Biodiversity and climate change, developing resilience in upland environments.

Ian Crosher – March 2015

What temperature are we developing resilience for?

Changing approach as the climate changes

1°C > 2°C > 3°C > 4°C

enable persistence ---> accept change

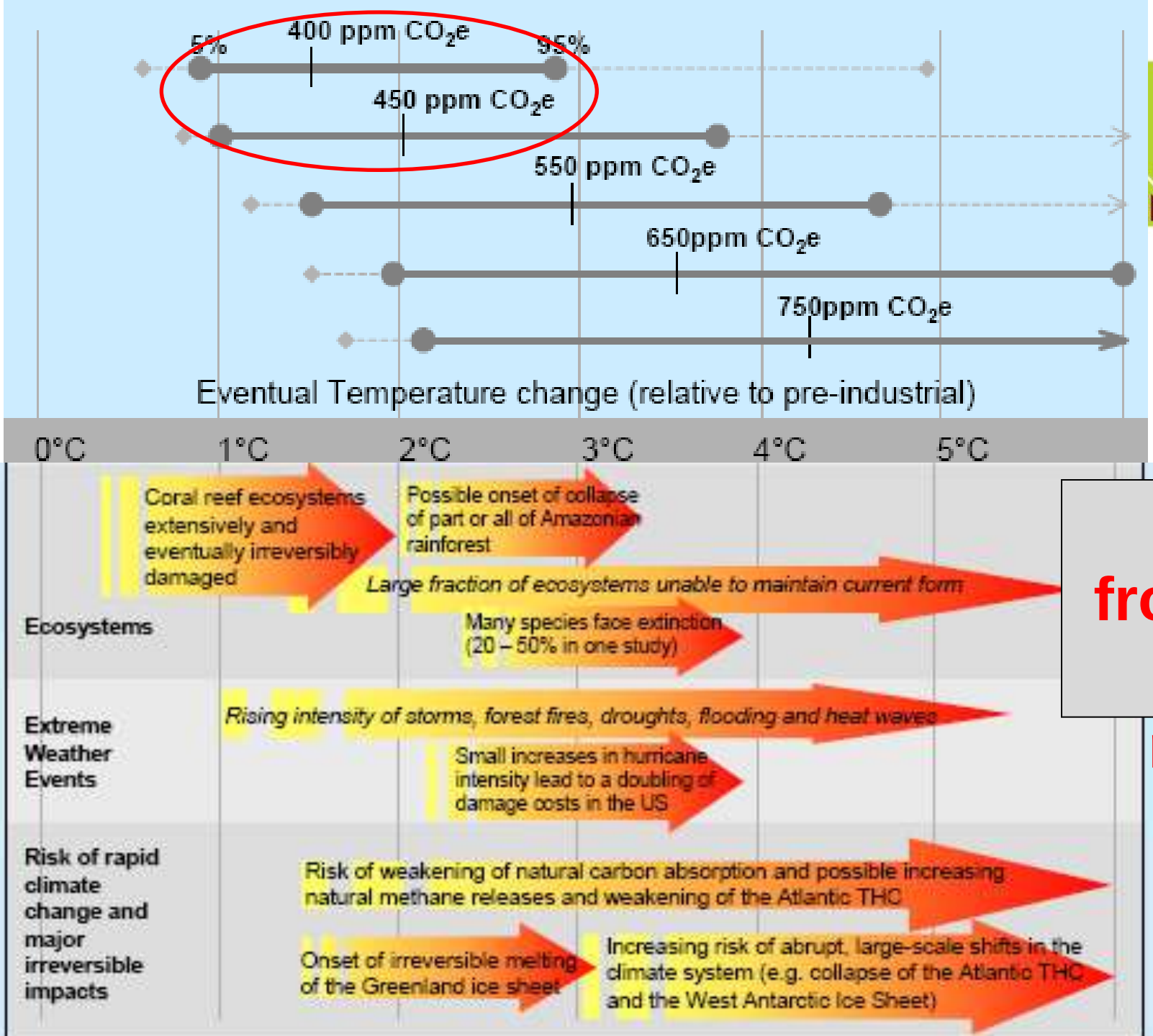
---> promote transformation ????

Morecroft, M.D., Crick, H.Q.P., Duffield, S.J., and Macgregor, N.A. (2012) Resilience to climate change: translating principles into practice. *Journal of Applied Ecology*, 49(3): 547-551.

Overview

- Climate Change in Context for the future.
- 2015 an Important Year
- How CC is affecting wildlife.
- Developing Resilience some helpful tools.
  - Climate Change Vulnerability Model.
  - Adaptation Manual
  - Niche Approuch.
  - Outcome 1D – Habitat Potential Mapping.

How is Climate Change going to affect how & what is delivered in future?



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Taken from the Stern review (2006)

The Six Degrees of Climate Change

Degree Change	Actual temperature (^{0}C)	Action Needed	CO_2 Target
One	0.1 -1.0 ^{0}C	Avoidance Not Possible	350 ppm (at 380 ppm today)
Two	1.1-2.0 ^{0}C	Peak Global Emissions **By 2015**	400ppm
Threshold for	**Carbon Cycle feedback?**		
Three	2.1 -3.0 ^{0}C	Peak Global Emissions By 2030	450pm
Threshold for	**Siberian methane**	**feedback?**	
Four	3.1 -4.0 ^{0}C	Peak Global Emissions By 2050	550ppm
Five	4.1 – 5.0 ^{0}C	Allow Constantly rising emissions	650ppm
Threshold for	**Oceanic methane hydrate**	**becomes possible**	
Six	5.1- 5.8 ^{0}C	Allow very High emissions – China & India live our high carbon lifestyle.	800ppm

Adapted from Mark Lynus ' six degrees of climate change'

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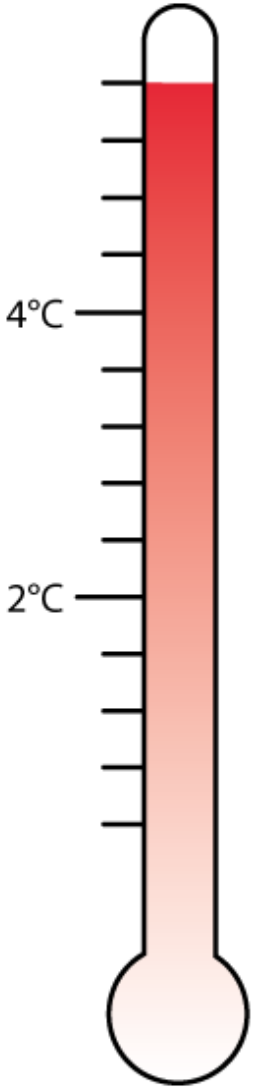
May 2014 = 401.88 ppm

Carbon Threshold will be the first one that will be crossed.



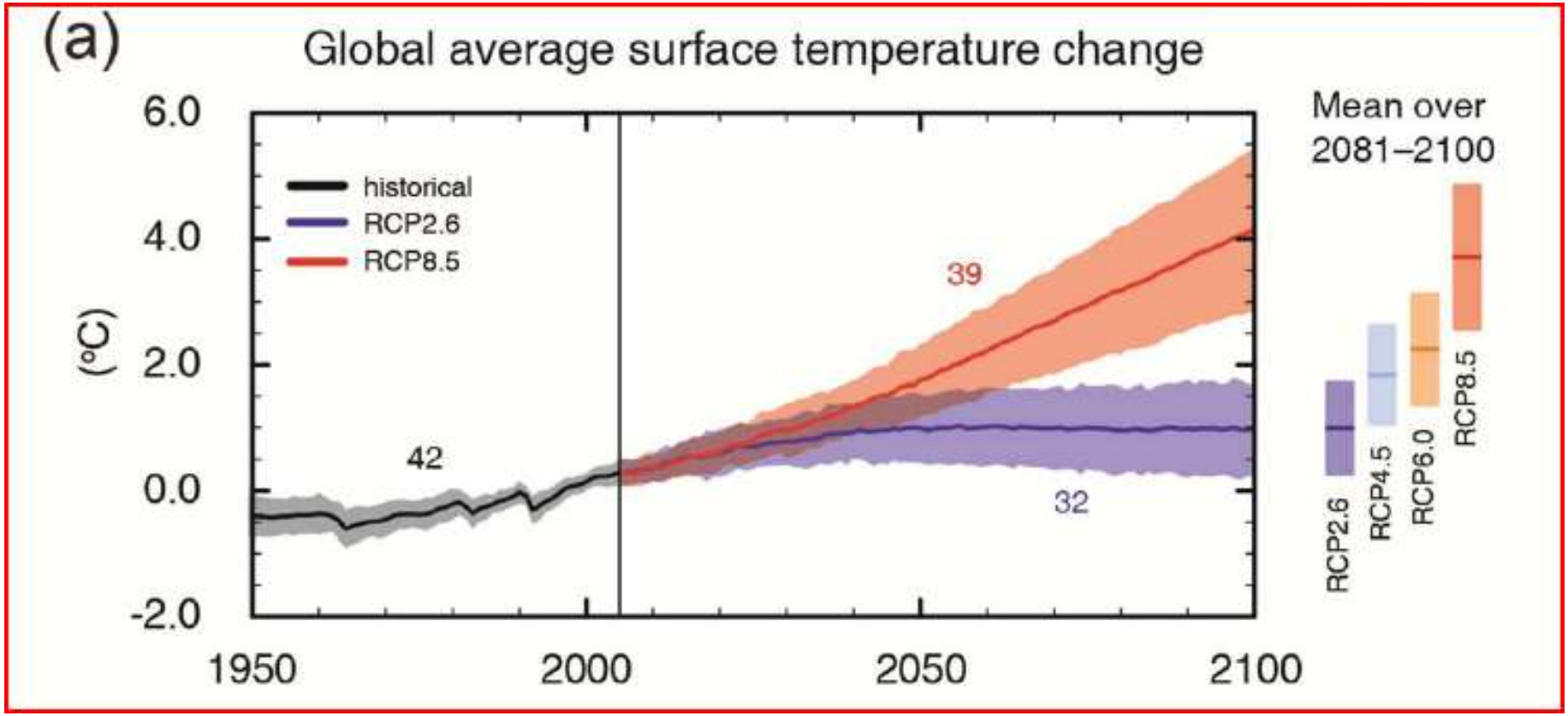
Global warming beyond 4°C would see major increases in vunerability across the world, with the adaptive capacity of many systems exceeded.

