WORK PACKAGE ORDER
Framework for Environmental Stewardship Monitoring and Evaluation

FRAMEWORK AGREEMENT AND LOT NUMBER: **24931 Lot 7**	DATE: **18th July 2018**

WORK PACKAGE NUMBER: ECM52672
Farmland birds work programme 2018/19
Reviewing the benefits of agri-environment schemes for farmland biodiversity and predicting the extent of agri-environment provision needed to reverse population declines of farmland birds in England

FROM: Natural England	TO: Lot 7 Contractor British Trust for Ornithology
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Project Officer: ▓▓▓▓▓ Job Title: Senior Environment Specialist - ▓▓▓▓▓	FAO: ▓▓▓▓▓▓▓▓
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SERVICES: Evidence Programme Ref: RP04293

CONTRACT PERIOD: Commencing from date of this Work Package Order
Duration: For completion by 31 Mar 2019

CONTRACT PRICE EXCLUDING VAT:	CONTRACT PRICE INCLUDING VAT:
£66,499.20	£79,799.04

CONFIRMATION OF REQUIREMENTS:

The services should be supplied in accordance with:

- The specification (reproduced as attached at Annex A)
- British Trust for Ornithology tender proposal uploaded to Bravo itt4451 (reproduced as attached Annex B)

Timetable – contract to commence as soon as possible following signature of this Work Package Order and be completed by 31 March 2019.

Payment profile:
40% - ▓▓▓▓▓▓. Submit brief written progress report on both modules.

60% - ▓▓▓▓▓▓ Written comments on reports. Natural England confirms invoice can be submitted.

See breakdown of **rates and charges** below.

ESME Farmland Birds Work Programme - reviewing the benefits of agri-environment schemes. Lot 7 RFQ ITT 4451
Pricing Schedule
Tenderer Name: **British Trust for Ornithology**

COSTS (Weighting 30%)	Module 1 Daily rate	Number of days	Total excl VAT	Module 2 Daily rate	Number of days	Total excl VAT	Combined total (modules 1 & 2) Total excl VAT
Senior Project Manager				█	▪	█	█
Project Manager							
Technical / Specialist				█	▪	█	█
Technical / Project Support							
Travel and Subsistence (please provide a full breakdown)							
Other (RSPB subcontract - breakdown provided in table below)			█			█	█
TOTALs			█			█	£66,499.20
TOTALs inc VAT			█			█	£79,799.04

Please note that VAT will be payable at standard rates on this entire work package. We confirm prices will remain fixed and firm for the duration of the contract.

BREAKDOWN OF RSPB SUBCONTRACT COSTS

COSTS (Weighting 30%)	Module 1 Daily rate	Number of days	Total excl VAT	Module 2 Daily rate	Number of days	Total excl VAT	Combined total (modules 1 & 2) Total excl VAT
Senior Project Manager	█	▪	█	█	▪	█	█
Project Manager	█	█	█				█
Technical / Specialist	█	█	█	█	█	█	█
Technical / Project Support	█	█	█				█
Travel and Subsistence (car / rail fares to meetings)			█			█	█
Other (laptop for specialist)						█	█
Other (External Reviewer)			█			█	█
TOTALs		█	█		█	█	█
TOTALs Inc. VAT			█			█	█

Terms: Terms and Conditions as detailed and agreed in the Environmental Stewardship Monitoring and Evaluation Framework reference 24931 shall apply to this Work Package Order. Please note in particular clause 9.2 regarding payment terms (which are up to 50days) and clause 9.5 advising invoices must be submitted to Natural England's Project Officer at such address (including in electronic format where agreed with the Contractor) as Natural England may notify the Contractor from time to time.

Additional Terms:

Should the Contractor not intend to submit an invoice to the Natural England Project Officer at the profiled milestone date agreed in this work package order or at the inception meeting, the Contractor must provide one month's notice, in writing, to the Natural England Project Officer to advise them of this. A new profiled invoicing date should also be provided at this time.

