NATURAL ENVIRONMENT RESEARCH COUNCIL

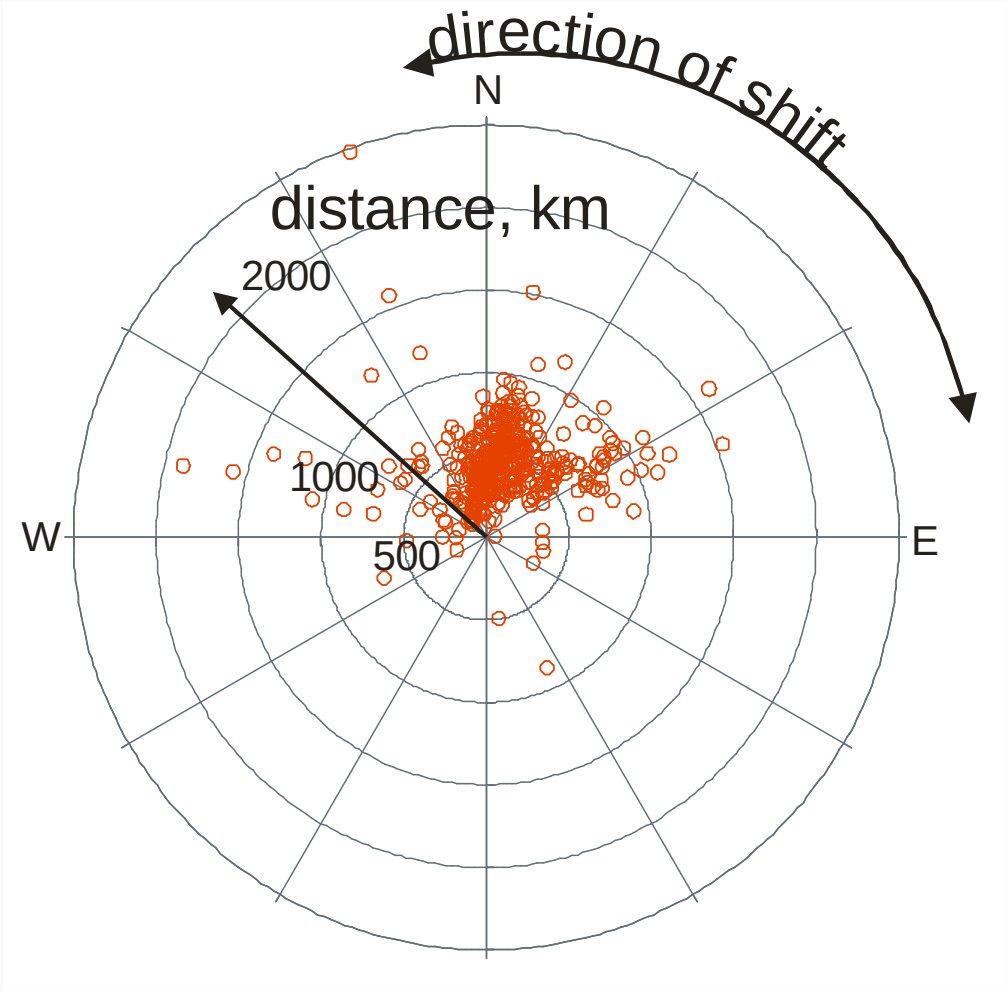
UNIVERSITY OF LIVERPOOL

Improving long-distance connectivity for climate change: planning restoration using Condatis

JENNY HODGSON,
KATHERINE ALLEN

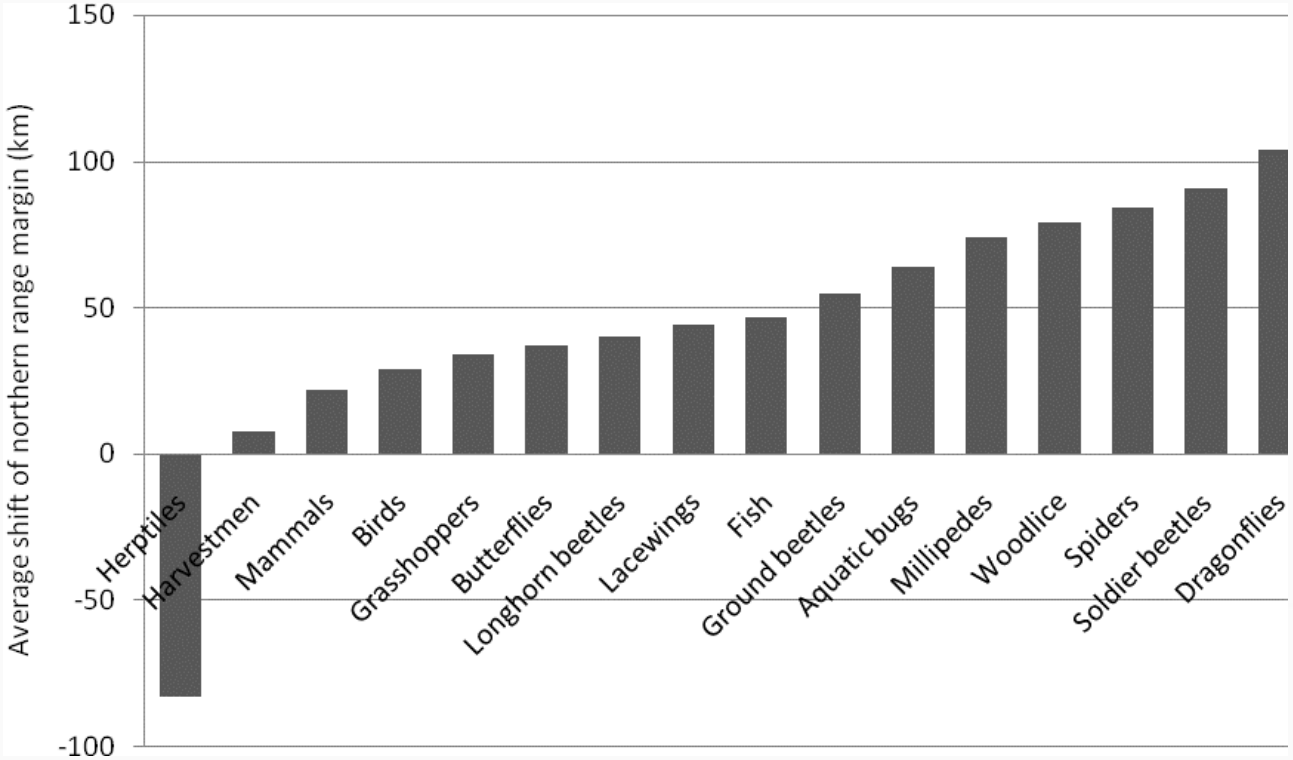
condatis

Species need to move because of climate change



Huntley et al. (2007) *A climatic atlas of European breeding birds*

Species in Britain are on average shifting northwards

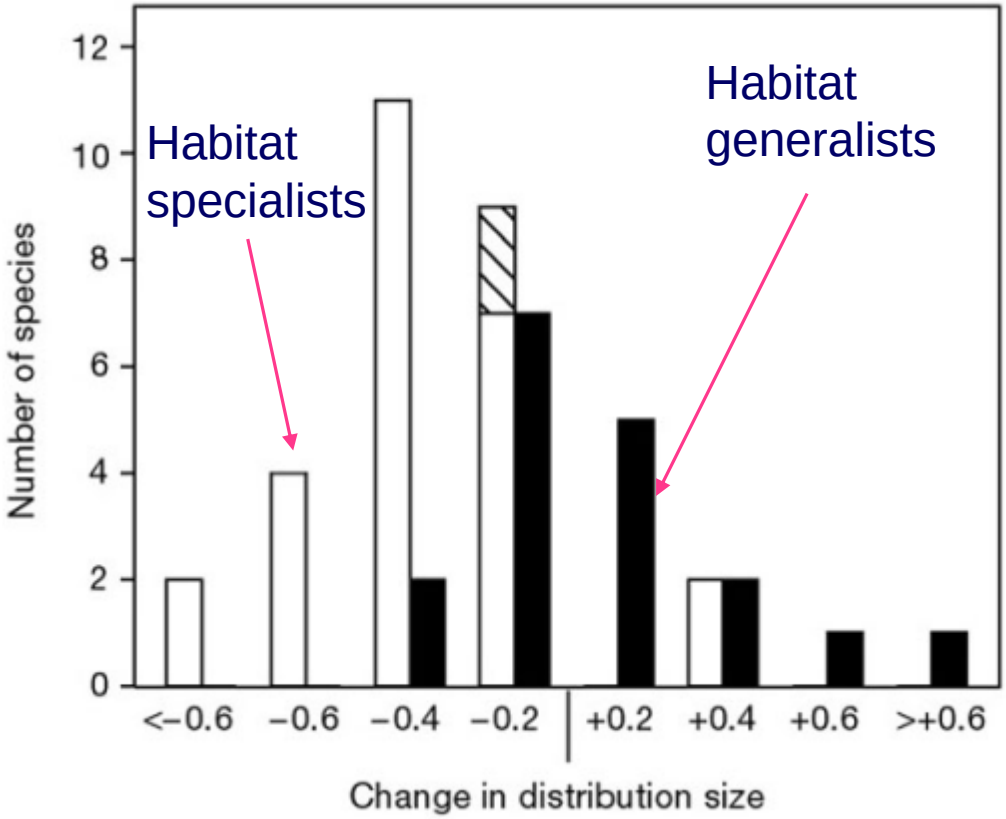


Each individual landscape will have species moving in and out

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

Lack of habitat is prime culprit in species failure to shift

Silver studded blue (*Plebejus argus*)



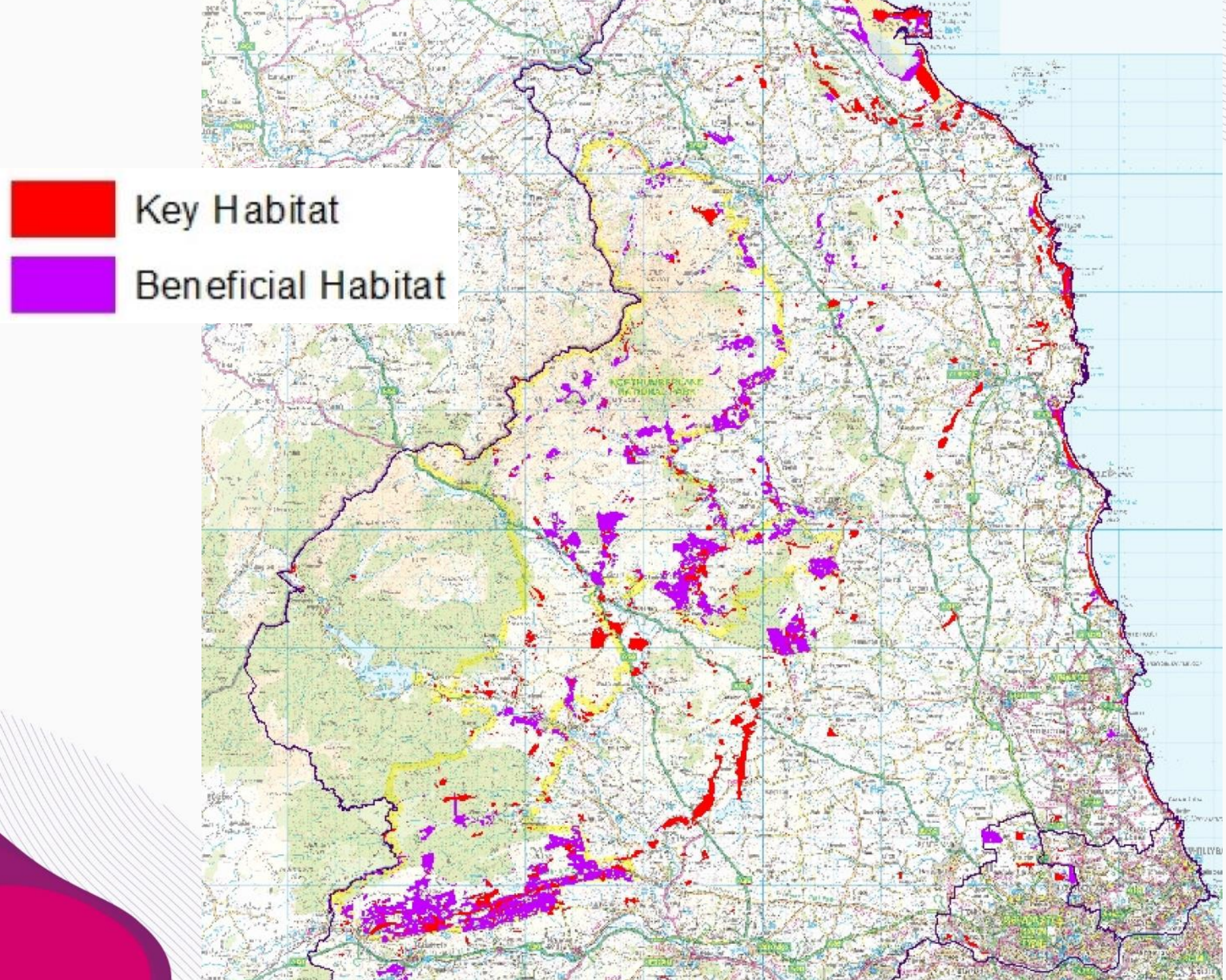
Speckled wood (*Pararge aegeria*)

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

There are increasingly plans for habitat restoration, e.g.

