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What can management option uptake tell us about ecosystem services delivery through agri-environment schemes?

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ABSTRACT

Agri-environment schemes (AES), currently embedded in EU and UK policies, actively promote 'greening', 'sustainability' and 'ecosystem services' approaches to land management. The funding structures of these policies, however, run counter to this sustainable approach, and create barriers to AES success, primarily through a continued focus on productivity support. In this study, we aim to determine the effectiveness of action-based AES, as a delivery mechanism for ecosystem services, using secondary data analysis techniques to unravel the complexities of AES funding distribution and scheme structure and geographic information systems (GIS) to explore the spatial extent and uptake of AES management options, using Wales, UK as a study area. Our results show 84% of recipients of AES payments receiving <£10k annually, comprising only 35% of the total available funding. 15, out of a total of ~165, management options, accounted for >75% of all advanced level management contracts awarded in both 2015 and 2017. This bias in option uptake, in many cases, positively prevents further deterioration of existing habitat condition through a 'business as usual' approach. However, we argue that the voluntary, over prescriptive nature of the schemes limits management option uptake, negatively impacts on the schemes ability to deliver ecosystem services, and lessens the government's ability to promote long-term behavioural change. If AES are to deliver the '"Public Goods"' that future policy demands, then targeted and adequate levels of funding and a willingness to participate must be combined with greater farmer autonomy and clear outcomes to deliver management options at a landscape scale.

Keywords: Conservation; Ecosystem services; Glastir; Habitat management. Land use policy.

1. Introduction

The '*Sustainable growth: natural resources'* category funds the Common Agricultural Policy's (CAP) two payment streams (Keep, 2017). First, is the European Agricultural

Guarantee Fund (EAGF) (Pillar 1) which makes payments directly to farmers, and funds measures to regulate agricultural markets, and second, is the European Agricultural Fund for Rural Development (EAFRD) (Pillar 2) which aims to develop rural economies and increase the productivity of farming and forestry. As a direct result of the 23rd June 2016, UK referendum on EU membership, the UK payment structure is facing reform and is likely to move away from this two Pillar structure (Helm, 2017; Dwyer, 2018; Gove, 2018). Future financial support is expected to pay farmers to deliver clear environmental or ‘public good’ benefits rather than through direct payments (Gove, 2018; WG, 2018). In the EU, an average of 16.8% of the EAFRD is spend on Agri-Environment-Climate contracts but in the UK, this currently varies between the devolved nations (Gravey, et al., 2017). The Welsh Government (WG) views agri-environment schemes (AES) as, “the state … buying environmental goods and services (“Public Goods”) from farmers who would otherwise not supply them” (Rose, 2011). This would suggest, that in Wales, structures are in place to meet the UK government’s challenge (Gove, 2018) to enhance our natural environment and hand on a country, and a planet, in a better state than we found it. The current ‘action-based’ AES schemes, employed across the UK to deliver environmental outcomes, include a suite of land management ‘options’, designed to ensure the availability of suitable options, across all land types, within the remit of the particular scheme (Rose, 2011; Munday, 2018). However, the prescriptive nature of this type of scheme is often seen as a barrier to scheme uptake (Wilson and Hart, 2000) and long-term behaviour change (de Snoo et al., 2013). The cost-effectiveness (Ansell et al., 2016), and ecological impact of this type of 'action based' AES, on birds (McHugh et al., 2016; Princé et al., 2012; Sabatier et al., 2012: McHugh et al., 2016), insects (Wood et al., 2015; Caro et al., 2016) and biodiversity (Kleijn and Sutherland, 2003; Kleijn et al., 2006; Fuentes-Montemayor et al., 2011; Wilkinson et al., 2012; Ekroos et al., 2014) is also widely debated in the literature. Many suggest schemes which link payments to the provision of desired environmental outcomes, rather than to prescribed management activities, could represent a more effective way of rewarding farmers for the delivery of “Public Goods” (Matzdorf and Lorenz, 2010; Sabatier et al., 2012; Moxey and White, 2014; Russi et al., 2016). It is also argued that ‘results-based’ schemes are more effective at enhancing social capital (Burton and Schwarz, 2013) and redirecting much needed funding to marginal upland, and some lowland areas, where income streams are low (Helm, 2017). Current studies consider the advantages, and disadvantages of both action, and results-based AES, in determining effectiveness but we found none that focus on the impact that option uptake and payment distribution may have on effectiveness.

In the present study, we aim to determine if current action-based AES are an effective means of delivering ecosystem services, using Wales as a study area. We achieve this by using secondary data analysis techniques to unravel the complexities of AES funding distribution and scheme structure, and GIS to explore the spatial scale and uptake of AES management options. We discuss the findings to establish if the payment distribution and option management structures of AES, currently funded through the CAP, provide effective ecosystem services delivery, or additional income support streams for farmers in low production areas. In conclusion, we suggest how a UK exit from the EU can provide policy-makers with the opportunity to design AES which can effectively deliver ‘“Public Goods”’ whilst subsequently providing farmers with the additional human and social capital needed to fully support social, economic and cultural objectives in Wales.

Methodology

2.1. Study area

Wales was selected as the case study area for its focus on sustainability (WG, 2015a; WG, 2016a; WG, 2017a), and for the following reasons: (i) agriculture being the dominant land use (84% of the total land area of 2.1 million ha; WG, 2017b), (ii) the proportion of famers who participate in AES (in 2017, 4781 farmers received AES payments, representing 13% of the total number of holdings in Wales; Defra, 2017b), (iii) the low average income of most farmers and their reliance on Direct and AES payments (62% of cattle and sheep farms (less favoured area, LFA) either made a loss or would have done so without subsidy, compared with 41% of cattle and sheep (lowland) farms and 44% of dairy farms; WG, 2017c), (iv) amount of land (0.8 million ha) being in higher or entry level AES (JNCC, 2017a), and (v) the availability of reliable AES data.

2.2. CAP payments data

Secondary data analysis techniques were used to identify the extent, and distribution, of current spending on agri-environment schemes (Johnston, 2014). The 2015/2016 CAP payments datasets, published for transparency by Defra (2017b) in compliance with Regulation (EU) No 1306 (EC, 2013) and Commission Implementing Regulation (EU) No 908 (EC, 2014), were used as the primary data source. Produced for accountability at both UK and EU governmental levels, these datasets are an accurate reflection of spending on rural development (Pillar 2) in the UK.

The dataset variables include funding categories, payment beneficiaries and total farm payment received. We created agricultural production, social, agri-environment and support and forestry, target area variables and assigned funding categories to the relevant target area based on descriptions found in Wales' 2014-2020 Rural Development Programme (WG, 2017d). We summed funding category payments in each focus area giving total expenditure per target area category and expressed these as a percentage of total Pillar 2 expenditure. We expressed total AES expenditure as a percentage of total Pillar 2 and of total CAP expenditure. The total number of recipients receiving financial support through both Pillar 1 and Pillar 2 payments and those receiving payments for agri-environment were collated to quantify the percentage of 'active farmers' enrolled in AES.

Payments were collated by postcode prefix (first two letters (postcode area) = postal town/ postcode district; number following postcode area = location within the postal town boundary) and a detailed analysis was conducted to identify the total number of recipients, the total payment per district and the mean farm-level payment. The total number of payment recipients and the total payments expenditure within the postcode district was expressed as a percentage of the total recipients and expenditure across Wales. Sixteen payments categories in the range £0-400k recipient^{-1} were generated and the total number of recipients and total payments made identified in each of the payment ranges.

2.2. Glastir AES data

The Glastir AES provides financial support to farmers and land managers to promote sustainable land management (Rose, 2011). Rural Payments Wales (2017) provided anonymised ESRI ArcInfo polygon shapefiles, mapped to OS Mastermap features at a 1:10000 scale, for the Glastir Entry (GE), Glastir Advanced (GA), Glastir Commons (GC), Glastir Woodland Creation (GWC) and Glastir Woodland Restoration (GWR) elements for the years 2015 and 2017. The first 5 year Glastir contracts started on 01st January 2012 and ended on 31st December 2016 (WG, 2012). Access to both the 2015 and 2017 datasets allowed for comparisons between option uptake pre and post the end of the first 5-year contractual period. Datasets for the Glastir Efficiency Grants (GEG), Glastir Organic (GO) and Glastir Small Grants (GSG) were not available. We provide a full description of the Glastir AES elements in Appendix A.

Natura 2000 (NRW, 2015) apportions Glastir management options to land management categories (Habitat, Tree, Infrastructure and access, Water and drainage, Stock, Wildlife, Agri-management, Vegetation and birds). In this study, we extracted management option descriptions from the RPW attributes data (RPW, 2017) and grouped them by Natura 2000 management categories. We used the total number of management contracts awarded to identify the most popular 15 options, and the most prominent management categories, for GA and GE. Appendix B contains further details on the breakdown of each of the management categories. ArcGIS-ArcMap 10.4.1 (ESRI, 2017) was employed to conduct a spatial analysis of the options data using overlay and geoprocessing techniques. Comparisons were made with the Predictive Agricultural Land Classification (ALC) Map 2017, designed on a 50 m raster (1:50,000) (WG, 2017e) and the Habitat Land Cover Map 2015 (LCM2015; CEH, 2017) supplied as a vector product with a minimum mappable unit of 0.5 ha and a minimum feature width of 20 m.

3. Results

3.1. CAP and AES payments to farmers in Wales

The UK receives a total of £2.8 billion per year from the EU to cover payments made under CAP. Pillar 1 gives around £2.3 billion per year to UK farmers mainly under the Basic Payments Scheme (BPS), provided they carry out certain agricultural activities and comply with standards in areas such as food safety, animal welfare, environmental protection and land maintenance. Pillar 2 gives £0.6 billion of EU funding per year to fund rural development programmes in the UK (NAO, 2017). In 2016, total spending in Wales was £248 million with £190 million allocated to Pillar 1 and £58 million to Pillar 2 (Fig. 1).

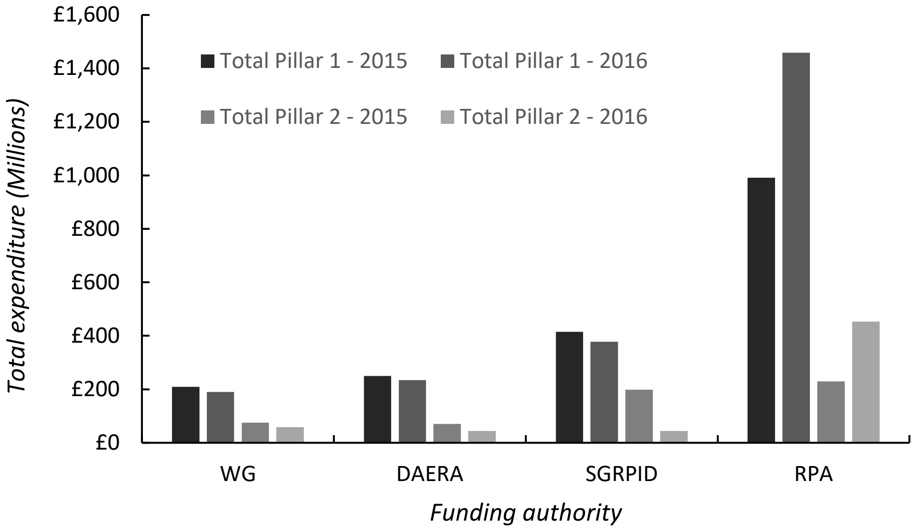

Figure 1. Total UK spending on Pillar 1 and Pillar 2 subsidies for the 2015/16 period divided by individual country. WG (Welsh Government), DAERA (Department of Agriculture, Environment and Rural Affairs, Northern Ireland), SGRPID (Scottish Government Rural Payments and Inspections Directorate) and RPA (Rural Payments Agency, England). (DEFRA, 2017).

Table 1 shows the distribution of Pillar payments by funding category and focus area. Overall, 63% of Pillar 2 funding was spent on AES (2.2% in admin support) and 23% in support of production with the remainder split on administration (3.2%), forestry creation and restoration (8.4%) and support for social enterprises (2.4%).

Table 1. Distribution of Pillar 2 subsidies in Wales by funding categories and focus area (DEFRA, 2017).

Funding category	Payment (£)	Payments (% of total)	Focus area
Technical assistance	1,849,989	3.2	Administration
Non-productive investments	1,288,860	2.2	Agri-environment (Support)
Agri-environment-climate	27,834,285	47.8	Agri-environment
Agri-environment payments	7,573,423	13.0	Agri-environment
Investments in physical assets	7,657,814	13.0	Production
Organic farming	3,957,679	6.8	Production
Development of new products, processes and technologies	942,128	1.6	Production
Modernisation of agricultural holdings	883,297	1.5	Production
Implementing local development strategies	33,810	0.1	Production
Implementing cooperation projects	47,505	0.1	Production

Investment in forest area development and improvement of forest viability	3,222,356	5.5	Forestry
Adding value to agricultural and forestry products	1,532,227	2.6	Forestry
First afforestation of agricultural land	106,051	0.2	Forestry
First afforestation of non-agricultural land	17,132	0.1	Forestry
Implementing local development strategies. Quality of life/diversification	456,453	0.8	Social
Basic services for the economy and rural population	366,332	0.6	Social
Skills acquisition, animation and implementation of local development strategies	244,731	0.4	Social
Vocational training and information actions	170,782	0.3	Social
Running the local action group, acquiring skills and animating the territory	104,751	0.2	Social
Payments to farmers in areas with handicaps, other than mountain areas	48.87	0.1	Social
Total	58,289,654	100.0	

Analysis of AES payments and recipient numbers by postcode areas showed the North-West region (LL postcode) received the largest proportion of AES funding and has the highest levels of participation. The South-West region (SA postcode) had slightly lower levels of participation but funding does not match that of the North-West suggesting participation occurring on a smaller scale (Fig. C1). We observed uneven distribution patterns between payment ranges (Fig. 2). Analysis of farm payment data revealed that 84% of recipients of AES payments were in the £0-10k category, comprising only 35% of the total available funding. Of these, 54% of the recipients received <£4k year^{-1} (Fig. C2). In contrast, <1% of the total number of recipients received payments exceeding £100k, accounting for 14% of the total available funding.

