Evenstad, 15/08/12

# Using hurdle models to create maps of prey density in southeastern of Norway

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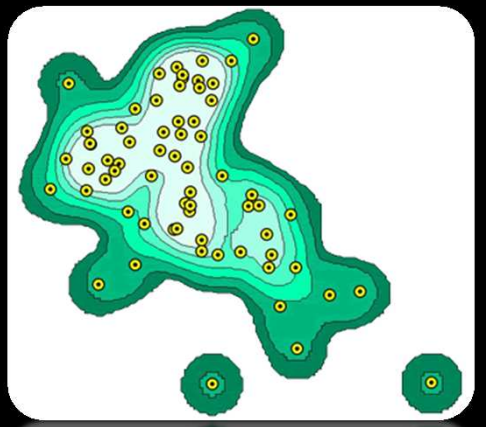
# Introduction

- **Return of large carnivores**
- **Managing their recovery in the heavily human-modified landscapes of Europe**
- **Prey distribution and density in areas where carnivores are present = understanding of carnivore movements and habitat use**

PREY DENSITIES MAPS

# Introduction

- **Large carnivore home ranges: 100km² to 1500 km²**
- **Herbivore home ranges: 1km² to 50km²**



- **Models of prey habitat = much smaller scales than the areas over which it will be applied**
- **With large carnivores: use of predictive models needed to extend the model to a larger scale in order to include all the individual home-ranges**