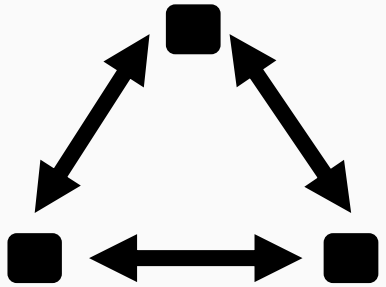
Nature Improvement Areas, Natural England

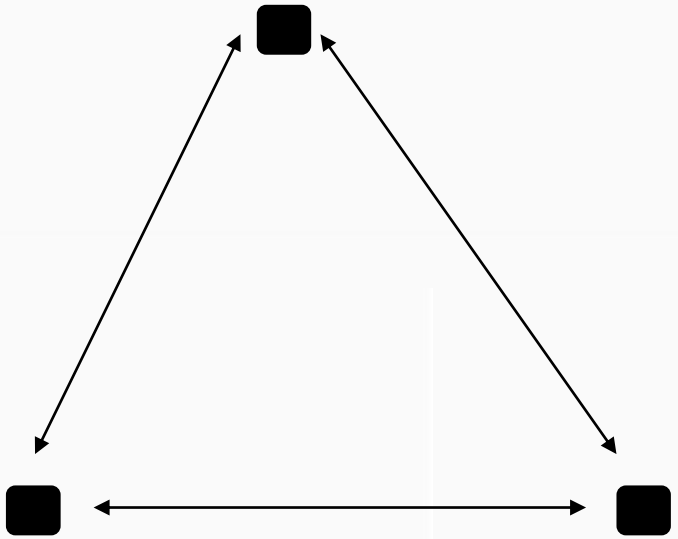
Buglife Coast to Coast B-lines


Key Habitat
Beneficial Habitat

“Classical” principles of reserve arrangement

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



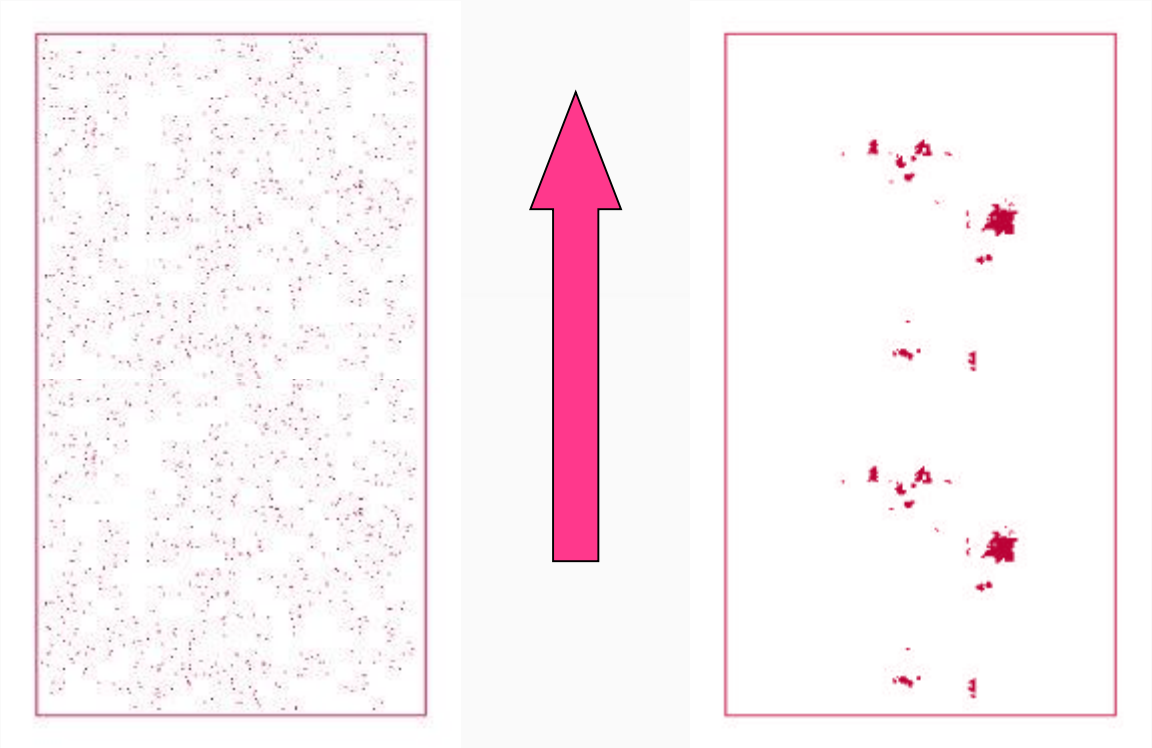


Benefits of clustering

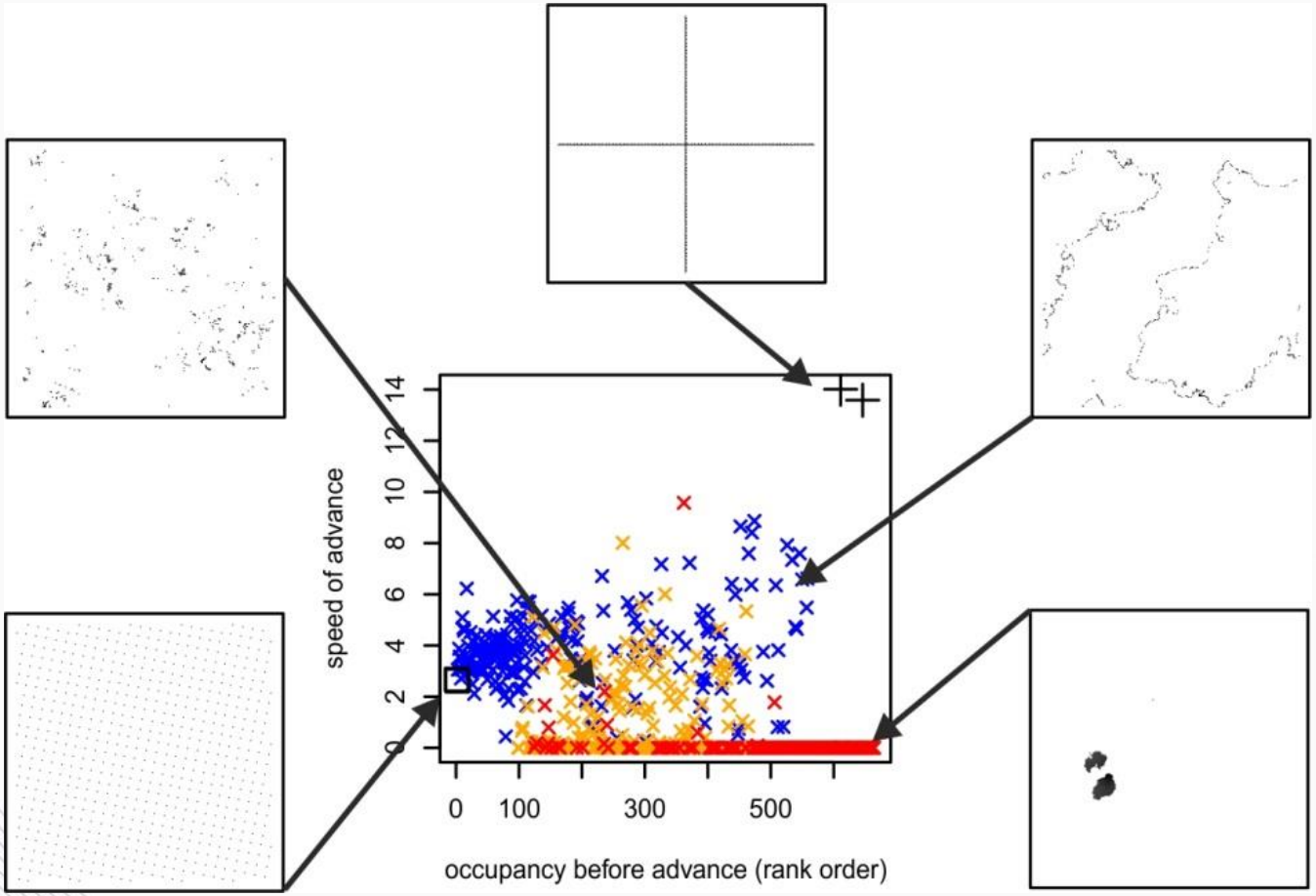
- Rescue after chance extinctions
- Less dispersal mortality

But with climate change

- Bigger aggregated clumps mean bigger gaps
- “increase connectivity” is ambiguous

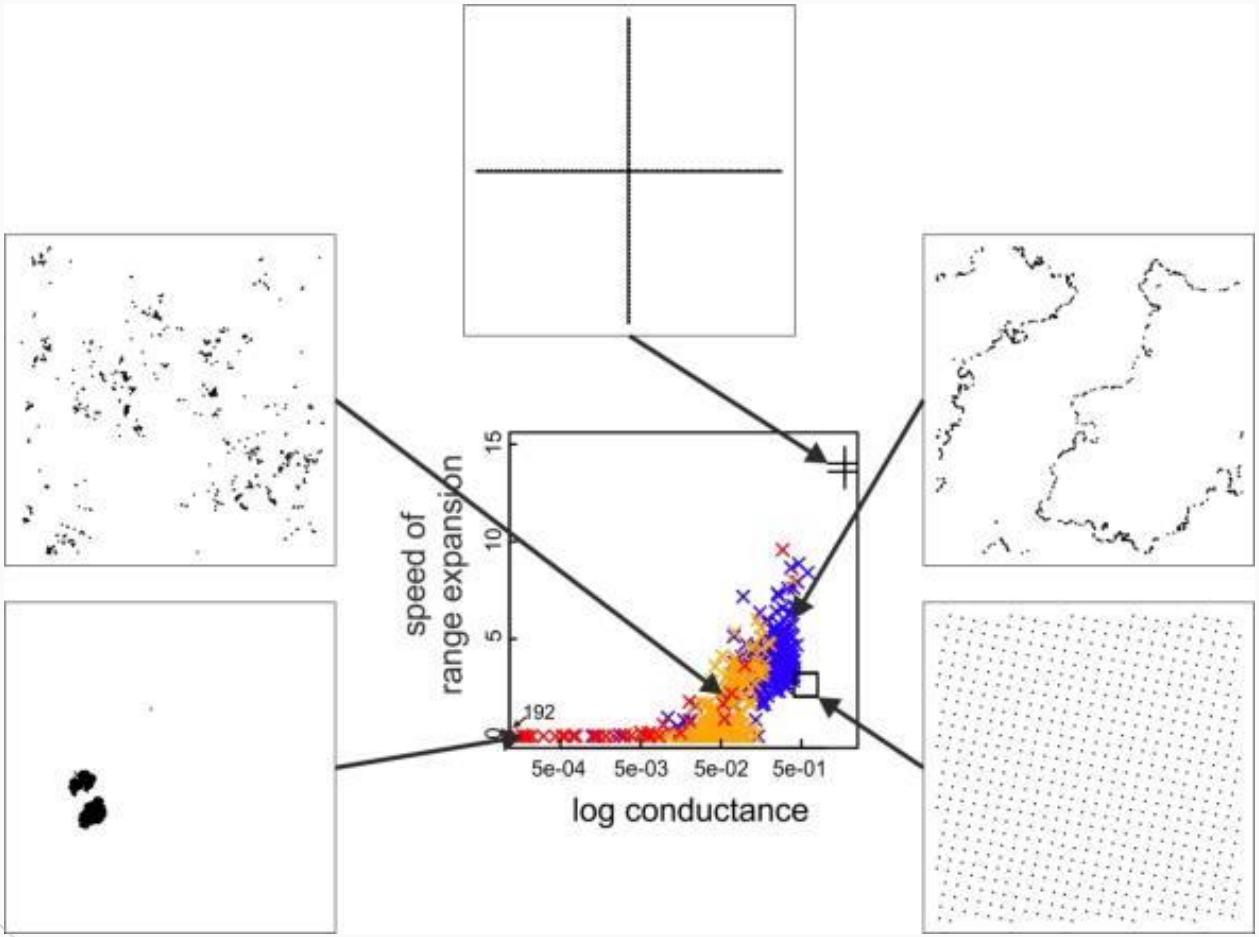


Local viability does not predict range shift speed

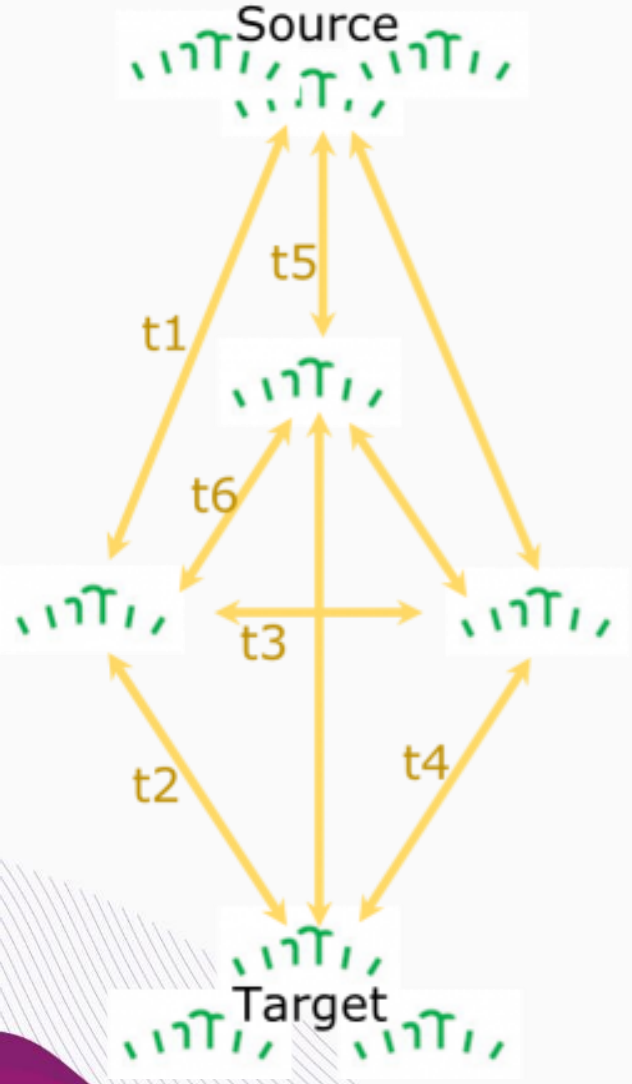


Hodgson, J.A., et al (2012) The Speed of Range Shifts in Fragmented Landscapes. *Plos One*, 7, e47141.

