Natural England Research Report NERR085

Agri-Environment Evidence Annual Report 2018/19

A summary of findings from recently published projects

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Agri-Environment Evidence Annual Report 2018/19: A summary of findings from recently published projects

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Executive Summary

This annual report highlights recent work of the Agri-environment Evidence Programme. The eight projects featured in this report provide evidence relevant to a range of agri-environment schemes and outcomes. Projects looked at the effectiveness of schemes on plants and soils and how schemes contribute to natural capital and climate change mitigation. Additionally, this report includes a number of projects which investigate the social impacts of AES and the development of methods to assess this.

Evaluating environmental effectiveness at different spatial scales

The effectiveness of agri-environment schemes (AES) was assessed at the field, farm, regional and national scales. A range of methods were used including field surveys, agreement holder interviews, modelling and reviewing previously published research. This annual report highlights the benefits that AES can bring about at a range of different scales, as well as contributing to natural capital benefits such as climate change mitigation and cultural services. Despite this, challenges remain with regards to data availability and upscaling site specific findings to the regional or national scale.

At the field scale, projects yielded evidence that agri-environment arable options can result in a significant increase in soil organic carbon (SOC) over a 10 year period, for example through the inclusion of grass/clover ley in rotation and the addition of farmyard manure. This project also highlighted however that lags between management and environmental responses can last beyond agreement timescales, for example a decrease in grassland SOC was found after 10 years of option implementation, potentially linked to the system still being affected by historic drainage.

As shown in the 2017-18 Annual Report, it can be difficult to determine if the direct effects of agri-environment options at the field scale provide additional benefits at a larger scale. This difficulty is also demonstrated in this years' report. Consensus of AES impact on the environment was not possible from literature reviews on a number of topics including Sites of Special Scientific Interest; agreements on organic farms; and Upland Hay Meadow rush extent. The findings from these projects highlight a joined up approach of the various aspects of agri-environment monitoring could be beneficial, such as recording information on both agreement and SSSI features during site visits, and where historical data is available, differences in monitoring techniques reduce the robustness of analysis.

Agri-environment options can also provide a range of benefits for ecosystem services. The potential greenhouse gas (GHG) emission reductions associated with Countryside Stewardship (CS) options were developed using a life-cycle component approach. Overall, modelling estimated a decrease in emissions of approximately 1 $Mtyr^{-1}$ from 2018 CS option uptake. Modelling GHG emissions comes with a number of caveats, however field measurements of SOC changes over a 10 year period also revealed increases in SOC attributed to CS option implementation. Climate change mitigation is one of many natural capital benefits of agri-environment, and the value of natural capital benefits was investigated in a separate project. Generally CS was found to be having a positive effect on the natural capital of England and providing a wide range of ecosystem services. Mapping CS options to natural capital indicators was challenging, with a lack of evidence regarding the benefits and values of options, especially biodiversity which is a core aim of CS. The value of CS options could be most robustly quantified for interventions relating to carbon sequestration, flood mitigation, recreation and pollution reduction, however significant future research is required to provide robust valuation of all CS options.

Evaluating scheme design and implementation

The social aspects of agri-environment evaluation have received limited attention to date, however progress is being made through the completion of two projects focusing on the development of social indicators and the impact of CS Facilitation Fund (CSFF) groups. Identified from a literature review, social indicators were linked to land managers' quality of engagement with their agreement and the social outcomes from agreements, as well as how these link to environmental outcomes. Survey questions were developed based on these indicators and tested on a small number of agreement holders and Natural England advisers. The evidence review found links between the quality of farmer engagement with their schemes and environmental outcomes. Harnessing factors such as interest and knowledge of the environment, increased social connections, and experience of positive agreement outcomes are important considerations for developing quality of engagement. Negative social outcomes identified included increased stress due to scheme bureaucracy and increased workloads. Similar findings arose in a separate project through facilitator interviews, where early evidence indicated CSFF groups increased farmer interactions and consequently their confidence and knowledge in delivering environmental outcomes. Both projects highlighted the substantial potential of AES to contribute to social outcomes, however further development is needed before rolling out monitoring and evaluation to a wider scale.

Evaluating the Monitoring and Evaluation Programme

As highlighted in the 2017-18 Annual Report, detecting change over time is challenging, with limited counterfactual data available, either spatially (non-AES land) or temporally (prior to AES implementation). The successful use of counterfactual sites assessing SOC within the climate change mitigation project emphasises the robust analysis which can be achieved through specific monitoring designs, though a common land owner across the sites in this project reduced some of the challenges typically faced when establishing counterfactuals.

