MLURI PhD Seminar

Spatial distribution of heather offtake by sheep across heather/grass mosaics.

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Introduction

- create insight into the spatial pattern of herbivore foraging
- Blackface sheep on heather/grass mosaics in upland Scotland
- draw a parallel with urbanization processes
- use a mathematical model to describe the spatial pattern

Spatial distribution of heather offtake by sheep across natural heather/grass mosaics

Heather moorland

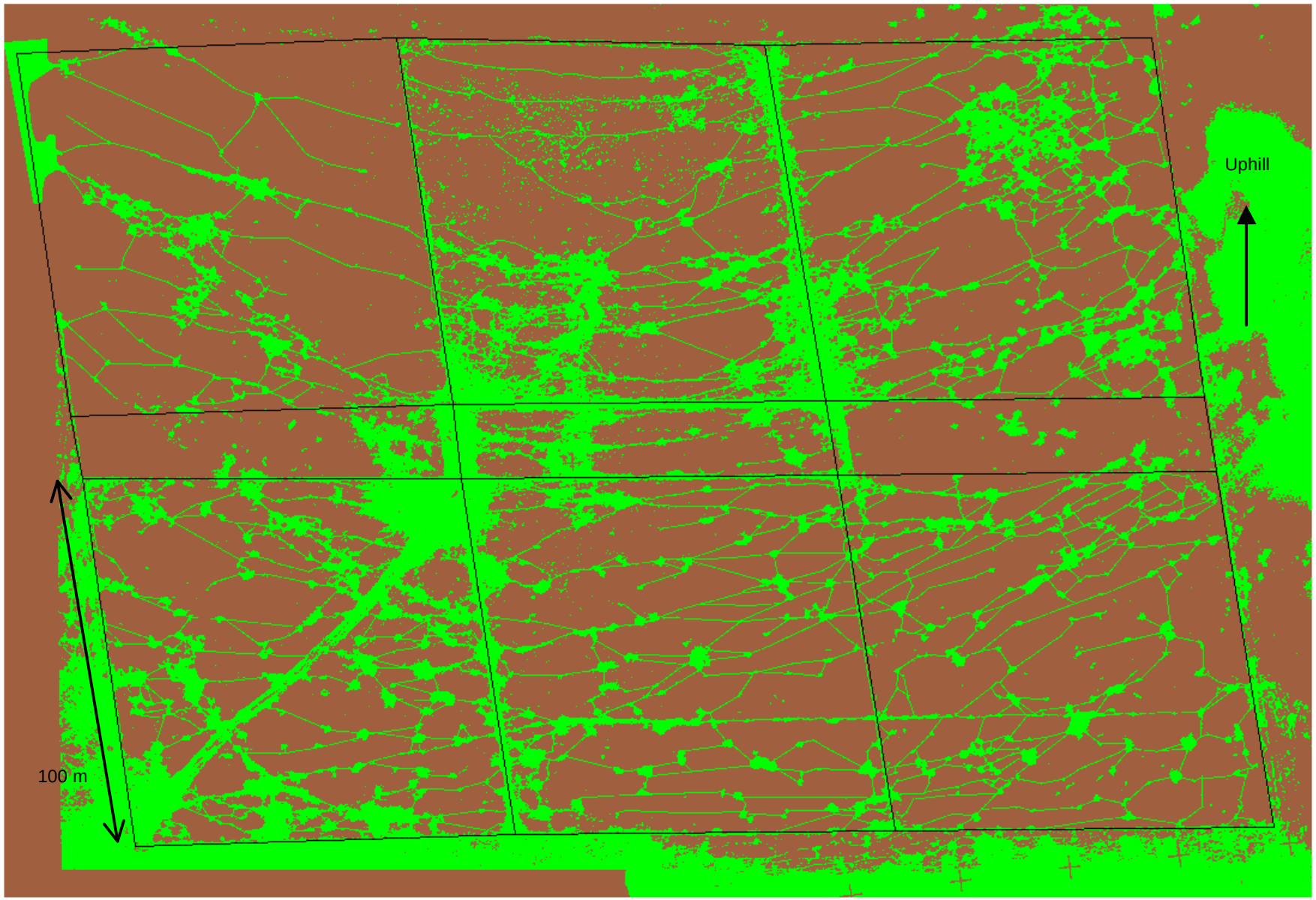
- internationally important natural resource
- management aimed at maintaining heather cover

- grazing management based on '40% rule'
- grazing pressure = number of sheep / hectare

