The environmental effectiveness of the Higher Level Stewardship scheme; Resurveying the baseline agreement monitoring sample to quantify change between 2009 and 2016

Full technical final report

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Executive summary

Agri-environment schemes (AES) are one of the most significant mechanism for delivering environmental policy within England, both in terms of expenditure and coverage of land. AES are multi-objective, primarily addressing conservation of wildlife, landscapes and the historic environment and providing public access as well as addressing broader environmental issues such as climate change and flood management. This project contributes to evaluation of the Higher Level Stewardship (HLS) AES, which was designed to achieve the highest standards of environmental management and target features of the greatest conservation value, including Sites of Special Scientific Interest (SSSIs). Monitoring is a key element of scheme delivery in order to assess the efficacy of AES, and determine which factors contribute to successful AES outcomes.

Here, we resurveyed a sample of HLS agreements (surveyed 6-7 years previously), to assess environmental outcomes and in particular change in plant communities over time in relation to AES management. The assessment of change over time allowed the effects of AES management to be quantified against defined objectives, as opposed to drawing conclusions from a single assessment where the conservation value of land entered into an AES can be confounded with AES management effects. The inclusion of a semi-structured survey to quantify agreement holder characteristics and experience enabled the relationship between these social attributes and environmental outcomes to be tested, in addition to quantifying the contribution of geographical and physical variables to environmental outcomes. An assessment of the effectiveness of HLS is made more robust if land within a scheme can be compared with a control or counterfactual dataset for the same period representing ecologically equivalent land not impacted by higher level agri-environment scheme (AES) options. However, as a tailored counterfactual comparison was not possible, a comparison was attempted by using similar data from other independent surveys at each time point.

The **objectives** of this study were to:

1) Quantify change between the HLS baseline survey (2009 – 2011) and HLS resurvey (2015 – 2016), in terms of habitat type and extent, habitat condition, characteristics of plant communities (e.g. species richness), and assess desired outcomes (as defined by indicators of success) towards the end of HLS agreements, both in detail at the scale of individual management options, and more broadly across all agreements surveyed.

2) Quantify and describe agreement holder characteristics in order to assess their previous experience, motivation, experience of participation in HLS (both in terms of the application process and agreement implementation), and plans for the future in relation to AES involvement and independent environmental practice.

3) Compare HLS environmental variables and outcomes (listed in objective 1) between different types of habitats and features, and assess the role of agreement holder characteristics and geographical and physical variables (such as size of agreement, altitude or type of agricultural land) on these variables.

4) Evaluate changes on HLS agreements between the baseline survey and resurvey in the context of changes in botanical variables across the wider countryside over a similar time period, through conducting a counterfactual comparison.

Approach

One hundred and seventy-three HLS agreements, widely distributed across England, were resurveyed in 2015 and 2016. These agreements had been selected for baseline survey in 2009 – 2011 using randomised stratified sampling, to ensure good coverage of grassland, moorland and arable HLS management options, and also included agreements targeted to increase representation of heath, fen and bog and calcicolous grassland options. Up to three parcels of land managed under each HLS option were resurveyed on each agreement, with survey work focussing on 70 management options identified as priorities for resurvey by Natural England (Section 2.1).

Field surveys took place between April and September in 2015 and 2016, and consisted of:

1. Mapping changes in the extent and type of broad and priority habitats since the baseline survey.
2. Assessing the condition of each feature to which HLS management was applied, following Farm Environment Plan (FEP) feature condition assessment criteria as specified in the FEP features manual (Natural England, 2010).
3. Collecting detailed botanical data through recording the presence and percentage cover of plant species in quadrats (for lowland parcels) and species presence at stops (for upland parcels), using the same standardised protocols that were used in the baseline field survey. The number and size of quadrats varied with habitat type and parcel size.
4. Assessing HLS outcomes by determining whether the Indicators of Success (IoS), which are specified by Natural England at the start of each HLS agreement, had been met.
5. Where SSSI units overlapped substantially with parcels under HLS management that were being surveyed, additional survey work was undertaken to obtain an assessment consistent with the Common Standards Monitoring (CSM) approach used for SSSI monitoring. These assessments cannot, however, be compared directly with published CSM condition data, as the current project only assessed those parts of SSSIs that overlapped land under HLS management, and did not always cover whole SSSI units.
6. An additional winter bird survey was carried out of management options designed to provide resources for wintering birds (e.g. HF12), which entailed two survey visits in winter of 2015 / 16. This allowed additional IoS that require winter bird observations to be assessed.

Face-to-face interviews were used in a survey of 137 of the agreement holders using a semi-structured questionnaire, between October 2015 and August 2016. The questionnaire was designed to collect a range of quantitative and qualitative information in seven key areas:

1. Business profile: This introductory section collected information about the farm business/site/institution/company.
2. Respondent profile: This section focused on the respondent in order to build a basic profile of each agreement holder.
3. Previous engagement with independent environmental practices: This section focused on agreement holders' previous engagement with any independent environmental practices, i.e. done outside of the scheme. These data were used to build a picture of the agreement holders' experience of and interest in environmental practices.
4. Previous engagement with environmental schemes: This section focused on agreement holders' engagement with any previous/other environmental schemes.
5. HLS application: This section focused on agreement holders' experiences of, and decision making relating to, the HLS application process.
6. The HLS agreement: This section explored the implementation of the HLS agreement in some detail, including collection of data on option specific data for the priority management options (as identified by NE) which make up the agreement, as well as perceptions about the outcomes of the agreement.
7. The future: This section provided the agreement holders the opportunity to reflect on the delivery of HLS, and sought to ascertain the likelihood of involvement in such schemes or activities in the future.

A series of detailed statistical analyses were conducted, using a range of techniques, to meet the objectives set out above. Analyses of HLS field survey data included the use of multivariate analyses of plant community data and generalised linear mixed models and generalised linear models to assess the role of agreement holder characteristics and other variables in affecting environmental outcomes. Contingency table analyses were used to test whether agreement holder variables were independent of one another.

In the absence of a repeated survey of the wider countryside covering the same time span as the HLS baseline survey and resurvey, a counterfactual comparison was constructed using data from 1588 plots selected from Countryside Survey (CS) for 2007 and the National Plant Monitoring Scheme (NPMS) for the years 2015 and 2016. All plots were 5x5m in size and represented seven broad habitats (broadleaved, mixed & yew woodland, neutral grassland, acid grassland, arable & horticulture, dwarf shrub heath, fen, marsh & swamp and bog). 276 of these plots had been in higher-level AES for at least 5 years prior to recording. These were coded as 'in-scheme' and only kept in the counterfactual analysis if initial testing showed that no significant differences in vegetation over time (i.e. between surveys) could be attributed to the effect of being in scheme. While there was broad overlap between surveys in the habitat diversity of the sampled landscape units (1km squares), NPMS plots in dwarf shrub heath,

acid grassland and fen, marsh & swamp were more likely to sample habitat in southern England than CS plots.

Key findings

1. The extent of most areas of broad and priority habitats did not change between the two surveys, apart from a minority of habitats under creation or restoration options.

The majority of habitats surveyed under HLS management did not change in extent or habitat type between the baseline (2009 – 2011) survey and resurvey. Where changes to priority habitats occurred, these were mainly due to a loss of lowland dry acid grassland and lowland meadow priority habitats, with few transitions from one type of priority habitat to another between the two surveys. Priority habitats for conservation would generally be more likely to be entered into maintenance HLS options, rather than creation or restoration options, as the focus is on managing them to maintain or slightly improve their condition.

Some broad habitat categories showed a greater percentage change to other habitat types between the baseline survey and resurvey, compared to priority habitats. The majority of those that changed category were under restoration or creation options, and consistent with the objectives of HLS management. For example, substantial proportions of both improved grassland and bare ground with early successional vegetation under restoration or creation management changed to neutral grassland between the two surveys. A smaller proportion of broad habitat under maintenance options changed to another broad habitat type between the two surveys.

2. Plant community composition changed little between the two surveys, especially in the uplands. In the lowlands, grassland communities changed under HLS creation and restoration options, with reduced grazing pressure a likely driver. Woodland ground flora under the HLS maintenance option indicated reduced disturbance at the resurvey. Change in plant communities under lowland heathland options was indicative of a move towards more characteristic heathland flora.

Multivariate analyses of vegetation change also found little evidence of change between surveys in the majority of habitats, including all upland habitats surveyed. Within lowland habitats, there was some evidence of vegetation change between the two surveys, in certain habitats. This apparent difference between upland and lowland habitats may be partly due to differences in survey methods (quadrats which included percentage cover were used in surveys of enclosed land vs. stops converted to frequency data per parcel in unenclosed upland habitats) and in replication, as more parcels were surveyed in several lowland habitats than in the uplands.

Among the lowland habitats, the multivariate analyses showed changes in grassland communities under HLS creation and restoration management options. The latter may be

explained by a shift towards plant assemblages more typical of wetter conditions or reduced grazing. Analyses of univariate responses indicate that average sward height increased in species-rich semi-natural grassland parcels under option HK7 (restoration), but that Ellenberg moisture attributes did not differ between the baseline and resurvey (Section 5.3.1 and below), which suggests that a reduction in grazing pressure may have been the key driver of change in plant assemblages under this option. For the woodland maintenance option, changes in flora between the baseline and resurvey indicate a move towards less disturbed conditions. Lowland heathland plant assemblages became more indicative of heathlands between the two surveys, both under restoration and maintenance options, though the sample size for these options were relatively small (33 parcels across 9 agreements were surveyed under options HO1 and HO2).

3. Changes in habitat condition between the two surveys were most strongly affected by the baseline habitat (FEP habitat feature) and condition. Priority grassland habitats were less likely to improve in condition between the two surveys than semi-improved or improved grasslands. Timescales for grassland restoration to achieve conservation priority grassland status may be greater than the time that elapsed between these two surveys.

4. Agreement holder characteristics and baseline panel appraisal scores affected change in habitat condition for some management options.

5. An analysis of change in habitat condition showed little or no difference between change in condition for paired maintenance and restoration options targeting the same type of habitat. A minority of parcels surveyed may have been in the wrong type of option – for example, those having a baseline condition of C but placed in a maintenance option.

Change in condition of land under management options for species-rich semi-natural grassland between surveys was strongly related to type of starting habitat. In contrast, condition outcomes for grasslands under management options that primarily target animal taxa were more strongly linked to agreement holder characteristics and baseline panel appraisal scores, and in fewer cases to the type of habitat. Changes in condition between the two surveys for features under upland options (HL9 and HL10) was most strongly influenced by starting condition, with better outcomes predicted for features with a baseline condition of A (good) or B, vs. C (poor). The likelihood of a positive change in condition of features under the rough grassland (HL7 and HL9) or woodland options (HC 7 and HC8) was less strongly related to the baseline condition.

Where we analysed change in condition for paired options targeting the same habitat, there was little evidence of different outcomes between the restoration and maintenance option in each pair. This may partly be due to numerous examples of habitats with a baseline condition of C being entered into a maintenance option, when a restoration option may have been more

appropriate. For example, 41 out of 102 surveyed features being managed under HLS option HK15 (maintenance of semi-improved or rough grassland for target species) had an initial condition of C (poor). Analysis condition across all agreements and options confirmed that a positive change between the surveys was most strongly linked to baseline condition and the habitat feature. This may reflect the dominance of options for species-rich semi-natural grassland options (HK6 and HK7) in the dataset. Timescales required for grassland restoration to reach thresholds for priority habitat status may be greater than the time that elapsed between these two surveys of HLS agreements.

6. Many botanical variables showed no changes between the two surveys. Where change in variables such as species richness did occur they were mainly positive, but often small in scale and limited to particular areas or habitats.

Many botanical response variables showed no change between the two surveys. In general, where change did occur, response variables derived from the botanical data showed positive responses (e.g. increase in species richness). However, these changes were small, and often related to particular habitats, areas of England (environment zones) or types of agricultural land (agricultural land classification). For example, species richness under option HK7 (restoration of species-rich semi-natural grassland) increased if a supplementary option was also used to tailor management further, and under maintenance option HK6 increased on lowland meadow habitats. Larger scale analyses of data from multiple options across all agreements showed an increase in species richness in five of nine broad habitats assessed and a reduction in the Ellenberg fertility attribute in six broad habitats. The positive response for species richness at multi-option scale may be due to inclusion of data from parcels under management options that were not replicated well enough for option scale analyses, for example creation options.

For some options, botanical variables showed an improvement between surveys, where condition did not. For example, the condition of lowland calcareous grasslands under a restoration option did not improve, but there was a shift towards reduced dominance of competitive plant species. This indicates an improvement in the plant community, but not so far as to meet condition criteria thresholds in the timescales between the surveys.

7. Agreement holder characteristics could be related to botanical outcomes for several HLS options. For grassland, woodland and moorland options, an agreement holder rating of management as easy or very easy was linked to improved botanical outcomes between the two surveys. For one arable option a rating of management as easy was associated with worse botanical outcomes at the resurvey, although replication of this option was low. At the larger agreement-scale, agreement holder characteristics did not relate to outcomes for habitat condition, IoS or botanical characteristics.

Eight variables relating to agreement holder characteristics, ranging from the type of agreement holder to their perception of the success of HLS, were assessed in analyses using

data from across all agreements and options. No strong evidence was found for agreement holder characteristics altering outcomes from these broad-scale analyses. However, more detailed analyses (of options and pairs of options) showed relationships between outcomes and agreement holder characteristics that were specific to options. Agreement holders attributed scores for ease of management to specific options, which relate to one or several of the botanical response variables derived from habitats under the majority of the options tested. These relationships differed between habitat or option types (between arable and other options). Among the grassland, woodland and moorland options, a management rating of easy or very easy was associated with improved botanical outcomes between the two surveys, for those response variables where a relationship existed. In contrast, species richness of the arable option HF12 was lower on agreements where the management had been rated as easy. This latter result corresponds to a relationship found between agreement holder confidence and ecological outcomes for Entry Level Stewardship arable options in a previous study (McCracken et al., 2015). The results of both projects suggest that if agreement holders rate management as easy for arable options that require creation of a new habitat (e.g. winter bird food plots), they tend to underestimate the management demands, resulting in worse outcomes. There were only sufficient data for analysis of a single arable option here, of which only one response variable of two related to ease of management rating. Generalisations across arable habitats should thus be treated with caution, but the correspondence with a previous study lends weight to this result.

8. Agreement holders were often over confident about achieving IoS. IoS were more likely to be met on agreements with SSSI land present.

The majority of IoS (63%) were judged to have been met at the resurvey. Analyses of relationships between agreement holder characteristics and environmental outcomes at the option scale also showed a tendency for agreement holders to be overconfident about achieving IoS, many of which have been shown in previous research to be set at inappropriate or unachievable levels (Jones et al., 2015). Development of indicators that can be more readily assessed by agreement holders, and are set at appropriate levels, might improve the outcomes of HLS agreements. From analyses of all agreements and options, the likelihood that indicators of success were met towards the end of agreements were affected by whether the agreement included SSSI land. HLS agreements with SSSI land on average had a greater proportion of IoS that were met at resurvey, compared to those without SSSI land. Within SSSI land, the recorded frequency of positive indicator species was within targets for some habitat types but not all.

9. Did panel appraisal scores awarded following the baseline correspond with the outcomes of the resurvey?

Following the baseline survey, a summary of findings for each agreement was assessed by an expert panel and scores awarded for various aspects of agreement design, including the use of management prescriptions within specific options and the use of options across agreements.

In a few cases, there was a relationship between these scores and changes in botanical variables between the two surveys, and also to the proportion of IoS met at resurvey. A high score for appropriate and well-tailored management prescriptions was generally associated with positive botanical change between the two surveys, but for one option the opposite was found. Panel appraisal relies on expert judgement, and can only use the evidence available at the time of scoring. Overall our findings suggest scores derived from panel appraisal may not provide a consistently reliable guide to future botanical outcomes across all options.

10. In the absence of a tailored counterfactual comparison, a counterfactual was constructed from various independent datasets. This yielded some useful comparisons, for example we found a positive effect of HLS woodland management relative to a long-term decline in woodland species richness in the absence of HLS management. However, the differences in methods between the datasets used to build the counterfactual reduce confidence in some of the other results found. In the absence of an ongoing national botanical survey, comparable counterfactual data must be collected at the same time to ensure a rigorous assessment of AES can be undertaken.

Within the counterfactual dataset, a significant effect of HLS scheme status was only found for arable land. Across both CS and NPMS data, Grime C score (measuring the proportion of more competitive plants in the vegetation plot surveyed) was found to be 13% lower in plots in-scheme than those not in higher-level AES. NPMS indicator species richness was higher for NPMS plots than in CS plots in all broad habitats apart from broadleaved woodland, where indicator richness was lower in NPMS plots. Mean Ellenberg R and N were higher in NPMS plots than in CS plots in broadleaved woodland, dwarf shrub heath, acid grassland and fen, marsh & swamp. These differences may be a reflection of deliberate differences in the sampling strategy between CS and NPMS associated with their different objectives and other methodological differences between surveys. An exception may be the lower indicator richness in NPMS in broadleaved woodland, which is consistent with other sources of evidence for a long-term decline in woodland understorey richness in England and elsewhere across Britain. Evidence from the HLS resurvey analysis suggests locally positive effects of woodland management options on species richness.

Overall, this large-scale resurvey of HLS agreements achieved three of the objectives listed above, to 1) quantify change between the two surveys at the scale of individual options and across all agreements surveyed; 2) quantify and describe agreement holder characteristics and 3) compare HLE environmental variables and outcomes with these characteristics and other variables. The fourth objective to evaluate changes though a counterfactual comparison was thoroughly explored through detailed analysis, but could not be fully met across all habitats under HLS management. This was due to the lack of a comparable, ongoing national survey of land not under AES management. The counterfactual comparison did provide useful comparisons in some habitats.

1. Introduction – Evaluating and monitoring Higher Level Stewardship

1.1 Agri-environment schemes – development and improving their effectiveness

Agri-environment schemes (AES) were introduced in England following the 1986 Agriculture Act to allay the negative environmental impacts of agriculture, support existing environmentally valuable farming practices, and enhance habitats and landscapes. The original Environmentally Sensitive Areas (ESAs) and Countryside Stewardship (CSS) Schemes ("classic schemes") were replaced by Environmental Stewardship (ES) in 2005. This need for a new AES acknowledged that the "classic schemes" had reduced the rate of habitat loss but the available monitoring data provided less evidence that these schemes were successfully addressing ongoing declines in biodiversity, in particular habitat quality and key species. Thus, ES sought to integrate the most successful elements of the original schemes and build upon them by offering more targeted management. This would be delivered by a multi-tier approach delivering desired scheme outcomes through Entry Level Stewardship (ELS), Organic Entry Level Stewardship (OELS) and, the focus of the present project, Higher Level Stewardship (HLS). The ES schemes form a core element of England's Rural Development Programme (RDP). From the outset AES had objectives addressing biodiversity, landscape and the historic environment and over time their scope has been extended to address other objectives including public access, natural resource protection, genetic diversity and climate change.

HLS was designed to achieve the highest standards of environmental management and targeted features of the greatest environmental value, including managing priority habitats listed in the Government's Biodiversity 2020 Programme and Sites of Special Scientific Interest (SSSIs). The targeting approach developed for HLS was based around a framework of 110 target areas (defined by habitats, species, landscape and/or history) identifying local priorities, with regional theme statements enabling prioritisation of features of high value outside the target areas. For each HLS application, a Farm Environment Plan (FEP) was required which characterised the environmental features present on a holding, described their current condition and set out the applicant's views on management priorities. Natural England (NE) advisors used the FEP to negotiate the agreement, recommending the adoption of appropriate HLS options and management prescriptions and setting out Indicators of Success (IoS) as criteria against which the success of management would be assessed. The resulting HLS agreement was designed to achieve delivery of site, regional and national AES goals. More detailed information on HLS and its component options is provided by NE (Natural England, 2010, 2013).

A requirement of the schemes run under the RDP is to gather evidence that can contribute to the overall evaluation of the programme. Natural England and Defra operate a monitoring programme aimed at providing evidence for the effectiveness of Environmental Stewardship. As part of this a baseline survey of HLS was commissioned from the NERC Centre for Ecology and Hydrology (CEH) in 2009 (Mountford et al., 2013). The baseline project had an immediate distinct aim of evaluating the building of HLS agreements and using evidence from field survey alongside agreement information to predict the capacity of individual

agreements and the scheme as a whole to deliver its intended outcomes. This baseline study was also undertaken in the assumption that a resurvey would subsequently be able to test whether the scheme was delivering as anticipated. The resurvey described in this report had two broad goals: (1) to appraise progress toward environmental goals since the HLS baseline survey and (2) to explore whether agreement holder characteristics affect the achievement of these environmental outcomes.

1.2 The HLS resurvey project

The resurvey was commissioned in May 2015 under Lot 1 (agreement scale monitoring) of Natural England's Environmental Stewardship Monitoring and Evaluation Framework (ESME) of 2013. The project's approach was designed collaboratively by CEH and the Centre for Rural Policy Research (CRPR) at the University of Exeter, focussing on gathering data at the agreement scale and including assessment of the most important or extensive HLS options. The core of the project comprised a resurvey of 173 agreements which had been assessed in 2009-11 for the baseline survey.

The ecological outcome of AES can be affected by social drivers. For example, McCracken et al., (2015) found that farmers' previous experience in environmental management and confidence to carry out required management both affected the quality of habitats created under arable ELS management options (specifically EF2 and EF4). In addition, past research by the resurvey project team (Lobley et al., 2013; McCracken et al., 2015) suggests that the quality of farmer engagement with their agreement influences the management and thus its likely success. To test the influence of such potential social drivers, the resurvey project included an assessment of the contribution that agreement holders, their motives and experience, make to the success of scheme implementation. This was conducted through structured face-to-face interviews with as many as possible of the agreement holders whose land was subject to field survey. The interviews were designed to collect information on a) the history of agri-environmental management (both formal and informal); b) participation in relevant advisor and training events; c) overall understanding of the purpose of the agreement (selection and management of options as well as their delivery); and d) the overall commitment of the agreement holder to the HLS agreement.

In addition to social drivers, analysis of the ecological data collected at baseline and resurvey tested the influence of geographical and topographic variables, such as environment zone (uplands vs. westerly lowlands vs. easterly lowlands), altitude and slope in relation to environmental outcomes. In addition, the resurvey data allowed a test of how well the "proxy assessment" made by expert panels during the baseline project (Mountford et al., 2013) were reflected by empirical assessments of change over time.

1.3 HLS baseline survey (2009-11) – key results

The aim of the baseline was to survey each agreement in the first year after it was signed. In each of the three years agreements were selected to ensure a key group of options were well

represented. Year 1 (2009) focussed on 100 agreements in the lowlands, generally comprising grassland and arable options. The second year (2010) involved surveys of 50 upland agreements, as well as a separate study of the contribution of HLS to ecosystem services (which is not considered further here). The final survey year (2011) involved two elements: a) to increase the sample size for a few previously poorly-represented HLS options; and b) another separate study looking at groups of agreements within a particular landscape type (again not considered in the current resurvey). The results of the baseline were described in a series of annual interim reports and in the final published report (Mountford et al., 2013). The account below provides an outline of the key results.

1.3.1 Habitat mapping outputs

Habitat mapping indicated that *ca* 60% of land under maintenance options was priority habitat and thus that HLS and its options had largely been targeted on appropriate habitat features. Similarly, many of the restoration options appeared to have been applied correctly, although here there were some significant exceptions.

1.3.2 Feature condition and indicators of success (IoS)

The baseline made *ca* 1200 distinct assessments of feature condition, based on repeating the FEP methodology (Natural England, 2010). Of these 28% were found to be in condition A (good condition), especially hedge-banks, upland calcareous grassland, grazing marsh and reedbeds. Overall 42% of features were in condition B (moderate; one out of multiple condition criteria was not met), with arable margins, purple moor-grass and rush pastures, several moorland habitats and native semi-natural woodland being most frequently represented. Of the 30% of features in condition C (poor; two or more condition criteria not met), no particular habitats were primarily in this category, although both BAP grasslands and lowland heaths were notably frequent.

