Decision support for restoring ecological networks.

Jenny Hodgson, **Katherine Allen**, John Heap & Lydia Cole

CIEEM Autumn Conference ● 20th November 2018

Introduction to Condatis

- Why?
  - Why do we need Condatis? What questions does it answer?
- What?
  - What exactly is Condatis?
- How?
  - How does it work? How do we interpret the outputs?
- When?
  - How has it developed over time?
- Who?
  - Who has used it already and what for?
- Where?
  - Where can it be used? What inputs are required?

+ Discussion

Condatis - background

- The problem:

  - The climate is getting warmer – species need to move

Species in Britain are on average shifting northwards
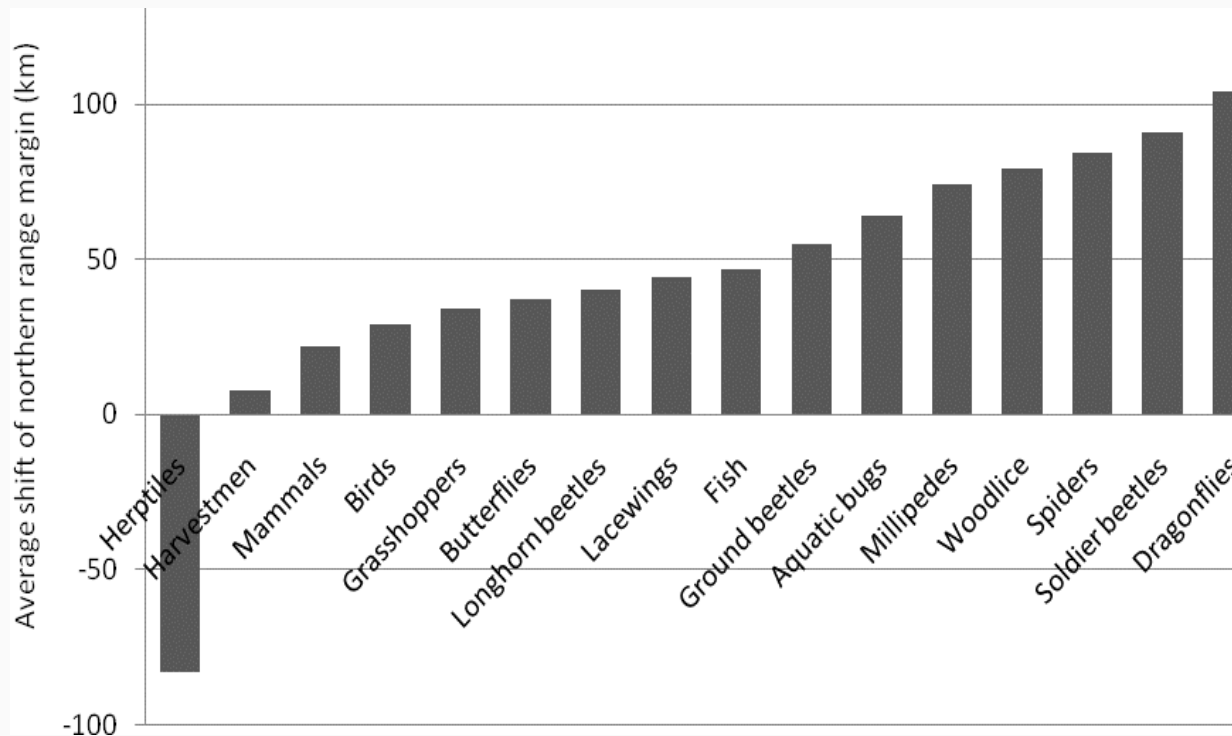
Each individual landscape will have species moving in and out

Pateman and Hodgson (2015) The effects of climate change on the distribution of species in the UK. Biodiversity climate change impacts report card technical papers. LWEC partnership
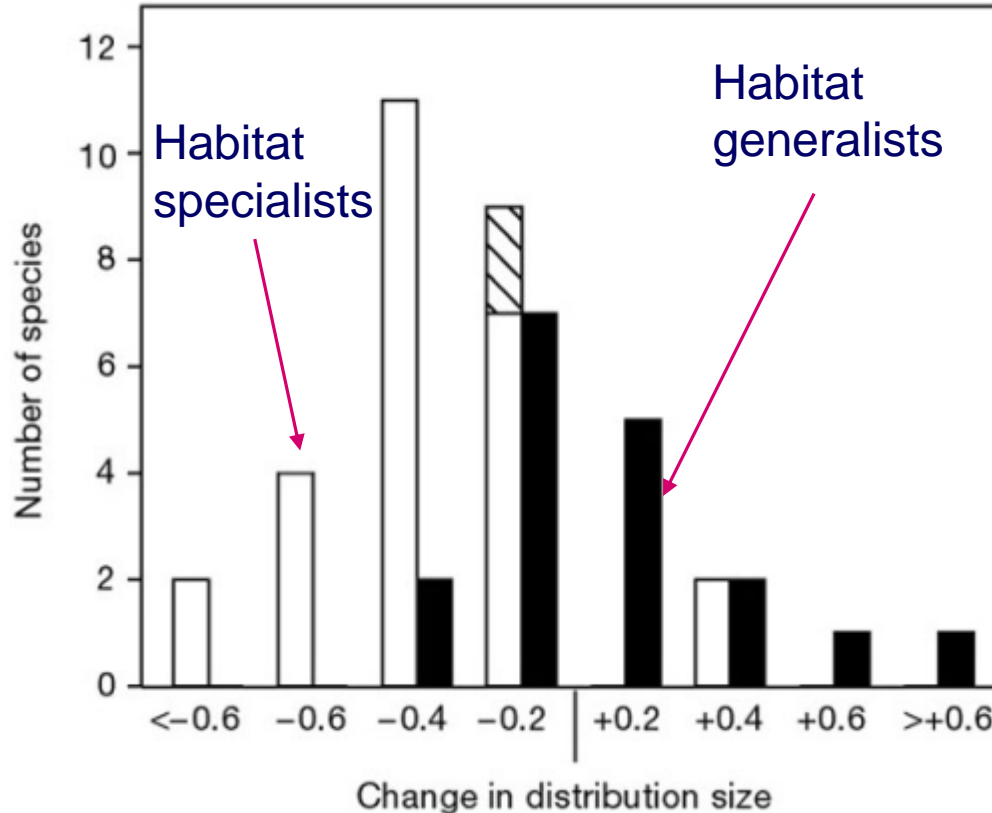
Condatis - background

- The problem:

  - The climate is getting warmer – species need to move

  - There is less habitat and it is increasingly fragmented – species can't move

There is not enough natural habitat

# Lack of habitat is prime culprit in species failure to shift

Warren, M.S....& Thomas, C.D. (2001) Rapid responses of British butterflies to opposing forces of climate and habitat change. *Nature,* **414,** 65-69.

Condatis - background

- The problem:

  - The climate is getting warmer – species need to move

  - There is less habitat and it is increasingly fragmented – species can't move

- The solution:

  - Create new habitat or restore degraded habitat

  - But, where?

Key Habitat

Beneficial Habitat
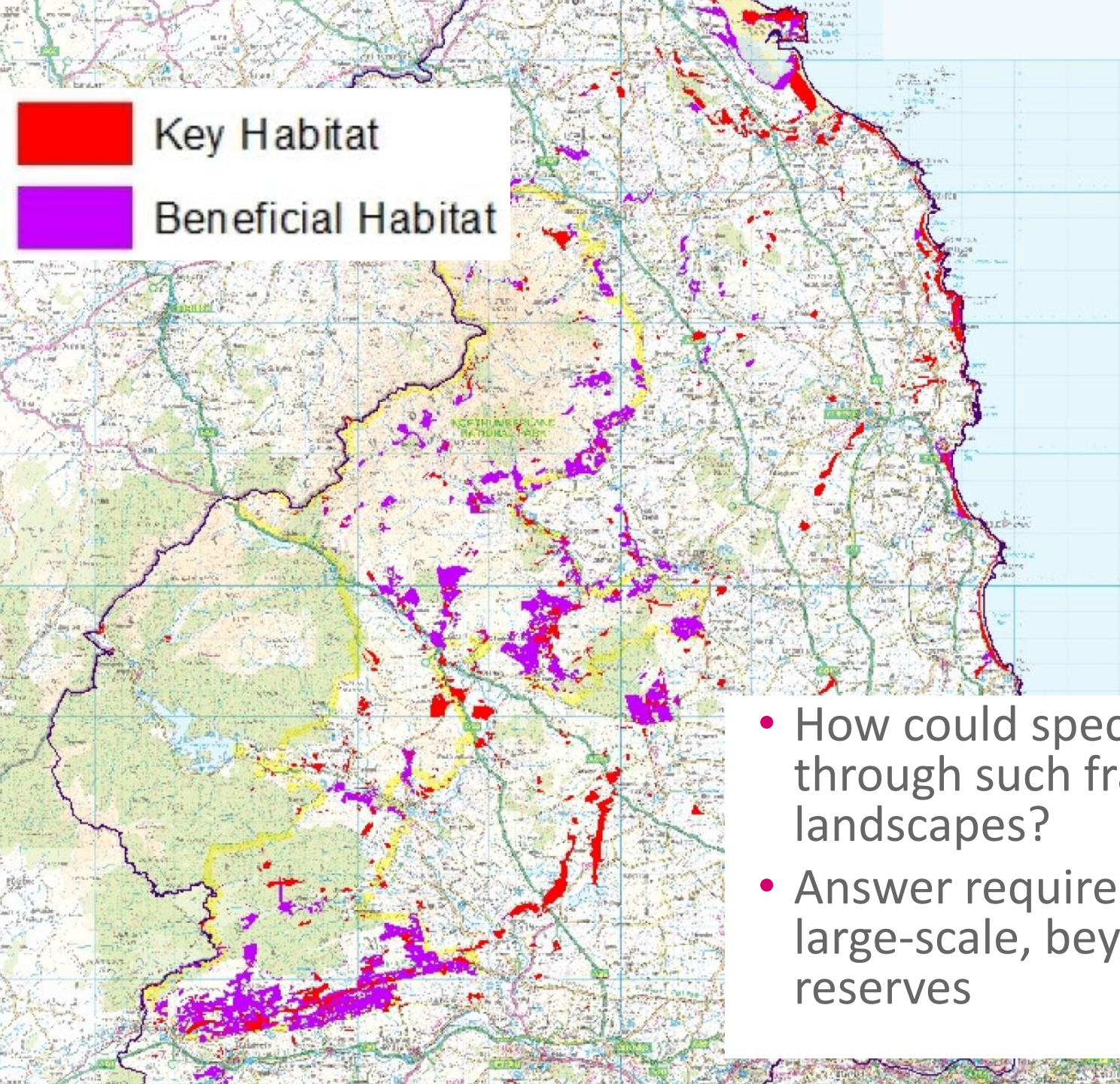
- How could species shift through such fragmented landscapes?
- Answer requires thinking large-scale, beyond reserves

"Classical" principles of reserve arrangement

- Aim to prevent population decline and extinction
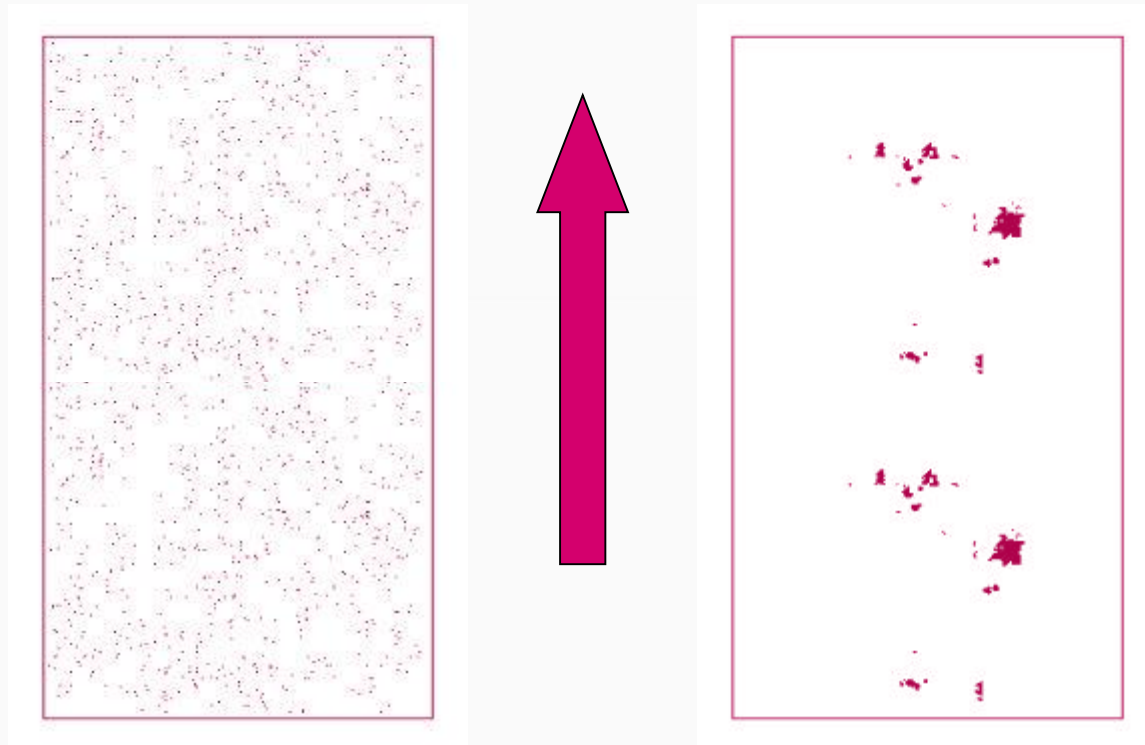- Theory recommends clustered/ aggregated configurations

