Workshop on R and movement ecology:

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Eric Dougherty, Dana Seidel, Wayne Getz

Lecture 2

Introduction to Movement Ecology

DEPARTMENT *of* ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT

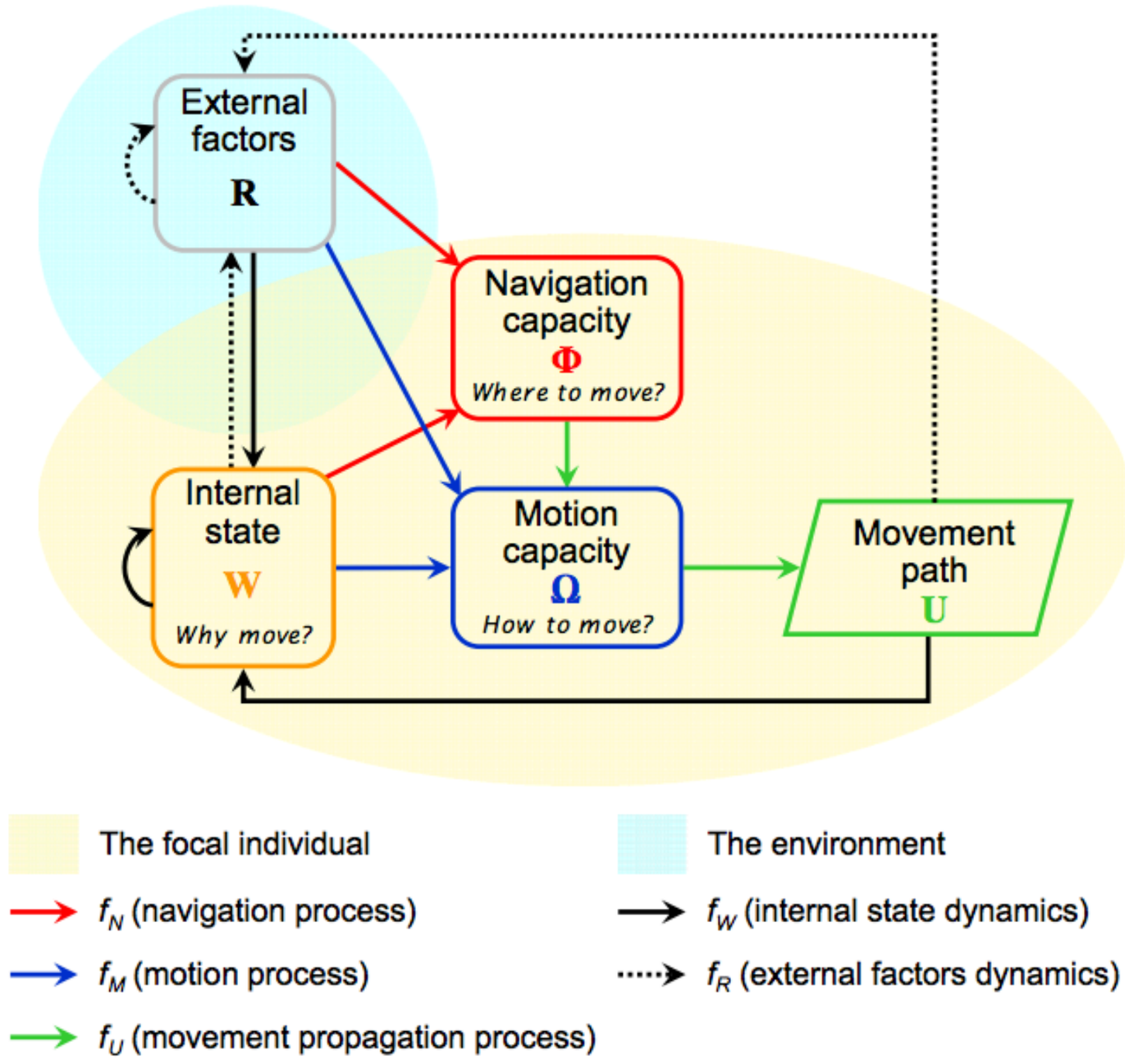
Berkeley UNIVERSITY OF CALIFORNIA College of Natural Resources

On the Movements of Animals

“The movement of animals that belong to each genus, and how these are differentiated, and what the reasons are for the accidental characteristics of each—all this we have considered elsewhere. But now we must consider in general the common reason for moving with any movement whatever (for some animals move by flying, some by swimming, some by stepping, some in other comparable ways)”

-Aristole, *De Motu Animalium (~300 B.C.)*

Movement Ecology Paradigm



Nathan et al. 2008; PNAS

Four Fundamental Components

- Internal State – the question of whether or not to move is dictated in large part by the internal needs and motivations of an animal

- Motion Capacity – The biomechanical elements that enable or preclude an animal from making particular movements

