

SPATIAL DATA MODELLING

A Predictive Model for Identifying the Potential
Location of *Hoplodactylus* in the South Island of
New Zealand



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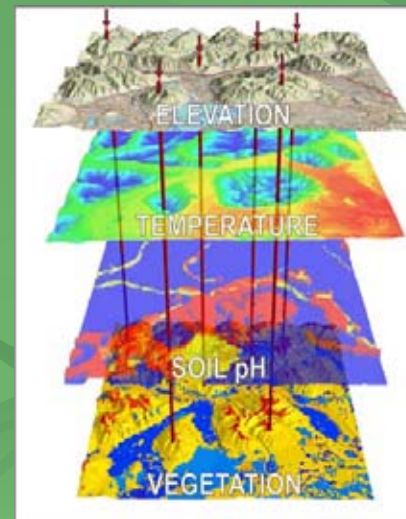
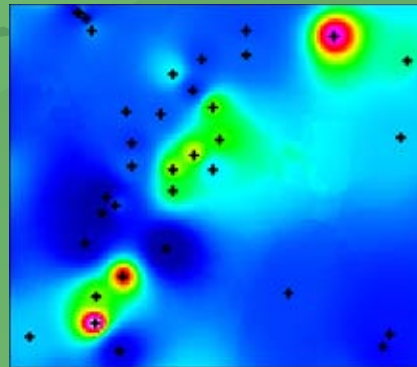
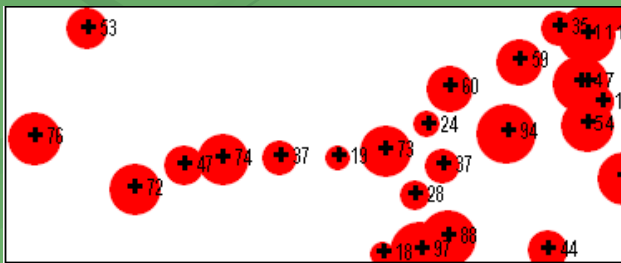
Why undertake spatial modelling?

- Create predictive maps from digital data and maximise the knowledge
- Modelling can be a non-bias view of data
- Save time and money
- Take advantage of digital data, computer power and storage
- Combine spatial data and knowledge



Types of Modelling

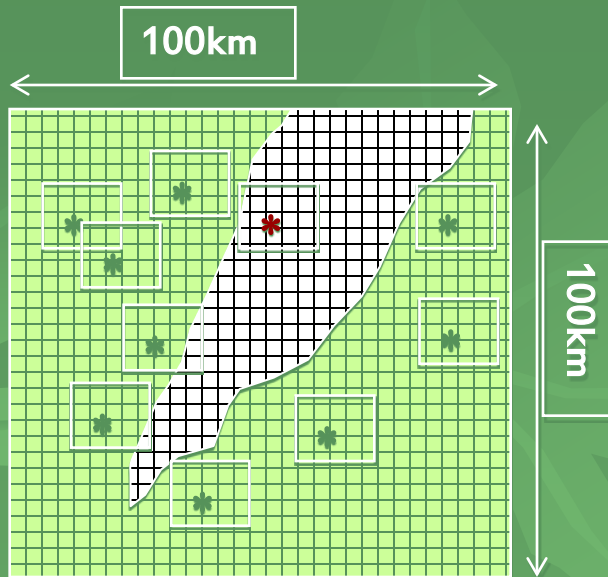
- Illustrated maps – highlight important features
- Single layer modelling using interpolation
- Multi-variable models – fuzzy logic, neural networking and weights of evidence



Weights of Evidence Modelling (WoE)

- Developed from medical industry for use in mineral exploration – Graham Bonham-Carter at Geological Survey of Canada
- Prediction of a “disease” given a list of “symptoms”
- Applied to different types of industries as spatial data has become available (e.g. Energy, Agricultural, Archaeology, Environmental)
- WoE is a probability based method – Bayesian statistical approach





a = total study area (e.g. 10,000 km²)

