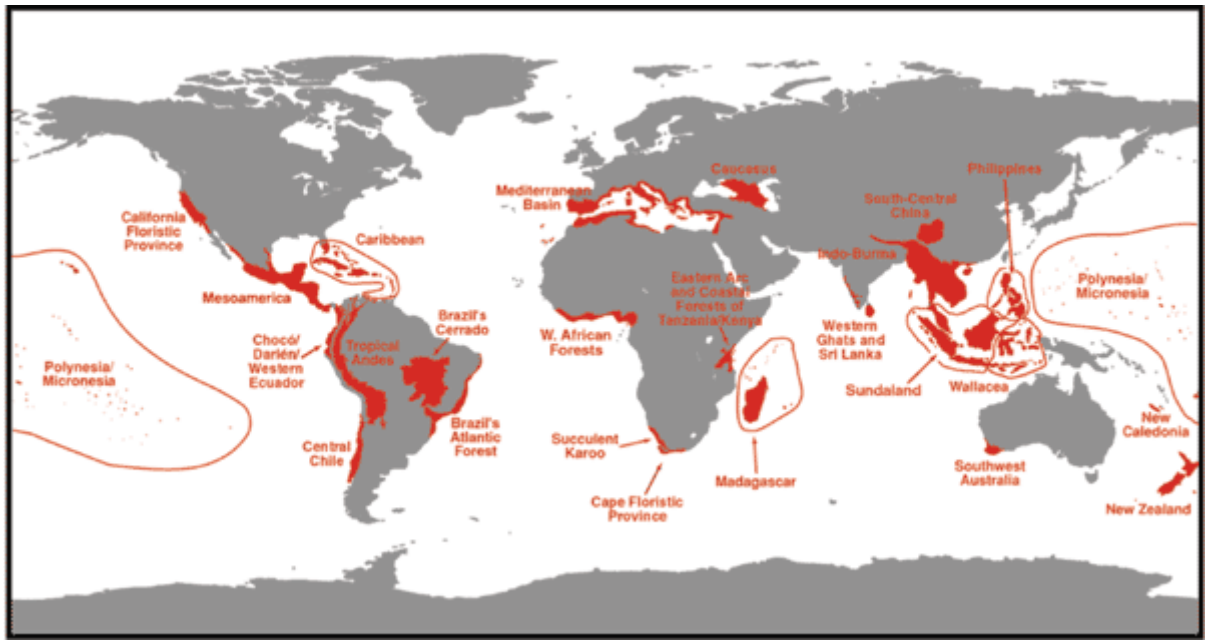

Regional and National Biodiversity Modelling and Analysis

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Albertus G. Toxopeus

ITC, The Netherlands

Measuring biodiversity

Diversity is like an optical illusion: The more it is looked at, the less clearly defined it appears to be

Diversity is hard to define because it consists of two components

- Species richness (number of species)
- Relative abundance of species

Most investigations are restricted to species richness

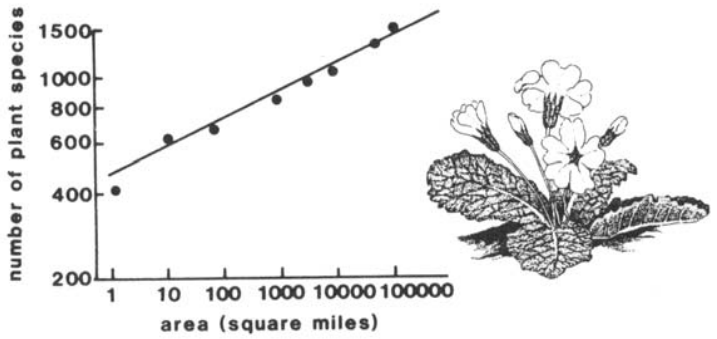
What is Biodiversity?

Biological diversity is defined as the variability among living organisms

- –Within species (alpha)
- –Between species (beta)
- –Of ecosystems (gamma)

Measuring biodiversity

The number of species invariably increases with sample size and sampling effort



Measuring biodiversity

Diversity indices

A number of indices have been developed using some combination of **S** (number of species recorded) and **N** (total number of individuals, summed over all S species).

$$D_{\mathrm{Mg}} = (S-1)/\ln N$$

Margalef's diversity index (Clifford and Stephenson, 1975)

