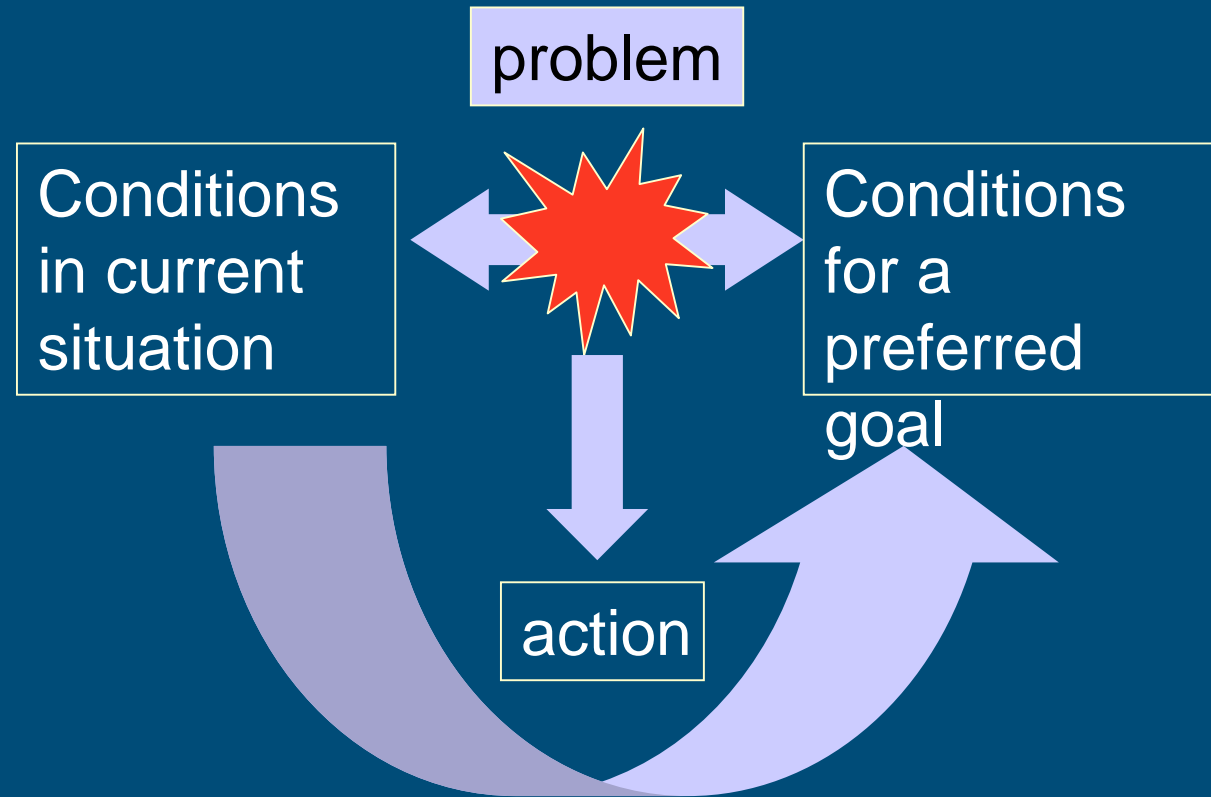


How to manage dynamic landscapes under climate change for biodiversity conservation?

Paul Opdam

Wageningen University - Land Use
Planning & Alterra - Landscape centre

Management: action to solve a problem



So what is the goal (of biodiversity conservation)?

- **Function**

- Regulatory function in ecosystem?
- Delivery of genetic resource?
- Specific fibre?

- **Species**

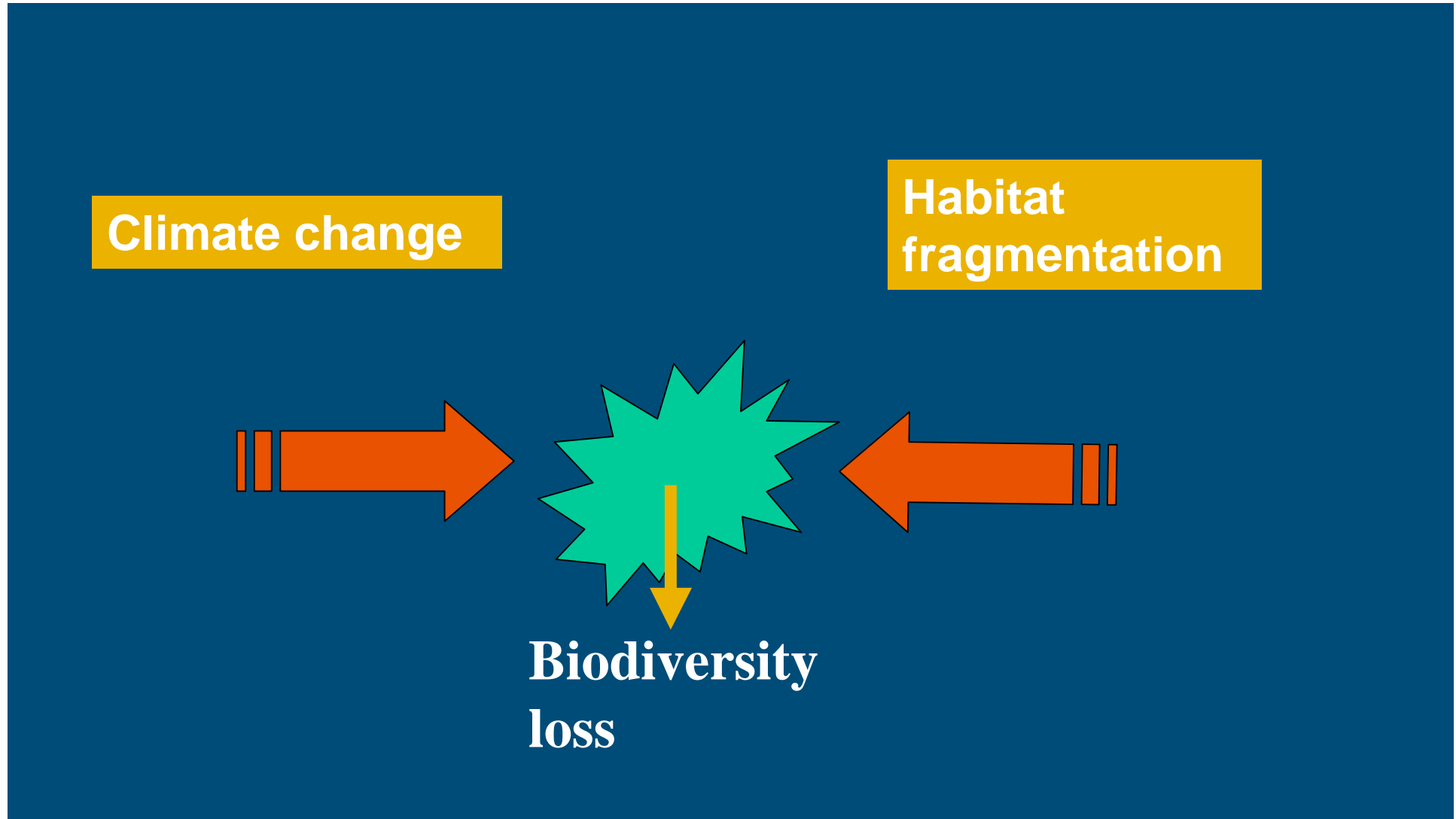
- Which species? European policy habitat directive? Regional policy?
- Abundance?
- **Persistence in a region?**
- Persistence on a larger level of scale?

So what is the goal?

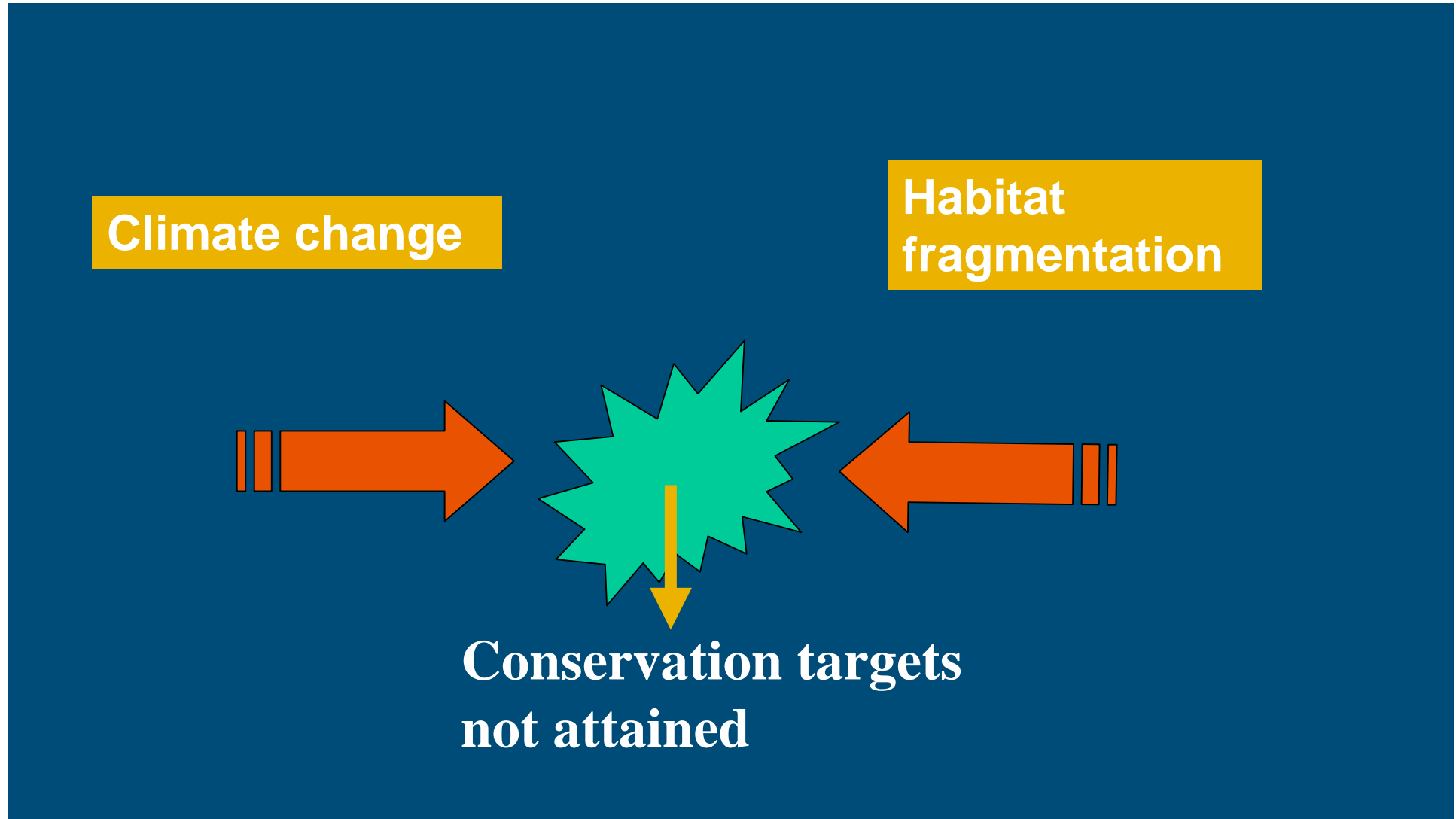
- Provide the conditions in a region that a species or a set of species will persist (with a certain probability)
- Habitat quality conditions
- Spatial conditions (if the landscape is fragmented)

What's the problem?

Problem: because it is likely that:



And if we decide that such a loss is a problem:



Then we have to adapt the landscape

Climate change

Fragmentation



We can't stop
climate change

So we must adapt
the landscape

Land use change: an opportunity for solving this problem or a threat aggravating it:

- Change in coverage and spatial distribution of ecosystem types (increase ecosystem fragmentation or the reverse)
- Change of habitat quality
- Infrastructural, urban and land use barriers appear and disappear

“We need a more offensive strategy”

A strategy that can be part of land development and spatial planning.

Tell politicians and planners what is necessary to attain the goals societies have agreed upon.

Which strategy effective?