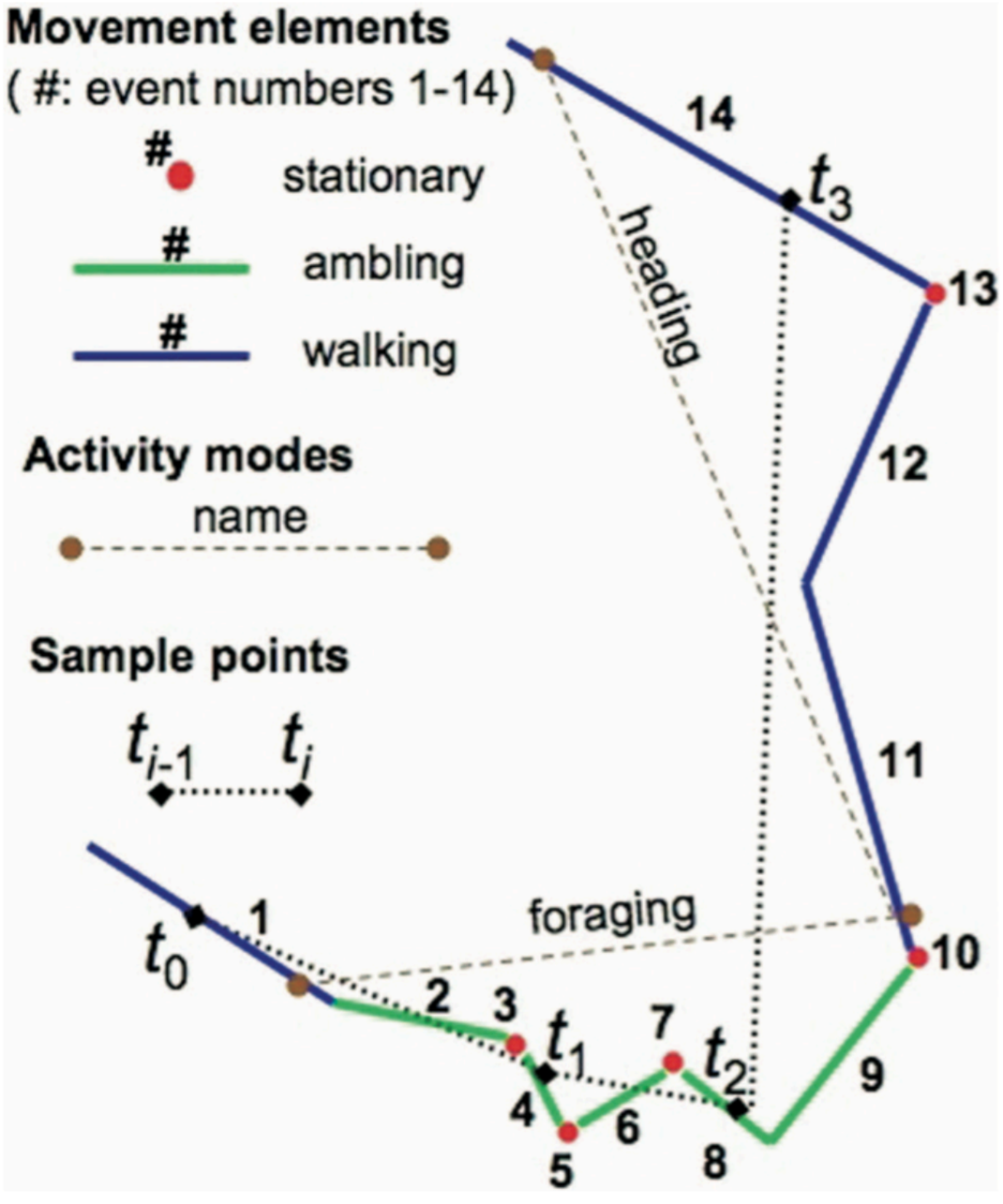
- Navigational Capacity – the ability to determine a direction and speed of movement will emerge largely from memory and perception

- External Factors – the environment (resources, predators, competition, etc.) will expand or reduce possible movements

Measuring Movement

- Fundamental Movement Elements (FMEs) – extremely fine-scale motor movements that comprise all movements, such as a lunge versus a step taken at normal speed

- Canonical Activity Modes (CAMs) – distributions that emerge from the mix of FMEs that characterize the activity in question, such as foraging