Benefits of clustering

- Rescue after chance extinctions
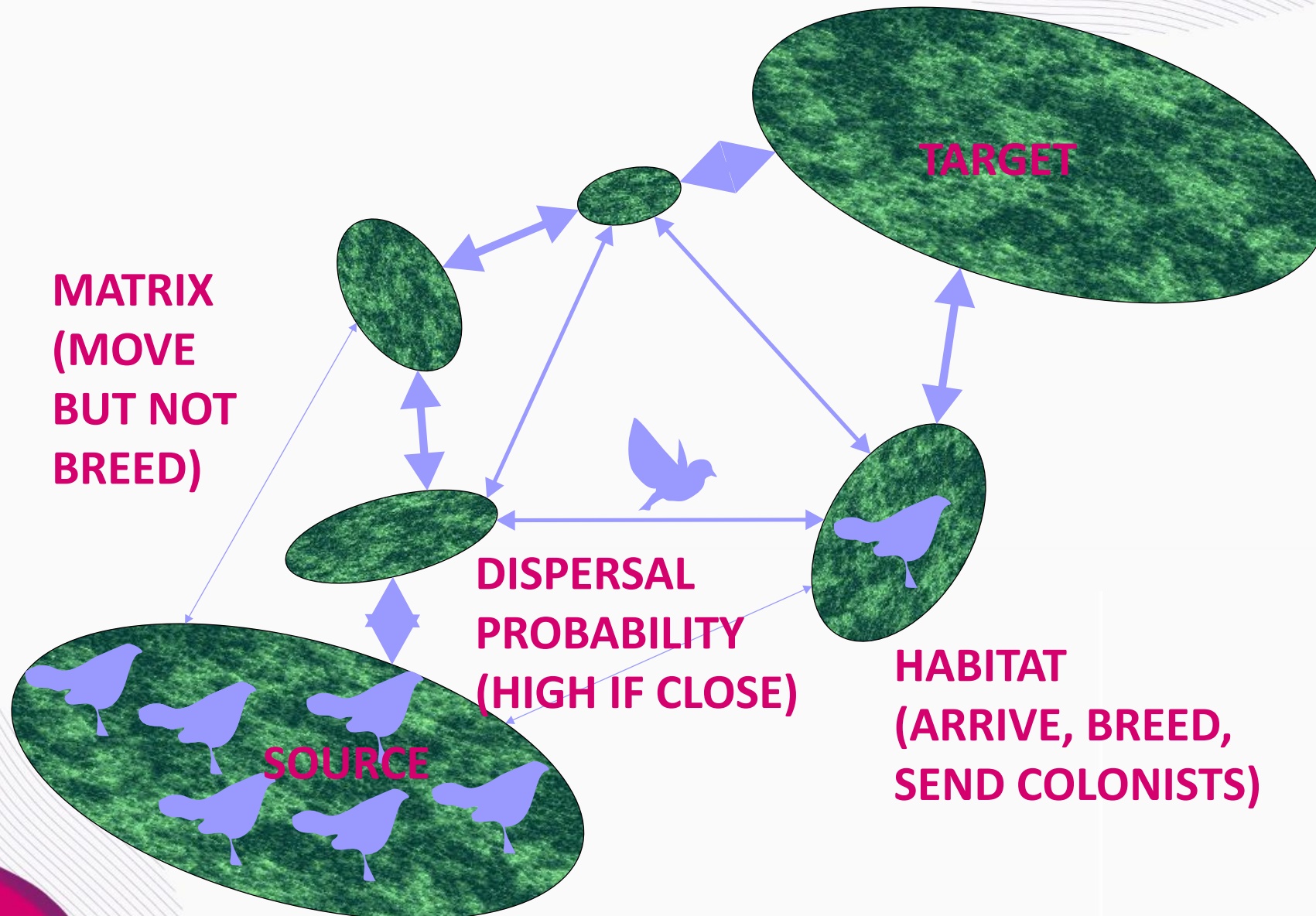- Less dispersal mortality
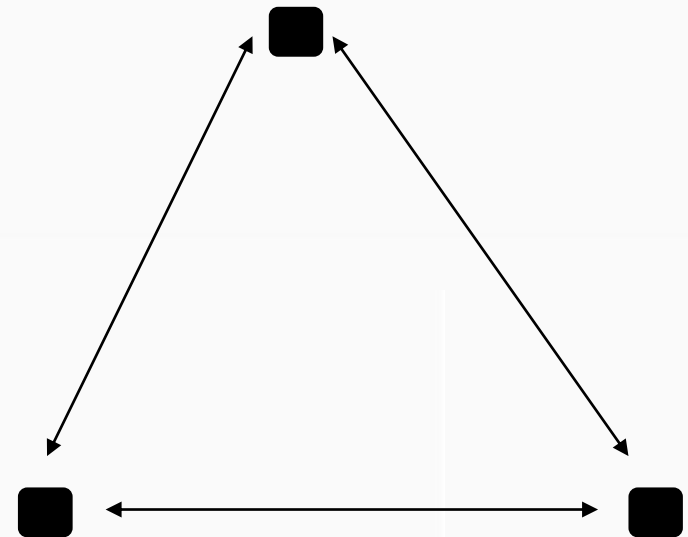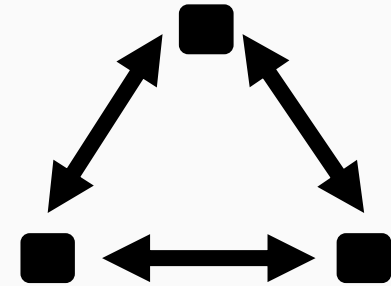
But with climate change

- Bigger aggregated clumps mean bigger gaps
- "increase connectivity" is ambiguous
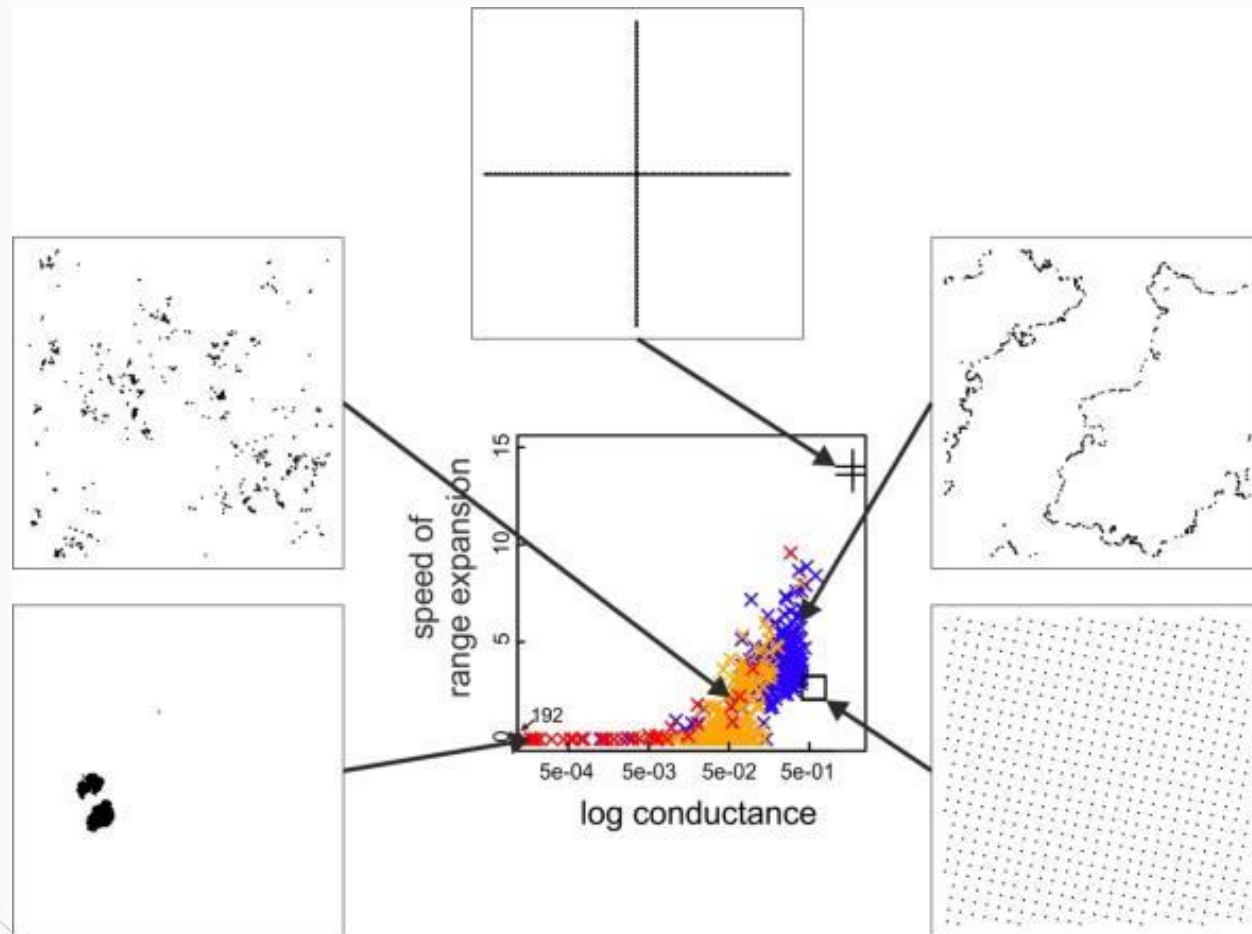
Introduction to Condatis

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Condatis concepts: multi-generation connectivity

TARGET

MATRIX (MOVE BUT NOT BREED)

DISPERSAL PROBABILITY (HIGH IF CLOSE)