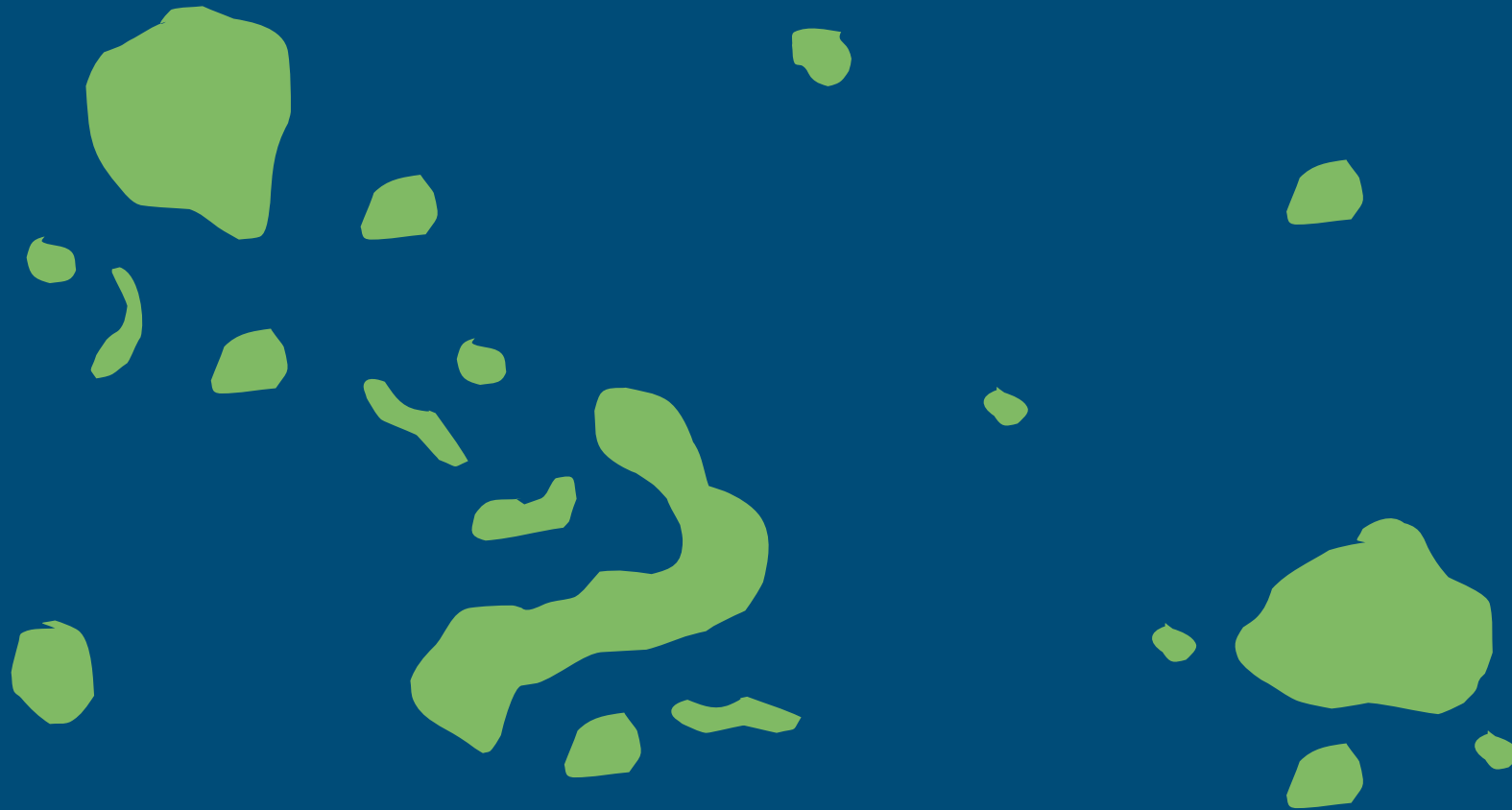
- Protected isolated areas?
- Large protected isolated areas?
- Ecosystem networks?
- Ecosystem networks with large key areas?
- A European network of ecosystem networks?

Unit of management: ecosystem network

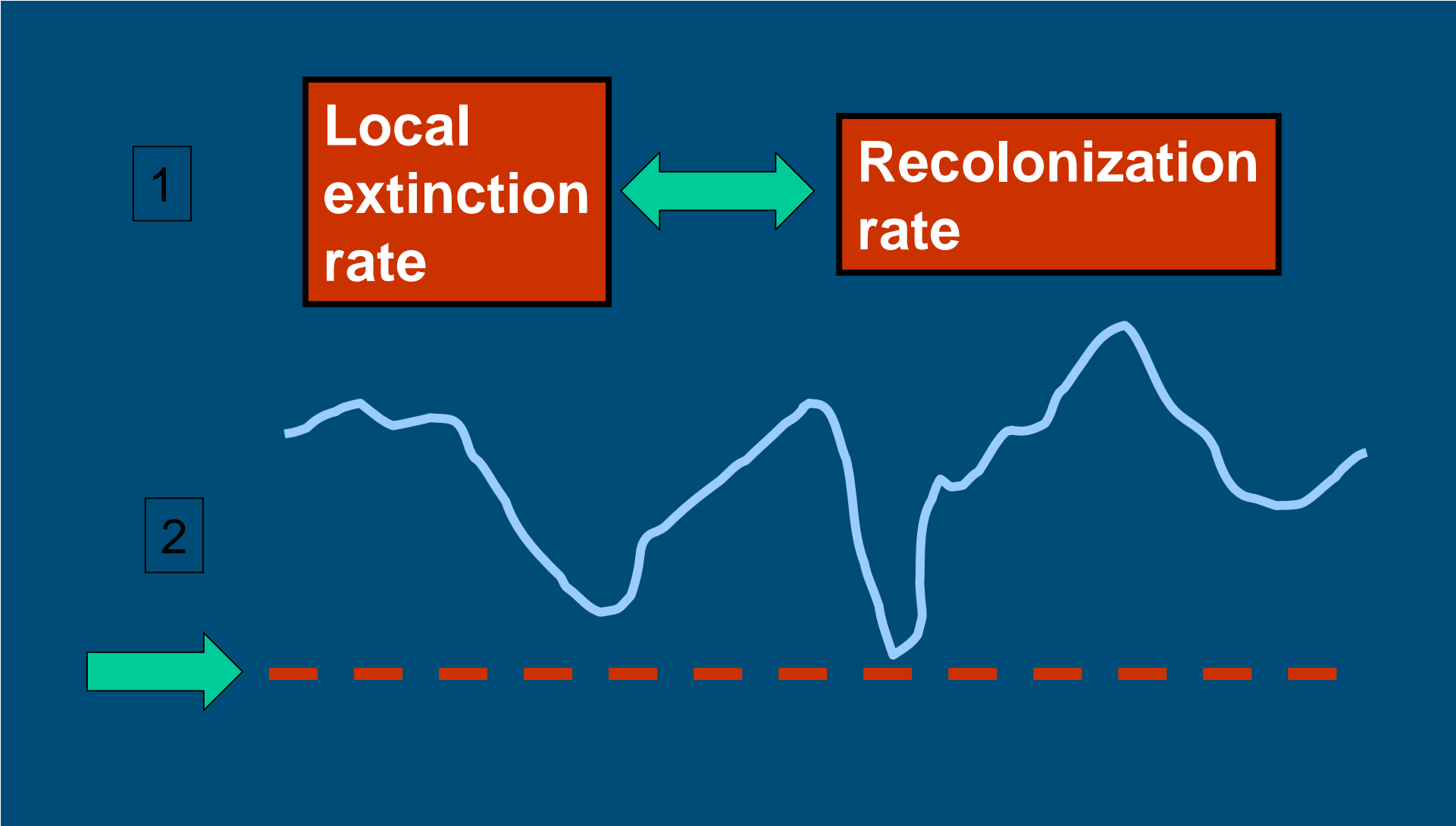
**Scale of management: landscapes and
regions**

ECOSYSTEM NETWORK

With network population(s)



