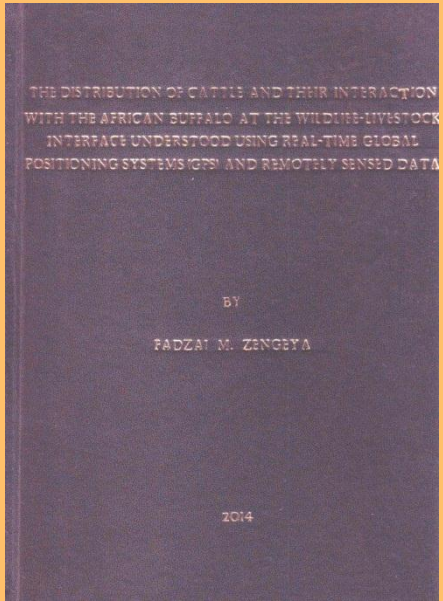
Présentée par Hugo Valls Fox

To drink or not to drink?
The influence of resource availability on elephant foraging and habitat selection in a semi-arid savanna

Boire ou ne pas boire?
De l'influence de la disponibilité en ressource sur l'approvisionnement et la sélection de l'habitat d'éléphants dans une savane semi-aride

Soutenue le 14 Décembre 2015 devant le jury composé de

Mr Simon CHAMAILLE-JAMMES, CR, CNRS	Directeur de Thèse
Mme Anne LOISON, DR, CNRS	Rapporteur
Mr David CUMMING, PR, University of Cape Town	Rapporteur
Mr Simon BENHAMOU, DR, CNRS	Examinateur
Mr Nicolas GAIDET-DRAPIER, CR, CIRAD	Examinateur
Mr Mark HEWISON, DR, INRA	Examinateur
Mme Marion VALEIX, CR, CNRS	Examinateur
Mr Michel De GARINE-WICHATITSKY, CR, CIRAD	Examinateur


THE DISTRIBUTION OF CATTLE AND THEIR INTERACTION WITH THE AFRICAN BUFFALO AT THE WILDLIFE-LIVESTOCK INTERFACE UNDERSTOOD USING REAL-TIME GLOBAL POSITIONING SYSTEMS (GPS) AND REMOTELY SENSED DATA

BY

FADZAI M. ZENGEYA

2014

Contents lists available at ScienceDirect

Remote Sensing Applications: Society and Environment

journal homepage: www.elsevier.com/locate/rsase

Spatial overlap between sympatric wild and domestic herbivores links to resource gradients

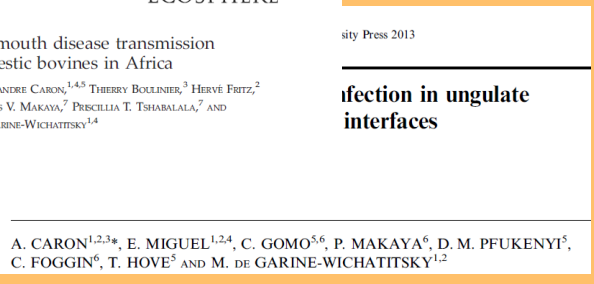
Fadzai M. Zengeya[a,*], Amon Murwira[a], Alexandre Caron[b,d], Daniel Cornélis[b], Patience Gandiwa[c], Michel de Garine-Wichatitsky[b,c]

esa

ECOSPHERE

Contacts and foot and mouth disease transmission from wild to domestic bovines in Africa

Eve Miguel,[1,2,3,4,†] Vladimir Grosbois,[1] Alexandre Caron,[1,4,5] Thierry Boulinier,[3] Hervé Fritz,[2] Daniel Cornélis,[1] Chris Foggin,[6] Pious V. Makaya,[7] Prescillia T. Tshabalala,[7] and Michel de Garine-Wichatitsky[1,4]


sity Press 2013

ıfection in ungulate interfaces

A. CARON[1,2,3]*, E. MIGUEL[1,2,4], C. GOMO[5,6], P. MAKAYA[6], D. M. PFUKENYI[5], C. FOGGIN[6], T. HOVE[5] AND M. DE GARINE-WICHATITSKY[1,2]

Introduction

- *Public perception*

Beautiful Iconic Big Fives

Media » The beautiful Big Five

08 August 2013 by Lethabo-Thabo Royds

The beautiful Big Five

The prospect of seeing the Big Five is a major reason for many people to visit game reserves in South Africa.

A leopard rests in a tree in the Sabi Sand Reserve in Mpumalanga, adjacent to the Kruger National Park. Photo courtesy of Cameron B, aka Celtics24

Iconic elephant shot in Zimbabwe

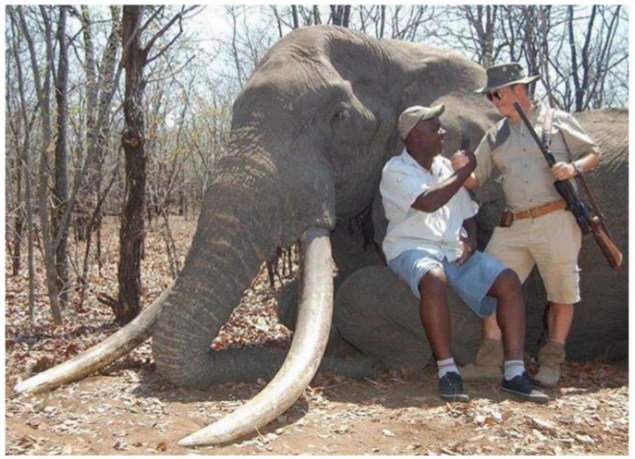
Posted on 15 October, 2015 by News Desk in Hunting, News and the News Desk post series. — 94 Comments

Posted: October 15, 2015

Share 8100 Like 8.8K Tweet 241 G+1 66 Pinterest 13 Email 17

EXTRACT FROM THE FOLLOWING THIRD PARTY SOURCE: *Written by Adam Cruise for Conservation Action Trust. Images sourced on Facebook.*

On the 8th of October an elephant with tusks estimated to weigh over 120lb (54,4+kg) each was shot in the Malapati concession, located in southeastern Zimbabwe near Gonarezhou National Park.



Introduction

- *Public perception*

Beautiful Iconic Big Fives vs **The Dangerous Villain**

Free Ranging Zimbabwe Buffalo Hunting Safaris.

In terms of Dangerous game, Zimbabwe is one of the most affordable places in Africa to hunt Cape buffalo.

Introduction

- *Public perception*

Beautiful Iconic Big Fives vs **The Dangerous Villain**

Free Ranging Zimbabwe Buffalo Hunting Safaris.

The African buffalo: A villain for inter-species spread of infectious diseases in southern Africa

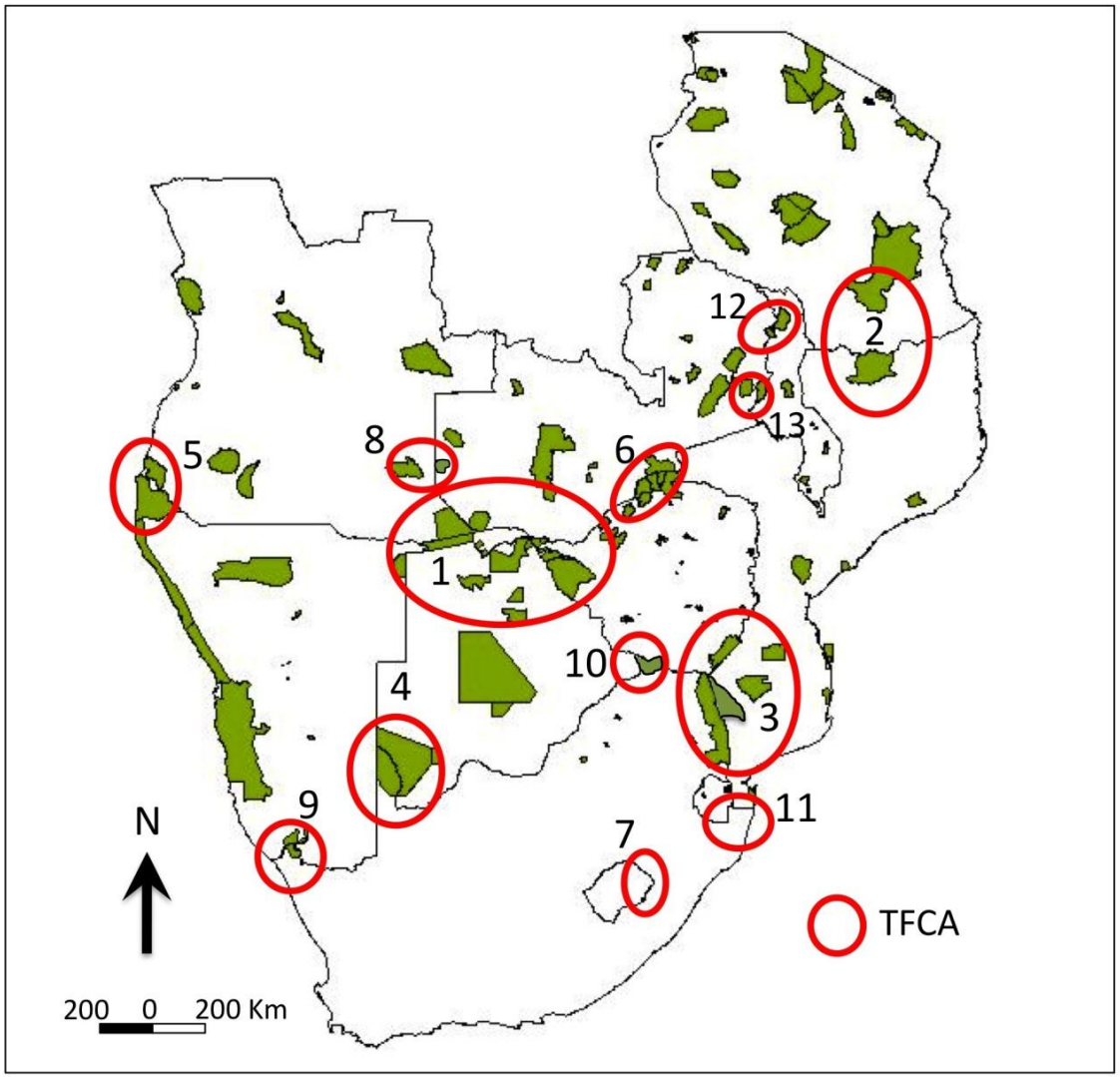
Authors:
Anita L. Michel[1]
Roy G. Bengis[2]

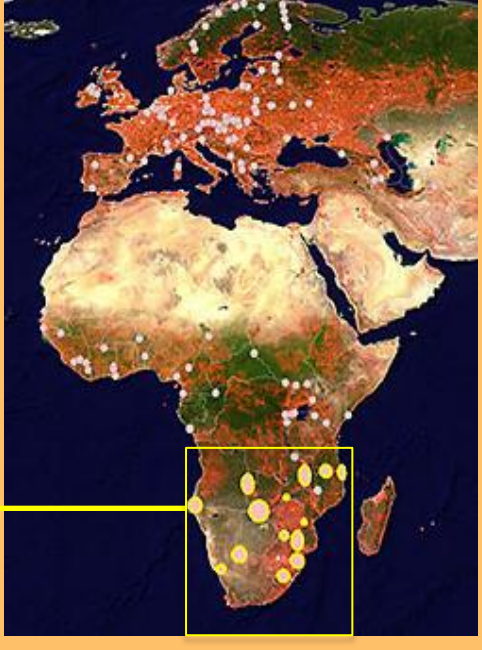
African Wild Ungulates Compete with or Facilitate Cattle Depending on Season

Wilfred O. Odadi,[1*] Moses K. Karachi,[2] Shaukat A. Abdulrazak,[3] Truman P. Young[1,4*]

Introduction

- *Justification : TFCAs*





Cumming, Dzingirai & de Garine-Wichatitsky. 2013. In TFCA: people living on the edge, Earthscan

Objectives:
Transboundary
- Conservation
and
- Development

Introduction

- *Justification : Coexistence and OneHealth*

- **Promote biodiversity conservation (« wildlife corridors »)**

- **Promote wildlife-based activities: (transboundary) tourism**

- **Mitigate human-wildlife conflicts**

- **One Health (people/livestock/wildlife)**

Introduction

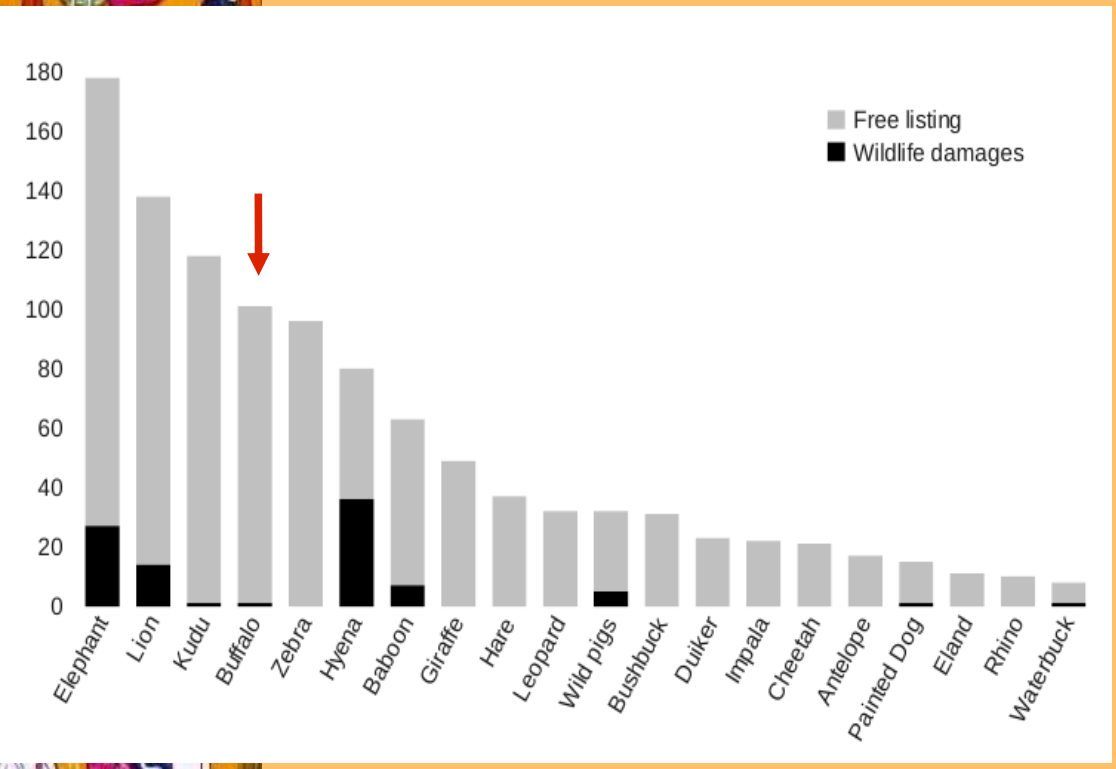
- *Human-Wildlife (buffalo) conflicts*

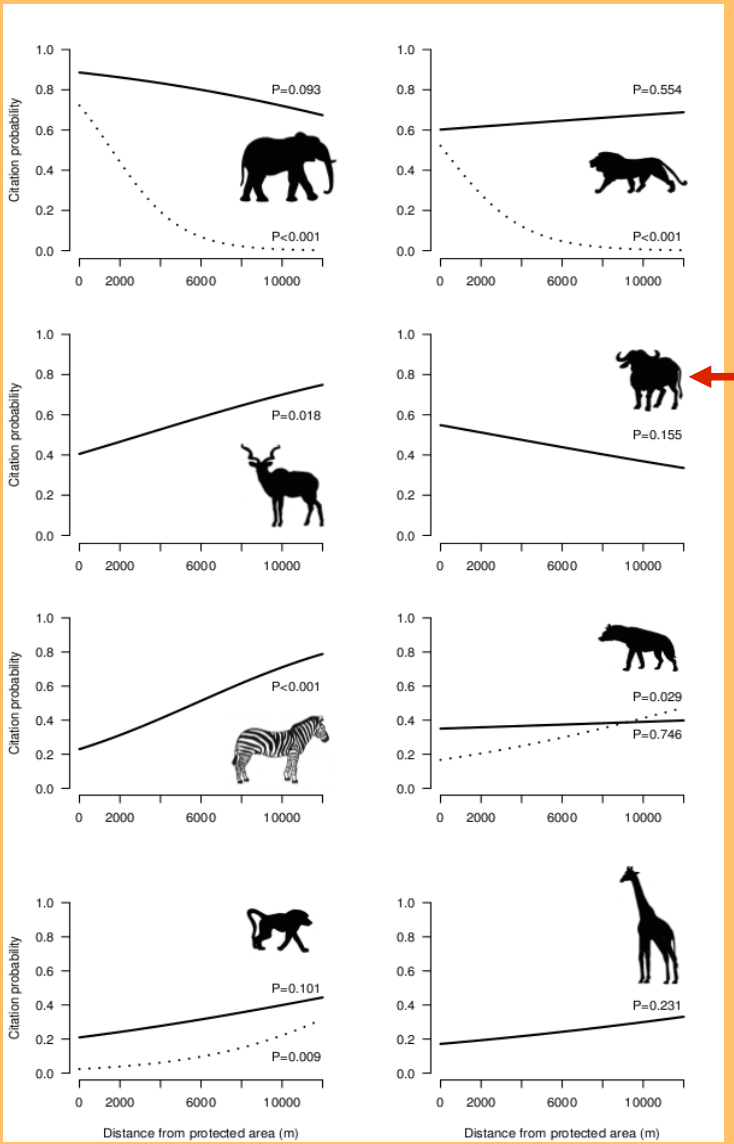
Dete CL. Grazing areas and resources - mapping based on interviews and group-discussions; 217 households; May to July 2011

Guerbois. 2012. PhD Thesis.

