

## 1 Introduction

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### 1.1 Introduction

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 the Welsh Government as to how to spatially target payments to maximise benefits as the scheme progresses.

Beyond Glastir outcome reporting, GMEP data and models has potential to 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. It is hoped greater resilience of our natural resources will in turn provide social and economic benefits thus helping to underpin the 'A Resilient Wales' Goal of the Well-being and Future Generations Bill. Another potential use of the GMEP data is in the 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.) . Work is currently ongoing in by Defra which includes some test case studies in Wales. 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, this 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, Freshwater Habitats Trust, St Andrews University, Staffordshire University, University College London, University of Aberdeen, University of Southampton, and Victoria University of Wellington, New Zealand.

## **1.2 The GMEP approach**

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; and 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 report<sup>1</sup> 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. Metrics under consideration are:

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

Strategic Objective	Reportable Indicator
1.To increase the level of investment into measures to mitigate greenhouse gas emissions with the aim of contributing towards a reduction of net emissions from the land based sector in line with our international obligations	Contribution by land use and land use change (ktCO <sub>2</sub> e yr <sup>-1</sup> ) (excludes Peat Soils)
	Agriculture Emissions <sup>6</sup> (CO <sub>2</sub> eq (kt N <sub>2</sub> O + CH <sub>4</sub> ))
	Agriculture emissions including embodied emissions (typical average farm data only tCO <sub>2</sub> e/ha)
	Beef Dairy Mixed Sheep
2.To increase the level of investment into measures for climate change adaptation with the aim of building greater resilience into both farm and forest businesses and the wider Welsh economy and environment to ongoing climate change	Farmer Practice Survey to give an indication of farm business split by dairy, cattle, mixed and sheep and forestry
	Species richness / diversity of the wider countryside split by plants, birds and pollinators on arable land, improved land, habitat land and woodland
	Farmland bird indicator
	Habitat diversity
	Mean patch size (for habitat and broadleaved woodland only)
3.To increase the level of investment into measures to manage our water resources effectively with the aim of contributing towards an improvement in water quality in Wales and to meeting our obligations under the Water Framework Directive	WFD compliant headwater stream site classification (uses a broad set of indicator of ecological condition based on macroinvertebrates, diatoms, habitat modification, nutrients) (% in high or good condition)
	Modelled area of land mitigating runoff /flood (%) <sup>1</sup>
4.To focus increased resources on an identified list of priority species and habitats with the aim of contributing towards a reversal in the decline of Wales's native biodiversity and to meeting our obligations under the EU Biodiversity 2020 agenda	12-15 Priority Habitat extent and condition (Only where both are reportable together)
	Priority species numbers (birds (17 of the 51 Section 42 species), butterflies (6 of the 15 Section 42 butterfly species))
	Proxy habitat condition bespoke for particular needs of priority species (aggregated metric across all species) in and out of scheme
5.To put in place measures and investment which maintain and enhance the characteristic components of the landscape and historic environment of rural Wales and to encourage increased public appreciation and access to the countryside	Landscape quality - Median Visual Quality Index (index from 0 – 1.0) in and out of scheme initially (then change over time)
	Historic Environment Feature Condition (% in 'Sound' or 'Excellent' condition) <sup>2</sup>
	Public Rights of Way (% open and accessible).
	Outdoor recreation use survey metric
6.To use agri-environment investment in way that encourages positive environmental outcomes but also contributes towards farm and forest business profitability and the wider sustainability of the rural economy	Farmer Practice Survey – with a question asking whether the business has benefitted from the Glastir scheme. Split by forest, dairy, cattle, sheep and mixed enterprise.
	HNV Farmland area (aggregate metric under development)

**Table 1.2.1** *Impact Indicators for reporting against the six Strategic Objectives of Glastir*

This table illustrates 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.

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. To gain an early insight into what changes we may expect in the future, modelling results from the GMEP Year 1 provide a useful insight into the scale, location and timing of potential outcomes. Here we present the highlights from the Year 2 programme.

Much of the Year 2 work focussed on analysis of the data from the rolling field survey which accounts for ca. 55% of the total GMEP budget with the remainder for socio-economic surveys, data analysis, informatics including development of the GMEP Data Portal and project management. By Glastir Outcome, work focussed on biodiversity (including woodland habitats) accounts for 42% of the total GMEP budget with 41% allocated across soils, waters, climate change mitigation, landscape and historic, trade-offs and co-benefits, and the remaining 17% allocated to underpinning activities such as informatics and project management. The field survey involves two parts namely the Wider Wales and Targeted components. Wider Wales 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.

As priorities for Year 2, GMEP has focussed on analysis of other available data notably Plantlife, UK Butterfly Monitoring Scheme and the Breeding Bird Scheme, and their integration with GMEP data. Analysis of GMEP data was undertaken 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. Approaches to quantify benefits for Priority species and habitats was the focus of the work by the biodiversity team. In Year 1 modelling was focussed on exploring scenarios of possible outcomes from Glastir uptake. For year 2 the work was focussed on identifying opportunities to improve 7 ecosystem services at a national scale and an analysis of their potential trade-offs using the LUCI model, plus reporting of the Bangor footprinting tool to identify direct and indirect greenhouse gas emissions from test farms and the potential benefits of the Glastir Efficiency grants.

### **1.3 Current Status of Glastir Uptake**

This section explores the Glastir uptake data received from the Welsh Government, summarising how uptake varies by Glastir Elements, Glastir Outcomes, and in its geographic distribution across Wales.

#### ***1.3.1 Spatial data acquired for analysis***

##### ***1.3.1.1 Glastir uptake data***

Data delineating uptake of the six Glastir Elements was supplied by the Welsh Government in the form of seven spatial layers, which can be visualised and analysed with Geographic Information System (GIS) software to provide a geographic context to uptake (Table 1.3.1.1.1). Each of the spatial layers contain geometry representing either individual Glastir options polygons, or whole land parcel extents (e.g. farm boundaries, commons, woodlands), along with attributes including landowner unique identifiers e.g. Scheme Reference Numbers (SRN), or Client Reference Numbers (CRN), and where applicable, Glastir option codes. To define the magnitude and distribution of uptake, the analysis approach has been to identify where land management options under Glastir will have an active effect. As such, Glastir Entry, Advanced and Woodland Management uptake was analysed at a management option and capital works scale (together referred to as options from now on), rather than as whole farm boundaries. As uptake under Glastir Commons, Woodland Creation, Efficiency Grants, and Organic operates at a whole parcel scale, they have been processed as complete land parcel extents.

<b>Glastir Element Layer</b>	<b>Received</b>	<b>Data Description</b>
Entry	August 2014	Options polygons for Glastir Entry Level uptake.
Advanced	August 2014	Options polygons for Glastir Advanced uptake.
Woodland Management	August 2014	Options polygons for the Woodland Management component of the Woodland Element.
Woodland Creation	February 2015	Whole extents of Woodland Creation operational areas, as received from NRW. A component of the Woodland Element.
Commons	August 2014	Whole extents of registered common land which has entered the Commons Element.
Glastir Efficiency Grants (GEG)	August 2014	Whole extents of farms that have entered the GEG Element, derived from Land Parcel Identification System (LPIS) data and a list of GEG entrants.
Organic	April 2015	Whole extents of fields that have entered the Organic Element, derived from Land Parcel Identification System (LPIS) data and a list of subscribed fields.

**Table 1.3.1.1.1** *The Welsh Government Glastir Element uptake layers used to define and analyse uptake.*

#### *1.3.1.2 Land parcels data*

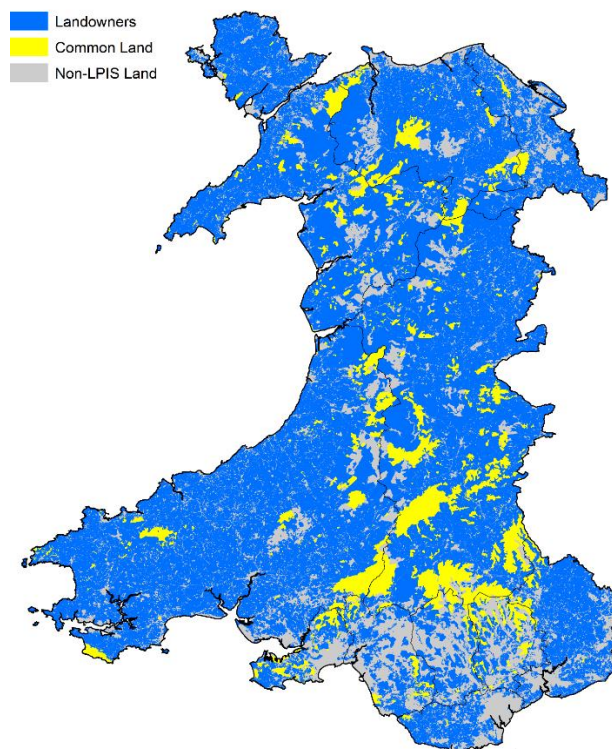
Land Parcels Identification System (LPIS) and landowner contact details data are sourced from the Welsh Government annually. Together, these datasets can be used to identify the spatial boundaries and ownership status of most private rural land and registered common land throughout Wales, covering 81% of the country. This dataset is used here as a baseline estimate of rural land that could have been eligible to enter Glastir. A summary of landowners from the latest version received (October 2013) is shown below in Table 1.3.1.3.1, including the number of unique landowners or commons (which may be utilised by multiple landowners, but are only registered under a single identifier), the number of individual land parcels, and the total area covered by the land parcels in kilometres squared (km<sup>2</sup>). Parcels that could not be matched to a landowner by a Client Reference Number (CRN), or Common Land Number (CLN), have been excluded. Figure 1.3.1.3.1 shows the spatial distribution of LPIS land parcels across Wales, as landowners, commons, or other land not registered with LPIS (e.g. government owned, urban).

#### *1.3.1.3. Other data*

Other data used in analysis were look-up tables to match Glastir Scheme Reference Numbers to the LPIS Client Reference Numbers, and agricultural small areas boundaries, which are used by the Welsh Government for agricultural census reporting. The small areas have been used here to aggregate Glastir uptake metrics to report on the spatial trends in uptake, without disclosing the location of individual entrants. Where data is displayed as maps, NUTS3 (Nomenclature of Territorial Units for Statistics) regions for Wales have been used to outline the country, edited to remove minor islands that are not in Glastir.

Summary Metric	Individual Landowners	Registered Common Land	Total
Total Landowner Count	22,096	327	22,423
Total Land Parcels Count	587,076	3,129	590,205
Total Parcel Area (km <sup>2</sup> )	14,869	1,906	16,775

**Table 1.3.1.3.1** Summary of the Land Parcels Identification System (LPIS) data used in analyses.



**Figure 1.3.1.3.1** Spatial distribution of the Land Parcels Identification System (LPIS) data used in analyses.

### 1.3.2. Glastir uptake analysis methodology

#### 1.3.2.1. Uptake Element spatial layers processing

The Glastir uptake layers in Table 1.3.1.1.1 were processed using Python programs, running ESRI ArcGIS geo-processing tools. The uptake parcels in each of the spatial layers were iterated through, with attributes calculated for the following metrics, split by Element:

- Entrant count: The number of unique Glastir entrants present, preferably identified from SRNs, or if not available, using CRNs.
- Parcel area: The total area covered by all uptake features, in kilometres squared (km<sup>2</sup>). Where the extents of parcels overlap, the overlapping area has only been counted once, by using a dissolve geometry procedure. This was done using a separate process, and does not affect the other metrics.
- Parcel count: The number of individual features in the layer, whether option polygons or whole land parcels.
- Number of option codes: The number of unique options codes taken up. Where given as an average per landowner, only the landowners present in the options layers (Entry, Advanced, and Woodland Management) have been counted.

- Linear option length: Where options are present for linear features such as hedgerows and footpaths, and may not be significant when represented as areas, the total length of options has been counted, measured in kilometres (km). Where given as an average per landowner, only the landowners present in the options layers (Entry, Advanced, and Woodland Management) have been counted.

Where total values for all Elements are given, the same metrics as above have been calculated, except that any entrants, options codes, and parcels common to multiple Elements have only been counted once, rather than simply summing the Element-level values.