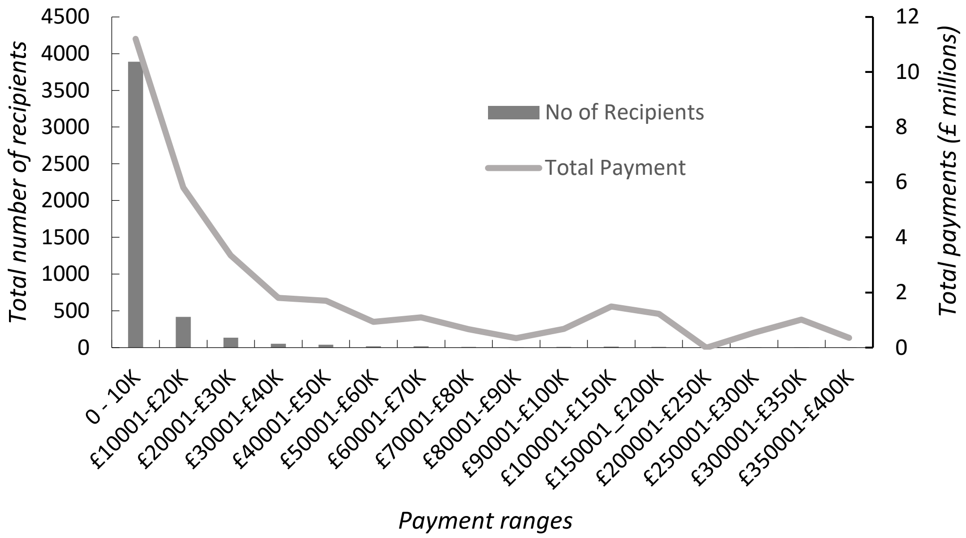

Figure 2. Distribution of 2016 agri-environment payments in Wales/UK showing the total number of recipients and the total payments received by payment range (DEFRA, 2017).

3.2. Distribution of options within the Glastir entry (GE) and Glastir advanced (GA) AES

Glastir is the latest in a line of AES which has seen land involved in Welsh AES rise from 0.01 million ha in 1992 to 0.25 million ha in 2016 (Banks and Marsden, 2000; JNCC, 2017). Glastir contracts consist of a Whole Farm Code (WFC), which contains general rules affecting all land on the farm, and various management options (Table C1; Table C2). In GE level schemes, farmers select options that meet or exceed a point's threshold related to the area of eligible land on the farm entered into the scheme (WG, 2015b). In GA level schemes, applying farms are assessed for their ability to deliver against objectives (WG, 2015c). The maps in Figure 3 show the uptake and distribution of management options within land parcels entered into agreements under the Land Parcel Identification System (LPIS; see Appendix A for further details of the LPIS). This enabled us to highlight the levels of spatial overlap between schemes, especially at GA and GE levels where, prior to 2015, participation in the lower level scheme was a prerequisite for entry into the higher. Our study shows the greatest concentration of AES management options occurring in upland unimproved agricultural areas (Agricultural land classes 4 and 5; Fig. 4a) predominantly comprising of acid and calcareous grasslands and heather moorland habitats (Fig. 4b).

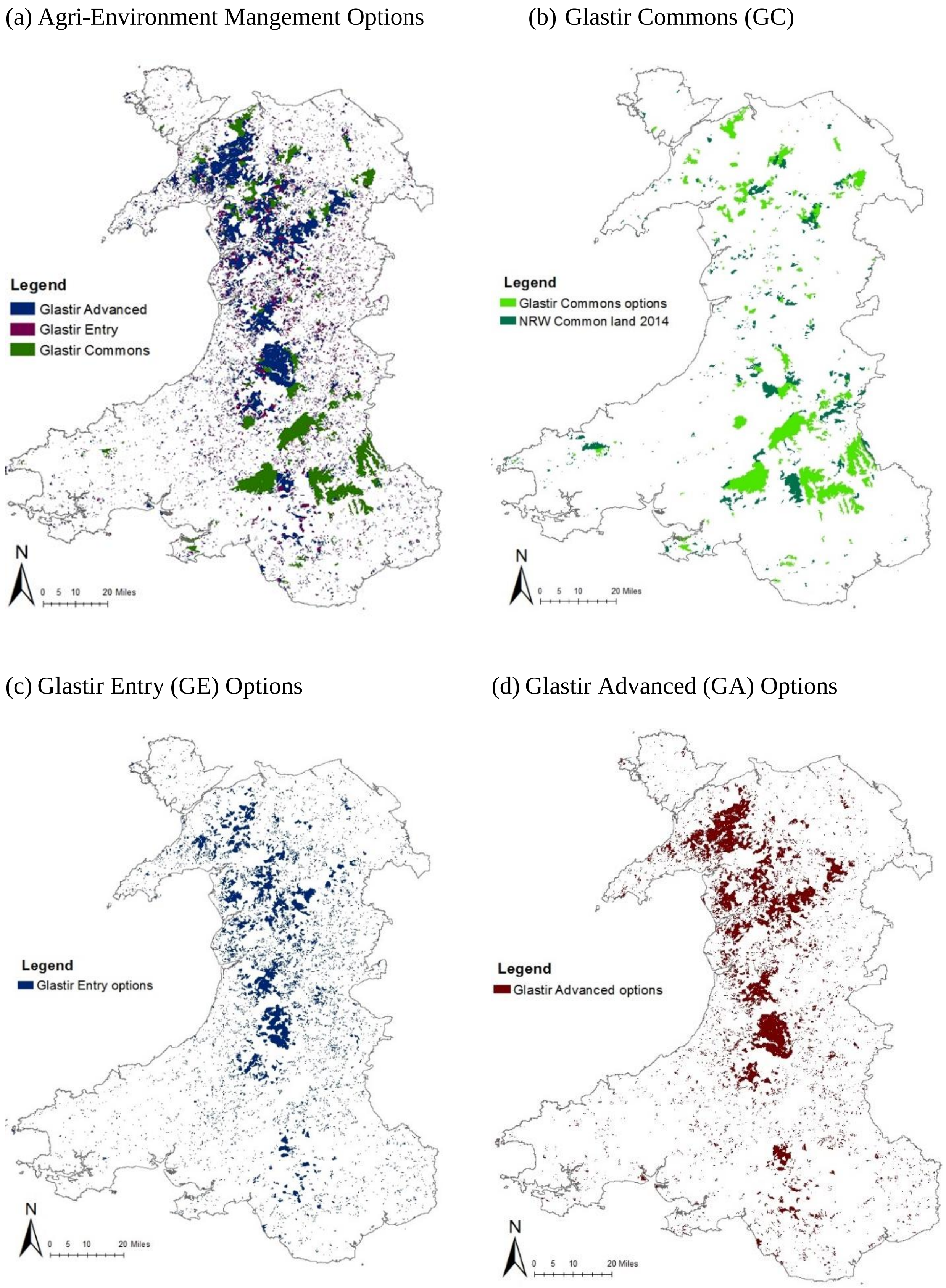

Figure 3. Scale and concentration of targeted management options within land parcels entered into the agreement under the land-parcel identification system (LPIS) in Wales. (a) Combined agri-environment schemes, (b) Glastir Commons superimposed onto the NRW (2014) Registered Common Land map (RPA, 2017), (c) Glastir Entry, and (d) Glastir Advanced. © RPA /NRW/ WG. © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service.

3.3. Distribution of Glastir commons (GC) Glastir woodand creation (GWC) and Glastir woodland regeneration (GWR)

In 2016, GC covered 118,000 ha of common land (JNCC, 2017). This was significantly higher that under the predecessor to Glastir (Tir Gofal, 1999-2011), where agreements covered only 2% of the common land in Wales (WG, 2015d). By superimposing the 2017 GC dataset onto the NRW (2014) Registered Common Land Map we were able to create a GC distribution map (Fig. 3b) showing GC management options covered 65% of common land, principally upland habitats.

"Woodlands for Wales", the Welsh Government's fifty-year strategy for promoting woodland planting and management in Wales, was published in 2001 and revised in 2009 (WG, 2015e). It contained an aspiration to create 100,000 ha of new woodland between 2010 and 2030 as a means to help Wales meet its carbon emission reduction targets (WG, 2010; WG, 2016b). The latest indicators of its success (WG, 2015e), however, showed a slight decrease in the estimated area of woodland cover in Wales from 2001-2010. With a requirement to deliver woodland planting at a rate of 5,000 ha annum^{-1} this target was subsequently assessed to be unachievable and a government-commissioned review in 2014 amended the aspiration to 50,000 ha by 2040 (WG, 2016b). We show the uptake of GWC options across the country to be very limited, occurring on a small scale and often located on existing acid grasslands (Fig. 4b; Fig. 4d). GWR options aim to replant areas of larch *Larix decidua* felled to help prevent the spread of *Phytophthora ramorum* disease (WG, 2017c). Fig. 4d shows a greater uptake of GWR options than GWC, restoring woodland in areas currently devoid of trees, (Fig. 4c). Uptake of GA and GE level woodland options is low and sporadically distributed throughout the country (e.g. GA woodland options made up only 9% of the total option uptake in 2015, dropping to 3% in 2017; Fig. 4d).

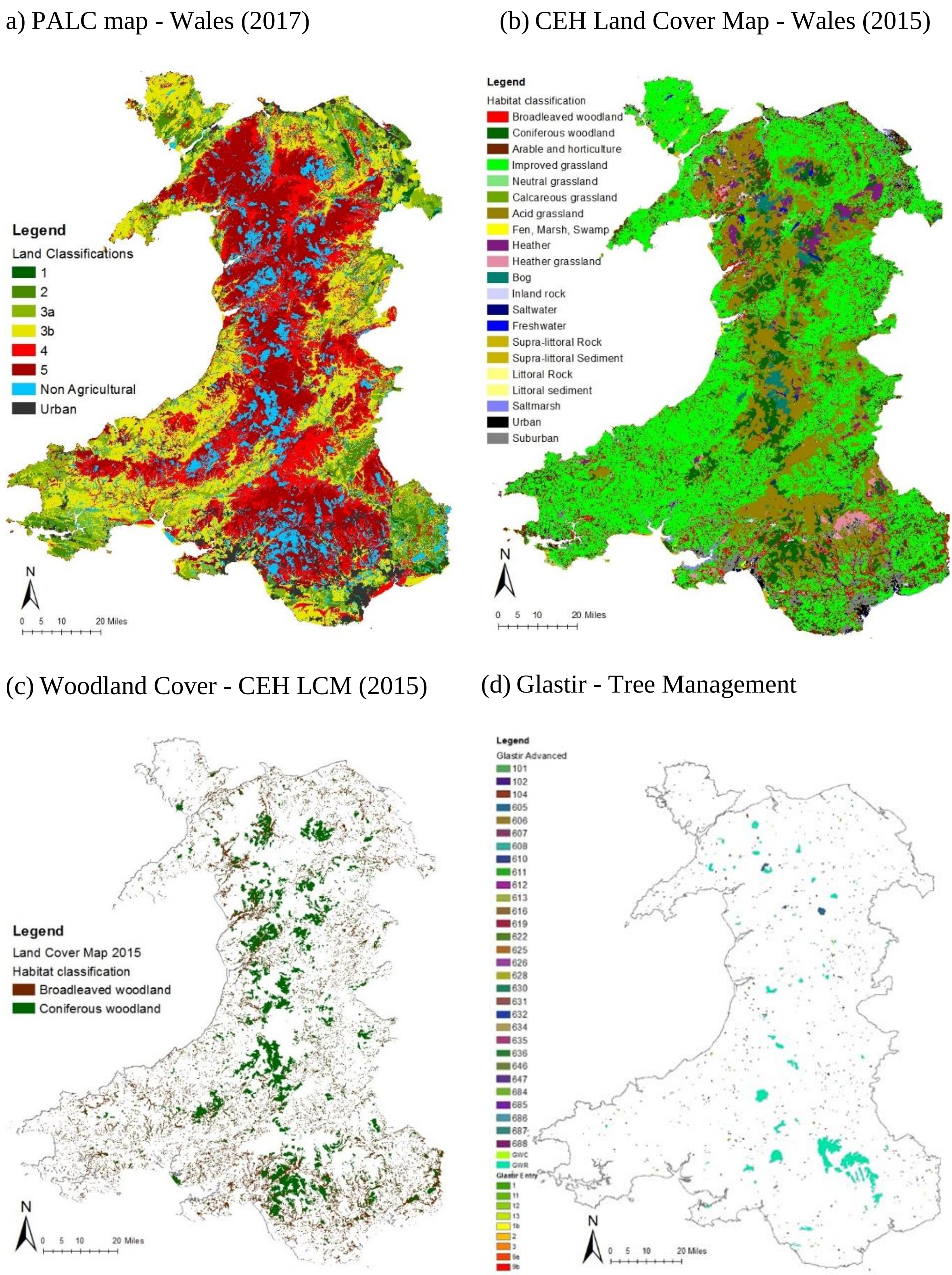

Figure 4. (a) Predictive Agriculture Land Classification (PALC) (See Appendix A for land classification descriptions). (b) Land Cover map for Wales. (c) The distribution of woodland habitats in Wales and (e) The woodland management options delivered through Glastir Advanced, Entry, Woodlands Creation and Woodlands Restoration. (RPA, 2017; CEH, 2017; WG, 2017e). *© Welsh Government © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service.*

3.4. Glastir management options and land management categories

Glastir AES contracts are issued for a five-year period. In 2015, there were 168 targeted GA and 57 GE management options available to farmers. In 2017, the number of managed options had changed, 166 for GA (Table B1) and 61 for GE (Table B2). Of those, 15 management options accounted for >75% of all management contracts awarded in both 2015 and 2017. Further, ca. 40% of all GA and GE management options were targeted towards low or no input grazed pasture or woodland stock exclusion (Table 2). In 2017, 78 of the 166 GA options, individually, comprised $\leq 0.1\%$ of the total option uptake. Of these 35 options had <10 contracts awarded per option.

Table 2. Top 15 management agri-environment scheme options adopted by farmers in the Glastir Entry (GE) and Glastir Advanced (GA) schemes in 2017 (RPA, 2017).

Option description	**No. of contracts awarded**	**Options (% of total)**
Glastir Entry (GE)		
1. Grazed pasture - no inputs	10759	18.2
2. Grazed pasture - low inputs	10547	17.9
3. Management lowland marshy grassland	5306	9.0
4. Hedgerow management - both sides	3253	5.5
5. Hedgerow management external boundary (1 side only)	3128	5.3
6. Continued management of existing streamside corridor	2886	4.9
7. Enhanced hedgerow management - both sides	2180	3.7
8. Grazed pasture - low inputs and mixed grazing	2105	3.6
9. Hedgerow restoration without fencing	1931	3.3
10. Hedgerow restoration with fencing	1681	2.8
11. Maintenance existing hay-meadow	1634	2.8
12. Grazing management of open country	1345	2.3
13. Grazed pasture - no inputs and mixed grazing	1201	2.0
14. Create streamside corridor on improved land on both sides of a watercourse	1170	2.0
15. Create streamside corridor on improved land on one side of a watercourse	955	1.6
Total	50081	84.9
Glastir Advanced (GA)		
1. Grazed pasture - no inputs	11391	20.6
2. Woodland - stock exclusion	10438	18.9
3. Lowland marshy grassland	2758	5.0
4. Management lowland marshy grassland	2657	4.8
5. Grazed pasture - low inputs	2531	4.6
6. Additional management payment - reduce stocking	2246	4.1

7.	Grazing management of open country	1671	3.0
8.	Streamside corridor management	1549	2.8
9.	Hard surfacing	1531	2.8
10.	Maintenance existing hay-meadow	1098	2.0
11.	Enhanced hedgerow management - both sides	1095	2.0
12.	Scrub clearance - hand	1028	1.9
13.	Bracken control - mechanical two cuts/year	824	1.5
14.	Lowland unimproved acid grassland	636	1.1
15.	Grassland managed with no inputs between Oct. and Jan	631	1.5
	Total	42084	76.6

3.5.Habitat management

The uptake of habitat management options exceeded all other management categories in both GA and GE across both years (Fig. B1). Overall, 58% of GA options were targeted at habitat management and 19% to stock management while for GE, 44% of the options delivered habitat management in the form of grazed pastures and stock reduction/exclusion (Fig. 5). Comparison between the distribution of zero, (Fig. 5cd) or low-input (Fig. 5e), grazing options and management of open countryside (Fig. 5f) with land cover (Fig. 4b) found the greatest concentration of these options occur on acid or calcareous grasslands (ALC class 4 and 5) where there is little history of land improvement or nutrient input (i.e. business as usual) regardless of entry in AES. These options will help ensure the maintenance of low or no input situations, preventing increases in nutrient burdens over the 5-year contractual period.

