

GMEP Year 2 Executive Summary

The Glastir Monitoring and Evaluation Programme (GMEP) provides a comprehensive programme to monitor the effects of Glastir and contribute towards providing national trend data towards a range of national and international biodiversity and environmental targets. GMEP is now in its third year of the initial four year baseline assessment period. This annual report presents results from the second year of the programme. GMEP fulfils a commitment by the Welsh Government to establish a monitoring programme concurrently with the launch of the Glastir scheme and as such is a major development from past monitoring programmes which have only reported after schemes have been closed. The project ensures compliance with the rigorous requirements of the European Commission's Common Monitoring and Evaluation Framework (CMEF) through the Rural Development Plan (RDP) for Wales. The early findings from GMEP has already provided fast feedback to Welsh Government as to how to spatially target payments to maximise benefits as the scheme progresses.

Beyond Glastir outcome reporting, GMEP data and models may also contribute to a range of other reporting requirements including the Water Framework Directive, Habitats Directive and the Greenhouse Gas Emission Inventory and actions which arise from the Environment Bill such as the State of Nature Resources report, National Natural Resources Policy and Area Statements. Central to the Environment Bill is the need to adopt a new, more integrated, approach to managing our natural resources in a more sustainable way while safeguarding and building the resilience of natural systems to continue to provide these benefits in the long term. Resilience is considered to be greater where extent, condition, connectivity and diversity are high. Many GMEP metrics can be mapped onto these requirements and thus could be exploited to map these 4 properties for different areas in the future. These benefits will underpin certain aspects of the Well-being and Future Generations Bill. Another potential use of the GMEP data is in support of work by Defra and Welsh Government in their development of National Accounts to include aspects of the natural resources (i.e. carbon, water and soil) and their combined value as whole ecosystems (i.e. forests, wetlands etc). GMEP data can contribute to the provision of the underpinning robust and auditable data required for this activity.

GMEP will therefore improve the empirical evidence base for the current state and integrity / condition of Wales's natural assets (termed natural capital) and how these are changing in response to drivers such as climate change, land management practices and air pollution onto which Glastir options are superimposed. The challenge to the GMEP team is to isolate the changes connected to Glastir options itself which is the primary purpose of the monitoring and evaluation programme. Changes in the extent and integrity of the natural capital in turn impacts on how well they can deliver the ecosystem functions and services we need and value. This link is currently not well quantified. The distinction between natural capital and services is important as capital is a longer term asset which we want to protect for the future and is hard to value in itself, whereas the services which flow from this capital are what economists and social scientists are able to value and which have particular relevance for the Well-being of Future Generations Bill. This valuation step is an essential one if we are to provide a grounded framework for understanding the choices government and society face. The GMEP team is working on these issues through its work on landscape perception and use, social surveys and farmer practice surveys. However, there is a large topic which will need additional work beyond what resources are currently available within the GMEP project.

The GMEP team which is delivering this comprehensive programme comprises a mix of organisations with different specialisations covering the different schemes activities, objectives and outcomes. The programme is led by the Natural Environment Research Councils' Centre for Ecology

& Hydrology (CEH), an independent public research body. CEH has a research station in Bangor which provides the leadership and coordination of GMEP. The project consortium includes ADAS, APEM, Bangor University, Biomathematics and Statistics Scotland, Bowburn Consultants, British Geological Survey, British Trust for Ornithology, Butterfly Conservation, ECORYS, Edwards Consultants, Staffordshire University, University of Aberdeen, University of Southampton, and Victoria University of Wellington, New Zealand.

The GMEP approach and reporting requirements

In summary, the basic approach of GMEP is a combined data and modelling programme which utilises existing data enhanced by a major new rolling field survey which provides co-located data for a range of environmental metrics. Modelling work provides methods for integrating and upscaling survey data for national scale reporting and exploring possible future scenarios of possible outcomes of the scheme. The co-located survey data allows reporting against the six intended outcomes of Glastir and the trade-offs and co-benefits of Glastir payments between these outcomes. The six outcomes are: Combating climate change; Improving water quality and managing water resources to help reduce flood risks; Protect soil resources and improve soil condition; Maintaining and enhancing biodiversity; Managing and protecting landscapes and the historic environment; Creating new opportunities to improve access and understanding of the countryside; and Woodland creation and management.

In addition to these original Glastir Outcomes, in September 2014 the Auditor General for Wales published his report¹ on Glastir. The report contained a series of observations and related recommendations including a number associated with the setting of scheme targets and monitoring actual scheme impact against scheme targets which has had an impact on the reporting requirements of the GMEP project. He identified six Strategic Objectives. To respond to these recommendations, GMEP has worked with the Welsh Government and the GMEP Advisory Group to develop a small number of impact indicators for each Glastir Strategic Objective. These are available to view in the main GMEP Year 2 Report and on the GMEP data portal: www.gmep.wales. This indicator exploits the wide range of environmental outcomes and measurements embedded within the GMEP programme of work i.e. a range of soil and water quality metrics, landscape and historic features, plant and freshwater diversity, greenhouse gas emissions, condition assessment of historic features, pollinator and four bird surveys, socio-economic surveys of benefits to the farming and forestry industries and the wider Wales community.