The challenges of using historical data to determine changes over time was also highlighted in this annual report. A study of rushes in upland hay meadows found that agreement holders judged rush extent to have increased by up to 75%, along with increases in density and vigour. Field re-surveying of rush extent was inconclusive, and the use of multiple historical data sources made it difficult to determine whether no real change occurred in rush extent, or the data available were insufficient for robust analysis. Together, this highlights the challenge of designing evaluation with sufficient survey replication, methodologies and counterfactuals to provide statistically robust analysis within the resource and cost constraints of monitoring.

Designing monitoring and evaluation programmes which enable environmental change to be detected is crucial, and this report summarises the proposed methodology for evaluating organic options, and comparing organic and conventional farms. This framework emphasises the need to use monitoring techniques which complement well-established national surveys, as well as existing agri-environment evidence projects. Further to this, the impact of sample size is assessed, with the uptake of some organic options too low to detect small impacts at a statistically significant confidence level.

Contents

Background - Agri-Environment Schemes

Agri-environment schemes (hereafter referred to as AES) encourage farmers and other landowners to protect and enhance the environment on their land by paying them for the provision of environmental services. Each scheme offers a range of options to deliver target outcomes for specific features. Prescriptions set out the management that must or must not be carried out for each option, and Indicators of Success (IoS) describe what success will look like. The AES referenced in this report are:

- Classic Countryside Stewardship Scheme (CSS) - open to applications between 1996 and 2004.

- Environmental Stewardship (ES) - open to applications between 2005 and 2014, it consisted of three tiers; Entry Level Stewardship (ELS) aiming for high coverage of basic options, Organic Entry Level Stewardship (OELS), and Higher Level Stewardship (HLS) with more demanding options targeted to features of high environmental value.

- New Countryside Stewardship (CS) – the current AES for England. The first agreements started 1st Jan 2016. Like ES, the scheme consists of two main tiers, a Mid-Tier (MT) and a Higher Tier (HT), however CS also consists of Wildlife Offers, Hedgerow and boundaries grants, historic buildings grants, woodland support and Facilitation Fund.

Introduction to the Agri-Environment Evidence Programme

England's agri-environment schemes receive funding from the Rural Development Programme for England (RDPE), and a condition of this funding is that schemes are continually assessed through a planned national programme of monitoring and evaluation, which also feeds into Europe-wide evaluation of Rural Development Programmes. Following initial pilots, full roll out of the new Environment Land Management scheme is due in 2024 which will replace the existing schemes. The Agri-Environment Evidence Programme (formerly Agri-environment Monitoring and Evaluation) is a joint programme delivered by Natural England and the Environment Agency on behalf of Defra, with input from the Forestry Commission and Historic England. The programme was funded through the RDPE Technical Assistance Fund and will be directly funded by Defra from 2020.

A small number of Natural England specialists and project managers, led from the Evidence Services Team, design the programme and provide support and guidance for the monitoring and evaluation work, which is generally carried out by external contractors.

The programme delivers evidence to:

- Evaluate the delivery of agri-environment schemes and their effectiveness in achieving their intended policy objectives.

- Inform current and future agri-environment policy, scheme delivery and development.

- Fulfil domestic and European reporting requirements.

Purpose of this report

This report aims to summarise and synthesise findings from projects in the Agri-Environment Evidence Programme that were published during 2019 and 2020. It also includes findings from relevant Research and Development projects that sit outside the RDPE agri-environment monitoring and evaluation programme.

Natural England works with Defra to understand these findings and interpret what they mean for AES development and operational delivery. Additionally, key messages are shared internally to inform Natural England staff and ensure the organisation remains evidence-based. This report is also intended to be shared with key partners who contribute to and have an interest in the performance of AES.

Each project referenced in this report has a unique code which is used to identify it. A list of the project codes and their titles can be found in the list of projects below. The 2018-19 Annual Report covers eight previously published projects which are available on the Defra Science Pages.

Project reports 2018-2019

This annual report summarises the following projects funded by the monitoring and evaluation programme in 2018-2019.

LM0469 - Monitoring rush encroachment in AES

> Is rush cover increasing in upland hay meadows? A literature review of rushes in upland hay meadows coupled with field surveys in 2017 of 115ha of meadows. Additionally 43 field-specific Farm Management Questionnaires were completed to assess the agronomic impact of rushes.

LM0470 – Agri-environment schemes and climate change mitigation

> To what extent do AES schemes contribute to climate change mitigation? Phase 1 of this report carried out a lifecycle assessment for CS options and generated a GHG emission factor for each. National GHG emissions were calculated by upscaling CS option uptake data from 2016 – 2018. Phase 2 assessed the impact of ES options on soil organic carbon across two farmed estates by re-surveying arable and grassland sites, including counterfactual sites, which had been in ES for up to a decade.

LM0473 - CS Facilitation Fund Evaluation & LM0479 - Countryside Stewardship Fund Phase 2

> Does the CS Facilitation Fund (CSFF) provide environmental benefits beyond those which would be achieved by agreements alone? CSFF groups established in the first two years of CS were assessed to evaluate whether agreements were better aligned with priorities and more connected compared to agreements not within a CSFF group. The potential socio-economic benefits of groups was assessed through online facilitator surveys and land manager interviews from 10 case studies in phase 1 and a further 28 in the phase 2 report.