New metric of conductance predicts speed of range expansion



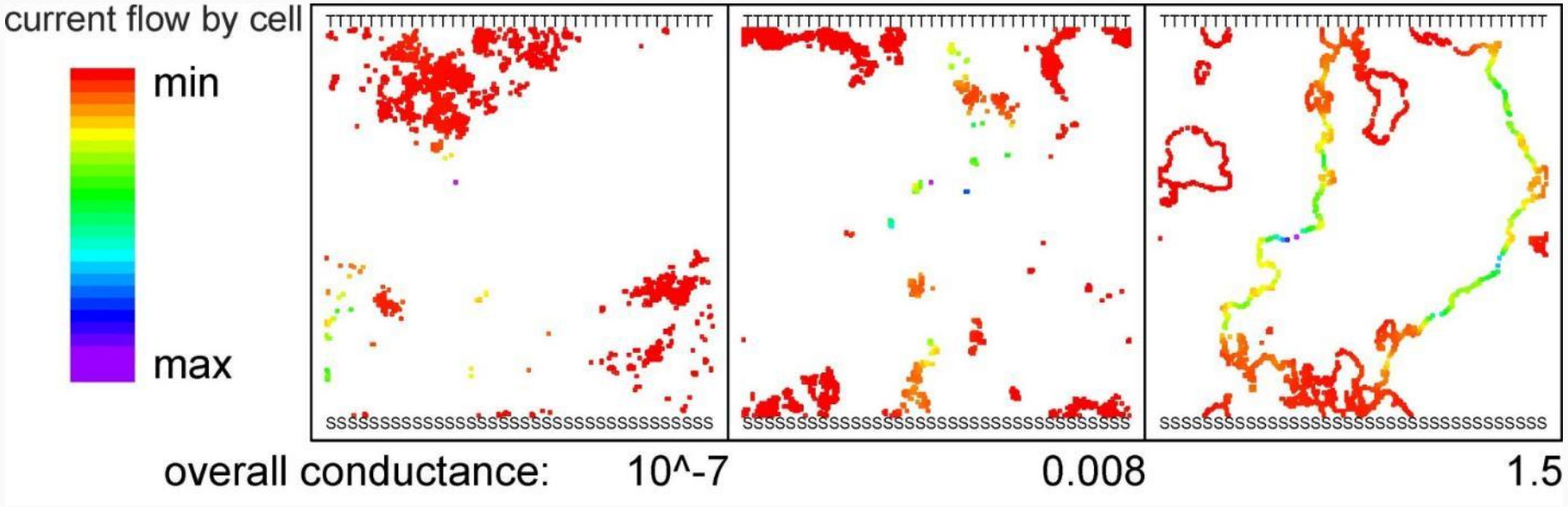
Hodgson, J.A., et al (2012) The Speed of Range Shifts in Fragmented Landscapes. *Plos One*, 7, e47141.



What is flow?

- Range expansion is a chain of colonisation and establishment events over time (t).
  - t1 + t2 or
  - t1+ t3 + t4 or
  - t5 + t6 + t2 or all possible routes
- Time ≡ electrical resistance
- Time depends on habitat area, emigration rate and dispersal distance.
- Flow ≡ electrical current
- The overall flow (speed) of a landscape is voltage at source (nominally 1) divided by the cumulative time taken to cross all possible routes between every habitat cell
- The flow through each habitat cell is a proportion of the overall flow, distributed according to each cells contribution, and illustrated to the right with the higher flow dark, lower flow light coloured.

‘Flow’ through each cell shows important routes



- Leads to ‘dropping’ routine

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*, Online early.

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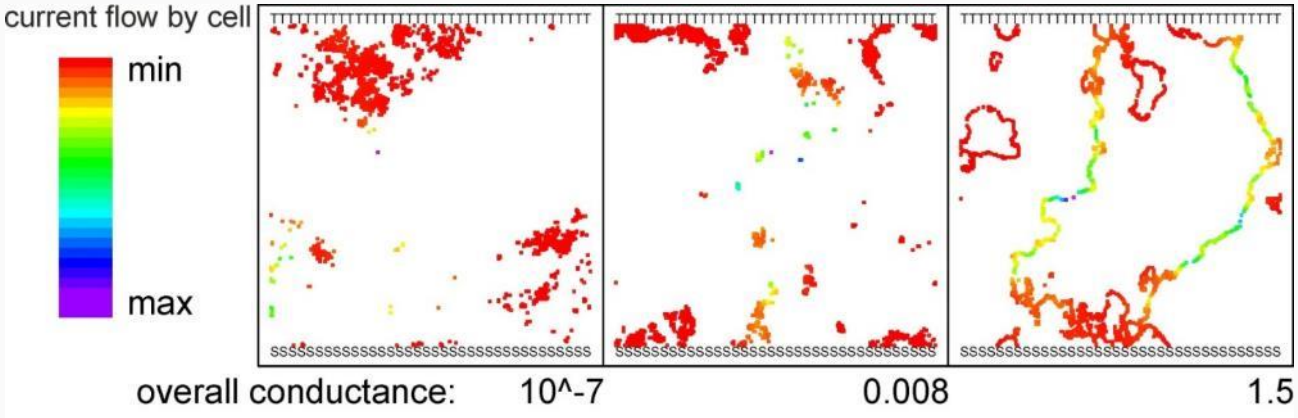

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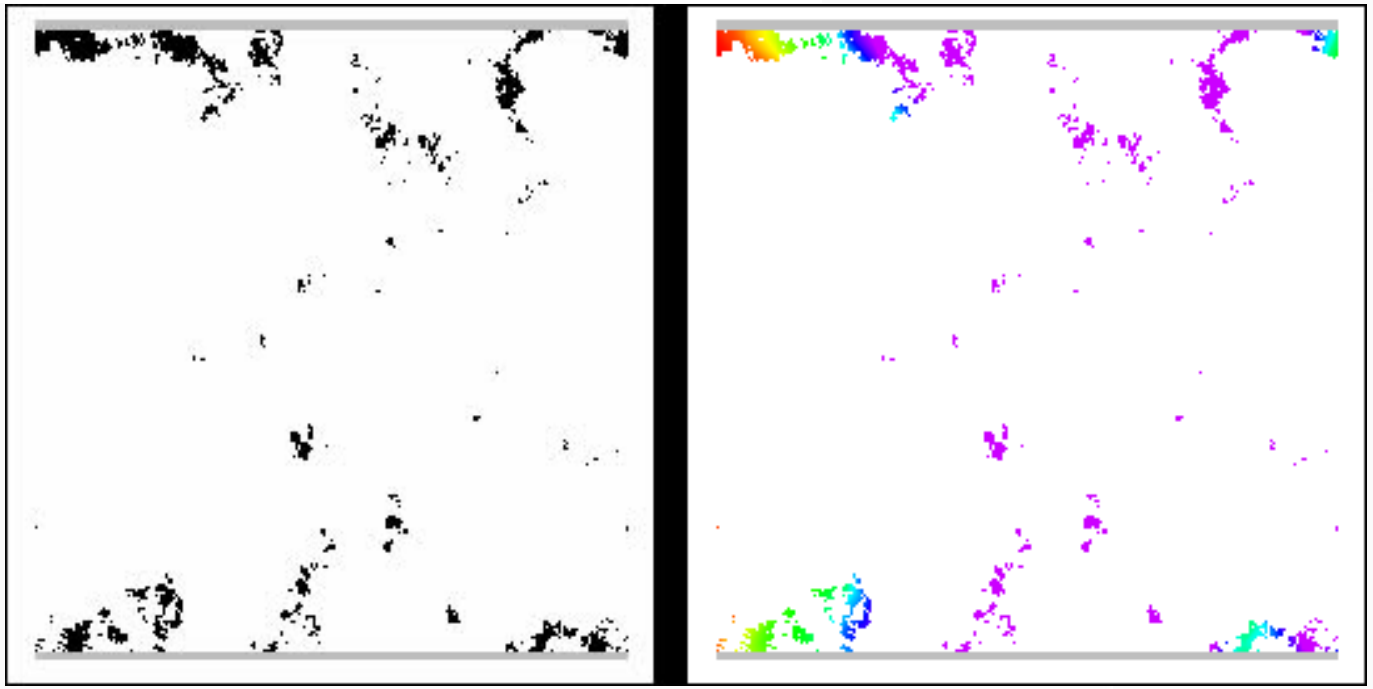
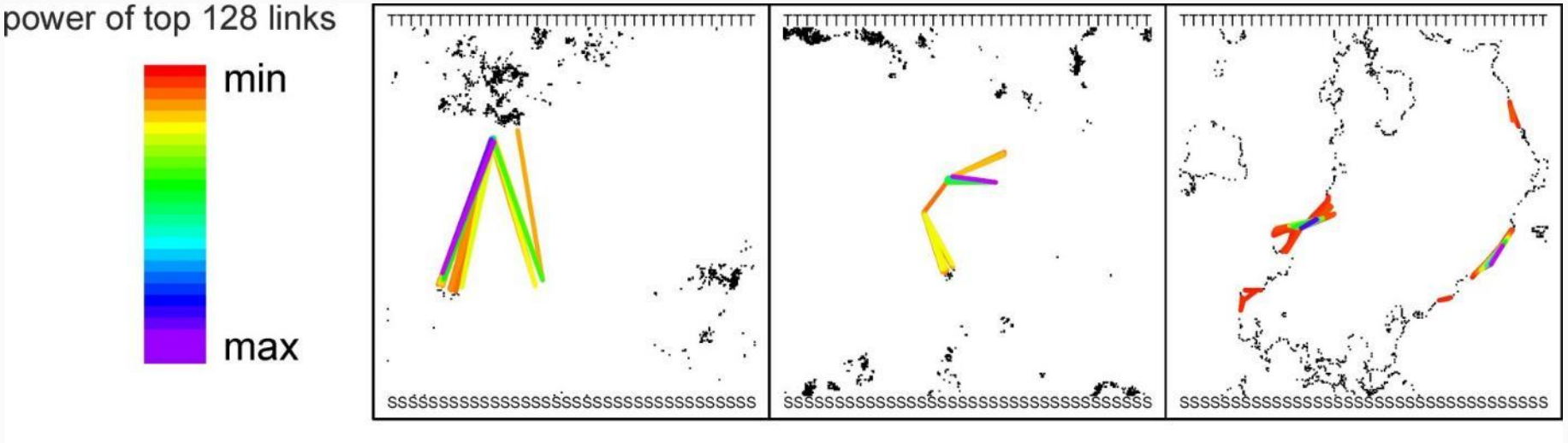