Key processes in network populations



Network cohesion

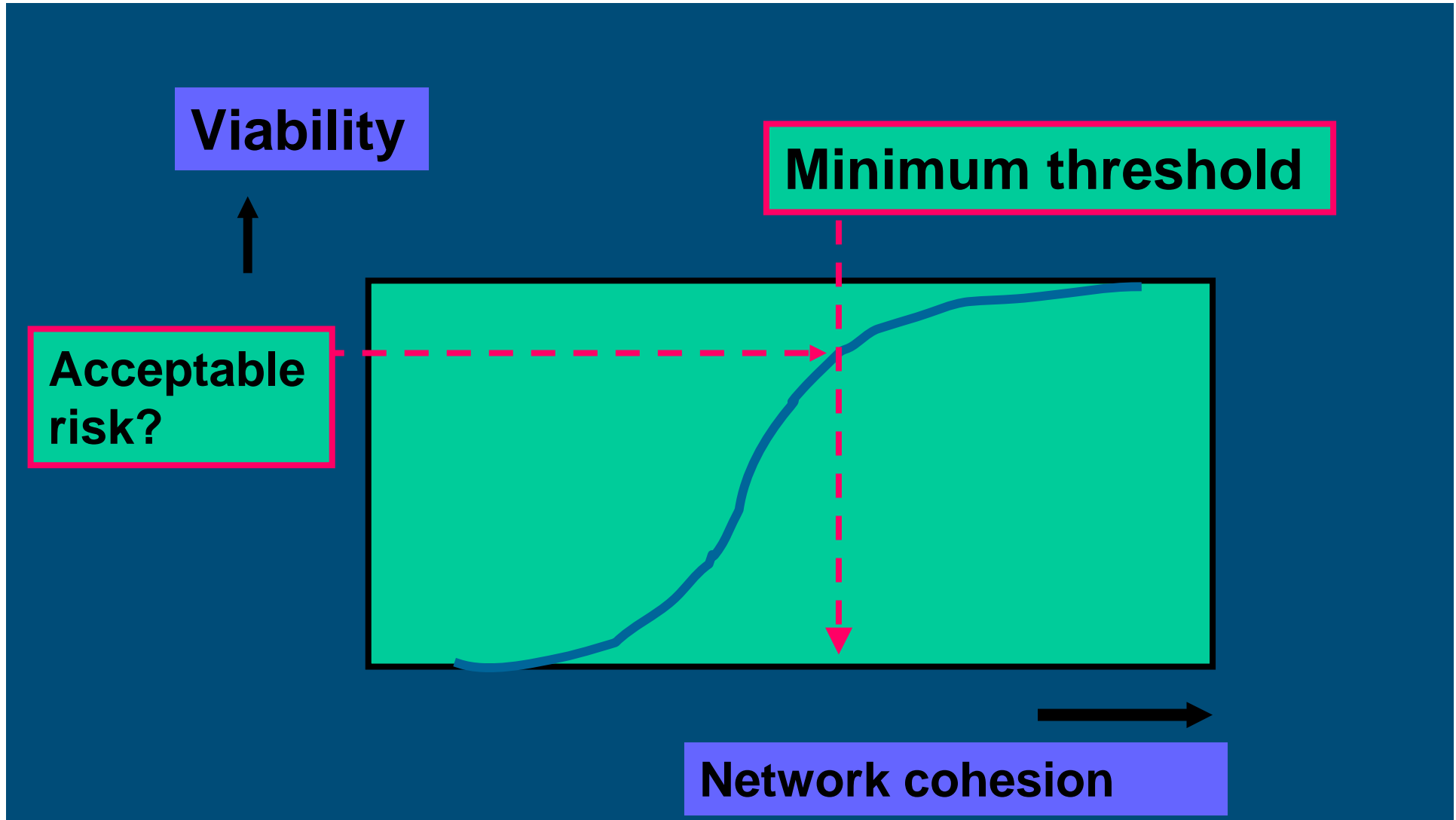
Patch
quality

Network
density

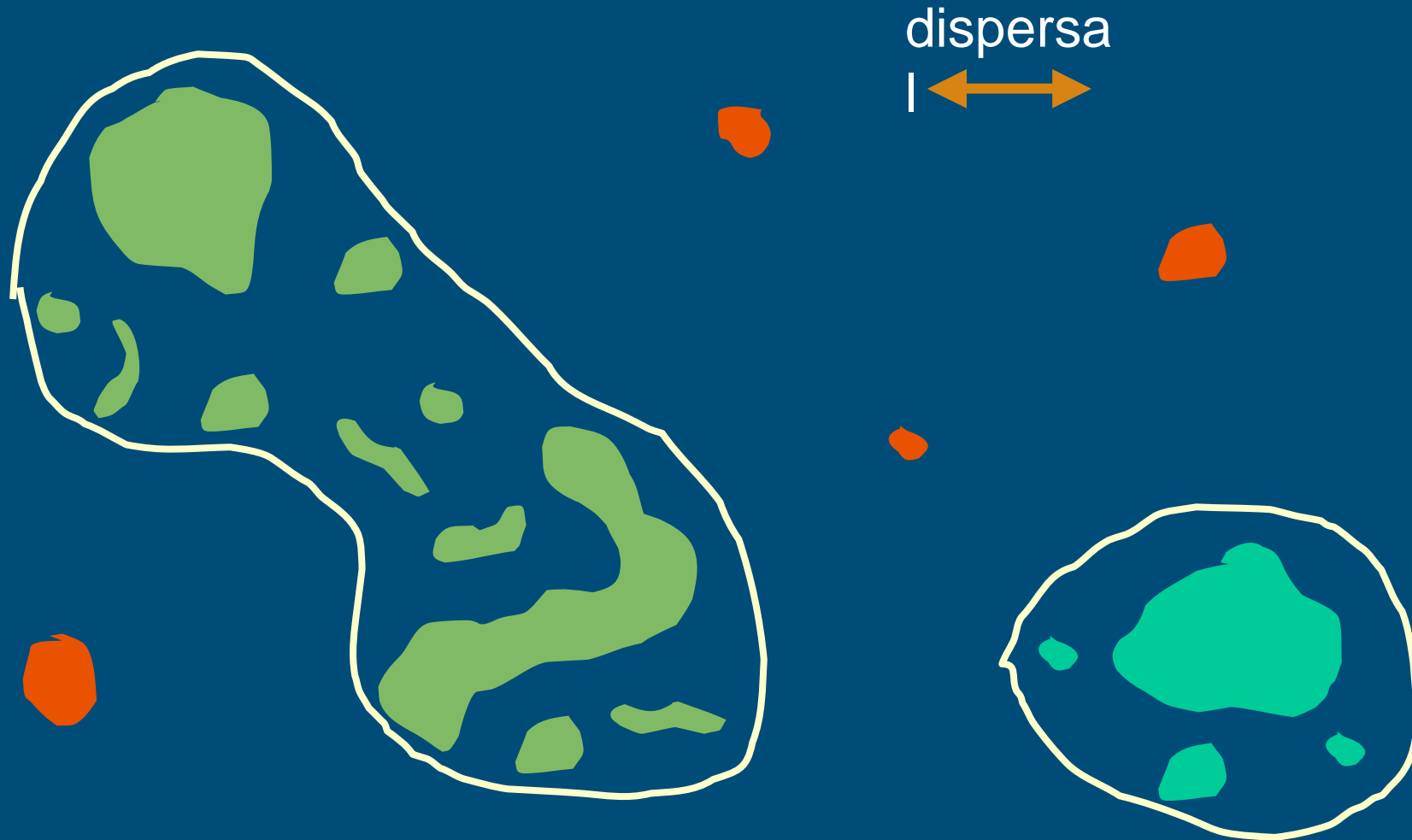
Network
area

Matrix
permeability

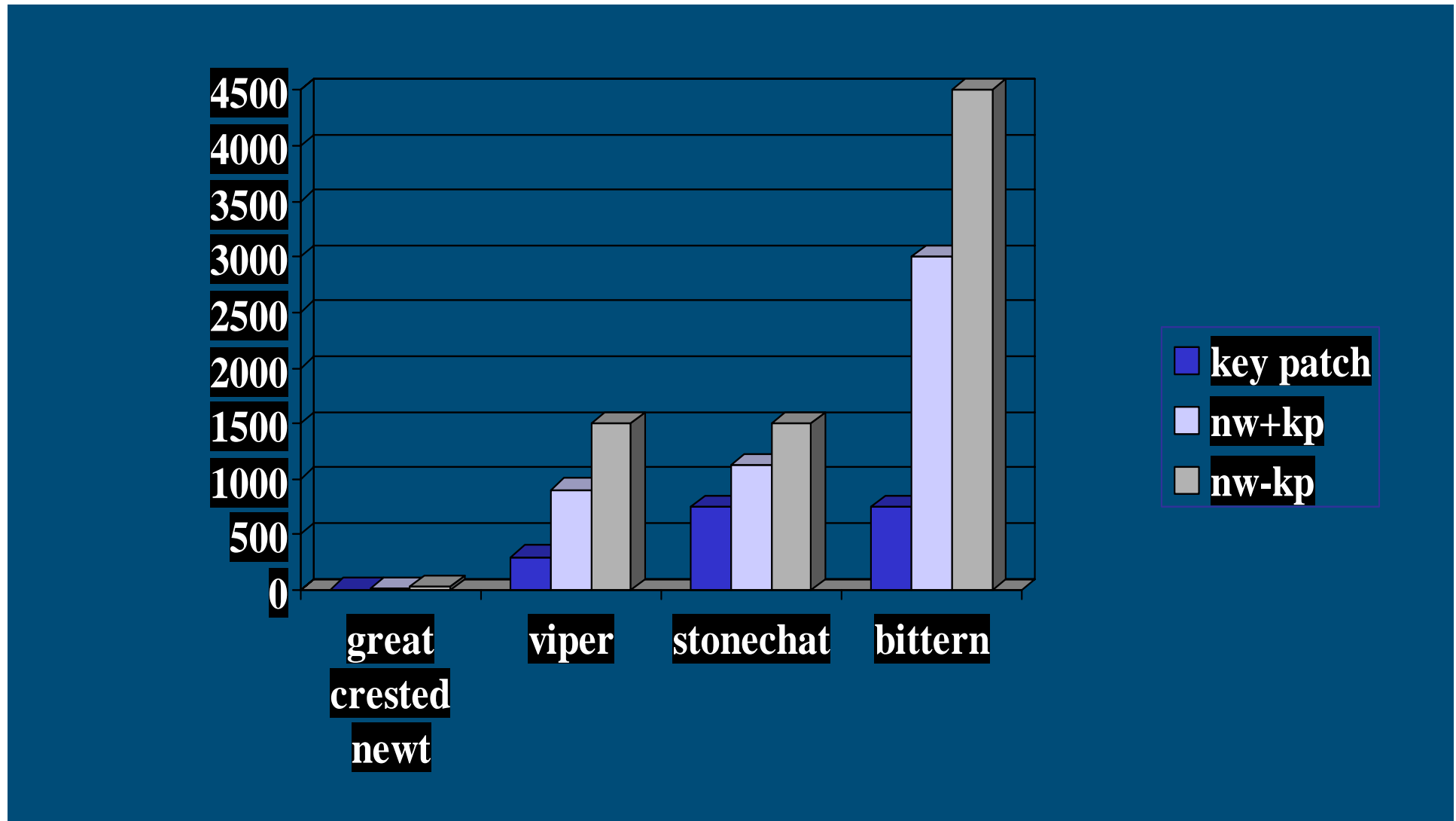
The challenge: to calculate the minimal required amount of cohesion

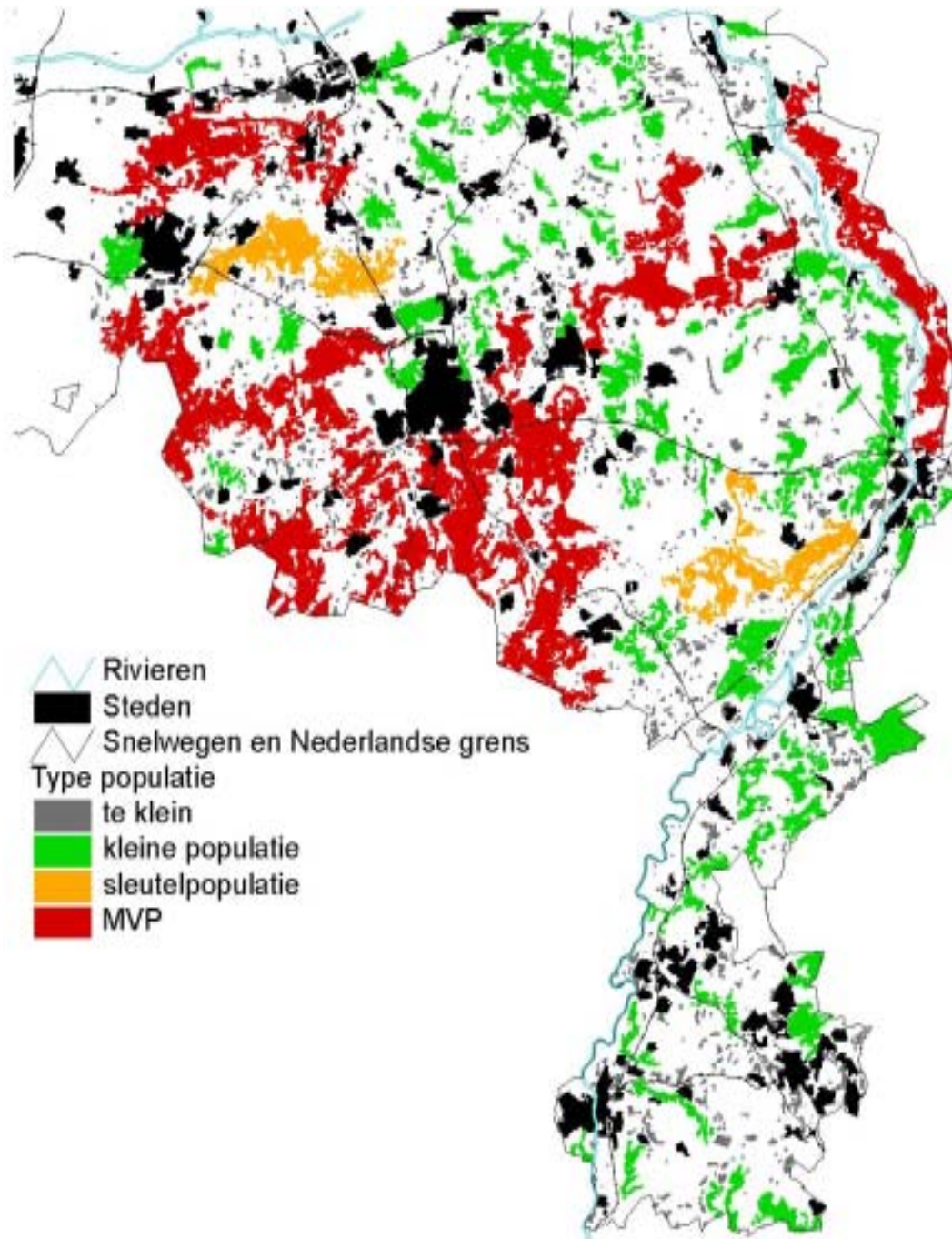


HABITAT NETWORKS



Area of good quality habitat required for a sustainable network under stable pattern and environment (ha)





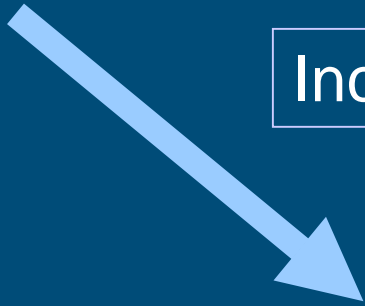
Red Deer Habitat cohesion assessment (LARCH)

What happens to populations under climate change?