#### *1.3.2.2. Allocating uptake to Glastir Outcomes*

Parcels from the Glastir uptake layers were matched to the six Glastir Outcomes of Biodiversity, Soil, Landscape and Access, Freshwater, Woodlands, and Climate Change Mitigation as follows: Individual option codes for Glastir Entry Level, Advanced, and Woodland Management were allocated to each Outcome, according to guidance in the Welsh Government publications and CEH expert opinion, as the actual outcome as designated by the Glastir Project Officer for the agreement was not available to GMEP at the time of this report. As the Commons, Woodland Creation, Glastir Efficiency Grants, and Organic uptake operates at whole land parcel scales, they were allocated as complete layers, rather than separated by option. In many cases, options or extents apply to multiple Outcomes, and have been processed as belonging to each of those, as the primary objective is not known. The same metrics as above were then calculated, with values aggregated by Outcome rather than by Element.

#### *1.3.2.3. Spatial distribution*

To visualise the spatial distribution of Glastir uptake without disclosing locations or precise values of entrants, the same metrics were calculated for each agricultural small area (see section 1.3.1.3), with the uptake parcels clipped to the boundaries. The results have then been mapped at a small area scale as choropleth maps, where results are converted to ratios and grouped into discrete categories. In the case of Glastir-wide values, results are presented as percentages of the LPIS total, or mean values per Glastir entrant. For Element and Outcome level results, the maps represent the relative proportions of the Glastir total for that small area (e.g. the amount of total Glastir land that is part of the Entry Level Element), displayed using quantiles to equalise the classification range between Elements and Outcomes, to enable comparing relative uptake between the maps.

### **1.3.3. Glastir uptake analysis results**

#### *1.3.3.1. Total Glastir uptake*

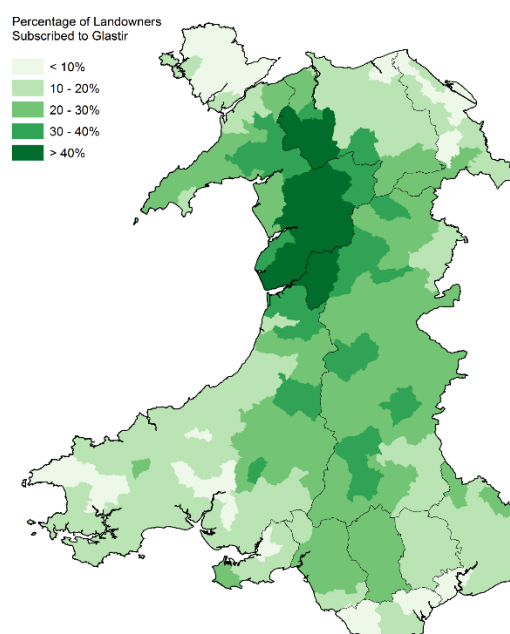
From all Glastir Elements combined, 4,911 unique entrants were identified as having joined the scheme, 22% of all landowners registered with LPIS in Wales (Table 1.3.3.1.1). Grouped by agricultural small area, the percentage of LPIS landowners subscribed to Glastir varied from 4% to 51%, with the highest proportions present in Snowdonia (Figure 1.3.3.1.1). The total area covered by Glastir options (see definition in section 1.3.1.1) was 3,263 km<sup>2</sup>, 19% of the available LPIS area and 16% of the total Wales land area. This percentage of land under Glastir varies by small area, ranging from less than 1% of the available LPIS parcel area to a maximum of 71% (Figure 1.3.3.1.2). A total of 78,958 individual option polygons or land parcels were present in the layers, with the number of parcels per entrant varying from one Glastir parcel, to a maximum of 317 (Figure 1.3.3.1.3).

4,109 Glastir entrants (84%) subscribed to options under Entry Level, Advanced, or Woodland Management. Across Wales, 190 unique Glastir options codes have been taken up, including 3,050

km of linear options (Table 1.3.3.1.1). The spatial variation in average option codes and linear option lengths is shown in figures 1.3.3.1.4 and 1.3.3.1.5, respectively.

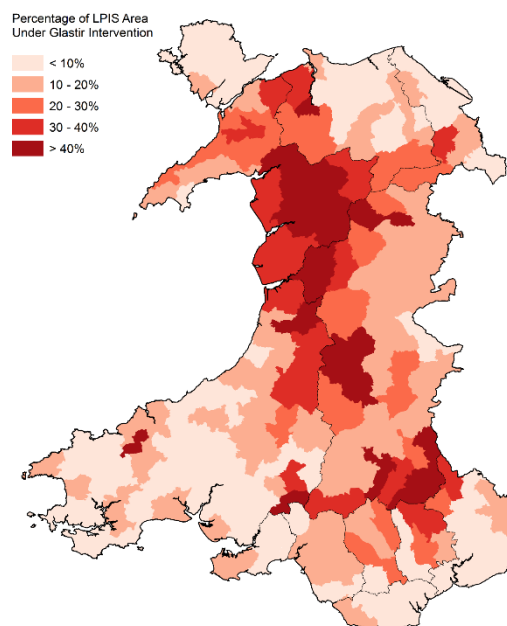
Summary Metric	Uptake Value	Minimum per Entrant	Maximum per Entrant	Average per Entrant
Total Entrant Count	4,911	N/A	N/A	N/A
Total Parcel Count	78,958	1	317	16
Total Parcel Area	3,263 km <sup>2</sup>	5 m <sup>2</sup>	100 km <sup>2</sup>	0.66 km <sup>2</sup>
Unique Option Codes Count*	190	1	22	4
Linear Option Length*	3,050 km	<0.01 m	24 km	0.62 km

**Table 1.3.3.1.1** Summary of the Glastir uptake spatial layers. Metrics marked with an asterisk (\*) only apply to entrants present in the Entry Level, Advanced, or Woodland Management layers.

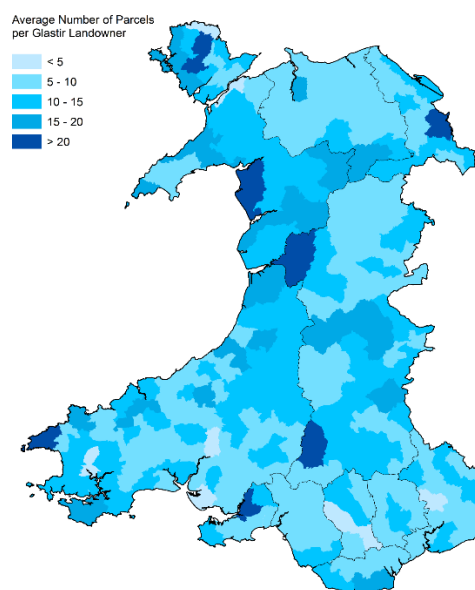


**Figure 1.3.3.1.1** Percentage of LPIS landowners that have subscribed to Glastir, aggregated by agricultural small area.

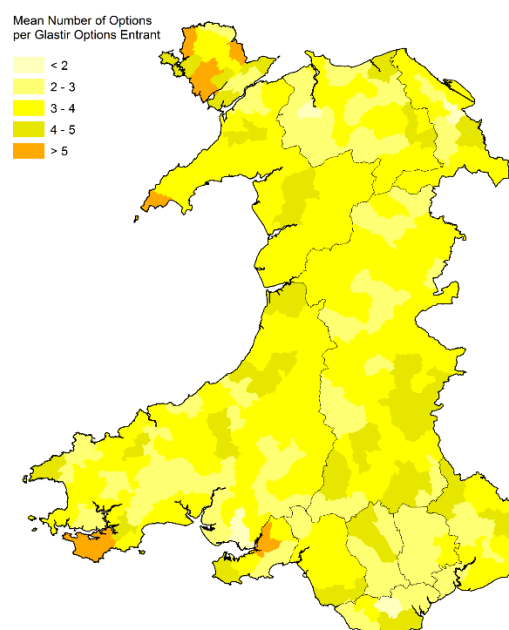




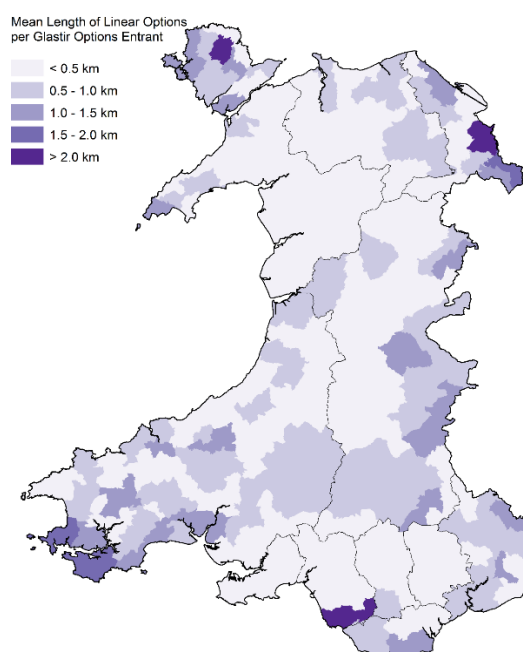
**Figure 1.3.3.1.2** *Percentage of LPIS landowner area that overlaps with Glastir uptake parcels, aggregated by agricultural small area.*



**Figure 1.3.3.1.3** *Average (mean) number of uptake parcels per uptake entrant, aggregated by agricultural small area.*



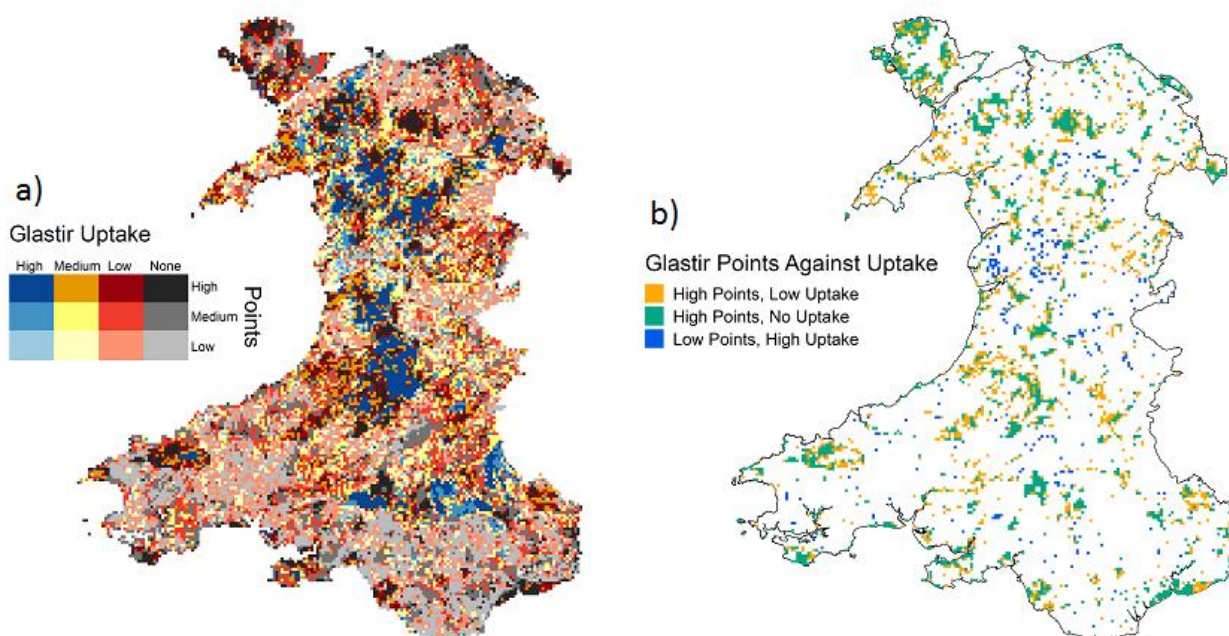
**Figure 1.3.3.1.4** Average (mean) number of uptake options per options entrant, aggregated by agricultural small area.



**Figure 1.3.3.1.5** Average (mean) length of uptake linear options per options entrant, aggregated by agricultural small area.