The GMEP cycle

As GMEP survey sites are revisited on a 4-year rolling cycle and we are currently in Year 3 of this initial 4 year cycle, the current Year 2 results contribute towards a baseline against which the future impacts of Glastir payments will be assessed. By Glastir Outcome, work focussed on biodiversity (including woodland habitats) accounts for 42% of the total GMEP budget, 41% is allocated across soils, waters, climate change mitigation, landscape and historic features, trade-offs and co-benefits, and the remaining 17% allocated to underpinning activities such as informatics, the data portal and project management. The field survey involves two parts namely the Wider Wales and Targeted components. The Wider Wales survey squares are chosen to represent the background conditions across Wales and are chosen by randomly sampling within assigned land classes. This helps GMEP to deliver the required data on national trends. Targeted squares are then chosen to specifically capture Glastir related activity.

¹ <http://audit.wales/publication/glastir>

Summary of progress

Years 1 and 2

Within Year 1, GMEP focussed on establishing the field programme and using an ensemble of models to explore potential outcomes from different scenarios of uptake of 6 Glastir options. In Year 2, we have continued with the field survey and focussed on analysis of Years 1 & 2 data together with data from other sources notably Natural Resources Wales, the National Forestry Inventory, Plantlife, UK Butterfly Monitoring Scheme, the Breeding Bird Scheme and Countryside Survey. Long term trends identified are reported here (or in the data portal). We also analysed the GMEP data to identify if land coming into the scheme was different in quality to that outside, and if we could detect the legacy effects of past agri-environment schemes. The biodiversity team focussed on developing techniques for reporting on impacts for Priority species and habitats with work continuing on the development and testing of the landscape quality/perception tool. Modelling efforts were focussed on establishing the baseline data for direct and indirect greenhouse gas emissions in response to Glastir Efficiency Grants funding and assessing possible confounding effect of climate change on greenhouse gas emissions. Soil and freshwater analysis reports on Year 1 data only due to the time required for biodiversity assessment. An analysis of 7 ecosystem services and their potential trade-offs was carried out including the development of a metric to estimate area of land mitigating runoff/flood. Work also included a major new and completed piece of work involved developing new methods for mapping and assessing the condition of peat soils of Wales and their potential contribution to reducing greenhouse gas emissions.

Future plans for Years 3 and 4

Year 3:

- The field survey for Year 3 is already underway with 75 squares selected for survey.
- A decision regarding the inclusion of Countryside Survey squares into the Wider Wales Survey of GMEP will be sought
- Finalisation of the new High Nature Value (HNV) Farmland indicator.
- Development and launch of the GMEP Data Portal at the Royal Welsh Show 2015.
- Reporting of metrics needed for the new agreed 6 Strategic Objectives and Targets for Glastir under development by the Welsh Government. These metrics together with high level indicators for the 6 Glastir Outcomes will be used to provide annual updates through the GMEP Data Portal.

Year 4:

- Completion of the final 75 1km field survey squares to complete the 300 GMEP baseline 1km survey squares will be undertaken.
- Repeat of the Farmer Practice Survey in the summer of 2016 to identify actual changes on the farm and any benefit to farm and forestry profitability and resilience.
- Modelling work to identify benefits of Glastir for water quality in Water framework Directive catchments based on changes quantified in the Farmer Practice Survey of summer 2016 for reporting in Spring 2017
- Farmer interviews combined with modelling to quantify benefits to direct and indirect greenhouse emissions by farm type.

Key findings

The following represents a high level summary of some of the key findings structured by Glastir outcome with additional sections added for analysis of Glastir uptake, peat soils, High Nature Value farmland and Ecosystem trade-offs and opportunities. Many others results can be found in the full report or in the GMEP Data Portal www.gmep.wales.

Analysis of Glastir Uptake

²4,911 unique entrants were identified as having joined the scheme by Dec 2014. The total area covered by Glastir options is 3,263 km², 19% of the available LPIS area and 16% of the total Wales land area. Uptake of Glastir applied most to biodiversity and climate change depending on the metric used to assess uptake. The Woodlands Outcome had the fewest entrants. If the levels of uptake are compared to amounts of points available, clearly points have driven uptake with only 308km² (ca. 1% of Wales) where there was high uptake in areas with low points. However, there was 3041km² (ca. 15% of Wales) with high points where there was little or no uptake. Habitat representation in this category was proportional to that observed in the high uptake /low points with the exception of coniferous woodland which appears to be overly represented i.e. it has had disproportionately low uptake.

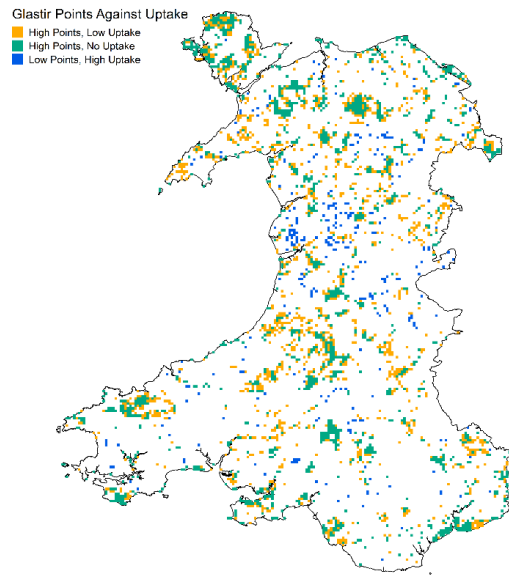
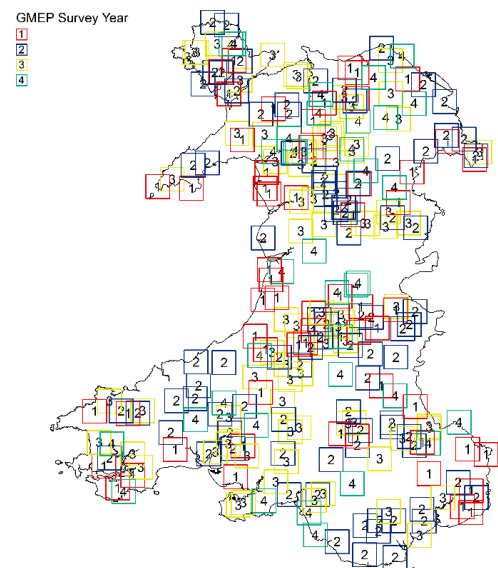


