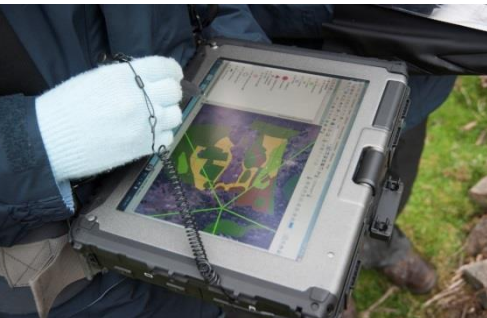


The Glastir Monitoring and Evaluation Programme (GMEP)

Bridget Emmett
Centre for Ecology & Hydrology
....and the whole GMEP team



Glastir



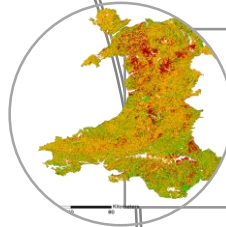
Glastir Monitoring and Evaluation Programme

- To provide constant feedback on the scheme's success the Welsh Government commissioned CEH to run a parallel Glastir Monitoring and Evaluation Programme (GMEP)
- Quantify impact of Glastir payments against 6 outcomes
- Set within the context of ongoing change of our Natural Resources in Wales
- Provides evidence for other reporting requirements

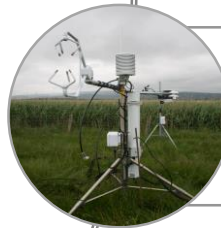
How to deliver this?



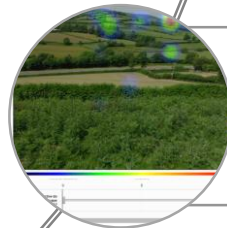
GMEP Field Survey and analysis of data from agencies and citizen science



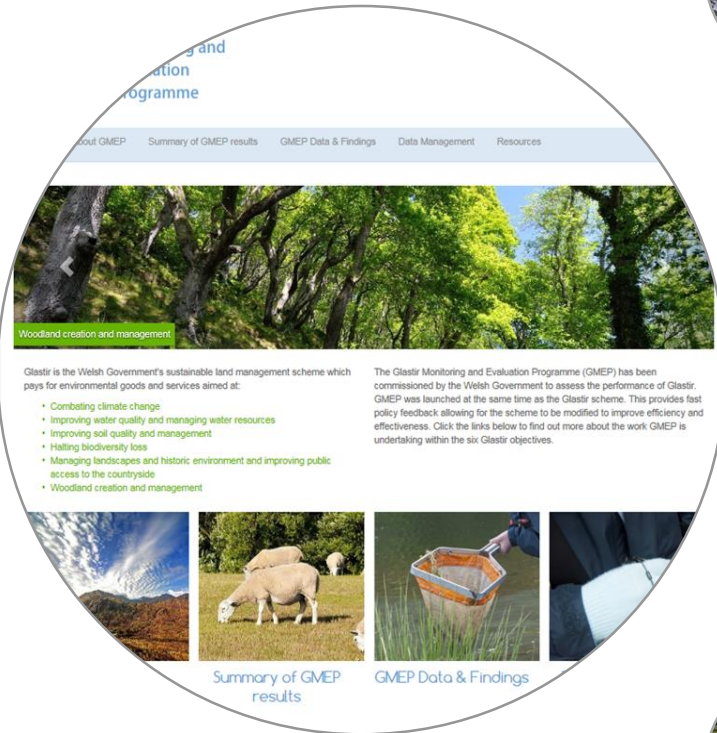
Models run in forecast mode



Development of new technologies



Socio-economic surveys to find out impacts on farmers and wider society



Field Survey – the challenges

(1) Scale

- 1km² sampling unit with squares sampled to ensure:
 - good range of habitat types.
 - landscape scale impact captured
- Unbiased by land ownership
- Easily upscaled to national scale
- Consistent with Countryside Survey; Breeding Bird Survey and the UK Butterfly Monitoring Scheme scale

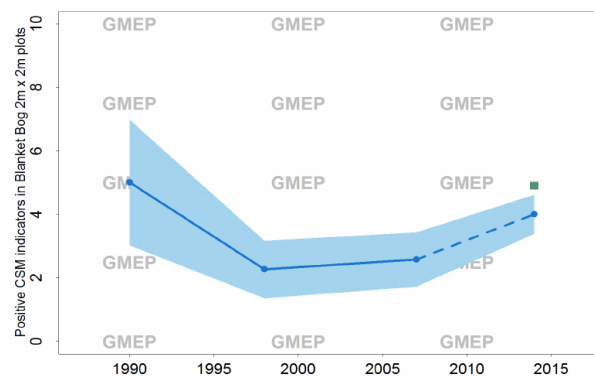
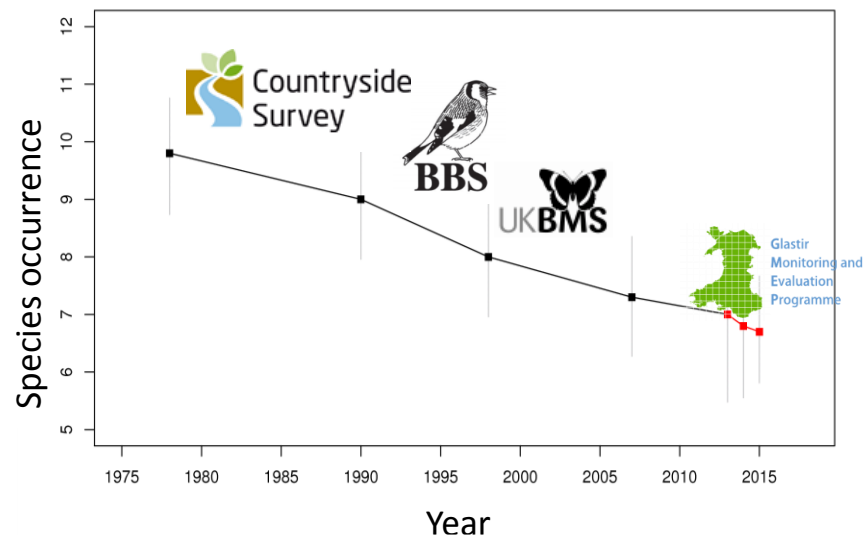
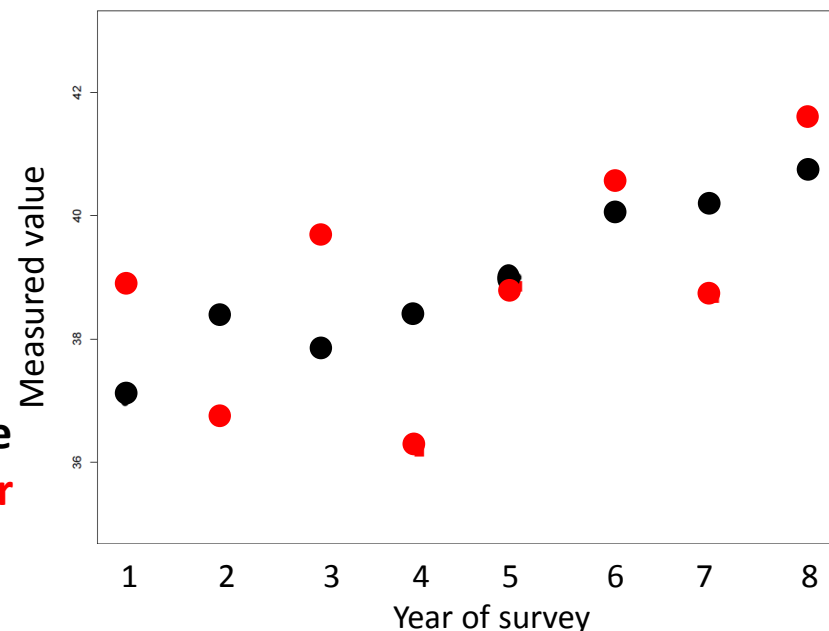


FIGURE-GMEP-BD-033-A-1: Trends in Blanket bog condition as indicated by trends in the average number of common standards monitoring positive species

Field Survey – the challenges

(2) Frequency

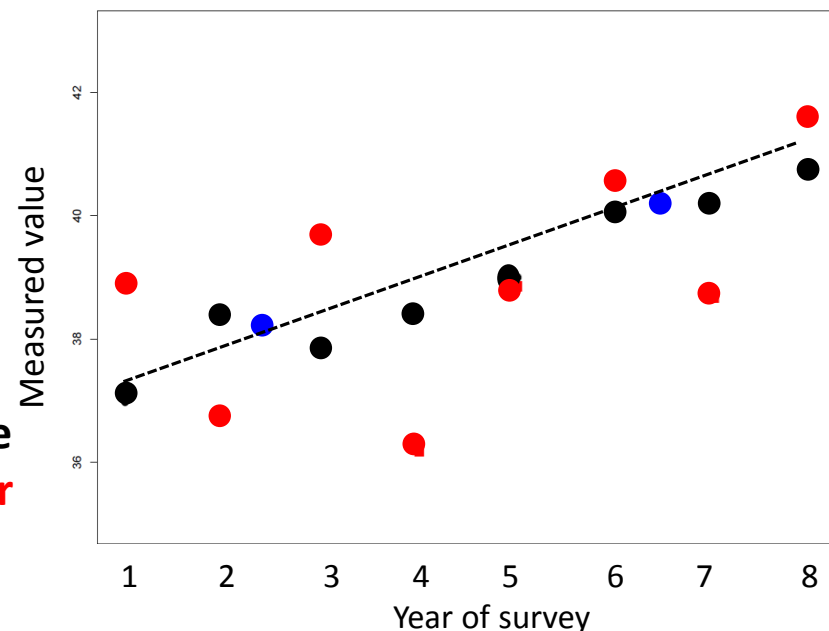
- Rolling 4 year programme
 - Baseline data years 1-4 (2012 – 2016)
 - Sites revisited in year 5 starting 2017
 - Annual cycle picks up impacts of pulse and chronic pressures
- Black = true value
Red = Within year estimate



