Animal movement and the conservation of the Serengeti-Mara Ecosystem

Grant.Hopcraft@glasgow.ac.uk

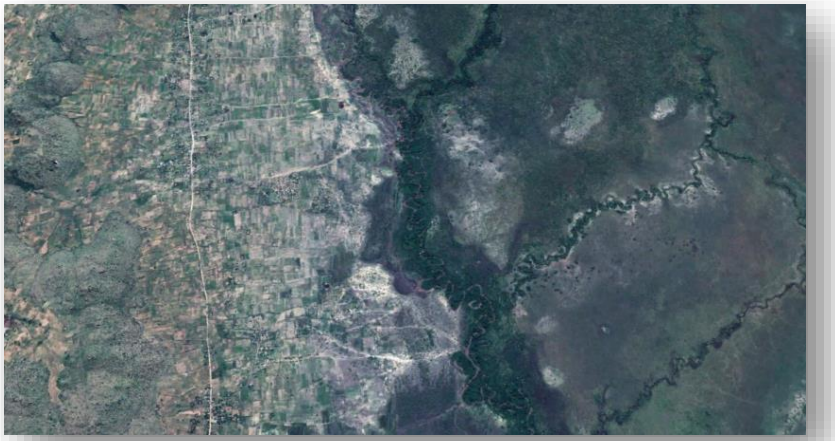
University of Glasgow

A global ecological crisis

Amazon, Brazil

Bialowieża, Poland

Yellowstone, USA



Serengeti, Tanzania

Amazon, Brazil

Bialowieża, Poland

Yellowstone, USA

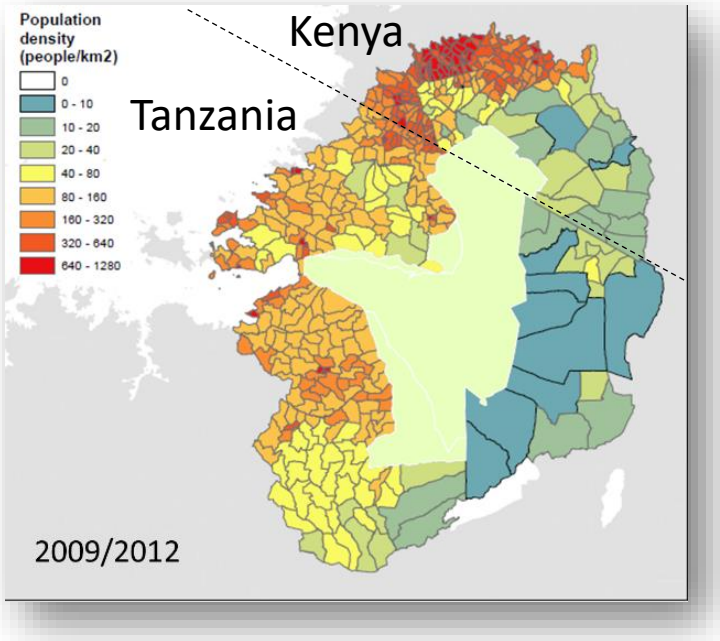
A global ecological crisis

Challenge

Ecological effects are often:

- DELAYED
- DISPLACED
- DISPROPORTIONAL

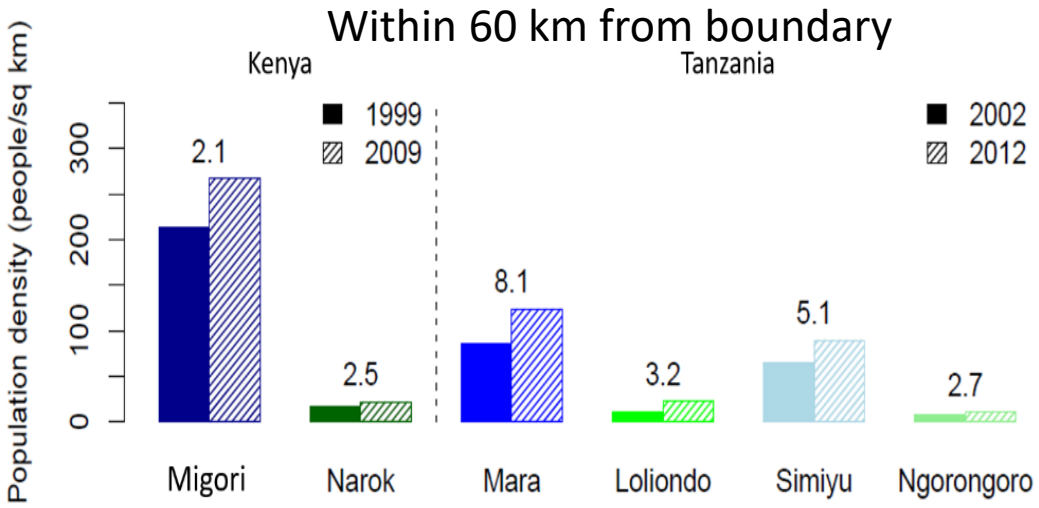
What's happening at the edges?
Human population growth



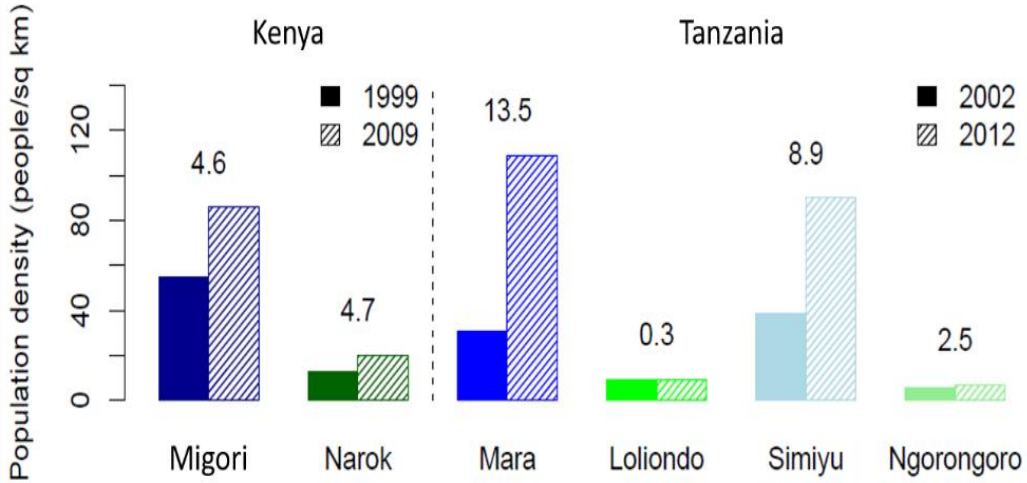
What's happening at the edges? Human population growth

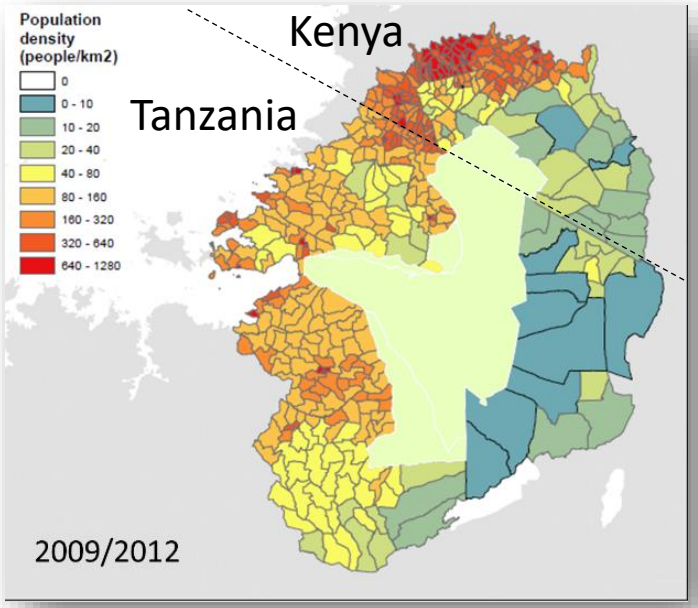
Michiel Veldhuis

Han Olff



Within 15 km from boundary



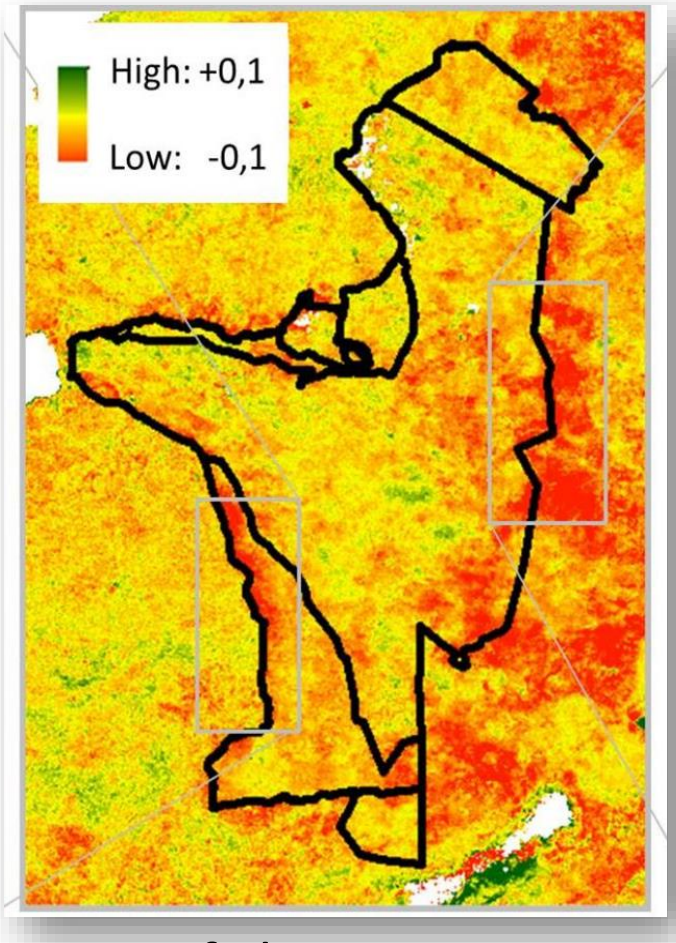


Veldhuis et al (2019) Science

What's happening at the edges? The squeeze

Michiel Veldhuis

Han Olff



Rate of change in NDVI

Veldhuis et al (2019) Science

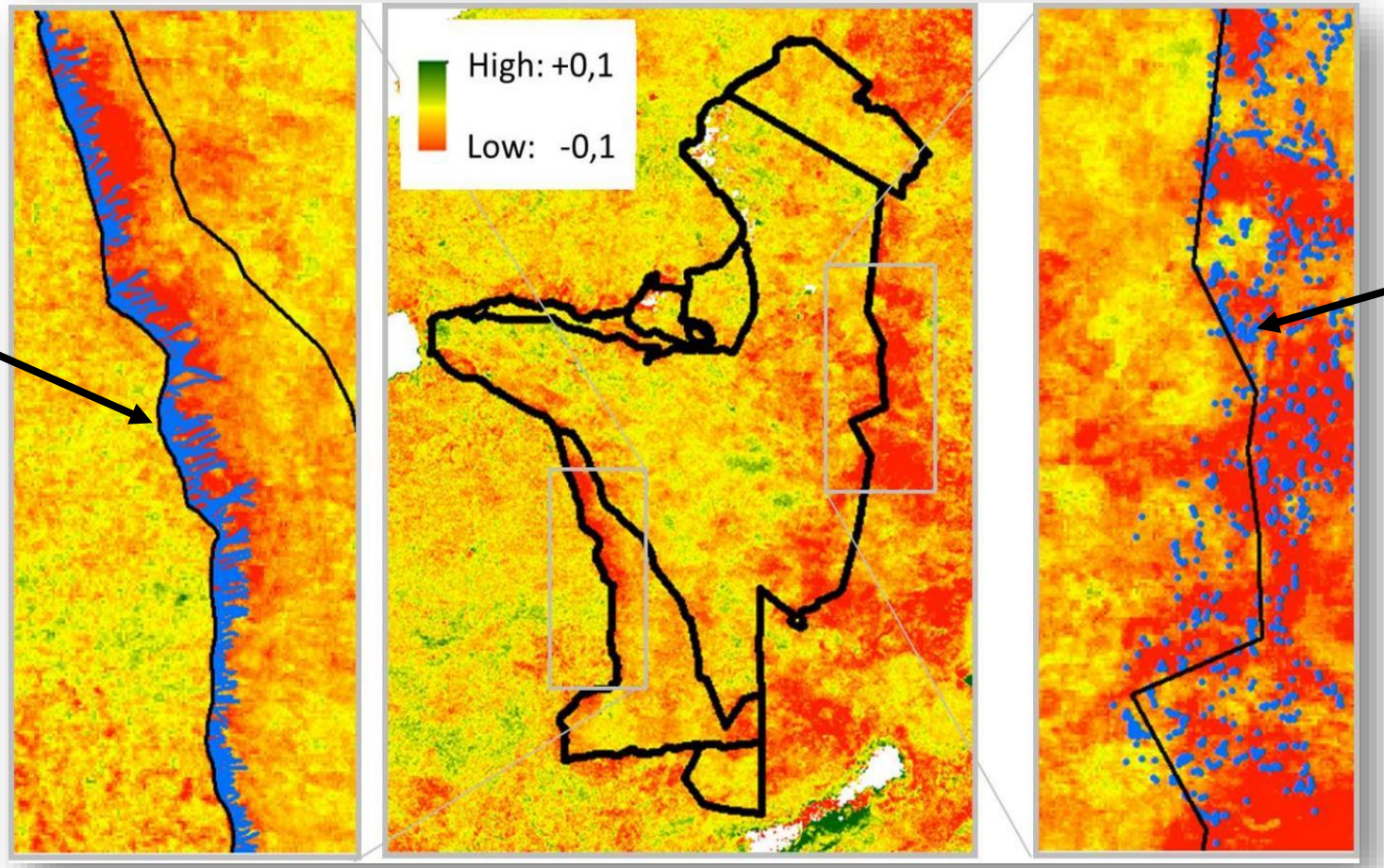
What's happening at the edges? The squeeze

