Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)
Sustainable Farming Scheme Evidence Review

Report 10b: Considerations for the new scheme

Emmett, B.A.[1], Alison, J.[1], Braban, C.[1], Dickie, I.[2], Gunn, I.D.M.[1], Healey, J.[3], Jenkins, T.[4], Jones, L.[1], Keenleyside, C.B.[5], Lewis-Reddy, E.[6], Martineau, A.H.[7], Newell-Price, P.[6], Old, G.H.[1], Pagella, T.[3], Siriwardena, G.M.[8], Williams, A.G.[9], Williams, P.[3] & Williams, J.R.[6]

[1] Centre for Ecology & Hydrology, [2] eftec, [3] Bangor University, [4] Forest Research, [5] Institute for European Environmental Policy, [6] ADAS, [7] Ricardo, [8] British Trust for Ornithology, [9] Cranfield University

Client Ref: Welsh Government / Contract C210/2016/2017

Version 1.1

Date 08/07/2019

Funded by:

Llywodraeth Cymru
Welsh Government

Canolfan Ecoleg a Hydroleg
Centre for Ecology & Hydrology
Natural Environment Research Council

Series	Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP) - Sustainable Farming Scheme Evidence Review (WP11)
Title	Report 10b: Considerations for the new scheme
Client	Welsh Government
Client reference	C210/2016/2017
Confidentiality, copyright and reproduction	
CEH contact details	Bronwen Williams Centre for Ecology & Hydrology, Environment Centre Wales, Deiniol Road, Bangor, Gwynedd, LL57 2UW t: 01248 374500 e: erammp@ceh.ac.uk
Corresponding Author	Bridget Emmett, CEH
How to cite (long)	Emmett, B.A., Alison, J., Braban, C., Dickie, I., Gunn, I.D.M., Healey, J., Jenkins, T., Jones, L., Keenleyside, C.B., Lewis-Reddy, E., Martineau, A.H., Newell-Price, P., Old, G.H., Pagella, T., Siriwardena, G.M., Williams, A.G., Williams, P. & Williams, J.R.. (2019). Report 10b: Considerations for the new scheme. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.
How to cite (short)	Emmett, B.A. et al. (2019). Report 10b: Considerations for the new scheme. ERAMMP Report to Welsh Government (Contract C210/2016/2017) (CEH NEC06297)
Approved by	Chris Bowring James Skates

Mae'r ddogfen yma hefyd ar gael yn Gymraeg / This document is also available in Welsh

Version History

Version	Updated By	Date	Changes
0.2	WG	18/6/2019	Responses from WG (to combined 10)
0.3-1.0	BE	27/6/2019	Edit to WG comments (10a & 10b split)
1.1	PMO	8/7/2019	For publication

Contents

1 Introduction

The Welsh Government (WG) asked of Review 10 the following:

> *"The objective of this task is to undertake an integrated analysis across all tasks to identify interdependencies, conflicts and synergies. In undertaking this task a vision of what a new Sustainable Farming Scheme could look like based on the findings should be included."*

At the request of Welsh Government (WG) this review was split into two parts due to the fundamentally different nature of the two elements embedded in the task outlined above.

The first part of the WG request was for an Integrated Analysis that required an objective synthesis of the other nine Evidence Reviews exploring the interactions and co-benefits of individual interventions and outcomes. The outcome of this task is presented in Review 10a (i.e., Technical Annex 10a).

The second request provided an opportunity for the team to offer some suggestions as to the concept, design, operation and evaluation of the new scheme. An overall vision for the scheme was not possible within the tight time schedule of the project and it is anyway unlikely a consensus could have been reached. Instead, in Review 10b here, we provide a series of considerations we hope is of value to Welsh Government during their deliberations. It should be noted that whilst the other Reviews were thoroughly debated and all co-authors take joint ownership of their final Review, the views presented here represent a mix of issues raised by members of the team during the discussions. Where this led to a difference of opinion or emphasis we have noted this as we have been encouraged by Welsh Government to emphasise where there is not consensus in the community. Therefore, it should be noted all issues raised in this Review 10b do not necessarily represent the views of all co-authors - and where they do not, we have identified the lack of consensus.

We highlight here some important research needs and evidence gaps that limit our current understanding and add to uncertainty levels. However, we also highlight where the empirical evidence is good and consensus is present within the expert community but continuing misconceptions appear to be commonplace within the wider populace. Clearly, improved communication remains a continuing need as we work together to ensure a common understanding of the evidence base going forward.

2 Sustainable Farming Scheme (SFS)

2.1 Conceptual issues

During the Evidence Pack workshops, the team had robust debates about some fundamental issues that lie at the heart of the proposed new scheme. Many issues are at the edge of current research and expose a lack of consensus either within the research community or between the research community and stakeholder communities. We note where these issues were identified and highlight that some topics below therefore rely on expert judgement rather than empirical evidence.

2.1.1 Resilience

Some members of the team highlighted potential constraints in the definition of "ecological resilience" which underpins the proposed new SFS scheme and is taken from SoNaRR[1]: "the capacity of ecosystems to deal with disturbances... whilst retaining their ability to *deliver services and benefits* now and in the future". We therefore note the lack of consensus in the community as to how to blend and/or prioritise a focus on services and benefits with that of conservation *per se* as we move forward.

We also note that making resilience operational as a concept is extremely challenging and an active area of research in the community. Whilst the concept of using the key attributes which confer resilience (i.e. area, condition, diversity and connectivity) appears appealing, the approach of 'bigger, better and more connected' may at times be at odds with some of the landscapes valued in Wales (e.g. farmland with a mosaic of habitats like High Nature Farmland (HNV) Type 2. Furthermore, increased connectivity can lead to spread of disease and non-native species and to synchronised rapid runoff to watercourses. An approach to explore further may be one similar to that taken for HNV farmland where different types of land with an associated variable balance of metrics related to resilience are defined.

