Natura 2000

From patchwork to network?

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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?

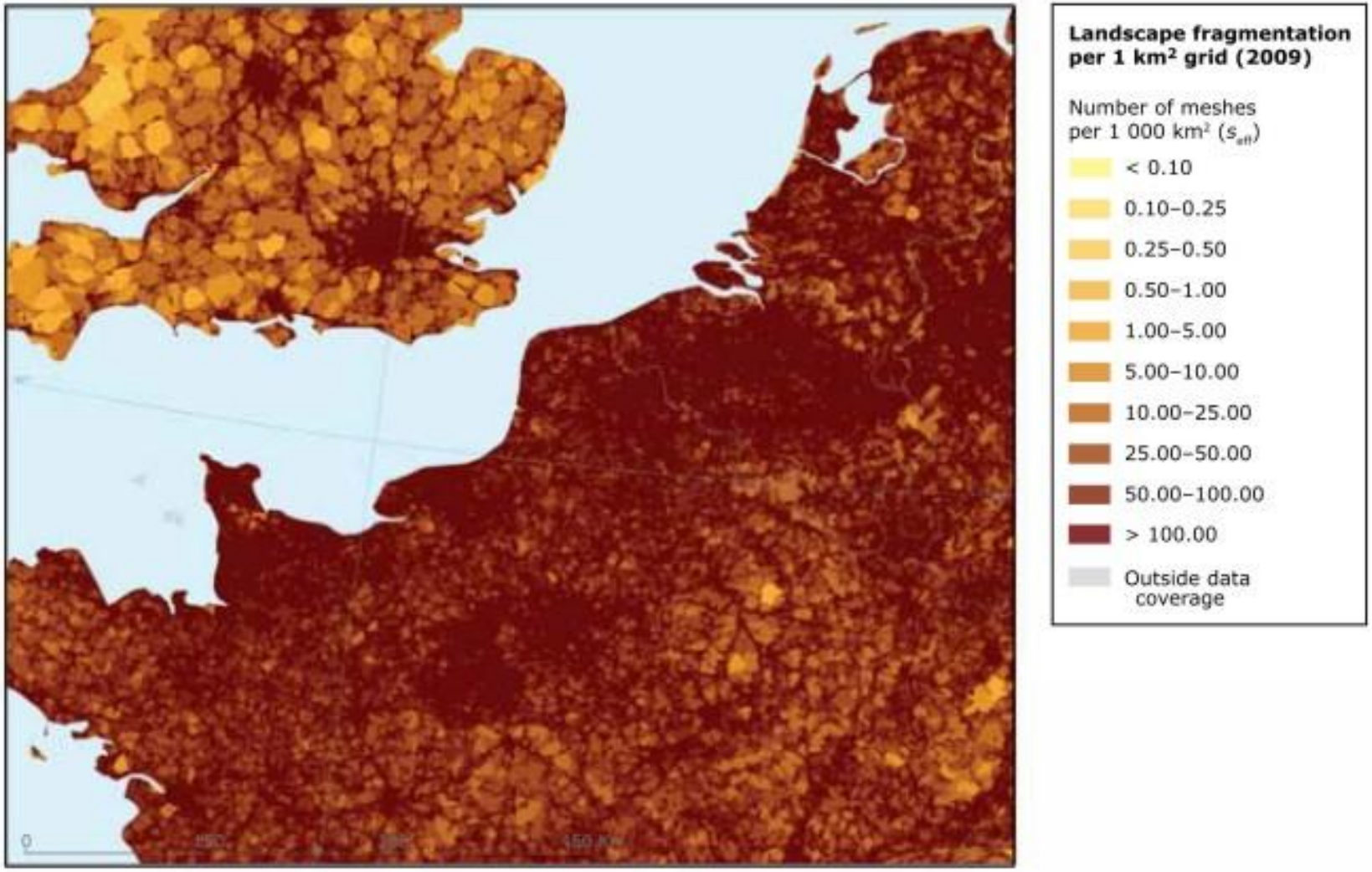
Natura 2000 is the sum of bird and habitat directives

- 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**



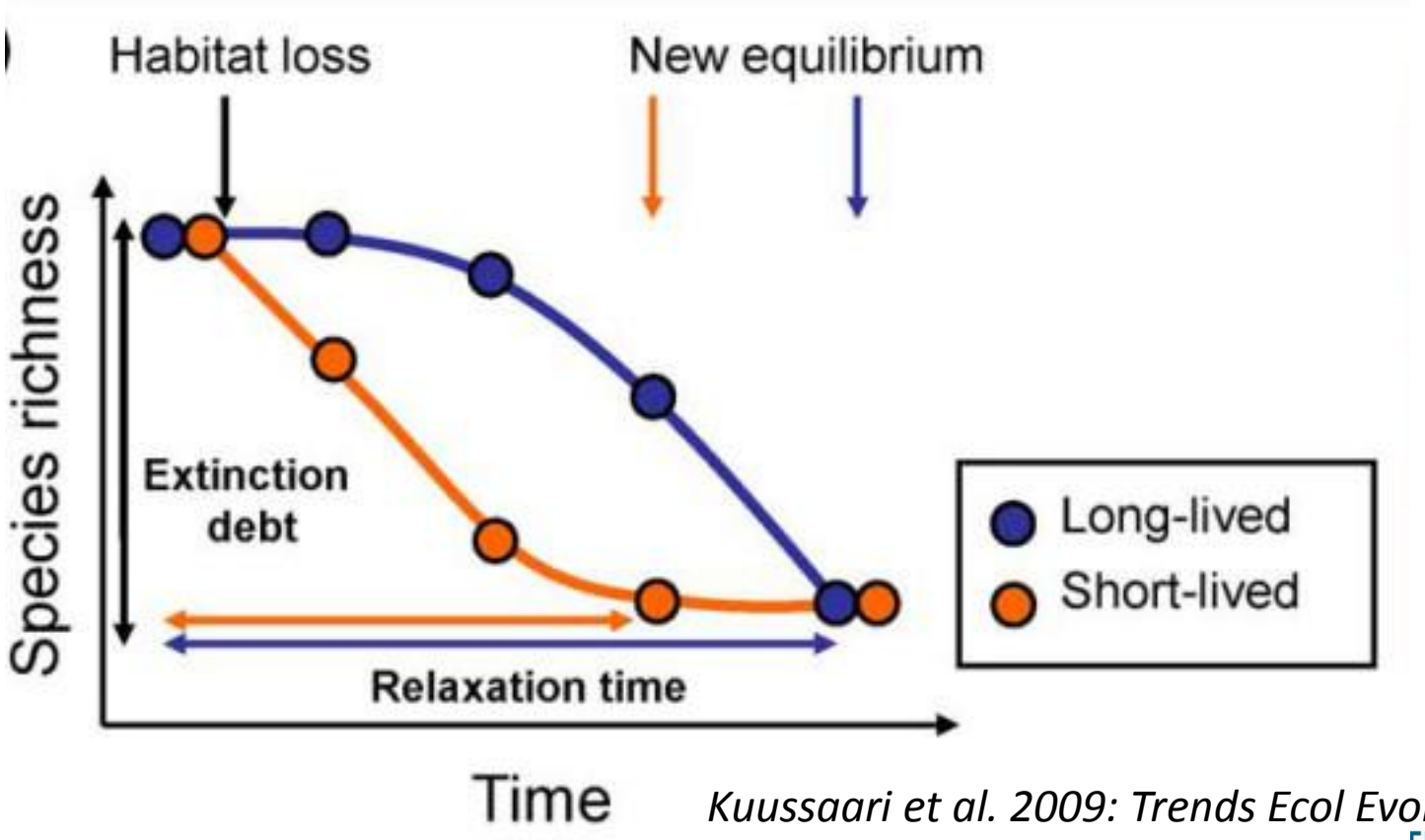
Note: Landscape fragmentation was calculated using fragmentation geometry FG-B2.

