Ecological Niche Factor Analysis
Modelling species Habitat Suitability with presence only data

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Introduction
Habitat suitability modelling

Environmental space

Geographic space

Elevation
Slope
Limestone
Glacier

Geographic space
Habitat Suitability: input

- Ecogeographical maps
- Observation map

- Rock frequency
- Altitude
- Distance to towns

CORRELATED
Habitat Suitability: input

- **Input**
  - Ecogeographical
  - Observation map

![Observations](image)

- Sighting = Presence
- No sighting = Absence???
Absences

An “absence” (=no observation) may be due to:

- Species undetected ⇒ FALSE ABSENCE
- Dispersal barriers ⇒ FALSE ABSENCE
- Local temporary extinction ⇒ FALSE ABSENCE
- Too small territory ⇒ FALSE ABSENCE
- Unsuitable habitat ⇒ TRUE ABSENCE
Habitat Suitability: input

- Input
  - Ecogeographical
  - Observation map

Observations
Ecological Niche Factor Analysis
Ecological Niche Factor Analysis

• Principles:
  – Summarises all variables into a few uncorrelated factors.
  – Takes only presence data into account.
  – Compares the species distribution to the global (available) environment.
  – Built on the concepts of marginality and specialisation.
Marginality & Specialisation

- Species niche is a subset of the global environment.
- Species set of EGV differs from global set by:
  - **Marginality** (deviation from the global mean)
  - **Specialisation** (niche breadth)

\[
\text{Marginality} = \frac{|\mu_G - \mu_S|}{1.96\sigma_G}
\]

\[
\text{Specialisation} = \frac{\sigma_G}{\sigma_S}
\]
Factor computation: Marginality

- **MF** = Marginality factor
- **μ_G** = global barycentre
- **μ_S** = species barycentre

Projection along the marginality factor
Factor computation: Specialisation

Min. species variance

Max. global variance

Specialisation factor
From geographic space to environmental space

24 predictors

6 factors = 80% of information
Habitat suitability
Habitat suitability computation

• Let’s keep only the first factors (here, two)

• We compute for each cell its probability to be in the species distribution
Median envelopes

- **BIOMAPPER 1.0**
  (Hausser 1995, Hirzel *et al.* 2002)

- Envelope defined by the *frequency distribution* and the *median*.

- Assumes an unimodal and *symmetrical* distribution.
Compute the geometric mean of the distances:

\[ H_G = \sqrt[N]{\prod_{i=1}^{N} d_i} \]

BIOMAPPER 3.0 (Hirzel & Arlettaz 2003, Hirzel et al. 2004)
Distance geometric mean

Do that for the whole environmental space, computing a habitat suitability field.
Distance geometric mean

50% of the points: core habitat
90% of the points: marginal habitat

Envelopes are based on this field and the observation points.
Distance harmonic mean

Similar to the geometric mean, but based on the harmonic mean of the distances:

\[
H_H(P) = \frac{1}{\frac{1}{N} \sum_{i=1}^{N} \frac{1}{\delta(P, O_i)}}
\]
Minimum distance

Or just keep the distance to the closest point:

$$H_{\text{min}}(P) = \text{Min}\{\delta(P, O_i)\}$$
Biomapper

• This method has been implemented into a software named *Biomapper* that pools eco-GIS tools allowing to:
  – Prepare the **variable maps** (circular analysis, normalisation, etc.)
  – **Explore** them (visually and statistically)
  – Model the species **ecological niche**
  – Build **Habitat Suitability maps**
  – Evaluate them

• More information and download on [http://www.unil.ch/biomapper](http://www.unil.ch/biomapper)
Related papers and co-authors