ELECTRONIC SIGNATURE
Acceptance of the award of this Contract will be made by electronic signature carried out in accordance with the 1999 EUDirective 99/93 (Community framework for electronic signatures) and the UK Electronic Communications Act 2000.
Acceptance of the offer comprised in this Contract must be made within [7] days and the Agreement is formed on the date on which the Contractor communicates acceptance on the Customer's electronic contract management system ("Bravo").
No other form of acknowledgement will be accepted.

Appendix A **Specification**

Purpose

This mini-tender consist of two modules of work that will make a major contribution to Defra/Natural England's Environmental Land Management Schemes Monitoring and Evaluation Plan 2015-2020. Module 1 is concerned with undertaking a quantitative review of the studies based in North West Europe that have investigated the benefits (or otherwise) of agri-environment scheme (AES) provision to farmland biodiversity. Module 2 will attempt to predict the extent of AES provision needed to reverse population declines of farmland birds in England.

The outputs from this mini-tender will inform specific elements of the Plan, in particular, the formal review of Environmental Stewardship (ES) in the context of the stated impact/result indicators (note: the key result indicator that this work will contribute to is 'Site/landscape level response of key species groups to management options', and the key impact indicator 'Trends in Farmland Bird Indicator'). The work will also provide vital evidence to inform the future operational delivery of the current Countryside Stewardship scheme, and the design and delivery of the new environmental land management system (as per the Government's 25 Year Environment Plan) to be launched in England after the UK exits the EU, as well as delivery of Outcome 3 of *Biodiversity 2020*.

Module 1: Reviewing the benefits of agri-environment schemes for farmland biodiversity

Background

Enhancement of farmland biodiversity is typically a key objective of many AES across Europe, and AES is still the most widely available policy mechanism for enhancing the wildlife associated with farmland. Previous reviews have suggested only limited success of AES measures aimed at wildlife (e.g. ███████████ 2003; ████ et al. 2006), while other more recent studies have considered landscape context but focused mainly on species richness rather than abundance (e.g. Concepcion et al. 2012; Batary et al. 2015). Enhancing abundance of species that have suffered severe declines is obviously a key outcome for AES if depleted wildlife populations are to be recovered.

In June 2017, RSPB conducted a rapid qualitative literature review of the effects of AES management on farmland wildlife. The study was intended to inform RSPB's AES policy and was therefore restricted to temperate terrestrial farmland habitats in North West Europe (mainly EU countries, plus Switzerland & Norway). RSPB conducted systematic literature searches using a fixed set of key words on the following literature sources: Web of Science, CAB Direct, ProQuest Dissertations & Theses, Networked Digital Library of Theses and Dissertations, Electronic Theses Online Service, DART-Europe E-theses Portal and Google Scholar. Their search located 159 peer-reviewed scientific studies to add to the 62 studies identified by ███████████ (2003). These 159 studies included 1,968 comparisons of either species richness/diversity or abundance/density between farmland AES and appropriate 'control' sites. Most of the comparisons related to plants, arthropods (mainly insects and spiders) and birds, and most came from the British Isles (1,523). Their review simply categorised the proportion of comparisons with significantly more plants or animals on AES habitats or sites as 'successes', and the proportion with significantly fewer as 'failures'.

This simple qualitative assessment produced some interesting patterns. For example, AES success rates were higher for arthropods (56%) and plants (54%) than for birds (24%). Within birds, there was a relatively high failure rate for ground-nesting species, particularly waders (17%). Success rates for birds were higher where AES measures were designed to provide specific ecological requirements. The RSPB review found that the most extensive information is available for England. The original Countryside Stewardship Scheme (1991-2004) achieved a higher all taxa success rate (46% success, 2% failure) than its successor Environmental Stewardship (ES)(27%, 11%), though the latter is deflated by the inclusion of numerous tests of bird responses to unsuitable habitats entered into AES. Within ES, the targeted, advisor-supported Higher Level Scheme (HLS)(35%, 3%) outperformed the untargeted, unsupported Entry Level Scheme (27%, 11%). Only the highly-targeted experimental Arable Stewardship Pilot achieved a higher success rate (49%, 12%).