If the levels of uptake are compared to amounts of points available, clearly points have driven uptake with only 308km<sup>2</sup> (ca. 1% of Wales) where there was high uptake in areas with low points. However, there was 3041km<sup>2</sup> (ca. 15% of Wales) with high points where there was little or no uptake (Figure 02). To try and identify if there was any consistent pattern of land not coming into scheme, we analysed the land according to its habitat type. Broadly similar proportional amount of the dominant Broad Habitat land was present occurred in the extremes of this assessment i.e. high uptake / low points versus low uptake / high points i.e. the two classes were linearly related

suggesting there was no consistent bias of land coming in, or not coming in, to the scheme. The one exception was coniferous forest which was an outlier. There was proportionally a larger area with little uptake despite high points and proportionally lower area of land with high uptake and low points relative to the other 7 major habitat types. The issue of poor uptake of the Woodland Creation scheme which this data would support is further addressed in Chapter 3.



**Figure 1.3.3.1.6 a** Comparison of uptake by farmers compared to total points available across all outcomes;

**Figure 1.3.3.1.6 b** Simplified figure highlighting the extremes of Figure 02a.

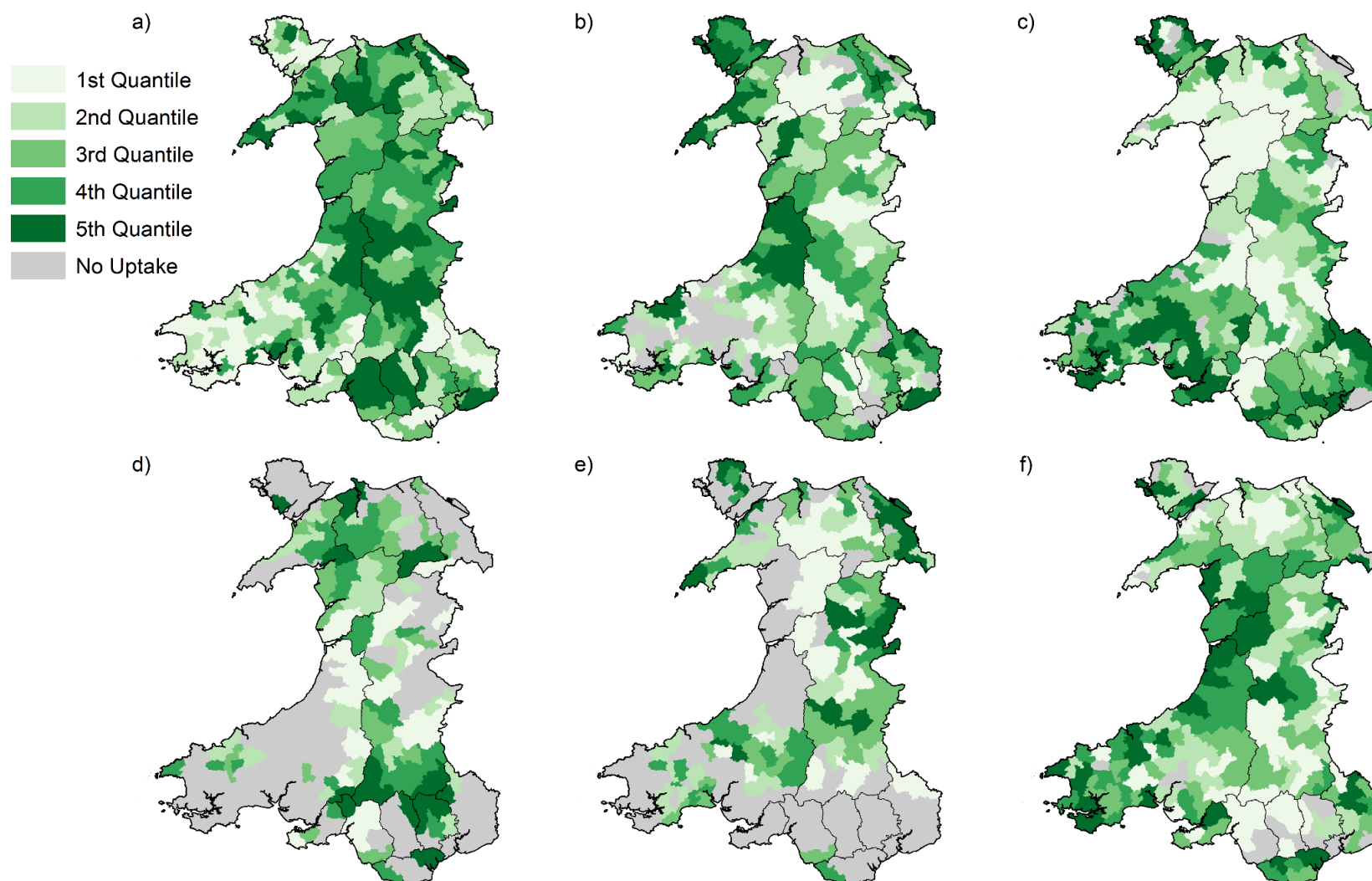
#### 1.3.3.2. Glastir uptake by Element

Uptake of Glastir was not equal across Elements, with the Entry level Element having the highest number of entrants, and also the largest total parcel area, the highest number of parcels, and the longest total linear option length (Table 1.3.3.2.1). Options only apply to the Entry and Advanced elements, and the Woodland Management component of the Woodland Element, with Advanced having the highest number of unique options codes. As the Commons, GEG, and Organic Elements are whole extents, the total parcel area is large relative to the number of entrants, with Organic being the second highest uptake Element by entrant, area, and number of uptake parcels.

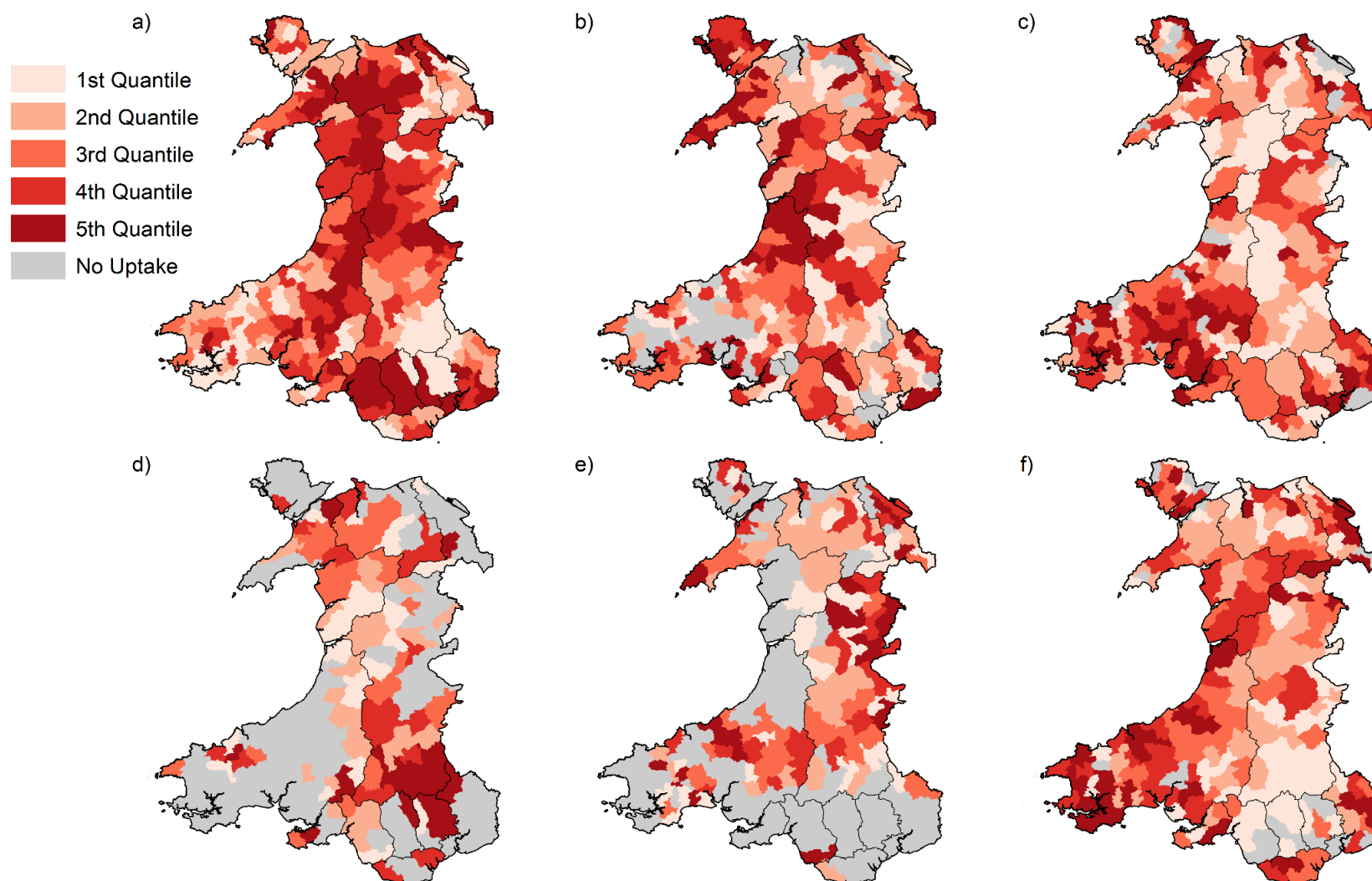
Small areas maps displaying uptake metric values per Element are shown in Figures 1.3.3.2.1-1.3.3.2.5. For each small area, the proportion of the Elements metric value from the total across all Elements has been calculated for each metric. To allow the individual Element maps to be categorised into equally distributed classes, the results are shown by quantile, where the values are grouped into five classes of roughly equal sizes, with the 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%. This provides a method to spatially compare the relative uptake of each metric between Elements, without disclosing actual uptake values.

<b>Summary Metric</b>	<b>Entry</b>	<b>Advanced</b>	<b>Woodland</b>	<b>Commons</b>	<b>GEG</b>	<b>Organic</b>
Total Entrant Count	3,936	546	732	130	109	578
Total Parcel Area (km <sup>2</sup> )	1,554	271	43	733	206	853
Total Parcel Count	46,534	8,736	2,197	359	111	21,021
Unique Option Codes Count*	62	131	51	N/A	N/A	N/A
Linear Option Length (km)*	2,967	60	23	N/A	N/A	N/A

**Table 1.3.3.2.1** *Summary of the Glastir uptake spatial layers, split by Element. Metrics marked with an asterisk (\*) only apply to entrants present in the Entry Level, Advanced, or Woodland Management layers.*