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



Kuussaari et al. 2009: Trends Ecol Evol

Extinction debt

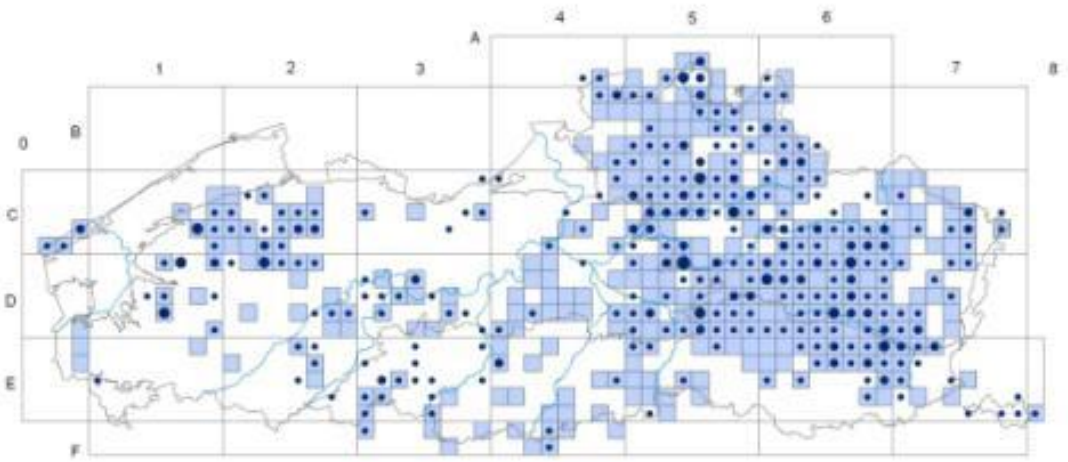
Succisa pratensis

67% N_e < 50

18% 50 < N_e < 100

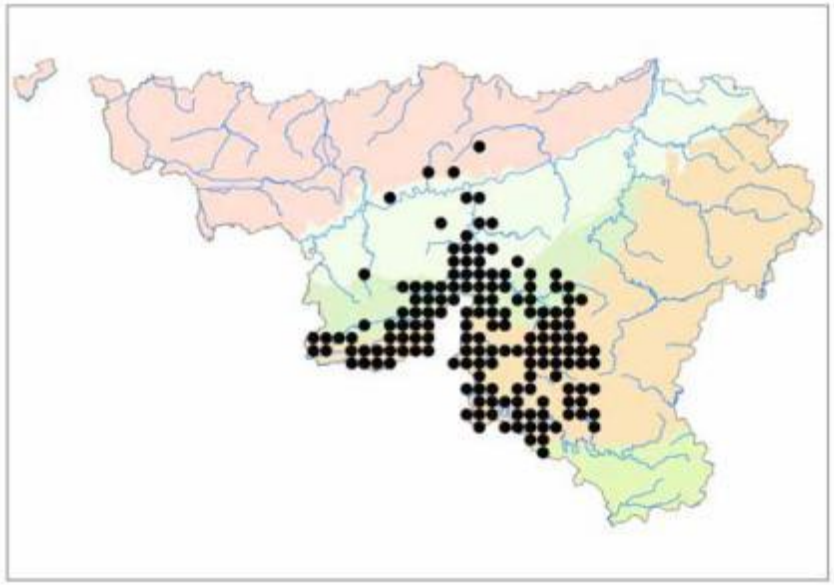
15% 100 < N_e

>75% decline since 1970

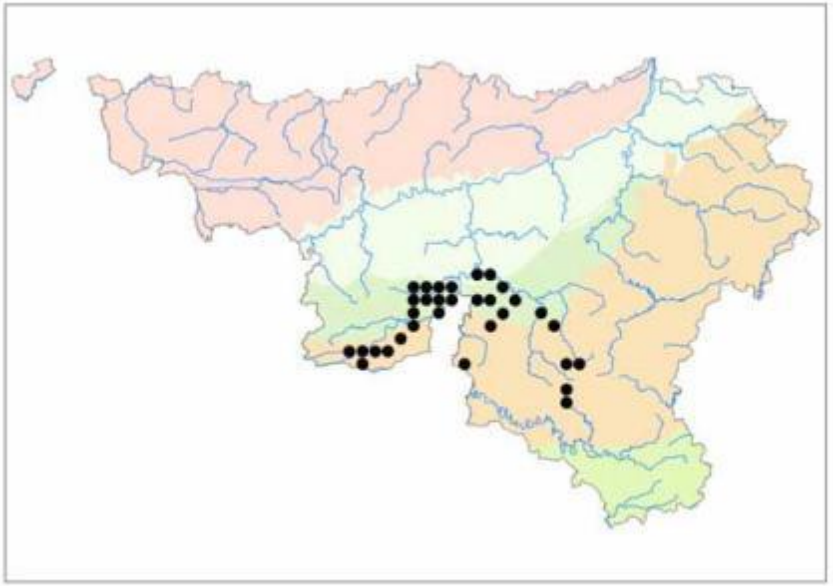


Common viper

1980 - 2001

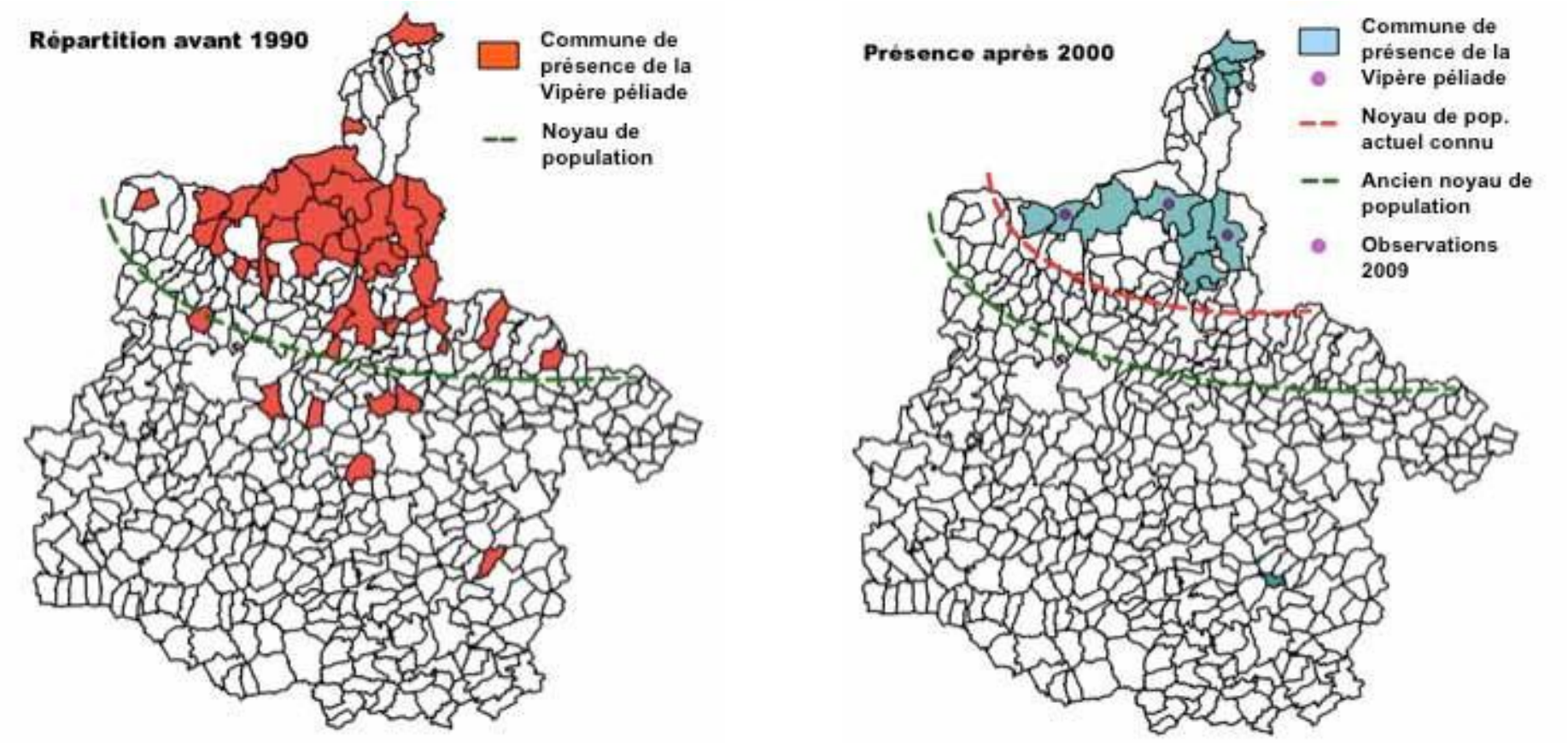


2001 - 2012



E. Graitson, 2012

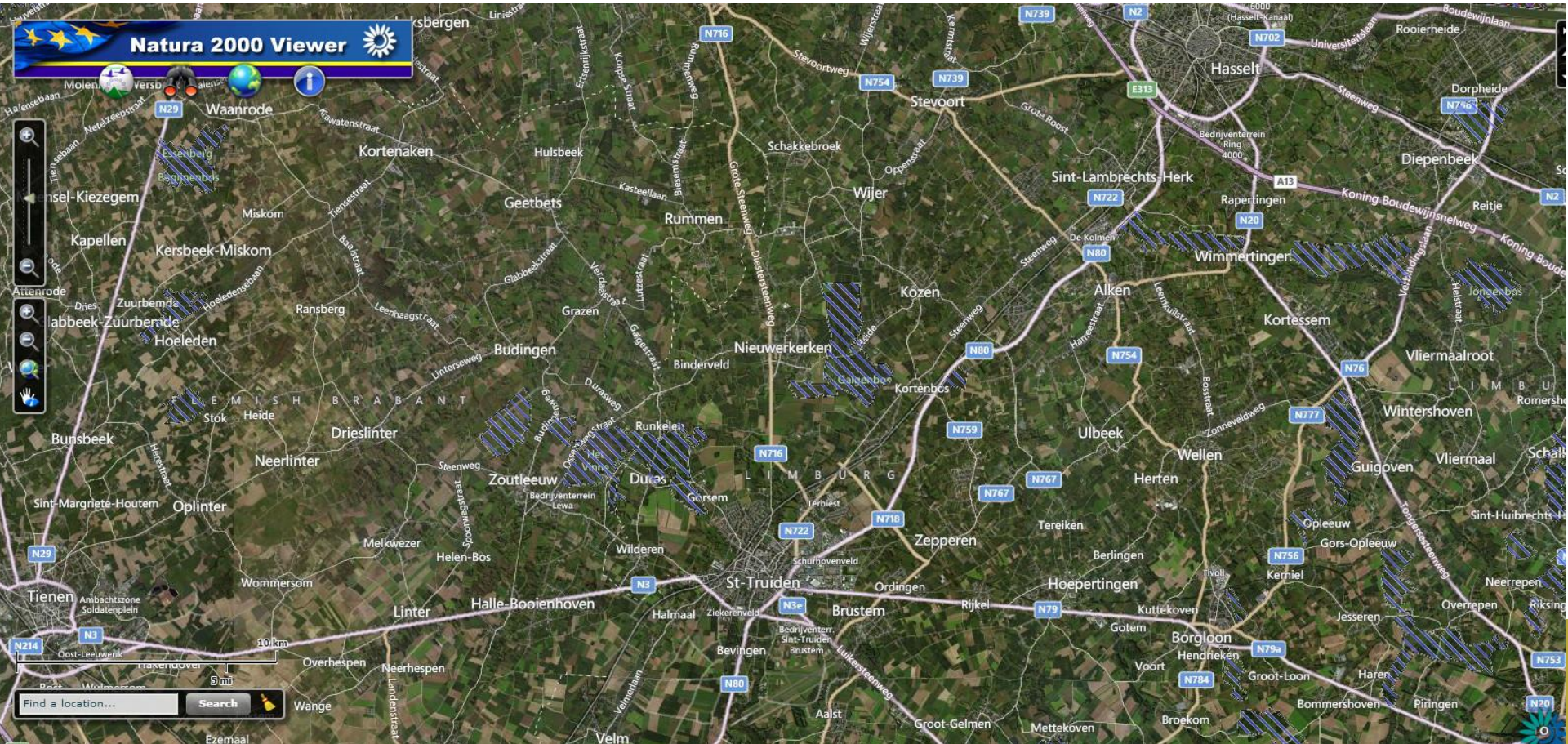