Preliminary assessments of the potential to meet IoS were made using a red amber green (RAG) framework: 61% of HLS options had already achieved or were predicted to achieve all their IoS whereas 21% had failed or were thought likely to fail at least one IoS. The greatest predicted success was within arable options (HE and HF), whilst predicted failure rates were highest for some grassland options (HK6, HK7 and HK16), moorland restoration (HL10) and lowland heath options.

1.3.3 Comparison of HLS land and the wider countryside

The timing of the baseline survey allowed detailed comparison with the results of the 2007 Countryside Survey (Carey et al., 2008). This comparison focussed on response variables derived from species attributes (e.g. Ellenberg indicator values and Grime indices) as well as species richness, grass:forb ratio and Ericoid cover. This comparison enabled an evaluation of whether HLS agreements had targeted areas where habitats and vegetation were of higher quality. Most habitats under HLS did indeed tend to be more species-rich, to have fewer ruderals and fewer indicators of fertility as well as better representation of stress-tolerant species. Evidence for effective agreement location was especially clear in woodland,

improved and neutral grassland, bracken and arable land. However a few habitats including acid grassland, bog and fen/marsh/ swamp appeared to show a contrary trend, with HLS vegetation reflecting more fertile situations with higher cover of competitors and ruderals.

1.3.4 Agreement building: Conclusions of the appraisal panels

The panels assessed each agreement using nine criteria:

- Farm Environment Plans appeared to have no worse than minor discrepancies in almost three-quarters of cases and were judged unlikely to have a negative impact on outcomes.
- Most agreements were judged to be well designed in relation to local and national HLS targets, although it was noted that targeting might be applied more strictly in some cases.
- The choice of HLS options suggested rather few missed opportunities, although almost half the agreements had at least one mismatch between feature and option that could impact adversely on the achievement of outcomes. The panels reported five frequently encountered problem areas relating to:
  - exaggerated quality of semi-natural grasslands, leading to inappropriate option choice;
  - vague objectives associated with use of options HK15-17 to benefit target species;
  - poorly-justified woodland management;
  - over-use of "more of the same options" (i.e. ELS options in HLS);
  - HLS being applied to semi-improved features with limited potential value for restoration under the proposed management.
- HLS management prescriptions were too frequently applied generically, where greater tailoring would potentially enable better outcomes *e.g.* moorland stocking rates and management plans, insufficient support for restoration options, safeguards that had been removed from prescriptions and too generalised prescriptions for woodlands.
- The panels judged IoS to be the most frequently deficient element in agreement building. Generic indicator suites were frequently used, which did not provide a clear framework to assess progression, often were not tailored to site condition, and in some cases were not amenable to objective measurement. Frequently noted issues with IoS included: a) woodland IoS too general; b) the use of essentially identical indicators for maintenance and restoration options; c) failure to tailor IoS to individual parcels, e.g. where there was variation in initial condition; d) on moorland wet areas i.e. mires and flushes, these were sometimes not properly addressed in the IoS; e) poor or no linkage to the use of capital items; f) IoS for SSSI features not linked to targets set in favourable condition tables; and g) the lack of requirement for IoS in relation to ELS "more of the same" options applied in HLS.
- Usage of capital works was generally acceptable, but with some evidence of slow implementation that might affect the success of the related HLS options.
- Using the field RAG assessments and taking account of the proposed management, panels identified five options where >30% of examples were predicted as unlikely to deliver the desired high value outcomes: HE10, HK6, HL10, HQ6 and HQ7.
- Almost 80% of agreements were assessed as at least likely to achieve most desired outcomes, though with some significant weaknesses. Within these almost 30% of agreements were scored at a higher level of success (achieving all or most outcomes). It was recognised that these predictive assessments of relative success or failure would be

influenced by the competency of the agreement holder, and so could be tested through resurvey.

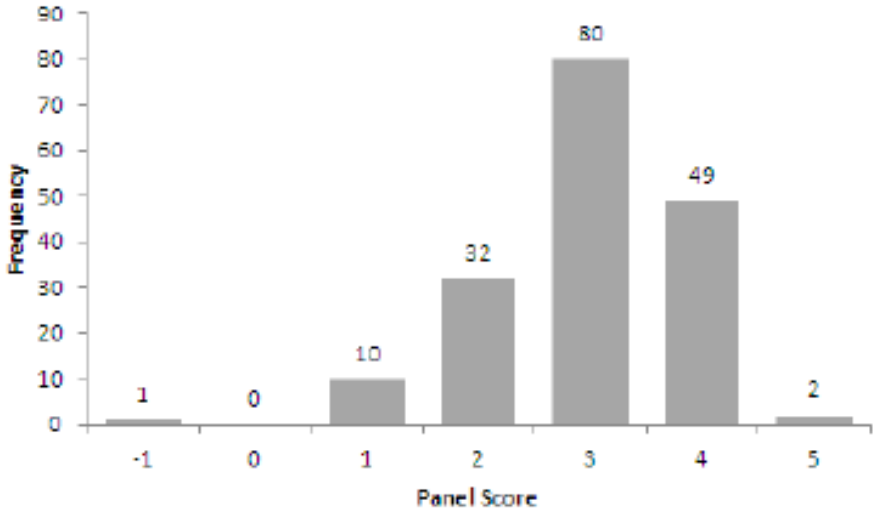

Figure 1.1 Agreement level outcomes. Summary of panel scores (-1 to 5) for the 174 HLS agreements assessed as part of the baseline survey. Taken from Mountford et al., (2013), Figure 6.12

1.3.5 Overall conclusions from the baseline survey

When the baseline survey reported, there were 9900 HLS agreements, with the most extensive management options in terms of area being for moorland restoration (HL10), moorland maintenance (HL9), maintenance and restoration of species-rich semi-natural grassland (HK6/7), maintenance of grassland for target features (HK15) and restoration of lowland heath (HO2/3). Options for arable margins were much less extensive but very frequently applied.

The baseline survey provided a broadly positive assessment of HLS and its potential to deliver desired outcomes and this reflected the use of more targeted management than had been available through the classic schemes. The project identified certain issues requiring attention to improve the overall implementation of HLS, relating to the need in some areas for better option targeting, better justification of option choice, greater tailoring of IoS, improved recording of decision making, clearer practical description of prescription, establishing acceptable levels of success for HLS and providing advisers with both more freedom and the training to improve individual agreements.

In conclusion, the baseline survey succeeded in creating a representative sample from which to judge progress with HLS at agreement and option level and gave preliminary insight into the delivery of the desired outcomes. The need for a resurvey was always anticipated and it was suggested that this might take place in the final three years of the agreement period. The agreements included in the present resurvey are now in their sixth to seventh year, and comprised a sample with potential to assess outcomes in a rigorous quantitative way.

2. Survey methodology

Two approaches were used to collect data for this project:

1) A resurvey of the agreements that had been surveyed during the HLS baseline project (Mountford et al., 2013). This field survey was conducted to collect ecological data on land under HLS management including mapping habitats, assessments of feature condition (CA), vegetation species cover and indicators of success (IoS).
2) A survey of the agreement holders to collect information about their attitudes and approaches to HLS and prior experience of agri-environment management.

2.1 Field survey

The methods employed in the field survey were essentially the same as described by Mountford et al., (2013). These are summarised below.

2.1.1 Sample of HLS agreements and options

The 2015 and 2016 HLS resurvey sample aimed to revisit the agreements surveyed during the baseline project. The core baseline sample comprised 174 HLS agreements: 100 in lowland England (2009), focussing on arable and grassland options; 50 in the uplands (2010), with an emphasis on moorland options; and 24 lowland agreements (2011) targeting options on heath, fen and bog and calcicolous grassland. In 2011, an additional (Module 3) and essentially separate baseline survey covered 62 more agreements within six National Character Areas (Dorset Downs & Cranborne Chase, Dunsmore & Feldon, The Fens, High Weald, Southern Pennines and the Upper Thames Clay Vales NCAs; Mountford et al., 2013). Sampling a few of these additional agreements in the resurvey provided scope to slightly increase the coverage of some option types.

The sample selected for resurvey included all 174 core baseline agreements. In order to bring the original sample up to 180 agreements, CEH and CRPR reviewed the Module 3 sample to select a few agreements containing certain priority options. This prioritisation was on the basis that the options are among the 40 most important in England (assessed by area or frequency) and that their representation in the baseline sample was <1% of the English population of that option. The list of priority HLS options for resurvey provided by NE is given in Appendix A (Table A1). When agreement holders were contacted, it became apparent that six agreements of the 180 were no longer in HLS, and these holdings were removed from the study. In addition, permission to access land was refused by one agreement holder. The spatial distribution of the 173 HLS agreements that were resurveyed in 2015 and 2016 is shown in Figure 2.1.

Figure 2.1 Distribution of the 173 HLS agreements that were resurveyed in 2015 (red circles) or 2016 (red triangles).

Within each agreement, HLS management options that were priorities for field survey were selected according to the list provided by NE (Appendix A, Table A1). With a few exceptions (Table 2.2), HLS options were resurveyed on parcels of land where a baseline survey had been carried out. If multiple parcels had been surveyed for any options during the baseline survey, a maximum of three parcels per option were resurveyed, due to time constraints. Table 2.1 shows the number of HLS agreements that were resurveyed for each management option in 2015 and 2016 using the methods outlined below, and Table 2.2 shows more detail (the number of parcels and quadrats surveyed) for the most frequently surveyed options.

Option code	Option description	Number of agreements resurveyed
HB11	Management of hedgerows of very high environmental value (both sides)	7
HB12	Management of hedgerows of very high environmental value (one side)	8
HC5	Ancient trees in arable fields	1
HC7	Maintenance of woodland	25
HC8	Restoration of woodland	29
HC10	Creation of woodland outside the LFA	2
HC11	Woodland and livestock exclusion supplement	8
HC12	Maintenance of wood pasture and parkland	2
HC13	Restoration of wood pasture and parkland	3
HC14	Creation of wood pasture	1
HC15	Maintenance of successional areas and scrub	7
HC16	Restoration of successional areas and scrub	6
HC18	Maintenance of high value traditional orchards	2
HC19	Maintenance of traditional orchards in production	1
HC20	Restoration of traditional orchards	9
HC21	Creation of traditional orchards	2
HD2	Take archaeological features out of cultivation	1
HD4	Management of scrub on archaeological sites	1
HD5	Management of archaeological features on grassland	8
HD7	Arable reversion by natural regeneration	1
HD9	Maintenance of designed/engineered water bodies	2
HD10	Maintenance of traditional water meadows	1
HE3	6m buffer strips on arable land (conventional)	3
HE10	Floristically enhanced grass margin	10
HF4	Pollen and nectar flower mixture	6
HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)	33
HF13	Fallow plots for ground nesting birds	2
HF14	Unharvested, fertiliser-free conservation headland	4
HF20	Cultivated fallow plots or margins for arable plants	1
HG7	Low input spring cereal to retain or re-create an arable mosaic	4
HJ3	Arable reversion to unfertilised grassland to prevent erosion or run-off	1
HJ4	Arable reversion to grassland with low fertiliser input to prevent erosion and run-off	2
HJ5	In-field grass areas to prevent erosion or run-off	4
HJ6	Preventing erosion or run-off from intensively managed improved grassland	2
HJ8	Nil fertiliser supplement	1

Table 2.1 Number of agreements for each management option that was covered by HLS resurvey field survey. Options with prefixes HB – HJ above, continued below.

Option code	Option description	Number of agreements resurveyed
HK1	Take field corners out of management outside the LFA	1
HK2	Permanent grassland with low inputs outside the LFA	1
HK3	Permanent grassland with very low inputs outside the LFA	1
HK5	Mixed stocking	2
HK6	Maintenance of species rich semi-natural grassland	48
HK7	Restoration of species rich semi natural grassland	64
HK8	Creation of species rich semi natural grassland	8
HK9	Maintenance of wet grassland for breeding waders	10
HK10	Maintenance of wet grassland for wintering waders and wildfowl	7
HK11	Restoration of wet grassland for breeding by waders	7
HK12	Restoration of wet grassland for wintering waders and wildfowl	1
HK13	Creation of wet grassland for breeding waders	2
HK14	Creation of wet grassland for wintering waders and wildfowl	1
HK15	Maintenance of semi-improved or rough grassland for target species	36
HK16	Restoration of semi-improved or rough grassland for target species	19
HK17	Creation of semi-improved or rough grassland for target species	6
HK18	Hay-making supplement	21
HK19	Raised water levels supplement	2
HL2	Manage in-by grassland with low inputs (LFA land)	1
HL3	Manage in-bye pasture and meadows with very low inputs (LFA land)	1
HL5	Enclosed rough grazing (LFA land)	1
HL7	Maintenance of rough grazing for birds	12
HL8	Restoration of rough grazing for birds	7
HL9	Maintenance of moorland	14
HL10	Restoration of moorland	32
HL11	Creation of upland heathland	4
HL12	Management of heather, gorse and grass by cutting or swiping supplement	11
HL13	Moorland re-wetting supplement	2
HL15	Seasonal livestock exclusion supplement	16
HL16	Shepherding supplement	7
HN2	Permissive open access	8
HN3	Permissive Footpaths	7
HN4	Permissive bridleway/cycle path access	2
HN7	Upgrading CRoW access for cyclists/horses	1

Table 2.1 continued Number of agreements for each management options that was covered by HLS resurvey field survey. Options with prefixes HK – HN above, continued below.

Option code	Option description	Number of agreements resurveyed
HO1	Maintenance of lowland heathland	3
HO2	Restoration of lowland heathland on neglected sites	10
HO3	Restoration of forestry areas to lowland heathland	1
HO4	Creation of lowland heathland from arable or improved grassland	1
HP2	Restoration of sand dunes	1
HQ1	Maintenance of ponds of high wildlife value <100 sq m	4
HQ2	Maintenance of ponds of high wildlife value >100 sq m	6
HQ3	Maintenance of reedbeds	4
HQ4	Restoration of reedbeds	3
HQ6	Maintenance of fen	7
HQ7	Restoration of fen	9
HQ8	Creation of fen	1
HQ9	Maintenance of lowland raised bog	1
HQ10	Restoration of lowland raised bog	2
HQ11	Wetland cutting supplement	2
HQ12	Wetland grazing supplement	3
HR1	Cattle grazing supplement	20
HR2	Native breeds at risk grazing supplement	12
HR4	Supplement for the control of invasive plant species	7
HR5	Bracken control supplement	7
HR6	Supplement for small fields	7
HR7	Supplement for difficult sites	6
HR8	Supplement for group applications	3
OHD5	Archaeological features on grassland (organic)	1
OHF4	Pollen and nectar flower mixture (organic)	1
OHF13	Uncropped, cultivated areas for ground-nesting birds (organic)	1
OHK1	Take field corners out of management outside the LFA (organic)	1
OHK5	Mixed stocking (organic)	1

Table 2.1 continued Number of agreements for each management options that was covered by HLS resurvey field survey. Options with prefixes HO – OHK above.

2.1.2 Field survey planning, training and manuals

Natural England provided the contact details and agreement paperwork for each HLS agreement that was surveyed. Natural England and CEH wrote to each agreement holder at the start of the year in which their agreement was scheduled for field survey (Appendix A1), explaining the objectives and nature of the resurvey (both field survey and agreement holder interview components). Subsequent the agreement holder was contacted by telephone to discuss suitable times and dates for visits.

The main field survey in 2015 took place from mid-June to the first week of October, and covered 94 lowland agreements (circles on Figure 2.1), the majority of which had originally been surveyed in 2009, with a few from 2011. In 2016, the field survey was undertaken from late March to early August, in part due to the need to survey some agreements early to avoid disturbance to breeding birds. The field survey in 2016 mainly comprised upland agreements that had been originally surveyed in 2010, together with the remaining lowland agreements. In addition, a winter bird survey was conducted in winter 2015/16, focussing on 28 agreements with options designed to provide resources for overwintering birds (HF12 and HK10, Table 2.1 for option descriptions).

Field surveyors were trained for 3-4 days each in May 2015 and March 2016. Two field manuals which had been prepared for the baseline survey were updated, one detailing approaches to habitat mapping (Carey, 2009) and the other describing methods of vegetation survey and condition assessment (Carey & Radley, 2009). These methods remained largely the same, although the emphasis on habitat mapping which was central to assessing agreement building in the baseline study, was reduced in the current resurvey. Surveyors also used the Farm Environment Plan (FEP) Features Manual which has been updated several times since HLS was launched (Natural England, 2010). These revisions have included changes to the range of targeted FEP features, resulting in a few potential inconsistencies in condition assessments between the baseline project and current resurvey.

The condition assessment manual included copies of all the recording forms used in the survey and guidance on how to complete them, as well as information on Common Standards Monitoring (CSM) of SSSIs and other complementary recording (Carey & Radley, 2009). For the resurvey, the forms were adapted for input directly into an Access database (Appendix A, Figures A1 – A3) on ruggedised tablet computers used in the field. The mapping manual included a key to the identification of broad and priority habitats, as well as guidance on mapping polygons and point features and gave step-by-step information on which attributes should be recorded for each habitat polygon or point. The output maps from the baseline survey were loaded onto the tablet computers so that, together with aerial photographs of the target agreements, these maps could form the basis for habitat mapping in the current resurvey. Use of ArcPAD mapping software (v10.2 © ESRI, 2013) and Microsoft Access allowed data to be downloaded securely and frequently and incorporated directly into the main project database.

2.1.3 Mapping of habitat and features

The approach in 2015-16 was to record changes in the extent and quality of habitats and linear/point features since the baseline survey, and not to conduct a full remapping of all baseline parcels. This reduced mapping effort was adopted because of a recognition that marked changes in the type and extent of features would be unlikely during the *ca* 5 years between the surveys. Thus, in the resurvey, the mapping was intended to record broad scale changes which would otherwise remain undetected by the more detailed quadrat data *e.g.* removal/degradation of individual features and subdivision of land parcels into different broad or priority habitats.

Hence, the revised mapping manual outlines a protocol under ArcPAD which took a simple 'target notes' approach to record change. On opening, the ArcPAD project showed several background layers from the baseline survey (hedges, linears, points, polygons, trees) superimposed on aerial photography. All these layers were locked for editing. Two layers were available for recording change and thus accessible for editing:
1) Points layer: for recording change (or lack thereof) at a whole feature level *e.g*. removal of a feature, change in broad or priority habitat). All resurveyed features were marked with a point, in order to distinguish 'no change' from 'not surveyed'.
2) Polygon layer: used to delineate new features or to indicate areas where change had occurred.
Completing a new feature in either of these layers brought up a custom data entry form with fields on target type (point, line or polygon), condition change (broadly positive, broadly negative, destruction/removal of feature, creation of a new habitat or placement of a new feature) and a notes field for additional information.

2.1.4 Habitat condition assessments

Condition assessments were made to help assess the success of the HLS options. The FEP features assessed in each parcel were the same as those assessed in the baseline survey, except for a minority of parcels under creation or restoration options for which the main habitat feature had changed since the baseline survey. In such cases, surveyors carried out a condition assessment for the 'new' feature that was present in the parcel at resurvey. A condition assessment was made for each of the FEP features in each parcel, using the criteria set out in the FEP handbooks (Natural England, 2010). Each condition assessment involves categorising a number of criteria as passed or failed, from which feature condition was assessed as:

A = good; all criteria passed
B = moderate; one criterion failed
C = poor; two or more criteria failed.

Where a condition of B or C was recorded, a note was made of which criteria the condition had failed on.

2.1.5 Vegetation quadrats in lowland enclosed parcels

Detailed vegetation data collected in quadrats were central to providing a quantitative assessment of the impact of HLS options since the baseline survey, and underpinning the condition assessment by providing detail of any change in plant community attributes. Parcels under HLS management were categorised as either enclosed lowland or unenclosed upland parcels, following a classification based around the 'moorland line' that had been used in the baseline survey and other ecological surveys (Mountford et al., 2013). Enclosed and unenclosed parcels were surveyed using different methodological protocols to record vegetation data (quadrats and stops respectively). Protocols for the condition assessments, assessments of Indicators of Success (IoS) and mapping were the same for enclosed and unenclosed parcels.

Quadrat size for lowland enclosed parcels varied with habitat type:

1 × 1m for grassland and arable margins
2 × 2m for heath and wetland
10 × 10 m for scrub and woodland.

Where possible, at least five vegetation quadrats were recorded per enclosed parcel surveyed. More quadrats were recorded in larger parcels (based on <5 ha = 5 quadrats, 6 10 ha = 6 quadrats, 11 20 ha = 7 quadrats, 21 40 ha = 8 quadrats, 41 80 ha = 9 quadrats, >81 ha = 10 quadrats), whilst in many scrub and woodland patches, the area of habitat was too small to accommodate more than one or two 10m × 10 m blocks. Quadrats were positioned across each parcel, along the five points (or more frequently for larger parcels) of a W shaped walk. Within each quadrat, a full inventory of the higher plant species present was recorded and the percentage cover of each species was estimated. Moss percentage cover was recorded in three groups (*Sphagnum* spp., Acrocarpous bryophytes and Pleurocarpous bryophytes), and the percentage cover of bare ground and thatch / litter were also recorded. For some habitats, additional variables (e.g. sward height in grasslands) were recorded. Table 2.2 below shows the number of parcels surveyed and quadrats recorded per option.

2.1.6 Vegetation recorded at stops in upland unenclosed parcels.

The total number of sampling points on unenclosed upland parcels was determined by the area of the moorland unit and the time available for survey. On parcels less than 50ha twenty stops were allocated, for areas of 51-100ha forty stops, and areas greater than 100ha sixty stops were allocated within each parcel. Additionally, each SSSI unit (which could be smaller than a moorland unit) was allocated at least 20 stops. Some upland parcels consisted of mosaics of multiple habitats and features, so in order to ensure comparable areas were surveyed, GPS locations were used to locate stops in approximately the same positions in the current resurvey as were used in the baseline. The baseline stop locations for unenclosed parcels had been randomly allocated.

The species and level of taxonomic resolution recorded depended on the upland habitat being surveyed, as protocols varied slightly with habitat (see Table A2 in Appendix A for details of taxa recorded by upland habitat protocol). At each stop the presence of vegetation within a circle with an approximately 2 m radius centred on the stop point was recorded. Additional data were also recorded, for example the percentage cover of negative indicator species.

HLS option		Resurvey and baseline		Resurvey only		Number of quadrats at resurvey
Code	Description	Parcels	Agreements	Additional parcels	Additional agreements	
HC7	Maintenance of woodland	29	21			77
HC8	Restoration of woodland	41	25			111
HC10	Creation of woodland outside the LFA	1	1			1
HE10	Floristically enhanced grass margin	9	5	9	4	120
HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)	1	1	50	25	397
HF14	Unharvested, fertiliser-free conservation headland	5	3			35
HJ4	Arable reversion to grassland with low fertiliser input to prevent erosion and run-off	1	1			5
HK6	Maintenance of species rich semi-natural grassland	86	40			504
HK7	Restoration of species rich semi natural grassland	165	58			882
HK8	Creation of species rich semi natural grassland	11	8			53
HK9	Maintenance of wet grassland for breeding waders	7	3			122
HK10	Maintenance of wet grassland for wintering waders and wildfowl	7	4	1	0	55
HK11	Restoration of wet grassland for breeding by waders	8	5			63
HK15	Maintenance of semi-improved or rough grassland for target species	91	31			484
HK16	Restoration of semi-improved or rough grassland for target species	35	18			209
HK17	Creation of semi-improved or rough grassland for target species	8	5			45
HL7	Maintenance of rough grazing for birds	25	6	7	1	188
HL8	Restoration of rough grazing for birds	11	6			74
HL9	Maintenance of moorland	15	9			31
HL10	Restoration of moorland	49	28			76
HL11	Creation of upland heathland	4	4			
HO1	Maintenance of lowland heathland	2	2			31
HO2	Restoration of lowland heathland on neglected sites	31	7			118
HP2	Restoration of sand dunes	3	1			12
HQ6	Maintenance of fen	7	6			32
HQ7	Restoration of fen	10	8			51
HQ8	Creation of fen	1	1			2
HQ10	Restoration of lowland raised bog	5	2			25

Table 2.2 Number of HLS parcels, agreements and quadrats that were surveyed by option in both baseline survey and resurvey, for the most frequent HLS options.

