Natural England Research Report NERR074

Agri-Environment Monitoring and Evaluation Programme Annual Report 2016/17

A summary of findings from recently published projects

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Agri-Environment Monitoring and Evaluation Programme Annual Report 2016/17- A summary of findings from recently published projects

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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 schemes referenced in this report are:

- Environmentally Sensitive Areas (ESA) – introduced in 1987 and replaced by Environmental Stewardship in 2005. There were 22 ESAs in England.
- 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 two tiers, Entry Level Stewardship (ELS) aiming for high coverage of basic options, 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 tiers, a Mid-Tier (MT) and a Higher Tier (HT).

Introduction to the Agri-Environment Monitoring and Evaluation 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. The Agri-Environment Monitoring and Evaluation Programme 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 is funded through the RDPE Technical Assistance Fund.

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 Monitoring and Evaluation Programme that were published during 2016, 2017 and 2018. It also

includes findings from a number of relevant Research and Development projects that sit outside the Agri-Environment Monitoring and Evaluation Programme.

Natural England aims to work with Defra on understanding these findings and what they could mean for Agri-Environment Scheme development and delivery, as well as sharing the key messages internally to inform delivery staff and ensure that Natural England remains an evidence-based organisation. We also aim to share this report 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 at Annex 1.

Executive Summary

The 18 projects featured in this report provide evidence relevant to a range of the target outcomes for agri-environment schemes. Biodiversity is considered in 15 of the 18 projects. The species groups featured are birds, invertebrates and herptiles, while habitats include grassland, lowland heathland, upland heathland, fens, and woodland. Other featured outcomes include resource protection, water quality, climate change adaptation, landscape character and historic environment.

Evaluating environmental effectiveness at different scales

- Many of the projects focussed on evaluating the effectiveness of specific options or groups of options for target features. This produced useful evidence that certain options are effective in delivering at least some of their intended benefits. However, often benefits could not be quantified because no direct counterfactual was available, and the benefits were sometimes geographically specific or applicable to individual species, showing the complexity of evaluating option performance.

- Fewer studies were designed to evaluate effectiveness at the agreement or holding level, and these focussed on delivery of specific objectives rather than assessing overall agreement performance, so this could be an area for future projects. However, these projects do provide evidence that particular schemes or option packages are positively associated with specific target features, and that positive effects extend beyond the parcels that are managed under an option.

- There is increasing recognition of the importance of monitoring that is capable of detecting landscape-scale impacts that are sustained over time (e.g. species population increases), and/or spillover effects onto surrounding land not under AES management. Some studies were able to provide evidence of landscape-scale effects for particular features/objectives, and one study was able to estimate the level of scheme uptake required to halt the decline of priority farmland birds at a regional scale.

Evaluating scheme design and implementation

- Opportunities to improve delivery of the intended outcomes were identified at all stages of scheme design and implementation. Some of these are ‘quick wins’ where options could be fine-tuned to increase their effectiveness for specific features through simple changes to option wording, or through additional feature-specific guidance. However, the introduction of new options may be needed to support some outcomes.

- There is strong evidence that AES can deliver for farmland birds, and support for the farmland bird package approach pioneered in ES, which has informed the CS Wild Pollinator and Farm Wildlife Package and the new simplified CS MT packages. There was also evidence of added value from carefully-targeted ‘higher’ options, compared to a broad and shallow approach.

- There was evidence that the targeting of Environmental Stewardship schemes has been effective for breeding waders and beneficial for improving connectivity of ecological networks. There was also evidence to support the approach of targeting to deliver multiple objectives. However, some features or objectives may benefit from stronger targeting. Two projects developed tools to improve targeting, for climate change adaptation and for the historic environment.

- The setting up of individual agreements was found to be a critical stage in determining the success of agri-environment interventions. Outcomes could be improved by increasing the accuracy of feature identification and ensuring that the right options are used in the right locations.

- The setting of Prescriptions and Indicators of Success (IoS) could also be improved in some cases. Good baseline information and understanding of the key influences are key to getting this right.

- Delivery of more complex bespoke management and multiple outcomes could benefit from increasing the uptake of certain options and the careful siting of combinations of complementary options.

- Issues with agreement set-up were reported more commonly than problems with implementation. However, there were some examples where specific options were not implemented effectively, perhaps indicating that further training, guidance, support and advice could improve outcomes.

Evaluating the Monitoring and Evaluation Programme

- The projects featured in this report provide some useful feedback for optimising future project design. This covers sample size, spatial scale, frequency and duration of monitoring, detecting landscape-scale impacts, the importance of robust counterfactuals and structured datasets, interactions between multiple attributes, and the utility of volunteer surveys.

- Several studies identified that future evaluations should move beyond correlation between AES and target features to demonstrating causality. It is becoming increasingly important to demonstrate that AES benefits extend beyond short-term changes to localised abundance, and instead deliver landscape-scale impacts that are sustained over time in terms of population growth/stabilisation, and/or extend more widely onto surrounding land not under AES management.

- Some of the surveys featured in this report could usefully be repeated in future years to investigate longer term impacts of management. Other methodologies have potential to be adapted or developed further.