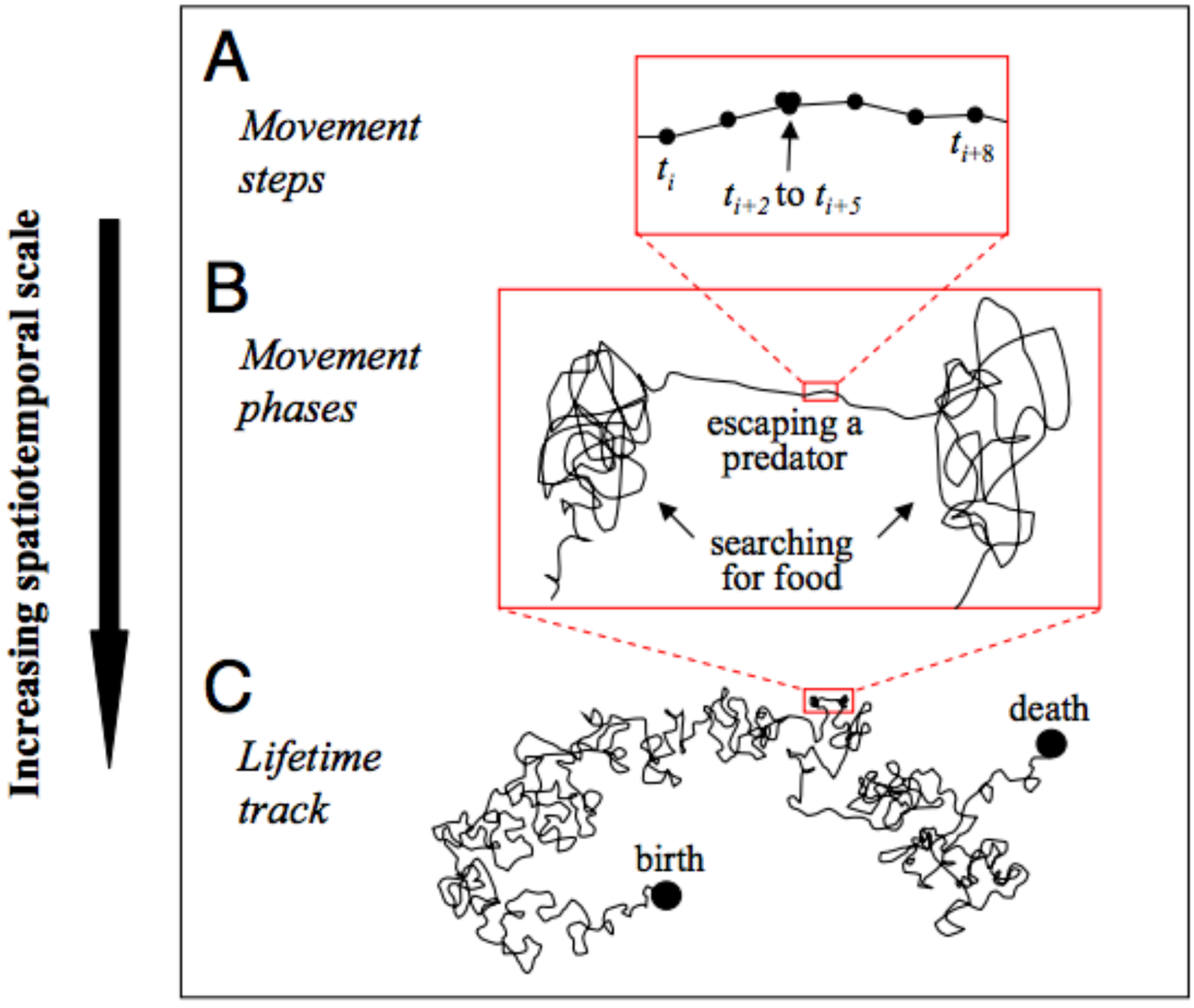


Getz & Saltz 2008; PNAS

Types of Movement Data

- Irregular interval data
  - Direct observation; Very High Frequency (VHF) telemetry; Autonomous arrays; Genetic profiles.
- Regular interval data
  - GPS monitoring; new tags may even include video, photo, or proximity capabilities
- Complementary data sources
  - Accelerometers, altimeters, physiological metric monitors

Scales of Movement Analysis



Questions we ask in ME

1. Questions of Animal Behavior
2. Questions of landscape structure and function

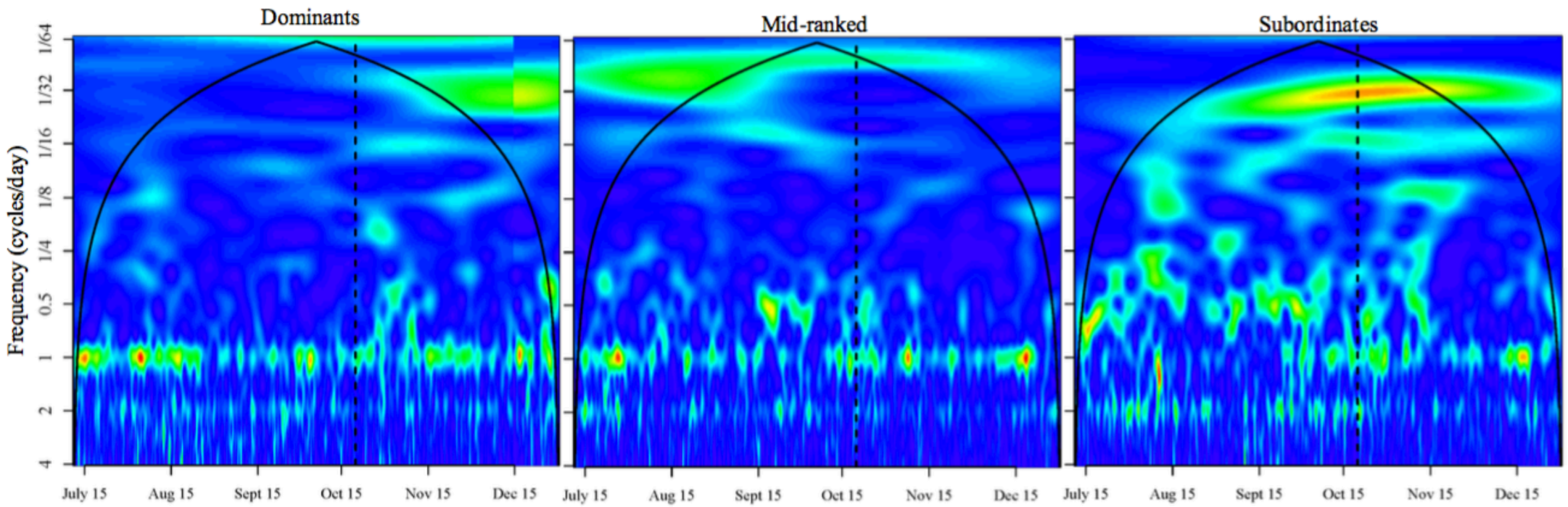
Applications

- Understanding land use
- Evaluating the impact of global climate and land use change on animal populations
- Predicting/Preventing human-wildlife conflict
- Understanding social structure
- Understanding territoriality
- Understanding landscape connectivity
- Predicting range shifts
- Predicting disease outbreak/risk/spread
- Evaluating gene flow