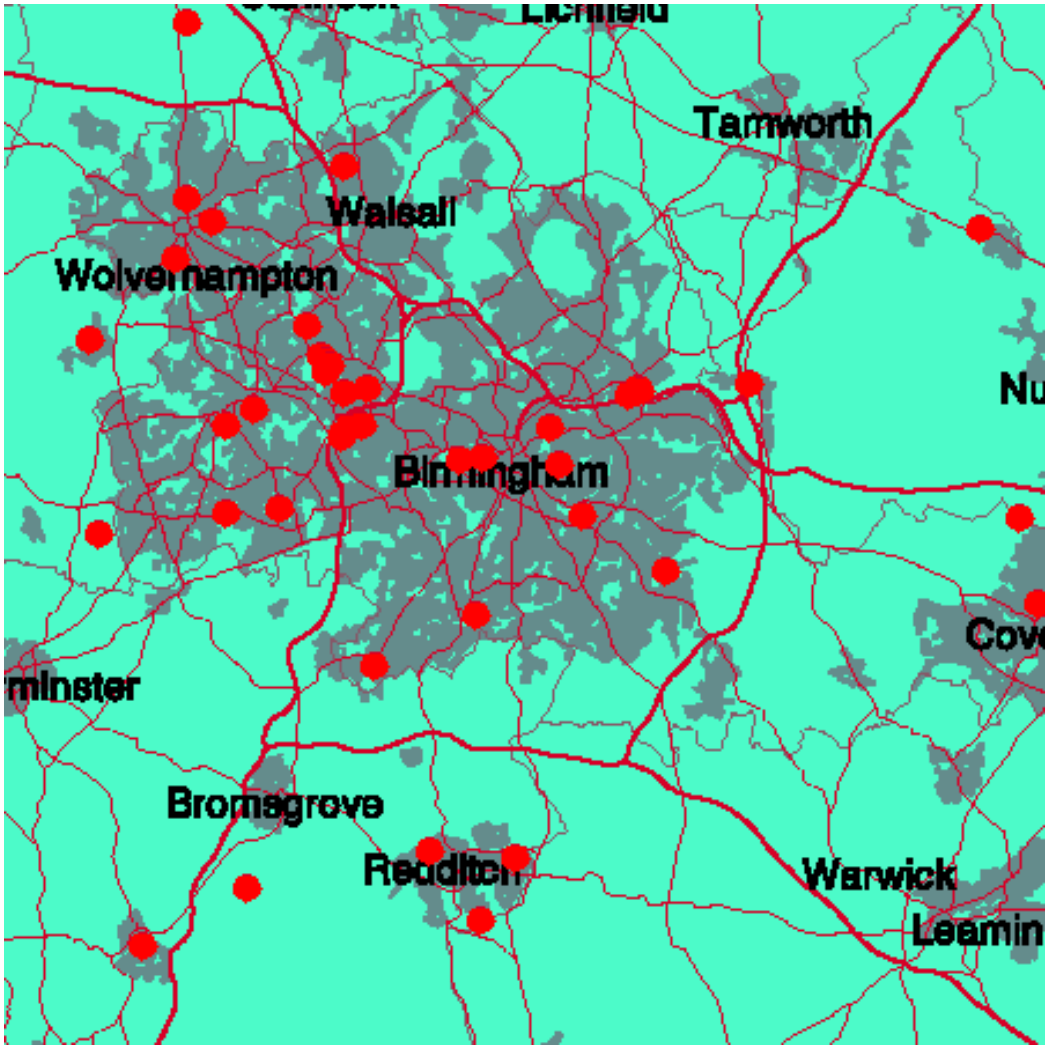
- but: - animals only use part of the landscape intensively
  - high offtake can occur locally even at low stocking densities
- so: - where do animals go in a landscape ?

Plot layout

Spatial distribution of heather offtake by sheep across natural heather/grass mosaics



Urbanization



Economic attraction :