Loss of resilience

Cause and effect are spatially DISPLACED

Michiel Veldhuis

Han Olff

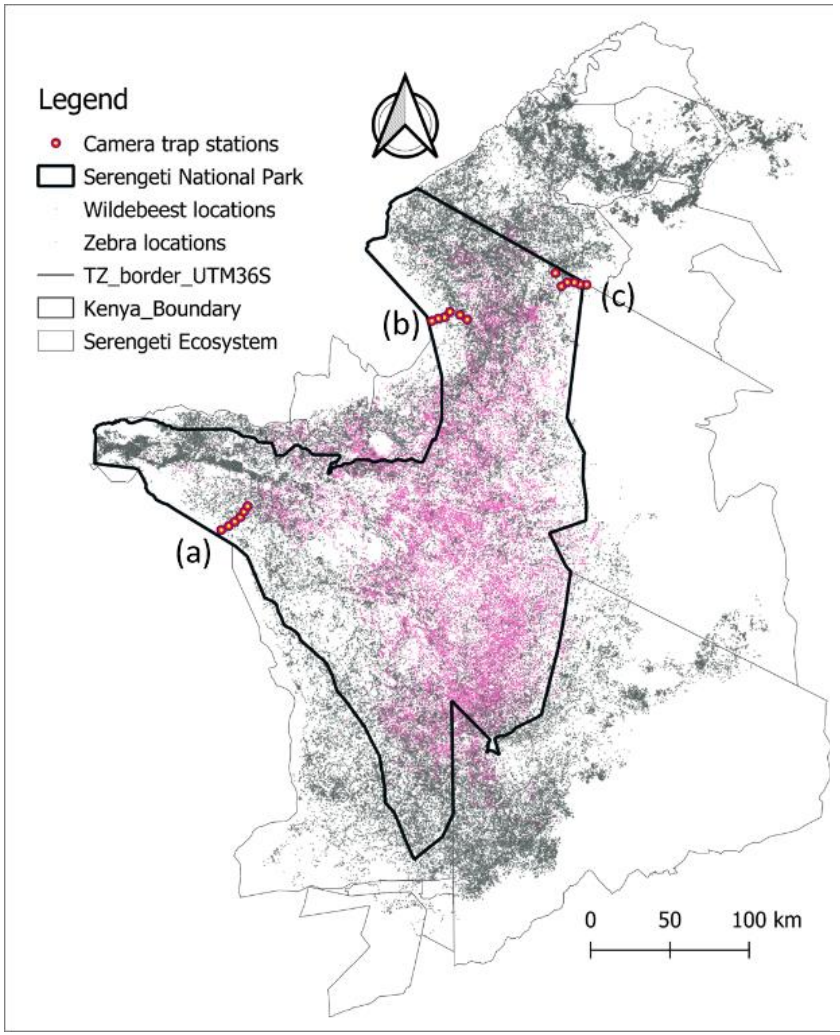


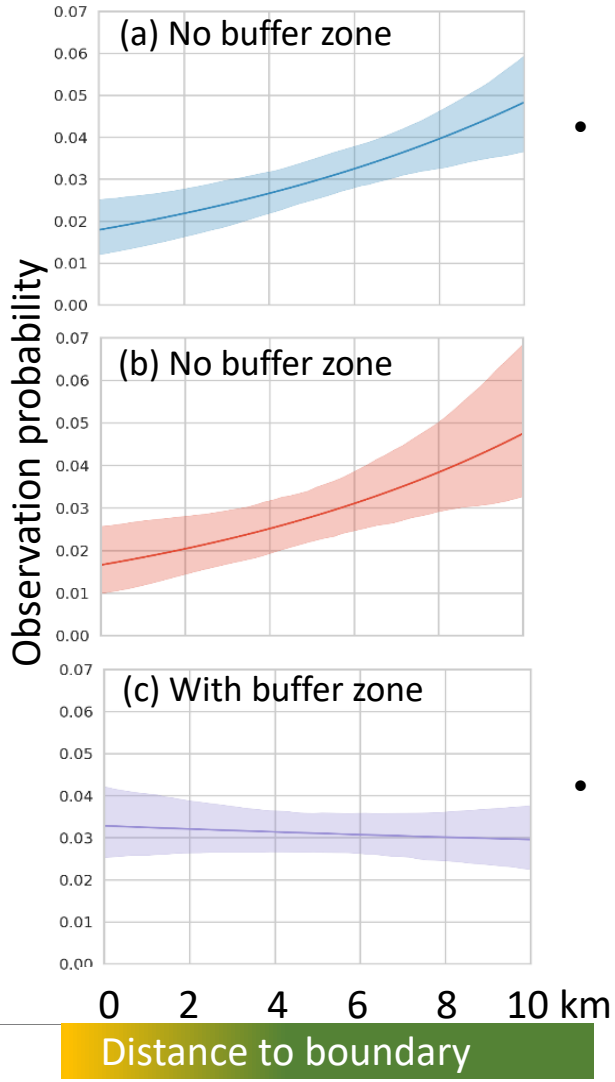
Rate of change in NDVI

Veldhuis et al (2019) Science

What's happening at the edges? Wildebeest and zebra avoid hard edges


Cyrus Kavwele

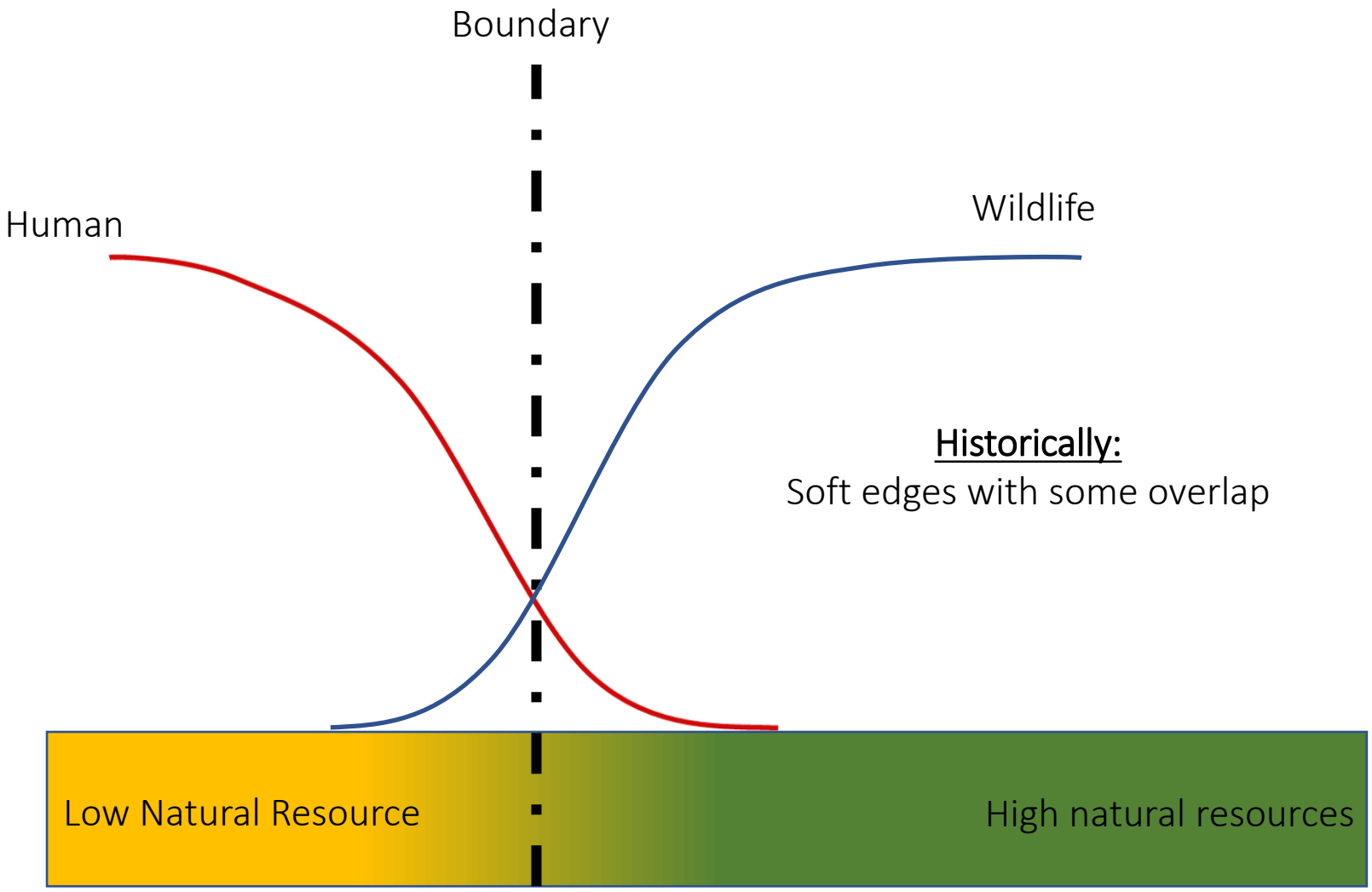




- Serengeti
  - 129km of boundary is "hard" (17.4%)
  - Equivalent to 1000km^2 legally protected but rarely used by the migration because of associated risk
- Effective size is smaller than geographic size

Kavwele et al. (2022) Ecological Solutions & Evidence

Animal response to the boundary



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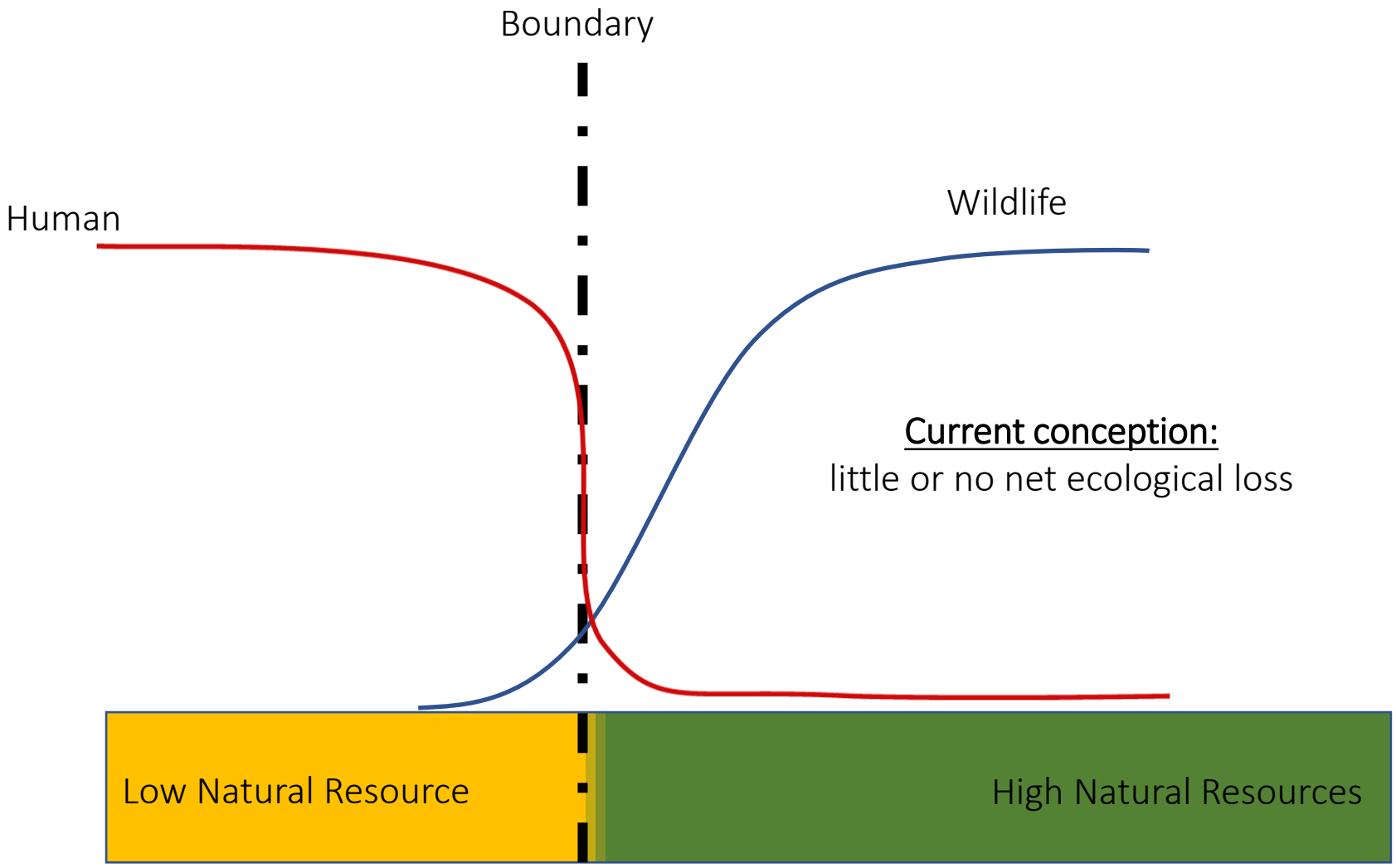
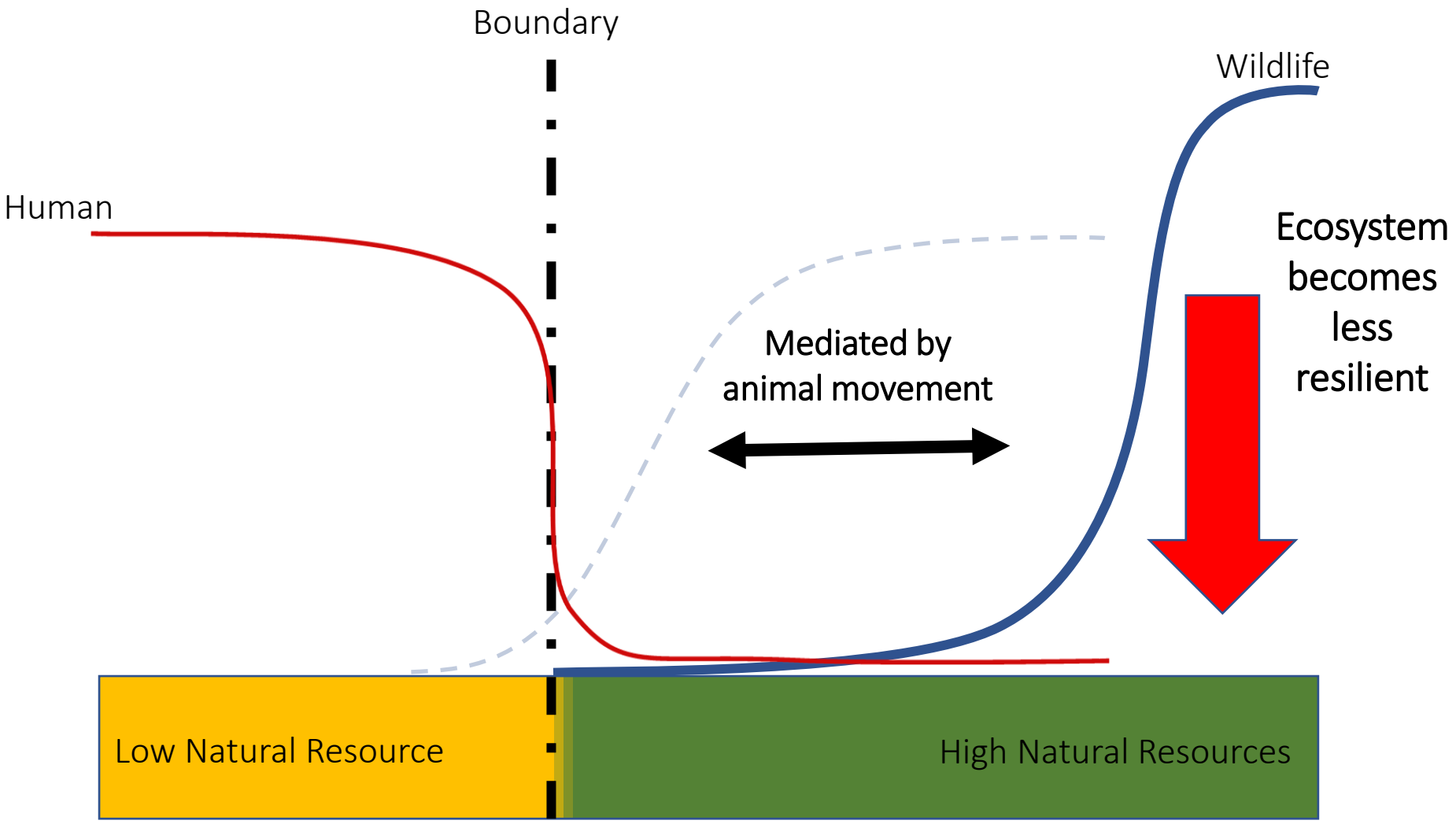
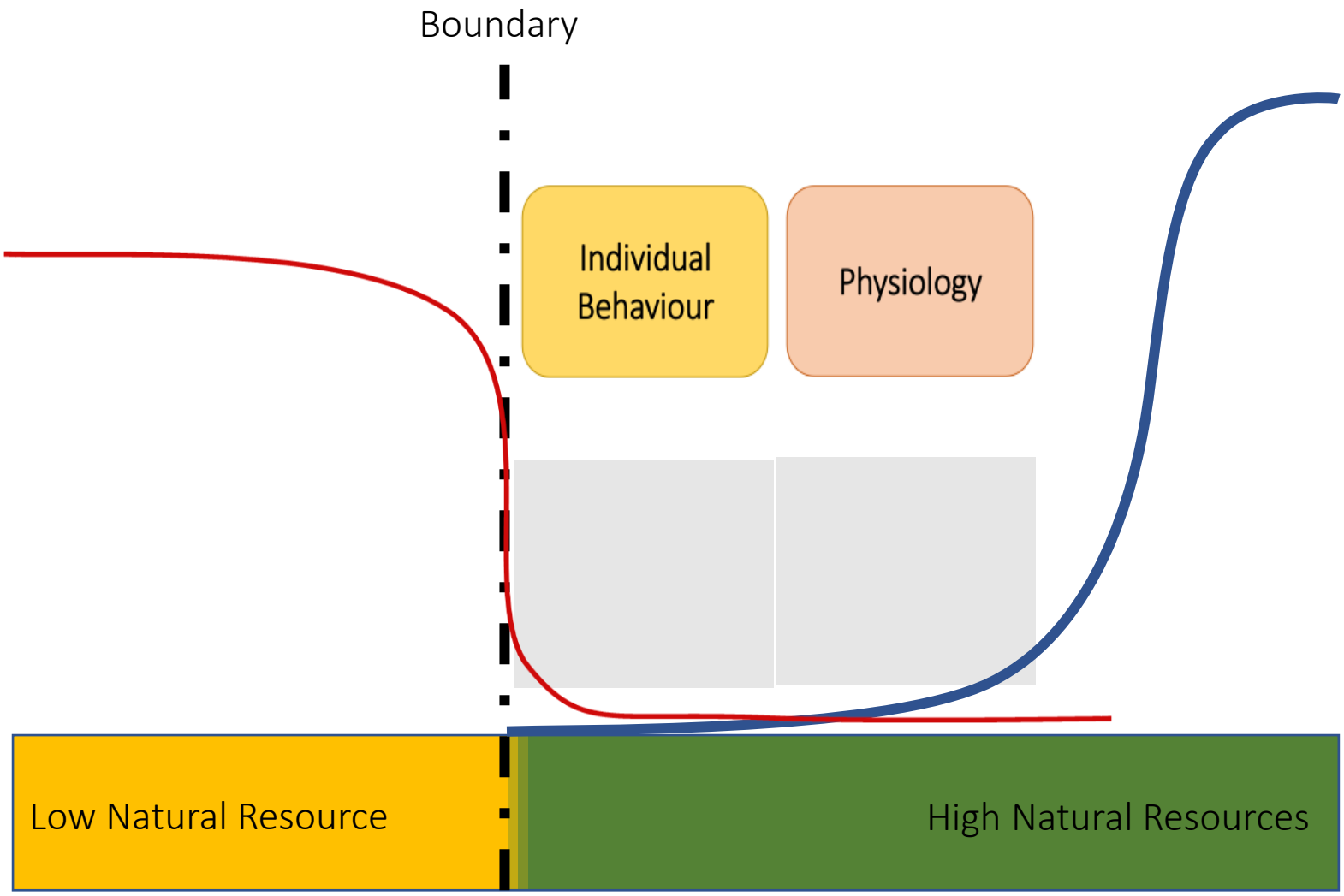


