Glastir Monitoring and Evaluation Programme

Summary of GMEP results by Glastir Outcome

A wide range of results are now available from Years 1 and 2 of the Glastir Monitoring and Evaluation Programme (GMEP). These provide evidence of ongoing changes in Wales' Natural Resources. A subset of results have been agreed with the Welsh Government and the GMEP Advisory Group as high level indicators for the 6 Outcomes of the Glastir Scheme, and are reported here. The six outcomes are:

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

As GMEP survey sites are revisited on a 4-year rolling cycle and we are in Year 3 of the first cycle, the current results are a baseline against which the future impacts of Glastir payments will be assessed. To gain an early insight into what changes we may expect in the future, modelling results were reported in the GMEP Year 1 report and are now available in the GMEP Data Portal in addition to a wider range of the GMEP survey data. Many of the results captured by GMEP are relevant to assessing the area, condition, diversity and connectivity of the Welsh countryside which is important as these are considered important features for understanding and monitoring resilience. Promoting the resilience of the countryside is a new duty required of public authorities in the Environment (Wales) Bill.

Woodland

Outcome: Woodland creation and management

Woodlands deliver a wide range of benefits including a contribution to the Wales economy, the capture of carbon from the atmosphere to contribute to the mitigation of climate change, and an important habitat for a wide range of distinctive wildlife. A range of data are available in the portal including modelling work to look at co-benefits and trade-offs with other services. Here we present a selection of indicators as a high level summary of ongoing change in this important ecosystem type.

Please see the Biodiversity section for Priority Species and Habitats relevant to Woodlands. A social survey of land managers has been conducted to identify barriers to uptake of Glastir Woodland options and wider economic benefits of the Glastir Efficiency Grants. Please go to the results section of the portal to see the findings of this study.

Overall the GMEP results indicate:

- A significant trend for increasing area of woodland over the last 15 years
- Improved condition as indicated by high quality indicators and lower canopy density
- An increase in woodland bird indicators
- Butterfly and pollinator data is under analysis

Please note, as the sampling and analytical methodology used for woodland assessment in GMEP is identical to that used in Countryside Survey these datasets can be combined to look for long-term national trends and in future years the impacts of Glastir payments. Difference with other data sources such as Forestry Commission data occur due to the capture of small

woodland parcels by GMEP (20m x 20m) which are not currently included in Forestry Commission data but are important when considering Glastir options and impacts. (Countryside Survey / GMEP categorises an area to be woodland if 25% of the vegetation is above 1 m high). Various other methodological differences exist therefore it is recommended both datasets are considered together to get a complete picture.

FIGURE GMEP-W-OUTCOME-A-1: Trends in Woodland Creation and Management. Figures show:

a. Total area of Woodland in Wales;
b. Coniferous Woodland in Wales over time;
c. Total area of Broadleaved Woodland in Wales over time;
d. Ground Vegetation Light Score as a proxy for canopy density;
e. Mean number of Ancient Woodland indicator species;
f. A Habitat Connectivity index for Broadleaved Woodland over time (uses simple metric of straight line distance);
g. BTO / JNCC / RSPB Breeding Bird Survey Woodland Bird Indicator

Countryside Survey data is indicated by a solid line and GMEP by a dotted line. Grey line if present show the CS Great Britain average for 1978 – 2007 to provide national context.

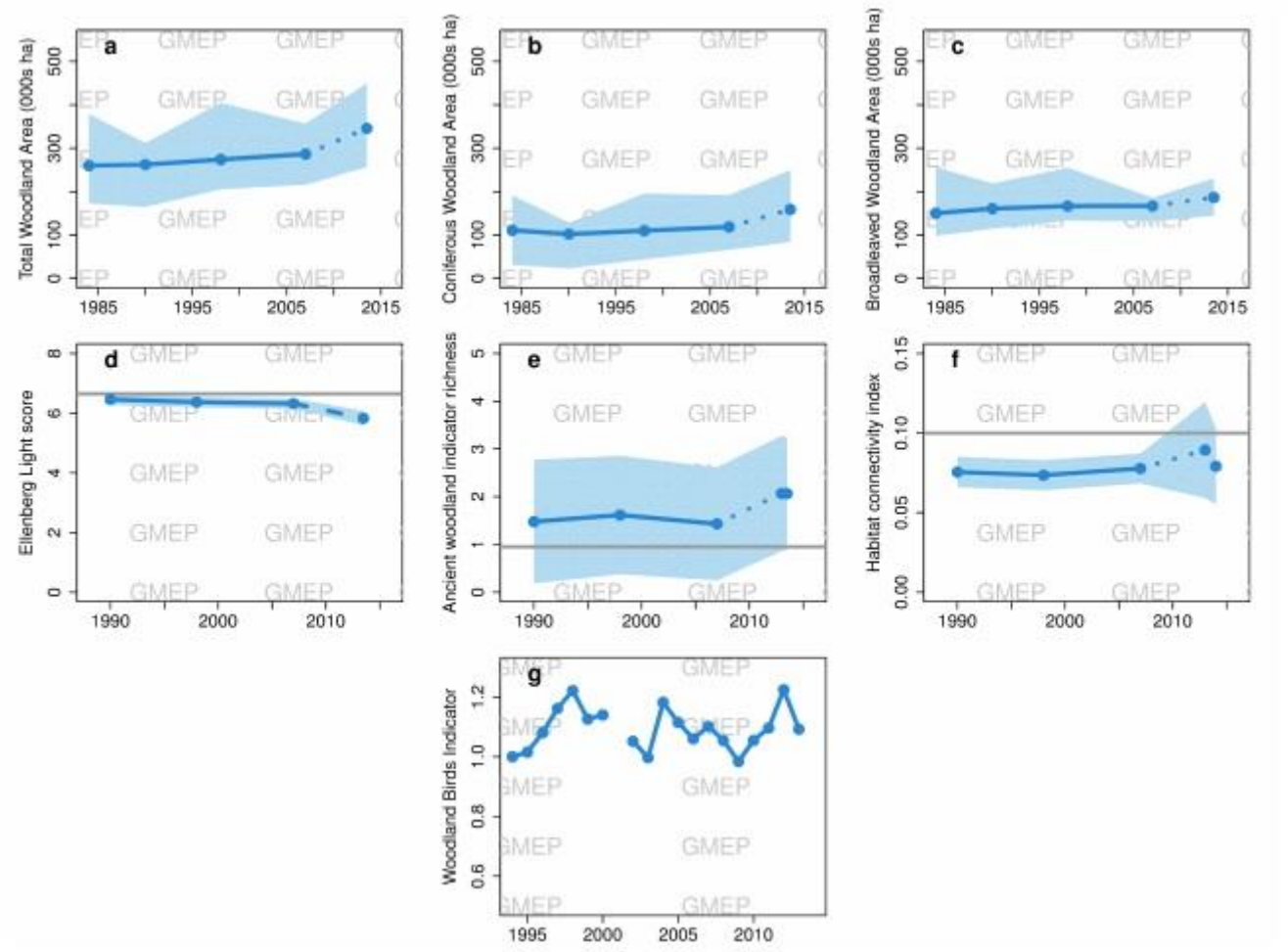


TABLE-GMEP-W-OUTCOME-A-1: Trends in Woodland Creation and Management. Data from Countryside Survey (CS), GMEP. Forestry Commission (FC) and BTO/JNCC/RSPB Breeding Bird Survey (BBS).

