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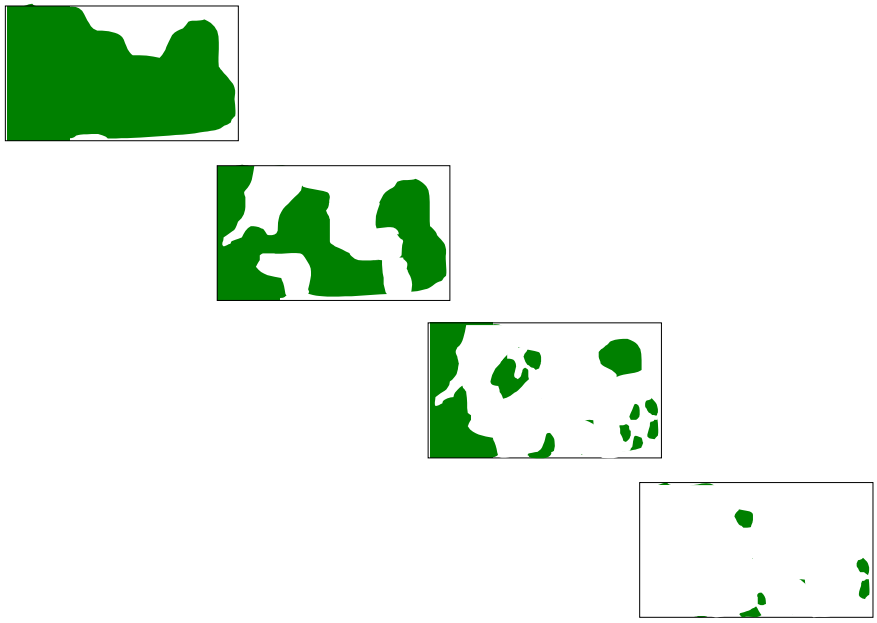
Effective protection of the Annex IV species of the EU-Habitats Directive: The landscape approach



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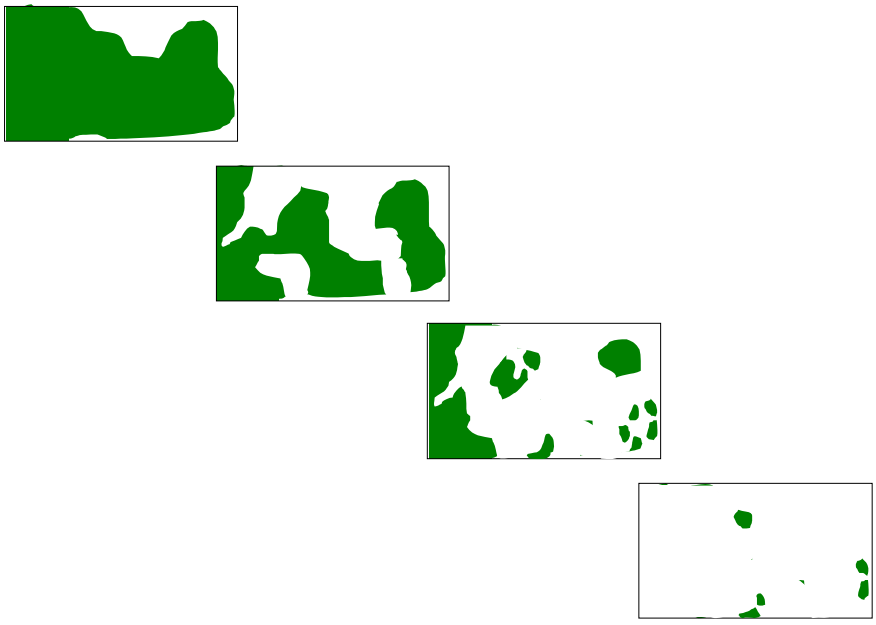
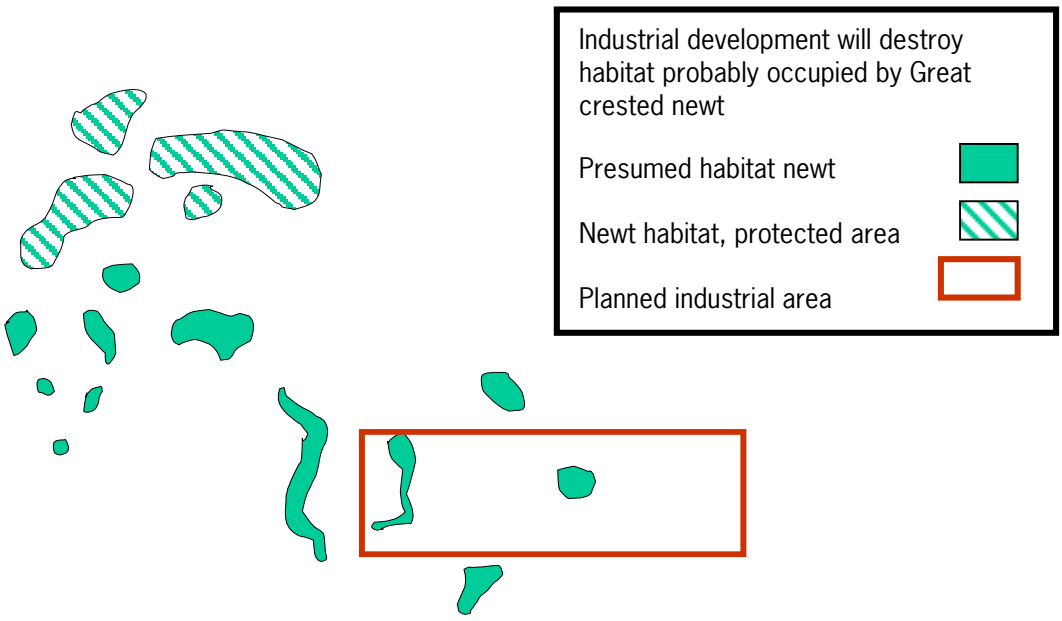


1. Why use this book?

➢ If you recognise the following problem ……

A planned industrial area (red block) will partly cover two patches of natural habitat



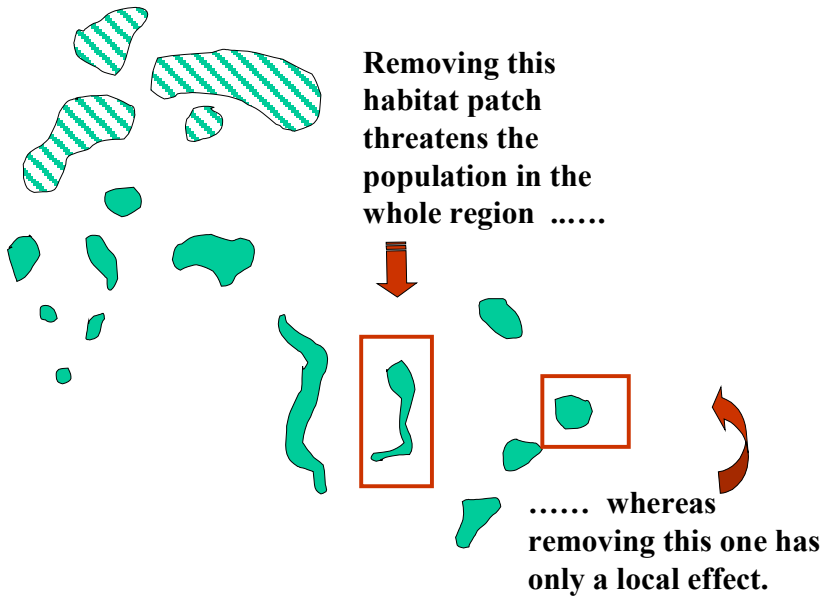
(green), in which individuals of the Great crested newt have been observed several years ago. It also occurs now and then in similar habitat patches elsewhere in the region, some of which are designated as habitat protected under the EU-Habitats Directive (green, hatched). Environmental pressure groups claim that the plan should be stopped, because of significant damage to a species protected under the EU-Habitats Directive, Annex IV.

