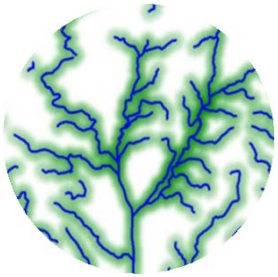
Estimating American mink, *Neovison vison*, density in complex river networks using spatial capture-recapture.

Chris Sutherland[1], Angela Fuller[1,2] & Andy Royle[3]

1. NY Cooperative Fish and Wildlife Research Unit, Cornell University.
2. U. S. Geological Survey
3. U. S. Geological Survey, Patuxent Wildlife Research Center



Abundance and Density

Why is it important?

- important measure of the state of a population
- basis for species assessment
- basis for management decisions

How many are there?

Abundance and Density

Why is it important?

- important measure a population
- basis for species assessment
- basis for management decisions

endangered

managed

SPECIES

Abundance and Density

Why is it so hard?

- impossible to <u>census</u> across large spatial scales
- expensive and/or impractical

Abundance and Density

Why is it so hard?

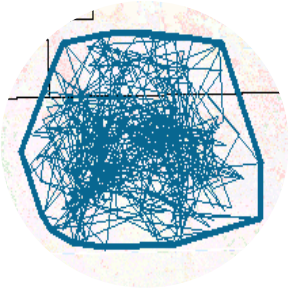
- impossible to <u>census</u> across large spatial scales
- expensive and/or impractical
- imperfect detection of species

Abundance and Density

Why is it so hard for carnivores?

secretive

nocturnal



far-ranging

densely vegetated/remote areas

low density

American Mink (*Neovison vison*)

Important

Difficult to study

American Mink (*Neovison vison*)

Important

- economically important
- top predator
- community regulator
- indicators of ecosystem health
- successful invasive species

Difficult to study

American Mink (*Neovison vison*)

Important

- economically important
- top predator
- community regulator
- indicators of ecosystem health
- successful invasive species

Difficult to study

- elusive
- semi-aquatic
- low density
- mainly solitary
- mainly nocturnal

American Mink (*Neovison vison*)

Important

- economically important
- top predator
- community regulator
- indicators of ecosystem health
- successful invasive species

Difficult to study

- elusive
- semi-aquatic
- low density
- mainly solitary
- mainly nocturnal

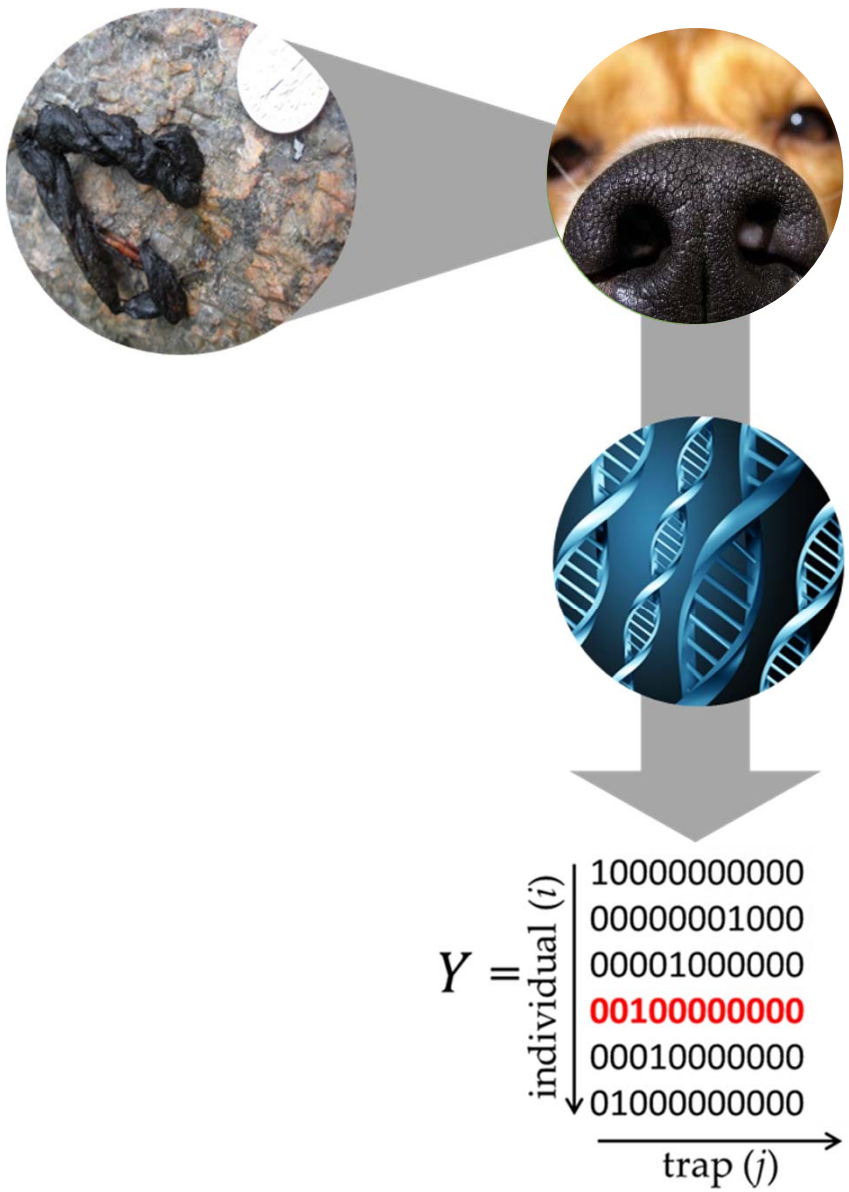
Few attempts at estimating *absolute* abundance

- relative abundance
- sign (scat, track) surveys

American Mink (*Neovison vison*)

- How can we survey mink?
- How can we estimate mink abundance/density?