3.6.Livestock exclusion/reduction and vegetation management

Comparison between vegetation management options to promote biodiversity (Fig. 6b) and stock exclusion (Fig. 5a) and stock reduction (Fig. 5b) options shows significant overlap (i.e. conflict) within the same land parcels. Analysis of the extent of upland and lowland bracken cover (Fig. 6a) was shown to far exceed the levels of bracken control (Fig. 6b) provided through GA and GE management options.

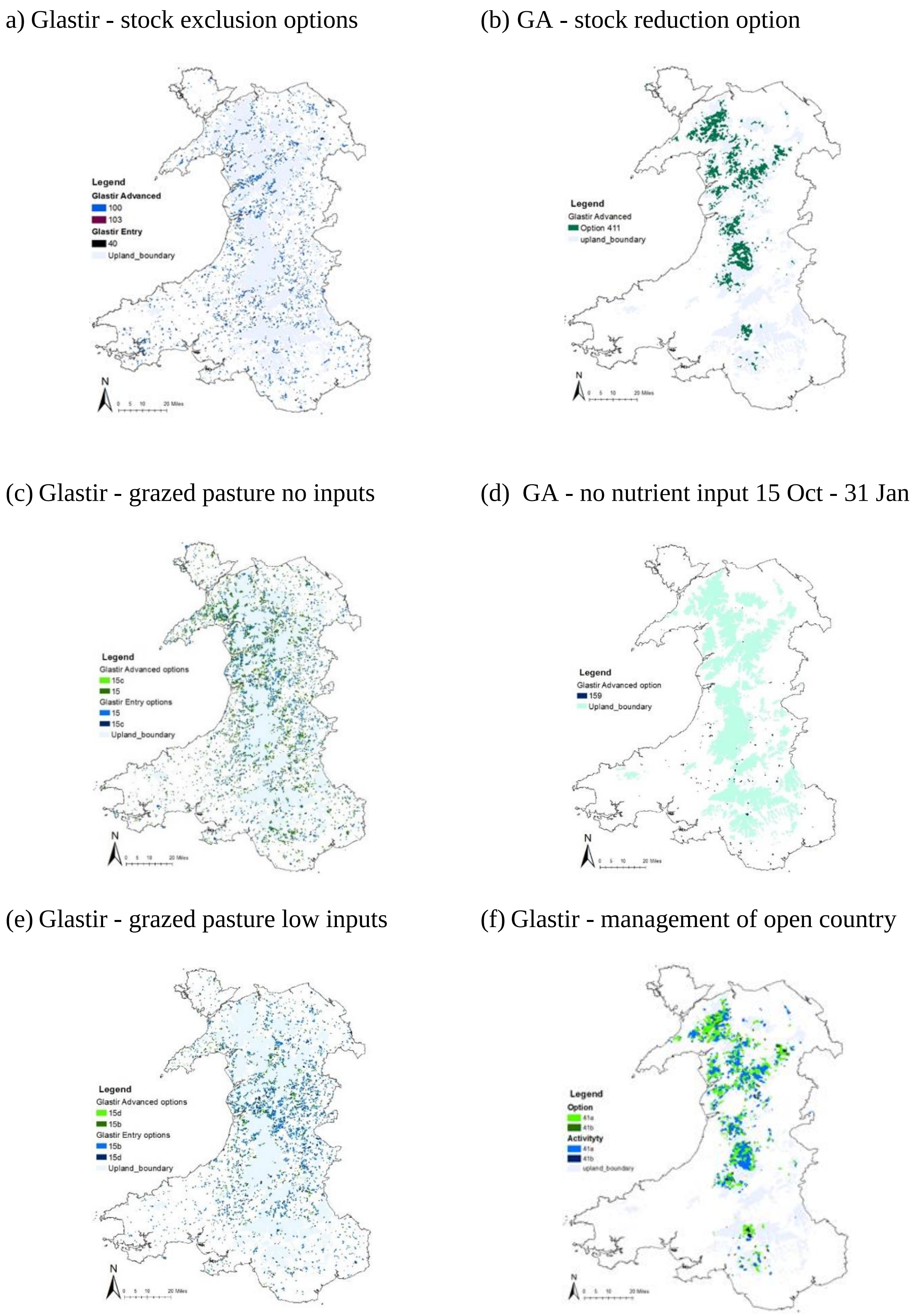

Figure 5. Habitat management by grazing and stock exclusion in 2017. (a) Stock exclusion management options for GA/GE. (b) GA stock reduction option. (c) GA/GE grazed pastures with no inputs and with no inputs and mixed grazing. (d): Stock exclusion during certain dates. (e): GA/GE grazed pasture with low inputs and with low inputs and mixed grazing. (f): GA/GE management of open country options (RPA, 2017). © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service.

3.7. Habitat management for birds

GA has a number of management options aimed at habitat management to promote bird populations (Fig. B6). Figure 6c shows the relatively low uptake and sparse distribution of these options at the national scale. Using lapwing (*Vanellus vanellus*) management options as an example, we explored distribution patterns to identify the potential effectiveness of current options. Overlaying the GA management options for lapwing onto the current lapwing distribution map (Zolnai, 2017; Fig. 6d), showed no habitat management options occurring close to the highest lapwing population areas. Conversely, it showed concentrations of option uptake in areas with no previous history of nesting lapwing populations.

3.8.Water related management options

Water related AES options make up only 3% of total option uptake, and consist of options mainly targeting riparian zones through streamside corridor management, and the introduction of buffer zones (Figs. B1-2). The majority of streamside management contracts are awarded in the 'broad and shallow' GE element (Fig. 7 a). Jones et al., (2017) demonstrate that AES can deliver reductions in diffuse pollution from agriculture but scheme effectiveness is difficult to determine and effects, where detected, are not evenly distributed across the landscape. This study supports these findings by showing an uneven distribution of GA management options countrywide, with large gaps in coverage in the South East and South West. A comparison with the Water Watch Map (NRW, 2016), which provides key information relating to the Water Framework Directive (EC, 2000) river water quality classifications, (Fig. 7b), shows major gaps in management option distribution coinciding with areas with the poorest water quality.

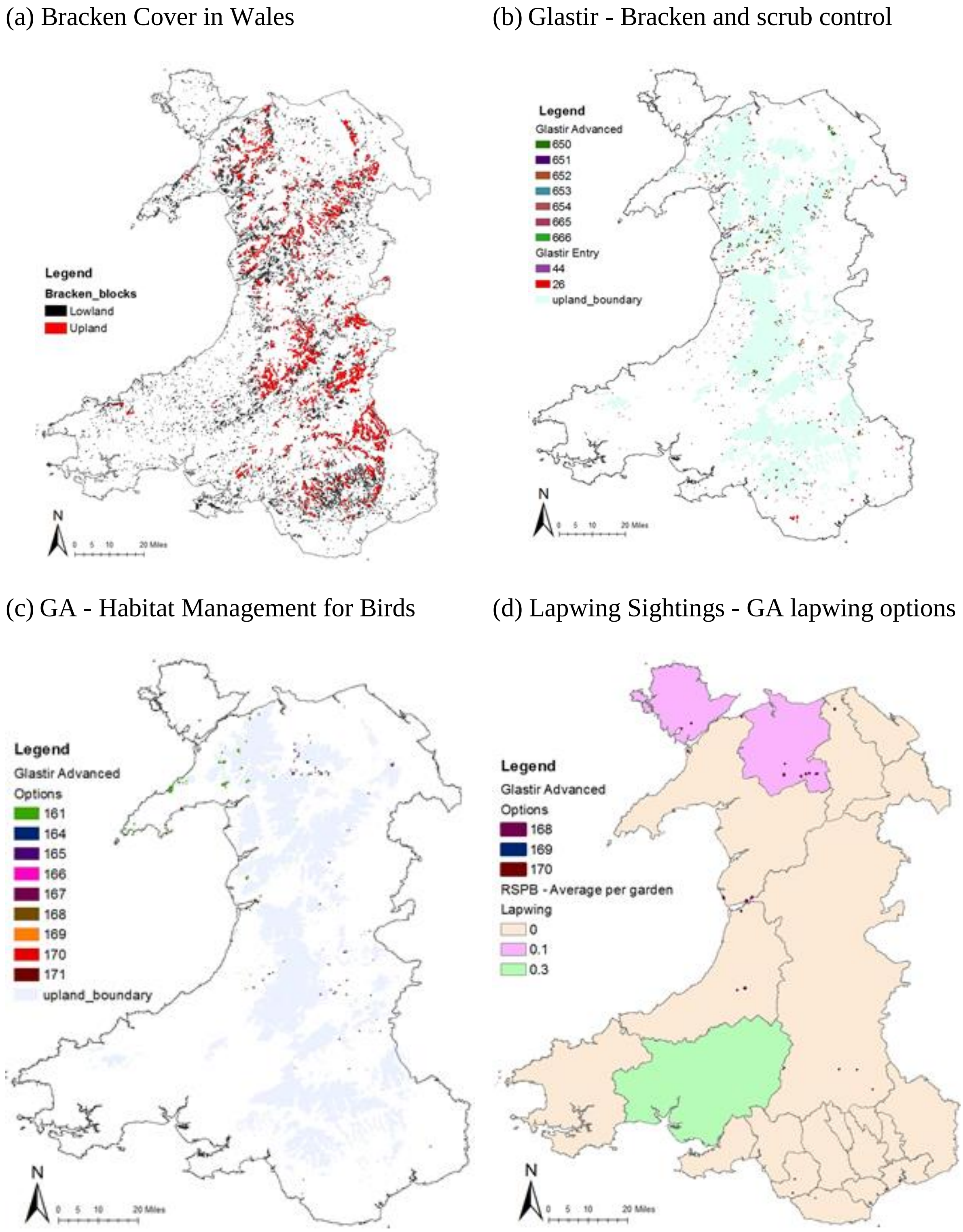

Figure 6. Vegetation and bird management categories. (a) Bracken coverage map taken for the NRW Phase 1 terrestrial habitat data. (b) GA and GE bramble, bracken and scrub management options (Aerial, hand, mechanical and tractor delivered). (c) The distribution of GA options targeting lapwing habitat and (d) the results from the RSPB Garden Survey (2016) showing the mean sightings of lapwings Vanellus vanellus in Wales (RPA, 2017; Zolnai, 2017). "Contains Natural Resources Wales information © Natural Resources Wales and database right". © RSPB © RPA/WG © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service. Ordnance Survey license number 100019741.

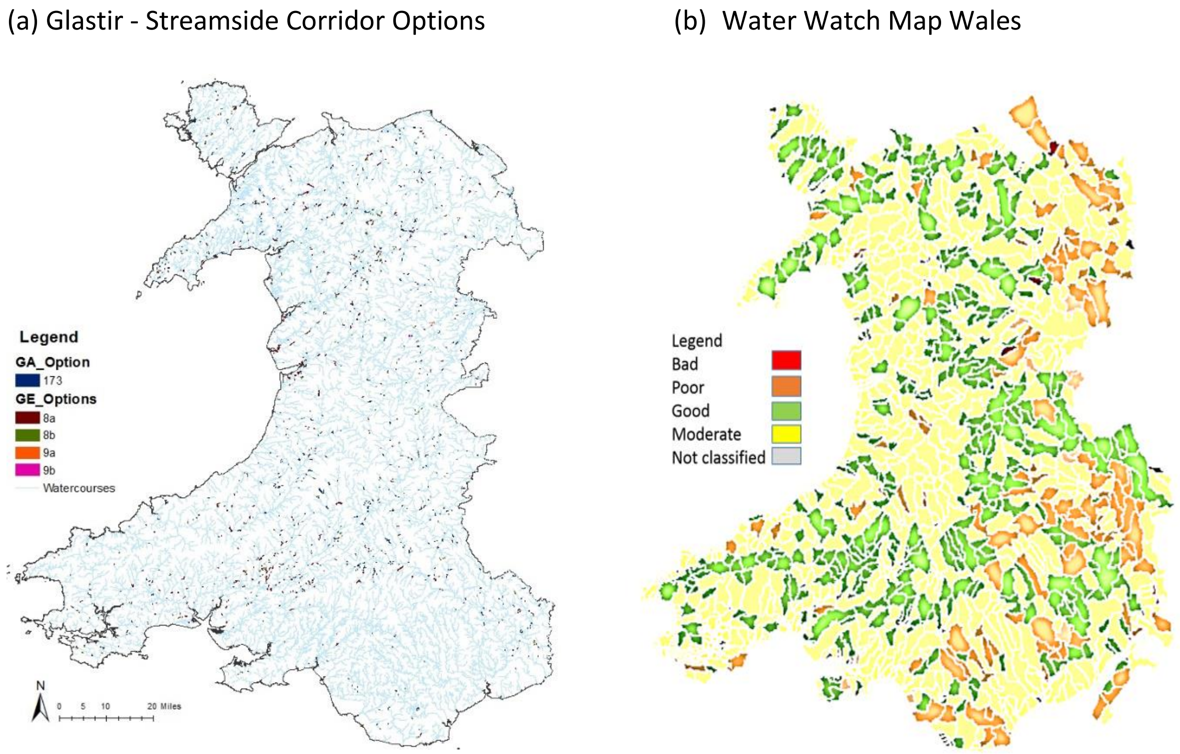

Figure 7. (a) Glastir Entry and Glastir Advanced streamside corridor management options overlaid onto the river courses of Wales (OS, Opendata, 2017). (b) The Water Watch Map of Wales - Cycle 1 Rivers and waterbodies showing the condition of the river from poor to good with an 'as yet unclassified' category (RPA, 2017; NRW, 2016b).