Wittemeyer et al. 2008

- A fascinating and inventive use of movement analysis applied wavelet methods to identify dominant frequencies in autocorrelation of elephant steps

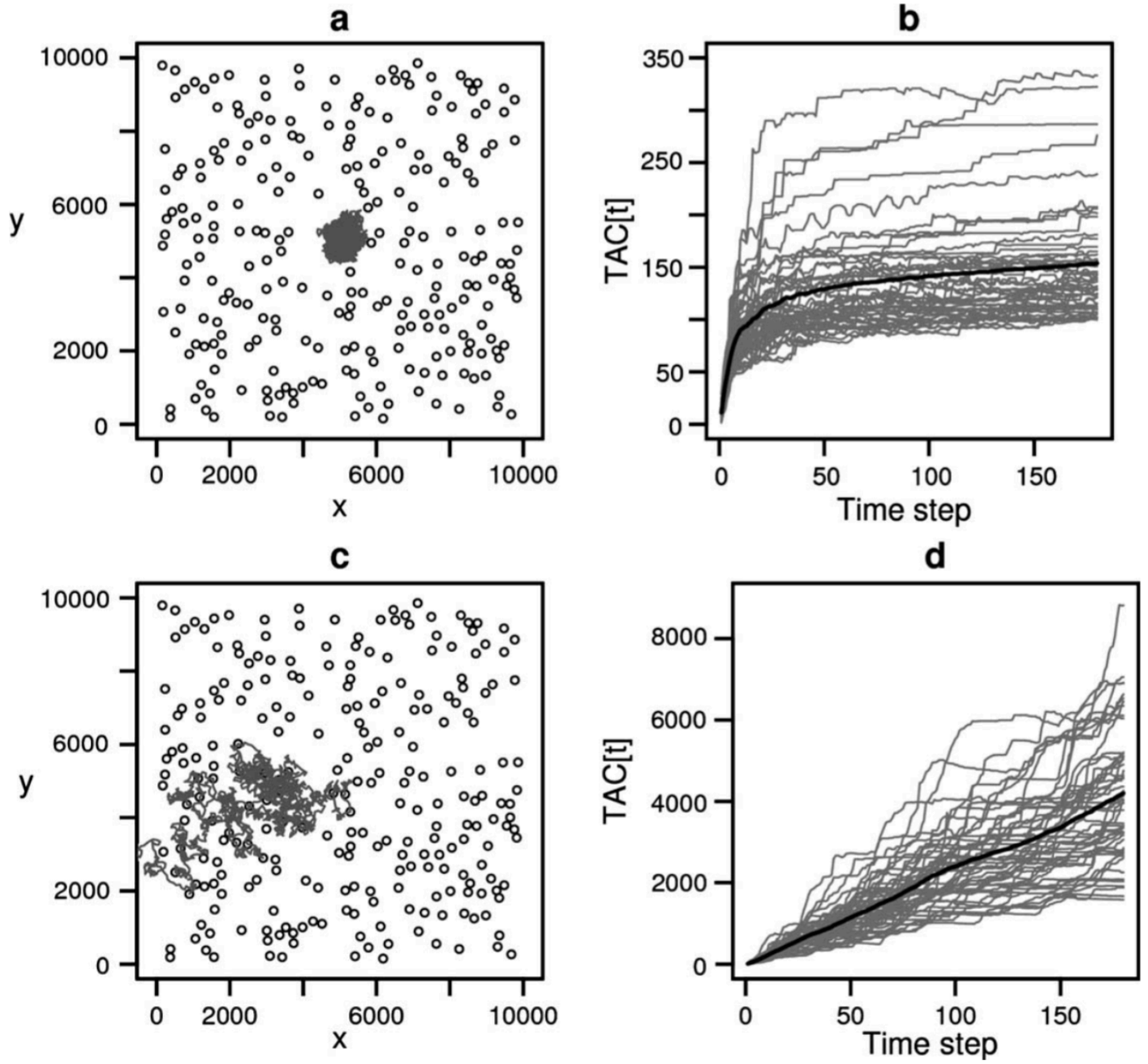
- They recognized that they could separate dominant individuals from mid-ranked and subordinate individuals based on the frequency of forays to watering holes.