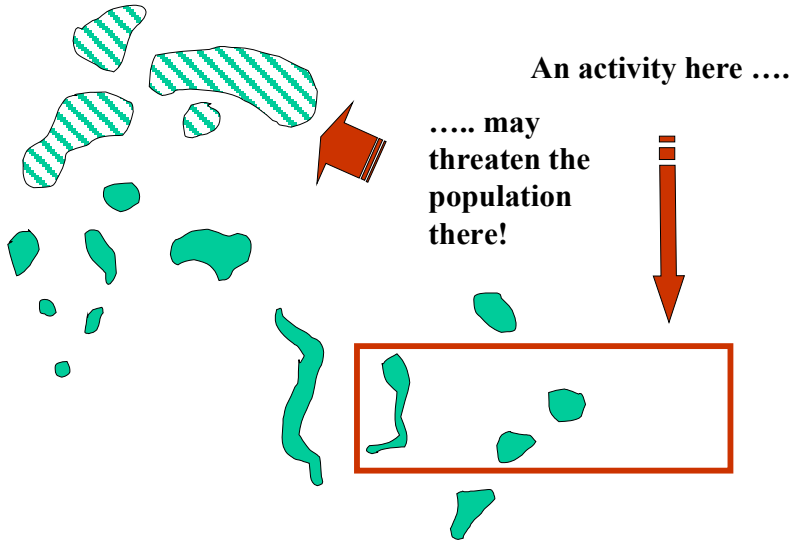
➢ …… then ecological networks may be helpful !

- Because the future of the newt population depends on the ecological network
- Because habitat network planning (the landscape approach) may show you a way out of the controversy

Network ecology learns that:

- The effect of the planned action may be found kilometres away
- A planned action affecting one site may do little harm at the landscape level
- The impact of a particular development depends on the network cohesion
- There are often several alternatives to compensate a particular damage





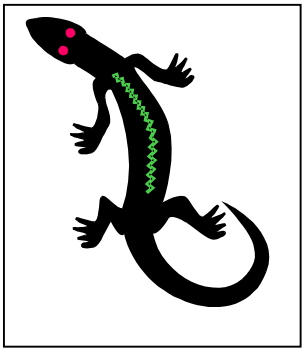
2. Species conservation goals of the Habitats Directive

- 'Conservation status of a species' is the conditions allowing the long-term distribution and abundance of populations (Article 2).

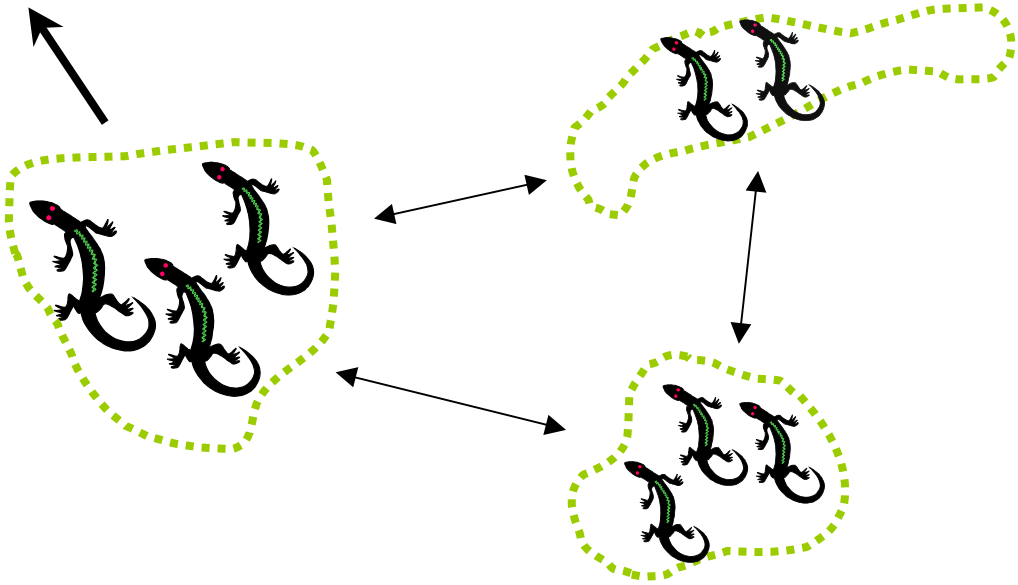
- 'Conservation status will be taken as favourable when':
  - the population dynamics data indicate that a species is maintaining itself on a long-term basis in its natural habitat,
  - the natural range of the species is not being reduced now or in future,
  - there is and probably will be a sufficiently large habitat for long-term persistence.

- This requires two basic conditions for persistence:
  - quality of habitat (allowing enough reproduction),
  - habitat area (to prevent extinction by accident).

Individual fate and population persistence



Catching and killing individuals or removing eggs may, but should not, decrease local population size. Effects may be compensated by local demographic processes and by immigrants form elsewhere in network.



3. Why choose ecological networks as the basis for species conservation under the Habitats Directive?

➢ *Why is a single piece of habitat not enough?*

In our human-dominated world, habitat sites often are too small for long-term persistence. Small sites contain small populations that are likely to go extinct by chance processes. Studies on metapopulations, networks of local populations interacting by dispersing individuals, learn that while local populations are not stable, networks can be. Therefore, the conservation goals of the Habitat Directive are only effective if networks with enough spatial cohesion can be protected, or restored.

➢ *Which species are most vulnerable to fragmentation?*

- Species with small dispersal capacities, particularly ground-moving species: for example snakes and lizards, frogs and toads, and quite a number of insects en plants
- Species with large area requirements: for example medium sized and large mammals

➢ *Which ecosystems are most fragmented?*

Forest, heath, semi-natural grasslands and fresh water marsh ecosystems.

Vulnerable species in highly fragmented ecosystems are fully depending on sound network conservation!

➢ *When should biodiversity conservation be based on habitat networks?*

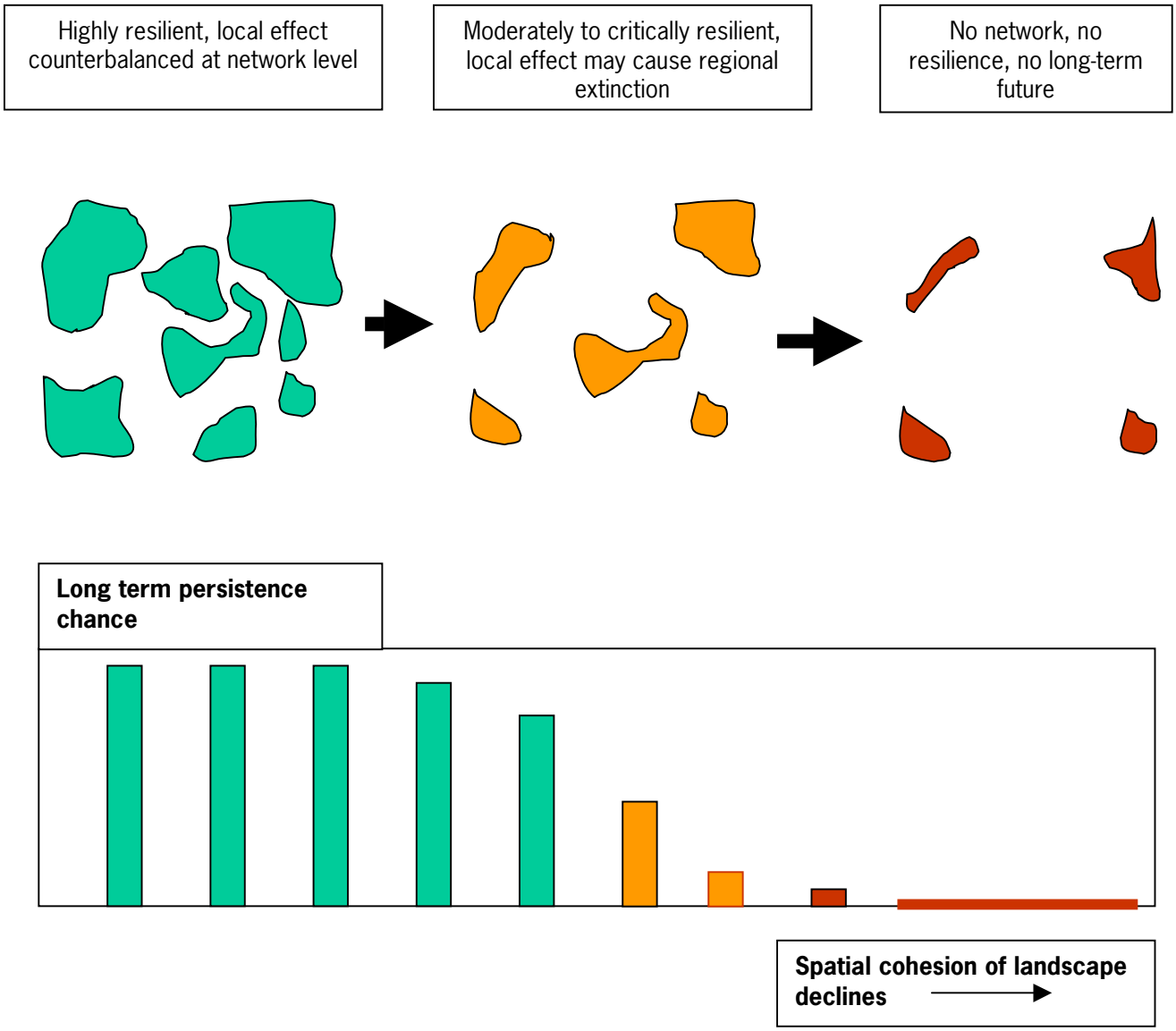
- If nature reserves are so small that sustainability is only possible as a network
- If species are often absent and occur in small numbers in suitable habitat
- If species in fragmented landscapes will be affected by climate change