Figure 01 Areas of low or no uptake / high points (yellow and green) and high uptake / low points (blue)

Coverage by GMEP of Glastir

In total, 197 of the 260 GMEP 1 km survey squares (76%) currently selected or surveyed overlap with some form of Glastir uptake parcel. By Outcome, the overlap within GMEP squares indicates a similar distribution to uptake numbers with the majority capturing biodiversity options with 78% of land parcels with biodiversity options. This compares to 62% in the scheme. As for uptake, Woodlands had the lowest coverage in GMEP at 16%. This compares to 10% in the scheme.

Figure 02 Distribution of GMEP 1km survey squares but enlarged to cover 10km grid to protect locations. Squares include Years 1-3 Wider Wales Survey and Targeted Survey but only Wider Wales Survey for Year 4 as Targeted Survey will be selected according to uptake in autumn 2015.



Field survey update

The main biophysical survey of 90 1km squares to deliver the Year 2 baseline survey was delivered from April to Sept 2014. 68% of landowners contacted who had landholdings with the GMEP 1km survey squares gave permission to survey, 5% refused access, with the remainder providing no response. In total 80% of land within the 90 1km survey squares was surveyed in 2014. This co-located integrated programme of monitoring and survey which includes measurement from soils to greenhouse gases and waters, plants to birds and pollinators, landscape to historic features and

² These assessments are based on allocation by the project team as the actual intended outcome of the payments intended by the Glastir Project Officer was not available at the time of writing this report.

landscape perception enables the inter-dependencies between these elements to be explored in future reports. It is consistent with the aims of the Environment Bill to develop more integrated approaches to managing our natural resources in a more sustainable way.

Peat soils

Peat soils cover 4.3% of Wales, and support nationally and internationally rare bog and fen habitats. In addition to their importance for biodiversity, peat soils act as Wales' largest terrestrial ecosystem store of carbon, and in good condition have the potential to contribute to climate regulation through ongoing CO₂ sequestration. However, Welsh peat soils have been detrimentally impacted by centuries of human activity including drainage, over-grazing and conversion to grassland and forestry. As a result Welsh peat soils are currently thought to act as a source of greenhouse gas (GHG) emissions. Measures supported through Glastir aim to reduce these emissions, and to restore the carbon sequestration function of Welsh peat soils, through a reduction in land-use pressures on a range of both upland and lowland bogs and fens. GMPE was commissioned in year 2 to do a major piece of new work to develop improved metrics for assessing the condition of peat soils in Wales.

Key findings:

Outputs include a new unified peat map which should allow a more reliable assessment of the state of the Welsh peat resource as a whole, with better representation of lowland peats, and more accurate targeting of Glastir peat soil-related measures on those areas where peats are present. This map has now been passed to Glastir Contract Managers to use when negotiating new Glastir Agreements.

With respect to peat soil condition, overall the picture is one of highly modified peat soils across Wales with only 30% in good condition. As a result of these activities, Welsh peat soils are currently estimated to be generating 'anthropogenic' emissions of around 400 kt CO₂-equivalents per year (equating to around 7% of all Welsh transport-related emissions). This compares to an estimated natural 'reference' condition (i.e. if all the currently mapped peat area was natural bog or fen) of approximately 140 kt CO₂-eq yr⁻¹. The only recent improvements are in the cessation of peat extraction and in the condition of bogs i.e. using plant species as a proxy for bog condition, between 1990 and 2007 there was a slight increase in the number of characteristic ('positive indicator') bog species presumably due to recent targeting of bogs for restoration.

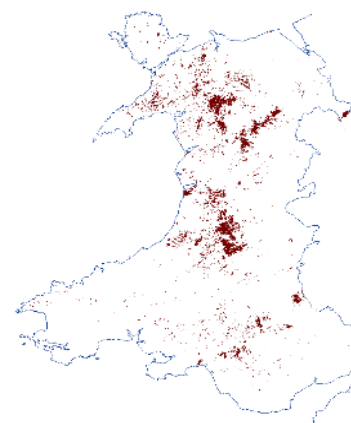


Figure 03 A new unified peat map of Wales

Socio-economic benefits

GMPE undertakes a range of activities to capture the wider socio-economic benefits of the Glastir scheme. These benefits may arise from a range of Glastir activities including payments from farmers into the local community for labour or services to more indirect pathways such as an improved visual landscape quality which has the potential to benefit both local communities and the tourism industry. More generally it is hoped the greater protection of our natural resources intended from Glastir payments will contribute to the 'Resilient Wales' Goal of the Well-being and Future Generations Bill.

Key findings:

Respondents to a survey of farmers receiving Glastir Efficiency Grants reported 44% farm customers and clients had experienced beneficial financial effects from the grants indicating off-farm benefits into the wider community. More than 90% of respondents agreed that Glastir Efficiency Grants (GEGs) had encouraged them to undertake new capital investments. Similarly, the majority of farmers (83%) agreed that access to GEGs increased their scale of planned investment.