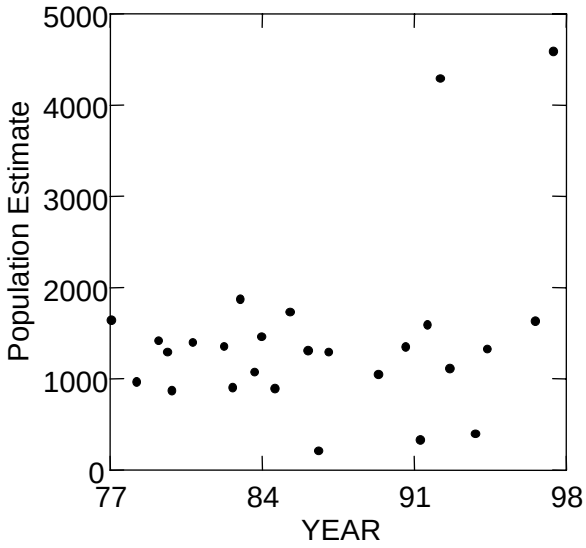
$$D_{\mathrm{Mn}} = S/\sqrt{N}$$

Menhinick's index (Whittaker, 1977)

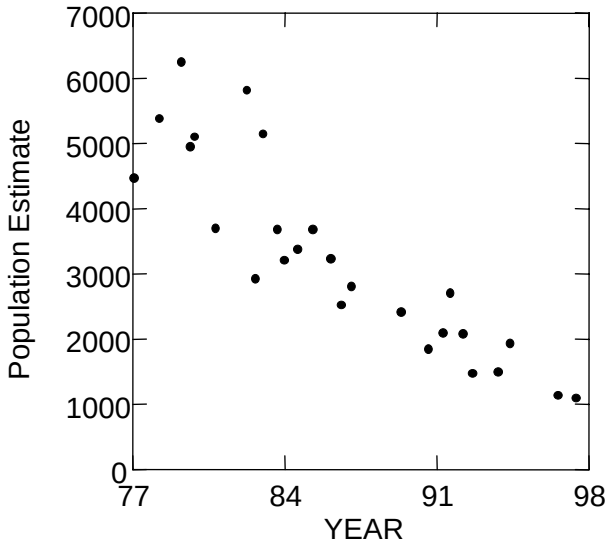
The advantage of this is the ease of calculation