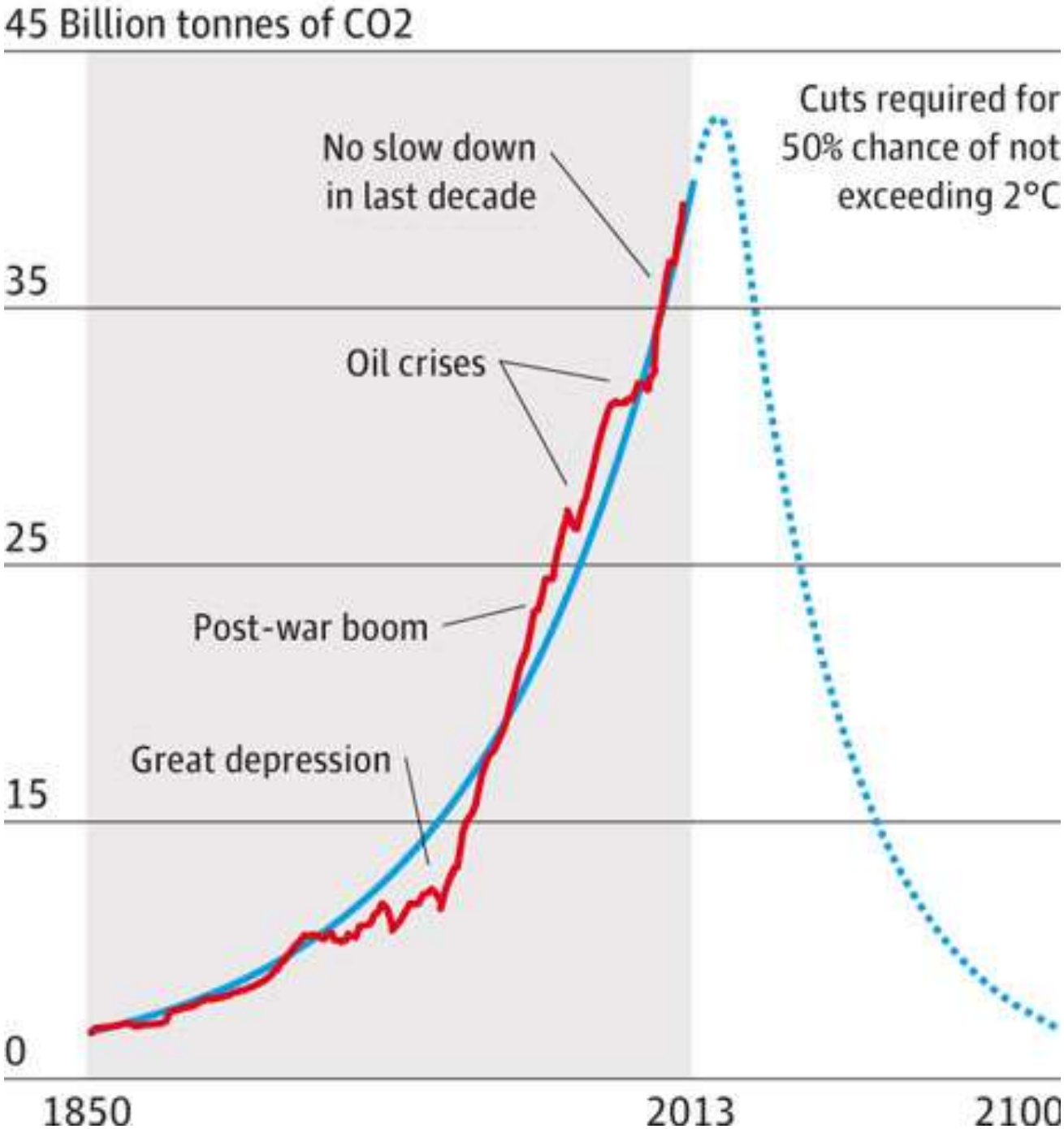
2-4°C warming would lead to worsening impacts at all scales, such as decreased global agricultural productivity and widespread biodiversity loss. If sustained, the ice sheets of Greenland and the West Antartic could melt, leading to several metres of sea level rise over the course of the coming centuries.

Impact less than 2°C would exacerbate impacts already being observed. These include increases in human mortality, loss of glaciers and increases in extreme events. Other impacts would be triggered such as reduced food security in many poorer regions. Some systems might benefit, such as global agricultural productivity.

Global average temperature above pre-industrial levels thermometer
Source: Adapted from IPCC WG2 AR4.

Climate Change – the likely future





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The Year we reach the peak is crucial in what the long term outcome.

Pathways to stay below 2 degrees

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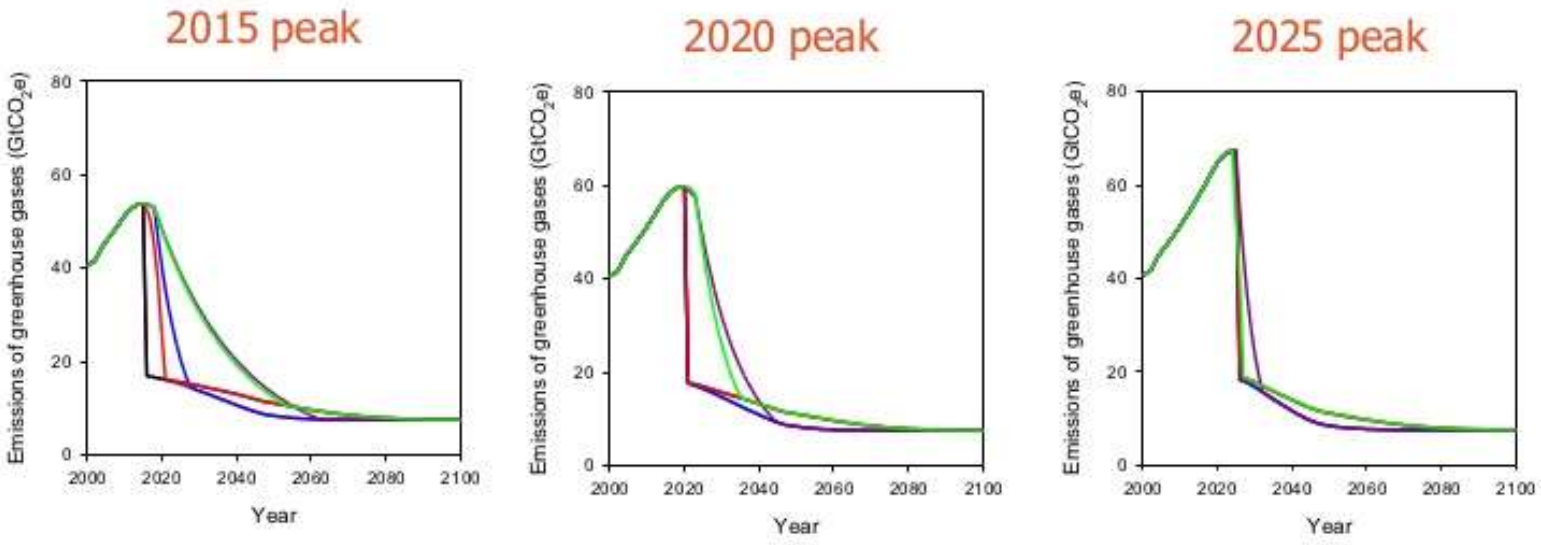
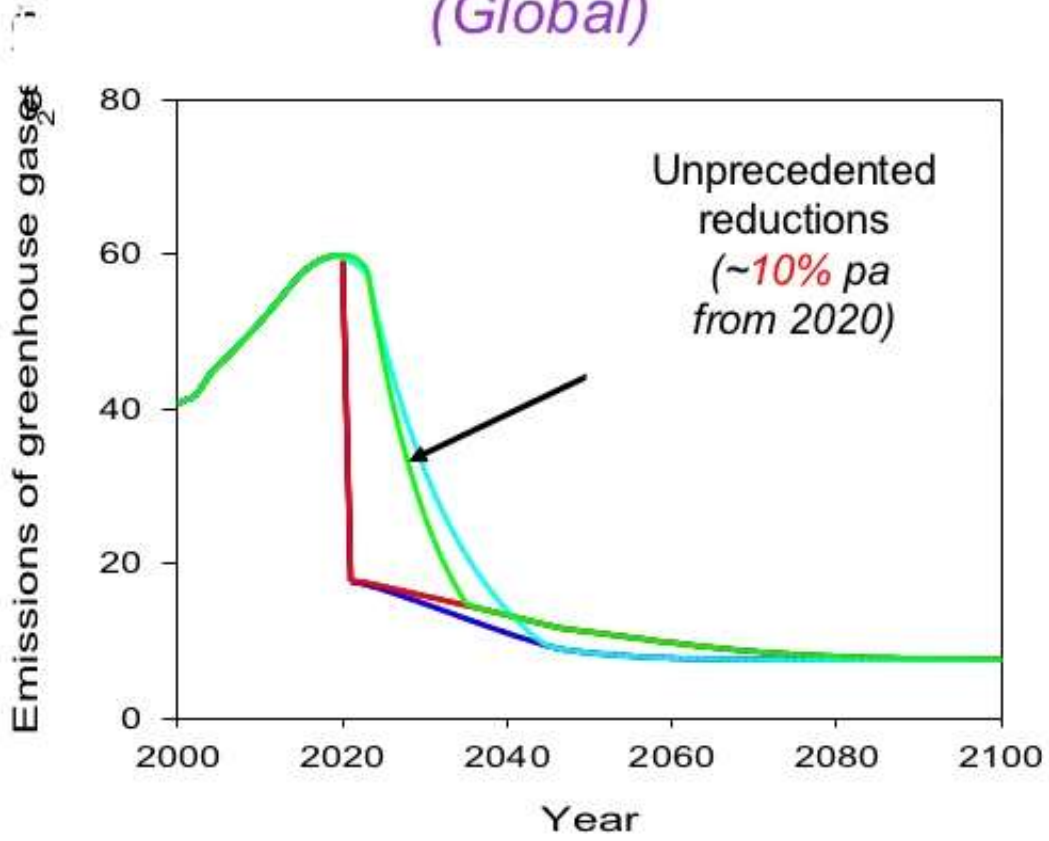
Total greenhouse gas emission pathways