2.1.7 Indicators of Success

Indicators of Success (IoS) are specified by NE as success criteria for each management option within an HLS agreement, and are usually designed to be assessed in the second half and/or towards completion of the 10 year agreement (some IoS relate to the mid-point of an agreement). Most IoS were thus measurable in the current resurvey and these were recorded as having been met, partially met or not met, or with their status uncertain. Both in the current resurvey and the baseline, a number of indicators were recorded as "Could not assess", usually due to the survey occurring at an unsuitable time of year, for example in the autumn/winter for options which target wintering birds. To minimise this issue and to obtain better outcome data for a few autumn and winter delivering options, the present resurvey included an additional winter field survey (Section 2.1.11).

The great majority of IoS could not be assessed during the baseline project, as the agreements were at too early a stage. A predictive assessment was made of the likelihood that IoS would be met by the end of the agreement, during the baseline survey. This was based on a red amber green framework with IoS classed as red if they were considered unlikely to be met, amber if it was thought they might be met within the agreement schedule, and green if they were considered very likely to be met within the HLS agreement timetable. These predictive assessments were available for comparison with the measured outcomes at resurvey.

2.1.8 Capital works

Resurveys took place after the great majority of capital works should have been installed. Hence in 2015-16, the presence of works in the surveyed parcels was recorded together with evidence for their efficacy. For some capital works, the length of time between the baseline and resurvey made it difficult for the surveyors to be confident that the works had indeed been completed in a timely fashion (e.g. fence repairs within years 1 and 2).

2.1.9 SSSI Common Standards approach

SSSI protocols that had been applied during the baseline survey were repeated, involving a condition assessment of the notified feature using the generic common standards methodology (CSM) involving a structured walk of 20 stops across the SSSI unit. At least five of these stops recorded as full quadrats (for consistency with the core resurvey methodology). However, as only the area where the SSSI unit and an HLS option overlapped was surveyed, and this often did not cover the whole SSSI unit, SSSI condition assessments made for this project cannot be compared directly to published data. The published SSSI condition data are assessed across the whole area of each unit and also take into account all notified features (e.g. includes species features which were not monitored here).

2.1.10 Photographs

Photographs were taken where the surveyors judged there were important features worth recording or where obvious change had occurred.

2.1.11 Survey of options for wintering birds

The additional winter surveys focussed both on observing bird usage of options and evaluating the success of arable bird crop establishment. The survey targeted options delivering resources for birds in winter (HF12 and HK10) on 28 agreements, with all the parcels also assessed in summer, using the standard summer field survey methods. Bad weather (including floods in winter 2015/16) and consequent problems of access meant that certain agreements had to be prioritised. Highest priority was given to those agreements that contained more than one option for wintering birds. Despite this, 27 of the 28 agreements were successfully recorded. The two components of the winter survey were 1) an assessment of bird food availability in arable option HF12 and 2) assessment of bird usage of both the bird food (HF12) and wet grassland options (HK10), in order to allow winter IoS to be assessed. Two visits were made to each agreement, the first of which took place between the end of October and mid-December 2015 and the second between January and March 2017. Two experienced ornithologists conducted the winter bird surveys.

2.1.11.1 Bird-food

The bird-food plots were assessed by adapting the approach developed by CEH for the NE/Defra enhanced fallow research project (Pywell et al., 2015). The objective was to estimate depletion of seed availability at two points during early and mid-winter. All species sown as part of the HLS option were recorded together with those unsown which are both seed-bearing and abundant in the plot, using a modified DAFOR score of species abundance (D=dominant; A=abundant; F=frequent; O=occasional; R=rare):

Dominant	The main species by far, accounting for >50% of the cover
Abundant	Common throughout the plot and with significant cover (>20%)
Frequent	As latter but cover maybe 5-20%
Occasional	Scattered through the plot and with <5% cover
Rare	Present as a few individuals and with no significant cover (<<1% of plot)

Very small or low-growing annual plants and grasses were not included.

The rate of seed depletion was measured by estimating the proportion of 'seed remaining' on each species on the first and second bird count using the following scores:

0 = 0
1 = 1-25%,
2 = 26-50%
3 = 51-75%
4 = 76-100%

2.1.11.2 Bird usage – arable plots and wet grassland

The approach used was similar to that followed in previous research projects (Hinsley et al., 2010; McCracken et al., 2015). Bird counts started as soon as the light was good enough, and would normally halt around noon. The surveyors avoided making counts in high winds and heavy rain, or at times when the site was being grossly disturbed (e.g. by farm activity or dog

walkers). Bird numbers using the plots were made from the margins, with rapid estimates made if the birds were in flight, and with birds within the bird-seed plot or wet field recorded separately from those in the boundary features. Birds that were actively feeding were distinguished from those that were just roosting. As well as a marginal walk, the assessment included a traverse through the plot or field flushing any birds that were skulking in the vegetation. Any clear examples of birds feeding on specific plants were noted.

2.2 Survey of agreement holders

The role of the HLS agreement holder is a key factor in understanding success and failure in the design and implementation of HLS agreements. If it is assumed that the design of the HLS scheme is essentially suitable to meet stated objectives, then it is the actions of the agreement holder that becomes one of the key factors determining the success of the agreement. The survey of agreement holders was designed to develop understanding of how a range of factors are associated with environmental outcomes. As well as structural factors (e.g. farm size, type and tenure), we built on the findings of previous research (e.g. Lobley et al., 2013; McCracken et al., 2015) suggesting that the 'quality' of farmer/agreement holder engagement with their agreement can be important, influencing management (and by extension likely success, other things being equal). Consequently, our survey (see below) was also designed to collect information on the history of agri-environmental management (both formal and informal), sources of advice, understanding of the purpose of the agreement, the selection and management of options, understanding of delivery requirements and overall commitment to the HLS agreement.

2.2.1 Carrying out the survey of agreement holders

The agreement holder survey took the form of face-to-face interviews using a semi-structured questionnaire in order to generate a range of quantitative and qualitative data. The design of the questionnaire was informed by previous successful questionnaires such as the RELU FARMCAT questionnaire which examined the role of various farm and farmer factors in the environmental performance of specific ELS options (EF2 and EF4; see McCracken et al., 2015).

The questionnaire was developed and piloted over the summer of 2015 during which time SCU (Defra Survey Control Unit) approval was also sought and gained as well as approval of the research ethics committee of the College of Social Science and International Studies of the University of Exeter. A copy of the questionnaire and covering letter are in Appendix A2, although it should be noted that the version of the questionnaire actually used in the field is embedded within Excel. The use of Excel served multiple purposes: it allowed the majority of data (particularly emerging from closed questions) to be recorded directly into the spreadsheet during the interview, saving time on post-interview data entry; it included data validation, which had the advantage of excluding data entry errors; and it was password protected and prepopulated with the options data on which some questions were based; this aimed to save time and increase the smoothness of the interview.

Figure 2.2 Grouping of agreement sites for agreement holder interviews

The survey was undertaken by 8 interviewers (4 from the University of Exeter and 4 from Newcastle University), all of whom received training in the use of the questionnaire and the spreadsheet, as well as a briefing on the background to the project and the HLS scheme. Every effort was made to make the interview process as efficient as possible for both the agreement holder and the interviewer. The questionnaire was piloted with agreement holders

at 1 farm and 1 non-farm site, both in Devon. These were chosen to reflect the diversity of the sample (i.e. a mixture of farms and non-farms, including Nature Reserves, educational institutes etc.). Neither of the pilot agreement holders were in the research sample. Following the pilot interviews and feedback from the pilot agreement holders, the number of questions was reduced (see below) and the structure of the questionnaire streamlined. Following these amendments, interviews could be conducted in or under 60 minutes.

Seventy agreement sites (Group 11, Figure 2.2) were allocated to the Newcastle team. The remaining sites were grouped to aid interview logistics and subsequently allocated to members of the Exeter team. Grouping them this way meant interviewers could base themselves in a central location for a period of time, reducing the number of journeys and time/expense incurred. It also allowed interviewers to offer agreement holders a variety of interview times during the days/weeks they were in the area.

Interviewers sent covering letters to agreement holders prior to contacting them by phone, allowing interviewers to reference the letter rather than 'cold calling'. Interviews were arranged at a time and location identified by the agreement holder. Most interviews were conducted at the agreement holder's home or office and typically took an average of 60 minutes, although depending on the agreement holder and the complexity of the agreement or farm/site, they ranged from 35 minutes to 2 hours. Agreement holders were reassured of anonymity and confidentiality in both the letter and subsequently, during phone contact; such assurances were key to recruiting many agreement holders.

2.2.2 Questionnaire content

The questionnaire included a mix of closed and open questions. It comprised 7 sections:

1. Business profile: An introductory section covering basic information about the farm business/site/institution/company
2. Respondent profile: A section focusing on the respondent in order to build a basic profile of them as the agreement holder
3. Previous engagement with independent environmental practices: This section focused on agreement holders' previous engagement with any independent environmental practices, i.e. done outside of the scheme. It intended to build a picture of the agreement holders' experience of and interest in environmental practices.
4. Previous engagement with environmental schemes: This sectioned focused on agreement holders' engagement with any previous/other environmental schemes
5. HLS application: A section focusing on agreement holders' experiences of and decision making relating to the HLS application process
6. Your HLS agreement: A section exploring the HLS agreement and looking in some detail at the priority options – as identified by NE – which make up the agreement (see below), as well as the outcome of the agreement.
7. The future: This section provided the agreement holders with the opportunity to reflect on the delivery of HLS, and sought to ascertain the likelihood of involvement in similar schemes or activities in the future.

In the interests of efficiency, many questions were supported by 'show cards' which allowed respondents to tick relevant answers from longer lists of options.

In many cases (where permission was granted by the agreement holder), the interviews were recorded using a digital recording device, allowing the interviewer to transcribe more open-ended responses post-interview. Where this was not possible, interviewers made handwritten notes, entering them into the spreadsheet after the interview.

Section 6 of the questionnaire looked at the level of *confidence in achieving IoS* and *ease of carrying out the management prescriptions* for all priority options (as identified by NE; Appendix A, Table A1).

The questionnaire then looked in greater detail at 2 'focus options' in the agreement. These were identified from the list of priority options for resurvey (as identified by NE). Where there were more than 2 priority options in an agreement, CEH reviewed the agreement and identified the two which were most pertinent to (i) the agreement and (ii) the research objectives. Originally, we had intended to address 3 focus options per agreement, however, following the pilot, this was reduced to 2 because of the limited time available. By addressing a 'focus option', agreement holders were able to discuss (in the form of open questions):

- Why the option was chosen
- Why they chose to locate the option where they did
- How confident they felt about achieving the IoS for the option and why
- How easy or difficult they found carrying out the management prescriptions for this option and why
- If there were any management issues associated with delivering the option

The survey was conducted between October 2015 and August 2016 (with a 4 week break from 27 May-23 June due to 'purdah'). A total of 137 face-to-face interviews were conducted representing an overall response rate of 80.1 per cent (Table 2.2). A total of 15 agreement holders (8.8 per cent) declined an interview; generally these agreement holders claimed to be too busy to be interviewed. A small number (5, 2.9 per cent) were not available when interviewers were in the area. These were added to a 'revisit list' and reviewed in August 2016. Given the geographical spread of these sites, the resources required to visit them and the number of interviews completed by that time, no revisits were arranged. A total of 13 agreement holders (7.6 per cent) could not be contacted, despite successful entry to the sites by the CEH team and multiple and extensive attempts by CRPR team members. Typically, this occurred when a tenant or someone using the land – who was able to grant access to the land for the ecological survey – did not know who the agreement holder was or was unable to contact them. This was more common in the non-farming context and in larger institutions, where agents were initially employed as the agreement holder and had since moved on/retired etc. One site (0.6 per cent), on the Isles of Scilly, was deemed too logistically difficult/expensive to access.

Table 2.2 Breakdown of response rate for agreement holder interviews

	Frequency	Percent
Interview carried out	**137**	**80.1**
Declined	15	8.8
'Maybe later'	5	2.9
Failed to contact	13	7.6
Logistically difficult	1	0.6
Total	171	100.0

The majority of agreement holders surveyed were farmers (108, 78.8 per cent). Of the remaining 29 agreement holders, 22 (16.0 per cent) were Nature Reserves and a further 7 (5.1 per cent) classed themselves as 'Other'.

As above, assurances of anonymity, confidentiality and independence from NE and Defra were central to achieving such a positive response rate. For this reason, direct quotes and references to agreements and agreement holders contained within the following analysis have been reviewed and where necessary, identifiable characteristics such as names, places and/or distinguishing details have been removed or generalised. Agreement holders have been allocated an arbitrary ID and will be referred to using this throughout the analysis, e.g. agreement holder 45.

2.3 Summary of approaches to statistical analyses of HLS survey data

Details of statistical analyses are given at the start of Sections 4 – 9, so the description here is a brief summary of the objectives and analytical approaches. For some aspects of analysis and reporting, HLS options were grouped into maintenance, restoration, creation and arable option types. These types and associated options are in Table 2.3 below.

2.3.1 Multivariate analyses of HLS vegetation data

Multivariate analyses of plant communities were carried out, both to explore the variation within the vegetation from baseline and resurvey datasets and to investigate the impact of HLS management by assessing whether consistent shifts in plant community composition have occurred for particular types of options. Vegetation data from all parcels surveyed were analysed, regardless of whether the FEP feature(s) present had changed between baseline and resurvey. This is because the method of assessment (quadrat or stop) is consistent across all types of features within a given option. Details of the multivariate analyses are in Sections 4.1.1 and 4.2.1.

Option type	HLS code	Code definition
Arable	HD6	Crop establishment by direct drilling (non-rotational)
Arable	HF11	6m uncropped, cultivated margins on arable land
Arable	HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)
Arable	HF13	Fallow plots for ground nesting birds
Arable	HF14	Unharvested, fertiliser-free conservation headland
Arable	HF2	Wild bird food mixture
Arable	HF20	Cultivated fallow plots or margins for arable flora (rotational or non-rotational)
Arable	HF4	Pollen and nectar flower mixture
Arable	HG6	Fodder crop management to retain or re-create an arable mosaic (rotational)
Arable	HG7	Low input spring cereal to retain or re-create an arable mosaic
Creation	HC10	Creation of woodland outside the LFA
Creation	HC14	Creation of wood pasture
Creation	HC21	Creation of traditional orchards
Creation	HC9	Creation of woodland in the LFA
Creation	HD7	Arable reversion by natural regeneration
Creation	HE10	Floristically enhanced grass margin
Creation	HE2	4m buffer strips on arable land (conventional
Creation	HE3	6m buffer strips on arable land (conventional)
Creation	HE6	6m of buffer strips on intensive grassland
Creation	HF7	Beetle banks
Creation	HJ3	Arable reversion to unfertilised grassland to prevent erosion or run-off
Creation	HJ4	Arable reversion to grassland with low fertiliser input to prevent erosion and run-off
Creation	HJ5	In-field grass areas to prevent erosion or run-off
Creation	HK13	Creation of wet grassland for breeding waders
Creation	HK14	Creation of wet grassland for wintering waders and wildfowl
Creation	HK17	Creation of semi-improved or rough grassland for target species
Creation	HK8	Creation of species rich semi natural grassland
Creation	HL11	Creation of upland heathland
Creation	HO4	Creation of lowland heathland from arable or improved grassland
Creation	HP8	Creation of inter-tidal and saline habitat on grassland
Creation	HQ5	Creation of reedbeds
Creation	HQ8	Creation of fen
Maintenance	HB11	Management of hedgerows of very high environmental value (both sides)
Maintenance	HB12	Management of hedgerows of very high environmental value (one side)
Maintenance	HC12	Maintenance of wood pasture and parkland
Maintenance	HC15	Maintenance of successional areas and scrub
Maintenance	HC18	Maintenance of high value traditional orchards
Maintenance	HC19	Maintenance of traditional orchards in production
Maintenance	HC5	Ancient trees in arable fields
Maintenance	HC6	Ancient trees in intensively managed grass fields
Maintenance	HC7	Maintenance of woodland

Table 2.3 HLS management options and associated option type, used in data summaries and analyses in Sections 3 – 8. Continued below.

Option type	HLS code	Code definition
Maintenance	HD10	Maintenance of traditional water meadows
Maintenance	HD3	Reduce cultivation depth
Maintenance	HD4	Management of scrub on archaeological sites
Maintenance	HD5	Management of archaeological features on grassland
Maintenance	HD9	Maintenance of designed/engineered water bodies
Maintenance	HF1	Management of field corners
Maintenance	HJ6	Preventing erosion or run-off from intensively managed improved grassland
Maintenance	HK10	Maintenance of wet grassland for wintering waders and wildfowl
Maintenance	HK15	Maintenance of semi-improved or rough grassland for target species
Maintenance	HK2	Permanent grassland with low inputs outside the LFA
Maintenance	HK3	Permanent grassland with very low inputs outside the LFA
Maintenance	HK5	Mixed stocking
Maintenance	HK6	Maintenance of species rich semi-natural grassland
Maintenance	HK9	Maintenance of wet grassland for breeding waders
Maintenance	HL2	Manage in-by grassland with low inputs (LFA land)
Maintenance	HL3	Manage in-bye pasture and meadows with very low inputs (LFA land)
Maintenance	HL6	Moorland rough grazing (LFA land)
Maintenance	HL7	Maintenance of rough grazing for birds
Maintenance	HL9	Maintenance of moorland
Maintenance	HO1	Maintenance of lowland heathland
Maintenance	HP5	Maintenance of coastal saltmarsh
Maintenance	HQ1	Maintenance of ponds of high wildlife value <100 sq m
Maintenance	HQ2	Maintenance of ponds of high wildlife value >100 sq m
Maintenance	HQ3	Maintenance of reedbeds
Maintenance	HQ6	Maintenance of fen
Maintenance	HQ9	Maintenance of lowland raised bog
Restoration	HC13	Restoration of wood pasture and parkland
Restoration	HC16	Restoration of successional areas and scrub
Restoration	HC20	Restoration of traditional orchards
Restoration	HC8	Restoration of woodland
Restoration	HD2	Take archaeological features out of cultivation
Restoration	HK1	Take field corners out of management outside the LFA
Restoration	HK11	Restoration of wet grassland for breeding by waders
Restoration	HK12	Restoration of wet grassland for wintering waders and wildfowl
Restoration	HK16	Restoration of semi-improved or rough grassland for target species
Restoration	HK7	Restoration of species rich semi natural grassland
Restoration	HL10	Restoration of moorland
Restoration	HL8	Restoration of rough grazing for birds
Restoration	HO2	Restoration of lowland heathland on neglected sites
Restoration	HO3	Restoration of forestry areas to lowland heathland
Restoration	HP2	Restoration of sand dunes
Restoration	HQ10	Restoration of lowland raised bog
Restoration	HQ4	Restoration of reedbeds
Restoration	HQ7	Restoration of fen

Table 2.3 continued. HLS management options and associated option type, used in data summaries and analyses in Sections 3 – 8. Continued below.

2.3.2 Change in habitat condition and plant assemblage variables at the option scale

Analyses were carried out on data from individual or pairs of related options, to test whether condition and plant community variables had changed between the baseline survey and resurvey, and whether any changes found were affected by agreement holder characteristics and geographical variables. HLS options analysed included examples applied to grassland, moorland, woodland and arable land. Results for other options, for which the datasets were too small for robust analysis, are presented in tables but were not analysed statistically (Section 5 and Appendix D).

Option scale analyses of change were carried out for habitat condition and the plant assemblage response variables calculated from quadrat and stop vegetation data, as summarised below in Table 2.4. Condition criteria vary with FEP habitat feature (Natural England, 2010). The majority of FEP habitat features were the same at resurvey as recorded in the baseline, and change in these conditions could be analysed quantitatively. However, a minority of FEP features changed between the baseline and resurvey, as would be expected for options where the objective was restoration or creation (e.g. in 15 parcels out of 150 parcels surveyed under option HK7, restoration of species rich semi-natural grassland). Results for parcels where the habitat feature did change, and hence the condition criteria differed between baseline and resurvey, are summarised (Section 5.2.1) but not included in the statistical analysis.

The group of plant response variables analysed varied depending on the objectives of the management option and the habitat to which it was applied – e.g. cover of sown species was relevant for some arable options, while species richness was used for analyses of grassland and woodland options. Covariates based on the agreement holder survey data (Section 2.3), geographical variables such as altitude and environment zone, and predictive panel appraisal scores of how well each agreement was designed (allocated during the baseline HLS project; (Mountford et al., 2013) were included in option scale analyses where appropriate, and are summarised in Table 5.2. Generalised linear mixed models were fitted where possible for analyses of change in condition and plant response variables, and generalised linear models for the less well replicated options (Crawley, 2007). The possible covariates for each response variable were assessed through an automated multi-model comparison process for each option or option pair. The final model for each option / response variable is presented and discussed in Section 4, along with more technical details of the analytical process.

The only exception to analysis of change between baseline and resurvey for option scale analyses was for arable options. These were typically being newly established during the baseline survey, and often comprised open soil or fresh sowings, hence baseline data were generally not gathered. In addition, as many of the HF12 plots surveyed were rotational, locations changed between baseline and resurvey, so analysing change would not have been a valid approach for this option. Data from all options were pooled for the analyses at agreement scale (Section 8).

Response variable	Response variable details	Scale of response variable	Data source
Species richness	Total higher plant species richness	Parcel	HLS ecological baseline and resurvey
Ellenberg N	Mean score calculated from Ellenberg fertility attribute for each species present, where possible weighted by percentage cover (quadrat data), not weighted for stop data	Quadrat / Stop	HLS ecological baseline and resurvey and PLANTATT scores for species[1]
Ellenberg R	Mean score calculated from Ellenberg reaction attribute (surrogate for pH) for each species present, where possible weighted by percentage cover (quadrat data), not weighted for stop data	Quadrat / Stop	HLS ecological baseline and resurvey and PLANTATT scores for species[1]
Ellenberg F	Mean score calculated from Ellenberg moisture attribute for each species present, where possible weighted by percentage cover (quadrat data), not weighted for stop data	Quadrat / Stop	HLS ecological baseline and resurvey and PLANTATT scores for species[1]
Grime C	Mean score calculated from competitiveness attribute for each species present, where possible weighted by percentage cover (quadrat data), not weighted for stop data	Quadrat / Stop	HLS ecological baseline and resurvey and CSR attributes for species[2]
Grime R	Mean score calculated from ruderality attribute for each species present, where possible weighted by percentage cover (quadrat data), not weighted for stop data	Quadrat / Stop	HLS ecological baseline and resurvey and CSR attributes for species[2]
Grime S	Mean score calculated from stress-tolerator for each species present, where possible weighted by percentage cover (quadrat data), not weighted for stop data	Quadrat / Stop	HLS ecological baseline and resurvey and CSR attributes for species[2]
Grazing score	Mean score calculated from grazing indicator attributes for each species present, where possible weighted by percentage cover (quadrat data), not weighted for stop data	Quadrat / Stop	HLS ecological baseline and resurvey and ADAS grazing scores for species[3]

Table 2.4 Response variables used in analyses of HLS resurvey and baseline field survey data (Sections 4, 5 and 8), continued below. [1](Hill et al., 2004), [2](Grime et al., 2007), [3] (Critchley et al., 1996).