Field Survey – the challenges

(2) Frequency

- Rolling 4 year programme
- Baseline data years 1-4 (2012 – 2016)
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- Annual cycle picks up impacts of pulse and chronic pressures

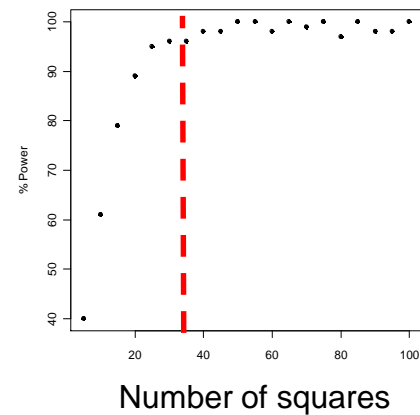
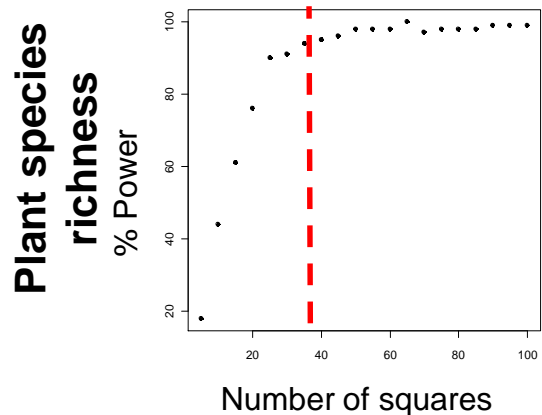
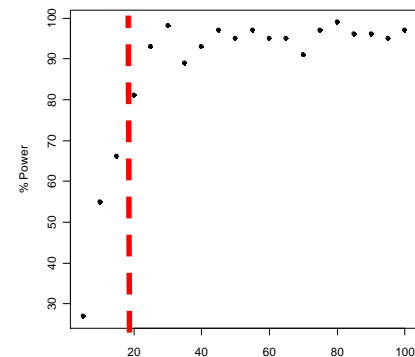
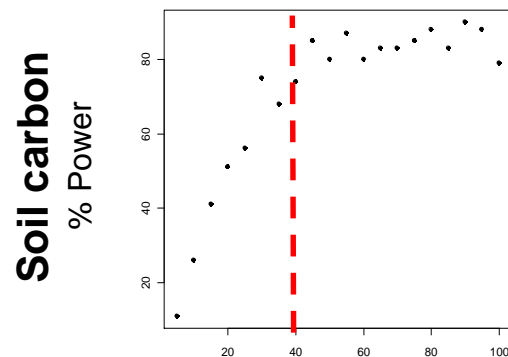


Black = true value
Red = Within year estimate
Blue = estimated value over a 4 year period (mean of annual estimates)

Field Survey – the challenges

(3) Population

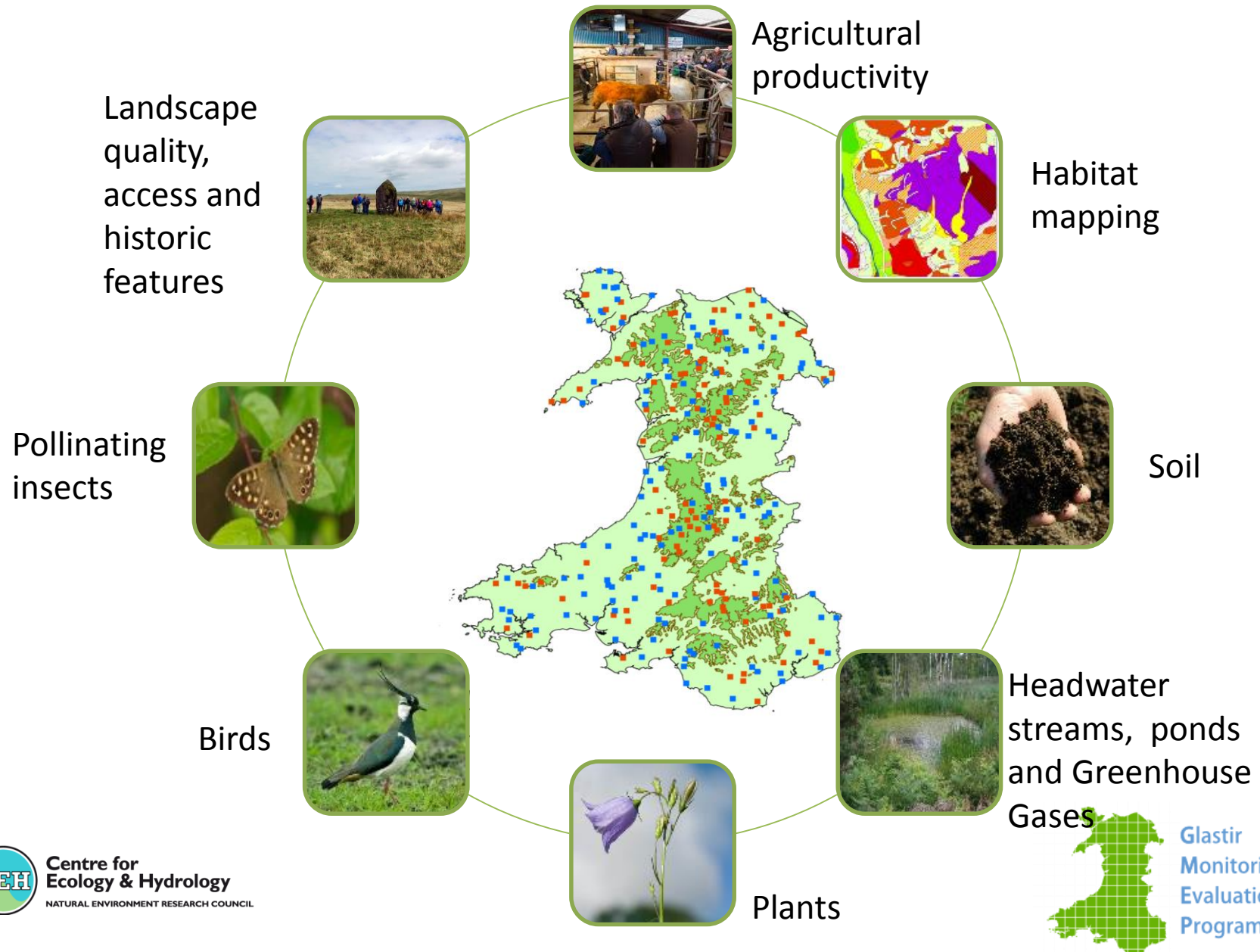
- Power analyses to identify number of sites required
- 300 x 1km squares (ca. 1.5% of Wales)
- 76% of GMEP squares selected overlap with some Glastir uptake
- And interventions surveyed mirror national uptake of interventions



Trend

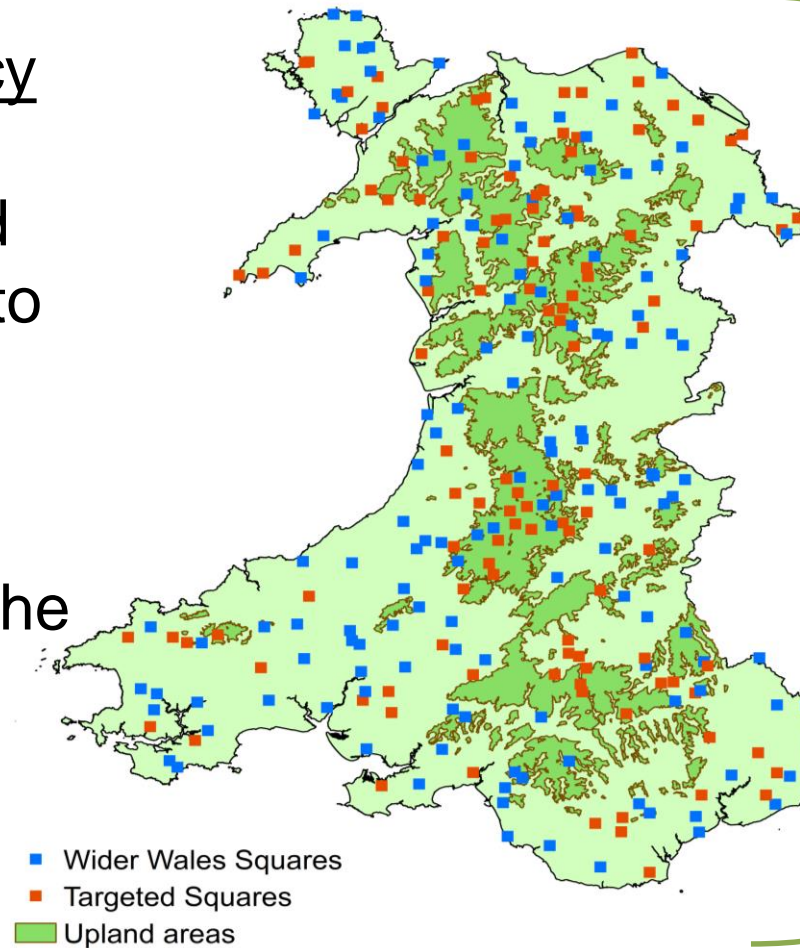
Change in 4 years

Ecosystem Approach - what to measure?