LM0474 – Environmental effectiveness of organic management options

> A scoping study to establish a protocol for systematic monitoring and evaluation of organic management and conversion options at a national scale. The project undertook a literature review to propose specific monitoring questions, followed by the identification of existing data suitable for a baseline. Finally a methodology was recommended to test the monitoring questions.

LM0478 - Scoping study - Evaluating the social impacts affecting AES delivery

This project undertook an evidence review to identify a set of social indicators that could be used to assess the social outcomes of AES agreements and their link to environmental outcomes. A set of survey questions were developed to test a shortlist of social indicators with 19 agreement holders and 10 Natural England advisers.

LM0480 - An assessment of the contribution of agri-environment schemes to natural capital.

To what extent can the contribution of current schemes to natural capital be described, quantified and valued? A natural capital logic chain approach was used to map CS options to Natural Capital indicators, from which the value of a subset of CS options was assessed.

LM0481 – Assessment of the impact of agri-environment schemes on SSSI recovery

To what extent have AES contributed to the management and enhancement of SSSIs and assess the attitudes and behaviours of those who manage SSSIs? This study undertook a literature review of ecological surveys and datasets as well as on attitudes towards managing protected sites. Existing datasets for potential re-analysis and evidence gaps were identified.

Environmental Effectiveness

Option level

Soil

In Phase 2 of project LM0470 the impact of Environmental Stewardship (ES) options on soil organic carbon (SOC) over a 10 year period was assessed through the re-surveying of plots at two locations; Wallington Estate, Northumberland, and Wimpole Estate, Cambridgeshire. This project used the same methods as the original baseline study 10 years earlier (Bell, 2011 and Bell & Worrall, 2009). Land use was found to have a statistically significant impact on SOC in the re-survey, as was detected in baseline survey, though there was no longer a significant difference between SOC levels in arable land and grassland at the Wallington Estate. The hierarchy of SOC content increased from; arable < improved temporary grassland < improved permanent grassland < rough permanent grassland.

SOC was found to have increased since 2008 on arable land at both estates, with a significant change observed at the Wimpole Estate. Arable management had a significant impact on SOC, with counterfactual analysis identifying increases in SOC where a grass/clover ley was included in rotation or organic amendments such as straw or farm yard manure. Options that removed a proportion of land from agricultural production, for example to protect sensitive habitat features or vulnerable soils, also played an important role in the enhancement of SOC on arable land. Changes such as these enable agricultural production to continue and therefore have a low to moderate displacement risk.

In contrast, the SOC levels in rough permanent grassland and marshy grassland had significantly declined compared to the 2008 baseline. The observed decline in marshy grassland could be a consequence of remnant drainage systems in grasslands occupying former wetland habitat, which although had been left to deteriorate, were still resulting in net SOC losses and the benefit of the restoration options was not realised during the 10 year agreement. Although ten years is a relatively short timescale with regards to SOC monitoring and the loss of SOC may have slowed during the agreement, the findings of this project highlight that option implementation may not be sufficient to overcome the legacy effects of previous management within the lifetime of an agreement. Along with a need for longer term management, an explicit focus of option Indicators of Success on soil functioning, rather than vegetation changes, could improve the effectiveness of options delivering improvements in SOC.

Agreement level

Site of Special Scientific Interest (SSSI)

The effectiveness of AES on improving SSSI condition was assessed through a literature review and analysis of existing datasets (LM0481). The review found that generally, where SSSIs had been included in AES monitoring and evaluation, it was by chance, rather than by design. Detection of the impact of AES on SSSIs was found to be most robust in habitat specific studies from the literature. For example, studies on grassland habitat found features were more frequently under maintenance options, when restoration options would in fact be necessary to realise the condition improvement needed, however surveys were not exclusively carried out on SSSIs. Literature on a number of SSSIs found AES options were not focused on habitat features and therefore were not leading to the required condition improvements, because options were focused on breeding or wintering bird features which were beyond the scope of the original surveys. This highlights the need for appropriate option prescriptions which are consistently aligned with SSSI targets, to enable effective AES monitoring against SSSI condition. Wider conclusions from this project could not be drawn even where data were available for a number of reasons, including, survey timings and agreements not in

place for sufficient time to assess full effects. Further to this, the lack of up-to-date condition monitoring on SSSIs restricts the availability of baseline data against which future monitoring can be compared. The overall lack of empirical data meant that this project could not establish a causal relationship between AES management and SSSI condition, and studies could not be used to generalise findings of AES impact on SSSIs. Similarly, no conclusions could be drawn regarding the impact of agreement holder attitudes on SSSI condition, as no analysis could be identified which specifically considered SSSI presence alongside agreements.