Grouping AES measures from across NW Europe showed that some types of intervention have been more successful than others in delivering more wildlife. Small patches (typically in-field margins) of seed- or flower-rich habitat were consistently successful at increasing the abundance and/or species richness of birds, plants and arthropods. Boundary measures (hedgerows, ditches) performed relatively poorly compared to other groups of measures, while reduced intensity grassland management achieved low success rates for birds and plant abundance. The effect of AES on avian species richness has received little study and success rates have been low, except for seed-rich habitat.

Scope of the contract

Whilst the RSPB study has been very worthwhile, the work of this module will greatly strengthen the existing qualitative assessment by conducting an underpinning statistical analysis of the reported patterns in success & failure rates (employing univariate or multivariate Generalised Linear Models (GLMs) of success and/or failure rates). In addition, the work will be additionally strengthened by a quantitative meta-analysis of average AES effects sizes (comparison of Hedge's d statistic) for abundance/density, and separately species richness, testing hypotheses of interest (e.g. taxonomic group, landscape type and complexity, option type, before/after the 2007 EU review of AES effectiveness). It will also update the evidence base to include newly available studies.

Module 2: Predicting the extent of agri-environment provision needed to reverse population declines of farmland birds in England

Background

Reversing the decline in farmland bird populations was a targeted outcome of ES, and remains a key priority for CS. This reflects the fact that the state of farmland birds is an 'impact indicator' for AE schemes at an EU level, and that farmland bird populations are used as an indicator of progress with the England Biodiversity Strategy *Biodiversity 2020*. As a result, monitoring the response of key farmland bird species is a key element of the Defra/Natural England Environmental Land Management Schemes Monitoring and Evaluation Plan 2015-2020.

Since 2005, a number of projects have successfully evaluated the biological and behavioural responses of key farmland bird species to particular elements of ELS and HLS (e.g. ███████ et al. 2009, Field et al. 2011), ES as whole (e.g. ██████ 2010a &b, █████ et al. 2012, █████████ et al. 2014), or tiers within ES (e.g. █████ et al. 2015, ██████ et al. 2018). This multi-scaled approach is continuing within the current ES Monitoring and Evaluation Framework relating to birds (Lot 7). Previous work under Lot 7 has successfully repeated the analysis of ████ et al. (2012) using a longer data run, investigated the effectiveness of the supplementary feeding options in ELS and HLS, evaluated the package of HLS measures being deployed for the rapidly declining turtle dove and for farmland birds in general, and conducted a repeat survey (in 2017) of the breeding birds on 70 HLS farms (across three English regions) originally surveyed in 2008 and, again, in 2011 and 2014 ████████ et al. 2015, ██████ et al. 2018).

Using the results of the 2014 resurvey of HLS farms, ██████ et al. (2018) made an initial attempt to predict the extent of typical HLS provision (7-9% of the farm area under agreement devoted to bird-friendly management) needed in the wider farmed landscape to halt ongoing declines of farmland birds. In the case of the 'East Anglia' and 'Oxfordshire' regions, HLS agreements (where growth in the FBI averages 4.7% per annum) would need to target approximately 35% of farmland birds in order to offset the continuing losses in the wider farmed landscape. This prediction, however, ignores the likely positive effects on bird abundance of lower level AES provision, such as was provided by ELS (as noted in █████ et al. 2012) and is being provided by the Mid-Tier of CS.

Scope of the contract

Building on the work of Walker et al. (2018), and the results of a further re-survey of the same HLS farms in 2017, this module will produce more current and more complete predictions, which can be further refined by comparing changes in priority farmland bird abundance during the period 2008-2017 across three potential tiers of bird-friendly AES provision:

(1)   7-9%* of the farmed area under agreement (typical of HLS & Higher Tier CS)

(2)   1-4%* of the farmed area under agreement (typical of ELS & Mid-Tier CS)

(3)   0% AES provision (typical of the wider farmed countryside).

* The adopted boundaries will be informed by inspection of the real data.