Wildlife decline in Kenya

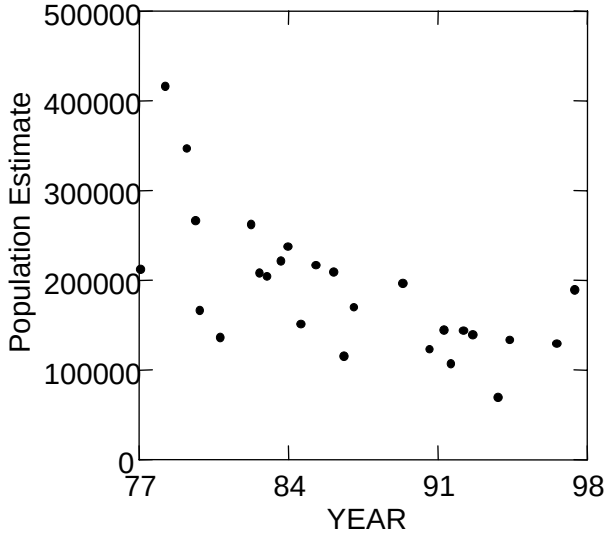
ELEPHANT TRENDS



GIRAFFE TRENDS

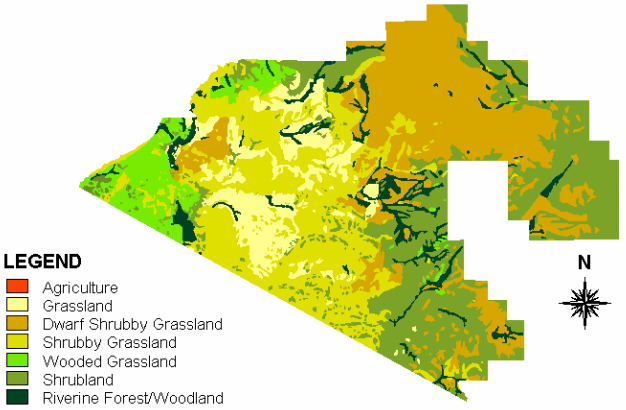


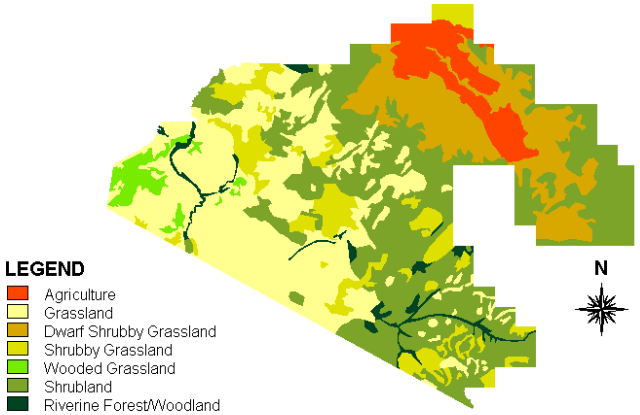
NON-MIGRATORY WILDLIFE TRENDS



Cause of the wildlife decline in Kenya

1975



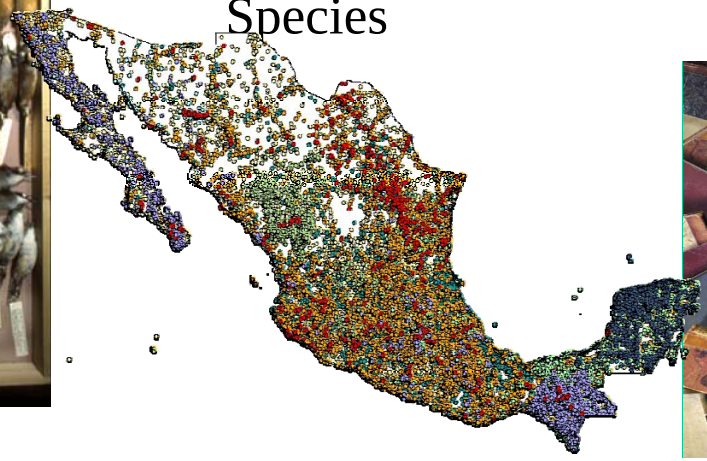


1995

To develop sustainably, we need biodiversity data to develop models :

Under-utilized information

- 250 years of published information
  - Taxonomic studies, Herbarium collections, Field studies – plot/obeservation based, Species lists, Research projects, Atlas/environmental profiles, Amateurs, Environmental indicators
- ~2 billion museum specimens
- Unconnected networks of experts
  - Kenya – meta-analysis
  - Asia; Europe - IUCN Red List of Threatened Species



Documenting the status of biodiversity

- International agreements to document biodiversity & minimise human impacts:
  - Convention on Biological Diversity (CBD)
  - RAMSAR convention on wetlands of international importance
- Bind parties to integrate biodiversity considerations into decision making for sustainable development
- Implicit in these agreements are international interactions

Biodiversity Exchange and Storage

- CBD Clearing House Mechanism (CHM)
  - "…develop a global mechanism for exchanging and integrating information on biodiversity…"
- GBIF Global Biodiversity Information Facility
- ENBI European Network for Biodiversity Information
- ARCBC ASEAN Regional Centre for Biodiversity Conservation
- IABIN Inter-American Biodiversity Information Network