The re-analysis of existing monitoring and evaluation data could be possible for future SSSI investigations due to the use of common unique identifiers for agreement holders, however this poses a risk where data is not suitable for use beyond the scope of the original project. The LM0481 project concluded that a targeted sampling approach would be the most effective way of assessing the impact of AES on SSSIs, given the heterogeneous nature of agreements, SSSIs and agreement holders. In addition to this, the identification of SSSIs in wider monitoring and evaluation datasets as a standard would increase data available for analysis, whilst a statistically robust systematic review of SSSIs to underpin regular condition assessments would be beneficial.

Ecosystem services

Agri-environment scheme impact on ecosystem services was evaluated through a natural capital approach (LM0480) as well as a project focused specifically on climate change mitigation (LM0470).

Natural capital

The natural capital value of the Countryside Stewardship scheme was assessed through two stages in project LM0480; firstly identifying how well the existing evidence base could be used to quantitatively link AES options to ecosystem services and benefits, followed by the valuation of general environmental management techniques where this was possible. This project worked within a natural capital logic chain approach to identify the impact of management interventions on ecosystem assets, services and benefits. Literature reviews showed that evidence linking CS management interventions to benefits and values was scarce, with the metrics found within the literature either too broad to relate to specific AES options, or too specific (eg with regards to spatial scale) and therefore not suitable for national scale generalisation. Given this limited evidence, a pragmatic approach was adopted to link the CS options into the natural capital logic chain using expert opinion. CS options were mapped to Natural Capital Indicators (NCI, from Lusardi et al., 2018), which linked the provision of ecosystem services to a set of environmental indicators that function as measurable attributes of the state of natural capital. The output of this work has been made accessible in an Excel mapping tool which includes the ecosystem services and benefits derived from each CS option through their NCI relationships.

Assessment of the contribution of CS options to natural capital quality and quantity with regards to land area was undertaken using 2018 option uptake data. CS options contributing to the quality of natural capital assets in enclosed farmland had the greatest coverage and includes management such as flagship species or pollinator habitats. Options are primarily delivered against six NCIs (see box), which in turn are linked to 17 different benefits ranging from clean air and water to timber provision and crop pollination. The two natural capital assets most supported in terms of area are permanent pasture and broadleaved woods, although this assessment is restricted to CS and does not include priority habitats or SSSIs under Environmental Stewardship (LM0480).

CS supports a wide range of ecosystem services ranging across many broad habitat types. For example, biodiversity whilst valued as an asset in its own right, also contributes towards cultural services (eg the support of flagship species) and supporting services (eg pollination and pest regulation). A large number of CS options (covering >1.8m ha) support cultural services, which includes landscape benefits and flagship species indicators, and is an expected finding given the focus of CS on biodiversity. Large areas under CS options also contribute to the maintenance of nursery populations, climate regulation, soil erosion regulation (mass stabilisation) and pollinator and

seed dispersal, though the latter is smaller, possible due to the linear nature of features. The high level analysis from this project indicates CS is having a positive impact on the natural capital of England, providing a range of ecosystem services which deliver multiple benefits.

The valuation part of the LM0480 project aimed to estimate the societal benefits of CS through assigning monetary values to the benefits associated with CS option implementation. Literature reviews found few robust valuation typologies existed, and thus valuation was carried out on a small subset of options (see box). This subset of options predominately focused on resource protection, for which their benefits (eg carbon sequestration, pollution reduction) are well established within natural capital modelling and can currently be valued most robustly. Preliminary valuation of CS options calculated the net present value of benefits ranging up to £49,972/ha for interventions targeting the creation of coastal wetlands over a 10 year agreement. The lack of evidence to value the natural capital benefits of CS options, particularly biodiversity, is a significant limitation to comprehensively quantifying the natural capital provided by CS implementation. To enable the natural capital benefits of CS to be realised in the future, there is a need for robust metrics which are applicable at the national and regional level, as well as an understanding of the interaction of multiple benefits provided by options and how these may result in enhanced value.

CS options for which Natural Capital benefits could be valued:

- Woodland habitat creation, restoration or maintenance
- Moorland and peatland restoration
- Inland and coastal wetland creation, restoration or maintenance
- Arable land interventions to prevent soil erosion and compaction
- Arable land interventions to prevent water pollution

Climate change mitigation

Agriculture accounted for 10% of UK GHG emissions in 2016, with methane (CH_4) and nitrous oxide (N_2O) emissions dominating (57% and 32% of agricultural emissions respectively) (DBEIS, 2018). The role of ES and CS in GHG emission reductions is highly complex owing to both direct and indirect impacts on emissions from the options themselves, coupled with spatial variations such as climate, soil type and legacy effects of past management or land use. Phase 1 of project LM0470 investigated the potential CS has in contribution to climate change mitigation, using a life-cycle assessment (LCA) approach to assess how CS options will impact GHG emissions when compared to a baseline scenario. This project updated previous work on ES options undertaken in Defra project BD2302. Calculations were relevant to the agreement lifetime (5-10 years) but the permanence of the land management change once the CS agreement has ended was not in scope of the project. Options were categorised into those which retained original land use but modified the management; changed the land use; created or managed semi-natural habitat; and organic land.