(Anderson & Bows. 2008 Philosophical Transactions A of the Royal Society. 366. pp.3863-3882)

Extracted from Slides by **Professor Kevin Anderson - Climate Change: Going Beyond Dangerous**
http://www.slideshare.net/DFID/professor-kevin-anderson-climate-change-going-beyond-dangerous

50:50 chance of Dangerous Climate Change *(Global)*



(Anderson & Bows. 2008 Philosophical Transactions A of the Royal Society. 366. pp.3863-3882)

'Annual Reductions of greater than 1% PA have only been associated with economic recession or Upheaval'

Stern 2006

Extracted from Slides by **Professor Kevin Anderson - Climate Change: Going Beyond Dangerous**
http://www.slideshare.net/DFID/professor-kevin-anderson-climate-change-going-beyond-dangerous

What are the impacts on wildlife?

http://www.lwec.org.uk/resources/report-cards/biodiversity

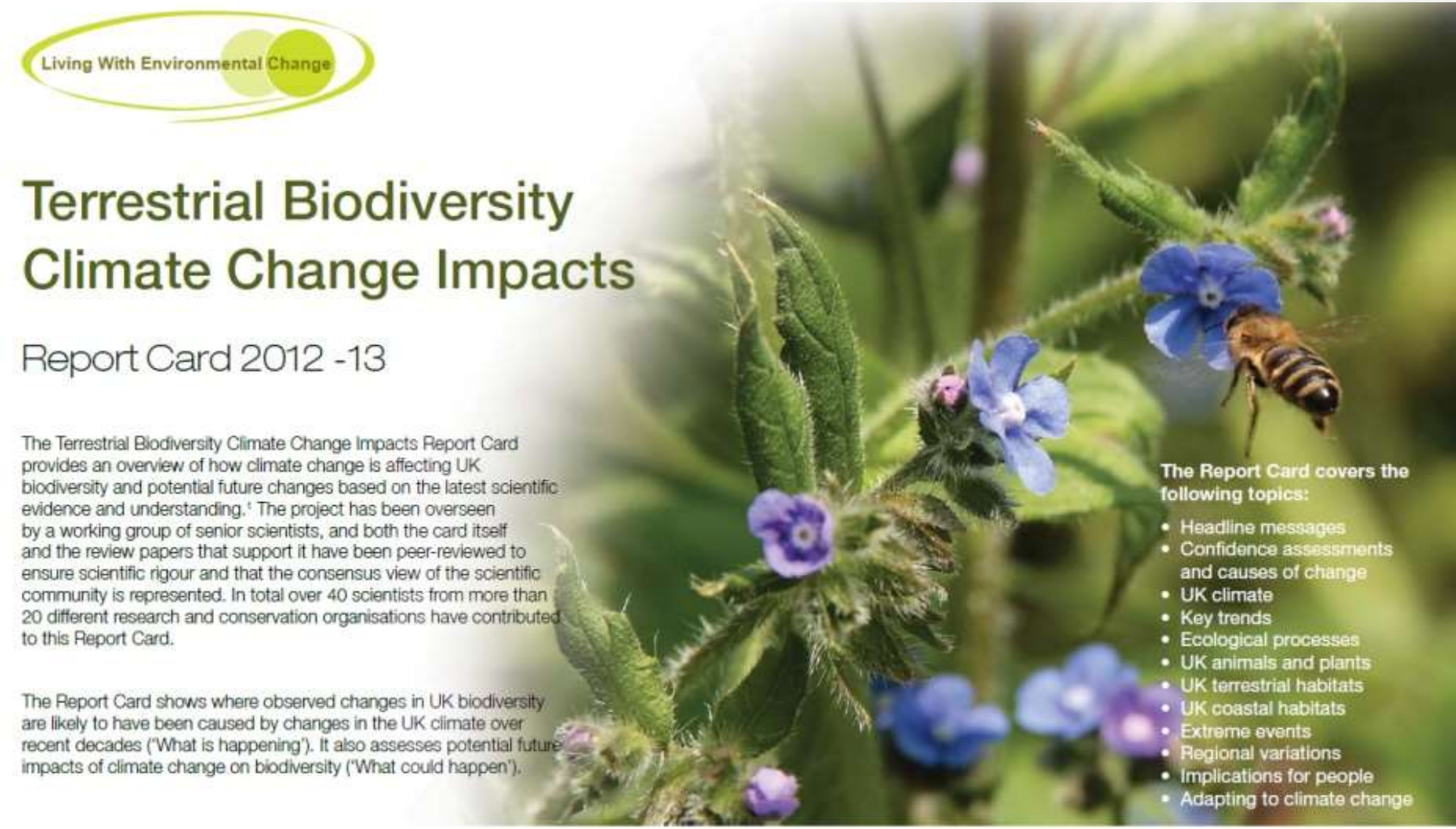
Living With Environmental Change

Terrestrial Biodiversity Climate Change Impacts

Report Card 2012 -13

The Terrestrial Biodiversity Climate Change Impacts Report Card provides an overview of how climate change is affecting UK biodiversity and potential future changes based on the latest scientific evidence and understanding.[1] The project has been overseen by a working group of senior scientists, and both the card itself and the review papers that support it have been peer-reviewed to ensure scientific rigour and that the consensus view of the scientific community is represented. In total over 40 scientists from more than 20 different research and conservation organisations have contributed to this Report Card.

The Report Card shows where observed changes in UK biodiversity are likely to have been caused by changes in the UK climate over recent decades ('What is happening'). It also assesses potential future impacts of climate change on biodiversity ('What could happen').



The Report Card covers the following topics:

- Headline messages
- Confidence assessments and causes of change
- UK climate
- Key trends
- Ecological processes
- UK animals and plants
- UK terrestrial habitats
- UK coastal habitats
- Extreme events
- Regional variations
- Implications for people
- Adapting to climate change

[1] *The Report Card is based on 15 technical review papers, each commissioned to provide in-depth analyses of specific topics. The key findings from these papers are presented in the Report Card.*

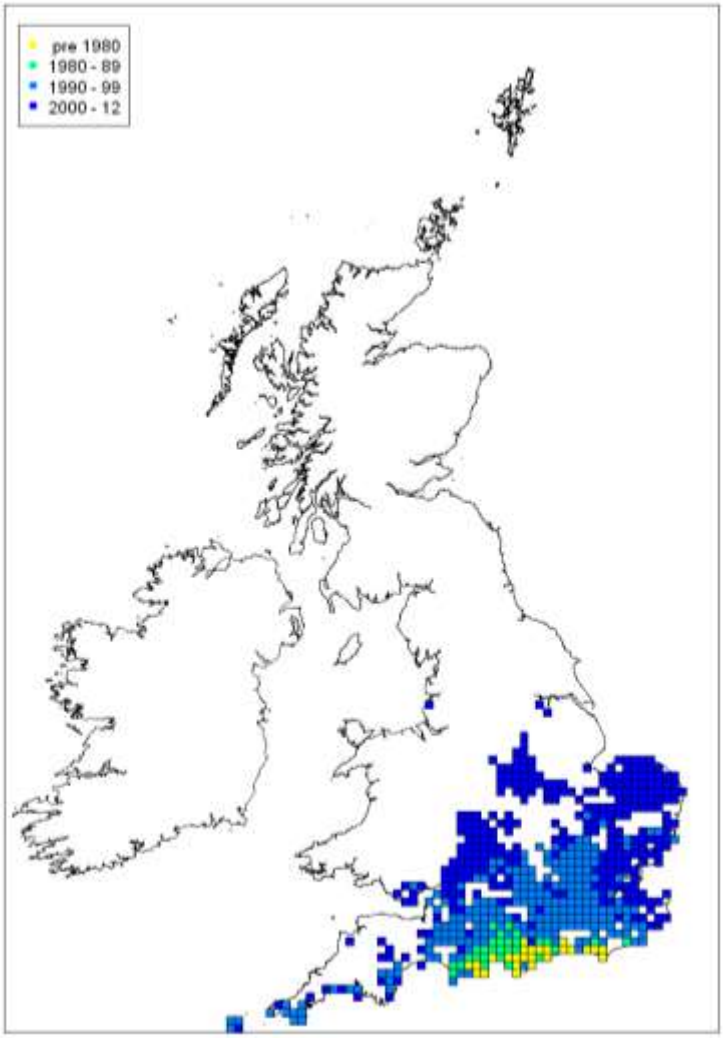
Headline messages

There is strong evidence that climate change is already affecting UK biodiversity. Impacts are expected to increase as the magnitude of climate change increases.