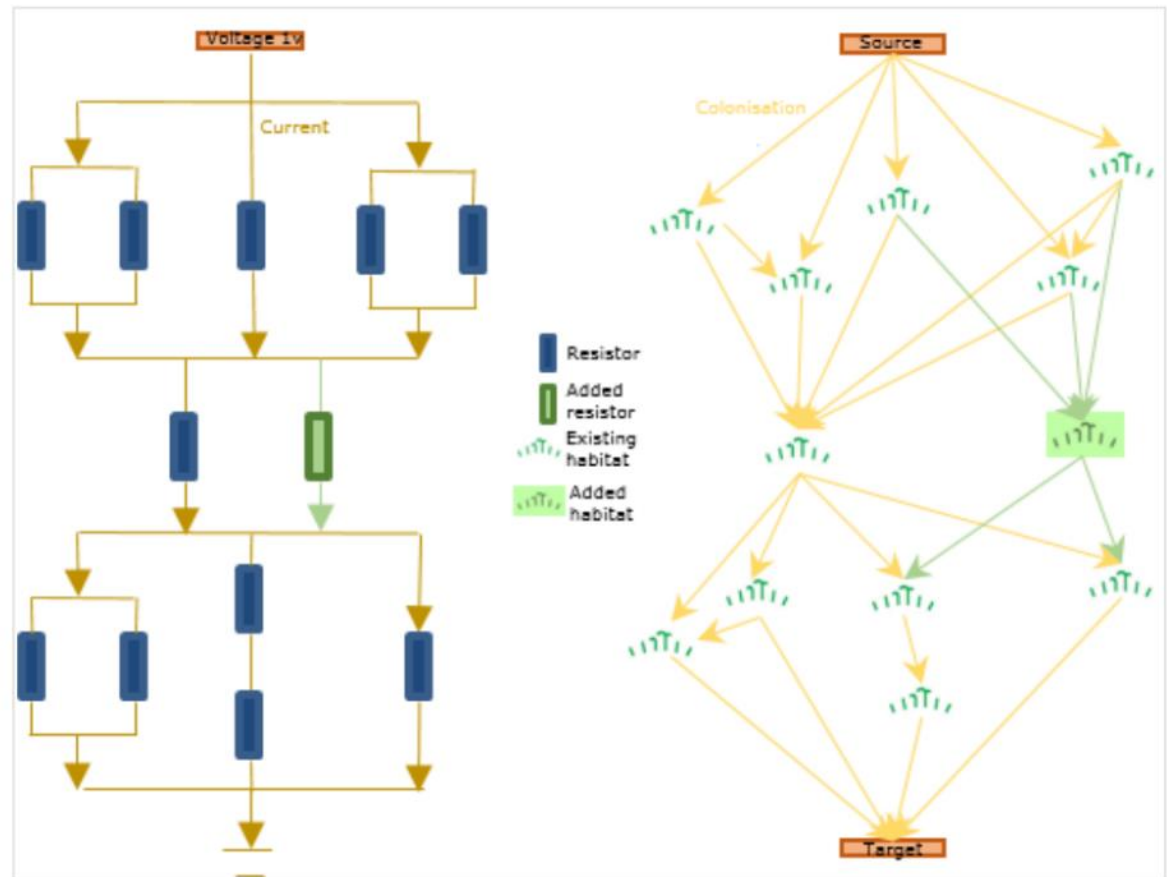HABITAT (ARRIVE, BREED, SEND COLONISTS)

SOURCE

Network 'conductance' predicts speed of crossing landscape

Hodgson, J.A., et al (2012) The Speed of Range Shifts in Fragmented Landscapes. *Plos One*, 7, e47141.
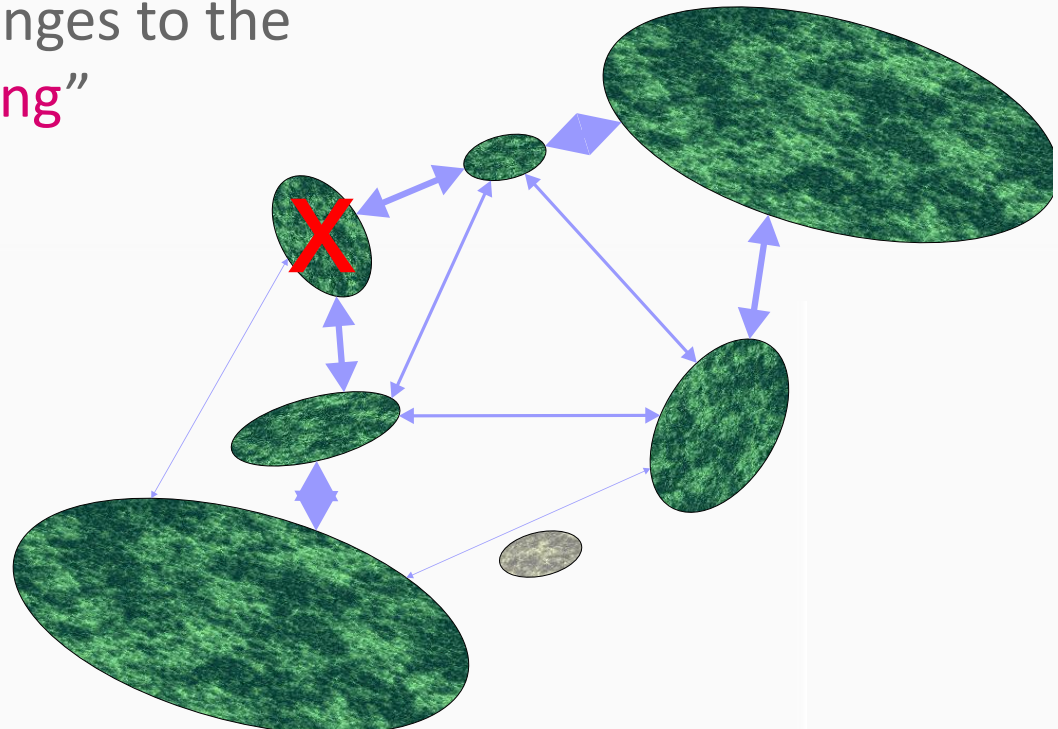
What is conductance?

- Time until colonisation ≡ electrical resistance

- Use maths of circuits -> combined flow along all possible routes

Electrical circuit on the left and comparable stylised habitat map on the right. Green represents adding a resistor or additional habitat to each to increase the number of pathways available and therefore improve the flow.

Functions of Condatis

- Quantify existing range-shifting potential: "Speed/Flow"
  - Between specific source and target, over multiple generations

- Assess the impact of changes to the habitat network "Dropping"

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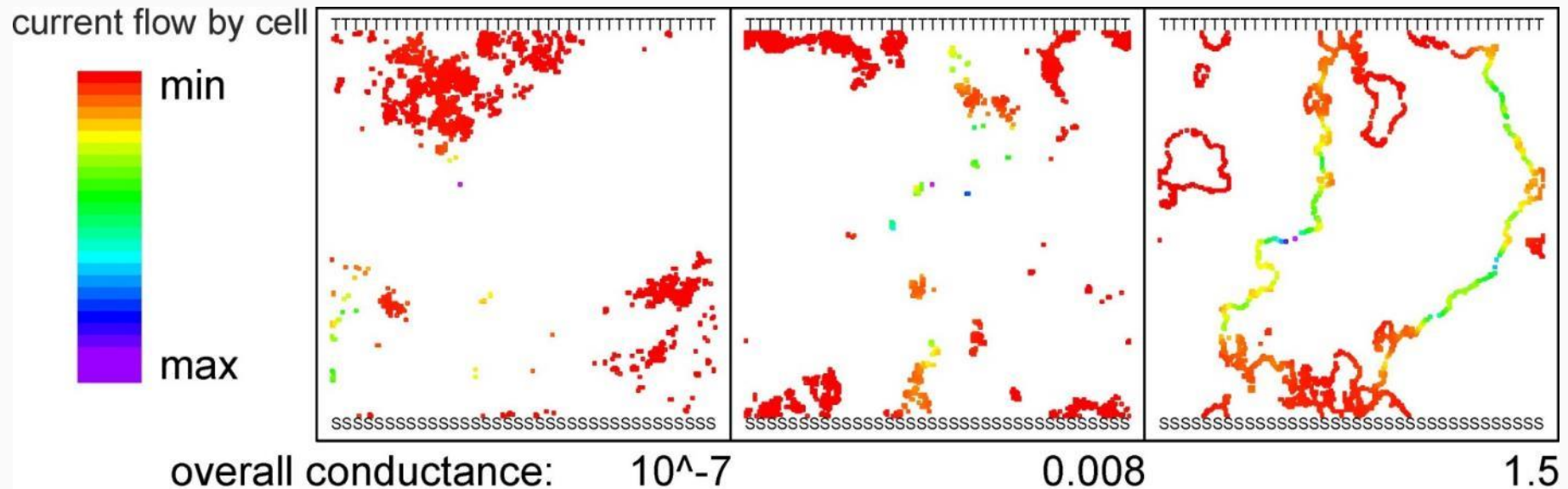# Conductance, aka speed, can quantify overall improvement
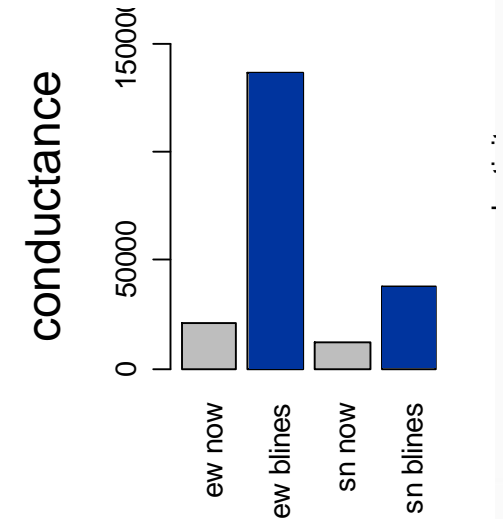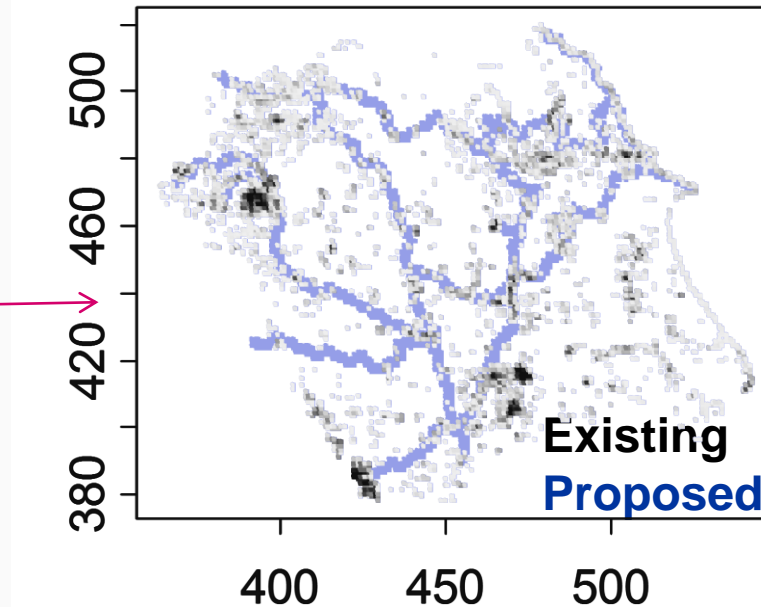
- Yorkshire and Humber B-lines project with Paul Evans, Buglife, 2012
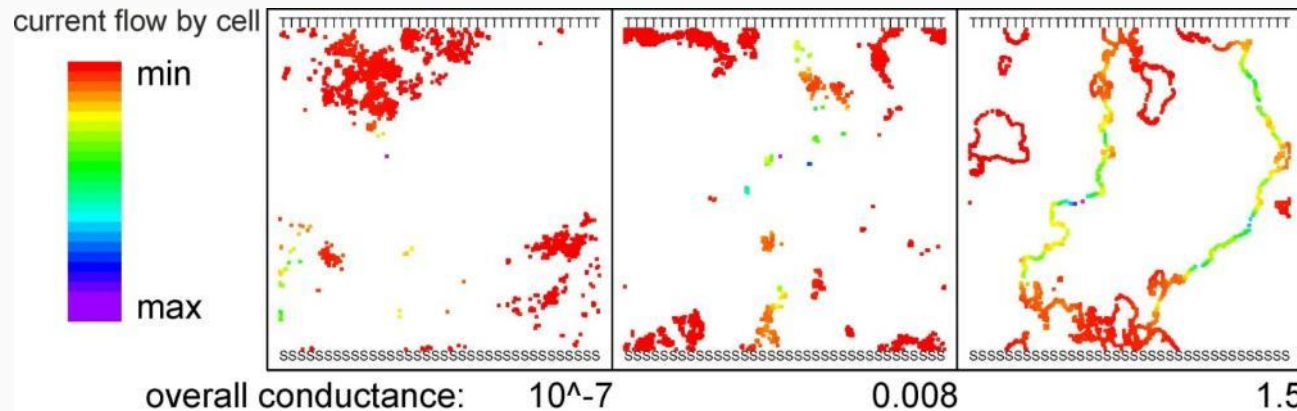
Bombus terrestris by Vera Buhl

