Natura 2000
From patchwork to network?

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ALTER-Net

Ghent, Belgium 15-18 April 2013
Natura 2000 is an ecological network of protected areas, set up to ensure the survival of Europe's most valuable species and habitats.

The green infrastructure it provides safeguards numerous ecosystem services and ensures that Europe's natural system remain healthy and resilient.
“Member states must encourage the management of features of the landscape which are essential for the migration, dispersal and genetic exchange of wild species”

- Green network to connect N2000 sites
- How to define a functional network?
  * The real world is also patchy
  * How much connection is needed?
Natura 2000 is the sum of bird and habitat directives

- Not based on spatial coherence
- Not designed to be functional network
- Based on “best remaining sites”
- Heterogenous quality across member states
- Heterogenous fragmentation
Fragmentation

Jaeger et al. 2011

Map 3.4  Landscape fragmentation per 1 km² grid in the Channel region in 2009

Note: Landscape fragmentation was calculated using fragmentation geometry FG-B2.
Fragmentation in Flanders

- 462 inh/km$^2$
- Urbanisation: 98.3%
- Urbanisatie surface: 25%
- Agriculture: 62%
- Protected nature: 3%
  - Av size: 26 ha
- Densest road network EU
Extinction debt

Delayed loss of diversity after habitat loss


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Extinction debt

Succisa pratensis

- 67% $N_e < 50$
- 18% $50 < N_e < 100$
- 15% $100 < N_e$

>75% decline since 1970
Common viper

1980 - 2001

2001 - 2012

E. Graitson, 2012
Common viper, Ardennes

E. Graitson, 2012

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Natura 2000 is the sum of bird and habitat directives

- We need effective protection of Natura 2000 sites to “ensure the survival of Europe's most valued species and habitats”
Natura 2000 is the sum of bird and habitat directives

• We need effective protection of Natura 2000 sites
• We need more than Natura2000 for functional connectivity
Misconception: green infrastructure connects ecosystems / nature reserves
Species differ in their perception of fragmentation

- Need for defragmentation varies across taxa
- Physical connection does not guarantee functional connectivity and vice-versa
Species differ in their perception of fragmentation

• Species differ in their perception of connectivity (grain)
• Functional connectivity is defined at the species level
• Connections should be tailored to species
Misconception: green infrastructure connects ecosystems / nature reserves

- Organisms do not actively seek connections
- Anthropogenic view on connectivity
TWO STUPID CHICKENS:

HOW DO I GET TO THE OTHER SIDE?!!!

YOU ARE ON THE OTHER SIDE!
Functional network is not merely rolling out green carpets between N2000 sites
Functional network?

- Colonization
- Exchange
  - Compensation of stochastic processes
  - Allow spread of adaptive genes
Why do we need a functional network?

• To ensure the **survival** of Europe's most valuable **species** and **habitats**

Among habitats
Among species
Within species
Processes affecting diversity

Among species
- Ecological drift ↓
- Dispersal ↑
- Speciation ↑
- Species sorting ↑ ↓

Within species
- Genetic drift ↓
- Gene flow ↑ (locally)
- Mutation ↑ (globally)
- Selection ↑ ↓
Processes affecting diversity

When dispersal rate equals rate of drift (stochastic loss of diversity)

→ no net loss of diversity

Defines required connectivity
Conservation of diversity

- Interaction between size and dispersal
  - Loss of diversity by chance is function of size
    - Species-area relation
    - Genetic diversity – effective size relation
Connectivity and the paradox of small populations

- Small populations lose diversity more rapidly
- Rate of loss $\sim \frac{1}{2N_e}$

**Genetic drift at $N_e=10$ and $N_e=100$**

Diversity

Time
Connectivity and the paradox of small populations

- If $N=10$, migration rate must be $> 5$
- If $N=100$, migration rate must be $> 0.5$
- Small populations require more robust connections
Connectivity and the paradox of small populations

The stronger the landscape fragmentation, the more focus there should be on enlarging

Irrespective of density-dependence

→ Very little dispersal in low-quality habitats
Functional connectivity

• Is easier to reach among large populations

• Increasing connectivity helps, but first there needs to be high quality sites with thriving wildlife populations to connect. (Lawton et al. 2010)

• In highly fragmented landscapes enlarging more cost-efficient (Ovaskainen 2012)
Components of ecological network

- Core areas ➔ Natura 2000
- Corridors and stepping stones
- Restoration areas
- Buffer zones
- Sustainable use areas

Lawton et al. 2010: DEFRA report
How much connection is needed?

Genetic criteria for population size

At *metapopulation scale*: maintain 95% of genetic diversity over 100 years, t generations

* Subpopulations functionally connected

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Metapopulation size

- Common tree frog, *Hyla arborea*. $N_{e,95} = 244$
- Estimates of $N_{e}$

<table>
<thead>
<tr>
<th>Location</th>
<th>$N_{e}$</th>
</tr>
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<tbody>
<tr>
<td>Zwin</td>
<td>~50-100</td>
</tr>
<tr>
<td>Merkske</td>
<td>~5-10</td>
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<tr>
<td>Mariahof</td>
<td>~10-50</td>
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<tr>
<td>De Brand</td>
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<tr>
<td>Maasmechelen</td>
<td>~10-50</td>
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<td>Wijvenheide</td>
<td>~&gt;400</td>
</tr>
<tr>
<td>Dautenweyers</td>
<td>~10-20</td>
</tr>
</tbody>
</table>
Metapopulation size

- Common tree frog, Hyla arborea. $N_{e,95} = 244$
- Majority of current “metapopulations” too small
- Most isolated populations or metapopulations cannot be connected functionally to other populations
  - ➔ enlarging only option
Metapopulation size

Common tree frog, Hyla arborea in Vijvergebied

- 2000: isolated small population
Metapopulation size:

Common tree frog, *Hyla arborea*, N = 244
Metapopulation size
Metapopulation size

Common tree frog, Hyla arborea in Vijvergebied

- 2000: isolated small population
- 2012 “Vijvergebied”:
  - Population size: c. 3000 – 4000 frogs
  - Distributed over area > 100x larger

Increasing habitat quality and quantity led to increased functional connectivity

Lawton et al. 2010, Ovaskainen 2012: Enlarging (UK, NL) is top priority. Enlarging will automatically increase average connectivity.
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Further reading