Measurements co-located in 300 X 1km²

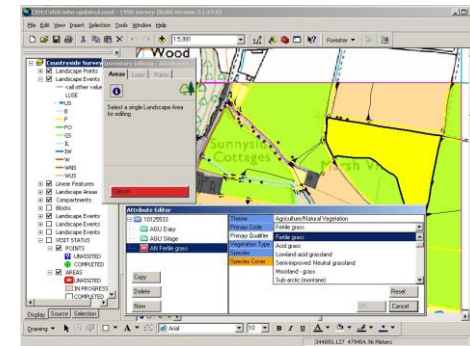
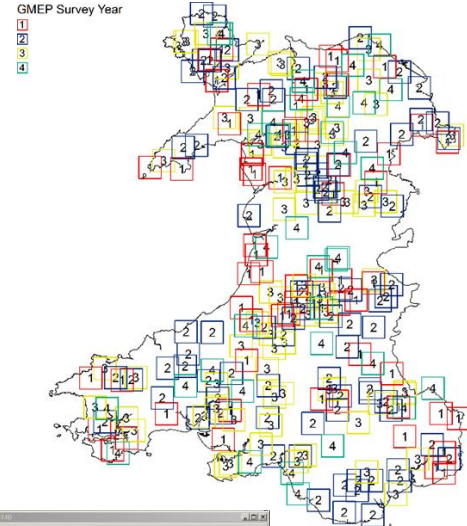
- Multi-purpose survey ensures cost-efficiency
- Delivers an integrated monitoring approach to deliver the scientific evidence
- Explicitly recognises the linkages between plants, soil and water and the atmosphere



Field survey measurements

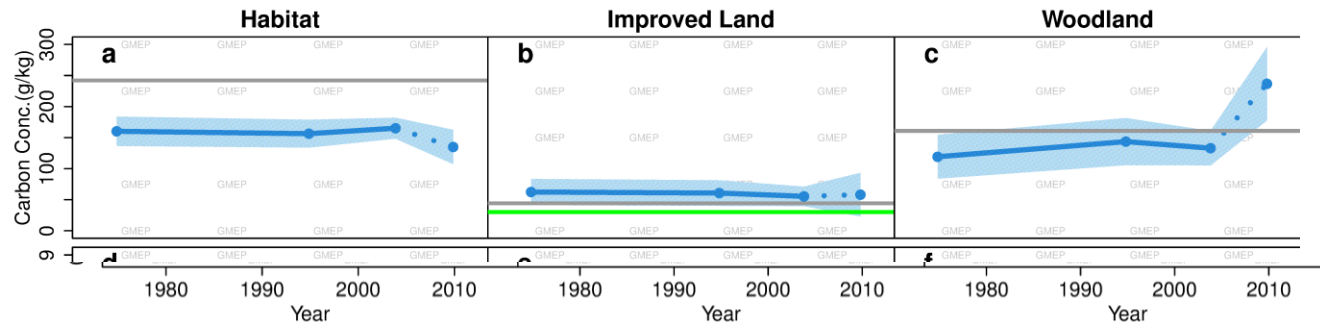
Within each 1km square surveyors...

- Record landscape features at various points (hedges, walls...)
- Map all habitat types
- Record bird, (BTO) butterfly, pollinating invertebrates (Butterfly Conservation)
- Record plant species in fixed plots
- Take topsoil samples from within a subsample of plant diversity plots
- Undertake pond and river habitat assessments and take water quality and invertebrate samples
- Many rare species will not occur and are not targeted e.g. Bats.



Findings (1): Ongoing change in Natural Resources

Stability
of soil
carbon

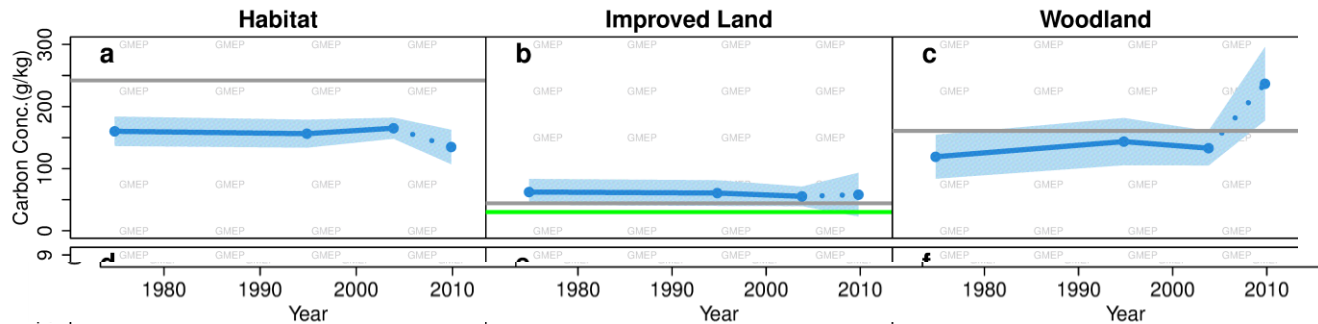


Centre for
Ecology & Hydrology

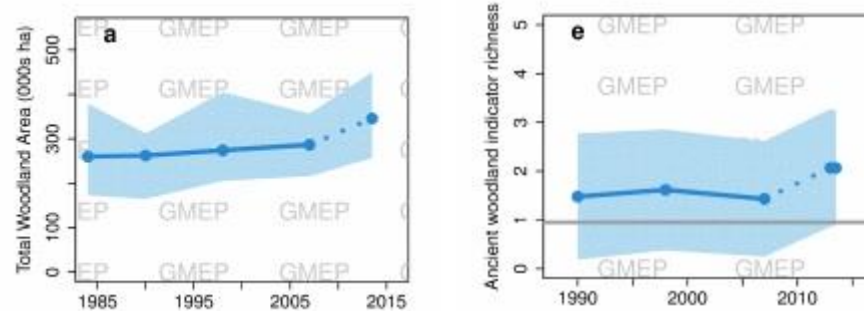
NATURAL ENVIRONMENT RESEARCH COUNCIL

Findings (1): Ongoing change in Natural Resources

Stability
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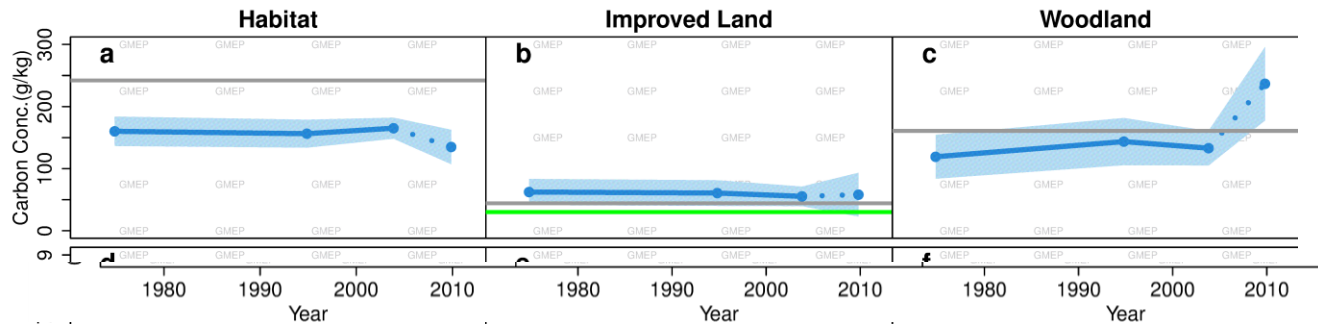


Increase in
area of
woodlands but
not condition

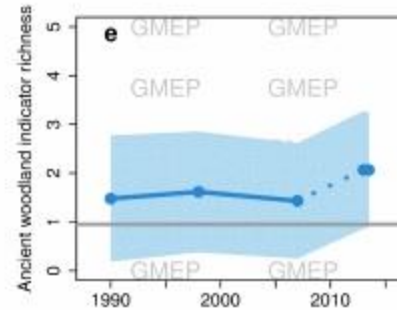
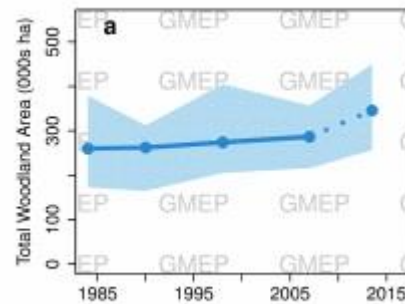