A = Unit Cell = 1 km² cell

$N(D)$ = number of deposits

$P(D)$ = prior probability

$N(T)$ = total area of study region

$N(B)$ = area of binary theme

$N(\bar{B})$ = area of binary theme not present

$N(T) = N(B) + N(\bar{B})$ (as long as no missing data)

$$W_+ = \ln \frac{N(B \cap D) / N(D)}{N(B) / N(T)}$$

$$W_+ = \ln \frac{P(B | D)}{P(B | \bar{D})}$$

$$W_- = \ln \frac{P(\bar{B} | D)}{P(\bar{B} | \bar{D})}$$

$$W_- = \ln \frac{N(\bar{B} \cap D) / N(D)}{N(\bar{B}) / N(T)}$$

$$W_{s+} = \frac{1}{N(B \cap D)} + \frac{1}{N(B)}$$

$$W_{s-} = \frac{1}{N(\bar{B} \cap D)} + \frac{1}{N(\bar{B})}$$

$$C = (W_+) - (W_-)$$

$$C_s = \sqrt{(W_{s+}) + (W_{s-})}$$

$$StudC = C / C_s$$

When unit cell inf. small



Correlation of Themes

$$W_+ = \text{natural log} \frac{\text{Proportion of deposits on theme}}{\text{Proportion of total area occupied by theme}}$$

$$W_- = \text{natural log} \frac{\text{Proportion of deposits not on theme}}{\text{Proportion of total area not occupied by theme}}$$

$W_+ > 0$ indicates positive association with theme

$W_- < 0$ indicates negative association with non-theme

$C > 3.0$ Strong correlation

$C 1.0 - 3.0$ Moderate correlation

$C < 1.0$ Weak to poor correlation



The Hoplodactylus Model

- Identify possible locations of Hoplodactylus in the South Island
- Develop a predictive map
- Conservationist can view all data together in context of each variable's relative importance



Probability Mapping in the South Island

- WoE modelling has been highly effective in mineral exploration and geo-hazard identification e.g. Crown Minerals
- Identified features important for *Hoplodactylus* habitat
- Model used coarse scale data already held by Kenex
 - LENZ
 - NIWA
 - GNS Science



Spatial Correlation Analysis and Results

- Training Points
- Study Area
- Spatial Correlations



Training Points

- WoE requires training data to test correlations with spatial data
- 21 point training data set
- Locations of four taxa
 - *Hoplodactylus* "Cascades"
 - *Hoplodactylus* *cryptozoicus*
 - *Hoplodactylus* *kahutarae*
 - *Hoplodactylus* "Roys Peak"



Study Area

- South Island
- Grid size – 100 x 100m
- Unit cell – 10km²



Properties impacting Hoplodactylus

- Climate
- Soil
- Vegetation
- Elevation and Slope



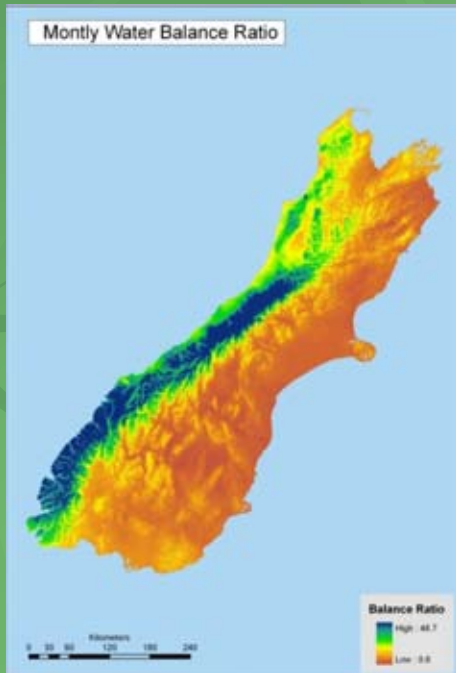
Spatial Correlations

- Twenty-four layers were tested for spatial correlation
- The habitat of *Hoplodactylus* Geckos is spatially associated with climate, soil and geographic themes
- Ten layers were used in final model



Monthly Water Balance Ratio

- Low-Moderate (2.5-8.6) and Very high (16-26)
- Spatial Correlation - 2.85



Vegetation Type

- Types of Vegetation:
 - Alpine grass and rocks
 - Sub Alpine shrubland
 - Herbaceous fresh water vegetation
 - Tall tussock grassland
- Spatial Correlation – 2.62