Systematic data collection, management & distribution

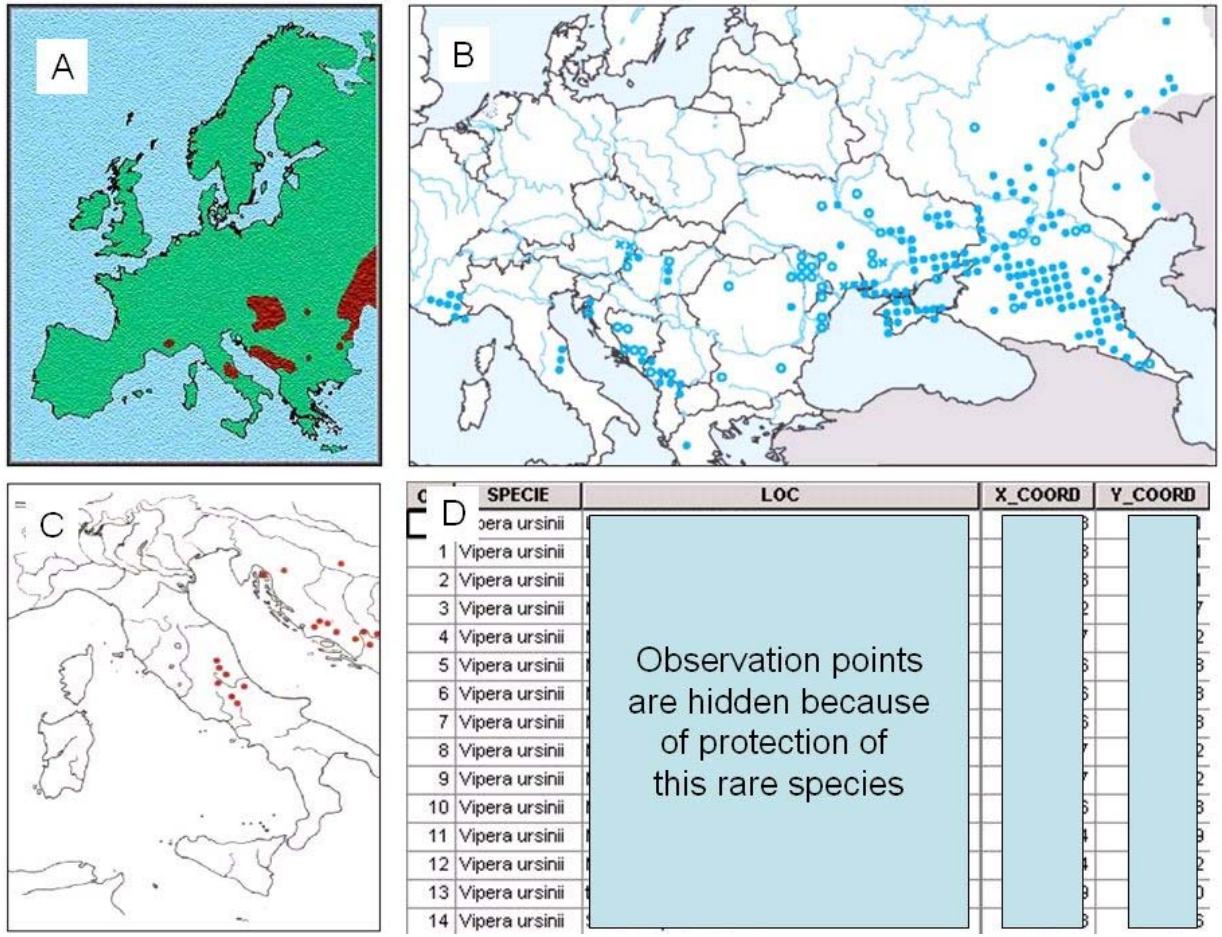
- Stamp collecting or Central planning? Is there a third way?
  - Do we require a central point?
  - Systematic centralized inventory of biological resources (State – National – continental – global)
  - Much information collected by individuals
  - Develop local expertise and taxonomic skills
  - Need active participation & efficient information transfer
- Quality assurance - Peer review & commentary
  - IUCN Red List
  - Points for validation need to be clear

Difficult to create a win-win situation for making biological data available

How will big pictures emerge from a sea of biological data?

Different distribution data for *Vipera ursini*

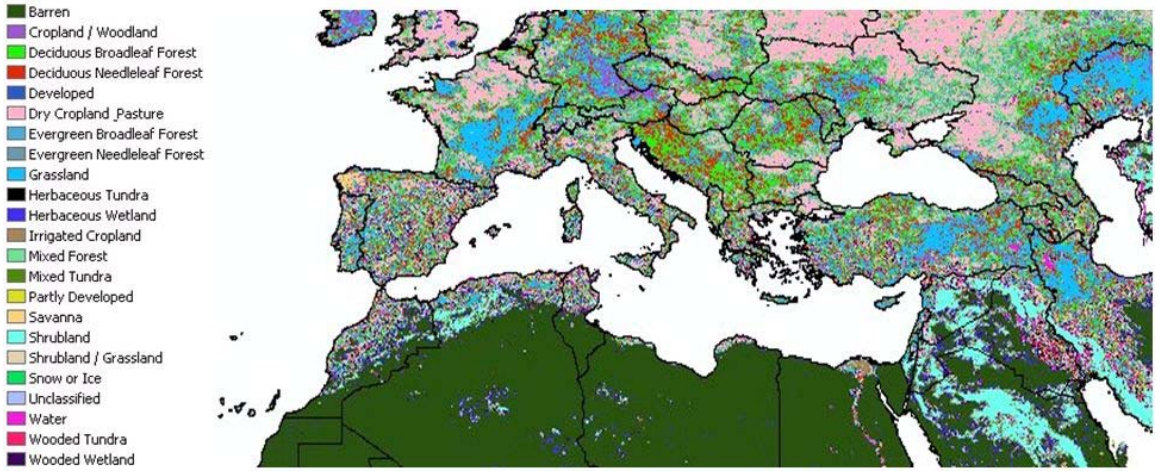
- a) outer distribution area map
- b) grid map
- c) point map
- d) observation points with x-y-coordinates



How will big pictures emerge from a sea of biological data?