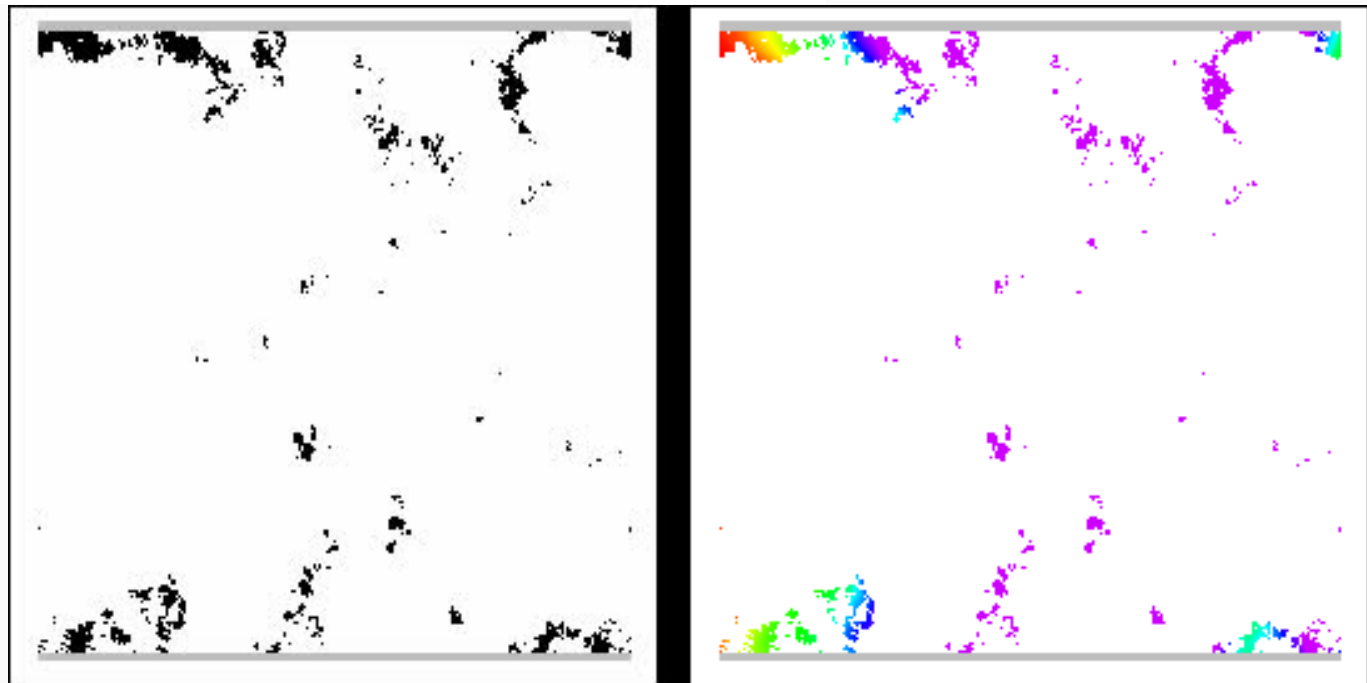# 'Flow' through each cell shows important routes

Hodgson, J.A., Wallis, D.W., Krishna, R. & Cornell, S.J. (2016)
How to manipulate landscapes to improve the potential for range
expansion. *Methods in Ecology and Evolution*

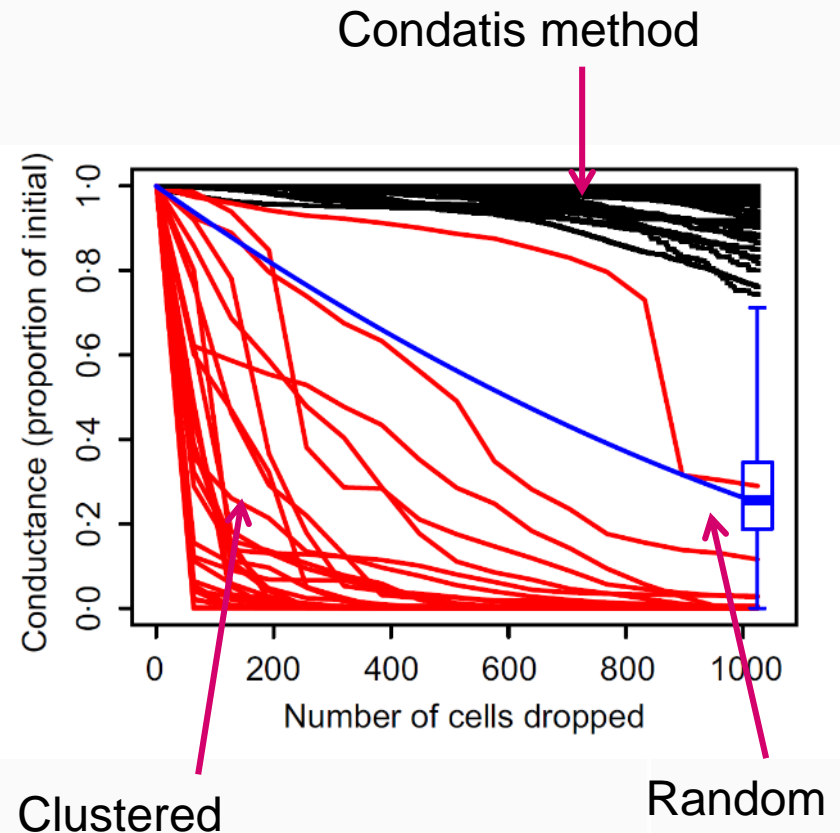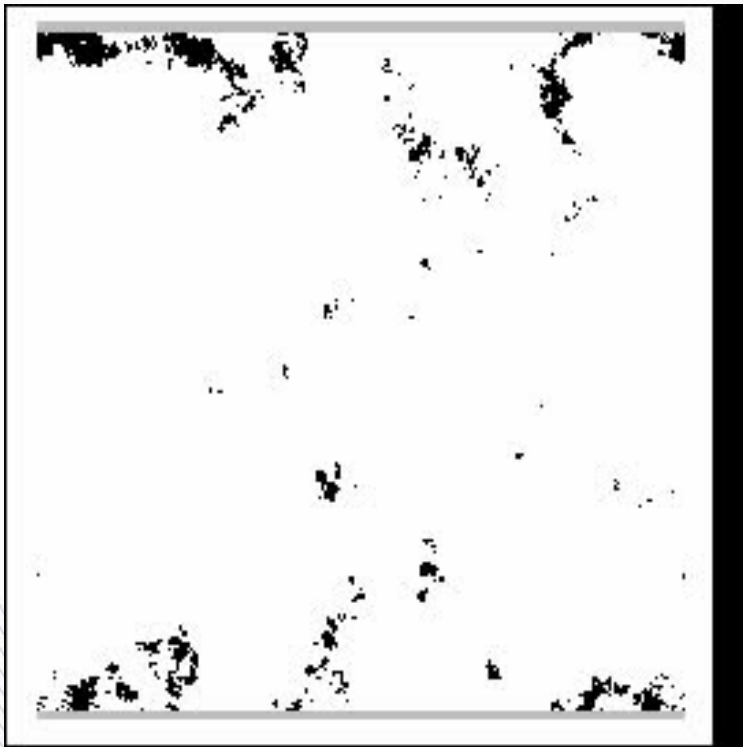# 'Flow' through each cell shows important routes

- Leads to 'dropping' routine

# How prioritisation works

- Validated using 30 experimental landscapes

Condatis method

Clustered

Random

Hodgson, J.A., *et al.* (2016) How to manipulate landscapes to improve the potential for range expansion. *Methods in Ecology and Evolution.*

Recap: Functions of Condatis

- Quantify existing range-shifting potential: "Speed/Flow"
  - Between specific source and target, over multiple generations

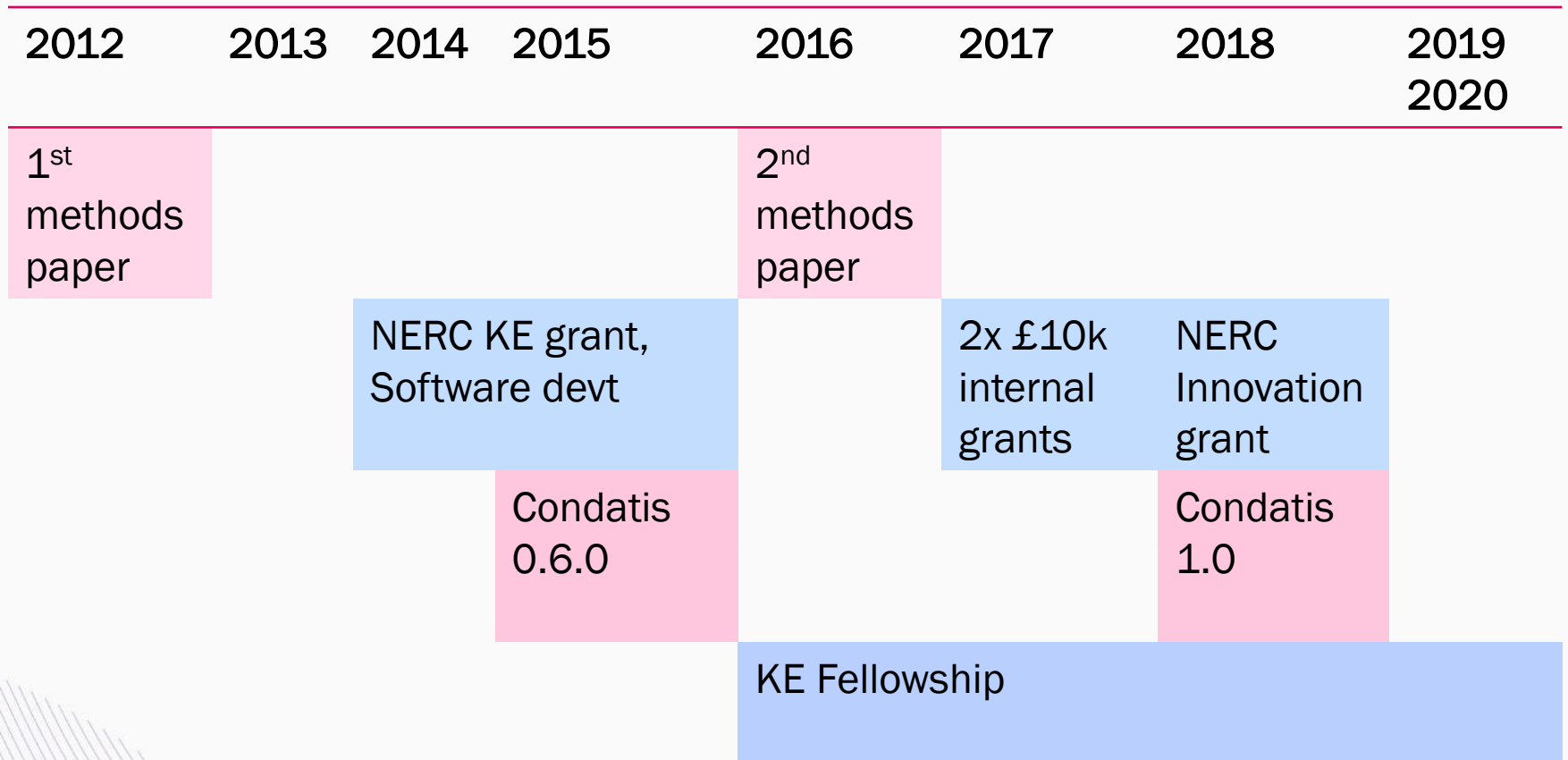- Assess the impact of changes to the habitat network "Dropping"
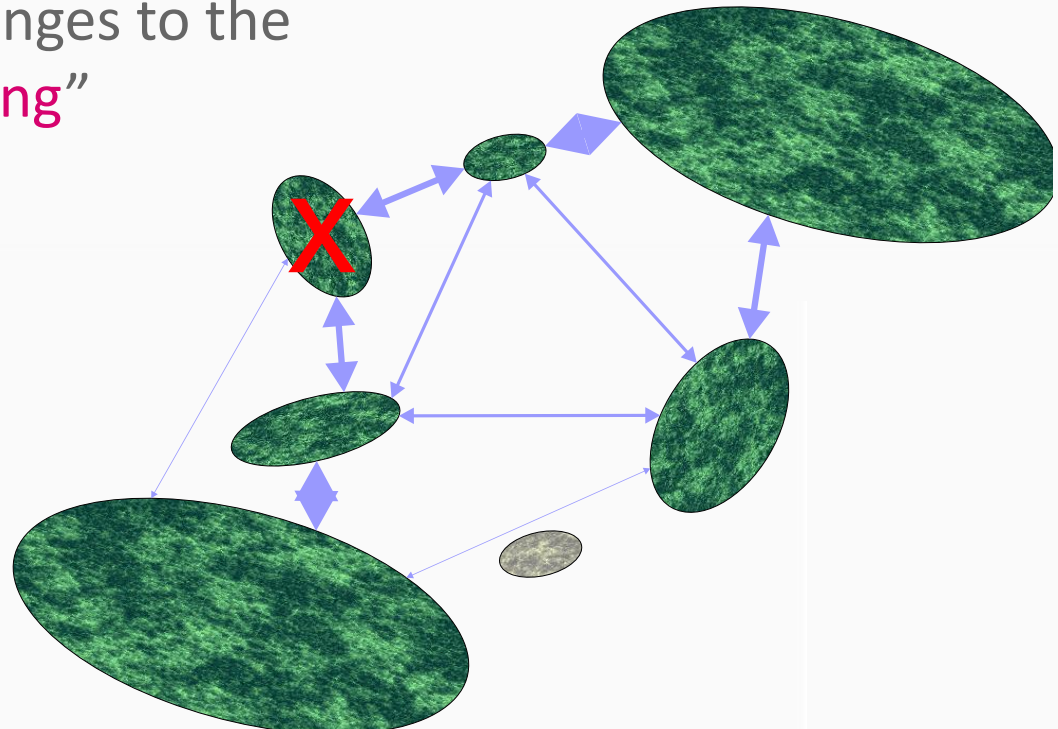
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- When?
 - How has it developed over time?