# Introduction

- **Prey species :**


***Capreolus capreolus***

***Alces alces***

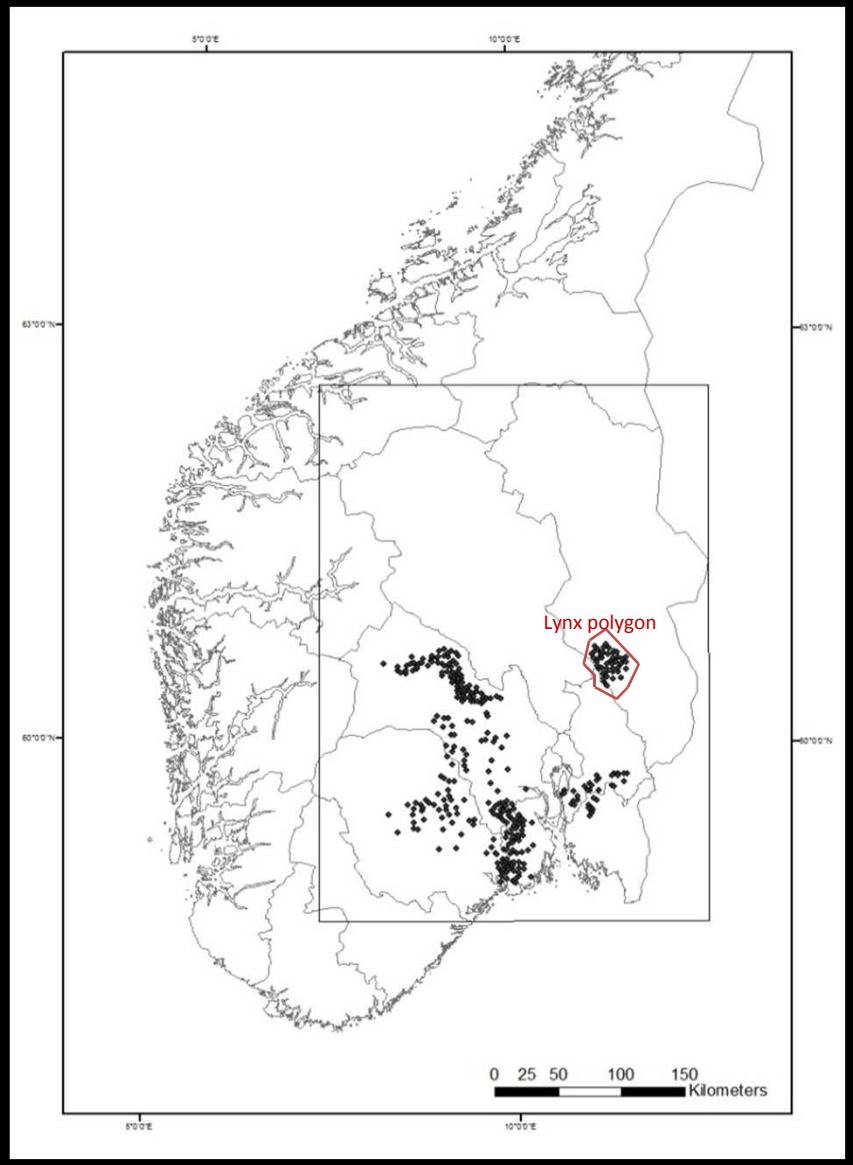
***Cervus elaphus***

***Lepus timidus***

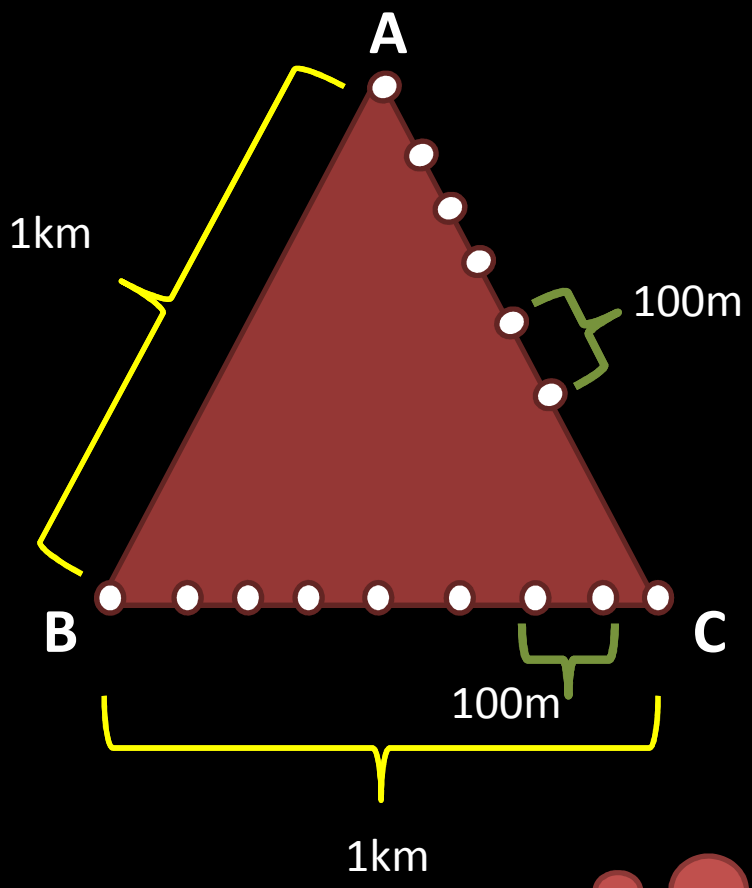
- **NO MAPS AVAILABLE IN NORWAY YET**

- **Pellet groups, Hurdle models**

# Materials and Methods




**430 transects covered between 2005, 2007, 2008 and 2011**



# Materials and Methods

- **Pellet group**

- **Data collected in spring (April-May) and autumn (September) to avoid a too high vegetation in summer and snow cover in winter**

