Agri-Environment Evidence Annual Report 2021

A summary of findings from recently published projects

First published November 2021

Natural England Research Report NERR104

www.gov.uk/natural-england

Natural England Research Report NERR104

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Published 2021

ISBN: 978-1-78354-856-9

Report details

This report should be cited as: SYKES, R. (2021). Agri-Environment Evidence Annual Report 2021: A summary of findings from recently published projects. Natural England Research Reports, Number 104.

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Acknowledgements

Thanks to the following colleagues for comments and advice:

Andrew Cole

Susanna Phillips

Jennifer Donaldson

David Martin

Executive Summary

This annual report highlights recent work of the Agri-environment Evidence Programme. The nine projects featured in this report provide evidence relevant to a range of agri-environment schemes (AES) and outcomes. Projects considered environmental effectiveness of options for woodland creation and improvement, arable reversion, habitat connectivity and conservation of coastal and floodplain grazing marsh. Additionally, this report includes a baseline assessment of agri-environment agreements within their first two years and projects assessing the role of self-monitoring and counterfactuals in the evidence programme.

Evaluating environmental effectiveness at different spatial scales

The impact of AES on woodlands was explored through projects assessing both woodland creation and improvement. There was strong evidence that management incentives and grants funded under the Woodland Improvement Grant, which was targeted towards improving woodland structure for a suite of regionally important woodland bird species, had a positive effect on the abundance of those species. Created farm woodland plots were occupied by common hedgerow, scrub, woodland-edge and open farmland species, as well as woodland species including priorities such as willow warbler and marsh tit. This may suggest locating new planting in less wooded areas will maximise colonisation and allow woods to be stepping stones, but that abundance of specialist species may be supported by placing new plots near to existing woodlands.

AES options for arable reversion were analysed through identification of the environmental assets and ecosystem services provided by the options and an exploration of the reasons why landowners retained or abandoned reversion following the end of an agreement. Remote sensing suggested a majority of arable reversion parcels were retained, with those lost typically replaced with cereal crops. Surveys revealed the benefit of long-term ongoing advice on maintaining the options, and those landowners with no previous experience of AES were least likely to enter a follow-on agreement to retain the reversion option. This highlights the need for sustained support, particularly for first-time agreement holders, through both official channels and peer-to-peer learning networks.

The contribution of AES options to the conservation of coastal and floodplain grazing marsh (CFGM) priority habitat was explored through mapping areas high in biodiversity and analysing the role AES plays in supporting important interest features. There are few options specifically related to CFGM, but a wide variety of options are nonetheless taken up in CFGM areas, particularly those within SSSIs and those identified as highly important for biodiversity. Case studies found that the development of floodplain wetland mosaics was challenging for agreement holders and as a result there is a generally low level of uptake of options specific to floodplain wetland mosaics. A catchment-based approach is recommended to overcome this in future schemes, in addition to greater flexibility and improved guidance and knowledge exchange.

At the agreement scale, this annual report provides detail on the baseline environmental condition of agreements at the beginning of Countryside Stewardship (CS). This provides a baseline from which future re-surveys will reveal the environmental effectiveness of CS options for biodiversity, resource protection, historic environment, landscape character and climate change mitigation and adaptation. Habitat condition at the start of an agreement will be important for assessing change over time. Baseline biodiversity condition varied, likely in part as some options seek to maintain environmental habitats, while others seek to restore habitats from poorer starting condition. Despite this variation, at least 77% of features were in good or very good condition for biodiversity (the highest categories). The project provides a baseline on which future surveys can assess change over time and the impact of AES agreements across the range of scheme objectives.

At the wider scale, the contribution of AES to habitat connectivity was investigated in a desk-based analysis. Preliminary research was carried out to identify which aspects of connectivity will be the most important in assessing the contribution of AES and to identify what tools are available to measure and report these. Overall, AES was found to contribute to ecological connectivity, particularly on SSSIs due to the high prevalence of habitat creation and restoration options on SSSIs.