Animal response to the boundary



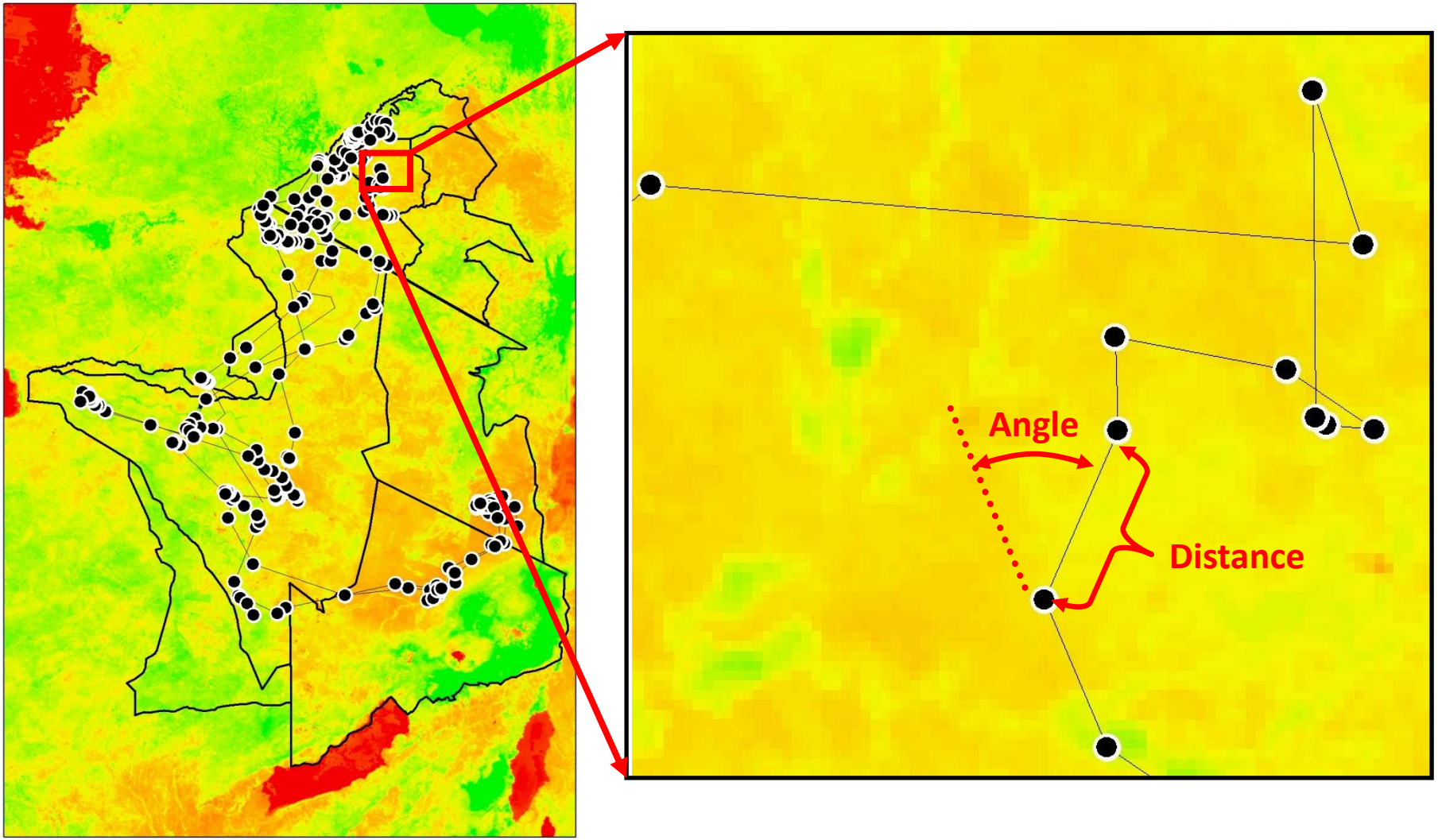
Animal response to the boundary



Individual Behaviour

Ask the animals

Movement in relation to environment

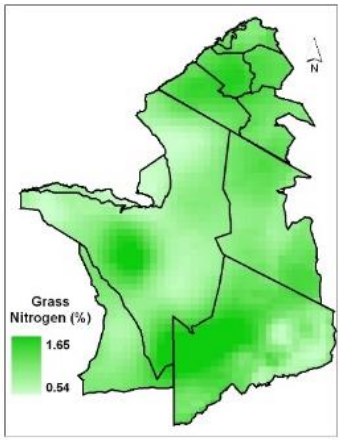


Hopcraft et al (2014) Ecol. Monographs

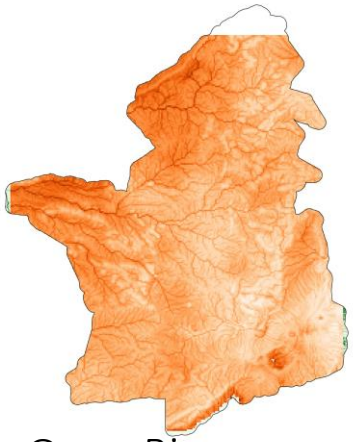
Landscape Attributes

Resource quality & quantity

280km

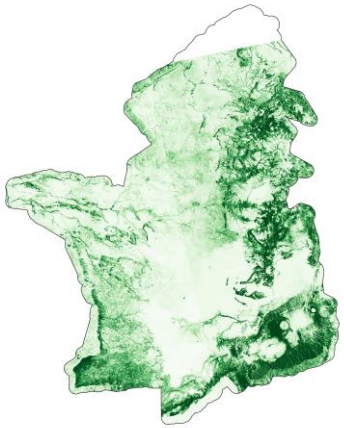


Grass protein



Grass Biomass

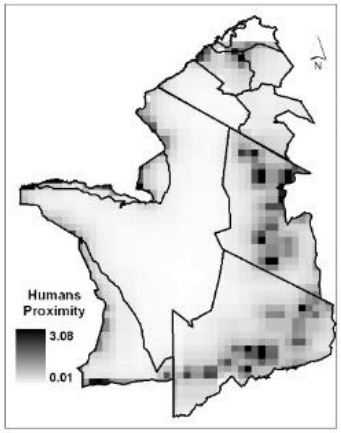
Natural risks



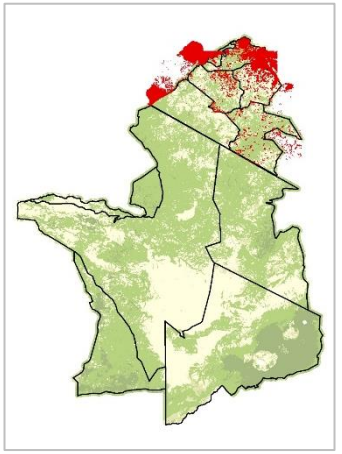
Woody cover

Predation risk

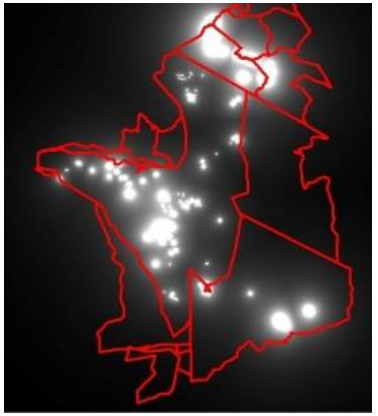
Anthropogenic exposure



Humans



Fences

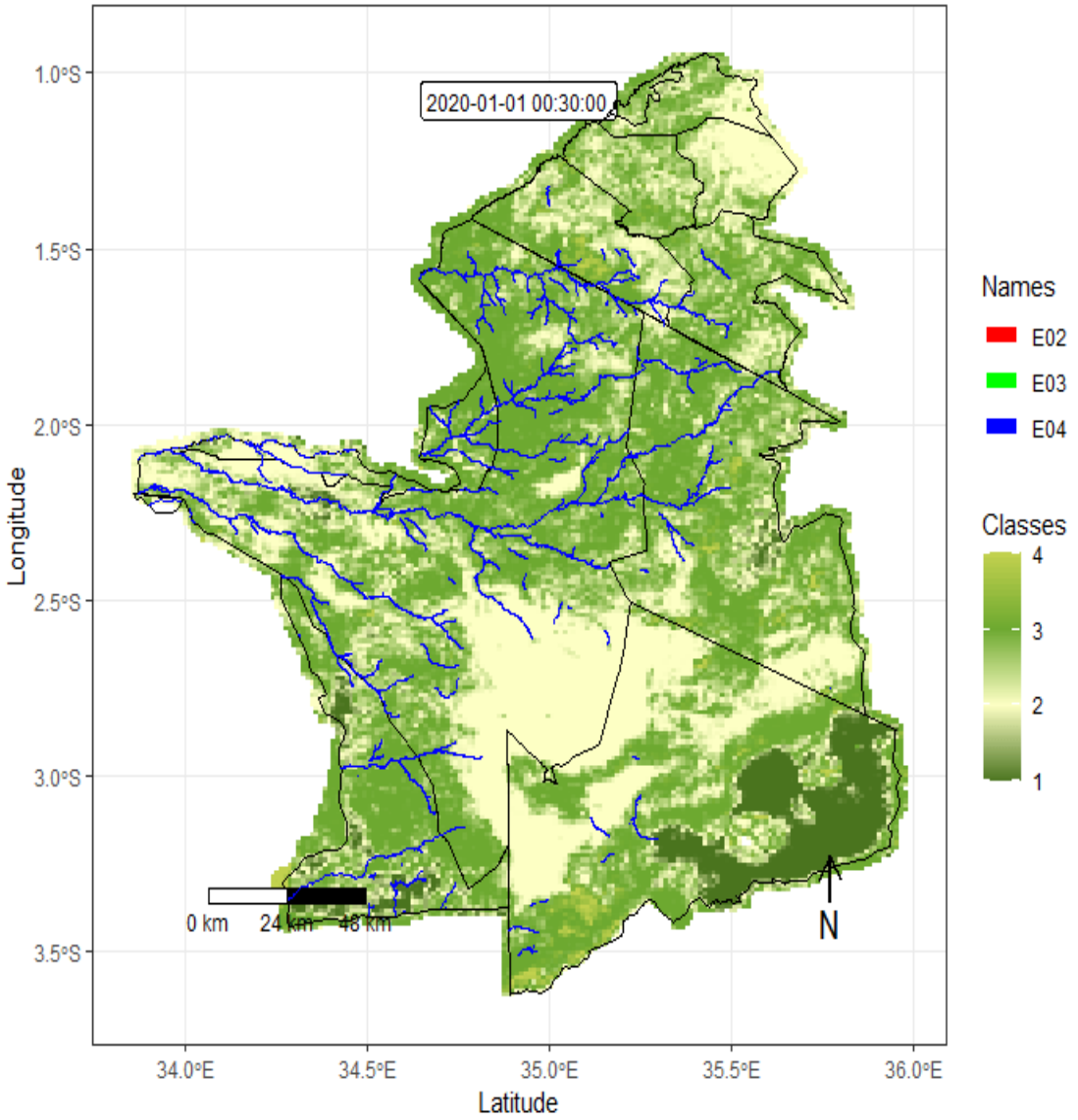


Tourism Infrastructure

Hopcraft et al, JAE (2005); Ecology (2010); JAE (2012)

