

# Home range estimations

Animal Movement PhD-course 4-8 September, 2023

# **What is a home range?**

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Territory or home range? - Thoughts on home range definition emerged from the reasoning about territoriality.

**William H. Burt 1943:**

Home range then is the area, usually around a home site, over which the animal normally travels in search of food. Territory is the protected part of the home range, be it the entire home range or only the nest. Every kind of mammal may be said to have a home range, stationary or shifting.

Only those that protect some part of the home range, by fighting or aggressive gestures, from others of their kind, during some phase of their lives, may be said to have territories.



~ HOME RANGE BOUNDARY  
 - - - TERRITORIAL BOUNDARY  
 BLANK--UNOCCUPIED SPACE  
 [Hatched Box] NEUTRAL AREA  
 ● NESTING SITE  
 ○ REFUGE SITE

FIG. 1. Theoretical quadrat with six occupants of the same species and sex, showing territory and home range concepts as presented in text.

## From Burt's definition

- i) Home ranges are the consequence of behavioural and environmental processes (foraging, mating, predator avoidance...)
  - ii) Exploratory forays are not part of the home range, where the animal perform normal activities
  - iii) Temporally stable – repeated visits to places within the home range
- What are normal activities?
  - When is the site fidelity enough?

## Method development

- Burt presented no model or method approach estimate the home range it was a theory developed from reasoning and observation
- With movement data we may quantify animal behaviour
- With models we may put up hypothesis and infer animal behaviour

# Geometric home range estimators

- Minimal Convex Polygon (MCP) – (Mohr 1947)
- Local convex hull (LoCoH) (Getz and Wilmers 2004)
- Straightforward and easy to understand

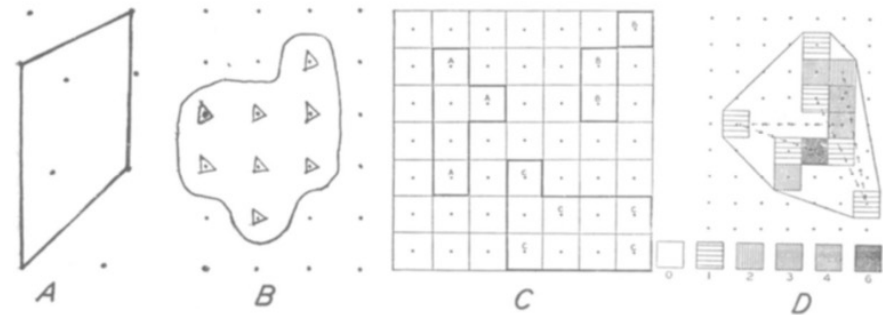


Fig. 1.—Methods of Delimiting Supposed Home Range.—A. Dalke's 1938 method, B. Burt's 1940 method, C. Haugen's 1942 method, D. Blair's 1942 method. Dots indicate position of traps. Outlines show the supposed outer limits of the home range of the animal in question. Trap-positions with letters, surrounded by triangles or enclosed in shaded grids are those in which animals were caught. Dalke's method has been called the minimum home range method. Others are modifications of the grid method. Blair's method stresses the number of times an animal is caught in each grid, which, in the case of the example was from 0 to 6 times.

*Home Range.*—Home range calculations were based on data furnished by 29 opossums which were caught at three or more stations, the minimum range being estimated by calculating the area enclosed by imaginary lines connecting the outermost stations visited by the individual in question as, indicated in fig. 1A.