➢ *What determines the conservation potential of habitat networks?*

How safe a landscape is for species survival, can be expressed by the quality index **spatial cohesion.** Spatial cohesion encompasses four components:

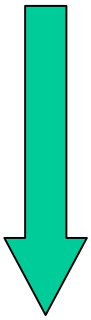
a) habitat quality (soil, groundwater, nature management),
b) total network area,
c) configuration (distribution of habitat across the landscape area),
d) landscape permeability (barriers, corridors etc.).

The higher spatial cohesion, the better the network population is in the landscape resilient to local and regional disturbances.



- *Activities may have impacts at long distances. This depends on species specific scales in the landscape*
  (From: Broekmeyer, M.E.A. & Steingröver E.G. (eds.), 2002. Alterra-report, Wageningen, in Dutch)

Increasing area requirements



Increasing dispersal distance

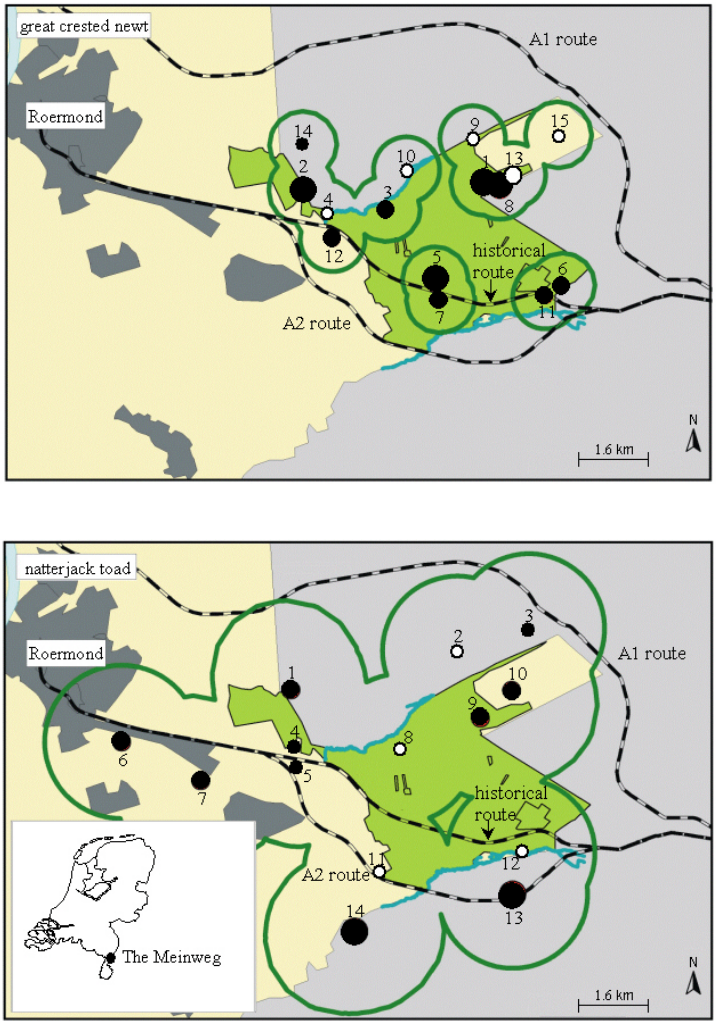
	Key patch < 0.1 km^2	Key patch 0.1 – 1 km^2	Key patch 1- 5 km^2	Key patch 50-150 km^2
0 – 1 km	Dusky large blue	Great crested newt		
1 – 3 km		Natterjack toad	Smooth snake	
3 – 7 km		Root vole		
15-25 km			Beaver	
> 35 km				Otter

- Species that form a network on a large spatial scale (large dispersal capacity and large area requirements) will be affected by human activities over a larger distance than small scaled species.

- The effect of a planned activity should always be assessed at two levels: the site level (the local habitat patch) and the network level. The extension of a network depends on the ecological scale of the species, and on the spatial extension of the network. If habitat fragmentation is moderate to small over large landscape areas, habitat networks may extend over hundreds of kilometers. However, the effect of a local measure on the persistence of the species in this network is then neglicible. In small networks, a deterioration of a local patch may affect the regional persistence of a species.

➢ *An example: different species have different spatial scales*
(From: Wieman, E.A..P., R.J.F. Bugter, E.A. van der Grift, A.G.M. Schotman, C.C. Vos & S.S.H. Lighthart, 2000. Alterra-report 081, Alterra, Wageningen, in Dutch)

Two species, two spatial scales: the Great crested newt has a smaller dispersal capacity compared to the Natterjack toad and therefore the habitat networks are smaller



The green lines represent the networks of the Great crested newt (above) and the Natterjack toad (below) in and around the National Park the Meinweg (green area) near the city of Roermond, the Netherlands. The inset shows the location of the Meinweg on the border with Germany (grey area). The circles denote the habitat patches; white means unoccupied, black means occupied; the size corresponds to the ability to sustain a small, medium, or large population. The buffers surrounding the local populations indicate the maximum dispersal distance, resulting in four separate habitat networks for the Great crested newt and one habitat network for the Natterjack toad. The historical route of the railroad and the two alternatives are shown.

4. Intermezzo: the scientific basis (1)

This book is based on the results of scientific research published in peer-reviewed journals. Spatial ecology and landscape ecology is fast growing branches on the science tree. In Europe, major research groups in spatial ecology are in the UK (Leeds, Prof. Thomas), Finland (Helsinki, Prof. Hanski), France (Montpellier, Dr. Olivieri), Germany (Leipzig, Prof. Wissel) and The Netherlands (Wageningen, Prof. Opdam). The Dutch research centre Alterra (Wageningen, NL) is leading in developing metapopulation ecology as the basis for conservation, landscape planning and landscape design.

Some literature for further reading

Frank, K. and Wissel, C. 1998. Spatial aspects of metapopulation survival - from model results to rules of thumb for landscape management. Landscape ecology 13: 363-379.

Groot Bruinderink, G., Sluis, T. van de, Lammertsma, D., and Opdam, P. 2002. The assessment of a tentative, coherent ecological network for large mammals in Northwest Europe. Conservation Biology (in press).

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Thomas, C.D. and Kunin, W.E. 1999. The spatial structure of populations. Journal of Animal Ecology 68: 647-657.

Verboom, J., Foppen, R., Chardon, P., Opdam, P. and Luttikhuizen, P. 2001. Introducing the key patch approach for habitat networks with persistent populations: an example for marshland bird. Biological Conservation 100: 89-101.

Vos, C.C. and Chardon, J.P. 1998. Effects of habitat fragmentation and road density on the distribution pattern of the moor frog *Rana arvalis*. Journal of Applied Ecology 35: 44-56.