Common viper, Ardennes



E. Graitson, 2012

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*

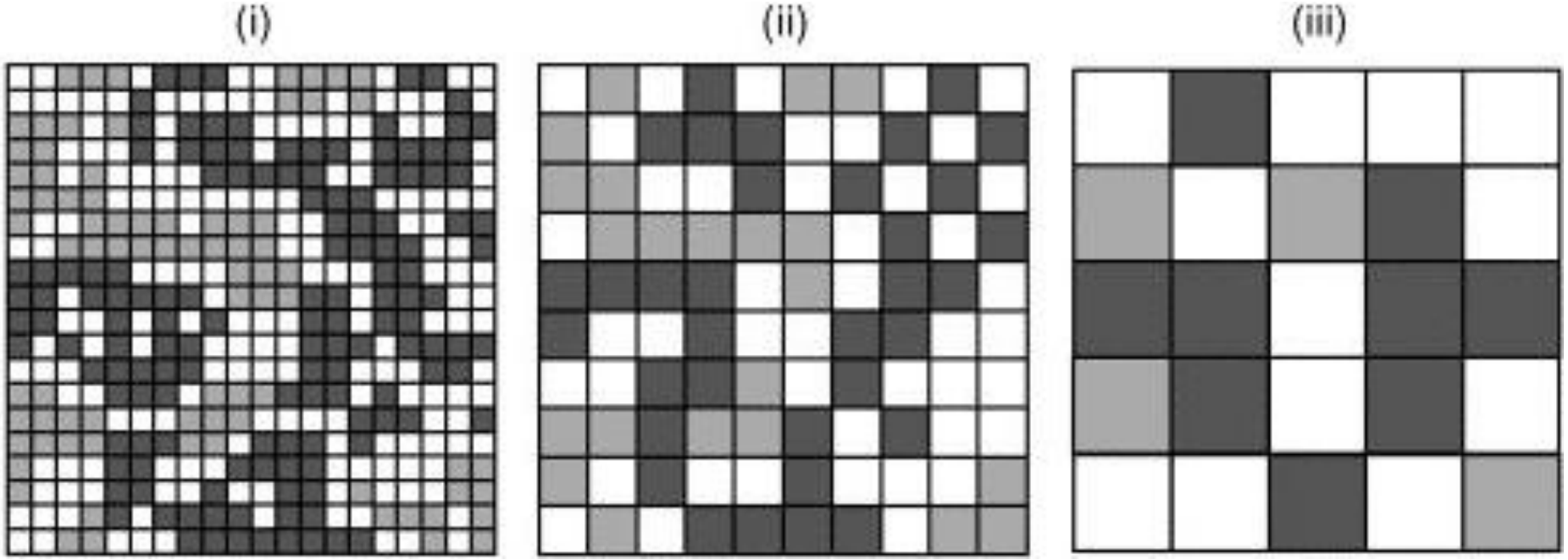


Natura 2000 is the sum of bird and habitat directives

- 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

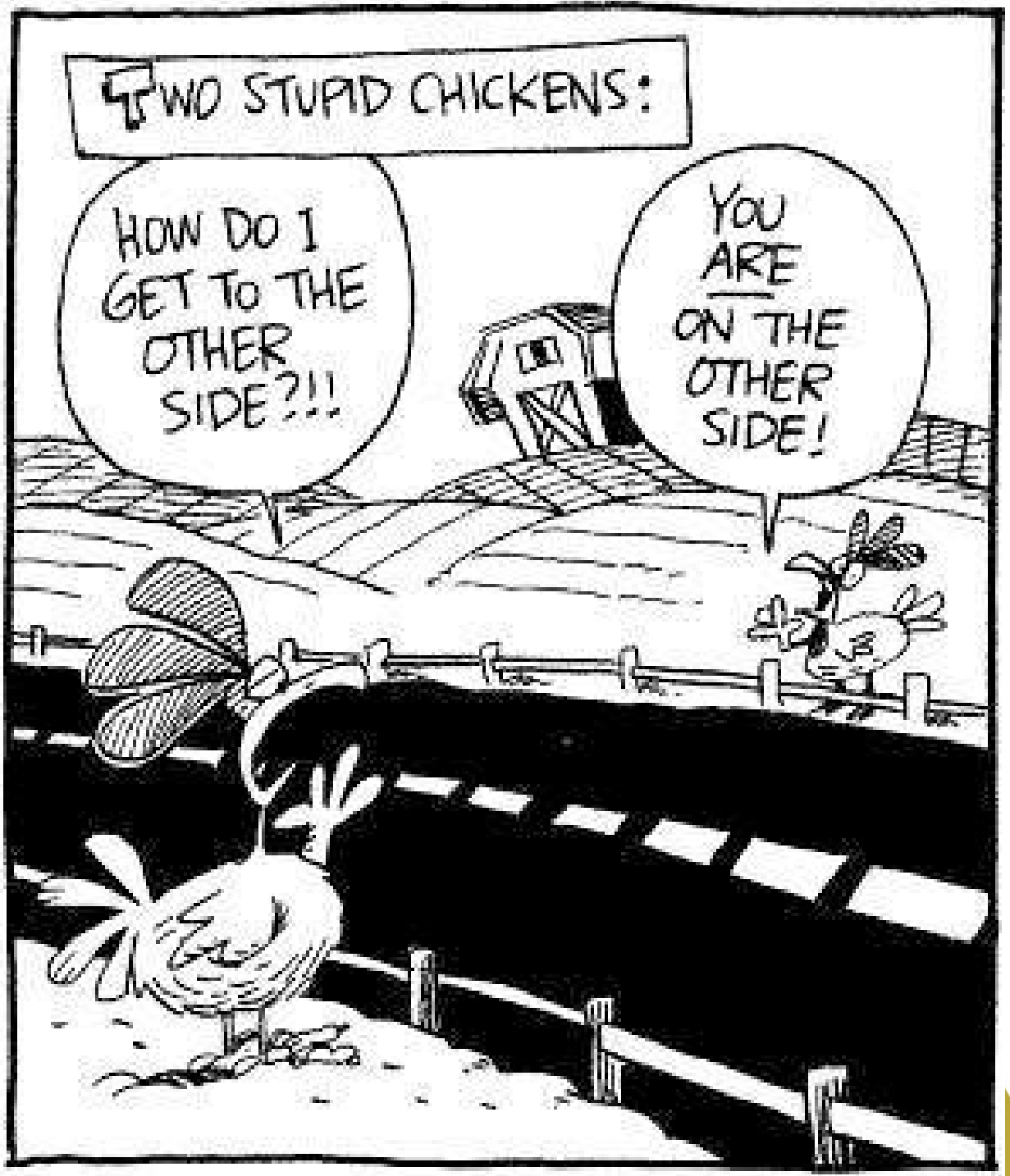
Species differ in their perception of fragmentation

- 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!

ALTER-Net

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