Determinants of wildlife perception in Communal Areas are mostly related to the cultural domains rather than damages to crops or livestok

Guerbois et al. 2013.
Biological Conservation





Cited in free-list
Cited as problem species

Introduction

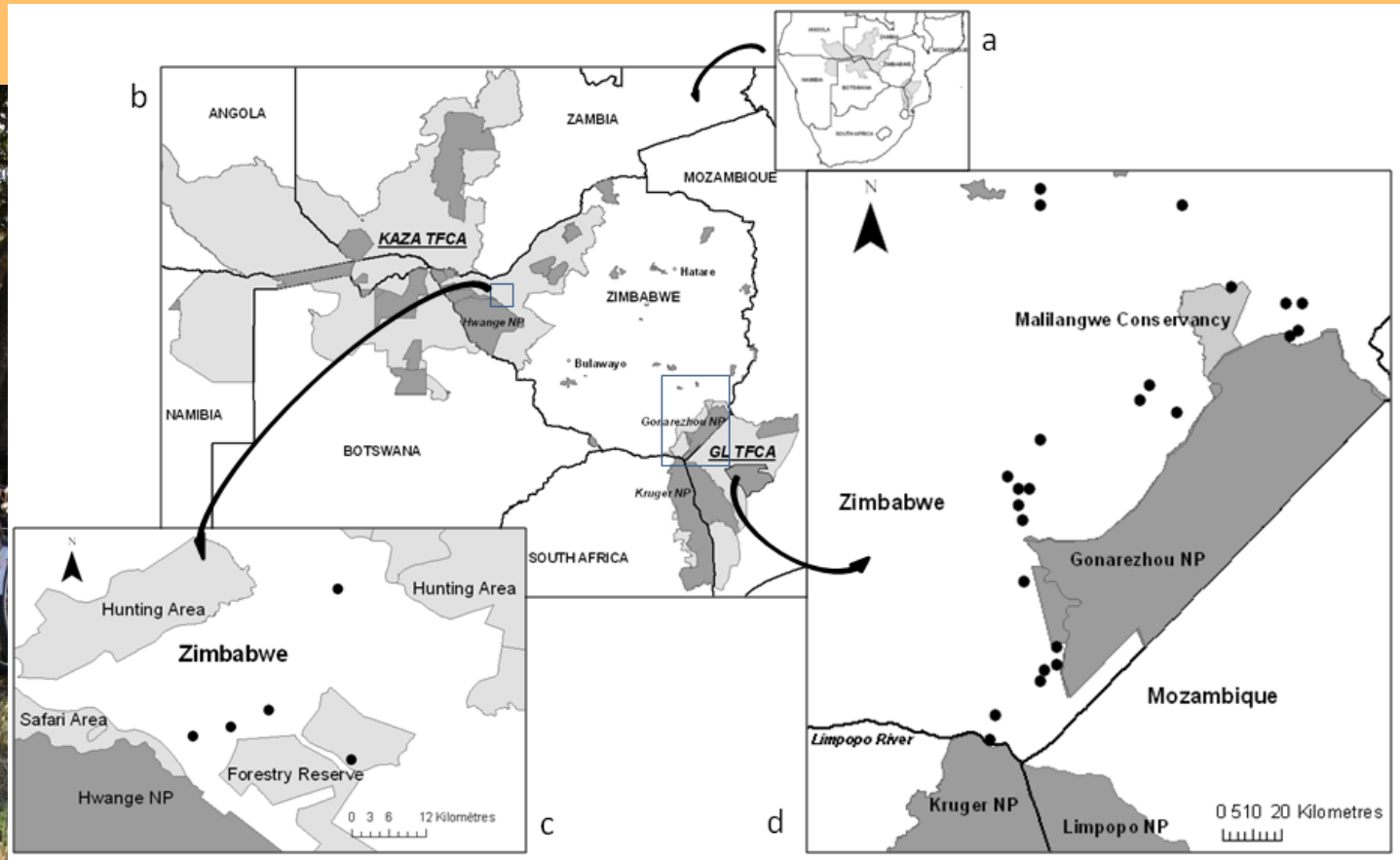
- *Human-Wildlife (buffalo) conflicts*

Cattle owners' awareness of disease risks and perceptions of the role played by wildlife

de Garine-Wichatitsky et al. 2013. CIMID

2008-10; 24 dip-tanks in periphery of Gonarezhou NP et Hwange NP

Free-list/semi-directed questionnaires (n=256), group discussions (DT comittees)



Q. « Involvement of wildlife in livestock disease epidemiology »?

Buffalo was (by far) the most frequently mentioned wildlife species, followed **by wildebeest** (but no mention of Alcelaphine Herpes virus 1)

Disease or syndrom	Citation (n)	Don't know	No	Yes	Species Citation	Main wildlife species cited	Second most cited wildilfe species
Foot and mouth	190	18%	4%	77%	171	Buffalo (82%)	Wildebeest (6%)
Lumpy Skin	127	52%	26%	22%	35	Buffalo (54%)	Wildebeest (17%)
Blackleg	122	39%	29%	32%	50	Buffalo (62%)	Wildebeest (14%)
Heartwater	89	39%	37%	24%	26	Buffalo (62%)	Wildebeest (11.5%)
Anthrax	67	46%	22%	31%	34	Buffalo (47%)	Wildebeest (15%)
Babesiosis	43	33%	47%	21%	10	Buffalo (80%)	Eland (10%), Elephant (10%)

- Involvement of wildlife in disease epidemiology

Buffalo was (by far) the most frequently mentioned wildlife species, followed by wildebeest (but no mention of Nasal Catarrh)

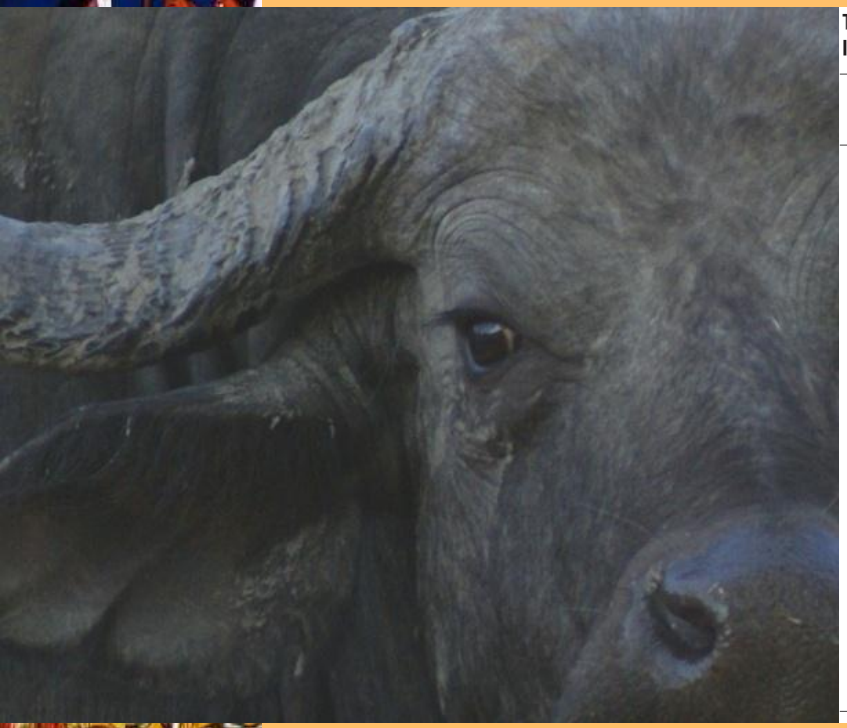


Table I
Infectious diseases commonly transmitted from wildlife hosts to domestic livestock

Disease and causative agent	Direct transmission (D) Arthropod-borne (A)	Maintenance host	Domestic animals affected	Epizootic potential
Foot and mouth disease (aphthovirus)	D	African buffalo and cattle	Cattle, pigs, sheep and goats	Major
Trypanosomosis (*Trypanosoma* spp.)	A *Glossina* spp. and biting flies	Elephant, wild ruminants and wild suids	Cattle, horses, pigs, sheep, goats and dogs	Moderate
African swine fever (asfarvirus)	A and D *Ornithodorus* spp.	Argasid ticks, warthogs	Domestic pigs	Major
Theileriosis or Corridor disease (*Theileria parva* group)	A *Rhipicephalus* sp. ticks	African buffalo	Cattle	Moderate
Heartwater (*Cowdria ruminantium*)	A *Amblyomma* spp. ticks	Suspect buffalo, other artiodactyls, chelonians and gallinaceous birds	Cattle, sheep and goats	Moderate
African horse sickness (orbivirus)	A *Culicoides* midges	Zebra	Horses and donkeys	Moderate
Rift Valley fever (phlebovirus)	A *Aedes* and *Culex* spp.	Aedine mosquitoes	Sheep, goats, cattle, wild bovidae	Moderate
Bluetongue (orbivirus)	A *Culicoides* midges	Various artiodactyls (uncertain)	Sheep and cattle	Moderate
Lumpy skin disease (capripox)	Uncertain, probably insect-borne	Uncertain	Cattle	Moderate
Malignant catarrhal fever (Alcelaphine herpesvirus-1)	D (?)	Blue and black wildebeest	Cattle	Limited (seasonal)
Newcastle disease (paramyxovirus)	D	Wild birds, exotic pet birds	Poultry	Major
Classical swine fever (hog cholera)	D	Wild boar	Pigs	Major

« The African Buffalo – a villain for inter-species spread of infectious diseases in Southern Africa »

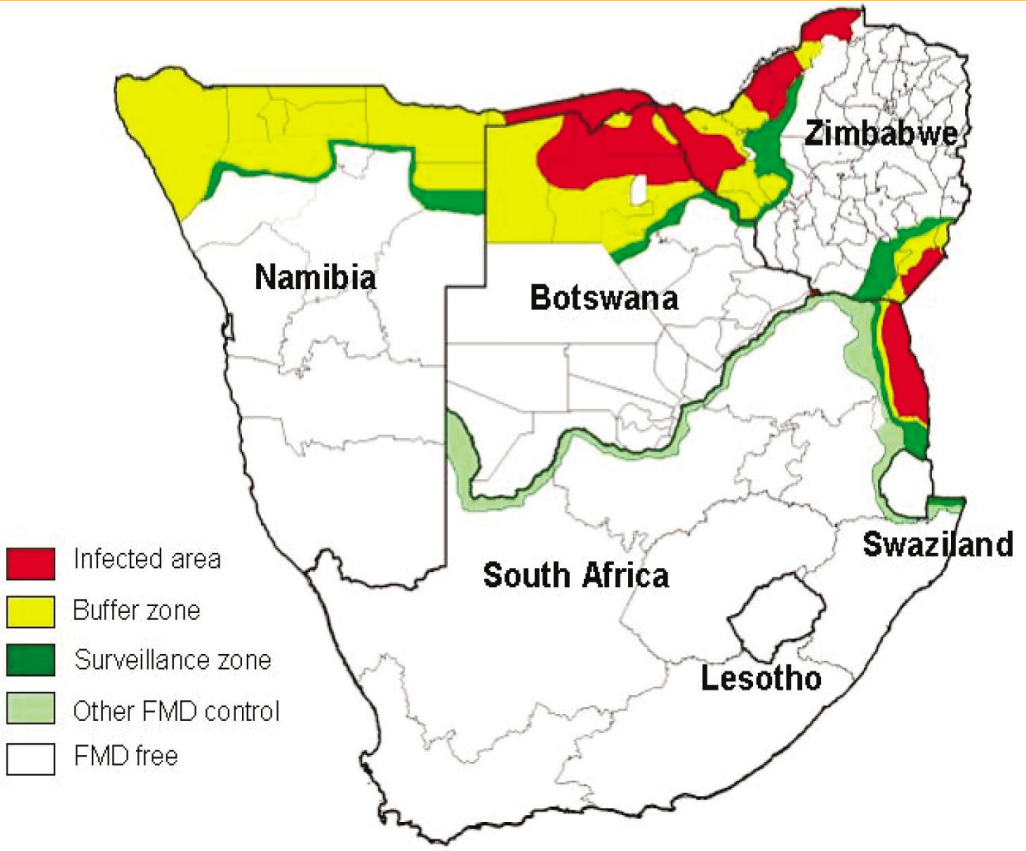
Michel & Bengis 2012

Bengis 2002

Kock et al. 2014. In Ecology, Evolution and Behaviour of Wild Cattle. Cambridge U. Press

Diseases at wildife-livestock-(human) interfaces

Indirect effects: movements and trade of livestock



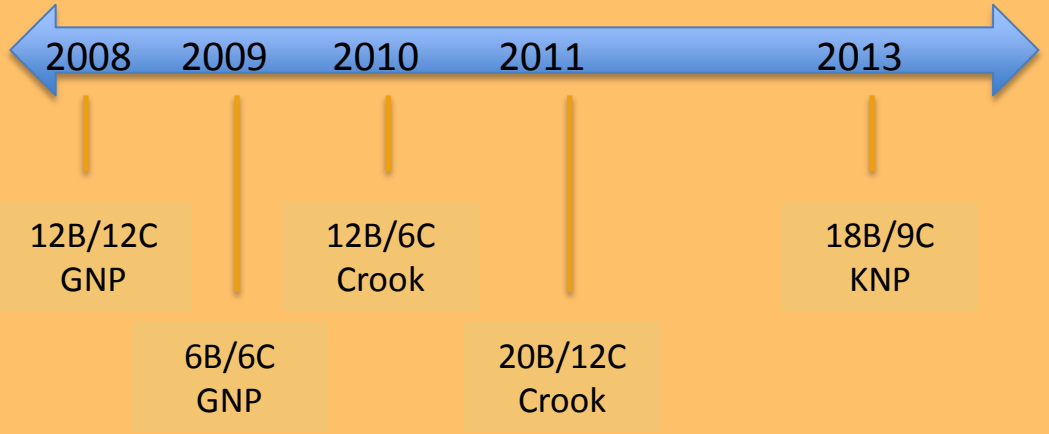
Movement Patterns

- *Buffalo Home Range*

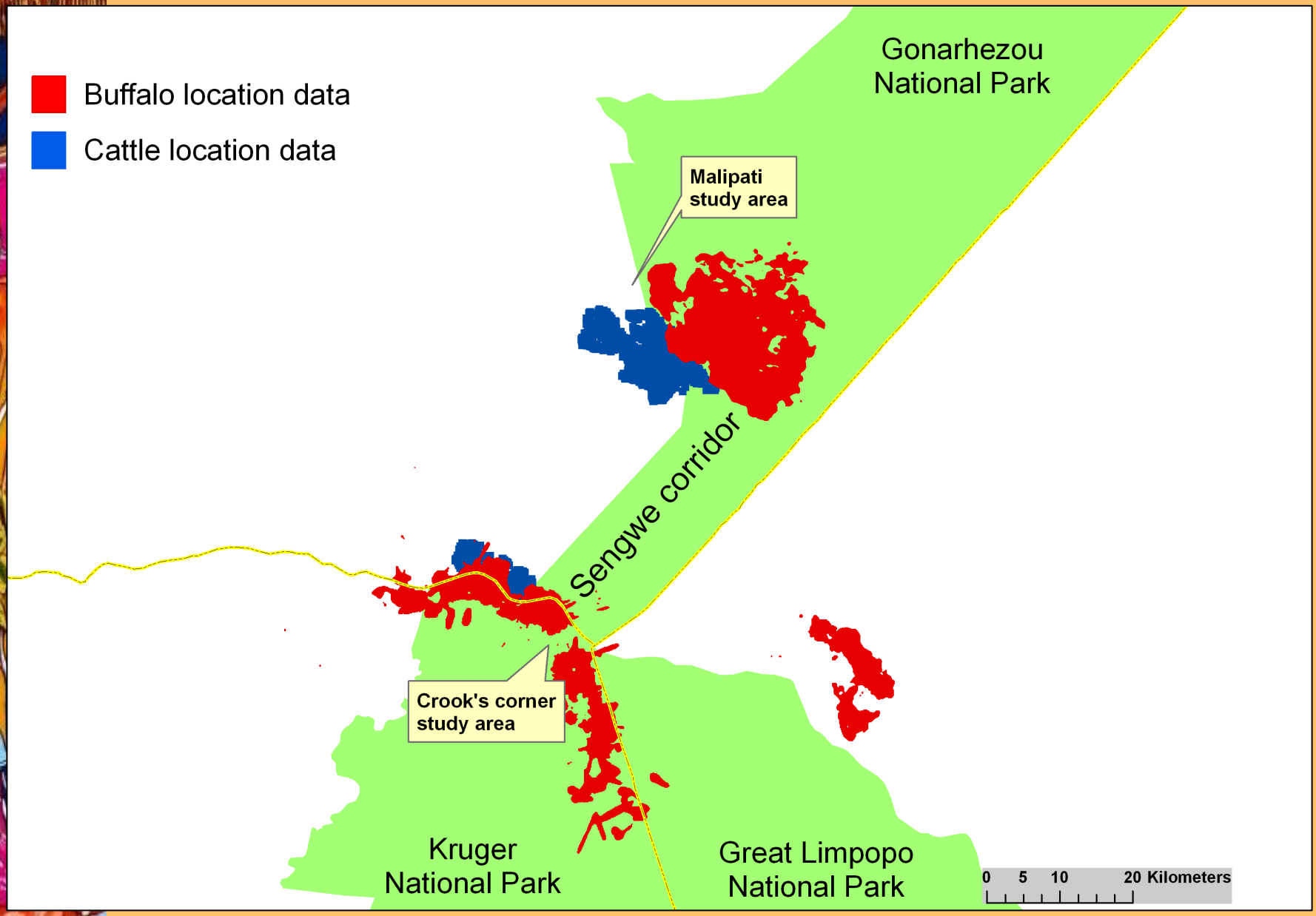
Buffalo Home Range: adult females

Communal area
•45 GPS collars on cattle (1/herd)
GPS point every hour

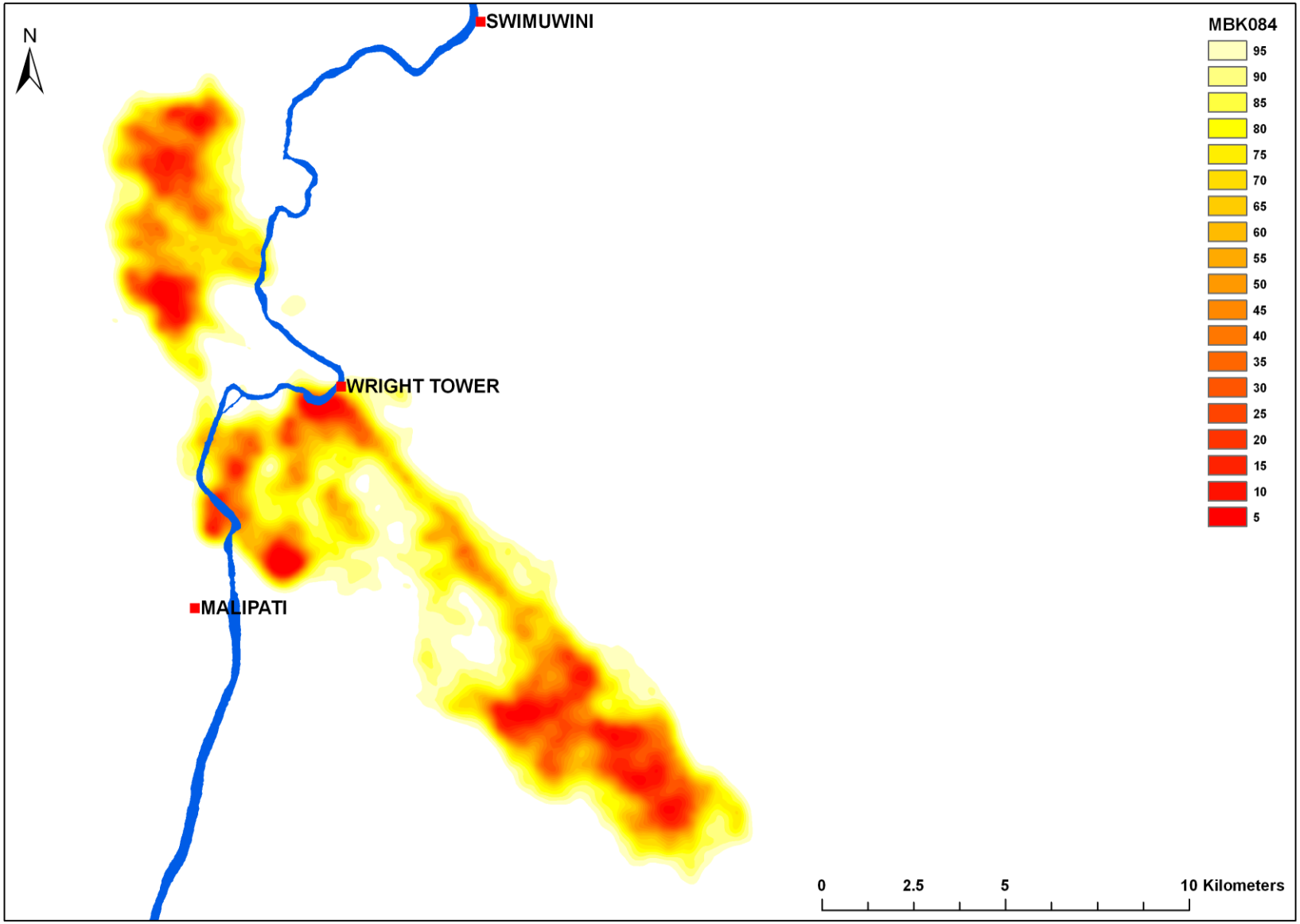
National parks
•68 GPS collars on buffalos (3/herd)
GPS point every hour