- most people work in city centres
- most people live in or near cities

® number of people per km^2 decreases with distance from the city centres

® number of people per km^2 higher near large cities

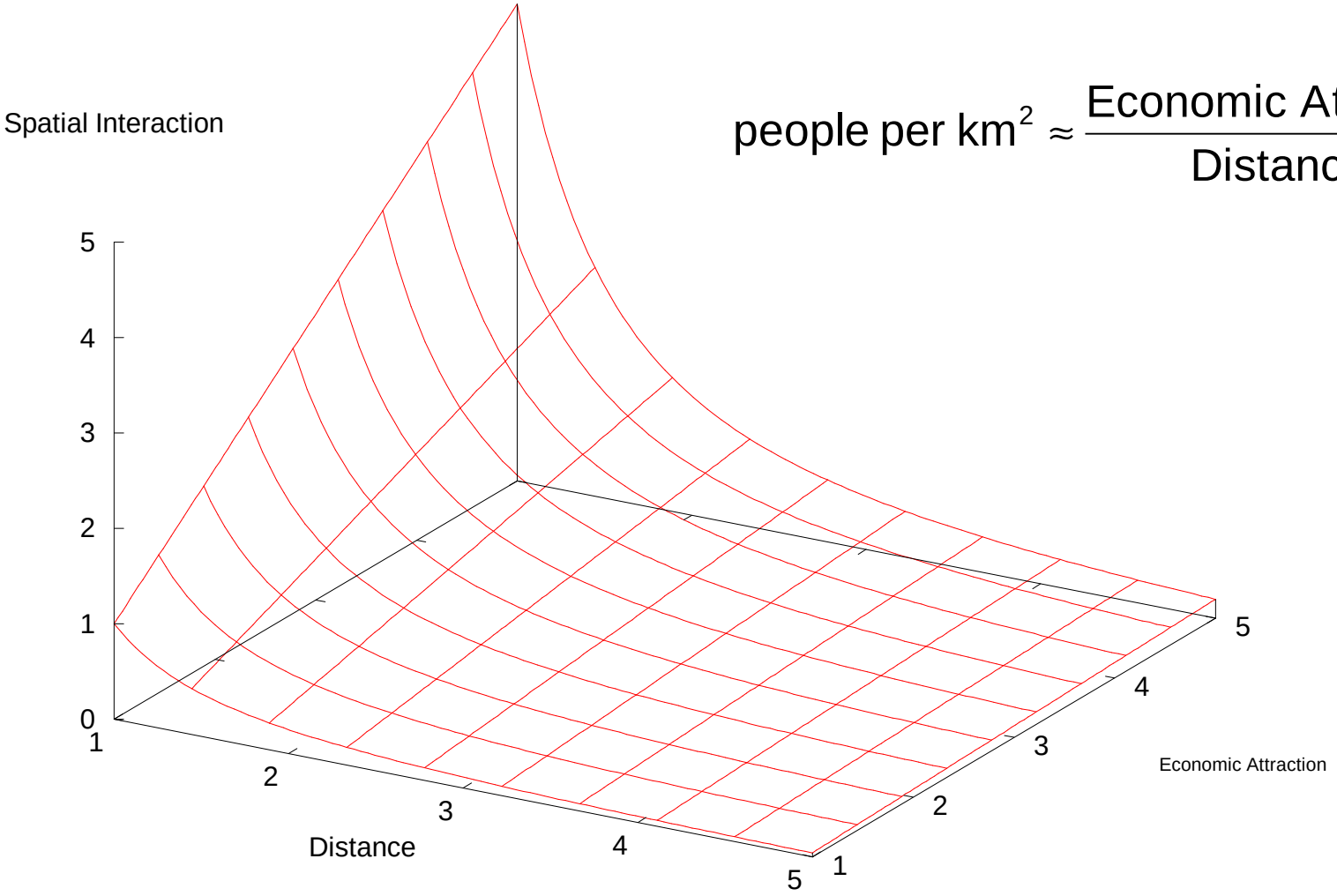
® large cities grow faster than small cities

Spatial interaction model

- process of urbanization described by spatial interaction model (SIM)
- model origin in 'Law of Gravity': $$\text{Force} = \frac{\text{Mass}}{\text{Distance}^2}$$
- model can predict number of people per km^2 :

$$\text{people per km}^2 \approx \frac{\text{Economic Attraction}}{\text{Distance}^2}$$

Urbanization - SIM



$$\text{people per km}^2 \approx \frac{\text{Economic Attraction}}{\text{Distance}^2}$$

Foraging behaviour

- sheep prefer eating grass over heather
  - ® grass patches are the source of attraction
- observations show mixed diet of grass and heather *
- pattern of heather offtake influenced by geometry of grass patches **