2.1.2 Management for ecosystems and biodiversity on improved land (Land Sparing versus Land Sharing)

We note that the brief for Review 4 "Building Ecosystem Resilience" was focused specifically on semi-natural or semi-improved habitats. Improved or arable land was not included in the brief for Review 4. Management for ecosystems and biodiversity involving improved or arable land can involve taking areas of improved land out of production, such as field margins or fallows in rotations, or reducing management intensity (stocking rates, chemical applications, etc.) and therefore reducing yield. Other elements consider management of parts of farms that are already non-productive, such as ponds, field corners and ditches, as well as micro-habitats that are recognised as 'habitat' land. We note that whilst not included in Review 4, these types of measures warrant consideration for a Sustainable Farming Scheme that is inclusive across farming systems and the wildlife habitats and landscapes that are

[1] State of Natural Resources Report (SoNaRR): https://naturalresources.wales/evidence-and-data/research-and-reports/the-state-of-natural-resources-report-assessment-of-the-sustainable-management-of-natural-resources/?lang=en

associated with farmland. We understand such measures are under consideration elsewhere within Welsh Government. The team would welcome an opportunity to review these for Welsh Government.

We also note that these are all examples of 'Land Sharing' where production agriculture and environmental benefits co-occur in the landscape. Some of the team noted that within the literature, the 'Land Sparing' concept to set aside land for exclusive use of biodiversity or wider environmental outcomes is gaining traction (e.g. Cannon et al. 2019; Balmford et al 2018 & 19; Egli et al. 2018; Loos et al. 2018; Marr et al. 2018; Styles et al. 2018). However, others noted that this approach needs to be considered carefully as many agricultural systems in Wales actually define the biodiversity outcomes (e.g. High Nature Value Farmland Type 2 "Farmland with a mosaic of habitats and/or land uses"). Also it may not be socially or politically acceptable to 'spare' land in Wales which might require still further intensification, above other parts of the UK with already existing intensive agriculture.

2.1.3 Interpretation of habitat and vegetation condition and their link to species metrics

Habitat condition: The group was keen to highlight that habitat condition may not equate to species presence, abundance or diversity, except where those species are actual constituents of the habitat definitions or condition metrics. Habitat type and condition are not always the critical drivers of the presence or abundance of species of interest. Other factors that cannot be controlled by scheme management (such as climate, weather, or conditions on wintering grounds) can be responsible for presence and/or abundance, so that monitoring species responses to local habitat management alone could be misleading.

Vegetation Condition: Monitoring of vegetation condition, for example by the use of positive Common Standard Monitoring (CSM) plant species (or desirable / expected species for that vegetation type), was designed for protected sites as an early warning system to prompt further investigation of potential risks for particular features of conservation interest. Monitoring CSM plant species has also been tested as a wider countryside indicator of vegetation condition (Smart et al. 2010). This usage reflects the logic chain that the same range of plant species are likely to be relevant to vegetation condition outside of protected sites as well as within. Some of the CSM may be less or more common but the pool of species is transferrable as would be expected (and the diversity of these same species can help discriminate designated versus undesignated examples of the same priority habitat). Using CSM plant species as an indicator of vegetation condition was also confirmed as a useful approach by a poll of British habitat experts (Rowe et al. 2016).

The relationship between habitat and vegetation condition: The relationship more broadly of habitat condition to vegetation condition (as assessed, for example by CSM plant species) is not well proven. CSMs take no account of scale, which is critical for many kinds of functional and non-functional biodiversity. Connectivity effects on plant genetics, bee foraging and nesting, threshold habitat areas and heterogeneity benefits (adjacent habitats providing complementary resources for

birds) are some examples of scale-dependent effects. Specifically, conceptual relationships between species and habitat type or condition may not be reflected in the particular habitats defined by Common Standards Monitoring categories (or other classification systems).

For example, a grassland habitat type might be defined in terms of the presence of a set of indicator plant species, but suitability for particular animal species may be determined more by vegetation management and structure, such as low density to allow access to the soil surface or a tussocky structure to provide cover. Further, context and scale may be critical, whereby habitat areas are only suitable when sufficiently large or either close to or far from certain other habitats that provide complementary resources or dis-benefits. This results in an important evidence gap and source of uncertainty that is dependent upon the precise habitat definitions that are adopted and emphasises that monitoring of species-level responses remains critical, because they cannot be assumed based on habitat and/or vegetation condition.

Potential approach: There is therefore a need for a 'basket of metrics' which reflect both vegetation condition (which has a biodiversity value in its own right) and other species-level monitoring approaches. Note that, in practice, species for which monitoring is most productive will be habitat-specialists which are sufficiently widespread to be recorded commonly in a random sample of a given habitat type, not extreme rarities.

2.2 'Future' versus 'current' native species

In the context of farm woodlands and agroforestry there is considerable evidence that climate resilience will be increased by planting tree species with greater drought, pathogen and pest tolerance than current native species (e.g. Broome et al. 2019). However, depending on location, this may come at a cost of some trade-offs with other services (e.g. existing biodiversity, current landscape character etc.). These potential trade-offs are the subject of much current debate and scientific evidence is unlikely to provide a sufficient basis for policy decisions. The simplistic categorisation of one set of species as "native" will need to be changed as a component of policy. The challenging concept of "future native" species as opposed to "current native" species will need to be incorporated.

3 Research gaps, Evidence Needs and Some Common Misconceptions

All reviews highlight remaining research needs and evidence gaps. We highlight needs and gaps here as well, and note some common misconceptions the team routinely comes across when engaging in workshops and meetings. These are some additional issues that are not covered in the Reviews but we hope will help bring us to a common understanding of the current evidence base.

3.1 Baseline and uptake activity data are needed

Several reviews point to the requirement for more detailed farm activity data, better definition of the baseline state of Welsh agriculture, and evidence of response to past agri-environment schemes (e.g. Reviews 1, 2, 4 and 7). These are required if we are to measure future improvements from the scheme and/or adapt the scheme to have higher uptake and impact. Some examples include:

- Fertiliser and manure management (some data could be derived from increasing the intensity of sampling in the British Survey of Fertiliser Practice).
- Repeating and enhancing the Wales Farm Practice Survey to track the temporal and spatial patterns in intervention uptake (and permanence if contract holders leave the scheme). It could also include for example use of control chemicals for which we have little information at present.
- Improved farmer segmentation data to understand the likely adoption rates of interventions and also adaptation to changing policy and trade situations (e.g. Brexit). This should include characterisation of attitudes by Robust Farm type, location, and size of the farm enterprise. Such information is currently not available and is limiting modelling work going forward by e.g. ERAMMP.
- Further exploration of the legacy impact of past schemes e.g. Tir Gofal.