Buffalo adult females

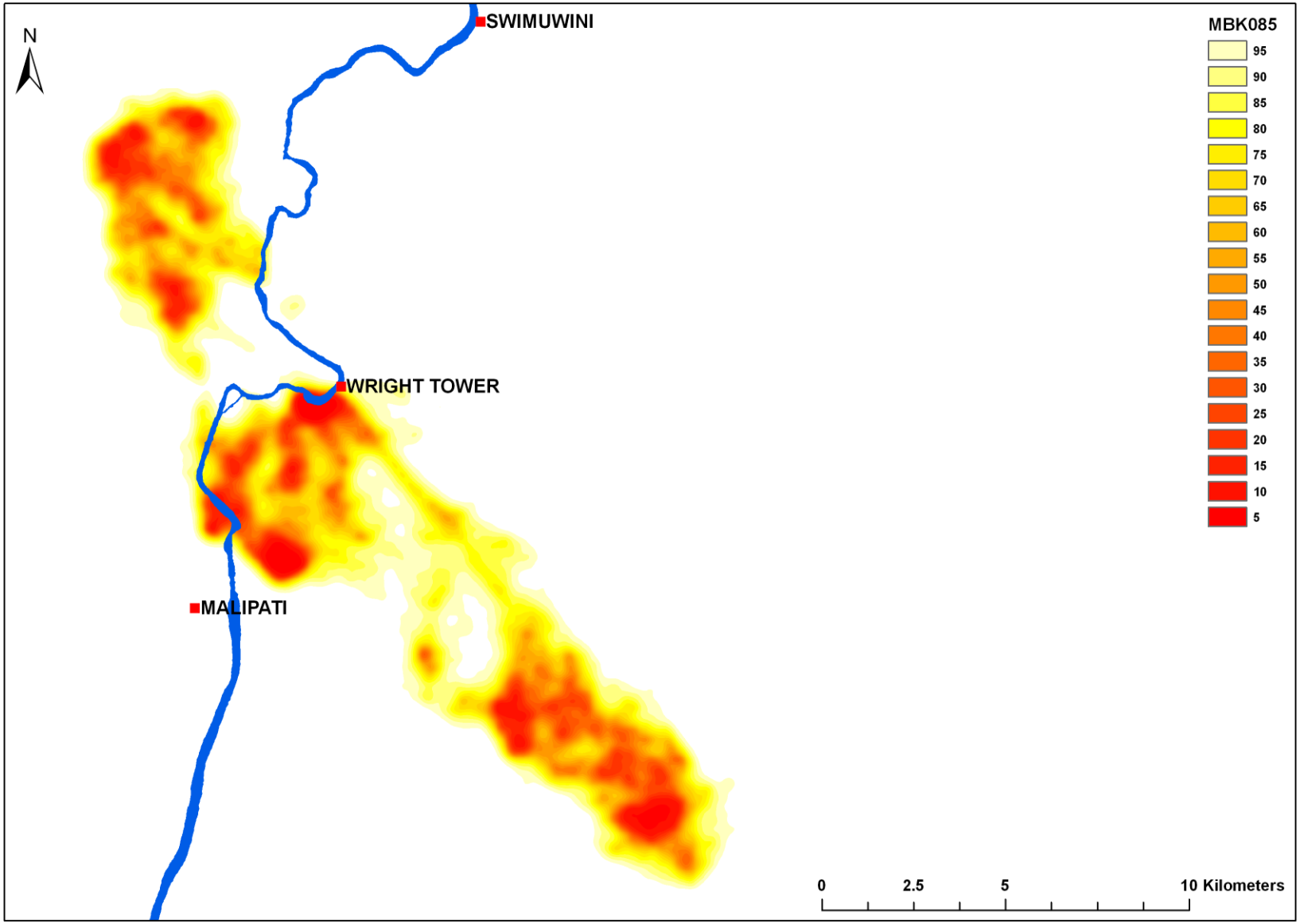


Annual home range - female 084



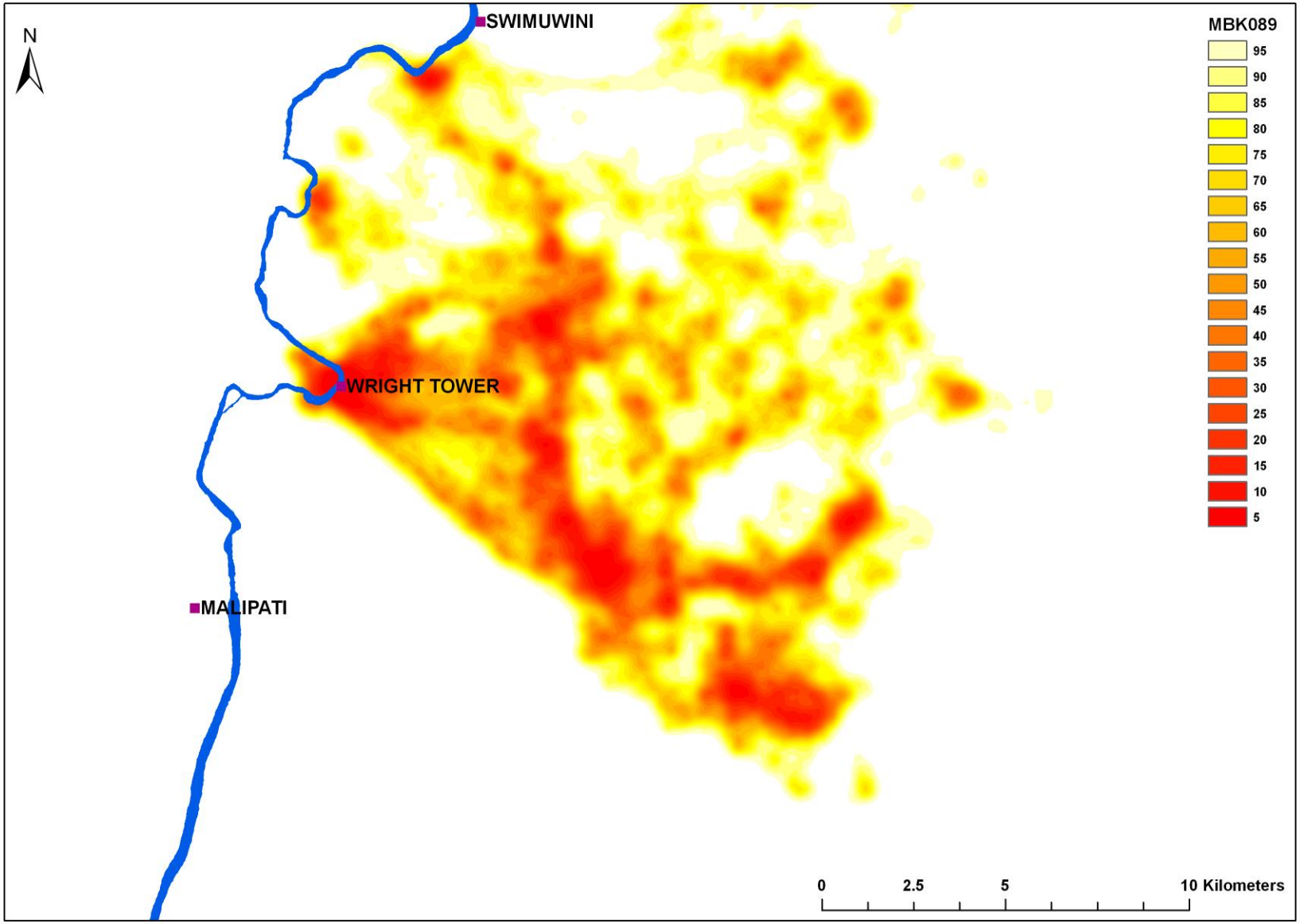
Benhamou S. & Cornélis, D., J. Wild. Manag. 2010

Annual home range - female 085



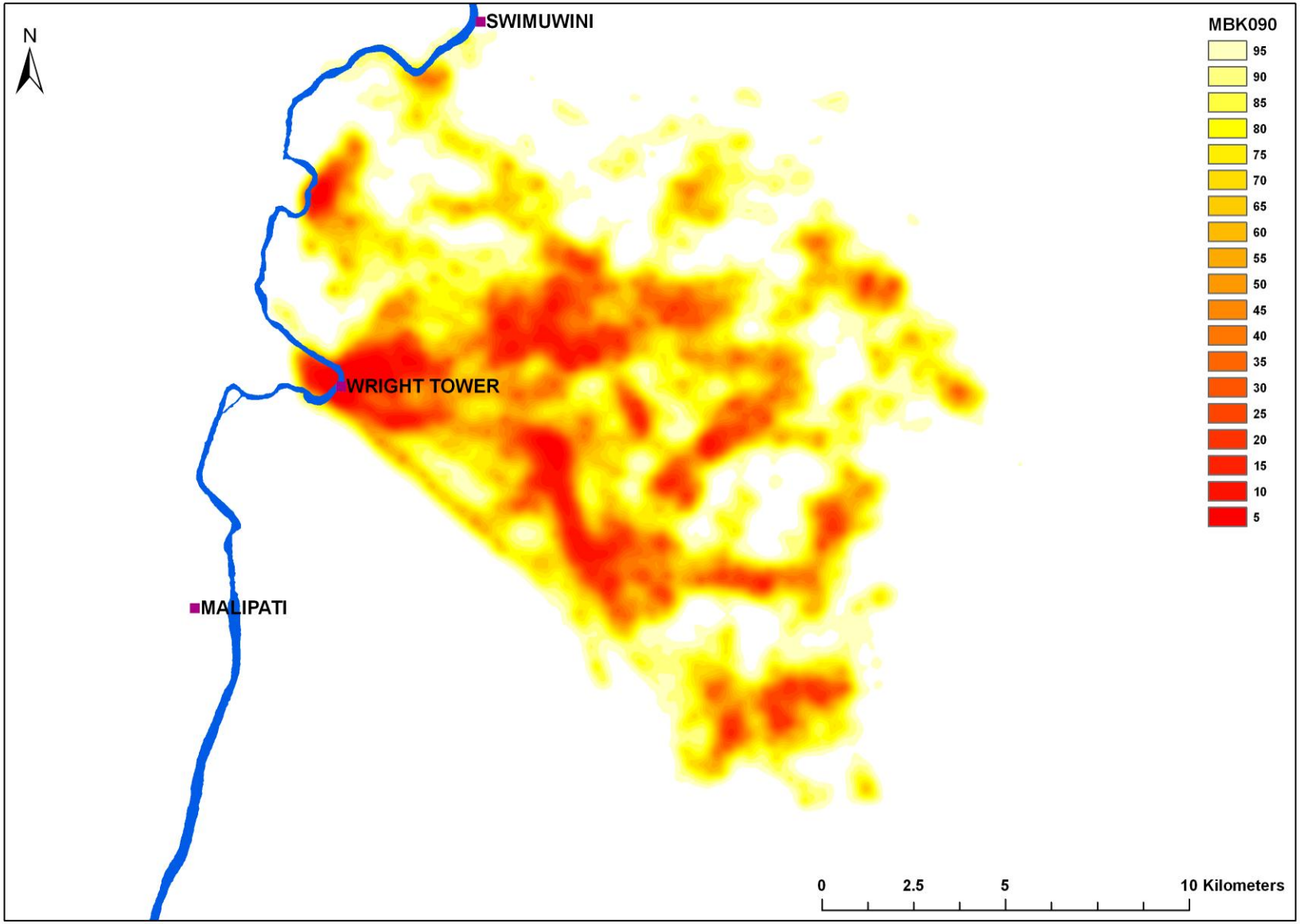
Benhamou S. & Cornélis, D., J. Wild. Manag. 2010

Annual home range - female 089



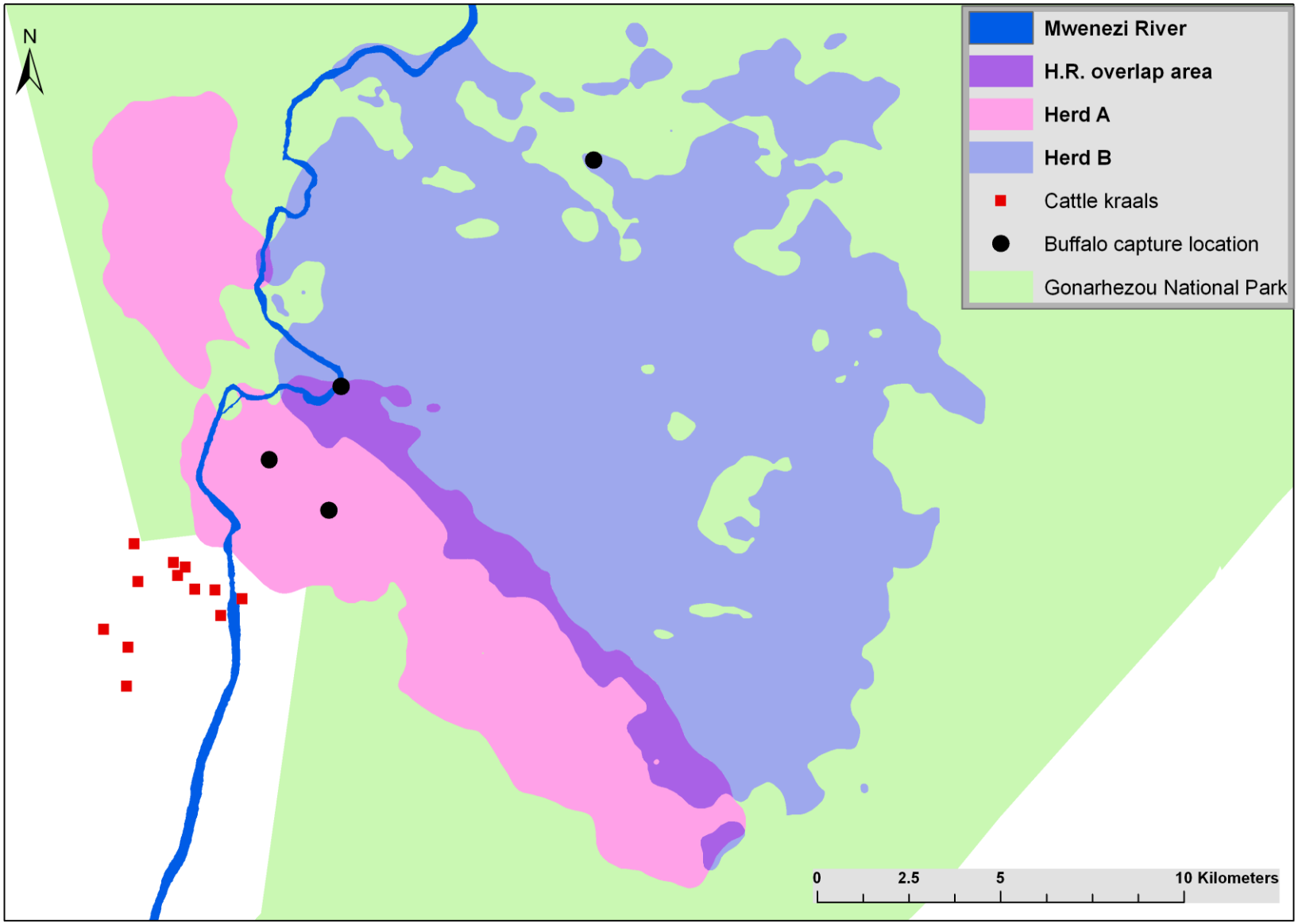
Benhamou S. & Cornélis, D., J. Wild. Manag. 2010

Annual home range - female 090

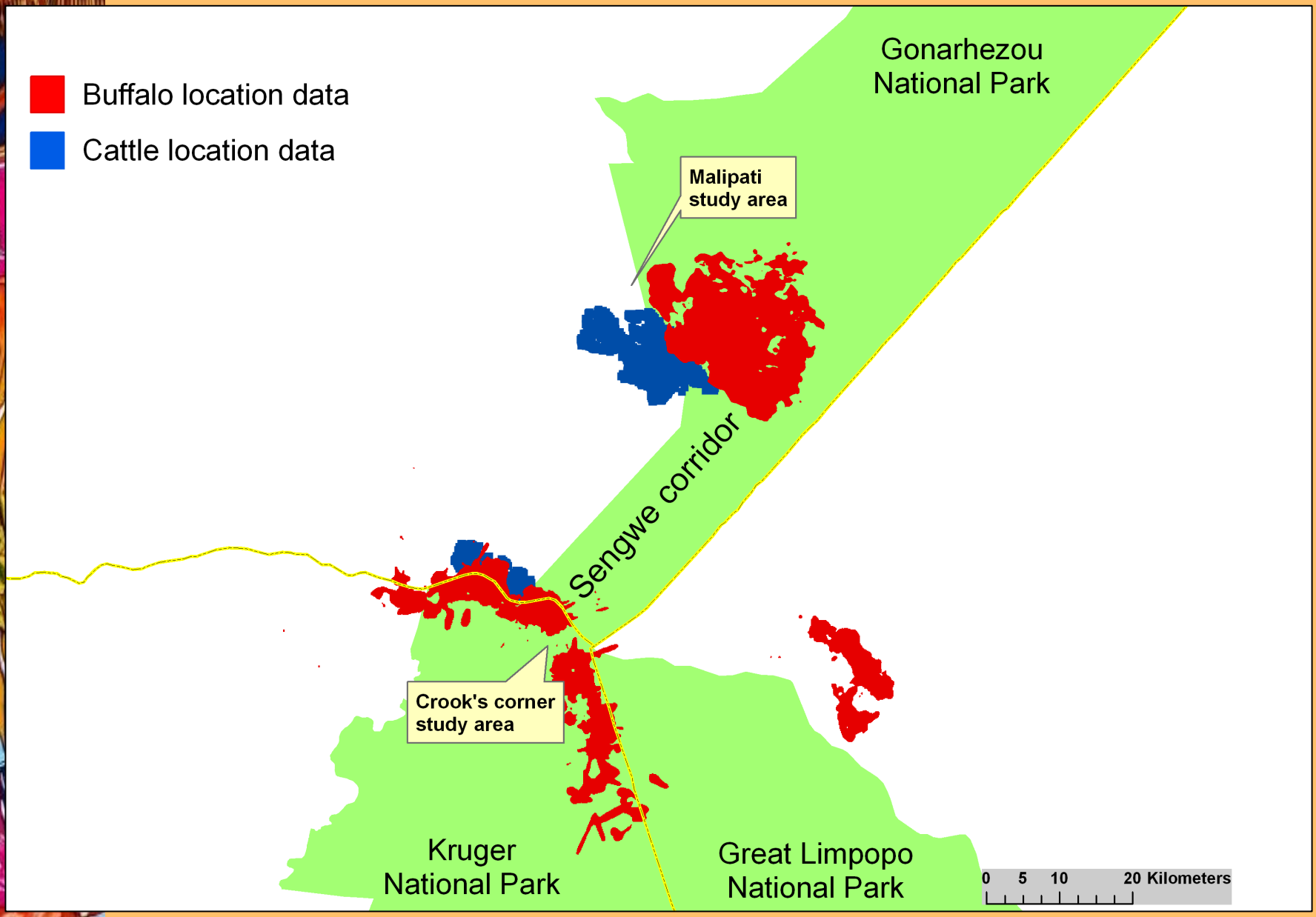


Benhamou S. & Cornélis, D., J. Wild. Manag. 2010

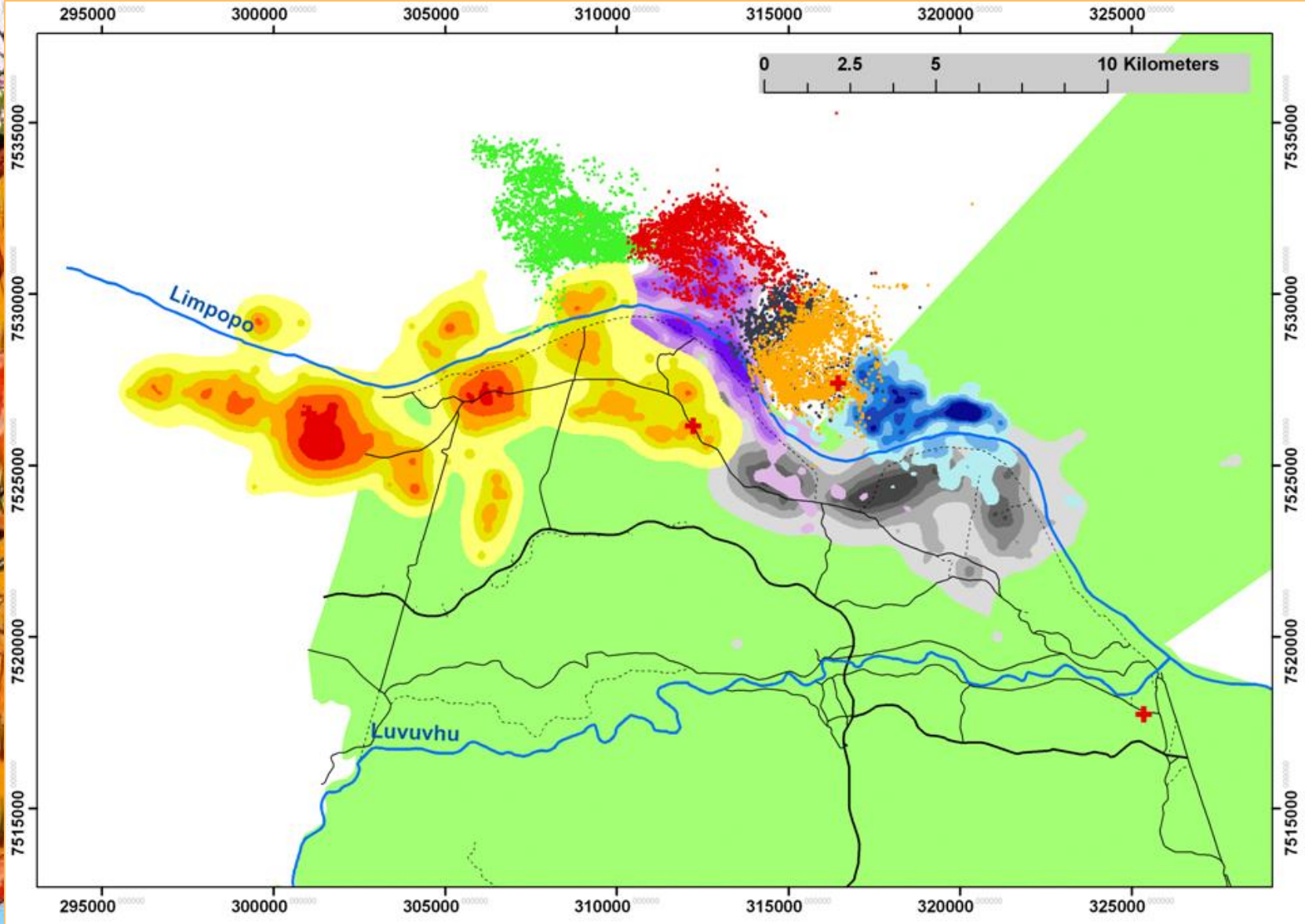
Space-use patterns (n=11)