- Some gaps in current knowledge were identified as potential areas for further research and evaluation to support option design and targeting, such as: the impact of management on soil carbon storage, management for pollinator species, the use of remote sensing to predict responses to agri-environment provision, management of grassland mosaics for priority invertebrates, and testing of pulse grazing systems.

- It could also be beneficial to consider how the evidence from the Monitoring and Evaluation Programme can be made more useful and accessible e.g. the development of supporting guidance and good practice case studies, and the integration of new resources with existing tools and systems. There may be opportunities to use the data alongside other data sets to add further value or contribute to other reporting requirements.

Environmental Effectiveness

Option level

Many of the projects focussed on evaluating the effectiveness of specific options or groups of options for target features. This produced useful evidence that certain options are effective in delivering at least some of their intended benefits. However, the design of the studies often meant that the benefits could not be quantified because no direct counterfactual was available, and the benefits were sometimes specific to certain geographical regions or species, showing the complexity of evaluating option performance.

LM0436 Supplementary Report - All of the declining seed-eating bird species apart from one (Skylark) showed significant use of food patches delivered under ES 'supplementary feeding in winter for farmland birds' options EF23 and HF24, compared with inconclusive or negative results for the control non-target species. The most responsive species were Chaffinch, Linnet and Yellowhammer. Although generally rare, surprisingly large flocks of Tree Sparrows, Corn Buntings and Reed Buntings were recorded on fed patches on individual sites, emphasising the potential draw of patches to priority species and, therefore, their potential value where these species are found.

LM0440 - Field surveys of buffer strips created under Environmental Stewardship (ES) confirmed their use by eight of the nine widespread herpetofauna species: common frog, common toad, great crested newt, palmate newt, smooth newt, common lizard, slow-worm, and grass snake, with only adder undetected.

LM0443 – A re-survey of grasslands managed under the options HK6 and HK7 (to maintain and restore species rich grasslands), showed that the options had a net positive effect, but the improvements were smaller than expected. Comparing the 2014 re-survey to the 2007 baseline survey showed that 25% of sites improved in condition; 64% maintained the same condition; and 11% declined in condition. The net gain was therefore 14%.

LM0455 – This study sampled 155 stands of lowland heathland, of which 97 stands were in HLS options HO1/HO2 ('maintenance/restoration of lowland heathland') and 58 stands were outside of HLS management so could be used as a control for comparison. There were SSSI and non-SSSI stands in both the HLS and non-HLS sample.

There was some evidence that heathland in HO1/HO2 was in better overall condition than if it was outside HLS management, with detectable differences in the vegetation (though statistical significance was restricted to a small number of attribute targets). In the non-SSSI sample, HO1/HO2 options were correlated with higher pass-rates for dwarf-shrub and graminoid diversity. Non-SSSI stands were also found to receive higher levels of active management if they were in HO1/HO2, and consequently have lower levels of 'negative' features such as scrub. However, higher levels of management also resulted in increased covers of disturbed bare ground (a negative attribute, the target is <1% disturbed bare ground), without increasing the cover of undisturbed bare ground (which is a desirable component with a target of 1-10% cover).

Grazing occurred on 62% of stands and was significantly more frequent in stands within HO1/HO2 options than those without. Vegetation analyses suggested that grazing is largely beneficial for lowland heathland condition as it is associated with higher levels of species richness of positive indicators and appears to control some negative indicators.

None of the lowland heathland stands in the study met all the criteria for favourable condition. Pass-rates were low for dwarf-shrub age-structure and undisturbed bare ground, as well as positive indicator species diversity. However, there is evidence to suggest that HLS heathland options are facilitating a greater range of management activity which may continue to improve heathland structure and condition in the future.

LM0442 - 74 sites in HLS fen management options HQ6 (maintenance of fen) and HQ7 (restoration of fen) were surveyed and assessed against both Common Standards Monitoring condition criteria and HLS Indicators of Success, providing a snapshot of current condition. 51% of sites were found to be in condition A (good), meeting the targets for all attributes, with a further 12% in condition B, and 37% in condition C (poor). There was no comparison with fens outside of HLS management, so the effect of HLS cannot be quantified. However, a large number of the fens surveyed were located within otherwise intensively managed agricultural landscapes, indicating that fen management is delivering some of the benefits anticipated in the design of HLS.

Agreement level (including option packages)

Fewer studies were designed to evaluate effectiveness at the agreement or holding level than at the option level, and they all focussed on delivery of one specific objective rather than assessing overall agreement performance against all objectives. However, they do provide evidence that particular schemes or option packages are positively associated with specific target features, and that the positive effects extend beyond just the parcels that are under an option.

LM0454 – One to two years after the implementation of the HLS bespoke Turtle Dove Package (TDP), there were indications that turtle dove occupancy and abundance were positively associated with agreements containing foraging habitat that delivered suitable conditions. Turtle doves were recorded on nine out of twenty agreements. Tetrads occupied by turtle doves had a (marginally statistically significant) greater area of option HK15 (maintenance of grassland for target features) and there was a tendency for greater abundance of turtle dove on squares with greater areas of HK15. There was similarly a tendency for turtle dove abundance to increase with increasing area of bespoke HF4 (nectar flower mixture option). However, only 28% of HLS TDP foraging options were classified as suitable for feeding (achieving suitable seed and bare ground provision).