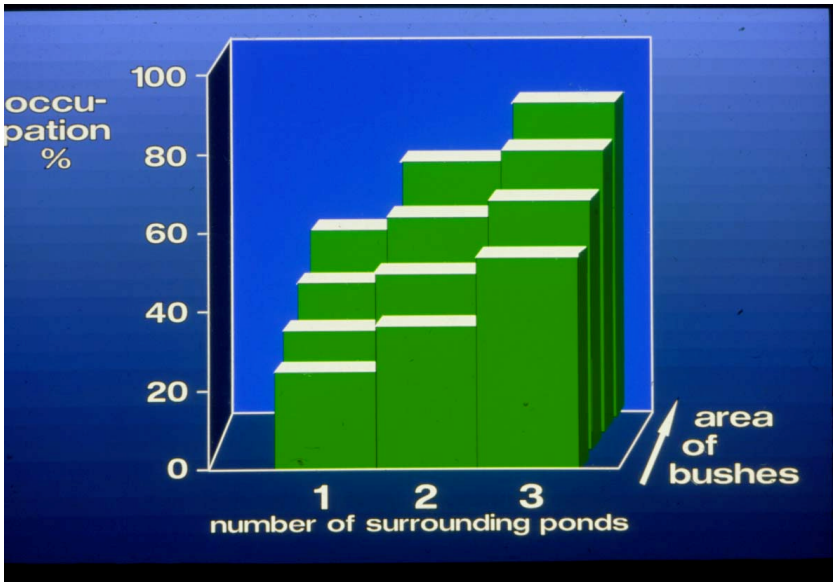
Vos, C.C., Ter Braak, C. J. F. and Nieuwenhuizen, W. 2000. Empirical evidence of metapopulation dynamics; the case of the Tree frog (Hyla arborea). Ecological Bulletins 48: 165 -180.

Vos, C.C., Verboom, J., Opdam, P.F.M. and Ter Braak, C.J.F. 2001. Towards ecologically scaled landscape indices. American Naturalist 157: 24-51

Intermezzo: the scientific basis (2)

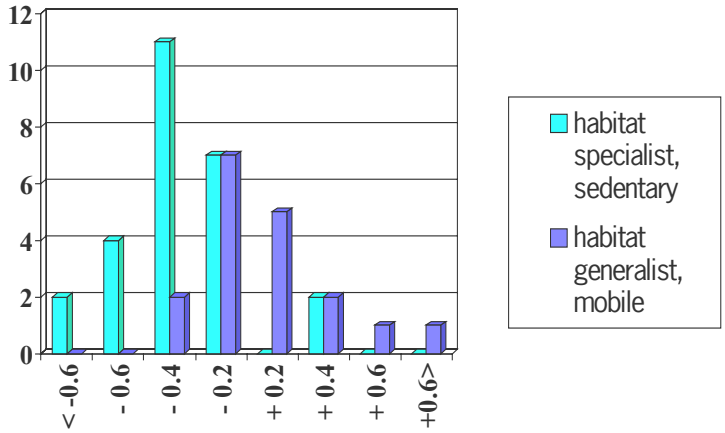
- *Two examples from research illustrating why networks give a better protection if the landscape is fragmented.*
  (From: Vos, C.C. & A.H.P. Stumpel, 1996. Landscape Ecology 11: 203-214 and From: Warren, M.S, Hill, J.K., Thomas, J.A., Asher, J.A., Fox, R., Huntley, B., Roy, D.B., Teffer, M.G., Jeffcoate, S., Harding, P., Jeffcoate, G., Willis, S.G., Greatorex-Davies, J.N., Moss, D. & Thomas, C.D. 2001. Nature 414: 65-69)

A better network ensures higher effectiveness of protection measures



Patch occupency by the tree frog increases when the density of ponds and bushes in the surrounding area increases.

Networks ensure a better protection against impacts of climate change



Y-axis: species number
X-axis: relative change

Changes in distribution sizes of butterfly species in Britain between 1979-1999. A warmer climate allows species to expand their range north, but this phenomenon is only shown in mobile species with a broad habitat choice (blue bars). Most sedentary species with special habitat choice decrease in range (green bars).

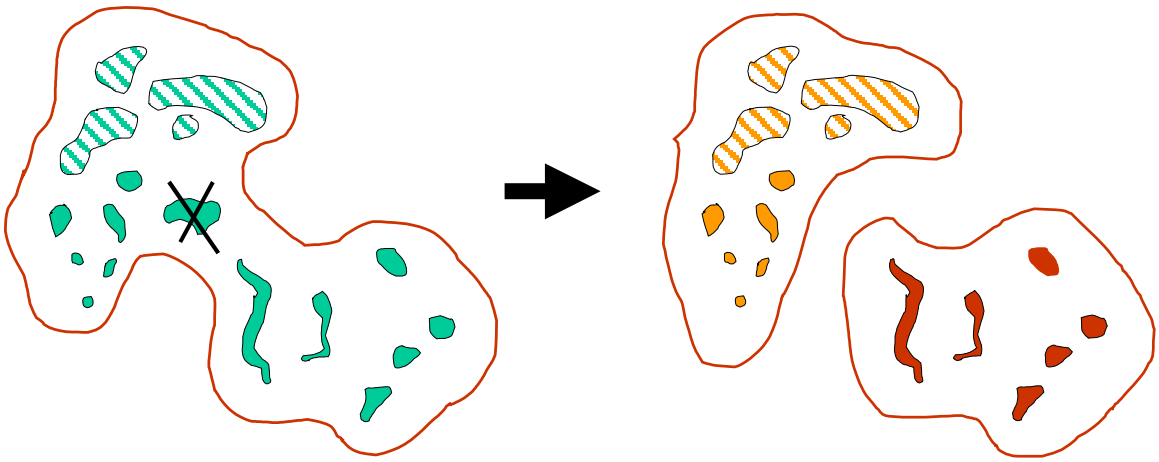
5. Assessing effects of landscape change on ecological networks

- Potentially, any landscape change affecting network cohesion may decrease network sustainability
- This depends on species: flying species may not be affected by infrastructure barriers, whereas walking species are

Three types of impact on network	Examples of activities causing impact
a. Destruction of (part of) habitat patch	Urban expansion, industrial plant, highway
b. Decreasing habitat quality of a patch	Recreation use, drinking water extraction, drainage, traffic noise
c. Decreasing connectivity in landscape	Highway, water channel, removing hedgerows or tree lines

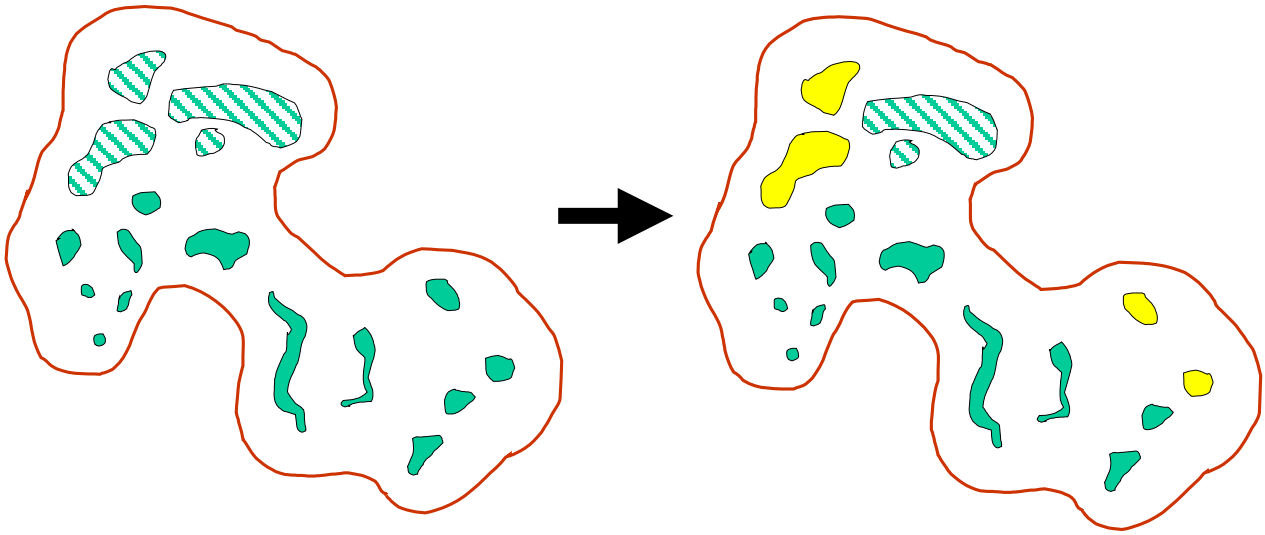
- *Impact by habitat destruction:*

Removing the black crossed patch divides the network in two halves (the resulting gap is too wide for the dispersal): the red network is non-viable, the orange one is near the critical viability threshold