Habitat	Indicator	CS 1984	CS 1990	CS 1998	CS 2007	GMEP 2013	GMEP 2014	Significant differences
Woodland	Total Woodland Area ('000 has)[1]	260	262	274	287	346		↑ 1990-2014
		FC 1980		**FC 1995-1999**			**FC 2014**	
Woodland	Total Woodland area ('000 has)[1]	241		287			306	
		CS 1984	**CS 1990**	**CS 1998**	**CS 2007**	**GMEP 2013**	**GMEP 2014**	
Woodland	Broadleaved woodland Area ('000s ha)	150	161	167	167	187		↑ 2007 – 2013/14
Woodland	Coniferous woodland ('000s ha)	111	102	110	119	159		↑ 1990-2014
Woodland	Ancient Woodland indicator plant species[1]		1.5	1.6	1.4	2.1		↑ 2007-2013/14
Woodland	Canopy density score[2]		6.5	6.4	6.3	5.8		↓ 1990-2013/14 1998-2013/14 2007-2013/14
Woodland	Connectivity[3]		0.08	0.07	0.08	0.09	0.08	No significant differences
Woodland	Patch size		9364	8619	13142	15022	15909	↑ 1998-2014
Woodland	Pollinators							Ongoing Analysis
		BBS 1994 – 1999	**BBS 2000-2004**	**BBS 2005-2009**	**BBS 2010-2012**	**BBS 2013**	**BBS 2014**	
Woodland	Woodland Bird Indicator (averaged)	1.10	1.09	1.06	1.13	1.09	Ongoing Analysis	↑ Recent increase
						GMEP 2013	**GMEP 2014**	
Woodland	Birds							Ongoing Analysis
Woodland	Benefits to Forest business							Metric to be developed

[1] Note that at present, counts are based on a list based largely on the distribution patterns of vascular plants among English woodlands. We would hope to update this list in due course in discussion with Natural Resources Wales.
[2] A light score which indicates light preference of ground vegetation is used as a proxy for canopy density
[3] Uses simple metric of straight line distance

Biodiversity

Outcome: Maintaining and enhancing biodiversity

High level Indicators have been selected which cover different elements of biodiversity both for the countryside as a whole and for Priority Species and Habitats. It is important the wider countryside is included to ensure conditions are not so hostile as to prevent the movement of species as conditions change e.g. due to climate change. The indicators also cover different elements of biodiversity which could contribute to resilience of our Natural Resources i.e. diversity, extent, connectivity and condition. Note that soil and water diversity have not been included as they are included as indicators for Soil and Water Outcomes.

Due to the rare nature of some Priority Species and Habitats and the many 1000s of parcels of land involved, a subset of 12 Priority Habitats have been selected for reporting using the survey data together with a subset of Priority birds and butterflies. For all other Priority species, GMEP is developing metrics quantifying improvement in habitat specifically required for each species. Six species were selected to start this process; lapwing, curlew, dormouse, rare arable plants, Lesser Horseshoe Bat and Marsh Fritillary Butterfly. This approach reflects the rationale behind Glastir farmer payments for creating or improving the condition of habitat within areas with known populations of the Priority species. GMEP can report on the success of those payments with respect to habitat area and condition when information for a specific species is not possible within available GMEP resources. Further information can be found under the Biodiversity section of the data portal.

Data are relevant to the evidence base required to assess progress towards reversing the decline of Wales' native biodiversity and meeting our obligations under the EU Biodiversity 2020 agenda.
The indicators are:

1. Species diversity for plants, pollinators and birds in the wider countryside
2. Farmland bird indicator
3. Habitat condition as indicated by Common Standard Monitoring plant indicators,
4. Habitat condition as indicated by habitat diversity and patch size
5. High Nature Value Farmland (indicator under development)
6. Priority bird species occurrence
7. Priority butterfly species occurrence
8. Metrics indicating habitat condition required by other Priority Species (indicators under development)
9. Extent of 12 Priority Habitats
10. Condition of 12 Priority Habitats

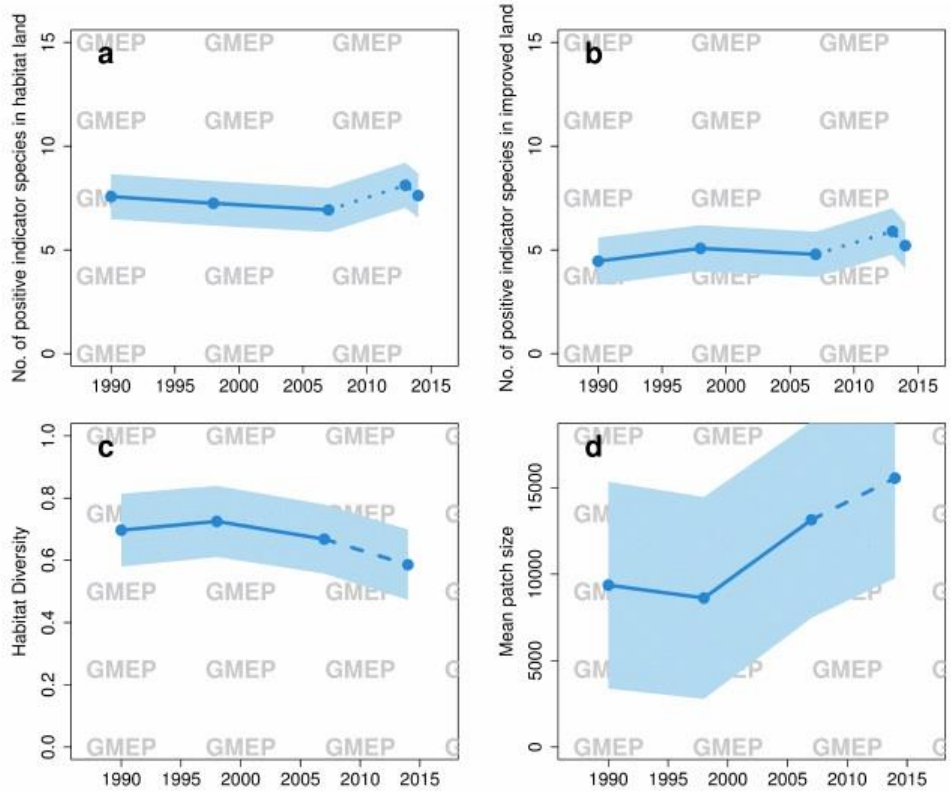
As the sampling and analytical methodology used for plant biodiversity assessment in GMEP is identical to that used in Countryside Survey these datasets can be combined to look for long-term national trends. Historic data is also provided from other surveys the BTO/RSPB/JNCC Breeding Bird Survey and UK Butterfly Monitoring Scheme to give an indication of long term trends wherever possible.