A GMEP survey identified greater flexibility and simplicity of the application process with less threatening audit process were all potential improvements to make to increase uptake of the Woodland Creation Scheme.

More than 2600 respondents have taken part in a survey to test a visual landscape quality (VQL) index developed by GMEP. Differences in landscape preferences by e.g. gender, age, nationality, location type of birth and current home were all explored. Surprisingly few differences were identified. This index is being used to assess impacts of Glastir on landscape quality and the links between ecological and landscape quality.

Half of historic features assessed were found to be in excellent or sound condition. Vegetation was the most prevalent threat. Two thirds of public rights of way fully open, physically accessible and easy to find. Changes in both due to Glastir will be reported when GMEP 1km squares are resurveyed.

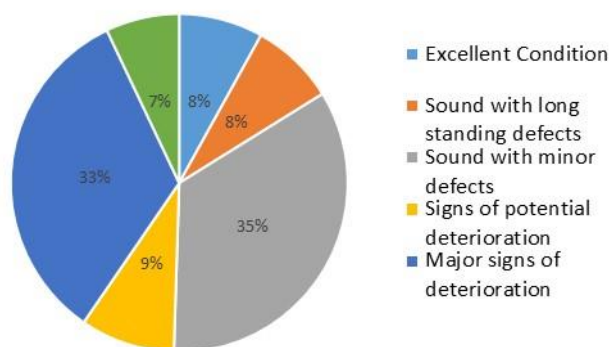


Figure 04 shows condition of Historic Environment Features (HEF's) from years 1 and 2 of GMEP 1km survey squares.

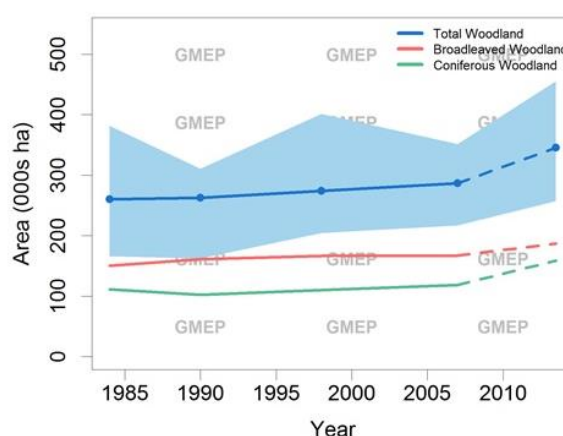
Woodlands

Woodlands are important for the provision of multiple Ecosystem Services, goods and benefits including timber, soil protection, flood prevention, recreation, climate regulation and wild species diversity (for both generalists and woodland specialists). Many of these services are additive and there are synergies between services rather than trade-offs, woodlands are multi-functional habitats. The environmental benefits of woodlands in Wales have been valued at £34 million. A recent survey demonstrated that nearly 65% of people in Wales visit Welsh woodlands regularly and 94% believe they provide a definite benefit to the local community.

Key findings:

Combining data from GMEP with Countryside Survey provides long term trend information. Overall the trend for woodland stock and condition is one of increased area but little evidence of improved condition. GMEP captures small areas of woodland which are very relevant to Glastir but are not captured by the Forestry Commission.

Figure 05 The area of woodland in Wales over time, created by national estimates from field survey from Countryside Survey (solid line) and GMEP (dotted line) data.



Groundflora data suggests woodlands may be more overgrown with increased shading, possibly due to less management. No consistent change in the Ancient Woodland Index was noted since 1990

There is no evidence of increased connectivity of woodland since 1990. An increase in cutting of hedgerows has been recorded but also large declines in new planting, layering and coppicing since 1990. An increase in the length of hedgerows becoming lines of trees suggests a decline in management overall. Land coming into Glastir is notably more rich in hedgerow length which will need to be taken into consideration in future analyses of Glastir impact to avoid false attribution of this initial difference to Glastir.

We have developed a new Woody Cover Product (WCP), which maps large hedgerows, individual trees and small patches of woodland, as well as larger woodland, across the whole of Wales at a 5m x 5m scale. The product uses a combination of airborne radar data (NEXTMap®), optical imagery from satellites and data from the National Forest Inventory. This has numerous potential applications, including investigations of habitat connectivity, modelling catchment run-off processes and quantification of carbon stocks. When validated against aerial photography for several test sites the product had a classification accuracy of 88 %.

Biodiversity

The conservation of biodiversity in Wales is motivated by the value people place on a rich heritage of wild species and habitats. Particular habitats and species have a stronghold in Wales whilst being rare or absent elsewhere in the UK and Europe so that Wales has a particular responsibility for their monitoring and conservation. In 2007 the Environment Agency Wales estimated that “wildlife-based activity” contributed a total output of £1.9 billion per year to the Welsh economy which exceeded the total agricultural output in 2011 of 1.3 billion. Therefore the contribution of biodiversity to prosperity, well-being and job creation in Wales should not be underestimated.

GMEP methods are particularly well suited to reporting change changes in biodiversity in the wider countryside which surround designated areas and thus provide important areas for species and habitats to connect and respond to changing environmental conditions such as climate change. In addition, GMEP has developed methods for detecting Glastir impacts on section 42 species and habitats determining the coincidence of options with species and habitats and deriving new indices of long term trends in biodiversity as the backdrop to GMEP. We are also developing methods to characterise High Nature Value farmland and to extend our estimates of biodiversity change and impacts of Glastir outside of the sample of GMEP 1 km survey squares and into wider Wales by integration with remotely sensed data products and biological records databases. For brevity not all national trend data are reported here but are available within the GMEP Data Portal. Data on Priority Habitats extent and condition are not yet available.