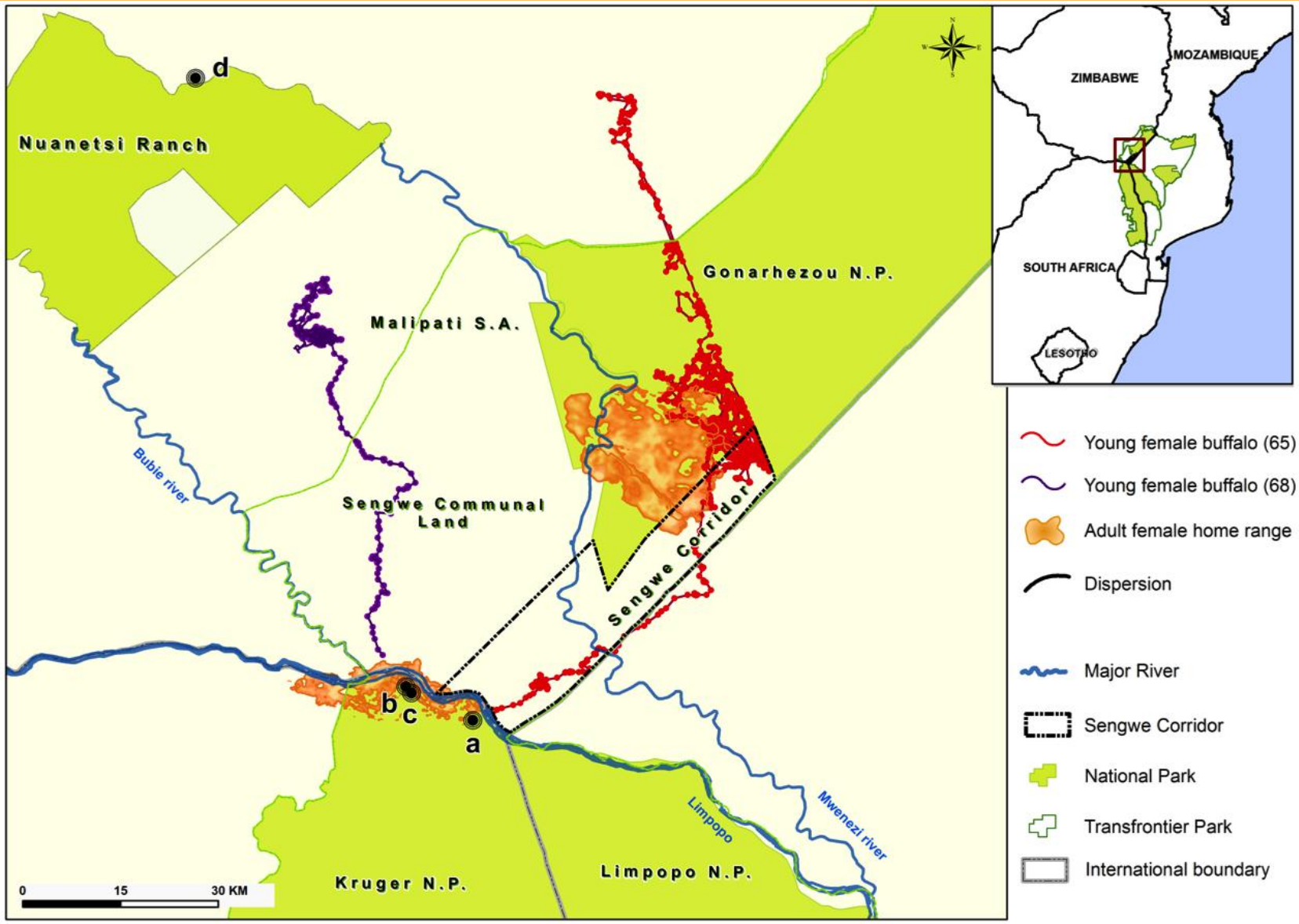
Crook's corner buffalo: adult females



Crook's corner buffalo: adult females



Crook's corner buffalo: young females



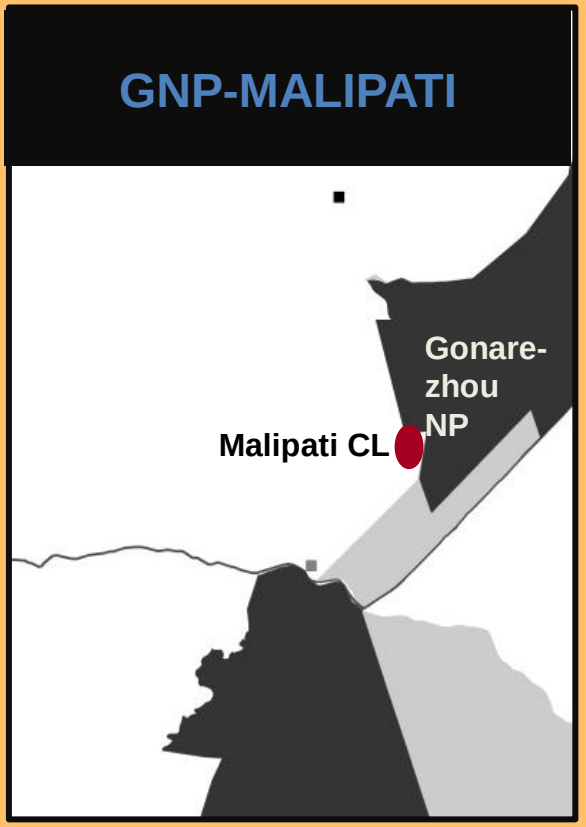
Caron et al., EID, submitted

Drivers of buffalo/cattle contacts

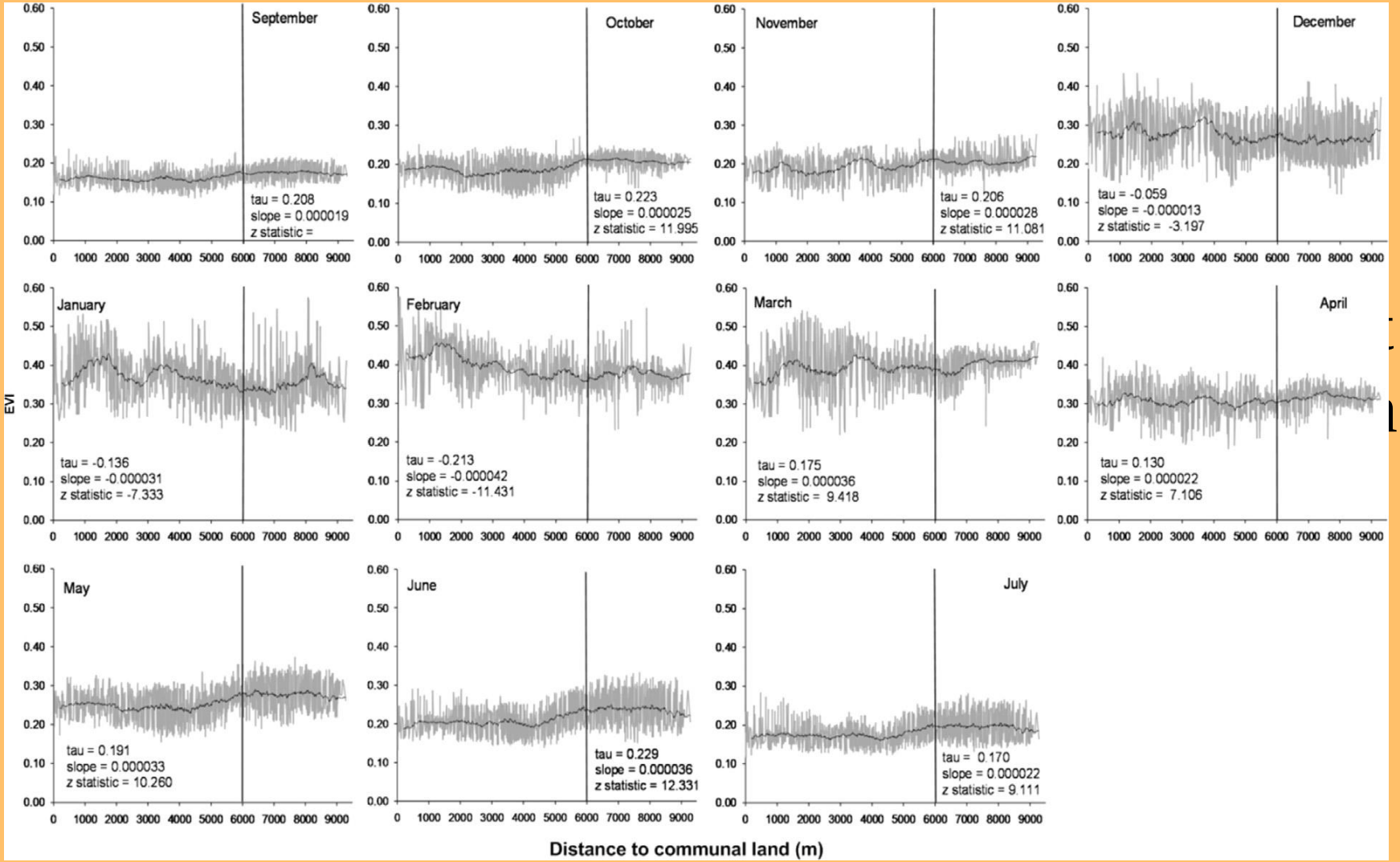
- *Resource gradients Malipati/GNP-Mabalauta*

Zengeya, F. 2014. PhD thesis

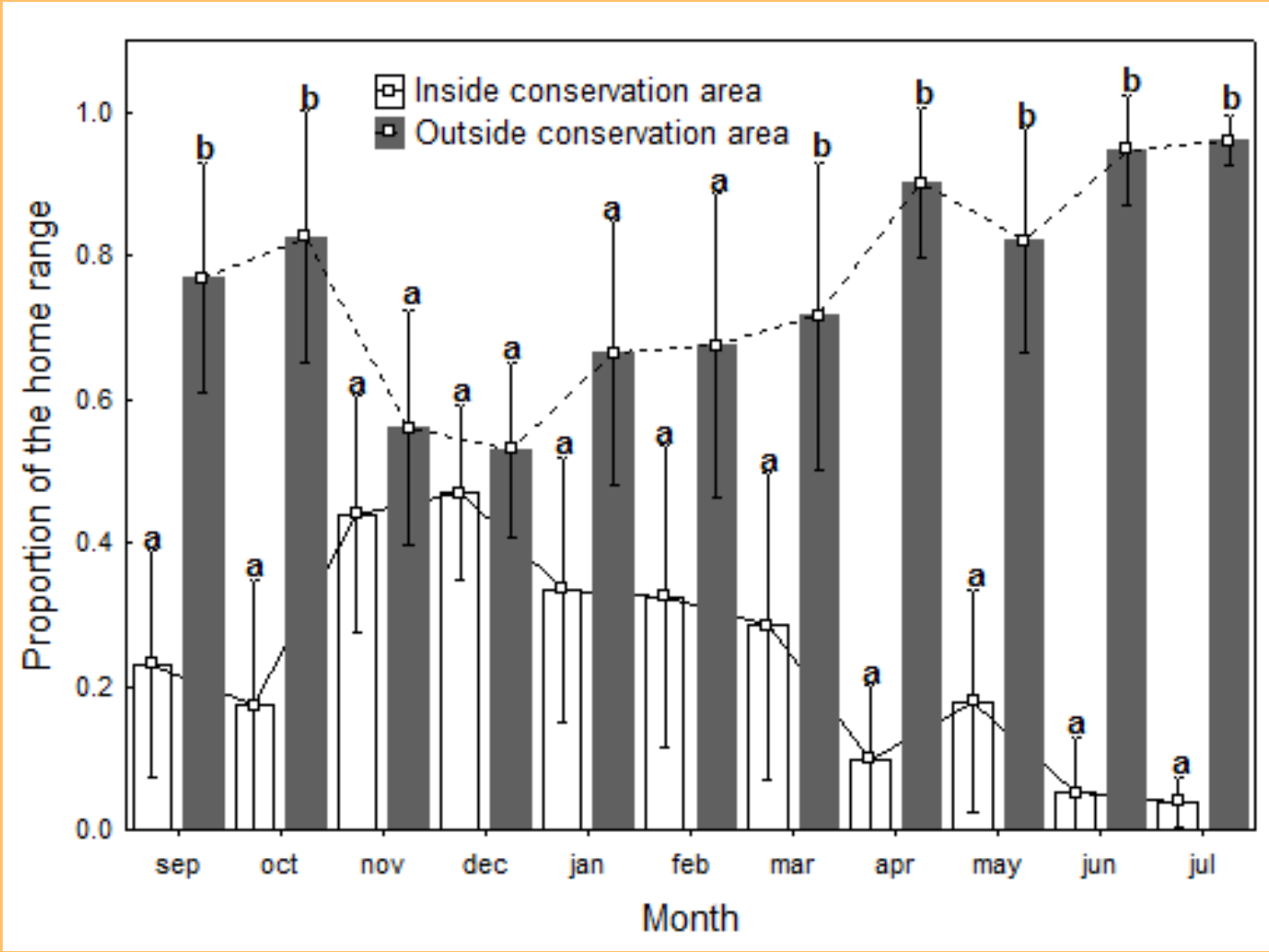
Zengeya et al. 2015 Remote Sensing Applications



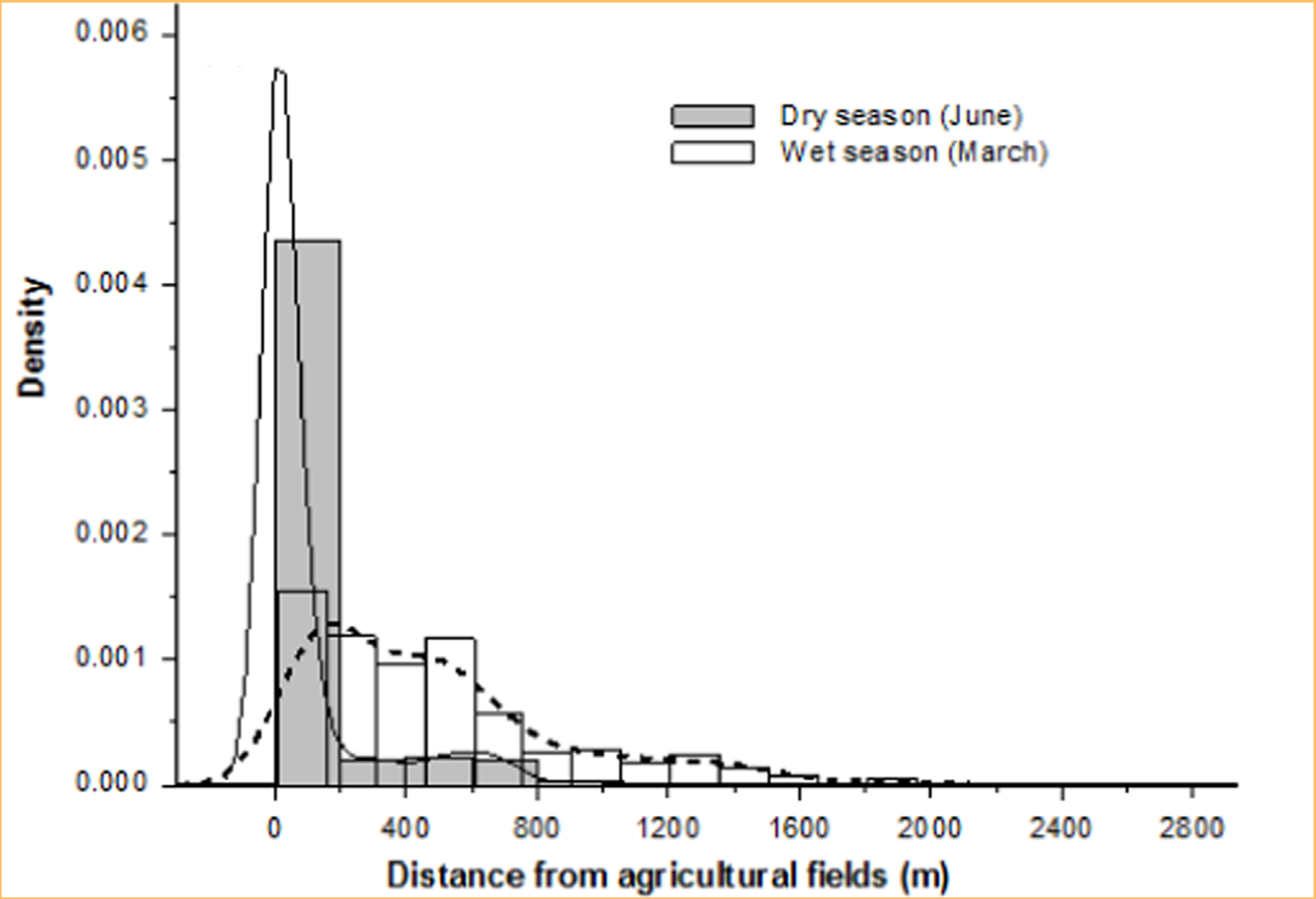
• Grazing resource gradients do exist at the interface and foraging resources are more abundant within the park during the dry season



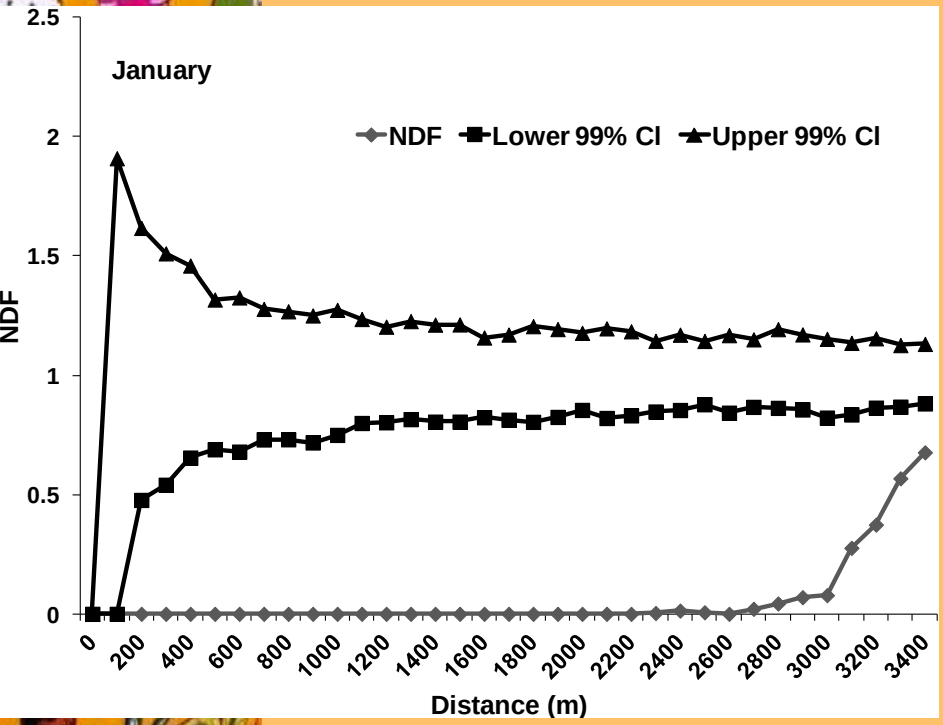
- Cattle use the park more during the wet season

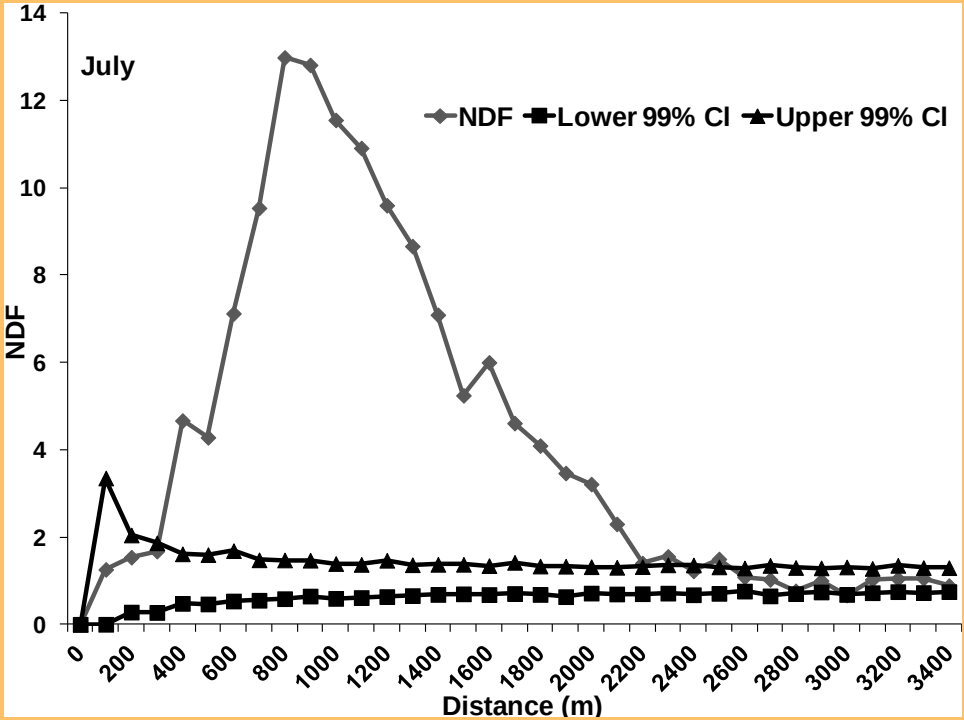


- Cattle use the park more during the wet season and forage close to agricultural fields during the dry season (residues)



- Cattle and buffalo are segregated during the wet season while they aggregate in the late dry season.