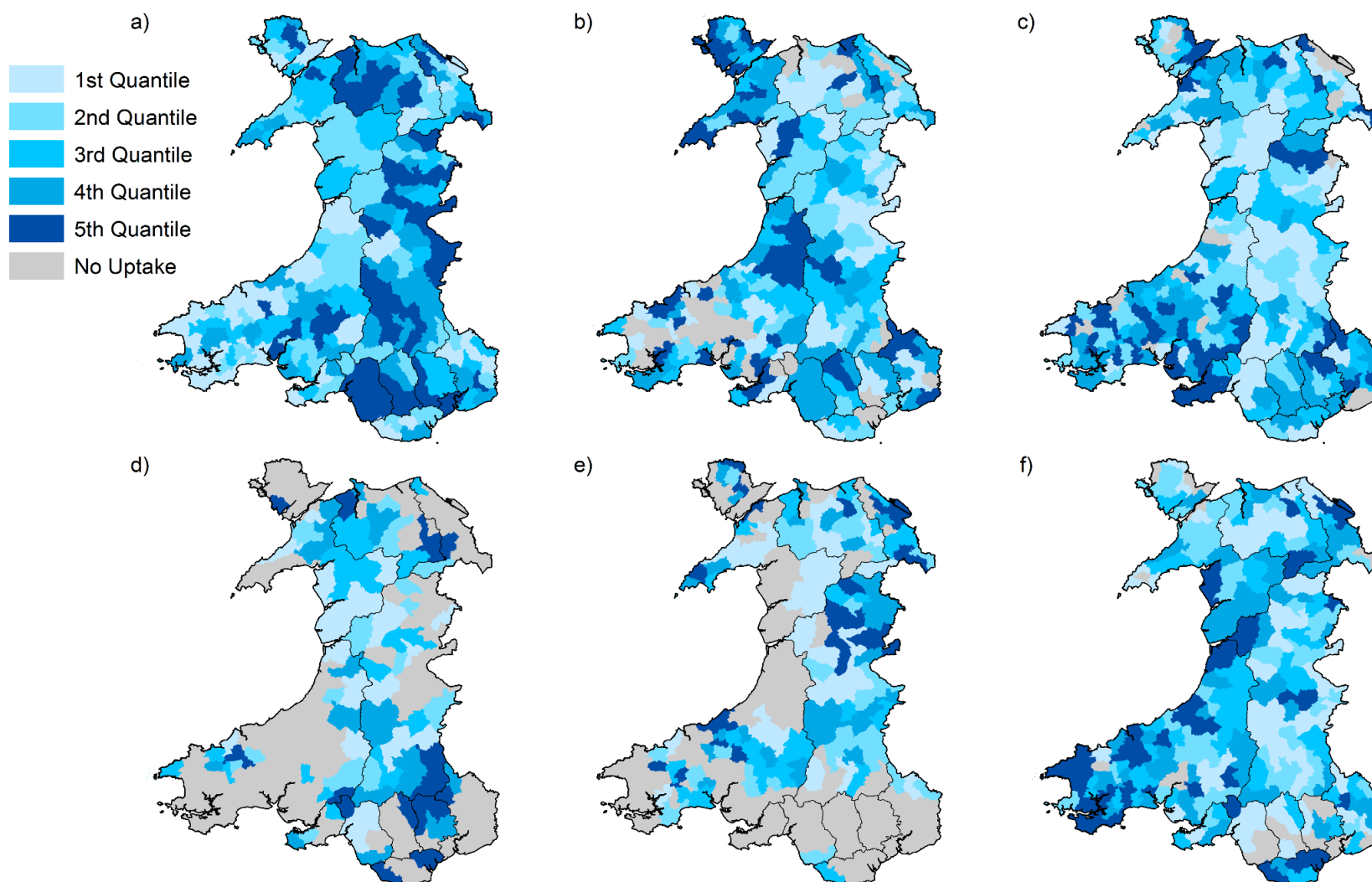


**Figure 1.3.3.2.1** Proportion of entrants to the a) Entry, b) Advanced, c) Woodland, d) Commons, e) GEG, and f) Organic Elements from the total Glastir entrants, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.

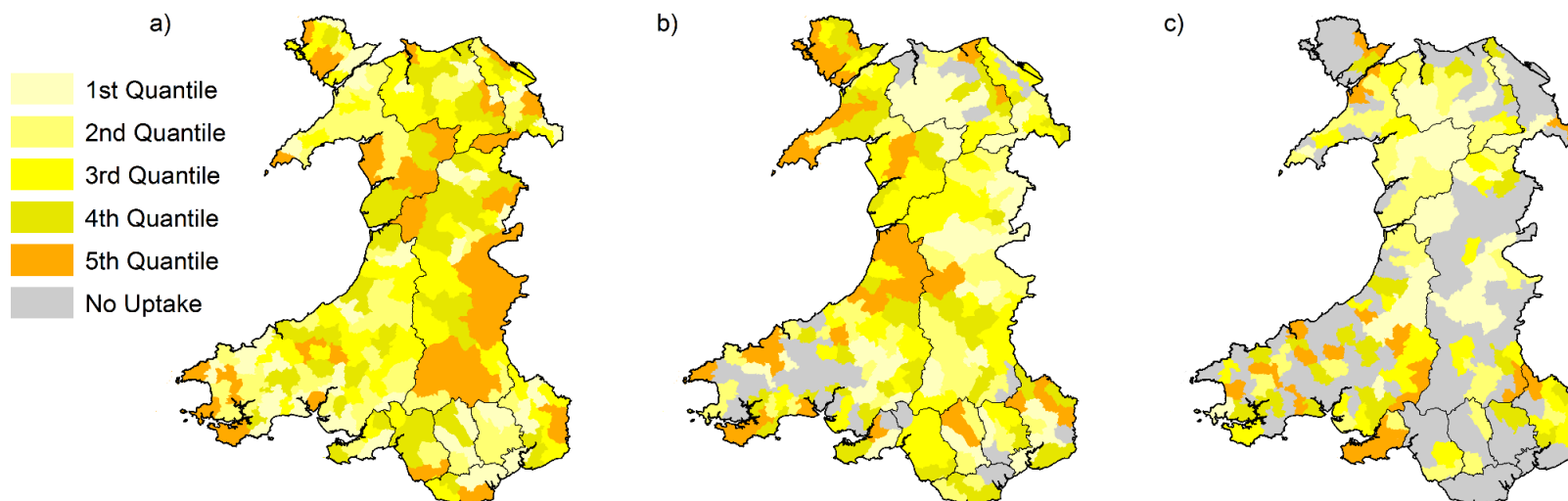


**Figure 1.3.3.2.2** Proportion of uptake parcel area occupied by the a) Entry, b) Advanced, c) Woodland, d) Commons, e) GEG, and f) Organic Elements from the total Glastir uptake area, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.

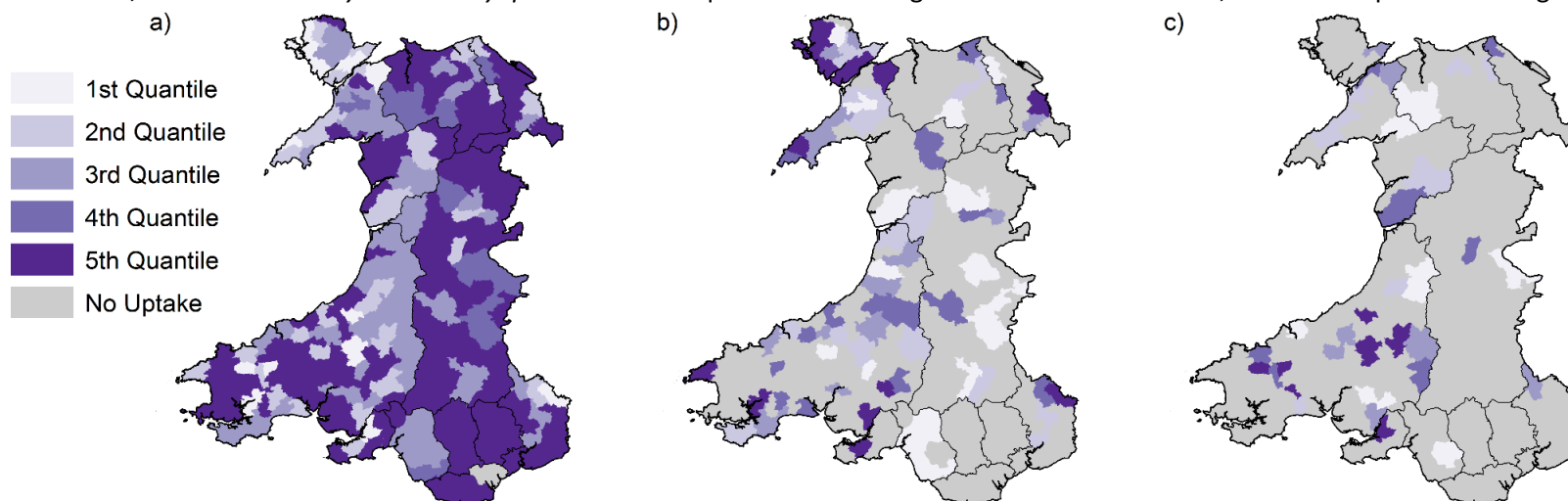




**Figure 1.3.3.2.3** Proportion of uptake parcels of the a) Entry, b) Advanced, c) Woodland, d) Commons, e) GEG, and f) Organic Elements from the total Glastir parcels, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.



**Figure 1.3.3.2.4** Proportion of options under the a) Entry, b) Advanced, and c) Woodland Elements from the total option uptake, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.



**Figure 1.3.3.2.5** Proportion of linear option lengths of the a) Entry, b) Advanced, and c) Woodland Elements from the total option lengths, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.



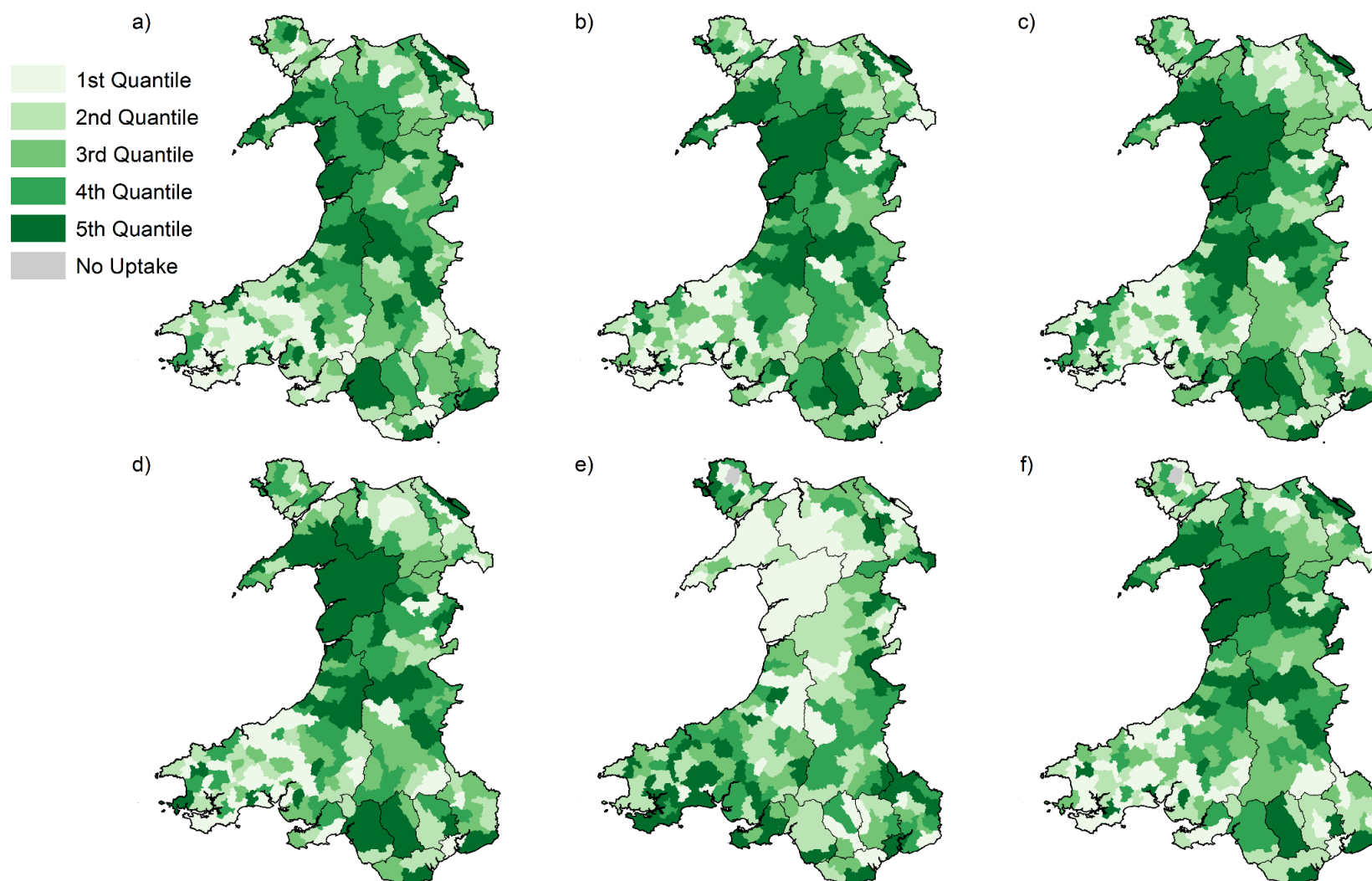
### 1.3.3.3. Glastir uptake by Outcome

Uptake of Glastir applied most to biodiversity, which had the greatest values for all metrics except parcel area, where climate change mitigation was the Outcome with most area under options (Table 1.3.3.3.1). The Woodlands Outcome had the fewest entrants, parcels, and total area, although with average values for the number of option codes and option length. No linear options were allocated to the soil or climate change mitigation Outcomes.