Key findings:

Analysis of long term species data

The overall picture for long term trends in biodiversity is some evidence of recent stability for some elements of biodiversity but little evidence currently of improvement. This emerges from new GMEP analysis of long term data from sources such as the UK Butterfly Monitoring Scheme, data held by the Biological Record Centre from a wide range of monitoring programme, the BTO/JNCC/RSPB Breeding Bird Survey and other bird survey data from a range of sources and Countryside Survey. For example. A newly constructed Priority Bird Species Index for 35 species with sufficient trend data available in Wales indicates at least half as increasing or stable since 1994 but with no pattern for an overall improvement in population health over time.

	1994-1999	2000-2004	2005-2009	2010-2014
Number of species with trend data	34	35	35	34
Number increasing/stable	23	21	17	22
Percentage increasing/stable	67.6	60.0	48.6	64.7

Table 01 Summary of population trends across priority (Section 42) bird species.

Priority Habitats and Species reporting direct from the GMEP survey

From the GMEP survey itself, it is expected there will be sufficient sampling power to report on change in extent for 13 Priority Habitats in the future. Recent trends identified from analysis of historical data are currently being discussed with NRW. There may also be sufficient data for reporting on trend data for 14 of 50 priority bird species and 7 of 15 priority butterfly species. Methods for reporting change in ecological conditions that would be expected to favour other priority species such as the Dormouse and the Lesser Horseshoe Bat are described.

Impact of Glastir and past agri-environment schemes on biodiversity

Establishing a baseline to track future change is one of the main reasons for establishing GMEP to run alongside the Glastir Scheme from its inception. Analyses indicate how critical this will be if false

positives benefits are to be avoided. For example, statistically significant higher habitat diversity of land and length of hedgerows entering the Glastir scheme have been detected. Initial difference in baseline bird densities of land in and out of scheme are indicated which must also be taken into consideration in future analyses of Glastir impact.

Work has also been undertaken to assess the impact of past agri-environment schemes. Some clear benefits of Tir Gofal options for some year to year changes i.e. population growth for bird species from 2 years before Tir Gofal to 2013 are reported particularly for woodland and hedgerow management, followed by arable seed provision and scrub management. Legacy benefits for plant species and habitat condition are less clear but may increase as the baseline survey is completed.

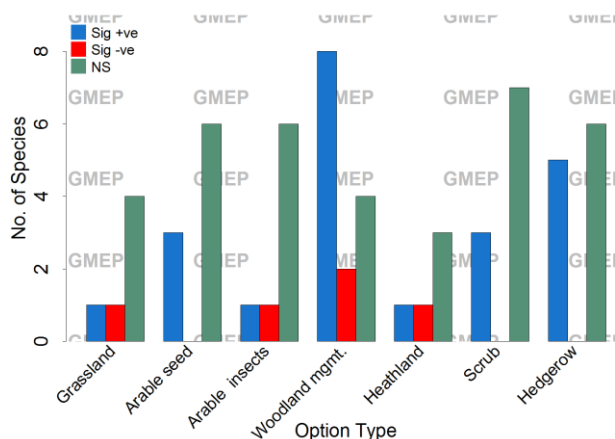


Figure 06 Numbers of bird species with positive, negative and non-significant associations with TG option groups.

New technologies for quantifying a 'Supporting' Ecosystem Service

We have produced a finely resolved predictive map of Annual Net Primary Productivity (i.e. plant growth) for Wales using a combination of remotely sensed data and plant trait modelling. Primary productivity underpins many of the provisioning services with intermediate levels related to highest levels of biodiversity.

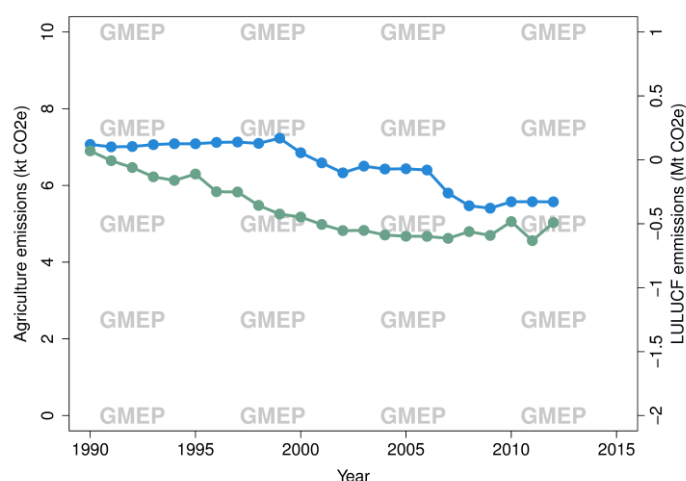
Climate change mitigation

Agriculture continues to be a significant source of diffuse water pollution and greenhouse gas emissions in Wales; whilst some agricultural practices are also responsible for losses and gains of soil carbon. The Welsh Government has set national targets to reduce greenhouse gas emissions, and the agricultural sector is expected to contribute to the meeting of these targets.