Non-invasive capture mark recapture

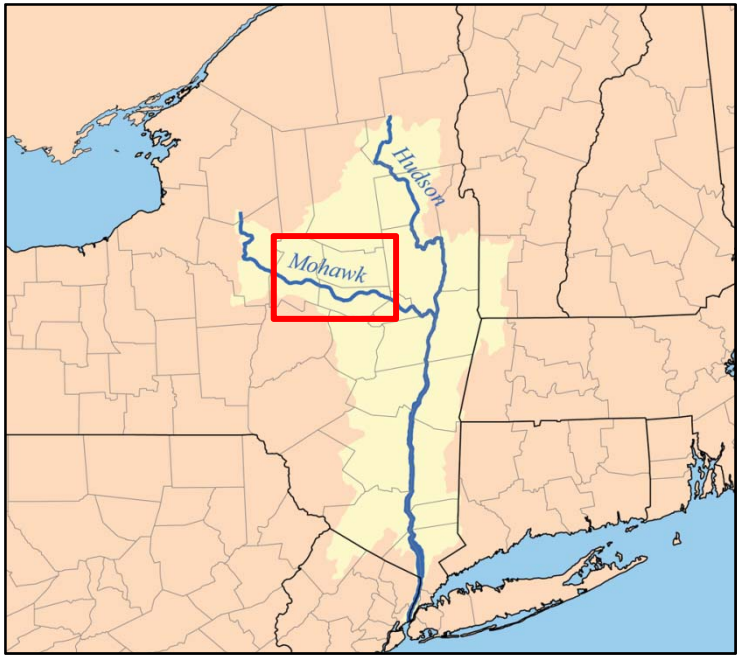


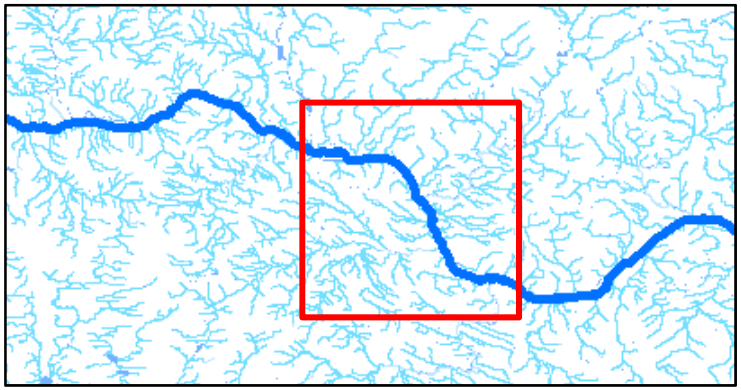
Scat detection dogs

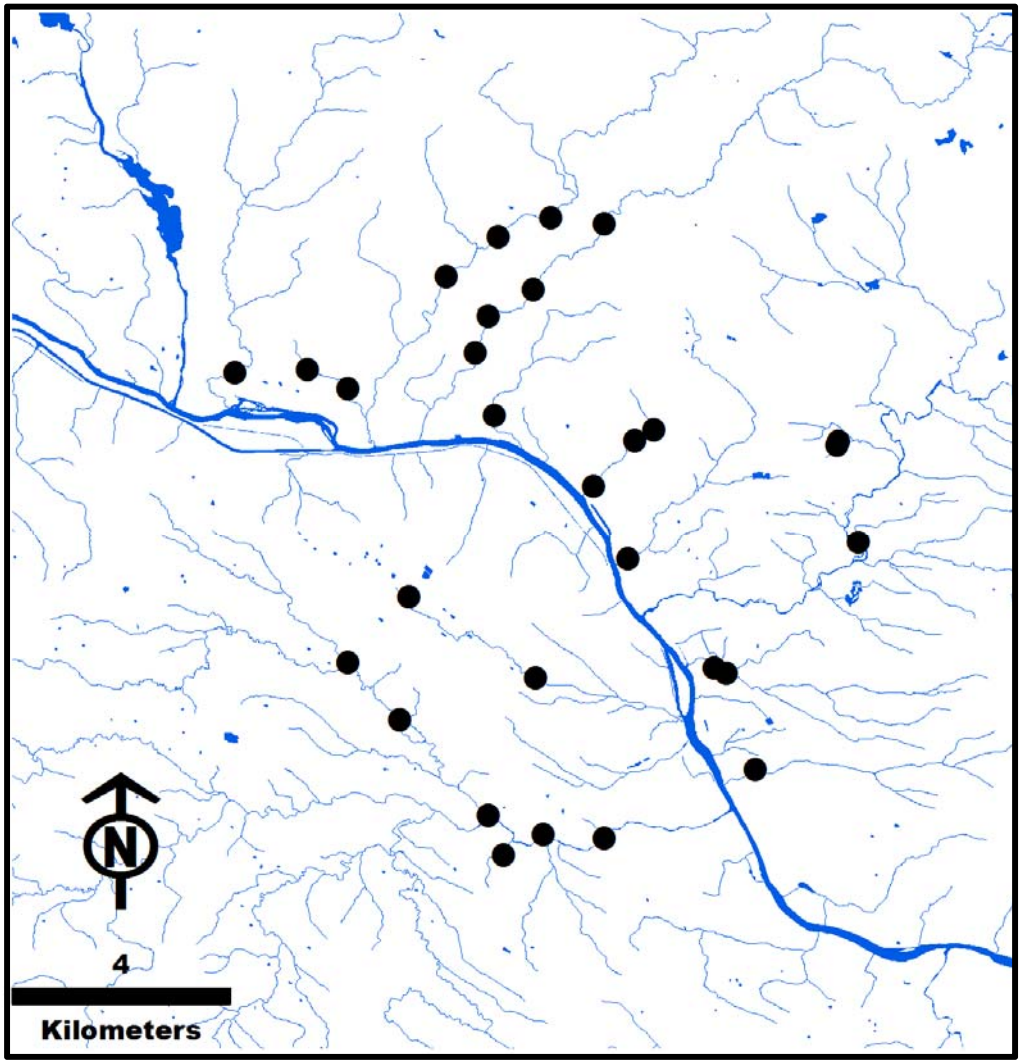
Genetic identification

Spatial capture-recapture

Mink Study in New York: Method assessment







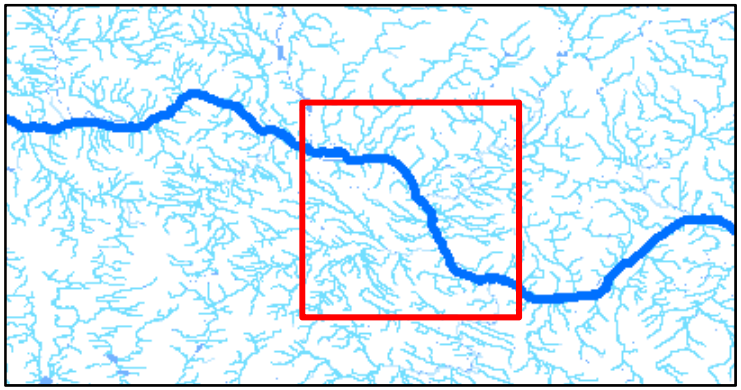
Mink Study in New York: Method assessment

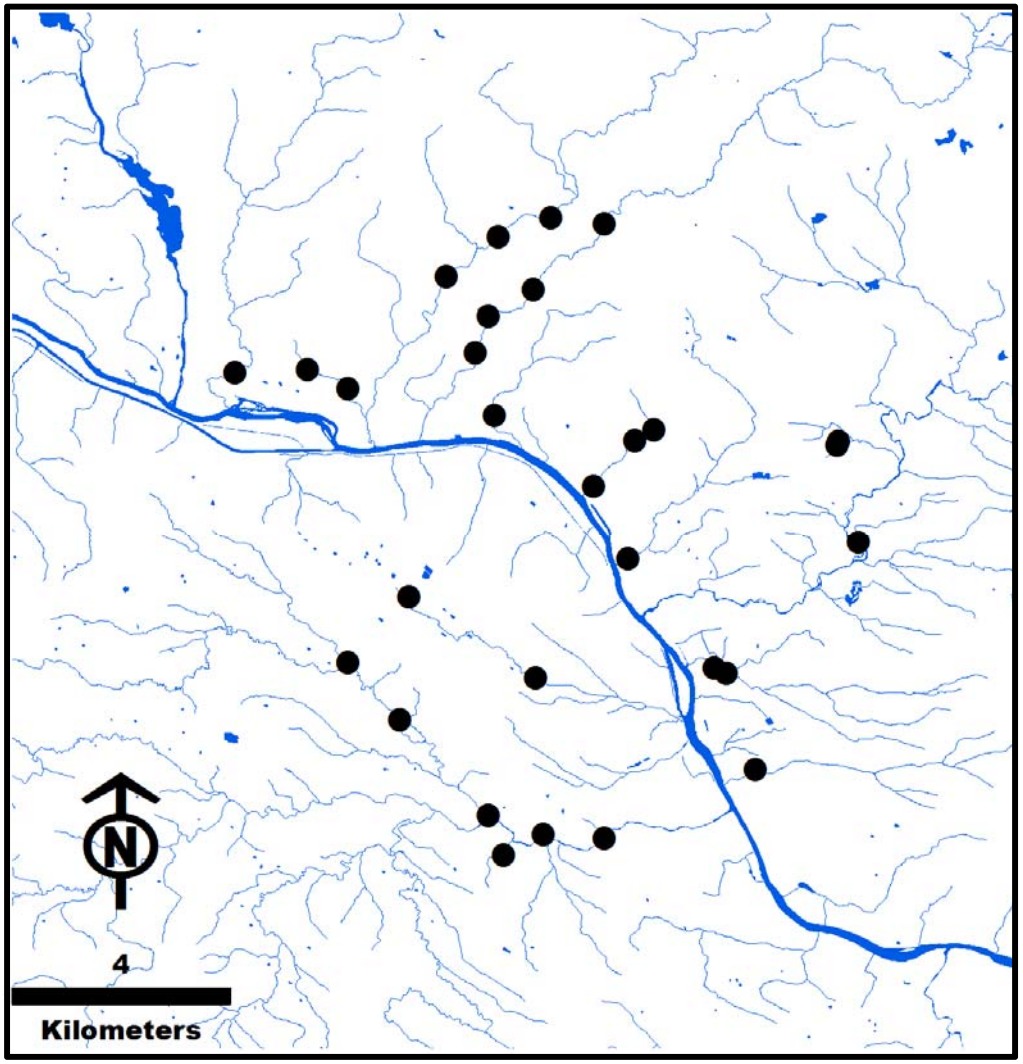
Mink Study (2012):