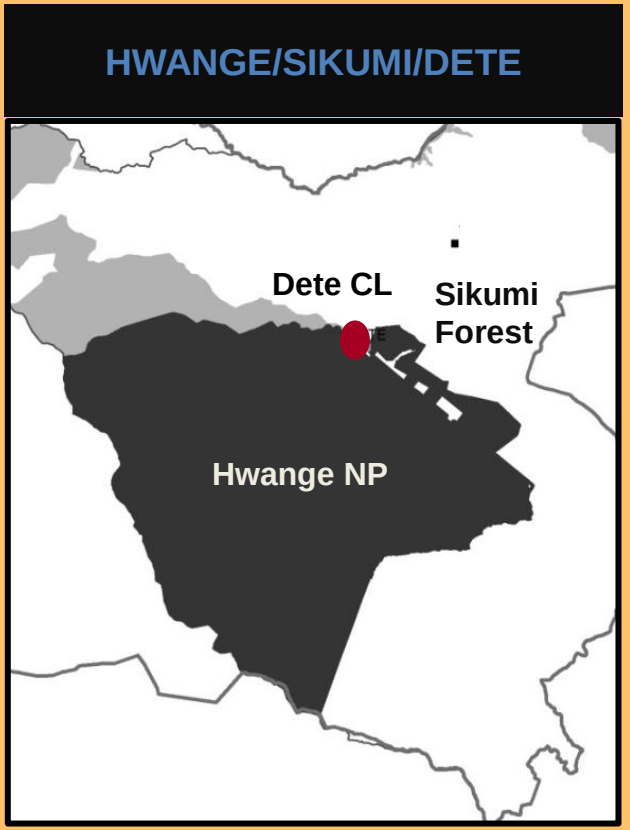


Resource selection

Does surface water availability shape the buffalo/cattle interface ?

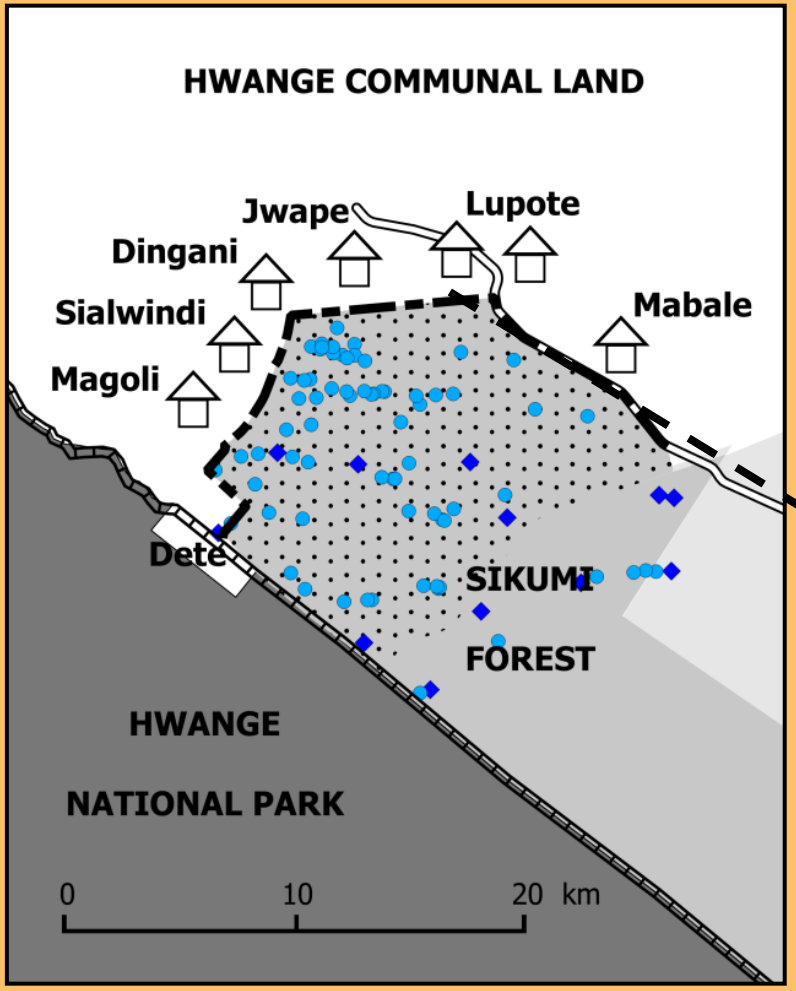
Valls Fox, H. 2015. PhD thesis

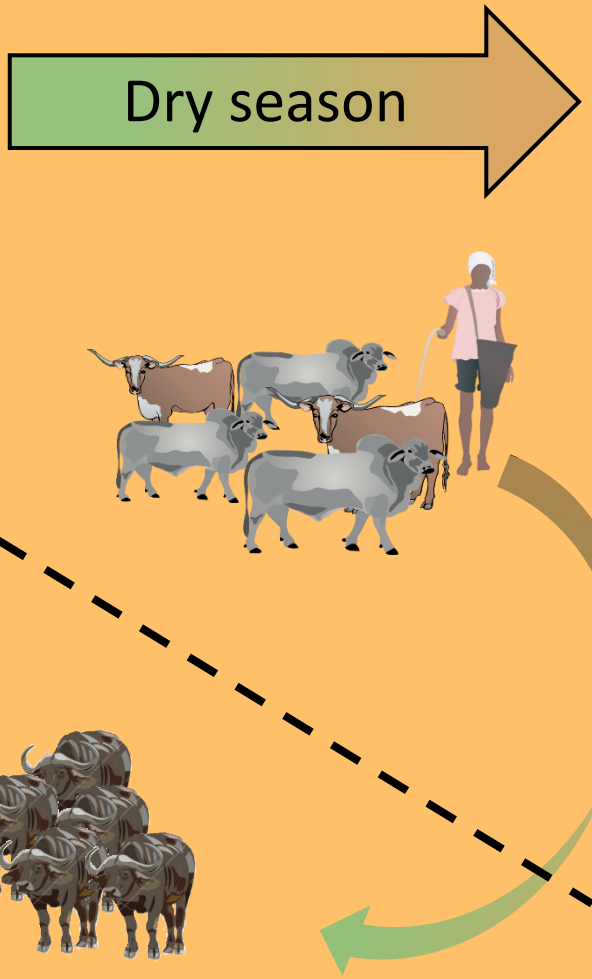
Valls Fox et al 2016 (in prep.)



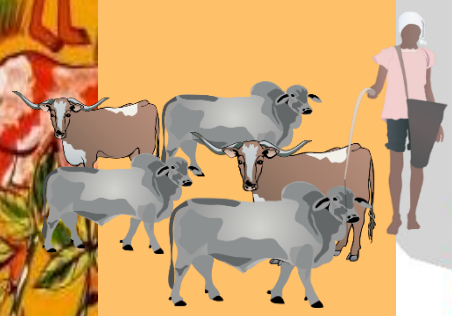
Resource selection

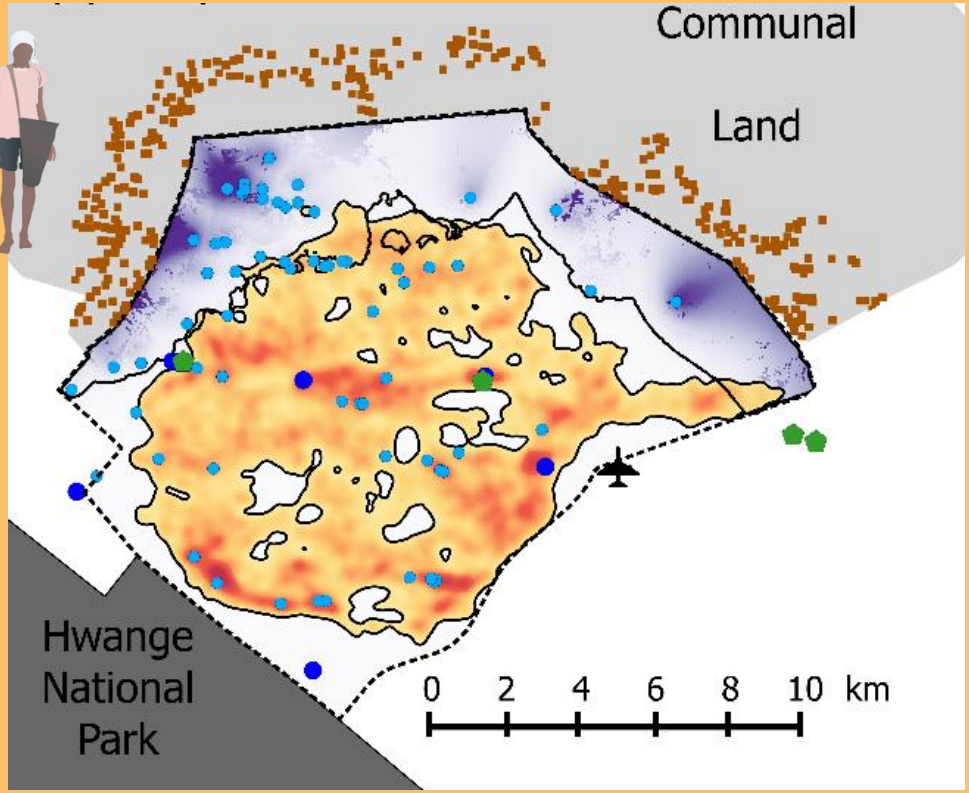
Does surface water availability shape the buffalo/cattle interface ?



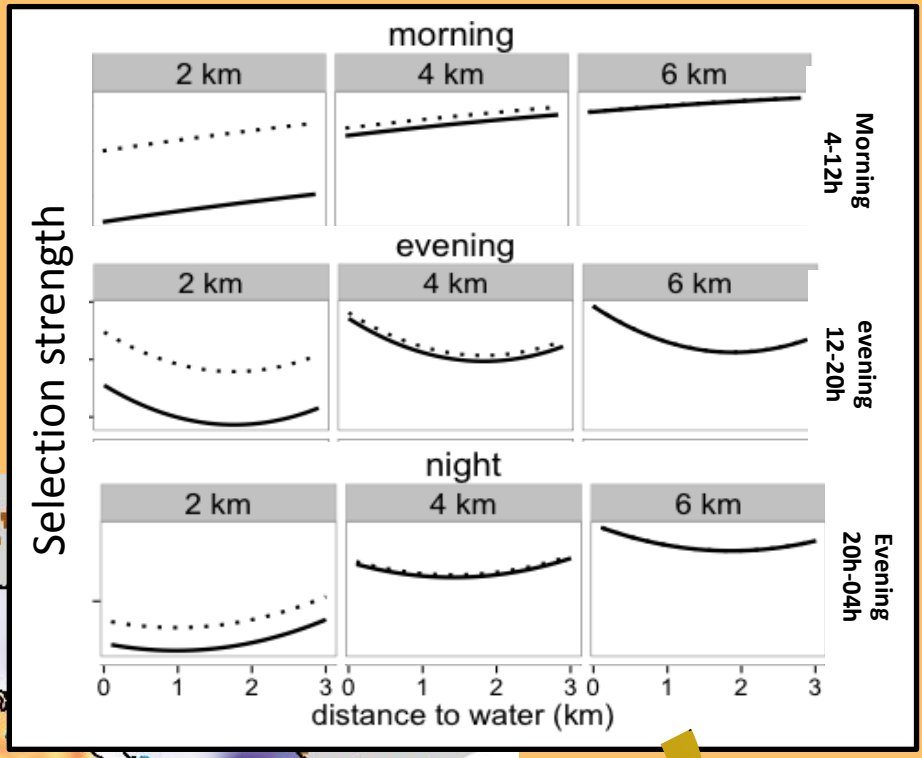


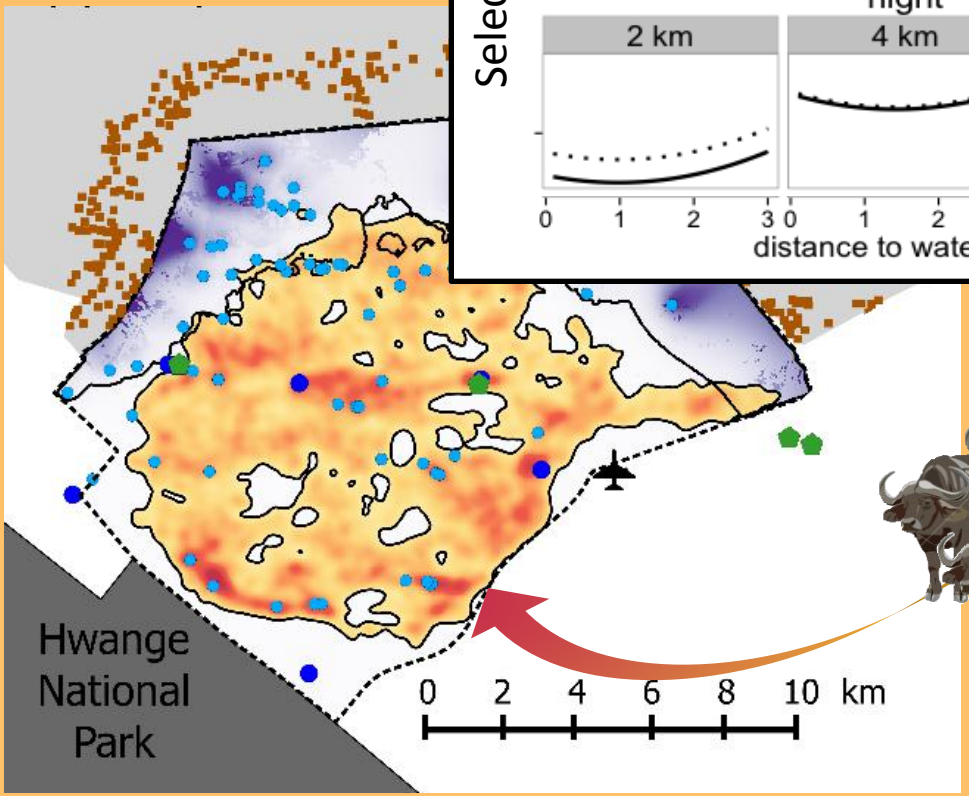
Cattle and buffalo seasonal habitat selection



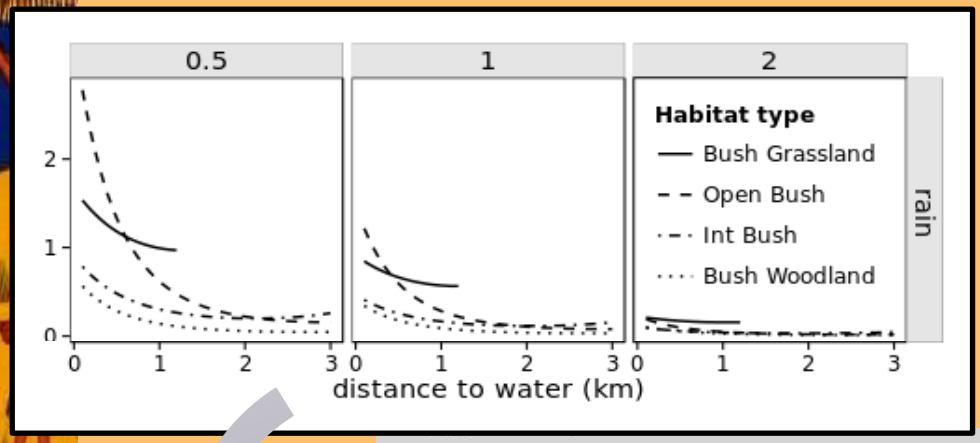


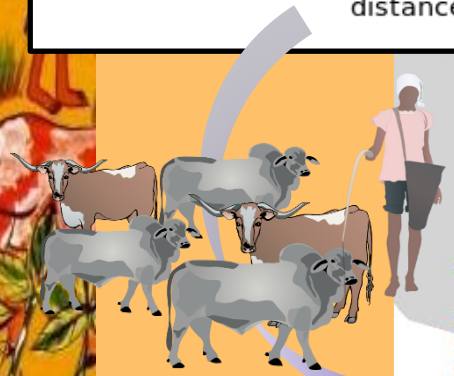
Cattle and buffalo seasonal habitat selection