- **346 triangles were kept for the analysis**

- **For red deer, only 245 triangles**

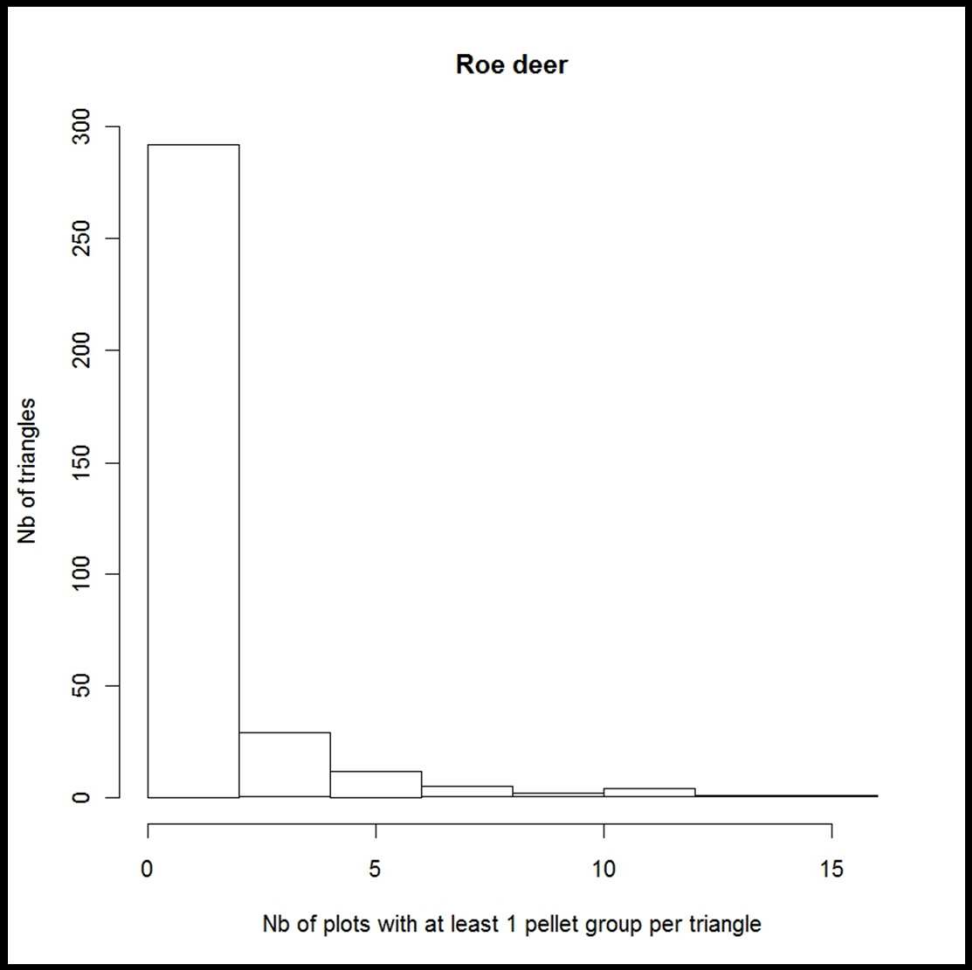
# Materials and Methods

## Environmental variables within a radius of 1250m or 2500m from the center of the plot

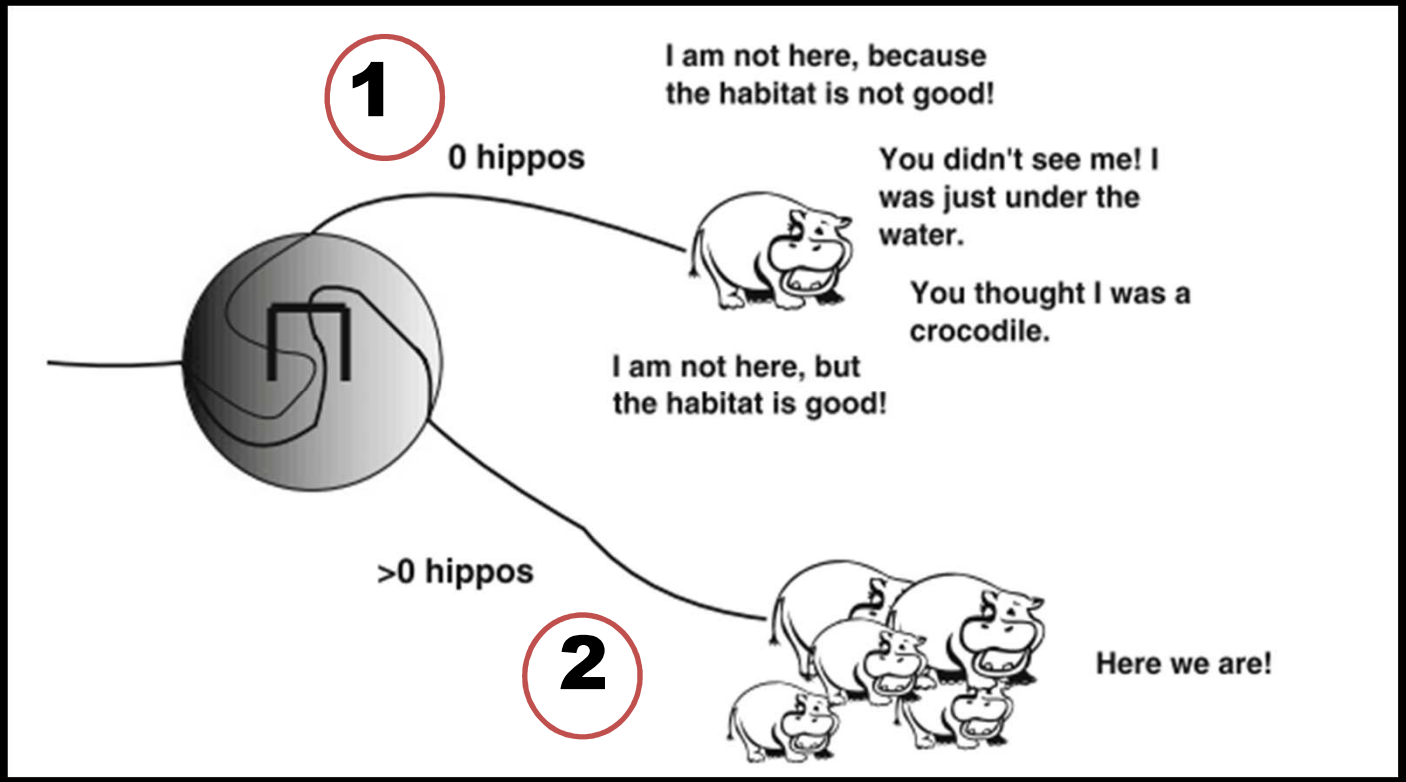
| Data | Signification |
|---|---|
| **Habitat** | |
| **Forest** | The km² of forest within each pixel |
| **Bogs** | The km² of bogs within each pixel |
| **Temperature** | The annual mean temperature (degree) within each pixel |
| **Snow** | The mean snow depth (mm) during winter within each pixel |
| **Elevation** | Mean elevation within each pixel |
| **Slope** | Mean of the slope (degrees) within each pixel |
| **Hillshade** | Index of the combination of the slope and aspect of the terrain in relationship to the azimuth and aspect of the sun within each pixel |
| **Climatic Gradient** | Regional variation (gradient) from coast to inland and from oceanic/humid to continental areas within each pixel |
| **Human activity** | |
| **Field** | The km² of agricultural fields within each pixel |
| **Public Roads** | The km of public roads within each pixel |
| **Private Roads** | The km of private roads within each pixel |
| **Human Density** | The density of humans within each pixel |

# Materials and Methods

**<u>Hurdle models</u>: used when the response variable contains more zeros than expected based on a Poisson or on a negative binomial distribution**