TIMELINE

2012	2013	2014	2015	2016	2017	2018	2019 2020
1st methods paper				2nd methods paper			
		NERC KE grant, Software devt			2x £10k internal grants	NERC Innovation grant	
			Condatis 0.6.0			Condatis 1.0	
				KE Fellowship			

1. Hodgson, J. A., Wallis, D. W., Krishna, R., & Cornell, S. J. (2016). How to manipulate landscapes to improve the potential for range expansion. METHODS IN ECOLOGY AND EVOLUTION, 7(12)
2. Hodgson, J. A., Thomas, C. D., Dytham, C., Travis, J. M. J., & Cornell, S. J. (2012). The Speed of Range Shifts in Fragmented Landscapes. PLOS ONE, 7(10)

Condatis is online!
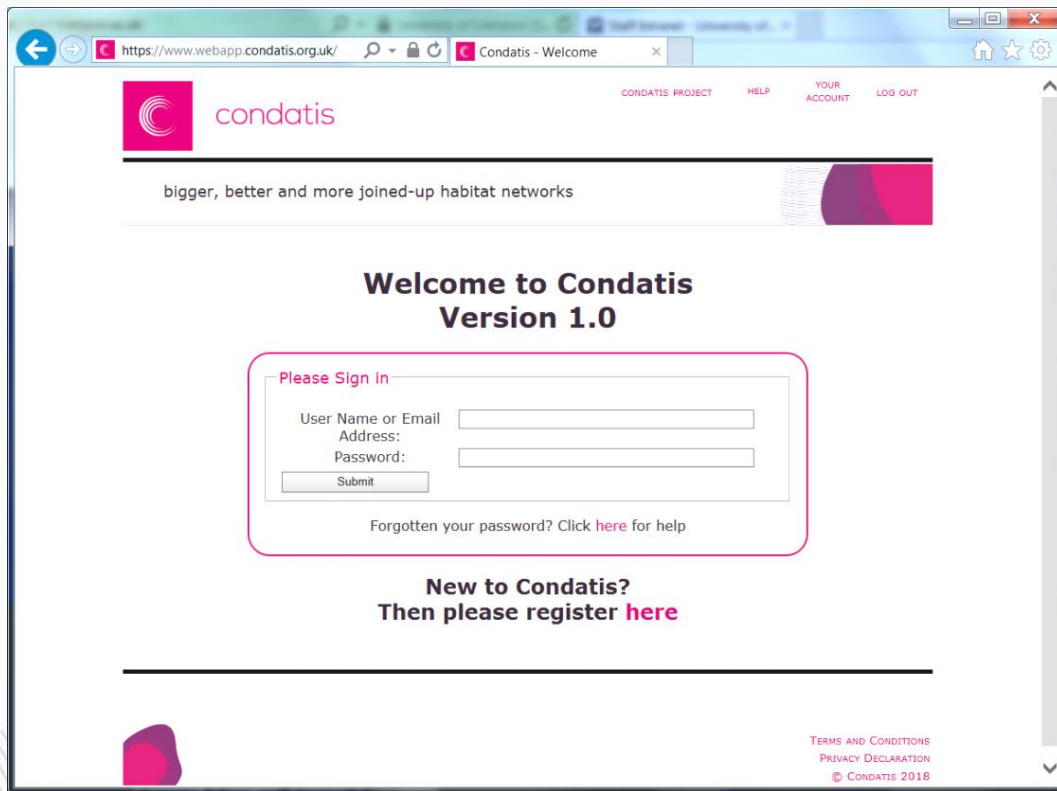
- Power; compatibility; backup

- Enhanced prioritisation (a.k.a. dropping)

- Handy report of your results

- New help documentation

- Our developer will stick around

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Thanks to partners old and new

- Special thanks to our beta testers

Warwickshire County Council

Regional Scale Connectivity

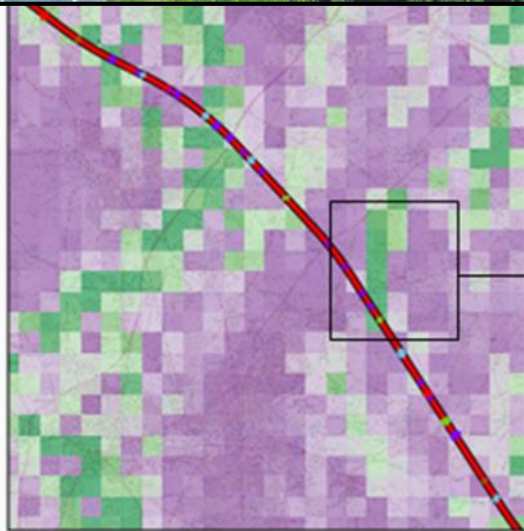Local Scale Connectivity
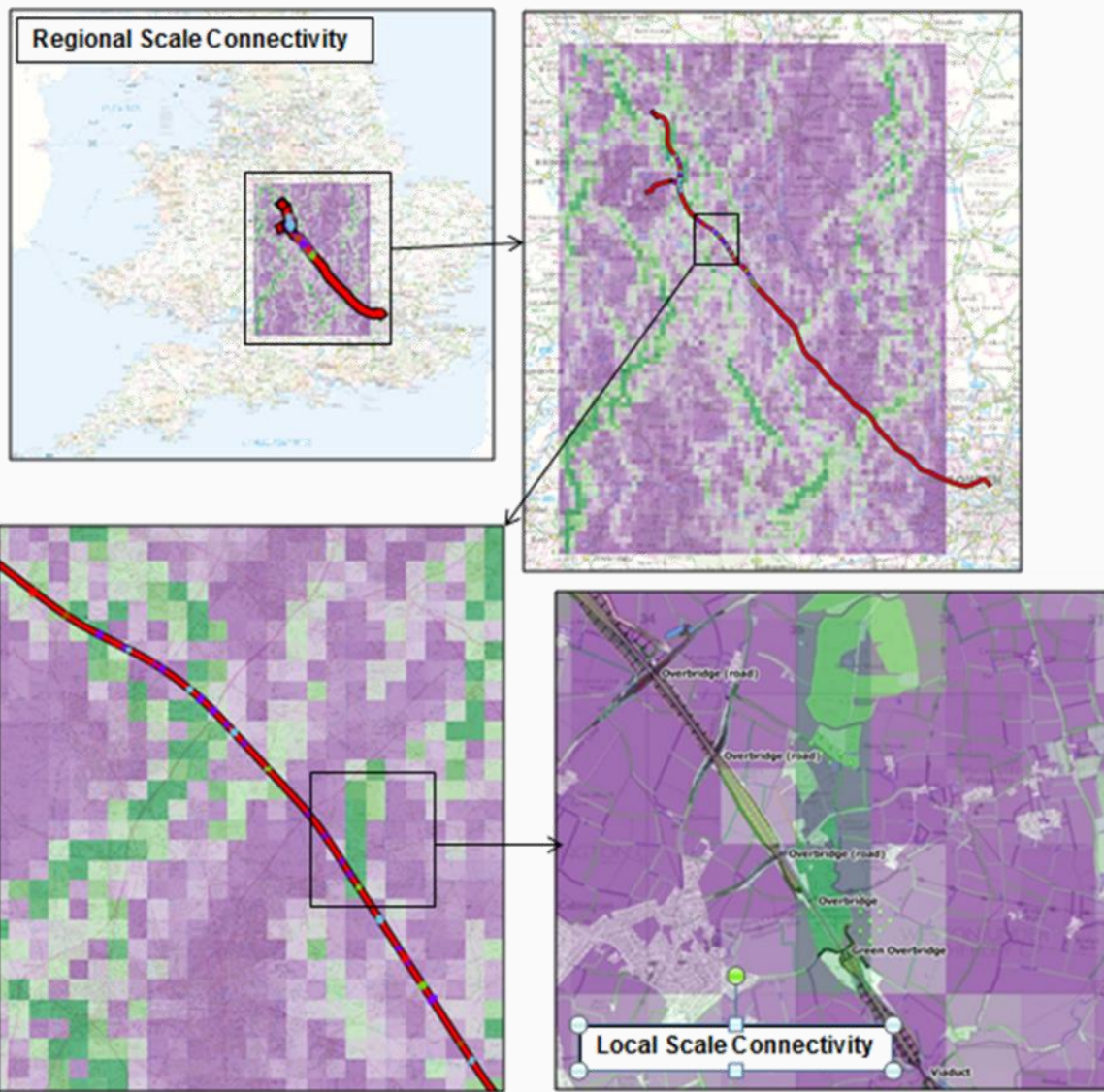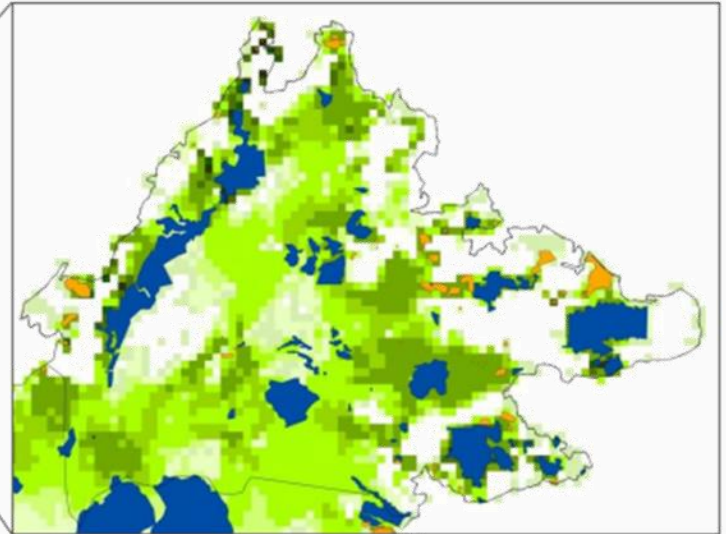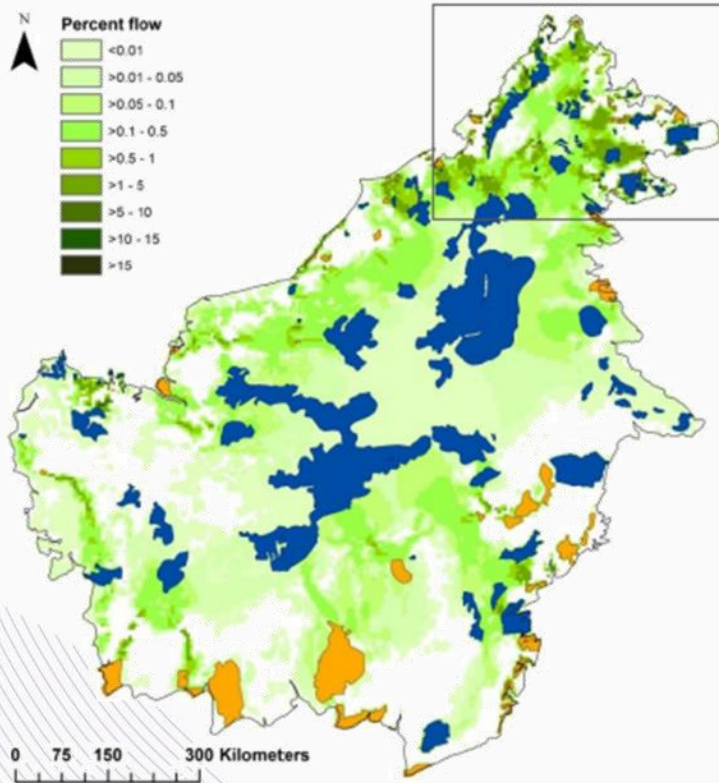
Warwickshire County Council
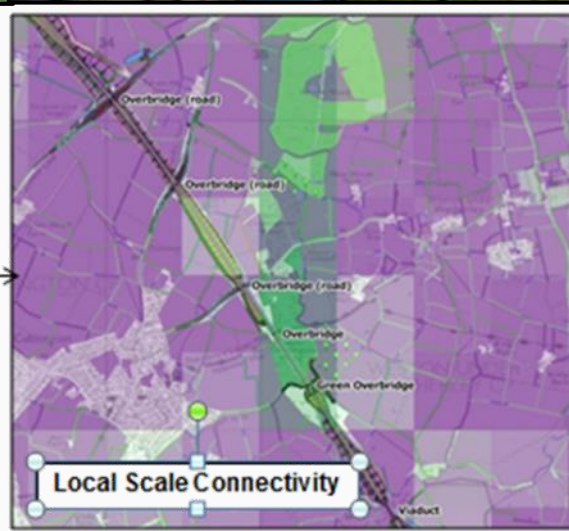
Sabah, Borneo

Target: to increase the extent of protected areas to 30% of land area.