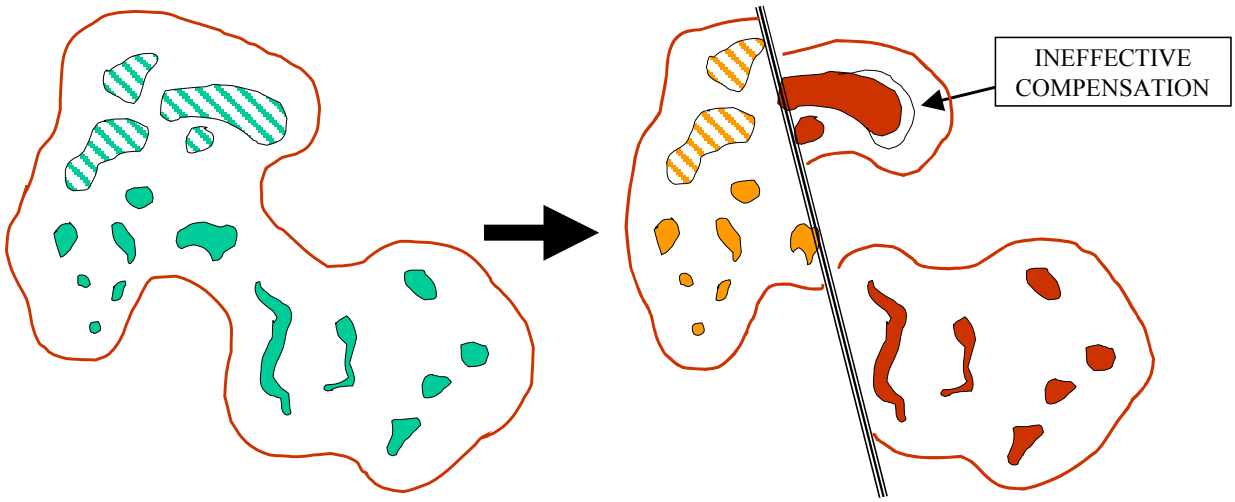
➢ *Impact on habitat quality:*

Both activities inside (e.g. wrong management) and outside the network area (e.g. an increase in drinking water extraction) may influence habitat quality, resulting in four (yellow) patches of poor-quality habitat, where the species can live but cannot reproduce. The whole network gets close to the critical viability threshold: it is still viable if everything goes well, but its resilience to disturbance is much smaller.

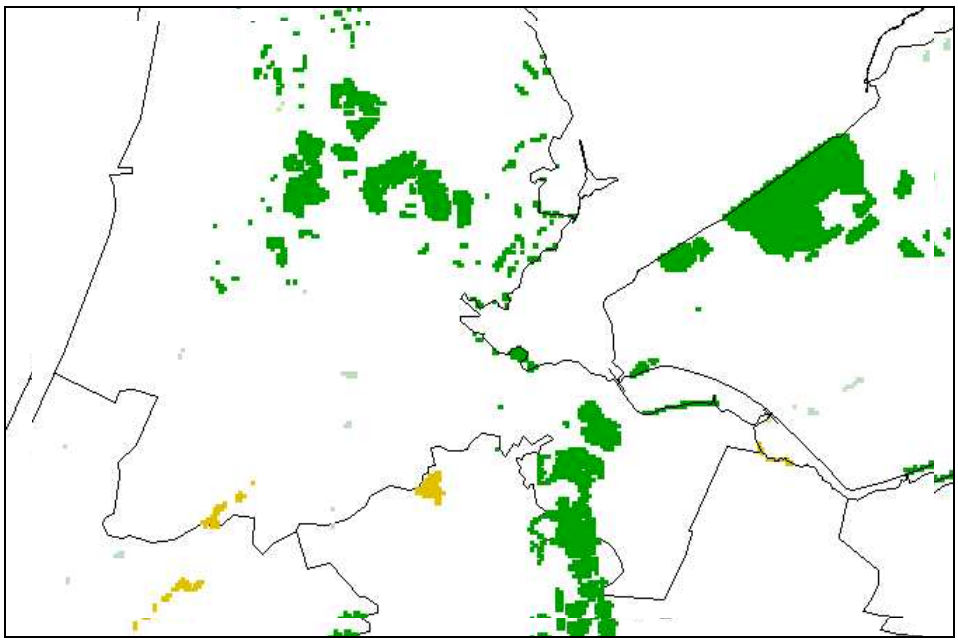


➢ *Impact by decreasing permeability:*

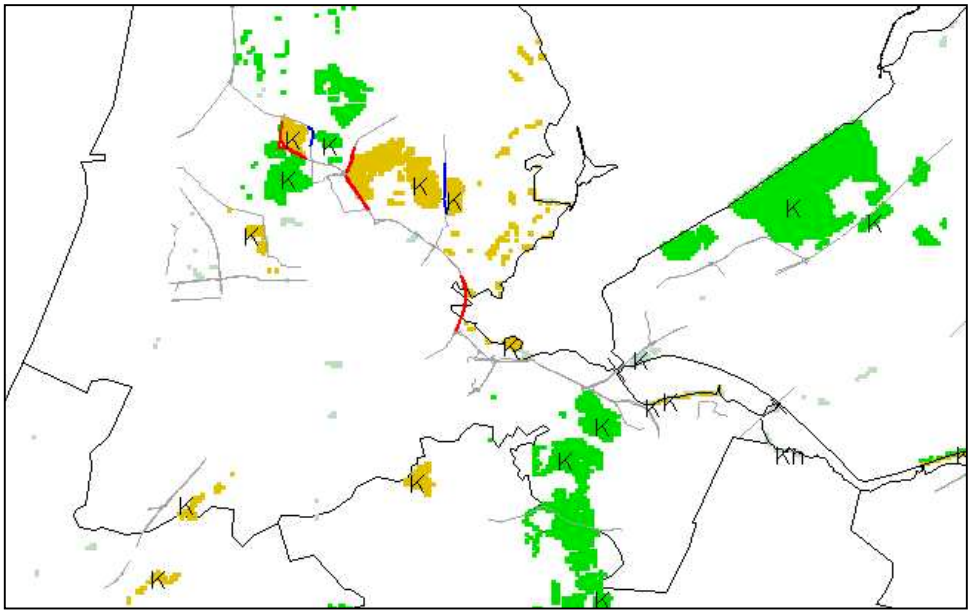
A highway is projected through the network of a tree frog. Up to now, no wild life passage is planned. The highway hits protected habitat area, and it is expected that the lost area is compensated by increasing the patch area on the right side of the road. However, in reality, the occurrence of the tree frog is depending on the whole network, which is now cut into three parts. Two of them, including the one where compensation is planned, are non-sustainable. Only the orange one is critically sustainable, including two protected habitat areas.