Evaluating scheme design and implementation

Results-based approaches to AES payments are attracting increased interest from policymakers both nationally and internationally. The potential value and inherent challenges of self-monitoring forming part of such a model was explored in new detail. Research investigated a variety of questions on its efficacy and how to ensure best practice. In particular, changes in quality of engagement were assessed where self-monitoring was linked to auditing, verification or payment, and when it is conducted on a voluntary basis. Extensive best practice recommendations are produced covering a wide range of considerations to help realise the full potential of self-monitoring.

Evaluating the Monitoring and Evaluation Programme

The role of counterfactuals within the programme was explored in a detailed review. This included approaches for establishing reliable counterfactuals against which to evaluate the effects of AES management on a wide variety of AES objectives, including biodiversity conservation, resource protection, landscape character, preservation of the historic environment, and climate change mitigation and adaptation. Methods reviewed include field data collection, use of pre-existing data sources, surveys of human perception and modelling. The review shows the range of approaches which can be used in future AES monitoring and will inform future monitoring design.

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:

- Environmental Stewardship (ES) - open to applications between 2005 and 2014, it consisted of tiers for; Entry Level Stewardship (ELS) aiming for high coverage of basic options, Organic Entry Level Stewardship (OELS), Uplands Entry Level Stewardship (UELS), 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

The Agri-Environment Evidence Programme seeks to monitor and evaluate existing Agri-Environment Schemes, including Countryside Stewardship and Environmental Stewardship. The programme is delivered by Natural England on behalf of Defra, with input from the Forestry Commission, Environment Agency and Historic England. Natural England's work focuses on terrestrial habitats, while monitoring by the Environment Agency includes freshwater habitats and resource protection.

A small number of Natural England specialists and project managers, led from the Evidence Services team, develop 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 reporting requirements.

The programme is funded by Defra, with close collaboration between colleagues in Natural England and those in Defra working on the new ELM scheme. Projects in this report have

relied on the expertise of staff across Defra, Natural England, Environment Agency, Forestry Commission and Historic England.

Purpose of this report

This report aims to summarise and synthesise findings from projects in Natural England's Agri-Environment Evidence Programme that were published during 2020 and 2021. Natural England works with Defra to understand these findings and incorporate them into AES development and operational delivery. Additionally, key messages are shared internally to inform Natural England staff and help 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.

Project reports 2021

LM0458 – Agreement scale monitoring of Countryside Stewardship agreements
LM0458 established a monitoring baseline at the agreement level against which to assess the effectiveness of Countryside Stewardship in a future resurvey. It considered multiple scheme objectives and investigated synergies across objectives.

LM0485 – Assessment of arable reversion retention
LM0485 used earth observation data to assess whether grassland created under AES options to revert arable land are maintained past the end of an agreement. It examined the contribution of these options to ecosystem services and explored how options could best support these in future.

LM0486 – Resurvey of AES woodland creation for woodland birds
LM0486 investigated the impacts of past woodland creation schemes on priority woodland bird species over 30 years, to gain insights into how contemporary AES management options could best be designed and delivered.

LM0487 - Resurvey of AES woodland improvement for woodland birds
LM0487 investigated the impact of the Woodland Improvement Grant (WIG) scheme on woodland structure and target bird species populations. It conducted a resurvey of areas, focussing on the East Midlands, and compared the results against baseline data collected nine years previously to assess effectiveness of management actions.

LM0493 - A social science analysis of the challenges, opportunities, benefits and disbenefits of the provision of self-monitoring and evidence by farmer/land managers within AES

LM0493 assessed the opportunities and challenges presented by implementation of self-monitoring and evidence gathering in result-based payment approaches to AES. A range of questions were examined, looking at quality of engagement, complexity of participation, quality of advice and support available, and potential risks and unintended consequences for AES outcomes.

LM0498 - Evaluating the contribution from AES to the conservation of coastal & floodplain grazing marsh

LM0498 evaluated the effectiveness of AES in conserving interest features of coastal and floodplain grazing marsh priority habitat and contributing to the improvement of natural floodplain functioning.