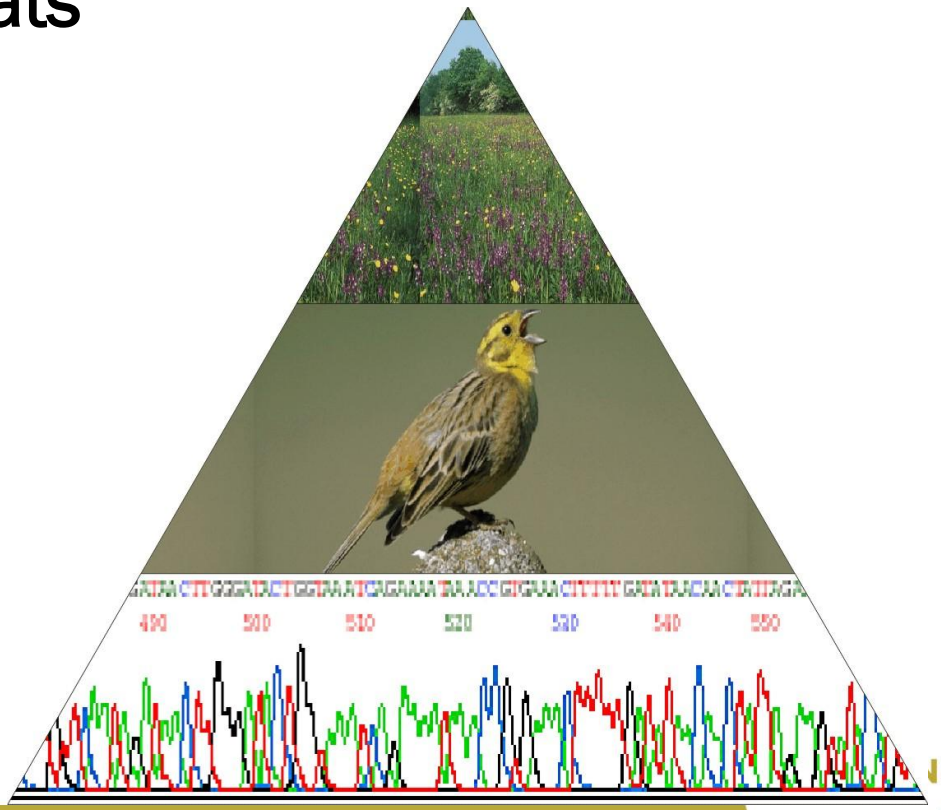
Why do we need a functional network?

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

Among habitats

Among species

Within species



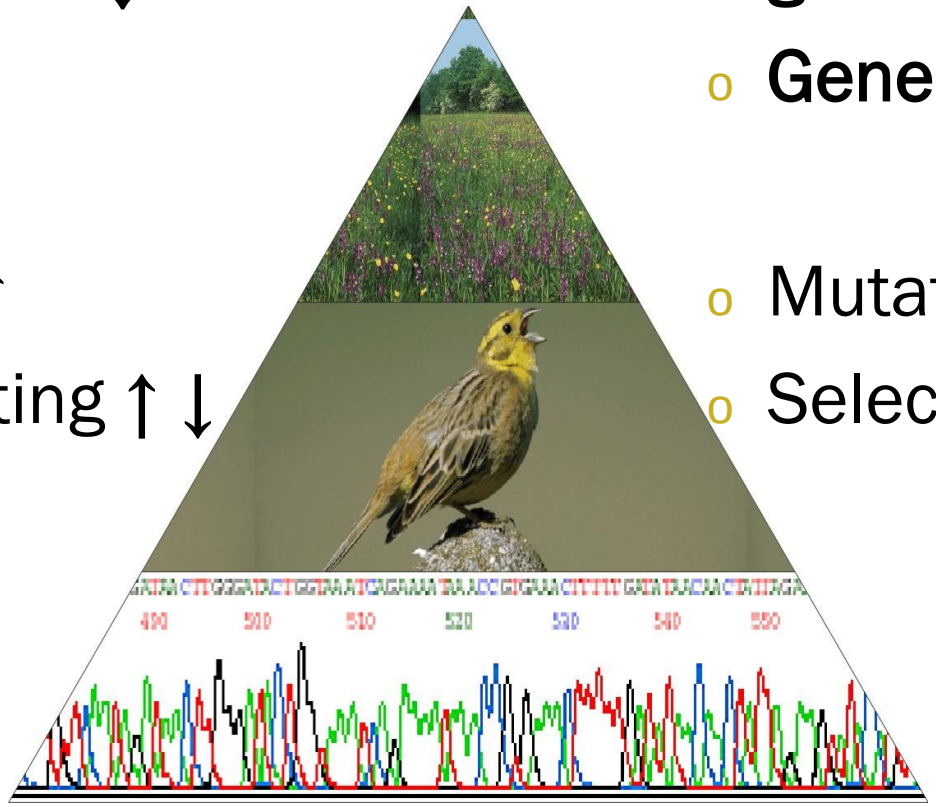
Processes affecting diversity

Among species

- **Ecological drift ↓**
- **Dispersal ↑**
- Speciation ↑
- Species sorting ↑ ↓

Within species

- **genetic drift ↓**
- **Gene flow ↑ (locally)**
- Mutation ↑ (globally)
- Selection ↑ ↓