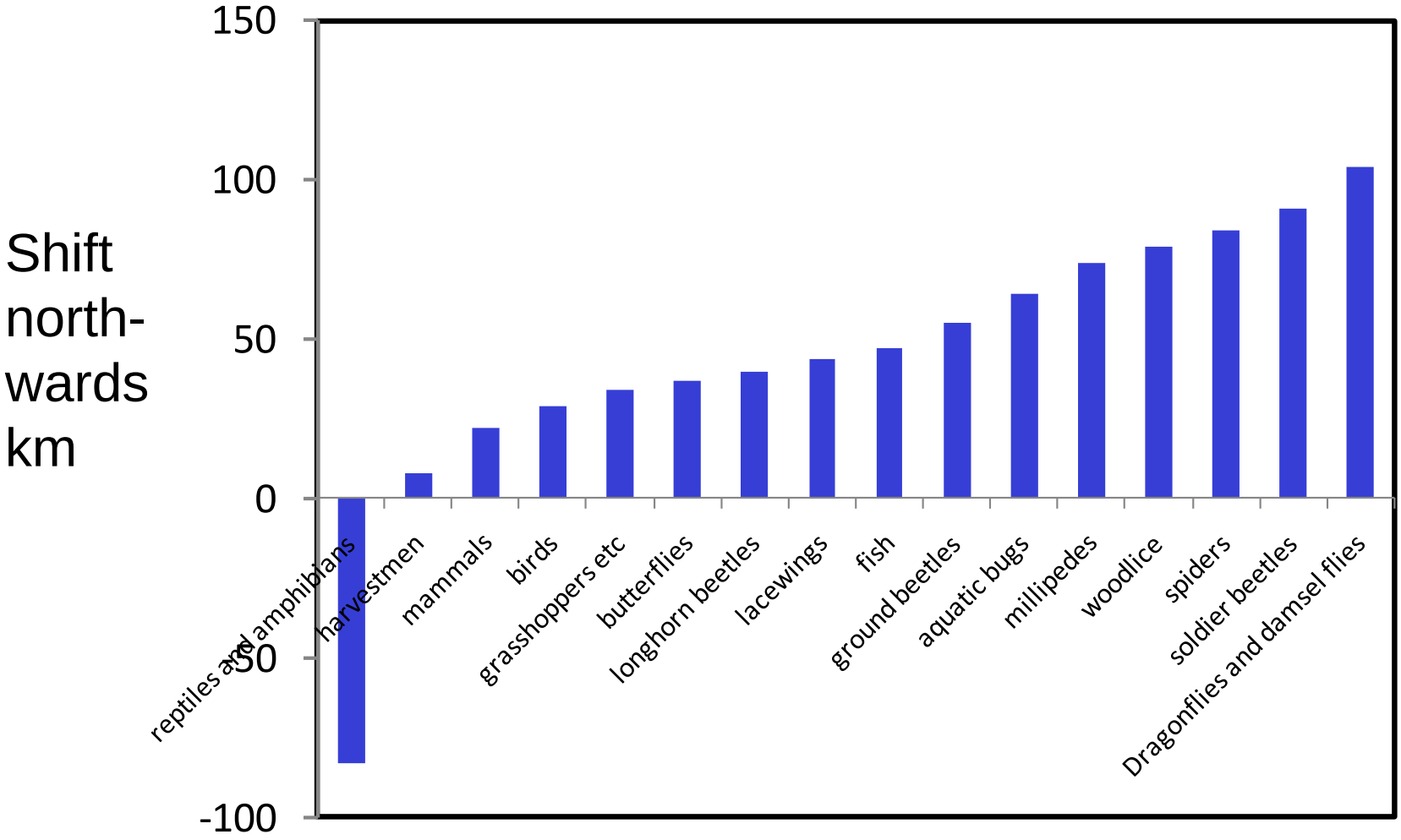
11 Headlines Messages a quick overview follows…..

Many species are occurring further north and at higher altitudes than in previous decades

Long-winged conehead
Conocephalus discolor



Rates of change in distributions differ between species



Hickling et al. 2006

Warmer springs in recent decades have caused a trend towards many biological events occurring earlier in the year (12 days average)

The rates of change vary among species, which may alter the interactions between species.

There is evidence of changes in the composition of plant and animal communities,

consistent with different responses of different species to rising temperature.

Species differ in their responses to variation in precipitation

The effects of climate change are less certain for precipitation than for temperature, but potential changes could lead to substantial changes in biodiversity and ecosystems.

Responses to drought 1995- 1997

'Winners'	'Losers'
Southern distributed	Northern distributed
Dry habitats	Wet habitats
Mobile	Restricted mobility

Morecroft et al. (2002) Global Ecology & Biogeography

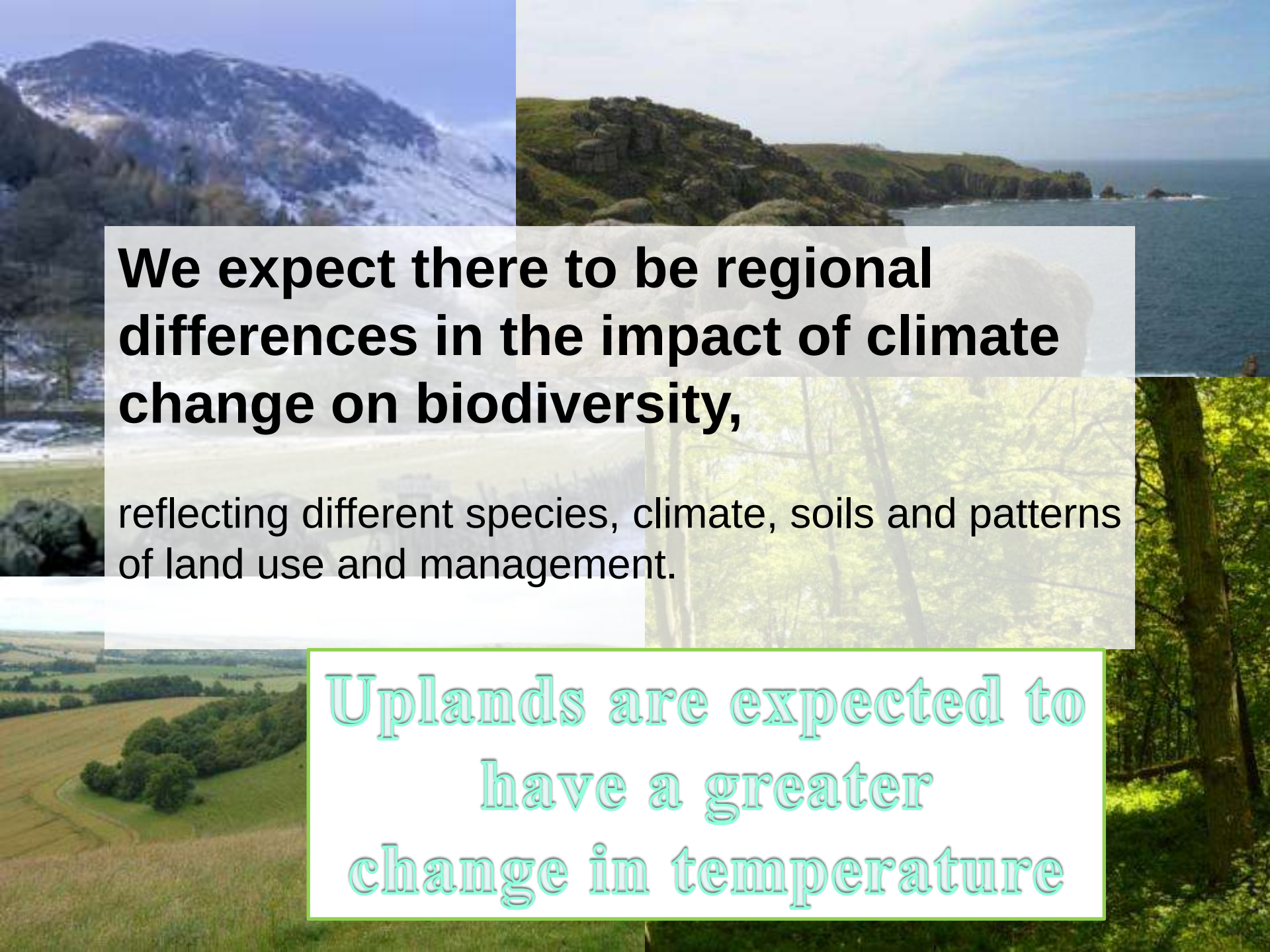
Some habitats are particularly vulnerable to climate change; the risks are clearest for montane habitats, wetlands and coastal habitats.

Climate change increases the chances that non-native species (including pests and pathogens) may establish and spread

.