The overall picture of biodiversity in Wales is:

- Improved habitat condition as indicated by increased numbers of positive plant species indicators for Improved, Habitat and Woodland land.
- Stable overall plant species richness
- A continuing decline (15 years) in lowland farmland bird species but an increase in woodland bird species
- An historic decline in specialist butterfly species with recent stability with no further decline over the last 10 years. Stable trends for more generalist butterfly species.
- No consistent trend in habitat diversity.
- Patch size data is being analysed
- A provisional assessment of habitat condition for six priority species showed that most condition metrics did not differ between land in and out of option. All metrics are subject to a process of ongoing agreement and consultation with species experts
- An initial analysis of change in extent and condition of 12 Priority Habitats has been completed but requires consultation with habitat experts in National Resources Wales before reporting to compare and integrate with other information. Condition of Ponds has been completed of which 62% are in good or moderate status.
- A new High Nature Value Farmland Index is in development

FIGURE-GMEP-BD-OUTCOME-A-1:
Trends in Habitat Condition including:

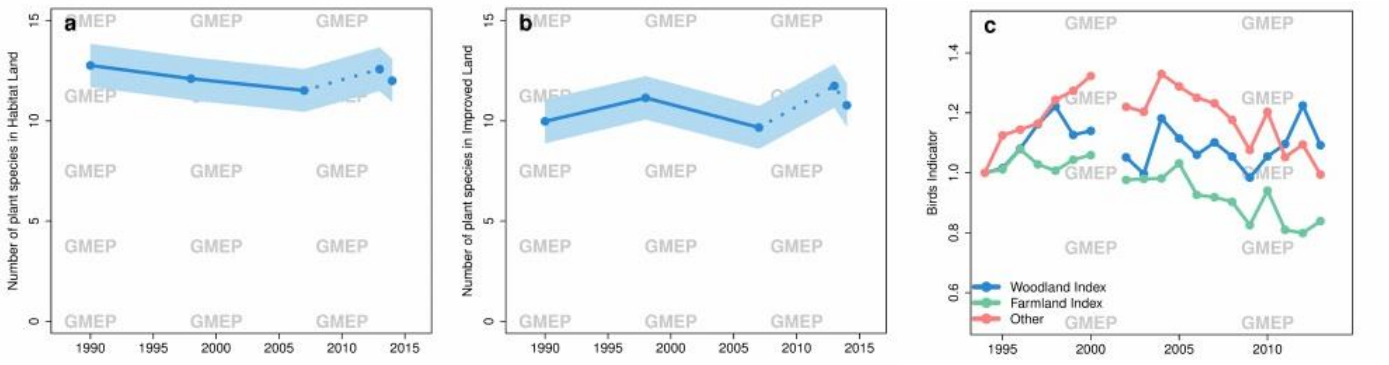
a. High-quality habitat plant indicator species (positive Common Standard Monitoring (CSM) Species) for Habitat Land. (Indicator species were drawn from a compilation carried out by Botanical Society of Britain and Ireland in 2013 based on published CSM guidance notes);
b. High-quality habitat plant indicator species (CSM positive) for Improved Land
c. Trends in habitat diversity (Shannon diversity index- standardised to create value between 0 and 1);
d. Trends in mean habitat patch size.



Countryside Survey data is indicated by a solid line and GMEP by a dotted line. Grey line when present indicates CS Great Britain average (1978 – 2007) to provide national context.

FIGURE-GMEP-BD-OUTCOME-B-1: Trends in Biodiversity including:

a. Total number of plant species in Habitat Land
b. Total number of plant species in Improved Land
c. BTO/JNCC/RSPB Breeding Bird Survey data



Countryside Survey data is indicated by a solid line and GMEP by a dotted line. Grey line when present indicates CS Great Britain average (1978 – 2007) to provide national context.

TABLE-GMEP-BD-OUTCOME-A-1: Trends for Habitat diversity and condition, and species richness. Habitat condition is calculated from presence of high quality plant indicators. Plant species richness are split by Whole Farm Code habitats for high level reporting. Farmland Bird indicators and data for butterfly and pollinators are also provided. Data for individual Broad Habitats, pollinator and bird groups are presented elsewhere in the report/portal.

Indicator	Sub-category	CS 1984	CS 1990	CS 1998	CS 2007	GMEP 2013	GMEP 2014	Significant differences
Habitat diversity (no. of habitats)	All[8]	0.71	0.70	0.73	0.67	0.59		No significant differences
Patch size (m^2)	Habitat and Woodland		6190	5983	8960	8913		No significant differences
Habitat condition	Arable[1]		1.2	1.9	1.2	1.1	1.4	No significant differences
	Improved Land[2]		3.4	4.0	3.6	4.8	4.2	↑ 2007-13 1990-13
	Habitat Land[3]		6.7	6.6	6.2	7.4	7.0	2007-14 1998-2013 ↑ 2007-2013 2007-2014
	Woodland[4]		1.5	1.6	1.4	2.1	2.1	↑ 2007-2013 2007-2014
	Wales[5]		5.6	5.6	5.2	6.4	5.7	↓ 1990-2007 2013-2014 1990-2013 ↑ 1998-2007 1998-2013 2007-2013 2007-2014
Plant species richness [6]	Arable		5.7	8.0	3.7	5.2	5.0	↓ 1998-2007
	Improved Land		9.9	11.0	9.3	11.6	10.6	↓ 1998-2007 1990-2013 ↑ 2007-2013 2007-2014
	Habitat Land		11.0	10.6	10.1	10.8	10.4	↓ 1990-2007
	Woodland		11.0	11.1	10.3	11.1	11.1	No significant differences

Indicator	Sub-category	CS 1984	UKBMS 1986	UKBMS 1998	UKBMS 2007	UKBMS 2013	UKBMS 2014	Significant differences
Butterfly abundance index	Habitat specialists		Awaiting data. Figure is in GMEP Year 2 report					Decline until 1998 then stable.
	Wider Countryside		Awaiting data. Figure is in GMEP Year 2 report					Stable.
Butterfly species richness[7]	Habitat specialists		3 (0.4)	2 (0.3)	2 (0.2)	2 (0.21)	2 (0.17)	Ongoing analysis.
	Wider countryside		12 (2.3)	14 (1.6)	13 (0.8)	15 (0.76)	16 (0.47)	Ongoing analysis.
						GMEP 2013	**GMEP 2014**	
Pollinator numbers per site[7]	Butterfly, bees and hoverflies					193 (9.9)	159 (8.9)	GMEP impact to be reported 2017
		BBS 1994 – 1999	**BBS 2000-2004**	**BBS 2005-2009**	**BBS 2010-2012**	**BBS 2013**	**BBS 2014**	
Farmland Bird Indicator	Upland	0.80-1.08	0.89-1.05	0.84-1.00	0.65-0.82	0.86	Ongoing analysis	Stable
Farmland Bird Indicator	Lowland	0.98-1.15	0.96-1.06	0.82-1.06	0.80-1.00	0.83	Ongoing analysis	↓ Continuing decline
						GMEP 2013	**GMEP 2014**	
Brid diversity[8]	Arable							GMEP impact to be reported 2017
	Improved Land							GMEP impact to be reported 2017
	Habitat Land							GMEP impact to be reported 2017
	Woodland							GMEP impact to be reported 2017
Farmland	High Nature Value Farmland							Indicator under development