Data for tier (1) are provided through the previously funded HLS evaluation work covering 70 individual HLS agreements during 2008, 2011, 2014 and 2017. Comparative data for tiers (2) & (3) will be provided by combining the Breeding Birds Survey and the AES option uptake data. The analysis will also test whether AES performance for farmland birds is affected by landscape context (e.g. cropping patterns from the CEH crop map, landscape complexity derived from UK Land Cover maps 2007 & 2015) and AES provision in the area surrounding individual agreements. This will

facilitate an exploration of the best means by which to spatially target AES delivery across England in order to maximise the effectiveness of delivery and value for money.

The proposed work will provide the first landscape scale quantitative assessment of the extent of AES provision required to reverse population declines of priority farmland birds, which has the potential to inform future operational delivery of the current Countryside Stewardship scheme, and the design and delivery of a new environmental land management system (as per the Government's 25 Year Environment Plan).

References

Baker, D.J., Freeman, S.N., Grice, P.V. & Siriwardena, G.M. 2012. Landscape-scale responses of birds to agri-environment management: a test of the English Environmental Stewardship scheme. *Journal of Applied Ecology* 49: 871–882.

Batáry, P., Dicks, L.V., Kleijn, D. & Sutherland, W.J. 2015. The role of agri-environment schemes in conservation and environmental management. Conservation Biology 29: 1006-1016.

Bright, J.A., Morris, A.J., Field, R.H., Cooke, A.I., Grice, P.V., Walker, L.K., Fern, J. and Peach, W.J., 2015. Higher-tier agri-environment scheme enhances breeding densities of some priority farmland birds in England. Agriculture, Ecosystems & Environment, 203: 69-79.

Chamberlain, D, Gough, S, Anderson, G, Macdonald, M, Grice, P, Vickery, J 2009. Bird use of cultivated fallow 'Lapwing plots' within English agri-environment schemes. *Bird Study* 56: 289–297.

Concepción, E.D., Díaz, M., Kleijn, D., Báldi, A., Batáry, P., Clough, Y. et al. (2012). Interactive effects of landscape context constrain the effectiveness of local agri-environmental management. *J. Appl. Ecol.*, 49, 695–705.

Davey, C, Vickery, JA, Boatman, ND, Chamberlain, DE, Parry, HR & Siriwardena, GM 2010a. Assessing the impact of Entry Level Stewardship on lowland farmland birds in England. Ibis 152: 459–474.

Davey, C, Vickery, J, Boatman, N, Chamberlain, D, Parry, H & Siriwardena, G 2010b. Regional variation in the efficacy of Entry Level Stewardship in England. Agriculture, Ecosystems and Environment 139: 121–128.

Field, R. H., Morris, A.J., Grice, P.V. & Cooke, A. 2011. The provision of winter bird food by the English Environmental Stewardship scheme. *Ibis* 153: 14-26.

Kleijn, D & Sutherland, WJ 2003. How effective are European agri-environment schemes in conserving and promoting biodiversity? *Journal of Applied Ecology* 40: 947-969.

Kleijn, D, Baquero, RA, Clough, Y, Diaz, M, De Esteban J, Fernandez, F, Gabriel, D, Herzog, F, Holzschuh, A, Jöhl, R, Knop, E, Kruess, A, Marshall, EJP, Steffan-Dewenter, I, Tcsharntke, T, Verhulst, J, West, TM & Yela, JL 2006. Mixed biodiversity benefits of agri-environment schemes in five European countries. *Ecology Letters* 9: 243-254.

Walker, L.K., Morris, A.J., Cristinaccea, A., Dadam, D., Grice, P.V. & Peach, W.J. 2018. Effects of higher-tier agri-environment scheme on the abundance of priority farmland birds. *Animal Conservation* (https://doi.org/10.1111/acv.12386)

Objectives

The objectives of **Module 1** are:

1.   To quantitatively evaluate the extent to which AES provision in temperate North West Europe has enhanced farmland wildlife at the option and farm (agreement) scales.

2.   Determine whether the success rate of AES interventions targeted at wildlife differ between taxonomic groups, landscape types, option types, schemes and over time.