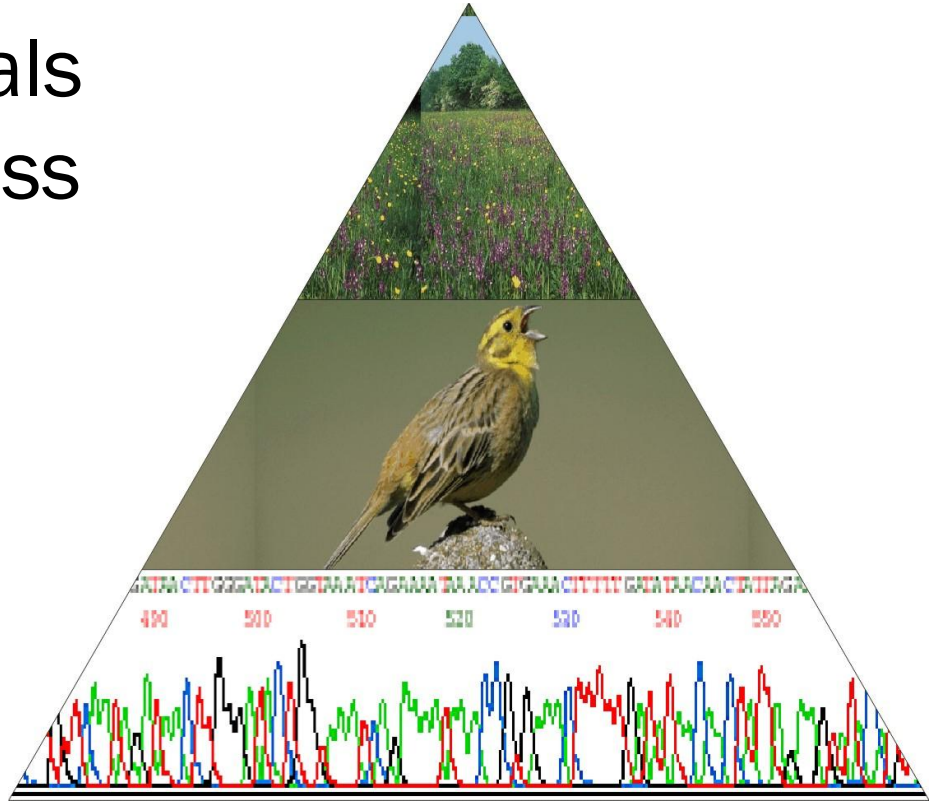


Processes affecting diversity

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

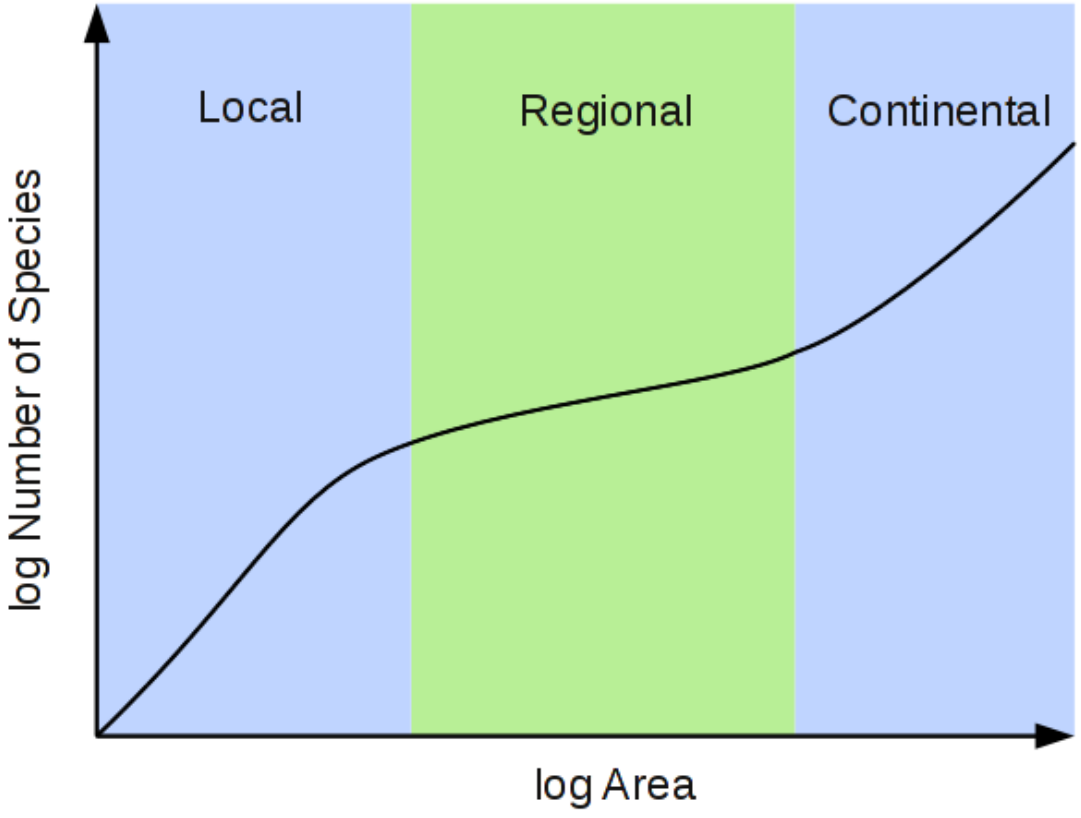
➔no net loss of diversity

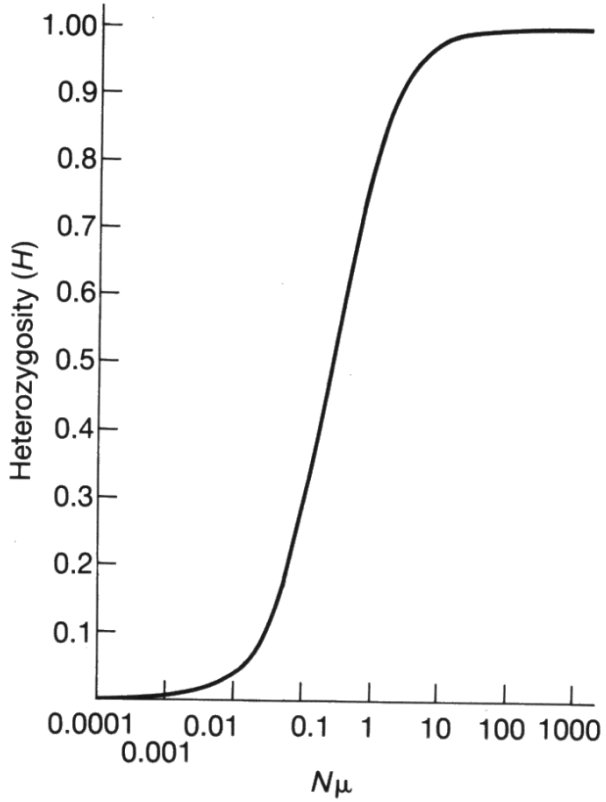
Defines required connectivity



Conservation of diversity

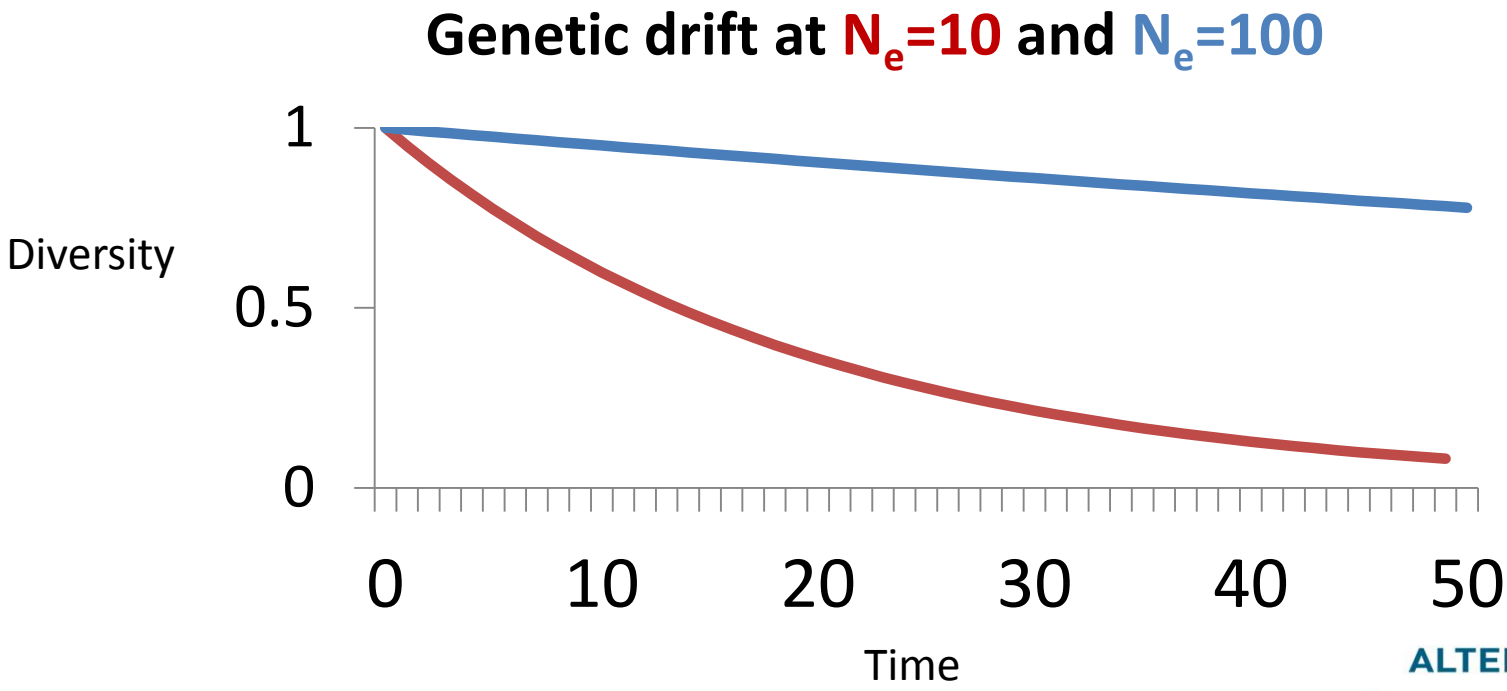