LM04100 - Agri-environment scheme contribution to ecological connectivity

LM04100 assessed the impact of AES option location on ecological connectivity through a review of methodologies and a national scale modelling exercise, taking into account structural connectivity of habitats and functional connectivity of mobile species.

LM04102 – Counterfactuals in agri-environment monitoring and evaluation

LM04102 examined approaches and supporting evidence for establishment of reliable counterfactuals against which to evaluate the effects of AES management on a range of objectives, including biodiversity conservation and provision of ecosystem services.

LM04103 – Evaluation of the Countryside Stewardship baseline agreement scale monitoring

LM04103 examined the Countryside Stewardship baseline monitoring conducted in project LM0458. It aimed to evaluate: how baseline monitoring fits within the broader context of AES, species and environmental monitoring; the methods and overarching design used; and the appropriateness of data collection, format and storage.

Environmental Effectiveness

The projects in this annual report assessed environmental effectiveness at the option, agreement and landscape scale and considered responses for particular species and habitats while also considering the broader ecosystem service benefits. The largest project reports on a baseline assessment of 500 Countryside Stewardship agreements including assessments of biodiversity, resource protection, historic environment, landscape and climate change adaptation and mitigation. Additionally, this annual report includes studies of the impact of woodland creation and management on priority bird species populations, how coastal and floodplain grazing marsh priority habitat can be maintained and enhanced, how arable reversion options can be sustained in the long term, and how AES contributes to habitat connectivity.

Do targeted woodland management grants increase woodland bird populations?

LM0487 assessed the effectiveness of AES woodland improvement options. Areas in nine estates under the East Midlands Woodland Improvement Grant (WIG) scheme were resurveyed for the first time and results were compared against baseline monitoring data from nine years previously (2010-2021). This was to test whether woodland structure and populations of target bird species changed due to management actions undertaken. Point counts and territory mapping methods were used to record activity and estimate number of breeding pairs of target species. The main aim was to understand whether these regional priority bird species populations had been better able to maintain or increase their numbers on managed sites funded by WIG as compared to non-managed sites. In addition, the project looked at whether the implemented management produced a detectable improvement in the canopy and understorey layers of the woodland that could provide benefits to the target species.

Abundance of most target species was found to be significantly greater on sites with grant-funded management than on control sites, and no target species individually showed a negative response to grant management. Point count data revealed an increase of 76% in abundance compared to decline of 39% on non-grant sites, while territory mapping data showed that all target species were recorded breeding on at least one site. Thus, as a group the target species exhibited a more positive change in abundance on grant funded sites than on control sites using both point counts and territory mapping, though the effect was greater for the target species than for the groups of all woodland specialists and woodland generalists. There was no consistent evidence of negative effects of the woodland management on any of the individual target species. Some of the target species are associated with mature woodlands having varied structure while others are associated with early successional scrub. Therefore, the structures required vary between species and the likely time scale of response to woodland changes may also vary between species.

Management grants also influenced woodland structure. Grant sites showed a reduction in basal area of conifers in comparison with non-grant sites, while basal area of broadleaves increased less due to the removal of trees through thinning and ride management and widening which reduced the increase from tree growth. These management options are likely to be delivering the positive effect of grant status on the target species, as presence of these options was observed to have an equal or greater positive effect on them as the presence of a management grant. There was also a negative response of woody understorey layers to grant status, contrary to expectation. Understorey growth may have been insufficiently supported by management options and stunted by removal of young trees as part of thinning, producing this effect. However, four species known to use dense understorey for feeding and nesting nonetheless exhibited a positive response to management intervention. This may be due to levels of accuracy in measuring management impact on understorey density, or because the species rely on wider areas and other resources meaning that responses are detected at a larger scale.

This study provides strong evidence that management incentives and grants funded under the Woodland Improvement Grant, which was targeted towards improving woodland

structure for a suite of regionally important woodland bird species, have had a positive effect on the abundance of those species. However, further research is needed to determine both the intensity of management required to maximise the potential benefits, and the scale of implementation needed to detect change through national-scale monitoring efforts.