3.2 On Farm assessment tools need improvement

The team noted the relatively poor quality of the carbon sequestration data available within the carbon foot-printing tools for farms. We note there is an opportunity for ERAMMP modelling work done by Forestry Research at 250m scale for 3 types of woodland and 5 management types using ESC[2] and CARBINE[3] to be developed into a C sequestration tool which could enhance current on-farm Greenhouse Gas (GHG) tools for Wales.

3.3 The risk of exporting our environmental footprint

Each review was asked specifically to consider the critical issue of ‘displacement’ or ‘leakage’. The question is, whether reducing activities in Wales (e.g. the production of

[2] Ecological Site Classification (ESC): https://www.forestresearch.gov.uk/tools-and-resources/forest-planning-and-management-services/ecological-site-classification-decision-support-system-esc-dss/
[3] Carbon accounting model: https://www.forestresearch.gov.uk/research/forestry-and-climate-change-mitigation/carbon-accounting/forest-carbon-dynamics-the-carbine-carbon-accounting-model/

food or timber) results in the export of that activity and its environmental impact to other regions or countries. Displacement to another region with potentially lower efficiency, less rigorous oversight of ethical issues, and/or increased transport costs could result in unintended consequences. On the other hand, some activities in Wales may have a larger environmental footprint than when displaced (due to the challenging nature of our climate and soils which can take significant fossil fuel use to overcome) and may produce food products which are not always nutritionally better (e.g. see Edwards-Jones 2010).

The benefits of greater connectivity between people and their food and the cultural aspects of our production systems also need to be considered. This issue was raised in Review 3 where the conversion of grassland to arable clearly has a negative effect on soil carbon stocks and thus was not recommended for inclusion in the new scheme. However, the potential impact of growing more grain and vegetables locally may have unforeseen benefits in diet, health and national awareness of natural resources and the primary industries in the same way the public can connect and value locally-sourced meat and dairy products.

These issues are important to consider as Wales has committed to the Well-being of Future Generations goal of ‘A Globally Responsible Wales’. This goal requires a focus on more efficient and resilient farming systems and developing more joined-up policies linking our farming strategy to considerations of our national diet, education and health outcomes. Likewise for the timber industry, we need to consider the final fate of harvested timber linking to the construction industry. These linkages, however, are difficult to evaluate because the effective boundaries of any farming or forestry system needed to quantify their ecological footprint are challenging to define. In the face of the complexities arising from displacement, there is a risk of adopting an overly simplistic approach such as focussing on greenhouse gas emissions only while ignoring biodiversity, ethical and social issues.

3.4 Which elements of biodiversity do we value?

Biodiversity is sometimes simplified to the more charismatic species, with hidden or less charismatic diversity over-looked. For example, an improvement in plant diversity is not always seen as a success if there is not a clear link to the more charismatic taxa such as pollinators or birds. In fact, the ‘greenness’ of the landscape is one element of landscape aesthetics people value highly (Swetnam et al. 2017) and many millions of people directly interact and value plants in their gardens. Another example of hidden biodiversity is soil biodiversity. Soils contains 25% of terrestrial species and are the source of most of the more commonly used antibiotics in medicine. How we balance our priorities between species which are directly linked to ecosystem function, versus species which are indicators of good condition, and finally species important for conservation, is a challenging task. This is particularly so when attempting to construct a balanced National Species Account as proposed by the UNEP-WCMC (2016), which emphasises the need to focus on national priorities to ensure change and improvement is realised.

3.5 Agroforestry is not a new practice that is unproven and alien to the culture of Welsh farming practice

Review 4 reminds us that diverse forms of agroforestry, including hedgerows, shelterbelts, riparian woodlands, retention of single or groups of trees in pasture (e.g. on patches of thin soil/rocky outcrops) have been part and parcel of farming practice (and the agricultural landscape) in Wales for millennia.

3.6 The permanence of the forest carbon stock

If a woodland is sustainably managed and each rotation of trees grows to return to the pre-harvest carbon stock, then the forest carbon stock is renewed on a cyclical basis. Furthermore, if the harvested wood is used in products with a long lifespan this can result in a timber production woodland system contributing more to climate change mitigation than an unharvested woodland. This benefit will be magnified further if the use of these harvested wood products: (a) substitutes for materials like concrete, steel or plastic; and (b) substitutes for wood imported from countries where the production forests are not managed sustainably. We therefore suggest that the decision to include more woodland in the landscape should not be based on a perceived lack of permanence of the forest carbon stock.

3.7 Is there an increased risk of fire with woody species?

This is an emerging topic and is covered only briefly in Review 3. Here, we highlight the issue as one that usually results in disagreement between different sectors. We encourage Welsh Government to undertake a review to provide a common understanding of the underlying factors that contribute to unintended fire outbreaks here in the UK. We appreciate that in other parts of the EU there is a clear known risk of increased woody cover and fire risk e.g. Le Houérou (1987), Newell Price (1998).

In summary, there are many factors that contribute to the risk of fire including:

- Proximity to urban centres
- Limited public awareness of risks of unattended fires
- The relationship to fuelwood load and the need identified in many countries for a programme of controlled fires to replace natural fires regimes that were previously supressed
- Flammability of the vegetation e.g. do we have less flammable hardwoods compared to the more flammable resinous species of the Mediterranean or Americas which will lower fire risk?
- The successional stage of vegetation with a potential of moving through a shrub-dominated successional window of high fire risk to a lower risk phase of later successional hardwoods e.g. Rowan, Birch.

We also note that the Natural Environment Research Council has just released a funding call on this topic recognising that many transferred assumptions from other countries may not hold for the UK.