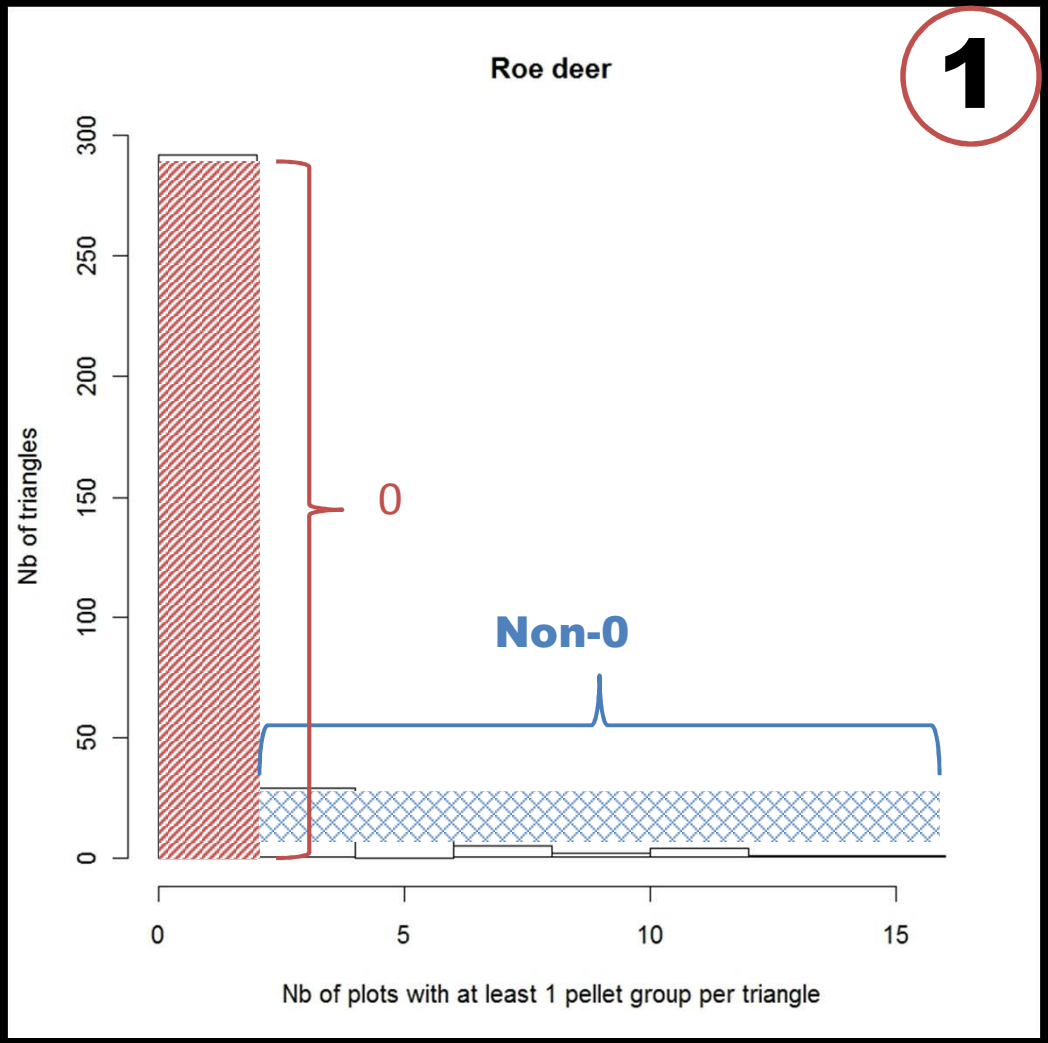
# Materials and Methods




**<u>Two ecological processes</u> :**

1) **Absence**
2) **When presence, influence on the number of animals**

# Materials and Methods



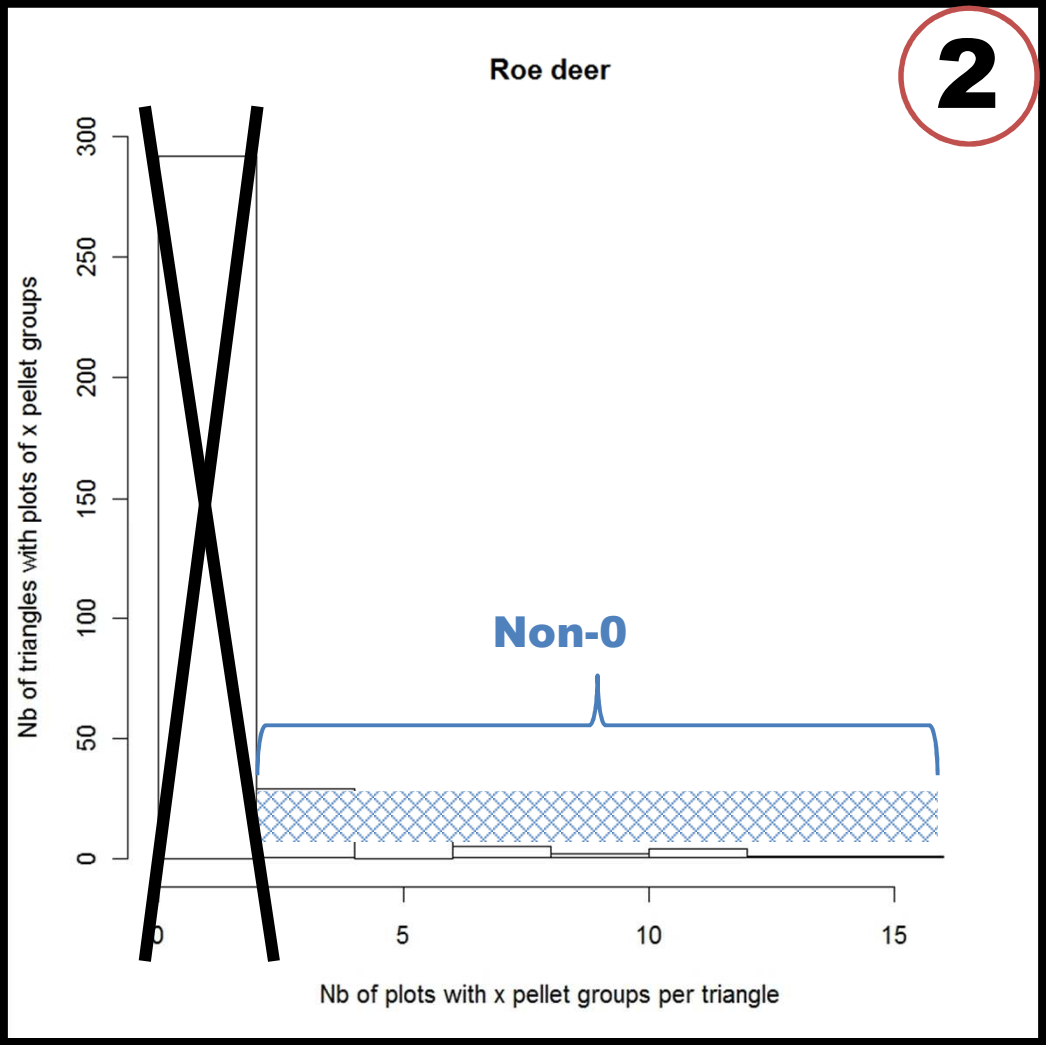

## Two parts model

1. Data = 0 vs. non-0

→ binomial model : proba that a 0 is observed

**Presence/absence**

# Materials and Methods




## Two parts model

**2. non-0 modeled with a truncated Poisson or truncated negative binomial model**

**→ cannot produce 0**

**Abundance**

# Materials and Methods

**Model evaluation:**

1) **A cross-validation based on a leave-one-out procedure carried out n times was realized with the same dataset used to create the distribution maps**