- **Weather extremes more frequent and stronger**
- **Temperature change**

Weather extremes

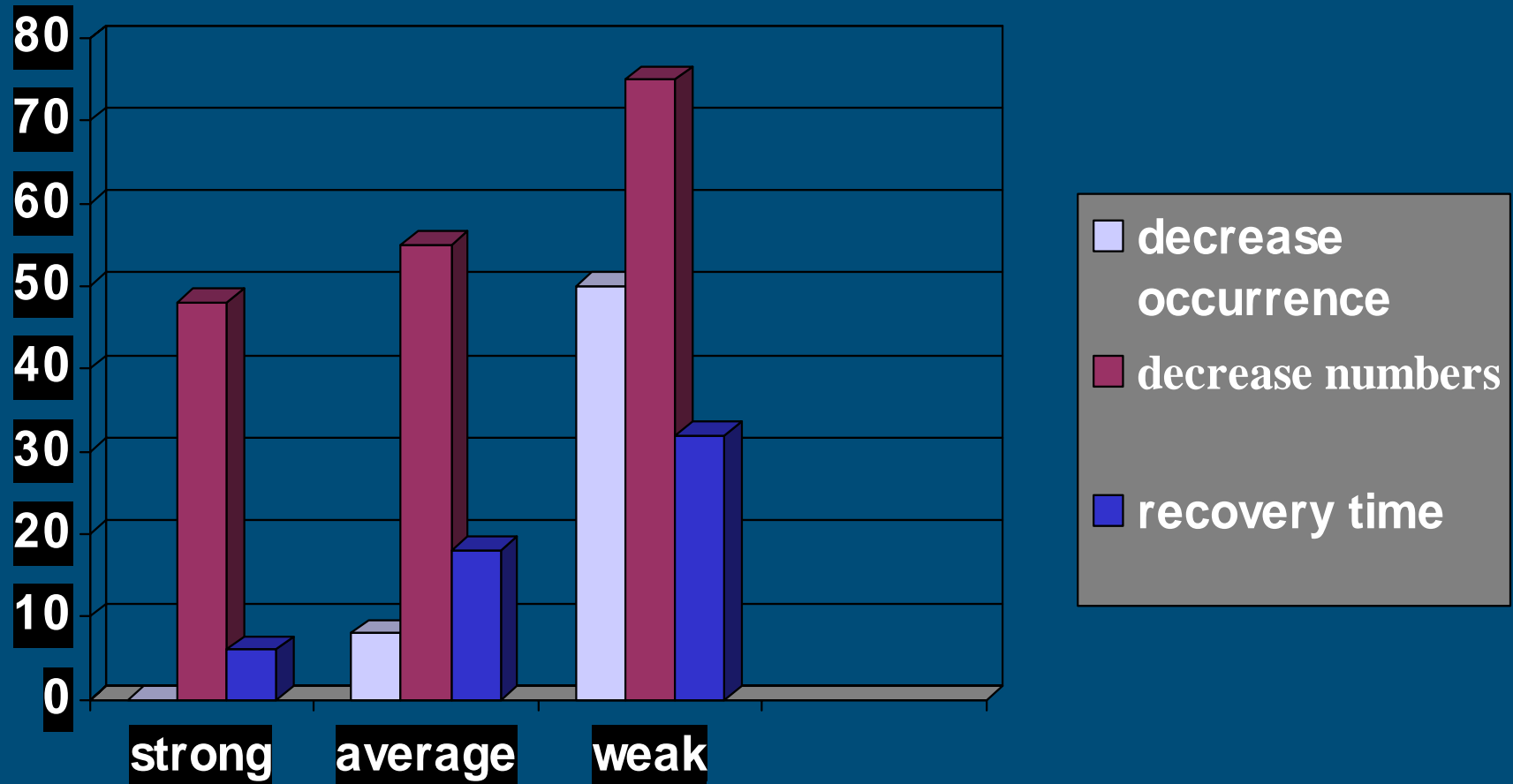
Increased frequency of weather extremes



Increased fluctuations in local abundance

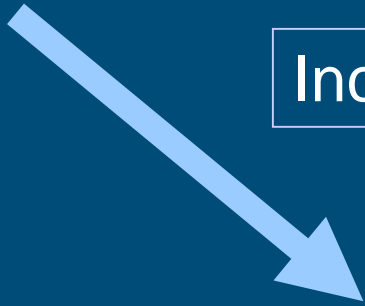
Increased probability of local extinction
esp. if habitat heavily fragmented

Sedge warbler in Dutch habitat networks during population crash



Weather extremes: Landscape strategies

Increased frequency of weather extremes



Increased fluctuations in local abundance

Increased probability of local extinction

Larger
minimum
areas

Increased
regional
connectivity

Local
heterogeneity

y

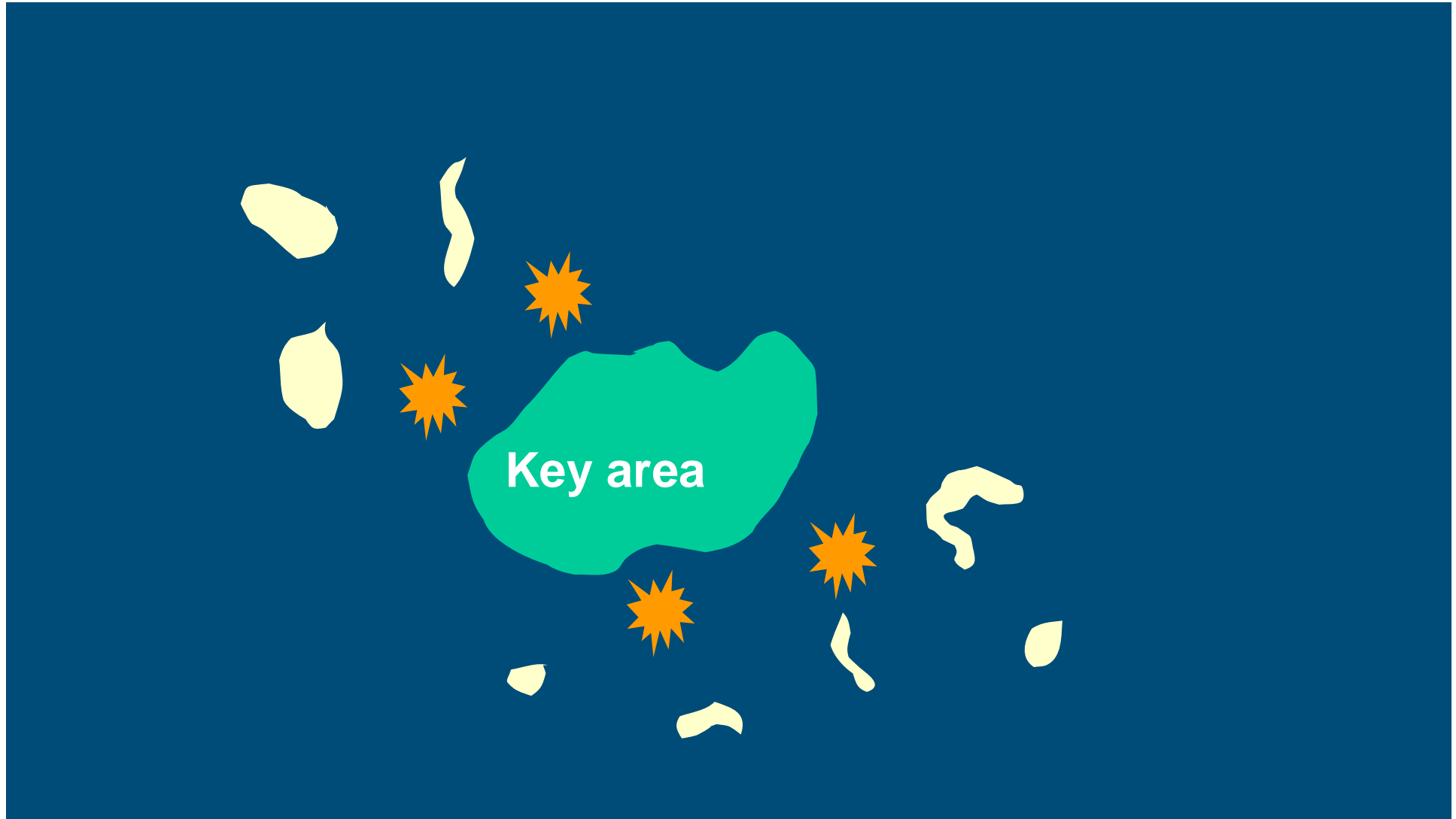
Strategy 1



Strategy 1



Strategy 2



Strategy 3

Heterogeneity



Strategy 3

**Habitat heterogeneity dampens population oscillations caused by weather fluctuations (Den Boer cs. 1970-1990)
Carabid beetles**

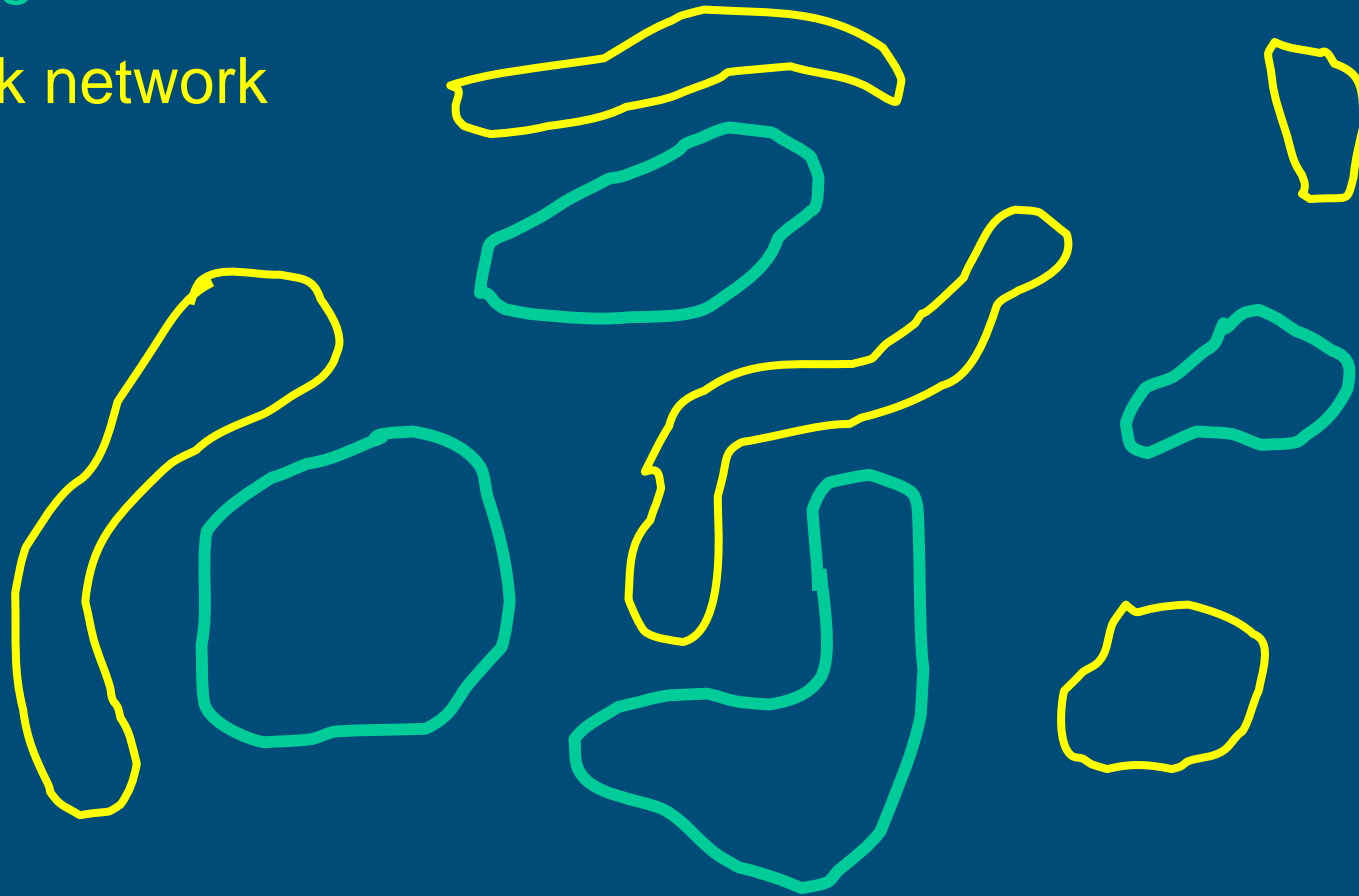
- **Heterogeneity lowers risks of large fires**

From network level to geographic range level

A species range is composed of networks.