Findings (1): Ongoing change in Natural Resources

Stability
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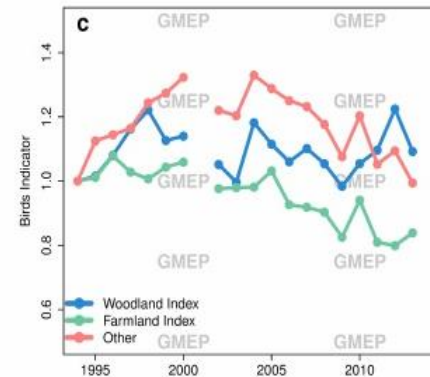
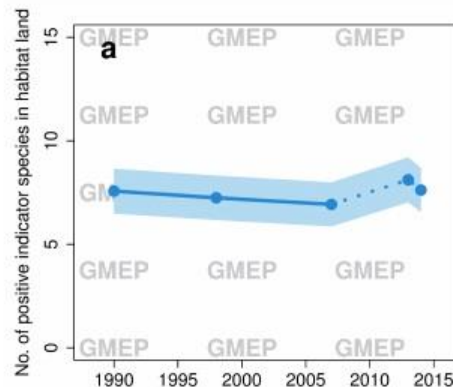


Increase in
area of
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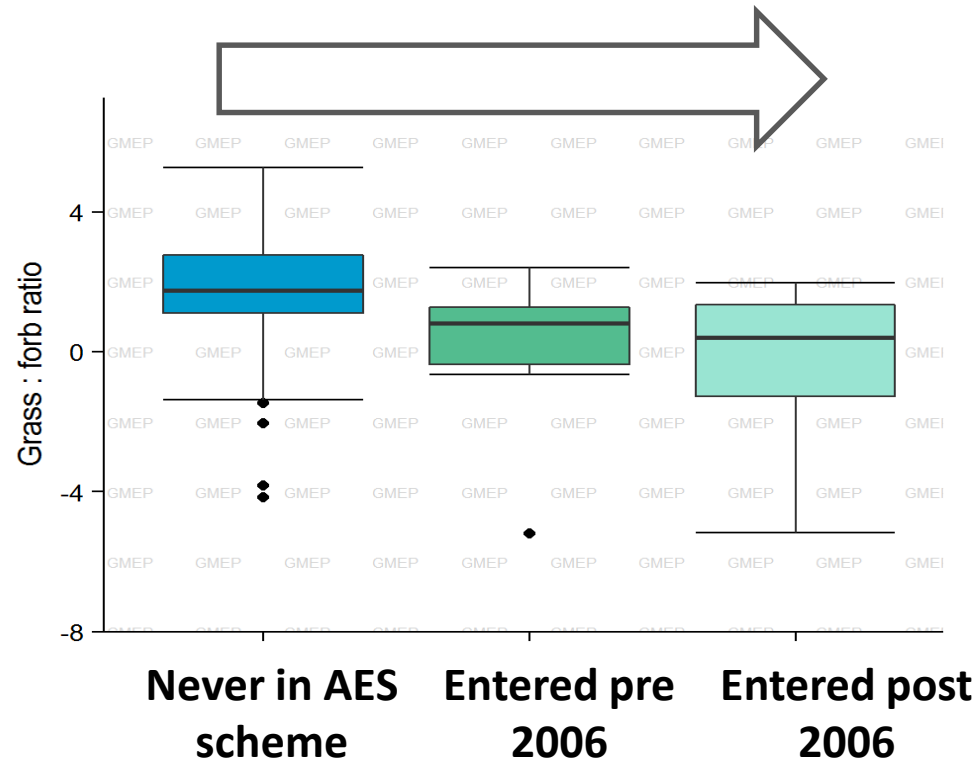
Evidence suggests
agri-environment
and other initiatives
have ensured
stability. Lags in
system responses
mean we need
continuity .

Complex
trends for plant
and bird
indicators



Findings (2): Legacy effects of past schemes

Reduced grass in heathland in GMEP squares which were previously in agri-environment scheme



Findings (3): Effect of Glastir Efficiency Grants on greenhouse gas emissions

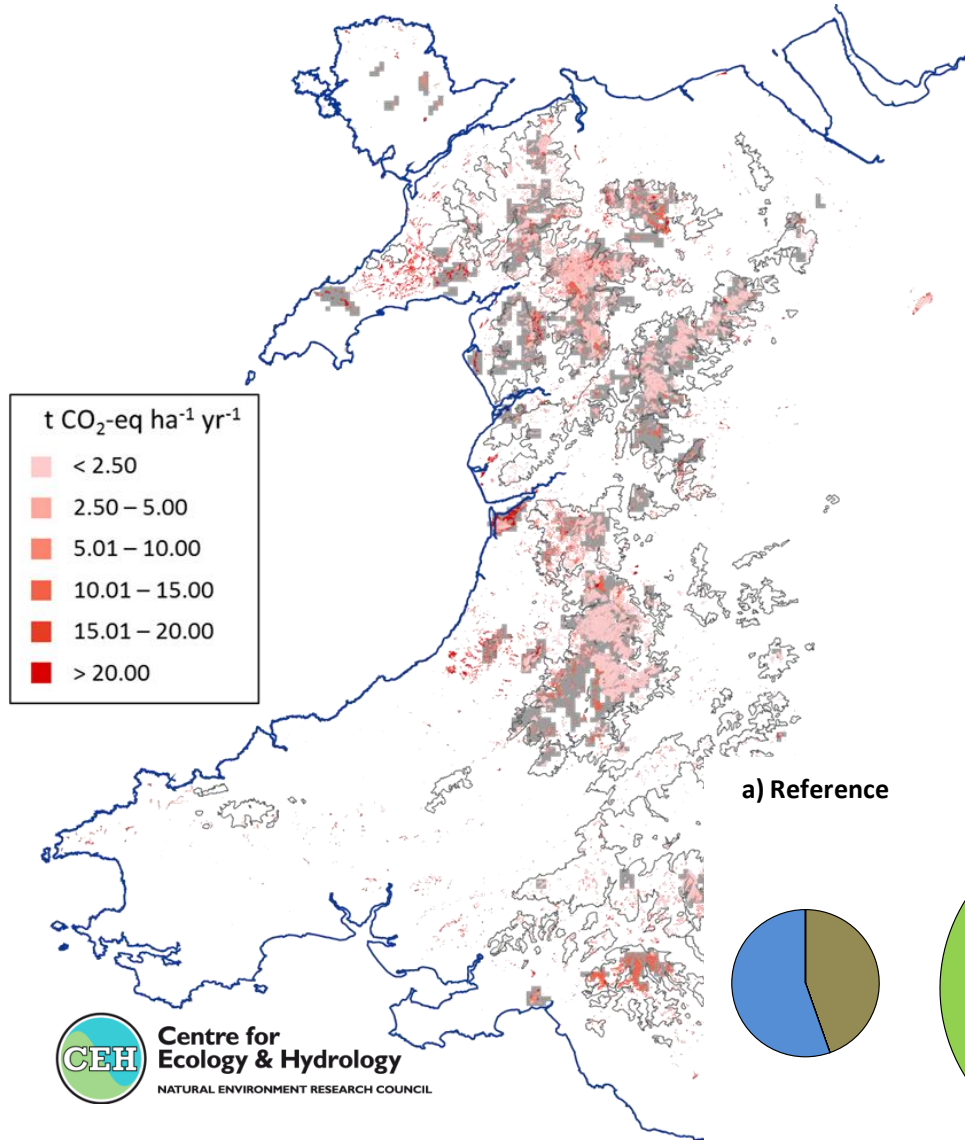
- Average farm CF was 10 tonnes CO₂/ha/yr (large range: 2 - 19 CO₂e/ha/yr)
- Dairy farms (14 tonnes CO₂e/ha/yr) was almost double that of LFA cattle and sheep farms
- CH₄ 47%, N₂O 24% and 'embedded' for 28%
- C sequestration was 1 tonne CO₂/ha/yr (range from 0.5 to 1.6 tonnes CO₂/ha/yr)

% contribution to whole farm sequestration	Grassland soil	Woodland	Isolated trees	Hedges
	80 (+47 - +100)	13 (-5 - +34)	5 (+0.5 - +21)	7 (+0.4 - +26)

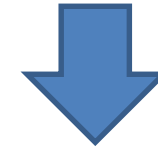
- Repeat C footprinting surveys of the 20 farms in 2016

Finding (4) Condition of, and GHG emissions, from peat soils

Present-day GHG emissions from Welsh peats



A new unified peat map for Wales



Area of drainage and Molina / forestry/agri impacted peats

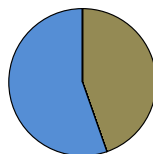


Condition assessment (only 30% in good condition)