Small red eyed damselfly

Oak processionary moth

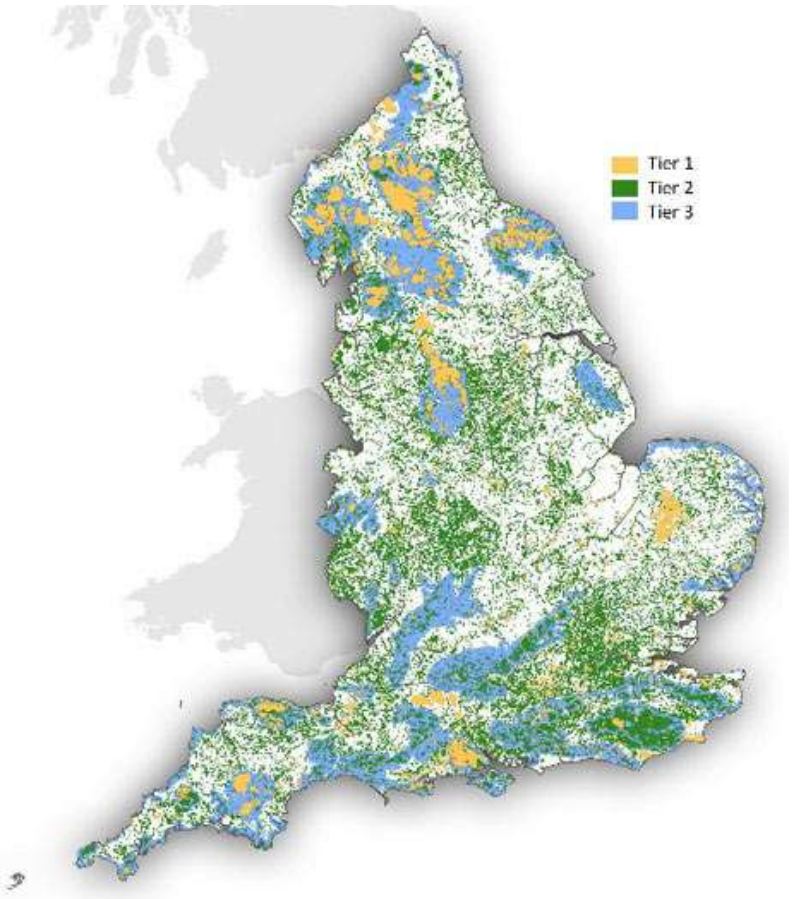


We expect there to be regional differences in the impact of climate change on biodiversity,

reflecting different species, climate, soils and patterns of land use and management.

Uplands are expected to have a greater change in temperature

The protected area network…. will continue to have a valuable role in conservation along with priority habitats.



although there will be changes in populations, communities and ecosystems at individual sites.

We also need to think of the site in context of it's surroundings as well as site based issues.

What are the key components of the system that we need to look to restore.

Climate change will interact with, and may exacerbate, the impact of other continuing pressures on biodiversity, such as land use change and pollution.

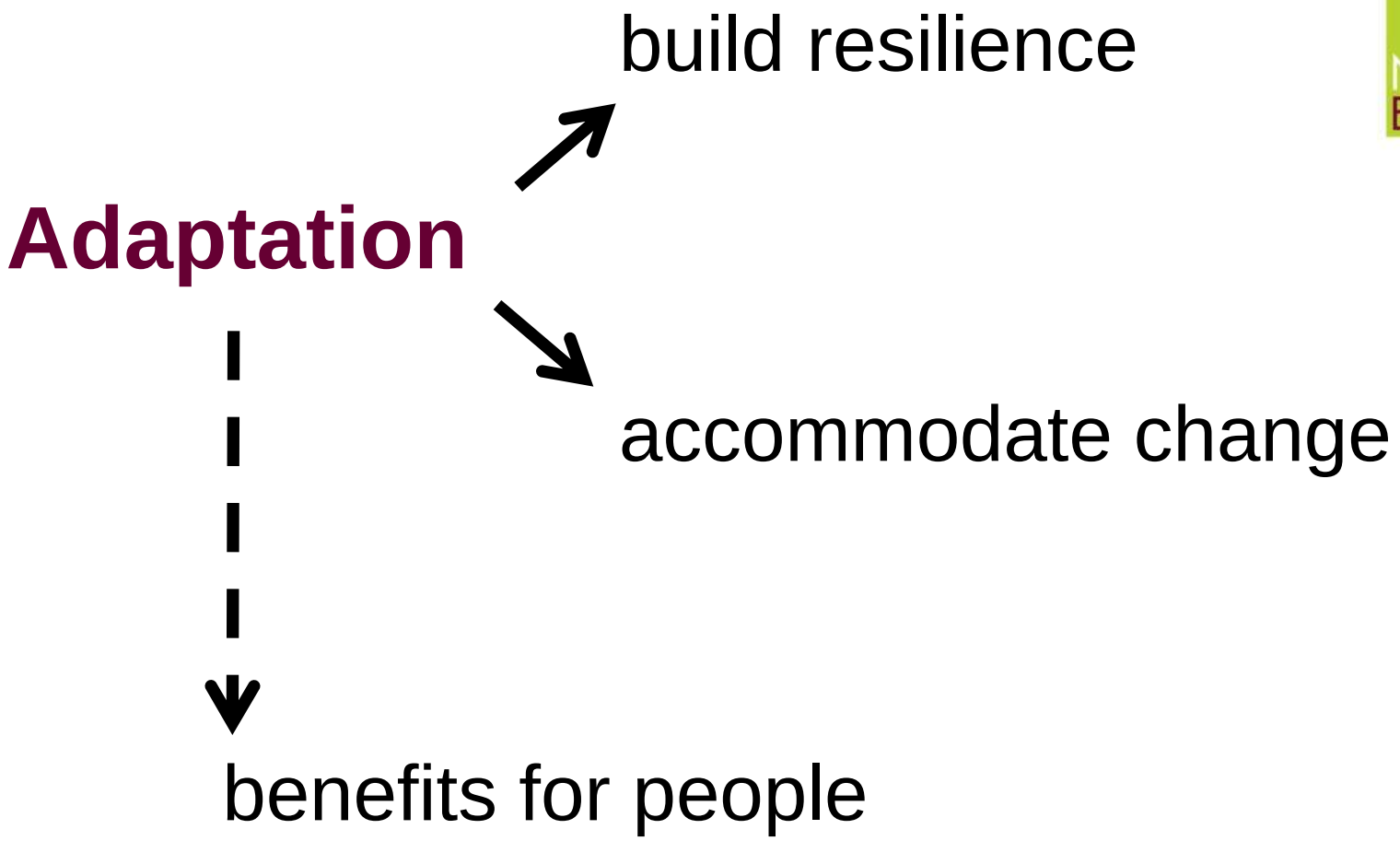
Indirect impacts of climate change

- New crops / varieties
- Water management
- Changing international markets
- Mitigation measures
- Adaptation measures

Extreme weather events, such as droughts and floods, have clear impacts on ecosystems and the ecosystem services they provide

climate change may alter the frequency and severity of such events.

So what should we be doing about it ?



Morecroft *et al*. (2012) *Journal of Applied Ecology*

Increasing resilience

Examples

- Ecological network of sites:
  - More - Bigger - Better – Joined
  - When are you big enough?
- Protect/create potential refugia (e.g. Cool microclimates)
- Maximise landscape variability (varying microclimates)
- Through maintaining or increase habitat heterogeneity
  - Increasing variability of types of habitats and also management variation within habitats.
- Promote genetic exchange between populations
- Protect & allow natural processes space to operate.

Moor- Bigger - Better - Joined

For me this is

Not the same solution for all areas

- Small sites in Fragmented Areas.
  - a bit of **Better** a lot of **Moor** and **Bigger**.
- Big sites but isolated.
  - **Better** and **Moor** habitat & variation around the sites so softening the matrix of land use surrounding.
- Large Sites.
  - Increase variation within habitats & types.
  - Understand Climate refugia locations.

Accommodating change
Examples

- Changing timing of operations e.g. Hay cut
- Protected site objectives e.g. new species
- Revising site boundaries e.g. Coastal erosion
- Habitat / community change e.g. Wetlands, montane

Accommodate change

- Natural development of rivers and coasts
  - » *how can we allow space for this to occur?*
- Shifting distributions of species.

Resilience or accommodation?

Changing approach as the climate changes

1°C > 2°C > 3°C > 4°C

enable persistence ---> accept change

---> promote transformation ????

Morecroft, M.D., Crick, H.Q.P., Duffield, S.J., and Macgregor, N.A. (2012) Resilience to climate change: translating principles into practice. *Journal of Applied Ecology*, 49(3): 547-551.

What should we be aiming for on the upland peatland systems.

- Need to get to active bog capable of biological responses as the climate changes.
- Many ecosystems have been reduced to small core areas of remaining habitat with little capacity to fully function or withstand change.
- Variation of management across sites and increasing habitat variability in the uplands through things like appropriate woodland expansion.

England Bio2020 - Outcome 1D

'Restoring at least **15%** of **degraded ecosystems** as a contribution to **climate change** mitigation and adaptation' by 2020

- **Broad interpretation** of adaptation & mitigation, **including**: **reducing emissions**; promoting **C sequestration**; adapting ecosystems to **benefit biodiversity & society**
- **Habitats** should be used **as a proxy** of ecosystems until a better approach developed
- **Focus on coastal, wetland and woodland habitats** in light of their significant contributions to climate change mitigation & adaptation