[1] Number of annual forbs per 4m^2 in arable fields.
[2] Number of positive Common Standard Monitoring (CSM) indicators per 4m^2 random plot for any of the habitats listed in JNCC guidance notes. Improved Land is defined as vegetation mapped as Improved Grassland or if Neutral Grassland then with >=25% summed cover of *Lolium perenne, L.multiflorum* and *Trifolium repens*. Habitat Land comprises all vegetation with <25% cover of Improved Land indicators if Neutral Grassland and excludes Broad Habitats mapped as woodland, arable, improved land, linear features, rivers, open water and canals, inland rock or urban.
[3] Number of Ancient Woodland Indicators per 4m^2 random plots located in all areas mapped as broadleaved woodland Broad and Priority (sec 42) Habitats. The indicator is under development and will change. At present it is based on an indicator species list largely defined for England and we hope to replace these counts with a Wales-only indicator in the near future.
[4] Numbers of positive CSM indicator species summed across all published lists and counted in 4m^2 plots in all habitats.
[5] Vascular plant species richness per 4m^2 plots classified to the same habitats as for Habitat condition categories.
[6] Mean count per UKBMS 1km square of all butterflies based on sites in Wales. Note that numbers can fluctuate greatly between years due to weather effects. Long-term annual trend lines for butterflies in Wales are reported elsewhere on the data portal. The classification of species into habitat specialists and wider countryside is the same as that routinely applied in analysis of UK long-term trends. Standard error in brackets.
[7] Mean count of numbers of individuals recorded per GMEP 1km square. Standard error in brackets.
[8] Species to be agreed

TABLE-GMEP-BD-OUTCOME-B-1: Trends in Priority species.

Indicator				GMEP 2013	GMEP 2014	Significant differences
Sec 42 butterfly species: mean number of individuals per site[1]				0.65 (0.81)	0.29 (0.54)	Impact of GLastir to be reported in 2017
	BBS 1994 – 1999	BBS 2000-2004	BBS 2005-2009	BBS 2010 - 2014		
Priority bird species index (% of species with increasing or stable populations) [2]	67.6	60.0	48.6	64.7		No consistent trend
				GMEP 2013	GMEP 2014	
Priority bird species[3]						Ongoing Analysis
Number of habitat suitability metrics for Priority species[4]				In scheme		50 out of 54 tests for a test set of 6 species indicate no difference
				Out of scheme		

[1] The following sec 42 butterfly species were found in GMEP 1km squares in 2013 or '14: Brown Hairstreak, White-letter Hairstreak, Small Pearl-bordered Fritillary, High Brown Fritillary, Wall Brown, Grayling and Large Heath.
[2] Data for Bar-tailed Godwit, Tundra Swan, Common Cuckoo, Eurasian Curlew, Common Scoter, Dunnock, Dark-bellied Brent Goose, Common Grasshopper Warbler, Golden Plover, Hawfinch, Herring Gull, Hen Harrier, House Sparrow, Kestrel, Northern Lapwing, Common Linnet, Lesser Redpoll, Marsh Tit, Greenland Greater White-fronted Goose, Pied Flycatcher, Reed Bunting, Ringed Plover, Ring Ouzel, Sky Lark, Spotted Flycatcher, Common Starling, Song Thrush, European Turtle Dove, Tree Pipit, Eurasian Tree Sparrow, Twite, Wood Warbler, Yellowhammer, Yellow Wagtail; data taken from BBS, WeBS and other sources (see Appendix 5.3 in the GMEP Year 2 report for more information)
[3] Data will be available for Bullfinch, Cuckoo, Curlew, Dunnock, Grasshopper Warbler, Herring Gull, House Sparrow, Kestrel, Lapwing, Linnet, Lesser Redpoll, Lesser Spotted Woodpecker, Marsh Tit, Pied Flycatcher, Reed Bunting, Skylark, Spotted Flycatcher, Common Starling, Song Thrush, Tree Pipit and Yellowhammer.
[4] Differences between habitat which has come into the scheme versus that outside in years 1and 2 were analysed in terms of 54 habitat condition metrics across six section 42 species; Marsh fritillary, Lapwing, Curlew, Dormouse, rare arable plants and 5 Lesser Horseshoe Bat. When repeat data are available we will report tests of change in ecological impacts between land in-option versus ecologically equivalent baseline land out-of-option. See year 2 report for further details.

Priority Habitat extent and condition

Extent of 12 Priority Habitats will be summarised into Whole Farm Code habitat types; Habitat and Woodland (there is insufficient data for improved Land). Condition of these 12 Priority Habitats for Wales will also be presented as indicated by high quality habitat indicators. Analysis is still in progress.

TABLE-GMEP-BD-OUTCOME-C-1: Trends on Priority Habitat area and condition from GMEP.

Indicator	Habitats to be included and methods
Priority Habitat area	Area of Priority Habitat to be reported by GMEP will include Blanket bog; Upland heath; Lowland heath; Purple Moor grass and rush pasture; Fen; Lowland hay meadow. We will also be able to report on Hedgerows, Upland flush, Ponds and Traditional orchards but some of these require more complex analysis (e.g. hedgerows) and some are more recently defined so difficult to will provide as trend data (Upland flush, Traditional orchards). Area of Priority Woodland will include Lowland Mixed deciduous woodland; Wet woodland; Upland oak wood; Upland mixed Ashwood.
Priority Habitat condition	Metrics to be included for reporting Priority Habitat condition: Arable field margin will be reported by count of annual forbs per 1x100m plots located at random on the cultivated margins of arable fields. Priority Habitat land by count of positive Common Standard Monitoring indicator species per $4m^2$ random plot summed across Blanket bog; Upland heath; Lowland Heath; Purple Moor grass and rush pasture; Fen; Lowland hay meadow. Priority Woodland by count of Ancient Woodland Indicator species per $4m^2$ random plot summed across Lowland Mixed deciduous woodland; Wet Woodland; Upland Oak Wood; Upland mixed Ashwood.

Freshwater

Outcome: Improving water quality and managing water resources

A small subset of Indicators have been selected to capture the monitor change in condition of headwater streams under-represented in ongoing monitoring by National Resources Wales and the amount of land helping to mitigate high flows. Indicators for ponds are presented in in the Priority Habitat table. Work is ongoing with National Resources Wales to agree metrics compliant with the Water Framework Directive for headwaters streams for future reports.

Results show:

- General ongoing improvement in the quality of headwater streams although that trend is not so clear when a broader set of metrics beyond macro-invertebrates are used.
- The percentage of land mitigating rainfall runoff and thus helping to mitigate flood peaks is similar for land in or out of scheme which provides a baseline for monitoring future benefits of payments

Many other metrics for aquatic plants, diatoms, macro-invertebrates and habitat physical structure are available in the portal.

FIGURE-GMEP-FW-OUTCOME-A-1: Long term trends in small Welsh streams derived from NRW monitoring. Figures indicate: BMWP score (left; an index of eutrophication and general degradation), Ntaxa (middle; the number of water quality sensitive taxa that contribute to the WHPT score) and ASPT (right; the sensitivity of the taxa to water quality which contribute to the WHPT score).