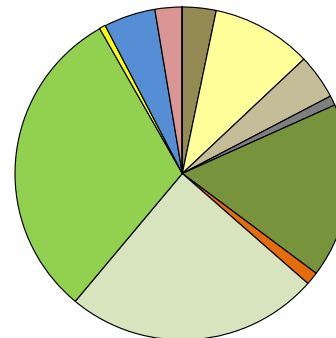


GHG emissions (400 kt eCO₂-per year)

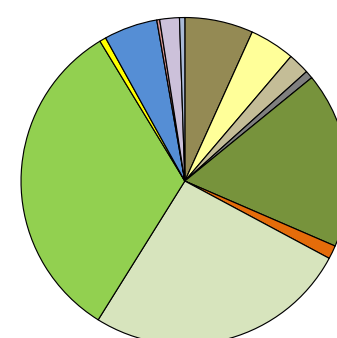
a) Reference



b) 1990



c) Present day

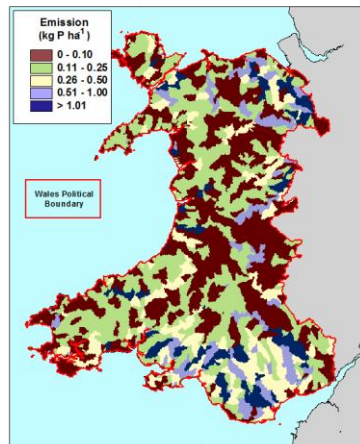


- Bog: Near natural
- Bog - modified
- Bog - drained
- Bog - eroding
- Woodland - conifer
- Woodland - broadleaf
- Unimproved grassland
- Improved grassland
- Cropland
- Fen
- Peat extraction
- Rewetted bog
- Rewetted fen

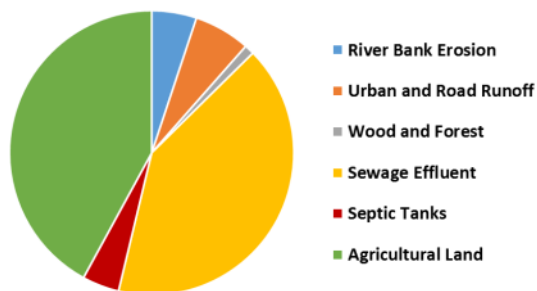
Findings (5): Modelling for optimising scheme

What is causing the problem of phosphorus in this rivers? Who do we target to change and what % reduction can we expect?

Present Day Modelled Phosphorus Emission from all Non-Agricultural Sources

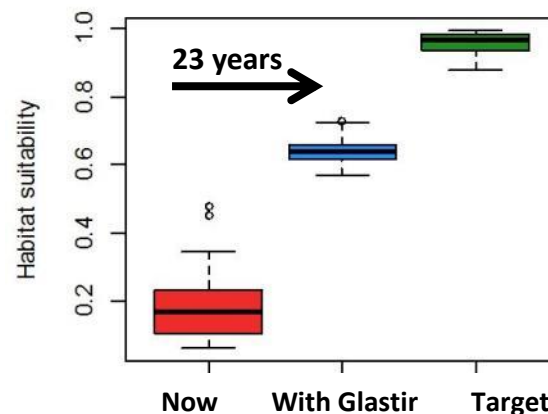


Sector Apportionment

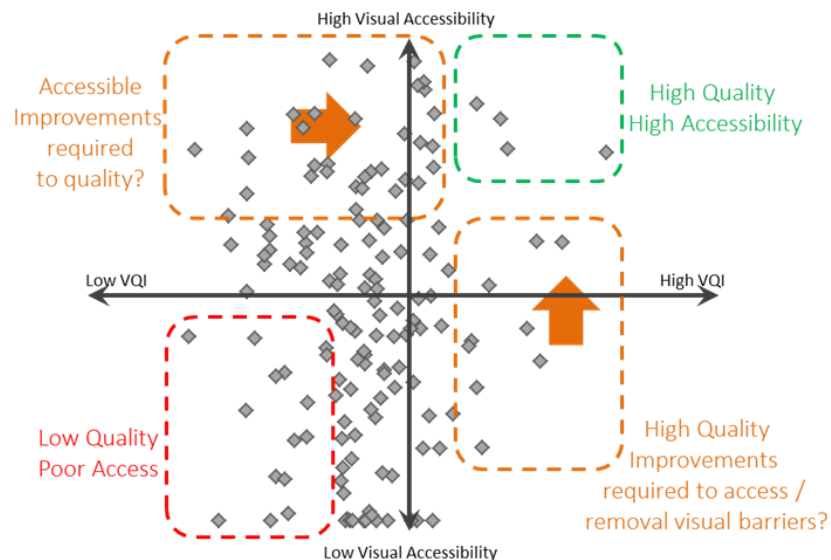


How long will it take for this woodland to become suitable for target species if woodland expansion option is introduced?

Bluebell



How do we improve benefits of our landscape to the wider public?



Findings (6): Modelling the impact of 6 interventions

1. Retain Winter Stubbles
2. Allow Woodland Edge to Develop Out into Adjoining Field
3. Grazing Management of Open Country
4. Grazed Permanent Pasture with No Inputs
5. Create Streamside Corridor with Tree Planting
6. Mechanical Bracken Control

Findings (6): Modelling rainfall runoff

- Potential reduction in fast flow runoff land of 1-9%



Findings (6): Modelling for water quality

- Potential reduction in flood-generating land of 1-9%
- Reduction of diffuse pollution and soil erosion of 1-15%



Findings (6): Modelling for carbon

- Potential reduction in flood-generating land of 1-9%
- Reduction of diffuse pollution and soil erosion of 1-15%
- Increased national carbon storage by ca. 0.4%



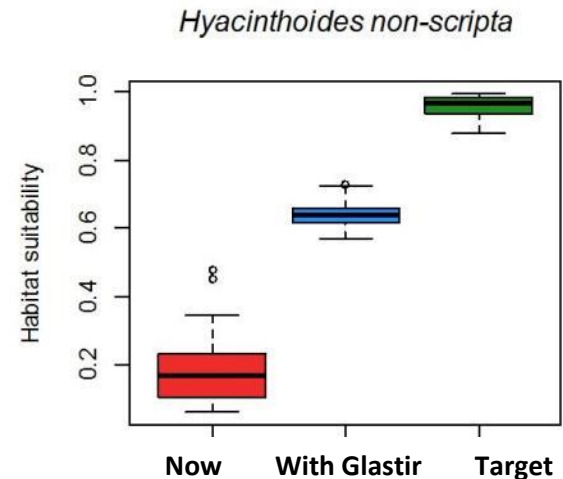
Findings (6): Modelling for greenhouse gas emissions

- Potential reduction in flood-generating land of 1-9%
- Reduction of diffuse pollution and soil erosion of 1-15%
- Increased national carbon storage by ca. 0.4%
- Reductions in nitrate leaching, nitrous oxide and methane emissions of 5-10%



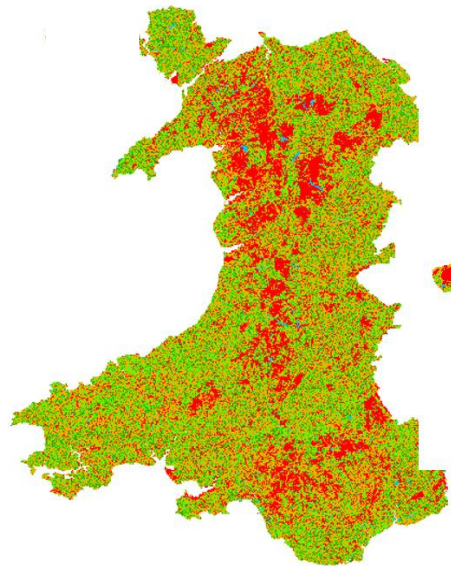
Findings (6): Modelling for biodiversity

- Potential reduction in flood-generating land of 1-9%
- Reduction of diffuse pollution and soil erosion of 1-15%
- Increased national carbon storage by ca. 0.4%
- Reductions in nitrate leaching, nitrous oxide and methane emissions of 5-10%
- Positive changes in habitat suitability projected for 75% of the 21 plant species modelled.