Species wise variation in movement

Melinda Boyers

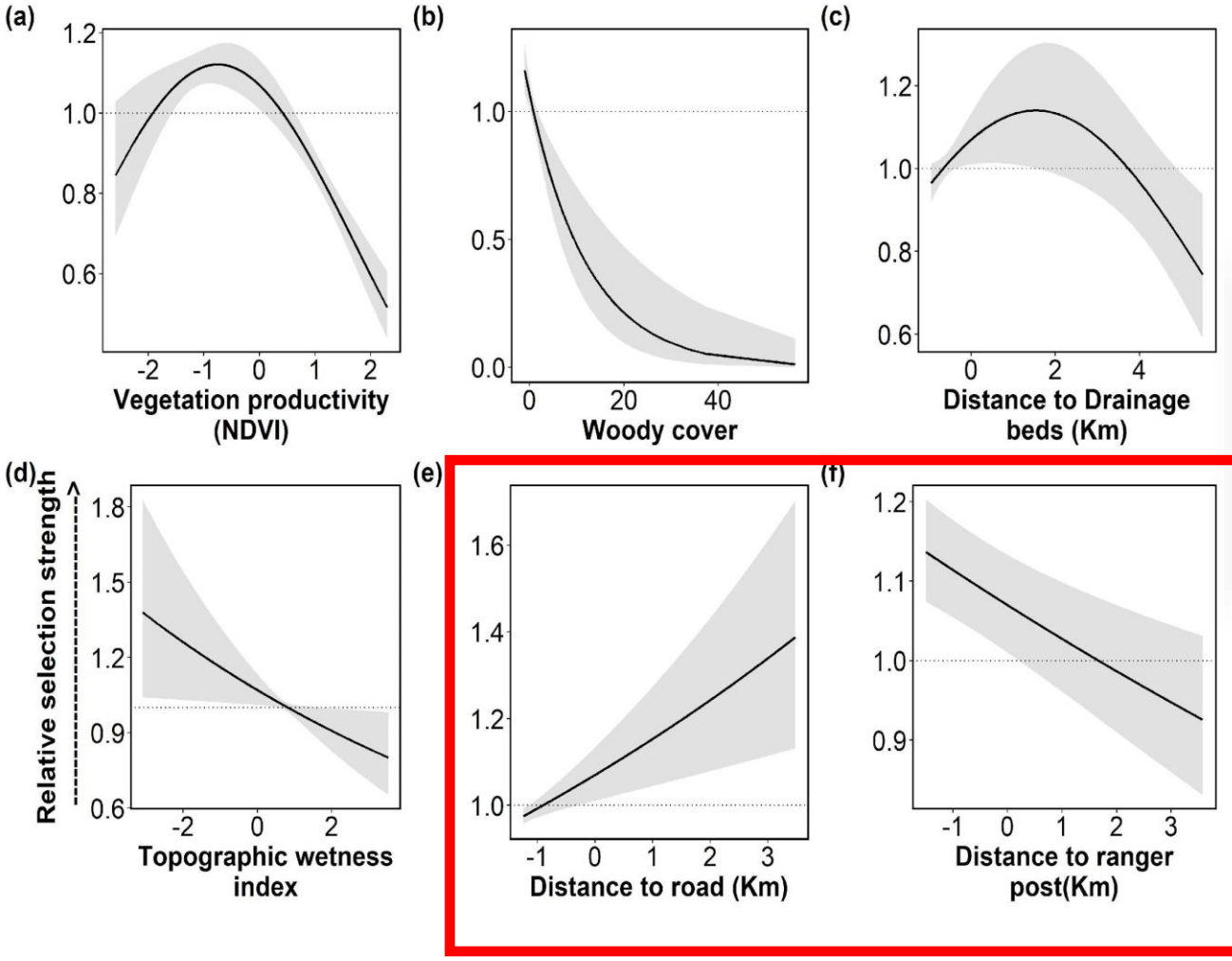


Eland

Boyers (2021) Royal Society Newton Fellowship Award with AfriMove Consortium

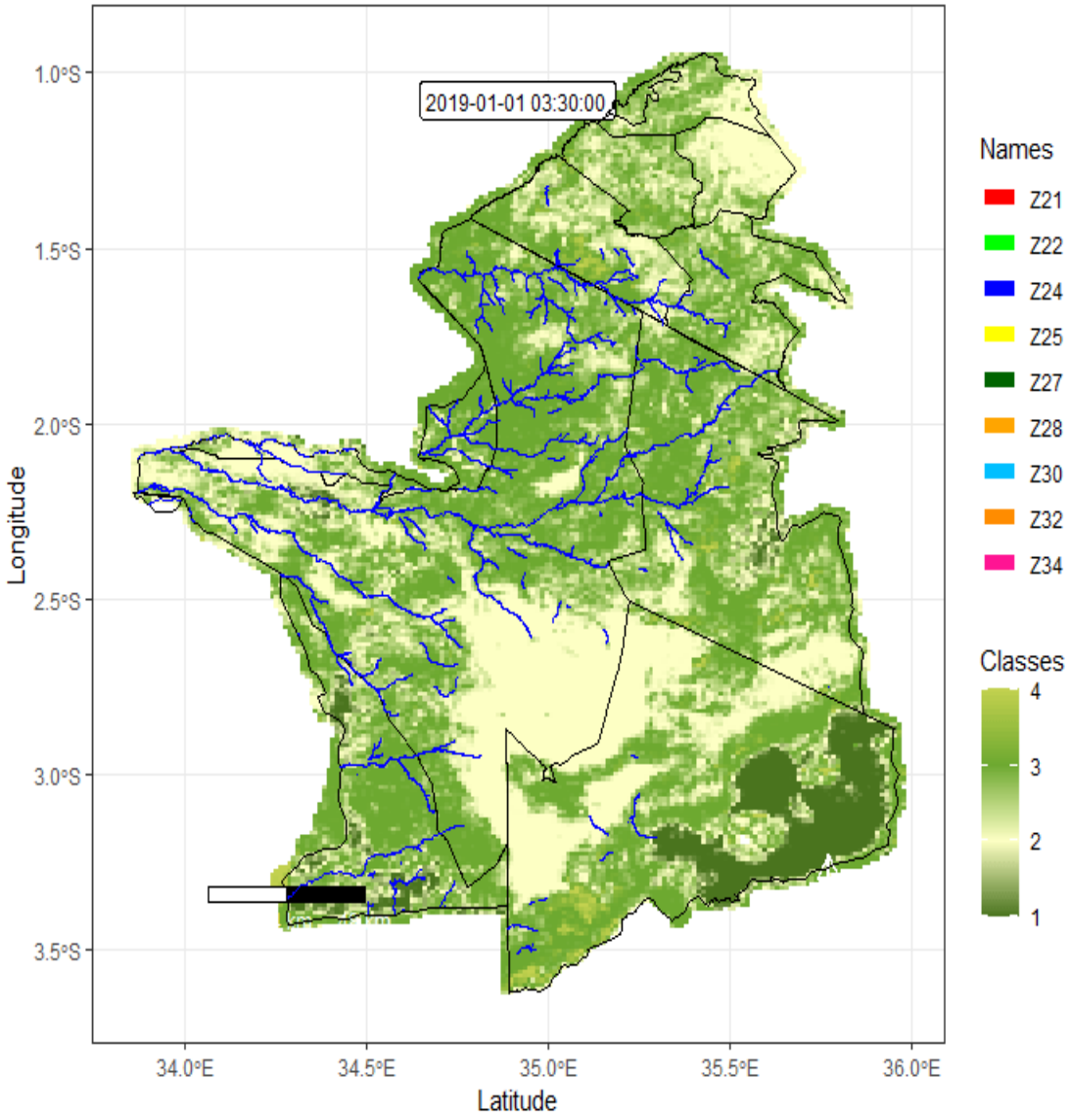
Animal response – Eland Integrated Step Selection Functions

Majaliwa Masolele



Species wise variation in movement

Melinda Boyers

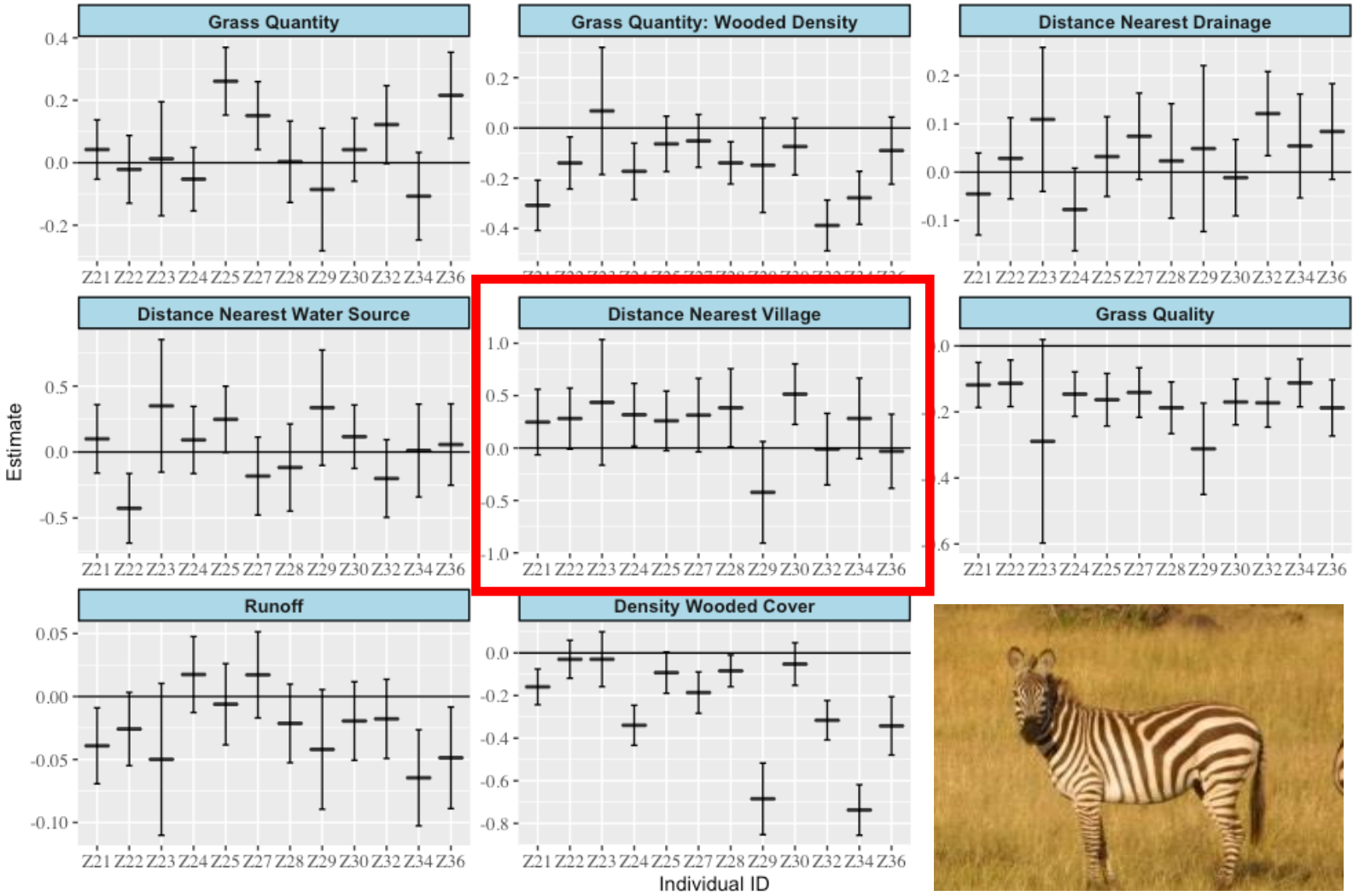


Zebra

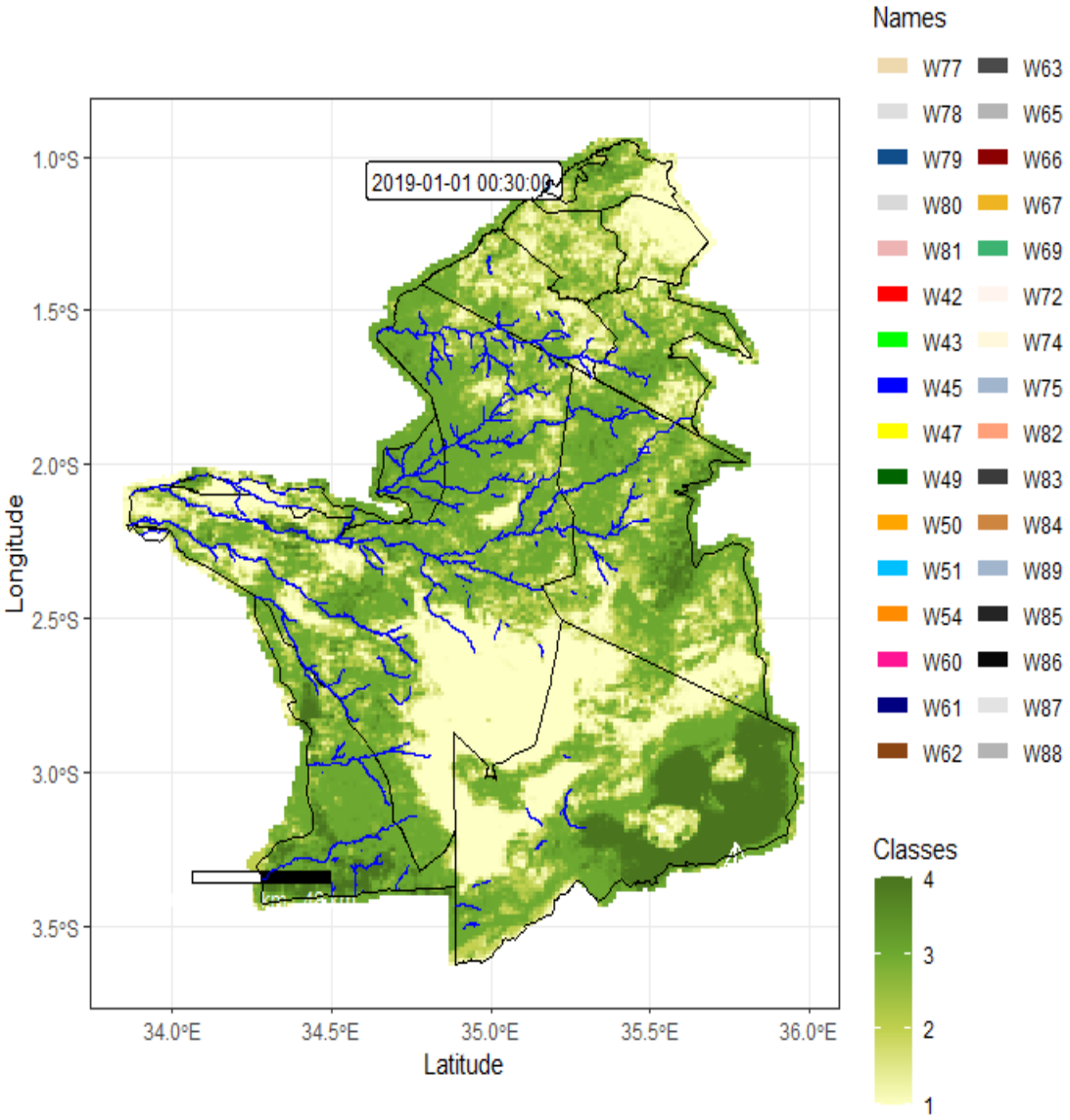
Boyers (2021) Royal Society Newton Fellowship Award with AfriMove Consortium