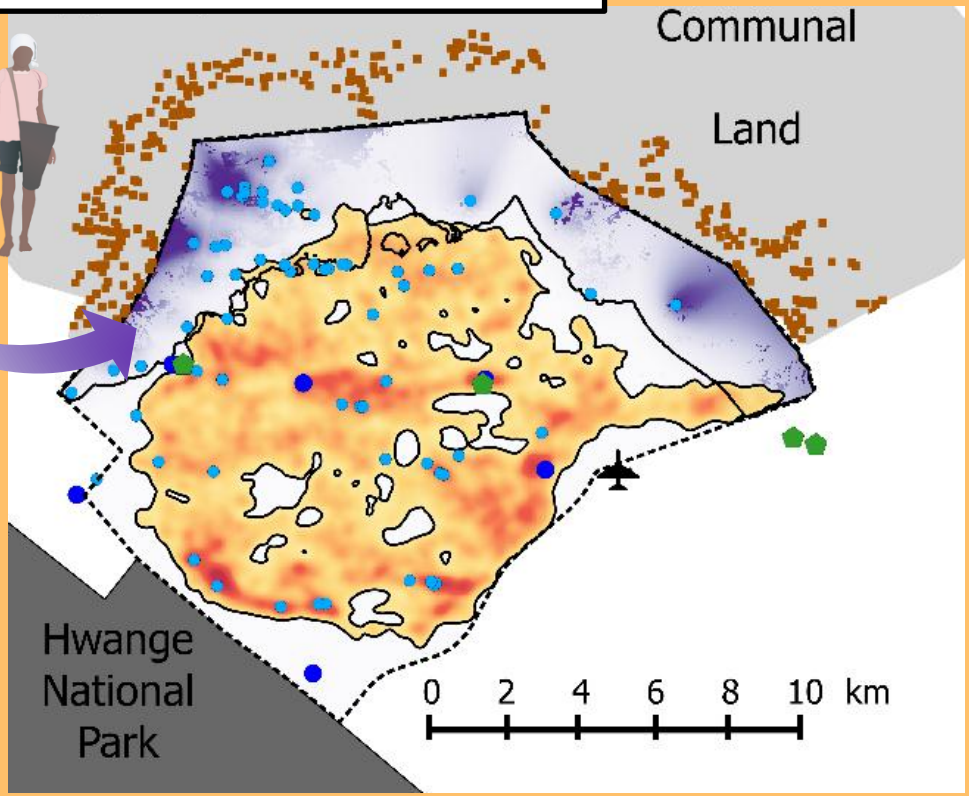




Cattle and buffalo seasonal habitat selection

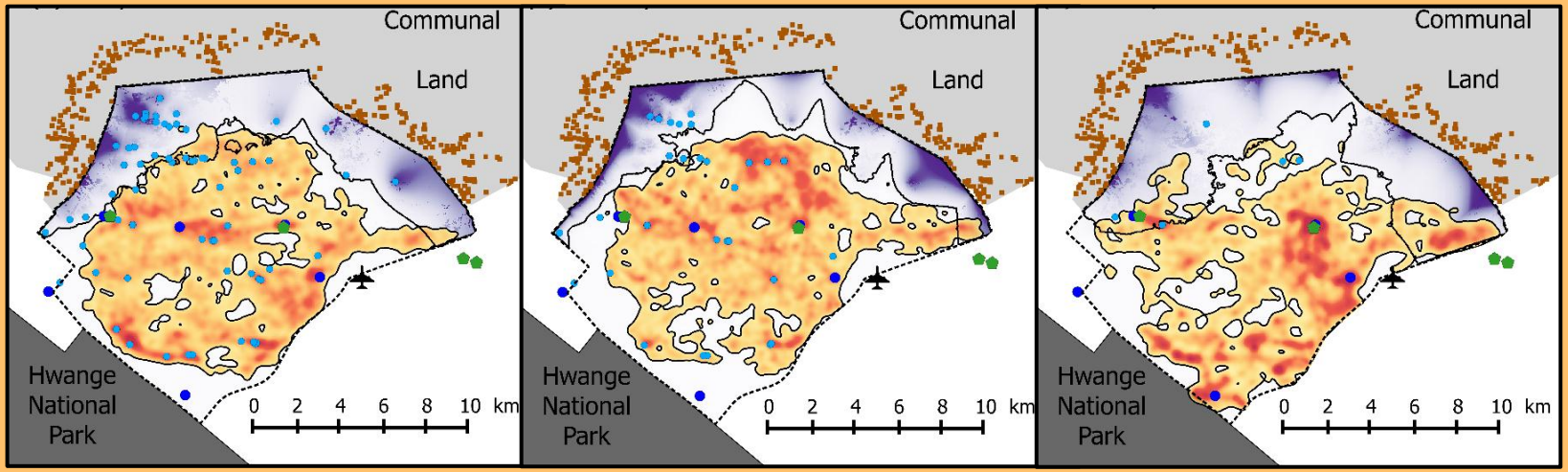






Getting to water *vs.* avoiding cattle & people

rainy season | cold dry season | hot dry season



- *Cattle go further: cropping & late dry season*
- *Buffalo home-range edge defined by cattle presence*
- *Buffalo avoidance decreases late dry season*

Buffalo-cattle contacts and disease transmission

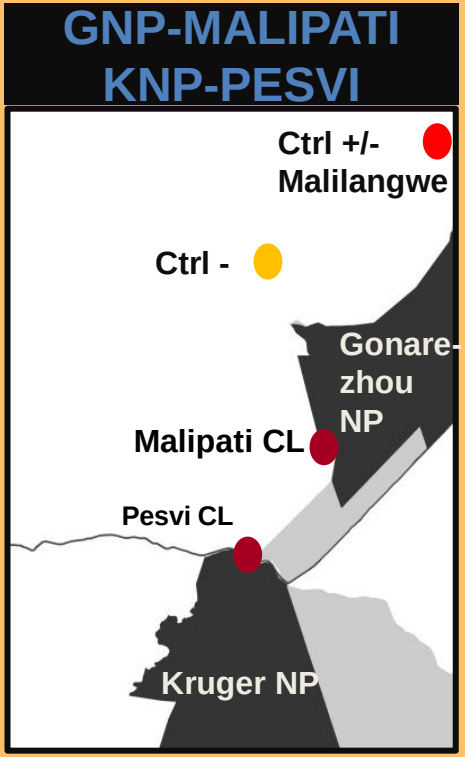
- *Disease prevalence in cattle populations with contrasted levels of potential interactions with wildlife (including buffalo)*

Caron et al. 2013 Epidemiology & Infection

Table 4. *Qualitative summary of disease detection results of cattle populations living at various wildlifellivestock interfaces and the buffalo population sampled*

	Unfenced interface			Fenced interface	No interface
	Malipati		Pesvi	Chizvirizvi	Chikombedzi
	Buffalo	Cattle	Cattle	Cattle	Cattle
Mycobacterium bovis	+	0	0	0	0
Foot-and-mouth disease	+++	+	n.d.	+	+
Brucella abortus	0	+	+	0	+
Rift Valley fever	+	+	n.d.	+	+
Theileria parva	+++	+	+++	0	0
Lumpy skin disease	0	+++	+++	+++	+++

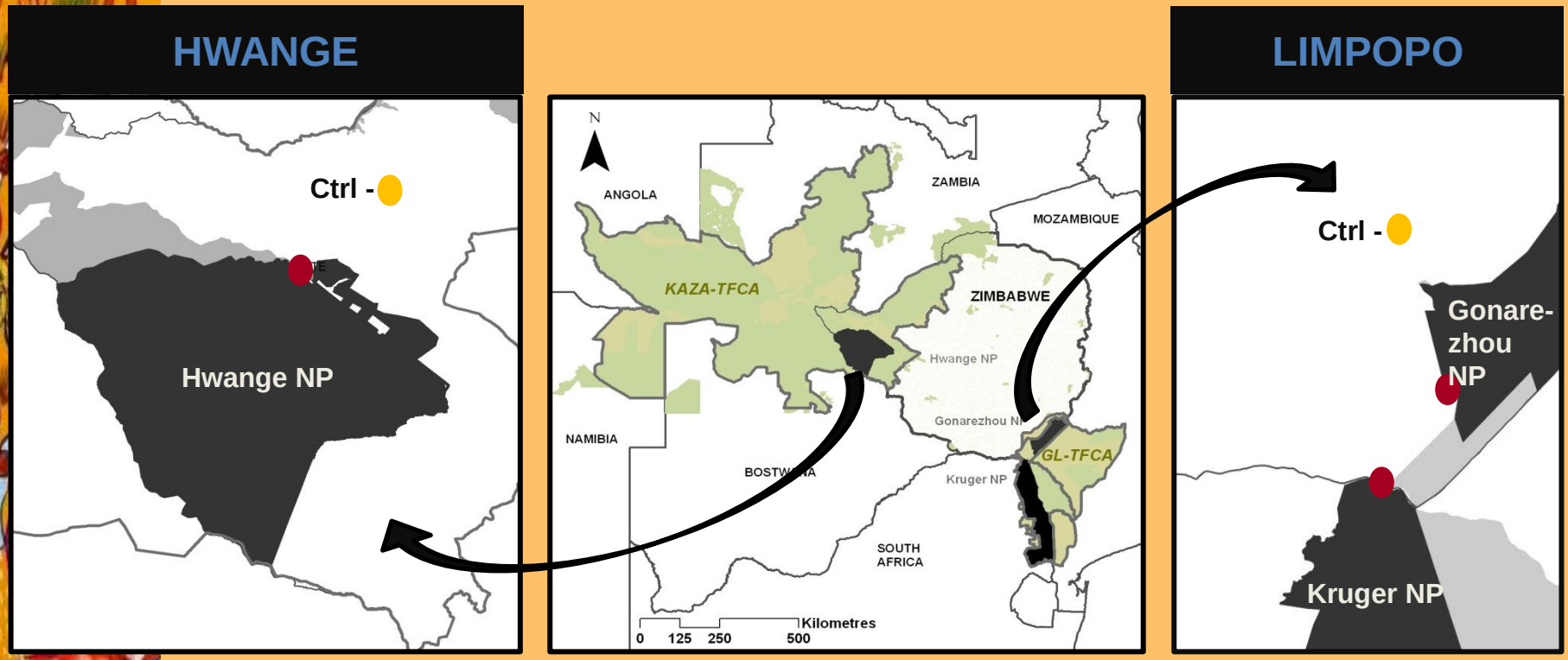
n.d., Not done.
0 = No detection; + = >0% to <20%; ++ = >20% to <40%; +++ = >40%.



Buffalo-cattle contacts and disease transmission

- *Foot and mouth disease transmission*

Miguel, E. 2012. PhD thesis; Miguel et al. 2013 Ecosphere



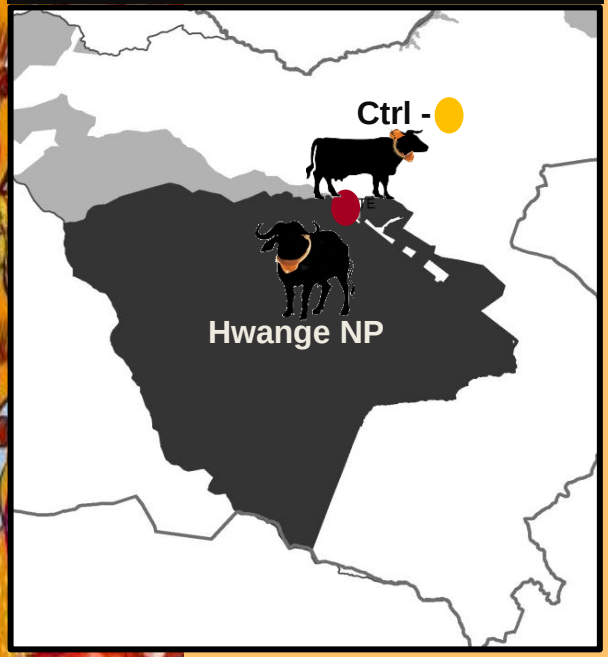
Buffalo-cattle contacts and disease transmission

- *Foot and mouth disease transmision*

Miguel, E. 2012. PhD thesis

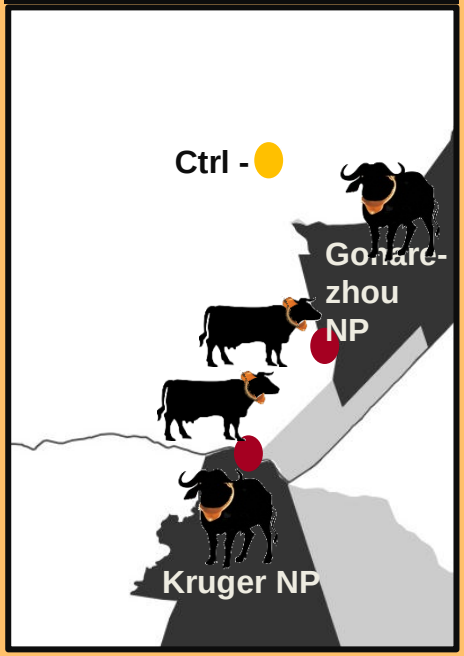
Miguel et al. 2013 Ecosphere

HWANGE



- **Similar sampling schemes**
- **GPS collars on sympatric cattle and buffalo**
- **Longitudinal sampling and serological FMD test for cattle populations**

LIMPOPO



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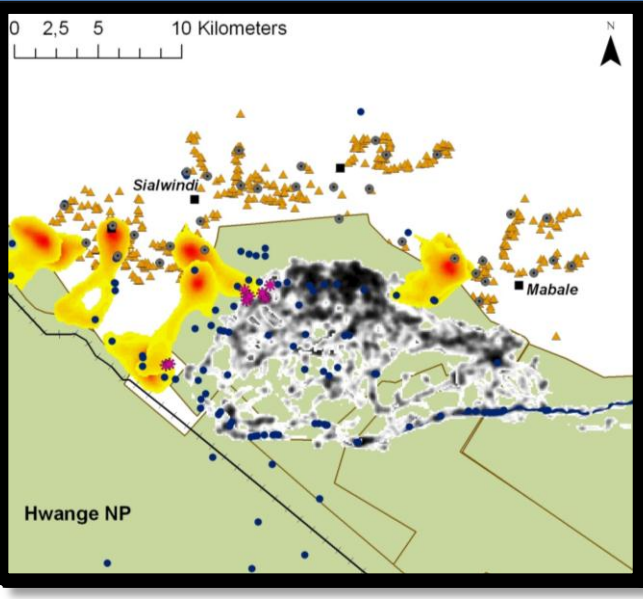
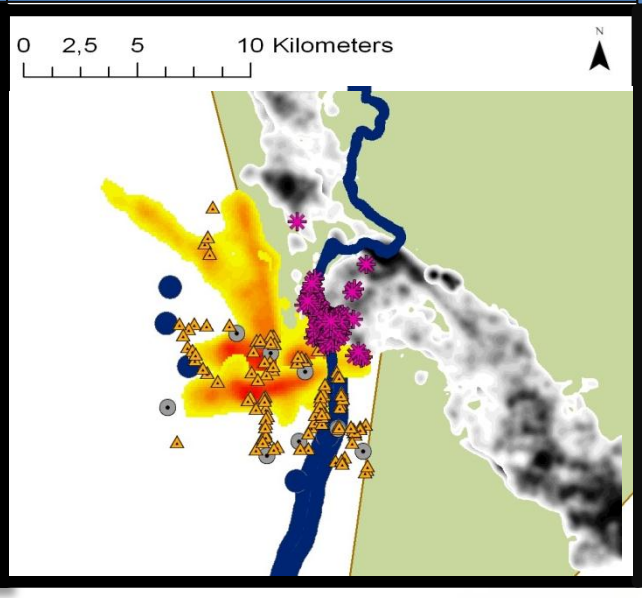
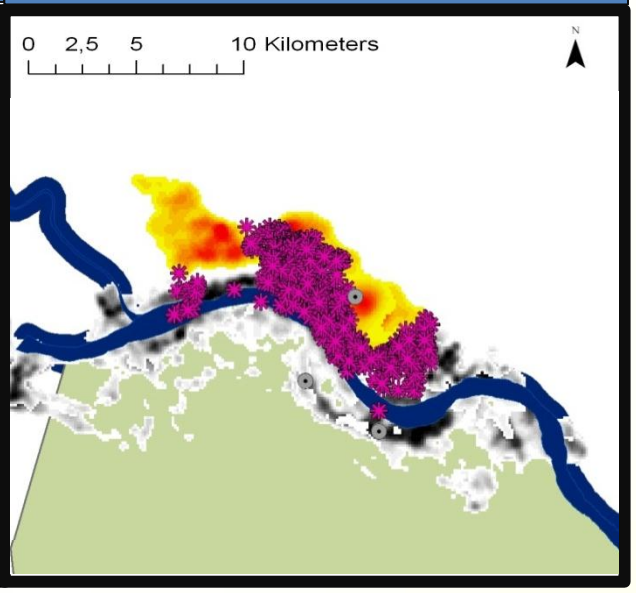