3.8 Can we measure soil condition?

There is a mixed acceptance of current metrics for assessing soil condition by national governments in the UK. However in Wales, the loss of soil carbon is accepted as a high-level national indicator of the Well-being of Future Generations Act. Within the research community, most workshops usually converge on the following trends in metrics as indicators of improved soil condition irrespective of soil type or their starting point:

- Increase in soil organic carbon
- Reduction in soil acidity
- Nutrient levels moving to within agreed thresholds reducing risk of GHG emissions and losses to water bodies
- Reduced contamination levels
- Reduced area of bare soil and thus lower erosion risk
- Reduced bulk density indicating lower compaction

However, there is currently an absence of biological measures in this list as there is no agreement in the community which are the appropriate metrics (other than for earthworm numbers which is suitable for improved land only). Overall soil community richness does not appear to be linked to soil function and spatial patterns are complex. Soil bacterial and fungal richness appears positively related to land use intensity whilst soil animal richness appears negatively to land use intensity. This data is from the Wales GMEP national survey (George et al. 2019). Measurements which may be particularly suited to on farm assessment by farmers versus national assessment are outlined in Review 3. The research task of identifying biological indicators will continue to benefit from the national record and 'Living Soil Archive' we have for topsoil bacteria, fungi and animals here in Wales from 2007 (Countryside Survey) and 2016 (GMEP). .

3.9 Are soil C sequestration rates high in grassland?

Improved pasture lands contain large stocks of C primarily because of their dominance in area coverage in Wales. Bradley et al. (2005) estimated soil C in pasture land to be equivalent to 47% of Wales' soil carbon stocks to a 1m depth. Preserving these and all soil C stocks are critical if soils are not to contribute to further climate change when they should be helping mitigate climate change by ongoing C storage.

C sequestration under any specific land management system moves towards an equilibrium and permanent grasslands are by definition close to or at equilibrium. Thus, C sequestration rates in permanent grasslands are limited. Rates are higher in temporary grassland during the switch from arable to grass, but loss rates are higher when temporary grass is cultivated. 73% of grazing land in Wales is "permanent" (i.e. defined as > 5 years old) managed grassland, 10% is "temporary" (< 5 years old) managed grassland and a further 17% is rough grazing (i.e. receiving negligible inputs and is permanent grassland). Thus, 90% of grassland in Wales is permanent grassland. C sequestration may be increased in permanent grassland by increasing its productivity, e.g. by liming, greater use of deep-rooting herbs and legumes

(diverse swards) or applying more fertiliser. However, there are additional GHG emissions associated with those activities that must be accounted for. Therefore, we highlight in Review 3 and 7 that there is no evidence that grasslands are accumulating soil carbon to an extent that could compensate for the large greenhouse gas emissions from the livestock and industry activities associated with grassland management.

This is contrast to woodlands, for example, where the carbon sequestered in above-ground biomass after management activities is accounted for, does lead to a net reduction of greenhouse gas emissions for the land sector. However, current rates of woodland growth and new woodland planting represent only about 5% of current agricultural emissions (see comparison figure in GMEP Final Report 2017 (Emmett et al. (2017)). We note also in Review 3 that the evidence for afforestation effects on soil carbon sequestration is limited and seems dependent on tree species and soil type. It is the above-ground tree biomass that provides the significant climate mitigation contribution.

3.10 Covering slurry stores is only a small part of abating ammonia emissions

Covering slurry stores is very effective for reducing ammonia emissions from stored slurry, but this is the smallest of three main terms (see Reviews 7 and 8). In slurry-based livestock management, emissions from housing and land spreading are much bigger sources than slurry storage. Land spreading is usually the easiest and most logical place to start for an engineering (rather than nutritional) approach. Reducing losses from housing without reducing losses from land spreading is a good place to start (and has the added benefit of reducing volume in high rainfall areas) however we emphasise that this must be aligned with precision application methods so losses avoided at storage are not wasted during spreading.

3.11 Wetlands / peatlands may not always act as sponges and mitigate flooding

There is a traditional view that ‘wetlands act as a sponge’ and reduce floods. But as reviewed in Review 9 this is a significant over-simplification. Their contribution is dependent on the location and management of the wetland or peatland. Overall natural flood management options will have only limited impact in some of the extreme, high intensity rainfall driven flood events that tend to make the media headlines. The ‘soil or wetland box’ has a finite capacity just as a sponge has and when they are saturated water will just flow over the surface with little mitigation of flow rates.

3.12 Peatlands restoration will help to mitigate climate change

Review 3 highlights that the key issue for peatlands is the maintenance of the large soil C stock in the peats through the raising of the water table but also the cessation of agricultural and forestry activities that often involve the addition of fertilisers, lime

and presence of grazing animals. It is as much the removal of these additional management activities and the stopping of peat degradation that provides the climate benefit i.e. in reducing enhanced greenhouse gas emissions. Carbon sequestration rates in peat formation in comparison is a relatively small proportion of the overall climate benefit both locally and nationally associated with peatland restoration.

4 Scheme design and operational issues

4.1 Minimal disruption versus major shifts

There may be a need for the scheme to leverage major change if adequate responses to likely future industry challenges post Brexit and ongoing climate change are to be made. For example with respect to climate change:

- The majority of evidence has looked at the 1.5ºC scenario, but in planning for climate risks consideration, at least until global emissions pathways alter, planning needs to consider a 4ºC scenario.
- The adaptation to climate change is not simply a question of adjusting to a different average (i.e. long term mean) set of conditions, but also to increased variability of conditions (e.g. more frequent and/or severe flood and droughts). So adaption is as much about resilience to variability as about optimising for changing average conditions. Brexit uncertainty only emphasises the need for greater resilience in our linked farming, forestry and environmental systems.

4.2 Farm Resilience

This leads onto the need to improve the resilience of the overall farm system. Review 5 explicitly explored this issue and the following recommendations were made:

Table 6.2.1 Summary of key interventions to improve resilience in the farm system Review 5.