Animal response – Zebra Integrated Step Selection Functions

Kyle Smith



Species wise variation in movement

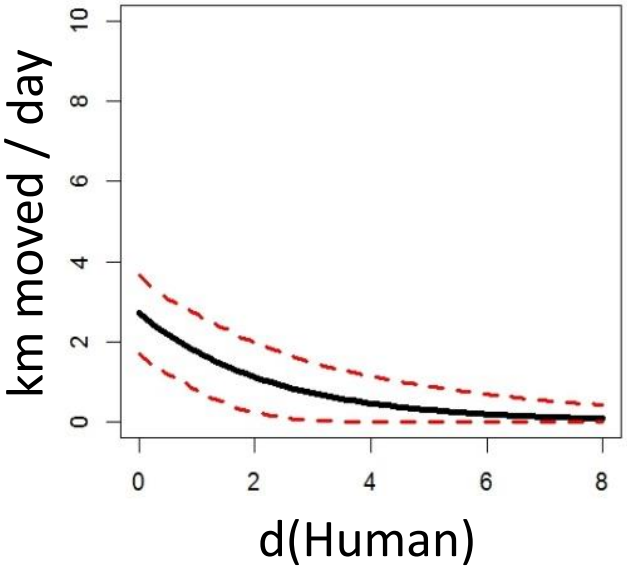


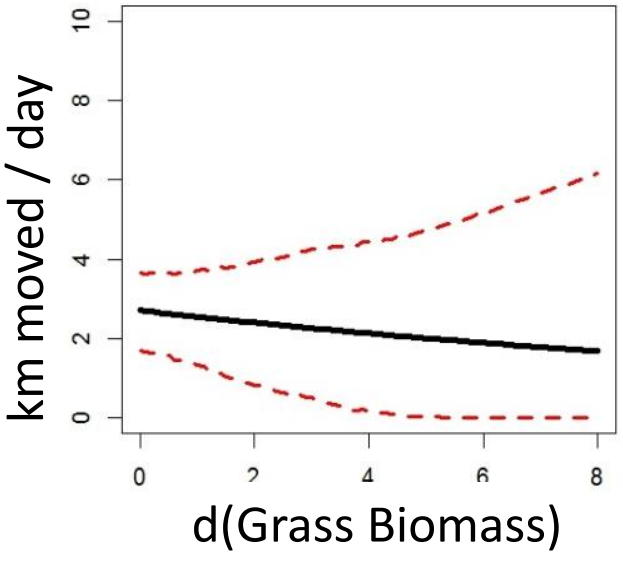
Melinda Boyers

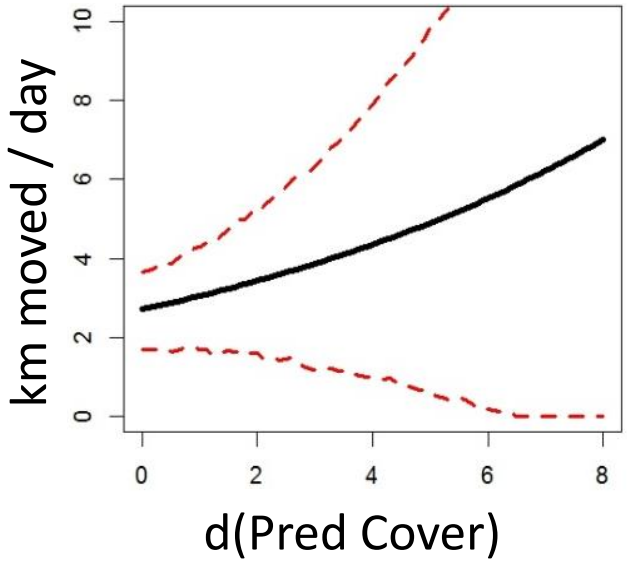
Wildebeest

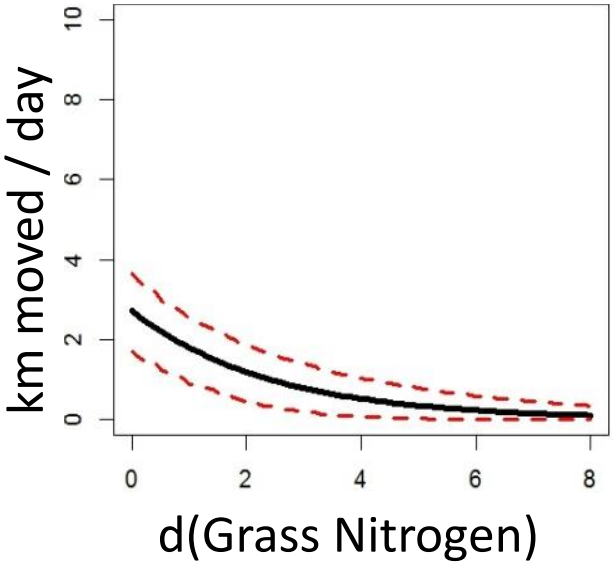
Boyers (2021) Royal Society Newton Fellowship Award with AfriMove Consortium

Animal response - Wildebeest









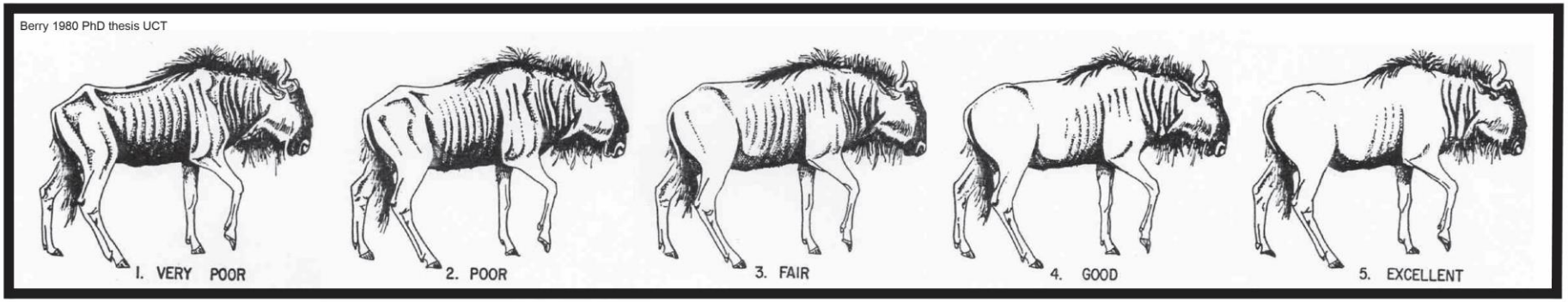
Hopcraft et al (2014) Ecol. Monographs

Physiology

Visual metrics of animal condition: Body score

Gareth Hempson

1 2 3 4 5



Visual metrics of animal condition: Body score

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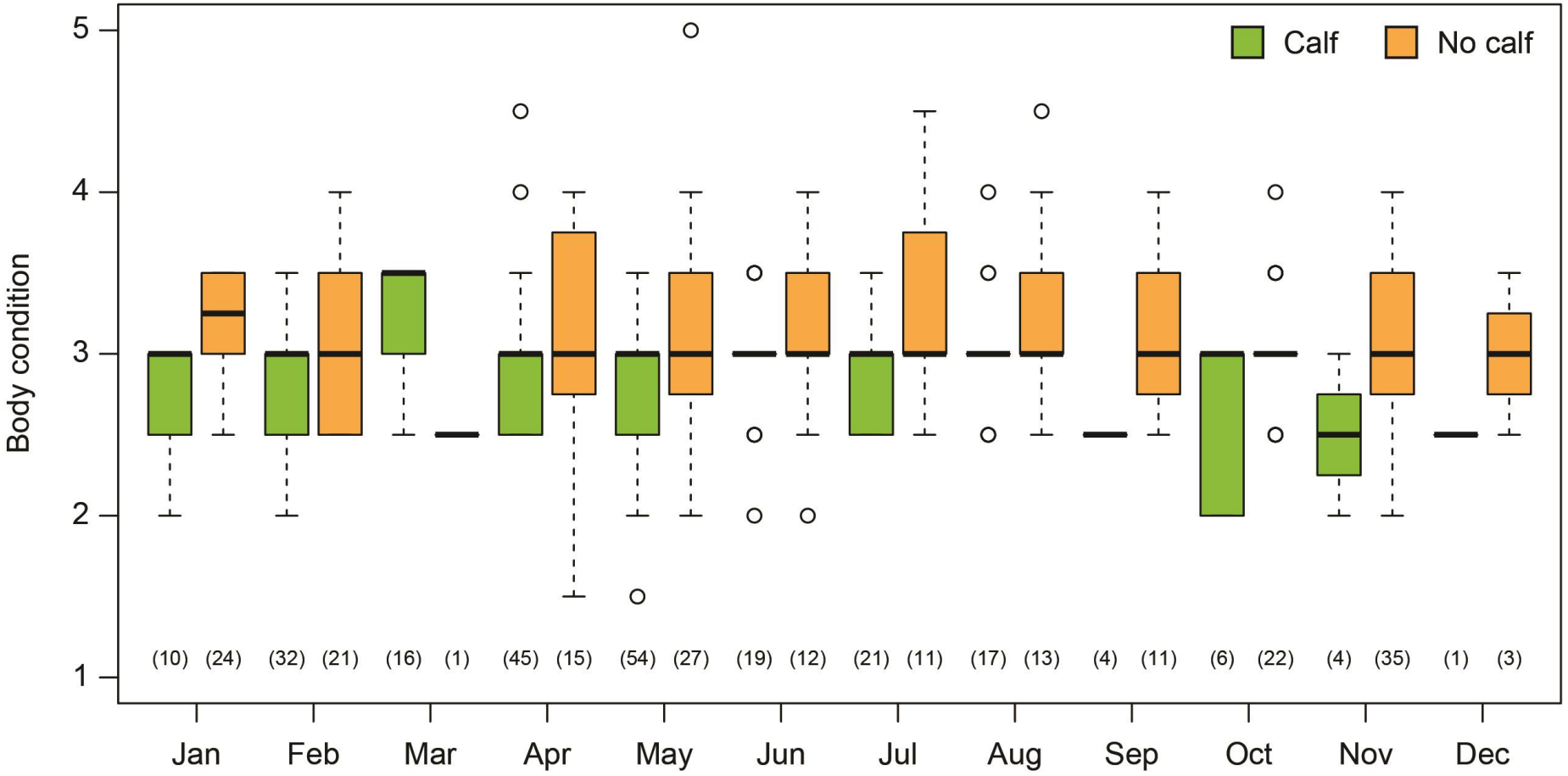

Physiological metrics of animal condition

Physiological metrics of animal condition

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Physiological metrics of animal condition

Healthy animals
thick white bone marrow

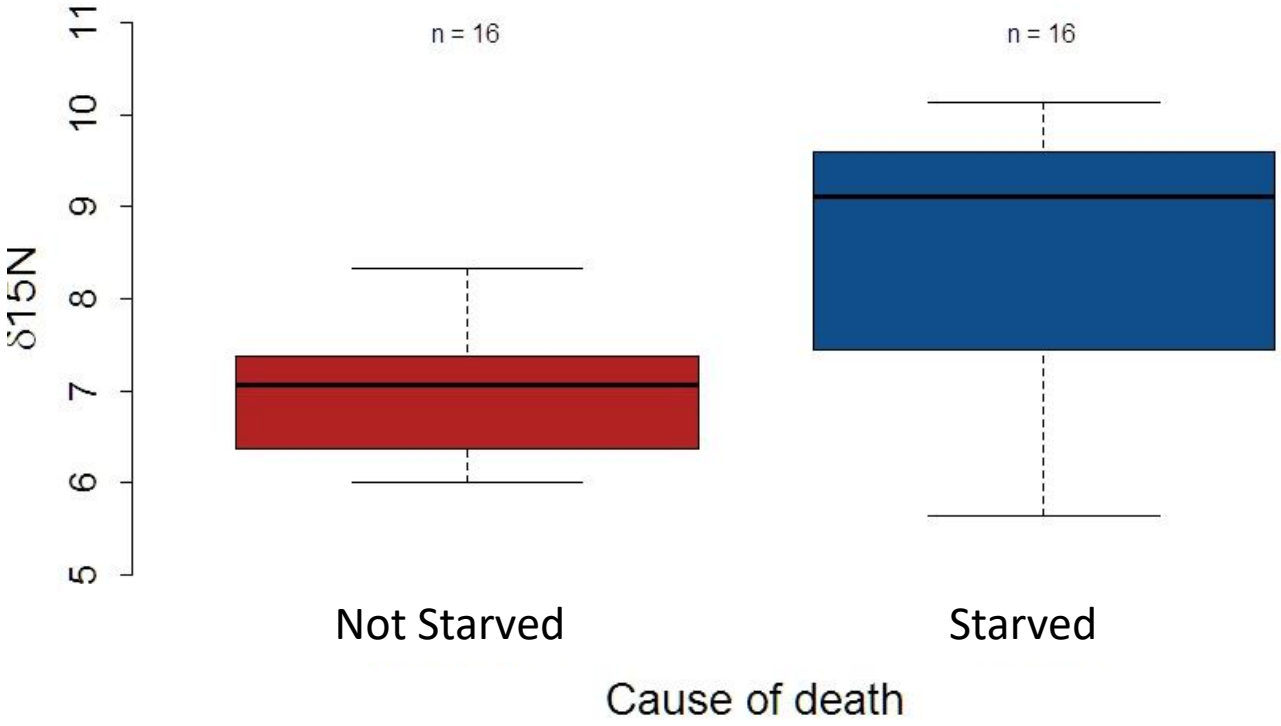
Starving animals
clear liquid bone marrow