Findings (6) Modelling for ecosystem services

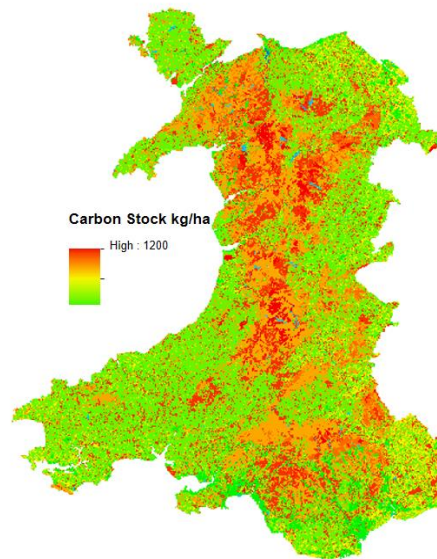
Fast flow runoff
generating and
mitigating land



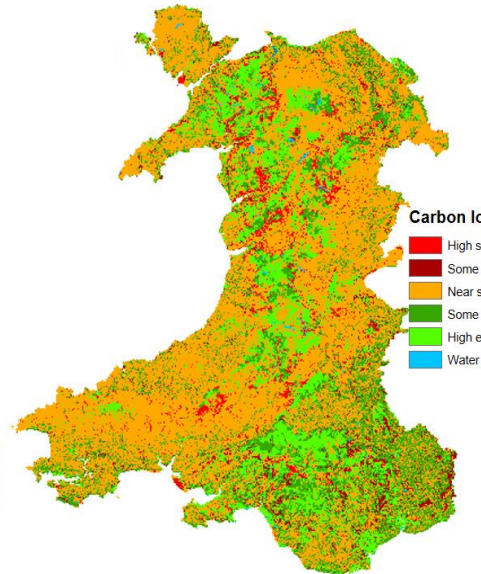
Legend

- Mitigating land
- Negligible "fast flow" concentration
- "Fast flow" concentration
- High "fast flow" concentration

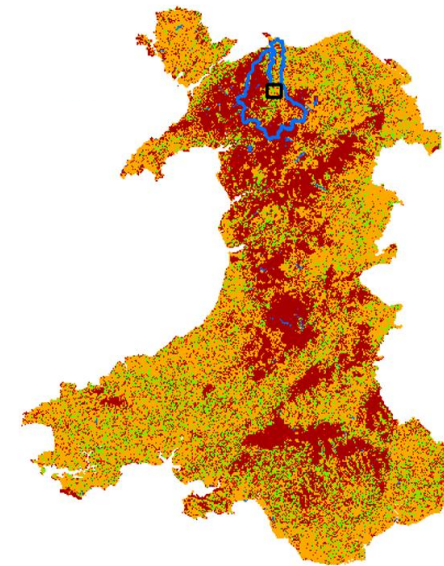
Carbon storage



Carbon emission



Woodland
connectivity and
priority habitats



5 by 5km "close-up" area

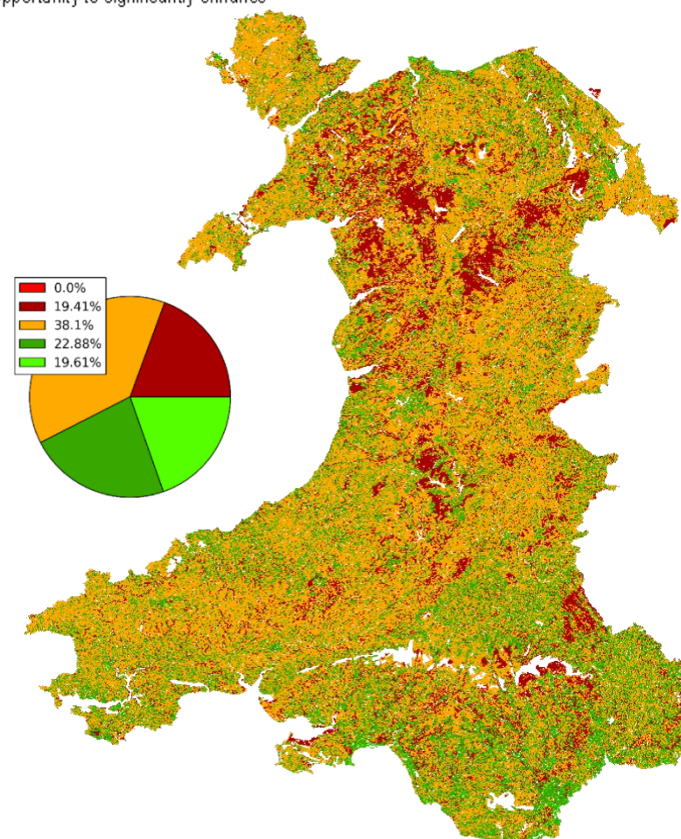
- Conwy catchment outline
- Existing broadleaf woodland
- Other priority habitat
- Habitat establishment possible
- Opportunity to extend existing habitat
- Water features

Findings (6) Modelling for trade-offs and opportunities

- Trade-off map examines:
 - Agricultural production
 - Soil carbon status
 - Nitrogen and phosphorus mitigation to waters
 - Erosion production and delivery
 - Broadleaved woodland connectivity
 - Runoff mitigation
- 10% of Wales has good provision of two or more co-located ecosystem services
- 28% has potential to gain more than it would lose in service provision if intervention measures were implemented.

Tradeoff

- Significant existing provision in multiple services
- Existing provision in multiple services
- Negligible opportunity or tradeoffs in provision
- Opportunity to enhance multiple services
- Opportunity to significantly enhance



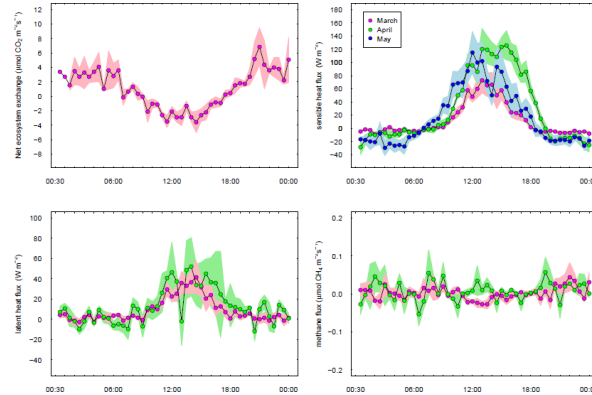
0 20 40 80 Kilometers



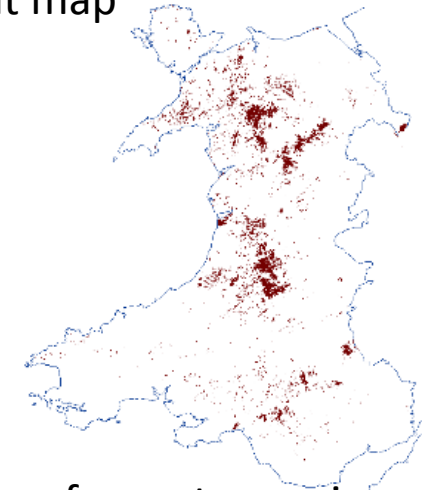
Glastir
Monitoring and
Evaluation
Programme

Findings (7) Exploiting new technologies

First mobile system measuring CO₂, CH₄, N₂O and soil moisture



Development of a new unified peat map



Use of remote sensing and field survey to develop predictive maps for plant growth

Exploiting new molecular techniques to explore soil microbial diversity



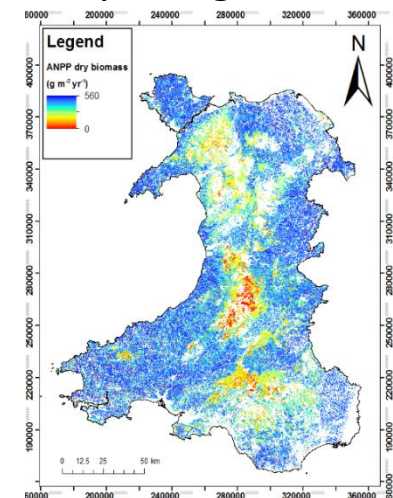
Molecular barcode:
a short DNA
sequence, used for
species
identification