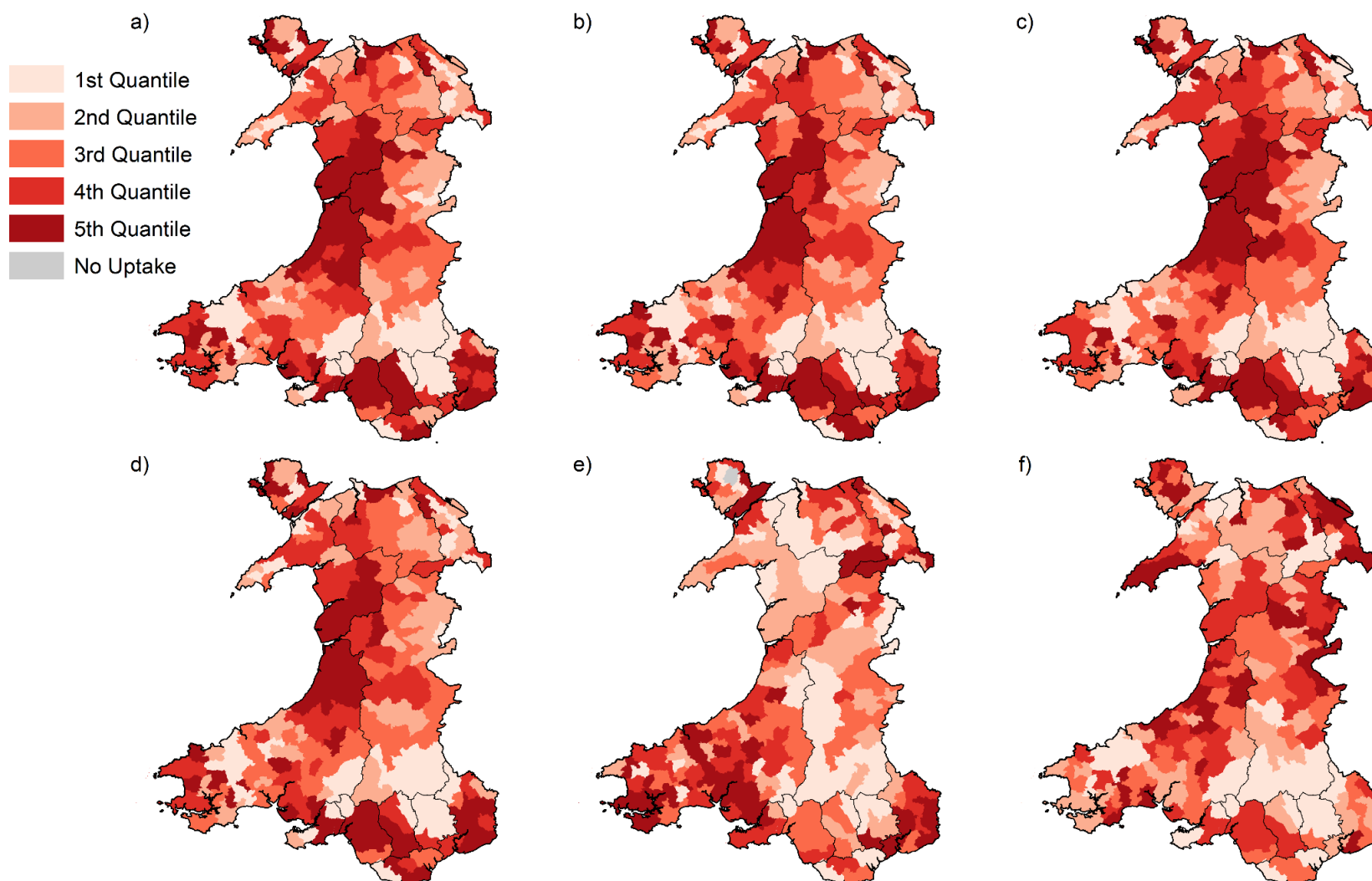
Small areas maps displaying uptake metric values per Outcome are shown in Figures 1.3.3.3.1-1.3.3.3.5. For each small area, the proportion of the Outcomes metric value from the total across all Outcomes has been calculated for each metric. To allow the individual Outcome maps to be categorised into equally distributed classes, the results are shown by quantile, where the values are grouped into five classes of roughly equal sizes, with the 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%. This provides a method to spatially compare the relative uptake of each metric between Outcomes.

<b>Summary Metric</b>	<b>Biodiversity</b>	<b>Soil</b>	<b>Landscape and Access</b>	<b>Freshwater</b>	<b>Woodlands</b>	<b>Climate Change</b>
Total Entrant Count	3,959	3,586	3,569	3,599	2,166	3,597
Total Parcel Count	48,516	34,298	38,295	38,638	7,811	34,578
Total Parcel Area (km <sup>2</sup> )	2,381	2,025	2,189	2,041	88	2,604
Unique Option Codes Count	107	47	80	68	74	48
Linear Option Length (km)	1,832	N/A	452	421	667	N/A

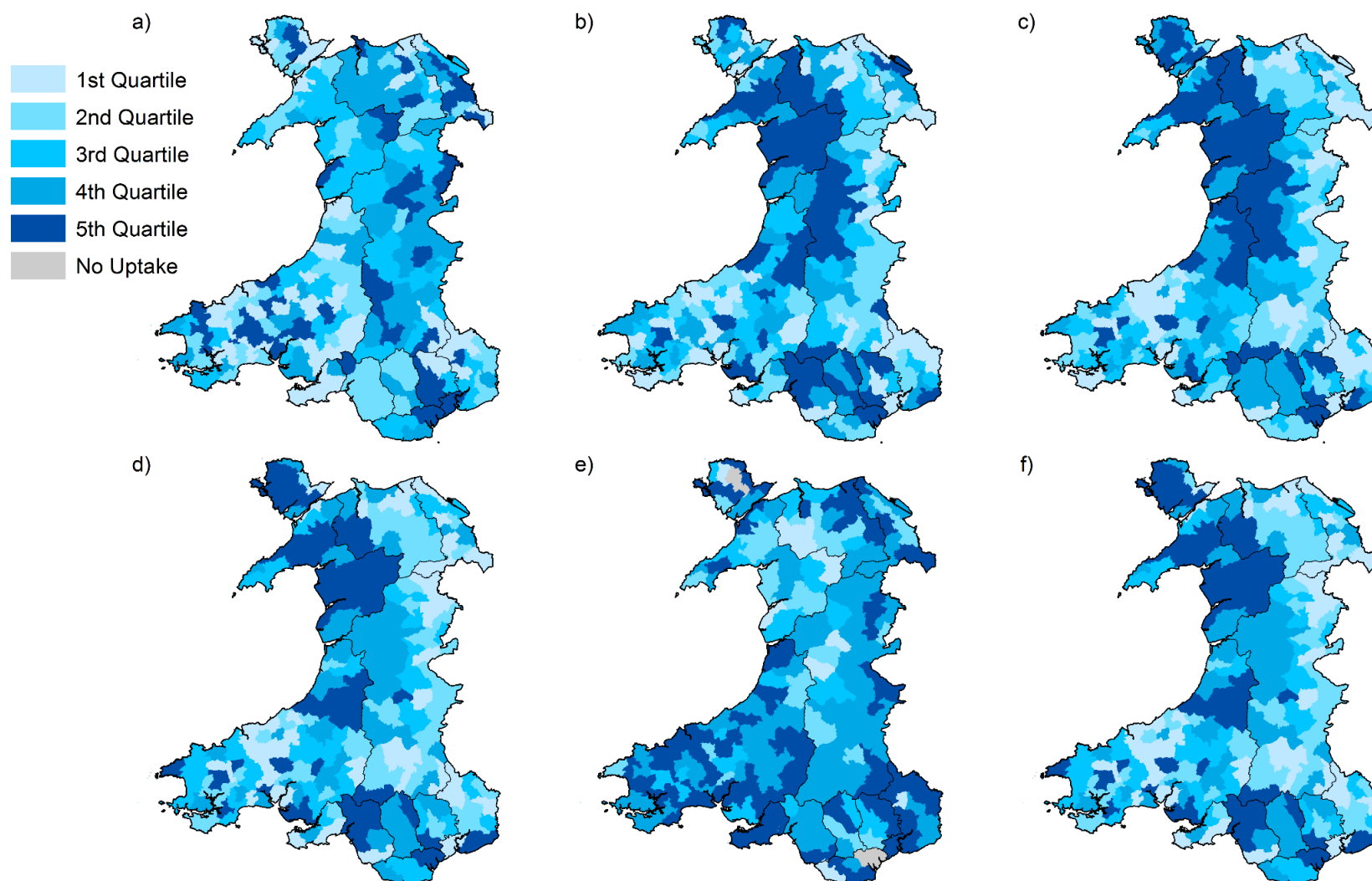
**Table 1.3.3.3.1** Summary of the Glastir uptake spatial layers, split by Outcome. Metrics can apply to more than one Outcome.



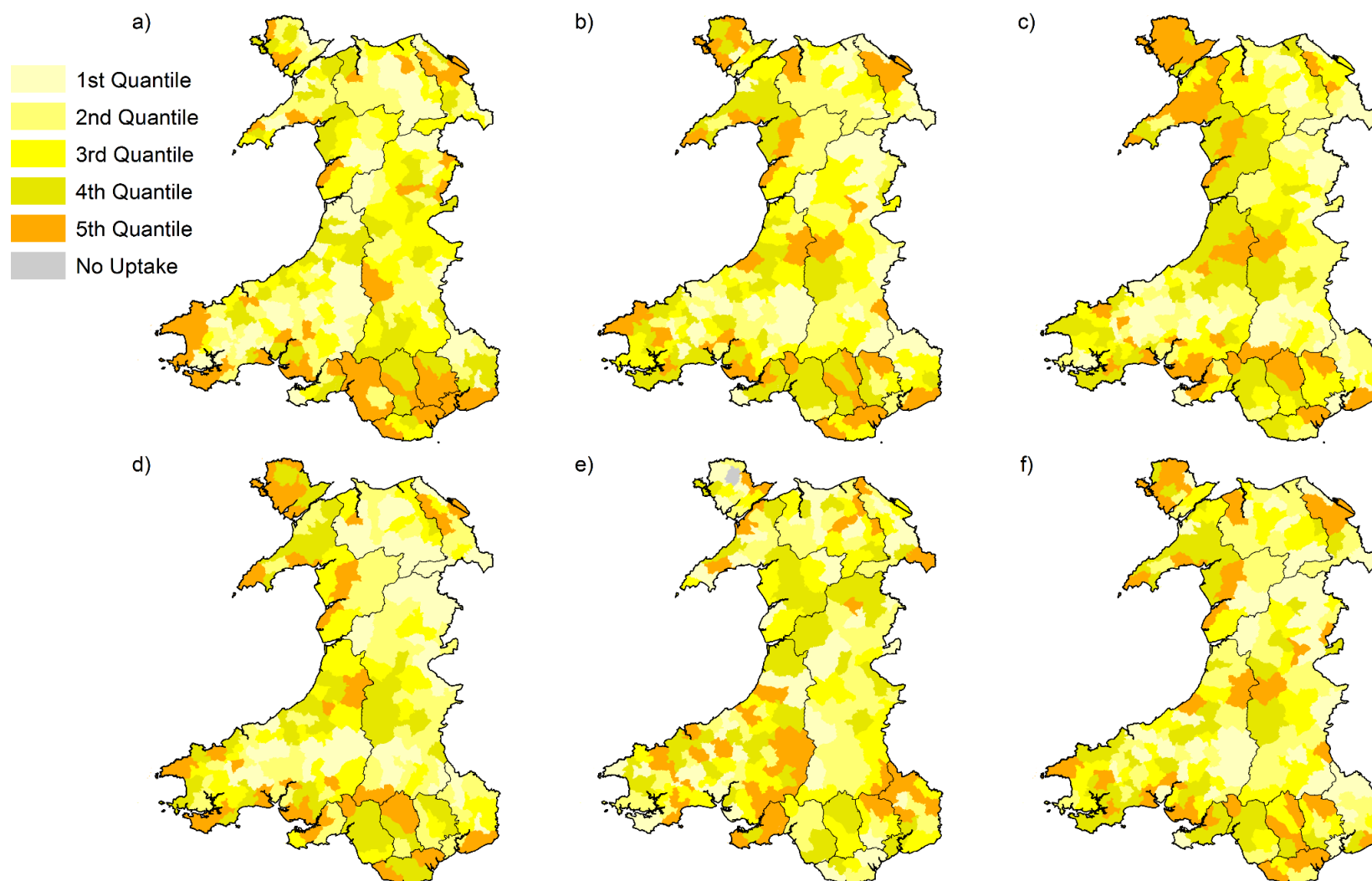
**Figure 1.3.3.3.1** *Proportion of entrants who apply to the a) Biodiversity, b) Soil, c) Landscape, d) Freshwater, e) Woodlands, and f) Climate Change Mitigation Outcomes from the total Glastir entrants, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.*