Response variable	Response variable details	Scale of response variable	Data source
Sward height	Height of plant sward	Quadrat / Stop	HLS ecological baseline and resurvey
Grass to forb ratio	Ratio of cover of grass to forb species	Quadrat	HLS ecological baseline and resurvey
Cover of woody species	Cover of plant species defined as woody or semi-woody	Quadrat	HLS ecological baseline and resurvey and PLANTATT species attribute for woodiness[1]
Cover of negative indicator species	Percentage cover of negative indicators plant species, as defined for habitat feature in FEP handbook [4]	Quadrat / Stop	HLS ecological baseline and resurvey
Cover of pollinator friendly species	Percentage cover of plant species thought favourable to insect pollinators	Quadrat	HLS ecological baseline and resurvey and CEH database of pollinator friendly plant species[5]
Cover of sown species	Percentage cover of plant species sown as part of arable management options (cover in early winter for winter bird food option HF12)	Arable plot	HLS ecological baseline and resurvey
Seed depletion of sown species	Average seed depletion score for sown species weighted by DAFOR cover score, at two points over the winter	Arable plot	HLS ecological baseline and resurvey
Condition assessment	Condition of habitat feature to which HLS management option is applied, using criteria defined individually for each habitat feature in FEP handbook [4]	Parcel	HLS ecological baseline and resurvey
Indicator of success	Indicator of success, as defined in HLS agreement documentation, assessed as met, partially met or not met	Parcel	HLS ecological resurvey

Table 2.4, continued. Response variables used in analyses of HLS resurvey and baseline field survey data (Sections 4, 5 and 8). [1](Hill et al., 2004), [5](Pywell et al., 2015).

2.3.3 Analyses of IoS at resurvey of HLS agreements

Potential relationships between IoS data at the resurvey and agreement holder confidence in achieving IoS were assessed using Chi^2 tests for independence (Section 6.3). The relationship between baseline RAG assessments of IoS and IoS assessments made during the resurvey were also compared (Section 6.6).

2.3.4 Analyses of agreement holder survey data

2.3.4.1 Quantitative data analysis

Following the completion of the interviews, a master spreadsheet was compiled. The quantitative data were then entered into SPSS. Initially, we produced descriptive statistics on all variables (including frequency, means, standard deviation, range).

Where appropriate, we ran cross-tabulations (including chi-square tests of statistical significance) to identify potential associations between variables and agreement holder typologies (see below). A particular emphasis was put on the association between agreement variables (such as perceived success of the agreement, attitude towards the scheme and likelihood of continuing a similar scheme in the future) and socio-demographic variables such as age, farm/non-farm status, agreement holder's role, educational attainment and so on.

Whilst a large part of the analysis focuses on the agreement level, in recognition of the fact that individual agreements can differ significantly, a proportion of the analysis focuses on specific options. However, analysis of each individual option was untenable, because of the large number of different options across the 137 agreements surveyed, and often any one option was being utilised by very few participants. In order to present some meaningful analysis options were grouped into broad categories of 'maintenance', 'creation', 'restoration' and arable option groups, depending on their purpose. The allocation of options to each of the groups was conducted by CEH. Rotational or transitory arable options were allocated to the arable grouping, whilst the one arable option (HE10 Floristically enhanced grass margin) was allocated to the 'creation' group because it remains in place for the duration of the agreement.

2.3.4.2 Qualitative analysis

The whole fieldwork spreadsheet (including quantitative data) was imported into qualitative data analysis software, QSR NVivo 11, as a dataset. NVivo was used to perform thematic analysis, understood as a process of identifying, analysing and reporting patterns in qualitative data (Bryman, 2012).

Each of the responses to open questions was coded; with key themes emerging from the text informing the creation of individual nodes. Each agreement holder's responses to each open question was read through thoroughly, and where salient words, lines, sentences or passages were identified, they were coded to a succinct label (a 'node'), according to the topic (see (Saldana, 2009). In line with Saldana's understanding, a code was understood as something that "symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute" (Saldana, 2009: 3). Nodes were stored in a hierarchical structure. Where necessary, as the coding framework evolved, new nodes were created, merged and renamed.

The emergent coding framework was formulated using an inductive approach, which involved the researcher deriving meaningful themes from the data; identified themes were strongly linked to the data themselves – or 'data driven'. The coding framework and their populations (i.e. the number of references to that specific node) were then examined, and where relevant grouped together, refined, combined or discarded to create a final list of nodes.

Given the qualitative nature of analysis, researcher judgement was used to perform the coding. Although the existence of the theme was not dependent on specific quantitative criteria, a strategy often deployed in thematic analysis, (i.e. had to be mentioned by 3 or more agreement holders), themes were decided on according to their general prevalence across the question *and* their relevance to the research objectives.

As well as coding transcript content, NVivo allowed qualitative responses to be organised and presented according to the responses to closed questions. For example, a list of the qualitative/open question responses for agreement holders who claimed to have 'Complete control' over their agreement design could be produced. Similarly, it allowed for answers to open questions to be presented according to socio-demographic attributes, such as age, number of years in charge of agreement or highest level of educational attainment, among other attributes. This allowed nodes (or more specifically text coded to each node) to be grouped according to these attributes, specifically using a series of Advanced Coding Queries and Matrix Coding Queries. Emerging patterns formed a significant part of the qualitative data analysis, showing broad patterns in ways of thinking and attitudes according to these characteristics. Arguments and conclusions were developed using these patterns as a starting point.

2.3.4.3 Development of the typologies

As detailed below, typologies used in both the ecological and social science elements of this research were devised from a combination of the qualitative and quantitative responses to the survey. Where typologies were devised from entirely quantitative data (Experience and Commitment typologies) there were no borderline cases. Where qualitative data was used (Motivation and Concern typologies) some cases emerged as borderline or open to a degree of interpretation. Borderline cases were highlighted and notes were made on their categorisation; following this, the cases and their notes were reviewed by social scientists on the team. Examples of notes made on borderline cases are given below.

1. Experience typology

The experience typology was devised entirely from quantitative data. It combined the number of previous formal schemes, as well as whether they had participated in any independent/informal agri-environment work. Agreement holders were allocated to one of 4 groups depending on their levels of experience, ranging from 'extensive experience' to 'no previous experience'.

2. Motivation typology

The motivation typology was devised from qualitative responses to the question 'Why did you decide to join HLS?'. As above, the responses to the question were read through and

responses coded to individual motivation nodes according to their content. For example, nodes included 'financial motivation', 'persuaded by 3rd party' and 'wildlife & biodiversity benefits'. A total of 21 parent nodes were created and were subsequently grouped under 4 key motivation types, including (1) financial (2) practical or fit with existing system (3) continue environmental work and (4) altruistic motivations. Where an agreement holder had more than one motivation, an assessment of their motivation type was made by drawing on the whole transcript and identifying the overall motivation from all of their responses. A total of six borderline cases were identified in the motivation typology data. These cases were revisited and revised where necessary.

3. Concern typology

The concern typology was devised from qualitative responses to two questions: 'Are the management prescriptions right for your land? Please explain' (Q34) and 'Do you have any suggestions for improvement of the scheme?'. As with the motivation typology, the responses to the questions were read through and responses coded to concern nodes according to their content. For example, 'flexibility issues', 'paperwork and red tape' and 'problems with RPA'. A total of 55 parent nodes were created and were subsequently grouped under 3 key concern types, including (1) lack of flexibility and opportunity for flexibility (2) more contact with NE needed and (3) administration and application problems, as well as a 'no concern' group.

A total of 20 borderline cases were identified within the Concern typology. As above, these were flagged and their whole transcript examined. The notes made on the transcript were then used by the research team to review and where necessary revise the categorisation.

The borderline case of AH40 is offered here as an example:

> **Answer to Q34:** This is the problem, for such a complicated site, it is really really hard because for example, the HLS prescriptions don't make reference to the SAC site features and the SAC site features on there are particularly sensitive, these are the white beak sedge bog pools on [……] and if you over graze, you damage those ... and yet they are the main international site features, so whatever you don you don't wanna damage those but then the compromise is, perhaps the sward height of some of the mire vegetation ... so it's very difficult to get prescriptions right so there's always a danger that we get pulled up because RPA carry out an inspection in a tickbox way, you know 'you're not getting your sward height right' but one would hope, and this is where it's so important to have this understanding when the prescriptions are being done, that there is sufficient wording in the prescriptions that gives flexibility so that in an attempt to deliver the HLS you're not compromising the site features
>
> **Answer to Q62:** There seems to be a trend, I know it's not the local NE team's fault - it's a restriction on time and resources but it is vital that discussion with local advisors. What is tending to happen … we never know to one week to the next what NE advisor we are going to have. What happens, whenever an NE advisor changes, it precipitates a site meeting where they come out and want to familiarise themself with the site and then in a few months time, the same thing happens - you can't call that an efficient use of resources, can you? More visits and not so overstretched

Notes made: Could be 1 (Lack of flexibility & opportunity for flexibility) but they stated the management prescriptions do 'partly' fit (see Q34 – Management prescriptions right for the land?) what is a very complex site, therefore I think the issue of turnover of NE staff which they claim "precipitates a site meeting where they come out and want to familiarise themselves with the site and then in a few months' time, the same thing happens" is the more prominent issue. Therefore I am recommending category 5 (More contact with/input from NE needed).

Following discussion this category was agreed.

4. Commitment typology

The commitment typology was devised entirely from quantitative data. It combined binary responses from the following questions:

1. Q24. What was your attitude before entering into HLS?
    - Positive response: Definitely wanted to do it
    - Negative response: Indifferent/did not want to do it
2. Q63. What is the likelihood of continuing similar scheme in the future?
    - Positive response: Definitely & quite likely
    - Negative response: Unsure & definitely not
3. Q65. What is the likelihood of continuing environmental work in the absence of a scheme?
    - Positive response: Definitely & quite likely
    - Negative response: Unsure & definitely not

Each positive response was allocated 1 point, with a maximum of 3 points per agreement holder. Depending on the score (0-3), Agreement holders were allocated to the following groups (1) High commitment (3 points) (2) Intermediate commitment (2 points) and (3) Low commitment (0-1 points).

To ensure the typologies derived from the data were internally consistent, we cross-tabulated them against socio-demographic data from the wider survey in order to identify any human errors in the typology allocation. Following the formulation of the typologies, they were used as a variable in the quantitative analysis.

2.3.5 Integrated analyses of ecological survey data and agreement holder survey data at the agreement scale

Individual HLS agreements contain varying suites of management options, applied to varying broad habitats and features. Many of the response variables calculated from quadrat and stop data (Table 2.4 above) depend on the plant communities from which they are derived, and so the full range of botanical variables were not appropriate for analyses comparing agreements which contain different habitats. The condition assessments and the IoS were used in analyses of environmental outcomes across all HLS agreements surveyed, as they were considered more independent of management option and habitat identity than the response variables derived from quadrat data. Indicators of success data were only available from the current HLS resurvey, so IoS were not analysed in the context of change since baseline.

A limited number of plant variables (species richness, Ellenberg fertility, Ellenberg reaction, Ellenberg moisture) were considered relevant across habitats, and these were analysed across all agreements, with the broad habitat identity included to assess differences between habitats. These analyses also allowed direct comparison with the botanical response variables analysed in the counterfactual assessment (below and Section 9), for which outcomes such as condition assessment and IoS were not available. Further details of these analyses are in Section 8, including the covariates which were included in the analyses (Table 8.1).

2.3.6 A counterfactual analysis of Countryside Survey and National Plant Monitoring Scheme data

Ideally, a counterfactual comparison would have been made of the HLS agreements, using data collected in the same years on farmland that was not being managed under Environmental Stewardship. However, non-agreement farmland was not sampled in the current project and no widespread surveys of farmland at a national scale were available over a similar timescale to the current HLS resurvey. A counterfactual comparison was carefully constructed using data from Countryside Survey collected in 2007 (Carey et al., 2008) and National Plant Monitoring Scheme (http://www.npms.org.uk/) data collected in 2015 and 2016. Every effort has been made to ensure that the data used from these two datasets are as comparable as possible, including consideration of the broad habitat categories covered and the methods used (further technical details in Section 9). Nonetheless, a counterfactual constructed with data from two different sources cannot be directly comparable to the HLS survey data, which were collected on the same agreements and parcels using the same methods in the baseline survey and resurvey. Results and discussion, including an analysis of the limitations of this type of counterfactual comparison, are given in Section 9.

3. Changes in mapped habitats under Higher Level Stewardship management

Mapping effort during the resurvey focussed on detecting areas where habitat type or condition had changed since the baseline. Key questions addressed by the mapping were:

Did habitats change in extent between baseline and resurvey?

Did changes in habitat extent differ between option types?

Most habitats had not changed substantially between the baseline and resurvey (Figures 3.1 – 3.3). Discussion below on habitat changes (Sections 3.1 – 3.5) should be interpreted in the context that the majority of broad and priority habitat areas surveyed under HLS management have not changed.

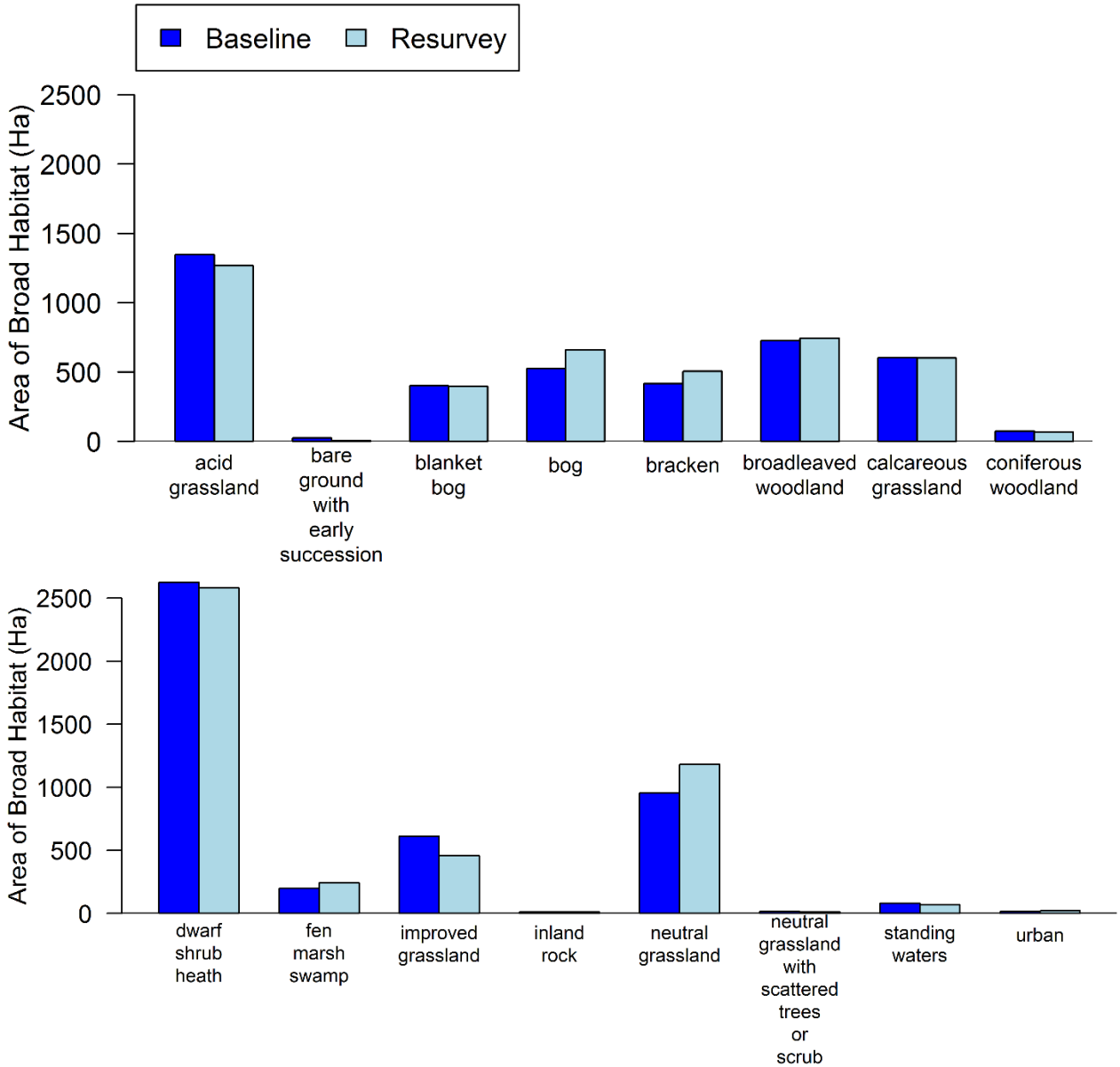

Figure 3.1 Area (hectares) of broad habitat categories of land under Higher Level Stewardship management surveyed in the baseline (2009 – 2011; dark blue) and resurvey (2015 – 2016; pale blue). Broad habitats where <10ha were surveyed are not included.

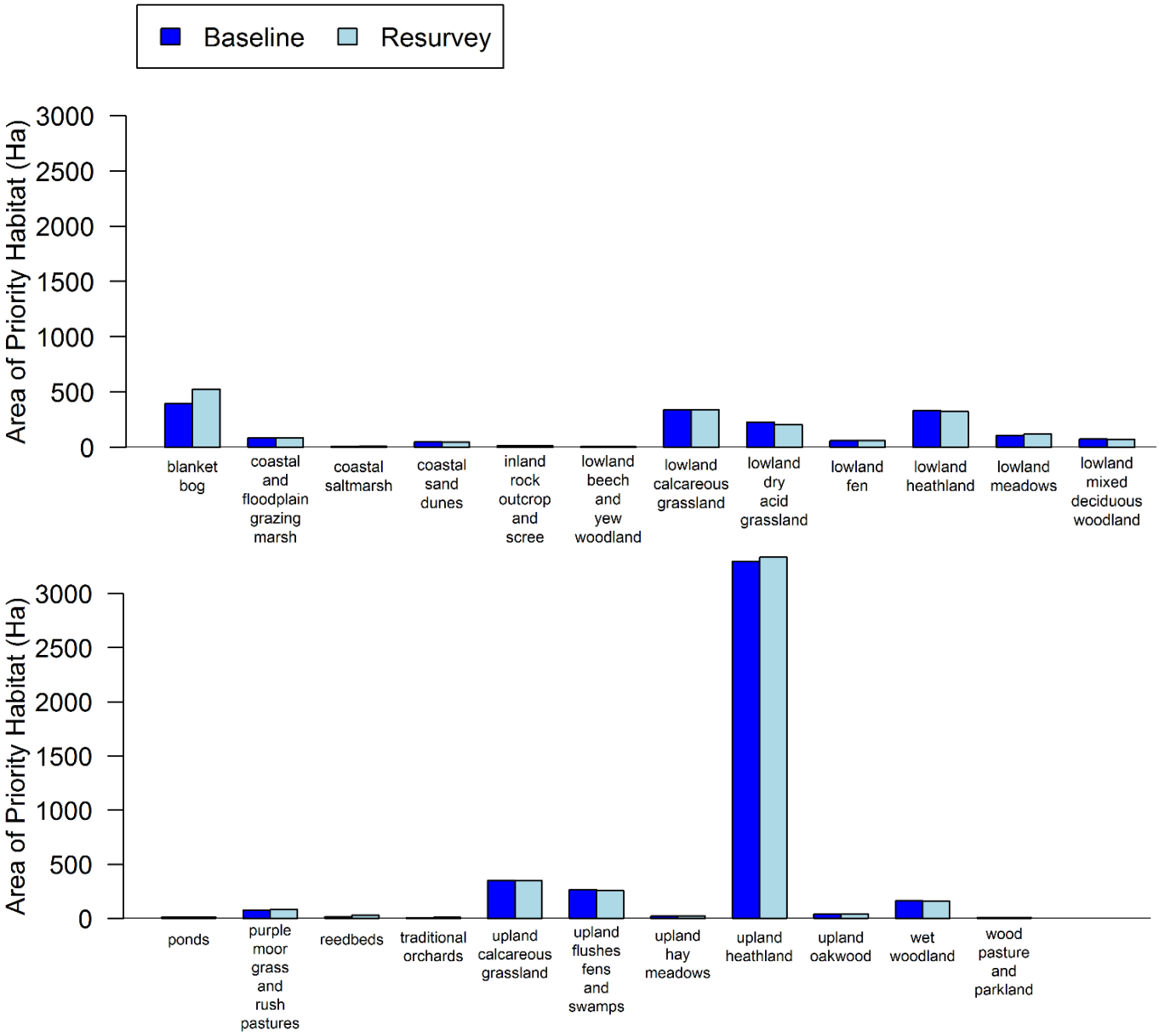

Figure 3.2 Area (hectares) of priority habitats surveyed in the baseline (2009 – 2011; dark blue) and resurvey (2015 – 2016; pale blue) of land under Higher Level Stewardship management. Priority habitats where <5ha were surveyed are not included.

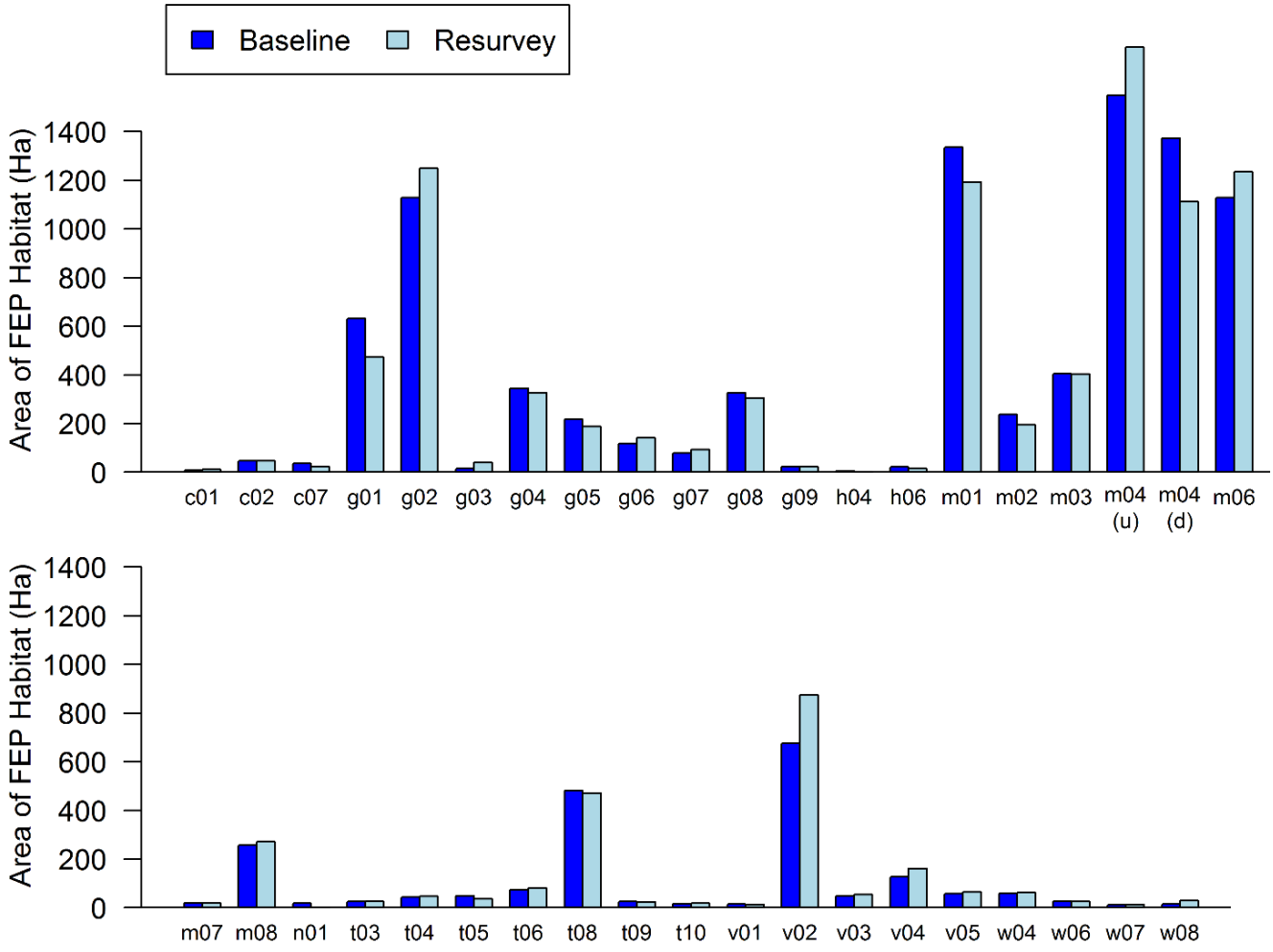

Figure 3.3 Area (hectares) of habitats classified by Farm Environment Plan (FEP) feature, surveyed in the baseline (2009 – 2011; dark blue) and resurvey (2015 – 2016; pale blue) of land under Higher Level Stewardship management. See Table 3.1 for a description of habitat feature codes. M04 (d) = dry upland heath, M04 (u) = undefined upland heath. Habitat features where <5ha were surveyed are not included.