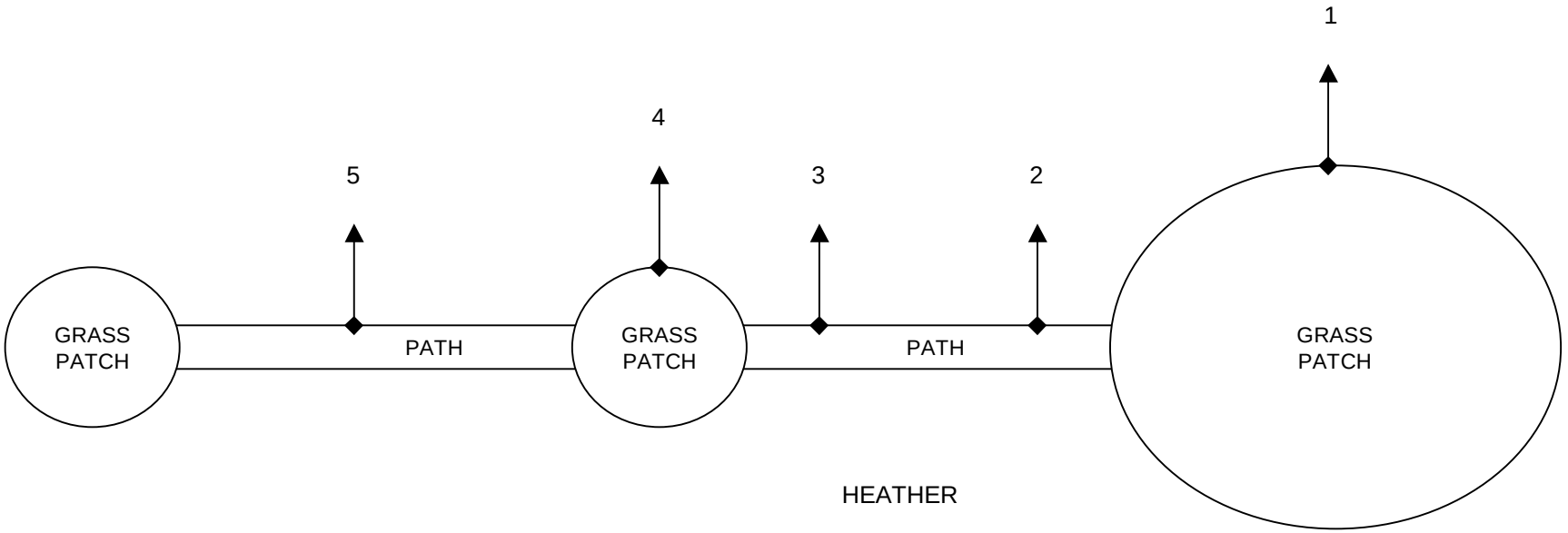
* Milne JA, et al (1978). *Br. J. of Nutr.* 40: 347-357

** Hester & Baillie (1998) J. Appl. Ecol 35: 772-784

Spatial foraging behaviour

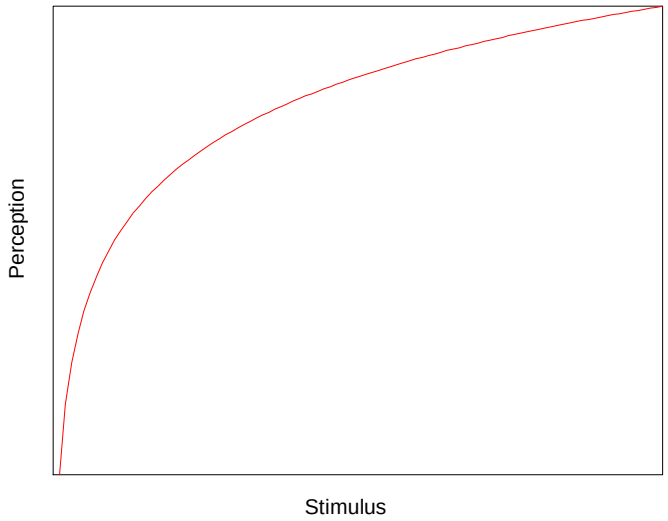
If grass availability determines heather offtake, then :

- offtake higher near *larger* grass patches
- offtake higher *near* grass patches than further away
- relationship different for winter when grass is low