Physiological metrics of animal condition

Physiological metrics of animal condition

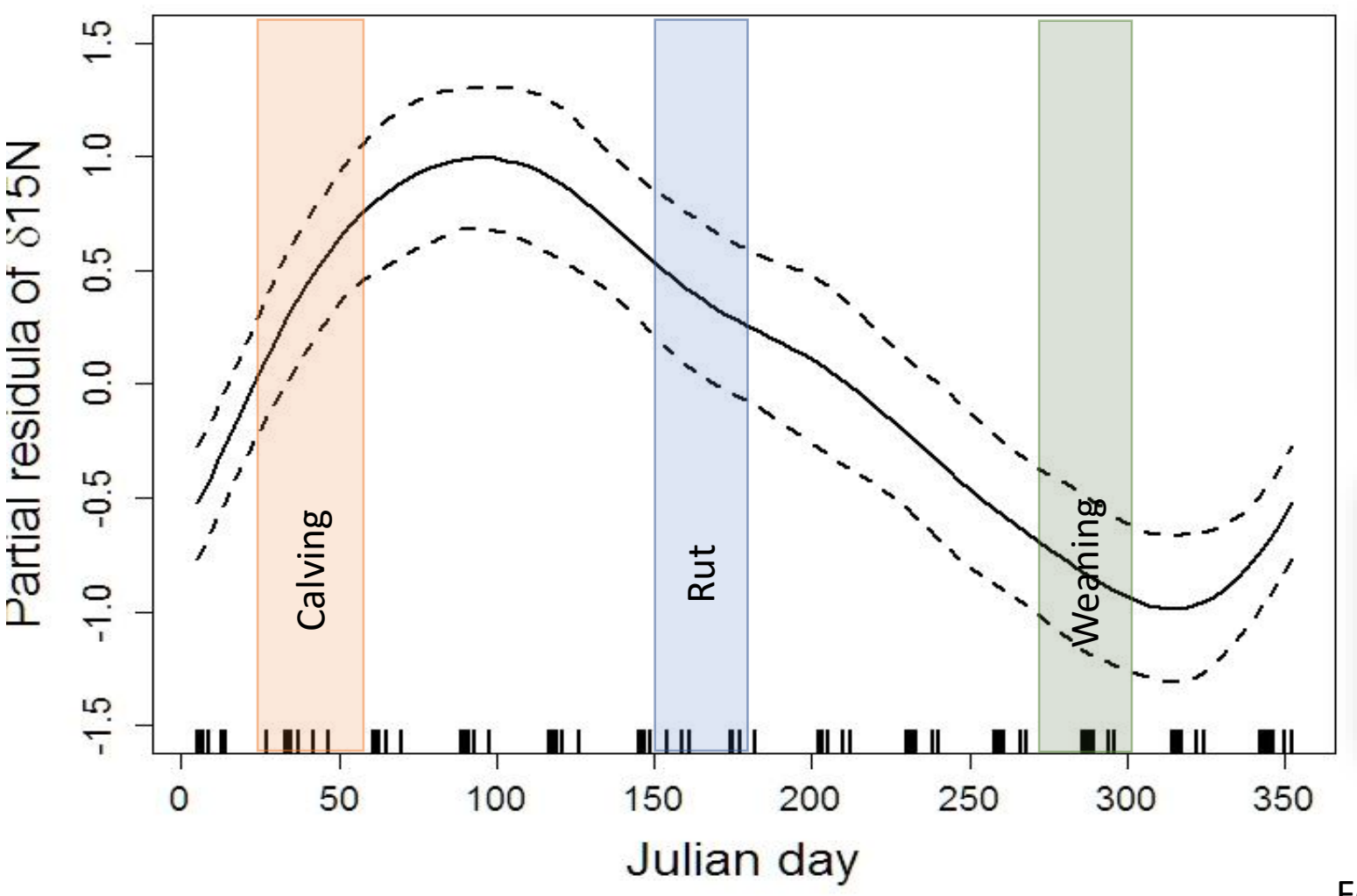
Kristyna Rysava

Zabibu Kabalika



Rysava et al (2016)
Rapid Comm Mass Spec

Indicators of animal condition - starvation



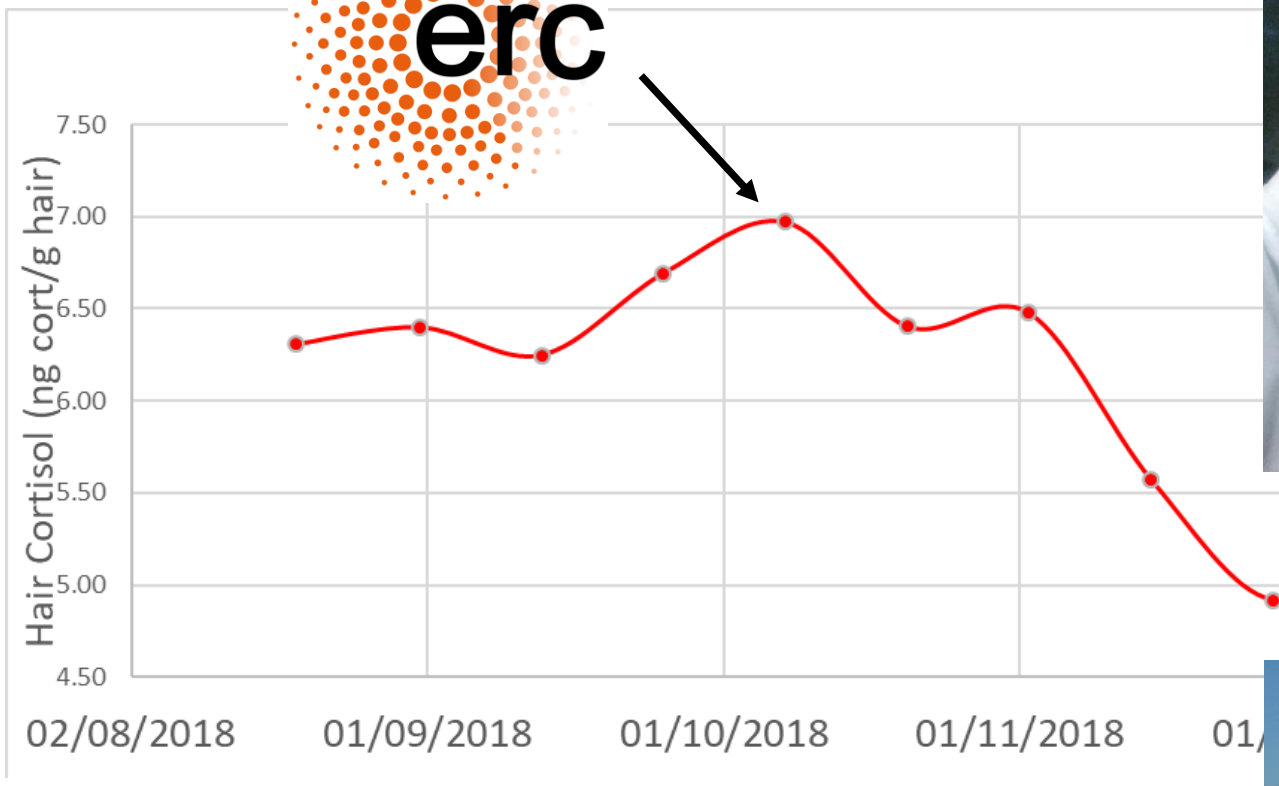
Kristyna Rysava

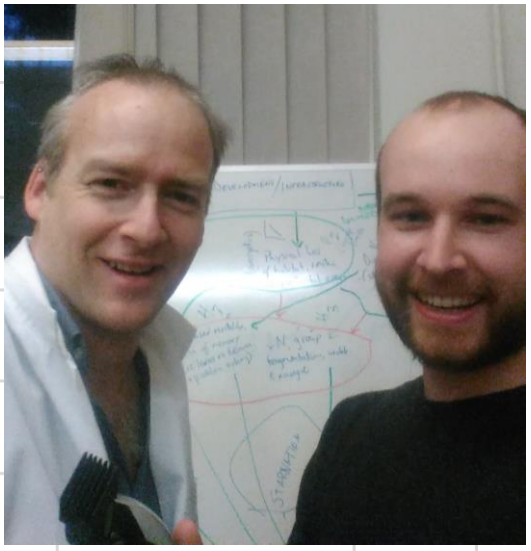
Zabibu Kabalika

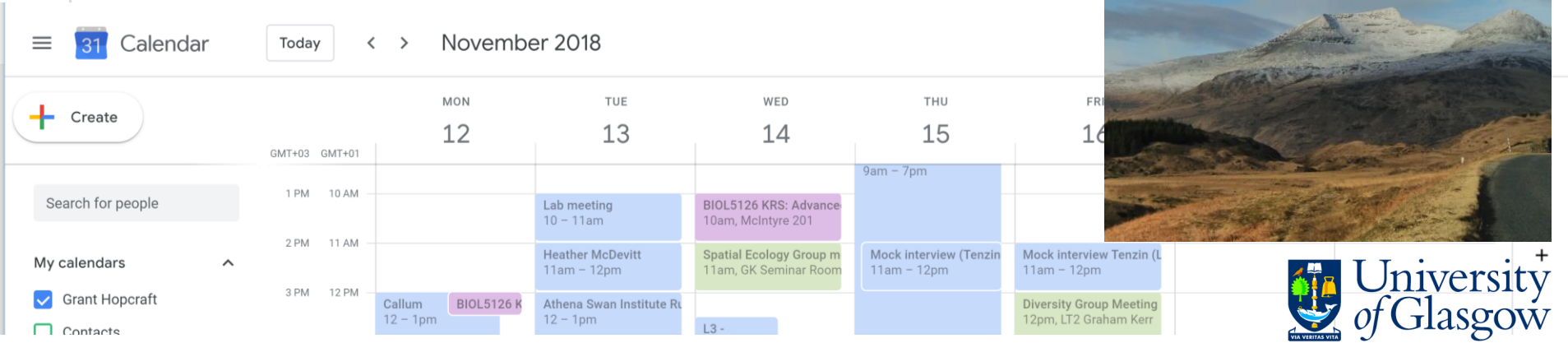
GAMM
Females w/ calves
ID as random
Age

Rysava et al (2016)
Rapid Comm Mass Spec

Indicators of animal condition - stress

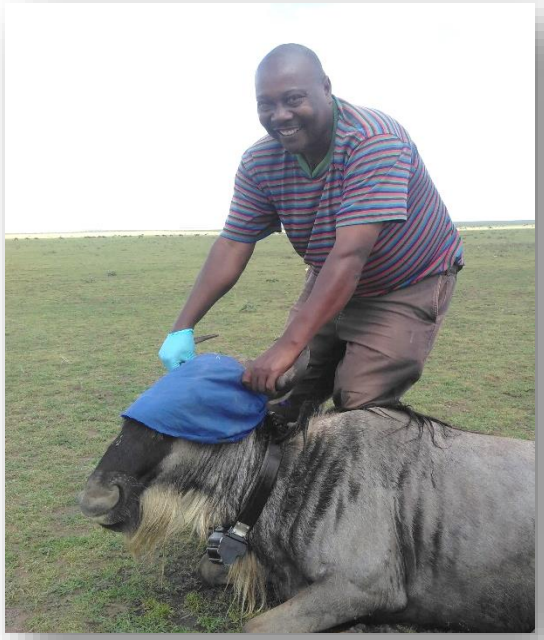




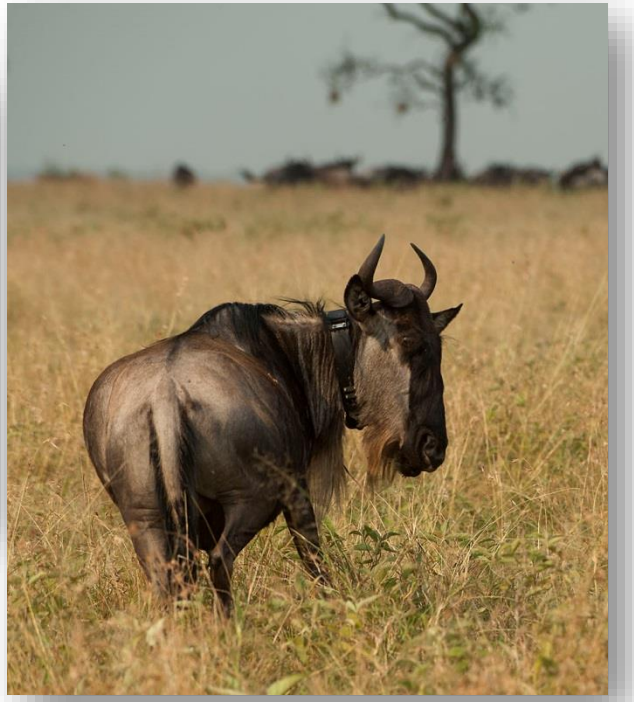


University of Glasgow

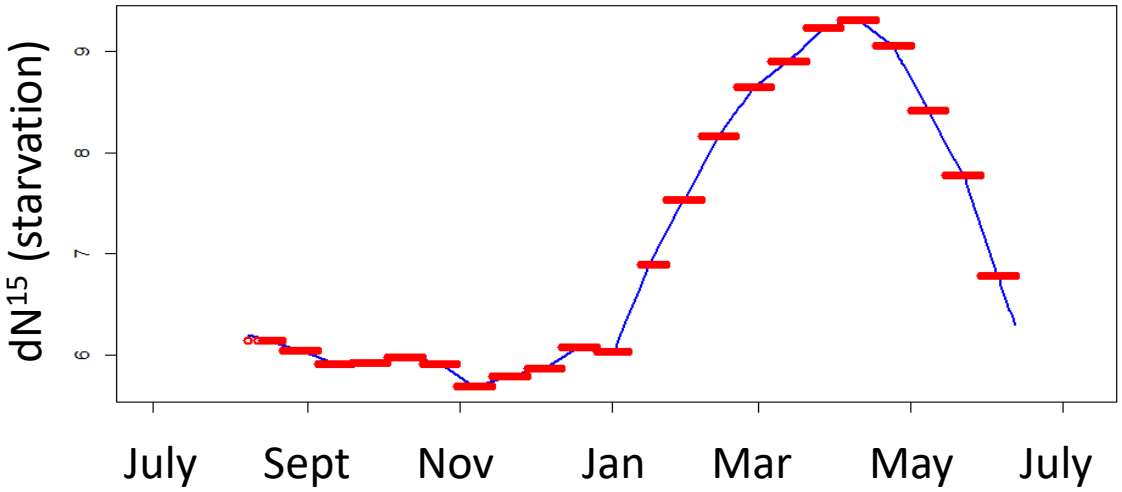
Combining movement and condition



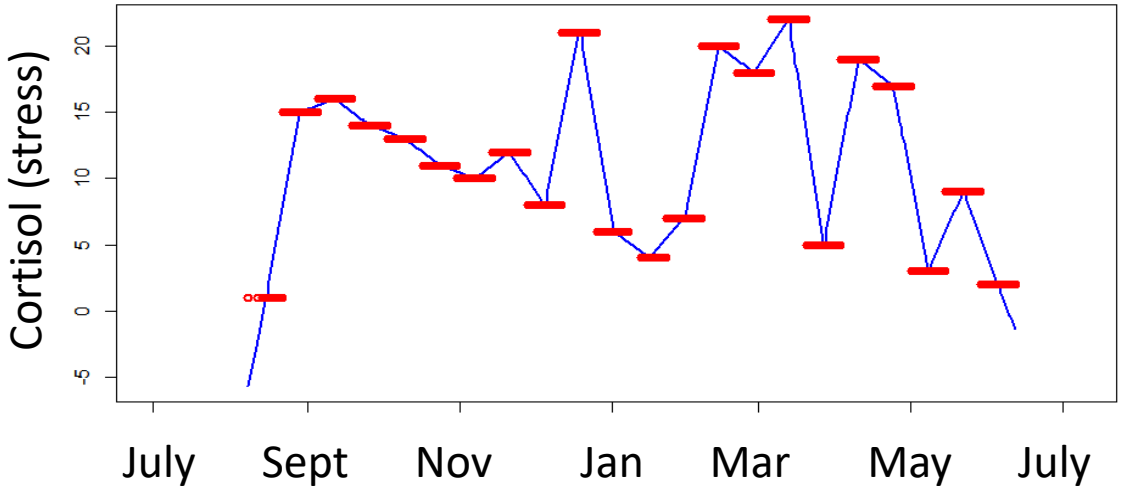
Joseph Masoy



Combining movement and condition