LM0462 – A study of upland wader presence/absence on in-bye land found that management under Environmental Stewardship (ES) and classic Countryside Stewardship Scheme (CSS, not new CS) showed significantly positive associations with presence of Curlew, Lapwing and Snipe. Local extinction was restricted by ES/CSS for Curlew.

LM0456 – this study assessed the effect of Environmental Stewardship on landscape character using 1km survey squares with a high concentration of landscape features in ES options. The impact of ES was judged to be ‘enhancing’, ‘conserving’ ‘maintaining’, ‘neutral’ or ‘detracting’ for each feature. The study found differences between features managed within ELS and HLS. 82% of ELS 1km survey squares were assessed as conserving landscape character whilst around 11% were having an ‘enhancing’ effect, but for HLS there was an even split of 46% of squares enhancing and 46% conserving, suggesting that HLS agreements are more effective than ELS for enhancing landscape character.

Landscape-scale and/or national impacts

There is increasing recognition of the importance of monitoring that can detect landscape-scale impacts that are sustained over time in terms of measurable change (e.g. population increases), and/or extend more widely onto surrounding land not under AES management. Some studies were able to provide evidence of landscape-scale effects on particular features/objectives, and one study was able to estimate the level of scheme uptake required to halt the decline of priority farmland birds at a regional scale.

LM0441 - Over 6 years of study (2008-2014) across three regions, 12 out of 17 bird species of conservation concern, and a wider suite of 19 species that make up the UK Government’s Farmland Bird Indicator (FBI) showed more positive changes in abundance on HLS farms than in the wider countryside, in at least one region. Population increases for those species were strongly positive, with a median change of +163%. Eight species exhibited sustained positive responses to HLS management in at least one region. A further eight species exhibited a temporary increase in at least one region during 2008-2011, but this increase was lost in the arable regions by the 2014 survey

following a large scale failure of key options to establish during successive wet and cold summers. These were species known to depend on the habitats provided by these options. Turtle Dove, Yellow Wagtail and Lapwing showed no response to HLS management. The Farmland Bird Indicator group on HLS farms increased by 31% (in the East Anglian and Oxfordshire regions) and 97% (in the West Midlands region) during 2008-14, compared to declines of 14% and 21% respectively, in the surrounding countryside in those regions. In order to offset ongoing declines (2.3 to 4.1% per annum) of Farmland Bird Indicator species in the wider farmed countryside, the study estimated that 26-33% of FBI populations would need to be subject to higher-tier AES-type management.

LM0439 – Mixed effect models using weekly water quality monitoring data, detected a negative association between the density of ES options in the upstream catchment (options per km^2) and the concentration of nitrate, orthophosphate and suspended sediment. The analysis suggests that ES is contributing to instream water quality improvements.

LM0456 - Overall, Environmental Stewardship is meeting the objective of maintaining and enhancing landscape character. This was the case across all 6 Agricultural Landscape Types and themes in the study. Landscape character was judged to be 'enhanced' (defined as restoring or adding new features that strengthen landscape character) on 21% of the 1km survey squares in the study, 'conserved' (supporting traditional features that have declined nationally) on 67% of squares, and 'maintained' (providing little added value) on 11% of squares. A 'neutral' or 'detracting' effect was recorded on less than 2% of squares. However, the study was unable to make comparisons with features not managed under ES, therefore the effect of ES could not be quantified. The study also investigated which options contribute most to landscape character, and found that buffer strips and seed mixes/plots on cultivated land help strengthen landscape character and tend to have an 'enhancing' effect, while field boundary options and low input permanent grassland are having a widespread 'conserving' effect.

LM0448 - The results of a national baseline assessment of the ability of agri-environment schemes to deliver ecosystem-based climate change adaptation demonstrate that ES is generally good at protecting the most important and vulnerable sites such as semi-natural habitats. Approximately 79% of priority habitats are located within the Utilisable Agricultural Area (UAA) which is eligible for agri-environment schemes, and around half (49%) of the area of these eligible priority habitats were covered by appropriate habitat maintenance and restoration options. However, some of the most sensitive habitats (e.g. lowland raised bog and coastal saltmarsh) do not have large land areas in the Utilisable Agricultural Area (UAA) so are not easily targeted by agri-environment schemes, and there was no evidence of prioritisation towards habitats classed as High Sensitivity. Agri-environment schemes are making only a limited contribution to reducing fragmentation and enhancing ecological networks. There is little evidence to suggest that areas of high habitat fragmentation are the focus for habitat creation, and very little difference in the uptake of habitat creation options between areas that are highly fragmented and those that are less fragmented. Coverage of options that support sequestration of carbon was high on blanket peat soils (73%) but very low on other peat soils (only 9%).