road-stream intersection •

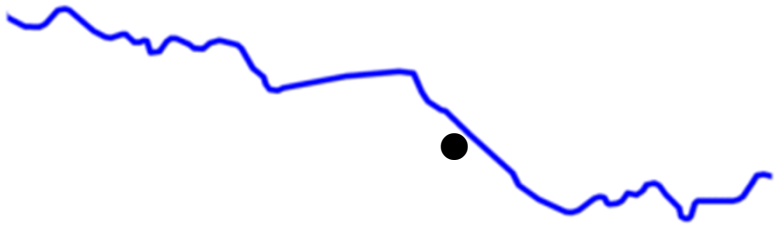
28 transects (~1 km)

- scat surveys along the water
- collect scat
- record scat location





Scat detection dogs

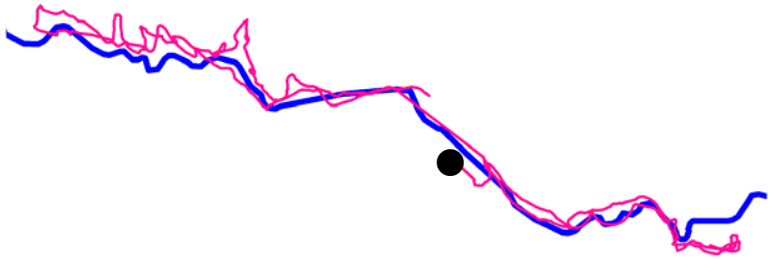


- non-invasive
- highly efficient
- increased detection rates
  - increased sample size
  - increased species certainty

species

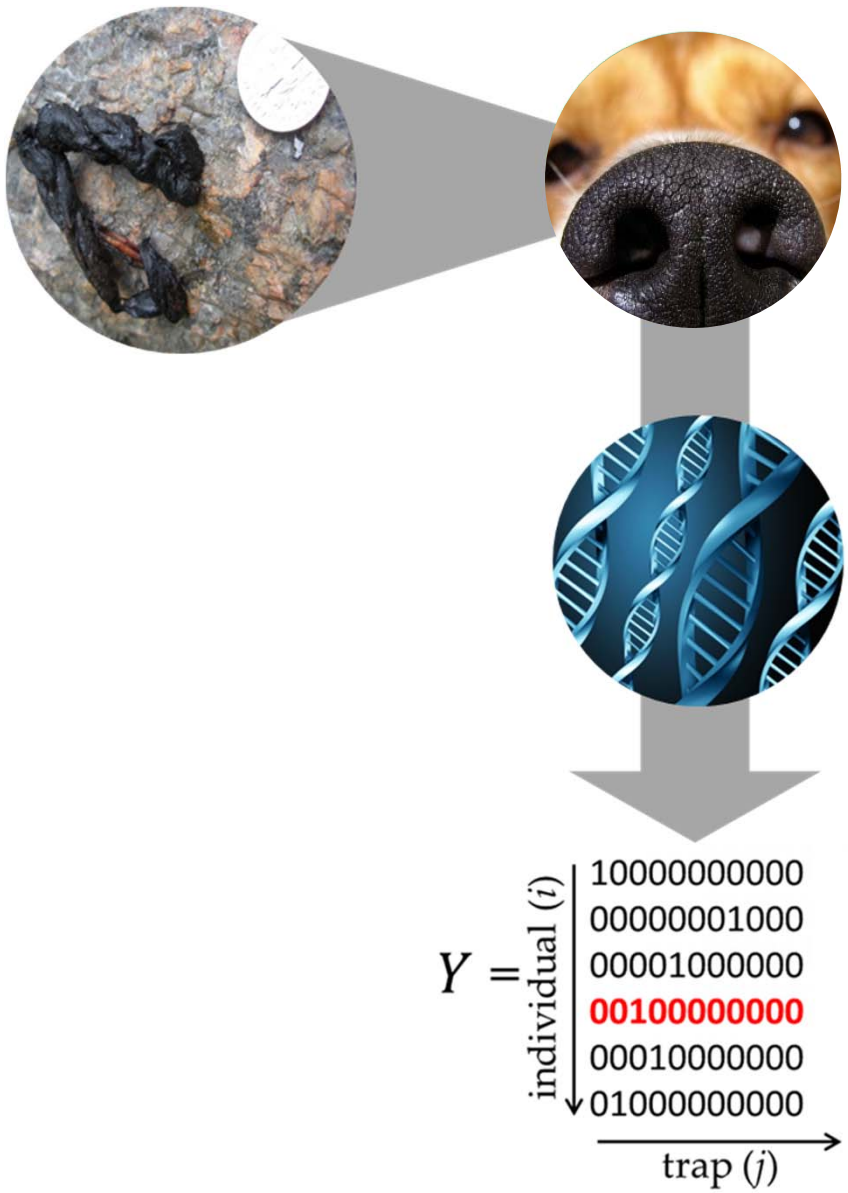
individual

Scat detection dogs

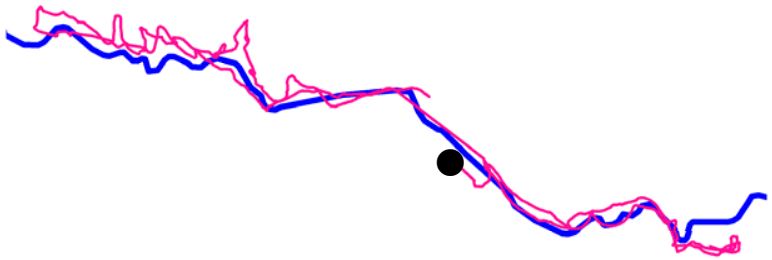


Genetic identification

- Scat found: *208*
- Successful DNA: *116*
- Unique individuals: *34*



Scat detection dogs



Genetic identification

- Scat found: *208*
- Successful DNA: *116*
- Unique individuals: *34*

Spatial capture-recapture

- Spatial recaptures: *15*

Spatial Capture-Recapture (SCR)

Two spatial components:

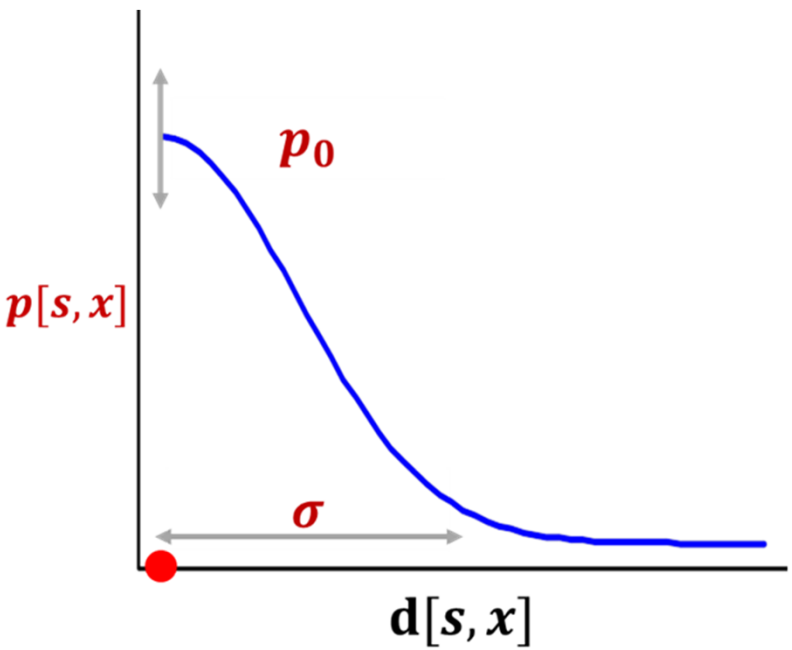
- spatial model for detection (space use)
- spatial model for distribution of individuals