Resurvey of AES woodland creation for woodland birds

LM0486 tested the impacts on priority woodland bird species of woodland creation schemes established in the 1980s and 1990s, to inform contemporary AES management options. Use of historical schemes allowed the effects on target bird species that occurred since the woodlands were created to be tested in a way that is not currently possible for contemporary schemes, due to the timescales required for the new habitat to reach maturity.

Surveys were undertaken to determine which species had colonised the created woodland, how the communities have changed since a previous survey in 1999, and how abundance is affected by landscape context and habitat characteristics, area and shape. The project aimed to support design and delivery of analogous woodland creation land management schemes today, given the difficulty of assessing the impacts of newly created habitat. Results will also be used to understand the effectiveness of volunteer survey protocols for monitoring and policy evaluation.

The study found that created farm woodland plots were occupied by common hedgerow, scrub, woodland-edge and open farmland species, as well as woodland priority species such as willow warbler and marsh tit (DEFRA 2020). Compared to previous surveys undertaken in 1999, only small overall differences in communities were observed, but diversity was slightly higher and woodland species occurred at higher densities than previously. Woodland area and number of patches appeared to be more important for species abundance at the local than landscape scale, while longer boundaries were associated with lower abundance of most species, indicating little preference for edge habitats. Plots near to existing woodland hosted more woodland specialist species. Larger woodlands hosted higher local abundance, richness and diversity of species overall, but the effect levelled off over 15-20 ha. However, this may differ for mature woodland. Birds appear to use farm woods less where there is more woodland nearby, perhaps because this alternative habitat is more mature and provides enhanced or increased resources. Little evidence was found for differing or stronger effects in ancient or SSSI woodlands.

Recommendations for woodland creation schemes going forward included locating new planting in less wooded areas to maximise colonisation and use as stepping stones by species generally, but abundance of specialist species is best supported by placing new plots near to existing woodlands.

What happens to arable reversion options at the end of Environmental Stewardship agreements?

LM0485 evaluated the effectiveness of AES options to revert arable land to grassland, and explored instances where reversion had been retained or abandoned following the end of an agreement, as well as the reasons underpinning landowners' decision-making in such cases. In addition, the project provided evidence on which environmental assets and ecosystem services are supported by arable reversion options, and made recommendations for how the options could better support natural capital benefits in future. The project comprised: firstly, an analysis of spatial and remote sensing data to identify changes in land use after an agreement had ended; secondly, a survey of land managers and agreement holders to examine what impact arable reversion had and the reasons why the grassland created was subsequently retained or lost; and thirdly, an analysis of ecosystem service delivery by the grassland created by arable reversion options that was later retained. This was one of the first projects in the AES Monitoring and Evaluation Programme to use earth observation to assess change following the end of agreements by employing Defra's CROME (Crop Map of England), a satellite and machine-learning based crop classification map covering the whole of England.

Analysis of spatial and remote sensing data covering 1,474 land parcels suggests that at least 56% of arable reversion parcels were retained, including both whole and part parcel options. In those areas where arable reversion was not retained, grasslands were replaced with cereal crops 57-67% of the time. However, in 10% of cases where remote sensing suggested arable reversion was lost, grassland was still found in at least part of the parcel. This suggests only partial rather than complete loss of grassland created under arable reversion options. Thus the 56% of grassland categorised as retained across all parcels may be an underestimate due to partial retention of grassland in fields. Remote sensing only provides a snapshot so it is unclear what management interventions there may have been between imagery while the study did not assess how grassland condition may have changed over time. Land manager surveys of 107 agreement holders found that 60% stated they had retained all grassland established, while 65% stated that large areas remained. Arable reversion options were reported as highly effective in establishing a sward and fitted in with the wider farming system rather than presenting as a burden or obstacle. However, the study also identified a need for direct monitoring to be better enabled through, for example, remote sensing, requiring digitisation of existing AES options records into a spatial format.