Scheme Development

Design at the scheme level

This year's reports found strong evidence that AES can deliver for farmland birds, and support for the farmland bird package approach pioneered in ES, which has informed the CS Wild Pollinator and Farm Wildlife Package and the new simplified CS MT packages. There was also evidence of added value from carefully-targeted 'higher' options, compared to a broad and shallow approach.

- A study of 60 HLS farms across three regions found strong positive population responses to HLS management in 12 of 17 priority farmland bird species and in the Farmland Bird Index group of 19 species, against a background of ongoing declines in the surrounding countryside. This shows that farmers and land managers have the potential to deliver large

and rapid increases of farmland birds through managing their land for wildlife if given the right funding and support (LM0441)

- In a study of the effect of Environmental Stewardship on landscape character, the percentage of 1km survey squares where landscape character was enhanced compared to conserved was higher for land in HLS than in ELS (ELS: 82% conserved, 11% enhanced, HLS: 46% conserved, 46% enhanced). These findings have implications regarding the effectiveness of carefully targeted higher tier options versus a 'broad and shallow' approach (LM0456).

Option design

There is potential to fine-tune some options to increase their effectiveness for specific target features. In many cases this could be achieved through some simple changes to option wording, or the provision of additional feature-specific guidance. In some cases, the introduction of new options could support specific desirable outcomes.

- Heathland needs 1-10% cover of undisturbed bare ground in order to be in Favourable Condition. In a survey of 155 heathland stands, both within and outside of HLS management, this attribute had one of the lowest pass-rates. Priority species on heathland could benefit from the introduction of specific options for bare ground creation by soil/litter/turf stripping (LM0455).
- Some evidence was found that turtle doves associate with appropriately managed grassland. It may be worth referring to the importance of this habitat for turtle doves in the Countryside Stewardship bespoke species guidance, and identifying suitable prescriptions to be applied under option GS13 Management of grassland for target features (LM0454).
- The majority of feed patches for the options EF23 and HF24 'supplementary feeding in winter for farmland birds' were located adjacent to field boundaries, in line with the advice in the prescriptions. However, skylarks generally avoid field boundaries so either this advice needs further consideration, or alternative option provision is needed to feed this species effectively (LM0436 Supplementary Report).
- The options which seemed to have the most positive correlations with breeding wader numbers were those that aimed to provide heterogeneous swards with some tussocks for nest sites and areas of short sward to facilitate effective foraging (LM0462).
- When creating buffer strips where grass snake and common lizard are a target, more varied and frequent mowing regimes in the part of the buffer strip closest to the crop would be beneficial. This will help to maintain access to basking areas and invertebrate prey whilst allowing more complex and highly structured vegetation to develop in uncut areas to be used as refuges (LM0440).
- Research has shown that when grazing is re-introduced after treatments to re-establish heather (*Calluna vulgaris*) on grass-dominated moorland, cattle-only grazing is preferable to sheep grazing in allowing the heather to persist (cattle grazing resulted in 40% heather cover compared to 50-60% in ungrazed plots, but this dropped to about 20% with sheep grazing). The study also found that a rotational or pulsed grazing system where the area was left ungrazed for a couple of years every 10 years may allow the heather to recover sufficiently to persist. Options to support pulsed grazing systems may therefore be beneficial for restoring heather moorlands (BD5105).
- Research into the benefits provided by grasslands has shown that multifunctional services can be delivered with the right management (including carbon sequestration, nutrient retention, pollination and biodiversity conservation), but there are trade-offs between some of these different services. The findings could have implications for optimizing future AE scheme option design, especially with relation to nutrient inputs, the intensity of grazing and cutting and the addition of seed (BD5003).

Regional/geographical targeting

This year's reports found evidence that the targeting of ES schemes has been effective for waders and beneficial for improving connectivity of ecological networks. There was also evidence to support the way CS is targeted to deliver multiple objectives. However, some gaps were identified where specific features or objectives are currently under-represented. Improved targeting of these features could help to address this. Two projects developed tools to improve targeting, for climate change adaptation and for the historic environment respectively. These tools are ready to be adopted in future approaches to targeting.

Support for current targeting strategies:

- Evidence from research into woodland creation supports the way new CS is being targeted to expand and connect ecological networks and deliver multiple benefits. Early results indicate that small mammal populations are influenced by the amount of ancient semi-natural woodland within 1km in the wider landscape, as well as the local woodland characteristics (LM0315).
- Positive correlations between the presence/absence of breeding wader populations on in-bye land and the management of that land under ES and (classic) CSS suggest that management has been targeted effectively for these species (LM0462).
- The majority of ES habitat creation was found to occur within 1 km of existing priority habitat but not abutting it. This should be good for improving connectivity of ecological networks and for building resilience to climate change (LM0448).