Strong network

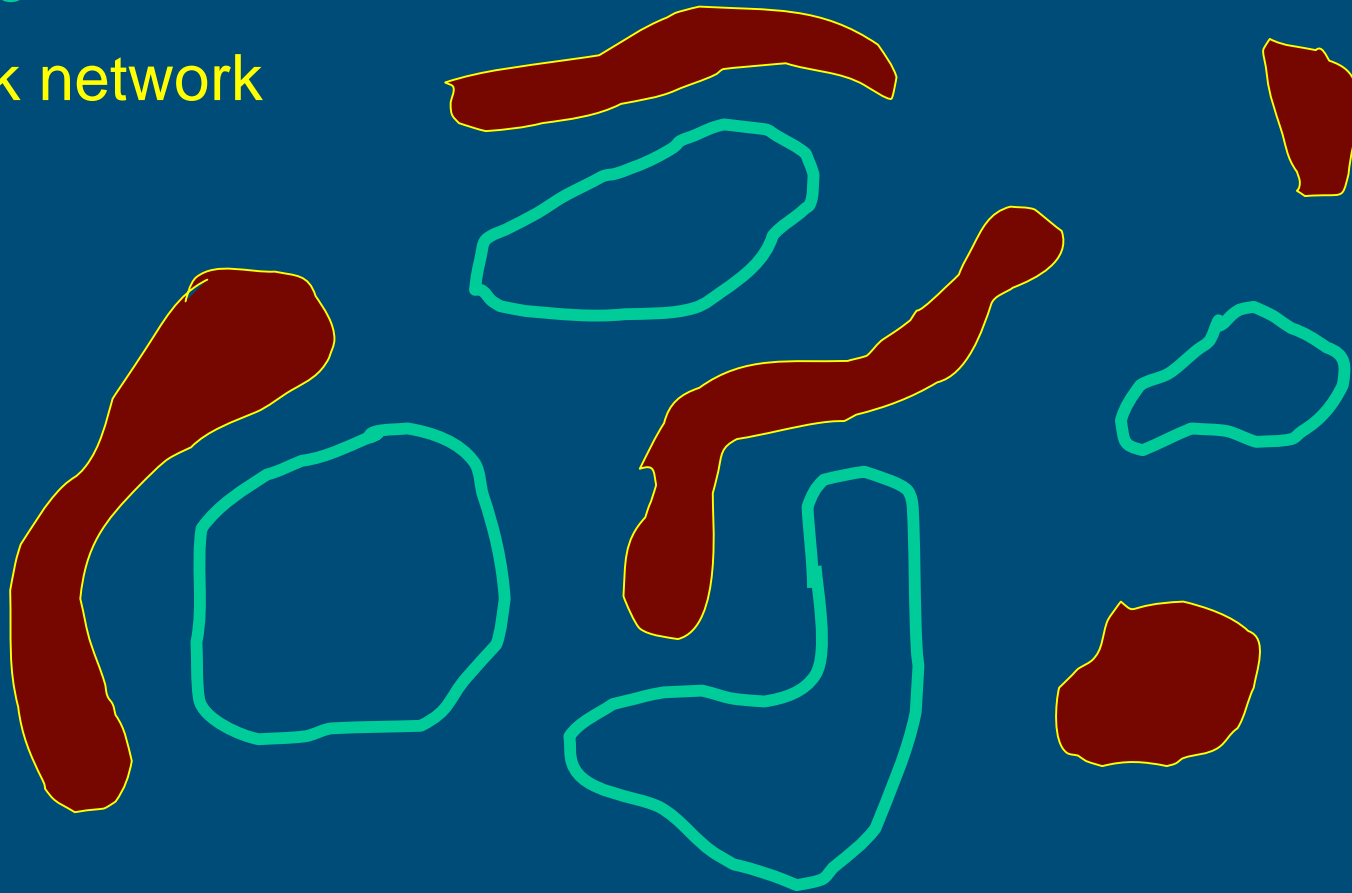
Weak network



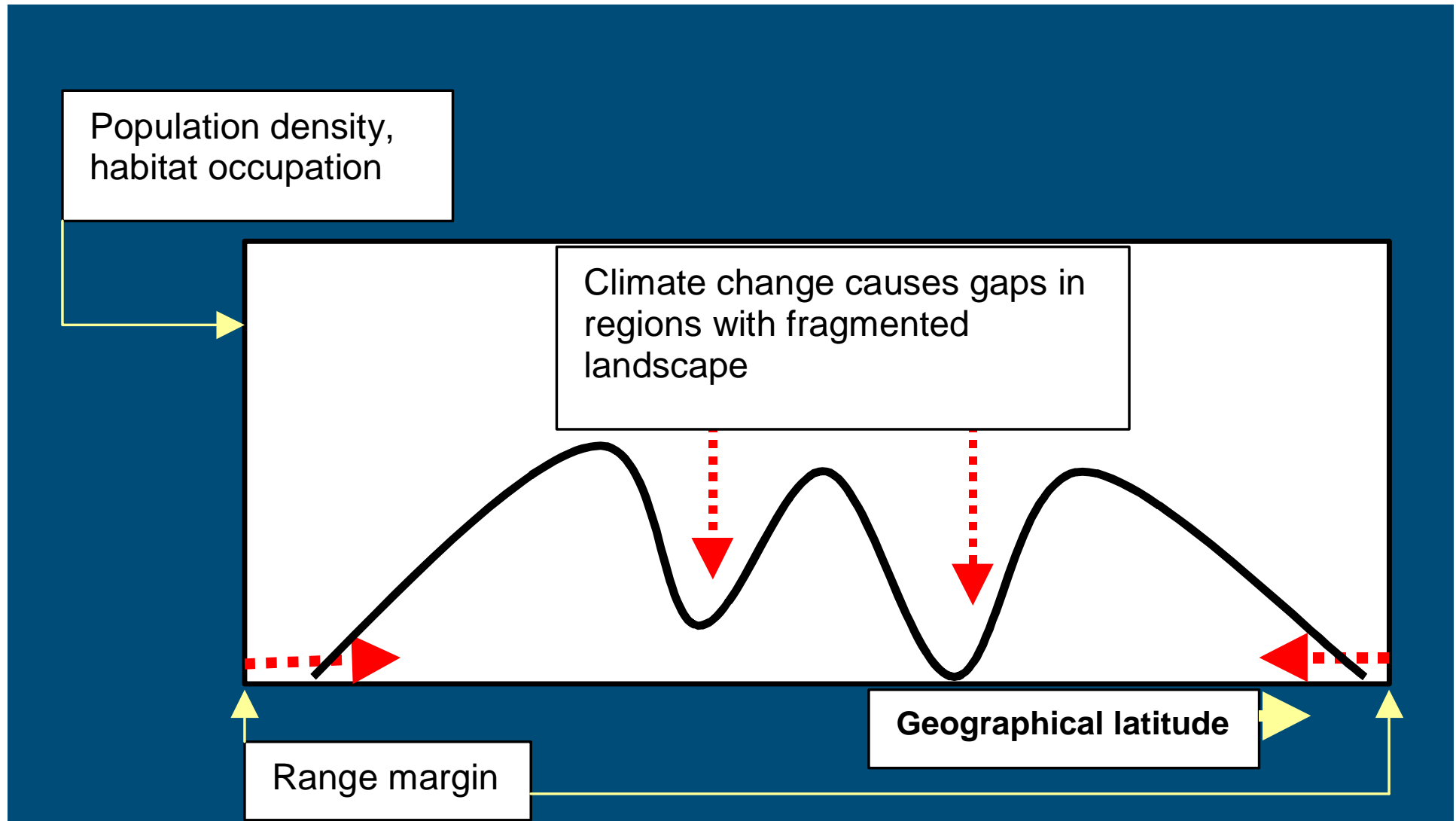
Increased weather perturbations: impact regionally different

Strong network

Weak network



Range dynamics during perturbations



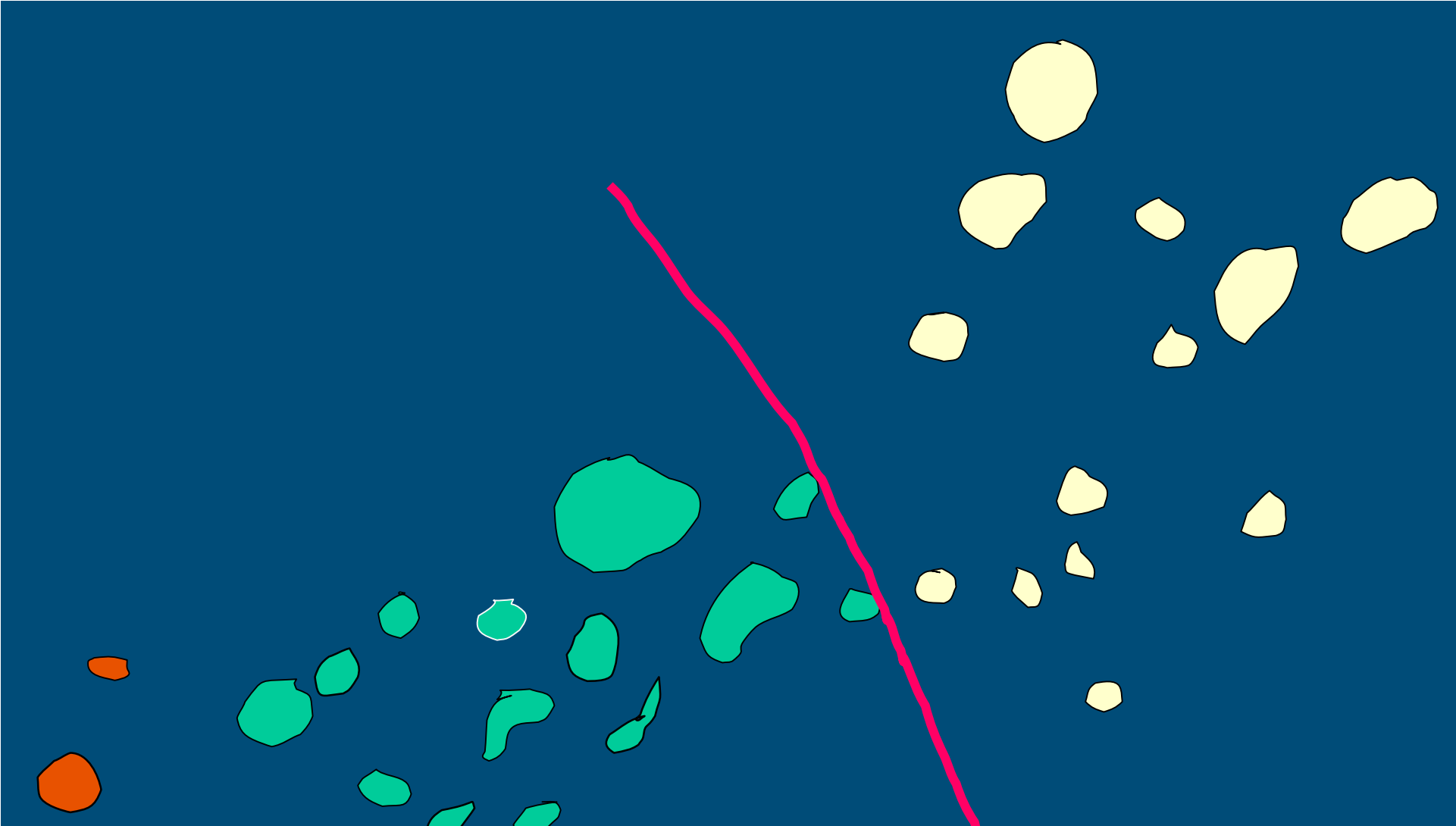
Research

- So we need large scale spatial cohesion analysis of the European landscape for a set of species with different spatial traits
- We also need to know the min. threshold in spatial cohesion to make ecosystem networks extreme-weather proof