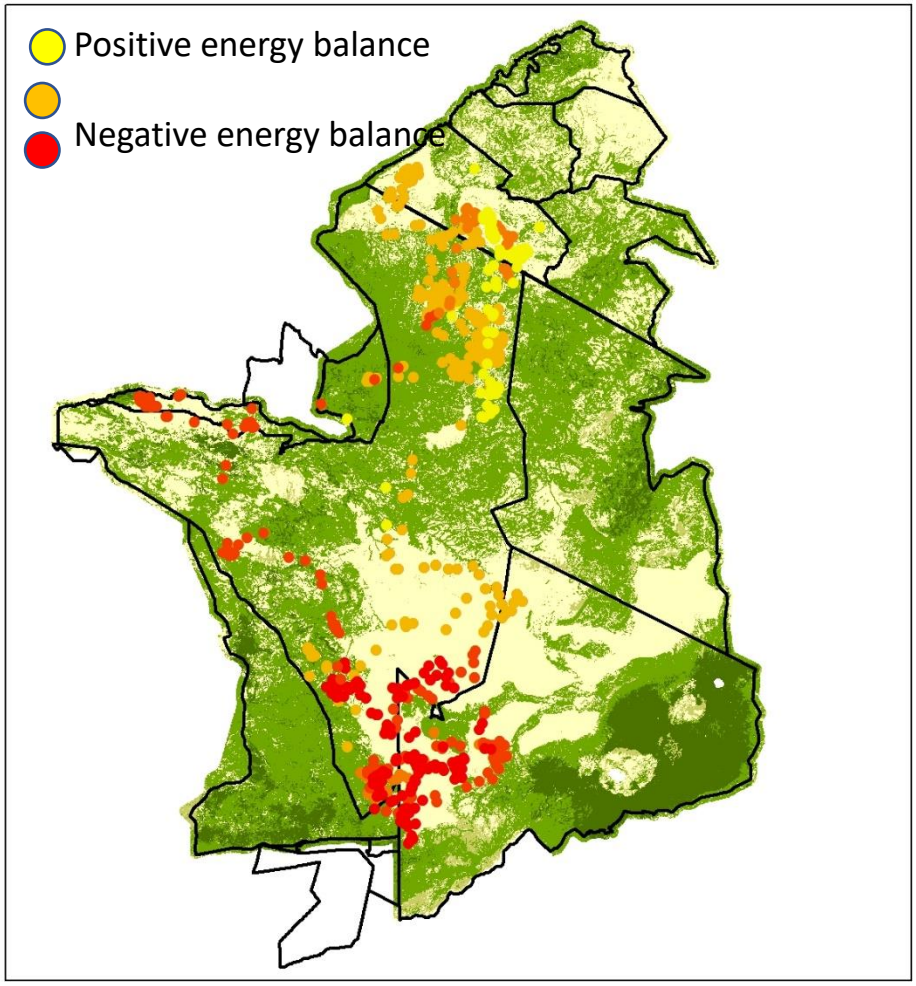
Callum Buchanan



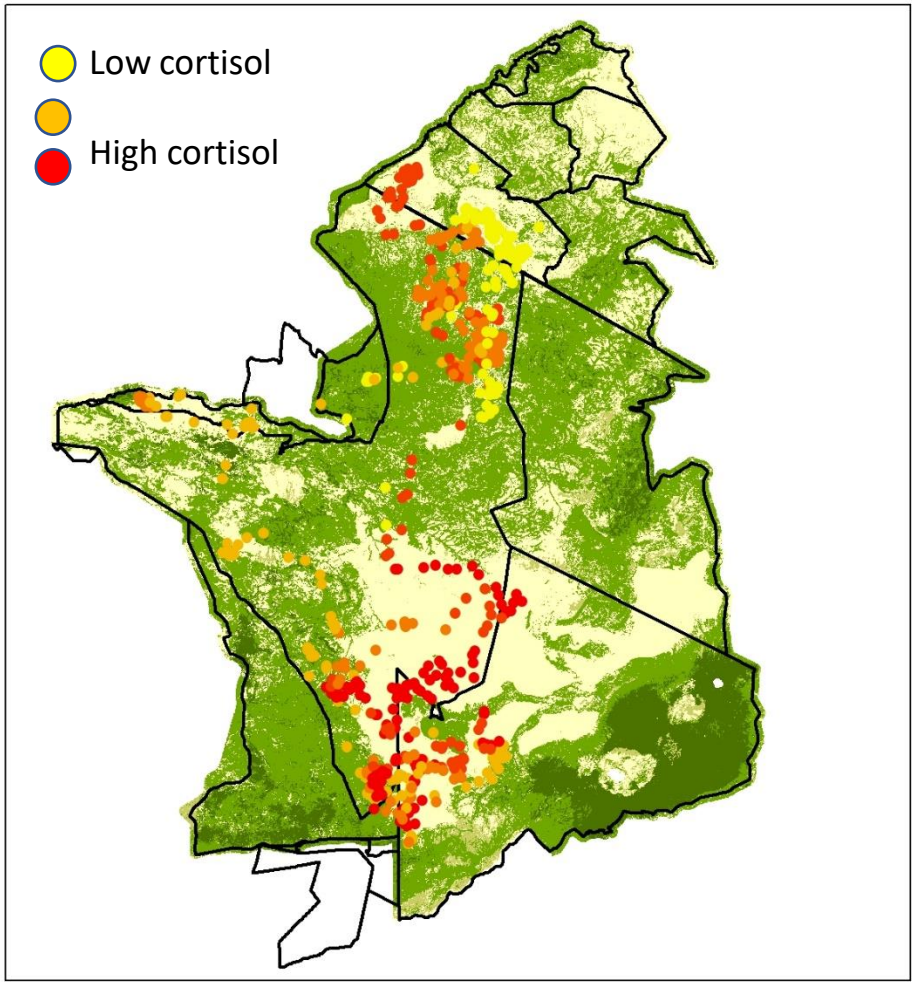
Buchanan PhD &
Buchanan et al (in prep)

Combining movement and condition

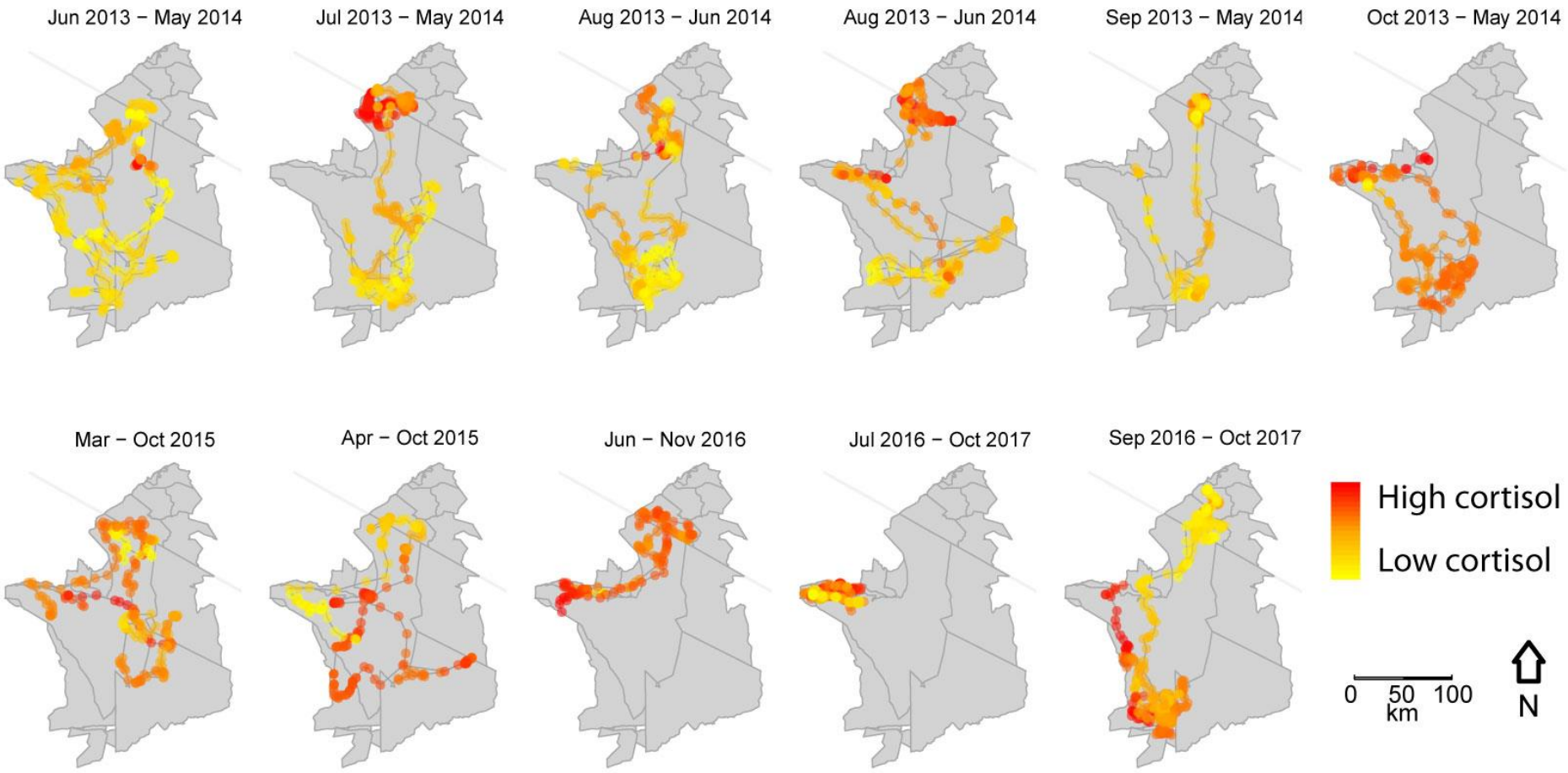
Starvation (dN15)



Stress (Cortisol)



Stress: cortisol concentrations over space



Buchanan PhD &
Buchanan et al (in prep)

What accounts for variation in cortisol?

Grass Nitrogen
Grass Biomass
NDVI
Proximity to Drainage Lines
Vegetation Cover (ie predator ambush)
Proximity to Water
Proximity to Village
Proximity to Fence
Tourism Footprint
Lunar Phase
Age
Resident versus Migrant
Sample from Dead or Alive Animal

Buchanan PhD &
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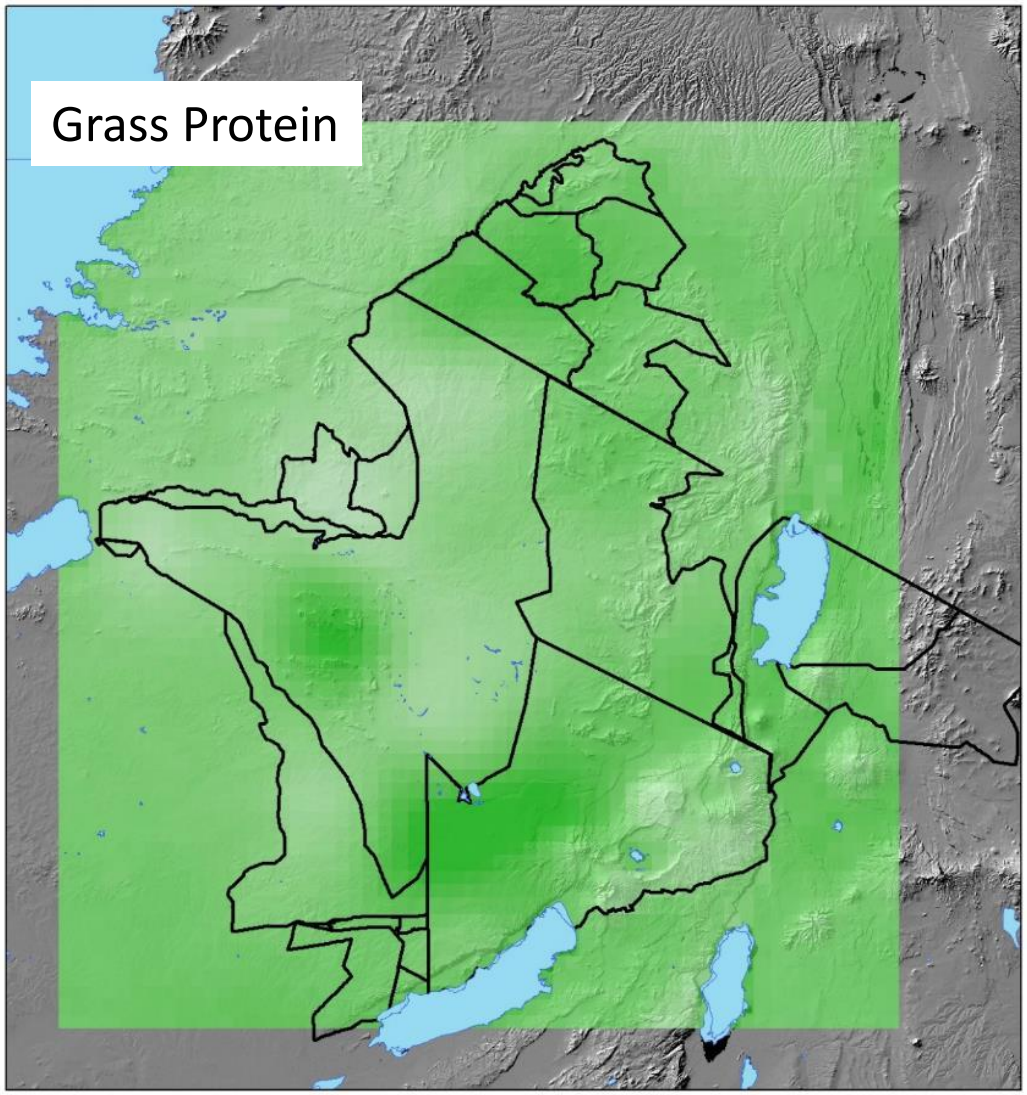
Tail hair allows us to look at DELAYED ecological effects as well as CUMULATIVE effects on survival