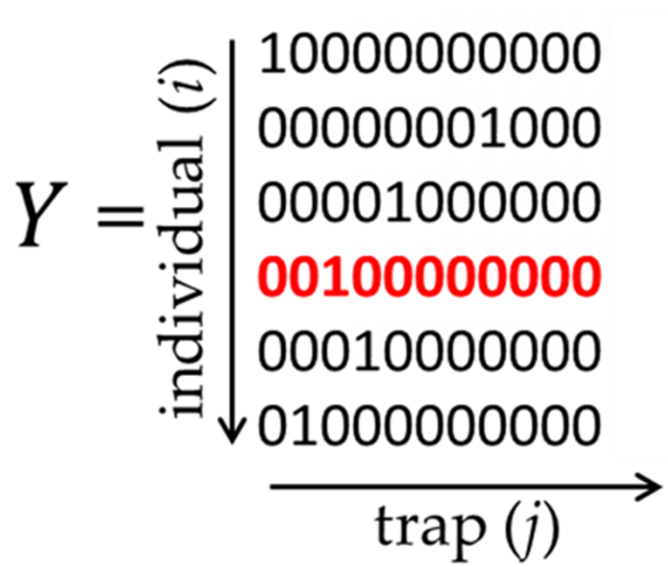
SPATIAL MODEL FOR SPACE USE

- **distance based** model for describing spatial patterns of detections
- prob. detection (p[s,x]) decreases with distance from activity center (●)

$\boldsymbol{p_0}$: probability of detection at an individual's activity centre

$\boldsymbol{\sigma}$: spatial scale of detection



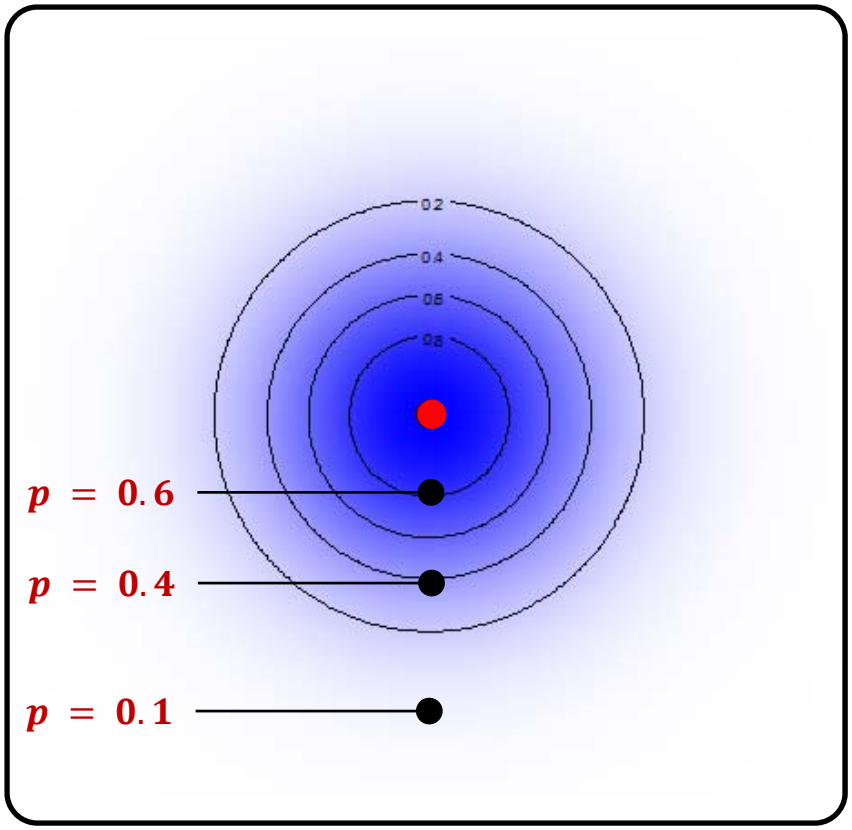


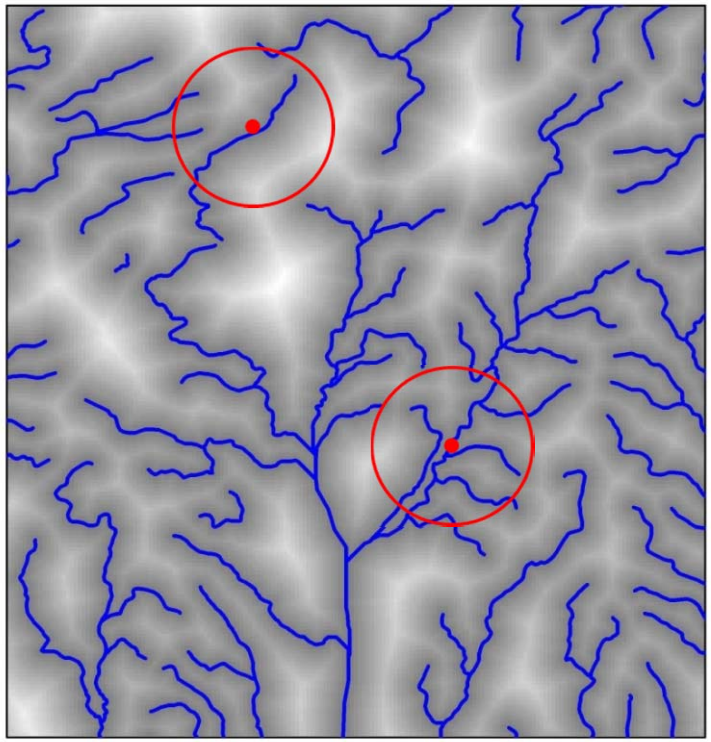
SPATIAL MODEL FOR SPACE USE

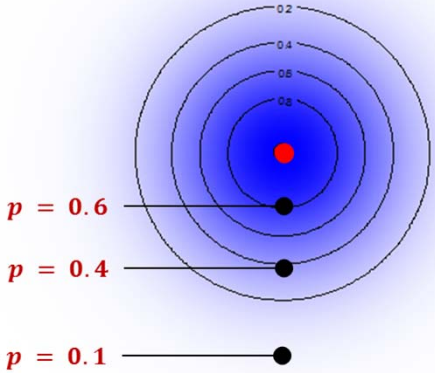
- **distance based** model for describing spatial patterns of detections
- prob. detection (p[s,x]) decreases with distance from activity center (●)

Spatial model for detection ~

- a model for space use
- a model for home range!