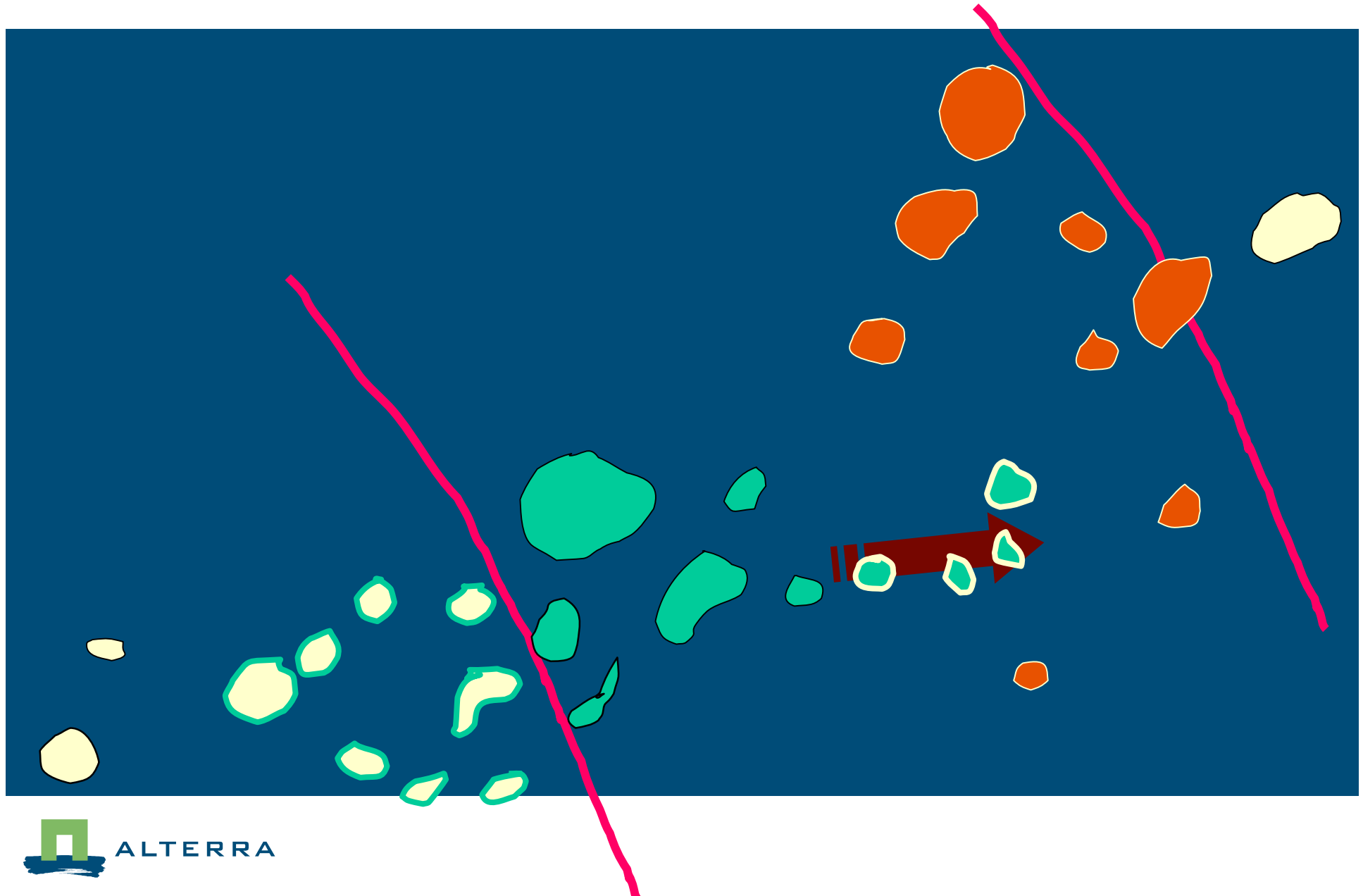
How will the climate change?

- **Weather extremes more frequent and stronger**
- **Temperature change**

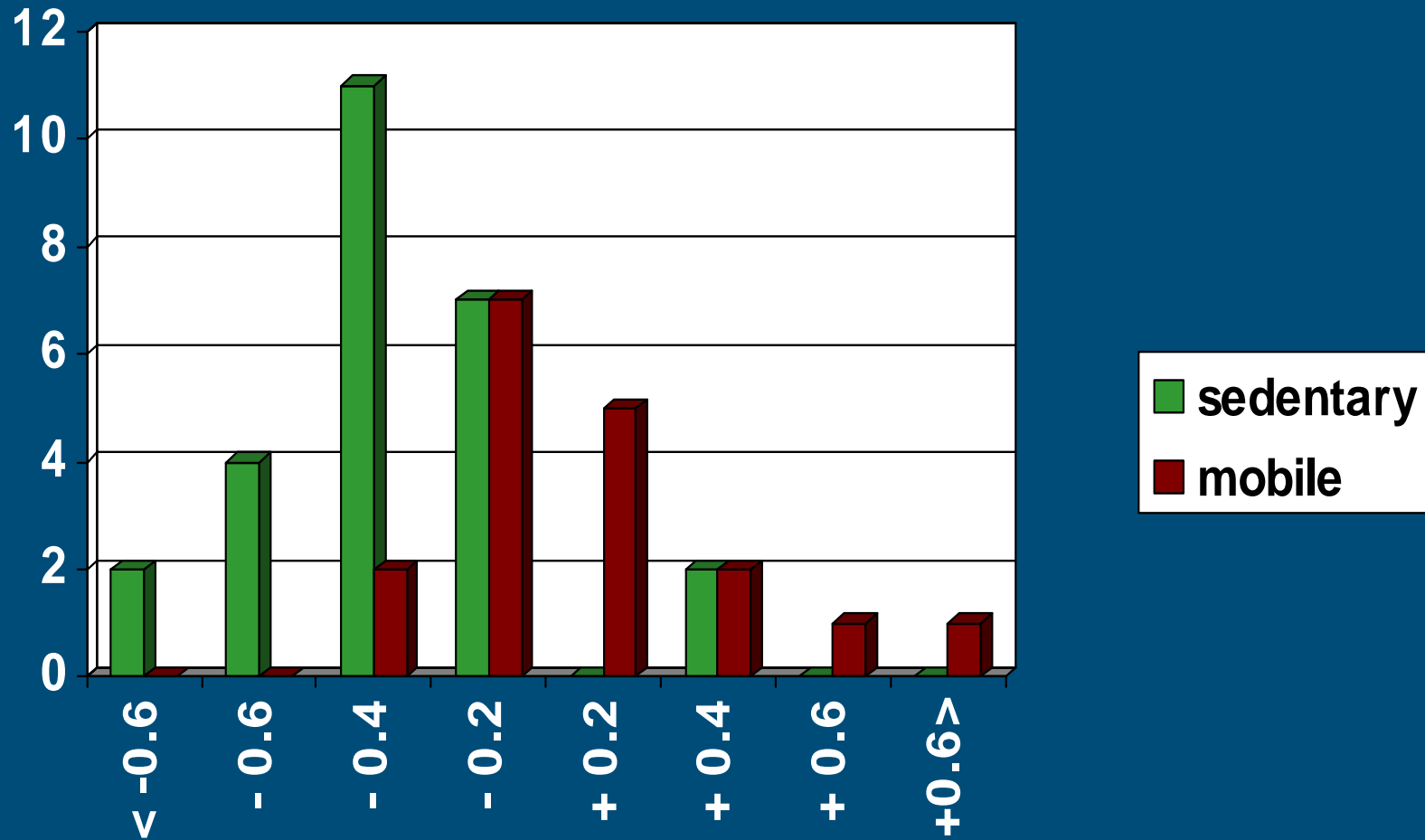
What happens during global warming?



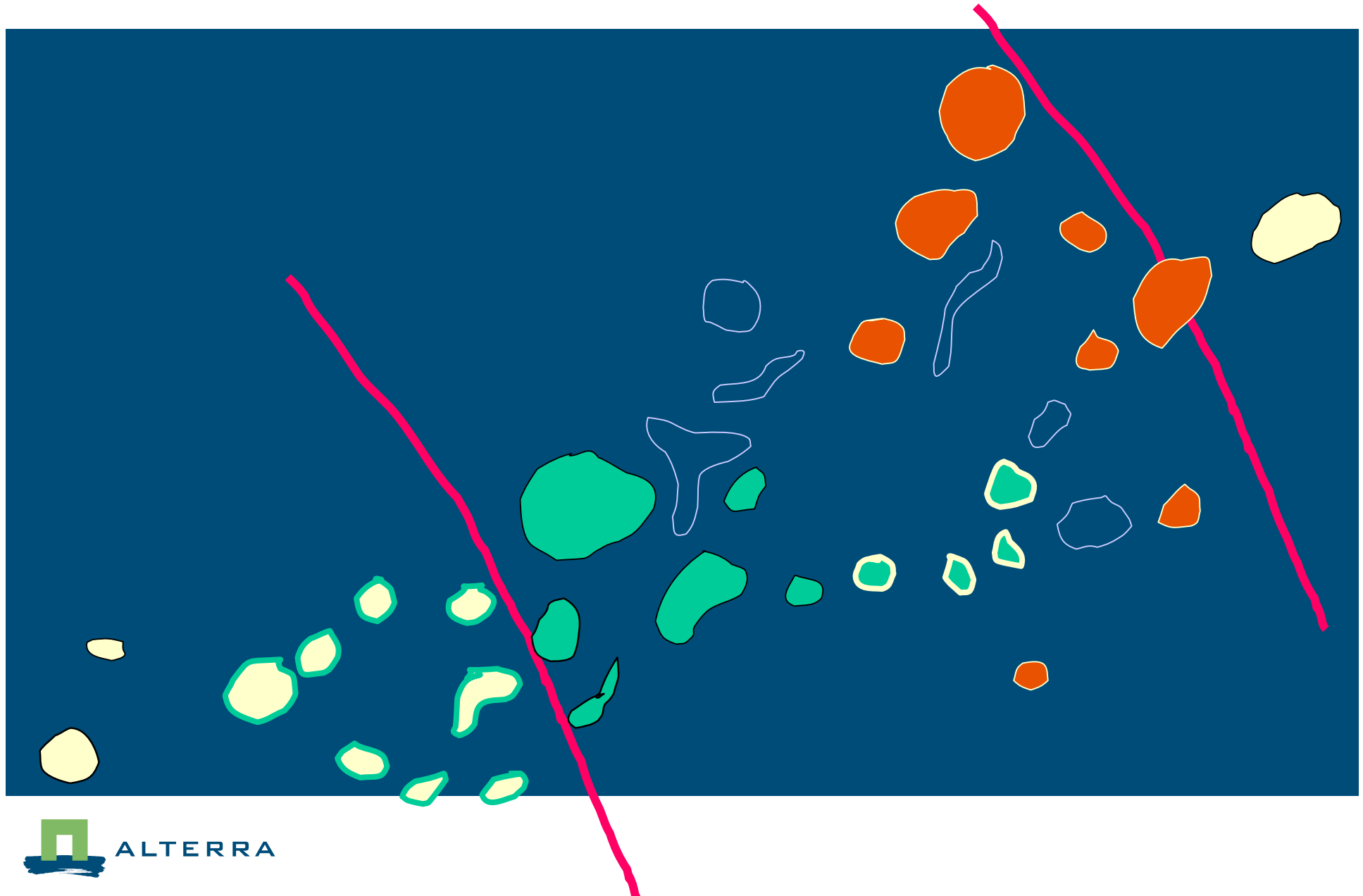
What happens during global warming?