Buchanan PhD &
Buchanan et al (in prep)

Tourism & long term changes in the migration

Thomas Morrison

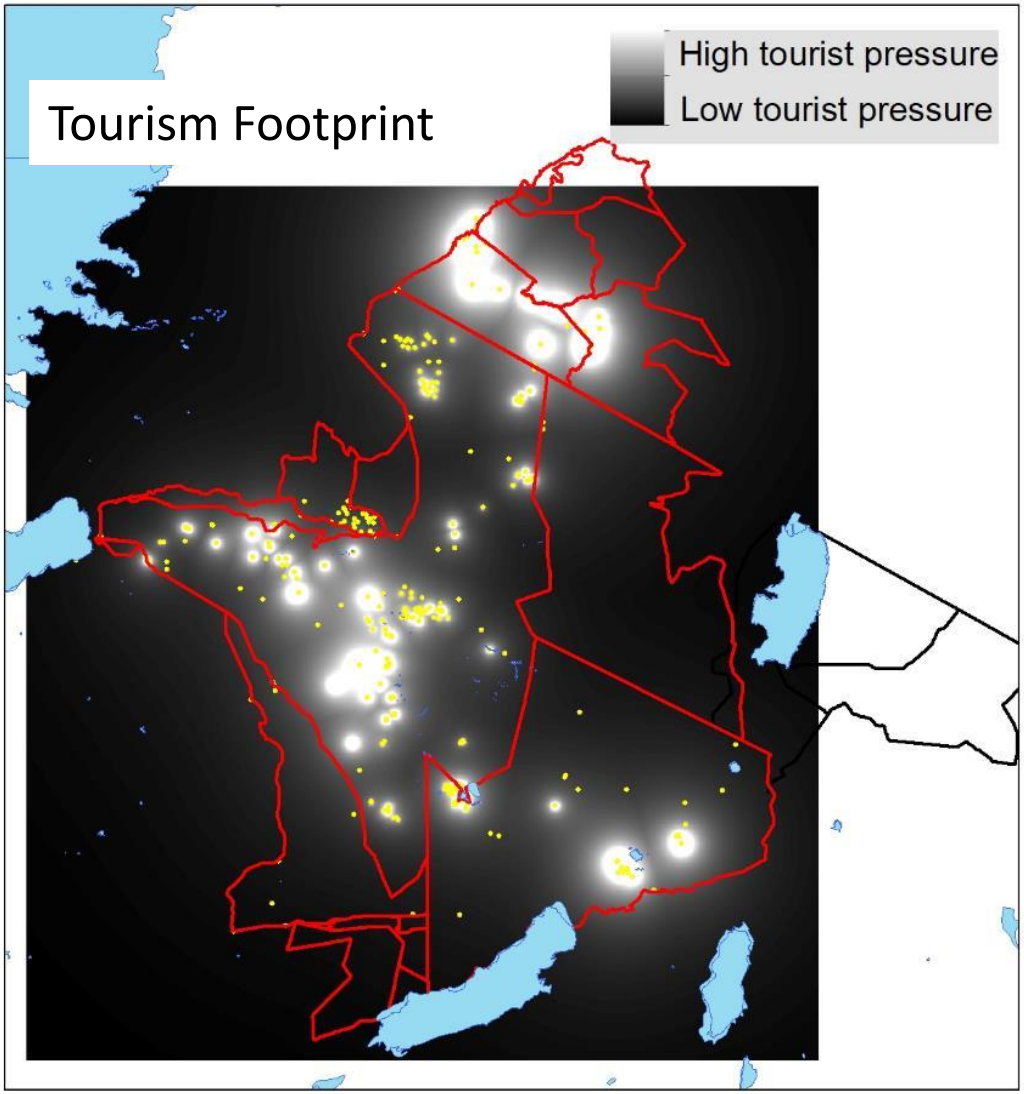
Freja Larsen



Larsen (in prep)
Seasonal inference of grass protein

Tourism & long term changes in the migration

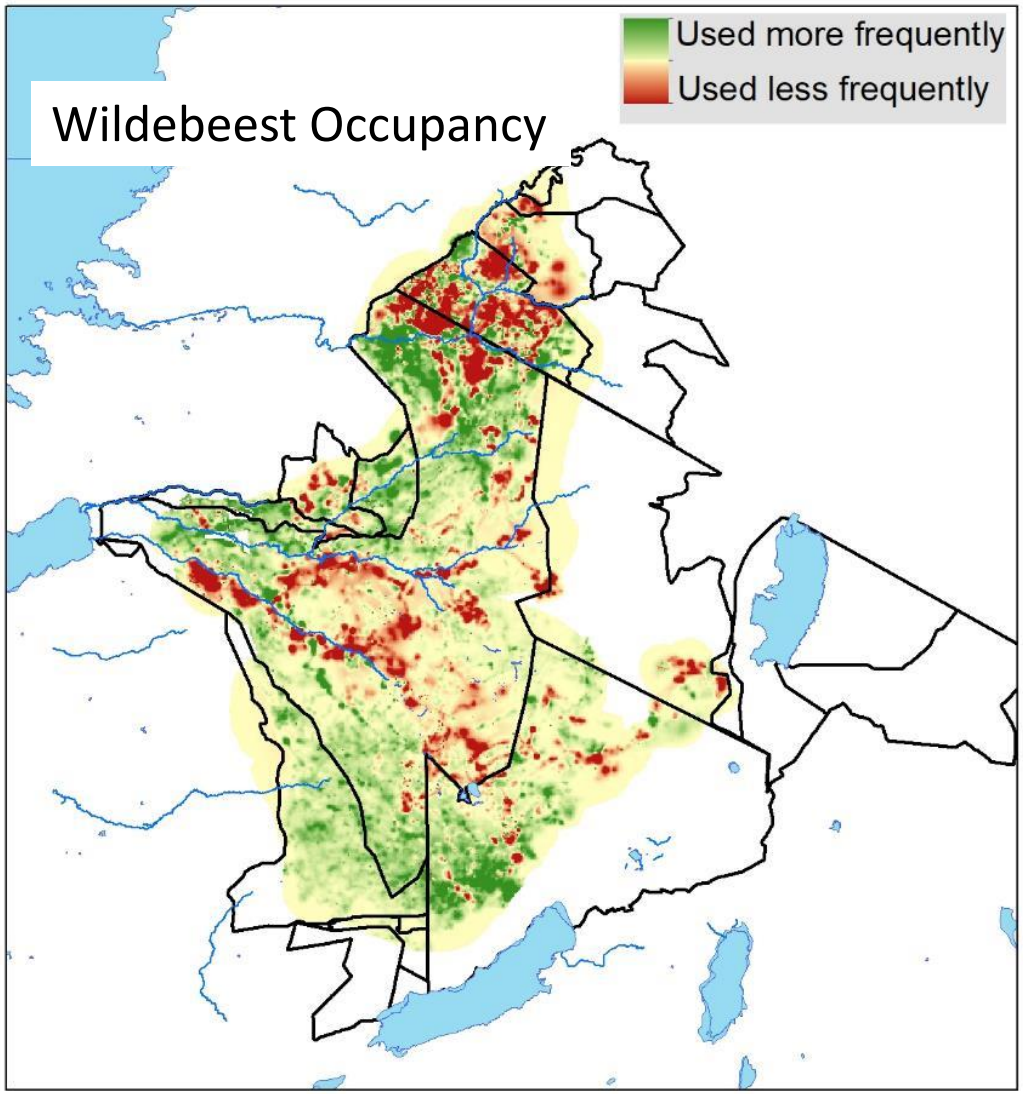
John Hongoa

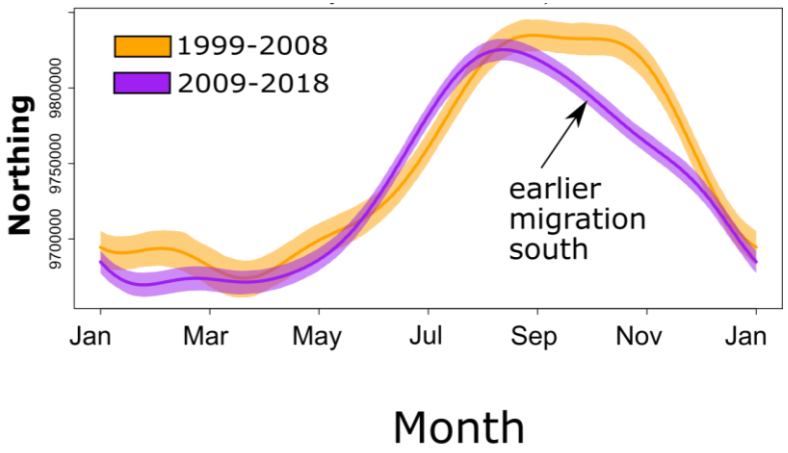


Tourism & long term changes in the migration

Thomas Morrison

Colin Torney

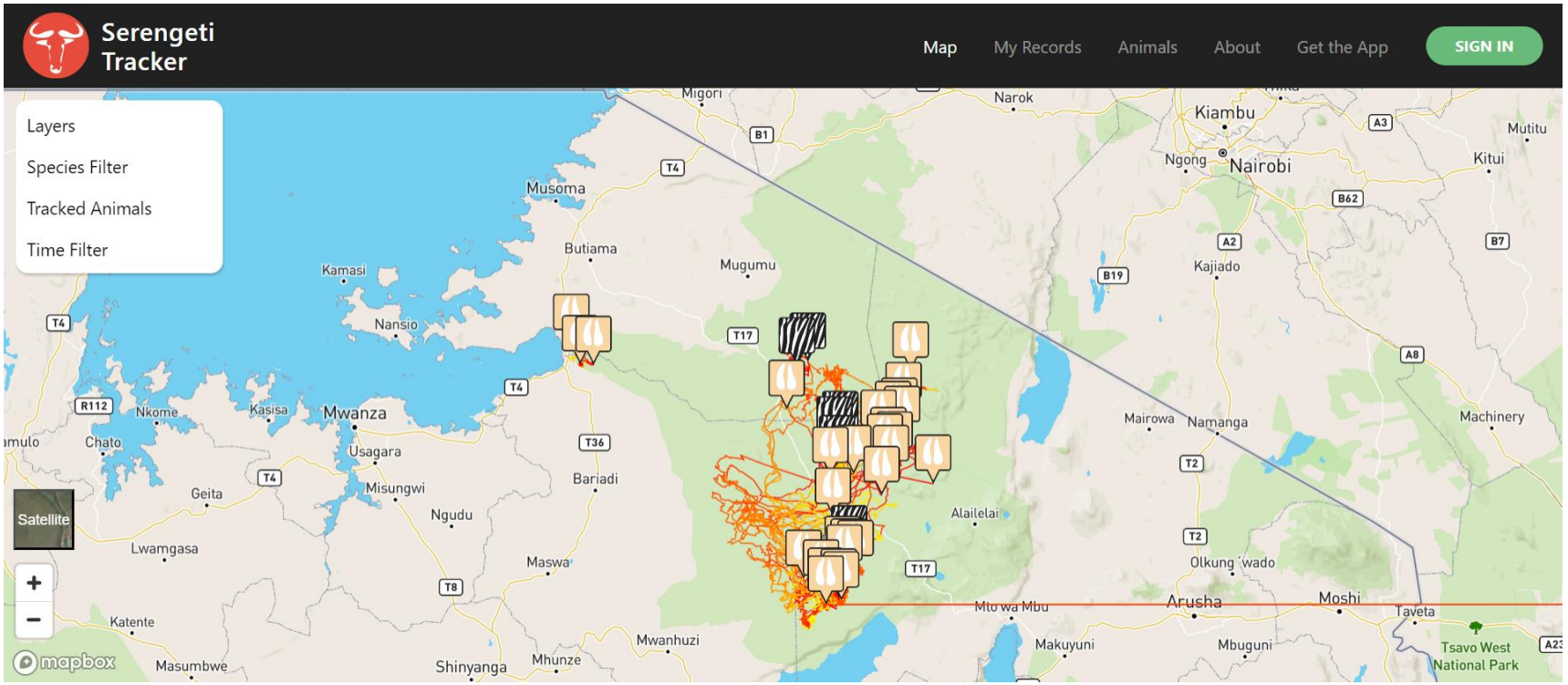




Morrison, Torney, & Hopcraft (in prep)

Serengeti Tracker - follow the migration in real time

https://www.serengeti-tracker.org/



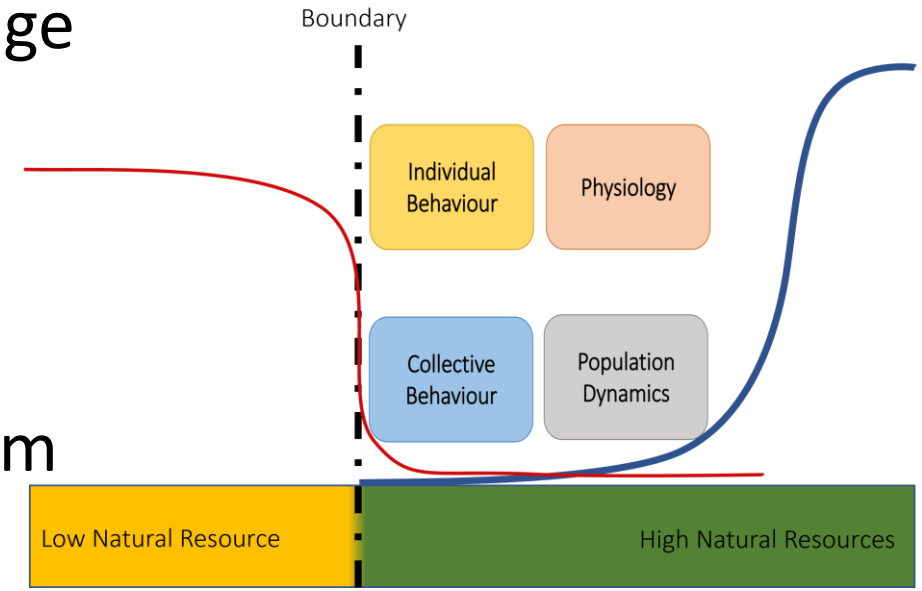
Or on your mobile phone

Android download

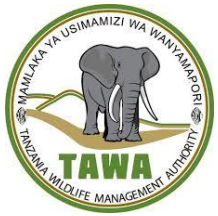
iOS download

Conclusions and take-homes

- Ecological effects are often Delayed, Displaced and Disproportional – the challenge is how to measure them
- Humans consistently have largest effect on distribution and behaviour of animals
- Ecosystems are being lost from the edges
- Infrastructure inside protected areas may be displacing animals (mass tourism)
- Consider managing aspect risk (not just resources)



Permits



Funding

Support

Grant.Hopcraft@glasgow.ac.uk