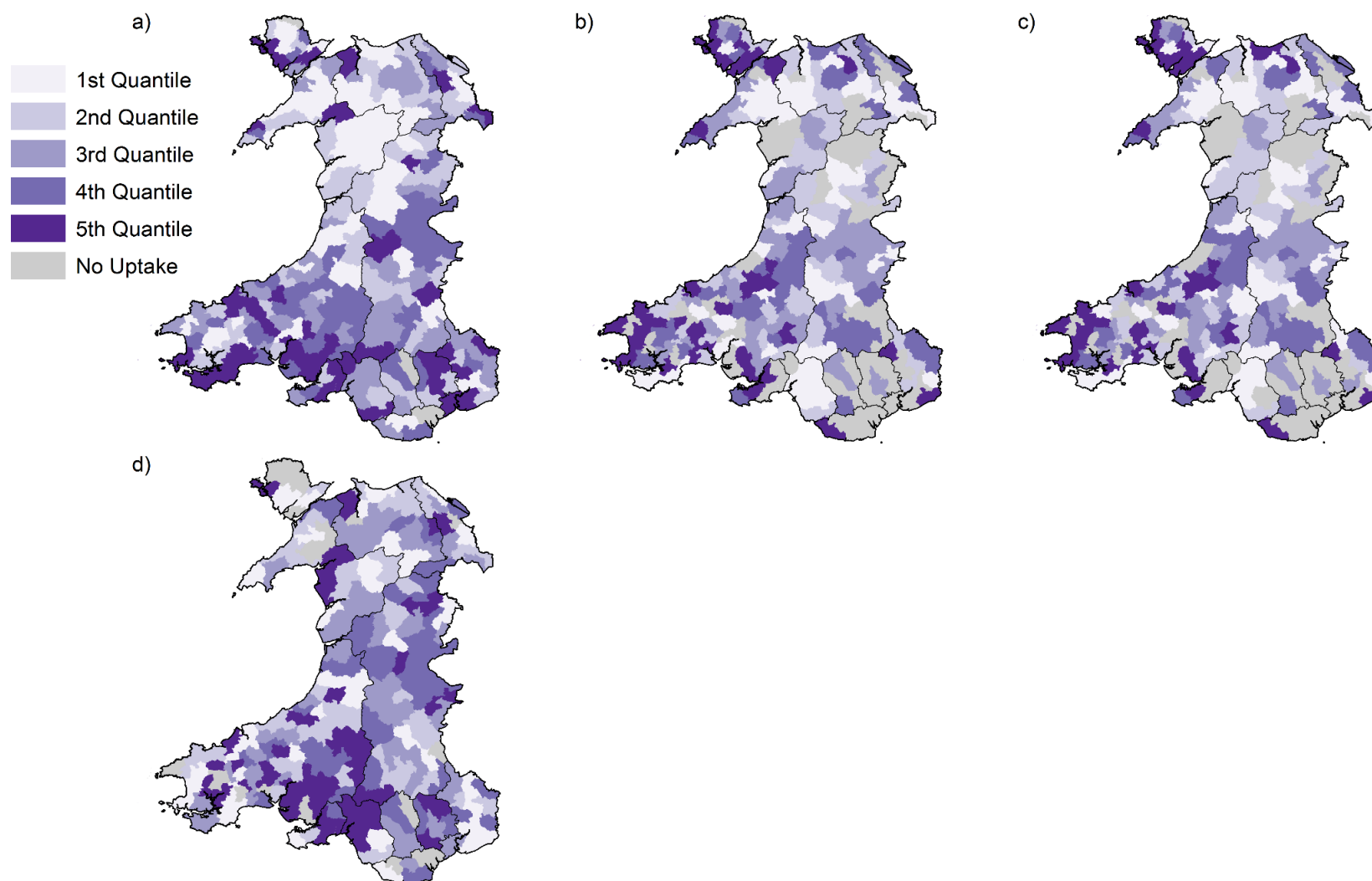
**Figure 1.3.3.3.2** Proportion of uptake parcel area that applies to the a) Biodiversity, b) Soil, c) Landscape, d) Freshwater, e) Woodlands, and f) Climate Change Mitigation Outcomes from the total Glastir uptake area, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.



**Figure 1.3.3.3** Proportion of uptake parcels that apply to the a) Biodiversity, b) Soil, c) Landscape, d) Freshwater, e) Woodlands, and f) Climate Change Mitigation Outcomes from the total Glastir parcels, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.



**Figure 1.3.3.3.4** Proportion of options that apply to the a) Biodiversity, b) Soil, c) Landscape, d) Freshwater, e) Woodlands, and f) Climate Change Mitigation Outcomes from the total option uptake, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.



**Figure 1.3.3.3.5** Proportion of linear option lengths that apply to the a) Biodiversity, b) Landscape, c) Freshwater, and d) Woodlands Outcomes from the total option lengths, aggregated by agricultural small area, and with values symbolised by quantile. The 1<sup>st</sup> quantile containing the lowest 20% of values, and the 5<sup>th</sup> quantile the highest 20%.

## **1.4. Current Status of GMEP Data**

### **1.4.1. Matching GMEP activities to Glastir uptake**

Wider Wales Component (WWC) squares in each year, over the four year cycle, were randomly sampled within strata defined according to the Land Classification of Great Britain (Bunce et. al., 2007) – a derived classification of the landscape based on its topography, geology, climate and physical attributes. Environmental heterogeneity is minimized within each stratum of the Land Classification and is maximised between strata. The proportion of the WWC squares randomly sampled from within each stratum was proportional to the size of the stratum in order best to allocate survey effort. Any square randomly selected that contained more than 75% of urban land or that was more than 90% sea (defined by LCM2007 and the UK Census mean high tide data) was excluded. This criteria ensures that we do not remove important coastline squares, which contain a significant number of priority habitats and comprise a high proportion of total land in Wales. The random sampling within these strata for each year of the rolling survey ensures that the square selection is unbiased and representative of the wider environment.

Alongside the randomly sampled WWC component of the monitoring, we also monitored a similar number of 1km squares targeted specifically at Glastir priority areas. This is important because the stratified random sampling for the WWC may not cover the management options prioritised by the Welsh Government to allow inference about changes in relevant metrics. As we wish to compare squares from the targeted monitoring to squares from the WWC monitoring, it was important that we preserved the same spatial scale. These Targeted Component (TC) squares were chosen specifically to map onto areas that the Welsh Government have emphasised as priorities for Glastir Advanced land management scheme delivery (climate change mitigation in Years 1 and 2 of GMEP). The selection of squares was therefore based on the target areas identified by the Welsh Government, using the scoring system that they have adopted in order to combine maps of Glastir priorities. In Years 3 and 4 we will be weighting the way we make the square selection according to actual uptake to provide this more targeted component of the survey as the data is now available. The total numbers of squares will remain at 300 1km squares for the WWC and TC surveys combined.

Due to the way squares are selected, the presence, magnitude, and type of Glastir uptake within and between survey squares will vary. The ability of the GMEP project to accurately monitor change due to Glastir uptake depends on how well the survey captures land representative of the different Glastir options, Elements, and Outcomes. This section summarises the overlap of GMEP survey squares and Glastir uptake data.

#### *1.4.1.1. Methodology*

There are currently 260 GMEP 1km survey squares that have been selected for the field survey: 150 that have already been surveyed in years one and two, 75 selected for the year three survey, and 35 Wider Wales squares selected for year four, with the locations of a further 40 Targeted squares for Year 4 still to be decided as more uptake data becomes available. As all Glastir land falling within the 260 squares should be permitted for survey by the landowners, under the terms of entering the scheme, the overlap of all 260 selected squares with Glastir uptake data has been studied.

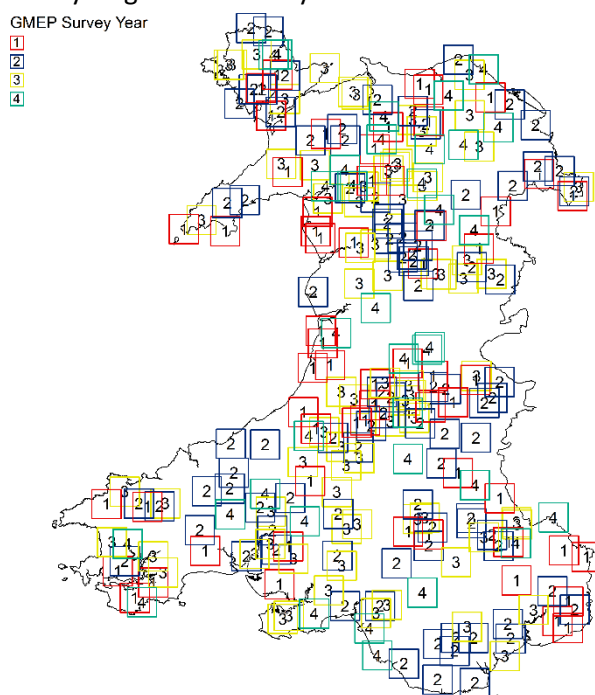
The same process referred to in section 1.3 has been used to define and quantify Glastir uptake. The uptake layers were clipped to the spatial extents of the GMEP 1km survey squares, and processed in the same way to calculate metrics for entrants, parcel area, parcel count, option count, and linear option length, summarised by Element, and Outcome.



#### 1.4.1.2. Results

In total, 197 of the 260 GMEP 1km survey squares (76%) currently selected or surveyed (Years 1-3 and Wider Wales element of Year 4) spatially overlap with some form of Glastir uptake layer. Squares distribution is shown in Figure 1.4.1.2.1. This includes 1,609 individual parcels belonging to 321 Glastir entrants and covering an area of 63 km<sup>2</sup>. From the 171 squares that overlap with options parcels, a total of 88 different options have been surveyed, including 38 km of linear options. Split by Element, the GMEP field survey capture of Glastir uptake follows the national trend, with Glastir Entry being the most surveyed Element for most metrics, followed by Organic. The lower uptake Elements of Woodland GEG overlap with the fewest squares. More Glastir Advanced parcels have been surveyed than those of Commons, although the large parcels of the common land mean the total area surveyed is larger.

By Outcome, the overlap within GMEP 1km survey squares indicates a similar skewed distribution compared to uptake numbers with the majority capturing biodiversity options with 78% of land parcels with biodiversity options (62% in the scheme). Woodlands did however have the lowest coverage at 16% (10% in the scheme). This analysis will need repeating now the data has come through which includes the intended outcome for the options within the Glastir contracts. Current assessment was based on likely target outcome by the GMEP team.



**Figure 1.4.1.2.1** Distribution of GMEP 1km survey squares but enlarged and relocated within a 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.

#### 1.4.2. Datasets acquired for the GMEP project

Data collected for, or generated by, the GMEP project is stored within a secure Oracle spatial database, managed with the ESRI ArcSDE application. This data is stored under one of a number of schemas – separate spaces within the database structure, designed to hold data in logical groups (Table 1.4.2.1). Project staff can then access the datasets stored under each schema with their own private connection, with read-only access permitted for the required data once the appropriate licensing agreements have been processed.