The project also asked the agreement holders with arable reversion options about their experience. It found that although 88% received advice during the build up to an agreement and at the start, only 46% received advice on long-term management. Agreement holders with historic environment themed agreements were the least likely to receive advice at the beginning or end of a scheme, while those with no previous experience of AES were the least likely to enter into a follow-on agreement. The study identified a need for:

- long-term ongoing advice and support, not just in the run up to or beginning of an agreement, especially for first-time agreement holders;
- knowledge exchange and peer to peer learning, particularly in light of the high levels of intervention required by arable reversion options;
- a clear pathway into follow-on agreements after grassland establishment to ensure continued delivery of ecosystem services and positive environmental outcomes, as those with no prior experience of AES were less likely to enter into a subsequent agreement.

In addition to a lack of adequate advice and support, some agreements holders reported dissatisfaction with the options. The most frequent change requested was for greater flexibility, for example in dates for cutting and management of weeds. Some farmers considered options to sometimes be too limiting, preventing their long-term participation. For many of those who did not retain arable reversion options, the decision to put the land back into production was often an economic one which they regretted having to take. Finally, some agreement holders also expressed concern about the level of understanding within scheme delivery bodies of the practicalities of implementing arable reversion options and maintaining them in the long term. Some reported that this would discourage them from applying again in the future.

Finally, the project investigated the environmental benefits provided by arable reversion AES options and considered how best to retain and enhance them. A theoretical, desk-based assessment scored options on their environment benefits and assessed impact of options due to overall uptake. The options were found to provide a wide range of benefits across multiple scheme objectives, supporting ecosystem services such as climate regulation, cultural heritage, biodiversity, erosion regulation, water regulation and landscape. However, ecosystem service delivery differs due to variations in option uptake across Agricultural Landscape Types. For example, options have a greater relative impact on cultural heritage in the lowlands and on erosion regulation in the uplands. The project recommends encouraging a broader appreciation of the ecosystem services that can be delivered by arable reversion options over the long term, and maximising these through careful targeting. This is particularly important as the loss of grassland created through reversion options can have irreversible consequences on, for example, cultural heritage ecosystem services through the damage or total loss of features as a result of cultivation practices.

What is the contribution of AES to the conservation of coastal and floodplain grazing marsh?

LM0498 aimed to determine how effectively AES conserve the interest features of coastal and floodplain grazing marsh (CFGM) priority habitat, and how they have contributed to improving natural floodplain functioning. Areas within the existing habitat under AES that are higher in biodiversity were firstly identified and mapped. Then a national analysis was carried out to explore the role of AES in restoring, conserving and enhancing the biodiversity value of coastal and floodplain grazing marsh, and to understand how CFGM can help support the development of floodplain wetland mosaics (FWM). Finally, case

studies were undertaken to identify barriers and enablers to AES, and to learn how a new scheme could be made more effective than previous schemes.

Of the existing 219,918 ha of current CFGM habitat, 28.2% was found to be 'highly important for biodiversity' (referred to hereafter as 'high value'). To qualify as 'high value' for biodiversity, CFGM areas must include all of the following: ground which partially or wholly floods within an annual cycle, with a network of ditches that retain a rich assemblage of aquatic wildlife, plants and invertebrates throughout the year; natural grassland and wetland communities and species; and, capacity to host breeding waders, wintering wildfowl or other important wetland species. For the remaining 71.6% of CFGM there was more limited evidence of high biodiversity value or it is under more intensive management. However, the project found that this land nonetheless retains the necessary hydrological attributes to function as CFGM and therefore could potentially be reverted to CFGM given the appropriate management.

A wide range of AES options are taken up in CFGM areas, although eight options account for 60% of take up. Option uptake was found to be generally higher within SSSIs and areas identified as highly important for CFGM. Options chosen include those not directly related to CFGM habitat or the development of FWM, while those which are directly related had low levels of take up overall.