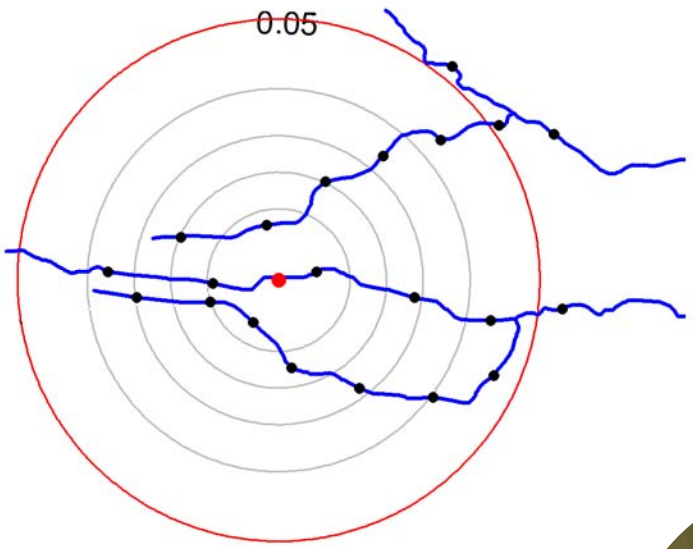





0.2
0.4
0.6
0.8
$p = 0.6$
$p = 0.4$
$p = 0.1$

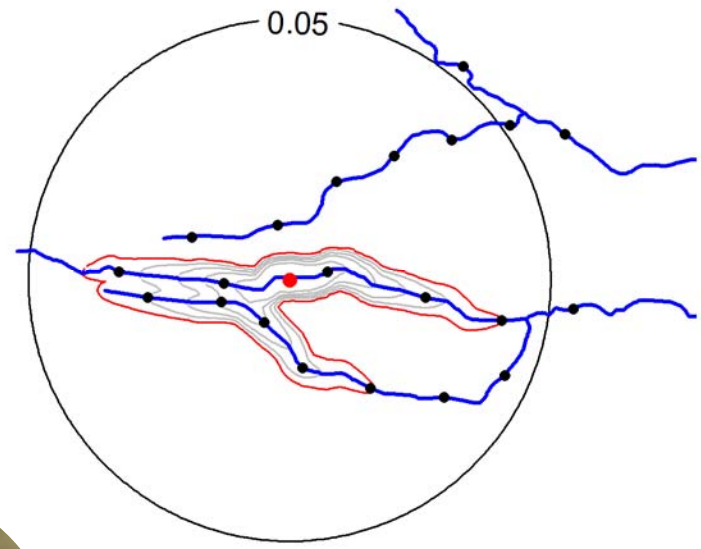
Euclidean distance

a ‘naïve’ measure of space use



Ecological distance

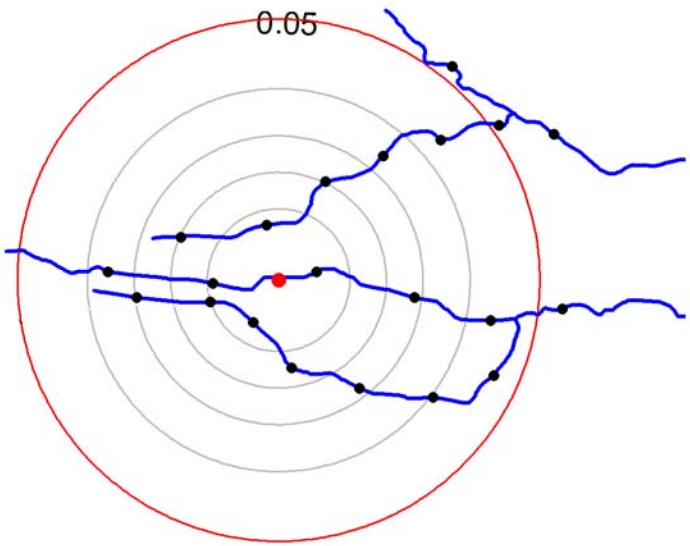
distance as perceived by the species



Sutherland *et al*. **Methods in Ecology & Evolution**. (2015) 6: 169–177

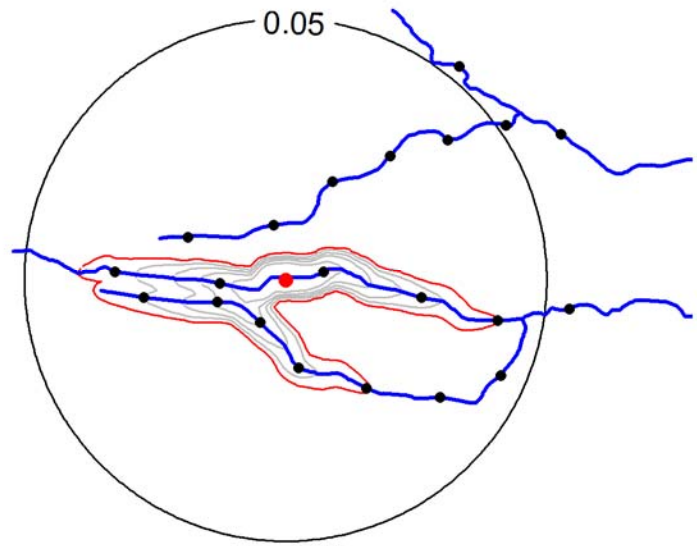
Euclidean distance

a 'naïve' measure of space use



Ecological distance

distance as perceived by the species



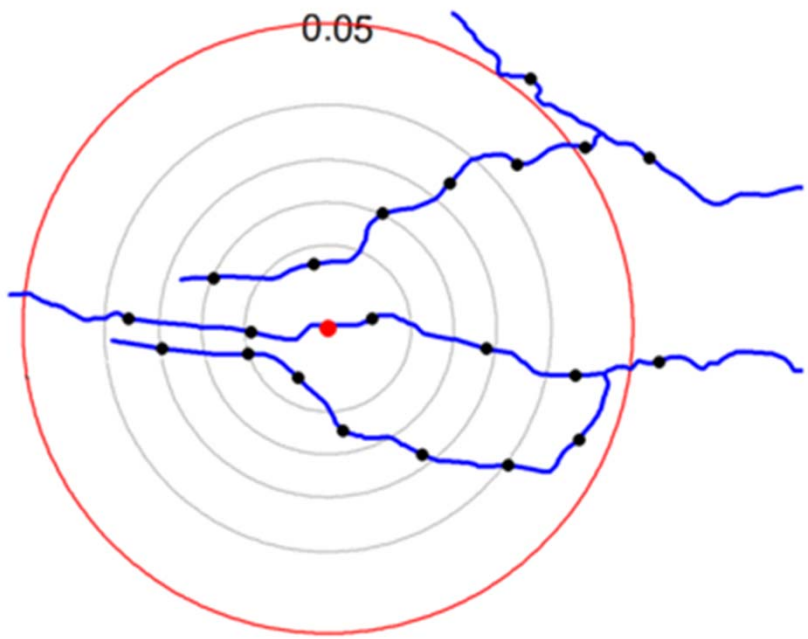
***r*:** a parameter to estimate the strength of association between space use and the structure of the landscape (water!).

Sutherland *et al*. **Methods in Ecology & Evolution**. (2015) 6: 169–177

Estimating the strength of association between space use and the structure of the landscape (water!).

$\boldsymbol{r = 0}$: exactly Euclidean distance

$\boldsymbol{r > 0}$: significant landscape-movement interaction

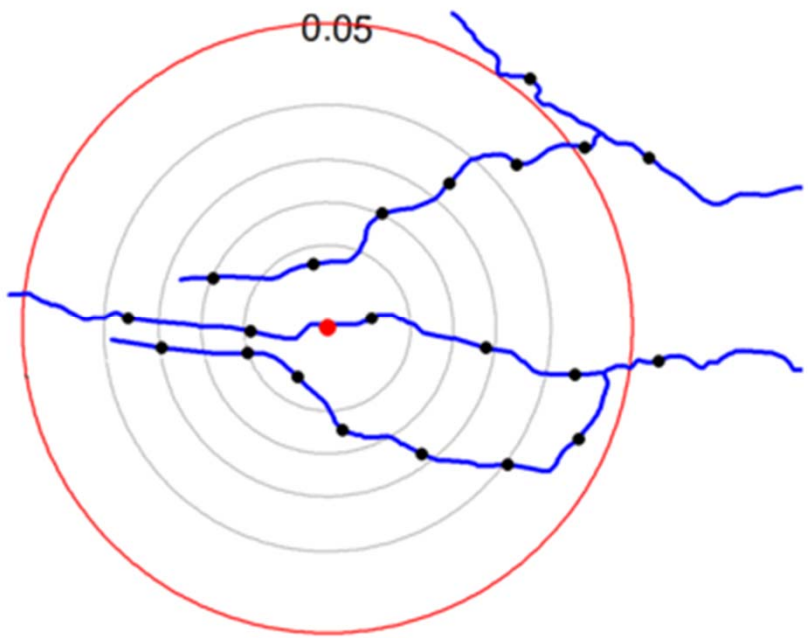


Sutherland *et al*. **Methods in Ecology & Evolution**. (2015) 6: 169–177

Estimating the strength of association between space use and the structure of the landscape (water!).