The objectives of **Module 2** are:

1.   To predict how much AES-type provision is needed in English landscapes in order to halt and reverse population declines of priority farmland birds. This will be quantified in terms of the proportion of key target populations that need to be subject to AES-type management and the quantities of generic option types that need to be provided on an England-scale.

2.   To explore what landscape factors might explain differences in AES delivery for priority farmland birds between different English regions.

3.   By utilising the above and information on the distribution of target species (using the 2007-11 Bird Atlas and/or extrapolated BBS data, as appropriate), explore ways that will provide an indication of the most appropriate landscape areas (eg National Character Areas) in England in which to target future AES-type interventions in order to maximise effectiveness/outcomes.

Duration

1 July 2018 – 31 March 2019

Outputs

The outputs of this mini-tender will be:
- Analyses of existing studies/data that will provide Defra/Natural England with a quantitative assessment of the benefits of AES provision for farmland biodiversity in NW Europe (**Module 1**) and a prediction of the level of AES provision needed in England to reverse the decline in farmland bird populations (**Module 2)**.
- For each module, a finalised, externally peer-reviewed project report suitable for publication as a Defra science report (note: the contractor will be responsible for arranging peer-review of both of the final reports by two appropriate reviewers, to be agreed with the Natural England project officer). The final reports will be structured in a format that facilitates rapid conversion into papers suitable for submission to an appropriate peer-reviewed scientific journal. In addition, a two-page summary of the main findings of the work will be produced for each module.
- Given a suitable platform, the results of both modules should also be presented at relevant scientific fora.

Reporting

- The contractor will liaise regularly with the Natural England project officer and schedule face-to-face meetings as necessary, chairing and taking key notes/actions as agreed with the Natural England project officer (see Governance and Timetable).
- Separate draft final reports (with accompanying 2-page summaries) will be sent to Natural England by 15 March 2019 and a meeting to present/discuss the results can be arranged soon afterwards if required.
- The contractor will aim to submit a manuscript to a peer-reviewed journal for each module of work as soon as possible after completion of the report, co-authored by RSPB/BTO and Natural England staff, as appropriate.

Governance and Timetable

The project manager within Natural England will be ▮▮▮▮▮▮, who will be the first point of contact within Natural England. The Contractor must also appoint a project leader, authorised to act on behalf of the contractor, who will be responsible for the management and delivery of the project to include data collation/analysis and reporting, and who will act as the liaison point with the Natural England project officer.

A brief inception tele call will take place within two weeks of the start of the Contract. Telecalls and face-to-face meetings, arranged by the Contractor, will take place regularly throughout the duration

of the project to monitor progress, identify issues/risks and discuss the detail of analyses and outputs, as necessary.

Tenders should include a project plan detailing the activities required to complete the Contract together with proposed milestones linked to invoice points (maximum of 2 invoice points, with no more than 40% of the contract value to be paid before completion of the contract) for the duration of the project.

As the project is being funded through the Rural Development Programme for England, there will be particular requirements around the submission of invoices, and the Contractor will be required to supply supporting information on time used and expenses incurred with the invoice as per the terms and conditions as detailed in the Environmental Stewardship Monitoring and Evaluation Framework award reference 24931. This will also be clarified at the inception meeting.

Property rights, publication and confidentiality

It should be noted that, for the purposes of this project in reference to clause 11.4 of the Natural England Terms and Conditions for Services (RDPE Technical Assistance), Natural England hereby agrees to joint ownership of Resulting Intellectual Property Rights of the field data that will be produced as part of the Services supplied under this project.

Natural England and Defra intend to publish the final project report as a Natural England Commissioned Report. The published report will be made available on the Natural England and Defra Science websites. It is likely to be shared directly with partners as part of regular liaison over the progress of Environmental Stewardship and wider RDPE Delivery.

Natural England encourages widespread publication, and welcomes the use of appropriate trade press, peer-reviewed journals and sector-specific journals, but it is a requirement that all plans to communicate outcomes, including publications and oral presentations, from funded research are agreed with the project manager (who will ensure Natural England and Defra QA requirements are met) before publication.

The Contractor(s) will be responsible for ensuring the quality of the work, the presentation of the final report and any other material to be published.