2) **A. Snow-tracks**

**B. Hunting data at the municipality level**

# Results

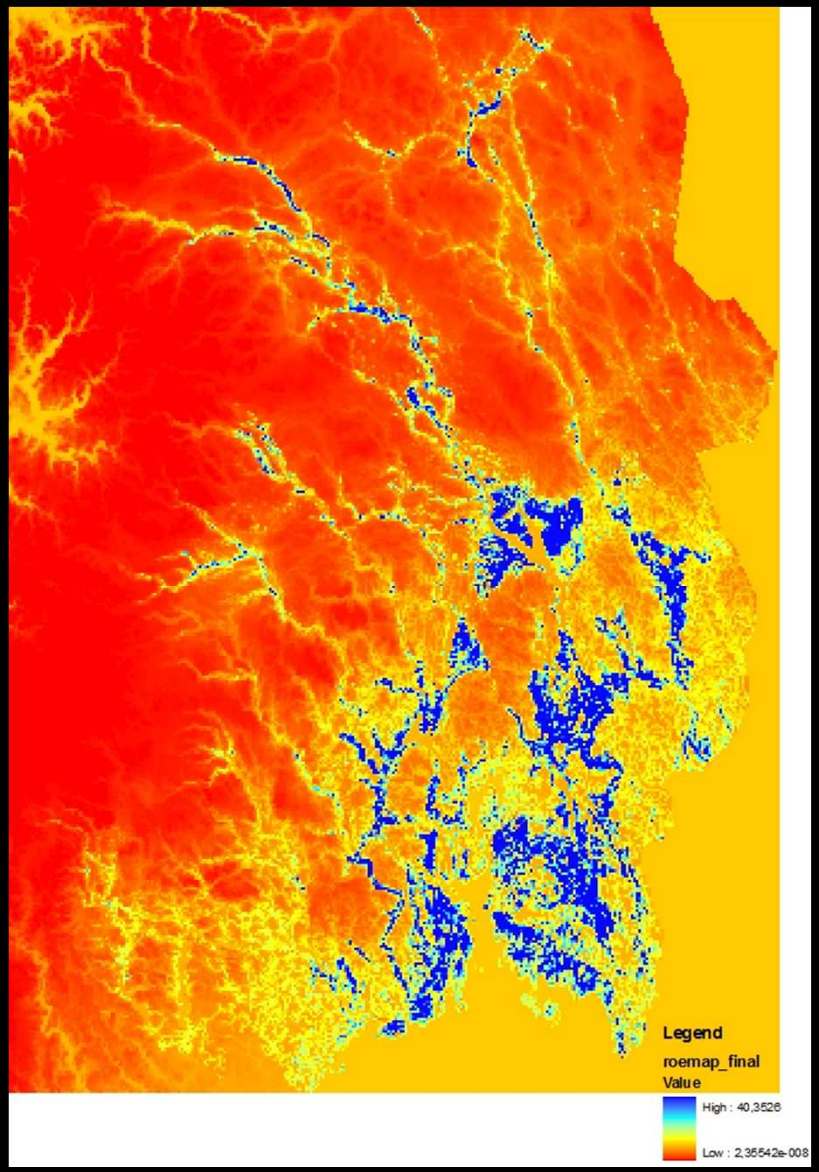
| | 1 Binomial part | | | 2 Negative binomial part | | |
|---|---|---|---|---|---|---|
| | Estimate | SE | p-value | Estimate | SE | p-value |
| **Roe deer** | | | | | | |
| Fields | 5.123 | 1.093 | <0.001 | 2.411 | 0.529 | <0.001 |
| Private Roads | _ | _ | _ | 0.985 | 0.316 | 0.001 |
| Snow | -0.004 | 0.0007 | <0.001 | -0.005 | 0.001 | <0.001 |
| Private Roads $^2$ | _ | _ | _ | -0.262 | 0.129 | 0.04 |
| | | | | | | |
| **Red Deer** | | | | | | |
| Forest | 2.938 | 1.160 | 0.01 | 3.821 | 1.122 | <0.001 |
| Public Roads | _ | _ | _ | 0.505 | 0.161 | 0.001 |
| Bogs | 10.388 | 3.019 | <0.001 | _ | _ | _ |
| Slope | 0.109 | 0.042 | 0.01 | _ | _ | _ |
| | | | | | | |
| **Moose** | | | | | | |
| Bogs | _ | _ | _ | -2.629 | 1.15 | 0.023 |
| Fields | _ | _ | _ | -1.05 | 0.45 | 0.021 |
| Human Density | _ | _ | _ | -0.003 | 0.001 | 0.024 |
| Snow | -3.548 | 1.284 | 0.006 | -0.001 | 0.0005 | 0.0292 |
| CG | -5.554 | 1.894 | 0.003 | 352.69 | 73.24 | <0.001 |
| Hillshade | 1.484 | 2.096 | <0.001 | _ | _ | _ |
| Private Roads | -7.674 | 2.125 | <0.001 | _ | _ | _ |
| | | | | | | |
| **Mountain Hare** | | | | | | |
| Bogs | _ | _ | _ | -2.538 | 1.266 | 0.044 |
| Public Roads | _ | _ | _ | -0.3527 | 0.141 | 0.012 |
| Snow | 0.003 | 0.0004 | <0.001 | 0.002 | 0.0006 | <0.001 |
| CG | 570 | 159 | <0.001 | 551 | 103 | <0.001 |
| | | | | | | |