Van Moorter et al. 2009

- A stochastic movement simulation model was used to explore the potential mechanisms underlying home range formation in natural systems

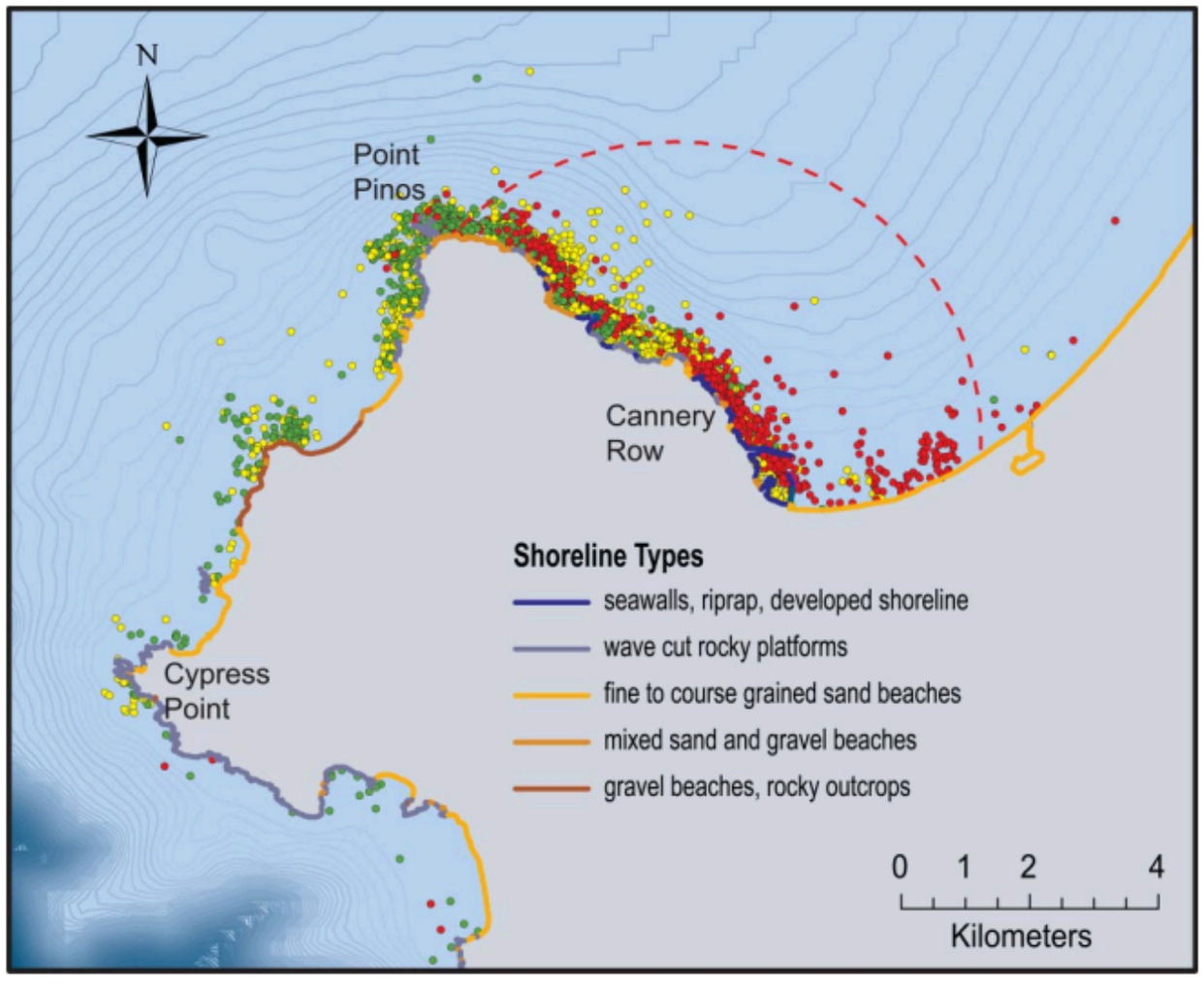
- Using two forms of memory (reference and working), home ranges were induced in a set of random walkers



Johnson et al. 2009

- Used radiocollars on sea otters to explore the connection between disparate resource exploitation strategies and infection dynamics