- *An example: assessment of spatial cohesion of habitat networks of Root Vole (Microtus oeconomus) in part of The Netherlands.*



Without effect of barriers

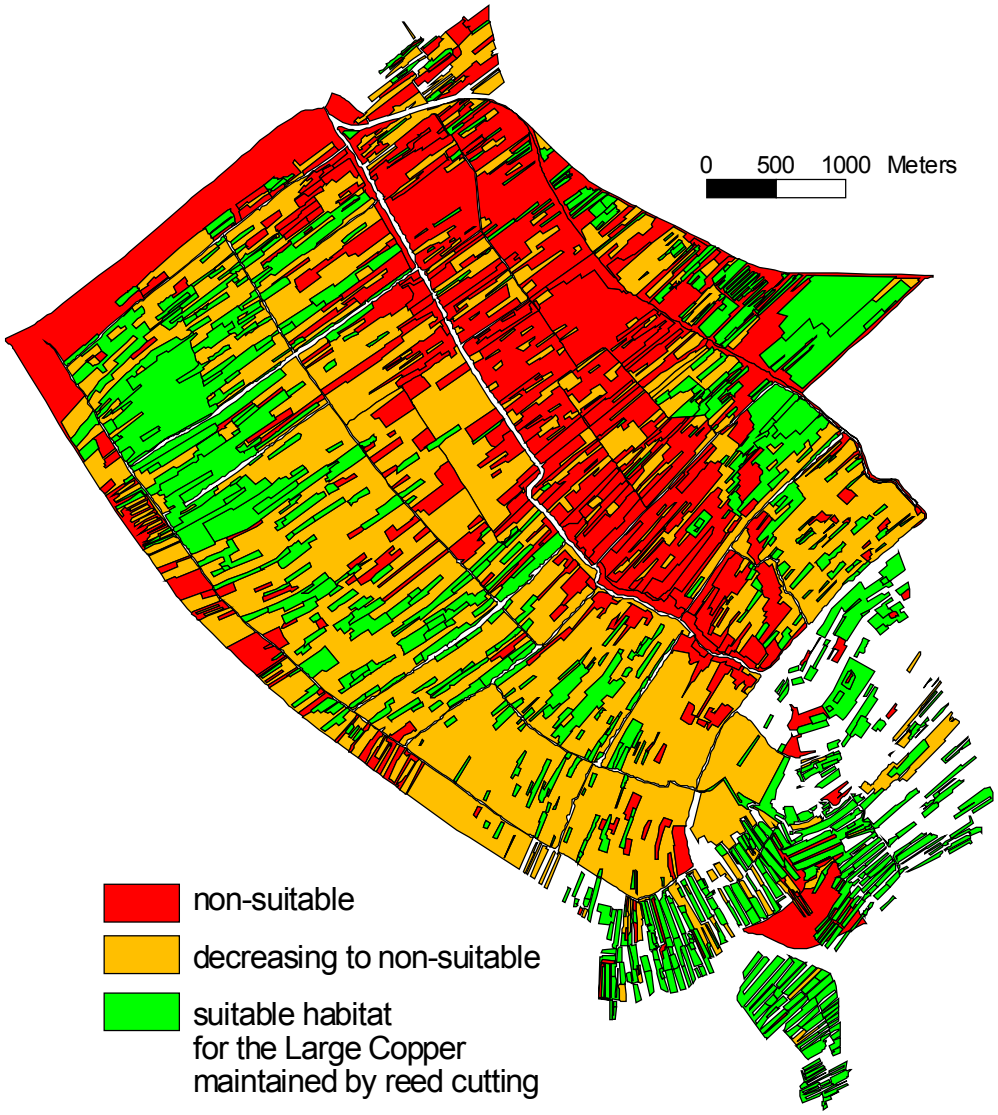


With barrier effect of roads

Grey areas indicate non-sustainable networks; yellow areas indicate sustainable networks; and green areas indicate strongly sustainable networks.
Red lines are highways; blue lines other important roads; and grey lines represent roads of less importance (differing in barrier effect).

- *An example: the impact of management on Large copper (Lycaena dispar) in the Weerrribben area in the north of The Netherlands.*
  (From: Sanders, M.E. 1999. Remotely sensed hydrological isolation. A key factor predicting plant species distribution in fens. Thesis Wageningen University, Wageningen)

The Large copper needs open, early successional reedlands. Improper or discontinuing management will change suitable habitat in unsuitable habitat, leading to a less cohesive habitat network.



6. Preventing and restoring damage

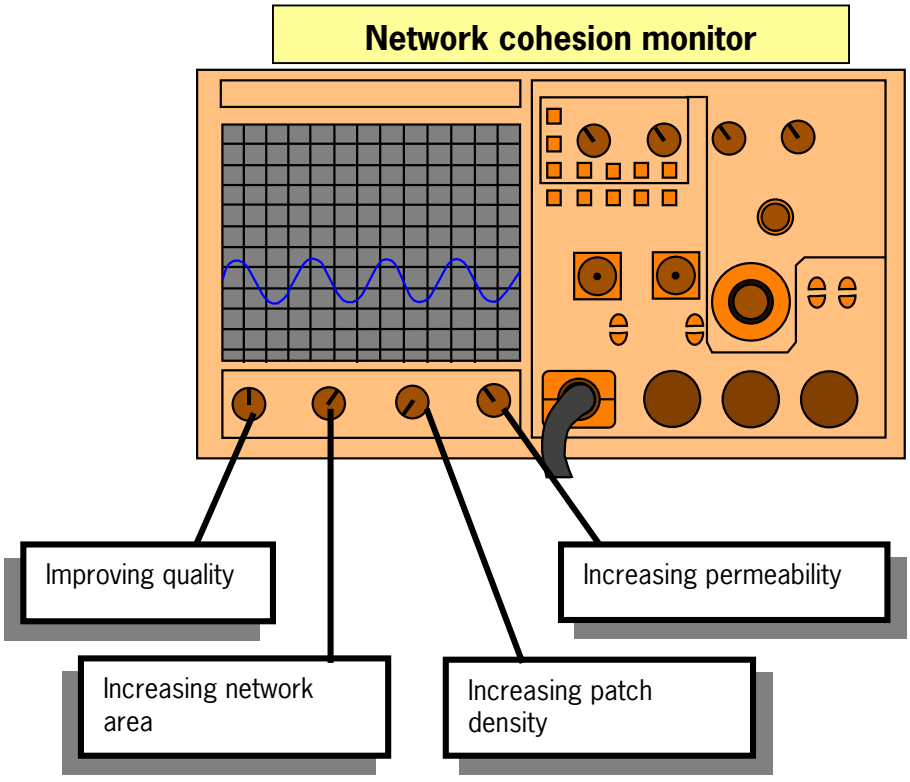
What if some activity will cause a network to become less cohesive, or even non-sustainable for a species?

What if the balance between local extinction and recolonization in a metapopulation will be disturbed?

➢ *To restore the network, one or more of the following components of spatial cohesion can be improved:*