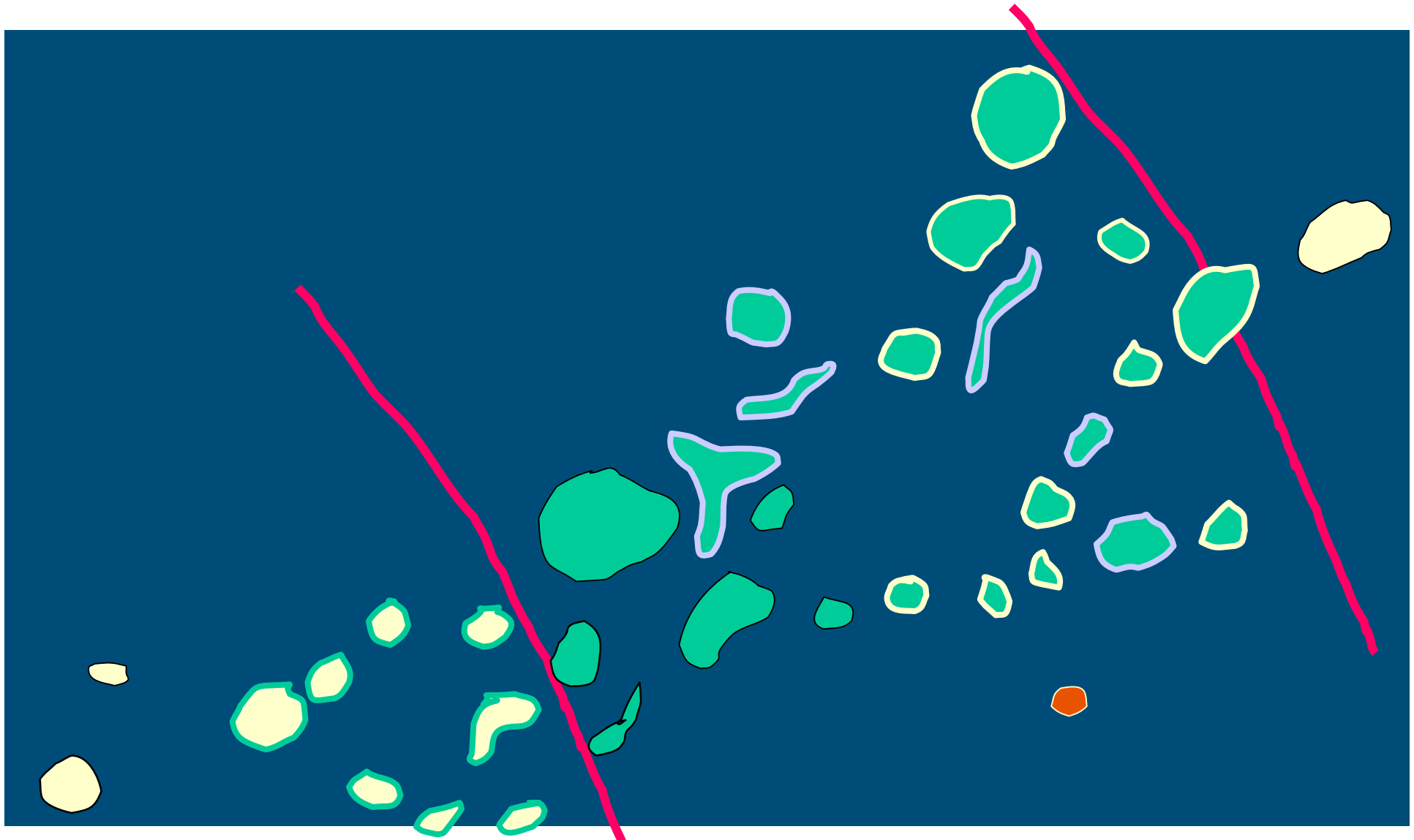
Decrease (<0) and increase (>0) of English butterfly species.



What happens during global warming?



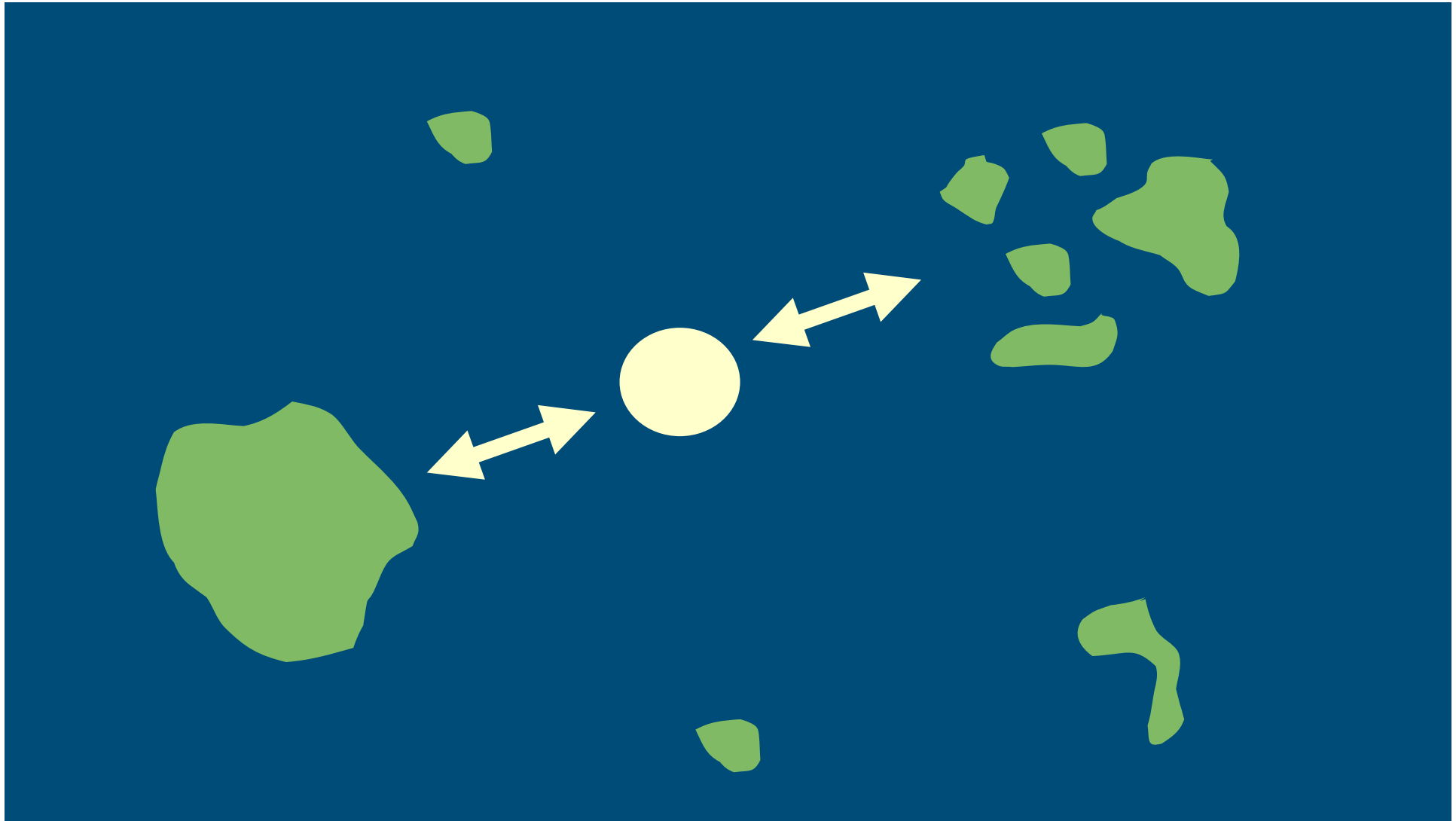
What happens during global warming?



Global warming: spatial strategies

- Increase connectivity between networks in strategic sites for ecosystems with many immobile species
- Increase cohesion of networks in strategic regions to make sure that the spread to new areas can take place

Global warming: spatial strategies



Research

- We need to find the weak parts in the spatial cohesion of the European landscape
- And combine these with land use change patterns to find opportunities to increase cohesion.
- We need to understand how species spread at the margins of shifting climate ranges, the role of long distance dispersal, the role of large habitat areas to build up populations

Concluding remarks

Which strategy effective?

- Protected isolated areas?
- Large protected isolated areas?
- Ecosystem networks?
- Ecosystem networks with large key areas?
- A European network of ecosystem networks?

Which strategy effective?

- Protected isolated areas?
- Large protected isolated areas?
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- Ecosystem networks including large heterogeneous areas?
- A European network of ecosystem networks?

Which strategy effective?

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- ✓ Ecosystem networks including large heterogeneous areas?
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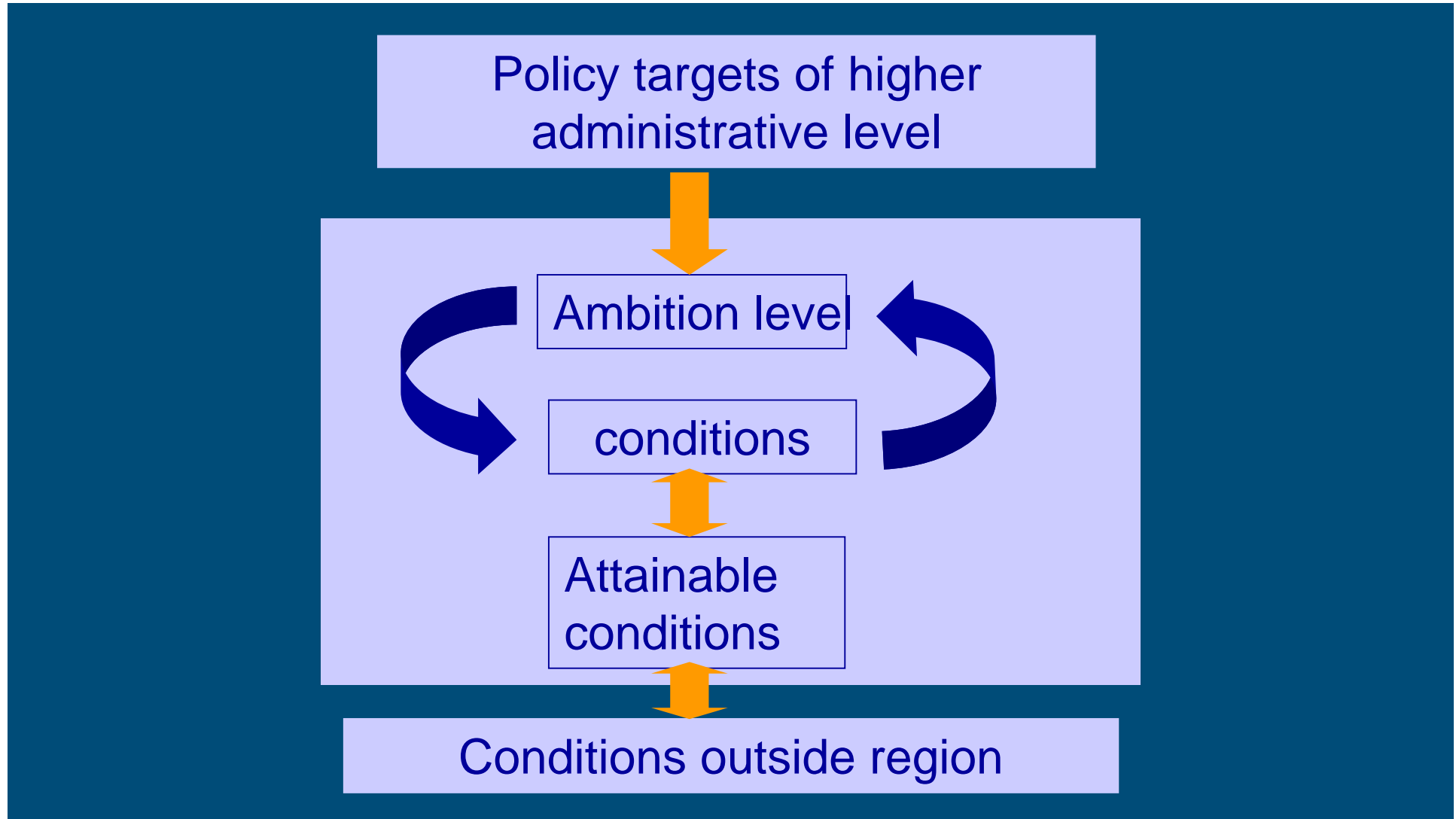
Paradigm shift in conservation