Power of each link shows bottlenecks



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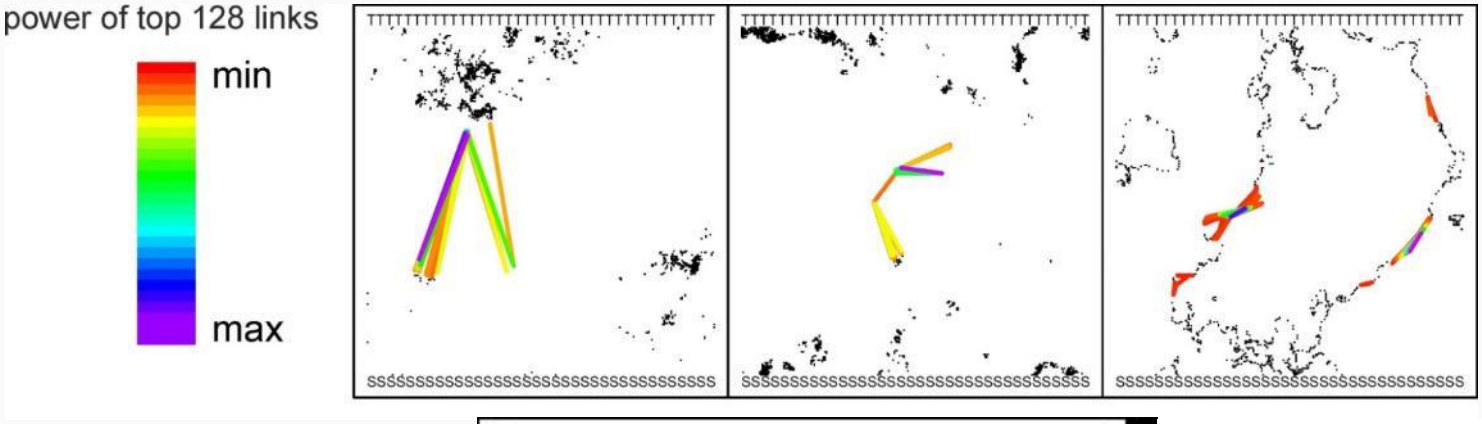
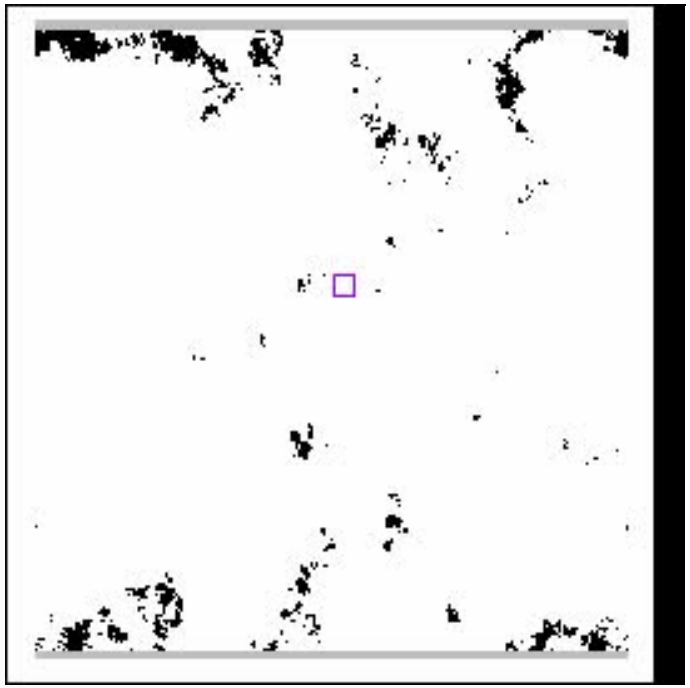
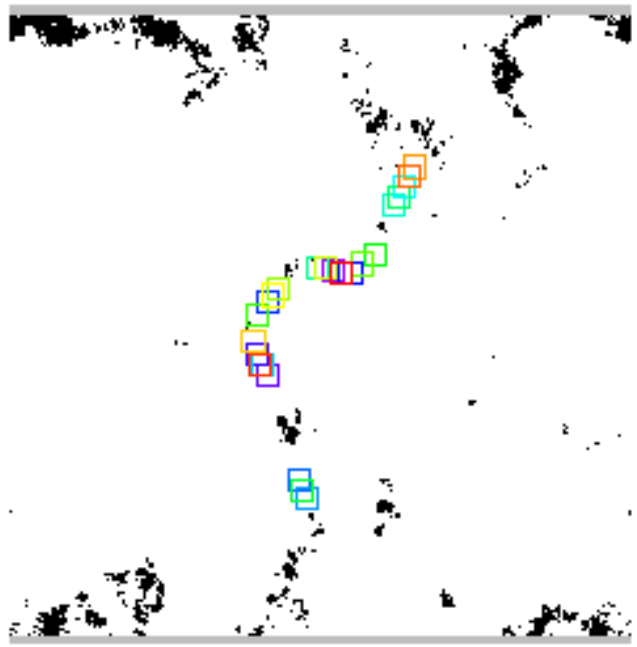
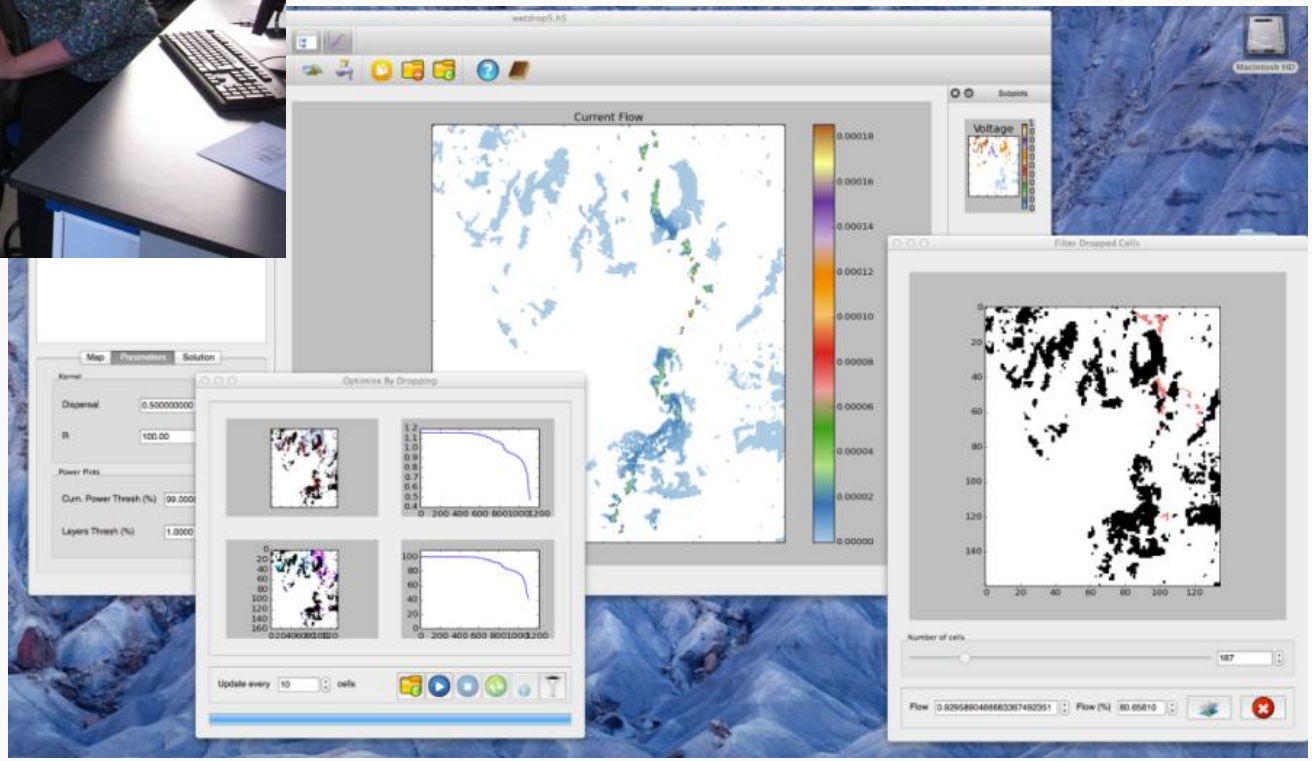


- Leads to ‘adding’ routine





From theory to software: Condatis



Functions of Condatis

- Quantify existing range-shifting potential
  - Between specific source and target
- Assess the impact of changes to the habitat network
  - Compare future proposal to existing
  - Identify bottlenecks
  - Optimise and rank proposed cells

Conclusions for conservation planning

- Protect existing habitat
  - Especially where it already covers climate gradient
- Improve habitat quality to increase source population sizes
- Restoration is potentially high-risk, high reward
  - Don't try to connect everything!
  - Find key bottlenecks e.g. using Condatis

Use of Condatis by Buglife

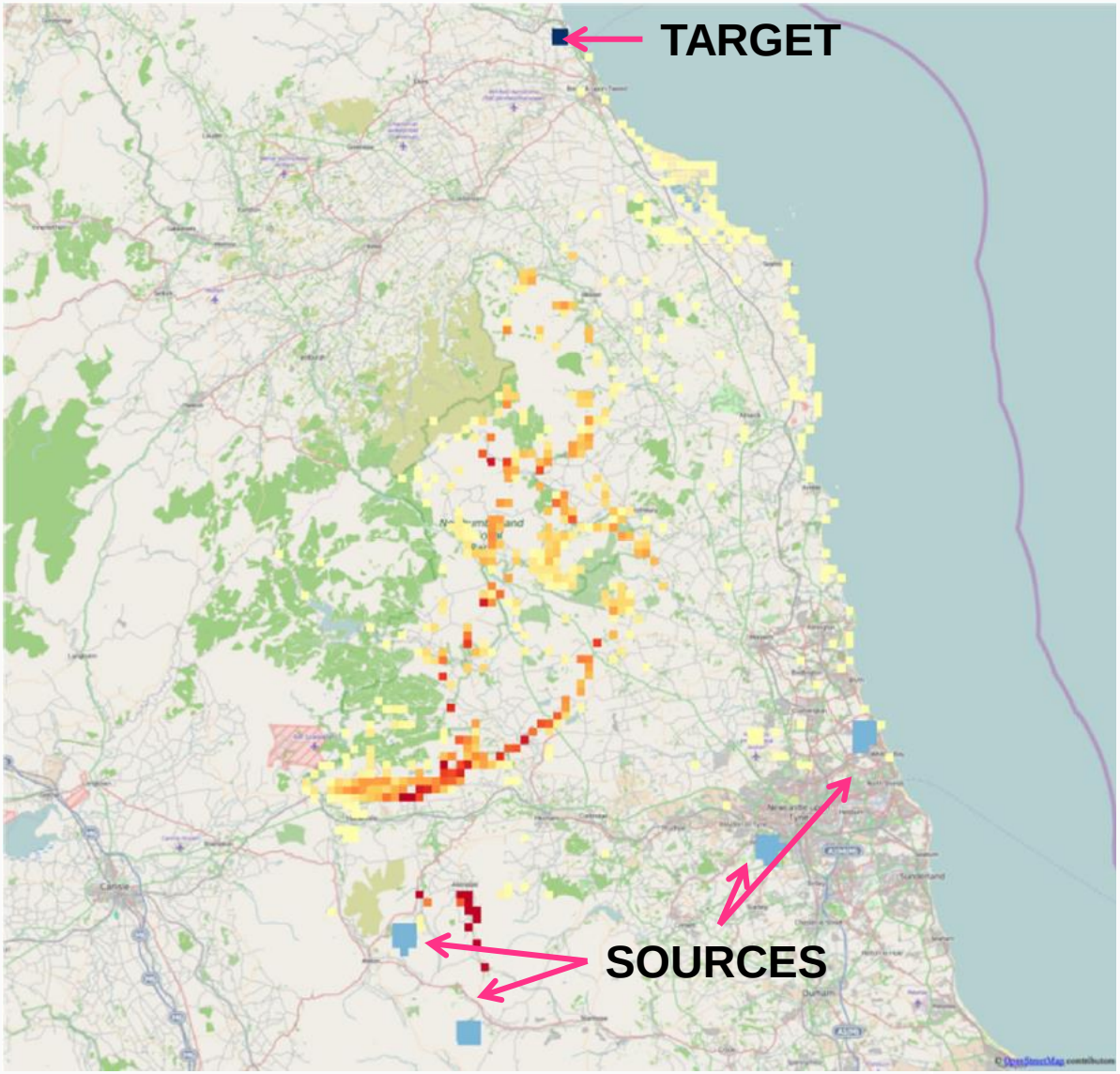
Use of Condatis by Buglife

- B-Lines aim to aid pollinator movement
- 3km wide 'dispersal corridors' linking existing wildflower-rich habitat
- Mapped by stakeholders