4. Discussion

4.1. Policy and payments data

Historically, a primary role of the CAP has been the provision of income support and social security for farmers (Helm, 2017), however, previous studies have found farms receiving greater direct payments were less efficient, on average, than other farms (Kleinhanß et al., 2007; Ferjani, 2008; Latruffe et al., 2017). Focusing on the distribution of AES funding, we show higher levels of funding in areas most suited to the delivery of ecosystem services, namely mid and north Wales. On a spatial scale, we view this distribution pattern positively, but argue that individual payment distribution patterns show, that like Pillar 1 payments (Helm, 2016), the majority of payments go to bigger and richer landowners with the majority (84%) of recipients receiving only 35% of the total AES budget.

It could be argued, that to achieve landscape-level impacts, funding should focus on those able to deliver AES on a large scale. We agree, but will show that in Wales the majority of recipients of AES payments deliver prescriptions on a field-scale level and argue that the prescriptive nature of the schemes means that the 957 farmers receiving 65% of the funding do not effectively deliver ecosystem services at a landscape-level. Difficulties arise in assessing the full impact of AES as habitat change is slow due to lag times in ecosystem processes (Emmett et al,. 2017), but we argue that the effectiveness of AES on a temporal scale will be significantly impaired by the spatial scale of delivery combined with the prescriptive, action-based nature of Pillar 2 funded schemes.

Future agricultural subsidy support is likely to be linked to the provision of ‘Public Goods’ (Gove, 2017), which are described as goods and services with properties of non-rivalry and non-excludability (Dwyer et al., 2015), which are often under-produced, or not produced at all in the private sector (Holcombe, 1997). This means that, less favoured areas (upland habitats), with their deeply entrenched ecosystem services and goods, are likely to feature significantly in the distribution of future funding. Such habitats are the source of around 70% of the UK’s drinking water, hold an estimated 40% of the UK’s soil carbon, and include some of the country’s most iconic cultural and aesthetic landscapes (UKNEA, 2011). The innovative ecosystem services approach, currently promoted by the Welsh Government as a delivery means, commodifies environmental goods in an attempt to counteract market failures, but it is not without challenges to its implementation (Davies-Jones, 2011; Wynne-Jones, 2013; Potter and Wolf, 2014). If policy-makers, engage farmers in scheme design (Davies-Jones, 2011), provide knowledge and skills that enhance cultural and social capital (Wynne-Jones, 2013) and overcome the methodological challenges of linking payments to outcomes (Potter and Wolf, 2014) they may be able incorporate these commodities into the production chain and hypothetically, create a ‘win-win’ situation, certainly in upland areas.

The first barrier to the success of AES and the delivery of 'Public Goods' is that of economics. The CAP, through its 'greening' element and Wales, through the Well-being of Future Generations (Wales) Act 2015 (WG, 2015a), uses a multi-functional, environmentally friendly discourse to promote social, economic, environmental and cultural sustainability (Daugbjerg and Swinbank, 2016; Davies, 2016, 2017; EC, 2017). However, this sustainability discourse is not reflected in reality when it comes to funding (Erjavec and Erjavec, 2015). Agricultural subsidies are heavily skewed towards direct support payments. For example, <15% of total agricultural support funding available in Wales is spent on AES with the remainder being spent in support of production and the development of rural communities (Defra, 2017b).

In Wales, the highest levels of AES payments are disbursed in areas rich in upland habitat, low-input farming and low farm incomes. This positive distribution pattern implies a level of targeting by the policy-makers and a willingness by farmers, in these areas, to participate in AES. Theoretically, this combination of targeted funding, suitable landscape and a willingness to participate should result in the successful delivery of "Public Goods". In reality, this combination has failed to effectively deliver results, for example, greenhouse gas (GHG) emissions from agriculture in Wales increased slightly 2009 and 2015, although they were 15% below 1990 levels (CCC, 2017), the UK farmland bird index decreased 9% between 2010 and 2015 (Defra, 2017c) and since 2013, the amount of farm woodland within a grant scheme has begun to decrease (WG, 2015e). In addition, the Auditor General for Wales (2014) found the Welsh Government had missed most of its targets for Glastir due to farmer participation being well below those expected by government. Where AES contracts are in place, their effectiveness is difficult to measure, partly due to a lack of measures to evaluate success (Auditor General for Wales, 2014; Jones et al., 2017). Direct subsidy removal would reduce farm household dependence on on-farm income/subsidies potentially creating externalities, which may be positive or negative. In New Zealand, which had a similar subsidy support system to Wales (Federated Farmers of New Zealand, 2002), sheep and beef farmers suffered severely, while for dairy, horticulture and cropping units the overall impact was generally minimal (Smith and Montgomery, 2004). Farming practices changed, dairy farming intensified and expanded dramatically whilst the sheep and beef sectors declined (Federated Farmers of New Zealand, 2002; Smith and Montgomery, 2004; Foote et al., 2015). Levels of intensification required to deliver production increases, which match subsidy loss, is likely to simultaneously increase negative environmental externalities (Foote et al., 2015). In contrast, sudden changes to the farmer's economic situation has the potential to directly impact on farm viability and increase the risk of land abandonment (Terres et al., 2015). Whilst abandonment may increase carbon sequestration (Munroe et al., 2013) and restore habitats (Keenleyside and Tucker, 2010), it also has the potential to reduce farmland biodiversity (Renwick et al., 2013), create fire risks (Moravec and Zemeckis, 2007) and impact on the cultural landscape (Navarro and Pereira, 2015). However, a shift in policy from a direct payment support system to a 'Public Money for Public Goods' approach (Gove, 2018) is likely to see upland farms in the less productive agricultural areas, more favourable to 'Public Goods' delivery, become the main beneficiaries (Helm, 2017) and that may encourage more farmers to enter AES (Lastra-Bravo et al., 2015). Financial investment which enhances farmer participation post-Brexit will help to deliver the "more" approach of Lawton et al. (2010), but significant improvements in the effectiveness of AES through the "bigger, better and joined" approach can only come through commitment to change. Governments must consider scheme design and clearly define the objectives, impact and spatial scale over which they expect schemes to deliver (Auditor General for Wales, 2014).

4.2. The spatial scale of scheme delivery and financial support

The spatial scale at which an AES becomes effective is still uncertain; some studies have shown an effect at local scales (Fuentes-Montemayor et al., 2011b; Wilkinson et al., 2012), whilst others cite the main reason for AES failure being a focus at farm scale rather than the landscape scale (Whittingham, 2007; Mckenzie et al., 2013). Tscharntke et al. (2005) argue that subsidies and agri-environment incentives predominantly fund farm-scale AES operations (e.g. reduced input of agrochemicals) and this is supported by this analysis of Welsh payments that found the majority of farmers receiving total annual payments in the £0-10k category. A recent review of the 'broad and shallow' GE scheme concluded that greater environmental benefits and better value for money could be delivered by adopting a more targeted and capital-based approach to agri-environment support (WG, 2017f). In this study, we show some levels of connectivity between options in upland (ALC 4 and 5) landscapes but the distribution of management options across the remainder of the country appears fragmented and disconnected. With farmland constituting the single largest habitat in the UK (World Bank, 2014), the need to understand the impact of agricultural intensification, and the associated habitat fragmentation, on biodiversity (Fahrig, 2003) and the environment (Tilman, 1999) is vital if AES are to deliver successful outcomes (Tscharntke et al., 2005). The principal risk arising from investment in individual farm scale operations, without attentions to habitat matrix restoration, is that of continued isolation and fragmentation (Donald and Evans, 2006).

4.3. Glastir options distribution and uptake

The Natura (2000) management categories are designed to enable Wales to make significant progress towards bringing Natura 2000 species and habitats into favourable condition and help meet its commitments under the European Habitats and Birds Directives (NRW, 2015). The results of this study indicate that option distribution patterns are disproportionately biased towards habitat (excluding wildlife and bird habitat management) and stock management categories. These represent options that can be easily implemented by farmers, or which actually require little or no change in land management (i.e. payment with no environmental benefit). It is therefore not surprising that this bias reduces the ability of Glastir to deliver landscape level environmental outcomes for Tree, Infrastructure and Access, Water and Drainage, Wildlife, Agri-management, and Bird management categories.

4.4. Habitat management

The management options associated with habitat management are largely located on upland farms, with lower agricultural capacity, where farmers often adopt AES as additional sources of income to offset the risks associated with agricultural production on low productivity land (Wilson and Hart, 2000; Lastra-Bravo et al., 2015). We found the most concentrated areas of habitat management occur on acidic and calcareous grasslands where little or no agricultural improvement has occurred supporting the theory that due to lower agricultural opportunity costs, peripheral, marginal and difficult-to-farm areas are particularly likely to be enrolled in AES (Evans and Morris, 1997). Farmers often select, or apply to participate in, scheme prescriptions that fit the farm situation with low costs of compliance or minimum changes to current management practice (Morris and Potter, 1995; Morris et al., 2000). This bias in option uptake has been identified as a primary reason why AES may fail to deliver biodiversity benefits (Evans and Morris, 1997; Davey et al., 2010). However, the five-year contractual period binding farmers to management option delivery and the whole farm element of AES does, at the simplest level, ensure the maintenance of existing habitats on farmland and, through favourable management practices, help prevent further agricultural intensification and habitat loss (Ovenden et al., 1998).

4.5. Livestock and vegetation management

Glastir has two main approaches to stock management - reduction and exclusion. These approaches are arguably easier options to monitor than habitat management but they frequently fail to deliver the desired effect of habitat protection (Joyce, 2012; Plantlife, 2012; Mansfield, 2015). In most woodland types, species and structural diversity are higher when some browsing and grazing occurs (Hodge and Pepper, 1998). Consequently, the introduction of exclusion zones often negatively affects structural complexity and habitat diversity due to a rise in domination by weed species (Plantlife, 2012). The Welsh Government (2015b), in a self-assessment, highlighted the fact that there was no option for light grazing and that the widespread use of stock exclusion risked replacing one kind of uniformity with another. In some cases the payment for reduced stocking was being made even though heterogeneity, in the form of shorter more heavily grazed areas, would have benefitted endangered bird species such as curlew, chough and ring ouzel, leading to the need for multiple management options on the same parcel of land (WG, 2015d). Our study supports these findings by showing additional vegetation management requirements, (scrub and bracken control), occurring on the same land parcel as exclusion options. This infers a failure to achieve the desired effect through the original management approach.

GA environmental goals include GHG emission reduction, Carbon storage increases and the reversal in the decline of Wales' native biodiversity (Appendix A). Enteric fermentation (CH_4 emissions) constitute the largest component of on-farm emissions from livestock production (e.g. ~58%, Taylor et al., 2010). The simplest approach to mitigating GHG emissions in grazed pasture systems is to reduce livestock numbers (Luo et al., 2010). Since 2012, however, sheep numbers in Wales have risen by ca. 1 million, dairy cattle have risen to 2004 levels and whilst beef cattle numbers reduced 2004 - 2016, they have since stabilised and started to increase once more. Beef cattle decreases are, most likely attributed to market forces and changes to the CAP single payment scheme (Neil, 2017). Joyce (2012) found a reduction in sheep numbers in the Cambrian Mountains but a 9-fold increase in nearby lowland areas so, whilst stock reduction options have had reduced numbers on the hill, they have had no effect on overall livestock numbers and consequently are expected to have little impact on net agricultural GHG emissions.

We show vegetation management options co-occur on the same land parcels as reduction and exclusion options. The removal of grazing can lead to an increase in scrub (Pollock et al., 2013), bracken (*Pteridium aquilinum*, Pakeman et al., 2000; Marrs et al., 2007) and Molinia (*Molinia varia*, Joyce, 2012). These increases represent a major invasive weed problem in agricultural grasslands (Alday et al., 2013) and are generally perceived to be bad for biodiversity (Marrs et al., 2000), with a few exceptions (Woodhouse et al., 2005). Management of these weed problems often requires intervention in the form of a vegetation control option (Ovenden et al., 1998). In the case of stock reduction and exclusion, a lack of impact assessment and defined outcomes has resulted in a failure to achieve the desired increase in biodiversity and an unnecessary doubling of payments on single land parcels.

4.6. Management for trees

A primary delivery mechanism to achieve strategic woodland objectives is through the GWC and GWR schemes, although both GE and GA have basic woodland management options. We have shown participation in woodland contracts in the farming community to be minimal and this is likely due to cultural barriers between farming and forestry and a lack of communication and engagement between government and the farming community (Osmond, 2012; Wynne-Jones, 2013). Where uptake has occurred a lack of impact assessment has led to cases (e.g. in the Monmouthshire and Denbighshire regions) where Glastir woodland has been inappropriately planted on species-rich semi-natural grassland (Plantlife, 2012). On a positive note, we show GWR having some effect at woodland restoration but a lack of connectivity to other woodland blocks potentially contributes to, rather than reduces, the island effect (MacArthur, and Wilson, 2001). Recent estimates, which suggest an increase in woodland cover since 2010, have been attributed to improved measurement techniques rather than physical increases in woodland coverage due to the success of delivery mechanisms (WG, 2016c).

4.7. Management for birds

The Royal Society for the Protection of Birds (RSPB), the UK's largest nature conservation charity, is actively involved in monitoring the effectiveness of AES in recovering farmland biodiversity across the UK (RSPB, 2017). Farmland bird populations, declining on a global scale, are widely used by policy-makers as indicators of the wider state of nature. In the US, populations of 57 of 77 (74%) farmland-associated species decreased from 1966 to 2013 (Stanton et al., 2018); in Europe, farmland birds have fared particularly badly, with 300 million fewer birds today than in 1980 (Magalhães, et al., 2013); whilst in the UK, they are generally believed to have declined by 48% since 1970 (Robinson, et al., 2016). There is evidence that both agri-environment prescriptions and targeted conservation management, through recovery projects, can provide positive benefits to breeding Lapwing, stemming or even reversing recent population declines (Sheldon et al., 2004). However, to be successful, AES measures at field, or farm level, must be targeted and embedded within landscape level habitats managed for suitable invertebrate food sources within easy reach (Stevens and Bradbury, 2006; Dallimer et al., 2010; McHugh et al., 2017). We show management options designed to promote bird population recovery, largely fragmented and confined to farm or field scale. With the exception of a small concentration of options in North Wales, the low uptake and fragmented levels of lapwing AES interventions, used as an example in this study, may limit usefulness as a tool for population recovery (Smart et al., 2013). The RSPB 2013 Birdcount (Zolnai, 2017) and the Breeding Bird Survey 2016 (Robinson, et al., 2016) report a continued decline in various bird populations targeted by AES suggesting a lack of impact.