Options which modified management whilst maintaining original land use reduced GHG emissions, through decreased inputs, for example via lower stocking rates of livestock or reduced application of synthetic fertilisers. A range of options specify limits to nitrogen fertiliser inputs and this is associated with GHG emission reductions, both from the manufacturing perspective and the loss of N_2O directly from the soil. Additionally, grassland options which stipulate the presence of legumes, eg as cover crops, helped to reduce the loss of soil nitrogen, both through nitrogen fixation, as well as assimilating surplus nitrogen.

Options which modified a proportion of the original land use area, such as establishing buffer strips along field boundaries support climate change mitigation via the accumulation of carbon in their soils and vegetation, less disturbance of the soils and reduction in fertiliser use. Buffer strips also have the potential to remove nitrogen within surface run-off through the interception and uptake of nitrogen by vegetation present. The effectiveness of buffer strips in this context is dependent on the appropriate siting of the option.

Options managing semi-natural habitats have the potential to protect carbon stocks and enhance carbon sequestration through their restoration, maintenance and enhancement. CS options targeting degraded peatland and fen habitats are associated with the greatest emission reductions with cultivated peat soils having significant potential. Woodland creation also resulted in additional carbon sequestration from new tree growth, however net sequestration generally does not occur until 25-35 years after planting, highlighting the long term land management required to realise the GHG benefits of this option.

Organic options provide mitigation benefits through the use of vegetation cover and preventing the use of fertilisers. Cover crops and undersowing crops enables excess nitrogen to be assimilated and prevents soil loss via erosion, reducing nitrate leaching and N_2O emissions as well as organic matter return to the soil. The establishment of multi-species leys will increase species diversity, and therefore potentially enables resource partitioning to occur. This may reduce competition between plant species, promoting biomass growth and return of organic matter return to the soil.

Phase 1 of report LM0470 has demonstrated that CS options can reduce GHG emissions. As of March 2018 and using CS option uptake data, it is estimated that emissions reductions are approximately 1Mt yr-1. When applying a CS option to land there is a risk that the change in land use may displace production, and it's associated GHG emissions, to another location. While the study reviewed this risk at a site/option level, it does not account for displaced emissions nationally.

Future mitigation in terms of CS needs to focus on reducing emissions coupled with minimising the risk of production displacement eg SW6 – Winter Cover Crops, which maintain agricultural production whilst protecting soils at risk of erosion and/or reducing nitrate leaching. Furthermore, CS has a key role to play in the protection and restoration of habitats with high carbon containing soils and mitigation of CO_2 emissions eg woodland and peatland habitats, though it is imperative management is sustained beyond the agreement length of 10 years due to the lag effect associated with land use change and/or restoration.

Scheme Development

Agreement holder and stakeholder perspectives

The social outcomes of agri-environment schemes as they relate to the social world of the agreement holder were investigated in project LM0478, with the aim of identifying measurable social indicators to evaluate the quality of farmer engagement and social sustainability of agreements. The link between these social indicators and environmental outcomes was also considered. The evidence review used an analytical framework based around 'farmers' willingness to engage', 'capacity to engage' and level of 'farmer engagement with others' to identify factors that affect two types of indicators; quality of farmer engagement with AES and social outcomes of AES. The strongest evidence for links between social and environmental outcomes were related to 'attitude to the environment', 'level of environmental knowledge and skills', 'level of bonding social capital[1]' and 'level of education'. The interaction between engagement factors, social outcomes and environmental outcomes were highlighted in a number of feedback loops identified in the literature, for example the more a farmer is involved in AES activities, the more knowledge is gained and confidence grows in their skills and abilities which means they are more likely to continue and go on to experience environmental success.

From the literature and expert consultation, a short list of social indictors were selected based on their relevance, practicability and end user value. These social indicators comprised 20 high level

[1] strong relationships between people who have the same values

indicators across the five themes listed (see box), with 45 sub-indicators. Survey questions were designed to assess each of the indictors and sub-indicators, and covered both the distance travelled by agreement holders during the agreement as well as a snapshot in time. Pilot surveys were carried out with 19 agreement holders and interviews with 10 farm advisers. These were mainly to assess the usability of the survey questions, whether the questions provided data on the indicators and to gather ideas from the interviewees.