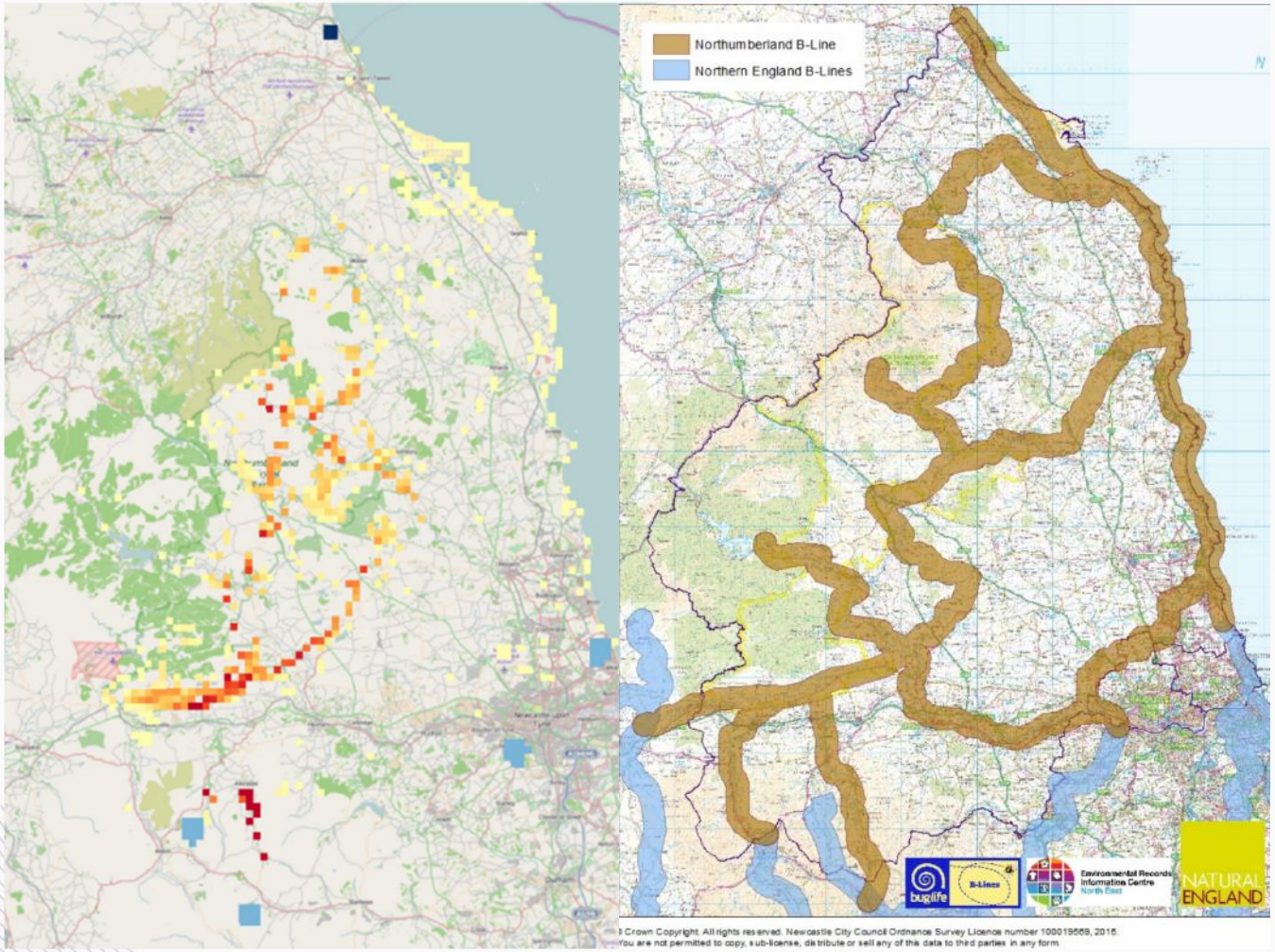
Buglife Coast to Coast B-lines

‘Flow’ Shows most helpful routes

Condatis flow:
Yellow = low
Red/brown = high



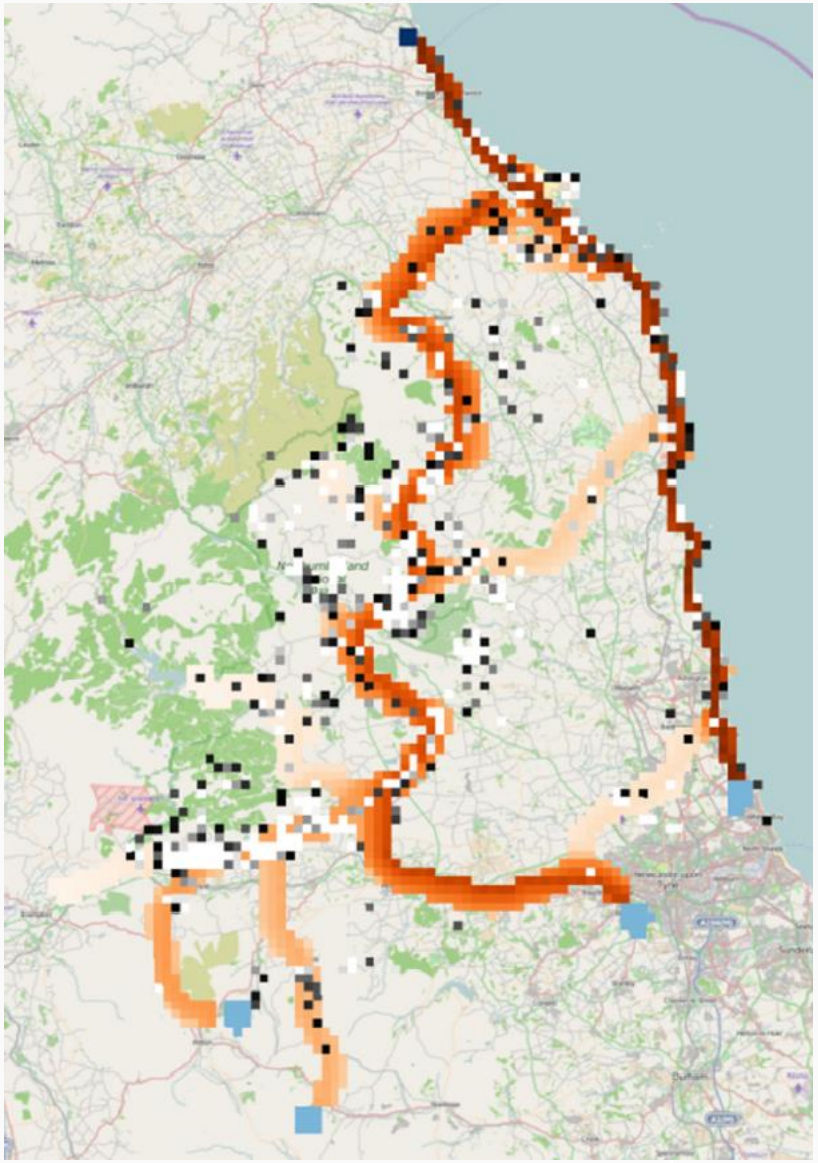
Current flow and proposed B-Lines



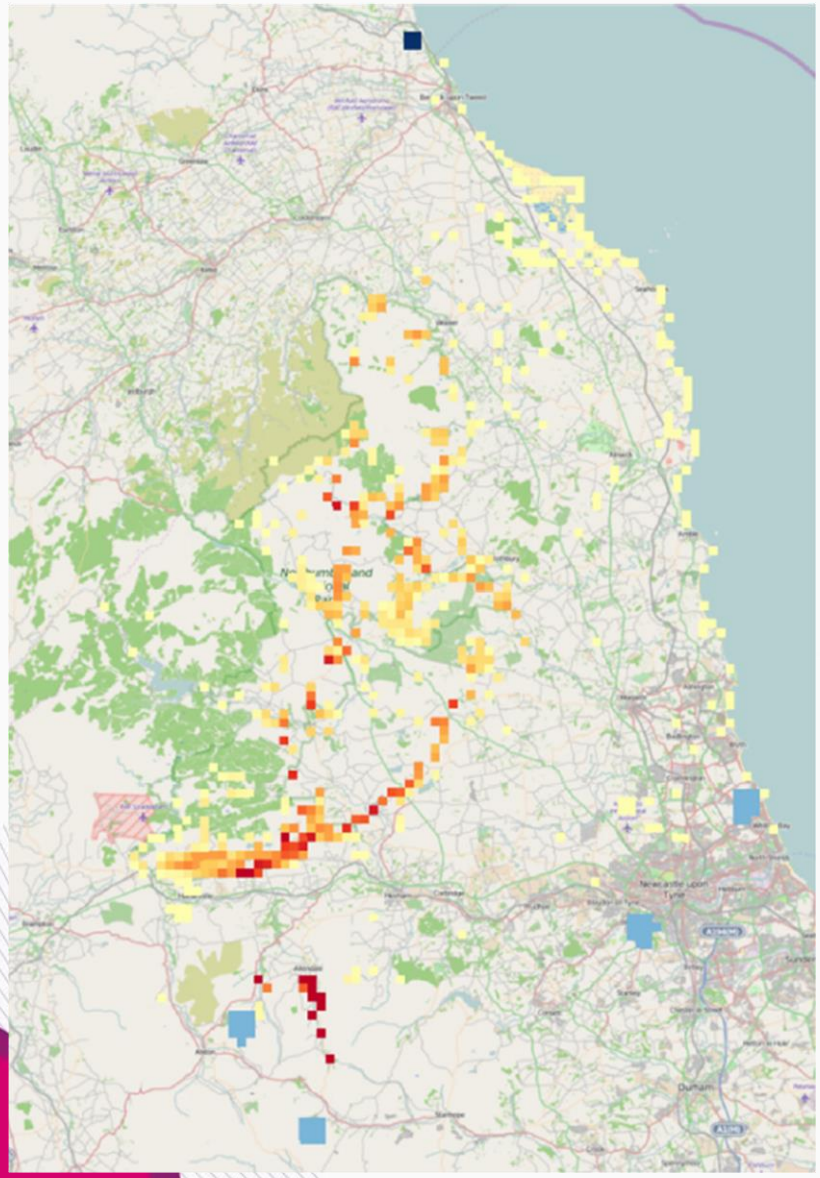
Proposed B-Lines map (brown)

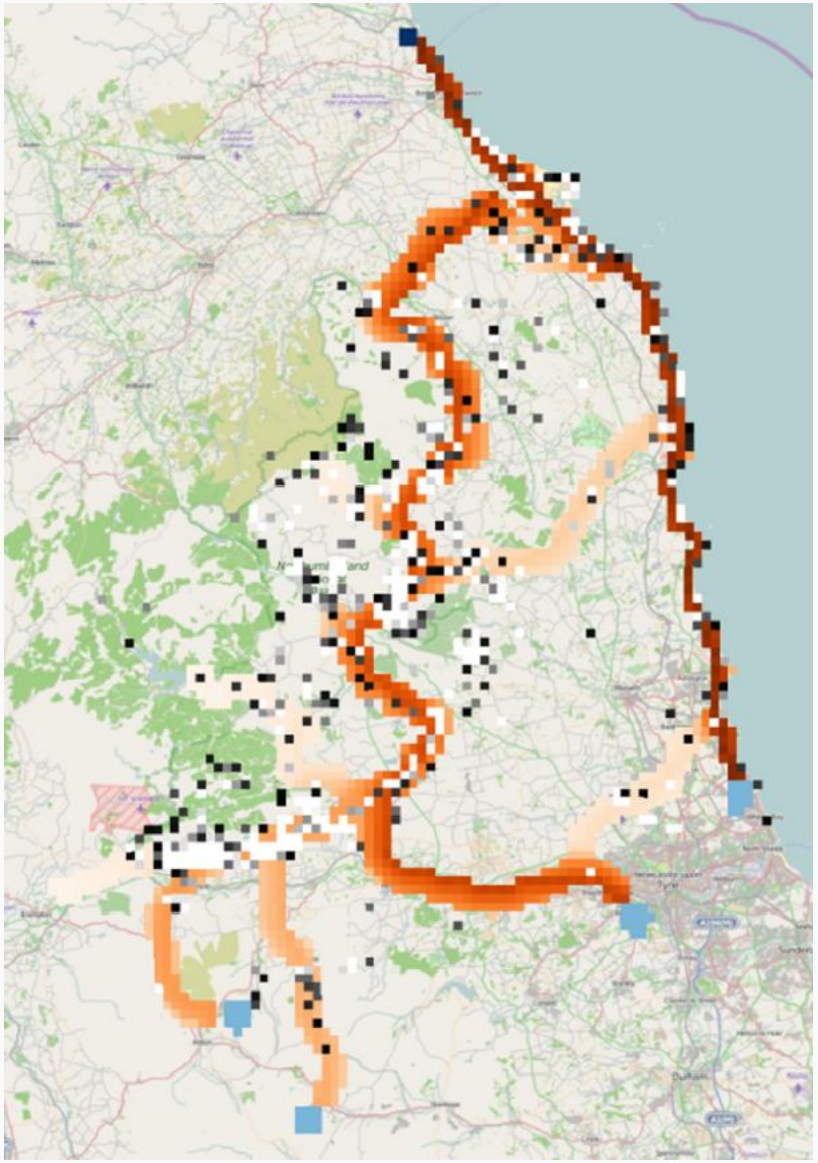
Prioritising within B-lines

- The Condatis ‘backwards optimisation’ routine ranks each cell
- Higher rank (brown) are highest priority if funding limited