FEP feature code	FEP feature description
C01	Coastal salt marsh – BAP habitat
C02	Coastal sand dunes – BAP habitat
C07	Saline lagoons – BAP habitat
G01	Improved grassland
G02	Semi-improved grassland
G03	Species-rich grassland
G04	Lowland calcareous grassland – BAP habitat
G05	Lowland dry acid grassland – BAP habitat
G06	Lowland meadows – BAP habitat
G07	Purple moor-grass and rush pastures - BAP habitat
G08	Upland calcareous grassland – BAP habitat
G09	Upland hay meadows – BAP habitat
H04	Large-scale archaeological feature
H06	Historic water meadow
M01	Grass moorland and rough grazing
M02	Fragmented heath
M03	Lowland heathland – BAP habitat
M04	Upland heath – BAP habitat
M06	Blanket bog – BAP habitat
M07	Upland cliffs and screes
M08	Upland valley mires, springs and flushes
N01	Land at risk of generating diffuse pollution
T03	Wood pasture and parkland - BAP habitat
T04	Broadleaved plantation
T05	Conifer plantation
T06	Mixed woodland
T08	Native semi-natural woodland
T09	Lowland beech and yew – BAP habitat
T10	Lowland mixed deciduous woodland
V01	Bank-side vegetation
V02	Bracken
V03	Rank vegetation
V04	Scrub
V05	Scrub of high environmental value
W04	Fens – BAP habitat
W06	Mesotrophic lakes – BAP habitat
W07	Pond
W08	Reedbeds – BAP habitat

Table 3.1 Farm Environment Plan (FEP) habitat feature descriptions, taken from Farm Environment Plan handbook (Natural England, 2010).

3.1 Changes to broad habitats between HLS baseline survey and resurvey

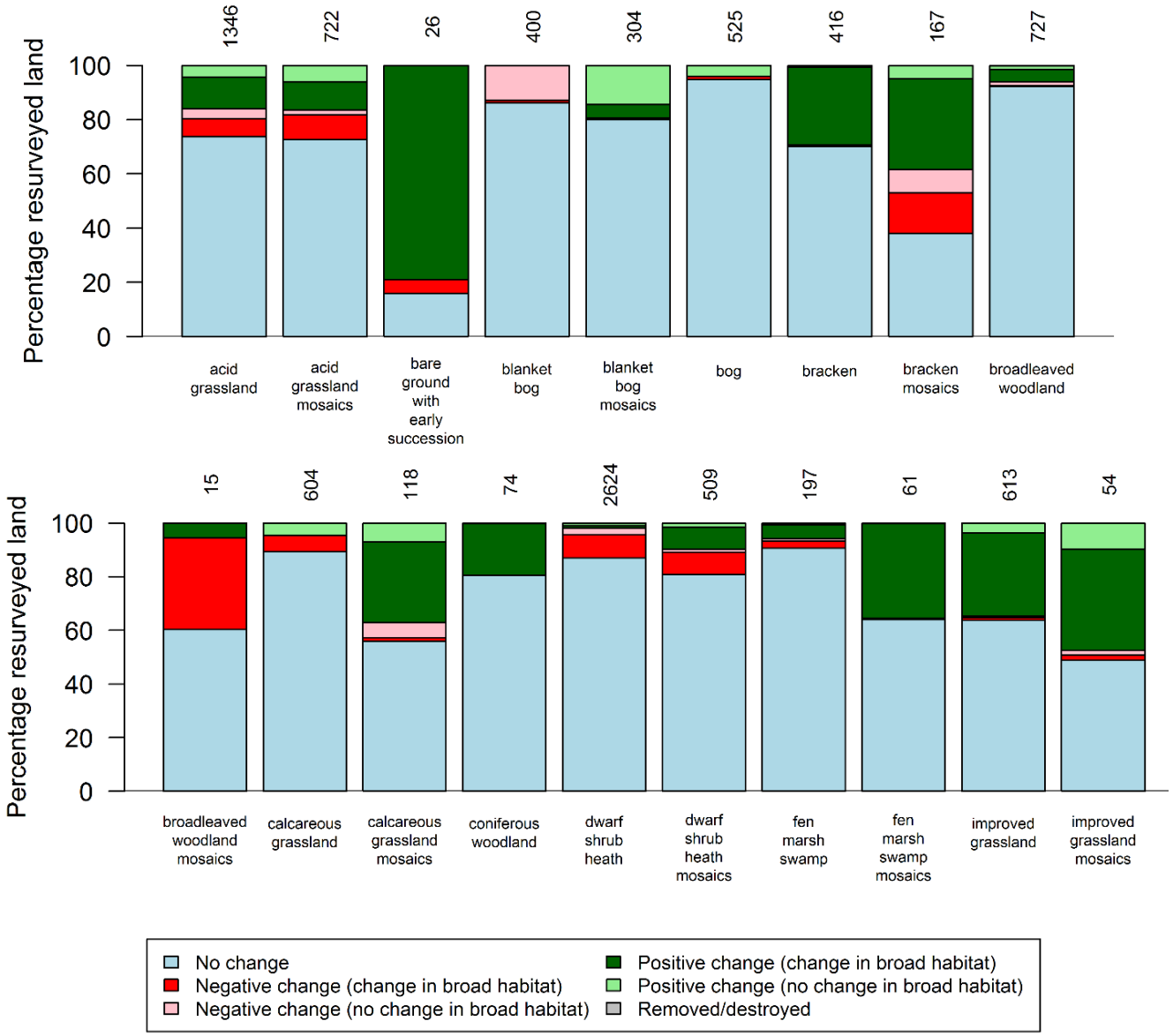

Figure 3.4 Changes in extent and condition of broad habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under Higher Level Stewardship management. Blue = no change, pink = negative change in condition but not extent of habitat, red = negative change in condition and extent, pale green = positive change to condition but not extent, dark green = positive change to condition and extent of habitat. Area surveyed in hectares given above each bar. Habitat categories showing no change are not included.

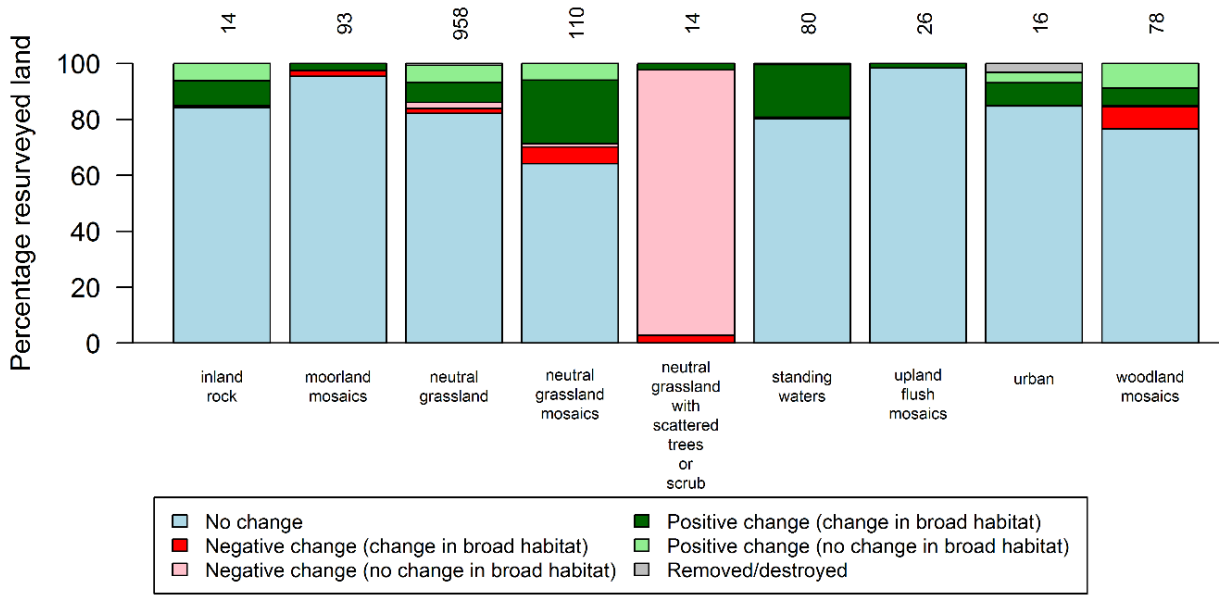

Figure 3.4 continued. Changes in extent and condition of broad habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under Higher Level Stewardship management. Blue = no change, pink = negative change in condition but not extent of habitat, red = negative change in condition and extent, pale green = positive change to condition but not extent, dark green = positive change to condition and extent of habitat. Area surveyed in hectares given above each bar. Habitats showing no change are not included.

The most extensive broad habitats mapped show relatively little change, with 70-90 percent of acid grassland, dwarf shrub heath, neutral grassland and the arable and horticulture categories showing no change in habitat extent or broad habitat condition (Figure 3.4). Changes in broad habitat extent or condition generally related to small areas. For example, neutral grassland with scattered trees or scrub shows the biggest decline in condition, and where this broad habitat changed category it was to bracken or broadleaved woodland (Figure 3.5). Such negative change may be due to a failure to control succession, leading to increased dominance of bracken, scrub and woodland species, though only 14 ha of this habitat was surveyed. Similarly, a small area (15ha) of broadleaved woodland mosaics was surveyed, of which about 30% showed a negative change in extent. The habitat with the largest positive change in extent was bare ground with early succession, the majority of which developed into neutral grassland between the baseline and resurvey.

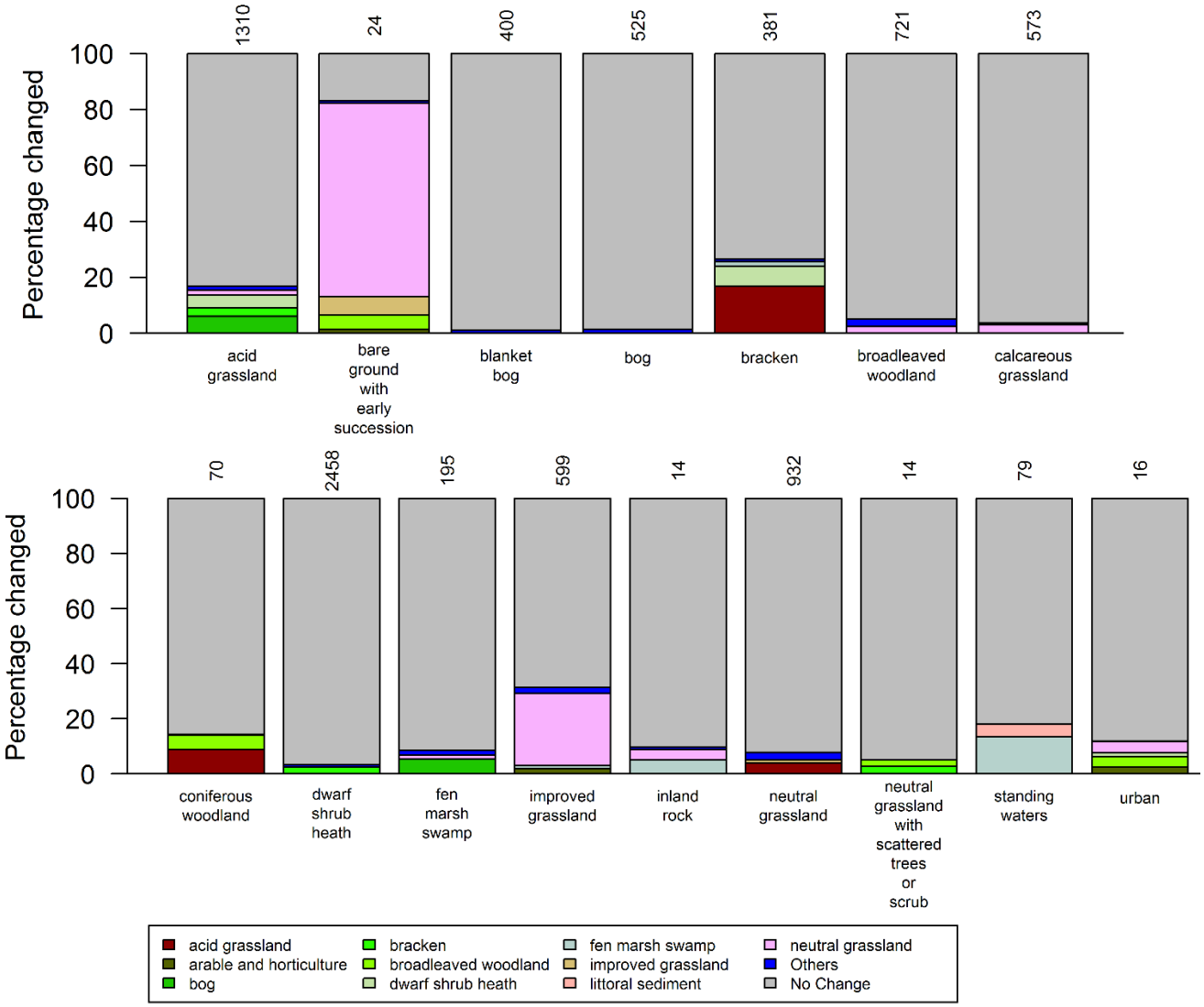

Figure 3.5 Transitions between broad habitat categories between baseline survey (2009-2011) and resurvey (2015-2016) of land under Higher Level Stewardship management. Habitats listed along x axis are baseline broad habitats, habitats in legend box are resurvey broad habitats. Area surveyed in hectares given above each bar. Habitats showing no change are not included.

3.2 Changes to priority habitats between HLS baseline survey and resurvey

The majority of priority habitat surveyed showed no change in extent or condition (Figure 3.6). Where changes were recorded, these were predominantly positive for the majority of priority habitat categories. The exceptions were lowland dry acid grassland, lowland heathland and lowland meadows, where there was some evidence for decline in extent and / or condition. For lowland dry acid grassland, negative changes were linked to a shift to tall, coarse or rank grassland. For all three of these priority habitats, where the extent was reduced this was due to loss of priority habitat, rather than change to another priority habitat (Figure 3.7). Both the lowland meadows and lowland dry acid grassland priority habitats were identified in the report on the baseline survey as including examples of relatively poorly targeted habitat, where the condition originally allocated in the Farm Evaluation Plan was

overly optimistic (Mountford et al., 2013), as discussed further in condition analyses (Section 5.2).

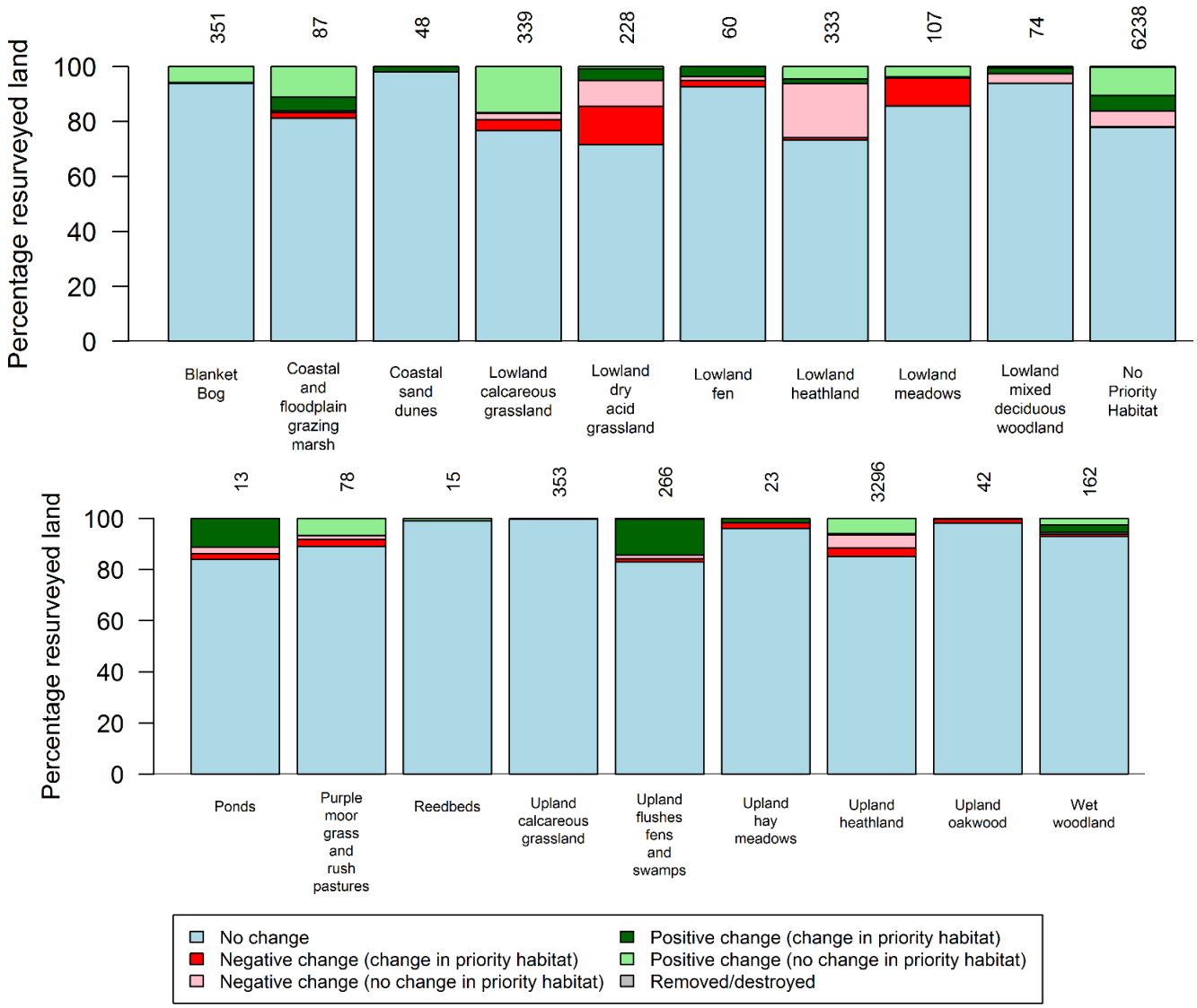

Figure 3.6 Changes in extent and condition of priority habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under Higher Level Stewardship management. Blue = no change, pink = negative change in condition but not extent of habitat, red = negative change in condition and extent, pale green = positive change to condition but not extent, dark green = positive change to condition and extent of habitat. Area surveyed in hectares given above each bar. Priority habitat categories showing no change are not included.

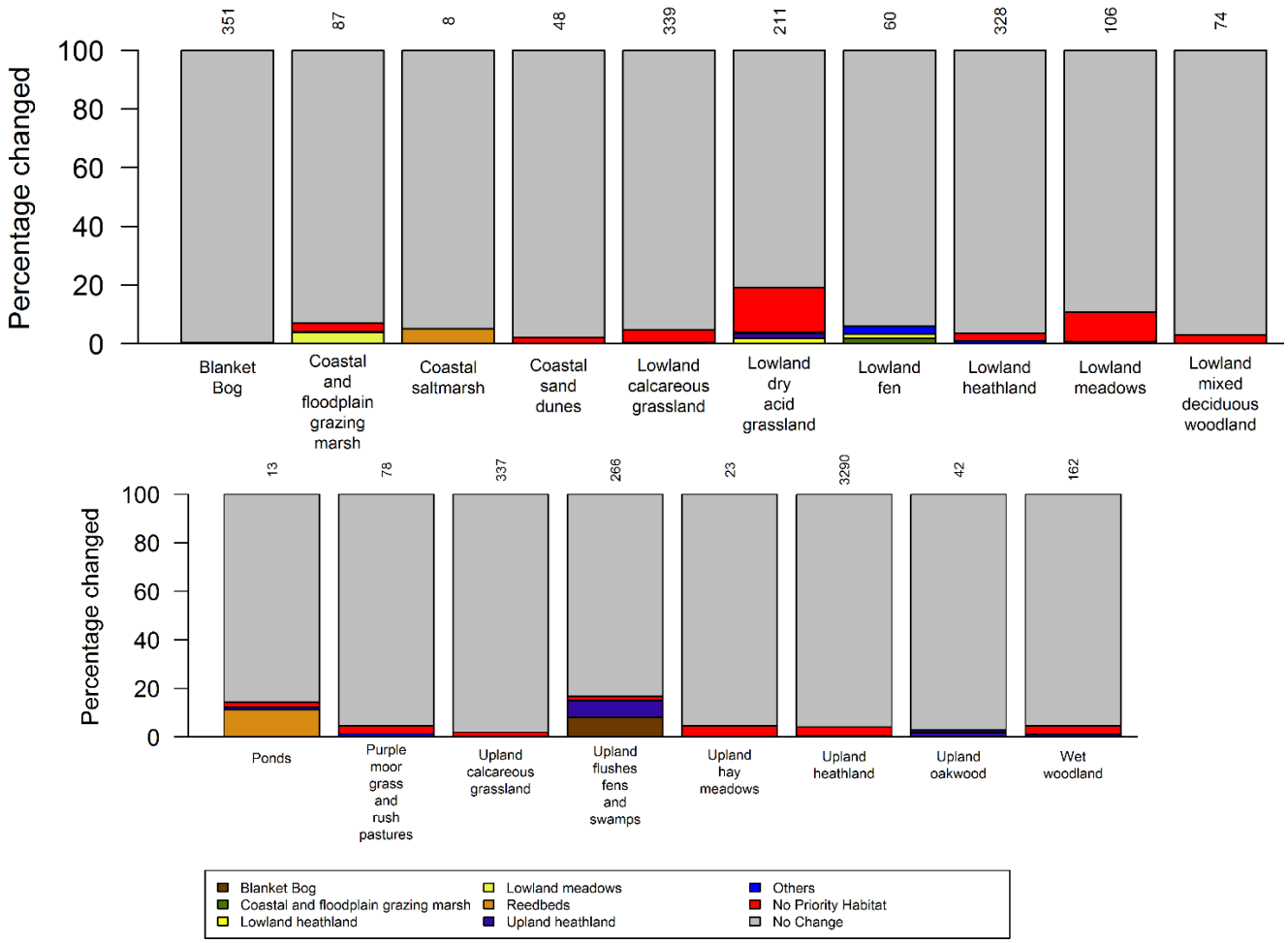

Figure 3.7 Transitions between priority habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under Higher Level Stewardship management. Habitats listed along x axis are baseline priority habitats, habitats in box are resurvey priority habitats. Area surveyed in hectares given above each bar. Priority habitats showing no change are not included.