- Interaction between size and dispersal
  - Loss of diversity by chance is function of size
    - Species-area relation
    - Genetic diversity – effective size relation





Connectivity and the paradox of small populations

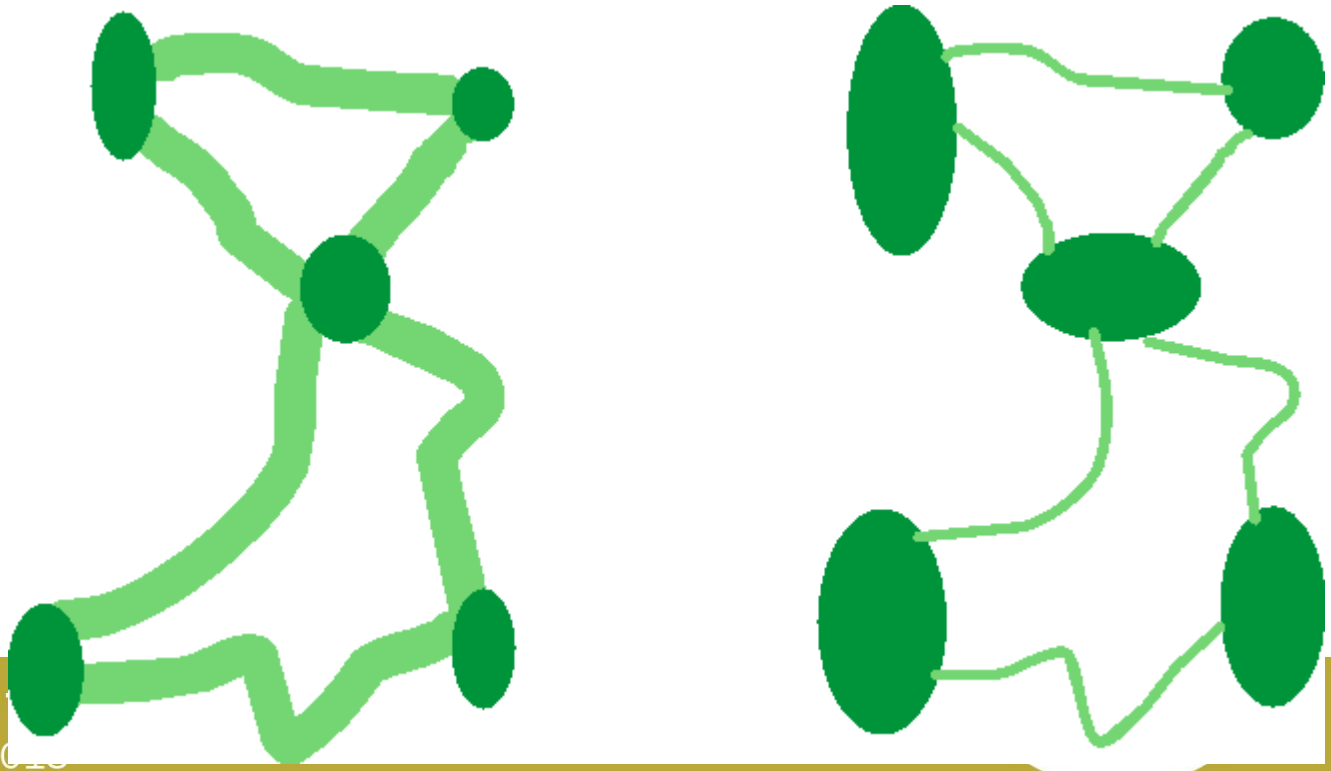
- Small populations lose diversity more rapidly
- Rate of loss ~ $1/2N_e$