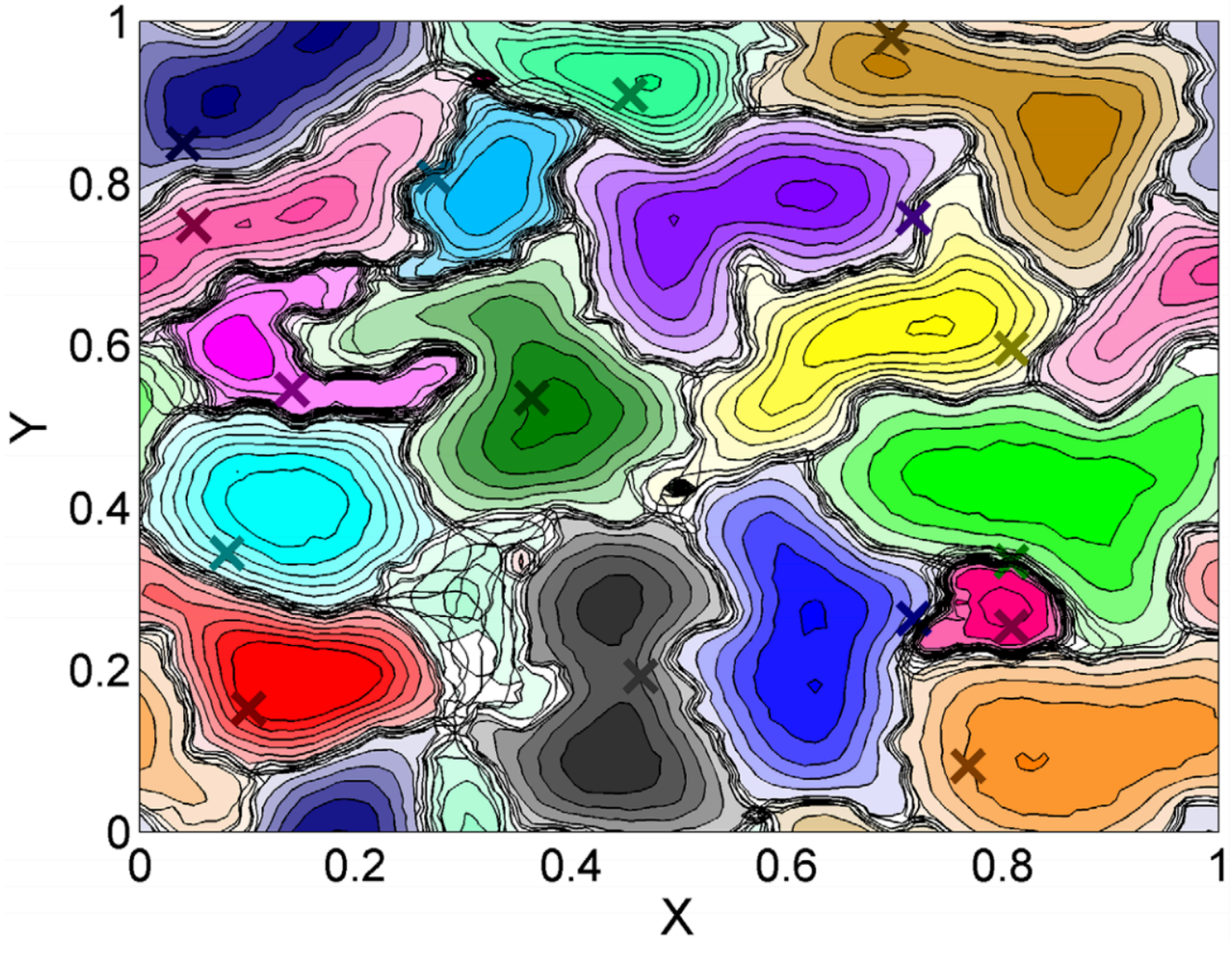
- Found that otters in resource-rich areas fed on abalone and had much lower infection prevalence than those in resource-poor regions feeding on marine snails



Giuggioli et al. 2011

- In another example of a mechanistic simulation model, the authors explored the emergence of territoriality in wild populations like the red fox

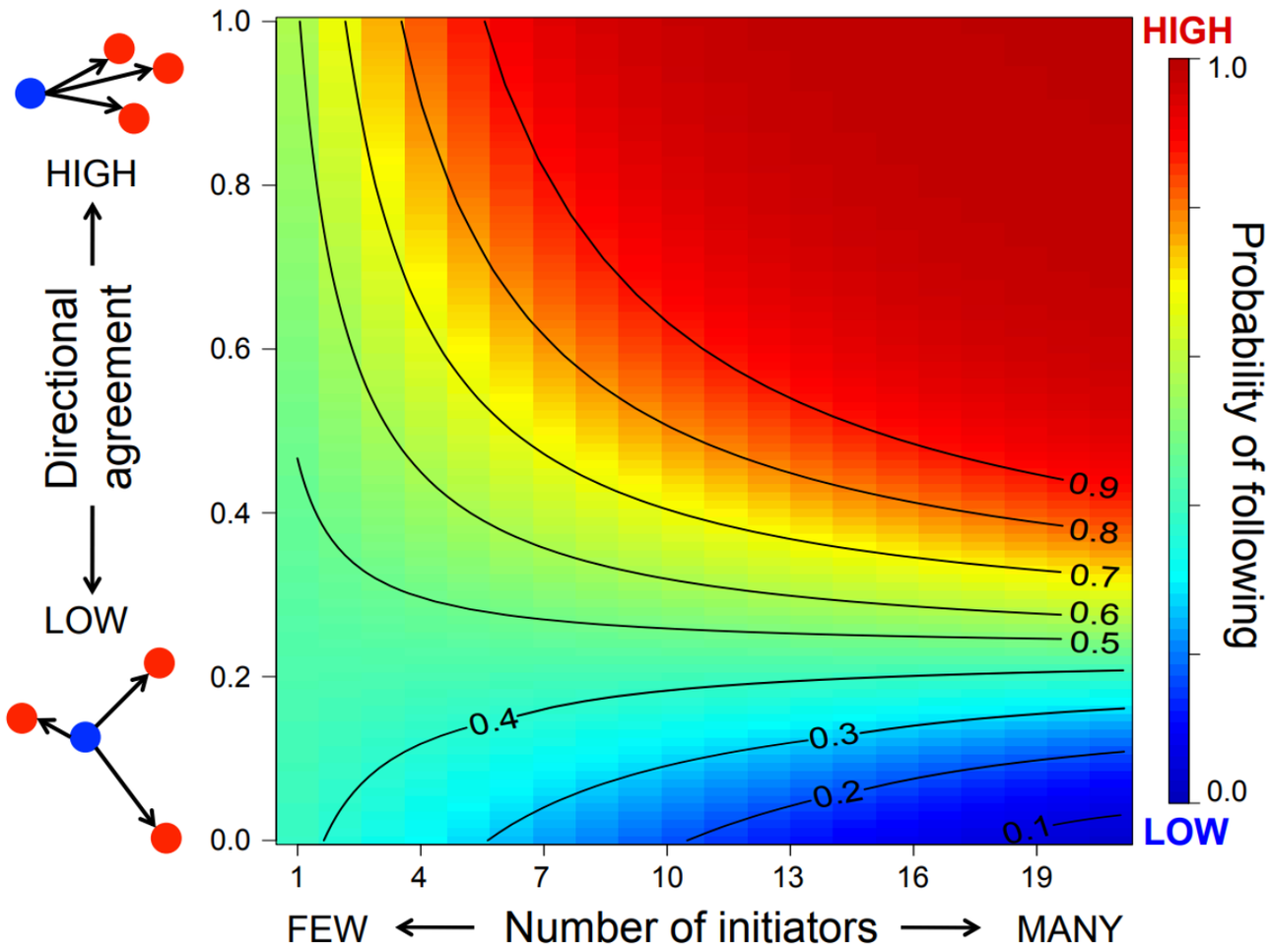
- Using simple rules to represent scent-marking dynamics, territory boundaries were established and maintained between individuals