3.3 Changes to mapped habitats by option groups between HLS baseline survey and resurvey

Land under arable options is not included in the option graphs, as many of the arable options surveyed were rotational, and so their location differed between the baseline and resurvey. Results of analyses of the condition and plant community variables for arable options are given in Chapter 5, along with other habitats. Additional maps showing changes to more option groups (HC, HO and HQ) and FEP feature habitats are presented in Appendix A of this report.

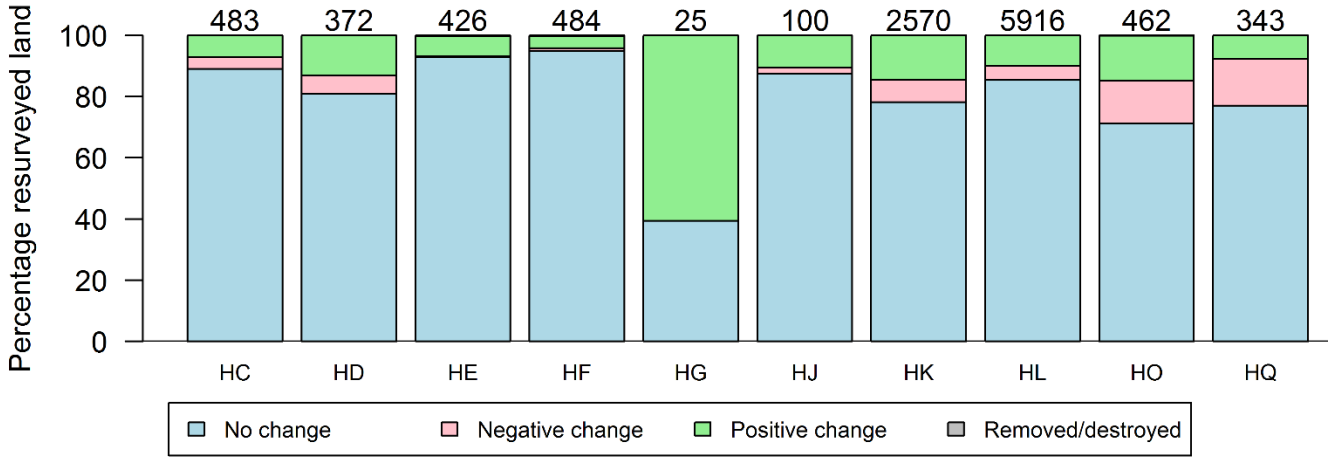

Figure 3.8 Changes in condition of habitats under HLS option code groupings between baseline (2009-2011) and resurvey (2015-2016) of land under Higher Level Stewardship management. For definitions of HLS codes see Table 2.3. Pink = negative change in condition (but not necessarily extent) of habitat under option, pale green = positive change to condition (but not necessarily extent), grey = areas destroyed or removed. Area surveyed in hectares given above each bar. Habitat categories showing no change are not included.

In common with the habitat categorisations above (Sections 3.1 - 3.3), the extent of land showing positive change under options groupings was larger than the extent of land showing negative change. The largest areas of land surveyed were under the HK grassland option group, and the HL ('moorland and rough grazing for birds') option group. Within the HK grassland options, the largest percentage change was between broad habitat categories were from improved grassland to neutral grassland (Figure 3.9). In the HL option categories, the largest percentage changes between broad habitat were all towards acid grassland, from neutral grassland, bracken and broadleaved woodland. The next largest group of changes were towards bog, from both fen, marsh and swamp and acid grassland. In the largest broad habitat categories surveyed in both option groups (neutral grassland and calcareous grassland for HK options, dwarf shrub heath and acid grassland for HL options), over 80% of habitat remained in the same broad habitat category between surveys.

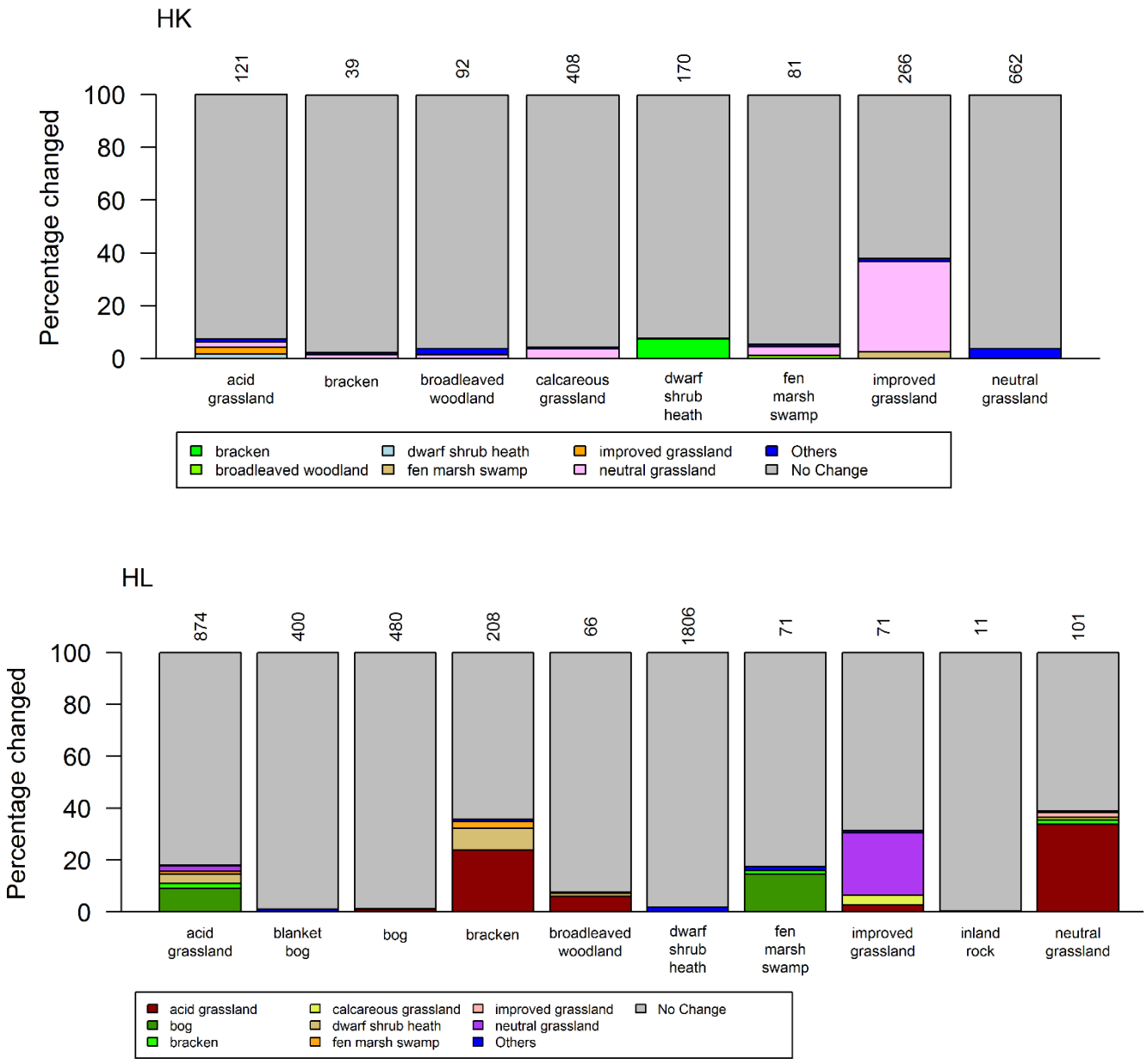

Figure 3.9 Transitions between broad habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under grassland (HK) and moorland (HL) option groups. Habitats listed along x axis are baseline broad habitats, habitats in legend box are resurvey broad habitats. Area surveyed in hectares given above each bar.

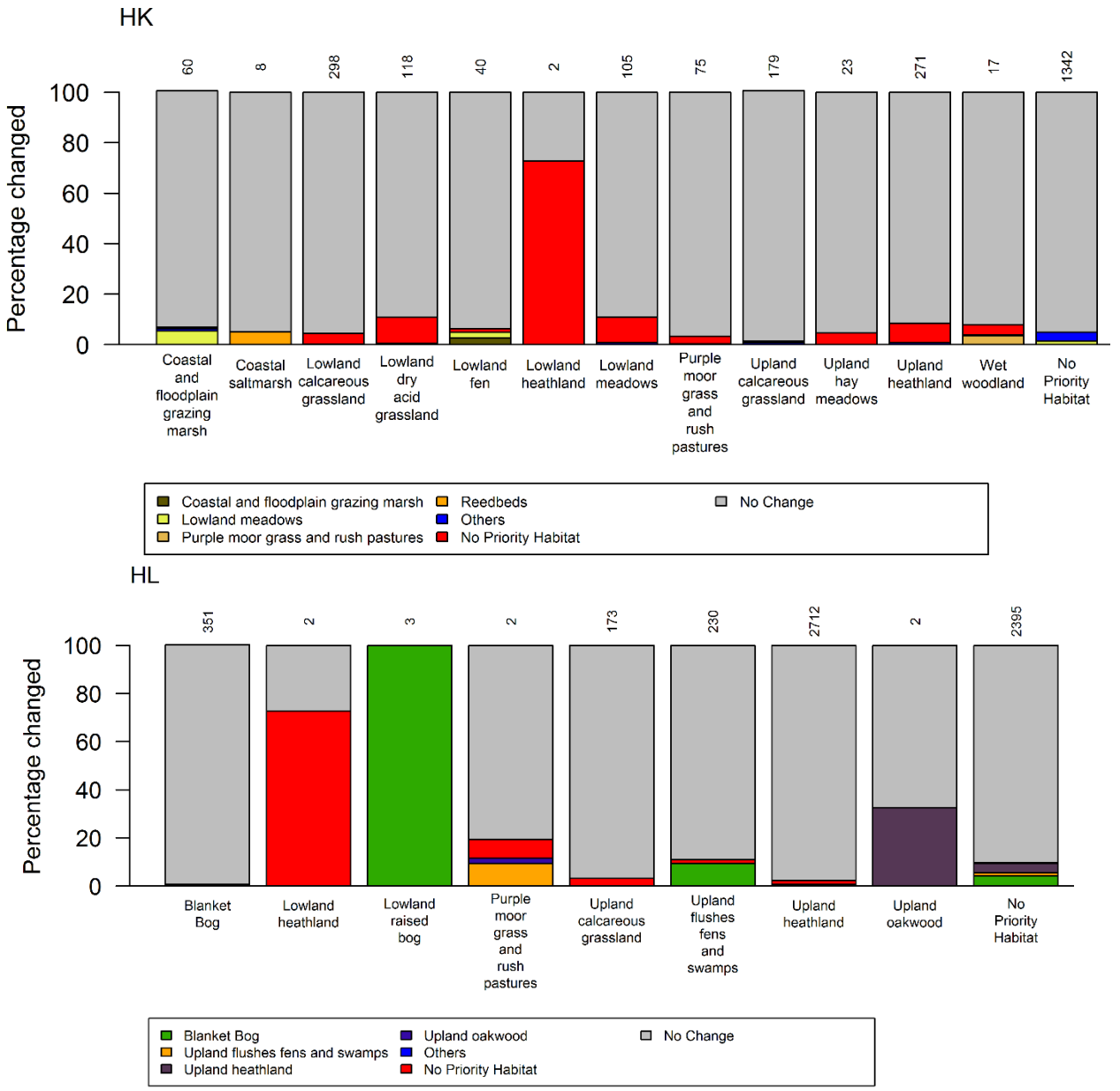

Figure 3.10 Transitions between priority habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under grassland (HK) and moorland (HL) option groups. Habitats listed along x axis are baseline priority habitats, habitats in legend box are resurvey priority habitats. Area surveyed in hectares are above each bar.

Most of the changes to priority habitats under HK and HL options (Figure 3.10) were due to a loss of priority habitat rather than a shift to another priority habitat type, as discussed above. Some movement between priority habitats were recorded in the resurvey; within HL options these were mainly changes to blanket bog and to upland heathland, involving small areas (<3 ha). An apparent shift from lowland raised bog to blanket bog under restoration options (Figure 3.11 below), may be partly due to a difference in interpretation and attribution of the two bog habitats between surveyors.

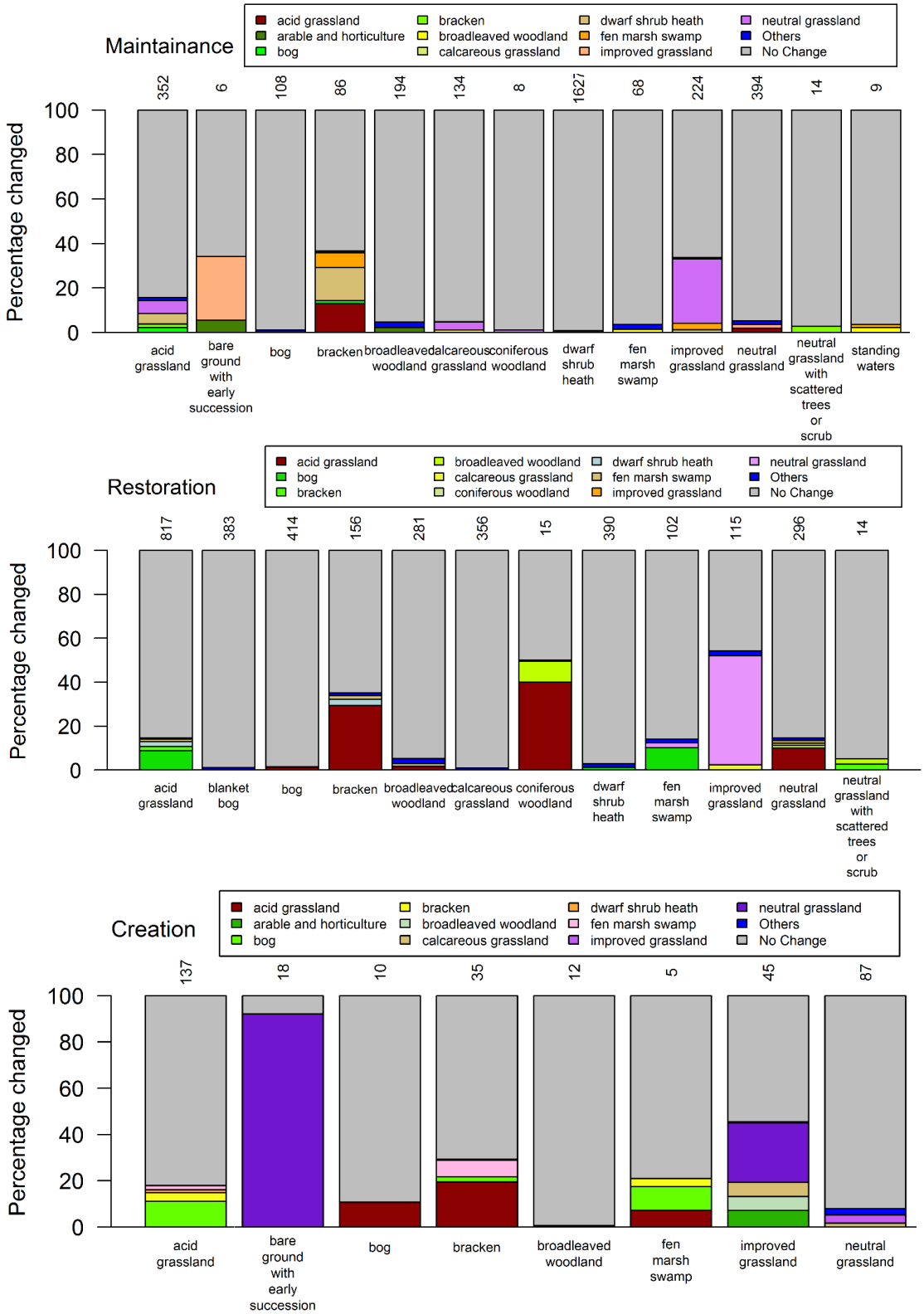

Figure 3.11 Transitions between broad habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under maintenance, restoration and creation option types. Habitats listed along x axis are baseline broad habitats, habitats in legend box are resurvey broad habitats. Area surveyed in hectares given above each bar.

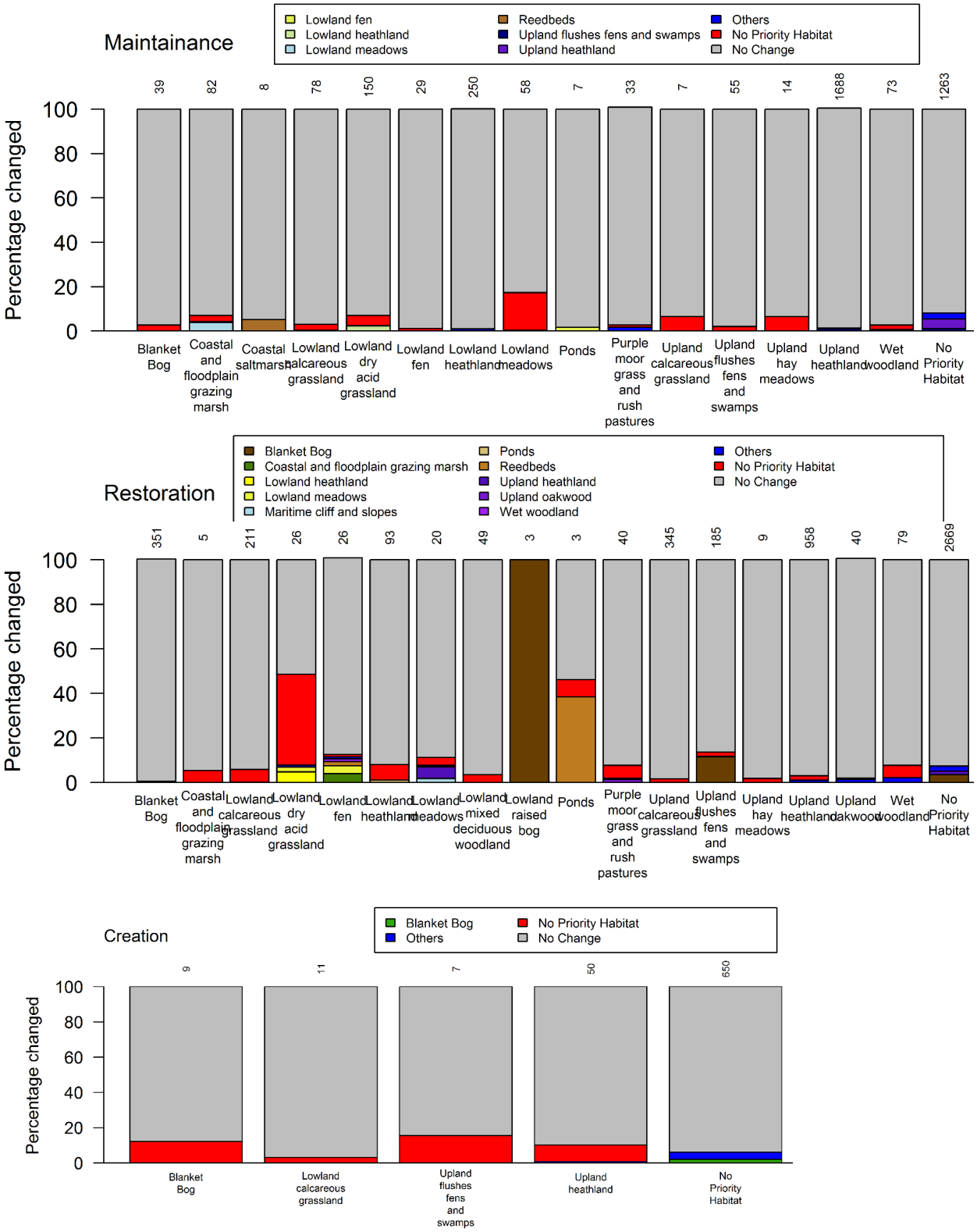

Figure 3.12 Transitions between priority habitat categories between baseline (2009-2011) and resurvey (2015-2016) of land under maintenance, restoration and creation option types. Habitats listed along x axis are baseline priority habitats, habitats in legend box are resurvey priority habitats. Area surveyed in hectares are above each bar.

In some broad habitat categories there were larger changes between baseline and resurvey among creation and restoration than maintenance options (e.g. neutral grassland and coniferous woodland, Figure 3.11), this would be expected given the aims of these options

groupings to facilitate change. Only a small proportion of the 'no priority habitat' category under creation options (Figure 3.12) had developed into a priority habitat by the resurvey, which suggests many cases longer time scales than the 5-7 years which elapsed between baseline and resurvey are needed in order to create new priority habitat (e.g. as previously shown for calcareous grassland; Fagan et al., 2008).

3.4 Changes to linear habitats between HLS baseline survey and resurvey

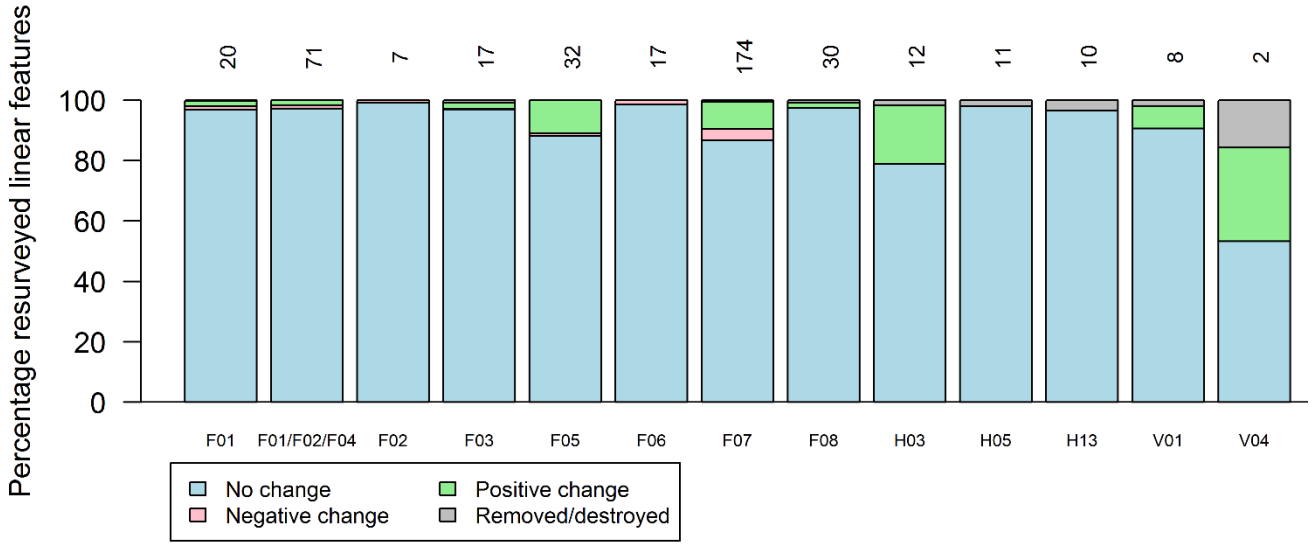

Figure 3.13 Transitions between linear features as defined by Farm Environment Plan categories, between baseline (2009-2011) and resurvey (2015-2016) of land under Higher Level Stewardship management. See Table 3.2 for descriptions of linear feature codes. Lengths surveyed in kms are given above each bar.

There was almost no change to linear features between baseline and resurvey, except for a very slight loss of H13 (fence/railing of historic or landscape importance) and a very small deterioration in condition of some stone walls. Most linear feature length was unchanged between the baseline and resurvey, perhaps reflecting the legislative protection provided to some linear features such as hedgerows.