4.8. Water related management

Riparian zones are most commonly referred to as vegetated buffer strips (e.g., riparian buffer strips) or as wildlife movement corridors (e.g. riparian corridors) (Fischer and Fischenich, 2000). Managed correctly, they can be effective in targeting a range of multiple objectives for water quality, stability, and habitat functions (Fischer and Fischenich, 2000) but recommended widths vary greatly according to the desired management outcomes (Wenger, 1999; Hawes and Smith, 2005; de Sosa et al., 2018). Simply fencing off riparian zones, may have limited effects on the conservation of farmland biodiversity (Madden et al., 2015) and, especially in the early formation stages, lead to the growth of invasive species such as Japanese Knotweed (Moore, 2018). Glastir management options stipulate that streamside corridors must be fenced off from stock, for the duration of the contract, at a minimum of 3.5 m from the watercourse. Narrow corridors such as these have proven effective in the short term, although long-term studies suggest the need for much wider buffers (Fischer and Fischenich, 2000; Poole et al., 2013; de Sosa et al., 2018). Once again the question of desired outcome arises. Fischer and Fischenich (2000) give recommended widths of corridors and buffer strips for vegetation, reptiles and amphibians, mammals, fish, invertebrates, birds and water quality. With the exception of one general recommendation for Detrital Input, there are no recommendations for widths less than 4 m, raising questions on the effectiveness of a 3.5 m buffer strip. In Wales, there is an even distribution of AES streamside corridor management across the country, but there are still large areas of poor water quality where options are needed but have not been adopted by farmers (e.g. SW and SE Wales) (NRW, 2016). We argue that the narrow width of Glastir streamside corridors, combined with the voluntary nature of the scheme, limit the effectiveness of prescriptive AES as a water quality, management tool. It could be argued that the controlled grazing regimes of GC, and other stock reduction options, contribute to water quality management in the upland headwater areas but in the South-East where there are reasonably high levels of GC participation water quality is amongst the poorest in the country.

4.9. Management for biodiversity

AES options, across all management categories, are aimed at maintaining and enhancing biodiversity (Appendix A). Current evidence differs on the effectiveness of action-based habitat options for promoting biodiversity. Interventions have been shown by some to be effective; small mammal communities on arable farmland (Broughton et al., 2014); honey bees on rural land managed under UK Higher Level AESs (Couvillon et al., 2014); hay meadows for biodiversity (Knop et al., 2006) and pollinator species richness and abundance (Albrecht et al., 2007). However, many studies have found current AES to be ineffective - no increase in herpetofaunal diversity in the short term (Michael et al., 2014); no improvement of plant biodiversity in ditch banks after a decade of agri-environment schemes (Blomqvist et al., 2009). Further, Kleijn et al. (2001) found management agreements had no positive effects on plant and bird species diversity. On balance, the evidence presented here, and elsewhere, suggests that better targeting of AES would deliver impacts that are more effective.

4.9.1. Human, social and cultural capital

In this study, we have discussed the complexities of option uptake and deliver through Glastir, the Welsh government’s action-based AES but one of the greatest barriers to the success of any scheme has to be a non-willingness to participate within the farming community and a lack of behavioural change. Voluntary AESs are voluntary in that participation, management options and area entered are optional (Burton et al., 2008). Methods of delivery are not voluntary, ‘they do not promote any voluntary actions for environmental protection; they just force farmers to follow the standard rule’ (Kaljonen, 2006). 5-year contracts require no deep personal involvement or changes in farm management strategies (de Snoo et al., 2013) and often, as a result of their prescriptive nature, do not even require farmers to learn anything about "good" conservation practice (Burton et al., 2008). The development of social and cultural capital is a key factor in the development of schemes which promote long-term behavioural change and foster a willingness to participate (de Krom, 2017; Burton and Paragahawewa, 2011). Result-oriented agri-environmental schemes are seen by some as a means to encourage farmer innovation in the production of environmental goods (Burton and Schwarz, 2013a) and improve AES efficiency (Sabatier et al., 2012; Schroeder et al., 2013). It is also worth considering at this point reasons for non-participation. Wilson and Hart (2000) found 49% (n=211) of interviewed farmers did not participate in AES as it `did not fit in with their farm management plans' but, non-participation may not necessarily be through choice. Entry into a scheme may be hindered due to a lack of eligibility, through farm size or land/habitat type (Wilson, 1997; WG, 2015c).

5. Conclusions and recommendations

AES, currently embedded in EU and Welsh policies, promote '*greening*', '*sustainability*' and '*ecosystem services'* approaches to land management. The funding structures of these policies, however, run counter to this sustainable approach, and create the first barrier to AES success, through a continued focus on productivity support. In this study, we have shown funding, scheme distribution and higher participation levels principally located on upland farms, in the less favoured areas, more favourable to 'Public Goods' delivery. Non-eligibility, a barrier to participation and therefore funding and scheme distribution, is more likely to affect lowland farmers, especially those wishing to gain access to higher-level schemes (GA), whose land may not be able to deliver the environmental benefits to levels attainable from upland habitats. This lack of eligibility may become significant in post-Brexit scheme design. Gove (2018), proposes the creation of a scheme "accessible to almost any land owner or manager who wishes to enhance the natural environment". We would argue that "almost any land owner" would depend on where you farm. Upland areas, may see an increase in AES participation, an increase in scale and an increase in willingness to collaborate with others but it is unlikely that farmers, willing to participate, but currently ineligible for higher scheme participation in lowland areas will have access to similar levels of funding. Whilst we have not discussed the possibility of 'land sparing' in this study, there is recognition that a change to policy may see the need to support 'sustainable intensification' in areas better suited to production whilst simultaneously taking land out of production in areas better suited to delivering ecosystem services (Bateman and Balmford, 2018).

A post-Brexit policy shift, could lead to an increase in the number of contiguous areas and the linking of habitats in those areas currently fragmented, but the "better and more joined" approach suggested by Lawton, et al. (2010) can only be addressed through co-ordination, and hence Government intervention. Glastir has a set of overarching objectives (Annex A) which it aims to deliver through management options but we would argue that scheme design hinders progress toward achieving these objectives. Literature clearly identifies causal relationships between prescriptions but, at a governmental level, overarching impact assessments or measurable outcomes for management options appear to be lacking. This leads to the misplacement of options, a duplication of funding within land parcels, and payments for '*business as usual*' options that requires minimum change to farming practice. Whilst this approach maintains a status quo, and stops further intensification and nutrient overload, it is unlikely, through current scheme design, to significantly improve biodiversity (Davey et al., 2010), at a landscape level, or promote long-term behavioural change (de Krom, 2017). Significant improvement in the delivery of "Public Goods" requires spatial coordination of environmental management across multiple farm holdings and collaboration among governmental and other actors, including, possibly, groups of farmers (Westerink et al., 2017), clear objectives for each habitat type and impact assessments which identify the full impact of management options. Policy-makers must think beyond the economic aspects of AES participation (Riley et al., 2018) and invest in structures which embrace the importance of social and cultural capital, promoting peer to peer exchanges and social learning which in turn will raise the professionalism of farmer groups (Westerink et al., 2017). GC is an example of targeted scheme management requiring the formation of collaborative grazing associations to manage common land (Reed et al., 2014). Assessed to be a relatively successful part of the scheme, its good progress was attributed to the provision of Commons Development Officers (CDO) who acted as an independent interface between the farmer group and the government (Brackenbury et al., 2012; Auditor General for Wales, 2014; FCL, 2015). An understanding of needs and good communications skills enabled farmer groups to develop (FCL, 2015) whilst safeguarding the social capital within the group (Riley et al., 2018). The formation of clear objectives and outcomes potentially creates pathways to result-oriented, agri-environment schemes which are on the increase across Europe. The Burren Programme in Ireland (Burren Life Programme, 2015); the Flowering Meadows programme in France (de Sainte Marie, 2014); and the Dartmoor Farming Futures Project (Manning, 2017) are examples of schemes where participating parties receive training to be able to understand the aim of outcomes, what the outcomes should look like and what is meant by good condition. These results-based payment systems allow farmers greater freedom to decide how to manage their land (with advice, if needed) and theoretically provide the taxpayer better value for money (Burton and Schwarz, 2013b; de Sainte Marie, 2014; Burren Life Programme, 2015). Despite the potential environmental, economic and social benefits of result-oriented schemes they are not without risk to the supplier, namely the farmer (Burton and Schwarz, 2013b). Outcomes are often out-with the control of the farmer. Factors such as climate change (Westerink et al., 2008), the behaviour of neighbouring farmers (Aviron et al., 2011) and the breeding, feeding, and migration patterns of mobile species (Westerink et al., 2008) all have the potential to influence willingness to participate. Potential increased transaction costs and difficulties in creating biodiversity metrics and vegetation standards means there may be situations where result-oriented schemes are simply not effective in meeting the provision-goals (Burton and Schwarz, 2013a)

In conclusion, we show that current AES funding and scheme structures, whilst in many cases positively prevent further deterioration of existing habitat condition through a ‘business as usual’ approach, the voluntary, prescriptive nature of the schemes limit option uptake, the effectiveness of the scheme as a deliverer of ecosystem services, and the ability to promote long-term behavioural change. We would argue that current AES are more effective at delivering income support to ensure community and cultural cohesion and the viability of predominantly upland farming lifestyles than ecosystem services. This may of course be a government objective but if AES are to deliver “Public Goods”, which meet policy demands, then targeted and adequate levels of funding, suitable landscape and a willingness to participate must be combined with greater farmer autonomy and clear outcomes to deliver management options at a landscape scale.

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Supplementary Information

Appendix A: The Glastir AES Scheme (Rose, 2011) and the Welsh Land Classification System (WG, 2017e).

1. Structure.

Glastir pays for the delivery of specific environmental goods and services aimed at:

- Combating climate change.
- Improving water management.
- Maintaining and enhancing biodiversity.

2. Glastir Advanced - scheme closed to new entrants.

Glastir Advanced is a five-year whole farm sustainable land management commitment designed to deliver the following environmental aims:

- Reducing carbon and greenhouse gas emissions.
- Adapting to climate change and building greater resilience into farm businesses.
- Managing our water resources to improve water quality and reduce flood risks.
- Contributing to economic sustainability of farms and the wider rural community.
- Protecting the landscape and the historic environment while improving access.
- Contributing towards a reversal in the decline of Wales' native biodiversity.

3. Glastir Commons - scheme closed to new entrants.

Common land forms an important element of the farming tradition in Wales, particularly as a grazing resource.

It also plays a key role in the management of habitats and the Welsh landscape.

3.1. Options

There were two options under Glastir Commons:

- A closed period of 3 continuous months in a 5 month period between November and March, or
- Minimum and maximum stocking densities tailored to each common with monthly diaries kept to record the movement of stock.

4. Glastir Efficiency Grants - scheme closed to new entrants.

A capital grant scheme aimed at improving resource and business efficiency, and reducing the carbon equivalent emissions of agricultural and horticultural holdings.

5. Glastir Entry - scheme closed to new applicants.

Glastir Entry was a whole farm, land management scheme open to all farmers and land managers throughout Wales. Successful applicants made a commitment to deliver environmental goods for five years under a legally binding contract.

5.1. The All Wales Element was comprised of 3 main components:

- Cross compliance - a set of compulsory requirements applied to all your agricultural land.
- The Whole Farm Code (WFC) - this applied to all the land entered into the contract
- Management options - you were able to select from a range of options that were best suited to your farm. A minimum number of options were required in order to reach your points threshold.

6. Glastir Organic - scheme closed to new entrants.

Glastir Organic was an element of the Welsh Government's Glastir Scheme. Glastir Organic provided support to organic farmers and producers, who delivered positive environmental land management.

6.1. Glastir Organic was a 5-year contract with Welsh Government, open to:

- Those who wished to convert to organic production.

- Existing organic producers who met the eligibility criteria.

7. Glastir Small Grants.

Land Managers and Farming Businesses across Wales have an opportunity to apply for Capital Works under the Glastir Small Grants Scheme.

This stand-alone scheme contributes to the delivery of Welsh Government's ambitions to tackle climate change, improve water management, restore traditional landscape features and enhance habitat linkage for pollinators.

7.1. There are three themes under Glastir Small Grants:

- Carbon – aid the delivery of Welsh Government's ambitions to increase carbon sequestration.
- Water - improve water quality and reduce the risk of flooding.
- Landscape and Pollinators - maintain the traditional landscape features in Wales, and provide habitat linkage for pollinating insects.

8. Glastir Woodland Creation.

Glastir Woodland Creation provides financial support for new planting. Financial support is also available for planting trees in areas that continue to be grazed as part of an agroforestry system i.e. combining agriculture and forestry.

9. Glastir Woodland Restoration.

Funding is available to replant areas of larch that have been felled to help prevent the spread of *Phytophthora ramorum* disease affecting the trees.

The area eligible for funding under Glastir Woodland Restoration will be equivalent to twice the area of larch identified on the Statutory Plant Health Notice or felling licence. For example, if 1 hectare of larch is shown on your felling licence, the maximum area eligible for funding under Glastir Restoration will be 2 hectares.

10. Post code areas.

The HR postcode district was excluded for the purpose of this research as it size, and location on the Wales/England border, makes it difficult to distinguish between payments being made to Welsh farmers with land in England or English Farmers with land in Wales.

11. Land Parcel Identification System (LPIS).

An IT system based on photographs of agricultural parcels used to check payments made under the Common Agricultural Policy (CAP).

12. Generalised Description of the Agricultural Land Classification Grades Grade and standard colour notations Description of agricultural land Detail (WG, 2017e).

Grade 1: Excellent quality No or very minor limitations on agricultural use. Wide range of agricultural and horticultural crops can be grown. High yielding and consistent.

Grade 2: Very good Minor Limitations on crop yield, cultivations or harvesting. Wide range of crops but limitations on demanding crops (e.g. winter harvested veg). Yield high but lower than Grade 1.

Grade 3: (subdivided) Good to moderate Moderate limitations on crop choice, timing and type of cultivation, harvesting or level of yield. Yields lower and more variable than Grade 2.

Grade 3a: Good Moderate to high yields of narrow range of arable crops (e.g. cereals), or moderate yields of grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops. 3b Moderate Moderate yields of cereals, grass and lower yields other crops. High yields of grass for grazing/ harvesting.

Grade 4: Poor Severe limitations which restrict range and/or level of yields. Mostly grass and occasional arable (cereals and forage), but highly variable yields. Very droughty arable land included.

Grade 5: Very poor Severe limitations which restrict use to permanent pasture or rough grazing except for pioneering forage crops.