Confidence	Intervention name	Key Outcomes	Key Benefits	Critical Concerns
Blue	Knowledge transfer and exchange: Improve skills and disseminate information to underpin socio-economic resilience in rural communities/ farm business	1. Ability to understand and adapt to new drivers of policy interventions (e.g. GHG emissions, Climate Change) 2. Ability to obtain alternative source of income (e.g. supply environmental management services)	Socio-economic resilience of farmer livelihoods, ability to adapt to new on-farm and rural economy opportunities.	Current Farming Connect system has a high level of engagement but currently no mechanism in place track whether the same cohort of farmers is participating in a range of activities or if attendance truly reflects engagement across the sector
Blue	Skills development: Implementation of mandatory education level for those wishing to participate in the SFS	1. Increased skills and knowledge base within the farming sector 2. Enhanced levels of professionalism within the sector	Recognition of the value of Continual Professional Development within the farming sector and greater resilience to changing market (public	How to implement within current system given range of capabilities currently operating in the sector. Level of education required needs to be carefully explored

			or private) demands	
Blue	Succession support for young and new entrants into farming	1. Stratification of age range within agricultural sector 2. Diversification of skills sets and perspectives within the farming sector	Increased levels of innovation and stability within the agricultural sector	Links closely with above intervention. Implementation of intervention will be key to efficacy (e.g. assessment metrics)
Amber	Producer Cooperation: Horizontal and vertical Supply-chain (produce custody) collaboration measures	Ability to manage and supply certified environmental products from different farm locations or production standards	Potential improved return on defined production locations/ standards.	Part of industry support measures – see link to industry/ sector policy positions.
Amber	Working Capital	Provides targeted capital investment to small business to counteract market failure and facilitate innovation	Support diversification of sector and uptake of economic and environmental efficiency mechanisms	Assessment for allocation of support will have to be robust to ensure best value for money and appropriate business planning
Pink	Financial measures	Mitigates the uncertainties of emerging and existing market systems	Facilitates innovation within the sector and increases market awareness	Interventions largely untested and limitations as to how effective Welsh Government can be in facilitating this within a global marketplace

Colour Key - colour codings in the table(s) above, as for all reviews, reflect the following:

- Blue = well tested at multiple sites with outcomes consistent with accepted logic chain. No reasonable dis-benefits or practical limitations relating to successful implementation.
- Amber = agreement in the expert community there is an intervention logic chain which can be supported but either evidence is currently limited and/or there are some trade-offs or dis-benefits which WG need to consider.
- Pink = either expert judgement does not support logic chain and/or whilst logic chain would suggest it should work there is evidence of one or more of the following:
  - its practical potential is limited due to a range of issues (e.g. beyond reasonable expectation of advisory support which can be supplied and/or highly variable outcome beyond current understanding or ability to target),
  - the outcome/benefit is so small in magnitude with few co-benefits that it may not be worth the administration costs,

We encourage the reading of the full Review to understand the complexity of this issue and to understand the background to the recommendations above.

4.3 Skills

The issue of improved skills arose frequently in many Reviews (see particularly Review 4 and 7 as well as above in Review 5). Many in the team highlight the potential value of investing more heavily in the number of on farm advisers and their agricultural and environmental expertise to ensure:

- The right assessment of baseline and opportunity
- The benefits of regular soil testing
- The application of best / appropriate management option / intervention
- The right post-payment outcome assessment
- More buy-in by farmers

It was also noted it could also be helpful to break down the previous barriers between agricultural and forestry skills, and the institutional divisions between provision of agricultural and woodland advice to landowners.

4.4 Funding options

Scheme design can facilitate combinations of 3rd party private and public funding for outcomes that have a combination of public and private good characteristics. Private funding also includes funding from farmers' own resources, which may be motivated by the scheme, but this is not 3rd party so is not covered, but should be recognised in scheme design and so farmers do not feel their existing efforts are overlooked.

1 3rd party private funding mechanisms include payments for ecosystem services (PES) approaches. The main private sector use of these in the UK relates to water company initiatives (e.g. SCAMP and subsequent schemes). Welsh Water and Severn Trent water are engaged in the work on these issues, but are not yet making widespread use of them within their investment planning. The new scheme provides an opportunity to level further funding from the water sector, but support within the regulatory regime for the sector is also necessary to achieve this objective.
2 Other private funding opportunities also have potential, but are still innovative in terms of their potential use in Welsh agriculture and land management. These include:

   - Product labelling, either through international certification (e.g. Organic, FSC), or location-defined standards (e.g. "sustainable Pembrokeshire lamb").
   - Bio-carbon credits within agriculture. This is a growing and potentially large market, but there are major questions, e.g. about: i) farming systems that are carbon positive that then have credits to sell, and ii) whether the credits should belong to Welsh Government or individual farmers.
   - NGOs can channel external sources of (public and private) funding and their own resources into land management.

- Procurement by the public sector in Wales has an opportunity to influence market demand - it could be a requirement to participate in the scheme to supply to the public sector in Wales.
- A variety of financial instruments can be used to motivate 3rd party private investment in improving biodiversity and ecosystems (eftec et al., 2012), and lessons on good and bad practice can be drawn from other environment policies (e.g. the Solar feed-in-tariff).
- Access to 3rd party and particularly innovative funding sources requires different skills that may not be present or explicit in the agriculture sector. These include the ability to write business plans that have financial, business and monitoring processes that are sufficient to give confidence to 3rd party funders.
- See also next section on the opportunities and limitations of a Results-based payment approach

Within the reviews there are some specific sections relating to actions beyond interventions that could be crucial for the scheme success.

4.5 Result-based payment schemes

Result-based payment schemes (RBAPS) are agri-environment or similar schemes where all or part of the annual payment per hectare (or other unit of management) depends on achieving a threshold value of one or more environmental indicators (the 'result indicators'), which are capable of being verified at field level. In practice, this is typically done by the farmer (because professional measurement of results is financially unviable outside pilot schemes) and control/verification is done using the same detailed protocol, which is defined in the rules of the scheme. The farmer is free to choose how to manage the land to achieve that result, because achievement of the result indicator is the basis for payment. RBAPSs have been used in Europe for many years, especially for species-rich grasslands and meadows (the first known example was set up by the Peak District NPA in the 1980s). Many of these schemes have operated within RDP agri-environment programmes, often as a higher-level top-up to an entry-level activity-based payment on the same parcel (Allen et al, 2014).