$\boldsymbol{r = 0}$: exactly Euclidean distance

$\boldsymbol{r > 0}$: significant landscape-movement interaction

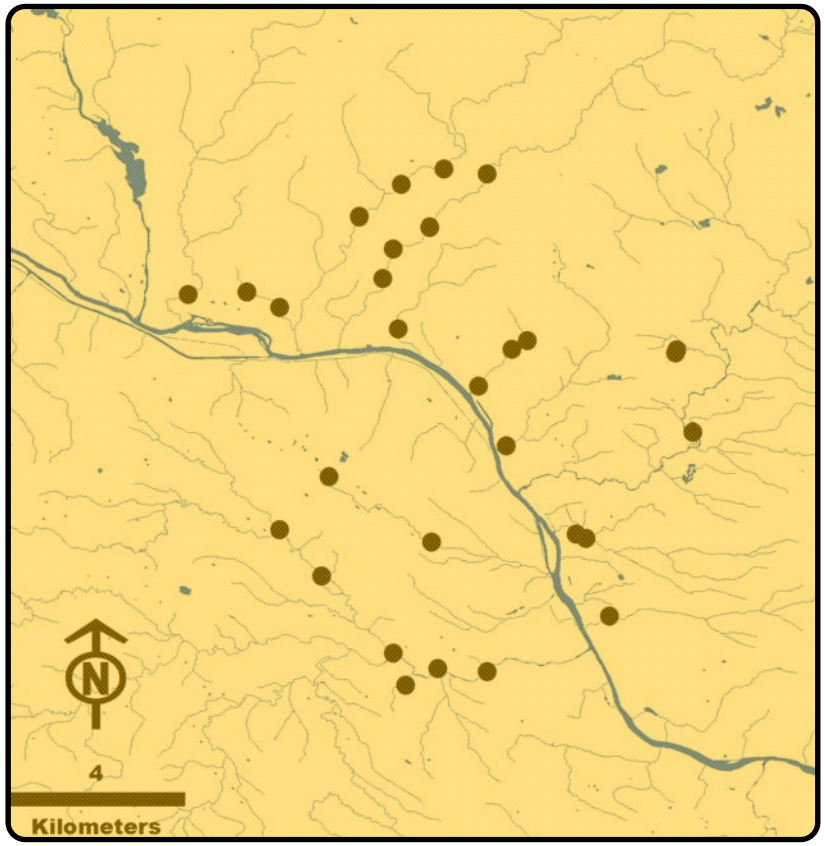


Sutherland *et al*. **Methods in Ecology & Evolution**. (2015) 6: 169–177

SPATIAL MODEL OF DENSITY

Distribution of individuals across the landscape:

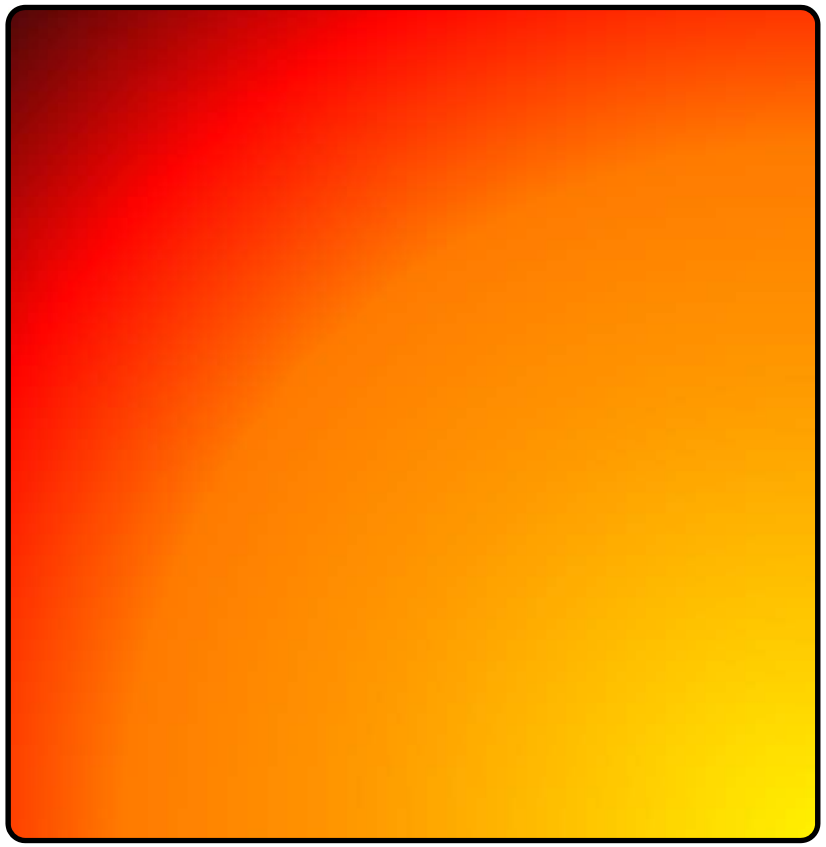
- uniform density



SPATIAL MODEL OF DENSITY

Distribution of individuals across the landscape:

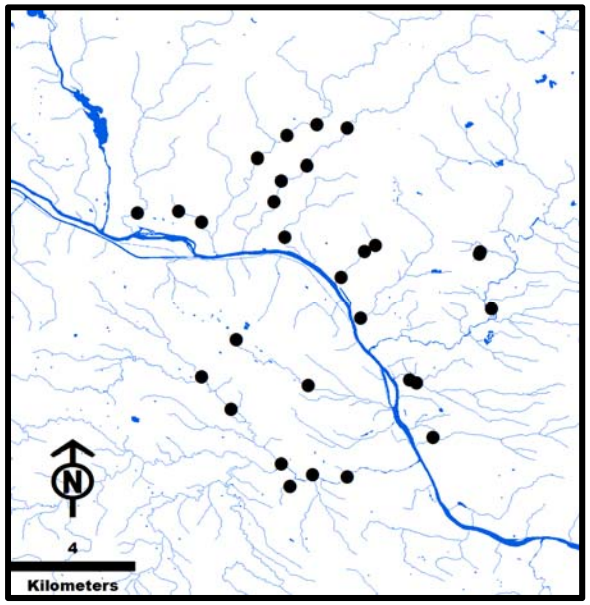
- uniform density
- spatial variation

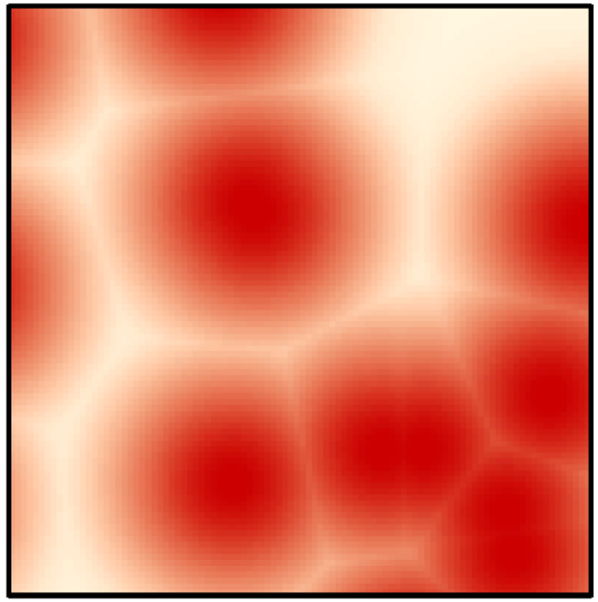


SPATIAL MODEL OF MINK DENSITY

Distribution of mink across the landscape:

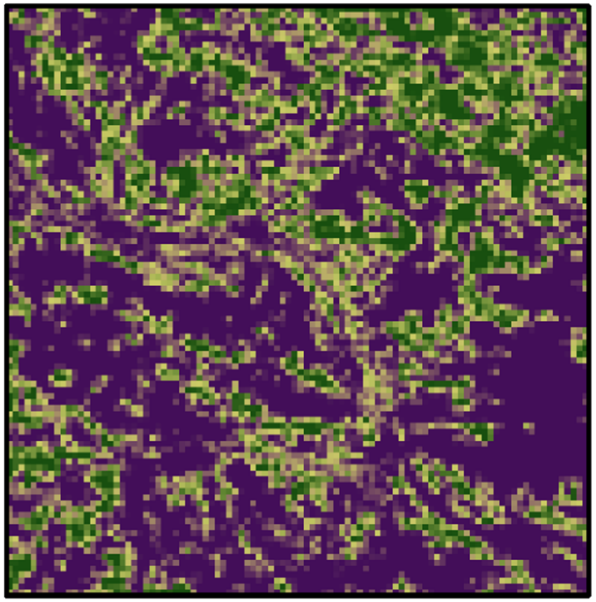
- uniform density?
- spatial variation?
  - distance to city/town
  - vegetation cover





Distance to City (km)

8 0



Vegetation Cover (%)

100 0

QUESTIONS

Is space use better described by Euclidean or ecological distance?

What is mink abundance and density, does it vary across space?

- Distance to urban areas
- % vegetation cover

How does landscape structure influence space use?

Fuller, Sutherland & Royle. (*In review*)

RESULTS

Ecological vs. Euclidean distance model

- Ecological systematically outperformed Euclidean (AIC)

Fuller, Sutherland & Royle. (*In review*)

RESULTS

Mink abundance and density:

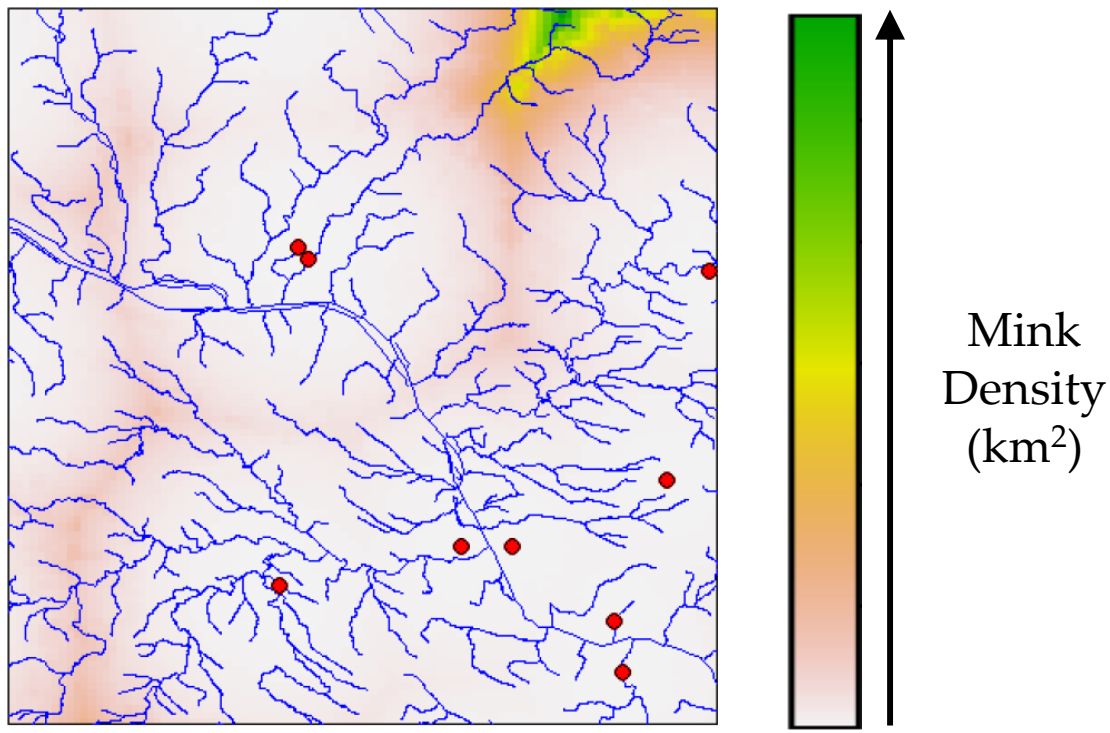
- negatively associated with urban areas: $\boldsymbol{\beta}_{\mathbf{d2city}} = 0.90\ (0.33 - 1.46)$
- abundance: $\widehat{\boldsymbol{N}} = 873\ (558 - 1377)$
- density: $\widehat{\boldsymbol{D}} = 2.25\ (1.44 - 3.55)$ per km^2

Fuller, Sutherland & Royle. (*In review*)

RESULTS

Mink abundance and density:

- negatively associated with urban areas: $\boldsymbol{\beta}_{\mathbf{d2city}} = 0.90\ (0.33 - 1.46)$
- abundance: $\widehat{\boldsymbol{N}} = 873\ (558 - 1377)$
- density: $\widehat{\boldsymbol{D}} = 2.25\ (1.44 - 3.55)$ per km^2



Fuller, Sutherland & Royle. (*In review*)

RESULTS

Estimating r is estimating home range geometry!

- $r > 0$ [*significant movement-landscape association: 3.32*]

Home ranges are:

- asymmetric
- non-stationary

Fuller, Sutherland & Royle. (*In review*)

RESULTS

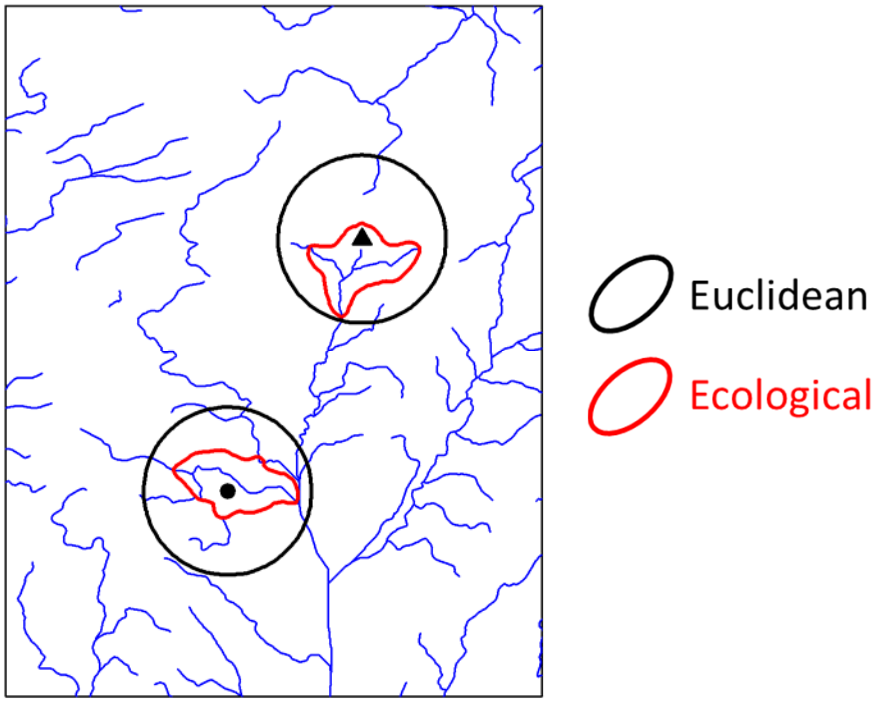
Estimating *r* is estimating home range geometry!