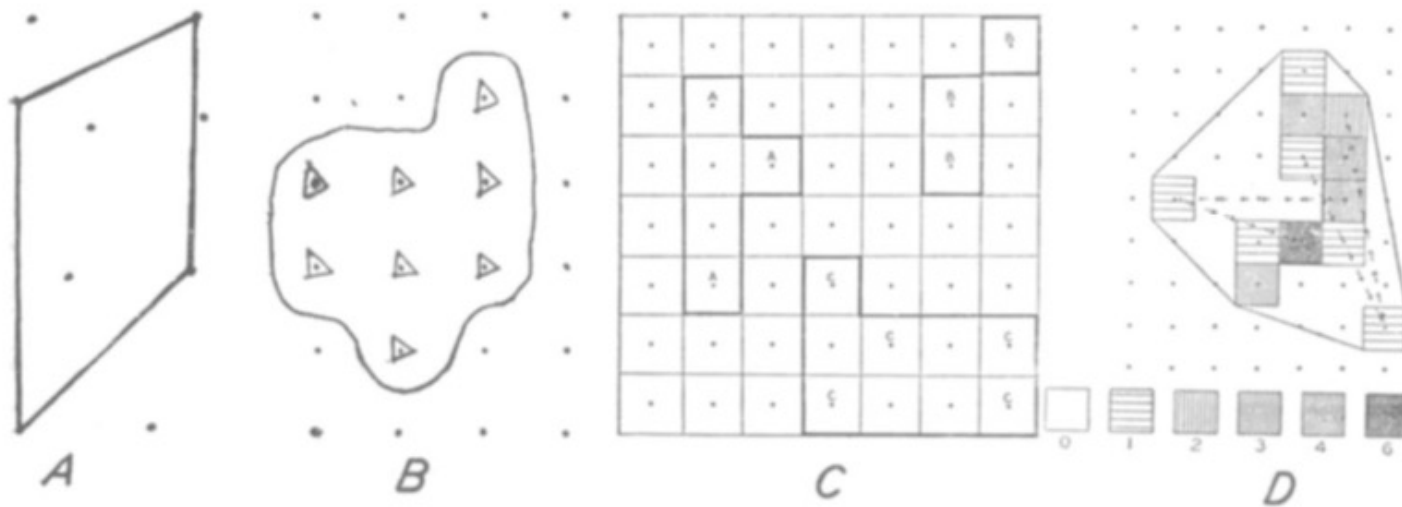
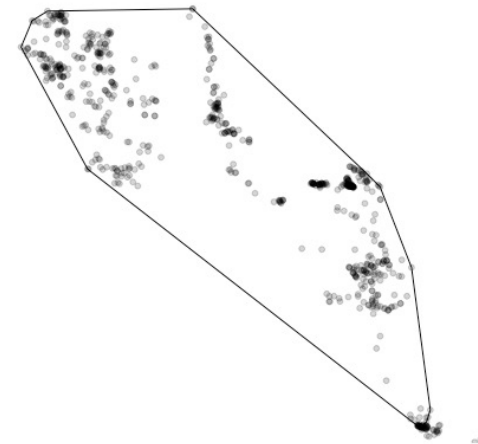


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## Minimum convex polygon – one reindeer

```
hr_mcp1 <- trk1 |>  
  hr_mcp(trk1,  
    levels = 0.95,  
    keep.data = TRUE)
```



MCP 95%



# Utilization distribution

- Density of use estimated – find hot spots in the landscape used by the animal
- Area used calculated using animal position during a certain time using a density estimation method
  - Kernel Density Estimation (KDE)
  - Brownian Bridge Movement Model (BBMM)
  - Auto-correlated kernel density estimation (AKDE)

February 1989

HOME-RANG

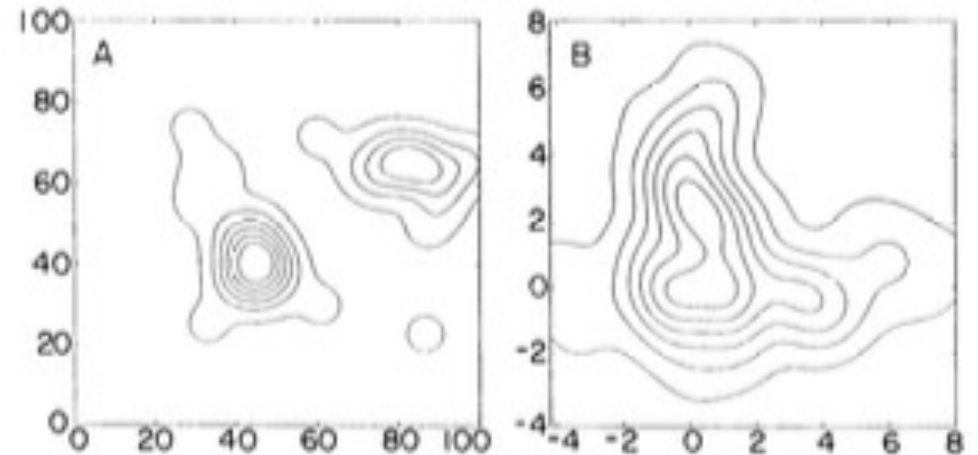


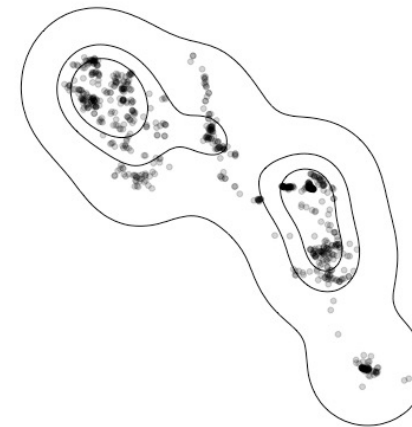
FIG. 3. Fixed kernel density estimates of the UD densities with the least-squares cross-validation choice of smoothing parameters for (A) the DC data set ( $h = 4.7$ ) and (B) the SIM data set ( $h = 0.77$ ).