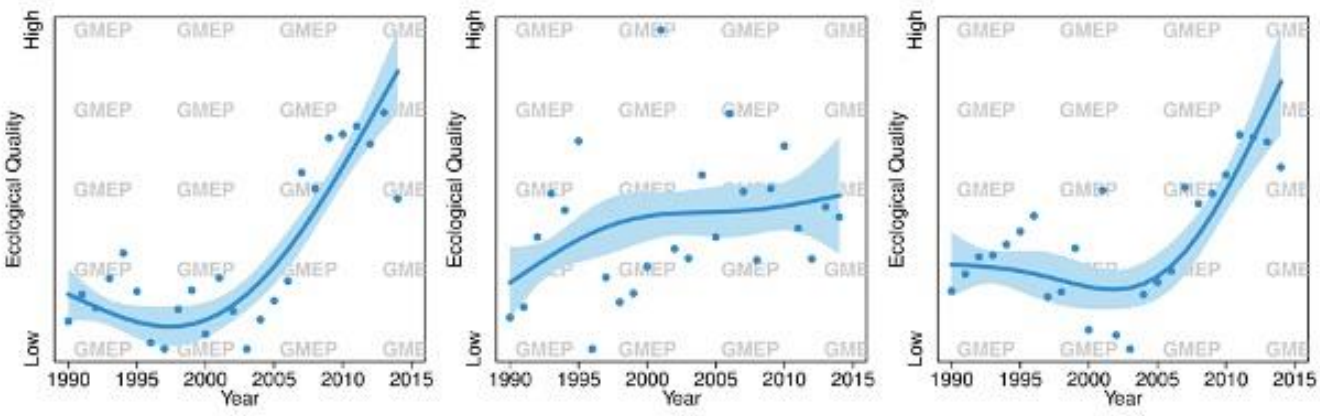


FIGURE-GMEP-FW-OUTCOME-B-1: Trends in nutrient status of small Welsh streams derived from NRW monitoring. Figures indicate: soluble reactive phosphorus (mg/L) and total dissolved nitrogen TDN (mg/l).

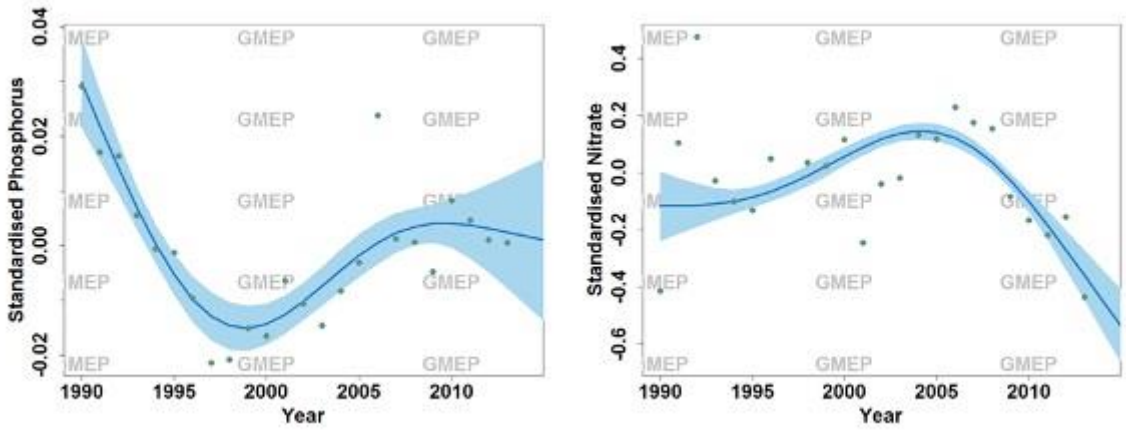


FIGURE-GMEP-FW-OUTCOME-C-1: Ecological quality of freshwaters sampled as part of Year 1 of the GMEP survey. Figures indicate a) headwater streams and b) ponds.

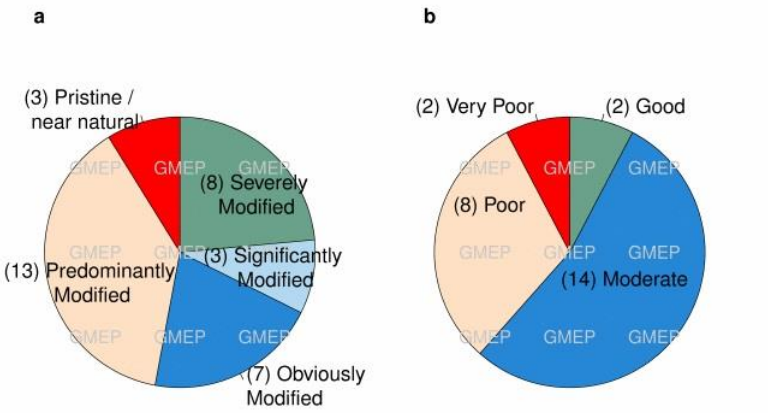


TABLE-GMEP-FW-OUTCOME-A-1 Trends in headwater stream quality and area of land mitigated for runoff (%).

Habitat	Indicator	1990		1998	2007	GMEP 2013	GMEP 2014	Significant differences
Headwater streams	Ecological condition - eutrophication & general degradation Macroinvertebrates [1](O/E ASPT – mean observed v expected number of sensitive taxa)			0.99	0.97	0.96	Ongoing analysis	Not Significant
		EA 1990	EA 1995	EA 2000	NRW 2005	NRW 2013	NRW 2014	Significant differences
Headwater Streams	Ecological status – WHPT score[2]	-0.06	-0.11	-0.11	0.00	0.20	0.40	↑ 2000-2005 2005-2010 2010-2014
Headwater streams	Near-natural or predominantly unmodified (%)					59		Impact of Glastir to be reported in 2017
Ponds	Good ecological condition (%)					8		Impact of Glastir to be reported in 2017
Headwater streams	Water Framework Directive class[5]							Metric under development
Land-water interface	Area of land mitigated for runoff /flood (%) (In scheme)[4]					19		Impact of Glastir from this baseline to be reported in 2017
	Area of land mitigated for runoff /flood (%) (Out of scheme)[4]					17		

[1] Average Score per Taxon (ASPT) indicates how sensitive the taxa used in calculating the The Whalley Hawkes Paisley Trigg (WHPT) score (see below) are to water quality based on their individual scores.
[2] The Whalley Hawkes Paisley Trigg (WHPT) score is an index of eutrophication and general degradation
[3]We calculated the ecological status of streams using 6 indicators derived from macroinvertebrates, diatoms, habitat modification and nutrients. The status is derived from biological indicators (i.e. diatoms and macroinvertebrates) then sites at high and good status are adjusted down to moderate status if habitat modification and nutrients do not meet the required thresholds for good status. This compares to values of 21% if using macroinvertebrate data only. The techniques deployed in rivers are all the accepted biomonitoring standards as adopted at the UK and EU level, thus our results can be directly compared to Environment agency WFD monitoring data. These survey techniques were macroinvertebrates (RiVPACS), diatoms (only, DARES), macrophytes (MTR) and habitats (RHS).
[4]This is calculated using the LUCI model for survey squares recorded that year. Impact of change in land use and management will be used to calculate a change metric in the 2nd cycle of survey (Years 5-8)
[5] Ongoing work with Natual Resources Wales to develop this metric for Headwater Streams

Climate Change Mitigation

Outcome: Combating climate change

The Land Use, Land Use Change and Forestry (LULUCF) and Agriculture Greenhouse Gas Emission Inventories provide a good national overview of ongoing trends but are relatively insensitive to changes in land management supported under Glastir although this is slowly changing. GMEP therefore reports the overall trends from the Inventories as background information but also more relevant and sensitive metrics. These include embodied emissions for 'typical' farm types in Wales which includes indirect greenhouse gas emissions associated with e.g. fertiliser production, and an assessment of the condition of peat soils due to their importance as a carbon store. Future metrics will also include mitigation associated with woodland expansion and creation. Metrics are already available on extent and condition under the Woodland Outcome section but these need converting into greenhouse gas metrics relevant for this climate change outcome. GMEP will work with Natural Resource Wales to agree a methodology for this which captures small scale woodlands and hedges/riparian features encouraged by Glastir.