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***

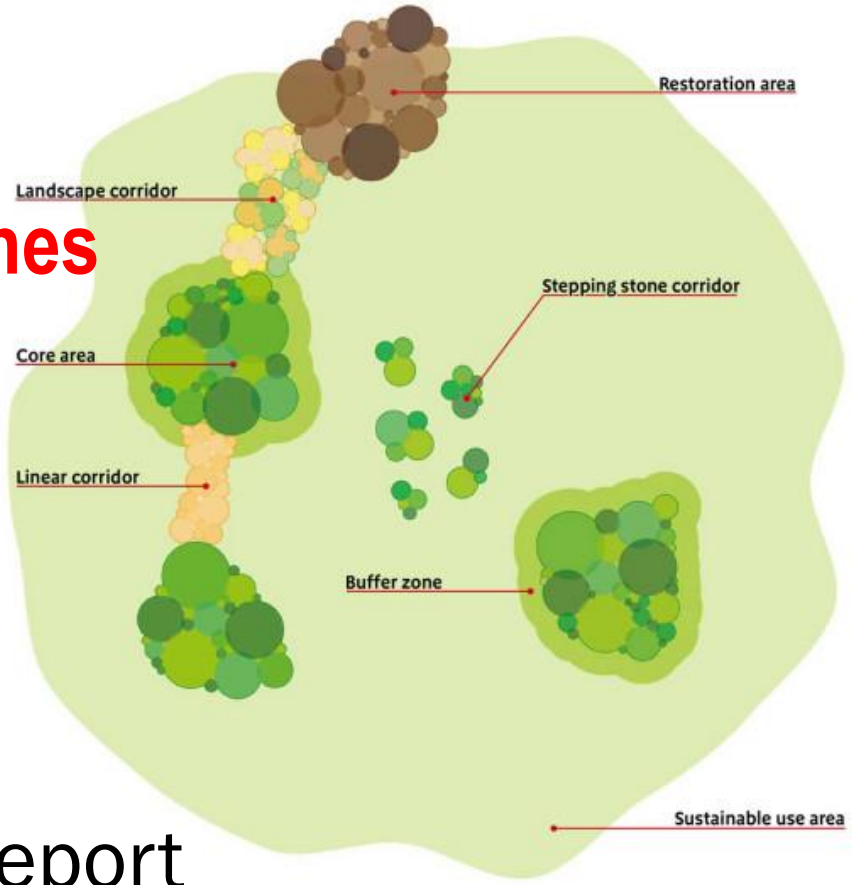
Functional connectivity

- 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*: mantain 95% of genetic diversity over 100 years, t generations

* Subpopulations functionally connected

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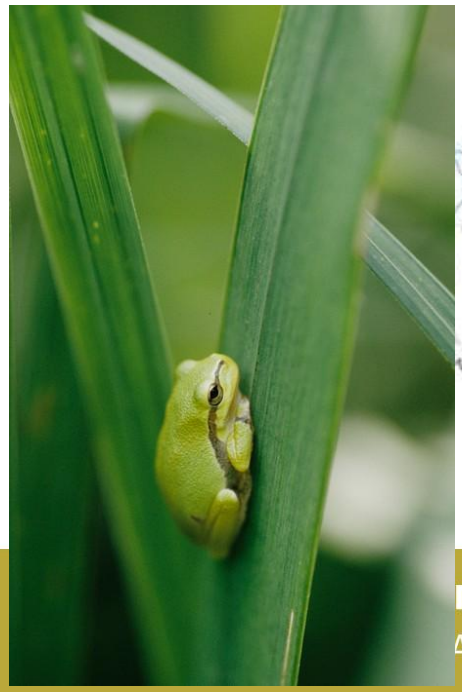
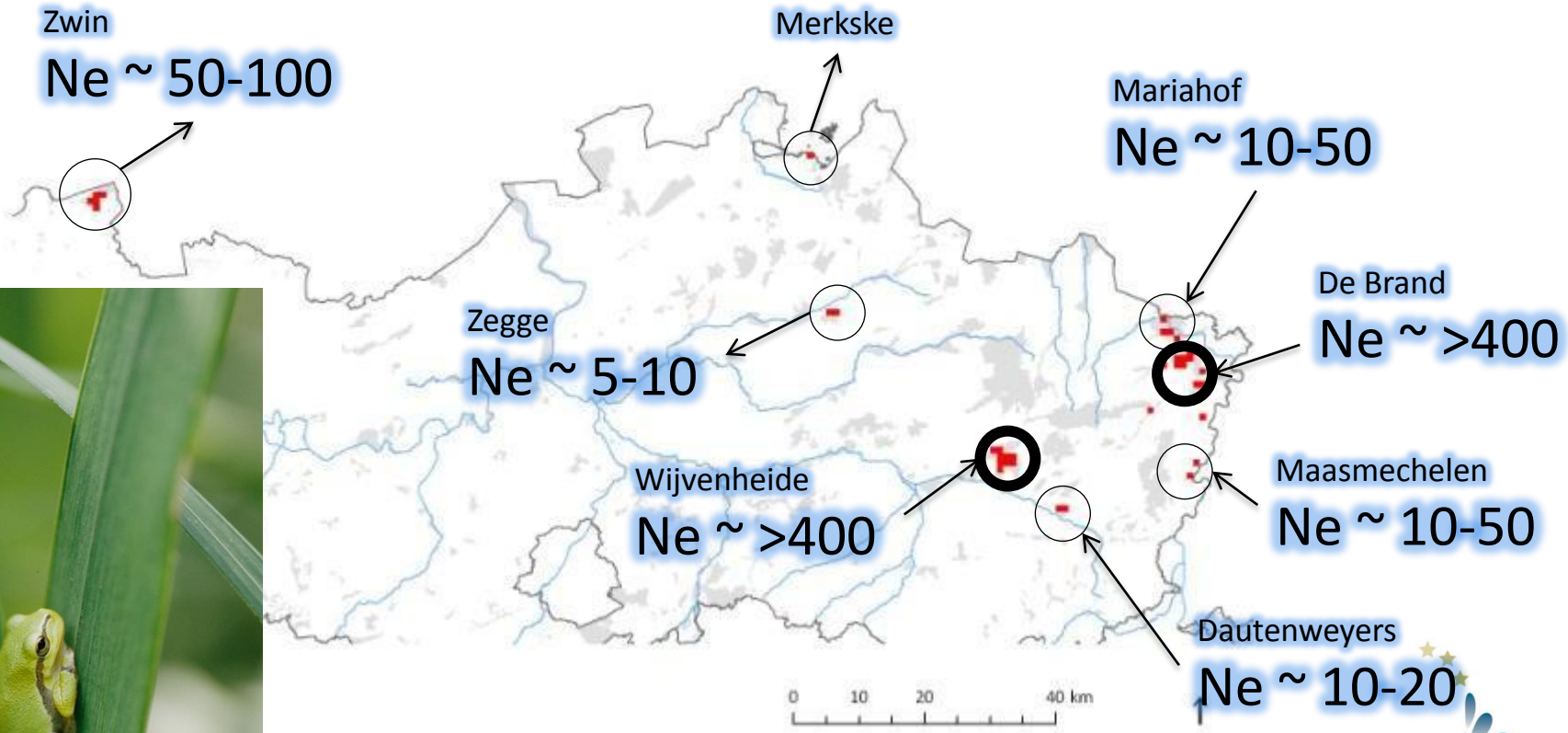
Metapopulation size