GONAREZHOU



KRUGER



Contacts

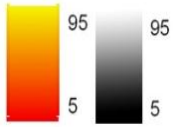
Water Points & rivers

Boreholes

National parks

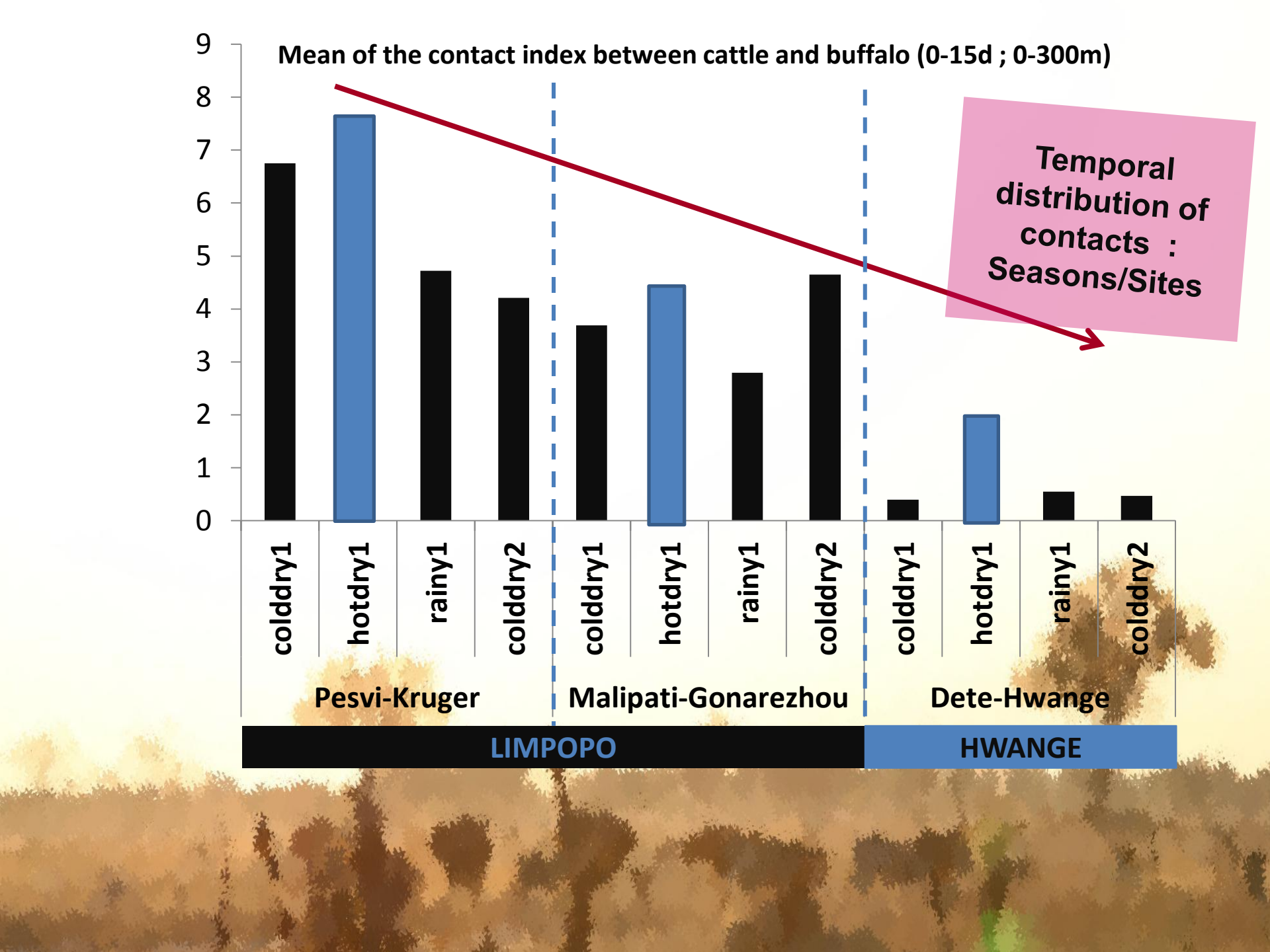
Owners

Cattle – Buffalo



Distribution ranges *(cumulative frequency %)*

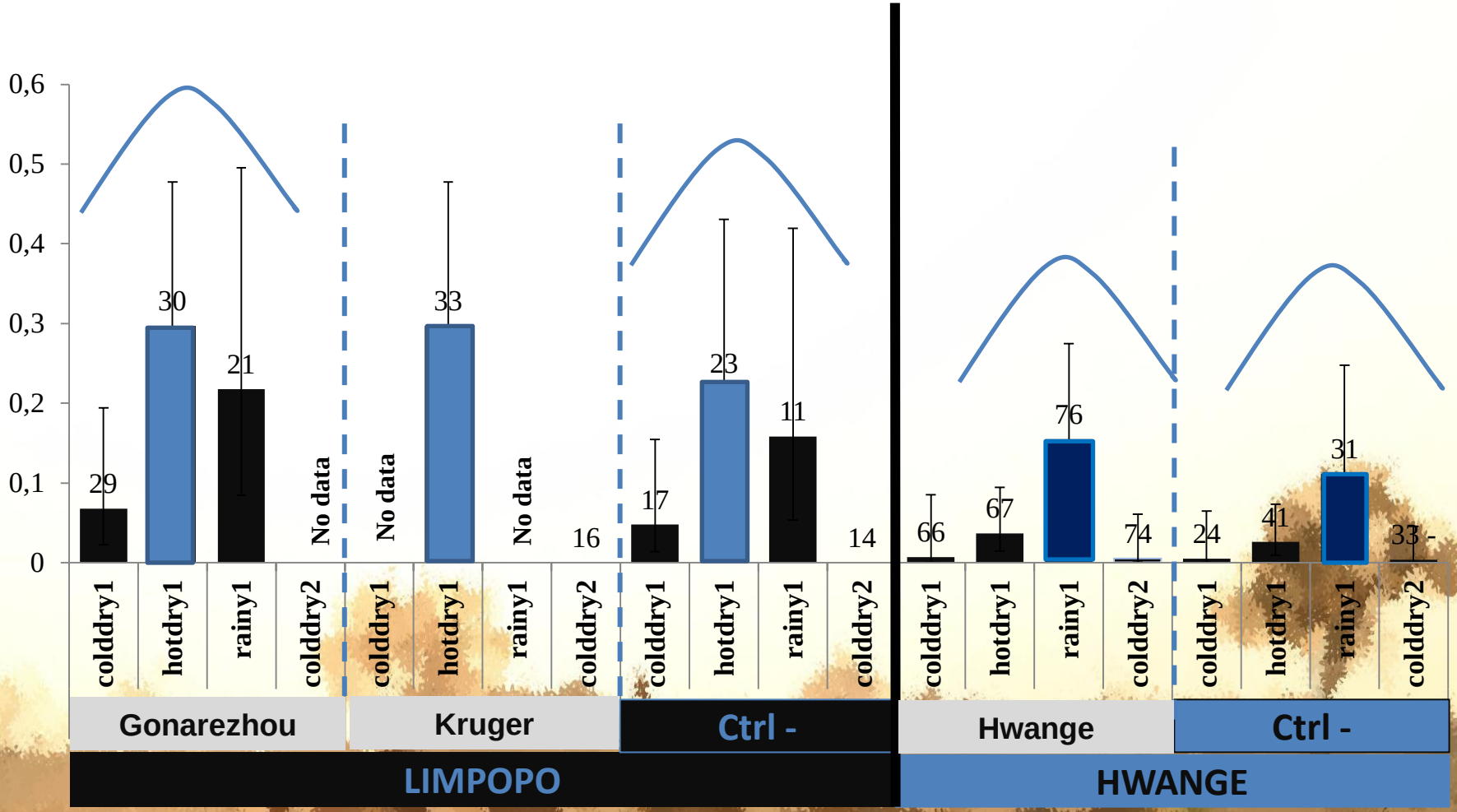
Spatial distribution of contact


Mean of the contact index between cattle and buffalo (0-15d ; 0-300m)
9
8
7
6
5
4
3
2
1
0
Temporal distribution of contacts : Seasons/Sites
colddry1
hotdry1
rainy1
colddry2
colddry1
hotdry1
rainy1
colddry2
colddry1
hotdry1
rainy1
colddry2
Pesvi-Kruger
Malipati-Gonarezhou
Dete-Hwange
LIMPOPO
HWANGE

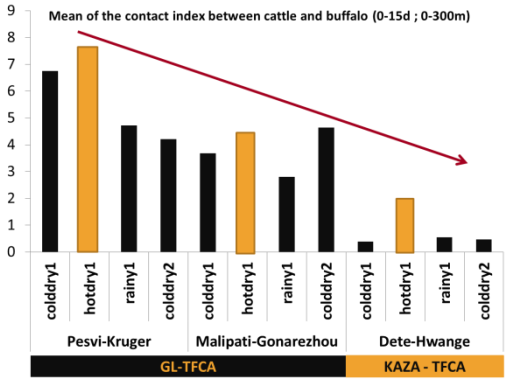
NSP : natural antibodies
INCIDENCE

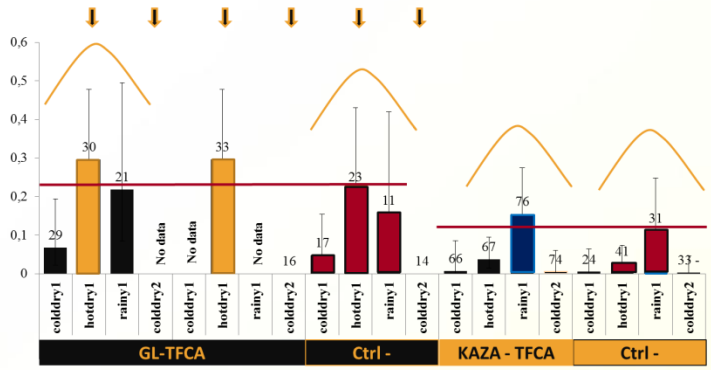
Incidence probability over 4 months periods
0->1 / (0->1+ 0 ->0)

FMD antibodies

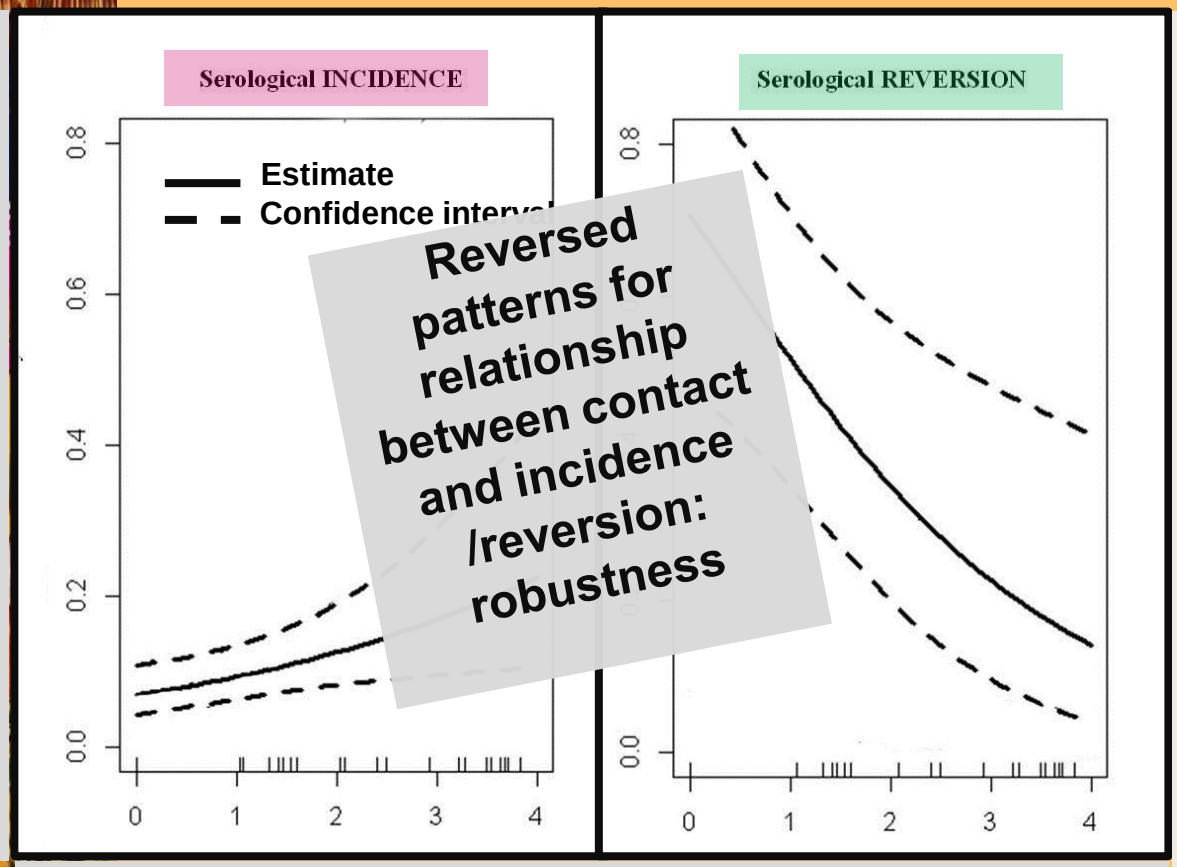


Are serological dynamics linked with interspecific contact dynamics ?





- **Integration of interspecific contacts, at the herd scale in incidence and reversion models**
- **Generalized linear mixed models**

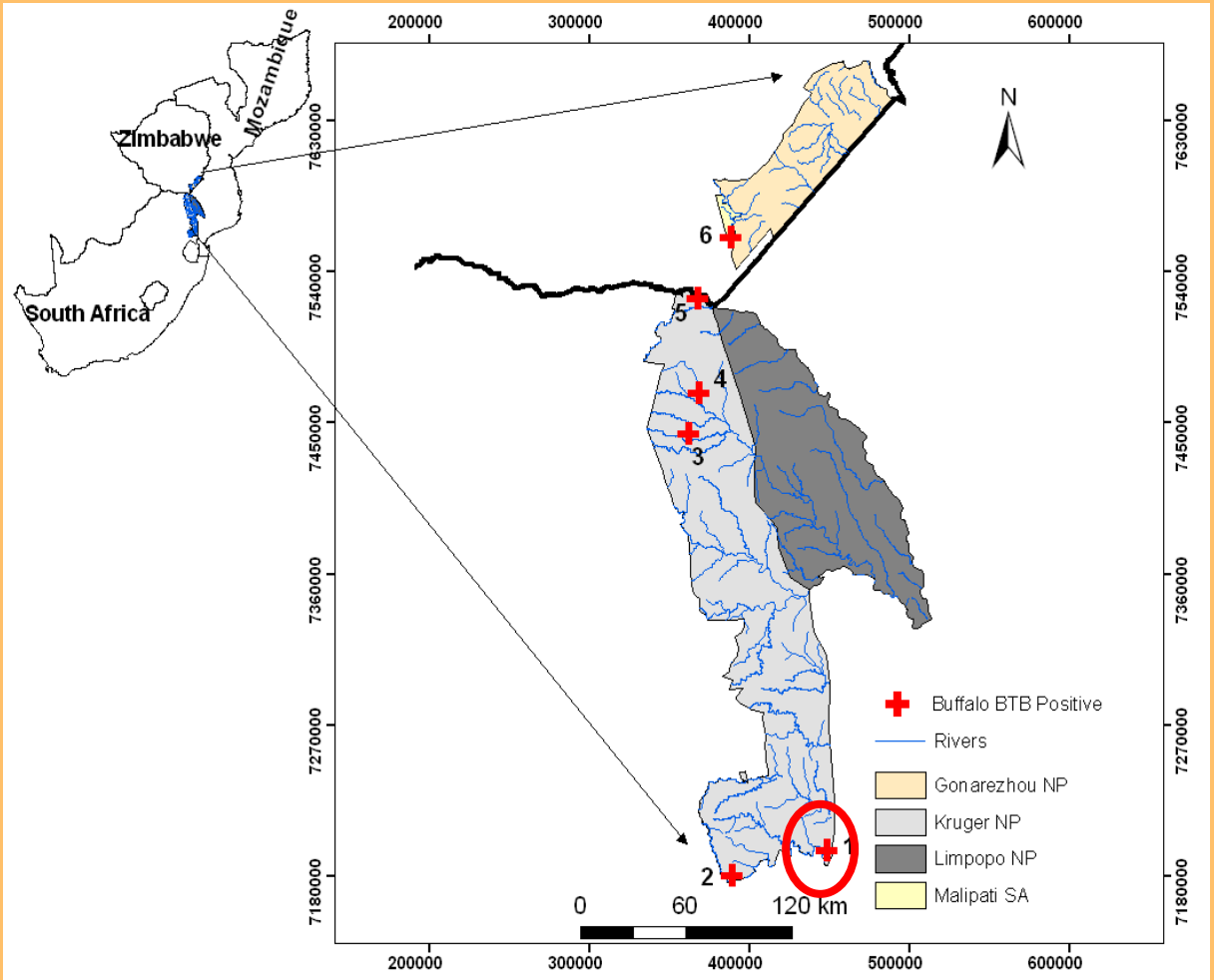


Reversed patterns for relationship between contact and incidence /reversion: robustness

Index buffalo contact / cattle herd / 4 months before the cattle sampling

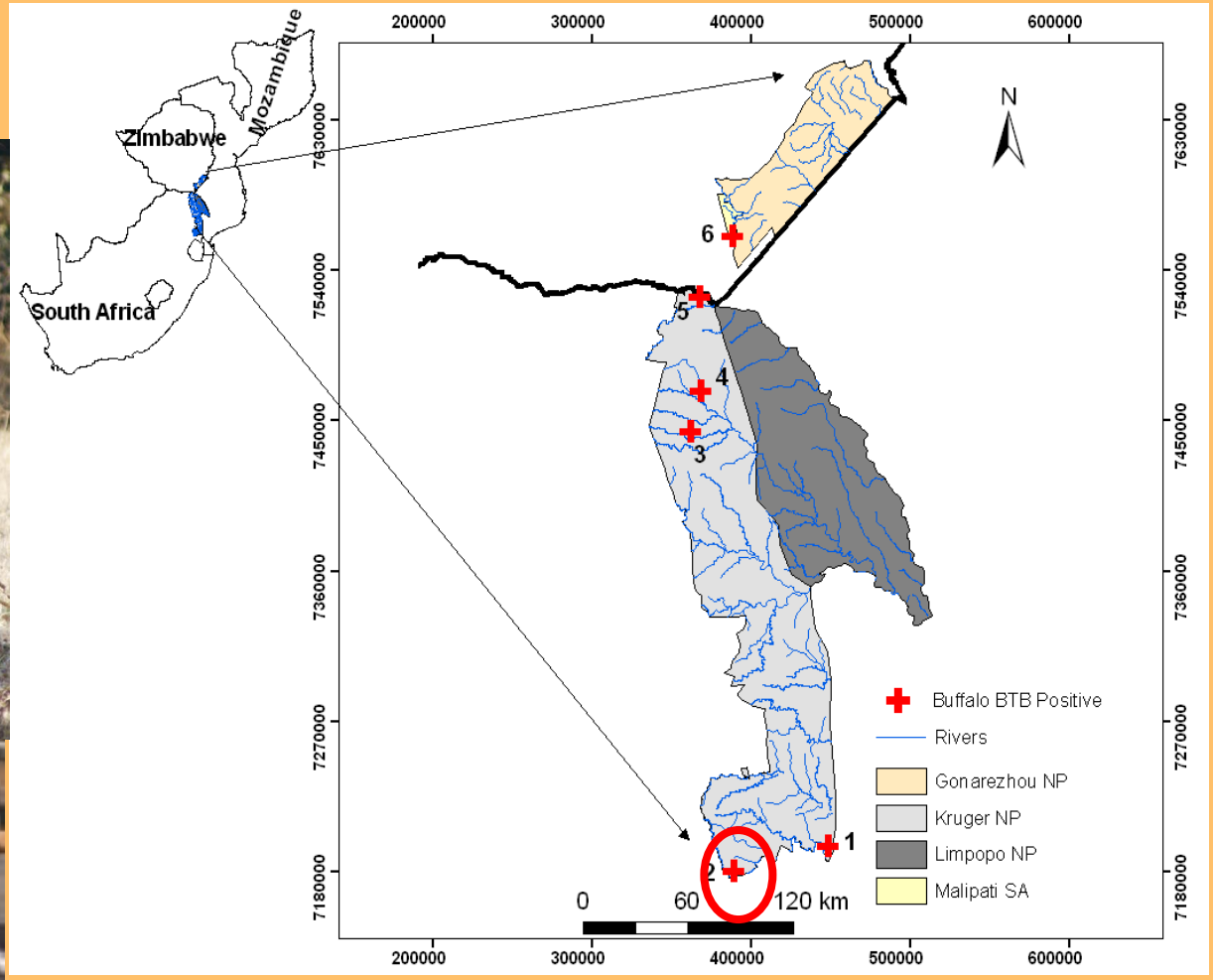
Interspecific contacts between wild and domestic bovines correlate significatively with probabilities of antibodies acquisition and loss in domestic bovines

Spread of bovine tuberculosis (bTB) across the boundaries of the GLTFCA *(de Garine-Wichatitsky et al. 2010, 2013)*



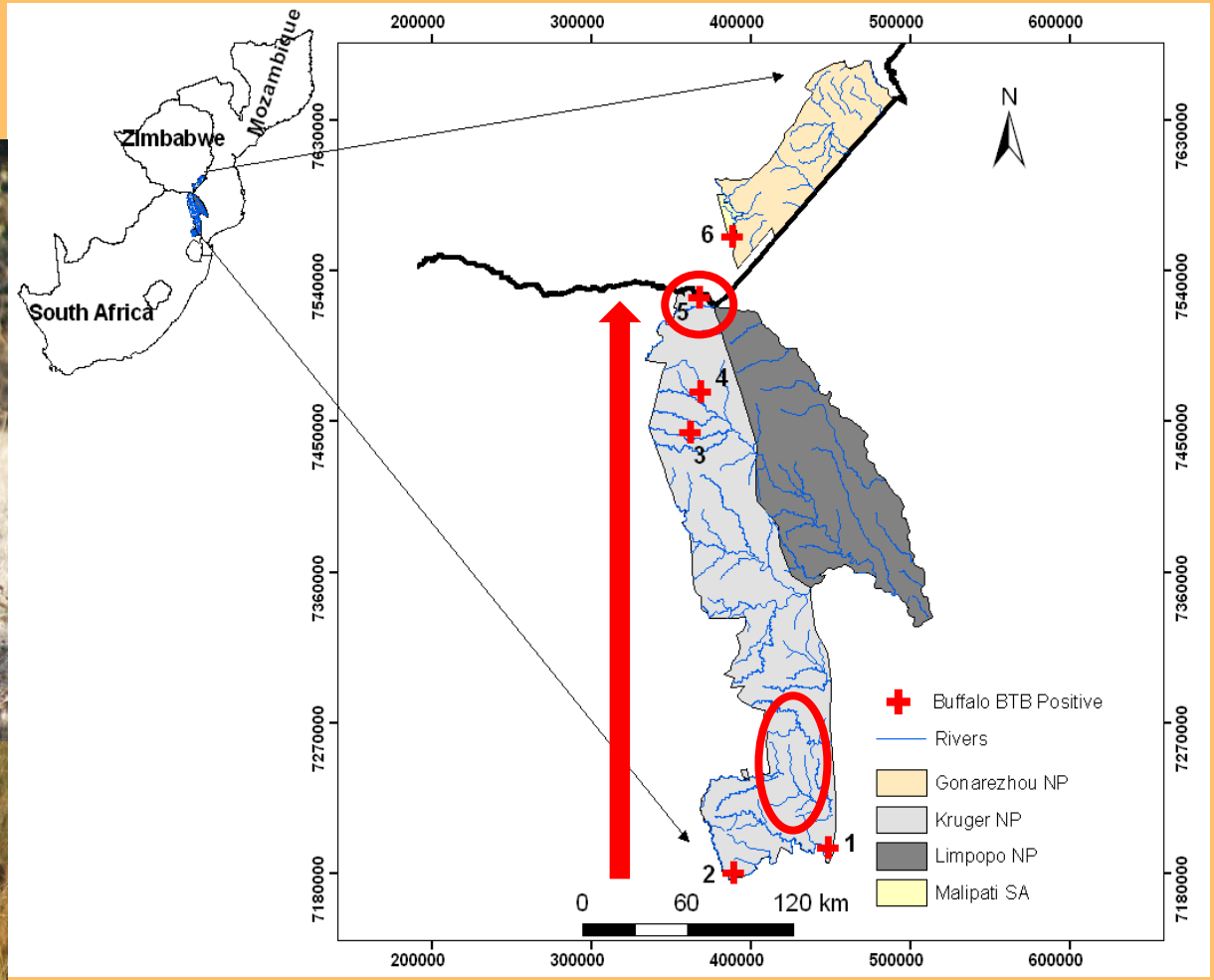
1: 1950s

Spread of bovine tuberculosis (bTB) across the boundaries of the GLTFCA *(de Garine-Wichatitsky et al. 2010, 2013)*