FEP feature code	FEP feature description
F01	Hedgerow
F02	Ancient and / or species rich hedgerow
F03	Line of trees
F04	Hedge bank
F05	Earth bank
F06	Stone-faced bank
F07	Stone wall
F08	Wet ditch
H03	Historic routeway
H05	Relict boundary of historic importance
H13	Fence / railing of historic or landscape importance
V01	Bank-side vegetation
V04	Scrub

Table 3.2 Farm Environment Plan (FEP) linear feature descriptions, taken from Farm Environment Plan handbook (Natural England, 2010).

3.5 Conclusions

Did habitats change in extent between baseline and resurvey?

The extent of broad or priority habitat did not change between the baseline and resurvey for the majority of habitat surveyed. For the most extensive broad habitats found in HLS agreements there was relatively little evidence for change in extent between the baseline and resurvey. Seventy to ninety percent of mapped acid grasslands, dwarf shrub heaths, neutral grasslands and the arable and horticulture categories showing no change in habitat extent. Where change had occurred, neutral grassland with scattered trees or scrub showed the biggest shift, towards bracken or broadleaved woodland indicating a failure to control succession, although only 14 ha of this habitat was surveyed. Similarly, a small area (15 ha) of broadleaved woodland mosaic was surveyed, of which about 30% showed a change in extent which could be considered negative.

Where changes to priority habitat occurred, these were predominantly positive for the majority of priority habitat categories. The key exceptions were lowland dry acid grassland, lowland heathland and lowland meadows, where a more substantial decline in extent and / or condition was recorded, largely due to a loss in extent of priority habitat.

The majority of linear feature length (e.g. hedgerows) was unchanged between the baseline and resurvey.

Did changes in habitat extent differ between option types?

Where broad habitats did change category, larger changed were recorded under restoration or creation than maintenance options. Priority habitats were generally entered into maintenance options, rather than creation or restoration options, as expected given the focus on managing them to maintain or slightly improve their condition.

Within the HK grassland options, the largest changes observed were from improved to neutral grassland, and from arable and horticulture to neutral grassland, though in the latter category only 7 ha were surveyed. In the HL option categories, the largest changes were all towards acid grassland, from neutral grassland, bracken and broadleaved woodland. The next largest changes observed in mapped habitat extent were towards bracken, from both fen, marsh and swamp and acid grassland. In the largest broad habitat categories surveyed in both option groups (neutral grassland and calcareous grassland for HK options, dwarf shrub heath and acid grassland for HL options), over 80% of habitat remained in the same broad habitat.

4. Multivariate analyses of vegetation data

4.0 Introduction

The first part of this chapter (4.1) presents the results of multivariate analyses of lowland habitat data, on an HLS option group basis, to explore change in broadly similar lowland habitat types undergoing similar management (creation, restoration or maintenance). The second part (4.2) deals with the analysis of upland habitat data on a 'per protocol' basis, to assess change in datasets circumscribed by the Common Standards Monitoring protocols used by the field surveyors.

Multivariate analyses of plant communities are based on the principal of dimension reduction. That is, in the real world, all species are assumed to have unique responses to environmental gradients (e.g. fertility, moisture, grazing etc.) Techniques such as the ordination (or 'ordering') approaches used here are one way of dealing with the complexities of datasets which contain many species responding to an unknown number of underlying environmental gradients. The ordination approaches presented here seek to reduce the multi-dimensional nature of this problem to two or three main 'axes' that can be visualised and comprehended (Gauch, 1982; Kent, 2012).

4.0.1 Key questions addressed by multivariate analyses

Is there evidence of change in plant communities between baseline and resurvey, within specific habitat types?

Have plant communities under creation or restoration options changed more than those in similar habitats under maintenance options?

Is there evidence that plant communities changed more between baseline and resurvey in the lowlands or the uplands?

4.1 Lowland option-based analyses

4.1.1 Methods

Nomenclature, spelling and formatting were harmonised across the lowland quadrat dataset to ensure that differences in recorder expertise between phases did not influence estimates of plant community change. In many cases, records at a finer taxonomic resolution (e.g. subspecies or varieties) were amalgamated to species or, occasionally, the species aggregate level (e.g. *Festuca ovina* agg.). All such changes were implemented in *R* and are detailed in the scripts developed for analysis. Table 4.1 details the breakdown of data relating to the various option codes corresponding to a particular analysis presented here, e.g. the analysis relating to the creation options as applied to grasslands covers the option codes HE10, HJ4, HK8, HK13 and HK17, and is presented in this chapter rather than an the relevant appendix.

For this set of analyses, parcels were included regardless of whether they were paired between survey phases; that is, there is an assumption that the two sets of baseline and resurvey parcels are representative of their respective HLS option populations. The individual units used for the following analyses, however, are the quadrats recorded within

parcels (i.e. symbols on 'site' ordinations below represent quadrats). The spatial structure inherent in the dataset (i.e. quadrats nested within parcels), was taken into account for the permutation-based multivariate ANOVA (PerMANOVA) analyses of difference between survey phases, where parcel was used to restrict permutations (i.e. only quadrats within parcels are considered to be exchangeable between time periods).

Analysis (option: habitat)	Relevant HLS option codes	Chapter or Appendix?
i. Creation: grassland	HE10, HJ4, HK8, HK13, HK17	Chapter
ii. Creation: lowland heath	HO4	Appendix
iii. Creation: fen	HQ8	Appendix
iv: Creation: woodland	HC10	Appendix
v.i Restoration: grassland	HK7, HK11, HK12, HK16	Chapter
v.ii Restoration: grassland, HK7	HK7	Chapter
vi. Restoration: woodland	HC8	Chapter
vii. Restoration: sand dunes	HP2	Appendix
viii. Restoration: lowland bog	HQ10	Chapter
ix. Restoration: fen	HQ7	Chapter
x. Restoration: lowland heath	HO2	Chapter
xi. Maintenance: woodland	HC7	Chapter
xii. Maintenance: fen	HQ6	Chapter
xiii. Maintenance: lowland raised bog	HQ9	Appendix
xiv.i Maintenance: grassland	HK6, HK9, HK10, HK15	Chapter
xiv.ii Maintenance: grassland, HK6	HK6	Chapter
xv. Maintenance: lowland heathland	HO1	Chapter

Table 4.1. Option-based multivariate analyses of change

As well as visual inspection of Detrended Correspondence Analysis (DCA) ordinations, the PerMANOVA analyses were used to test for a centroid location shift between survey phases (using function adonis in the vegan package, v. 2.4-1, permutations were constrained within parcels as discussed above; Oksanen et al., 2017). However, this latter test can be confounded by changes in the dispersion of multivariate dissimilarities, and so a permutation test for the homogeneity of multivariate dispersions was also used (functions betadispers and permutest in the vegan package). Where there was significant heterogeneity, a "multiple linear model" approach was used as an alternative test for shifts in community composition between phases; this used the manylm function of the mvabund package of (Wang et al., 2012; Warton et al., 2012); v. 3.11.9). Although the functions within this package were not designed for proportion data, an offset term (the log of the summed-proportions per site) can be used to investigate changes in terms of relative abundance using this approach (David Warton [mvabund lead developer], r-sig-eco mailing list comm., 25th February 2015).

4.1.2 Results and discussion

i. Creation: grassland

There is a significant PerMANOVA result ($P = 0.001$, $R^2 = 2.4\%$) indicating a difference between baseline and resurvey communities, but also significant heterogeneity in multivariate

dispersion (P = 0.001). The multiple linear model approach also indicated an effect of survey phase (P = 0.02). In general the ordination indicates a move away from weedy disturbed arable or tall ruderal communities towards grassland (Fig. 4.1). This is also supported by a standalone analysis of HLS option HK8 (Creation of species rich semi natural grassland; Fig. 4.2); for this analysis 24 quadrats in 2 agreements were excluded, as they appeared as extreme outliers on DCA axes 1 and 2. The HK8 analysis also provided evidence for a difference between the two survey periods (multiple linear model approach: P = 0.04).

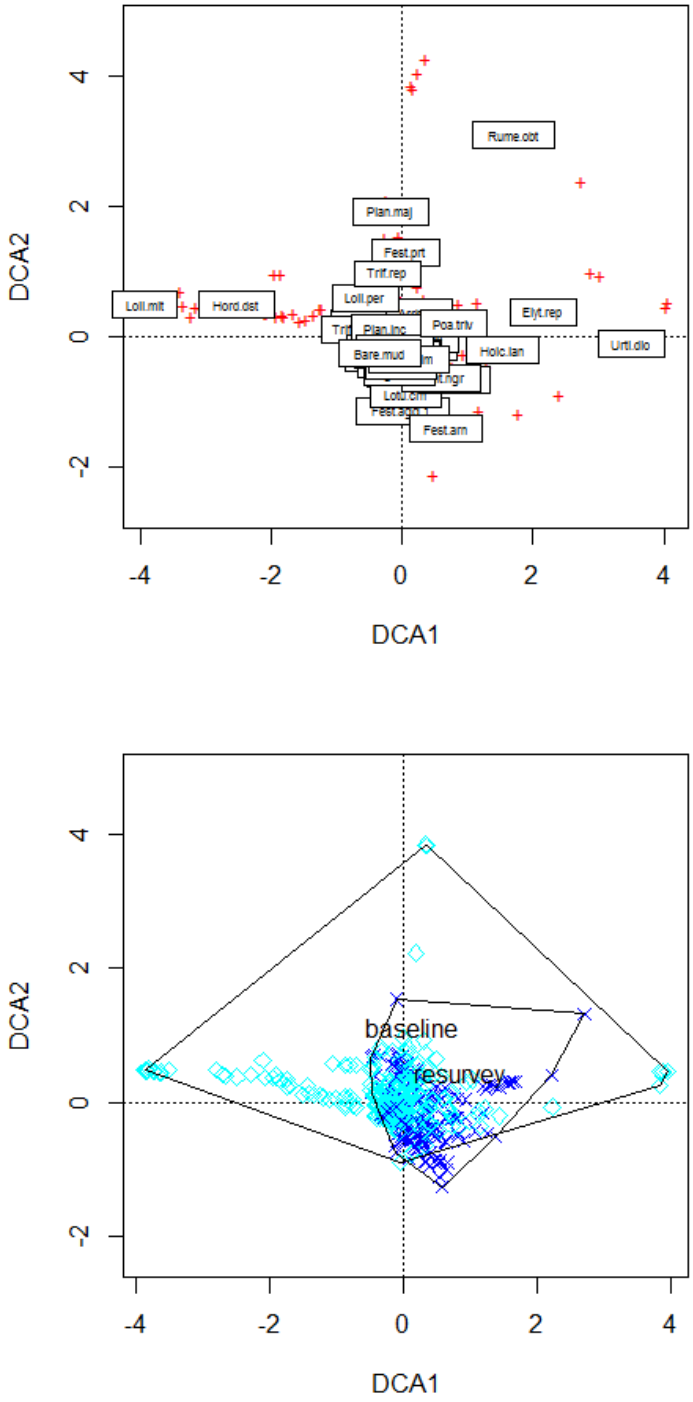

Figure 4.1. Creation: grassland. The top ordination shows species; only the most abundant species are shown, and these are layered in order of relative diversity using the inverse Simpson index; red crosses indicate rare species whose names have been suppressed to de-clutter the ordination. The bottom ordination shows sites, grouped by survey phase; phase text indicates the centroid of the group, the hull bounds observations within the group.

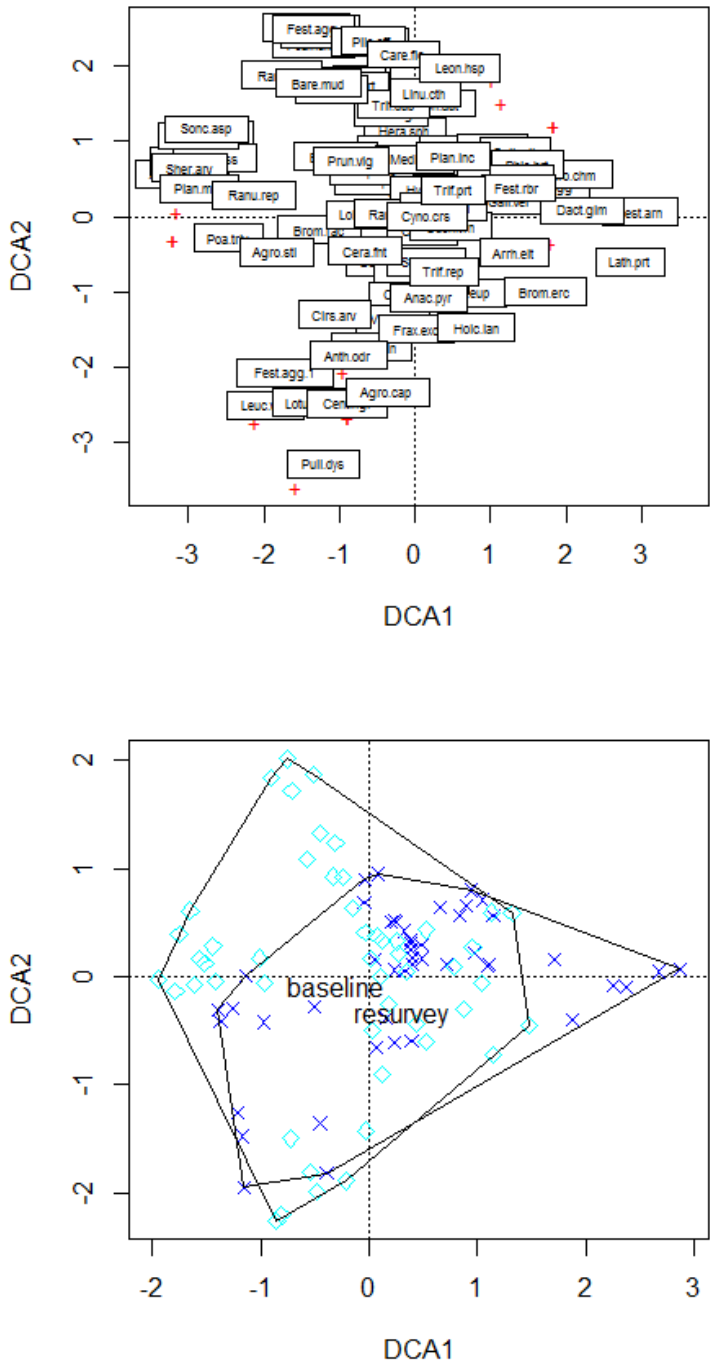

Figure 4.2. Creation: grassland, HK8 only. The top ordination shows species; only the most abundant species are shown, and these are layered in order of relative diversity using the inverse Simpson index; red crosses indicate rare species whose names have been suppressed to de-clutter the ordination. The bottom ordination shows sites, grouped by survey phase; phase text indicates the centroid of the group, the hull bounds observations within the group.

v.i Restoration: grassland

The PerMANOVA test indicated a small change between survey periods (R^2 = 0.3%; P = 0.001); the dispersion test was not significant (Fig. 4.3). The multiple linear model approach also indicated a very small but significant change (R^2 = 0.1%, P = 0.02), which may merely be an effect of the high power of this large dataset (2402 quadrats, 516 taxa). Figure 4.4, a breakdown of the top twenty most abundant species by survey phase, suggests that some sites may have become slightly wetter, or have experienced a reduction in grazing pressure, on the basis of increases in two species (*Agrostis canina*, *Molinia caerulea*); DCA axis 1 also looks to be associated with wetness, although there is no clear overall shift of quadrats along this axis between the baseline and the resurvey (Fig. 4.3).

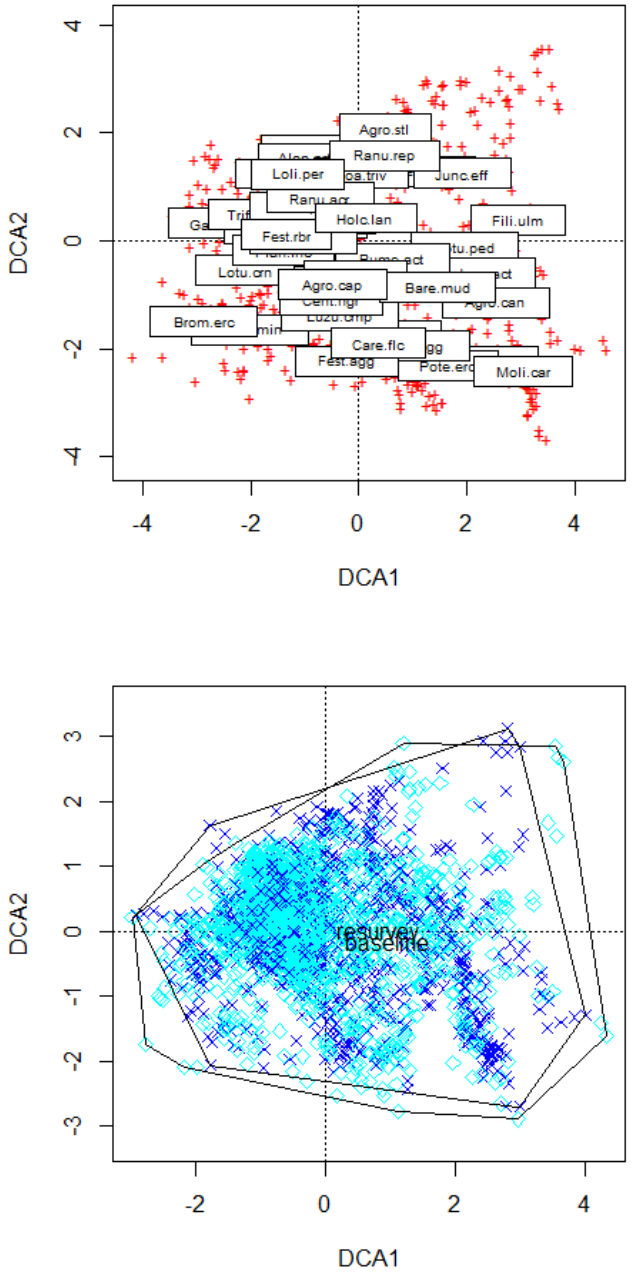

Figure 4.3. Restoration: grassland. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index); red pluses indicate species whose names have been suppressed to declutter the ordination. The bottom ordination shows sites grouped by survey phase.

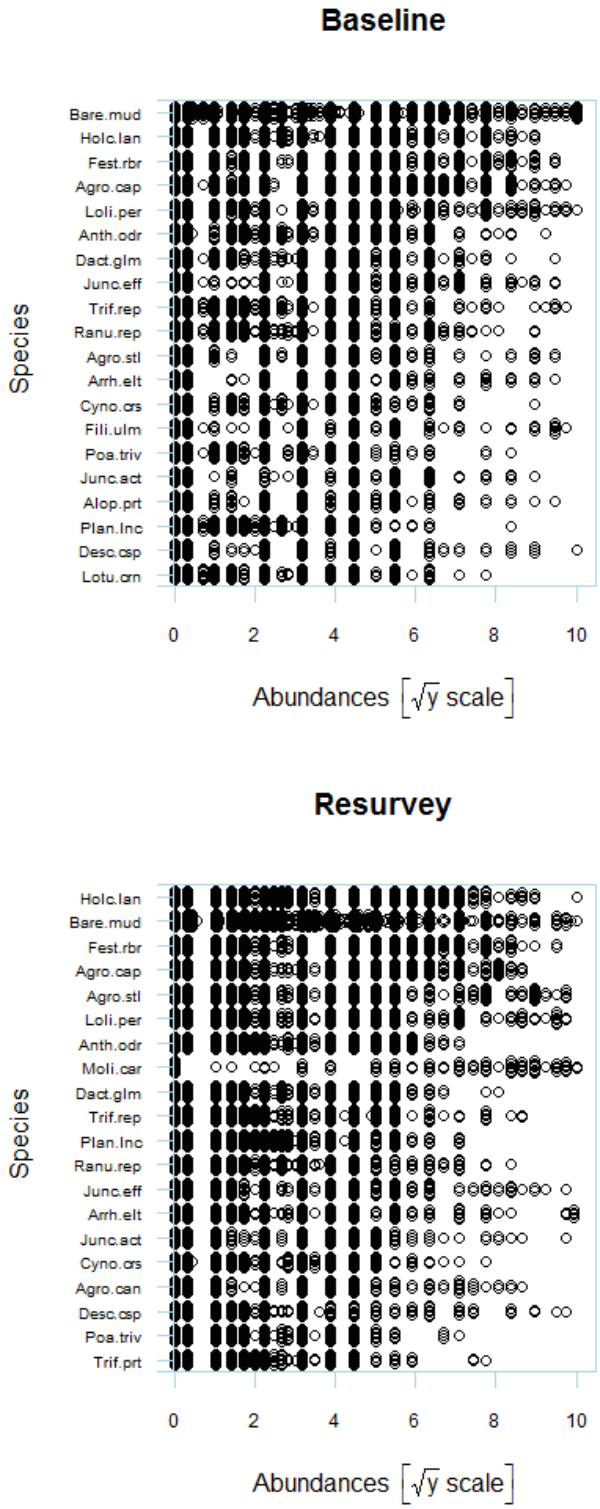

Figure 4.4. Restoration: grassland. The twenty most abundant species by survey phase.

v.ii Restoration: grassland, HK7

The PerMANOVA test indicated a small change between survey periods (R^2 = 0.5%; P = 0.001); the dispersion test was not significant (Fig. 4.5). The multiple linear model approach also indicated a very small but significant change (R^2 = 0.1%, P = 0.02), which, again, is likely to be an effect of the high power of this large dataset (1844 quadrats, 474 taxa).

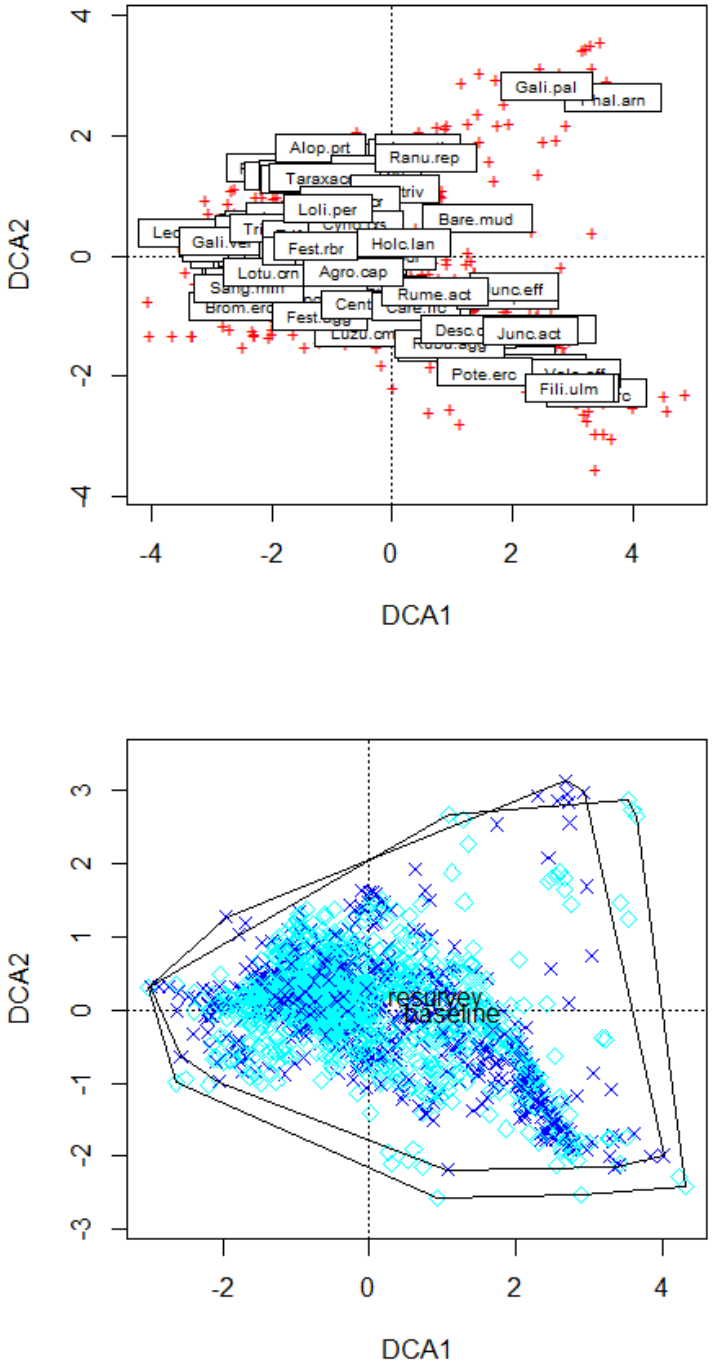

Figure 4.5. Restoration: grassland, HK7. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index); red pluses indicate species whose names have been suppressed to declutter the ordination. The bottom ordination shows sites grouped by survey phase.

vi. Restoration: woodland

The PerMANOVA is significant, but the effect is small (R^2 = 1.8%; P = 0.001; Fig. 4.6); however, there was a significant change in multivariate dispersion (P = 0.001). The multiple linear model approach also suggested a small, but significant change (R^2 = 2.2%; P = 0.03). The slight reduction in the length of the DCA axis 1 space occupied by the resurvey quadrats may be related to a move away from acid grassland (positive end of axis 1) and from fenny woodland (negative end of axis 1), although the latter trend may only be based on one or two quadrats (Fig. 4.7).