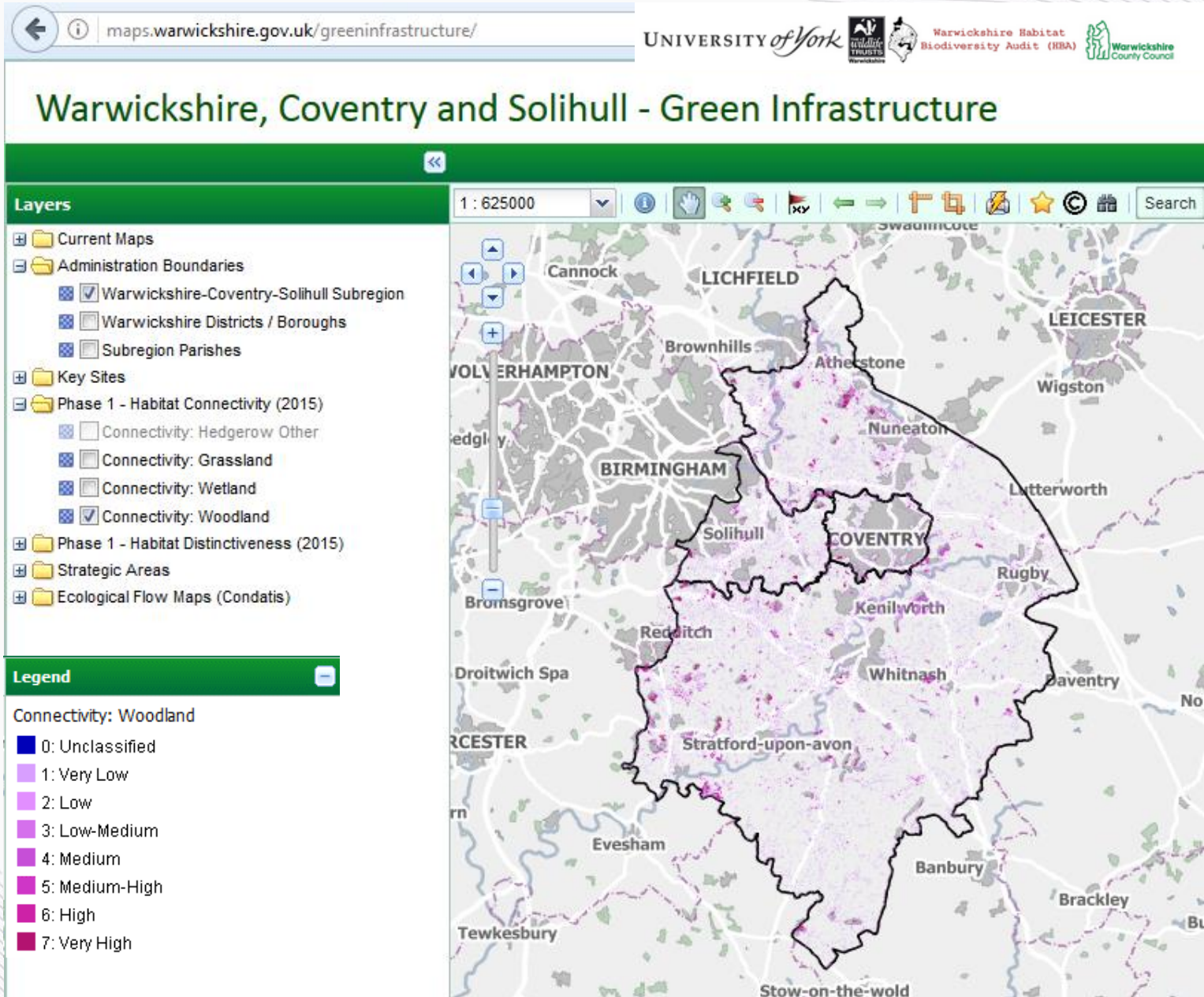


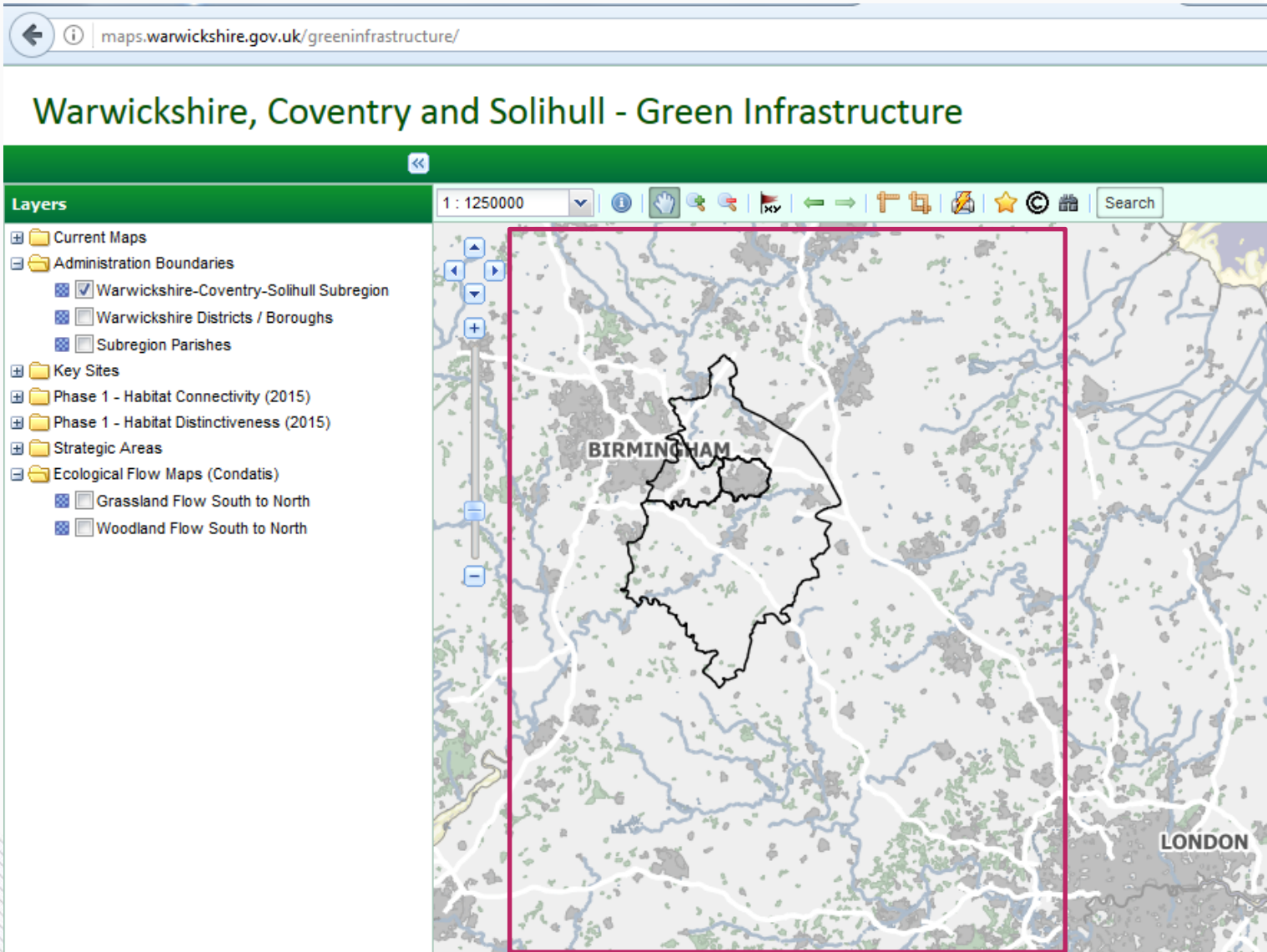
New and existing complementary





Use of Condatis by Warwickshire County Council


maps.warwickshire.gov.uk/greeninfrastructure/
University of York
Warwickshire Habitat Biodiversity Audit (HBA)
Warwickshire County Council
Warwickshire, Coventry and Solihull - Green Infrastructure
Layers
Current Maps
Administration Boundaries
Warwickshire-Coventry-Solihull Subregion
Warwickshire Districts / Boroughs
Subregion Parishes
Key Sites
Phase 1 - Habitat Connectivity (2015)
Connectivity: Hedgerow Other
Connectivity: Grassland
Connectivity: Wetland
Connectivity: Woodland
Phase 1 - Habitat Distinctiveness (2015)
Strategic Areas
Ecological Flow Maps (Condatis)
Legend
Connectivity: Woodland
0: Unclassified
1: Very Low
2: Low
3: Low-Medium
4: Medium
5: Medium-High
6: High
7: Very High
1 : 625000
Search
Cannock
LICHFIELD
LEICESTER
Brownhills
Atherstone
Wigston
Nuneaton
BIRMINGHAM
Lutterworth
Solihull
COVENTRY
Rugby
Bromsgrove
Kenilworth
Redditch
Droitwich Spa
Whitnash
Daventry
Stratford-upon-avon
Evesham
Banbury
Brackley
Tewkesbury
Stow-on-the-wold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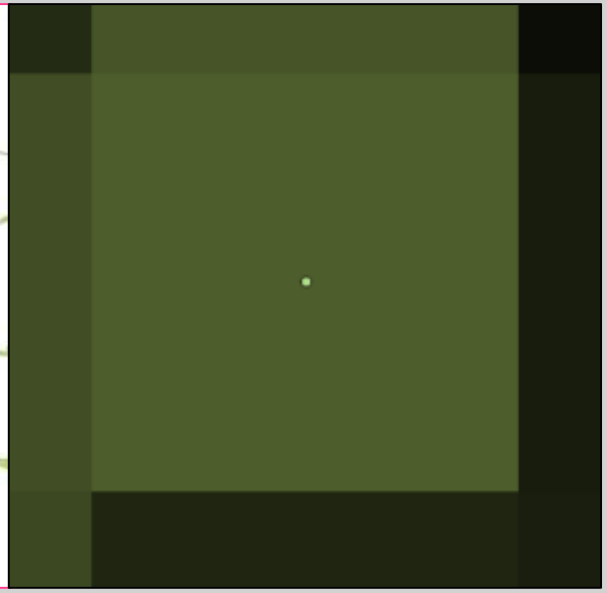
Warwickshire-Coventry-Solihull Subregion
Warwickshire Districts / Boroughs
Subregion Parishes
Key Sites
Phase 1 - Habitat Connectivity (2015)
Phase 1 - Habitat Distinctiveness (2015)
Strategic Areas
Ecological Flow Maps (Condatis)
Grassland Flow South to North
Woodland Flow South to North
1 : 1250000
Search
BIRMINGHAM
LONDON

Preparing the data using QGIS:



Predicting national ecological flows at a regional scale

Ben Wood (Ecological Assistant)