The potential advantages of RBAPS for biodiversity include a closer, more transparent link between payment and biodiversity achievement, and less 'deadweight' because in a well-designed results-based scheme there is a built-in incentive for farmers to select only the land where the biodiversity results are achievable. RBAPS for biodiversity habitat management and improvement typically require a minimum threshold result indicator value to qualify for entry, then stepped (or linear) increases in both indicator values and payment rates above the threshold. This provides from the outset an incremental financial incentive for year-on-year improvements in performance, then pays for maintenance of good habitat condition in the long-term. It also discourages 'managing down' to the threshold indicator value on parcels which enter at a higher indicator score of habitat quality. Farmers bear the financial risk of failure to achieve results, but this can be reflected to an extent in the payment calculation. One of the main concerns that farmers have about the results-based approach is the risk that the result will not be achievable, but if the result

indicators are well-chosen (e.g. vegetation proxies for habitat quality or effects on other targets), this risk should be low and reduced further by provision of targeted advice and technical support when the scheme is introduced. If a results-based approach is subject to a high degree of uncertainty, especially in the validity of the indicator-objective link or as a consequence of factors beyond the farmer's control, it is unlikely to be feasible. Keenleyside et al (2014) suggests result indicators for biodiversity objectives should meet the following criteria:

- be representative of the target habitat or species;
- occur consistently in target farmland habitats in the area;
- be easily identified by farmers and paying agency representatives;
- be measurable using a simple methodology;
- be sensitive to changes in agricultural management but otherwise stable;
- be unlikely to be influenced by external factors beyond the control of the land manager; and
- not be achieved easily by means other than agricultural management.

Examples of the design and testing of botanical indicators for RBAPS in Europe can be found in Underwood et al (2014), and in the results of recent on-farm pilots in Ireland (Byrne et al, 2018 and McLoughlin et al, 2018) and in the reports of the England pilots, which will be published soon. Successful results-based payment schemes require a considerable level of mutual trust between the parties involved, particularly the managing authority and the potential contract holders and their representatives. The non-prescriptive nature of the RBAPS contract and the need for farmers to have confidence that the results will be judged in ways that are fair and objective means that trust is particularly important for results-based payment schemes.

However, some of the team noted that RBAPS are not suitable for all biodiversity objectives or situations. The payment is based entirely on result indicators that are proxies for the specific environmental objective, and an RBAPS is not feasible if the effective result indicators cannot be chosen. The long running schemes in France and Germany are mostly for species-rich hay meadows, but it has been challenging to use RBAPS for 'mobile' species - birds or butterflies, for example – and to select effective indicators at field level. An early scheme for ground nesting birds in the Netherlands, showed a positive increase in the indicator (number of nests) but failed to achieve the objective of increasing the population, due to several factors, including predation. Recent on-farm pilots in Ireland[4] and England have tested an alternative approach, using result indicators of suitable habitat structures for target bird and butterfly species, rather than the species themselves. A Natural England arable pilot scheme, funded by the EC and Defra, is testing like-for-like replacement of conventional agri-environment payments by RBAPS for pollinator strips and winter bird seed crops on arable land[5]. Other pilot RBAP schemes are being developed for

[4] see www.rbaps.eu
[5] Evaluation of these on-farm pilots are expected to be published by Natural England by late Summer 2019.

upland livestock systems in the North Pennines, the Yorkshire Dales, and in Scotland.

There has been recent interest in northern Europe in using RBAPS for other environmental objectives, such as reducing nitrate pollution by run-off from arable land, and flood plain management, but such schemes are still in the very early stages of design and testing.

From the perspective of scheme organisation and environmental outcomes the principal concerns are firstly, that proxies (result indicators) which can feasibly be measured may not reliably predict effects on the ultimate objective of management; and secondly, that farmers' self-assessment of indicators of quality may not be reliable. The former is dependent on evidence being available to support the links between objectives, indicators and outcomes. On farmer self-assessment, the Natural England trial has returned mixed results (more promising for wild flower strips than for bird seed crops).

A full-scale scheme must also account for management types that fit the RBAPS model less well and operate effectively with farmers who are less enthusiastic than the early adopters who are likely to participate in trials. The upfront costs of data and evidence gathering to select and test the indicators and of training farmers, agricultural advisers and field staff will also need to be taken into account.

RBAPS are clearly not a panacea for achieving all environmental land management objectives, and in the UK are still in early stages of development (after a 30-year gap). As the results of current pilots emerge, they will provide much better information on the potential application of RBAPS only for certain biodiversity objectives, but application to other objectives, or on a much wider scale has yet to be tested.

4.6 Additionality; Eligibility of land; Legal and tax issues; Tenancy; and the Regulatory Floor

There are many complex issues tied up in this list and they need to be considered if unintended outcomes are not to emerge but are beyond the remit of the Evidence Pack. We only note the following just to reflect the fact they were mentioned in various debates during the Evidence Pack workshops:

- The balance of what should be included in the regulatory regime versus a payment scheme is beyond the remit of these reviews although clearly no regulatory floor will work unless there are sufficient resources for policing the rules.
- Input from organisations such as the Central Association of Agricultural Valuers to contribute to the debate on issues which could constrain uptake could be sought e.g. inheritance tax issues.
- We note the unintended outcome of a scheme can be undermined by verification technical requirements e.g. the change from just the area occupied by a tree being ineligible to the whole area covered by the canopy being ineligible; and secondly, if there are more than three trees in a group, the whole area occupied by the group is ineligible. This is likely to have actively

discouraged farmers from keeping or planting trees in fields and hedges and contributed to the poor uptake of woodland creation options in Glastir.

- There may be conflicts between timescales over which forward commitments of Government funding can be made (i.e. 5 year spending cycles) and timescales to achieve results from ecosystem management/recovery (decadal). This may be resolved through contract clauses to achieve longevity (e.g. renewal premiums).
- A decision needs to be made as to the importance of maintaining past shifts in management practices in response to past or current payment schemes and the need for additionality. This is particularly important when considering the long time periods involved in realising some ecological benefits (e.g. 10-20 years; GMEP Final Report 2017).

4.7 Facilitating debates and conflict management

Careful use of language can help reduce conflicts and unintended bias when communicating options and intended outcomes. As an example, if grazing has been reduced on an area of upland land and native woody species are colonising, different stakeholder communities may describe this in a participatory workshop as either:

- land abandonment with associated fire risk (e.g. farmers)
- natural regeneration of our native woodland (e.g. foresters)
- rewilding (e.g. conservationists)

The use of language may potentially block effective debate between the different communities.

Independent and trusted facilitation of the debates between different stakeholders is needed for a national consensus to be reached that will enable Wales to meet the many challenges and opportunities ahead. This facilitation needs to be supported and challenged by access to the evidence base such as that provided in this Evidence Pack.