Results indicate:

- Land Use, Land Use Change and Forestry in Wales has changed from a small GHG source to a sink between 1990 and 2012 due to forest planting since 1920, and an increase in the area of grassland at the expense of cropland. These changes have increased carbon storage in vegetation and soils.
- N fertiliser consumption across Wales reduced by ca. 40% between 1990 and 2010, from 132,000t to 76,000t which has contributed to the significant decrease in agricultural emissions since the base year as has the reduction in cattle and calf numbers by 17% (from 1.363M to 1.138M), and sheep numbers by 25% (from 10.935M to 8.244M)
- Dairy has the highest embodied GHG missions on an area basis followed by mixed, beef and sheep farm businesses. Work is ongoing to quantify the effect of Glastir Efficiency Grants on these emissions.
- The GMEP peatland work has identified ca. 70% peatlands are in a degraded state due to historic drainage and transformation into production agriculture and forestry. Data relating to change in the condition of blanket bog (which is only type of our peat soils) over the last 30 years indicates no overall change in condition.
- The benefits of woodland expansion and creation on mitigation will be reported in future years

FIGURE-GMEP-DPCCM-OUTCOME-A-1: Long term trends in; annual GHG emissions from the Land Use, Land use Change and Forestry for Wales and the Welsh Agriculture Inventories. Source: Emissions and Removals of Greenhouse Gases from Land Use, Land Use Change and Forestry (LULUCF) for England, Scotland, Wales and Northern Ireland: 1990-2012. Impact of Glastir will be added in 2016 when data from the Farmer Practice Survey is available.

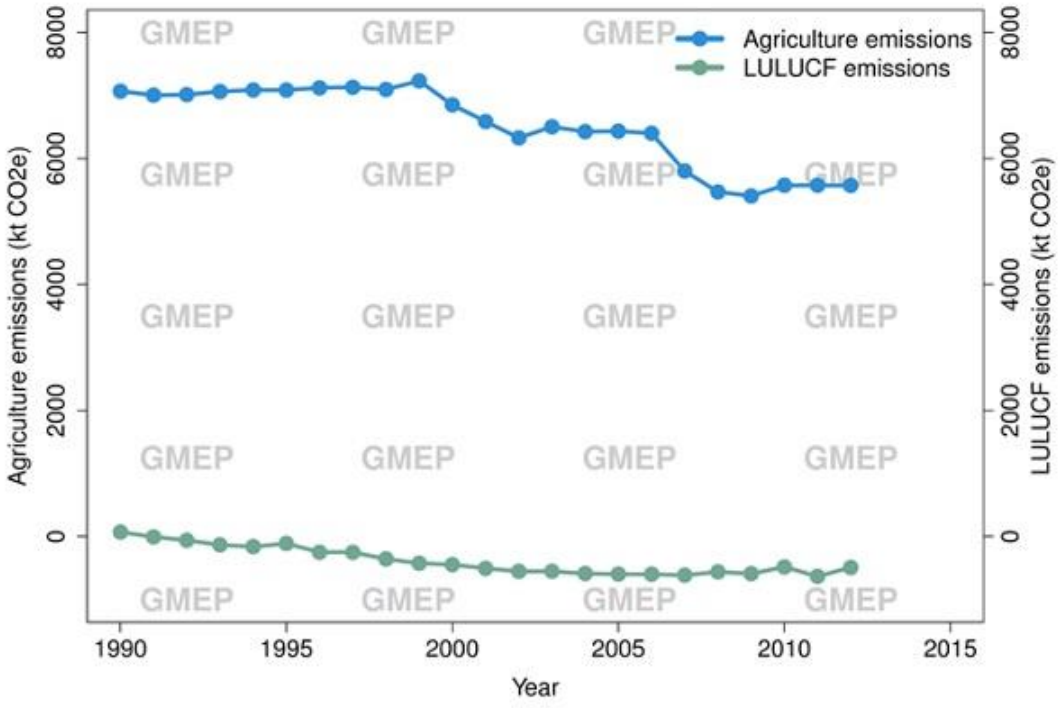


TABLE-GMEP-DPCCM-OUTCOME-A-1: Long term trends in greenhouse gas emissions.

Indicator	1990	1995	2000	2005	2010	GMEP 2013	GMEP 2014
Contribution by land use and land use change ($ktCO_2e\ yr^{-1}$) (excludes peatlands)[1]	69	-111	-447	-597	-483	Available 2016	Available 2017
Agriculture Emissions (CO_2eq (kt N_2O + CH_4))[2]	7,068	7,086	6,852	6,434	5,574	Available 2016	Available 2017
Agriculture emissions including embodied emissions (typical average farm data only tCO2e/ha)[3] Beef Dairy Mixed Sheep				 6.46 11.23 8.33 1.70		Available 2016	
Peatland condition ($ktCO_2e\ yr^{-1}$): Estimated total emissions[4]	577	Insufficient data			546[4]	Ongoing Analysis	Ongoing Analysis
Peatland condition: Blanket bog *Sphagnum* cover[5]	4.33		3.07		2.09	5.55	

[1] Data underlying Figure 13, Emissions and Removals of Greenhouse Gases from Land Use, Land Use Change and Forestry (LULUCF) for England, Scotland, Wales and Northern Ireland: 1990-2012 Miles et al (2014). http://uk-air.defra.gov.uk/assets/documents/reports/cat07/1406021226_DA_LULUCF_2012i_pub_version_1.1_300514.pdf
Modelled using the Business as Usual Scenario for LULUCF in Wales. Projections of emissions and removals from the LULUCF sector to 2050. Buys et al. (2014) http://uk-air.defra.gov.uk/assets/documents/reports/cat07/1407090749_ Projections_of_emissions_and_removals_from_the_LULUCF_sector_to_2050-PUBLISHED_VERSION-JULY2014.pdf

[2] Using IPCC 2000 Guidelines. Use of 2006 GL started for inventory year 2013, and this methodology will give different totals (and different proportional contributions of CH4 to N2O, CH4 likely to be a greater contributor)

[3] The Bangor Carbon Footprinting Tool outputs include: soil direct N_2O, indirect N_2O associated with nitrate leaching and N deposition, enteric CH_4, manure CH_4, CO_2 associated with electricity and energy use, embedded greenhouse gas emissions associated with feed and fertiliser production, agricultural productivity. Above and below ground carbon stocks are also included.