Soil Type

- Bare Rocks and Loam
- Spatial Correlation – 2.5643



Parental Material Particles Size

- High Size (classes 4 and 5)
- Spatial Correlation – 2.4809



Soil pH

- Soil pH > 5.2
- Spatial Correlation – 2.2104



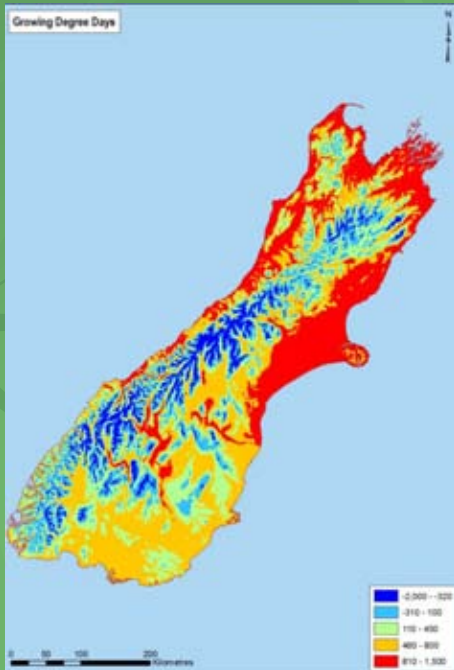
Annual Mean Temperature

- Between 1.1 and 6.56°C
- Spatial Correlation – 2.2104



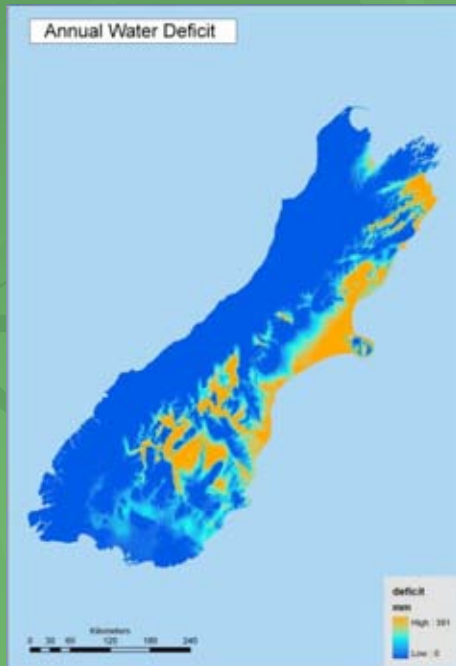
Growing Degree Days

- -983 - 105
- Spatial Correlation – 2.16



Annual Water Deficit

- Deficit of 0mm
- Spatial Correlation – 2.0977



Elevation

- Elevation higher than 727m