Strandburg-Peshkin et al. 2015

- Extremely high resolution movement data was collected from every adult individual in a troop of baboons

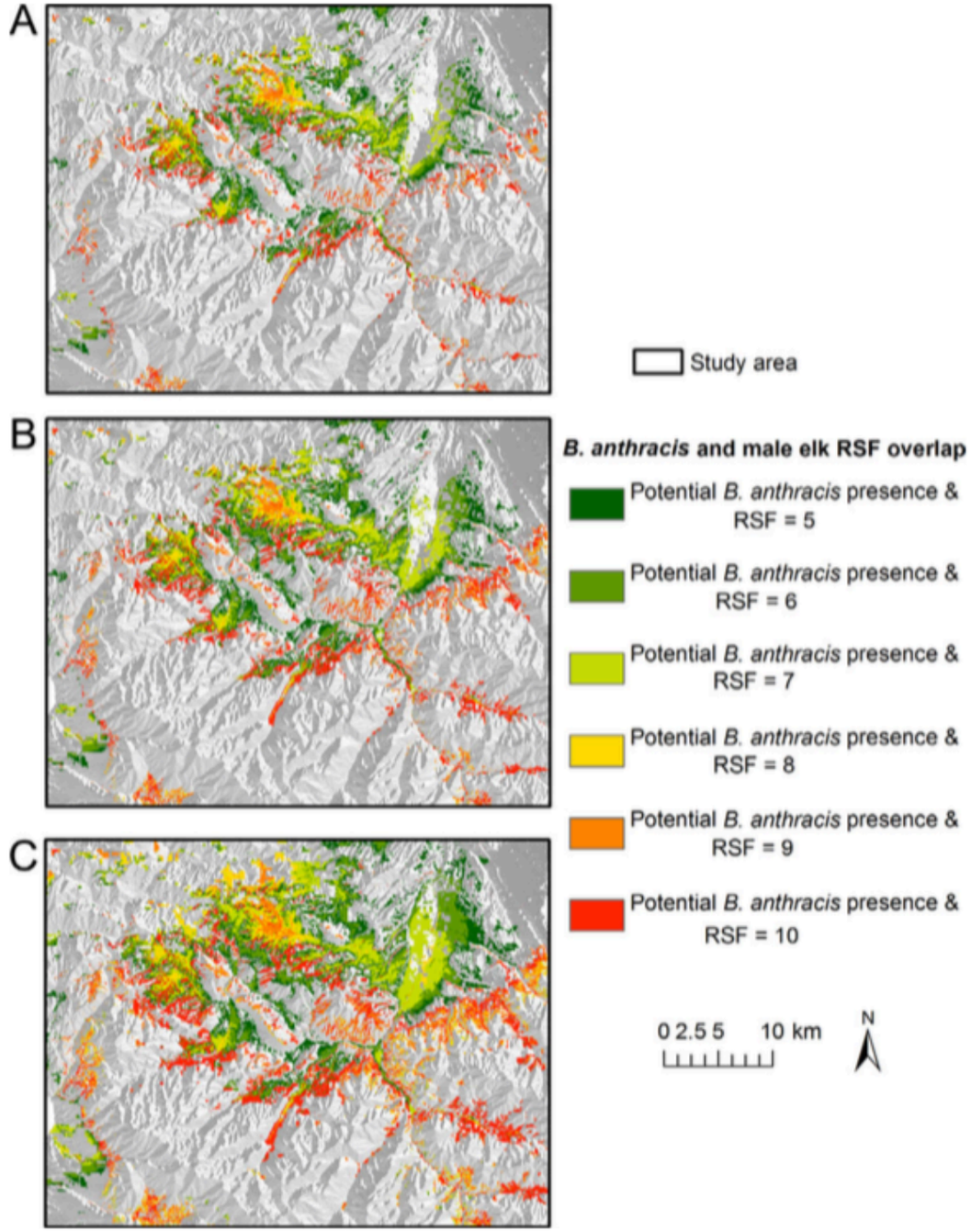
- Found that decisions regarding group movement were more likely to be democratic (i.e., movements were frequently induced by multiple individual at once) rather than autocratic (i.e., following a single dominant individual)