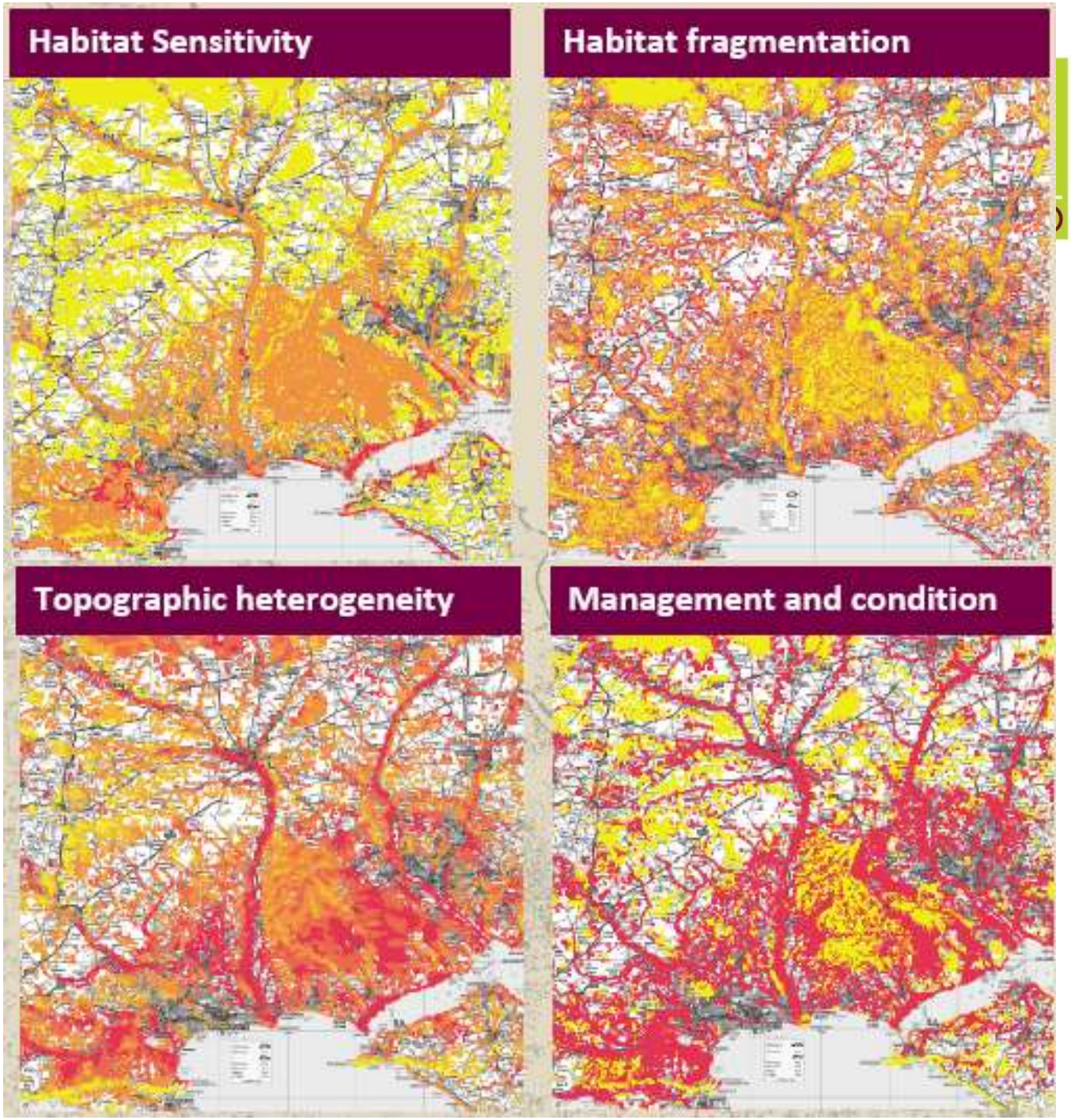
Broad habitat	Priority habitats
Coastal	sand dunes, saltmarsh, vegetated shingle, maritime cliffs & slopes
Wetlands	blanket bog, fens, lowland raised bogs & reedbeds
Woodlands	Native, broad-leaved woods

Some tools to help with delivery?

Assessing vulnerability

National Biodiversity Climate Change Vulnerability Model

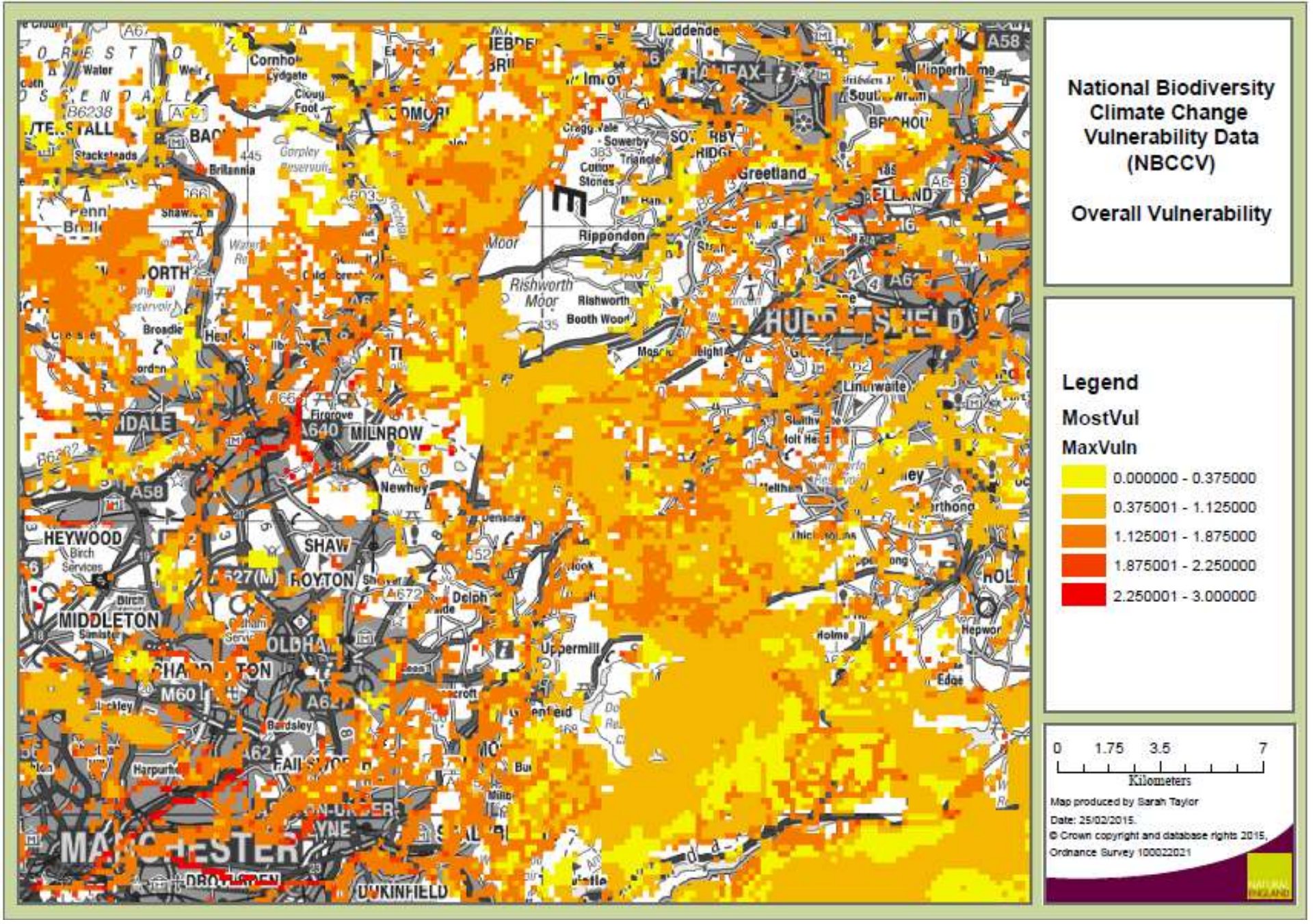
Taylor et al 2014



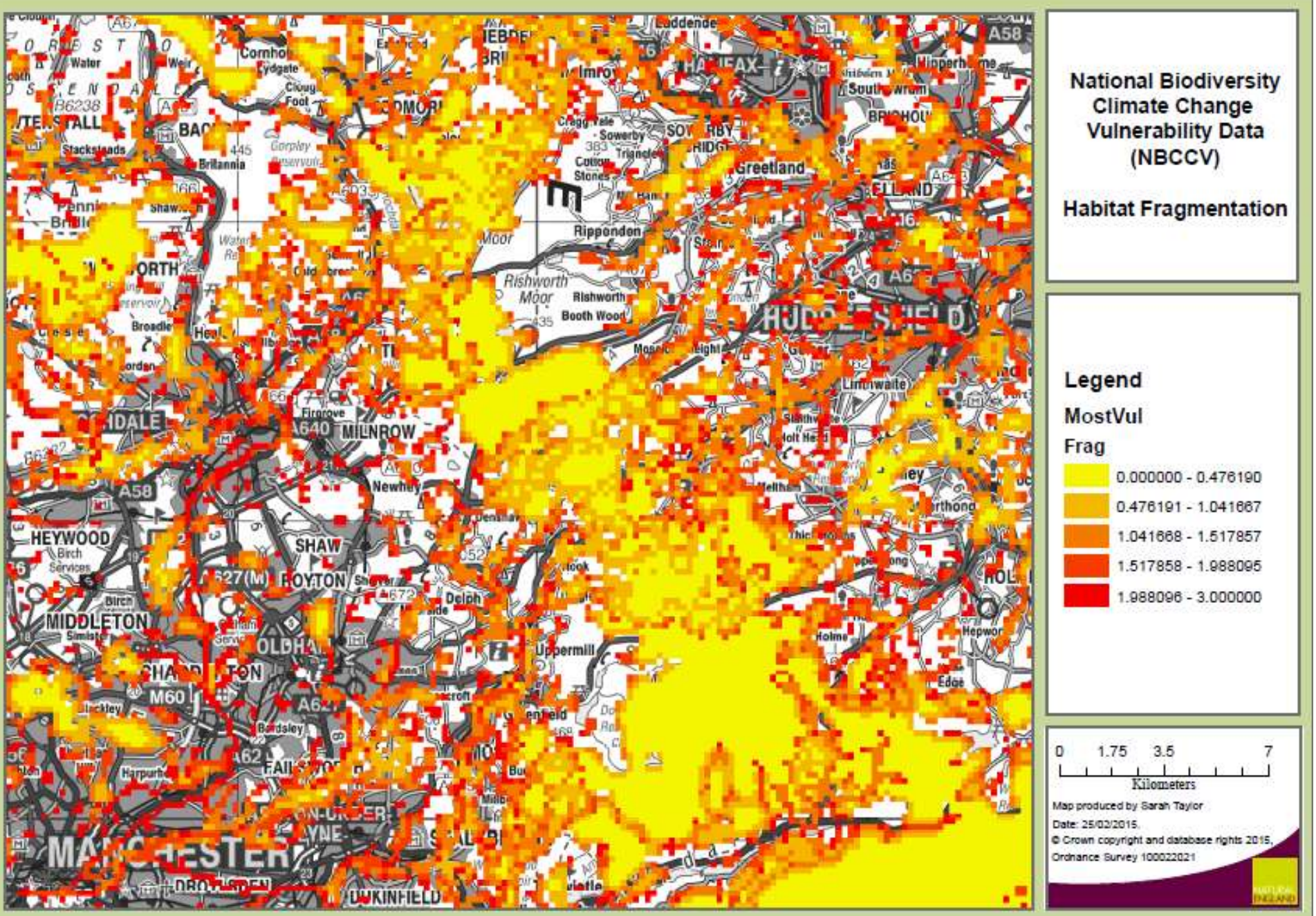
Assessing vulnerability - National Biodiversity Climate Change Vulnerability Model