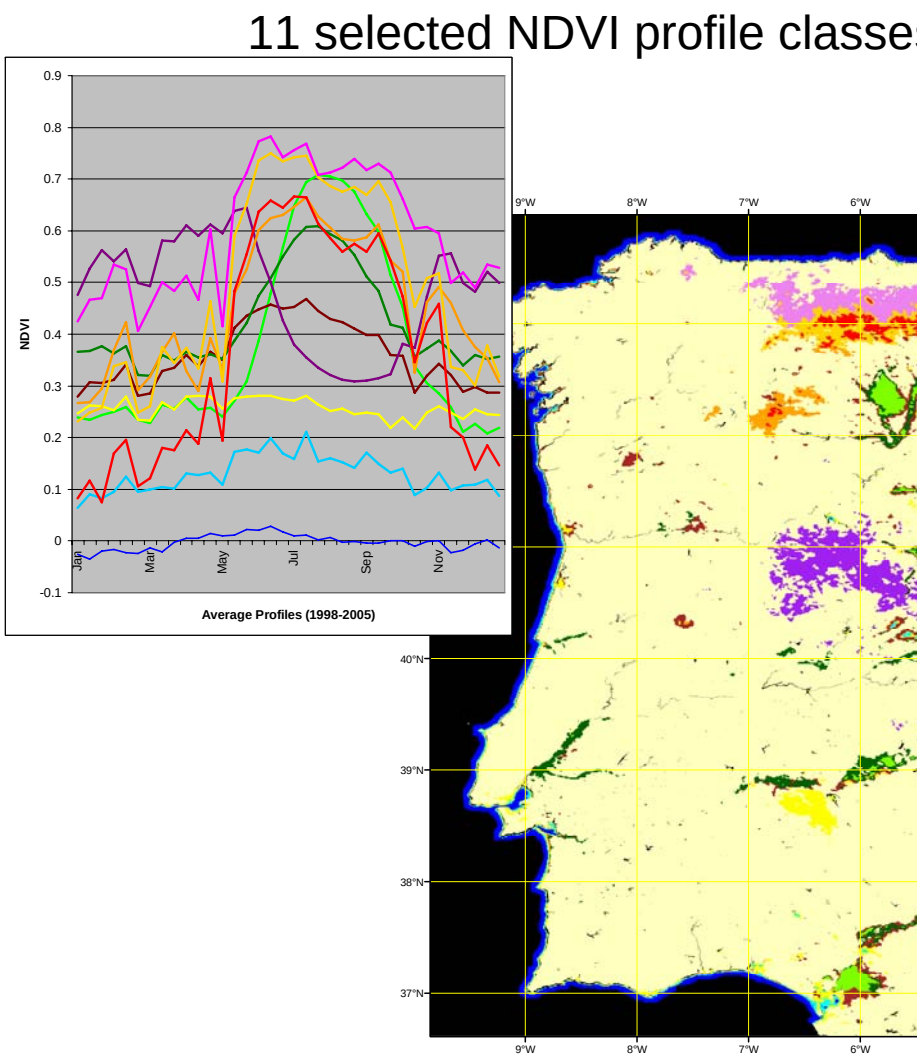
African climate and other environmental data

- Climatic data layers obtained from the WORLDCLIM database
  - precipitation records from 47,554 locations,
  - mean temperature from 24,542 locations and
  - minimum and maximum temperature for 14,835 locations.
- Terrain data derived from remote sensing (e.g., altitude, dem, slope, aspect, hill-shading, drainage, water bodies like lakes and ponds). Source: USGS, SRTM, SWBD, Vmap and others.
- Vegetation data (e.g., cover/land use, vegetation structure, NDVI). Source: USGS and others.
- Soil data (e.g., texture, moisture, depth, ph). Source: USGS, FAO and others.
- Derivates of item 1 to 4 (e.g., distance from drainage, water bodies, infrastructure, urban centers)



Remote Sensing

- For the 252 (April 1998 to April 2005) SPOT NDVI image data layers:
  - ISODATA clustering algorithm
  - generate a map with 45 profile classes (user specified #)
- selected 11 NDVI-profiles (annual averaged profiles)



How will big pictures emerge from a sea of biological data?

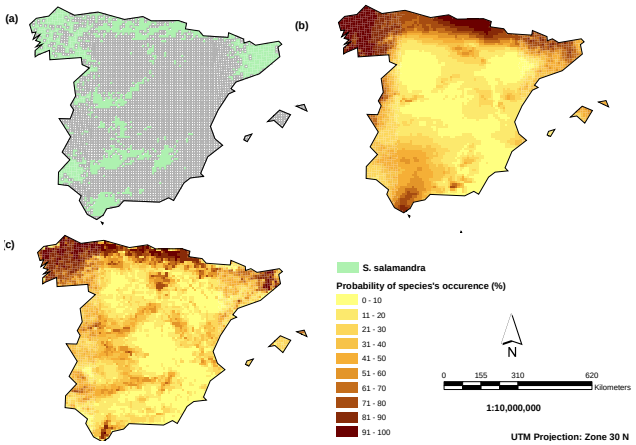
Biodiversity models using GIS & Remote Sensing

- Deterministic or Empirical Models
- CART/MARS/MAXENT
- BIOCLIM
- GARP
- etc

How will big pictures emerge from a sea of biological data?