High level social indicator themes (number of high level indicators)

Quality of engagement:

- Willingness to engage (4)
- Capacity to engage (6)
- Level of engagement with others (5)

Social outcomes:

- Quality of life (3)
- Health and well-being (3)

Interest in the environment was commonly identified as a factor affecting quality of engagement, with around half of farmers interviewed in LM0478 having an active interest such as conservation group membership. Evidence was also found that the quality of AES engagement and environmental outcomes increased when agreement holders engaged in open and constructive dialogue with their adviser, for example on-farm advice. The majority of farmers felt they had a high level of control over decisions affecting their farm business. Although around half of respondents thought that joining an AES had reduced their level of influence, some qualified this with comments that they had voluntarily joined the scheme and therefore did not mind/expected this. Most interviewees were members of a farming group or network and the social advantages of this were articulated and most had experienced collaborative working in the past six months. This supports the findings of the evidence review that development of bonding social capital is important in AES. The literature suggests that gaining social recognition for AES activities is a strong motivator for some land managers to engage in AES and around half of respondents had experienced some increase in engagement with the public owing to AES. However, some noted this had not been a positive experience, for example gates left open where permissive access had been established under AES. The majority of farmers felt it was important to be recognised for their AES work by the public but mixed levels of acknowledgement had been experienced with some feeling there was little awareness from the general public about AES and environmental benefits.

Questions regarding changes to job satisfaction as a result of AES involvement revealed that just over a third of agreement holders believed that joining an AES had resulted in a positive impact on job satisfaction ('being a farmer'), with no one stating it had resulted in a negative impact. A third believed it had improved their work-life balance, with 10% citing a moderate reduction in work-life balance (and the rest no change). A key message from the health and well-being indicators was the extent to which agreement holders' levels of stress were increased due to scheme administration, bureaucracy, inspections and financial issues. Improvements to administration and timely payments was identified as the clearest way of maximising positive social outcomes for farmers, as well as maintaining the trust and rapport built with individual advisers.

The evidence review and survey findings suggest that taking account of social indicators (ie quality of engagement with agreements and the social sustainability of agreements) is important for scheme success and to support scheme development. Natural England advisers found the interviews with agreement holders particularly useful as they enabled them to become more familiar with the agreement holders' motivations and barriers with regards to delivering their agreement. The information helped them tailor the advice they give. However, advisers reported they would feel uncomfortable asking some of the health and wellbeing questions face to face, and alternative approaches such as allowing agreement holders to enter answers to sensitive questions directly into a tablet might be beneficial.

Advice, guidance and training

Agreement holder engagement with advice and training was one of the key social indicators identified by the Social Indicators project evidence review (LM0478), with three suitable indicators identified for future AES monitoring and evaluation; level of engagement with environmental advice; level of rapport with adviser, and level of engagement in training. Advisers who took part in the project found use of the indicators helpful and a useful exercise in learning more about the agreement holders, particularly in terms of their farm history, individual values and future plans; all of which would help in tailoring their advice. The project recommendations suggest development of a suite of indicators which could be used by advisers to help them assess the quality of engagement an advisee has with their agreement, identify the trajectory of an agreement, as a way of learning about their advisee and so better support the advisee to improve delivery of environmental outcomes. The findings from project LM0478 emphasise how this learning could be used as part of adviser training to help advisers understand the social world of agreement holders, the impact of agreements and how this influences the success of an agreement (including links to pro-environmental behaviour change).

The role of advice and training in the success of AES was also investigated through evaluation of the Countryside Stewardship Facilitation Fund (CSFF) in projects LM0473 and LM0479. The programme provides funding for facilitators to bring together farmers and land managers within a defined area to collaborate, share knowledge and attend training to deliver environmental improvements at the landscape scale. CSFF therefore needs to be evaluated to assess whether options are being delivered at a scale and coherence beyond that which is achievable by individual agreements, as well as the socio-economic benefits of the collaborative approach. An evaluation framework was established in Facilitation Fund project phase 1 (LM0473), using a theory of change approach to develop indicators with associated monitoring criteria and data requirements. Testing of the framework during Phase 1 highlighted issues such as how to quantify additional environmental benefits at the landscape scale and data limitations for some indicators, though analysis from a limited subset of CSFF groups indicated early evidence of benefits of a collaborative approach.

Phase 2 of the CSFF Evaluation (LM0479) reviewed the evaluation framework developed during phase 1 and tested the indicators. Comparison of agreements within CSFF groups to those out of CSFF groups in the same National Character Area (NCA) found that option richness and diversity were significantly greater in facilitated agreements. From the analysis carried out it was not possible to attribute this increased agreement complexity to the CSFF advice available, and the difference may reflect a predisposition of more environmentally engaged agreement holders wishing to participate in the CSFF, given the mixture of agreements established before and after CSFF. Option uptake was almost always aligned with historic environment and resource protection priorities within NCAs. The results indicate an overall positive contribution of the CSFF to better connectivity and thus more resilient landscapes, with potential to improve connectivity for some specific species groups such as pollinators, granivorous birds and waders. Biodiversity priorities were less consistently addressed, with very high coverage of options for grassland and hedgerow targets, and low coverage for some priority habitats such as lowland peatlands and coastal habitats. This may reflect that little modification to existing management is often required to implement common options (eg hedgerow management), however from the high level analysis in this project, it was not possible to identify the reasons for some priority habitats being less well targeted. Alignment of AES options which mitigate water quality issues and flood risk was assessed for ten CSFF groups and some positive alignment was found in areas at higher risk for water quality and flooding, however the project also identified areas where additional options would help to reduce the inherent risks.