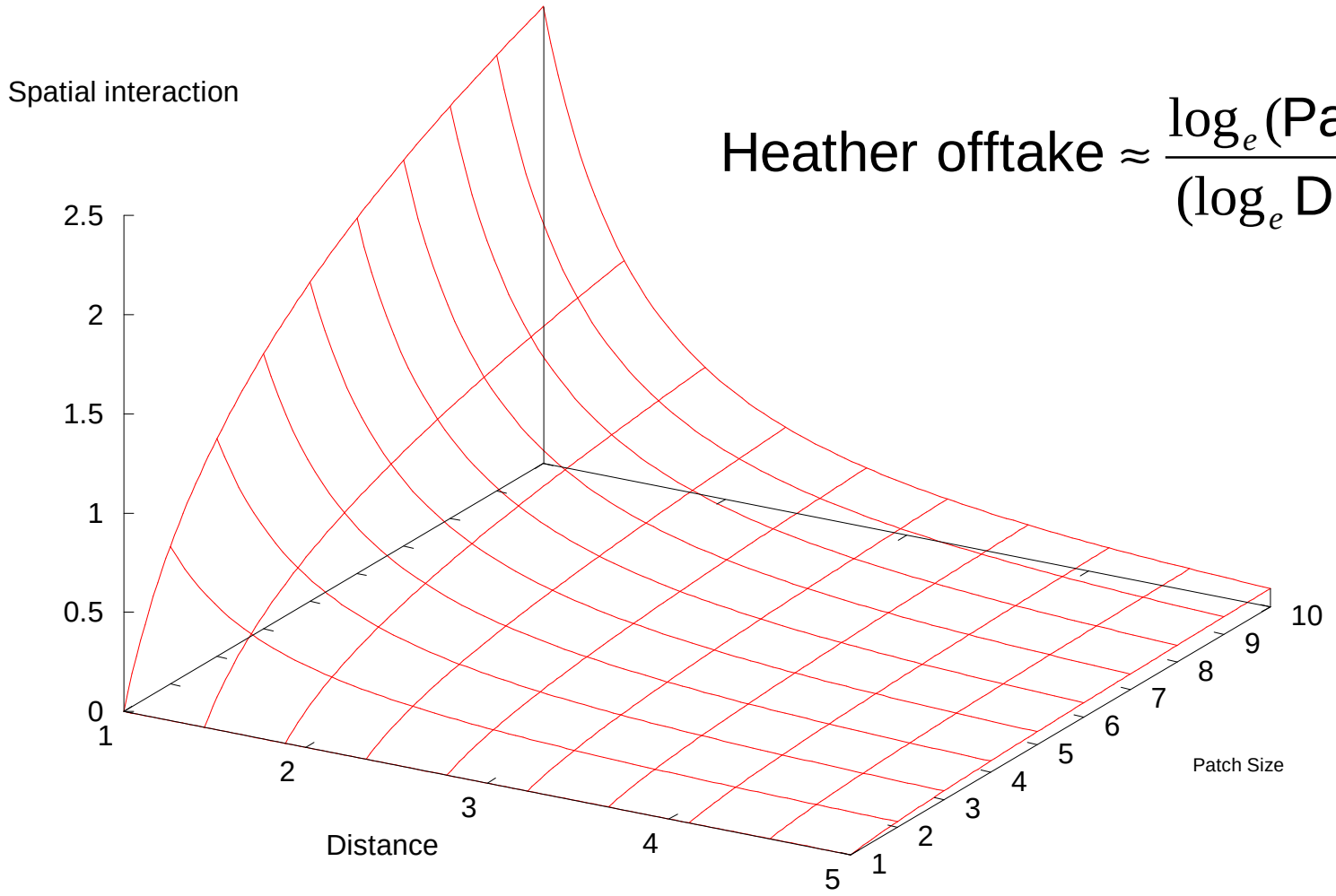


Weber's Law

- model assumes that sheep can estimate patch size and distance
- but Weber's Law predicts that sensory precision decreases with magnitude of stimulus
- we assume a logarithmic relationship between the stimuli (patch size and distance) and sheep perception