Empirical Models: Modeling *Salamanda* *Salamanda* across Spain

- Generalised Linear Models were used to fit different models for the NDVI-profile class data, as well as the climate data.

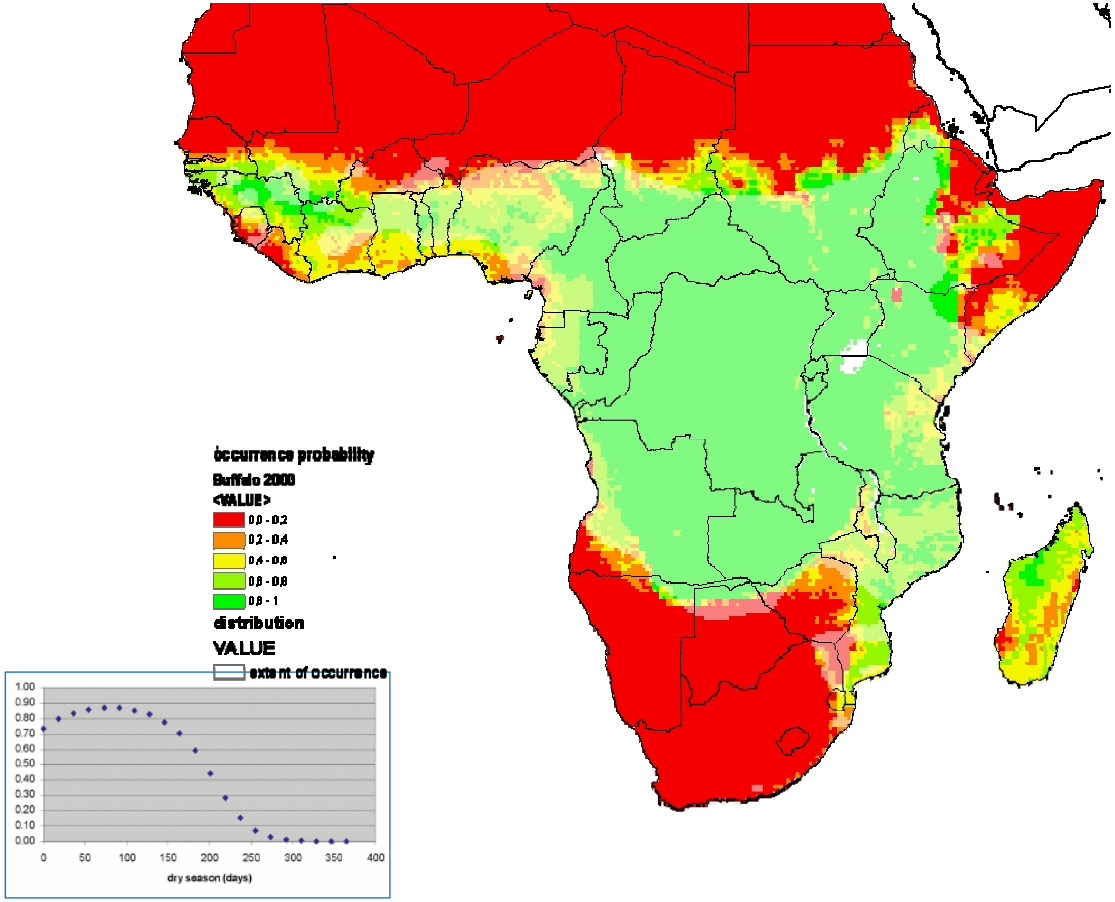


Spatial distribution of *Salamandra salamandra* in Spain (a) documented distribution on 10 x 10 Km UTM square, 1981 – 1997 (b) predicted distribution by climatic model (10 x 10 Km resolution), (c) predicted distribution by NDVI model (10 x 10 km resolution).

How will big pictures emerge from a sea of biological data?

