Management of Biodiversity in a changing world

Frontpage of the Danish newspaper “Information” 2 July 2008

‘It would have a better life in Albania’
Management of Biodiversity in a changing world

Carsten Rahbek

- Professor in Macroecology,
- Dept. Of Biology, Univ. of Copenhagen

- Director of DNRF’s Center of Excellence Macroecology, Evolution og Climate
  (http://www.macroecology.ku.dk/)
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Center for Macroecology, Evolution and Climate
Understanding the distribution of life
- In light of ecology, evolution and climate -

Biodiversity crisis

Ecosystem services (life support)

Impact of Global Change
(landuse and climate)
1st Take Home Message

Understand what Biodiversity is and acknowledge the magnitude of the crises

- Biodiversity is about securing the persistent of diversity of life and not to be confused with environmental or recreational issues
  - “Nitrogen Fields” to lower pollution from agriculture (or cities)
  - Fields with crops for Biofuel production or CO₂ storage, etc
  - Green trees to look at from the window of our houses
  - Forest with trails to exercise your dog – or yourself

- Management of Biodiversity requires specific strategies and tools
Management of biodiversity in a changing world with limited resources

- Requires socio-economic knowledge/tools and prioritization
  but is conditional upon biological knowledge
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3rd Take Home Message

The biodiversity crises is NOT caused by climate change

- Climate change may enhance the negative impact of those factors that are the prime cause
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4\textsuperscript{rd} Take Home Message

Climate change will cause dramatic changes in distribution of biodiversity

\begin{itemize}
  \item Static management of biodiversity will enhance problems
\end{itemize}
Management of Biodiversity in a changing world

5th Take Home Message

Approaches focusing (exclusively) to mitigate other environmental or climate change issues than biodiversity

- is often not neutral/positive to biodiversity, but may be negative
  - a multi-objective approach to management is needed
A Crash Course in biodiversity

- Biodiversity is a neologism combining 'biology' and 'diversity', where diversity refers to variation and magnitude of biological life and processes.

- The vast majority of species are very rare in numbers and has very small geographical ranges.

- Species co-exists with other species in assemblages and interact with its environment..........and all these functions may vary in time and space.

- Biodiversity value - life has two fundamental components of ‘value’: extrinsic (related to use in some way) & intrinsic (ethic and moral).

- Natural level of Biodiversity => stability in ecosystem functioning and resilience to global change.
• We are in the middle of Earth’s 6th period of mass extinction – the first ever caused by another species (i.e., humans)

• Rate of extinction is ca 1000 times higher than the background extinction rate

• 20-40% of species is classified by UN as in risk of extinction

• An extinct species …is gone!

A Crash Course in biodiversity

Today - future

For viewing purposes only
A Crash Course in biodiversity

For viewing purposes only
Human population density is 30 times higher than predicted for an omnivorous mammal of our size.

Humans use 40% of the planet’s gross terrestrial primary productivity.

30-50% of land surface has been transformed by human actions – the rest is impacted by human activities.

The main factors causing species extinction are:
- 36% Habit destruction
- 23% Hunting
- 39% Species introductions
- 2% Other

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The Convention on Biological Diversity (Rio 1992) signed by >150 countries/parties has three objectives:

- The conservation of biological diversity (e.g., all species)
- The sustainable use of its components
- The fair and equitable sharing of benefits

EU 2010 target: The loss of biodiversity within EU should be halted within 10 years (being replaced with a EU 2020 target)

The Danish target: Work in accordance with the guidelines set in the Convention, fulfill the EU-2010 target and secure the preservation of all Danish species
The Tropical Rain Forest

~90 % of biodiversity

The world’s most biologically-diverse biome
Making biological sense
Perception of connectiveness and complexity

Carsten Rahbek (University of Copenhagen)
Making biological sense

Perception of connectiveness and complexity

Establishment of new forest

The Danish Green Growth Strategy
Hedonic pricing => high
But little reflection upon biodiversity value

In total

(very low biodiversity-value)

Planted deciduous forest

(low biodiversity-value)

Pristine/native forest

(high biodiversity-value)

Forest in Denmark, showing an apparent increase,
hiding a decrease in pristine forest and biodiversity (Wilhjelmudvalget 2001)
Making biological sense
Which species to preserve – or prioritize

The good

The bad & the icky

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Making biological sense
Which species to preserve – or prioritize
Making biological sense
Perception of connectiveness and complexity
Average life span of a human: < 100 years
Perspective of many economic cost-benefits analysis: ~ 5 to 50 (100) years

Average life span of a species: ca. 1 million years
Restoration-time of ecosystems: > 100s years

The ‘discounting’ debate
Systematic conservation planning

Existing protected areas
• rarely representative or efficient
• opportunistic selection

Resources are always an issue
• limited land available
• limited funds available

Need to use available resources strategically (cost-effectively)
• large scales (priority setting)
• small scales (management planning)
Systematic conservation planning

Hotspot approach (single-site evaluation)

<table>
<thead>
<tr>
<th>Area</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>A</td>
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<td>B</td>
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</table>

Species: A, B, C, D, E

Richness: 3, 2, 2, 1, 1

Accumulated species richness:

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Systematic conservation planning

Complementarity approach (network-approach)
Systematic conservation planning

Typical questions

• Which areas are required to represent all species for minimum cost?
• Given a set budget – which areas would provide best value?
• How effective are existing network of nature-areas?

\[
\text{minimise } \sum_{j=1}^{n} c_j x_j \\
\text{subject to } \sum_{j=1}^{n} a_{ij} x_j \geq 1, \quad i = 1, 2, \ldots, m \\
x_j \in \{0,1\}, \quad j = 1, 2, \ldots, n
\]