Foraging behaviour - SIM



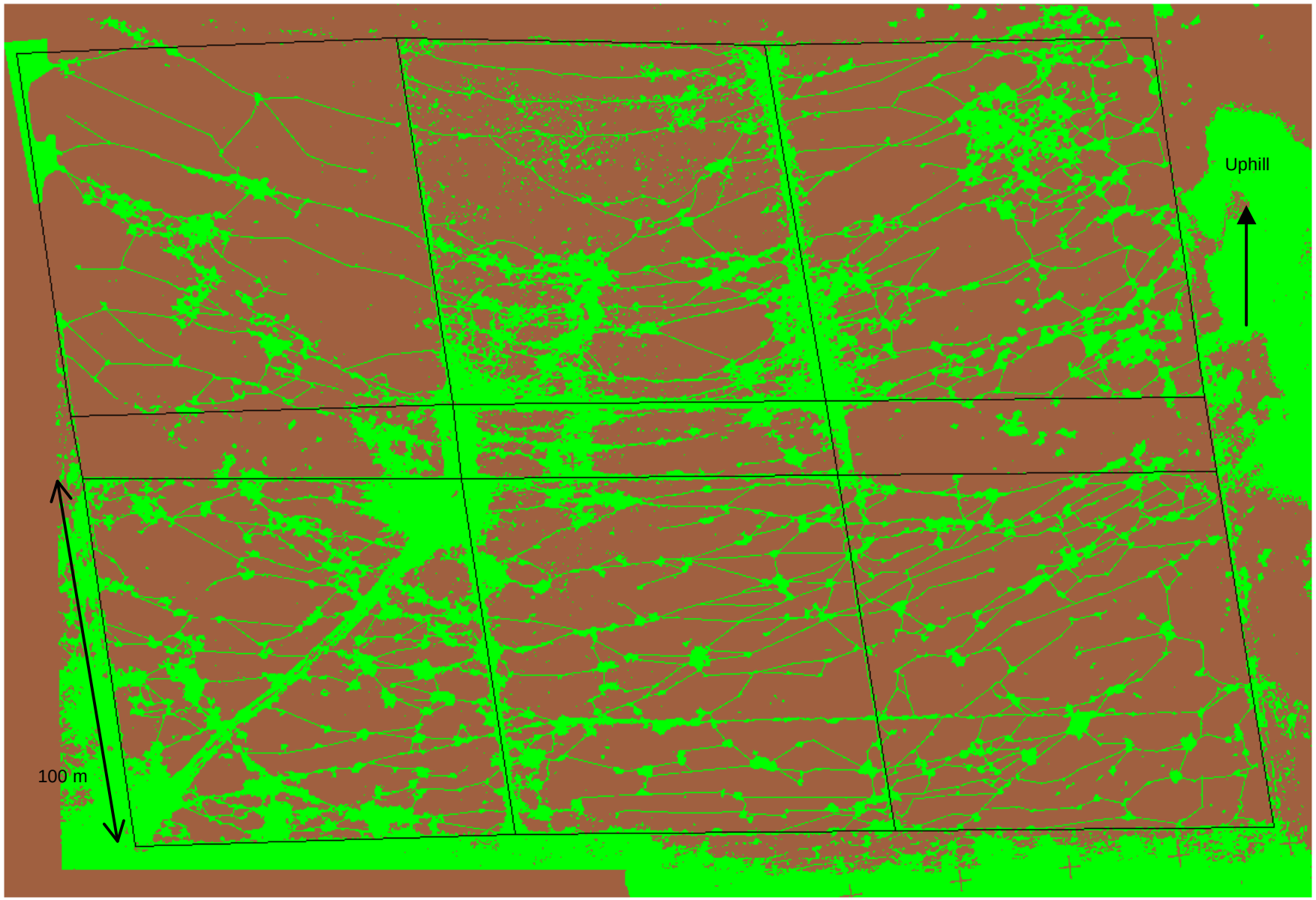
$$\text{Heather offtake} \approx \frac{\log_e(\text{Patch Size})}{(\log_e \text{Distance})^2}$$

Field experiment - Design

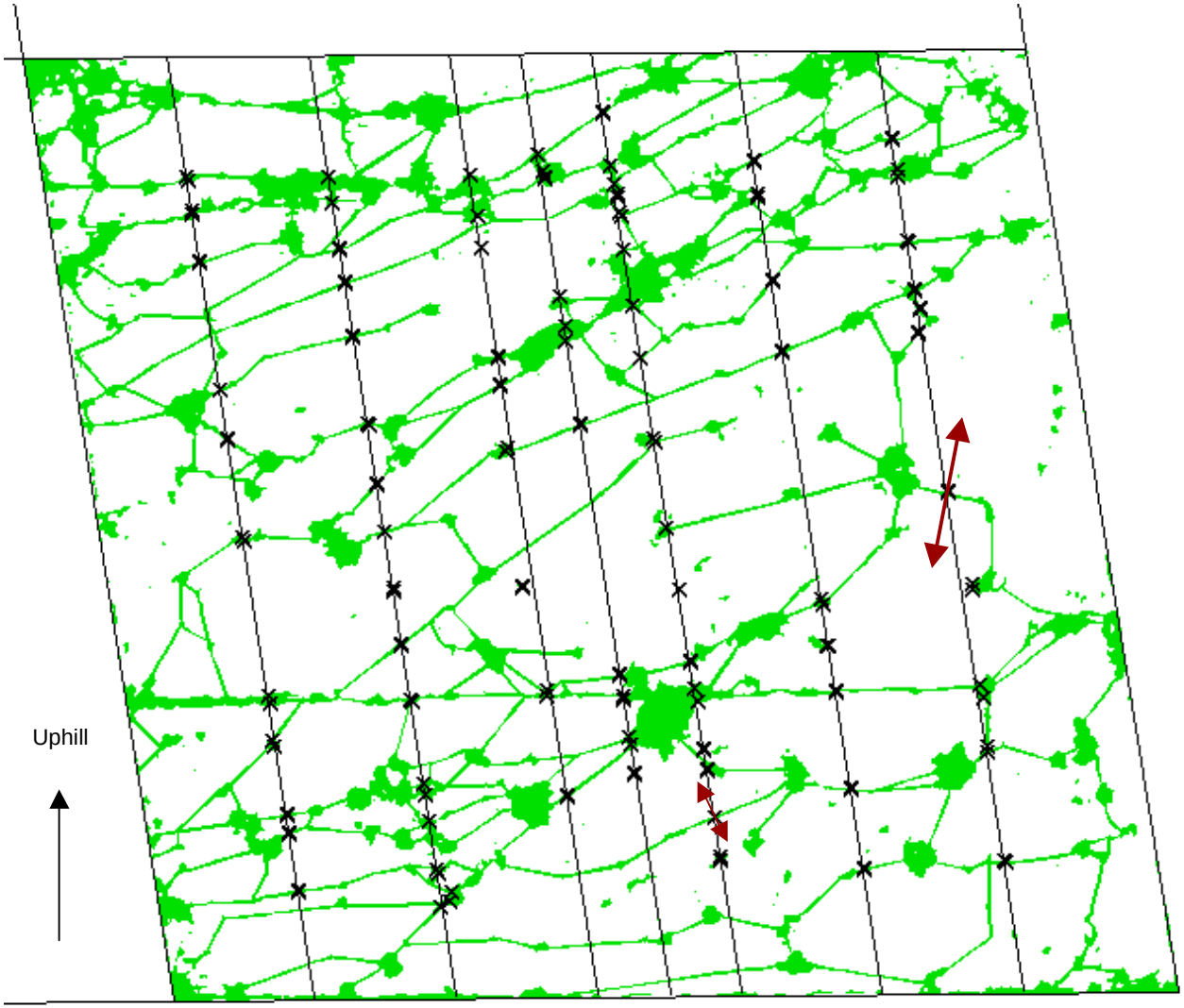
Study site	6 plots of 100 x 100 metres
Duration	3 years
Treatments	Scottish Blackface sheep 2, 3 and 4 sheep per hectare (groups of six, different frequency) year round grazing
Measurements	heather offtake (spring and autumn)