Biodiversity modeling with CART

Modeling animal species occurrence

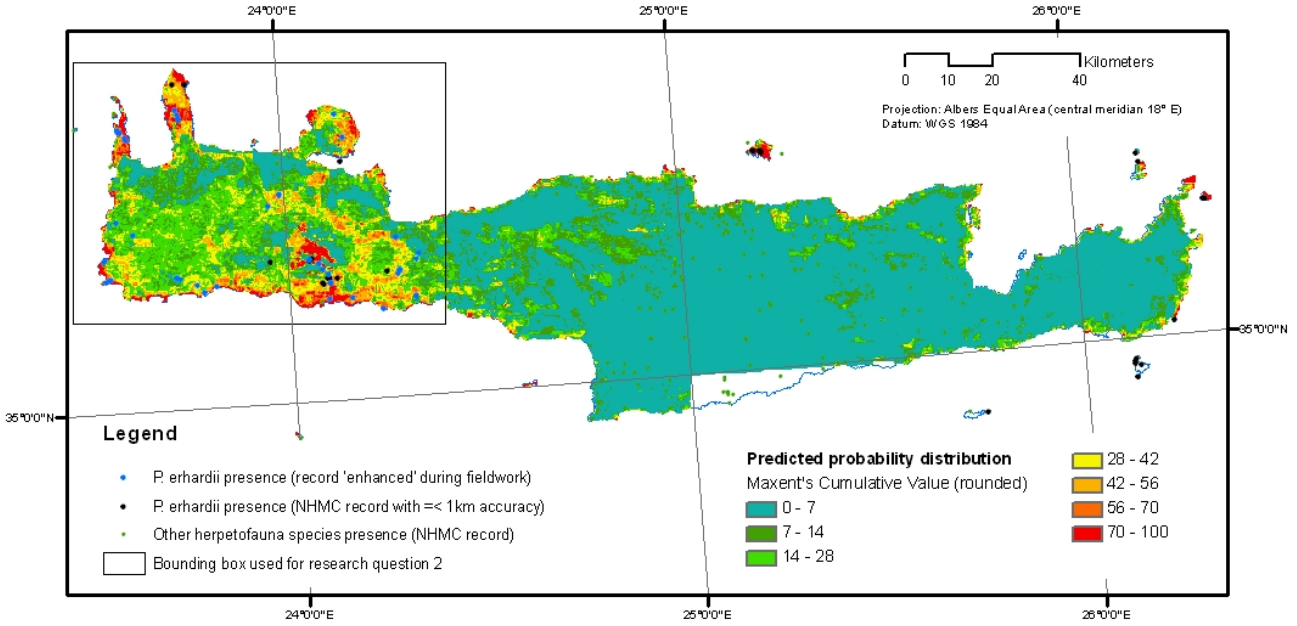


See also MARS – multivariate adaptive regression splines

How will big pictures emerge from a sea of biological data?

Modelling Habitat Suitability Of Erhard's Wall Lizard *Podarcis erhardii*

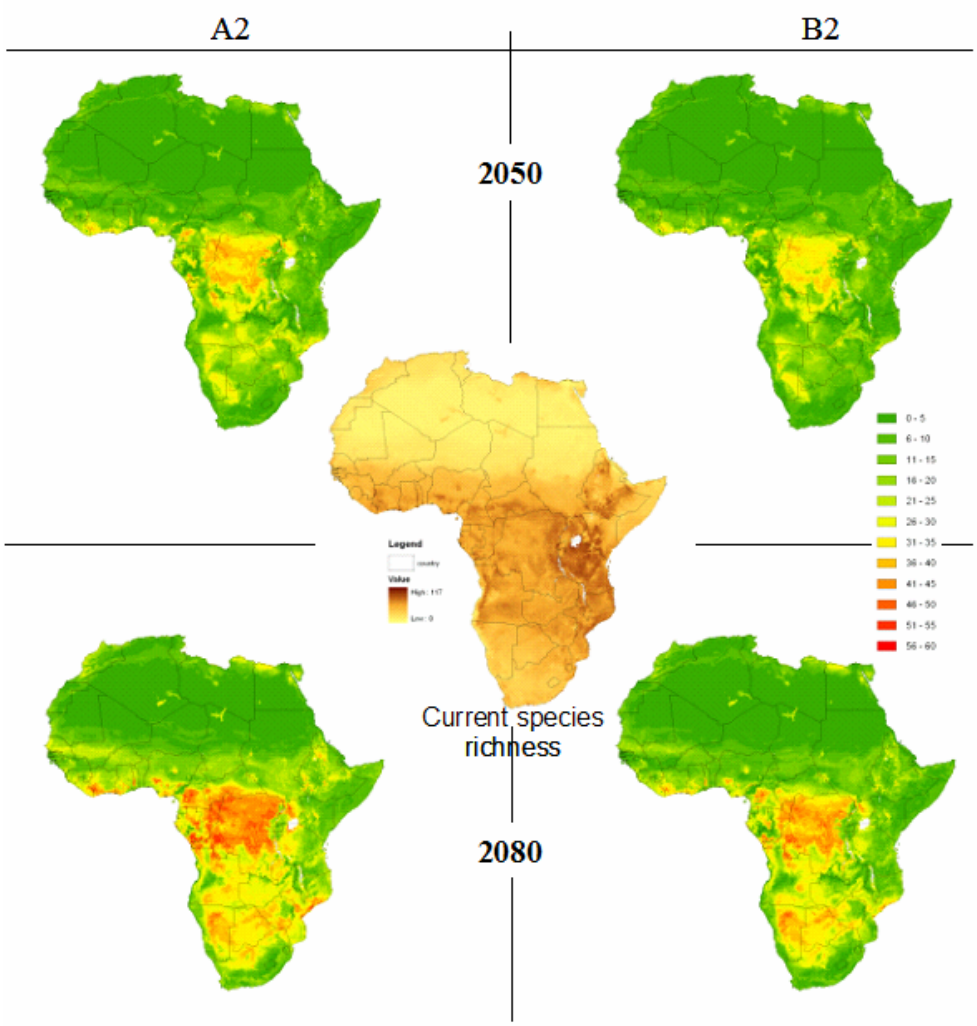
- Input: Remote sensing, climatic & physical data
- MAXENT model
- **Probability distribution across Crete**