Potential improvements for future targeting:

- The new climate change adaptation monitoring framework has developed indicators across nine categories such as; protecting the most vulnerable sites, reducing fragmentation, making species populations more resilient, improving water quality and storing carbon. These indicators are underpinned by spatial data and can be used to identify additional themes for targeting (LM0448).
- The unification of HLC information into the National Historic Landscape Characterisation (NHLC) is a significant step towards better spatial targeting for agri-environment, though expert input will be required to maximise the benefits (LM0461).
- Encouraging greater AES uptake on heaths under private ownership could increase the levels of beneficial management (LM0455).
- Common lizard and slow-worm would benefit from a higher degree of targeting than other herpetofauna as they exhibit least dispersion across farmland (LM0440).

Agreement design (appropriate option selection/targeting, setting prescriptions and indicators of success

Several studies found that the way that individual agreements are designed and set up is critical in determining the success or failure of agri-environment interventions.

Scheme outcomes could be improved by increasing the accuracy of feature identification and ensuring that the right options are used in the right locations:

- Approximately 50% of AES heath options included areas of non-heathland habitat which were not likely to be restored to heathland (LM0455), so it would be beneficial to ensure that boundaries are drawn more carefully.
- A study of fen habitat found that the success of management was dependent on the habitat being identified correctly at the outset, with 17% of fen options applied wrongly to habitat that was not fen. Correct targeting was best achieved by a field visit from an adviser familiar with

wetland habitats and not by relying uncritically on the results of the FEP survey, especially as the FEP handbook is very broad in its description of fen habitat (LM0442).

- The baseline condition of features and their potential for restoration was often misinterpreted, particularly where the aim was to maintain or restore priority habitat. Of 118 sites in HK6 and HK7, 16% were considered unsuitable for the establishment of species-rich grassland due to poor botanical suitability and/or high soil phosphate content at the outset. A further 16% were considered inappropriately targeted by HK6 as they would have been better managed under HK7 or other options. Therefore, 32% of the sample was always unlikely to deliver the desired outcome. (LM0443).
- Some fen sites placed under maintenance options were found to be in poorer condition than some under restoration options. 24% of the sites under HQ6 (maintenance) would have been better placed in HQ7 restoration management. It is important to ensure that sites are placed in the correct maintenance or restoration option to target management of the site correctly (LM0442).

Some studies also found potential to benefit scheme outcomes by improving the setting of Prescriptions and Indicators of Success (IoS). Good baseline information and an understanding of the key influences such as botanical composition and soil conditions were found to be critical to getting this right:

- Objectives need to be set with specific reference to the characteristics of the site. There are significant links between soil nutrient levels and whether grasslands are in ecologically 'favourable condition'. Knowledge of soil conditions is therefore essential when considering the management of vegetation of conservation importance, predicting the outcome of management changes and understanding constraints that might prevent sites achieving favourable condition (LM0444).
- For species-rich grasslands, more ambitious/demanding prescriptions requiring greater active intervention are often needed to achieve the desired outcomes. For sites that lack desirable high-value species at the outset, the introduction of suitable seed is strongly recommended, combined with carefully designed and implemented cutting and/or grazing regimes (LM0443).
- For most fen sites, carefully tailored grazing management, either alone, or in combination with topping, is required to deliver environmental benefits, and the majority of sites in good condition were under some grazing management (LM0442).
- 70% of heathland managers felt that the AES options and Indicators of Success (IoS) were at least mostly appropriate, but in some cases IoS need to be better tailored to sites (LM0455).
- IoS should be realistic and achievable given the resources available to the land manager and the potential to bring about positive changes in habitat condition. 46% of fen sites were set at least one indicator of success that was inappropriate for the habitat, or unlikely to be achieved (LM0442).

The delivery of more complex bespoke management and/or multiple outcomes could benefit from increasing the uptake of certain options and the careful siting of combinations of complementary options:

- Use of maps such as the species distribution models developed for herpetofauna may be a valuable tool in determining areas in need of attention to improve connectivity across the landscape. Mapping of scenarios of different placement for new field margins and ditches could allow an assessment of which areas should be targeted for AES options. Careful evaluation of the location for proposed new woodland areas could improve connectivity with other important habitats for amphibians and reptiles, and avoid negative impact on species not associated with woodland. (LM0440).
- Recovery of farmland bird populations at the landscape scale would benefit from delivery of packages of AES measures that are more resilient to the impacts of unfavourable weather on option utility. This may be achieved by providing multiple options delivering similar resources in the same locality. For example, winter seed could be provided through a combination of low

input overwintered stubbles plus wild bird seed mixes established at different times of year with different sown components (LM0441).

- 73% of the priority invertebrate species assessed need more than one habitat element to be present in a grassland to complete their life cycle The value of AES for creating a grassland mosaic with multiple elements to benefit priority invertebrates will depend on the use of multiple options and prescriptions at appropriate spatial scales within individual AES agreements (LM0202).

