MODELLING & GIS

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What is an ecological model ?

Definition

The description of a natural system using mathematical formula:

- **Response variable = Y (dependent)**
- **Explanatory variables = X (independent)**
- **Coefficients**
- **Exponents**
- **Constants**

[+ Evaluation measures]

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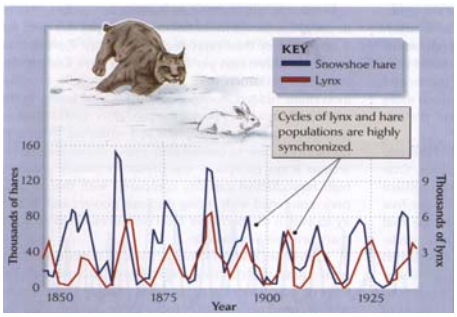
Example of an ecological model: predator & prey cycles



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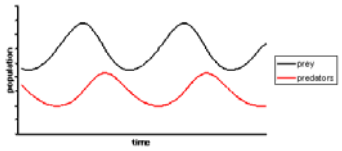
Example of an ecological model: Lotka-Volterra



$$\frac{dx}{dt} = x(\alpha - \beta y)$$

$$\frac{dy}{dt} = -y(\gamma - \delta x)$$

y is the number of predators
x is the number of its prey
t represents time
α, *β*, *γ* and *δ* are coefficients

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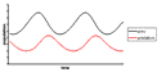
Why model ?

The terms populations, community & ecosystem imply **interaction**.
All things are 'connected' and models can be used to…..

- Improve our understanding of connections by describing relationships & interactions
- Reduce complexity
- Make predictions
  - presence/absence
  - response to impact or change
  - future trend over time
- Interpolate areas of 'missing data'



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How useful is the model ?

Predator-prey oscillations often 'dampened' because….

(i) There are alternative food sources for the predator
(ii) Several predators consume a single prey species

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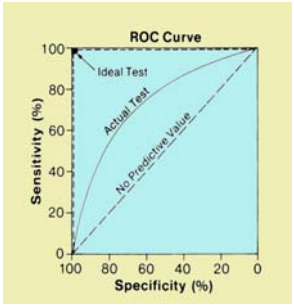
How 'valid' is the model ?

Model evaluation

- Best 'fit' measures
- Split-sample validation
- ROC curves

Many others…….



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Problems with modelling ecological systems

- Often difficult to obtain 'sufficient' measurements across range of conditions
- There can be extremely high variability within and between individuals and conditions
- Most environments are 'open' systems and therefore subject to broad range of conditions often not included as one of the model variables e.g. variation in annual weather pattern

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GIS data: what's the point in starting out ?

We know in ten years…

- Better data
- Higher resolution
- Less uncertainty

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Habitat suitability modelling

Models used to:

1. Identify a ***suitable habitat*** for a species
2. Identify ***potential distribution*** of a species/habitat

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Species distribution models (SDMs)

The most useful modelling technique for conservation !!

Relatively easy to get results with some key knowledge

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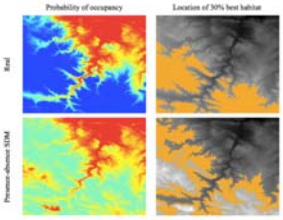
Species distribution models (SDMs)

The most useful modelling technique for conservation !!

- Work on 'presence only' data and then produce maps of ***HABITAT SUITABILITY***
- Provide significant habitat variables associated with species distribution and an evaluation of how good the model is !!



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Species distribution modelling: the software (FREE !!)

MAXENT

- Tested extensively on ecological data
- Relatively easy to use
- Model evaluation

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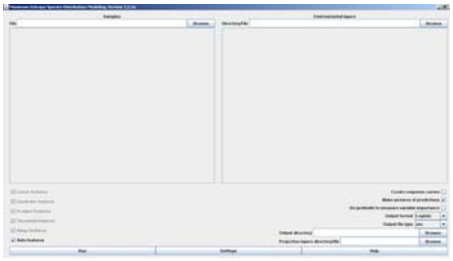
Species distribution modelling: the software (FREE !!)

MAXENT

http://www.cs.princeton.edu/~schapire/maxent/



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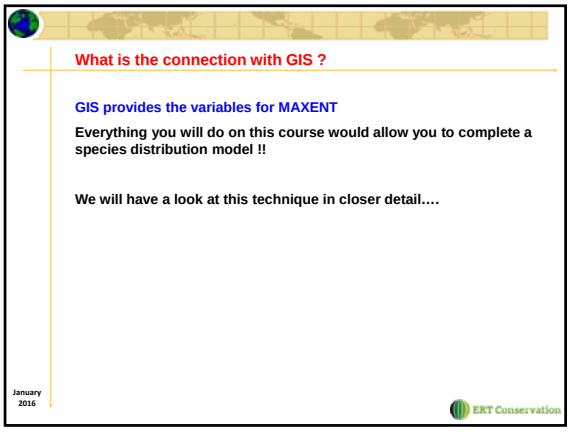
What is the connection with GIS ?
GIS provides the variables for MAXENT
Everything you will do on this course would allow you to complete a species distribution model !!
We will have a look at this technique in closer detail….
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