Natural England
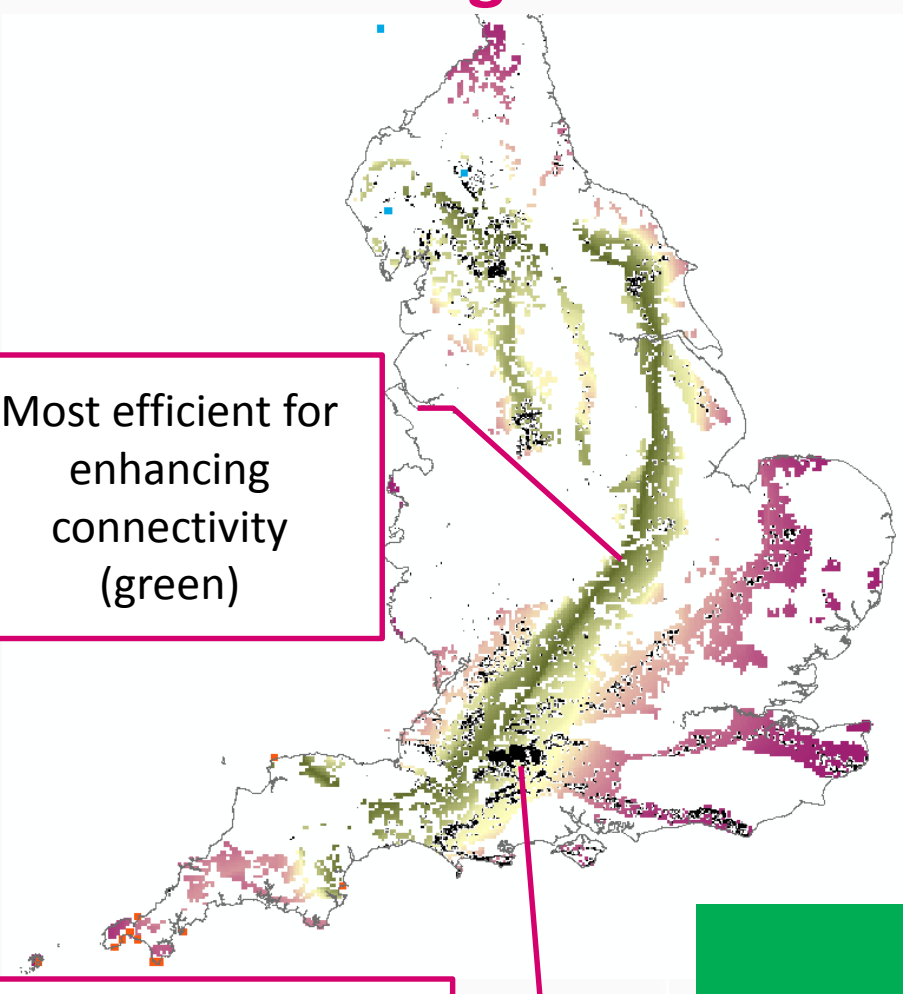## Restoration suggestions for calcareous grassland

- "Potential" = calcareous rock/soils

- 2017 pilot project with Sarah Taylor, Natural England

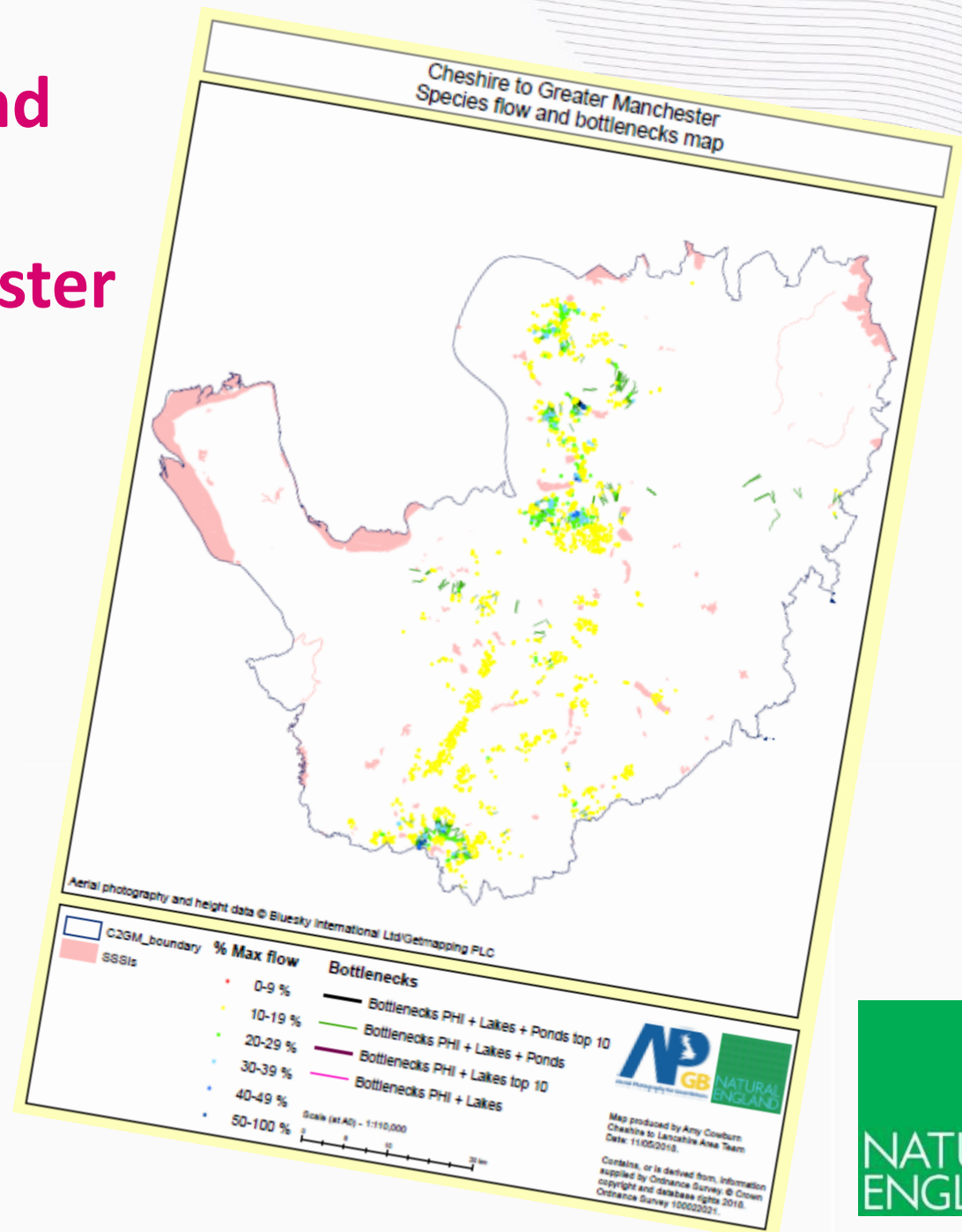- Source/target defined by Met Office 5km gridded data 1960-1990, mean of Jan/July

Most efficient for enhancing connectivity (green)

Existing habitat (black)

Natural England

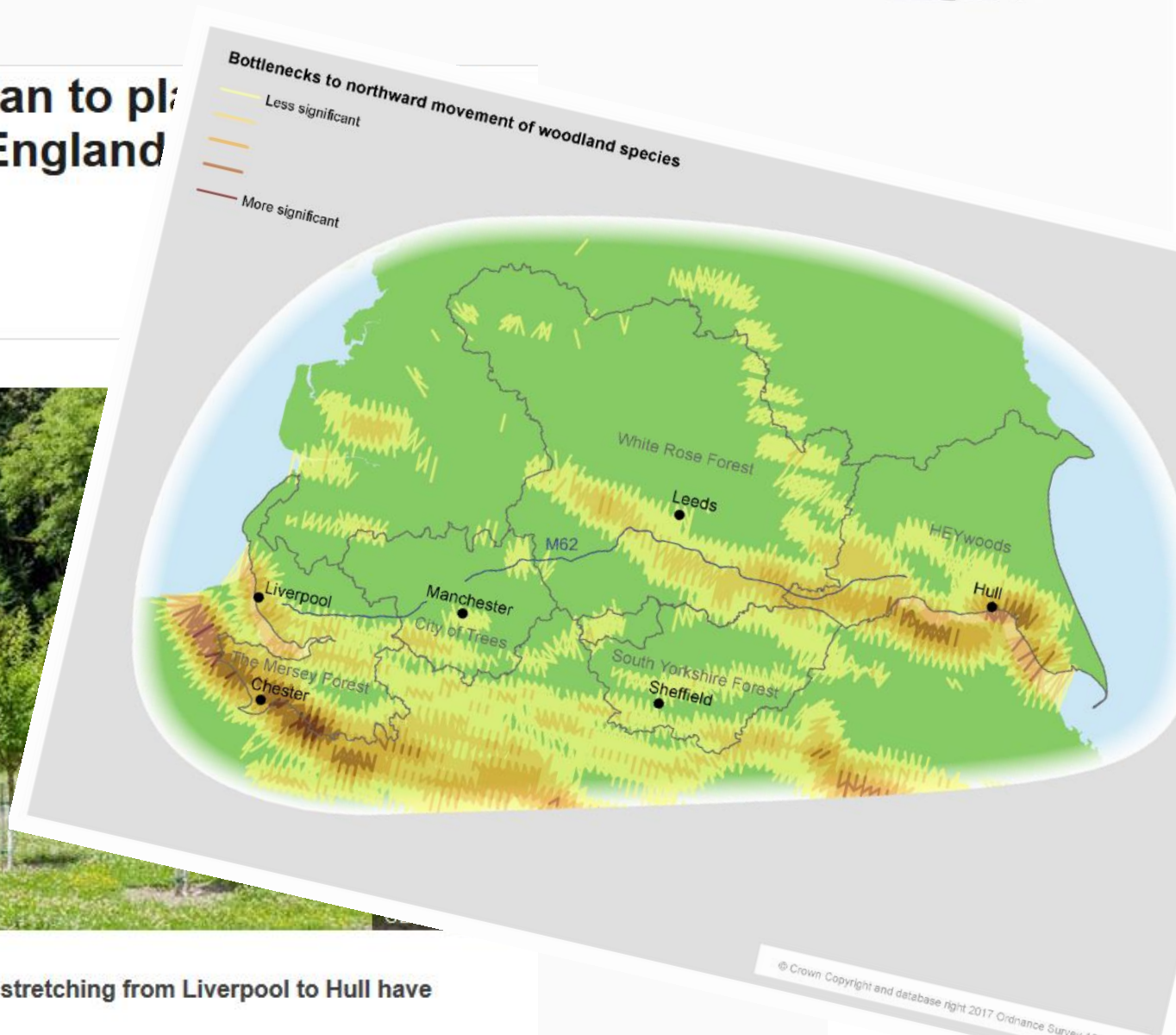## Greater Manchester Wetlands Partnership