Appendix B: The breakdown of Glastir management categories (RPA, 2017)

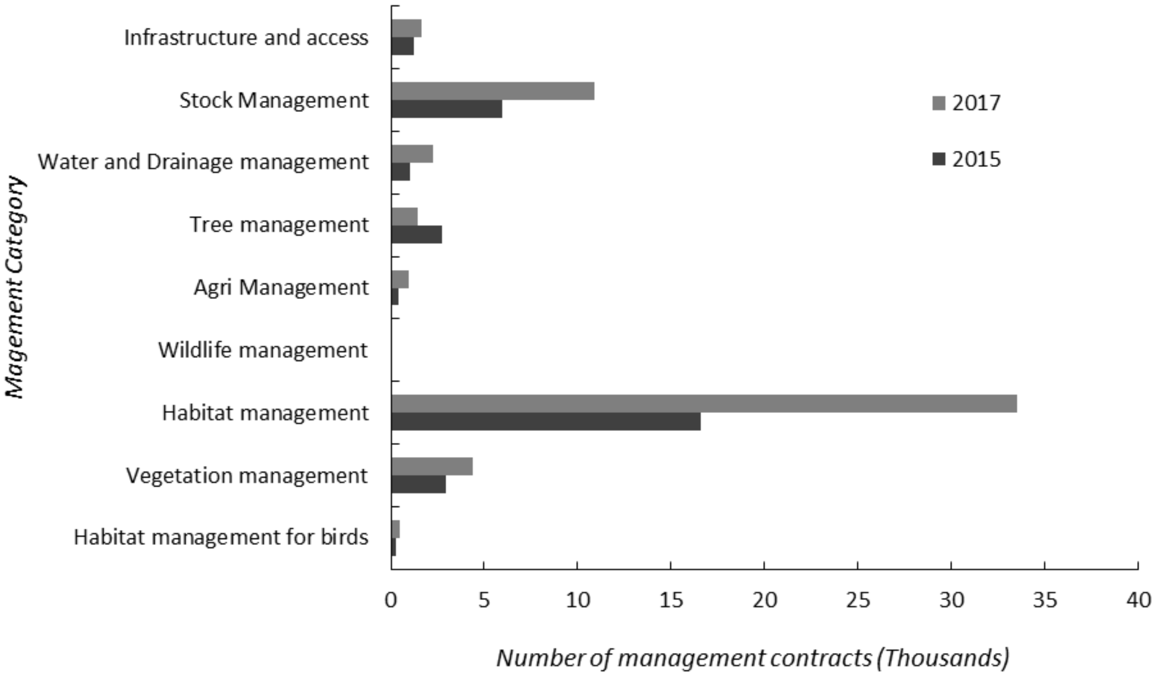

Figure B.1. Total GA management contracts by management categories for 2015 and 2017 (RPA, 2017).

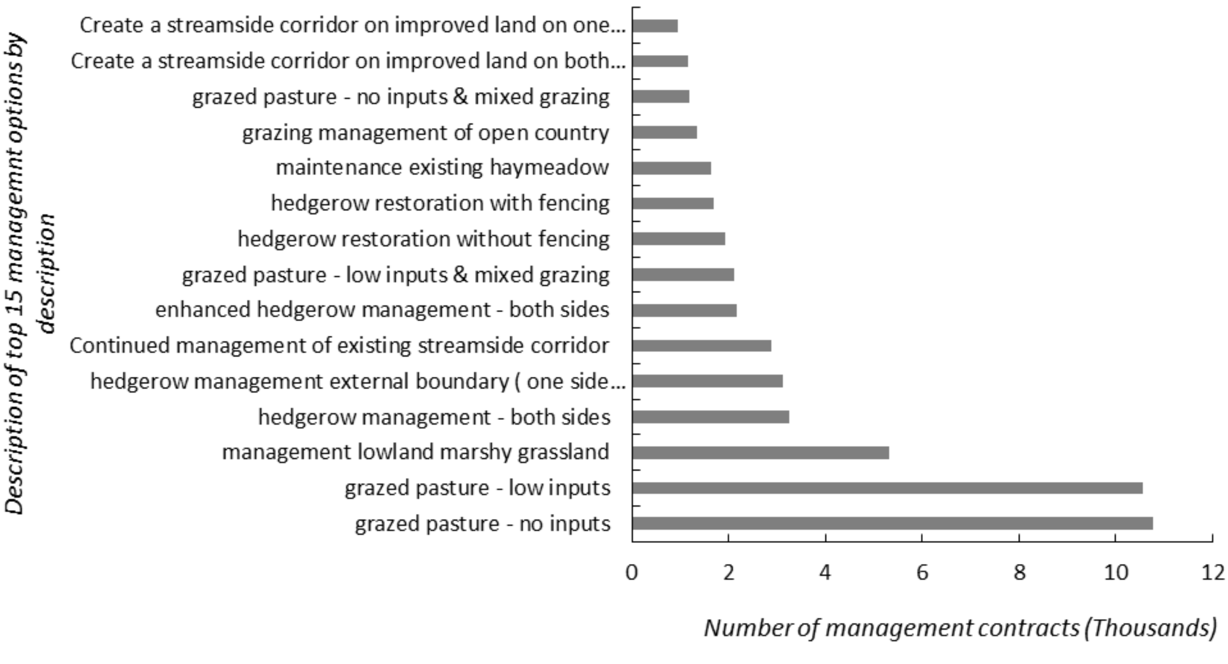

Figure B.2. Top 15 GE management options for 2015 by number of management contracts (RPA, 2017).

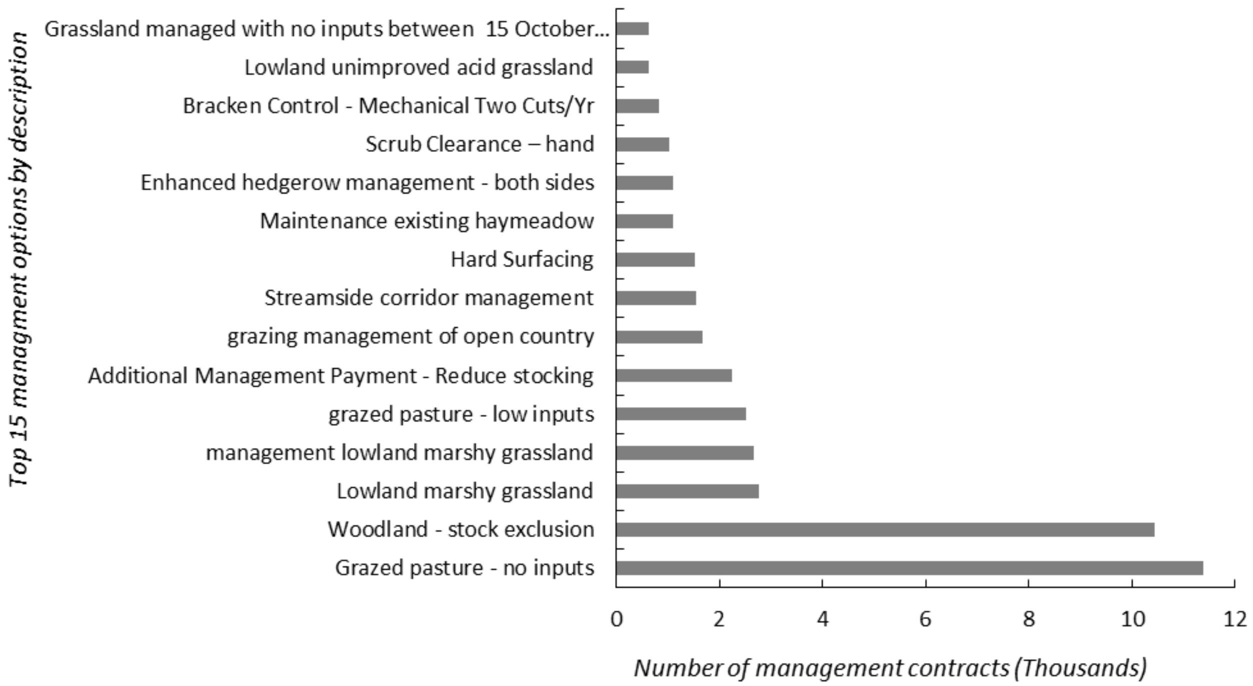

Figure B.38. Top 15 GA management options for 2017 by number of management contracts (RPA, 2017).

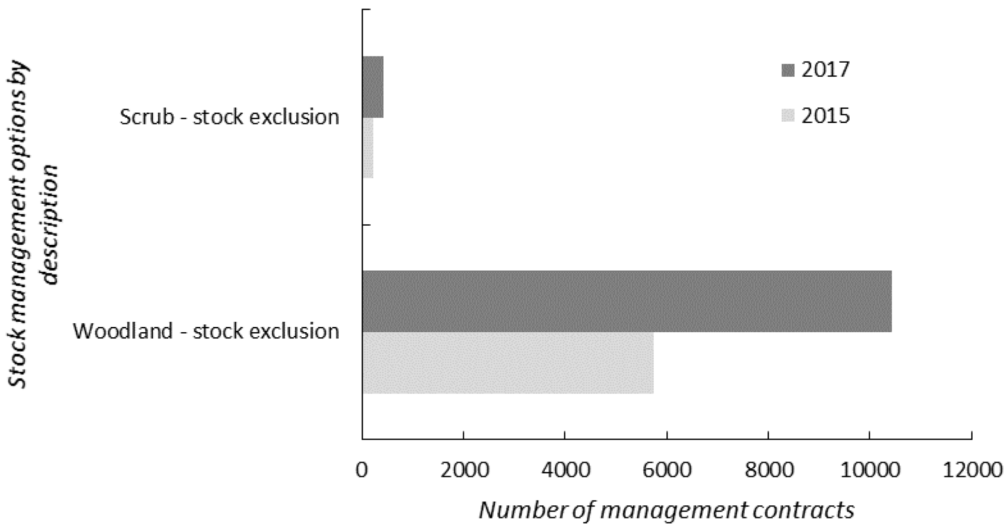

Figure B.4. GA stock management options for 2015 and 2017 by number of management contracts (RPA, 2017).

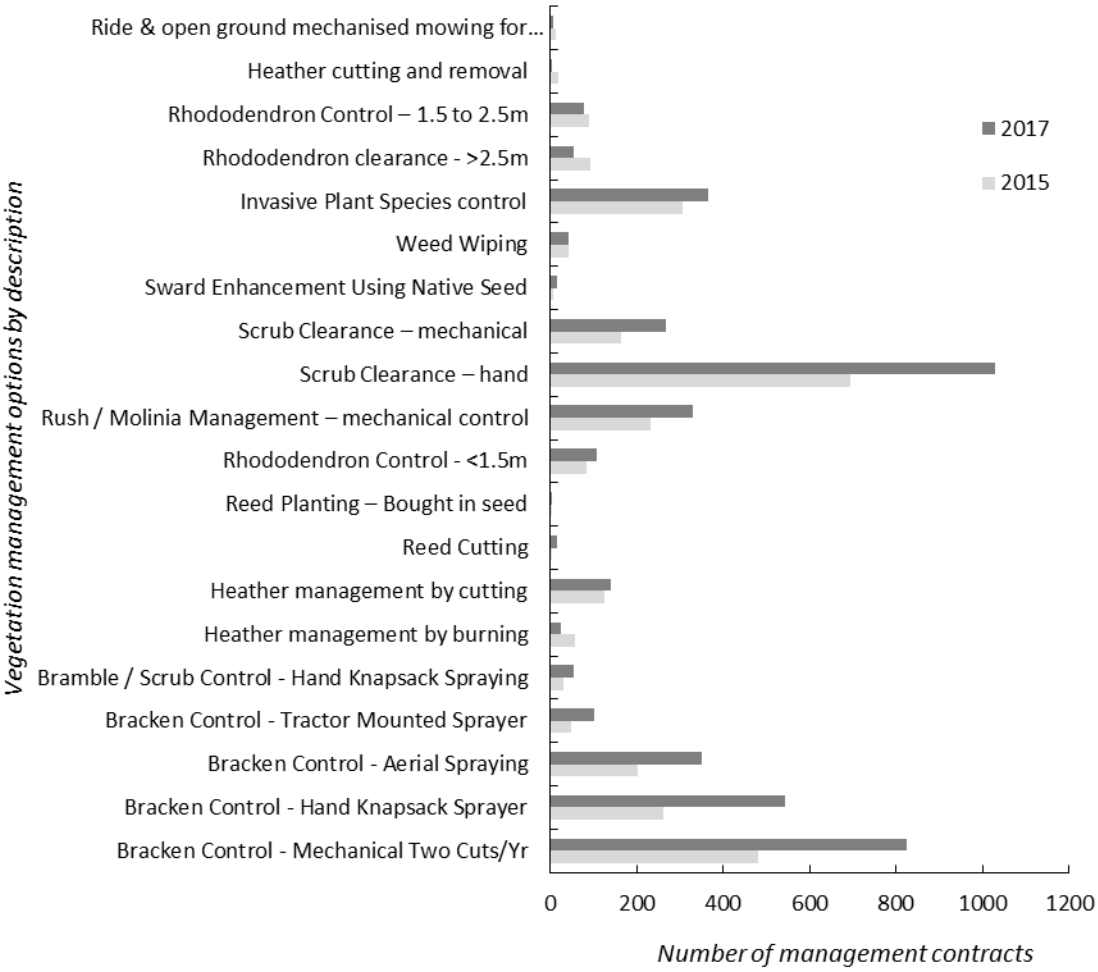

Figure B.59. GA vegetation management options for 2015 and 2017 by number of contracts (RPA, 2017).

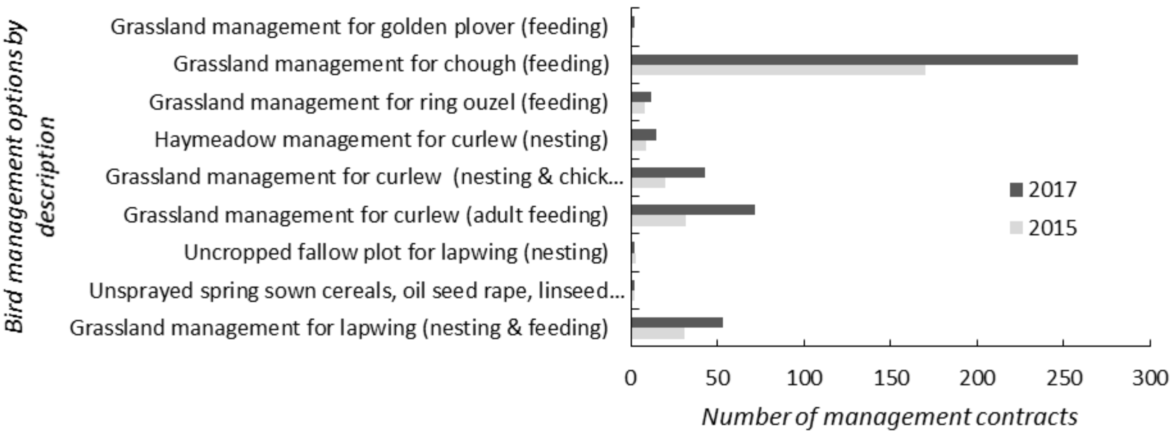

Figure B.6. GA bird management options for 2015 and 2017 by number of contracts (RPA, 2017).