All agreement information provided to the contractor for the purposes of this project shall be kept securely and confidentially and disposed of at the end of the project. It must not be used elsewhere without prior consent.

Suggested timetable for the outputs

Inception tele call	**By 26 July 2018**
Draft Report/Draft Scientific Paper	**By 28 February 2019**
Final Report/Scientific Paper and 2 Page Summary	**By 31 March 2019**

Module 1: Reviewing the benefits of agri-environment schemes for farmland biodiversity
Objective 1.1.- Quantitatively evaluate the extent to which AES provision in temperate North West Europe has enhanced farmland wildlife at the option and farm (agreement) scales.
An existing systematic literature review (completed by RSPB in June 2017) has identified 159 peer-reviewed studies published since the review of Kleijn & Sutherland (2003). These provide 1,968 comparisons of species richness or species-level abundance between farmland AES and appropriate control habitats in temperate NW Europe. These data have been extracted and summarised in a detailed database including covariates of potential interest. We will expand this database to include the 62 studies reviewed by Klein & Sutherland plus any recent studies, and add additional covariates such as whether responses to AES relate to priority species.

Objective 1.2. Determine whether the success rate of AES interventions targeted at wildlife differ between taxonomic groups, landscape types, option types, schemes and over time.
Response variables include species richness, diversity, occurrence, cover, density, relative abundance and changes in abundance through time, and are mostly measured at three spatial scales (patch, option/plot & site/farm). The wide variety of response variables, and frequent non-reporting of effect sizes/variances, would require meta-analyses of effect sizes to be conducted on sub-sets of the data repeated for multiple response variables. Our preferred approach follows that of Roos et al (Biological Reviews, 2018) and should allow us to incorporate most of the available studies into comprehensive analyses of (i) species richness/diversity and (ii) species-level abundance. The approach will involve deriving ordinal evidence scores that integrate the direction of any AES effect and the quality/biological importance of the study. We propose three categories of evidence quality:

Fair (score=1) : studies demonstrating differential usage / activity associated with AES habitats & resources (e.g. option scale studies of insects or birds)
Good (score=2): studies demonstrating differential species richness/occurrence/abundance at a single point in time, measured at an appropriate scale (e.g. field for plants, farm/1km^2 for birds)
Best (score=3): studies demonstrating or inferring population (or community) level demographic responses to AES, measured at an appropriate scale (e.g. studies of reproductive performance or of temporal changes in population size)

Evidence scores are positive when AES enhances species richness/abundance, negative when AES reduces species richness/abundance, and zero when AES has no significant effect (range -3 to +3). The 'Fair' category may be redundant for studies of species richness. Statistical analyses will use ordinal logistic regression to identify factors explaining variation in AES evidence scores. Tested factors will include taxon (plants, arthropods, birds), conservation status (priority species or not), landscape (arable, grassland, mixed, upland), option type (seed-rich, flower-rich, grass strip etc.), region (British Isles, NW Europe, Switzerland), and time period (e.g. before/after the 2007 EU review of effectiveness). The study will quantify and account for variation in the biological impact of AES interventions, and will be reported as a manuscript intended for scientific journal submission.

Module 2: Predicting the extent of agri-environment provision needed to reverse population declines of farmland birds in England.
Objective 2.1. To predict how much AES-type provision is needed in English landscapes in order to halt and reverse population declines of priority farmland birds. This will be quantified in terms of

the proportion of key target populations that need to be subject to AES type management and the quantities of generic option types that need to be provided on an England-scale.

Previous studies of the Higher Level Stewardship (HLS) Scheme in England have measured the relative abundance of farmland birds on a sample of 68 farms spread across three lowland regions during 2008, 2011, 2014 and 2017. These data provide measures of population growth rates (PGRs) of bird species subject to HLS management. Data from the wider Breeding Bird Survey (BBS) provide equivalent PGRs for birds subject to different levels of AES provision. A previous study under this framework compared PGRs of birds subject to HLS provision with those for birds on BBS squares subject to zero levels of bird-friendly AES provision within the same square (Walker et al, Animal Conservation, 2018). Knowing PGRs associated with different levels of AES provision allows us to predict likely levels of AES coverage needed to achieve particular policy objectives at the landscape scale.