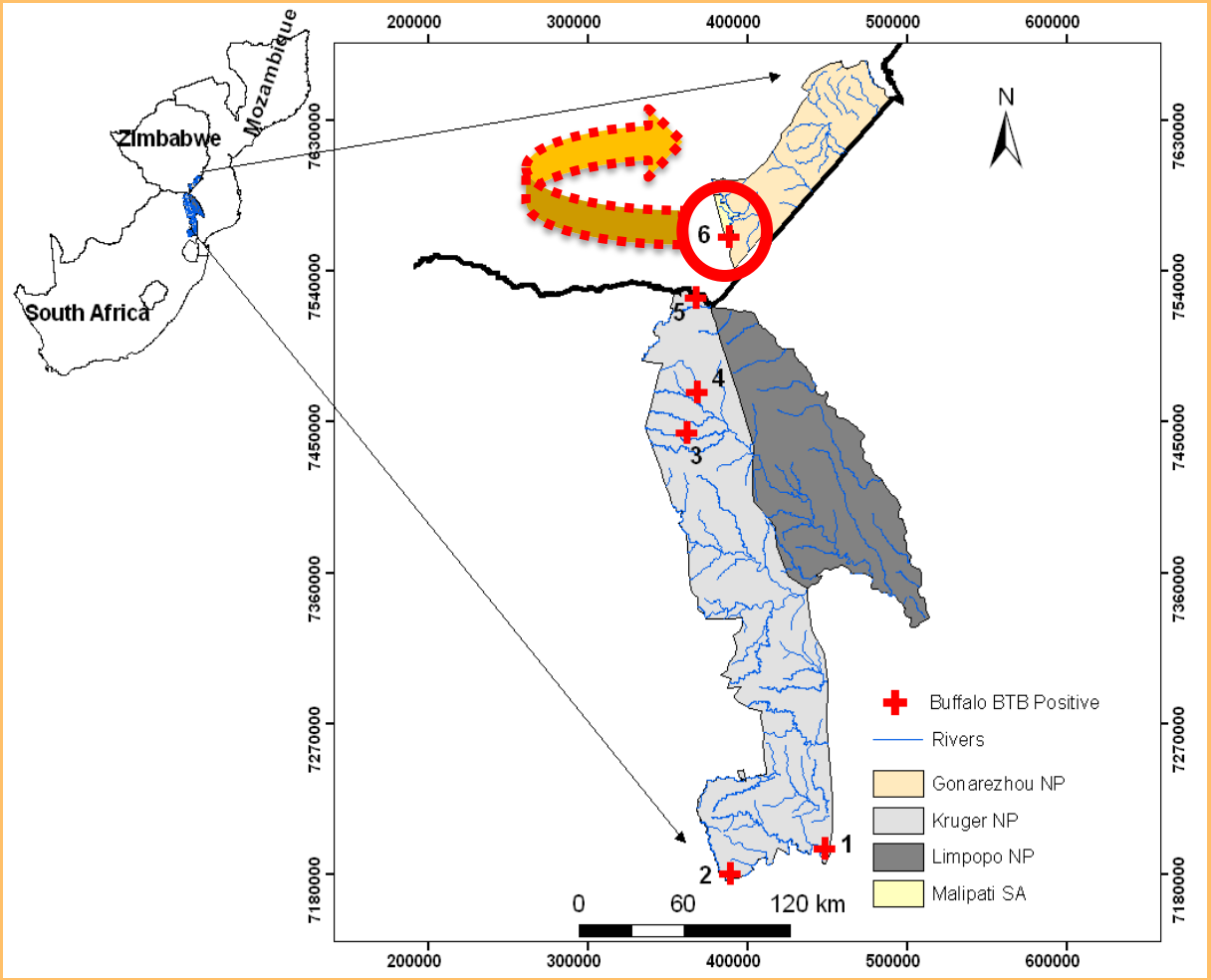
2: 1990

Spread of bovine tuberculosis (bTB) across the boundaries of the GLTFCA *(de Garine-Wichatitsky et al. 2010, 2013)*



5: 2005

Spread of bovine tuberculosis (bTB) across the boundaries of the GLTFCA *(de Garine-Wichatitsky et al. 2010, 2013)*



de Garine-Wichatitsky et al., 2010

Management implications: can we tame the beast?

- *Implications for TFCAs: long distance movement of buffalos → corridors, transboundary movement and disease spread*

- *Implications for TFCAs: local movement of cattle and buffalos → livestock management, fences*

Management implications

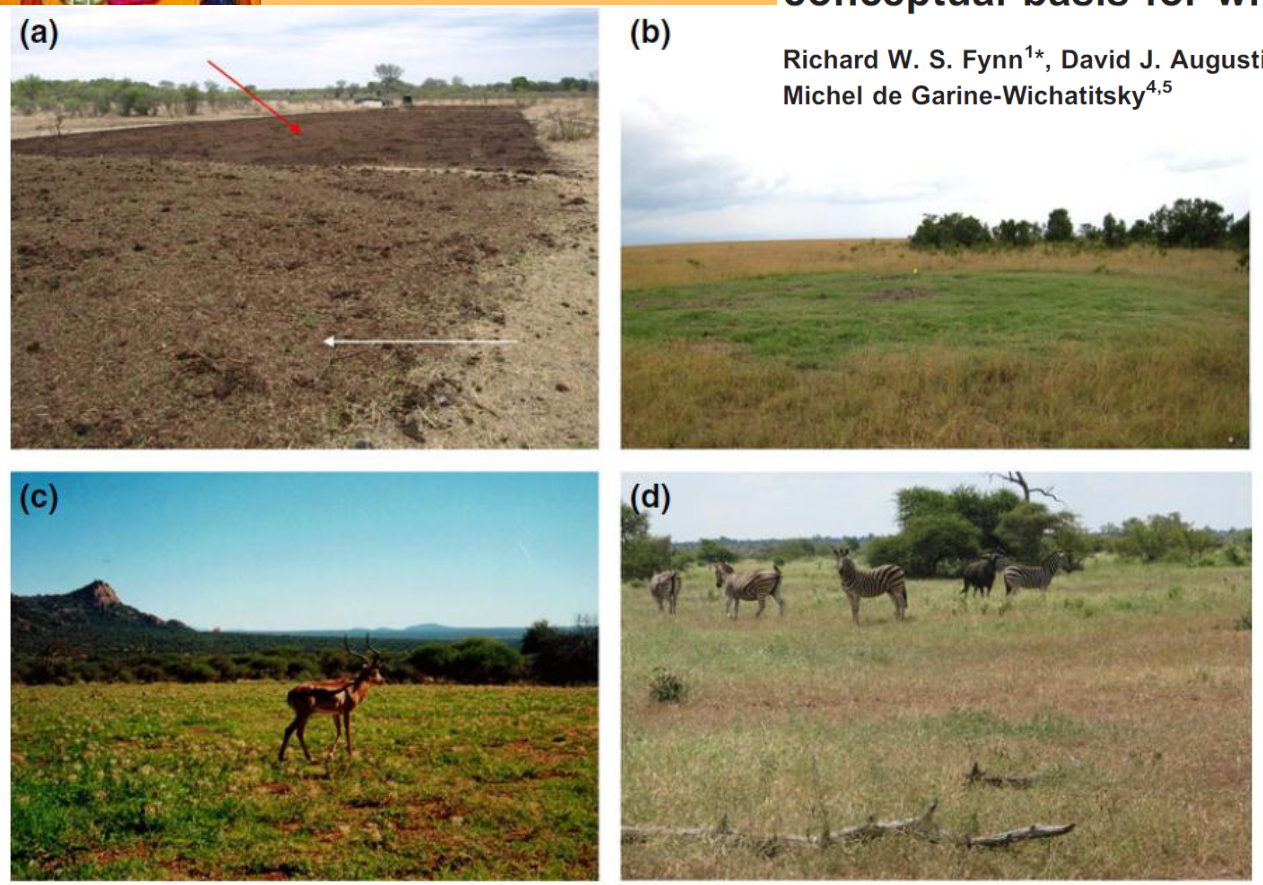
- *Strategic management of livestock grazing*

Journal of Applied Ecology 2015 doi: 10.1111/1365-2664.12591

REVIEW ARTICLE

Strategic management of livestock to improve biodiversity conservation in African savannahs: a conceptual basis for wildlife–livestock coexistence

Richard W. S. Fynn[1]*, David J. Augustine[2], Michael J. S. Peel[3] and Michel de Garine-Wichatitsky[4,5]



Niche differentiation between herbivores (competition/facilitation)

Functional resource heterogeneity

Management implications

- *Strategic management of livestock grazing to promote wildlife-livestock coexistence*

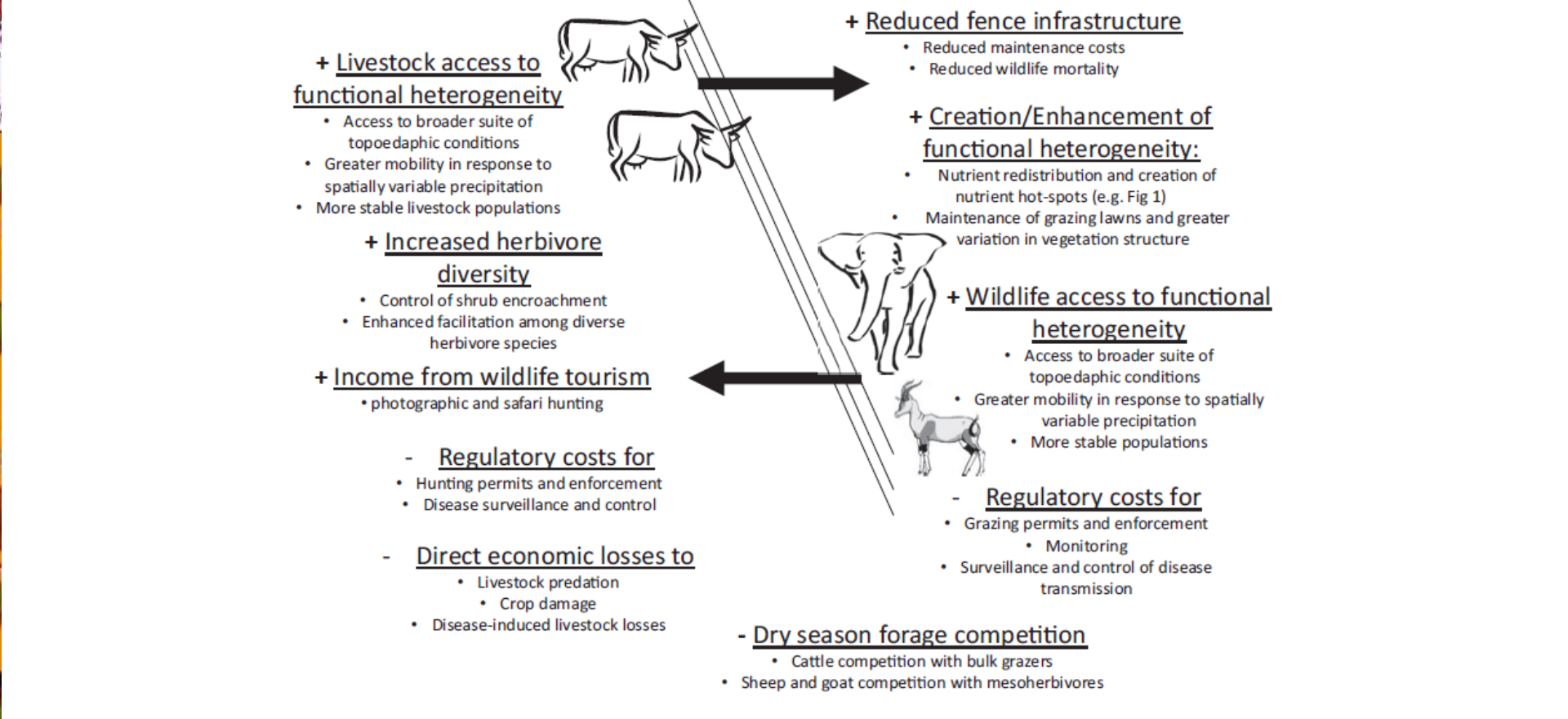


Fig. 2. Summary of the ecological and economic benefits (+) and costs (−) of mobility-based management strategies that allow livestock access into protected areas (right of fence) and facilitate wildlife access into lands managed primarily for livestock (left of fence). Benefits/costs to local communities are listed on the left and benefits/costs to protected areas are listed on the right. Dry season forage competition could affect wildlife or livestock in both areas and would be a key factor to address in livestock grazing plans and hunting regulations.

Table 1. Selection criteria to determine potential competitive or facilitative effects of livestock grazing on native ungulate herbivores. Potential for facilitation increases with increasing grass height and biomass with associated increased concentrations of indigestible compounds such as cellulose and lignin. Thus, livestock grazing may facilitate intake rates of energy and nutrients by wildlife when grass growth rates are rapid such as during the wet season or in high-rainfall regions or wetlands. Competition is expected under conditions of grass dormancy (dry season) or low productivity (dryland arid regions)

	Select or avoid	Mechanisms	Citations
Herbivore foraging strategy indicator			
Intermediate to tall-grass specialist home ranges (sable and roan antelope, waterbuck, reedbuck, hartebeest, eland, topi)	Avoid in all seasons	Intermediate to tall-grass specialists favour back-country regions with low herbivore densities and as such are vulnerable to competition for forage as well as direct disturbance effects	Grobler (1981); Schuette *et al.* (1998); Murray & Illius (2000); Hensman *et al.* (2013); Haveman (2014)
Short-grass specialist home ranges (Thomson's gazelle, Grant's gazelle, springbok, wildebeest)	Select in any season	Mesoherbivores favouring short-grass have specialized mouths (and low absolute food requirements) for foraging on short grass (unlike cattle) so are likely to be facilitated by cattle at moderate (but not high)* densities of domestic mesoherbivores (e.g. sheep and goats)	Western & Gichohi (1993); Fryxell *et al.* (2005); Arsenault & Owen-Smith (2008); Bhola *et al.* (2012); Georgiadis *et al.* (2007)*; Bhola *et al.* (2012)*
Bulk grazer home ranges (buffalo and zebra)	Avoid during dry season	Competition for forage by cattle, which have a similar niche	Young, Palmer & Gadd (2005); Odadi, Okeyo-Owuor & Young (2009); Odadi *et al.* (2011); Bhola *et al.* (2012)
Climatic and topoedaphic indicators (Strategic; Long-term)			
Very low productivity short grasslands over large spatial extent (arid regions; shallow or saline, moisture-limited soils)	Avoid in all seasons	Competition for grazing with migratory herbivores that use these short grasslands as key wet season ranges	Derner, Detling & Antolin (2006)
Medium productivity grasslands (semi-arid regions)	Select during wet season, avoid during dry season	Removes low-quality biomass and facilitates high-quality regrowth (or forms grazing lawns) during the wet season but creates competition for forage during the dry season	Arsenault & Owen-Smith (2008); Odadi, Okeyo-Owuor & Young (2009); Odadi *et al.* (2011)
High productivity grasslands such as bottomlands and wetlands (floodplains, swamps, marshes and dambos) or high-rainfall grasslands	Select during dry season, avoid during wet season*	Grazing needed to remove low-quality, productive biomass in patches and stimulate green regrowth over the dry season. *Wetland systems are resilient to heavy dry season grazing impact because they are generally avoided by or inaccessible to grazers during the wet season and store a large proportion of their biomass in rhizomes	Vesey-FitzGerald (1960); Bell (1970); Western (1973); Tinley (1977); Homewood (2008); Verweij *et al.* (2006); Fynn *et al.* (2015) *Observations by Vesey-FitzGerald (1960) and Pamo (1998). *Theoretical foundation in (Fynn 2012)
Weather and disturbance regime indicators (Tactical; Short-term)			
Wet season in average or above-average precipitation years	Select	Remove low-quality biomass and facilitate high-quality regrowth in grazing lawns; increase vegetative heterogeneity through spatially variable grazing Create long-term nutrient hotspots for wildlife following boma abandonment	Odadi *et al.* (2011); Muchiru, Western & Reid (2008); Augustine *et al.* (2011); Porensky & Veblen (2015)
Recent patchy fire	Select	Maintain patch burns in vegetative state; enhance structural heterogeneity; and facilitate smaller-bodied herbivores	Fuhlendorf *et al.* (2009)
Under-grazed regions with current low densities of bulk-feeding ungulate species	Select	Remove litter, facilitate high-quality grazing	Fryxell *et al.* (2005); Odadi *et al.* (2009); Bhola *et al.* (2012)
Below-average precipitation years	Avoid where wildlife densities are high	Competition for forage resources	Young, Palmer & Gadd (2005); Odadi, Okeyo-Owuor & Young (2009)
Presence of livestock in either of the previous 2 years	Avoid	Prevent loss of tufted perennial grasses and associated woody invasion* as well as minimize disturbance to sensitive wildlife species†	Fynn (2012)*; Fritz, de Garine-Wichatitsky & Letessier (1996)†

Avoid bulk grazer home range (buffalo, cattle) in dry season

Select medium productivity grasslands (semi-arid regions) during wet season, but avoid during dry season

Select high productivity grasslands (floodplains, swamps, marshes and dambos) during dry season, but avoid during wet season

Select: 1) during wet season in average or above-average precipitation years; 2) recent patchy fire; 3) under-grazed regions with current low densities of bulk-feeding ungulate species

Management implications Identify « risky » sites/periods/herds

- *Manipulate buffalo-cattle contacts*

Access to water, herding/kraaling

- *Protect cattle herds at risk*

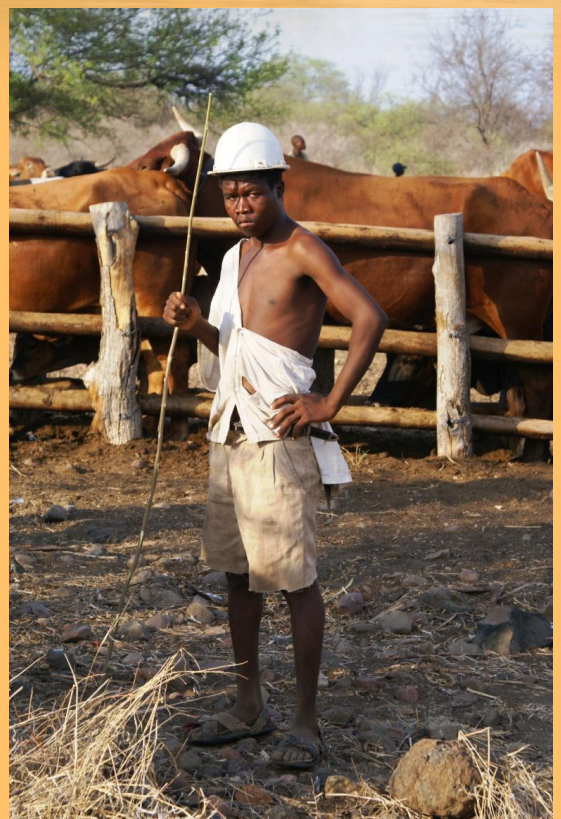
Acaricide dipping, vaccination (FMD, Theileriosis,…)

- *Monitor health of cattle herds*

Regular inspection: BTB, Contagious Abortion, …

- *Alternative management options*

Commodity-based trade, local “niche” marketing for “wildlife-friendly” beef



Management implications

- *Participatory approaches to co-design livestock management strategies*

Companion modelling, multi-stakeholder/multi-scale

Kulayinjana (« *Teaching Each Other* »): A Role Playing Game to elicit, model and simulate cattle complex herding strategies

Co-designed role-playing game that mimics local farmers everyday life to promote coexistence of PAs and their peripheries

***Perroton*, A. 2015. PhD thesis**
Perroton et al (in progress)

Thank you
Merci/Tatenda

- **Ministère des Affaires Etrangères**
  RenCaRe/FSP-2012

- **Agence national de la Recherche**
  SAVARID/ANR-11-CEPL-003
  PIAF/ANR-13-JSH1-0005

- **European Union**
  EU-PARSEL (2008-2011)

- **Cirad**
  Ain°6 (2008-2016)

- **Government Veterinary Services of Zimbabwe**

- **National Parks and Wildlife Management Authority of Zimbabwe**

- **South Africa National Parks**

- **Communities, local and traditional authorities**: Magoli, Malipati, Chikombedzi, Chizvirizvi, Chomupani

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