Implementation - establishment and management of the options

The selection and location of options and the setting of prescriptions and IoS were more often identified as issues, rather than how the management was being carried out. However, there were some specific examples where options were not being implemented correctly, perhaps indicating that further support and advice for agreement holders could improve outcomes:

- There were few examples (less than 2% of survey squares) of ES having a neutral or detrimental effect on landscape character, but where this did occur, it was most often due to poor management rather than inappropriate option choice (LM0456).
- The delivery of food to fed patches for farmland birds was variable between agreement holders in both ELS and HLS, and was started late on many farms, with the delivery rated 'poor' with no visible signs of seed being present, at 9 sites out of 40. Priority bird usage was significantly higher at 'good' patches compared to those integrated within game cover crops or those with 'poor' delivery. In 70% of cases, seed was broadcast in heaps or lines by the edge of a field, but hoppers were deployed at 30% of sites and this method was associated with a lower abundance of target birds, perhaps because it restricted the number of individuals or species that could access a patch. (LM0436 Supplementary Report).
- Five out of ten fen sites with the HQ11 wetland cutting supplement had not yet introduced a regular cutting regime when surveyed. Cutting management is successfully used with grazing on several sites, but may be less effective on its own as it is harder to deliver successfully due to inaccessibility of sites and the issue of disposal of cuttings (LM0442).

Advice, Guidance and Training

Some studies confirm that current scheme guidance has a firm evidence-base in habitat and species ecology:

- Patterns of association between the wader species and characteristics of in-bye fields provided evidence to support the existing scheme implementation guidance, such as the avoidance of woody field boundaries and associations with wetter or waterlogged ground. The results also underline the importance of multiple habitats and more heterogeneous sward structures to support multiple species (LM0462).
- Research into the links between soil nutrient levels and the ecological condition of grasslands showed that low phosphorus availability is essential for favourable condition in calcareous and mesotrophic grasslands. This supports the criteria that have been set for high botanical enhancement potential in the guidelines for Countryside Stewardship (LM0444).

There is some evidence that a good relationship between the agreement holder and adviser is associated with better agreement outcomes:

- A perceived good working relationship between fen owners and managers and their NE adviser was correlated with successful delivery (LM0442).

However, improved guidance, advice and training in specific areas could be beneficial:

- Fine-tuning of bespoke guidance for turtle dove to include a suitable grassland management option could help to make this option more effective. The Turtle Dove Package succeeds in providing potential nesting and foraging habitat in close proximity, but the suitability of these

habitats is rarely optimal. On-going guidance and support may be needed to ensure continuing appropriate management beyond option establishment (LM0454).

- 70% of the heathland managers that responded to a questionnaire were satisfied with their current management, but 20% of those in AES did not know whether their IoS were appropriate, and as none of the heathland stands in the study were meeting all of their targets, there may be a need for further advice or training. (LM0455).
- A survey of the supplementary seed food patches delivered under Environmental Stewardship options EF23 and HF24, carried out soon after the introduction of these options, showed inconsistencies of delivery and methodological interpretations made by farmers which suggest that communication about the importance of following the option prescriptions (or of the content of the prescription) has yet to be effective. Improving this could increase the efficacy of these options (LM0436 Supplementary Report).
- Additional guidance such as advisory documents and case studies.on the use of the National Historic Landscape Characterisation (NHLC) would help to ensure the issues, options and opportunities for management are identified (LM0461).

Agri-Environment Monitoring and Evaluation Programme Development

Data gathering and monitoring

The projects that completed in 2016-17 provided some useful feedback for the design of future monitoring and evaluation projects. Emerging themes included:

- Sample size - achieving sufficient statistical power to detect effects of interest is critical, but the sample size required varies with the research question and requires an understanding of biological effect sizes (LM0462). The nationally significant sample size, and range of analyses able to be drawn from the large data sample, were advantages of the Rapid Survey approach used for assessing ES contribution to landscape character (LM0456).
- Spatial scale - Landscape-scale compared to local population monitoring tends to be more important for more mobile species (LM0457). It is useful for assessments to be replicated across contrasting landscapes (LM0441). A multi-scale approach can be useful in developing a mechanistic understanding of the relationships between ecosystem services e.g. small-scale experiments used alongside large-scale field observations (BD5003). At the option-scale, it is useful to have GIS layers that show the option boundaries, not just the parcels they are in (LM0455).
- Frequency and duration of monitoring - the benefits of AES for target biodiversity can vary through time e.g. in response to weather conditions, and there can be a lag between management implementation and detection of population-level effects. Therefore, evaluation studies would ideally entail ongoing periodic, rather than one-off, assessments (LM0441). Frequency of assessment must be appropriate to detect the effects of interest, e.g. weekly water quality monitoring is preferable to monthly data from national water quality monitoring programmes to detect improvements resulting from Countryside Stewardship (LM0439).
- A monitoring design that can detect landscape-scale impacts - i.e. distinguishing between short term, localised AES effects, and AES benefits that are sustained over time in terms of population change, or extend more widely onto surrounding land not under AES management (spill-over effects), or ideally both (LM0457). The most powerful assessments are those that compare temporal changes in biodiversity on AES sites throughout the duration of the agreement with those in the wider farmed landscape (LM0441).

- Robust counterfactuals and structured datasets - structured survey data with consistent, standardized sampling was found to be of great value. Use of national Bird Atlas and Breeding Bird Survey (BBS) data from BTO to provide the counterfactual was pioneered in project LM0462 to good effect.
- The value of considering the interactions between multiple attributes, including combined effects and trade-offs – e.g. the relationships between ecosystem services (BD5003), and the individual and combined effects of ecological network attributes (LM0315).
- Volunteer surveys – these can be a useful way to increase sample size, but it can be difficult to secure adequate coverage, especially in areas of low target species population which are of less interest to volunteers (LM0462).