The approach described above ignores levels of AES provision that are intermediate between those typical of HLS and no provision, such as that provided by many Entry Level Stewardship agreements. By merging BBS square location data with NE option uptake data, we will be able to assign levels of AES provision for each individual option in each 1km-square in England. This permits the categorisation of BBS squares according to their level of 'bird-friendly' AES provision. Preliminary analyses have identified three levels of 'bird-friendly' AES provision in our three study regions:

Level of provisio	Median cover (%) seed-rich	Median cover (%) insect-rich	Number of HLS farms / BBS squares
HLS	3.6	4.0	70
Low AES	0.3	0.1	61
No AES	0	0	100

Such partitioning of the data will allow us to estimate and compare PGRs of farmland birds across these three levels of AES provision. Preliminary analyses for skylark indicate significantly different PGRs with strong growth on HLS sites, moderate growth in squares having low-AES and strong declines in squares with no AES. This finding is important for two reasons: (1) it demonstrates that relatively low levels of AES provision are having positive demographic impacts on priority species, (2) it allows us to make predictions about the amounts of different types of AES provision needed to achieve different policy objectives. For example, in order to stabilize a lowland skylark population at the landscape scale, 31% of skylarks would need to be subject to HLS provision in the absence of any low-level AES provision. This falls to 22% HLS provision when 15% of skylarks are subject to low-level AES, and 13% when 30% are subject to low-level AES.

The proposed new work will extend these 'proof of concept' analyses to a full set of ca. 20 priority bird species and to the Farmland Bird Index. Average PGRs will be estimated for three levels of AES provision over the period 2008-2017 in two study regions (East Anglia & Oxfordshire) and over a shorter period (2008- 2014) in one region (West Midlands) due to concerns over data quality relating to HLS farm surveys in 2017. Analyses will involve fitting generalised linear mixed models (GLMMs) to maximum counts in relation to year (continuous covariate), AES provision level and region plus interactions. PGRs estimated for each level of AES provision will allow prediction about the combinations of higher- and lower-AES provision needed to achieve landscape-scale policy

objectives. A set of potential policy objectives will be agreed in advance with NE (and might include stabilizing populations within 10 years, or growing populations by 10% within 10 years).

Objective 2.2. To explore what landscape factors might explain differences in AES delivery for priority farmland birds between different English regions.

The above analyses will be extended to test whether PGRs at the three levels of AES provision are influenced by local land cover or cropping patterns. We will use CEH Land Cover data (2007 or 2015) summarised at the 1-km square level, and the RPA crop map of England (CHROME) for 2016. Variation in land cover (e.g. the extent of semi-natural habitats) and cropping patterns (e.g. crop diversity, arable-grass ratio, the proportion of winter cropping) will be summarised at the 5-km^2 x 5-km^2 and 10-km^2 x 10-km^2 scales, and added as covariates to the GLMM's described above

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Objective 2.3 By utilising the above and information on the distribution of target species, explore ways that will provide an indication of the most appropriate landscape areas (e.g. National Character Areas) in England in which to target future AES-type interventions in order to maximise effectiveness/outcomes.

As part of BBS development work under the BTO/JNCC/RSPB BBS Partnership, BTO is currently developing spatio-temporal generalized additive models (GAMs) of bird density. These GAM models will cover all years, but for this tender we propose to alter the modelling procedure to predict bird density at the 1-km square scale for short runs of years. The GAMs have the general form: Density ~ smooth(easting×northing) + habitat covariates + elevation + error, where *habitat covariates* represent the proportional cover of different land cover types in each square. For this project we will develop these models for the following priority and FBI species: lapwing, kestrel, grey partridge, turtle dove, stock dove, woodpigeon, jackdaw, rook, skylark, whitethroat, yellow wagtail, dunnock, starling, song thrush, house sparrow, tree sparrow, linnet, goldfinch, greenfinch, bullfinch, yellowhammer, reed bunting, corn bunting. Models will be used:

(i)   To estimate the density of each species in each 1-km square. Note that densities are expressed as numbers of individuals and not numbers of pairs.