High-throughput
(HT) sequencing
technologies

Illumina MiSeq

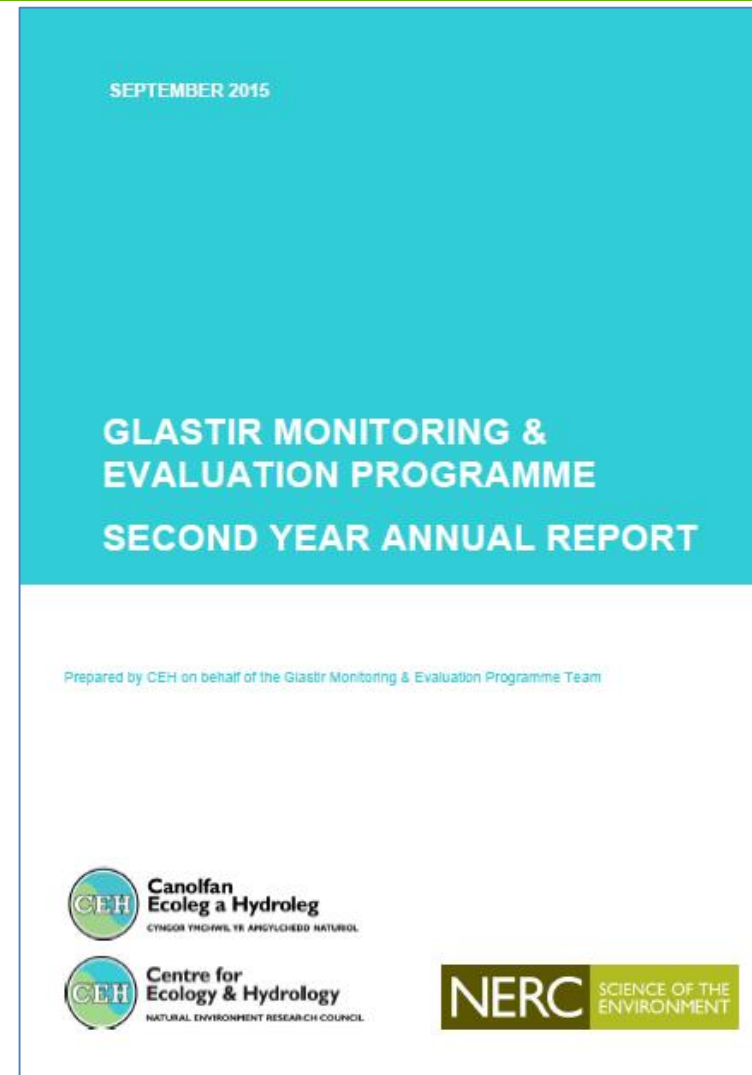
Bacteria
Archaea
Fungi
Eukaryotes



Some hard statistics from year 2 report

Ongoing change in Wales' Natural Resources

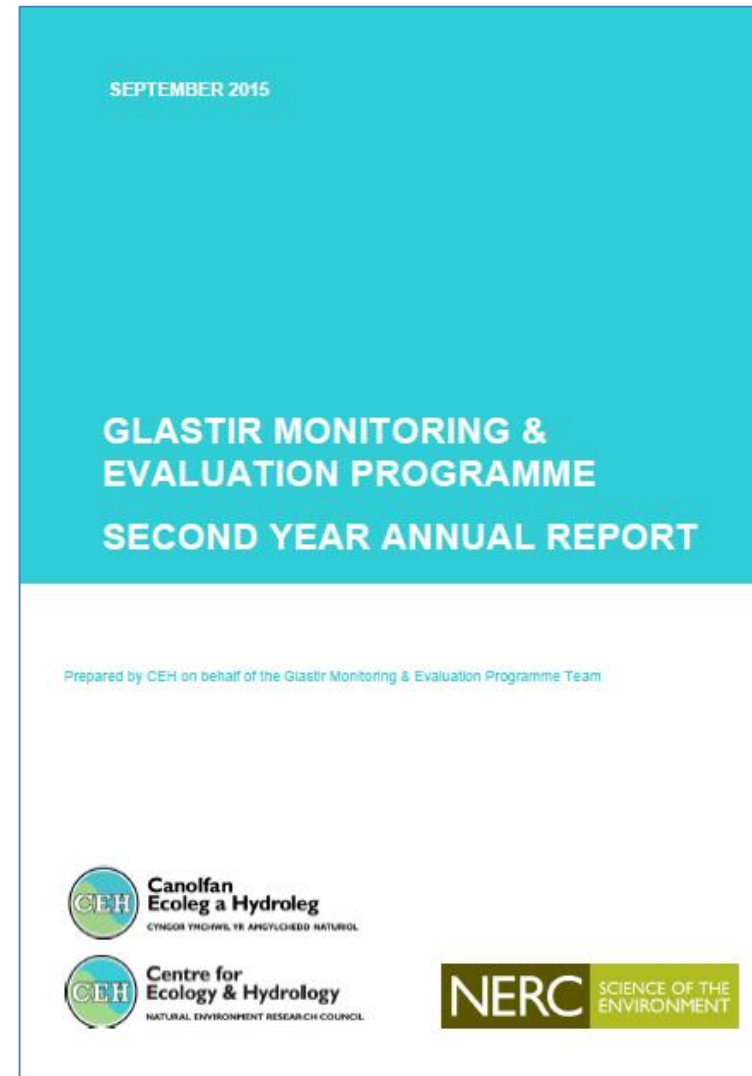
- Only 30% of peat soil in good condition
- No change in topsoil carbon content over last 25 years
- 33% increase in woodland area since 1984
- > 50% priority bird species stable or increasing. No improvement over time.
- 51% of historic features in excellent or sound condition
- Two thirds of public rights of way fully open and accessible
- 91% of streams had some level of modification but 60% retained good ecological quality



Highlights from year 2 report

Effect of Glastir and past agri-environment schemes

- We are in baseline years so main evidence will be in 2017
- Modelling emphasised effects can take decades to be measurable e.g for habitat condition improvement
- More immediate responses expected for GHG and water quality. Modelling interventions suggest individually they can contribute 1-15% improvement at national scale
- Spatial targeting likely to be more effective
- Early days but we can detect some legacy effects of past AES schemes
- Complexity of the application process impacts level on uptake



Flexibility so can adapt as policy landscape changes

Environment (Wales) Bill

- Putting in place a modern statutory process to plan and manage our natural resources in a joined up and sustainable way

Biodiversity underpins our ecosystems. The more biodiversity we have, the **more resilient our ecosystems** will become,.....

As part of the Welsh Government's commitment to reversing the decline in biodiversity in Wales and **increasing the resilience of our ecosystems**, the Environment (Wales) Bill will introduce a new biodiversity duty, which will also highlight biodiversity as an essential component of **ecosystem resilience**.

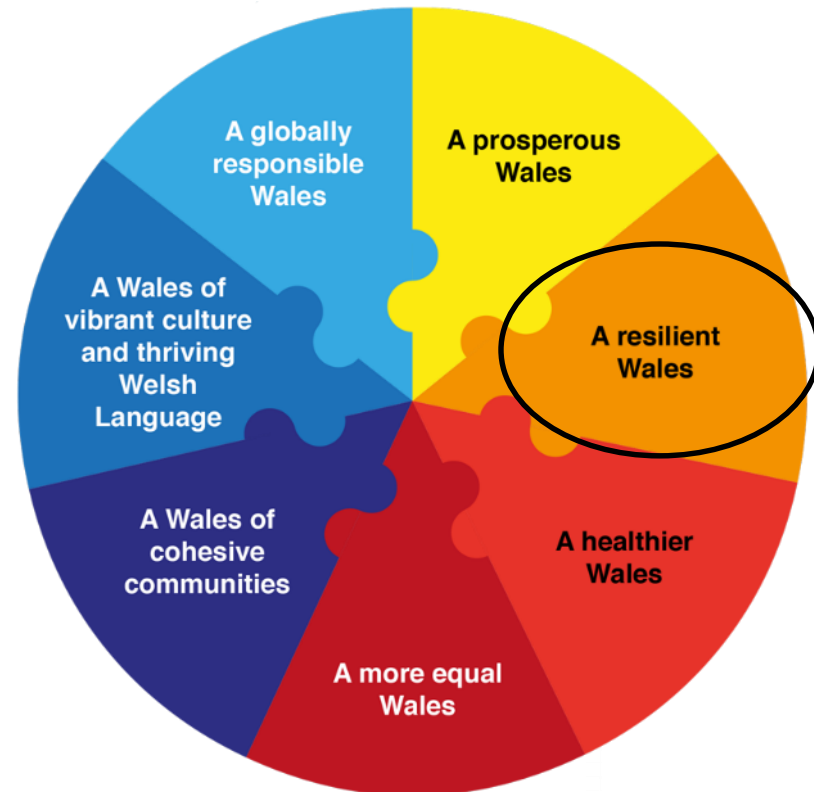
Flexibility so can adapt as policy landscape changes

Well-being of Future Generations (Wales) Act

- Placing seven well-being goals into law, and requiring public bodies to apply sustainable development principles

A resilient Wales

A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and **ecological resilience** and the capacity to adapt to change (e.g. climate change).



What is Ecosystem Resilience?

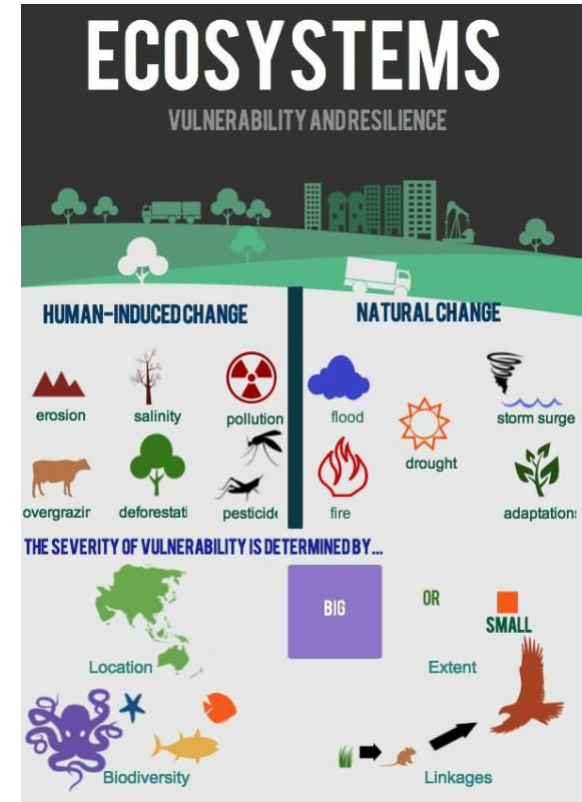
Ecosystems

- Complex systems including adaptive agents, self-organized, self-similar over time.
- Resilience is one of myriads of stability concepts in ecology.

What exactly “is” resilience? **Wrong question!**

What, exactly, do we “mean” by resilience?

- Resilience of what?
- In response to what?
- Perceived by whom?