5 References

Alison, J., Thomas, A., Evans, C.D., Keith, A.M., Robinson, D.A., Thomson, A., Dickie, I., Griffiths, R.I., Williams, J., Newell-Price, J.P., Williams, A.G., Williams, A.P., Martineau, A.H., Gunn, I.D.M. & Emmett, B.A. (2019). Technical Annex 3: Soil Carbon Management. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Allen B, Hart K, Radley G, Tucker G, Keenleyside C, Oppermann R, Underwood E, Menadue H, Poux X, Beaufoy G, Herzon I, Povellato A, Vanni F, Pražan J, Hudson T, Yellachich N (2014) Biodiversity protection through results based remuneration of ecological achievement. Report Prepared for the European Commission, DG Environment, Contract No ENV.B.2/ETU/2013/0046, Institute for European Environmental Policy, London.

Balmford, B.; Green, R.E.; Onial, M.; Phalan, B.; Balmford, A. (2019) How imperfect can land sparing be before land sharing is more favourable for wild species? JOURNAL OF APPLIED ECOLOGY Volume: 56 Issue: 1 Pages: 73-84 DOI: 10.1111/1365-2664.13282 Published: JAN 2019

Balmford, A, Amano, T, Bartlett, H, Chadwick, D, Collins, A, Edwards, D, Field, R, Garnsworthy, P, Green, R, Smith, P, Waters, H, Whitmore, A, Broom, D, Chara, D, Finch, T, Garnett, E, Gathorne-Hardy, A, Hernandez-Medrano, J, Herrero, M, Hua, F, Latawiec, A, Misselbrook, T, Phalan, B, Simmons, B, Takahashi, T, Vause, J, zu Ermgassen, E & Eisner, R 2018, 'The environmental costs and benefits of high-yield farming', Nature Sustainability , pp. 477-485. https://doi.org/10.1038/s41893-018-0138-5

Bradley R.I., Milne, R., Lilly, A, Jordan C. and Higgins, A. (2005) A soil and land use database for the United Kingdom. Soils Use and Management 21:363-369.

Broome, A; Ray, D; Mitchell, R; Harmer, R. 2019. Responding to ash dieback (Hymenoscyphus fraxineus) in the UK: woodland composition and replacement tree species. FORESTRY Volume: 92 Issue: 1 Pages: 108-119 DOI: 10.1093/forestry/cpy040 Published: JAN 2019

Byrne, D., C. Maher, V. Alzaga, C. Astrain, G. Beaufoy, A. Berastegi, A. Bleasdale, V. Clavería, A. Donaghy, K. Finney, S.B.A. Kelly, G. Jones, J. Moran, B. O'Donoghue & J. Torres. (2017) Developing Results Based Agri-environmental Payment Schemes (RBAPS) for biodiversity conservation in Ireland and Spain. Grassland Science in Europe 22: 299-301 download at https://www.europeangrassland.org/fileadmin/documents/Infos/Printed_Matter/Proceedings/EGF2017.pdf

Byrne, Dolores; Astrain, Massa, Carlos; Beaufoy, Guy; Berastegi, Asun; Bleasdale, Campion, David; Andy; Copland, Alex; Dunford, Brendan; Edge, Robert; Finney, Kathryn; Iragui Yoldi, Uxue; Jones, Gwyn; Lopez Rodriguez, Fabiola; Maher, Caitriona; Moran, James; McLoughlin, Derek and O'Donoghue, Barry (2018). Non-technical Summary: Results-based Agri-environment Pilot Schemes in Ireland and Spain. Report prepared for the European Union, Agreement No. 07.027722/2014/697042/SUB/B2.

Cannon, PG; Gilroy, JJ; Tobias, JA; Anderson, A; Haugaasen, T; Edwards, DP (2019) Land-sparing agriculture sustains higher levels of avian functional diversity than land sharing.

GLOBAL CHANGE BIOLOGY Volume: 25 Issue: 5 Pages: 1576-1590 DOI: 10.1111/gcb.14601 Published: MAY 2019

Edward-Jones G. (2010) Does eating local food reduce the environmental impact of food production and enhance consumer health? Proceedings of the Nutrition Society 69: 582 – 591.

Egli, L; Meyer, C; Scherber, C; Kreft, H;; Tscharntke, T (2018) Winners and losers of national and global efforts to reconcile agricultural intensification and biodiversity conservation. GLOBAL CHANGE BIOLOGY Volume: 24 Issue: 5 Pages: 2212-2228 DOI: 10.1111/gcb.14076 Published: MAY 2018

Emmett, B.E., Abdalla, M., Anthony, S., Astbury, S., August, T., Barrett, G., Beckman, B., Biggs, J., Botham, M., Bradley, D., Brown, M., Burden, A., Carter, H., Chadwick, D., Cigna, F., Collier, R., Cooper, D., Cooper, J., Cosby, B.J., Creer, S., Cross, P., Dadam, D., Edwards, F., Edwards, M., Evans, C., Ewald, N., Fitton, A, Garbutt, A., Giampieri, C., Gooday, R., Grebby, S., Greene, S., Halfpenney, I., Hall, J., Harrison, S., Harrower, C., Henrys, P., Hobson, R., Hughes, P., Hughes, S., Illian, J., Isaac, N., Jackson, B., Jarvis, S., Jones, D.L., Jones, P., Keith, A., Kelly, M., Kneebone, N., Korenko, J., Lallias, D., Leaver, D., Lebron, I., Malcolm, H., Maskell, L., McDonald, J., Moxley, J., Norton, L., O'Hare, M., Oliver, T., Owen, A., Parkhill, K.A., Pereira, M., Peyton, J., Pogson, M., Powney, G., Pritchard, N., Pritchard, S., Prochorskaite, A., Prosser, M., Pywell, R., Rawlins, B., Reuland, O., Richards, M., Robinson, D.A., Rorke, S., Rowland, C., Roy, D., Scarlett, P., Scholefield, P., Scott, A, Scott, L., Scott, R., Sharps, K., Siriwardena, G., Smart, S., Smith, G., Smith, P., Stopps, J., Swetnam, R., Taft, H., Taylor, R., Tebbs, E., Thomas, A., Todd-Jones, C., Tordoff, G., Turner, G., Van Breda, J., Vincent, H., Wagner, M., Waters, E., Walker-Springett, K., Wallace, H., Watkins, J., Webb, G., White, J., Whitworth, E., Williams, B. , Williams, P., Wood, C. and Wright, S. (2017) Glastir Monitoring & Evaluation Programme. Final Report to Welsh Government. Contract reference: C147/2010/11. NERC/Centre for Ecology & Hydrology (CEH Projects: NEC04780/NEC05371/NEC05782)

George, P., D. Lallias, S. Creer, F. Seaton, J. Kenny, R. Eccles, R. Griffiths, I. Lebron, B. Emmett, D.A. Robinson, and D. Jones. 2019. Divergent national-scale trends of microbial and animal biodiversity revealed across diverse temperate soil ecosystems. Nature Communications 10 Article Number 1107.