Some projects developed useful methodologies and datasets that can be applied more widely:

- A detailed field monitoring scheme has been developed for landscape-scale species monitoring. NCAs are used as the focus because they encompass land with similar characteristics, therefore measurement of AES effects should not be confounded by background landscape characteristics (LM0457).
- Models were used to simulate future water quality time series to inform the design of an optimal monitoring programme for assessment of future water quality outcomes from Countryside Stewardship. This showed that water quality benefits may be detected with >80% power using weekly data from 10 sites for nitrate, 30-40 sites for orthophosphate and 50-100 sites for suspended sediment. The best design would involve colocation of chemistry, ecology, habitat and flow gauging sites. A database of Environment Agency water quality monitoring sites that have been screened for point source sewage influence has been compiled with their associated ecology, water quality, catchment characteristics and ES intervention indices, representing a useful resource for future analyses (LM0439).
- A climate change adaptation monitoring framework has been developed for use in agri-environment monitoring projects. It uses indicators that have been evaluated at a national scale using a GIS-based approach to analyse spatial patterns of AES option uptake. At the local-scale, a methodology has been developed for the on-farm assessment of the contribution of AES to climate change that utilises a ground-truthing of the national-scale baseline assessment. This framework can be used to enable future scheme design to be informed by an assessment of how agri-environment schemes have performed in supporting adaptation (LM0448).
- A Rapid Survey method has been developed for assessing ES contribution to landscape character. It focuses on assigning simple quantitative 'score' judgements rather than subjective qualitative descriptions. This approach could usefully be applied to a future monitoring programme for Countryside Stewardship (LM0456).
- Use of maps such as the species distribution models developed for herpetofauna, may be a valuable tool in determining areas in need of attention to improve connectivity across the landscape (LM0440).
- A multi-scale approach using plot and mesocosm (pot-scale) experiments alongside large-scale field observations, proved useful in developing a mechanistic understanding of the relationships between ecosystem services, and could be applied more widely for this type of work. The multiple ecosystem services assessment that demonstrated the positive and negative effects and trade-offs of different experimental treatments could also be applied to a wider range of systems to help inform sustainable management options (BD5003).
- The approach used by the WrEN (Woodland Creation and Ecological Networks) project of evaluating the individual and combined effects of a wide range of ecological network attributes can be applied to other habitats (LM0315).

Future evidence needs

The agri-environment monitoring programme in 2016-17 identified some gaps in current knowledge and suggestions for further research and evaluation. It also demonstrated the value of long term monitoring programmes, with a well-designed baseline survey and a consistent and repeatable methodology, for providing continuous feedback into scheme design and operational delivery:

- A well-designed baseline survey and monitoring programme set up at the start of each agreement would facilitate a better understanding of the impacts of agri-environment schemes on heathland (LM0455).

Some of the surveys could usefully be repeated in future years to investigate longer term impacts of management:

- A re-survey of farms with the turtle dove package would be useful to assess the quality of habitat management as the agreements mature, and evaluate whether the package can halt/reverse population decline at a farm scale (LM0454).
- A further re-survey of birds on farms in HLS during 2017-18 should help to confirm whether the reduced benefit of AES seen in 2014 compared to 2008 and 2011 was a response to exceptional weather or part of a longer-term trend. It is also the last opportunity to re-survey these farms within the 10yr agreement lifespan (LM0441).
- The 2014 re-survey of grasslands in HK6/HK7 took place after 8-9 years of HLS management, but consistent improvement in grassland quality may only become apparent after more than 10 years, therefore a further re-survey after another 5-7 years would be useful (LM0443).
- It would be valuable to repeat the survey of in-bye land and wader populations in around five years to investigate the influence of management on population changes. This would show whether correlations between wader populations and AES indicate positive results from scheme management or just reflect how schemes have been targeted (LM0462).

Other methodologies have potential to be adapted or developed further:

- The Rapid Survey assessment of the contribution of agri-environment to landscape character could be adapted to understand the ‘counterfactual’ situation – i.e. surveying landscape features not under agri-environment option to research the ‘added value’ (or otherwise) of being under a scheme (LM0456).
- The next steps in evaluating the effectiveness and value of AES options for herpetofauna would be to assess the relative importance of field margins compared with other habitats in the farmed landscape, and test whether results are similar in pastoral or mixed farmland settings compared to arable. Assessing the value of field margins for adder would require a study targeted towards sites that are known to be occupied (LM0440).