[4] Emissions estimate for the Welsh peat area as defined from British Geological Survey and Natural Resources Wales (NRW) mapping, using peat condition data obtained from the NRW Phase 1 Habitat Survey augmented by drainage ditch maps digitised from aerial photographs, and CO2, CH4 and N2O emission factors taken from the IPCC Wetland Supplement (IPCC, 2014) and Peatland Code (Smyth et al., 2014). Note that total emissions have a high uncertainty where it has been necessary to use IPCC .Tier 1. emission factors based on non-UK flux measurements (notably for grassland, forest and near-natural fen); these estimates will be revised in future as new UK-specific measurements become available. For more information see Evans et al. (2015)

[5] Sphagnum cover data are taken from the 1990, 1998 and 2007 Countryside Surveys, and the 2013/14 GMEP surveys (2m x 2m plots), as an indicator for CO2 sequestration by blanket bogs (1998 and 2007 CS data are assigned to the relevant five-year reporting periods in the table). There was a significant increase in Sphagnum cover between the 2007 CS and 2013/14 GMEP surveys. Note however that the sample size was lower in the CS dataset (n = 3, 12 and 15 in the 1990, 1998 and 2007 surveys respectively) compared to GMEP (n = 97). Note also that this metric applies only to blanket bogs under semi-natural vegetation cover, i.e. it should not be taken as an indicator of CO_2 emissions/removals by other peatland types (fens or raised bogs), and does not represent areas of former blanket bog that have been converted to other land-use such as forestry or grassland.

Soil

Outcome: Improving soil quality and management

Indicators have been selected from those proposed and tested by the UK Soil Indicators Consortium. Indicators were proposed and road tested for specific functions. Those used to measure environmental interactions which include hydrological filtering by soils, habitat support and carbon gas exchanges with the atmosphere, were again road tested. The soil properties measured are related to soil and ecosystem function and are important for determining the soil resilience and the impact any environmental or Glastir changes may have on broad habitats and biodiversity. Specifically the soil measures contribute to the following Glastir strategic outcomes through assessment of carbon storage in soils which helps mitigate greenhouse gas emissions, nutrient and acidity levels which are important for maintaining productivity, impacting on water quality and contributing to the decline in

Wales native biodiversity and soil biodiversity which are thought to benefit a range of soil functions and underpin resilience to stresses.

As the sampling and analytical methodology used for topsoil in GMEP is identical to that used in Countryside Survey these datasets can be combined to look for long-term national trends and in future years the impacts of Glastir payments. Data have been summarised for Whole Farm Code habitat groups. Data for individual Broad Habitats are presented elsewhere in the portal.

Overall for Wales:

- The 30 year record of topsoil carbon indicates no decline and there is ongoing recover of soil acidity levels as acidic deposition declines. Both are positive outcomes.
- Nitrogen levels are highly variable but suggest no major change.
- A significant decline in available phosphorus has been seen for Improved Land moving soil into the zone to be maintained for sustainable production. This decline is likely to be of benefit for freshwaters as it linked to reduced risk of phosphorus being flushed out into water courses.
- Soil mesofauna numbers indicate no overall trend. This trend of three data points at a national scale is unique and thus interpretation will improve as annual data come through.
- Data for change in blanked bog condition is variable between different metrics but overall no clear trend is apparent.

FIGURE-GMEP-S-OUTCOME-A-1: Long term trends in topsoil (0-15cm) condition for Habitat, Improved Land and Woodland for the following properties:

a, b and c) topsoil condition for carbon
d, e and f) acidity
g, h and i) nutrient levels -nitrogen
j, k and l) nutrient levels - available phosphorus
m, n and o) soil mesofauna numbers

Countryside Survey data is indicated by a solid line and GMEP by a dotted line. Grey line when present indicates CS Great Britain average 1978 – 2007) to provide national context. Red lines indicate thresholds which are to be avoided exceeding. Green lines indicate thresholds not to fall below.

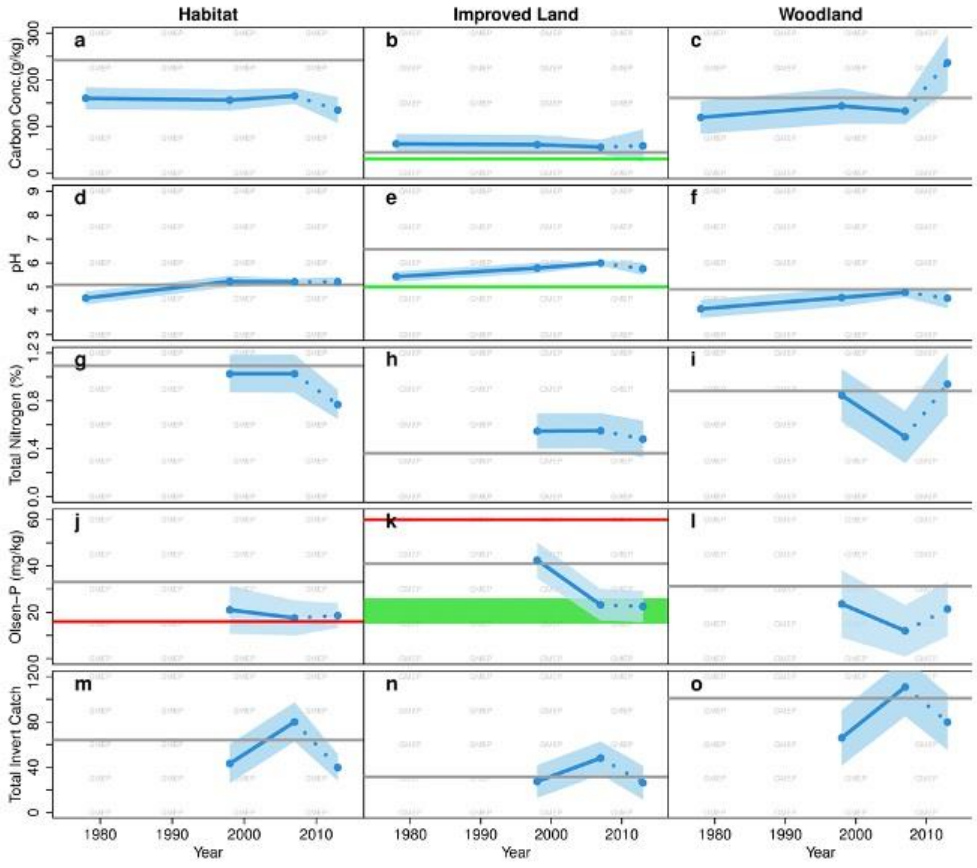


TABLE-GMEP-S-OUTCOME-A-1: Long term trends in topsoil (0-15cm) condition.