Greenhouse gas emission trends from the national inventories

In 2012, Agriculture contributed 13% of CO₂e emissions in Wales. Agricultural sector GHG emissions in Wales have decreased by >20% since 1990 (Figure 12). The overall trend in reductions of emissions from soil have been the result of reductions in fertiliser nitrogen use (particularly in grasslands) and reduced numbers of livestock. The stabilisation of animal numbers in recent years means that there has been little change in emissions between 2011 and 2012 (0.2% increase). Wales has been an increasing net sink of greenhouse gases from LULUCF activities (Figure 12; i.e. numbers are negative). However the scale of emissions and sink is very different resulting in agriculture and land use being a net source.

Figure 07 Greenhouse gas emissions from agriculture and land use, land use change and forestry (LULUCF). Note the differences in scale; 0-10 for agriculture and -2 to 1 for LULUCF. Negative numbers indicate an uptake of carbon. LULUCF activities are clearly not compensating for emissions from agriculture.



Carbon Footprinting including indirect and embedded emissions

GMEP has studied in depth a set of 16 Welsh model farms to explore the impact of 4 Glastir options. The data indicated a variable impact but did have the intended effect of reducing GHG emissions and (in most cases) increasing C-sequestration in biomass and soils. The most effective option explored was reductions in livestock. We have also collected baseline data from a set of farms to quantify the effects of the Glastir Efficiency Scheme of Farm Carbon footprints as insufficient time had passed for farmers to implement GEGs grants on their farms to assess their effect on carbon footprints. The average estimated footprint per hectare across all farms was ca. 10 t CO₂/ha/yr, and ranged from 2 – 19 t CO₂e/ha/yr. The average footprint per hectare on dairy farms was almost double that of LFA cattle and sheep farms with smaller farms averaging a higher footprint per ha of land than larger farm. Based on this study recommendations include prioritisation of further grant allocation to the dairy sector, subject to feasibility.

Effects of Climate Change on Greenhouse gas emissions

The ECOSSE model was used to explore the potential confounding impact of climate change on greenhouse gas emissions from land use and management. The overall conclusion is that climate change will not significantly affect net GHG fluxes from Welsh soils or by net primary productivity by vegetation by 2050. This is primarily a result of the small differences between the baseline and 2050 climate scenarios (about ±2%).

Soil quality

Healthy soils produce our food, feed and fibre, whilst providing other important functions such as regulating climate and water and attenuating pollutants. They are a biodiverse ecosystem in themselves needing to be fed and watered, and contain an estimated quarter of global biodiversity, whilst remaining relatively unexplored with only ~1% of species as yet identified. It is the diversity of life below our feet that provides the engine fuelling nutrient cycling, breakdown of waste, water

filtration and plant growth which is why soils are central to environmental and biodiversity monitoring. Within GMEP topsoil (0-15cm) is sampled in 5 random locations within each square alongside permanent botanical plots.

Key findings:

Overall the picture is one of stability in topsoil condition for the metrics we have available to us. This emerges from analysis of Countryside survey together with the 2013 GMEP data. For example:

- There has been no over little change in topsoil carbon concentration in Wales since 1978.
- During the same period soil acidity was reduced probably due to decreased inputs of acidic atmospheric deposition.
- Nutrient levels since 1998 when records started indicate no change in nitrogen levels and a stabilisation of a recent decline in soil available phosphorus levels. Levels are still acceptable for production but will have reduced the risk of phosphorus leaching to freshwaters.
- No change in soil animal populations were found since 1998.
- Baseline data for soil microbial diversity have been collected. Variation is found to be predominanatly linked to land management rather than soil type which indicates real potential for Glastir to influence levels of soil diversity.

It should be noted these national topsoil statistics may mask changes within habitat types which should be reviewed individually. Of particular concern is whether arable systems are maintaining carbon levels. At the UK scale they are known to be in decline but sample numbers after only 2 years of GMEP are currently not sufficient to detect a similar level of change within Wales.

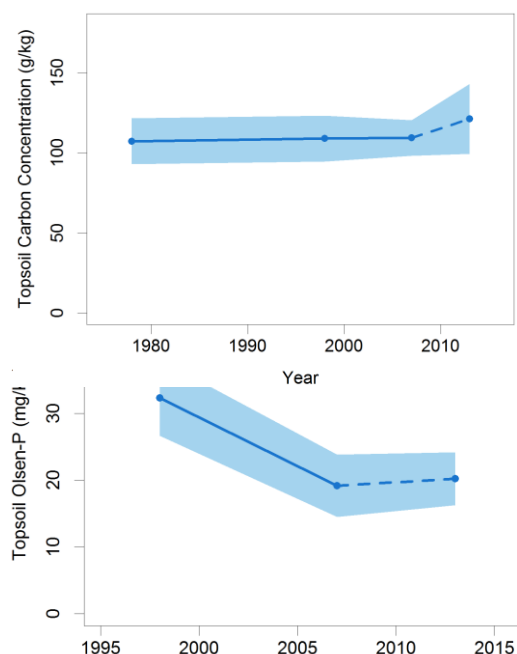


Figure 08 Long term trend data for topsoil carbon concentration (upper) bio-available phosphorus (lower). Data are 2013 Solid blue line (CS data); dashed blue line (GMEP 2013 Wider Wales Survey).

Innovative new work has exploiting new molecular techniques to explore soil microbial diversity. Combined with data from mesofauna from 1998 and 2007, it appears top soils in Wales are incredibly diverse and this biodiversity appears most responsive to land management regime rather than soil type indicating Glastir has real potential to influence soil quality.