Aside from the field survey data, and internally-generated derived data, a range of third party data has been acquired from the Welsh Government and other sources for the project, currently including over 700 individual files. A list of all third party data acquired for the project is listed in Table 1.4.2.2.

Database Schema	Description	Number of Files Stored
Third party data	Stores all external data gathered for the project such as Glastir scheme uptake and environmental data (see Table 1.4.2.2), and some key internal data such as GMEP 1km survey square locations.	722
Habitats	The database for the habitats field survey application (CS Surveyor), with the schema structure designed by ESRI. Collected field data is imported to the database using CS Surveyor, which updates the various tables and feature classes, not all of which are relevant to GMEP.	218
Habitats QA	As above, for the quality assurance field survey habitats data.	213
Vegetation	Tables and features from the Vegetation Plots application, containing botanical plots data. Field data is appended to the tables each year.	9
Vegetation QA	As above, for the quality assurance field survey plots data.	6
Freshwater	Tables from the various freshwater applications (RAPID, IRIS etc.), containing field survey data for freshwater. Field data is appended to the tables each year.	26
Soil	Processing results from the soil core samples, such as biological, physical and chemical characteristics. Data is appended to the tables each year.	7
Derived	Internally generated data, produced for use within the project. Includes reprocessed copies of third party data and field data, and intermediate analysis data.	26
Results	Final output analysis results tables generated for the GMEP report and data portal.	5

**Table 1.4.2.1** Schemas present within the GMEP Oracle geodatabase to store data for the project.

Data Type	Dataset	Description
Agri-environment schemes	Glastir Advanced	Advanced Element uptake extents and options.
	Glastir Commons	Commons Element uptake extents.
	Glastir Efficiency Grants	GEG uptake entrants and field boundaries.
	Glastir Entry	Entry Level uptake extents and options.
	Glastir Organic	Organic uptake entrants and field boundaries.
	Glastir Woodland	Woodland Creation and Woodland Management components of the Woodland Element.
	Organic Farming scheme	OFS entrants (previous scheme).
	Protected Zones	Extents of protected zones for certain species under Glastir.
	Target Areas	Glastir Target Areas from 2013-2015, including: Carbon, Water Quality, Water Quantity, Access, Landscape, Historic Environment, Biodiversity Habitats & Species.
	Tir Cynnal	Tir Cynnal extents and options (previous scheme).
	Tir Gofal	Tir Gofal extents and options (previous scheme).
	Aerial photography	High resolution (25 x 25 cm) Aerial Photography from 2009.

Contextual and basemaps	OS Master Map	Ordnance Survey vector line and polygon features.
	OS Raster	Ordnance Survey raster data at scales of 1:10,000; 1:25,000; 1:50,000; and 1:250,000.
	Public Rights of Way (PROW)	Linear features displaying public footpaths, bridleways etc.
	Stocking boundaries	Open Country and Upland Boundary regions, for calculating livestock stocking values.
	Wales boundaries	Mean high waterline, NUTS 3 regions and agricultural small areas of Wales.
Designated Areas	Areas of Natural Beauty (AONB)	AONB site boundary polygons.
	Biosphere	Biospheric and Biogenetic reserve boundary polygons.
	Heritage	Heritage coastlines polygons.
	National Nature Reserves (NNR)	NNR site boundary polygons.
	Ramsar	Ramsar wetlands boundary polygons.
	Sites of Special Scientific Interest (SSSI)	SSSI site boundary polygons.
	Special Areas of Conservation (SAC)	SAC site boundary polygons.
	Special Protected Areas (SPA)	SPA site boundary polygons.
Farm Holdings	Agricultural Census	Agricultural Survey and lookup tables.
	Land Parcel Identification System (LPIS)	Land parcel boundary polygons and supporting lookup tables to identify the owners of farms and common land.
	Landowner contact details	Contact details for LPIS land parcels.
Habitats and Land Cover	Agricultural Land Classification	ALC regions from 1977 survey.
	BAP Priority Habitats	NRW Biodiversity Action Plan Priority Habitat regions.
	Ffridd 1km	NRW Ffridd habitat 1km <sup>2</sup> locations.
	Habitat Diversity	NRW 1km <sup>2</sup> habitat diversity.
	Land Cover Map 2007	CEH land cover type vector and raster mapping.
	LANDMAP	NRW landscape dataset, including: Geological Landscape, Landscape Habitats, Visual & Sensory, Historic Landscape, Cultural Landscape.
	National Forest Inventory	NFI forest polygons.
	Phase I Habitat Survey	NRW Phase I habitat survey 1km <sup>2</sup> and polygon results.
	Phase II Habitat Survey	NRW Phase II habitat survey polygon features results.
Historic	Designated wrecks	Cadw shipwreck locations.
	Historic Environment Features (HEF)	Archaeological Trust historic features.
	Historic Landscape	Cadw Historic Landscape regions.
	Historic Parks & Gardens	Cadw Parks and Gardens polygons.
	Listed Buildings	Cadw listed buildings point locations.
	Scheduled Ancient Monuments (SAMs)	Cadw SAM polygons.
	World Heritage Sites	Cadw World Heritage Sites and Arcs of View within Wales.
Hydrology and Climate	Detailed River Network (DRN)	Environment Agency/NRW linear rivers features.
	Harmonised Monitoring Scheme	EA/NRW HMS point locations and auxiliary tables.

	Met Office Long Term Averages	Long Term Averages for temperature, precipitation, wind speed etc.
	National River Flow Archive	CEH NRFA catchments and auxiliary tables.
	NextMap Digital Elevation Model (DEM)	Intermap 5 x 5 m elevation raster.
	Water Quality & Biological Monitoring	EA/NRW water monitoring data.
	WFD catchment boundaries	Water Framework Directive.
	WFD water bodies	EA/NRW Water Framework Directive water bodies (rivers, ditches, canals, lakes etc.).
Soils	BGS Soil Parent Material	Soil parent material vector layers.
	Hydrology of Soil Types (HOST)	1km <sup>2</sup> soil hydrological properties.
	NRW Soil chemistry	Soil pH, P/K/Mg index values and report.
	NSRI NATMAP	National Soils Resources Institute (Cranfield University) vector and tabular soils data.

**Table 1.4.2.2** *Third party datasets acquired for the GMEP project.*

## **1.5 Current Status of GMEP Survey**

### **1.5.1 Overview of methods**

The 2<sup>nd</sup> year of the rolling national surveillance monitoring programme to quantify on-going change in the Welsh countryside and impacts of Glastir options was implemented from April through to September 2014. The main biophysical survey was managed by CEH; pollinator surveys (butterflies, bees and hoverflies) were managed by Butterfly Conservation (BC); and bird surveys were managed by the British Trust for Ornithology (BTO). A full time Farmer Liaison Officer employed by CEH coordinated the movements of all field teams and arrange land access permissions.

Landownership within each 1km square was identified using the Land Parcel Identification System (LPIS) database provided by the Welsh Government. In total, there were 684 individual land holdings contacted within the 90 1km squares surveyed in 2014. Of these, 629 were obtained directly from the LPIS database, with the remaining 55 identified from a combination of Internet-based research, local authorities, Government agencies, estate management services and Commons associations. Initial contact with landowners was made by letter outlining the objectives and timing of the field survey (see Appendix 1.1 for letter and accompanying GMEP 'flier'). The letter emphasized that the land selected for survey was randomly selected and not related in any way to any compliance inspection process for Glastir, Single Payment Scheme or any other scheme. It was also emphasized that personal data is protected by the Data Protection Act 1998 and information gathered through the survey is the property of the Welsh Government, subject to the appropriate data security. Landowners were also asked for information on any animal or plant diseases on their property and bio security measures they would like survey staff to comply with. Bio security measures were put in place for all GMEP surveys following the Welsh Government guidelines. See the GMEP Year 1 report for a full description of methods (Emmett et al 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 squares was surveyed in 2014.

### **1.5.2 Biophysical survey**

Twelve experienced botanists/field surveyors were appointed in April 2014 by CEH to cover the main biophysical survey. A comprehensive, three week training programme was held in to cover all aspects of data collection, Health and Safety, first aid and off-road driving before surveyors started

work in the field. The surveyors were split into three teams of three with three part time ‘floating’ surveyors to cover holiday leave and provide extra support where needed. Each team was allocated 30 1km squares to survey across three regions (north, mid and south Wales). Within each region the 1km squares were visited in order from either east to west or west to east which, along with the north/south division, was designed to avoid longitudinal/latitudinal bias in climate and seasonality. To maximize the efficiency of the field teams, a wide number of ecosystem characteristics were recorded on each visit under seven different activities.

All measurements collected as part of the biophysical survey have been mapped to specific or bundles of options and one of the five Glastir outcomes: climate change mitigation, improving water and soil management, maintaining and enhancing biodiversity, managing and protecting the Welsh landscape including the historic landscape, and creating new opportunities to improve access and increasing the area and management of woodlands. For a full account of field survey methods please refer to the GMEP first year report (Emmett et al 2014).

#### *1.5.2.1 Historic Environment Assets*

These measurements will contribute to the Glastir outcome: Managing and protecting the Welsh landscape including the historic landscape.

There were two types of Historic Environment Assets recorded as part of the survey work to provide data in the future on how Glastir options impact our historic landscape (further detail of which is provided in Chapter 2); Scheduled Ancient Monuments (SAMs) – nationally important with statutory protection and Historic Environment Features (HEFs) – regionally important but no statutory protection. A basic condition assessment of SAMs and HEFs were recorded where they occurred within a 1km square.

76 Historic Environment Assets were recorded in 34 of the 90 GMEP 1km survey squares in 2014.

#### *1.5.2.2 Landscape photography*

These measurements will contribute to the Glastir outcome: Managing and protecting the Welsh landscape including the historic landscape.

To support the work to be undertaken to quantify the impact of Glastir on landscape quality and how that is linked to ecological quality (further detail of which is provided in Chapter 3), fixed point photographs were taken within each 1km square. These provide repeatable, fixed-point images to monitor landscape change over time and a resource for assessing the planned work to link the perception of landscape quality by the public and ecological quality as assessed through our rolling national survey.

A total of 1,837 landscape photographs were taken across the 90 squares in 2014.

#### *1.5.2.3 Mapping habitats, linear and point features*

These measurements will contribute to the Glastir outcomes: Maintaining and enhancing biodiversity; Managing and protecting the Welsh landscape including the historic landscape; creating new opportunities to improve access and increasing the area and management of woodlands.

Collection of detailed spatial data on extent and composition of habitats and features across the entire 1km square was recorded to feed into the assessment of a multitude of Glastir options associated with habitat and to provide underpinning, contextual data for other areas of GMEP. Further details are provided in Chapters 3, 4 and 5. Information on habitat type and landscape features were recorded on a digital map, held on the ruggedized field computers.

Habitat areas (>20m x 20m) were mapped and classified using the Broad and Priority Habitat classification. Additional attributes were recorded using a comprehensive range of pre-determined options which relate directly to Broad and Priority Habitats, vegetation types and landscape features (e.g. Agriculture, Forestry, Buildings and structures); supporting attribute data (e.g. grass ley, burnt vegetation), indicative species presence and cover; and land usage (e.g. stock, cattle, sheep, timber production).

In 2014 the Broad Habitats with the greatest extent were Improved Grassland, Neutral Grassland and Acid Grassland, followed by Coniferous Woodland. The Priority Habitats with the greatest extent were Blanket Bog, Lowland Mixed Deciduous Woodland and Purple Moor-grass Pasture, followed by Wet Woodland (Table 1.5.2.3.1).