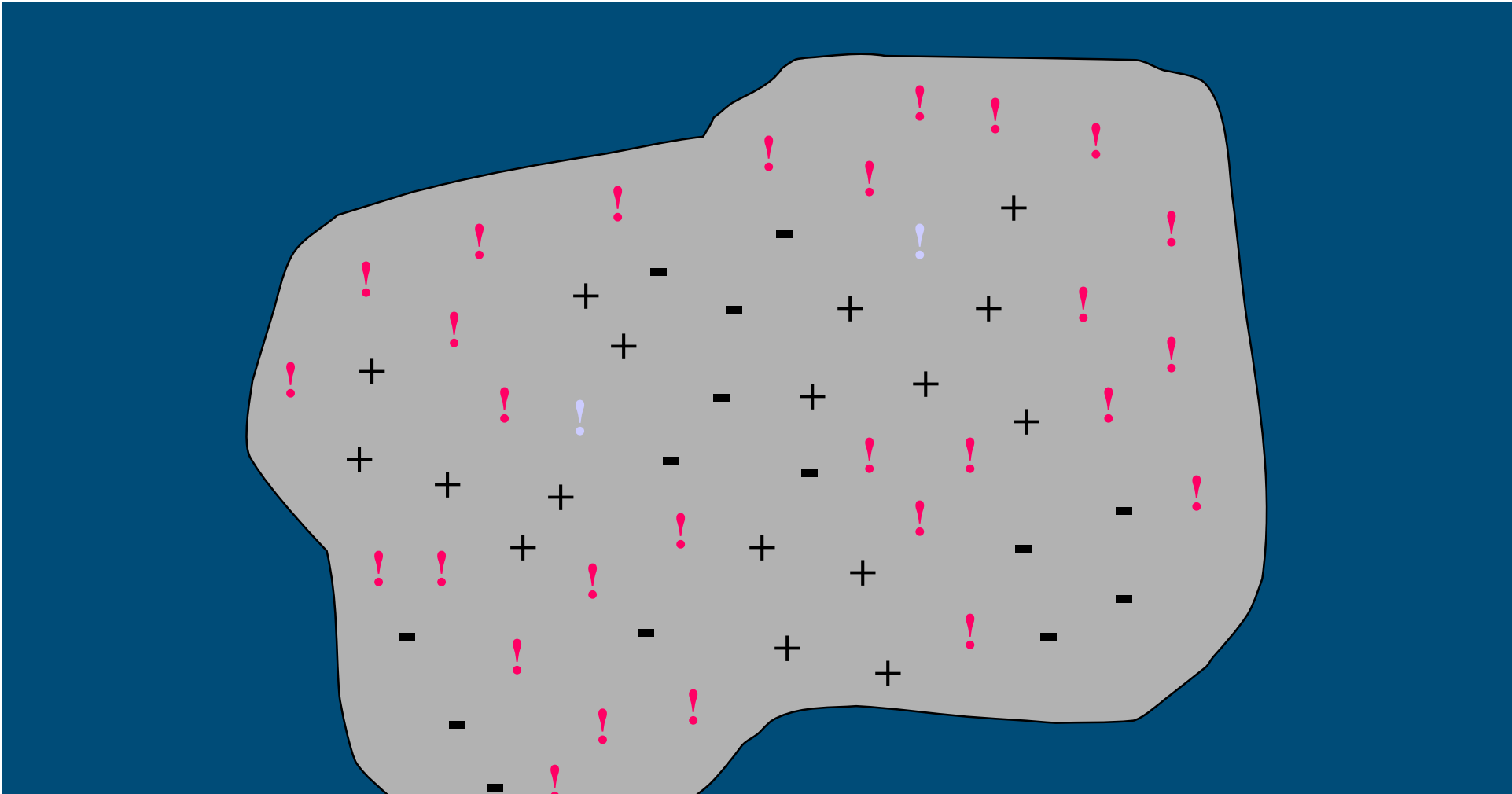
- Go for conditions for population resilience in stead of trying to control steady state
- Spreading the local risk of extinction across the regional scale in stead of focus on local management to prevent local extinction

When climate change meets fragmentation:
a large scale problem
that should be solved by land use changes at the
regional scale!



Simple decision making model for regional planning





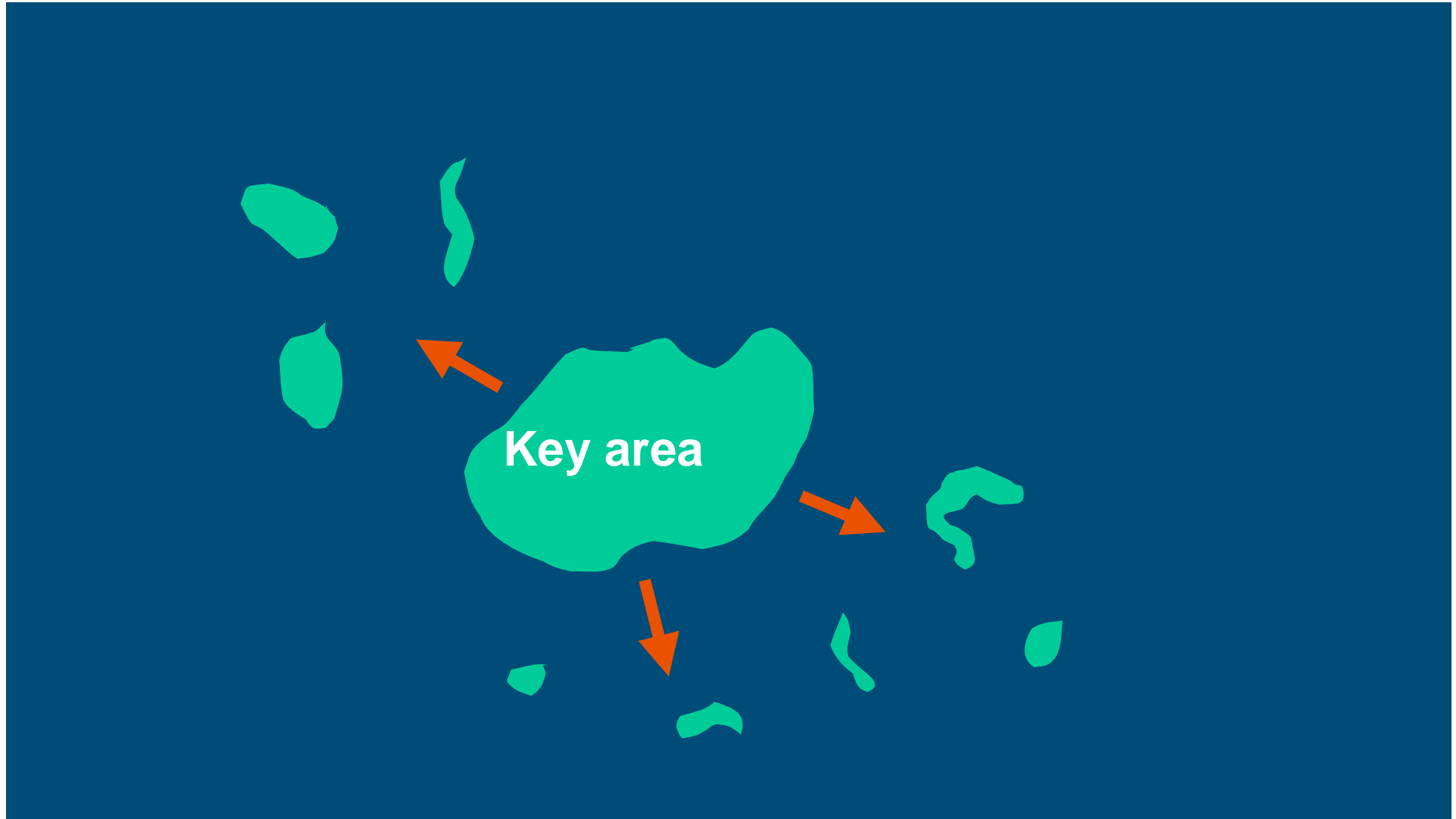
Which goal for species management ?

- Maximize numbers per unit area?
- Maximize probability of occurrence per unit area?
- Guarantee long term persistence of a species in a region?
- Maximize probability of persistence....?

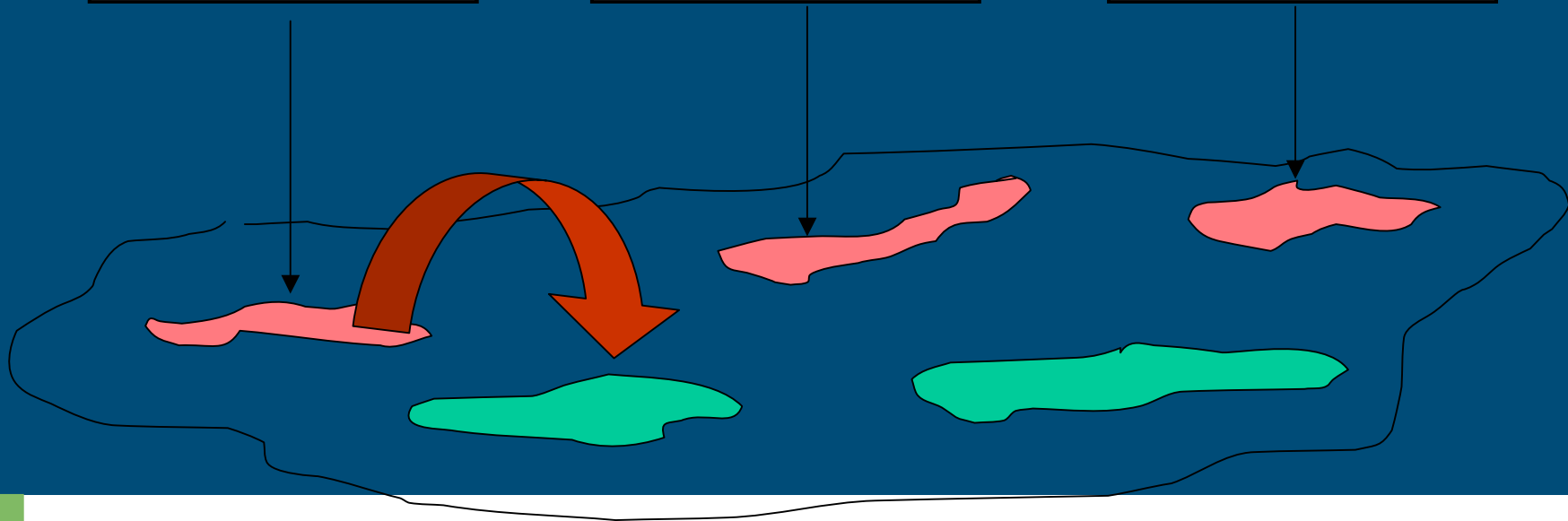
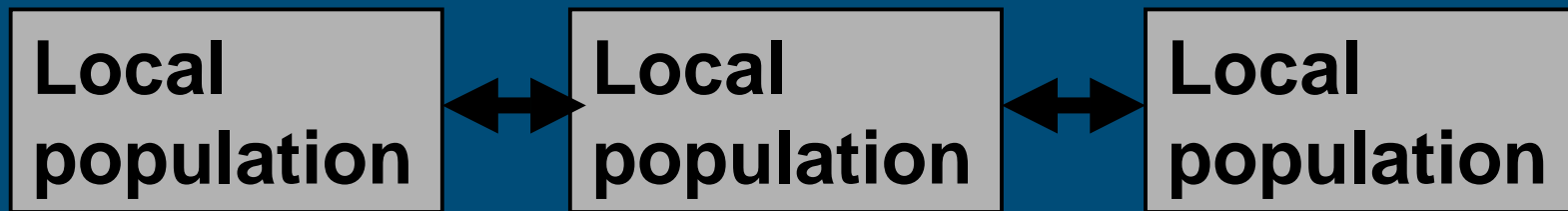
SEDGE WARBLER, AFRICAN DROUGHT AND DUTCH FRAGMENTATION (RUUD FOPPEN)

- **Period increased mortality**
- **Population crash**
- **50% decrease in abundance in most fragmented parts, 20% in least fragmented parts**
- **Regeneration time 8 years vs. 30 years**

Solution? Notion 1



Spreading the local risk over the landscape



What to do?

Determine impacts



Determine conservation problem



Choose spatial strategy

Available strategies

- Spreading of local risks across a region
- Minimize local risk

Key words

- **Manage** » action with a specific goal
- **Dynamic landscapes** » climate change and land use change
- **biodiversity** » certain species or function
- **conservation** » persistence of certain populations or some potential to deliver functions to future generations

- Forget about the “how”!

Metapopulation persistence

Extinction in
patches



Re-occupation of
empty patches

Metapopulation persistence