Worton 1989

## Kernel home range estimator – one reindeer

```
hr_kde1 <- trk1 |>  
  amt::hr_kde (  
    trk1,  
    h = hr_kde_ref(trk1),  
    trast = make_trast(trk1),  
    levels = c(0.25, 0.50, 0.95),  
    keep.data = TRUE)
```

```
plot(hr_kde1)
```



KDE with 25, 50 and 95 % isopleths

Resembles Burt's  
definition



## Different type of home ranges

### Range estimation

- Ex MCP, KDE and AKDE

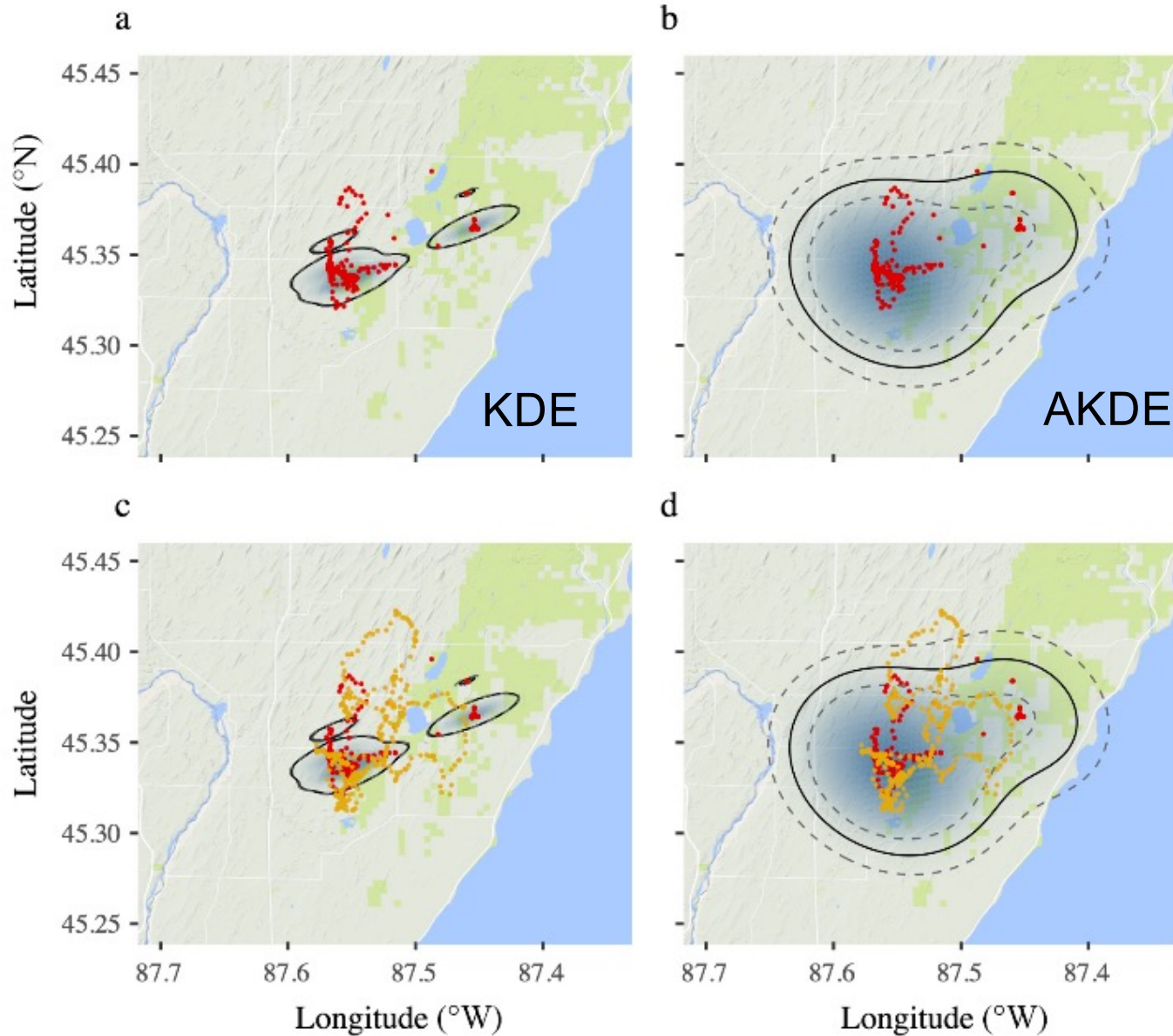
### Occurrence estimation

- BBMM

- Range estimators extrapolate space use into the future.
  - How much space does an animal need?
- Occurrence estimators interpolate within the sampling period
  - Where did the animal go during the study period?
  - Why did it go there?