Jones, L., Bealey, B., Braban, C., Martineau, A.H., Williams, A.G. & Dragosits, U. (2019). Technical Annex 8: Improving air quality and well-being. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Keenleyside C, Radley G, Tucker G, Underwood E, Hart K, Allen B and Menadue H (2014) Results-based Payments for Biodiversity Guidance Handbook: Designing and implementing results-based agri-environment schemes 2014-20. Prepared for the European Commission, DG Environment, Contract No ENV.B.2/ETU/2013/0046, Institute for European Environmental Policy, London.

Keenleyside, C.B., Beaufoy, G., Alison, J., Gunn, I.D.M., Healey, J., Jenkins, T., Pagella, T. & Siriwardena, G.M. (2019). Technical Annex 4: Building ecosystem resilience. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Keenleyside, C.B., Dickie, I., Alison, J., Lewis-Reddy, E. & Siriwardena, G.M. (2019). Technical Annex 6: Public and private funding. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Keenleyside, C.B. & Old, G.H. (2019). Technical Annex 9: Flood mitigation. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Lewis-Reddy, E., Turner, C. & Williams, A.P. (2019). Technical Annex 5: Building resilience in farm systems. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Le Houérou, H.N. 1987. Vegetation wildfires in the Mediterranean basin: evolution and trends. Ecologia mediterranea. XIII (4): 12.

Loos, J; von Wehrden, H 2018. Beyond Biodiversity Conservation: Land Sharing Constitutes Sustainable Agriculture in European Cultural Landscapes. SUSTAINABILITY Volume: 10 Issue: 5 Article Number: 1395 DOI: 10.3390/su10051395 Published: MAY 2018

Martineau, A H., Williams, A.G., Chadwick, D. & Thomson, A. (2019). Technical Annex 7: Systems approach to GHG emissions reduction. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Marr, EJ (Marr, Eric Joseph); Howley, P (Howley, Peter) 2018 Woodlots, wetlands or wheat fields? Agri-environmental land allocation Preferences of stakeholder organisations in England and Ontario. LAND USE POLICY Volume: 75 Pages: 673-681 DOI: 10.1016/j.landusepol.2018.02.008 Published: JUN 2018

McLoughlin, D. (2018) Pilot results-based agri-environment measures in Ireland and Navarra End of Project Technical Synthesis Report. European Forum on Nature Conservation and Pastoralism. Download at www.rbaps.eu

Newell Price, J.P. (1998) Actions taken by Moroccan national agencies to combat desertification in Morocco. In S.B. Burke & J.B. Thornes (eds) Actions taken by national governmental and non-governmental organisations to mitigate desertification in the Mediterranean. Concerted Action Report 1: 111-154. Office for Official Publications of the European Communities.

Newell Price, J.P., Siriwardena, G.M., Williams, A.P., Alison, J. & Williams, J.R. (2019). Technical Annex 2: Sward management. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Rowe EC, Ford AES, Smart SM, Henrys PA, Ashmore MR (2016) Using Qualitative and Quantitative Methods to Choose a Habitat Quality Metric for Air Pollution Policy Evaluation. PLoS ONE 11(8): e0161085. doi:10.1371/journal.pone.0161085

Smart, S., Dunbar, M.J., Emmett, B.A., Marks, S., Maskell, L.C., Norton, L.R., Rose, P., Simpson, I.C. 2010. An Integrated Assessment of Countryside Survey data to investigate Ecosystem Services in Great Britain. Technical Report No. 10/07 NERC/Centre for Ecology & Hydrology 230pp. (CEH Project Number: C03259). http://www.countrysidesurvey.org.uk/sites/default/files/CS_UK_2007_TR10.pdf

Styles, D, Gonzalez Mejia, A, Moorby, J, Foskolos, A & Gibbons, J 2018. Climate mitigation by dairy intensification depends on intensive use of spared grassland., Global Change Biology, vol. 24, no. 2, pp. 681-693. https://doi.org/10.1111/gcb.13868

Swetnam, R.D., Harrison-Curran, S.K. and Smith, G.R. 2017. Quantifying visual landscape quality in rural Wales: A GIS-enabled method for extensive monitoring of a valued cultural ecosystem service. Ecosystem Services 26: 4511-464. http://dx.doi.org/10.1016/j.ecoser.2016.11.004

Underwood, E (2014) Result indicators used in Europe: Results-based Payments for Biodiversity - Supplement to Guidance Handbook. Prepared for the European Commission, DG Environment, Contract No ENV.B.2/ETU/2013/0046. Institute for European Environmental Policy, London.

UNEP-WCMC (2016) Exploring approaches for constructing Species Accounts in the context of the SEEA-EEA. ISBN: 978-92-807-3582-6. https://www.unep-wcmc.org/resources-and-data/towards-an-approach-for-species-accounting

Williams J.R., Newell Price, J.P., Williams, A.P., Gunn, I.D.M. & Williams A.G. (2019). Technical Annex 1: Soil nutrient management for improved land. In *Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP): Sustainable Farming Scheme Evidence Review*. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

This page intentionally blank.

Enquiries to:
ERAMMP Project Office
CEH Bangor
Environment Centre Wales
Deiniol Road
Bangor
Gwynedd
LL57 2UW
T: + 44 (0)1248 374528
E: erammp@ceh.ac.uk

www.erammp.cymru

www.erammp.wales