Management of CFGM is complex and time intensive. AES provides financial support for conservation activity but there is no specific option for this habitat type, although there are relevant options for managing wet grasslands for breeding waders and wintering wildfowl. Therefore, decisions on options to use will vary according to land managers' priorities and desired outcomes. The move towards FWM was found to be challenging across all case studies, and there is a generally low level of uptake despite the range of options available to support development of FWM. Therefore, a catchment-based approach is recommended to restore functioning and sustainable FWM systems. Further recommendations for future schemes include: allowing greater flexibility in options that cover grazing and rush control to account for weather and site-specific issues; focusing management on achieving desired biodiversity outcomes rather than on maintenance of a specific habitat; and, establishing guidance and knowledge exchange for agreement holders that is sustained through the course of an agreement. Further research to build on this work should focus on areas outside of the CFGM priority habitat, using remote sensing to improve understanding of land in the 'potentially important' for CFGM category, and analysis to establish whether the hydrology of these areas could support development of FWM.

Baselining environmental effectiveness

The agreement scale monitoring of Countryside Stewardship agreements aimed to establish a baseline of habitats and features under CS in the first two years of the scheme, and developed monitoring protocols across the five broad objectives of the scheme (LM0458). Five hundred agreements were assessed across two years using a range of methods including field monitoring, desk assessments and modelling, to assess baseline feature condition, as well as the quality of agreements indicated by the suitability of option

choice, placement and implementation. The results from the baseline survey are summarised across scheme objectives of biodiversity, resource protection, historic environment, landscape and climate change adaptation and mitigation. As a baseline survey, assessments are generally restricted to initial habitat and feature condition with a future resurvey planned to provide evidence of change over time.

Biodiversity

For the baseline survey, biodiversity was assessed by looking at the targeting of options, option choice and implementation and the condition of features and habitats. The placement and choice of options for biodiversity objectives were generally found to be aligned with habitats and features, with option choice assessed as inappropriate in 0.9% of cases. Missed biodiversity opportunities were more common within Mid Tier agreements than Higher Tier, though generally low (average 1.5 features per agreement) and related to common features such as field boundaries and ponds. Habitat condition at the start of an agreement will be important for assessing change over time. Baseline condition varied, likely in part as some options seek to maintain environmental habitats, while others seek to restore habitats from poorer starting condition. Despite this variation, at least 77% of features were in good or very good condition for biodiversity (the highest categories). Future re-surveys will identify whether options have maximised biodiversity outcomes for a range of habitats.

Resource protection

At least half of the agreements assessed demonstrated there was a need for resource protection objectives to be addressed, including connectivity with a water course, soil erosion risk and runoff risk. Appropriate selection of options and capital items was identified in approximately half of agreements; however the project found a substantial number of missed opportunities, with a third of agreements not making use of any capital items for water quality or flood risk. Whilst Catchment Sensitive Farming (CSF) involvement did result in some improvement in the number of options selected, there was no conclusive evidence that option placement or choice was improved. Feature condition was again generally at least good, with the majority of options chosen and placed appropriately to address the risk of runoff and erosion, indicating that the options should act to protect watercourses and therefore mitigate water quality issues. Features of poorer quality, or where Indicators of Success had not yet been met, were typically where surveys had been carried out prior to option implementation and therefore any change in condition will not be determined until future re-surveys have been carried out.

Historic environment and landscape

Relatively small samples of historic environment (HE) and landscape character options were assessed in the CS Baseline project due to the prioritisation of biodiversity and resource protection options during surveys. Further to this, lack of surveyor expertise also restricted surveying, highlighting the challenge of completing field surveys which assess a wide range of scheme objectives.

Where assessed, historic environment options were considered to be implemented well, and the baseline condition indicated options were protecting the condition of features. The survey also found that in general non-HE specific options (e.g. those for grasslands, and buffer strips) appeared to be having either a neutral or positive impact on historic environment features. Overall options were more likely to be conserving or maintaining (73%) historic features, with only 5.5% assessed as enhancing feature condition. High level counterfactual analysis indicated that in the absence of a historic environment (or related) option, land management was more likely to be having a detrimental effect on non-designated heritage assets. Improved targeting could improve appropriate option selection, however this would rely on specific advice, for example from Historic England or local authorities.