- Spatial Correlation -1.72



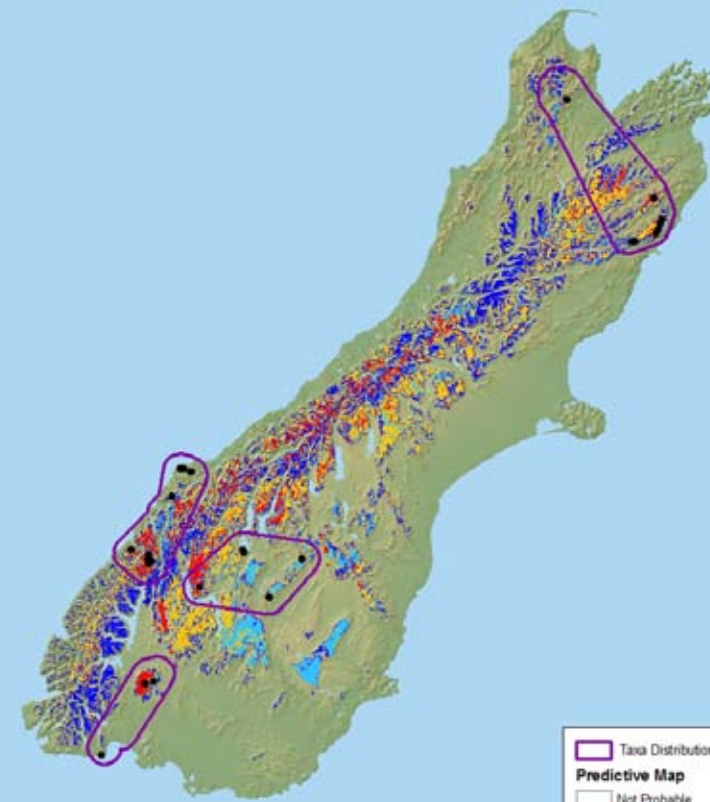
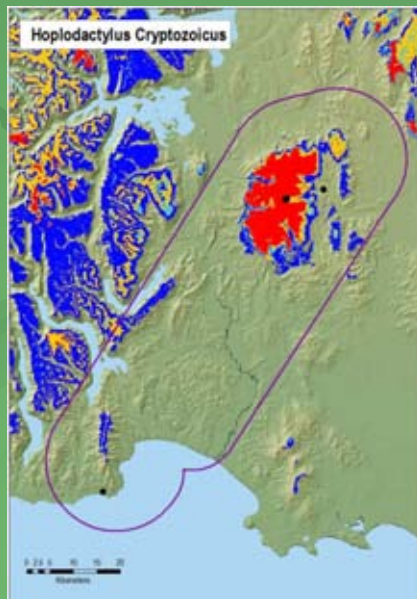
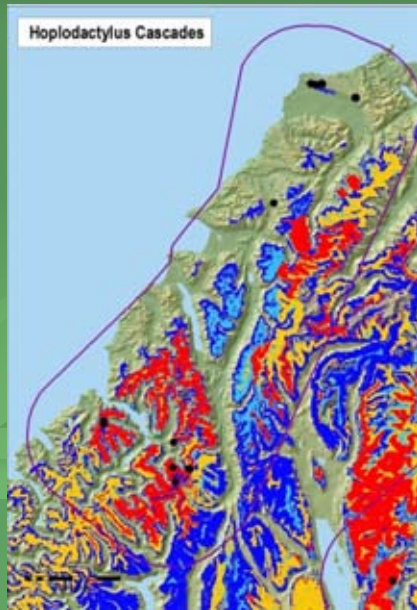
Slope

- Between 17 and 76 degrees
- Spatial Correlation – 1.6846

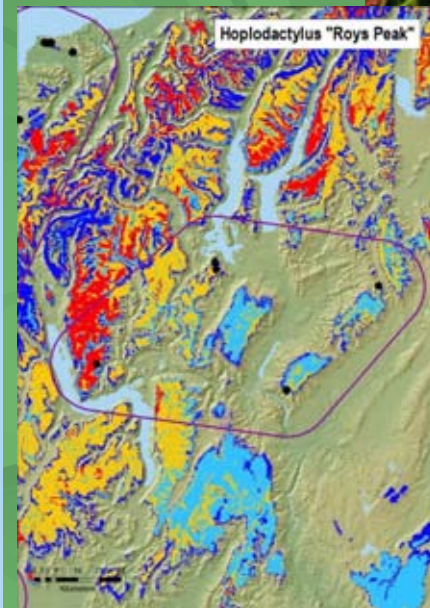
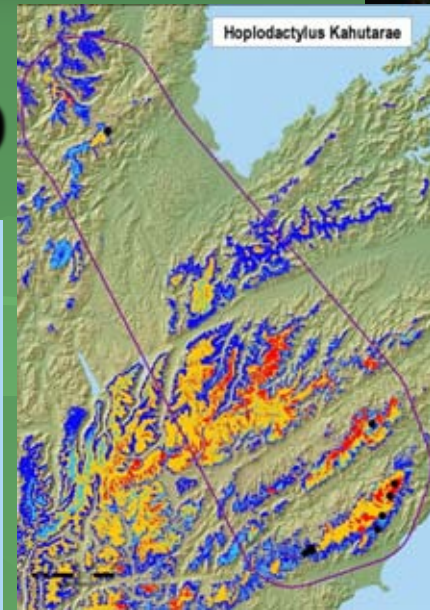


Final Predictive Map

South Island Hoplodactylus Geckos
Predictive Map



0 30 60 120 180 240
Kilometers



Future Work to Improve Model

- Expert input from DOC
- Higher resolution data
- Smaller study area
- Model individual taxa?
- Incorporate food source layers