## **AKDE - Autocorrelated-Gaussian reference function**

- Early estimators (MCP, KDE etc) assumes independence between positions.
- Less of a problem with few positions – radio telemetry. GPS-collars with frequent positioning have increased the problem with autocorrelation.
- Although its been a known problem it has been hard to control or check on the effect of autocorrelation in a good way.
- Noonon et al. 2019 evaulation of effects of autocorrelation and find that AKDE can handle autocorrelation in terms of...



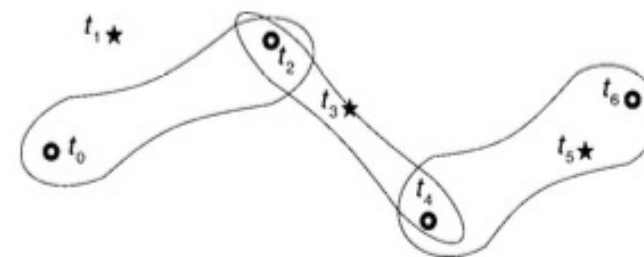
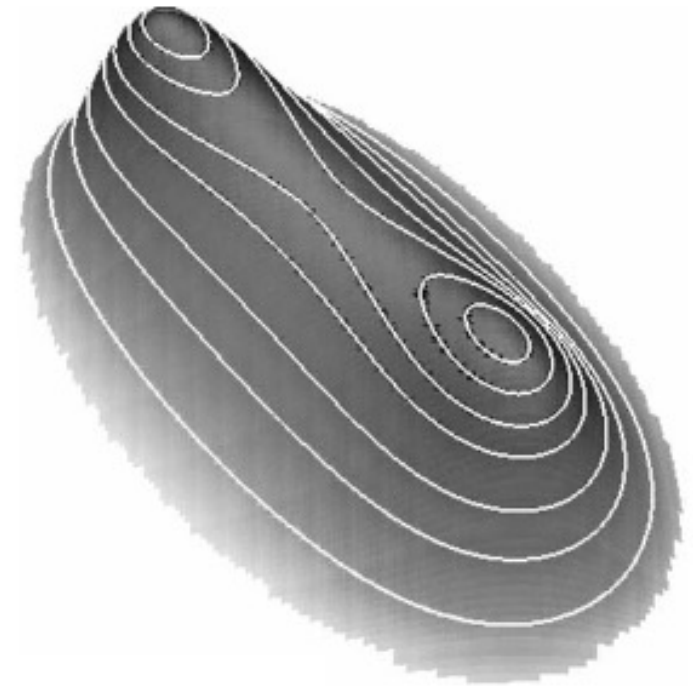
Home range estimated from the red dots

KDE underestimates and fail to include possible new area (orange dots) of the animal