Mersey Forest

Northern Forest: Plan to plant [...] woodland' across England

By Roger Harrabin
BBC environment analyst

🕐 7 January 2018

Plans to create a new Northern Forest stretching from Liverpool to Hull have been kick-started by the government.
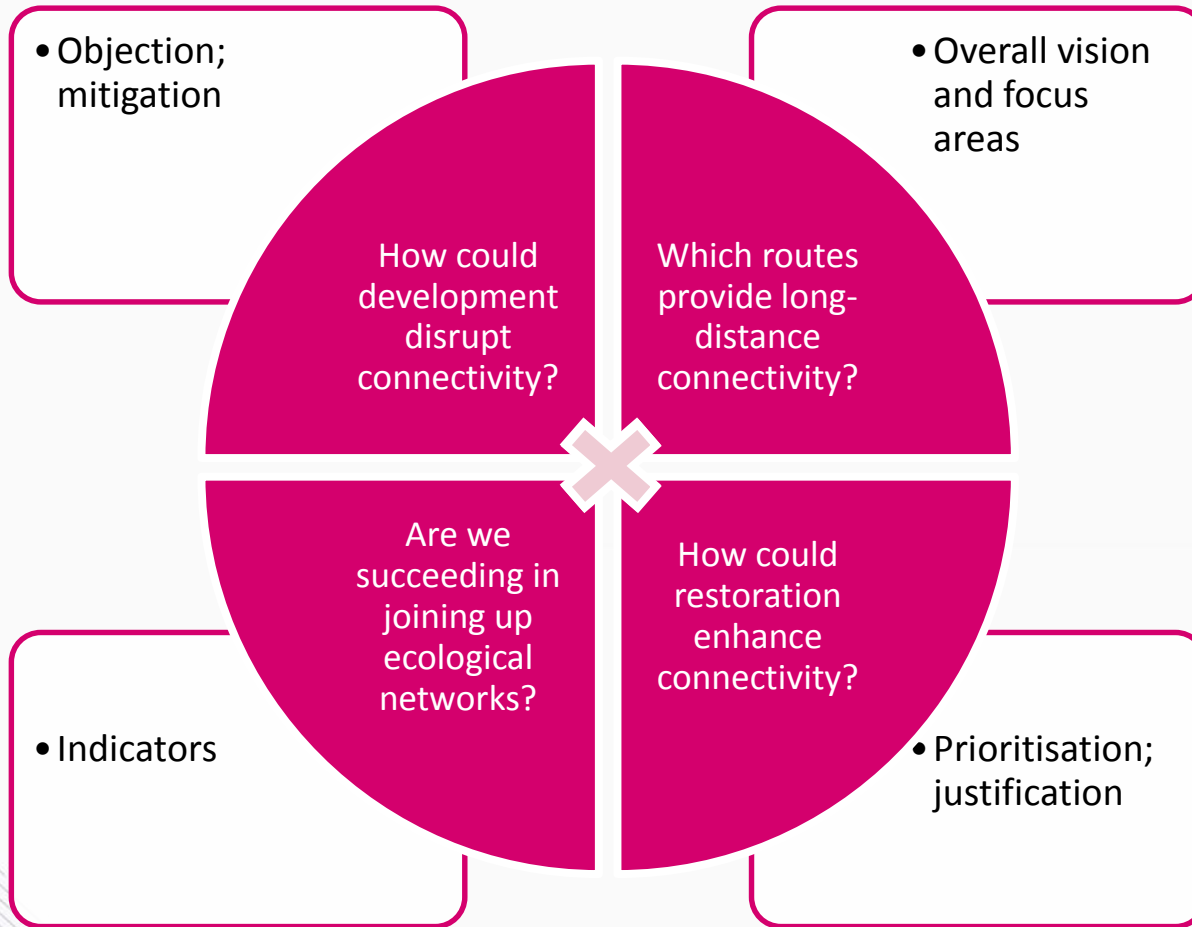
Bottlenecks to northward movement of woodland species

Less significant

More significant

White Rose Forest

Leeds

HEYwoods

M62

Liverpool

Manchester

Hull

City of Trees

The Mersey Forest

South Yorkshire Forest

Chester

Sheffield

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Policy uses

- Objection; mitigation

- Overall vision and focus areas

- Indicators

- Prioritisation; justification

How could development disrupt connectivity?

Which routes provide long-distance connectivity?

Are we succeeding in joining up ecological networks?

How could restoration enhance connectivity?

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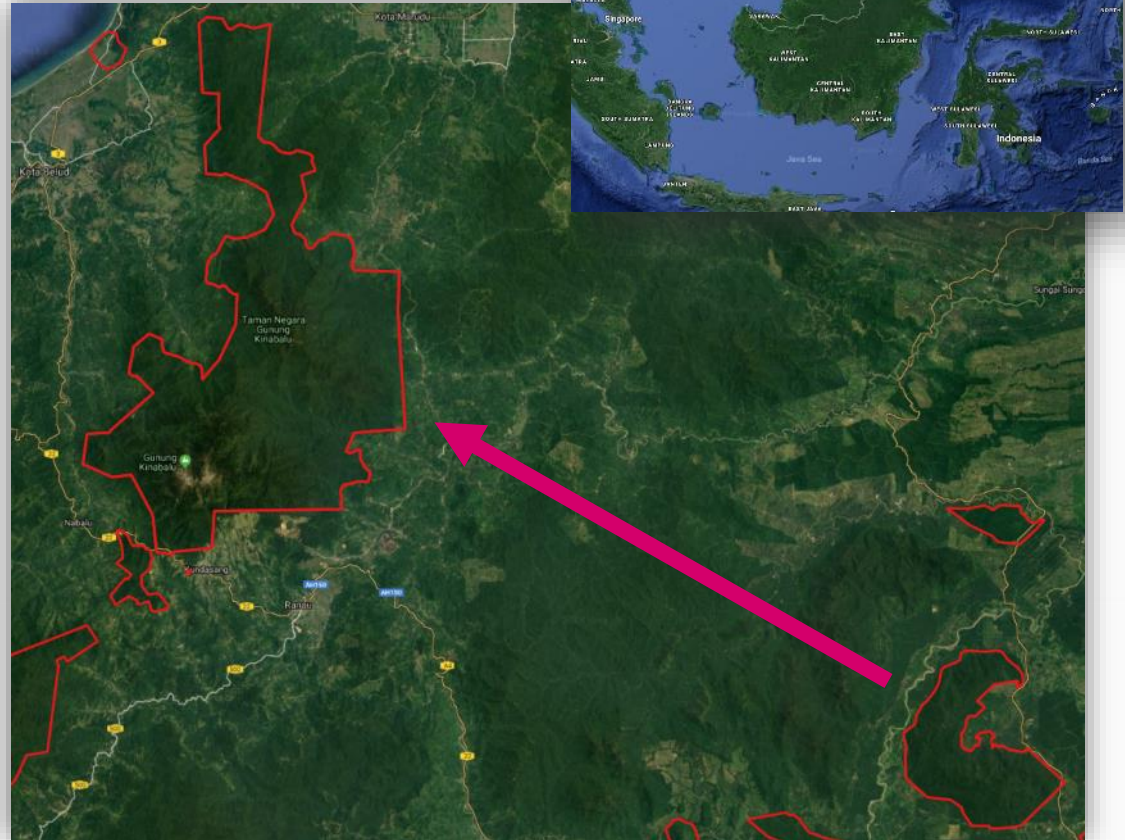 - Where can it be used? What inputs are required?

Key Conservation Questions

*Which **species** need to move in this landscape?*

*Between which **sources and targets**?*

*What constitutes **habitat** for those species?*

*Where is **additional potential habitat** that they could move through?*

Case study example: movement of a large-winged invertebrate in response to climatic change, from a lowland Protected Area (PA) to higher elevation habitat in Mount Kinabalu National Park.
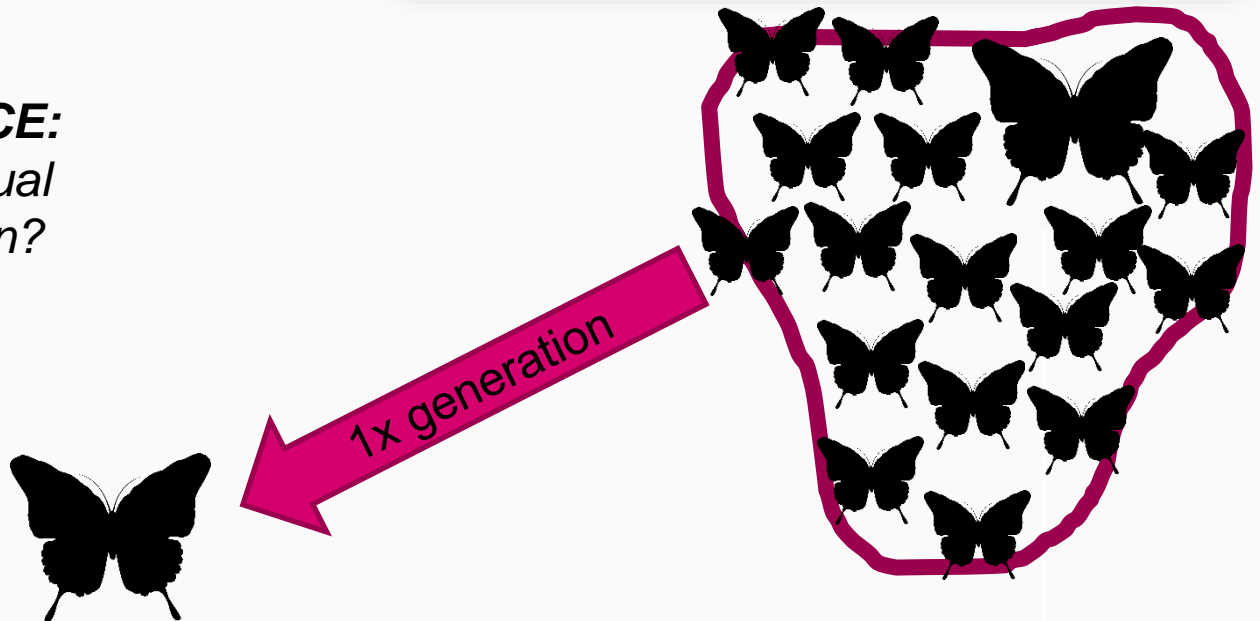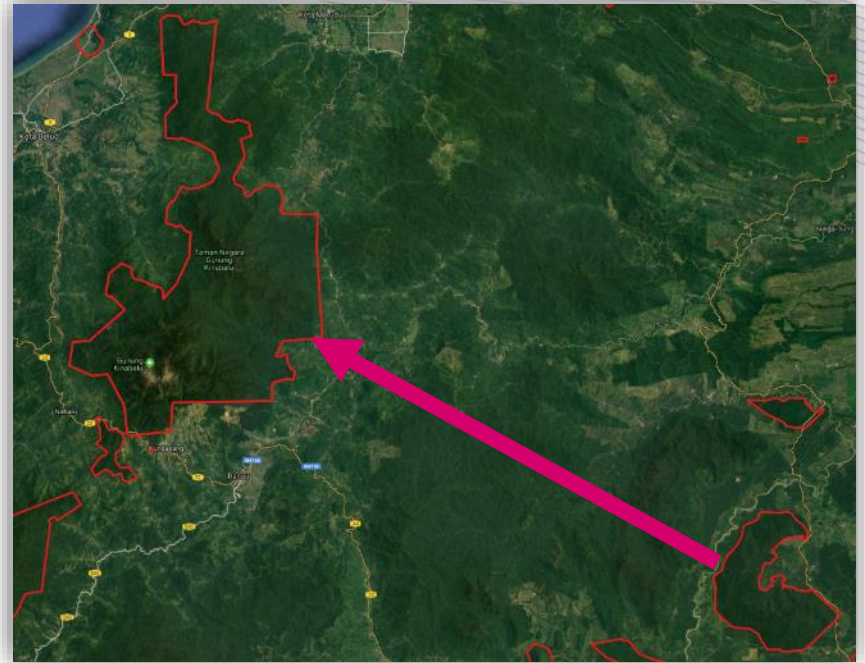
Species Data