Plot layout

Spatial distribution of heather offtake by sheep across natural heather/grass mosaics



Field experiment - Heather measurements



Transect

- perpendicular to grass/heather edge
- measurement locations:
  0,25,50,75,100,125,150,200,… ,500 (cm)

Location

- 10 shoots
- current years growth
- biomass removed:
  <50% , >50%, >100%
- mean % for 10 shoots

Data collection and analysis

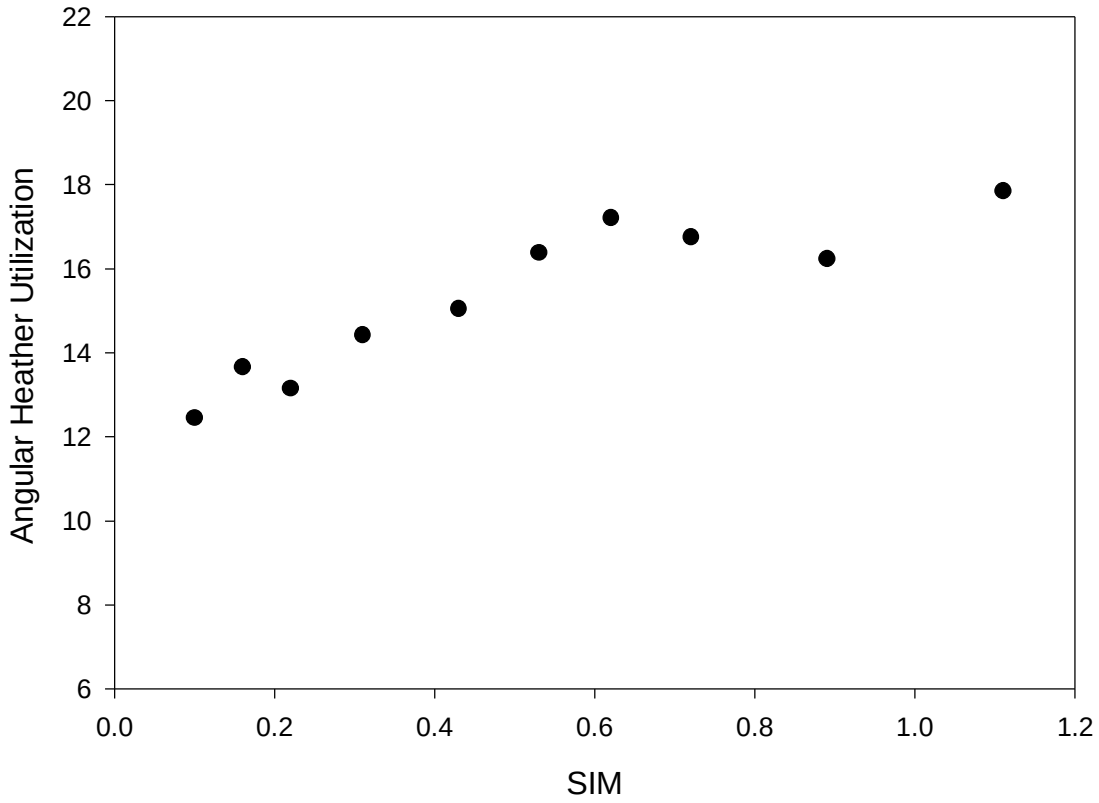
- transect location projected on the vegetation map
- each transect allocated to its nearest grass patch
- measurements :
  - distance to the nearest patch
  - area of the nearest patch
- heather offtake considered for 0, 25, 50 cm