Emerging areas for further research to support option design and targeting include:

- The impact of management practices on soil carbon storage - substantial stocks of carbon are contained at depth in grassland soils, which has implications for carbon accounting and the future management of grasslands for soil carbon storage and climate mitigation, and also for global carbon models. Research into the sensitivity of deep soil carbon to management, and optimum levels of nutrient inputs across a range of grassland types would be useful (BD5003). It would also be useful to compare the soil carbon storage of grasslands managed for conservation with those managed under more intensive regimes (LM0444).
- Work on pollination visitation alongside other ecosystem services, including the implications of flower visitations for plant community structure (BD5003).
- Use of remote sensing data in conjunction with habitat suitability models – could be a promising approach to predict AES responses in unsurveyed areas, i.e. enhancing the

information extractable from vegetation and habitat monitoring, but requires further testing and field validation (LM0457).

- Empirical research to quantify the links between grassland mosaics and the conservation of priority invertebrate species, for fine-tuning aspects of management guidance for some AES options. The monitoring of a wide range of invertebrates is recommended as priority invertebrates may not be abundant enough (LM0202).
- Pulsed grazing systems for heather restoration - these could be trialled on moorland sites containing a range of habitat types to test their effectiveness more widely. The most successful treatments for restoring heather (*Calluna vulgaris*) have been identified, but need to be rolled out at larger spatial scales to test their application at the scale of a moorland grazing unit (BD5105).

Several studies identified that future evaluations should move beyond correlation between AES and target features to demonstrating causality. It is becoming increasingly important to demonstrate that AES benefits extend beyond changes to localised abundance, which could be due to short-term redistribution of organisms in response to increased resources supplied by AES management. 'Landscape-scale' impacts of AES require a test of whether AES benefits are sustained over time in terms of population growth (or reduced rates of population decrease), or extend more widely onto surrounding land not under AES management (spill-over effects), or ideally both (LM0457).

In addition to further research and monitoring, it would be beneficial to consider how the evidence from these projects can be made more useful and accessible e.g. the development of supporting guidance and good practice case studies, and integration of new resources like the NHLC dataset with existing tools and systems (LM0461).

Annex 1 – List of projects referenced in the Annual Report

Link to Defra Science Page	Description
LM0202	Assessment of the appropriate scale of ecological intervention
LM0315	Woodland creation and ecological networks
LM0436	Supplementary Report - Monitoring the use of the 'Supplementary feeding in winter for farmland birds' options within Environmental Stewardship.
LM0439	Assessing the (current and future) RP benefits of AE through water quality monitoring
LM0440	Grass margins as wildlife corridors
LM0441	Effectiveness of HLS for conserving farmland birds: 2014 re-survey
LM0442	Effectiveness of use of Higher Level Stewardship Scheme (HLS) options for management of lowland fen and bog
LM0443	Resurvey of HLS Baseline for options HK6 and HK7: Species-Rich Grassland Maintenance/Restoration
LM0444	Soil pH and nutrient status on sites of high botanical value

LM0448	Climate Change Adaptation
LM0454	Evaluating Natural England's Turtle Dove HLS package
LM0455	Assessing the effects of Higher Level Stewardship options on lowland heathlands and its priority species, esp grazing effects
LM0456	Rapid Landscape Monitoring: 2014-16 survey
LM0457	Landscape-scale Scoping Study
LM0461	Development of a National Historic Landscape Characterisation
LM0462	Breeding Wader Survey
BD5003	Managing Grassland Diversity For Multiple Ecosystem Services
BD5105	Implications of grazing regimes on vegetation, invertebrates and livestock performance and following heather restoration on degraded heathland

Annex 2 – Examples of wider use of evidence from the Agri-Environment Monitoring and Evaluation programme

Here are a selection of papers and reports that have made use of evidence from the Agri-Environment Monitoring Programme from this year and/or past years.

Dales, NP, Doran, H and Macgregor, NA (Eds), 2016. **Natural England Chief Scientist's Report 2015-16**. Natural England Report NE622.
https://www.gov.uk/government/publications/natural-england-chief-scientists-report-2015-to-2016
Uses evidence from project LM0456 in Section 2: Monitoring the Natural World (p21), and from project LM0441 in Section 3: Practical Solutions (p28).

Alonso I & Hewins E, 2017, **Agri-environment scheme impact on improving the condition of lowland heathland in England**, European Heathlands Network Workshop 2017 - Lowland heaths under pressure: challenges in ecological restoration. Conference and abstract book. The Netherlands. Pg 75 (abstract and oral presentation).
http://publications.naturalengland.org.uk/file/6125965496811520
Uses evidence from project LM0455

Cooke, Andy, 15 August 2017, **How to create a wildflower meadow**, Natural England Blog.
https://naturalengland.blog.gov.uk/2017/08/15/how-to-create-a-wildflower-meadow/
Uses evidence from project LM0443

Douglas Warner, John Tzilivakis, Andrew Green, Kathleen Lewis, 2017, **Prioritising agri-environment options for greenhouse gas mitigation**, International Journal of Climate Change Strategies and Management, Vol. 9 Issue: 1, pp.104-122
http://www.emeraldinsight.com/doi/full/10.1108/IJCCSM-04-2015-0048
Uses evidence from project BD2302 which completed in 2007.

Natural England works for people, places and nature to conserve and enhance biodiversity, landscapes and wildlife in rural, urban, coastal and marine areas.

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