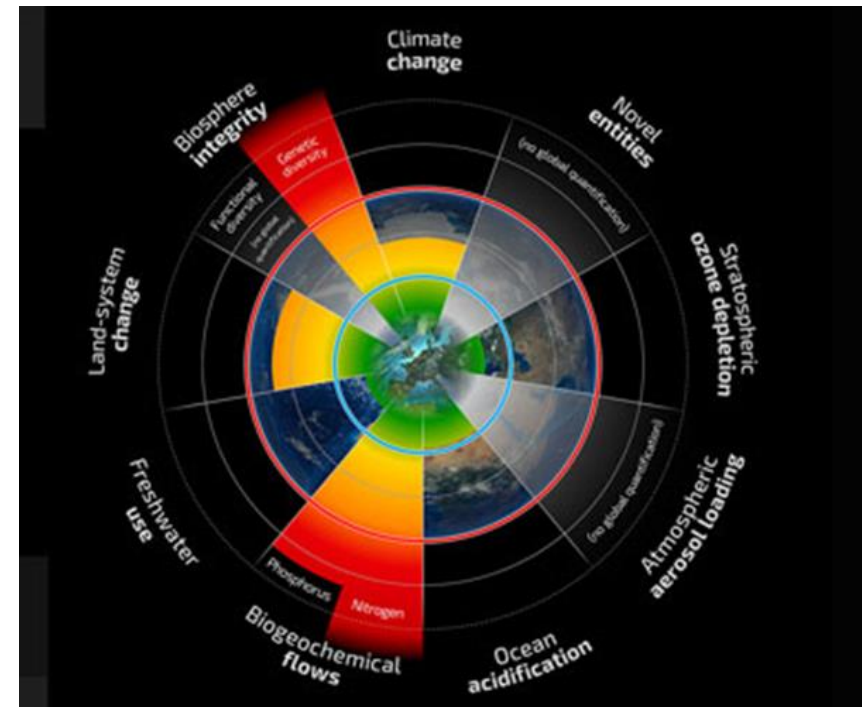
What are the pressures?

Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship

Four of nine planetary boundaries have now been crossed as a result of human activity, says an international team of 18 researchers in the journal Science:

- climate change,
- loss of biosphere integrity,
- land-system change,
- altered biogeochemical cycles (N&P).

(Steffen et. al, 16 January 2015, Science)



What do we want Wales' natural resources to do?

“Bend not break”

Be able to recover their function (so we receive the benefits) when exposed to:

Chronic pressures

- Warming
- Air pollution
- Land Management

Episodic pressures

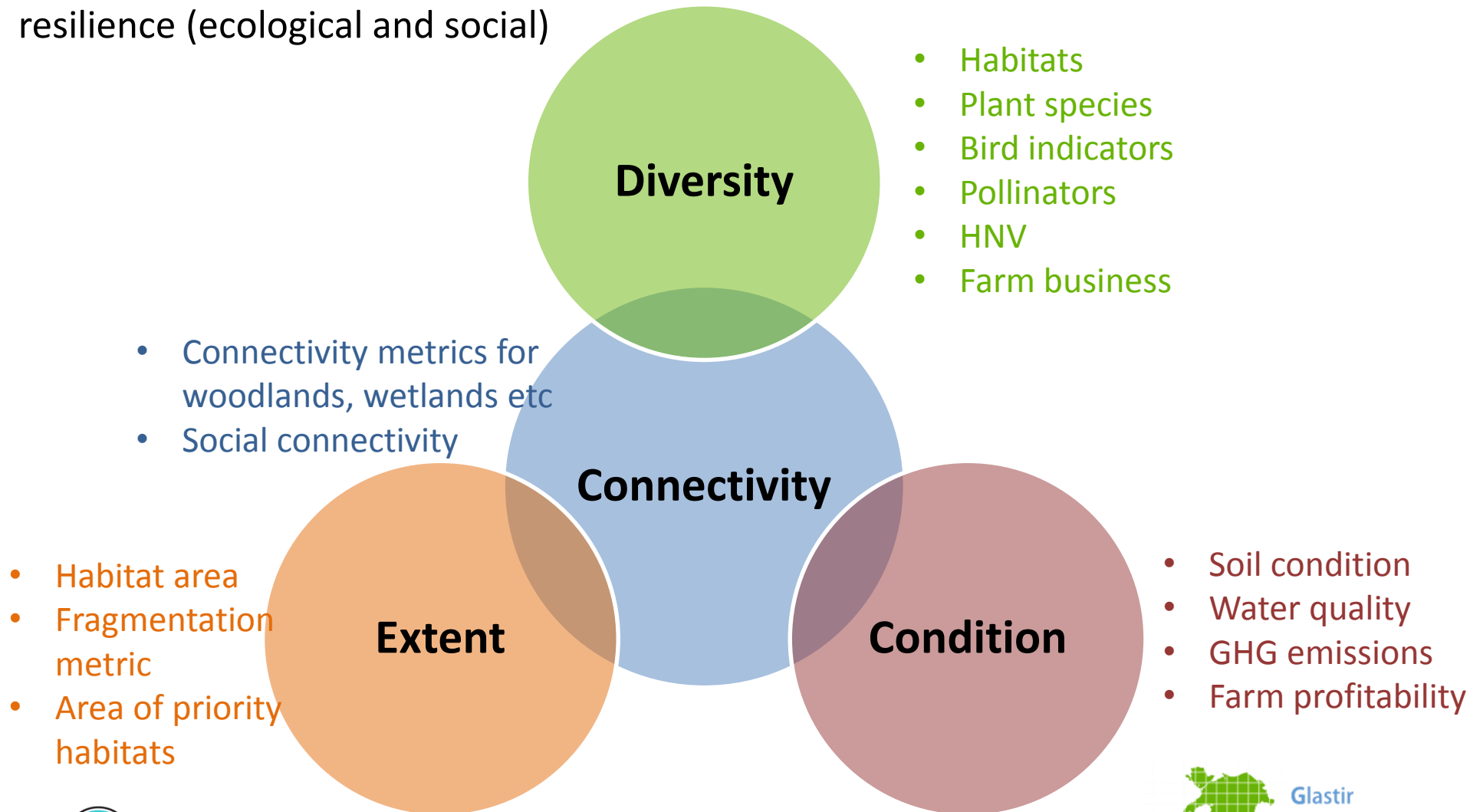
- Pests and disease
- Droughts and Storms



*i.e. be resilient
(& sustainable)*

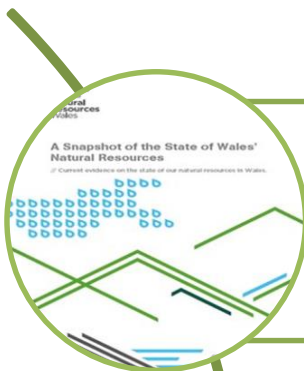
GMEP can contribute to reporting on metrics of resilience

Most studies identify 4 consistent properties which contribute to resilience (ecological and social)



GMEP's future

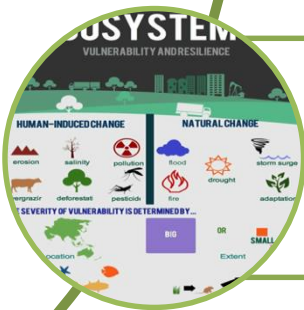
**One
programme
adaptable
to 3 aims**



**State of Natural
Resource Reporting
(SoNaRR)**

Glastir

Contribution to evidence for a
range of policy requirements
e.g. RDP, NRM, Habitats
directive, WFD etc



**Contribution to resilience
monitoring and assessment**

Future Opportunities for Integration

- Further integration in a new national monitoring programme
- Linking natural resources and human well-being
- Farmer empowerment through citizen science and self-reporting
- Optimising and managing our Natural Resources
- Reporting ecosystem resilience
- Thinking beyond the GDP towards a green economy



Woodland creation and management

Glasstir is the Welsh Government's sustainable land management scheme which pays for environmental goods and services aimed at:

- Combating climate change
- Improving water quality and managing water resources
- Improving soil quality and management
- Halting biodiversity loss
- Managing landscapes and historic environment and improving public access to the countryside
- Woodland creation and management

The Glasstir Monitoring and Evaluation Programme (GMEP) has been commissioned by the Welsh Government to assess the performance of Glasstir. GMEP was launched at the same time as the Glasstir scheme. This provides fast policy feedback allowing for the scheme to be modified to improve efficiency and effectiveness. Click the links below to find out more about the work GMEP is undertaking within the six Glasstir objectives.



[About GMEP](#)



[Summary of GMEP results](#)



[GMEP Data & Findings](#)



[Data Management](#)

Contact GMEP

If you have a question or want to be kept up to date with developments within GMEP you can contact us through the GMEP Project Office.

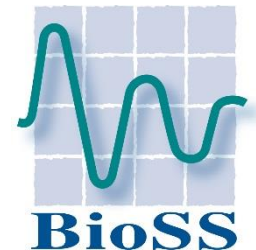
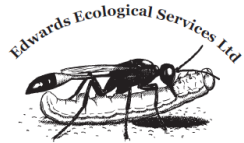
[Read more...](#)



Ariennir gan
Lywodraeth Cymru
Funded by
Welsh Government



The GMEP team



Thank you

e:gmep@ceh.ac.uk

<https://gmep.wales/>

<http://www.glastir-mep-surveys.org.uk/>