Evidence for water and wind erosion is sparse at national scales across the UK including Wales. GMEP does not have the resources to fill this gap however we need to quantify the impacts of Glastir. We are therefore using a modelling approach which provides both erosion estimates and area of land likely to be at risk of erosion loss and mitigating sediment delivery. See the GMEP year 1 report for more information.

No evidence of the limited samples in the Year 1 survey of any difference in topsoil quality of land coming into the Glastir scheme. This analysis will be repeated when the full Year 1-4 survey is complete.

Finally, we have developed a method which combines soil and land cover data sets to assess soil resource areas under different broad habitats which could be used as the basis for developing Natural Capital Accounts for soils.

Freshwater

Headwater streams are an important part of the river network, they typically account for most of river length in catchments (typically 70 to 80 %). The biota of headwater streams makes a significant contribution to biodiversity at a national level with many plants and animals geographically restricted to these characteristic habitats, while some use these habitats seasonally or intermittently. Headwater streams are currently under-represented in NRW monitoring programmes which GMEP is intended to fill. The impact of Glastir on larger rivers will be explored using a modelling approach to quantify change in the contribution of agriculture to nutrient inflow in Year 4 however formal WFD assessment will rely on NRW ecological assessments. There is no benefit of GMEP repeating this assessment. Ponds are more abundant than rivers and lakes, and are found in virtually all environments. Ponds, are recognised in Article 10 of the EU Habitats Directive for their role as 'stepping stones', between other waterbodies and wetlands, increasing freshwater habitat connectivity at wide spatial scales. Within the GMEP, 1 km survey squares are sampled for 1 headwater stream and 1 pond when present. Approaches are WFD compliant.

Key findings:

Overall the picture for small rivers is one of recent significant improvement over the last 20 years. Within the GMEP survey, ecological quality for diatoms and macroinvertebrates was good/high in over 60% of headwater stream sites, and phosphorous concentrations were consistent with good quality at 85% of the sites. However 53% of sites had elevated nitrogen levels and 91% had some form of habitat modification, which was extensive in 32% of sites. Lowland sites demonstrated nutrient enrichment and higher levels of habitat modification than uplands, as expected.

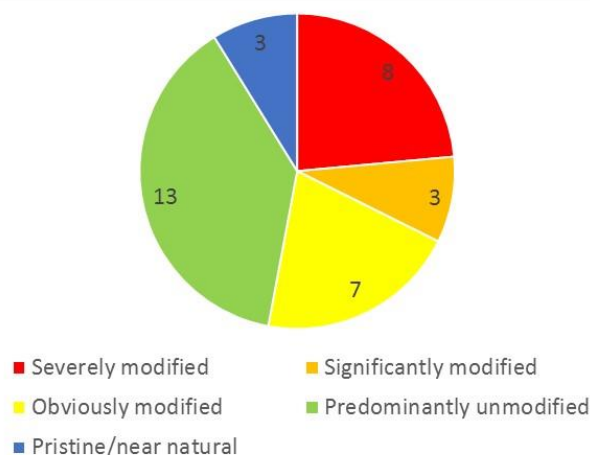


Figure 09: Number of headwater sites falling in the 5 habitat modification classes in GMEP survey from year 1

Only 8% of ponds were judged to be in good ecological quality, most others fell under moderate quality (Figure 16). This assessment is not related to WFD, as no assessment and classification protocol currently exists for ponds. The main drivers of the macro-invertebrate community were natural (alkalinity, altitude) but phosphorous concentrations were also an important driver and are likely to be influenced by human activity.

No evidence of differences to date have been observed for headwaters or ponds coming into Glastir compared to that outside of the scheme. It should be noted, impacts of Glastir on nutrient enrichment levels in freshwaters more generally will be quantified using a modelling work as described in the GMEP Year 1 report.

High Nature Value Farmland (HNV)

HNV farmland has been defined as 'areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports or is associated with either a high species and habitat diversity or the presence of species of European concern or both'. It is an agreed

indicator of one of the six Strategic Objectives of Glastir but requires development work to gain consensus as a valid metric which can be reported to the EU. It has been generally agreed that HNV farmland can be broken down into 3 types:

- Type 1: Farmland with a high proportion of semi-natural vegetation
- Type 2: Farmland with a mosaic of habitats and/or land uses
- Type 3: Farmland supporting rare species or a high proportion of European or world populations

Within the EU, Member States are committed to identifying and maintaining HNV farming; however, there are no specific rules or generic metrics and criteria established at EU level to determine HNV farmland. Each member state therefore interprets the concept and decides how best to apply it to their state. The GMEP team have been tasked by WG to explore these concepts and propose new ideas, criteria and metrics that might be applied to define land of 'High Nature Value' and form an indicator to create a baseline extent and measure changes in extent and quality. We are conducting this work in consultation with a range of partners and stakeholders who are also interested in the potential value of this metric including NRW, BTO and RSPB. A wide range of views were expressed which range from this "is a metric of little value which could confuse rather than illuminate" to "a potentially useful metric to communicate overall trends in biodiversity".