Warwickshire County Council

Scenario List

0: RasterAll4Percent

Map | Parameters | Solution

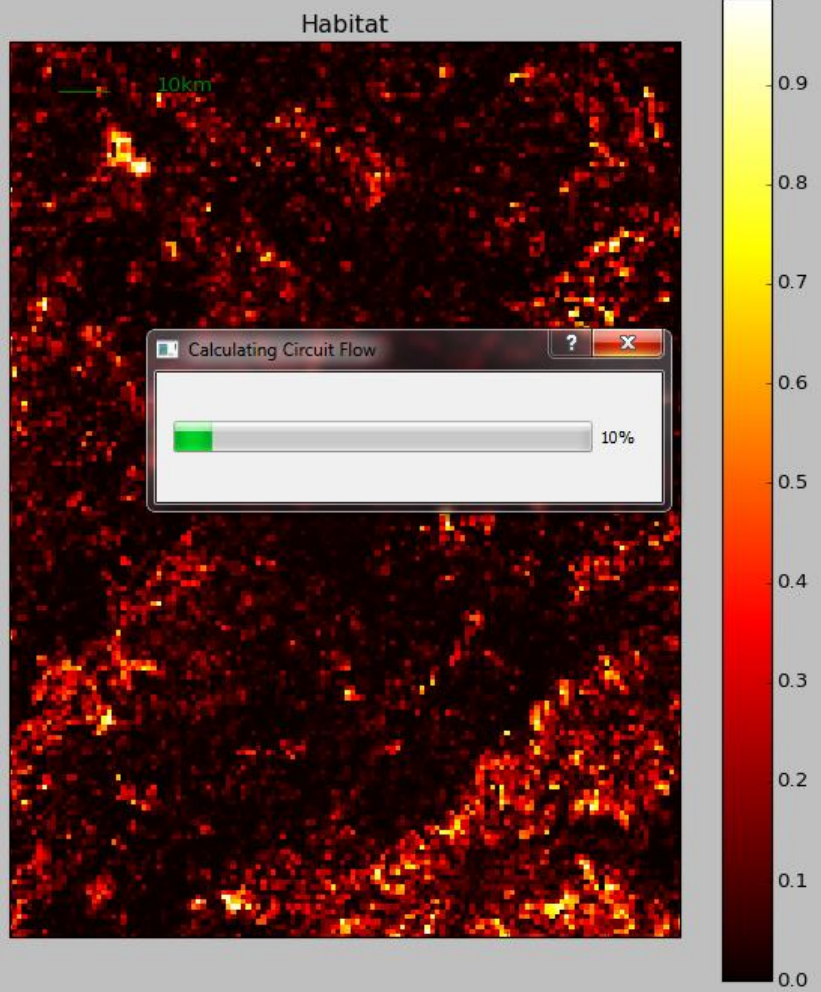
Kernel

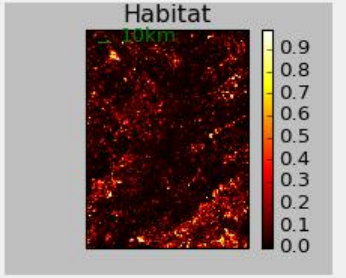
Dispersal 2.000000000 km

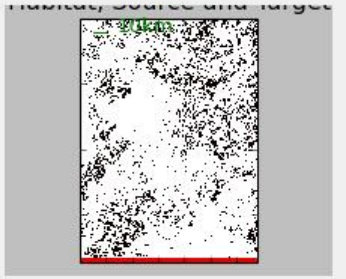
R 100.00

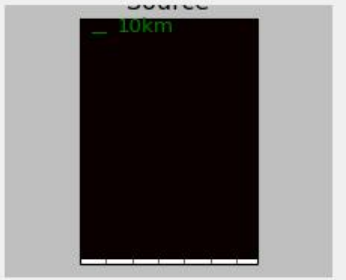
Power Plots

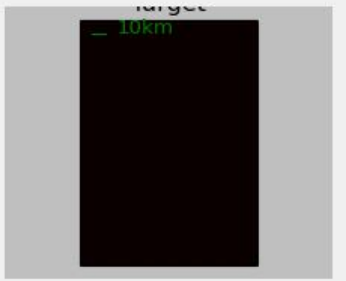
Bottlenecks Thresh 50.0000 Go





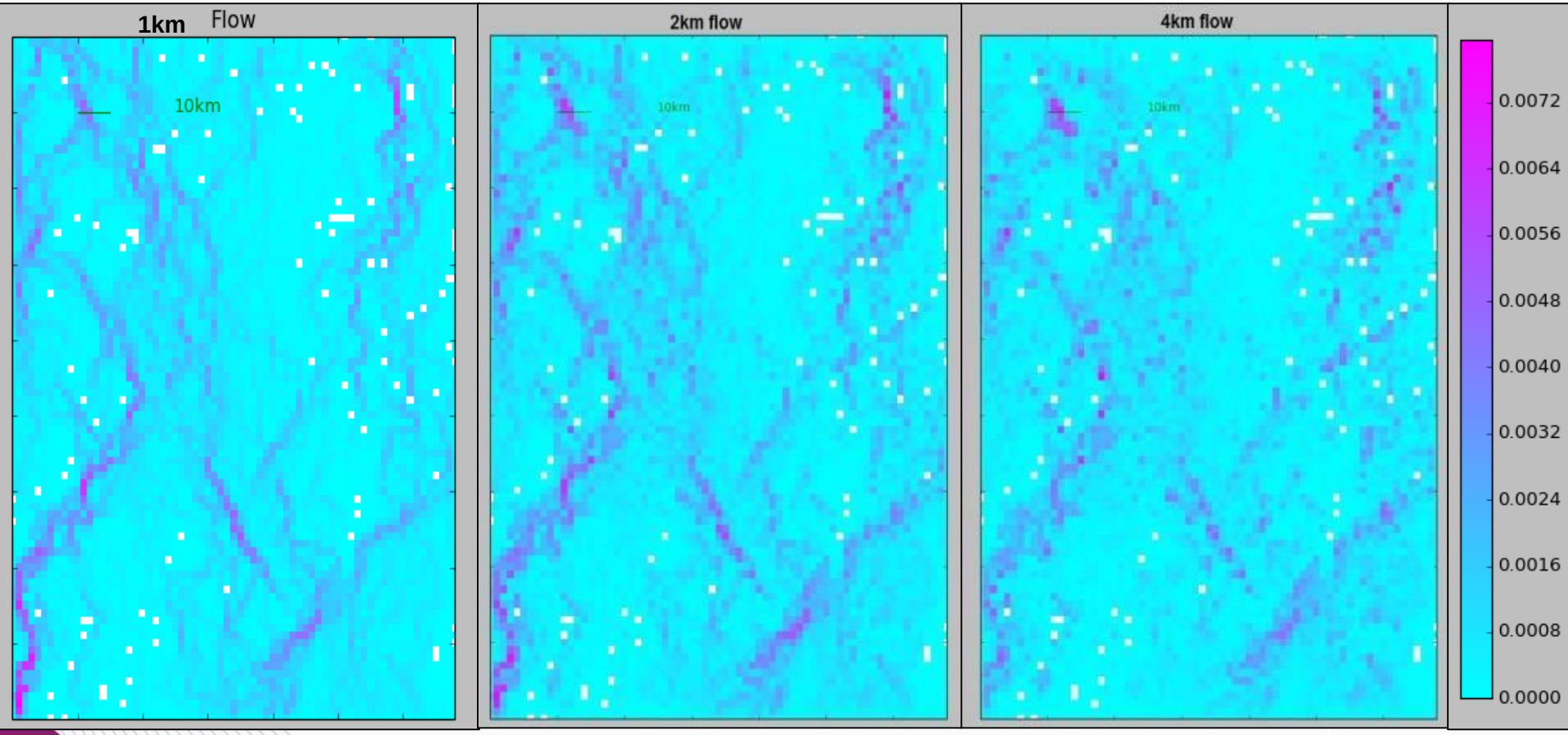




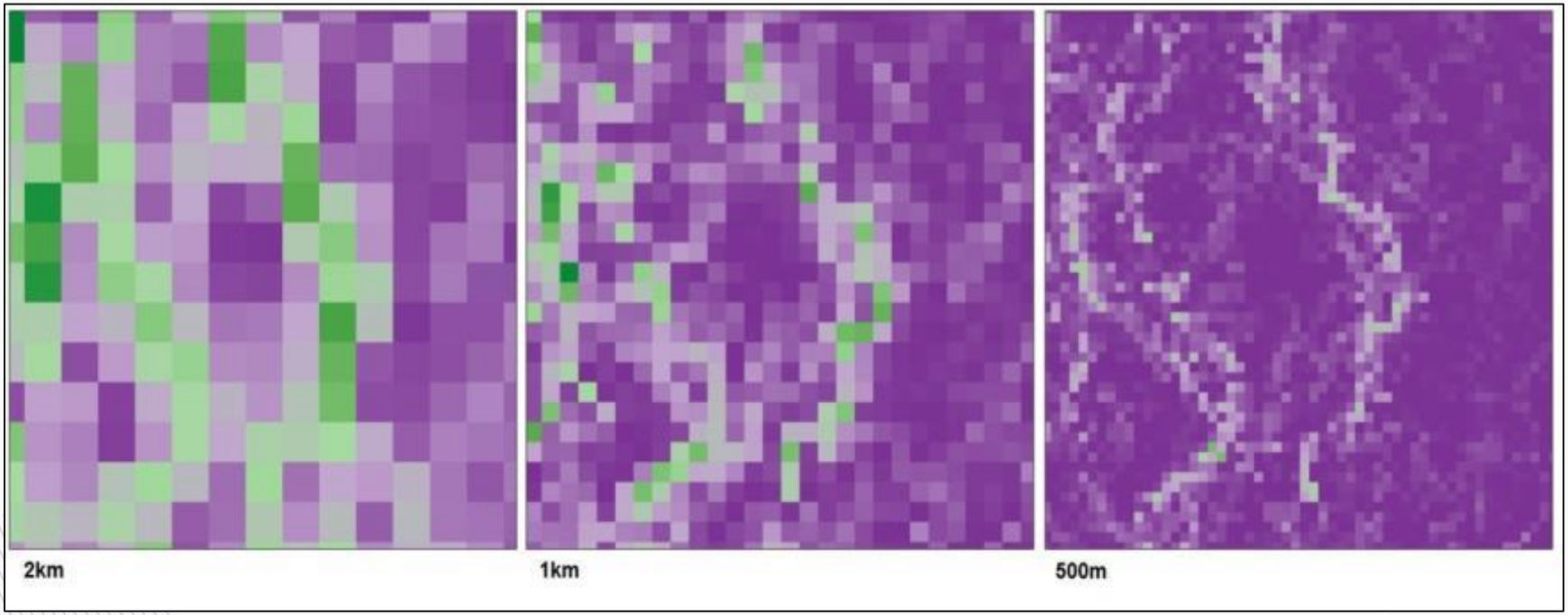


PROJECT: C:/Users/Bwoo2/condatis/projects/1kmALL.h5 SCENARIO: RasterAll4Percent | Please wait. Calculating...