Climate change – effect on biodiversity using BIOCLIM

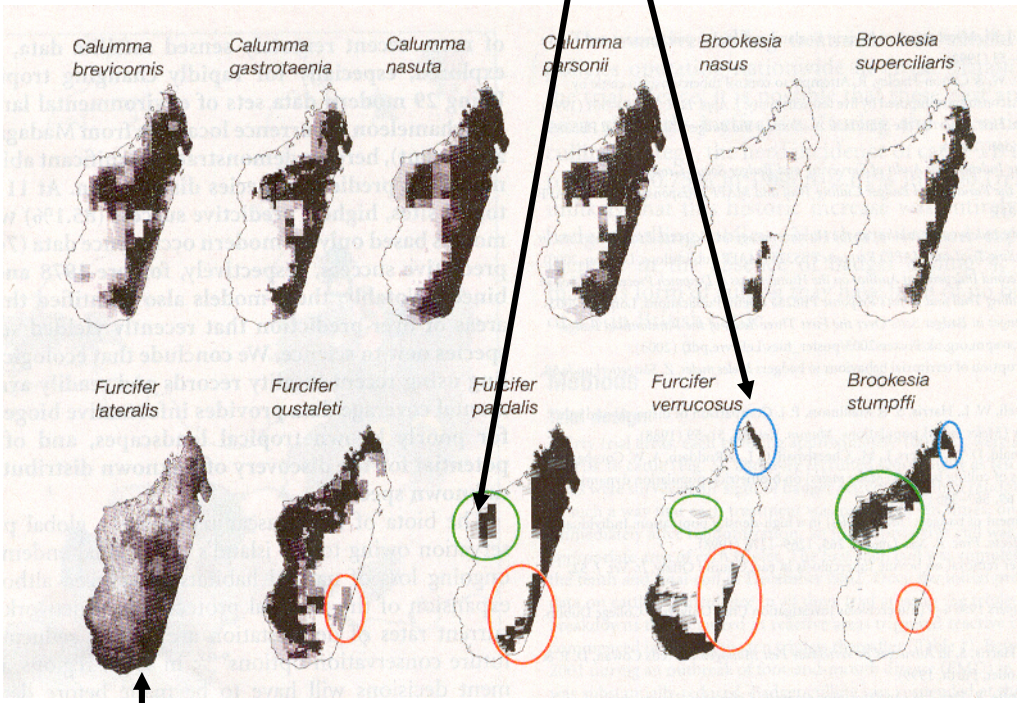
Forecast modeling

- *Quantitative assessment of effects of climate change on mammals biodiversity in Africa in the years 2050 and 2080*



GARP Genetic algorithm for rule-set prediction

Over-prediction areas yield new endemic species



Darker areas – best model agreement

Conclusions

- There is a lot of biodiversity, remotely sensed and environmental data out there
- Tools are being developed to extract information about biodiversity from these data – still a lot of work required!
- Explaining patterns of species diversity at the species level is one of the most complex problems in ecology
- But then using the information for improving governance and decision making… is another task!

Scholarships for study in the Netherlands

- NUFFIC – www.nuffic.nl offer short course, diploma, MSc and PhD scholarships for a limited number of countries
- European Union Erasmus mundus funded program
- Geoinformation Science and Earth Observation for Environmental Management www.gem-msc.org
  - 4 universities – Southampton, Lund, Warsaw, ITC
  - 18 month course
  - 40,000 euro scholarships!!!

2004

2005

2006