Features assessed for landscape character where chosen according to options which aligned with the National Character Area statement of priorities. Generally, options were assessed to be having a positive impact (enhancing, conserving, maintaining) on landscape character, and were generally in good condition. A few options were considered to be detracting from landscape character, the majority of which were arable options uncharacteristic or fragmenting predominately pastoral landscapes. As with the historic environment assessment, greater data collection is required to draw robust conclusions for these scheme objectives; highlighting the balance required for whole scheme monitoring and evaluation.

Climate change adaptation and mitigation

The results of the climate change adaptation assessment indicates that CS appears to generally perform well in identifying and managing highly climate vulnerable features such as maintaining priority habitats. In contrast, moderately vulnerable features were covered by fewer options which would address climate change adaptation, which was attributed to a lack of relevant options from which to choose. There was limited evidence of CS options restoring or creating priority habitat, and therefore contributing to ecological connectivity and climate change adaptation at the landscape scale, however this may be a factor of agreements assessed and limited field assessment.

Climate change mitigation in the CS Baseline project used the emission factors derived from project LM0470 to quantify the potential GHG emission reductions from option implementation. Analysis found that, as a whole, MT and HT schemes resulted in reductions in greenhouse gas (GHG) emissions, with the majority of emission reductions arising from a few options with high coverage, resulting in large cumulative GHG emission reductions. Increases in GHG emissions were associated with Woodland Management agreements where initial scrub clearance increases emissions, but which may be reduced or reversed in the longer term. The lag time between management interventions and GHG flux equilibrium is a significant caveat of this method where emissions are only estimated over the lifetime of the agreement.

How do AES contribute to ecological connectivity?

LM04100 sought to establish what impact AES option location has on ecological connectivity. An initial structured review was undertaken focusing on the different available methodologies for assessing ecological connectivity. Then the contribution of AES to ecological connectivity was evaluated through a national scale modelling exercise, which combined information on the locations of management options with that of SSSIs and priority habitats. The modelling took into account both the structural connectivity of habitats and functional connectivity of mobile species. Based on the review and connectivity modelling, recommendations were made for future research looking into how AES could contribute to ecological connectivity and to improve the reliability of modelling.

Eight methods for assessing connectivity were reviewed with four suitable for assessing how AES can impact connectivity. Specifically, two methods were explored in detail: the network enhancement zone mapping, which identifies areas close to existing habitat where primary habitat creation and restoration is expected to increase connectivity; and least cost path analysis, which identifies the least costly movement routes through a landscape for mobile species. Overall, AES was found to contribute to ecological connectivity through changes in structural connectivity (spatial configuration of habitat patches) and functional connectivity (how individuals move through the landscape). Additionally, AES significantly contributed to connectivity on SSSIs due to the high prevalence of habitat creation and restoration options on or near SSSIs. Results showed that 25% of the habitat creation area and 57% of the restoration area is found in land parcels intersecting with SSSIs.

Scheme Development

What are the challenges and opportunities of self-monitoring and evidence gathering by land managers within AES?

LM0493 explored the potential opportunities and challenges encountered in the implementation of self-monitoring and evidence gathering as part of a result-based payment approach to AES. The key research questions looked at how the quality of engagement with self-monitoring changed where the self-assessment was linked to auditing, verification and payment, and where it was conducted on a voluntary basis. Further questions examined the complexity of participation for land managers, the quality of advice and support available to those self-monitoring, and the potential risks and unintended consequences which could impact AES outcomes.