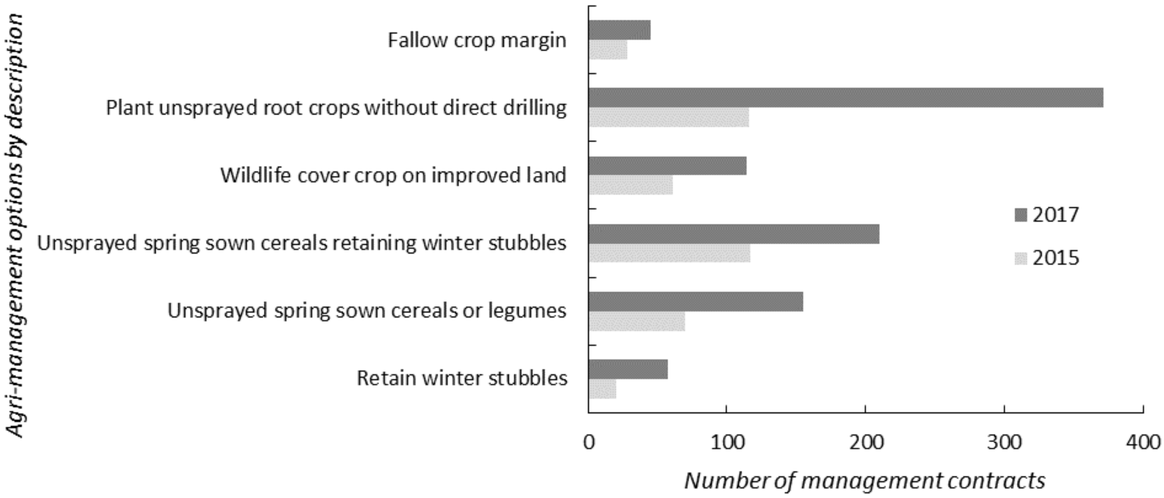

Figure B.7. GA agri-management options for 2015 and 2017 by number of contracts (RPA, 2017).

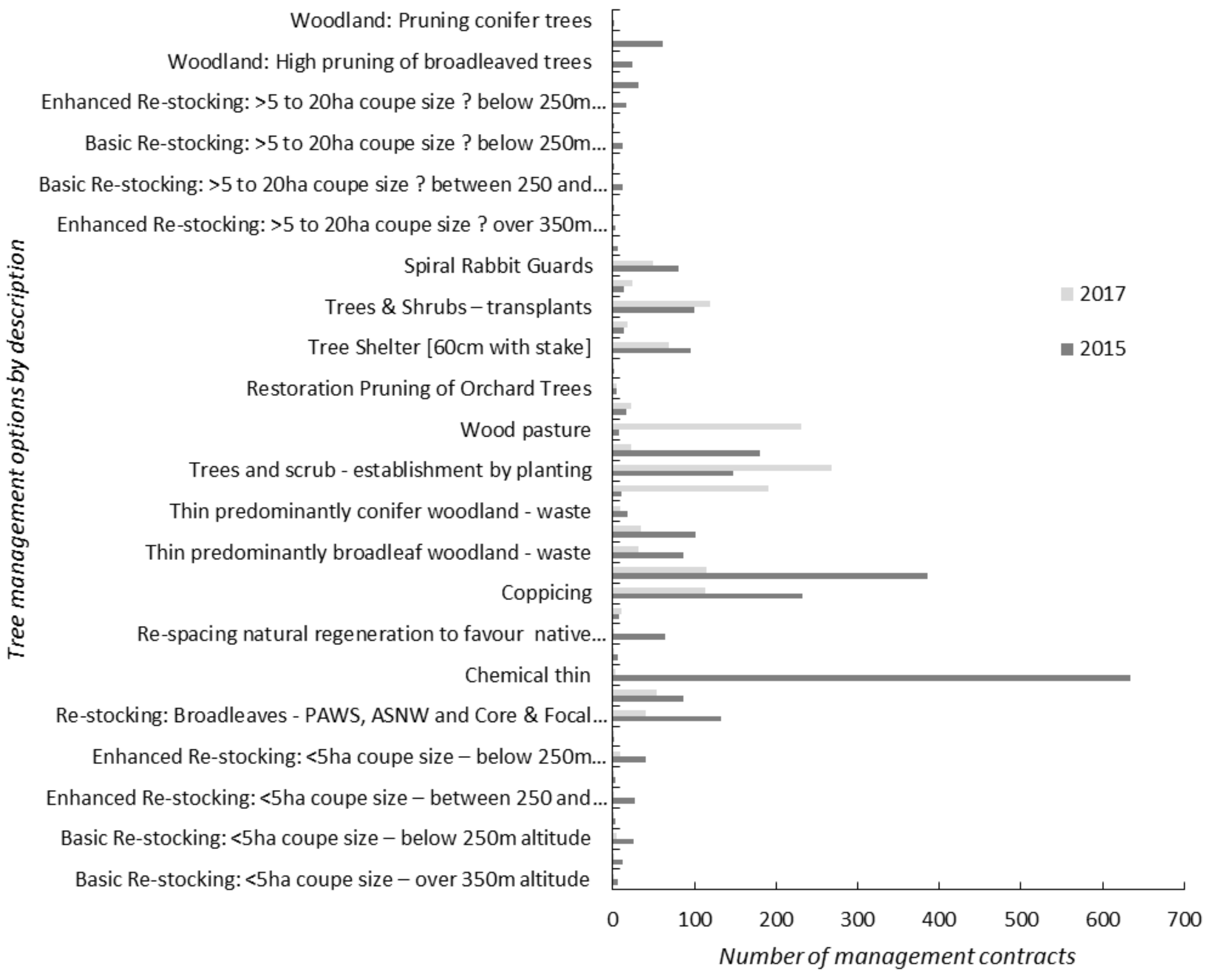

Figure B.8. GA tree management options for 2015 and 2017 by number of management contracts (RPA, 2017).

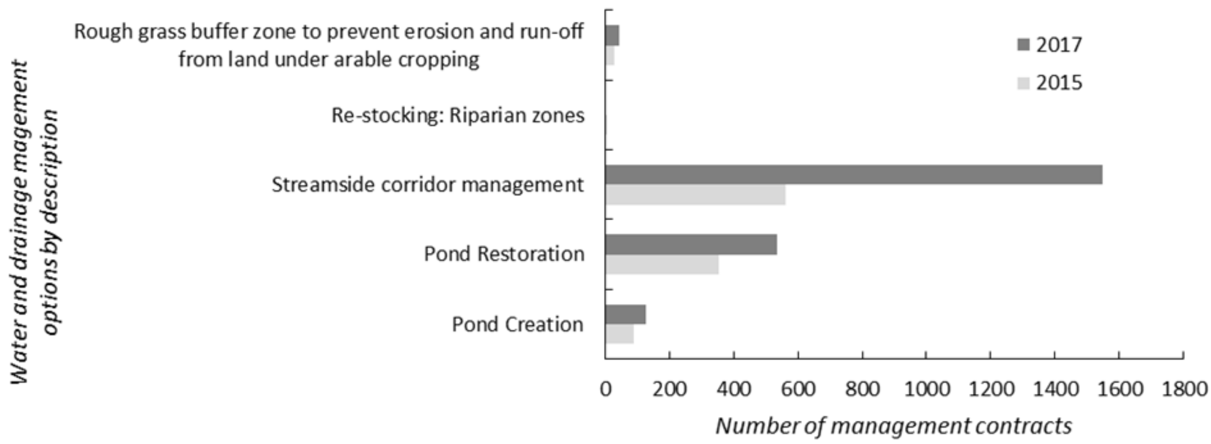

Figure B.9. GA water and drainage management options for 2015 and 2017 by number of management contracts (RPA, 2017).

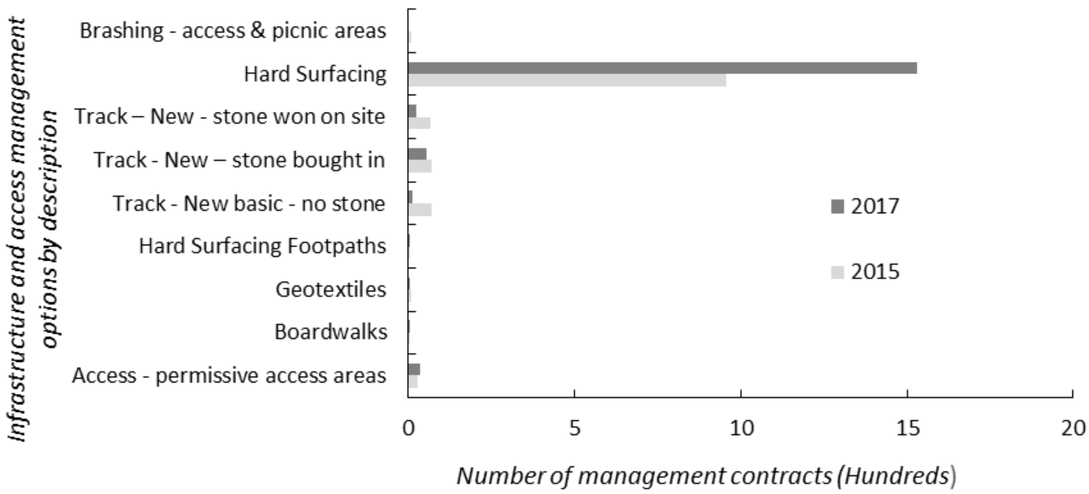

Figure B.100. GA infrastructure and access management options for 2015 and 2017 by number of management contracts (RPA, 2017).

Appendix C: Allocation of CAP spending

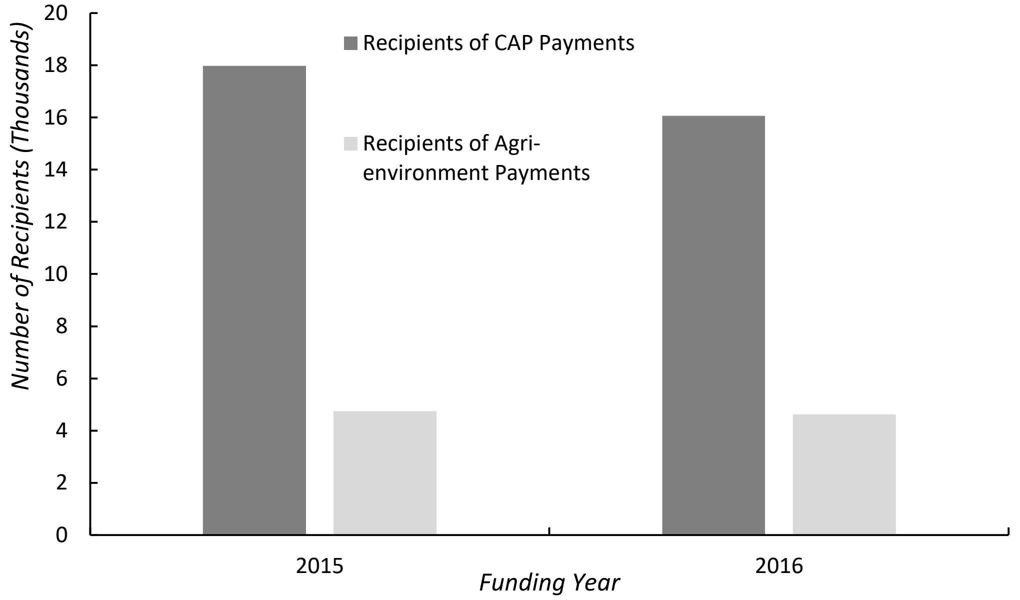

Figure C.11. Number of recipients of CAP payment (Pillar 1 and Pillar 2) and the number of recipients receiving AES payments for 2015 and 2016 (DEFRA, 2017)

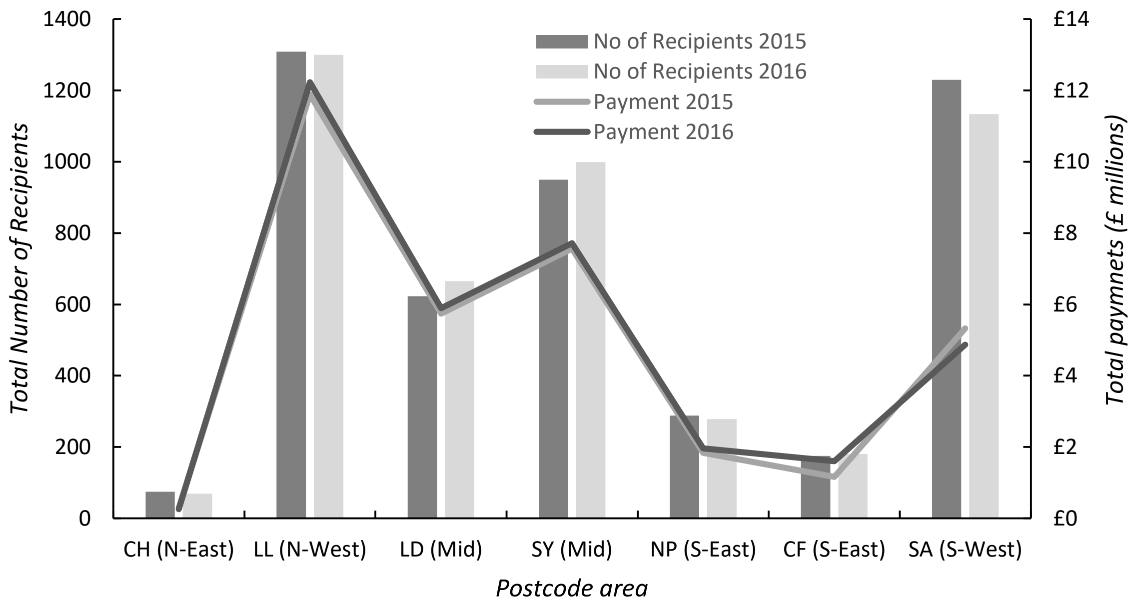

Figure C.2. Distribution of AES payments and recipients across the post code areas and regions of wales. Postcode areas identify the primary town or city in the region.

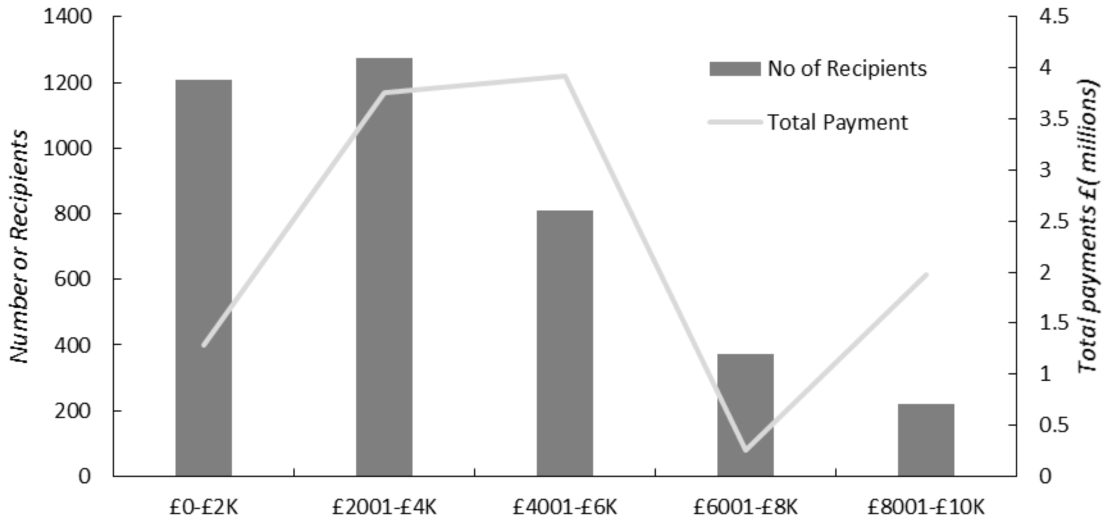

Figure C.3. Distribution of 2016 AES payments showing the total number of recipients and the total payments received across the £0-10K payment range. (DEFRA, 2017).