# Results

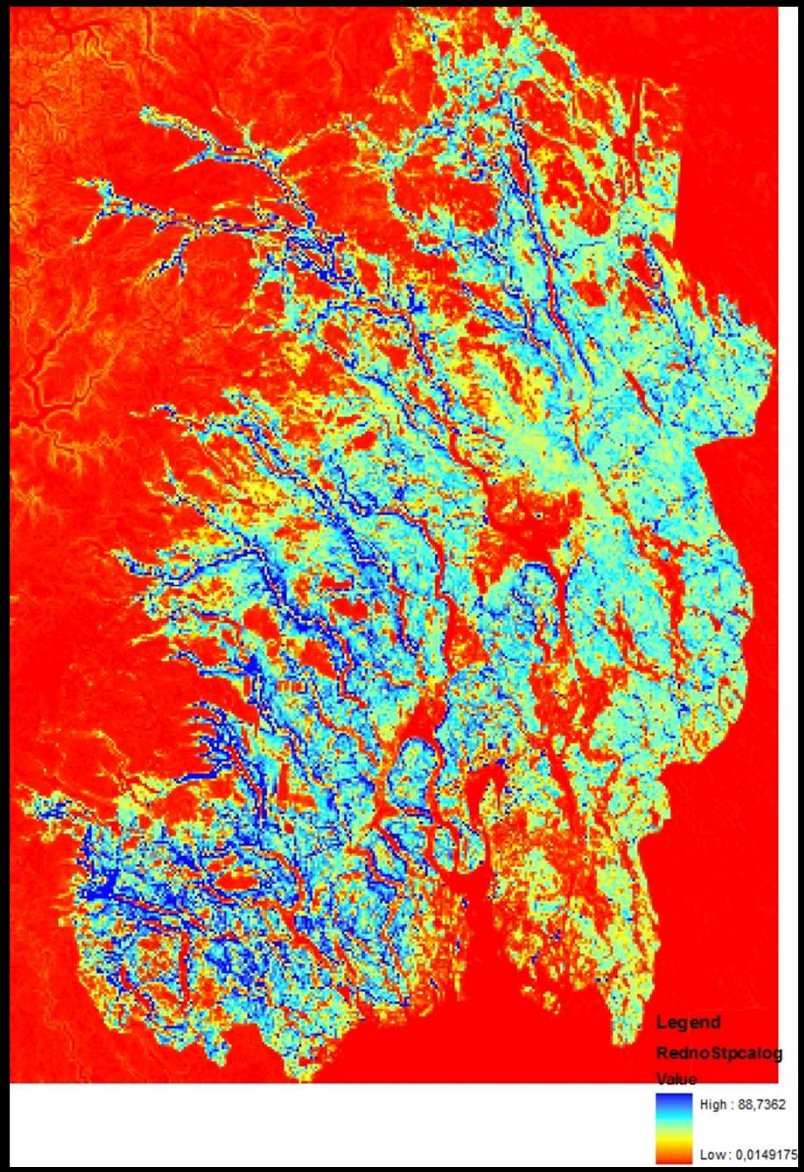
| Cross-validation | Roe deer | Red deer | Moose | Hare |
|---|---|---|---|---|
| RMSE | 2.30 | 36.04 | 10.84 | 2.90 |
| Rcor | 0.41 | 0.26 | 0.21 | 0.37 |

| Spearman's rank correlation | Roe deer | Red deer | Moose | Hare |
|---|---|---|---|---|
| Snowtrack data | 0.30 | 0.13 | 0.28 | 0.53 |
| Hunting data | 0.87 | 0.23 | 0.54 | _ |