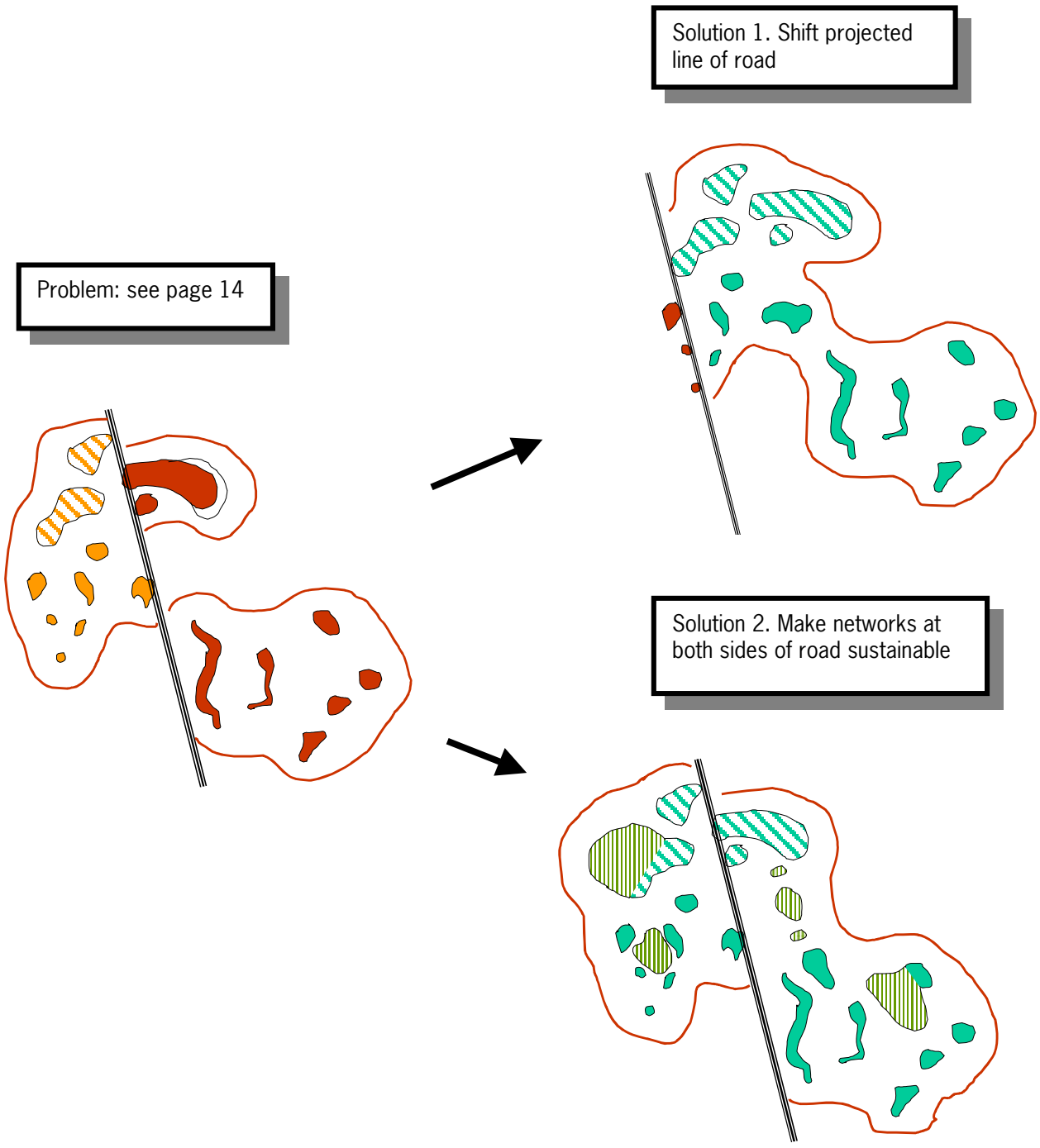
- quality of one big or several small patches,
- total network area, e.g. by enlarging largest patch, or by connecting 2 networks,
- patch density, by inserting extra patches,
- connectivity of landscape, e.g. by corridor or stepping stones.

So when restoring a habitat network for persistence of an Annex IV species, we can choose between alternatives !



Alternative options:

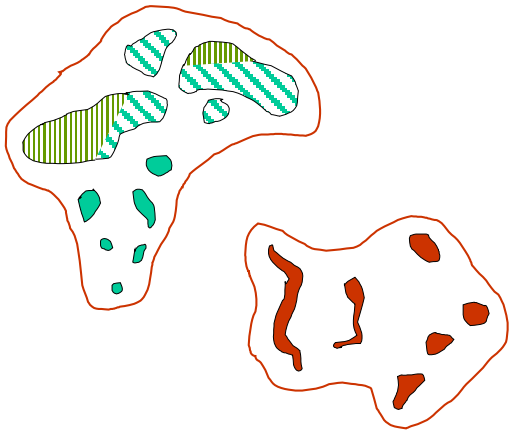
- *Choosing between strategies: example 1*



Alternative options

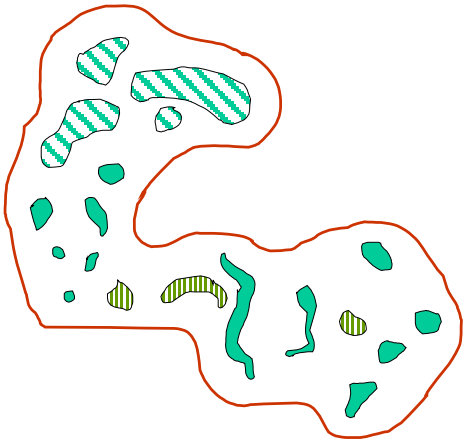
➢ *Choosing between strategies: example 2*

Solution 1. Make the best network sustainable by increasing the two largest patches



Problem: see page 13

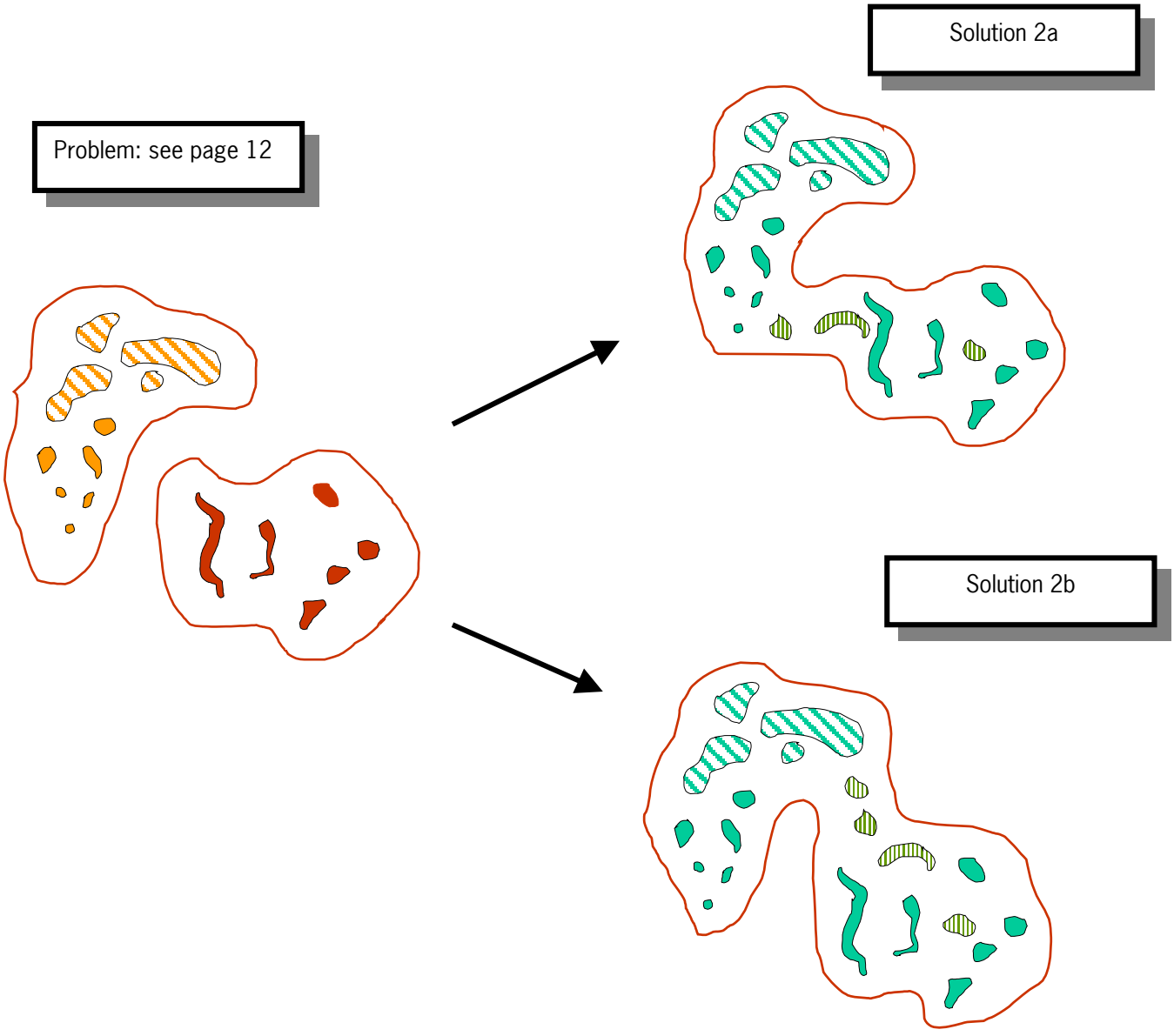
Solution 2. Connect the two networks and increase patch density