Habitat Groups	Indicator	CS 1978	CS 1990	CS 1998	CS 2007	GMEP 2013	GMEP 2014	Significant differences
Improved Land	Carbon (g/kg, from LOI)	62.4		60.8	55.4	58.2		
	pH	5.43		5.79	5.99	5.75		↑ 78-98
	N (g/100g dry soil)			0.07	0.07	0.08		Not significant

Habitat Groups	Indicator	CS 1978	CS 1990	CS 1998	CS 2007	GMEP 2013	GMEP 2014	Significant differences
	Phosphorus (Olsen P mg/ kg)			4.0	3.5	3.4		↓ 78-98
	Biodiversity (Total invert catch)			7.4	7.4	7.5		↑ 98-07 ↓ 07-13
Habitat	Carbon (g/kg, from LOI)	160.2		156.3	165.2	135.0		↓ 07-13
	pH	4.53		5.23	5.21	5.21		↑ 78-98
	N (g/100g dry soil)			0.08	0.08	0.06		↓ 07-13
	Phosphorus (Olsen P mg/ kg)			5.2	3.9	2.7		Not significant
	Biodiversity			8.7	8.8	5.9		↑ 98-07 ↓ 07-13
Woodland	Carbon (g/kg, from LOI)	119.2		143.6	133.0	236.7		↑ 07-13
	pH	4.08		4.55	4.77	4.52		↑ 78-98
	N (g/100g dry soil)			0.11	0.11	0.13		↓ 78-98 ↑ 98-13
	Phosphorus (Olsen P mg/ kg)			7.4	5.6	5.9		Not significant
	Biodiversity (Total invert catch)			12.4	13.1	12.6		↑ 98-07 ↓ 07-13
Wales	Carbon (g/kg, from LOI)	107.4		109.1	109.4	121.3		
	pH	5.01		5.39	5.53	5.31		↑ 78-98
	N (g/100g dry soil)			0.76	0.73	0.69		Not significant
	Phosphorus (Olsen P mg/ kg)			32.3	19.2	20.2		↓ 78-98
	Biodiversity (Total invert catch)			41.3	70.0	40.0		↑ 98-07 ↓ 07-13
Peatland	Peatland condition ($ktCO_2e\ yr^{-1}$): Estimated total emissions[1]	577			546[4]			Ongoing Analysis
	Peatland condition: Blanket bog *Sphagnum* cover[2]		4.33	3.07	2.09	5.55		Ongoing analysis

[1] Emissions estimate for the Welsh peat area as defined from British Geological Survey and Natural Resources Wales (NRW) mapping, using peat condition data obtained from the NRW Phase 1 Habitat Survey augmented by drainage ditch maps digitised from aerial photographs, and CO2, CH4 and N2O emission factors taken from the IPCC Wetland Supplement (IPCC, 2014) and Peatland Code (Smyth et al., 2014). Note that total emissions have a high uncertainty where it has been necessary to use IPCC .Tier 1. emission factors based on non-UK flux measurements (notably for grassland, forest and near-natural fen); these estimates will be revised in future as new UK-specific measurements become available. For more information see Evans et al. (2015)

[2] Sphagnum cover data are taken from the 1990, 1998 and 2007 Countryside Surveys, and the 2013/14 GMEP surveys (2m x 2m plots), as an indicator for CO2 sequestration by blanket bogs (1998 and 2007 CS data are assigned to the relevant five-year reporting periods in the table). There was a significant increase in Sphagnum cover between the 2007 CS and 2013/14 GMEP surveys. Note however that the sample size was lower in the CS dataset (n = 3, 12 and 15 in the 1990, 1998 and 2007 surveys respectively) compared to GMEP (n = 97). Note also that this metric applies only to blanket bogs under semi-natural vegetation cover, i.e. it should not be taken as an indicator of CO2 emissions/removals by other peatland types (fens or raised bogs), and does not represent areas of former blanket bog that have been converted to other land-use such as forestry or grassland

Landscape and access

Outcome: Managing landscapes and historic environment and improving public access to the countryside

Three high level indicators have been selected which capture the impacts of Glastir on landscape, historic features and access and thus potentially the benefits to a broad section of the community. As many visitors to the countryside tend to be concentrated around urban and coastal setting it is important GMEP squares do include land in these locations. As historic features are often a final target for a journey through the Welsh countryside information on their condition is presented as is the condition of Public Rights of Way. Benefits for business are being explored through a range of surveys including the benefits of the Glastir Efficiency Grants on farm businesses. A planned Farmer Practice Survey in 2016 will provide a wealth of data about actual changes payments have delivered on the ground. Historic data for all indicators is limited therefore conclusions on long term trends cannot be drawn. Trends will emerge as GMEP continues.

FIGURE-GMEP-L-OUTCOME-A-1:
a) Condition of Historic Environment Features (HEFs) from Years 1 and 2 of GMEP,
b) the difference in the Visual Quality Index (VQI) of land which has come into Glastir compared to that outside the scheme.

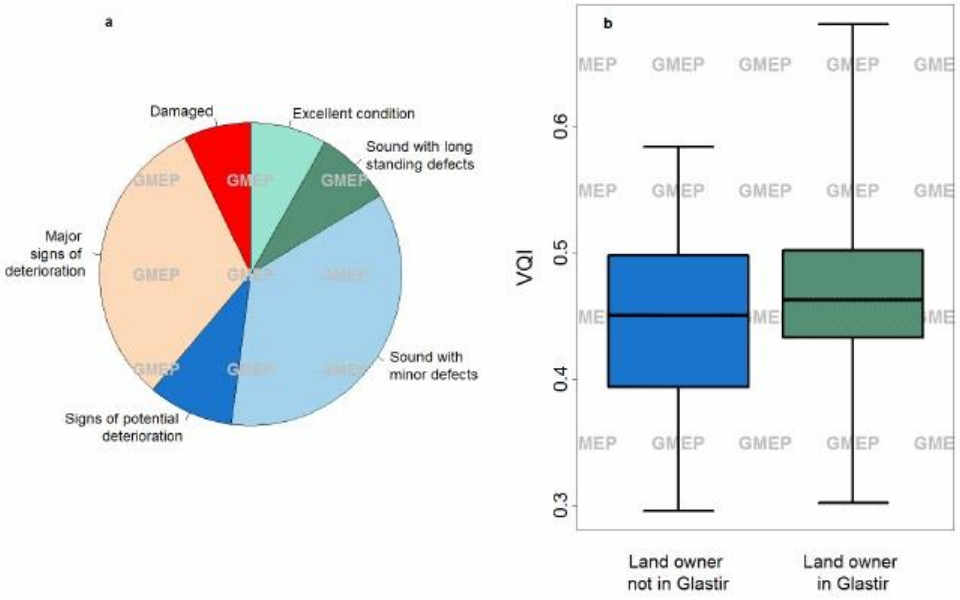


TABLE-GMEP-L-OUTCOME-A-1:
Socio-economic metrics including indicators of landscape quality, historic feature condition and farm and forest business profitability and resilience.

Habitat	Indicator	Other data sources	GMEP 2013	GMEP 2014
Landscape quality [1]	Median Visual Quality Index (index from 0 – 1.0): In scheme	No comparable data	0.463	
	Median Visual Quality Index (index from 0 – 1.0): Out of scheme		0.450	
Habitat	**Indicator**	**CADW**	**GMEP 2013**	**GMEP 2014**
Historic features	Historic environment assets (% in stable or improved condition[2]	78% - 79%		
	Historic Environment Feature Condition (% in 'Sound' or 'Excellent' condition)[2]		51%	
Farm and Forestry	Business profitability and resilience		Metric under development	

[1] This is a combined scoring of five key components from the GMEP survey squares: topography (how rugged / varied the landform is); .blue-space. (water features in the landscape); .green-space. (habitat diversity, vegetation complexity); anthropogenic (built components); historic / cultural (including presence of Scheduled Ancient Monuments etc). The validity of the index is currently being road tested in an array of web-based and social surveys and will be corrected according to values actually attributed to quality of landscape as perceived by a broad section of the population.
[2] Data from CADW as presented in the Programme for Government, Indicator OU095. This data is based on listed buildings and schedule ancient monuments so is not directly comparable to GMEP which include undesignated Historic Environment Features.