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





Metapopulation size

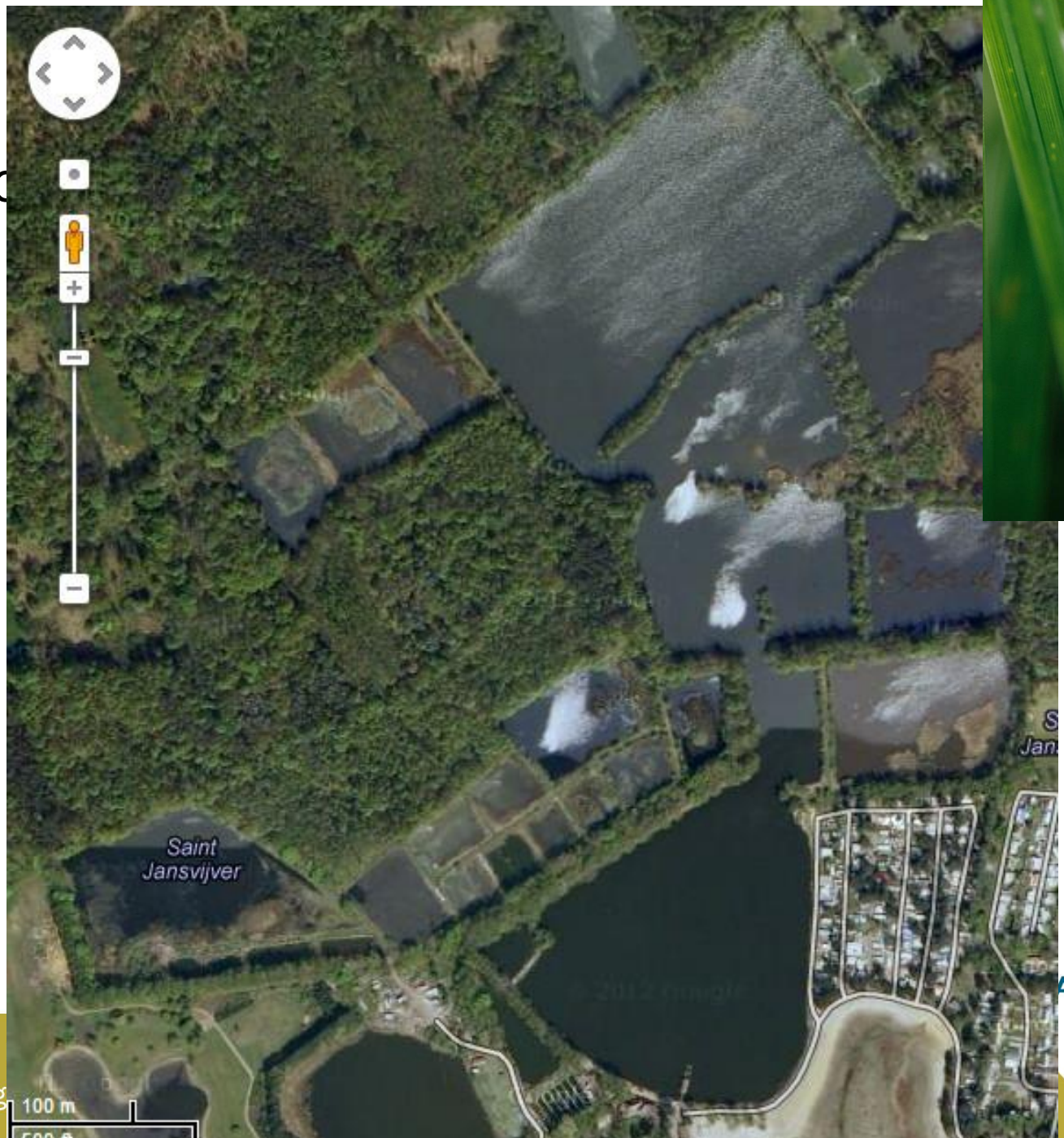
- Common tree frog, Hyla arborea. $N_{e,95}$ = 244
- Majority of current “metapopulations” too small
- Most isolated populations or metapopulations cannot be connected functionally to other populations
  - ➔ **enlarging only option**

Metapopulation size

Common tree frog, Hyla arborea in Vijvergebied

- 2000: isolated small population

- Co



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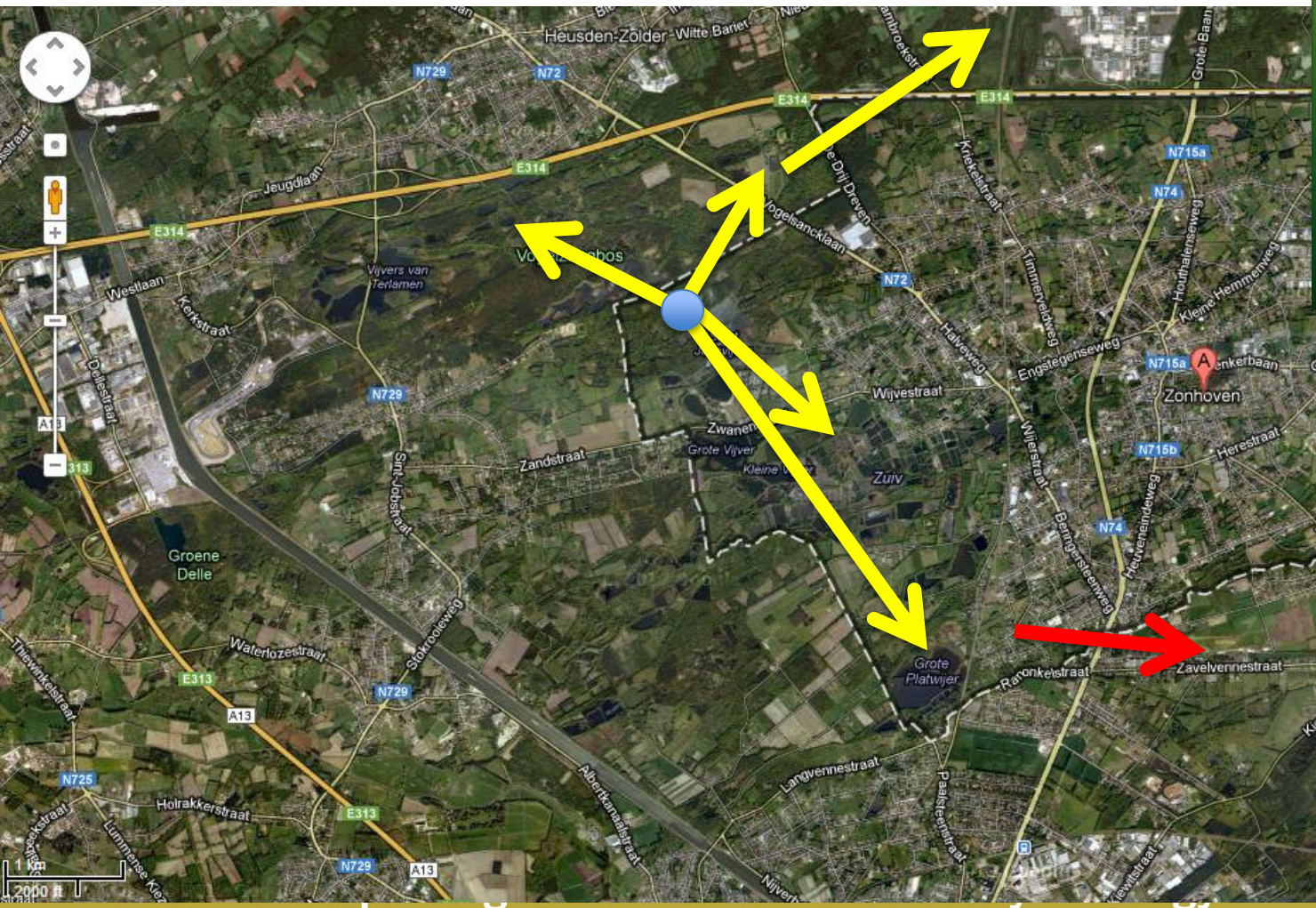

Metapopulation size

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

- **Lawton**, J. H., P. N. M. Brotherton, V. K. Brown, C. Elphick, A. H. Fitter, J. Forshaw, R. W. Haddow, S. Hilborne, R. N. Leafe, G. M. Mace, M. P. Southgate, W. J. Sutherland, T. E. Tew, J. Varley, and G. R. Wynne. 2010. Making Space for Nature: a review of England's wildlife sites and ecological network. Report to Defra.

- **Jaeger**, J. A. G., T. Soukup, L. F. Madriñán, C. Schwick, and F. Kienast. 2011. Landscape fragmentation in Europe. Joint EEA-FOEN report. EEA, Copenhagen, Denmark.

- **Ovaskainen**, O. 2012. Strategies for Improving Biodiversity Conservation in the Netherlands: Enlarging Conservation Areas vs. Constructing Ecological Corridors. Helsinki University, Helsinki, Finland.