The objective of the model is to provide:

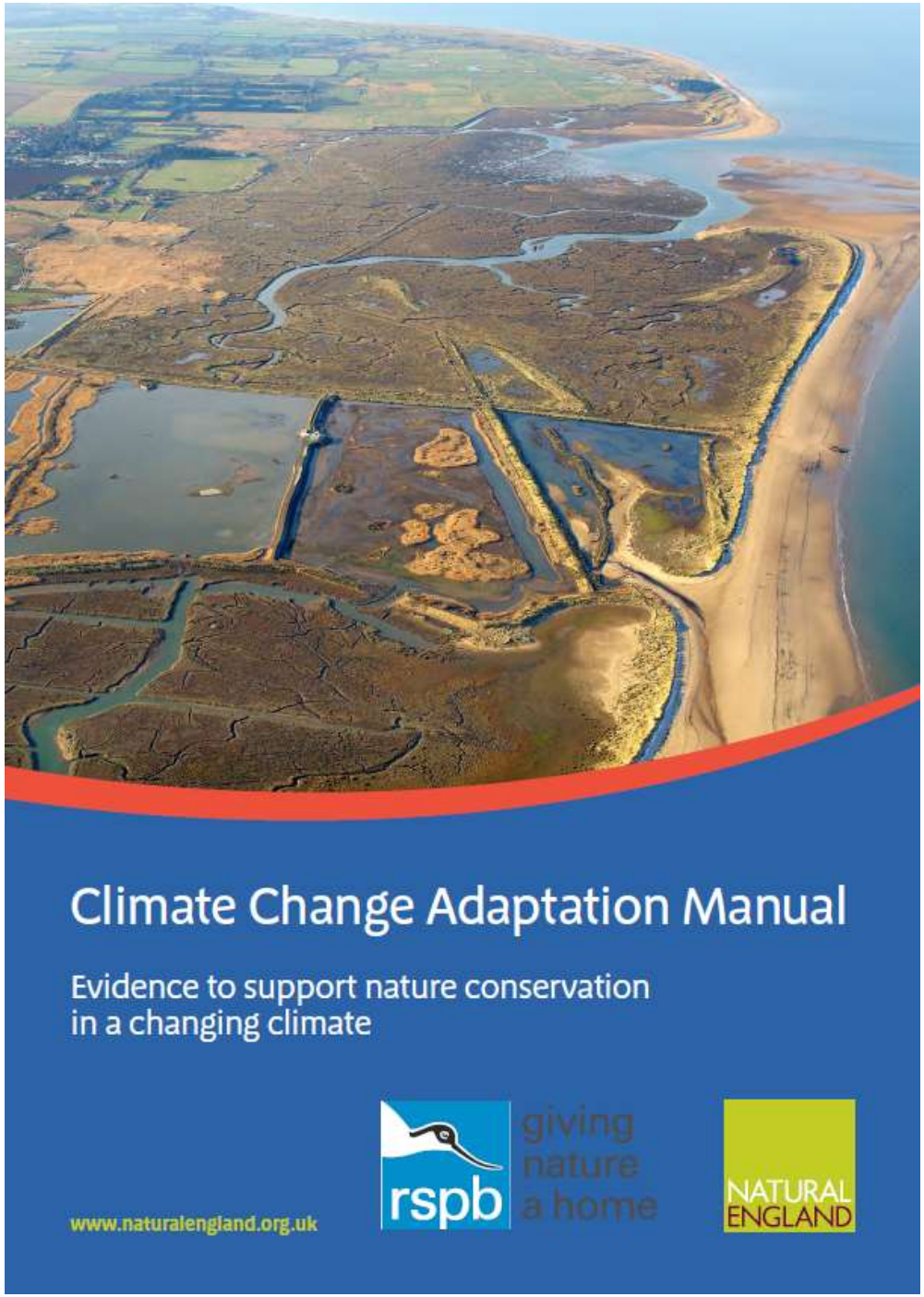
- **a spatial representation of relative vulnerability of priority habitats**
- **a decision support tool to assist practitioners in targeting action to build biodiversity resilience alongside other data**
- **National GIS grid model (200m^2)**
- **Spatial analysis metrics based on biodiversity climate change adaptation principles:**
  - **Habitat sensitivity to climate change**
  - **Habitat fragmentation**
  - **Topographic variety**
  - **Current management and condition**
  - **Conservation value**
- **Uses 'direction of travel' rather than specific climate change scenarios**
- **GIS outputs to enable climate change resilience spatial prioritisation**
- **Tool to allow data updates, use of local data and adaptation action scenario testing**



Provided by Sarah Taylor



Provided by Sarah Taylor



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www.naturalengland.org.uk/publications

Aims of the manual

- Support conservation decision-making
- Make available science, experience and case studies
- Provide habitat specific information
- Signpost to tools and resources
- A flexible resource that can develop

Audiences

- Reserve managers
- Conservation and land management advisors
- Environmental consultants
- Local authorities
- Statutory agencies
- NGOs

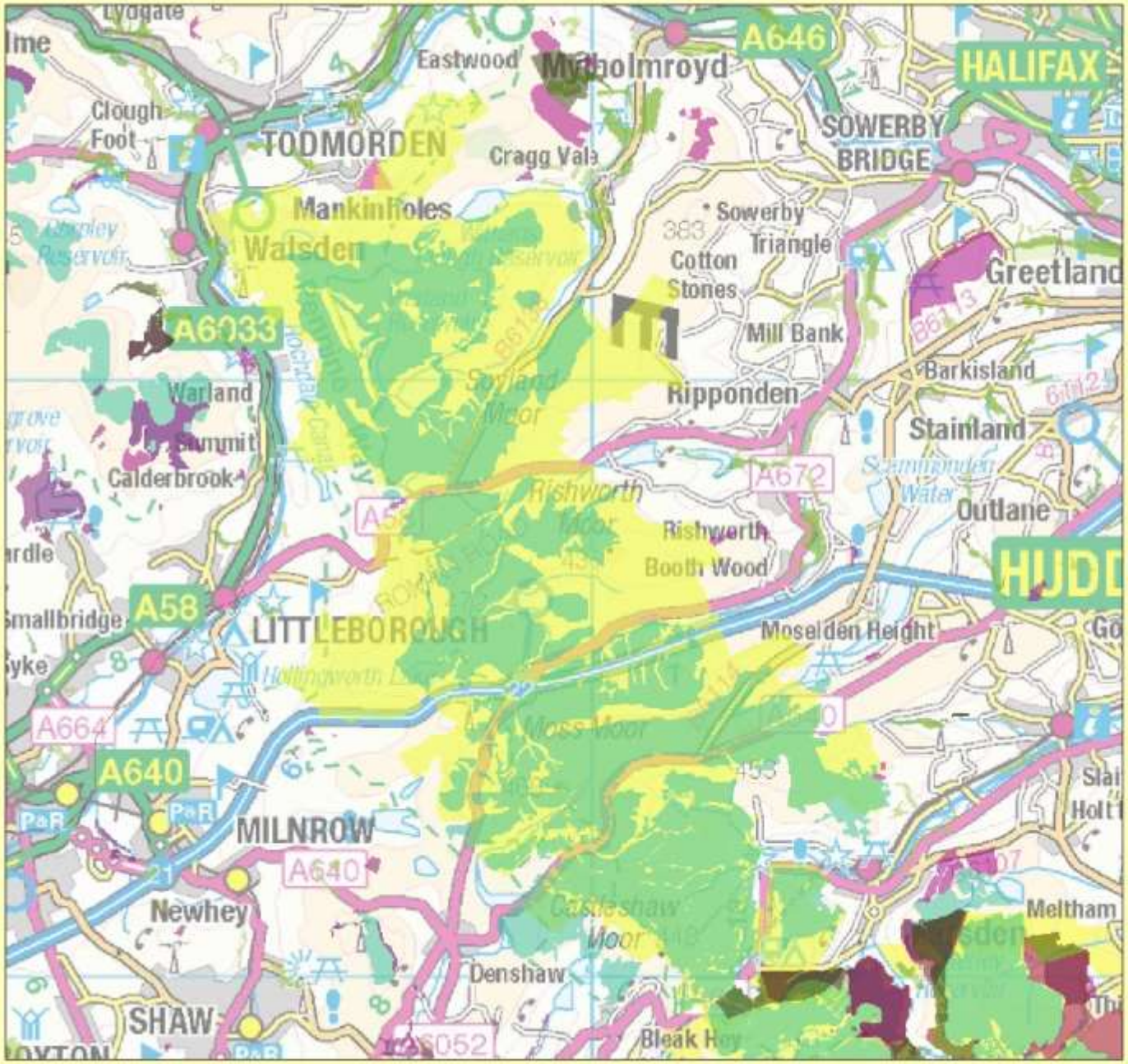
Contents

Increasing habitat heterogeneity through the Niche Approach?