- heather offtake angular transformed *
- experimental design inherently unbalanced
- statistical analysis with Residual Maximum Likelihood method (REML)

* $\text{Angular \% Util} = \frac{180}{p} \times \arcsin\left(\sqrt{\frac{\%\text{Util}}{100}}\right)$

Heather Offtake

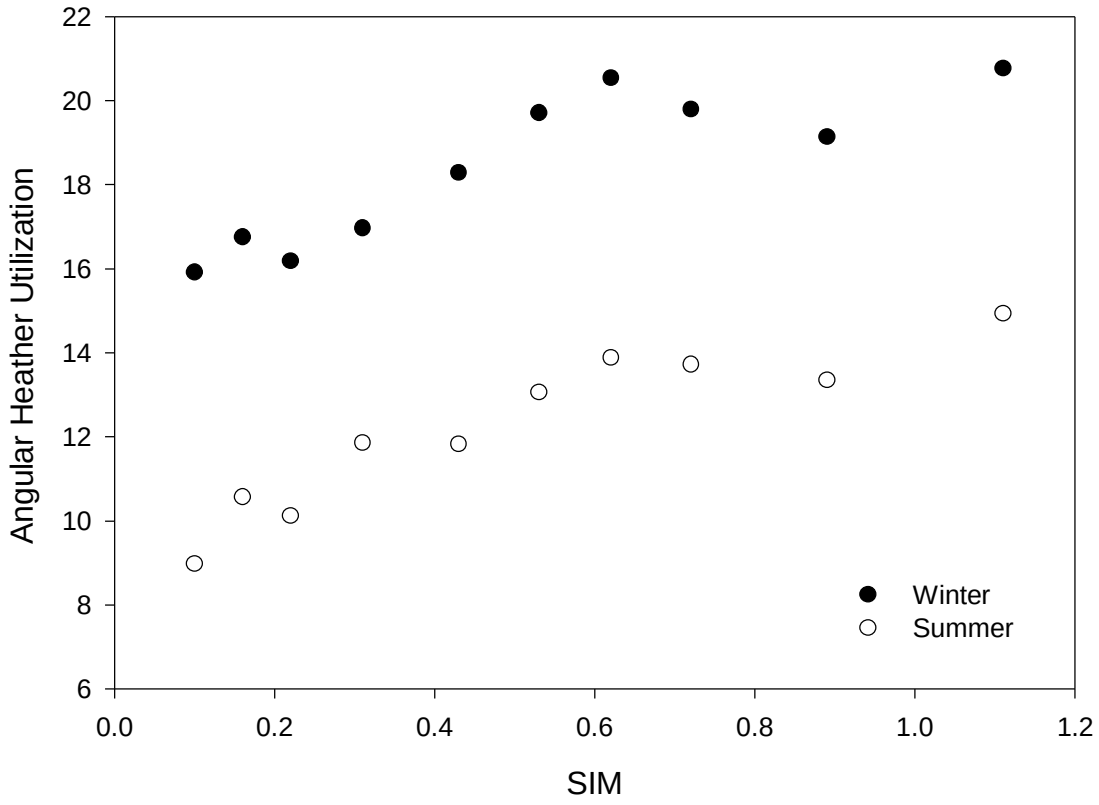
Heather offtake versus spatial interaction model



Effect	p-value
SIM	<0.0001
Sheep Density (SD)	ns
Season	<0.0001

Season Effect

Heather offtake per season versus spatial interaction model



- Pattern similar in summer and winter

Conclusions

- heather offtake is concentrated :
  - on part of the landscape
  - near larger grass patches
- heather offtake can locally be high, even at low stocking density
- pattern driven by grass patches both in summer and winter
- SIM provides description of spatial pattern of heather offtake
- next question :

  What individual foraging behaviour leads to this pattern ?

End

Spatial distribution of heather offtake by sheep across natural heather/grass mosaics