GMEP has collated a table of possible metrics and datasets to calculate and test HNV. Critically data has to be available at a national scale, at a resolution which is applicable and useful on the ground and repeatable to allow for change reporting. We have tested for four case study areas and based on the work undertaken so far the following metrics are being explored for HNV farmland in Year 3:

Type 1 Farmland with a high proportion of semi-natural vegetation:

- Areas of all semi-natural land parcels
- % semi-natural habitat and define a threshold – e.g. > 20 % - for HNV farmland

Type 2 Farmland with a mosaic of habitats and/or land uses:

- Use upper quartile of habitat diversity (Shannon's Index)
- Incorporate woodland connectivity and / or field boundaries into the metric
- Incorporate species richness or presence/abundance of selected species, particularly species which are characteristic of a mosaic of habitats including low intensity farmland

Type 3 Farmland supporting rare species or a high proportion of European or world populations:

- Incorporate data on protected areas SPAs, SACs, SSSIs or use as a separate dataset to compare HNV metric to.
- Adopt Glastir target layers and protected zones to identify HNV areas or use as a dataset for comparison with an HNV metric
- Develop an indicator based on species data, particularly species which are rare or species for which a high proportion of European or world populations are found in the UK.

We present several methods of potentially assessing the contribution of soil to High Nature Value land should the working group decide it is a natural resource which should be included in the HNV metric. We report that even common Welsh soils are relatively unusual in the global context, especially the surface-water-gley soils and to a lesser extent the podzols. We found that all of the rare or occasional soils are covered by SSSI's bar 1 emphasising the close link between soil and ecological properties.

Next steps will include a real-time participatory approach by the GMEP Advisory Group comparing outcomes from different combination of metrics using a web based data mapping tool CEH is developing which will be available in January 2016. Outcomes of different data combinations will be compared to protected areas, Glastir target layers and other metrics of natural capital and ecosystem services to assess their relationship.

Ecosystem Service Trade-off and opportunity mapping

There is a need to provide a decision-support tool which can help policy makers and land managers target specific areas in the Welsh landscape where opportunities are greatest to increase ecosystem service provision with minimal trade-offs. We have exploited the LUCI modelling tool described in the GMEP Year 1 report to start this process. This work was the first ever deployment of an ecosystem service model with such fine spatial resolution appropriate for the relatively fine scale options within Glastir at a national scale for 7 services. In Year 2, we have again used the LUCI model to identify where there is an opportunity to improve each service and where these opportunities may conflict. It should be noted that the LUCI model takes into account not just the area modified but the area affected downslope by land management as it has a topographical routing approach to water flow and nutrient/sediment transport i.e. it is not a suite of GIS map overlays. Finally it must be emphasised, LUCI provides a useful initial screening tool to identify areas to target for a ground-based assessment and provide national based metrics. It is strongly recommended that areas identified as having high potential for service improvement be re-visited with the model (or another ecosystem service modelling tool) to iterate options with local stakeholders incorporating best available local data. LUCI has been used, and indeed was initially developed, for this type of local engagement and negotiation approach to development of spatially explicit community planning.

Key findings:

Significant areas have opportunity to improve carbon (C) status (10508km²), however for the vast majority of these sites, there are other services in good condition, so care must be taken to avoid detrimental effects if options are targeted at improving C status. Similar metrics and maps have been produced for the 6 other services. Calculations have been performed on all outputs to identify where there are trade-offs and win-wins across all 7 ecosystem services considered. Results indicate large areas have more opportunities to improve than services with existing good status. These “win-wins” account for 67% of Wales. Almost 28% of Wales has at least 2 more opportunities to improve services than services to be preserved.

We explored a range of soil, climatic and topographical properties of the landscape to see when combined how well they could determine ecosystem service provision. The analysis identified only 3% of the spatial variation could be explained whilst land use in contrast explained 40%. This emphasises how much is determined not only but our use of the land but also the specific spatial and topographical configuration and connectivity of landscape properties. Combination of spatial point data e.g. in GIS overlays may underestimate service provision in many cases.

An assessment of the amount of land inside and outside of the scheme which was either mitigating or mitigated for rainfall runoff / flood mitigation was calculated. The results suggests there is little difference between the land inside and outside of the Glastir scheme currently with respect to either mitigating or mitigated features. The values are 19% and 21% for land in and out of scheme for mitigating features and 19% and 17% for mitigated features respectively. Further assessments to assess differences between land coming into the scheme will be undertaken in Year 3. Other

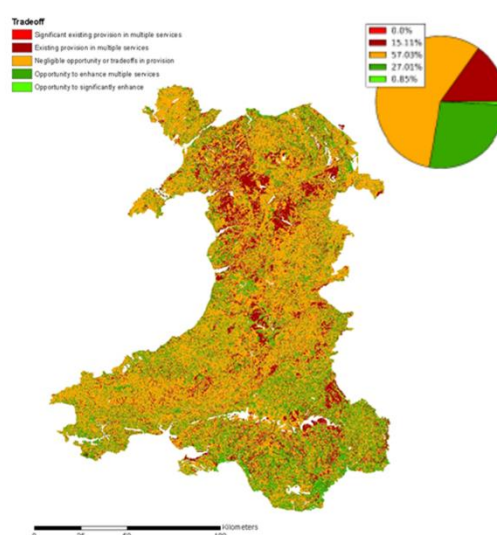


Figure 10 Outcomes for trade-offs between agricultural utilisation status, carbon status, nitrogen and phosphorus status, erosion status, broadleaved woodland connectivity and flood mitigation ecosystem services

developments includes significant progress on deploying a web-mapping service for LUCI appropriate for Welsh catchments, and setting up for more temporal /event reporting from LUCI over Wales.

Further information

The complete Year 2 GMEP report outlines in more detail all the work described in summary above with a fuller summary provided in the 'GMEP Report Summary' and a more easily accessible and shorter summary in the 'GMEP Citizen Summary'. The GMEP Year 1 report and many other GMEP findings can be found on the recently launched GMEP data portal www.gmep.wales.