The coherence of options was assessed in LM0479 to establish whether options within CSFF groups were better connected at the spatial scales required to provide resources for a range of biodiversity priorities. Generally option connectivity was greater within CSFF groups, however analysis did not take into account barriers, or resources not under AES options.

The surveying of facilitators suggested that CSFF was having a positive socio-economic effect with an increase in trust between facilitators and land managers, who were also noted to have increased awareness, expertise, confidence and collaboration. The importance of these factors to group success was supported by land manager interviews. Land managers also identified the main social

benefits from CSFF arose from group discussions and interactions, which would otherwise not have occurred to the same extent. Interviews provided insight into areas for the improvement of CSFF such as the need for simplification of administration and claims processes, as well as the continuation of support beyond the current lifespan of CSFF (LM0479).

Programme Development

Detecting change over time

Organics monitoring and evaluation

Organic Countryside Stewardship options account for approximately 1.3% of the Rural Development Plan for England, however as yet monitoring and evaluation has not quantified the environmental and public benefits of organic options. Project LM0474 set out to develop a monitoring protocol for organic CS options, building on evidence and data identified in the literature. Evidence on the environmental impacts of organic farming was found to be inconclusive in the literature review, with general environmental benefits identified on a per unit area basis, however when considered at the per unit production basis, the benefits were less clear or disappeared.

Data on CS organic options from previous M&E projects was severely limited, with no datasets of sufficient size or robustness available for analysis in this project. Biodiversity data was found to exist within the wider literature, however it was determined unlikely that the difference between conventional farms in CS and organic farms in CS could be analysed due to the lack of paired samples. A lack of data on organic CS options was identified for the remaining scheme objectives, thus a new sample is required to evaluate the impact of CS organic options.

517,000 ha of UK land farmed organically in 2017 of which:

- **64%** Permanent pasture
- **18%** Temporary pasture
- **7%** cereals

Within **CS agreements** in 2017:

- **412** organic options in MT
- **55** organic options in HT

The monitoring protocol developed in project LM0474 was designed to address evaluation questions for each of the scheme objectives, and proposed sample sizes for different sample stratifications, for example, comparison of organic and convention farms with both maintenance and conversion options.

With regards to biodiversity, the methods recommended overlapped with existing approaches such as habitat mapping and vegetation quality assessments used in a baseline assessment of CS (LM0458), though suggested greater detail, such as mapping all habitats visited under option and not just priority habitats. The most cost effective methodologies often included farmer self-assessment, for example for farmland bird species abundance, and pollinators (bees and butterflies), however these are reliant upon farmer or local naturalist knowledge. Technology was highlighted as potentially useful to replace expensive surveying eg for bats and ground dwelling arthropods, and genomics to detect the diversity of microbes and fungi within the soil.

The measurement of soil properties were highlighted as important to be able to determine impacts on soil health (eg soil organic matter) and soil erosion. GIS techniques developed by the Environment Agency were noted as a new way to identify fields at risk of erosion, which can then be visited soon after heavy rainfall/storms to assess signs of erosion. Differences in water quality between organic and conventional farms would require regular monitoring at the field scale to determine the impact of option implementation, such as sampling from ditches, or porous cups installed within fields. Changes in vegetation from water quality are unlikely to be able to respond at useful timescales for scheme assessment.

A range of landscape connectivity indicators are available, however at the time project LM0474 was being carried out, little research was available specifically looking at agri-environment scheme contribution to connectivity. Landscape patterns could be assessed through aerial photography, LIDAR or satellite imagery (LM0474) or modelling techniques such as those carried out in the CSFF evaluation (LM0479) could be used. Matched farms were recommended to evaluate whether organic farms impact the landscape in a different way to conventional farms.

Some of the public benefits of organic and conventional farms could be identified through interviews, such as access to the countryside and rural employment. Other public benefits such as climate change mitigation and adaptation could be assessed using previously established methods such as the CS option GHG emissions as calculated in project LM0470.

Power analysis and data availability was used in LM0474 to determine for which organic options it would be possible to detect different effect sizes, eg small effects will require a large sample size to ensure statistical robustness. At the time of the report, two options did not have enough coverage for monitoring to pick up any effects (OR4 – organic conversion horticulture and OR5 – organic conversion top fruit), and only three options had sufficient coverage to pick up small effects (organic land management OT1 – improved permanent grassland, OT2 – unimproved permanent grassland and OT3 – rotational land).