Interviews with a diverse sample of land managers resulted in extensive best practice recommendations to help realise the huge potential of self-monitoring mechanisms, through improving and supporting the quality of land managers' engagement with the scheme. These recommendations can be grouped within four broad themes:

1. Ensuring flexibility and not overburdening participants:
    - Self-monitoring mechanisms should be consistent
    - A risk-based and positively reinforced auditing and verification system should be devised
    - Farmers should be allowed to take on activities they are personally interested in
    - Administrative requirements should be kept to a minimum to ensure personal enjoyment and mental health benefits
    - A mobile application to record all reporting tasks should be developed
2. Accessibility and good fit with farming practice:
    - Obligations should be practical and achievable
    - Self-monitoring requirements should be designed with the farming calendar and potential for weather fluctuations in mind, and offer flexibility in reporting dates
3. High quality training:
    - Training should be well-designed and delivered, take account of existing knowledge, include practical instruction on self-monitoring activities, and continue throughout the programme
    - Informal training and support options, such as peer-to-peer discussion forums, should also be developed
    - Inclusivity should be ensured by considering issues such as existing levels of IT literacy, internet access and learning disabilities such as dyslexia.
4. Clarity in outcomes:
    - Focus on visible outcomes to improve engagement
    - Where outcomes are less visible, the importance of monitoring should be made clear to participants

Overall, LM0493 showed that self-monitoring has potential but may need careful management. Additional work will be required to assess self-monitoring, making use of interdisciplinary and empirical approaches to provide robust evidence.

Programme Development

Counterfactuals in agri-environment monitoring/evaluation

In AES monitoring, counterfactuals are locations without AES intervention which can act as a comparison or control site. Finding robust counterfactuals has been challenging in many previous AES monitoring projects. A specific review of counterfactuals and their potential role in monitoring AES was carried out in LM04102. The project identified approaches and supporting evidence for establishing reliable counterfactuals against which to evaluate the effects of AES management on a wide variety of AES objectives, including biodiversity conservation, resource protection, landscape character, preservation of the historic environment, and climate change mitigation and adaptation. A systematic review was undertaken to collate this evidence and summarise a range of evaluation methods that have previously been applied to evaluate AES management, with a focus on

approaches to defining the counterfactuals. Methods reviewed include field data collection, use of pre-existing data sources, surveys of human perception and modelling. These methods focus on comparable populations, responses, features and habitats that are not managed under AES but can be identified, controlled, measured and sampled for comparison. Methods that have performed particularly well or poorly in the context of evaluating different objectives were highlighted. For some AES management targets, these methods may not be appropriate and alternatives are required. The results will inform design and delivery of monitoring and evaluation programmes for future land management schemes, which is essential to ensure value for money, and assess delivery of environmental objectives.

Evaluation of the Countryside Stewardship baseline agreement scale monitoring

A review was completed to assess the choices to be made when resurveying the CS baseline (LM04103). It was considered that many aspects of the CS baseline project are appropriate for a resurvey. In particular, there were many benefits for a resurvey to use the same methods to enable comparability over time. A resurvey should also consider how to balance resources across monitoring of multiple scheme objectives, the role of counterfactuals, assessing missed opportunities outside of agreements themselves, and the role of agreement holder surveys.

Future Evidence Needs

The 2018-2019 Annual Report highlighted a need for further research into a variety of areas including natural capital indicators, social indicators and monitoring AES on SSSIs (Brown 2020). Previous reports also highlighted the need for further research into management for pollinators and invertebrates and unquantifiable effects of AES options on air quality (Oatway 2018; Cole 2019). This annual report includes research on the use of remote sensing to monitor arable reversion, helping to fill the previously highlighted evidence gap regarding AES and remote sensing. Projects in this report also point to some key future evidence needs:

- Digitisation of AES option records into a spatial format such as a geodatabase would allow for direct monitoring of options through remote sensing or other desk-based techniques (LM0485).
- Further research to determine the intensity of management required to maximise benefits of woodland improvement actions for target bird populations, and the scale of implementation needed to detect change through national monitoring (LM0487).
- Further research to assess self-monitoring programmes, making use of interdisciplinary and empirical approaches and investigating the potential role of smartphone/tablet applications to enable self-monitoring reporting (LM0493).
- Further research to investigate whether the hydrology of non-CFGM areas and areas in the ‘potentially important’ areas for CFGM category could support the FWM approach (LM0498).

- Further analysis on AES impacts on ecological connectivity should be run at smaller spatial scales to capture local impacts (LM04100).

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ISBN 978-1-78354-856-9

Catalogue code: NERR104

NATURAL ENGLAND