The Niche approach is about embedding simple ecological principles into habitat management to allow more species to benefit from the habitat already present.

Niche Approach based on Six Principles:

1. Soil/ Air/ Water Quality
2. Bare ground/mud and other sparsely-vegetated Habitats
3. Structural variation / Vegetation Heterogeneity
4. Ecotones
5. Large Scale Mosaics or Patchworks
6. Ecological Process



Moorlife
Rishworth Common
Example

Soil

Key

- Lowland Raised Bog - P Habitat
- Fen Habitat
- Deciduous woodland
- Blanket Bog Habitat
- Ancient Woodland
- Upland Heath
- SAC Designated Sites

Scale (at A3): 1:63,298

Map produced by Ian Crosher
GIAST(1)
Date:26/02/2015
Map Reference:NE140620-1106-612

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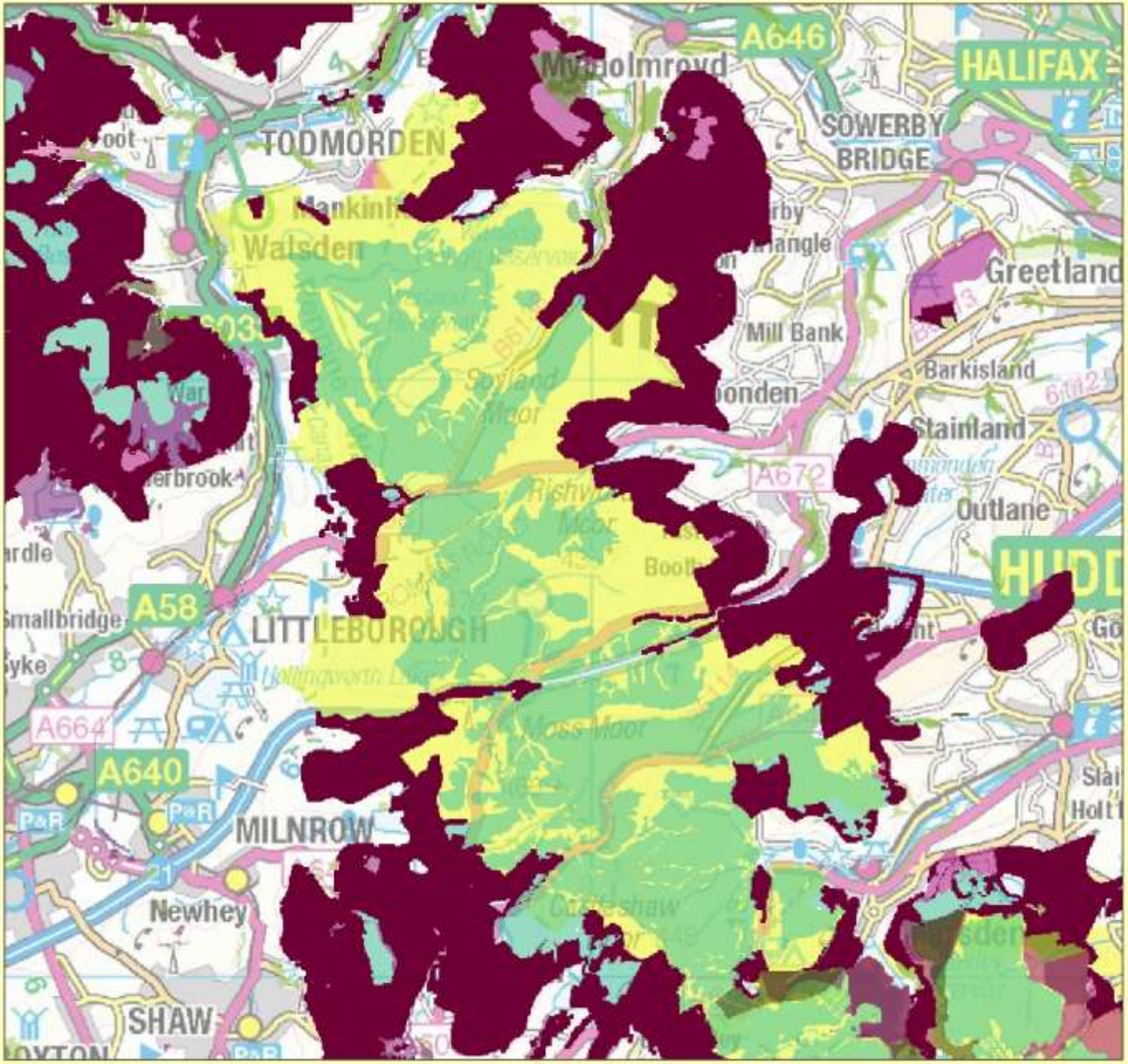

Moorlife
Rishworth Common
Example

Key Soil

- BB Habitat Potential (Peat Soil)
- Lowland Raised Bog - P Habitat
- Fen Habitat
- Deciduous woodland
- Blanket Bog Habitat
- Ancient Woodland
- Upland Heath
- SAC Designated Sites

Scale (at A3): 1:63,298

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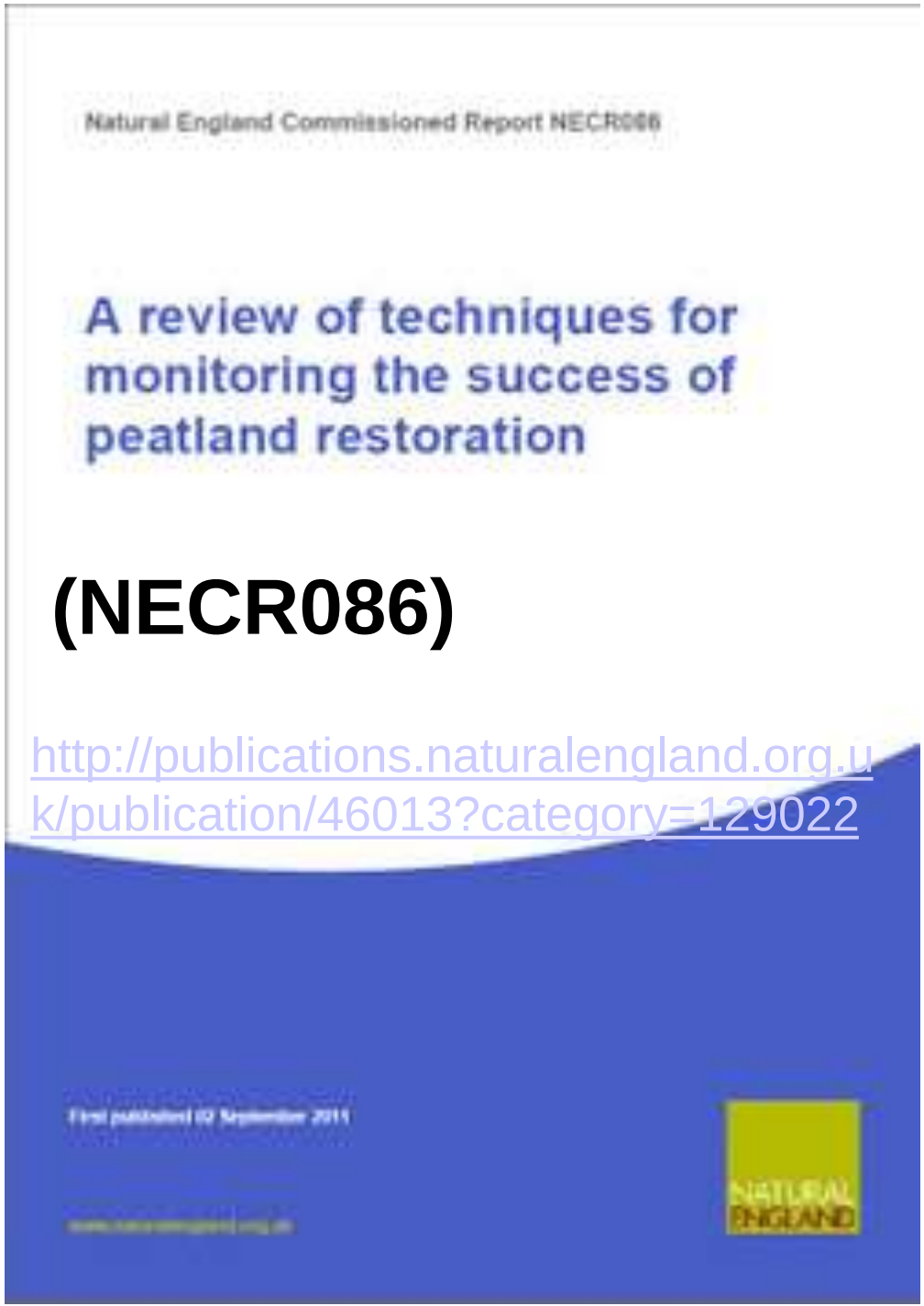

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http://publications.naturalengland.org.uk/publication/46013?category=129022

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Don’t Forget Monitoring and Adaptive Management Feedback in the light of what is now understood.

Peatlands Restoration is at the Leading Edge of being able to push the carbon threshold back – Your work is helping make sure that emissions are kept in the ground for longer.

Summary

- Please don't take this as a message of futility, but a wake up call to how bold we need to be with the task ahead.
- Ecological Timescale make it imperative that we plan now for 4 degrees as it is fast approaching.
- There is hope, but hard decisions need to be made. If we do manage to stay at 2 degrees what have we lost.

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