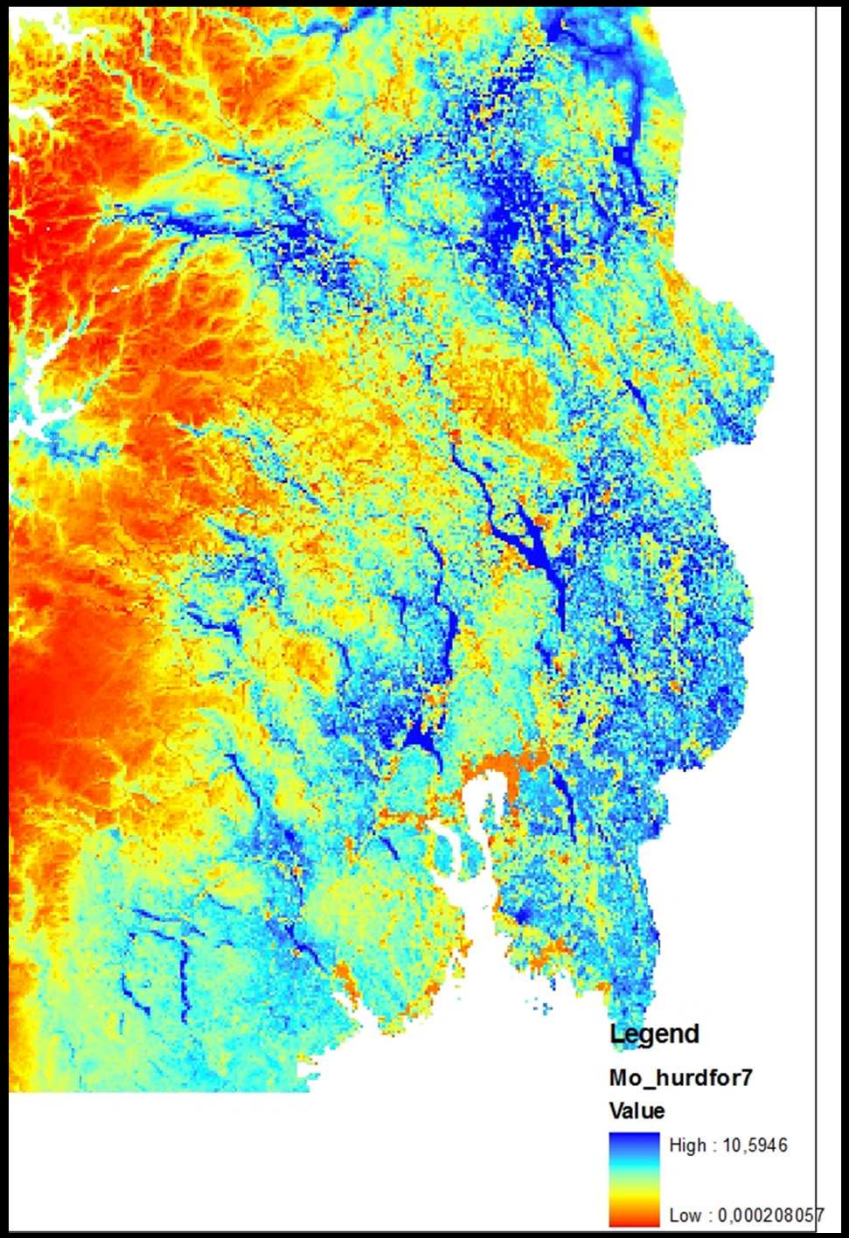
## Roe deer



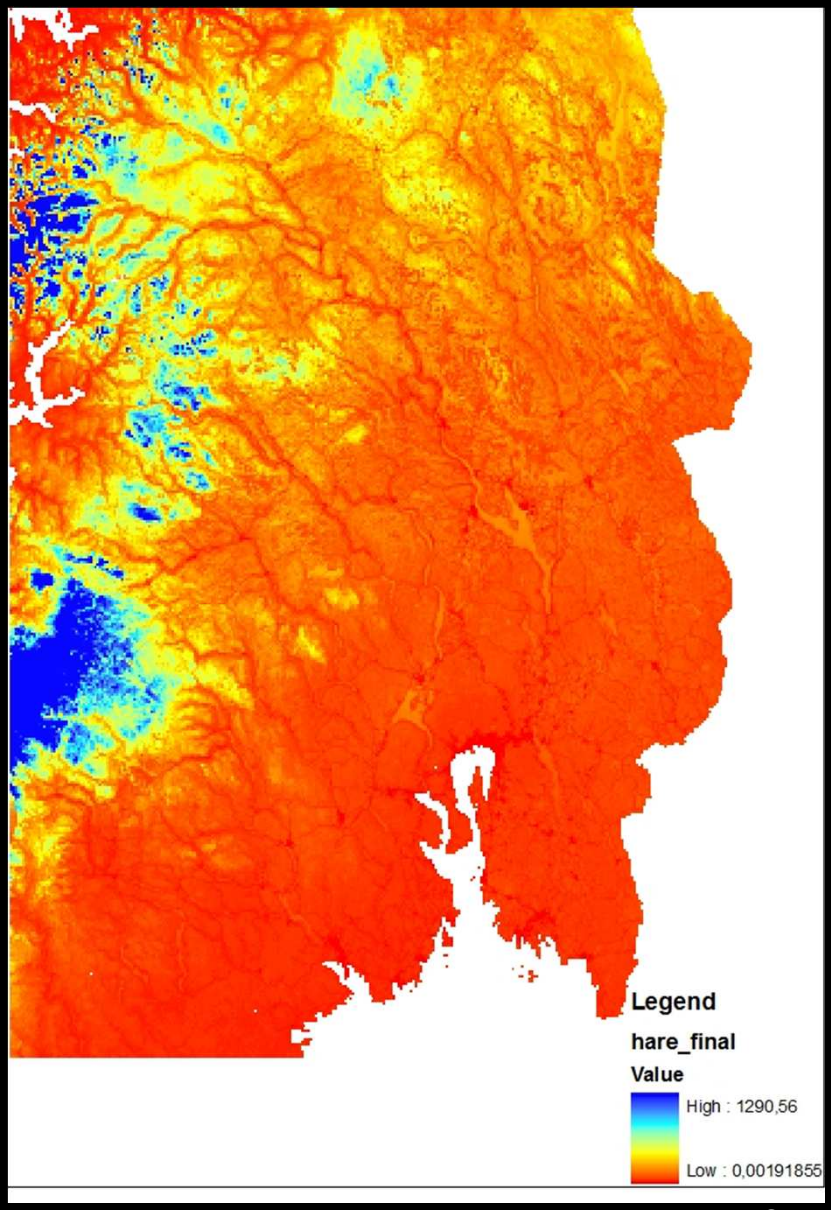

## Red deer



## Moose


Legend
Mo_hurdfor7
Value
High : 10,5946
Low : 0,000208057

## Hare


Legend
hare_final
Value
High : 1290,56
Low : 0,00191855

# Discussion

- **Hurdle models environmental variables conform with what we know of the species**
- **Create maps with pellet count groups and hurdle models**
- **Two validation approaches show that the predictive maps are a good representation of the real density and distribution of each species**

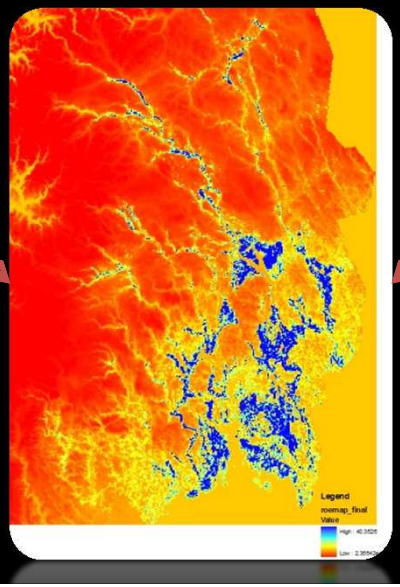
**BUT**

**Very generalist species !**

**Extension of scale → errors**

# Discussion

**Herbivores management in Norway:**




Thanks for your attention

## Source of 0

1. **Structural errors = a bird is not present because the habitat is not suitable.**

2. **Design error = where poor experimental design or sampling practises are thought to be the reason. As an example, imagine counting the number of puffins on the cliffs in the winter. It is highly likely that all samples will be 0 as it is the wrong season and they are all at sea. Another design error is sampling for too short a time period or sampling too small an area.**

3. **Observer error = some bird species look similar, or are difficult to detect. The less experienced the observer, the more likely he/she will end up with zero counts for bird species that are difficult to identify. Alter-natively, the observer may be highly experienced, but it is extremely difficult to detect a tiny dark bird in a dark field on a dark day.**