Rush extent

The perceived increase in rush species in upland hay meadows was investigated through a literature review, field study and Farm Management Questionnaire (LM0469). Farmer questionnaire responses varied, though a majority reported an increase of rushes in upland hay meadows, with farmer estimates of a 10-75% increase. The questionnaire also reported farmers to consider rushes to be denser and more vigorous, extending further into meadow areas.

Field surveys re-visited 51 sites from previous studies, covering 115ha of upland hay meadow, and recorded botanical and soil data from fixed quadrats and at the whole site level. Statistical analysis did not show conclusive evidence for an increase in rush cover in the upland hay meadow studies, though a significant increase in rush extent over time was found using combined rush species data at the site scale. The use of data from existing monitoring programmes as a baseline created additional challenges for analysis in LM0469, for example data had to be sub-divided by collection method, contributing to high sub-set variability, and pre-existing quadrat locations did not always contain rush. The study highlights the need to ensure sufficient sample size, suitable methodology and sampling intensity to deal with issues such as high site variability, spatial distribution of rushes and differing baseline dates. This does however, pose the challenge of increasing costs associated with the increased survey replication required for statistically robust monitoring. Further to this, the use of historical data from multiple sources does not necessarily mean high quality data (although it may have been appropriate for its original purpose), especially where there are differences in designs of monitoring programmes.

Counterfactuals

The challenge of counterfactual analysis was highlighted in a number of projects summarised in this annual report. It is important to compare the effect of agri-environment schemes to areas without equivalent intervention in a ‘real-world’ situation reflecting how management is implemented in agreements, rather than in an experimental simulation. The challenge of identifying non-AES equivalent sites for SSSIs is especially challenging as SSSI recovery was a principle aim of HLS agreements, resulting in 93% of all eligible SSSIs being under HLS, and therefore few protected sites remaining outside of a scheme which could serve as a counterfactual (LM0481).

The environmental response to management intervention can often occur on timescales beyond that of agreement implementation; an important consideration of counterfactual analysis as this may result in the use of data collection from separate projects. Measurements of SOC taken 10 years after a baseline survey were successfully used to detect changes over time as the same survey methodologies were used, as well as comparisons with non-AES counterfactual sites. This highlights the potential success of specifically designed monitoring regimes, which can be repeated in the future.

The successful application of counterfactual analysis varies between projects and further research is currently being undertaken to identify robust counterfactual monitoring techniques for a range of agri-environment objectives and different spatial scales (LM04102).

Future evidence needs

The 2017-2018 Annual Report highlighted gaps in knowledge regarding the application of local environmental impacts to different regions and upscaling to the national scale, as well as the issue of currently unquantifiable effects of options on ammonia emissions. The impact of CS targeted tree planting on reducing ammonia emissions is the focus of a future project being undertaken in 2020/2021. The projects in this report also point to areas where further evidence is needed.

Natural capital

- Further development of natural capital indicators and valuation methodologies which capture the benefits and value of AES options is crucial to be able to quantify the contribution of AES to the natural capital of England. This is particularly important for biodiversity, which is a core aim of AES, and provides a suite of benefits (LM0480).

Habitats

- The challenge of detecting change in rush cover in upland hay meadows, pointed to a requirement for further research on the ecology of rush species, increased and more effective monitoring and greater understanding of the agronomic impact (LM0469).
- Bespoke projects are required to assess the impacts of AES on SSSI condition, explicitly addressing scheme implementation alongside SSSI ownership. Up-to-date SSSI condition assessments should also be co-ordinated at the national scale, together with the alignment of monitoring approaches and targets for AES and SSSI (LM0481).

Agreement holder attitudes, engagement and experience

- Environmental behaviour of agreement holders has been shown to vary between land owners, and the same is likely true for agreement holders who own SSSIs. To date, agreement holder attitudes have not been explored alongside SSSI ownership, and is an area for further investigation (LM0481).
- Pilot testing of social indicator surveys is needed to improve confidence in survey questions and to develop a more parsimonious set of indicators where correlations arise between indicators and sub-indicators (LM0478).

- Introduction of routine social indicator monitoring and evaluation would build the evidence base identifying links between social and environmental outcomes and enable assessment of the social sustainability of AES (LM0478).

Monitoring data

- Early evaluation indicates that CSFF groups may provide greater alignment of AES options with priorities, increase in landscape-scale ecological connectivity and socio-economic benefits. However, the evaluation was found to be limited by variable group reporting and data capture issues which need to be addressed for longer term monitoring and evaluation.

- The recording of sites as SSSIs should be included as standard in agri-environment monitoring and evaluation projects to enable wider analysis of datasets (LM0481).

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