Morris et al. 2016

- Developed a model to predict the location of elk throughout the anthrax season on a ranch in Montana and assessed the risk of exposure they faced

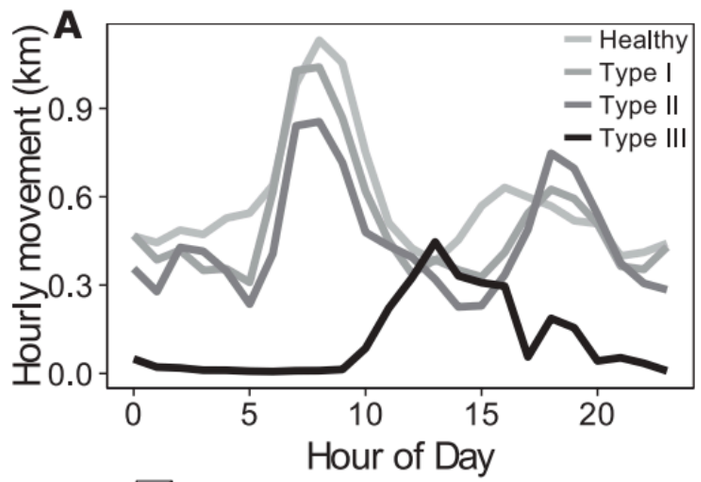
- Found that there were extensive regions of overlap between habitat selected by elk and areas with environmental features conducive to maintaining anthrax



Cross et al. 2016

- Deployed GPS collars on a population of wolves containing individuals infected with sarcoptic mange

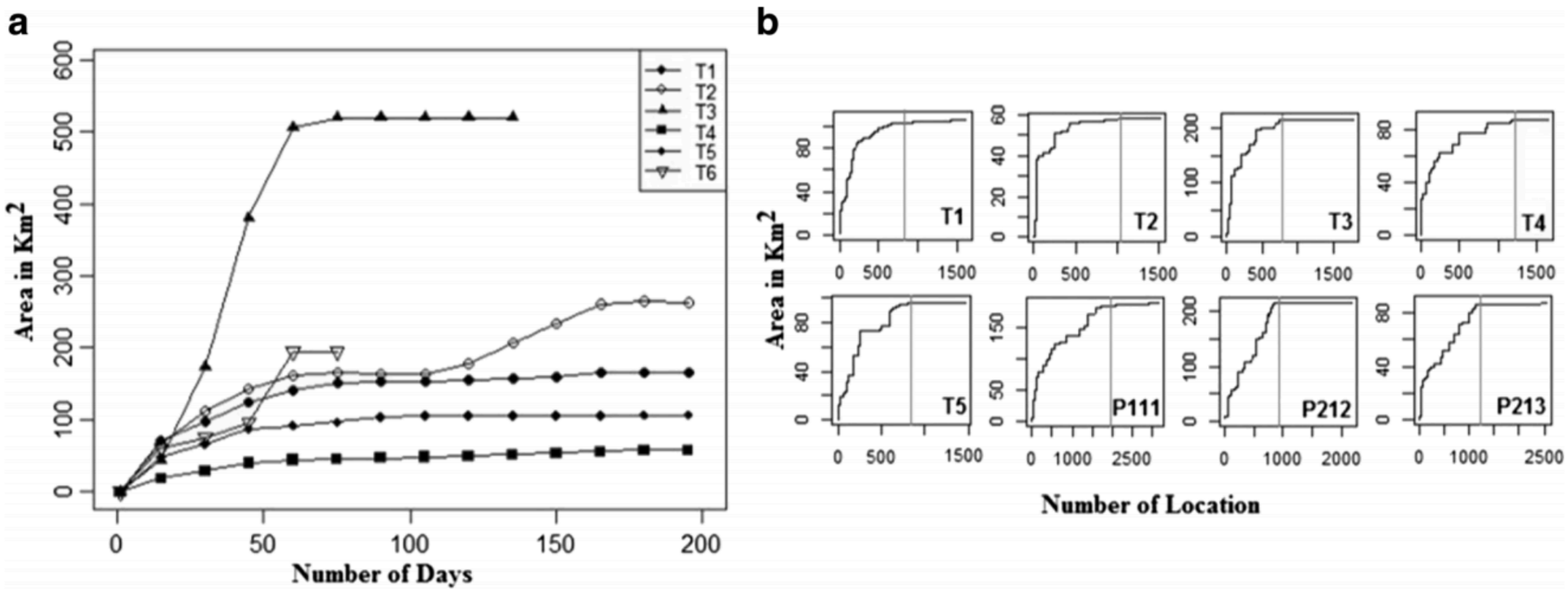
- Found that mange had notable impacts on the daily movements of individuals, with later stages of infection reducing total distance more than earlier stages. In addition, infected wolves spent significantly less time in an active behavioral mode than healthy wolves



Sarkar et al. 2016

- The reintroduction of tigers to a protected area in India offered an ideal opportunity to examine the manner by which individuals establish home ranges

- Found that all of the tigers established home ranges following a short exploratory phase, and they all demonstrated a high level of site fidelity once established



Kittle et al. 2016

- Used movement data to analyze the role of landscape features, prey availability, and competition in determining the distribution of large carnivores

- Found that lions were uninhibited by their competitors (hyenas), but that prey availability and habitat both influenced the distribution of lions across the Serengeti