Noonan et al. 2019

# Brownian Bridge Movement Model

- Time dependent home range estimation

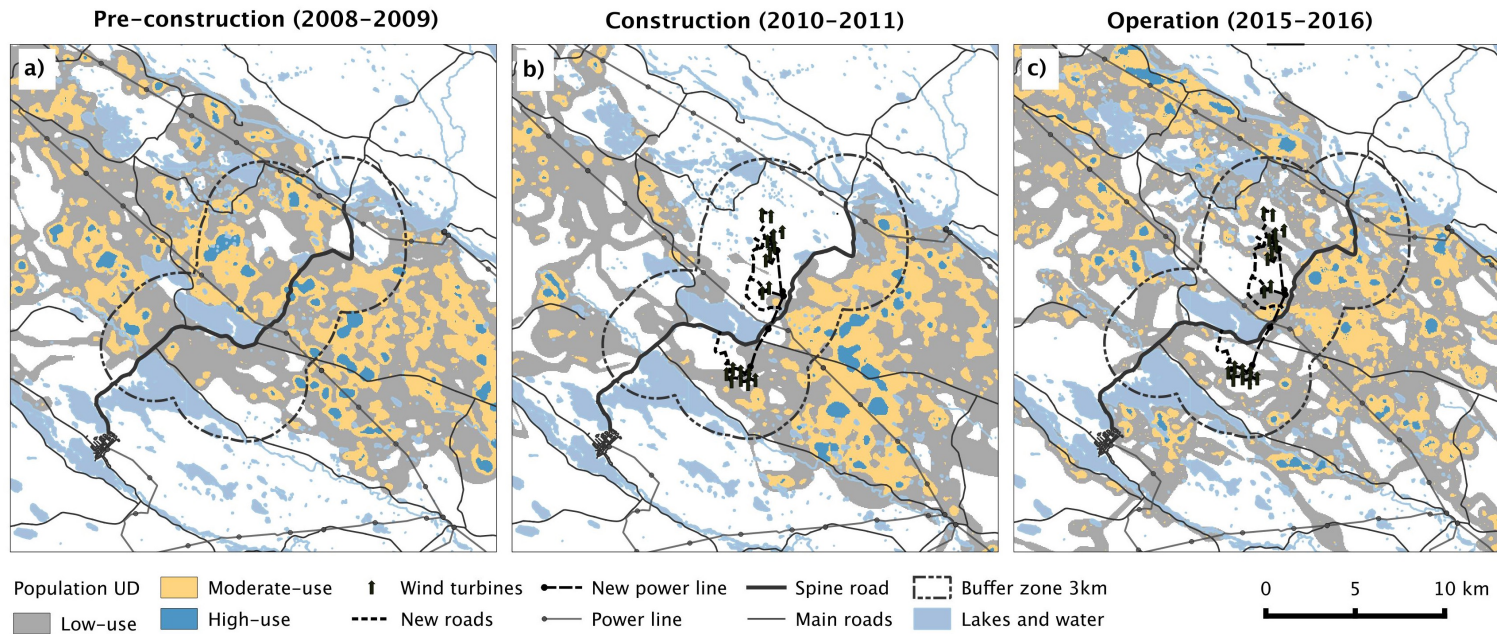


ty for the fraction of time spent in  
ted using the Brownian bridge  
were 280 m and 20 min apart.  
e  $\sigma_m^2$  was 642 m<sup>2</sup>, and the standard  
uted location error was 28.85 m.  
respond to the observed locations.

FIG. 2. Example of three Brownian bridges connecting even observations at time intervals  $[t_0, t_2]$ ,  $[t_2, t_4]$ , and  $[t_4, t_6]$ . The in-between observations at times  $t_1$ ,  $t_3$ , and  $t_5$  are independent observations from these Brownian bridges and can be used to estimate the Brownian motion variance parameter.



# Brownian Bridge Movement Model - example



# What is the animal doing?

- More data not necessary better – need to know what we are estimating
- Decision-making processes shaped by natural selection
- Link the home range to the cognitive map of the animal