- $r > 0$ [*significant movement-landscape association: 3.32*]

Home ranges are:

- asymmetric
- non-stationary
- **REALISTIC!**

Space use is location specific!



Fuller, Sutherland & Royle. (*In review*)

RESULTS

Estimating r is estimating home range geometry!

- $r > 0$ [*significant movement-landscape association: 3.32*]

r: the degree to which landscape structure impedes or facilitates movement

Sutherland *et al*. **Methods in Ecology & Evolution**. (2015) 6: 169–177
Fuller, Sutherland & Royle. (*In review*)

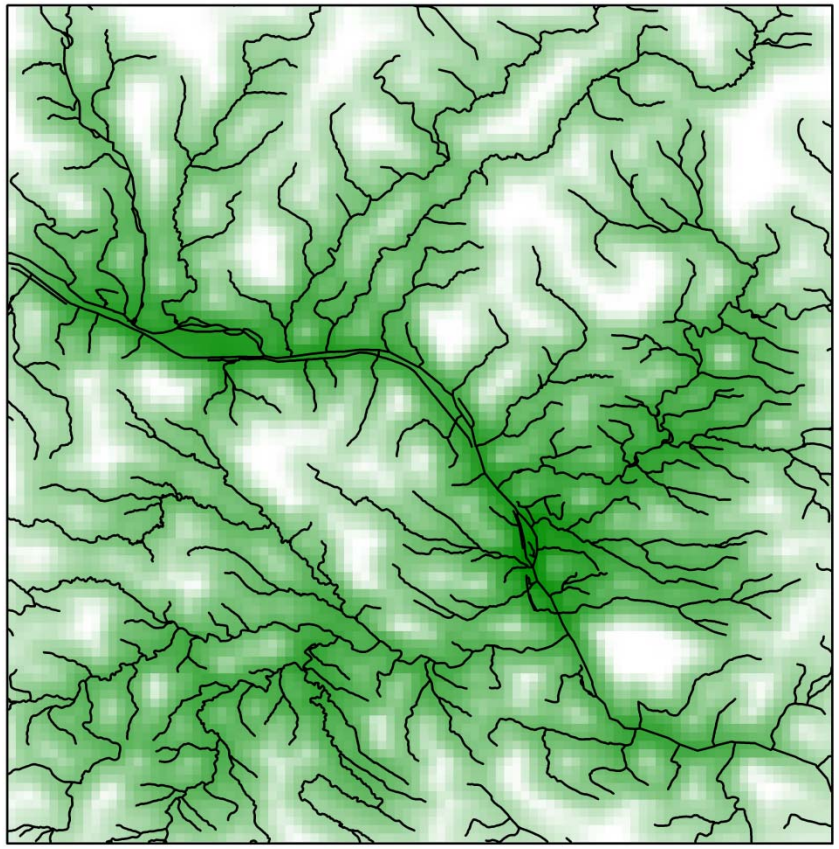
RESULTS

Estimating *r* is estimating home range geometry!

- $r > 0$ [*significant movement-landscape association: 3.32*]

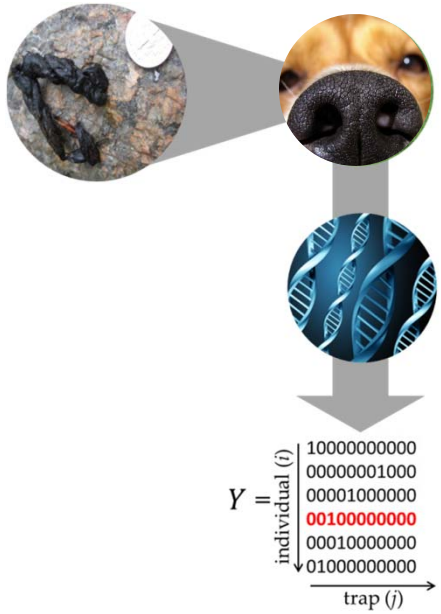
r: the degree to which landscape structure impedes or facilitates movement

LANDSCAPE CONNECTIVITY!

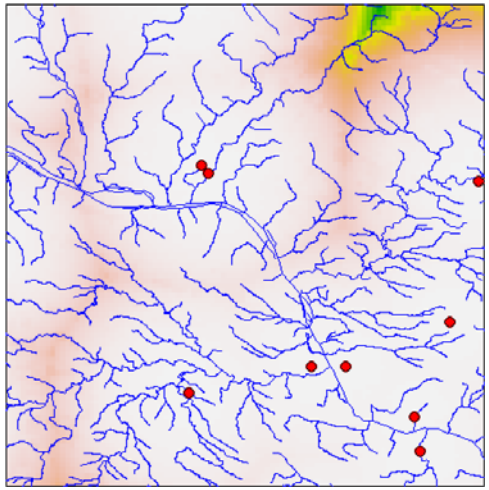


Sutherland *et al*. **Methods in Ecology & Evolution**. (2015) 6: 169–177
Fuller, Sutherland & Royle. (*In review*)

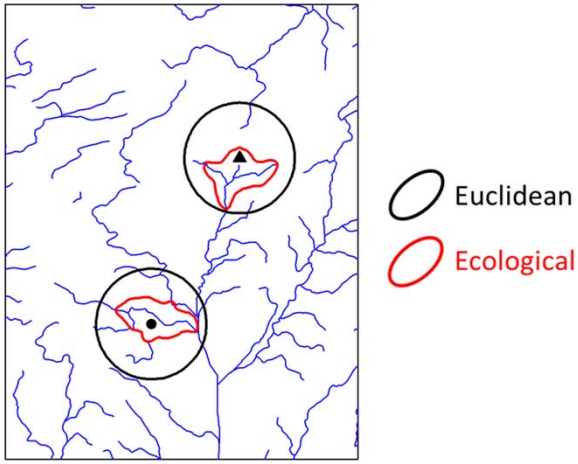
In Summary



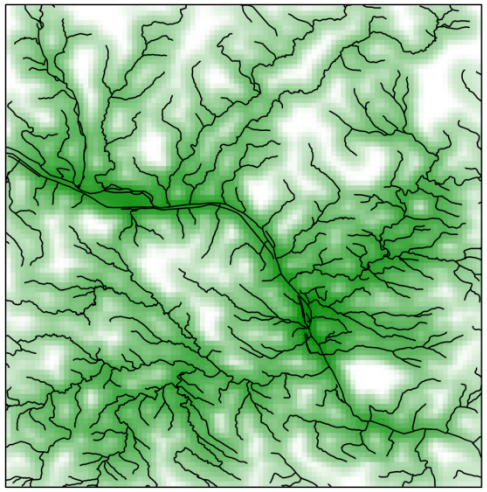
Spatial variation in abundance and density



Landscape – space use interaction



Landscape Connectivity



Thanks to:

- The Hudson River Natural Resources Trustees
- Many landowners for permission to access their properties

"The conclusions and opinions presented here are those of the authors, they do not represent the official position of any of the funding agencies, the Hudson River Trustees or the United States."

USGS

HUDSON RIVER TRUSTEES

ASSESSING AND RESTORING YOUR NATURAL RESOURCES

CORNELL UNIVERSITY FOUNDED A.D. 1865