(ii)   To estimate the density of each species in the farmed component of each square. We will predict bird density by setting coefficients to zero: first, the non-farmed ones and then the farmed ones. This allows estimation of the proportion of abundance in the square that is in farmland.

(iii)   To combine these densities with boundaries of National Character Areas and estimate the total number of individuals on farmland and non-farmland in each NCA.

(iv)   To assign each 1-km square to one of three AES provision categories (no, low, high) based on areas of key bird-friendly AES options, agreed in consultation with RSPB. NCA-level farmland population estimates will then be sub-divided into these three categories.

Results will be provided to RSPB in tabular form, with a short note describing methods and providing information on the robustness of underlying models for incorporation into the final report. Module 2 (incorporating objectives 2.1 – 2.3) will be written up as a single technical report to NE.

Project Plan

The project will be led by RSPB, overseen and managed by ███████████ (███████████████ ███████, RSPB). An early inception meeting will be used to agree priority questions, approaches, deadlines and timescales. Progress with Module 2 requires BTO to provide RSPB with merged BBS & AES data in agreed format (a dependency) but BTO hold all of these data and have previously supplied data in the required format.

Objective 2.3 is a stand-alone component to be provided entirely by BTO, managed by ███████

▮▮▮▮▮▮. All of the required data for both modules are currently either held by the project partners or can be readily accessed without payment or further access permission (e.g. the RPA crop map). There are no external dependencies, and the successive milestones describe the critical paths for each module.

Proposed Schedule (CS: Conservation Scientist; SCS: Senior CS; SRA: Senior Research Assistant):

TASKS / DELIVERABLES	LEAD / PARTICIPANTS	MILESTONE	INVOICE POINTS
Recruit contract CS	RSPB	███████	
Project Inception Meeting (telecall)	RSPB/NE/BTO	█████	
SRA updates existing Module 1 database	RSPB	█████	
Revised BBS & AES data sent to RSPB	BTO	████	
CS collates BBS, AES, land cover & cropping data	RSPB	█████	
CS conducts initial Module 2 analyses	RSPB	█████	
Project Update telecall	RSPB/NE	█████	
Submit brief written progress report on both modules	RSPB to NE	████	█████
Draft report on objective 2.3 to RSPB	BTO	█████	
SCS completes main Module 1 analyses	RSPB	█████	
Submit draft project reports (one for each module) to NE	RSPB	█████	
End of project meeting to discuss results	RSPB/NE/BTO	█████	
Written comments on reports. NE confirms 2nd invoice can be submitted.	NE to RSPB	█████	██████
Final Project Reports & 2-Page Summaries	RSPB to NE	█████	
External peer-review of both final reports	RSPB	█████	

Risk Analysis, Mitigation and Health & Safety

All objectives rely entirely on existing, accessible data, so force majeure associated with field data collection do not apply. All proposed work is office-based so of low health and safety risk. Most of the proposed work will be conducted by currently employed and experienced staff so is low risk in terms of completion. A contract Conservation Scientist will need to be recruited with the associated risk of not attracting applicants with suitable skills. However, the RSPB has a good record of filling such posts, which usually attract high-quality applicants. Should, at any point during the project, the appointed members of staff are unable to carry out the planned work, the RSPB would inform BTO and NE immediately, and look to cover the work from its pool of established staff.

Senior members of RSPB staff will oversee all data recording, and provide written protocols and training to ensure project staff extract and record data to a uniform, high standard. All data will be checked and cross-validated prior to analysis. Final datasets and analyses will be placed in a

secure central data archive. Any personal data will be held and used strictly in accordance with General Data Protection Regulations (2018).

RSPB applies risk assessment techniques and codes of practice to all work activities, equipment and locations. Risk assessment of field, travel and office-based tasks will be performed by trained staff to identify hazards and appropriate mitigation measures. These are recorded in formal risk assessment documents for each employee, copies of which are available on request. RSPB holds employers' liability & public liability insurance to the value of not less than ████ per incident.