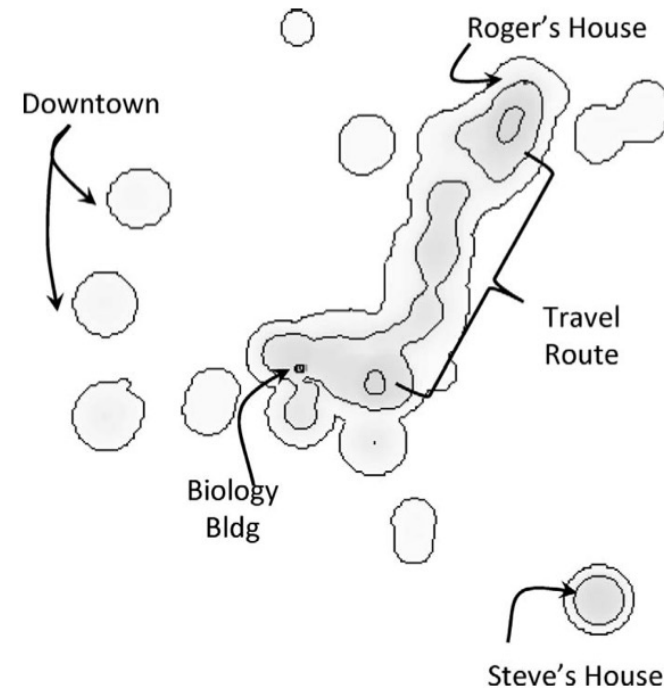
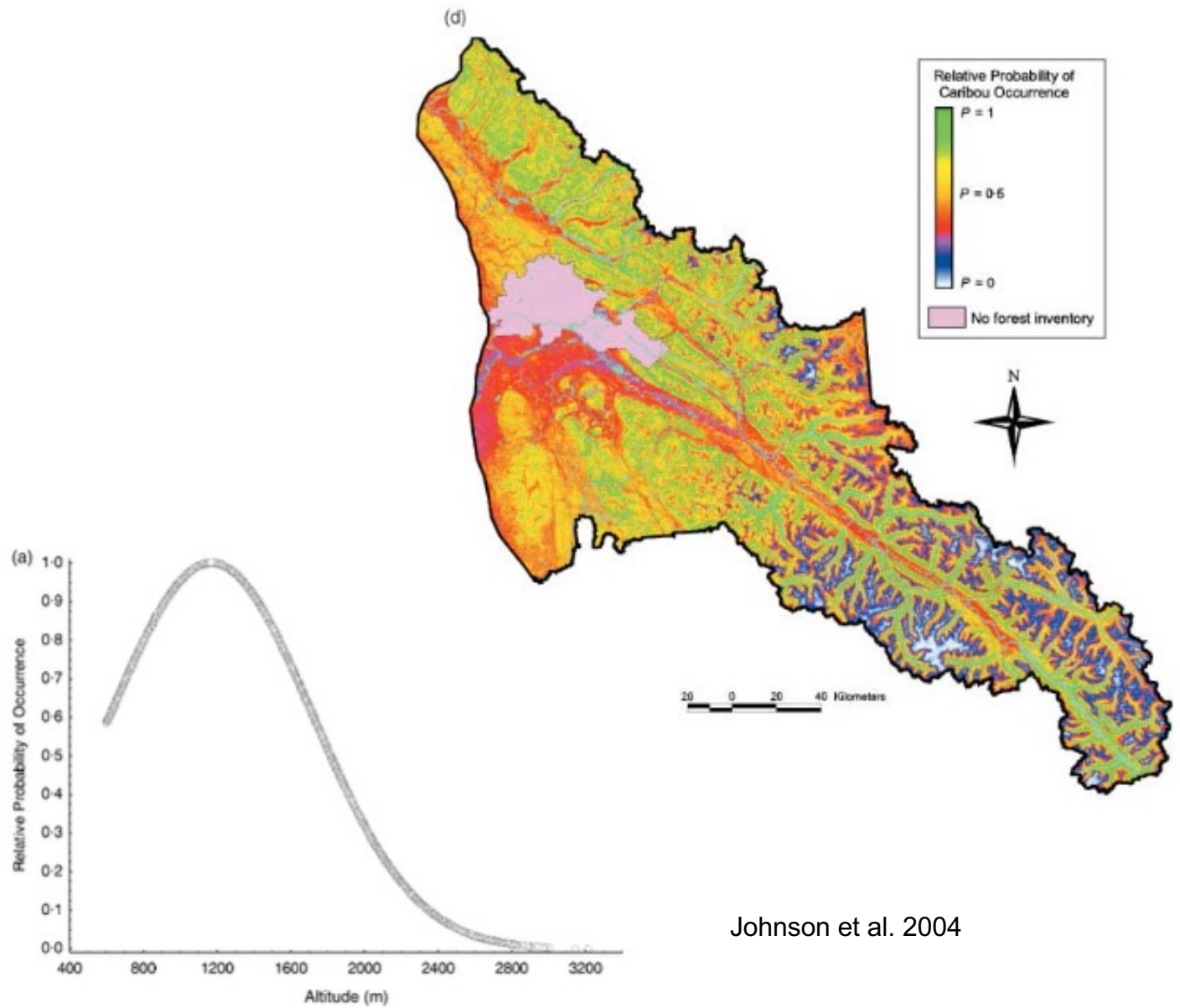


FIG. 1.—The 95% kernel estimate of Roger's home range in Laramie, Wyoming, where he spent sabbatical at the University of Wyoming in 1990–1991. Roger's house, the Biology Building on the university campus, Steve Buskirk's (a friend) house, and areas in downtown Laramie frequented by Roger are noted.



## Next step...

- Habitat selection



Johnson et al. 2004