Where, \( n \) = number of sites
\( m \) = number of species
\( c_j \) = cost of including site \( j \)
\( a_{ij} = 1 \) if species \( i \) is present in site \( j \) (else zero)
\( x_j = 1 \) if site \( j \) is in the solution set of sites (else zero).

\[
\text{maximise } \sum_{i=1}^{m} y_i \\
\text{subject to } \sum_{j=1}^{n} a_{ij} x_j \geq 1, \quad i = 1, 2, \ldots, m \\
y_i, x_j \in \{0,1\},
\]

Where, \( n \) = number of sites
\( m \) = number of species
\( B \) = budget available
\( c_j \) = cost of including site \( j \)
\( a_{ij} = 1 \) if species \( i \) is present in site \( j \) (else zero)
\( x_j = 1 \) if site \( j \) is in the solution set of sites (else zero)
\( y_i \) = if species \( i \) is present in a selected area

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Systematic conservation planning

Efficiency of strategies to preserve biodiversity in Africa

Balmford, ... Rahbek (2001) Science
Systematic conservation planning

Efficiency of strategies to preserve biodiversity in Africa

Balmford, ... Rahbek (2001) Science
Systematic conservation planning

Efficiency of strategies to preserve biodiversity in Africa

Focus on preserving species

Focus on preserving ecosystem services

Best funded strategy

Random selection

Upper and lower 2.5%

Balmford, ... Rahbek (2001) Science

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Systematic conservation planning

Efficiency of strategies to preserve biodiversity in Denmark

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Danish Economy – Autumn 2000
"Management of nature and biodiversity"

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Measurement of Biodiversity value

Danish National Parks and Biodiversity
Measurement of Biodiversity value

Plowing of > 100,000 ha set-aside land (~nature)

Before

A large number of Appendix IV species

After
Measurement of Biodiversity value

Grazing – cattle – and biodiversity?

Effect on Biodiversity

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Management of Biodiversity in Denmark

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’It would have a better life in Albania’
# Management of Biodiversity in Denmark: Status

Reports on the status of management of Biodiversity in Denmark

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Management of
Biodiversity in Denmark: Status

Performance (biodiversity management) in 30 European countries 2010

Source: Environmental Performance Index 2010 (Columbia og Yale Universitet, USA)
Management of Biodiversity in Denmark: Status

Status for the EU habitat directive in Danmark

Species:
- 31% Unknown
- 15% Favorable
- 32% Not Favorable
- 22% Highly non-favorable

Types of Nature:
- 24% Unknown
- 49% Favorable
- 17% Not Favorable
- 10% Highly non-favorable

Source: Danmarks Miljøundersøgelser 2008
Proportion of threatened species in Denmark (selected groups)

Data from the Danish red-listing 2007, Danmarks Miljøundersøgelser
Management of

Biodiversity in Denmark: Status

The problems:

- Lack of space
- Lack of space
- Lack of space
- Homogenizing of Danish Nature ("The Nitrogen cloud")
- Fragmentation of Danish Nature
- Invasive species
- Climate change
Climate change will cause dramatic changes in the earth's ecosystems, including the functionality of ecosystems.

Climate change will significantly impact the distribution of species, the composition of species assemblages and species abundances.

The effect of climate change will differ geographically – and depend on how much the climate will change.

Whether the effects of climate change will be neutral, negative or positive depends on the area, the species and what question one asks.
Little area – little nature – huge diversity
(> 30,000 species)
Potential range-shifts in species distribution caused by climate changes
Danish flora and fauna in 2050-2100

- An expected turnover of 20% of the Danish birds
  - disproportionally impacted will be threatened species

- Also a 20% turnover rate of vascular plants
  - disproportionally impacted will be species on nutrient-poor soil

- A potential doubling of mammalian species
Effect of Climate change on Species distribution

(Araujo & Rahbek, 2006, Science)
A mixed picture of model performance. Observed and predicted distributions of the red-backed shrike (Lanius collurio) and turtle dove (Streptopelia turtur) in Britain. Bioclimatic models predict the distributions in the 1970s reasonably well, but fail to predict the contraction of the range of the red-backed shrikes in the 1990s. However, the contraction of the range of the turtle dove is successfully predicted by models. Maps were produced with data and generalized linear models from (9).
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Management of Biodiversity in Denmark

Climate Change and species

Static management:
FOCUS: On current native species/Nature-types;
mitigation from negative impact caused by climate change

Dynamic management:
FOCUS: Nature are less managed and allowed to adapt to climate changes;
species abundances and occurrences are allowed to change
• Are there species that are unrealistic (expensive) to maintain as Danish species?

• Are Denmark ready to accept immigration from south of the border?

• Do we have the knowledge (and willingness) to conduct effective prioritization with regard to area- (and species-) management?
Should we do more or less for those species that are in potential risk of going extinct in Denmark due to climate change?

- May Thrush Nightingale go extinct – if Nightingale emigrate?
- May Red Kite disappear – if Black Kite occurs?

Should we prioritize to maintain nature as we know it – and like it
– or should we allow nature to change and adapt to the new climate
- Keep prioritizing wet green meadows – or give up allowing drier bush land area
- Lapwings, ducks and waders – or Hoopoe and Bee-eaters?
Larger areas for free succession

- Wetland and green meadows
- Marginal land, set aside land etc
- Forestry
- Agriculture
- Fishery
- Cities and infrastructure

Management of Biodiversity in Denmark

Win-win or Win-Loose?
Win-win or Win-Loose?

Larger areas for free succession

- Wetland and green meadows
- Biofuel production – Nature - Recreation
- Forestry
- Agriculture
- Fishery
- Cities and infrastructure