Broad Habitat	Extent (km <sup>2</sup> )	Priority habitat	Extent (km <sup>2</sup> )
Broadleaved Mixed and Yew Woodland	2.24	Lowland Beech and Yew Woodland	0.11
Coniferous Woodland	6.07	Upland Mixed Ashwood	0.02
Boundary and Linear Features	0.07	Wet Woodland	0.88
Arable and Horticulture	2.63	Upland Oakwood	0.25
Improved Grassland	18.11	Lowland Mixed Deciduous Woodland	1.86
Neutral Grassland	11.55	Native Pine Woodland	0
Calcareous Grassland	0	Lowland Hay Meadow	0.26
Acid Grassland	8.17	Upland Hay Meadow	0
Bracken	1.54	Lowland Calcareous Grassland	0
Dwarf Shrub Heath	2.63	Upland Calcareous Grassland	0
Fen, Marsh, Swamp	0.82	Lowland Acid Grassland	<0.01
Bog	1.04	Fen	0.27
Standing Open Waters and Canals	0.87	Purple Moor-grass Rush Pasture	1.77
Rivers and Streams	0.09	Reedbed	0.14
Montane	0	Blanket Bog	3.51
Inland Rock	0.12	Lowland Raised Bog	<0.01
Urban	4.25	Limestone Pavement	0
Supra-littoral Rock	0.04	Maritime Cliffs and Slopes	0.09
Supra-littoral Sediment	0	Sand Dune	0.15
Littoral Rock	0	Strandline/Coastal Vegetated Shingle	<0.01
Littoral Sediment	0.33	Coastal Saltmarsh	0.02
Sea	0.9	Northern Birchwood	0
Mosaic	1.12		

**Table 1.5.2.3.1** Total area of Broad and Priority habitat mapped within the 90 1km squares in the 2014 field survey

Linear features are landscape elements less than 5m wide that form lines in the landscape and have a minimum length of 20m and may include gaps of up to 20m. Linear features recorded include woody linear features (e.g. managed hedgerows and unmanaged lines of trees), streams and ditches, grass strips, banks, walls, fences and footpaths and tracks. In addition to mapping the length of linear features, a comprehensive condition assessment and secondary attributes are recorded. For example, for hedgerows extra information is recorded on height of base of canopy, management, trees, species composition and gappiness.

In Year 2 there were 1,716 km of linear features recorded within the 90 1km squares in the 2014 field survey (Table 1.5.2.3.2).

Linear feature	Length (m)
Fence	627,407
Inland water	232,930
Bank	230,925
Woody linear feature, natural shape	221,024
Woody linear feature, unnatural shape	185,844
Transport	107,285
Wall	66,560
Agriculture/Natural vegetation	24,115
Forestry	9,187
Grass strip	8,672
Inland physiography	2,049
Structures	631
Historic feature	218

**Table 1.5.2.3.2** *Total length of linear features surveyed in the 2014 field survey*

Point features are individual landscape elements that occupy less than an area of 20x20m. They include: forestry features such as individual trees, clumps of trees, patches of scrub, veteran trees; inland water features such as springs and ponds; inland physiography such as cliffs and rocky outcrops and structures such as buildings, quarries and wind turbines

In 2014 there were a total of 2,942 point features recorded. The most frequently recorded features were: Individual trees (1,671), clumps of trees (546), patches of scrub (498), rock outcrops and cliffs (158) and scattered trees (128).

Basic information on the condition of Public Rights of Way was captured by the bird survey teams as they moved around the 1km squares. Rights of way were assessed for quality of signage, accessibility and erosion or other signs of damage and results are presented in Chapter 3.

#### *1.5.2.4 Vegetation Plots*

These measurements will contribute to the Glastir outcome: Maintaining and enhancing biodiversity

Plant species presence and abundance was recorded in different sizes and types of vegetation plot allowing vegetation change to be expressed by habitat type, landscape location and whether in or out of the Glastir scheme (further detail of which is provided in Chapter 5). Plots can be located in any semi-natural vegetation; this includes amenity. For each vegetation plot general information was collected including species presence, cover and height. Ten plot types were used to record vegetation.

There were 2,405 vegetation plots recorded in Year 2 (Table 1.5.2.4.1).

Plot type	Number of plots recorded
Nested plots to provide a random sample of common vegetation types	437
Targeted plots to sample Priority Habitats and locations eligible for Glastir	266
Unenclosed plots to sample unenclosed Broad Habitats	300
Boundary plots running adjacent to field boundaries	398
Arable plots on field edges	16
Field margin plots to record new arable field margins that form part of land management agreements	3
Hedgerow plots recording diversity alongside hedgerows	119
Hedgerow diversity plots to record woody linear features and their physical condition	396
Streamside plots to record streamside diversity	235
Stream bank plots to record the upslope habitats	235

**Table 1.5.2.4.1** *Numbers of vegetation plots recorded in the 2014 field survey*

#### *1.5.2.5 Soil sampling*

These measurements will contribute to the Glastir outcome: Combating climate change through soil carbon storage assessment; improving water and soil management due to the direct link between soil and water quality; and also underpins modelling work to forecast maintaining and enhancing plant biodiversity as soil quality is a key constraint on habitat suitability for a range of plants. In addition, the soil sampling assesses major components of soil natural capital which underpins the delivery of ecosystem services, particularly provisioning and regulating services. In the way that financial capital can be assessed by the quantity of money in the bank, soil natural capital can be assessed by the stocks of nutrients, biomass and organisms etc. in the soil.

Soil samples were collocated from each 1km square to enable changes in several key topsoil characteristics in response to Glastir options to be studied (further detail of which is provided in Chapters 2 and 7). The soil samples were co-located with each of the nested vegetation plots. Four soil samples (for chemical, physical, and soil biological analysis) were collected from the top 15cm of the soil profile and a fifth, for the invertebrate sample from the top 8cm using a corer 5cm in diameter.

There were ca. 1,800 soil samples taken in Year 2

#### *1.5.2.6 Headwater stream survey*

These measurements will contribute to the Glastir outcome: Improving water and soil management; Maintaining and enhancing biodiversity.

The physical, biological and chemical condition of headwater streams was recorded to assess the impact of Glastir options on water quality (further detail of which is provided in Chapter 8). Water chemistry, diatom community, macroinvertebrate community, aquatic plant community, hydromorphological and physical characteristics of the watercourse (River Habitat Survey Amended) were recorded. The length of the headwater stream sampling site is 500m of watercourse which defines the limits of the River Habitat Survey area. Other measurements were taken within this same reach.

There were 51 GMEP 1km survey squares where headwater streams were sampled in 2014 out of the total square sample size of 90. Not all squares had headwater streams present.

#### *1.5.2.7 Pond mapping and sampling*

These measurements will contribute to the Glastir outcome: Improving water and soil management; Maintaining and enhancing biodiversity.

Two Glastir options relate to pond creation and condition and measures were included in order to assess the success of these options (further detail of which is provided in Chapter 8). A pond was defined as body of standing water 25m<sup>2</sup> to 2ha in area which usually holds water for at least four months of the year. All ponds present within the survey were mapped as part of the habitat mapping exercise from which one was selected for a detailed physical, biological and chemical condition assessment.

One pond was sampled in each of 40 GMEP 1km survey squares in 2014 out of the total square sample size of 90. Not all squares had ponds present.

#### *1.5.2.8 Description of QA activities*

Despite every effort to ensure consistency between field surveyors by rigorous training, detailed methodologies outlined in the field handbooks, quality control and frequent communication, there will inevitably be some variation. It is therefore important to produce a quantitative measure of consistency and reliability of the data. As such, a QA exercise was carried out to capture and understand this variation and to ensure that there was no significant bias in the data collected. See Year 1 report for full details. Six GMEP 1km survey squares were re-surveyed for Quality Assurance in 2014. See Appendix 1.2

#### *1.5.2.9 Bird Surveys*

These measurements will contribute to the Glastir outcome: Maintaining and enhancing biodiversity

##### *1.5.2.9.1 Breeding bird surveys*

The survey protocol described in Emmett et al. 2014 (Section 3.6.5) was followed again in 2014. Surveys were conducted on 90 squares, as used in the rest of the field survey. The bird surveys were the first conducted on each square during the year, so land access to the threshold proportion of each 1km square for surveys to be conducted was not always available at the start of the bird season in April. However, less access was sometimes needed for bird surveys than for the other field surveys because some parts of the square could be covered from public rights of way while access permissions were still pending. This caused a problem in one case only, where access permissions meant that a square was replaced in the GMEP sample after bird surveys had been conducted. This means that this square does not have the spatially matched field data from different protocols intended in the survey design, but the sample size for all protocols relative to the initial stratification remained unaltered.

As many as possible of the surveyors who had been recruited in 2013 were employed again in 2014, but some extra effort was required because the sample size was larger. The extra surveyors again came from the pool of skilled, reliable observers already known to the BTO, so no additional external recruitment was needed.

The field survey process went smoothly and completed field maps have since been processed at the BTO head office, with data from 2013 and 2014 being digitized using ArcGIS 10 for subsequent analysis under Work Package 6. This has entailed the development of efficient procedures for the processing of the data, with some inevitable trial-and-error, but systems are now in place that will facilitate rapid data provision in future years. Data on large mammals recorded during the surveys still remain to be extracted from the field maps; these will provide “added value” from the bird-focused surveys.



#### 1.5.9.2.2 Winter bird surveys

Additional survey work in 2014-2015 has considered birds in winter. This is important in order to assess the performance of Glastir options designed to provide resources for birds during winter and thus to influence breeding populations. In principle, this approach could be used for any management considered likely to influence wintering birds, but to date all options identified as potentially benefiting wintering birds are associated with arable farming. Surveys have, therefore, focused on GMEP survey squares containing more than 20% arable cropping by area, as identified by the field survey, with the addition of any squares with less arable land but in which relevant Glastir options were found. A standard survey protocol (Appendix 1.3) was applied in these squares from the 2013 and 2014 samples, in which, assuming permission had been given by the farmers concerned, a route covering all of the arable fields in the square and a representative selection of the non-arable land within the same farms was followed. This route also took in the arable fields in the focal farms that were outside the strict boundaries of the 1km square, which was important because arable management typically rotates around farms from year to year and birds, of course, will frequently move across square boundaries between seasons. Hence, arable habitats and Glastir management relevant to agreements that overlap GMEP survey squares in some years might not actually be present within the square boundary in all years. The surveys provide data on birds in arable (and adjacent) habitats that are unbiased with respect to the location of Glastir management, thus allowing investigation of the extent to which Glastir option areas are selected by birds, as well as information on use in winter that can be related to changes in breeding abundance of the species concerned between GMEP breeding bird surveys (Siriwardena et al. 2007).

Arable habitats have been rare in the survey squares covered in GMEP to date, but the two-visit winter survey protocol has been followed for the 13 squares that met the inclusion criteria, finishing in February 2015, and data will be processed in due course. Note that any tests of the efficacy of Glastir options cannot yet be conducted because only two squares covered to date included any relevant Glastir management. This reflects the rarity of the options concerned, the rarity of arable management in Wales and the targeting of the TG sample in the first two years of GMEP, which will tend to promote the sampling of habitats other than arable land.

#### 1.5.2.10 Pollinator survey

These measurements will contribute to the Glastir outcome: Maintaining and enhancing biodiversity

Butterfly Conservation subcontracted nine experienced ecologists to survey the 90 1km squares across six regions of Wales. A further region was covered by a BC employee. Pollinator surveys focused on three main pollinator groups: butterflies (*Lepidoptera: Rhopalocera*), bees (*Hymenoptera: Apoidea*) and hoverflies (*Diptera: Syrphidae*). Butterflies were recorded to species level, whilst bees and hoverflies were recorded as groups based on broad differences in morphological features associated with ecological differences. In addition, the abundance of common flowering plant groups (identified at the time of survey) was also recorded. Surveys were split into two independent parts: a standardised 2km transect route through each 1km<sup>2</sup> followed by a timed search in a 150m<sup>2</sup> flower-rich area within the square. In 2014 Year 2 field survey all 90 GMEP 1km survey squares were surveyed in July 2014 and due to access issues with one square, repeat surveys on 89 squares were completed in August 2014.

### 1.6 Future plans for Years 3 and 4

Year 3:

- The field survey for Year 3 is already underway with 75 squares selected for survey.
- Agreement if Countryside Survey squares should be incorporated with the Wider Wales Survey of GMEP

- 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
- Modelling work to quantify benefits to direct and indirect greenhouse emissions by farm type.