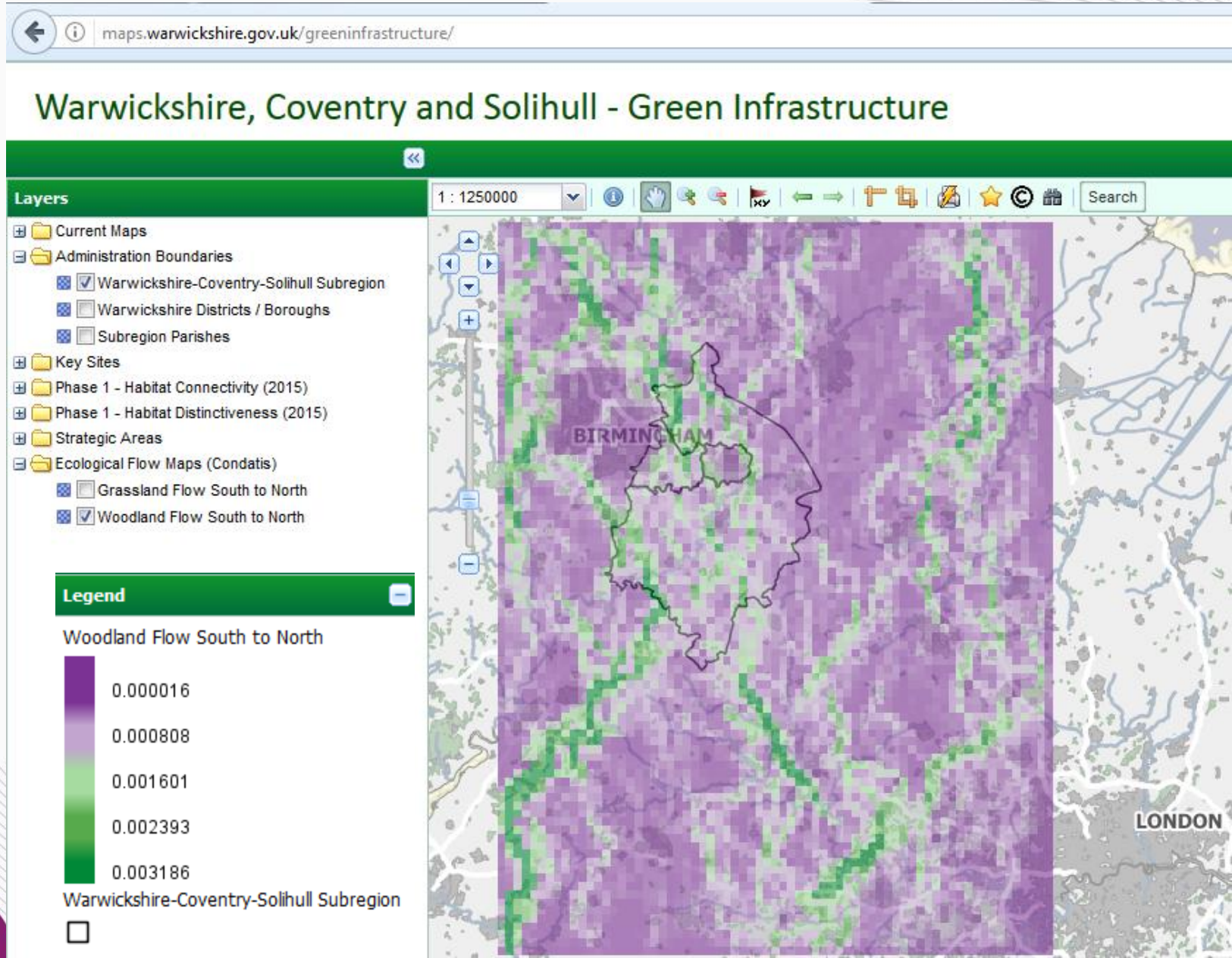
Comparing dispersal distances



Comparing resolutions

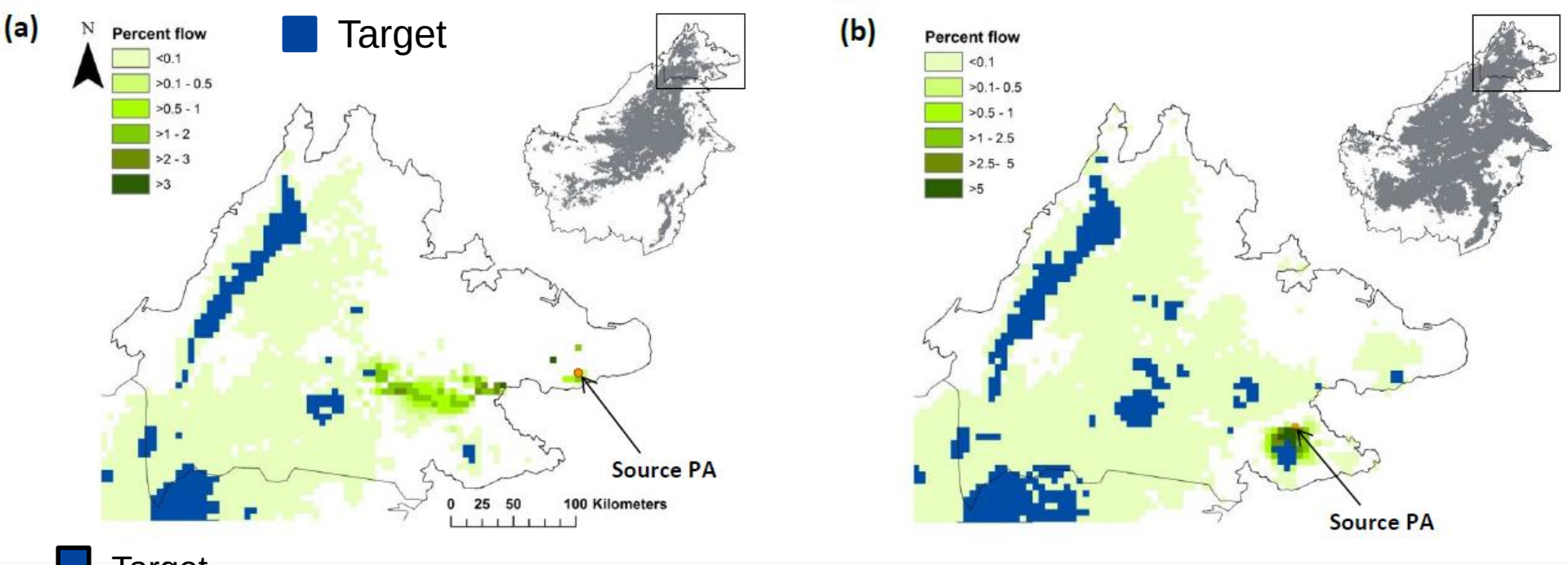


Flow routes to inform planning



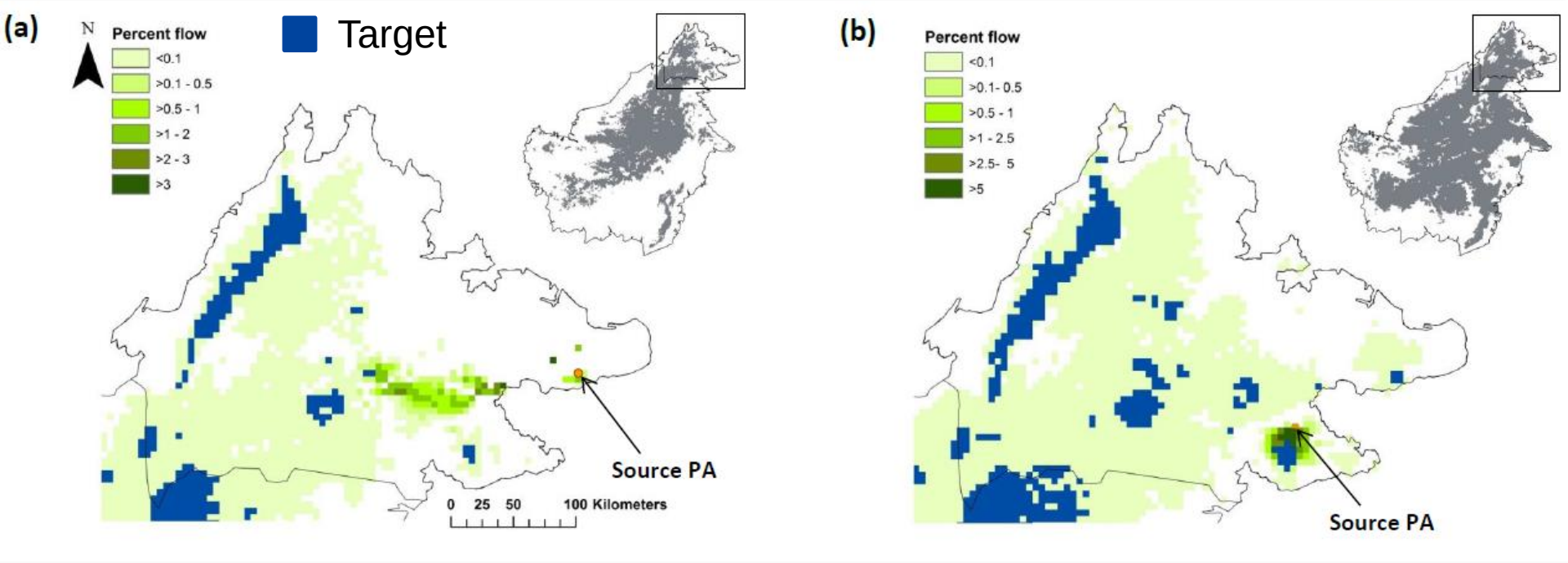
Borneo

Borneo's protected forests

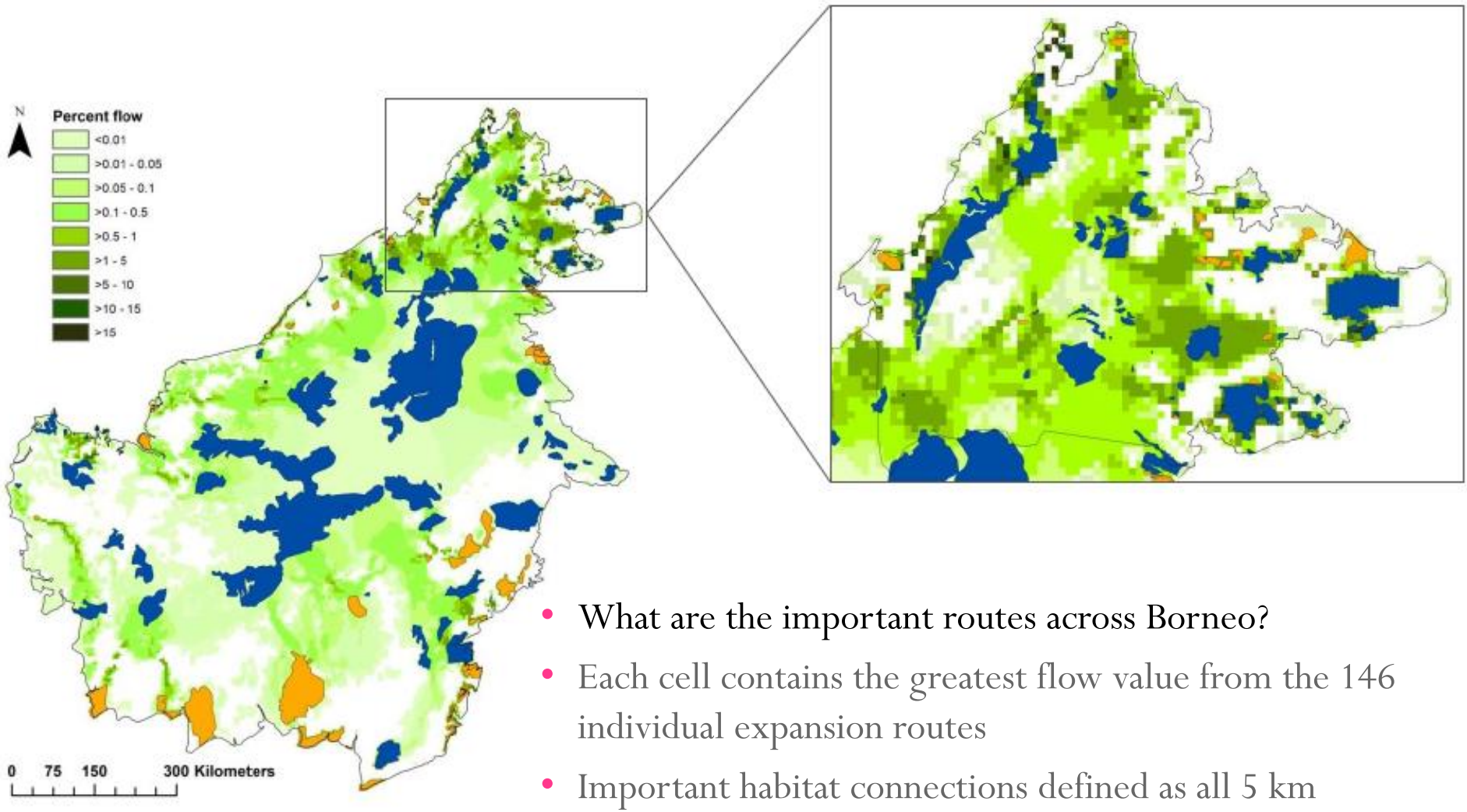


- HadGEM2-AO general circulation model (GCM) (IPCC 2013)
- IPCC AR5 Representation Concentration Pathways (RCP) 2.6 & 8.5
  - Current (1950-2000) and future (2061-2080)
  - RCP8.5 is the most severe ('business-as-usual') climate scenario - projects a temperature increase for Borneo of 3.2°C
- Forest cover
  - primary and high quality secondary (selectively logged) rainforest

Borneo's protected forests



- 240 PAs on Borneo
- 146 "Source" PAs predicted to increase in temperature – each analysed separately
- Each set of "Target" PAs have temp as cool or cooler than source in the future
- Flow analysed between each source PA and it's set of target Pas
  - constrained to forested areas



- What are the important routes across Borneo?
- Each cell contains the greatest flow value from the 146 individual expansion routes
- Important habitat connections defined as all 5 km forested grid cells that contained >0.5% flow
  - only 8.7% (1952 5km cells) had values >0.5% flow of which ~62% (20,626 km2) of forest area is not currently protected.
  - If this additional amount of forest was protected, it would increase the overall extent of protected areas from ~17% of Borneo's land area under protection, to ~20%.

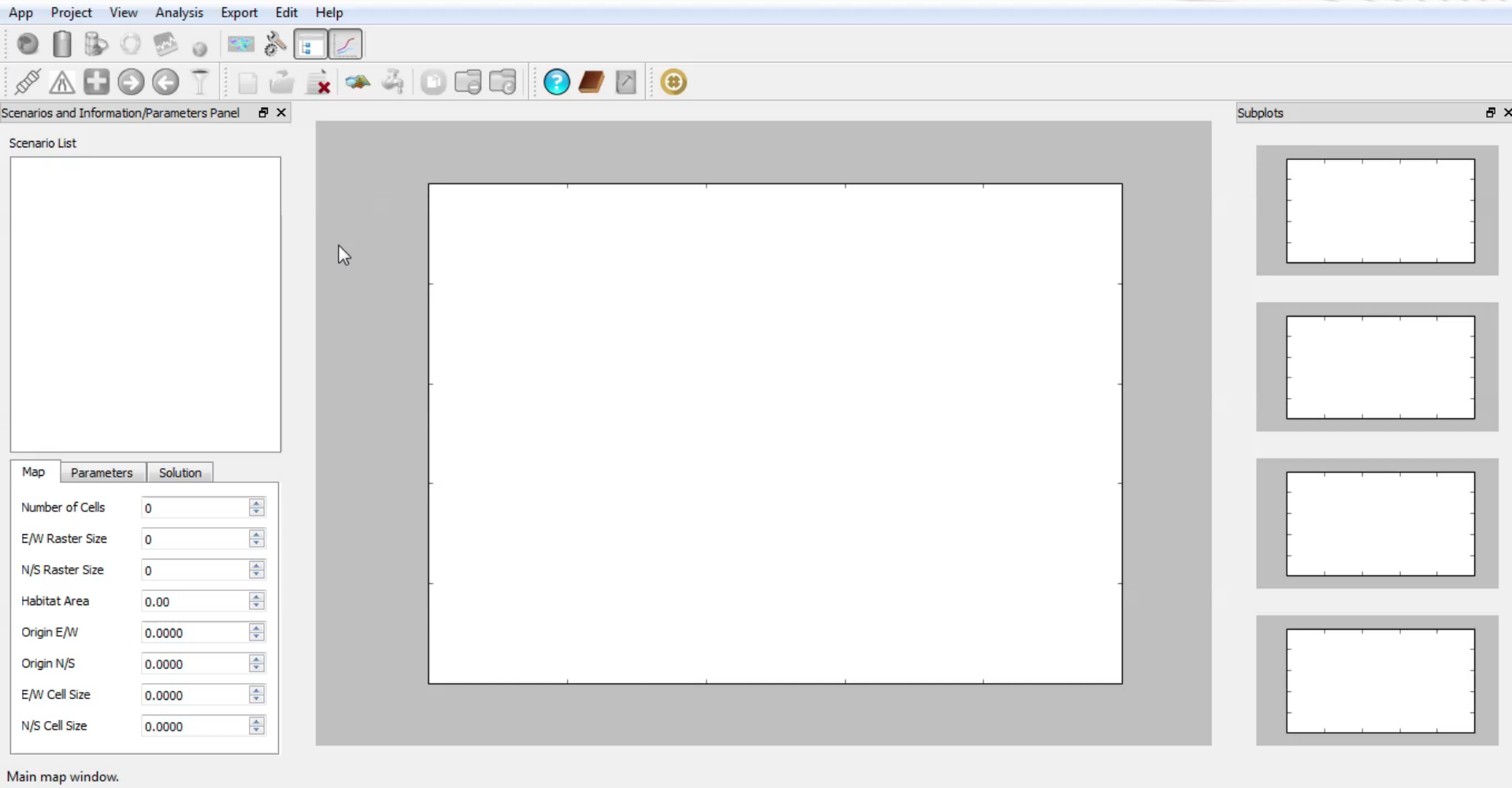
Summary

Advantages

- Strategic and large-scale
- Shows effect of interventions
- Relevant to climate change
- User-friendly
- Can complement other approaches

Issues

- Only one metric of benefit
- Demand to prioritise multiple habitats, directions, etc.


App
Project
View
Analysis
Export
Edit
Help
Scenarios and Information/Parameters Panel
Scenario List
Map
Parameters
Solution
Number of Cells
0
E/W Raster Size
0
N/S Raster Size
0
Habitat Area
0.00
Origin E/W
0.0000
Origin N/S
0.0000
E/W Cell Size
0.0000
N/S Cell Size
0.0000
Subplots
Main map window.

The future

- Other conservation organisations are trialling Condatis
- More functions are available
  - Hodgson, J.A., *et al.* (2016) How to manipulate landscapes to improve the potential for range expansion. *Methods in Ecology and Evolution*, Online early.
- We welcome suggestions
- Web application in development
- Knowledge Exchange project

Acknowledgements

- Buglife
- Durham, Lancashire and Yorkshire Wildlife Trusts
- Forest Research
- Natural England
- Natural Resources Wales
- RSPB
- Scottish Natural Heritage
- Warwickshire County Council

Find out more: www.condatis.org.uk

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