Table C.3. GA management option descriptions. The table shows the option number and the total number of management contracts awarded by year (Option count) (RPA, 2017).

Description	**Option Number**	**Option count 2017**	**Option Number**	**Option count 2015**
Enhanced hedgerow management - both sides	5	1095	5	287
grazed pasture - no inputs	15	11391	15	4583
Management lowland marshy grassland	19	2657	19	1133
Management lowland and coastal heath	20	89	20	64
Management grazed saltmarsh	21	66	21	21
Maintenance existing hay meadow	22	1098	22	448
Management of sand dunes	25	28	25	11
Fallow crop margin	27	45	27	28
Retain winter stubbles	28	57	28	20
Unsprayed spring sown cereals or legumes	30	155	30	70
Unsprayed spring sown cereals retaining winter stubbles	31	210	31	117
Wildlife cover crop on improved land	33	114	33	61
Unharvested cereal headland	34	3	34	3
Woodland - stock exclusion	100	10438	100	5747
Trees and scrub - establishment by planting	101	191	101	148
Trees and scrub - establishment by natural regeneration	102	268	102	181
Scrub - stock exclusion	103	437	103	214
Wood pasture	104	23	104	8
Historic parks and gardens	106	119	106	78
Calaminarian grassland	109	1	109	1
Lowland dry heath with less than 50% western gorse	115	87	115	44
Lowland dry heath with more than 50% western gorse	116	60	116	24

Lowland wet heath with less than 60% purple moor-grass	117	18	117	11
Lowland wet heath with more than 60% purple moor-grass	118	19	118	11
Lowland heath habitat expansion - establishment on grassland	119	56	119	39
Lowland unimproved acid grassland	120	636	120	465
Lowland unimproved acid grassland - reversion (pasture)	121	270	121	196
Lowland unimproved acid grassland - reversion (hay cutting)	122	51	122	36
Lowland unimproved neutral grassland - pasture	123	358	123	245
Lowland unimproved neutral grassland - haymeadow	124	390	124	244
Lowland unimproved neutral grassland - reversion (pasture)	125	345	125	251
Lowland unimproved neutral grassland - reversion (hay cutting)	126	225	126	168
Lowland unimproved calcareous grassland	128	50	128	20
Lowland unimproved calcareous grassland - reversion (pasture)	129	9	129	4
Lowland unimproved calcareous grassland - reversion (hay cutting)	130	11	130	7
Conversion from arable to grassland (no inputs)	131	50	131	24
Conversion from improved grassland to semi-Improved grassland (hay cutting)	132	129	132	88
Lowland marshy grassland	133	2758	133	1705
Lowland marshy grassland - reversion (pasture)	134	121	134	68
Lowland bog and other acid mires with less than 50% purple moor-grass	139	112	139	68
Lowland bog and other acid mires with more than 50% purple moor-grass	140	113	140	59
Lowland bog and other acid mires - restoration (no grazing)	141	41	141	16
Lowland bog and other acid mires - reversion (pasture)	142	23	142	17
Lowland fen	143	102	143	45
Lowland fen - restoration (no grazing)	144	6	144	4
Lowland fen - reversion (pasture)	145	9	145	10
Reedbed - stock exclusion	146	76	146	30
Reedbed - creation	147	3	147	3
Coastal grassland (maritime cliff and slope)	148	129	148	93
Saltmarsh - restoration (no grazing)	149	45	149	22
Saltmarsh - creation	150	4	150	1
Coastal vegetated shingle and sand dunes - creation	151	1	151	1
Red clover ley	153	64	153	33
Buffer zones to prevent erosion and runoff from grassland	156	493	156	296
Buffer zones to prevent erosion and runoff from grassland - ditch landscapes	157	56	157	46

Buffer zones to prevent erosion or run-off from land under arable cropping	158	81	158	34
Grassland managed with no inputs between 15 October and 31 January	159	631	159	239
No lime on improved or semi-improved grassland over peat soils	160	31	160	14
Grassland management for chough (feeding)	161	258	161	170
Grassland management for curlew (nesting and chick feeding)	164	43	164	20
Grassland management for curlew (adult feeding)	165	72	165	32
Haymeadow management for curlew (nesting)	166	15	166	9
Grassland management for golden plover (feeding)	167	2	167	1
Grassland management for lapwing (nesting and feeding)	168	53	168	31
Unsprayed spring sown cereals, oil seed rape, linseed or mustard crop for lapwing (nesting)	169	2	169	2
Uncropped fallow plot for lapwing (nesting)	170	2	170	3
Grassland management for ring ouzel (feeding)	171	12	171	8
Orchard management	172	231	172	133
Streamside corridor management	173	1549	173	560
Rough grass buffer zone to prevent erosion and run-off from land under arable cropping	174	43	174	29
Management of rough grassland - enclosed land	175	169	175	92
Additional Management Payment - Stock management	400	290	400	110
Additional Management Payment - Mixed grazing	401	504	401	355
Additional Management Payment - Control burning first 0.00 - 3.00 ha	402	29	402	74
Additional Management Payment - Re-wetting	403	82	403	33
Additional Management Payment - Grazing management for dung invertebrates	405	31	405	17
Additional Management Payment - Reduce stocking	411	2246	411	1034
Access - permissive access areas	505	36	505	29
Boardwalks	508	2	508	2
Geotextiles	511	2	511	7
Hard Surfacing Footpaths	512	1	512	1
Track - New basic - no stone	526	11	526	70
Track - New – stone bought in	527	53	527	69
Track – New - stone won on site	528	24	528	65
Squirrel hoppers - for control of grey squirrels outside red squirrel areas	550	1	550	16
Establish Red Clover Lay	551	50	551	30
Hard Surfacing	552	1531	552	955
Pond Creation	564	128	564	87
Pond Restoration	565	534	565	352
Establish Grass Lay	581	41	581	27
Removal of Conifers	605	23	605	17
Restoration Pruning of Orchard Trees	606	5	606	5

Tree Pollarding	607	2	607	2
Tree Shelter [60cm with stake]	608	69	608	95
Trees – Standards	610	18	610	14
Trees and Shrubs – transplants	611	120	611	100
Trees and Shrubs – Whips	612	24	612	14
Basic Re-stocking: <5ha coupe size – over 350m altitude	613	2	613	6
Basic Re-stocking: <5ha coupe size – between 250 and 350m altitude	616	2	616	12
Basic Re-stocking: <5ha coupe size – below 250m altitude	619	5	619	25
Enhanced Re-stocking: <5ha coupe size – over 350m altitude	622	1	622	3
Enhanced Re-stocking: <5ha coupe size – between 250 and 350m altitude	625	2	625	27
Enhanced Re-stocking: >5 to 20ha coupe size – between 250 and 350m altitude	626	2	626	4
Enhanced Re-stocking: <5ha coupe size – below 250m altitude	628	9	628	41
Enhanced Re-stocking: >20ha coupe size – below 250m altitude	630	1	630	1
Re-stocking: Broadleaves - PAWS, ASNW and Core and Focal networks	631	40	631	132
Re-stocking: Broadleaves - All other sites	632	54	632	87
Chemical thin	634	3	634	5
Clear fell conifer and extract using skyline on PAWS	635	2	635	6
Re-spacing natural regeneration to favour native broadleaved species or mixed woodland	636	2	636	64
Coppicing	644	113	644	236
Sabre Planting [no fence planting]	646	10	646	8
Spiral Rabbit Guards	647	49	647	81
Bracken Control - Aerial Spraying	650	352	650	202
Bracken Control - Hand Knapsack Sprayer	651	544	651	261
Bracken Control - Mechanical Two Cuts/Yr	652	824	652	481
Bracken Control - Tractor Mounted Sprayer	653	101	653	50
Bramble / Scrub Control - Hand Knapsack Spraying	654	54	654	31
Heather management by burning	656	26	656	57
Heather management by cutting	657	141	657	125
Reed Cutting	660	15	660	5
Reed Planting – Bought in seed	661	4	661	5
Rhododendron Control - <1.5m	663	108	663	85
Rush / Molinia Management – mechanical control	664	330	664	233
Scrub Clearance – hand	665	1028	665	693
Scrub Clearance – mechanical	666	267	666	165
Sward Enhancement Using Native Seed	667	16	667	6
Weed Wiping	668	44	668	43
Invasive Plant Species control	669	365	669	305
Rhododendron clearance - >2.5m	670	56	670	93

Rhododendron Control – 1.5 to 2.5m	671	78	671	90
Ride and open ground mechanised mowing for conservation reasons	672	7	672	12
Geojute Matting	681	7	681	0
Heather cutting and removal	683	1	683	18
Thin predominantly broadleaf woodland - extract	684	115	684	386
Thin predominantly broadleaf woodland - waste	685	31	685	87
Thin predominantly conifer woodland - extract	686	34	686	102
Thin predominantly conifer woodland - waste	687	5	687	18
Ring Barking	688	9	688	10
Grazed pasture - low inputs	15b	2531	15b	1996
Grazed pasture - no inputs and mixed grazing	15c	619	15c	227
Grazed pasture - low inputs and mixed grazing	15d	410	15d	339
Management lowland marshy grassland with mixed grazing	19b	144	19b	100
Management lowland and coastal heath with mixed grazing	20b	2	20b	1
Management grazed saltmarsh with mixed grazing	21b	24	21b	15
Management of sand dunes with mixed grazing	25b	10	25b	5
Plant unsprayed root crops without direct drilling	32b	371	32b	116
Unfertilised and unsprayed cereal headland	34b	11	34b	8
Grazing management of open country	41a	1671	41a	591
Grazing management of open country with mixed grazing	41b	140	41b	66
Brashing: access and picnic areas			520	7
Basic Re-stocking: >20ha coupe size: over 350m altitude			615	7
Basic Re-stocking: >5 to 20ha coupe size between 250 and 350m altitude			617	12
Basic Re-stocking: >20ha coupe size: between 250 and 350m altitude			618	2
Basic Re-stocking: >5 to 20ha coupe size: below 250m altitude			620	12
Enhanced Re-stocking: >5 to 20ha coupe size: over 350m altitude			623	3
Enhanced Re-stocking: >20ha coupe size: over 350m altitude			624	2
Enhanced Re-stocking: >20ha coupe size: between 250 and 350m altitude			627	1
Enhanced Re-stocking: >5 to 20ha coupe size: below 250m altitude			629	17
Re-stocking: Riparian zones			633	4
Heather restoration by seed and mulch			658	7
Woodland: Formative pruning of broadleaved trees			694	31
Woodland: High pruning of broadleaved trees			695	24
Woodland - light grazing			176	62
Woodland: Pruning conifer trees			696	1
Total number of individual option contracts	55248			30531

Table C.2. GE management option descriptions. The table shows the option number and the total number of management contracts awarded by year (Option count) (RPA, 2017).

Description	**Option Number**	**Option Count 2017**
3m wildlife corridor - include trees and shrubs	1	169
3m wildlife corridor include earth bank and tree/shrub planting	2	114
Wildlife corridor - wooded strip	3	104
Hedgerow management - both sides	4	3253
Enhanced hedgerow management - both sides	5	2180
Double fence gappy hedges 3m width	6	571
Continued management of existing streamside corridor	8	2886
Restore traditional orchard	11	114
Create new orchard	12	192
Plant individual trees	13	403
Grazed pasture - no inputs	15	10759
Upland Heath	16	25
Blanket Bog	17	9
Upland Grassland	18	125
Management lowland marshy grassland	19	5306
Management lowland and coastal heath	20	82
Management grazed saltmarsh	21	82
Maintenance existing hay meadow	22	1634
Small areas in corners of field revert to rough grassland/scrub	23	272
Woodland edge to develop out to adjoining (improved) fields	24	16
Management of sand dunes	25	17
Fixed rough grass margins on arable land	26	214
Fallow crop margin	27	39
Retain winter stubbles	28	154
Undersown spring cereals next to watercourses	29	17
Unsprayed spring sown cereals or legumes	30	510
Unsprayed spring sown cereals retaining winter stubbles	31	146
Unsprayed root crops on improved land	32	676
Wildlife cover crop on improved land	33	218
Unharvested cereal headland	34	4
Create wildlife pond - enclosed improved land	35	36
Buffering existing unfenced in-field ponds	36	55
Management of scrub etc from historic features	39	26
Fence around stock excluded woodland	40	806
Mechanical bracken control	44	343
Maintenance of traditional weatherproof buildings	45	251
Grazed pasture - low inputs	15b	10547
Grazed pasture - no inputs and mixed grazing	15c	1201
Grazed pasture - low inputs and mixed grazing	15d	2105
Management lowland marshy grassland with mixed grazing	19b	412
2m wildlife corridor- tree and shrub planting	1b	298

Management lowland and coastal heath with mixed grazing	20b	5
Management grazed saltmarsh with mixed grazing	21b	7
2m wildlife corridor include earth bank and tree/shrub planting	2b	137
Plant unsprayed root crops without direct drilling	32b	753
Unfertilised and unsprayed cereal headland	34b	11
Wildlife pond on enclosed land - variable size	35b	75
Grazing management of open country	41a	1345
Grazing management of open country with mixed grazing	41b	74
Hedgerow restoration with fencing	42a	1681
Hedgerow restoration without fencing	42b	1931
Double fence and restore hedge banks with planting	43a	238
Double fence and restore hedge banks without planting	43b	64
Maintenance linear permissive access - Tir Gofal bridleway	46a	96
Maintenance linear permissive access - Tir Gofal footpath	46b	315
Hedgerow management external boundary (one side only)	4b	3128
Double fence gappy hedges 2m width	6b	624
Create a streamside corridor on improved land on one side of a watercourse	9a	955
Create a streamside corridor on improved land on one side of a watercourse with tree planting	9a	18
Create a streamside corridor on improved land on both sides of a watercourse	9b	1170
Create a streamside corridor on improved land on both sides of a watercourse with tree planting	9b	28
Total number of individual option contracts		59026

1195