Alternative options

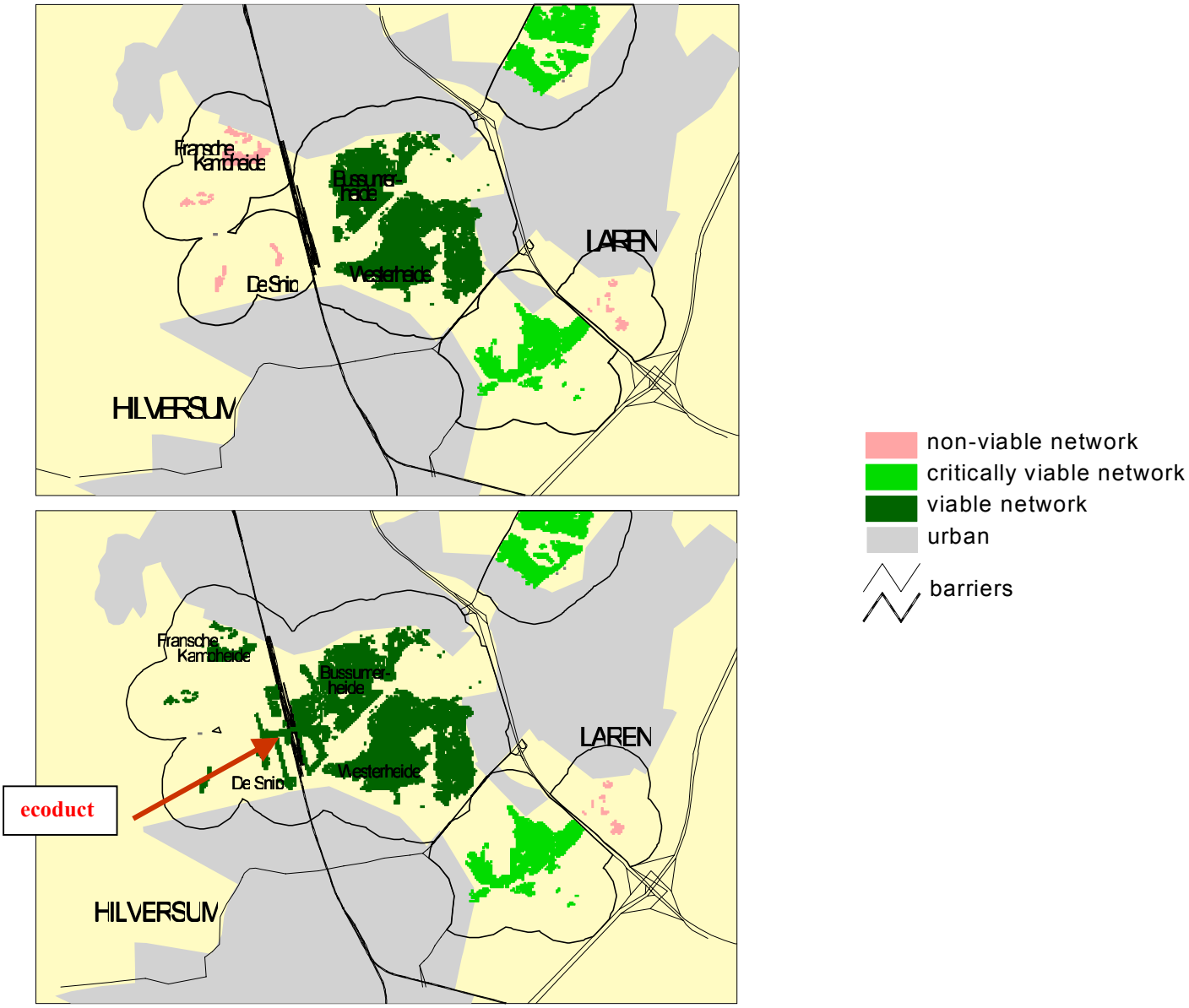
- *Find the best location:*

There is more than one way to connect the networks and increase patch density



Different locations for increasing habitat network cohesion giving the same sustainability may differ in the compatibility with other land use functions

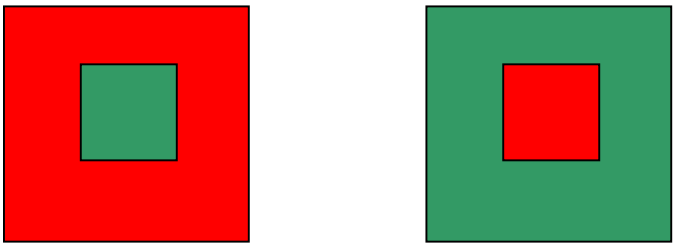
- *An example: effect of building a fauna passage (ecoduct) for the Sand lizard in part of The Netherlands.*
  (From: Van der Grift, E.A. & B.J.H. Koolstra (eds.), 2001. Alterra-report 168, Alterra Wageningen, in Dutch)



Effect of building a fauna passage (ecoduct) for the Sand lizard. Top picture: without fauna passage the network on the west side of the barrier is non-viable: it is too small and isolated.
Bottom picture: after building the ecoduct the non-viable network is connected to the larger network and has become viable.

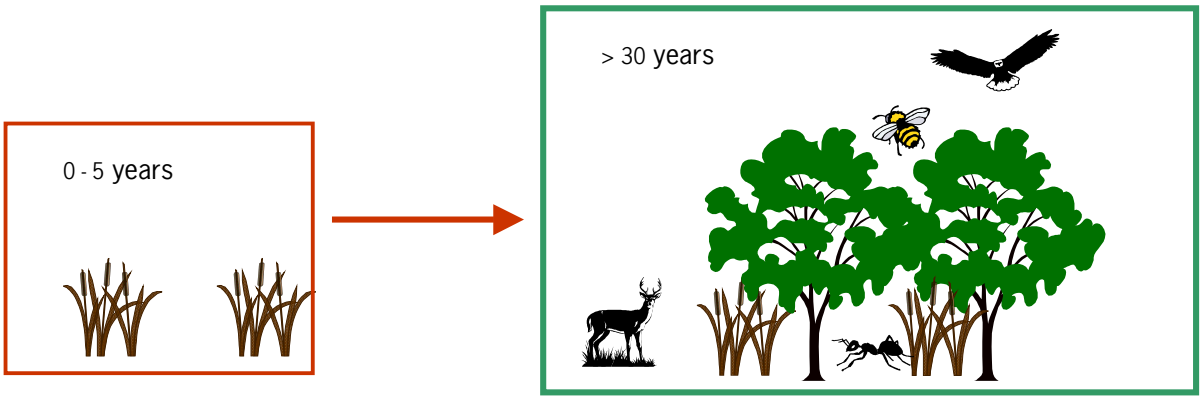
However, sometimes it is best to prevent any impact !

- Habitat development needs suitable conditions: availability of enough (ground) water of the right quality, and the amount of nutrients in soil and precipitation. Particularly for ecosystems depending on wet, nutrient poor soils it often is hard to find suitable conditions



Left figure: present situation in the Netherlands; nutrient-rich habitat (red) dominates nutrient-poor habitat (green). The nutrient-poor habitat will be strongly influenced by its surroundings.
Right figure: a better starting-point for creating new habitat.

- Another restriction is the time needed for development. Some ecosystems need 100 of more years to mature. This may take far too long before safe conditions have returned.



Low plant diversity
Low vegetation structure
Habitat not yet suitable for most animals

High plant diversity
High vegetation structure
Habitat suitable for high number of animals

7. Conclusions

1. The conservation aim of the Habitats Directive annex IV species is about long term persistence of populations.

2. In a world where most annex IV species find their habitat fragmented, long-term persistence of populations can not be ensured in local habitat sites, but require that these sites can interact in a habitat network.

3. Therefore, an effective implementation of the EU-Habitats Directive requires a landscape level approach: habitat networks.

4. An added advantage of habitat networks is that they allow alternative solutions to conservation problems in a multifunctional landscape. This may help in solving controversies in spatial planning, for example in finding the best place for compensation.

5. A network approach also learns that determining effects of activities on population persistence asks for a tailor-made approach. There is no such thing as a generic method that applies everywhere and for all species.

6. Neglecting the surrounding landscape in determining effects may cause serious underestimates of the significance of an impact.

7. The earlier in the planning process nature impacts are considered, the better both nature and public interests are served by applying the ecological network concept.

8. The landscape approach constitutes a scientific basis for active conservation of species, which at the same time considers public and economic interests.

Colophon

This report is a product of the Landscape Centre of Alterra – Green world research institute. It was commissioned by the Dutch Ministry of Agriculture, Nature management and Fisheries.

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