GIS research for biodiversity management and animal welfare

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Introduction

- 80% of All Data contains some reference to location (Franklin & Hane, 1992)
- IUCN/UNEP/WWF : "conserving biological diversity equals conserving ecosystems".
  - “Where are such ecosystems and how one is important in comparison to another?”
  - “How are species distributed geographically given its ecological space?”
GIS at the Department of Natural Sciences

• Digital Elevation Model (DEM) of islands for Biodiversity Management Research
• Species Distribution Modeling/Environmental Niche Modeling (SDM/ENM) for Biosecurity
• Spatial Analysis for Animal Welfare
Motu Kaikoura

Long Term Biodiversity Monitoring
Environmental Studies
Visualization capabilities

3D: satellite image “draped” over surface model
SDM approaches used

• Additive modeling
  – Ranked environmental factors according to suitability
  – Converted to Rasters
  – Overall suitability = Sum of Ranked value of cells

• Maximum entropy modeling (Phillips et al., 2006)
  – Machine learning approach
  – Estimate the relationship between species records at sites and the environmental and/or spatial characteristics of those sites (Franklin, 2009).
GIS Research for Biosecurity and Animal Welfare

2010

• Pacific Northern sea star (*Asterias amurensis*)
• Yellow crazy ant (*Anoplolepis gracilipes*)
• Rosy wolf nail (*Euglandina rosea*)
• Annual NETS 2011 Conference of the Biosecurity Institute in Takapuna – 4 Posters and 1 Oral Presentation

2011

• Maximum Entropy Modeling
• Indian House Crow (*Corvus splendens*)
• Stray Cats and Cat Colonies (*Felis catus*)
Marine Invasive Species: Northern Pacific sea star
(Asterias amurensis)

- Feeds on wild and farmed shellfish and a wide variety of other marine animals
- Serious impact on aquaculture and marine environment
- Found in Australia (Derwent Estuary in Tasmania and Port Philip Bay, Melbourne)
- Impossible to exterminate
- Modeled using OBIS and occurrence records
  - Worldwide
  - New Zealand waters with hypothetical initial occurrence sites

Creative Commons Image Ref:
Maxent model for A. *amurensis*

Suitability of New Zealand Waters if species is introduced and establishes itself at several Ports

Environmental Layers Used:
1. Depth
2. Sedimentation
3. Slope
4. Sea Surface Temperature
5. Tidal Current Velocity
Terrestrial invasive species

- One of five ants in world’s 100 worst invaders
- Found in South Pacific islands and tropical Australia

Threats to native snails
- Contributed (>50%) to extinction of tree snails in French Polynesia

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Indian House Crow

• Model 1: occurrence record from Australia and Bioclim layers (Maxent)
• Model 2: initial entry sites (Ports) in New Zealand and Bioclim layers (Maxent)
• Model 3: selected environmental layers (Additive Model)
Results

Model 1: Occurrence record from Australia and Bioclim layers (Maxent)

Model 2: Initial entry sites (Ports) in New Zealand and Bioclim layers (Maxent)

Model 3: Addition of ranked layers (Elevation, Temperature, Landcover and Population)
Stray Cats

• Most common pet
• Strays considered as pests
  – Threats to the native avifauna
  – Animal welfare issues
• Processing for GIS
  – Geocoding – from ordinary (SPCA March 2010-March 2011) data to GIS
  – Basemap development
  – Spatial distribution
• Exploratory spatial analysis
  – Global and local regression
  – Hotspot analysis
  – Geographical weighted analysis for social parameter correlation
Geocoding
Stray Cat Density (counts/km$^2$)

Aggregated Data from: March 2010-2011

Higher Densities in South Auckland
Global regression analysis (Moran’s I)

Results:
Moran's Index: 0.085825
z-score: 2.292071
p-value: 0.021902
Anselin’s Local Moran I

Significant clustering of Stray Cats in South Auckland
Stray Cat Density VS NZDI

• NZDI – New Zealand Deprivation Index 2006 (Salmond et al., 2007) - combines nine variables from the 2006 census which reflect eight dimensions of deprivation
  – Income: People aged 18-64 receiving a means tested benefit and People living in equivalised* households with income below an income threshold
  – Owned home: Support
  – Employment: People not living in own home
  – Age: People aged <65 living in a single parent family and People aged 18-64 unemployed
  – Qualifications: People aged 18-64 without any qualifications
  – Living space: People living in equivalised* households below a bedroom occupancy threshold
  – Communication: People with no access to a telephone
  – Transport: People with no access to a car

• Processed using GIS Tools OLS (Ordinary Least Squares) and GWR (Geographically Weighted Regression)
Results of SC Density vs Population Weighted NZDI

• Shows positive correlation

• GWR has better modeling results than OLS using the Akaike’s Information Criterion (AIC) with Difference > 3)
  – OLS: 1105.79
  – GWR: 1095.57
Cat Colonies

Density distribution
Ecological Niche Modeling using Maxent
Future Work

• Distribution of other species of importance
  – Biodiversity indexing
  – Endangered species mapping/SDM
  – Current issues (diseases, climate change effects, conservation priorities)

• Ecosystem vulnerability

• Networks of protected areas

• Risk management