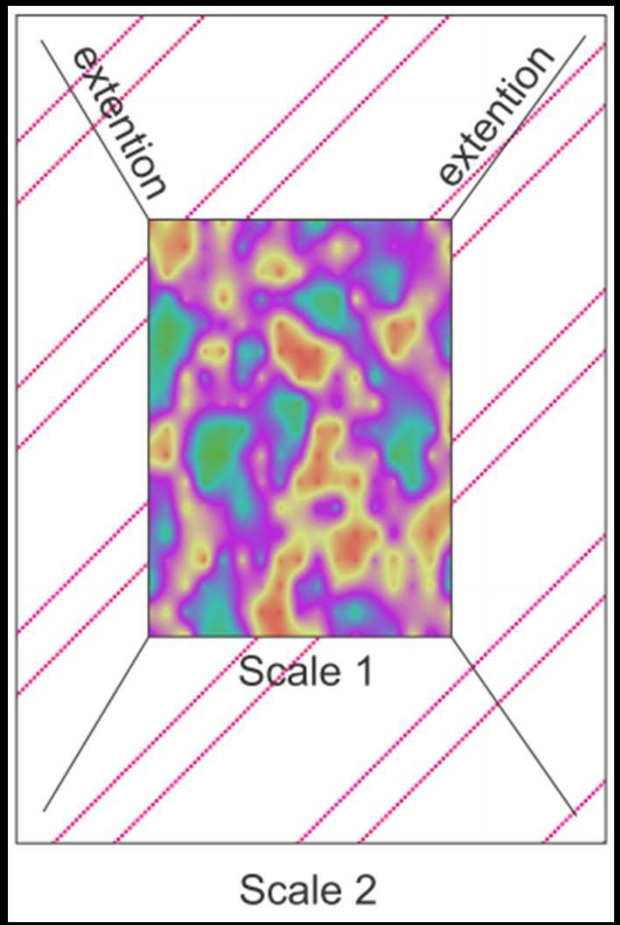
4. **The 'bird' error. This means that the habitat is suitable, but the site is not used.**

# Introduction

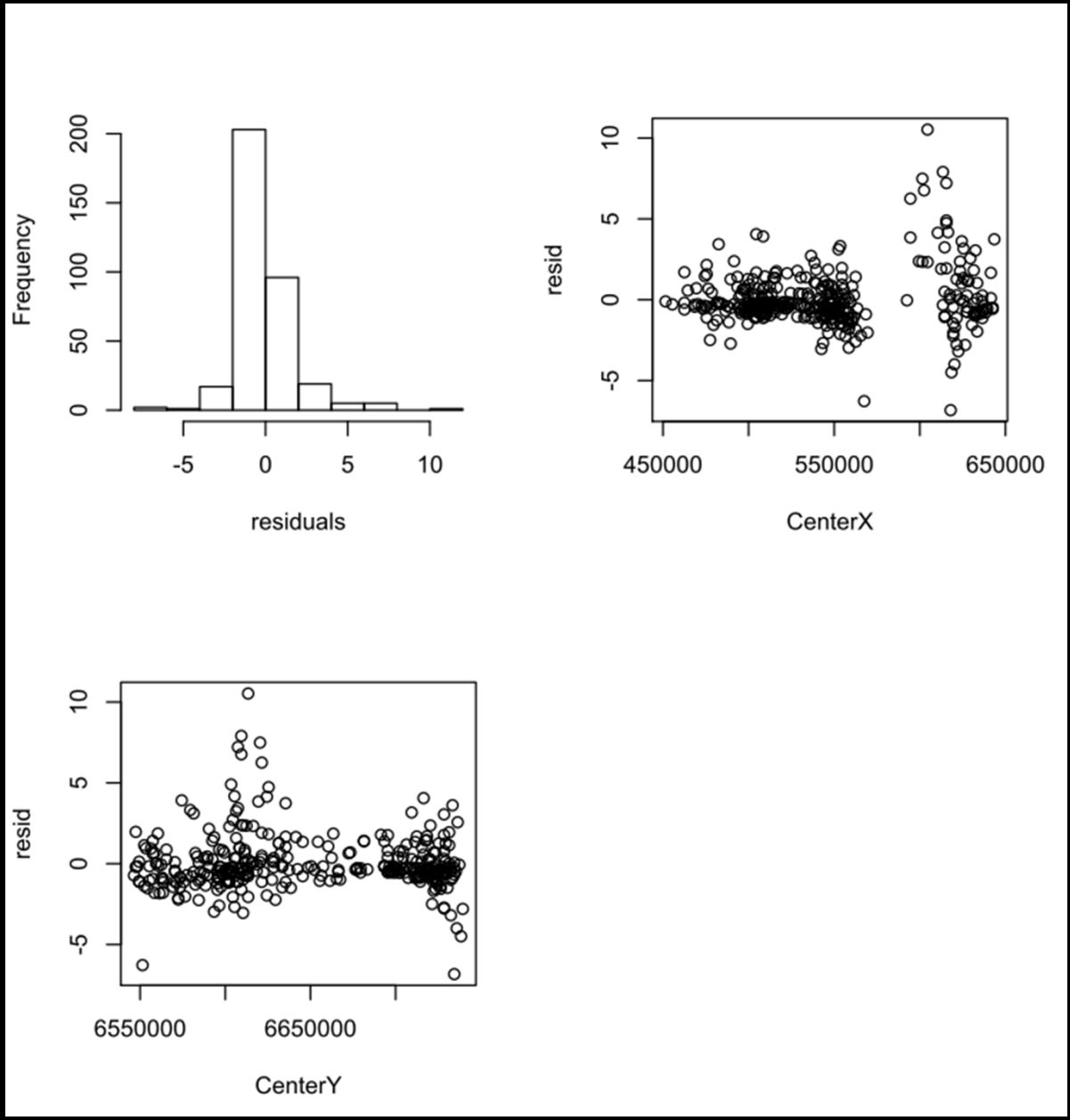
- **Predictive models – Indirect gradients (slope, elevation, aspect…)**

- **Drawback: model applied within a limited geographical extent without significant errors**

- **But: in ecology, it is sometimes necessary to extend a model to a larger scale than the scale of the sampling**



Roe deer


Frequency
0
50
100
150
200
-5
0
5
10
residuals
resid
-5
0
5
10
450000
550000
650000
CenterX
resid
-5
0
5
10
6550000
6650000
CenterY

RMSE is the square root of the variance

In statistics, the **mean squared error (MSE)** of an estimator is one of many ways to quantify the difference between values implied by an estimator and the true values of the quantity being estimated.