*What is the **species/taxa of interest?***

REPRODUCTIVE RATE:
How many emigrants could the species produce in one generation, in one km² of habitat?
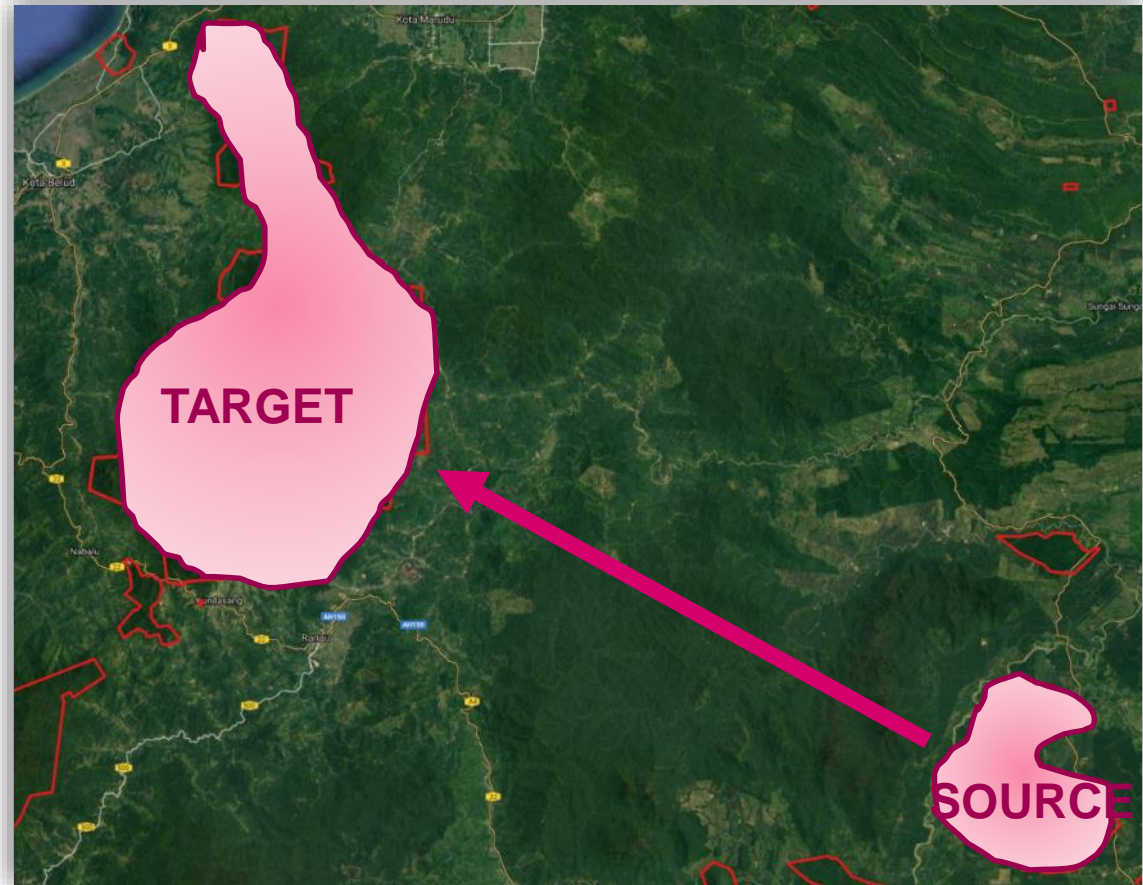
DISPERSAL DISTANCE:
How far can an individual travel in one generation?

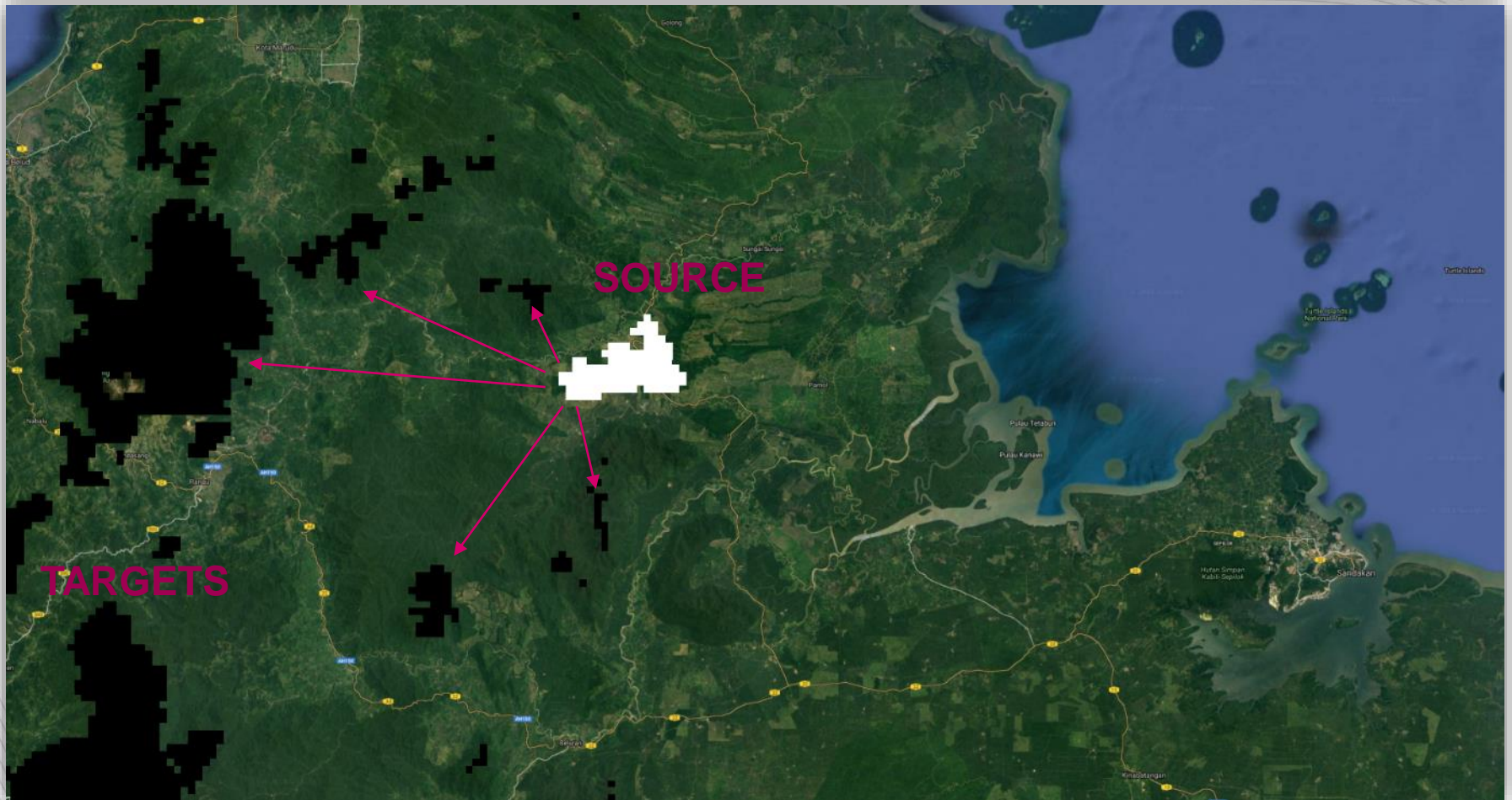1x generation

Movement direction – Source/Target

*Where is the species of interest moving from, i.e. the **source**?*

*Where is it moving to, i.e. the **target**?*

Movement direction

Example *SourceTarget.tif* raster file in QGIS

Habitat Data

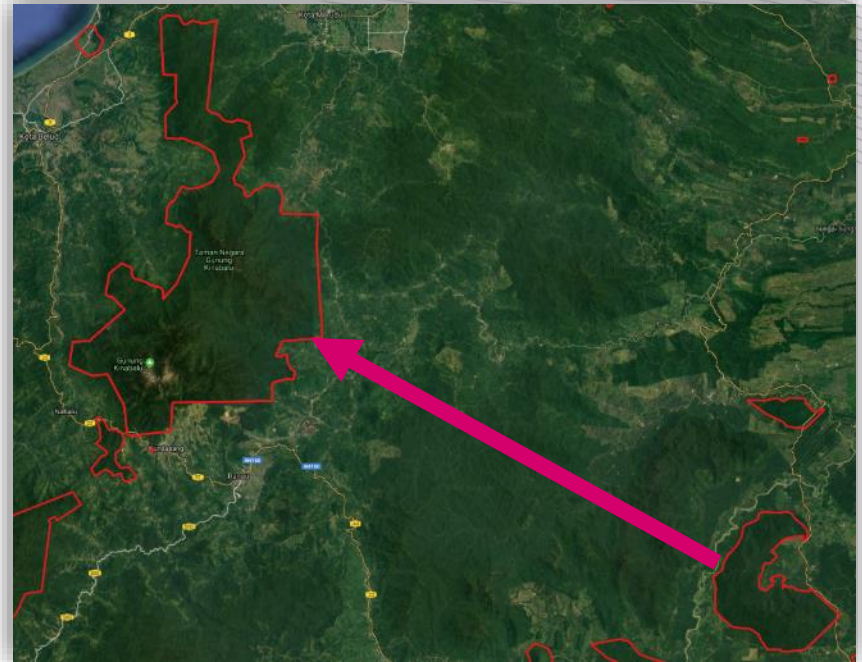*What is the **habitat** of the species of interest**?***

*What **proportion** of each grid cell does that habitat cover?*

= 0.76 =

*What is the **quality** of the habitat in that cell**?***

****Ensure *all* raster layers have the same pixel/cell size & geospatial extent****

Prioritisation Layer *(for Dropping analysis)*

*CONSERVATION: Where is **additional habitat** that your species could move through, e.g. unprotected forest?*
*Which of these potential habitat patches are a **conservation priority** to ensure future connectivity as species shift their ranges?*

...OR...

*RESTORATION: Where could habitat be **restored** in order to enhance movement pathways along key routes?*
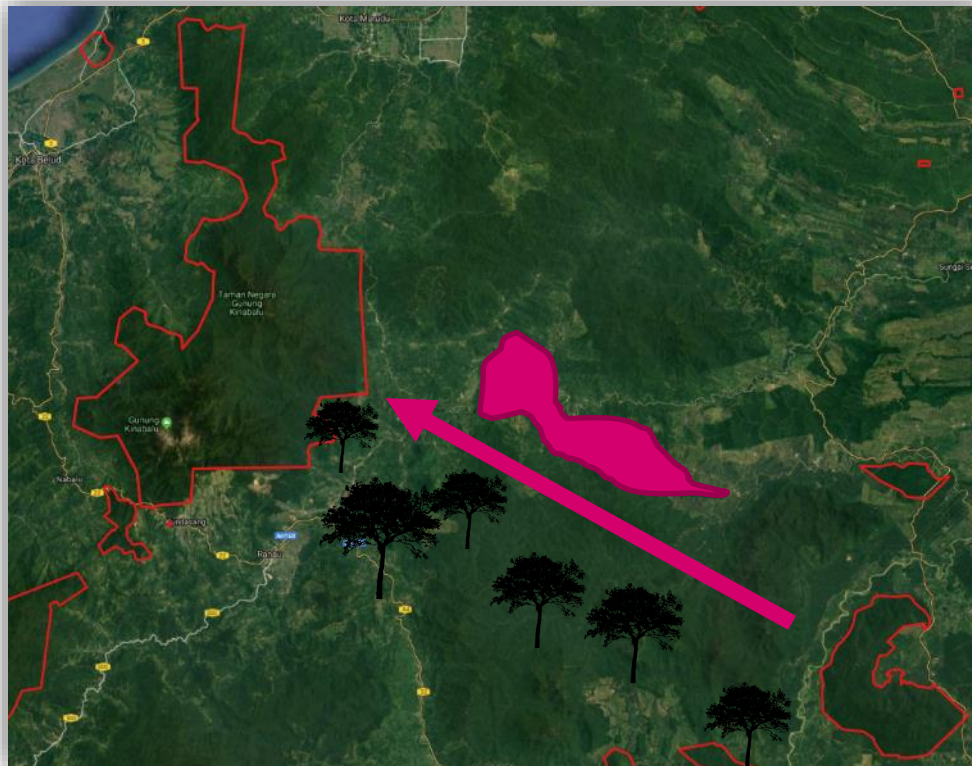
Prioritise conservation or restoration of additional habitat to enhance connectivity

Data inputs for Condatis

Data/files	Name
Reproductive rate	Number of individuals per km^2 per generation
Dispersal distance	km travelled per individual per generation
Source/target raster	Source cells labelled 1; target cells labelled 2
Habitat raster	Proportion of habitat per grid cell (0-1)
Prioritisation raster	Proportion of habitat per grid cell (0-1)

Now ready to go…..
www.webapp.condatis.org.uk

With training files -
condatis.org.uk/events/condatis-version-1-0-launch-event

Thank you!

Find out more: www.condatis.org.uk

Condatis online: webapp.condatis.org.uk

Email: contact@condatis.org.uk

Twitter: @condatiske