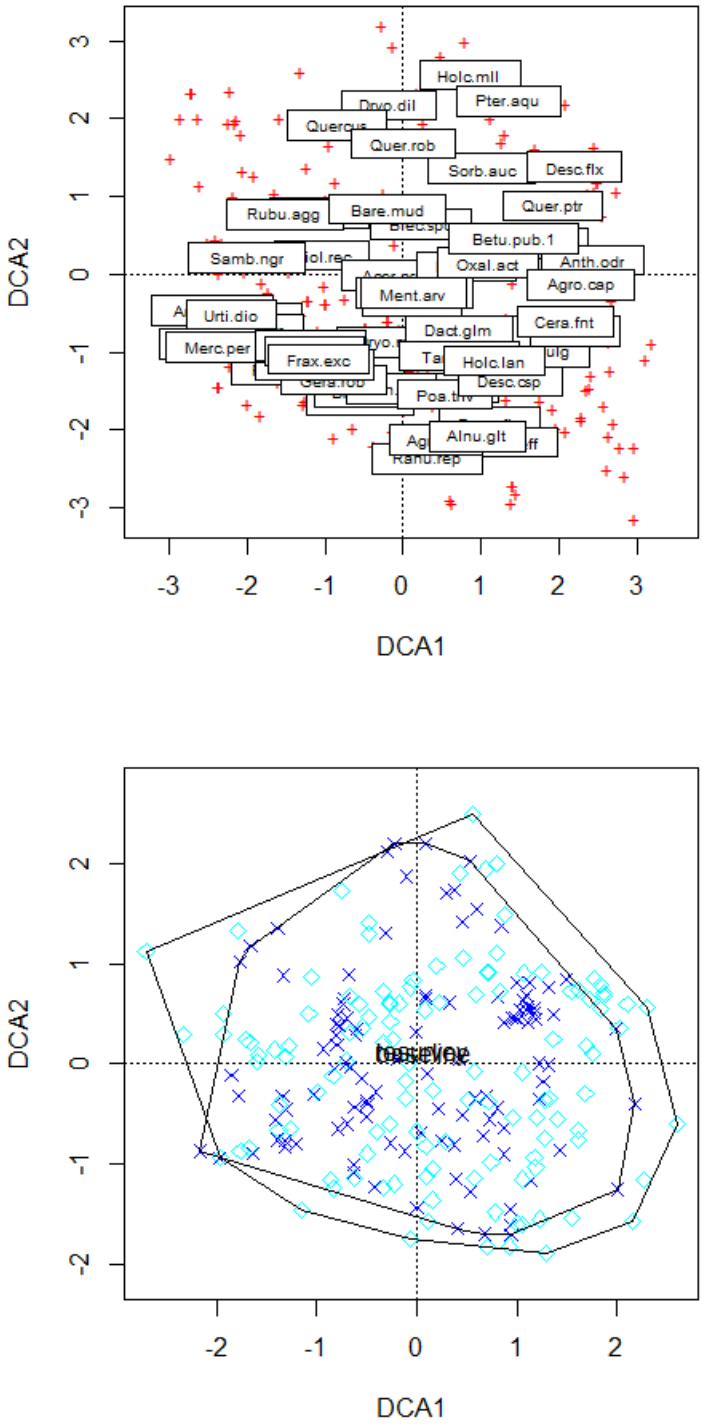

Figure 4.6. Restoration: woodland. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index). The bottom ordination shows sites, grouped by survey phase.

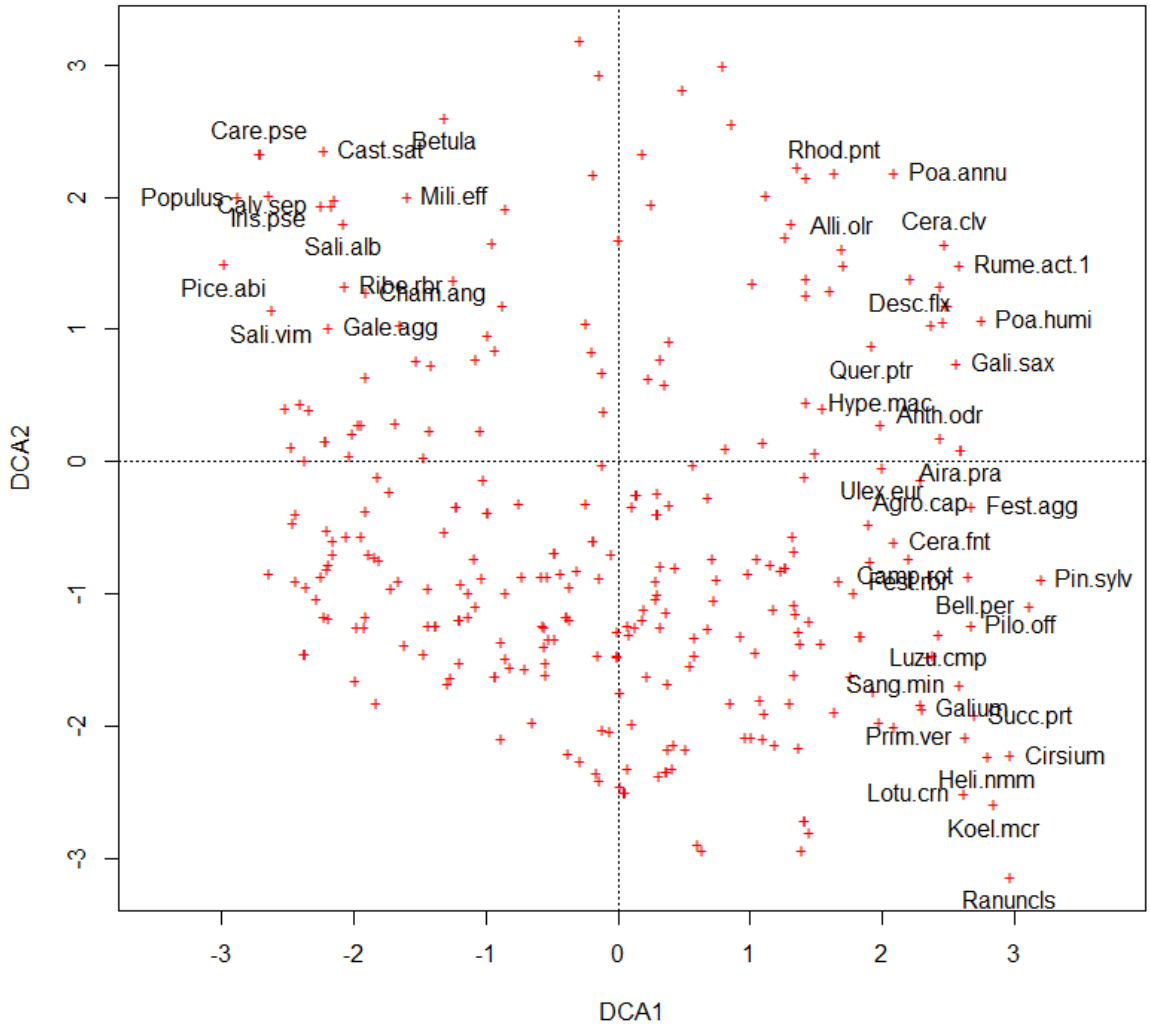

Figure 4.7. Restoration: woodland. For this species ordination, only species located in the areas where there appears to have been a retraction in community space on the site ordination have been labelled; red pluses indicate other, unlabelled, species.

viii. Restoration: lowland bog

A significant change in location between phases was found (PerMANOVA: R^2 = 3.7%; P = 0.001; Fig. 4.8), but there was also a highly significant change in dispersion (P = 0.001). The multiple linear model approach provided no evidence for change (R^2 = 2.5%; P = 0.248). Some of the species that appear to be associated with the change in dispersion (at least for DCA axes 1 and 2) do appear to be desirable species from the point of view of lowland bog habitat quality (e.g. *Eriophorum* species, *Sphagnum*) although some also indicate water richer in nutrients (*Juncus effusus*, *Carex rostrata*), drier conditions (*Calluna vulgaris*, *Digitalis purpurea*), or a ruderal element (*Epilobium ciliatum*). This diversity in the resurvey may reflect the development of bog structure, for example, the emergence of semi-natural hummock & depression micro-topography.

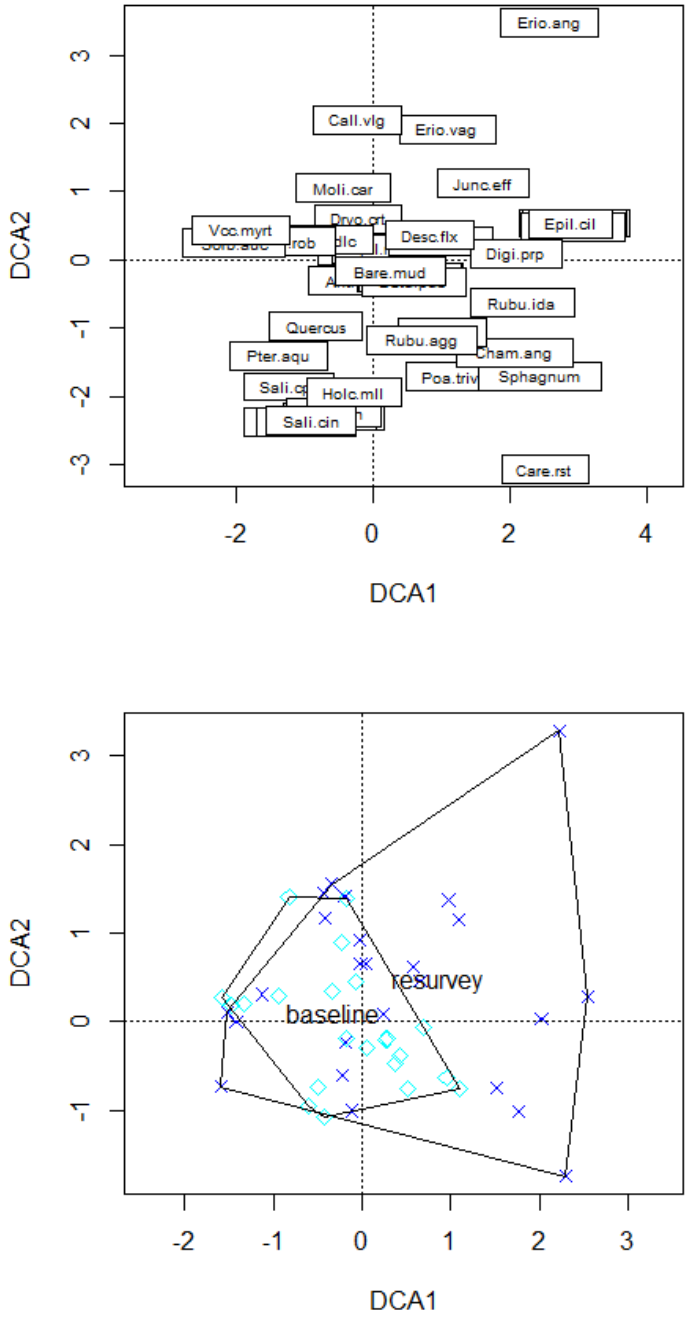

Figure 4.8. Restoration: lowland bog. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index). The bottom ordination shows sites grouped by survey phase.

ix. Restoration: fen

There is some evidence for increases in wetness from the ordinations (Fig. 4.9). Significant (PerMANOVA: R^2 = 2.9%; P = 0.001) or marginal (multiple linear model: R^2 = 1.4%; P = 0.069) test results were found, but the PerMANOVA significance may be due to changes in multivariate dispersion between time periods (P = 0.002); the reduced support for change from the multiple linear model supports this. The upwards shift on DCA axis 2 from baseline to resurvey appears to be a function of pH, with alkalinity increasing for higher axis scores on DCA axis 2 (Fig. 4.10). Axis one appears to be mainly related to wetness, although species that can tolerate shallow standing water also appear at the 'dry' end of axis 1 (e.g. *Phragmites australis*, *Epilobium hirsutum*; Fig. 4.10).

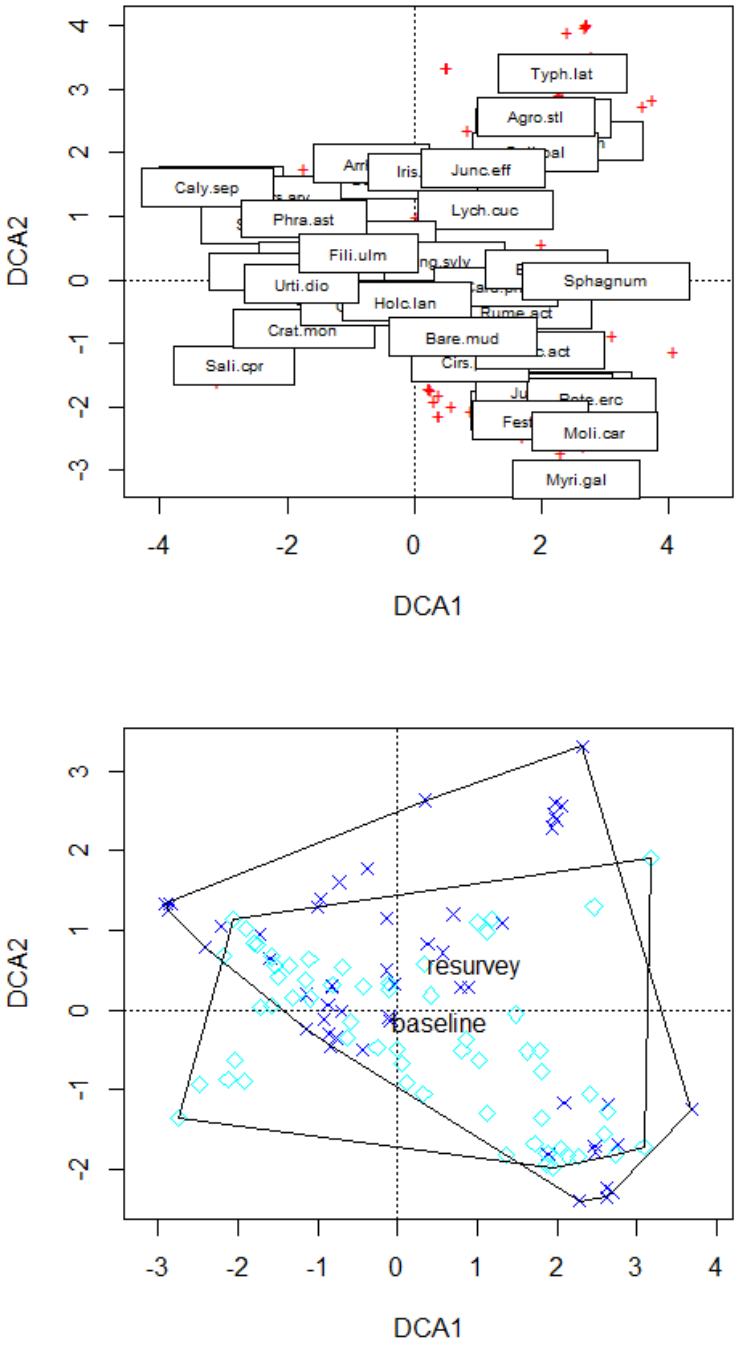

Figure 4.9. Restoration: fen. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index). The bottom ordination shows sites grouped by survey phase.

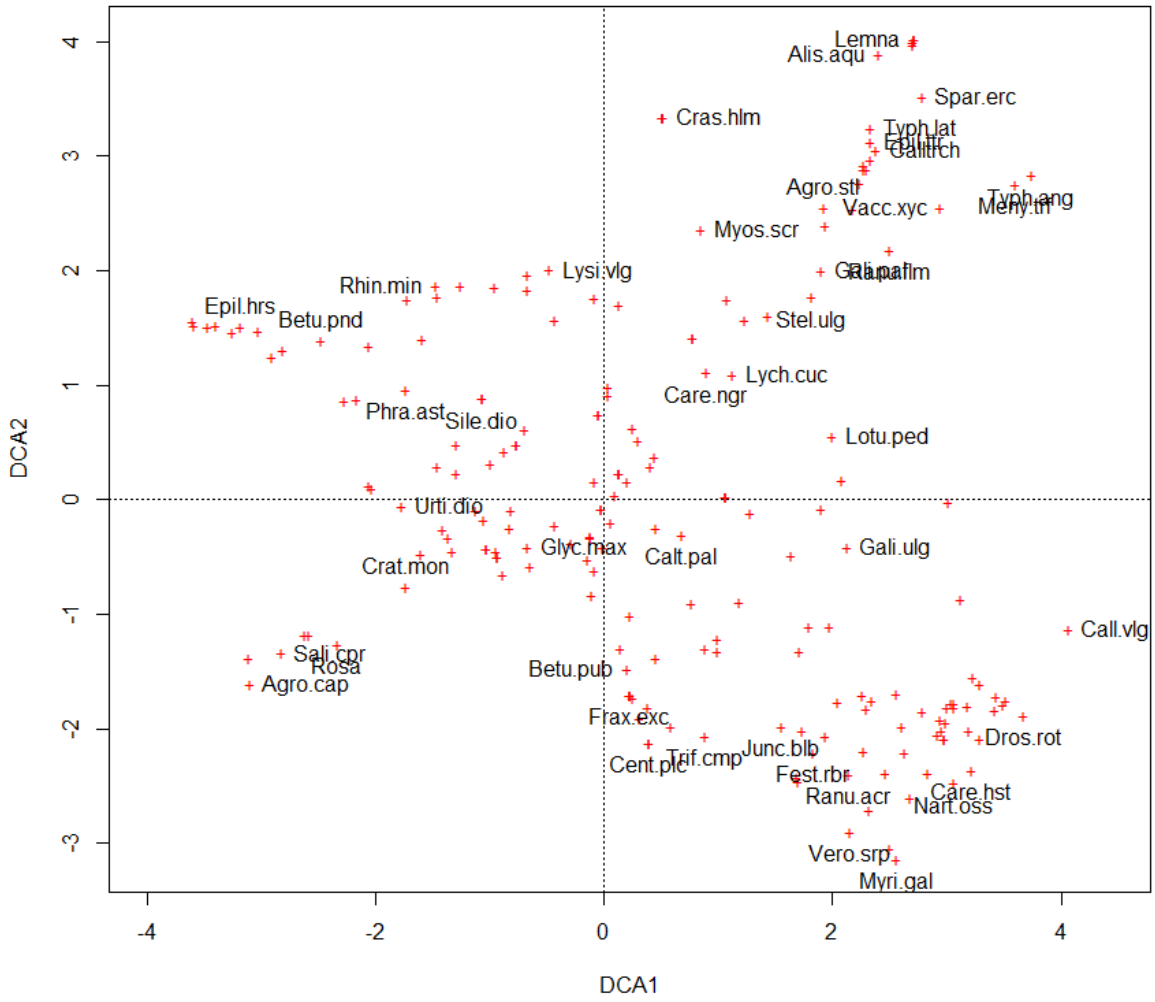

Figure 4.10. Restoration: fen. For this species ordination, species have been labelled to highlight potential causes of variation along both axes, other species are indicated by red plus symbols.

x. Restoration: lowland heath

Significant changes in location (PerMANOVA: R^2 = 2.3%; P = 0.004) and dispersion (P = 0.002) between phases were found. Multiple linear modelling supported a very small effect (R^2 = 0.9%; P = 0.02). The contraction in community space (at least along DCA axes 1 and 2), may be due to less heathy, more grassy sites moving towards a heathier condition between the survey periods. The species identified in Figures 4.11 and 4.12 would appear to support this conclusion.

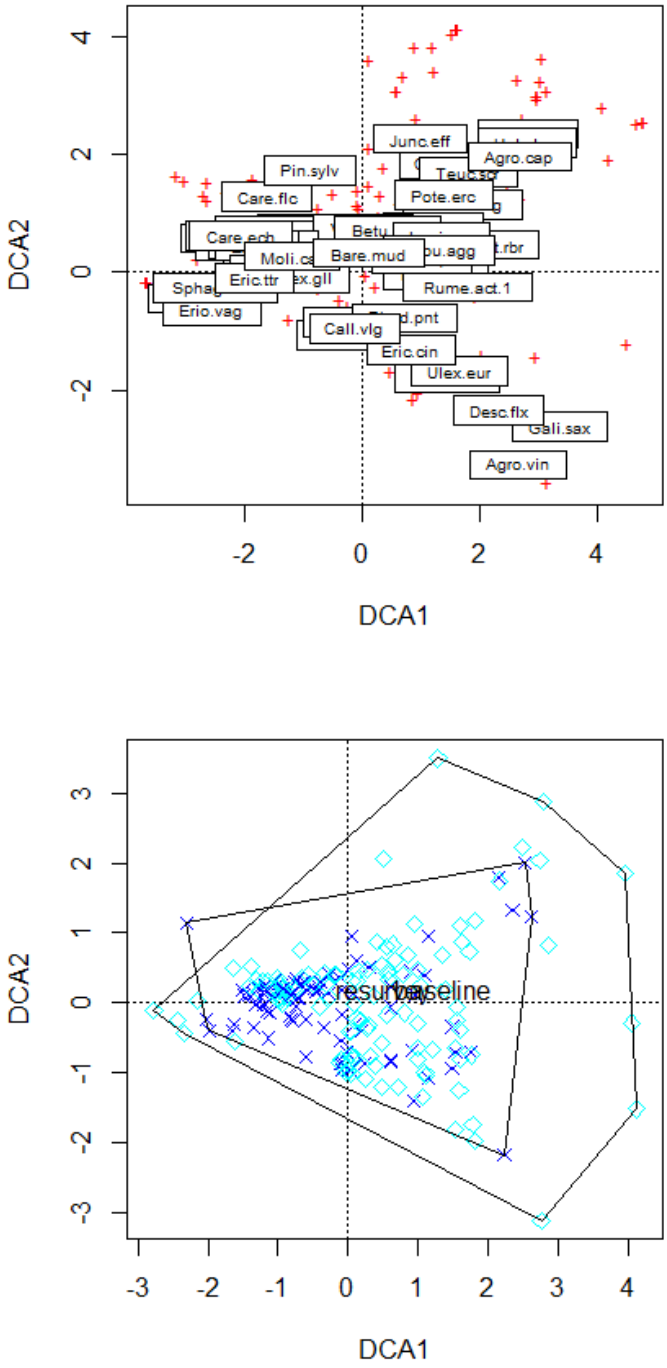

Figure 4.11. Restoration: lowland heath. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index); red pluses indicate other species. The bottom ordination shows sites grouped by survey phase.

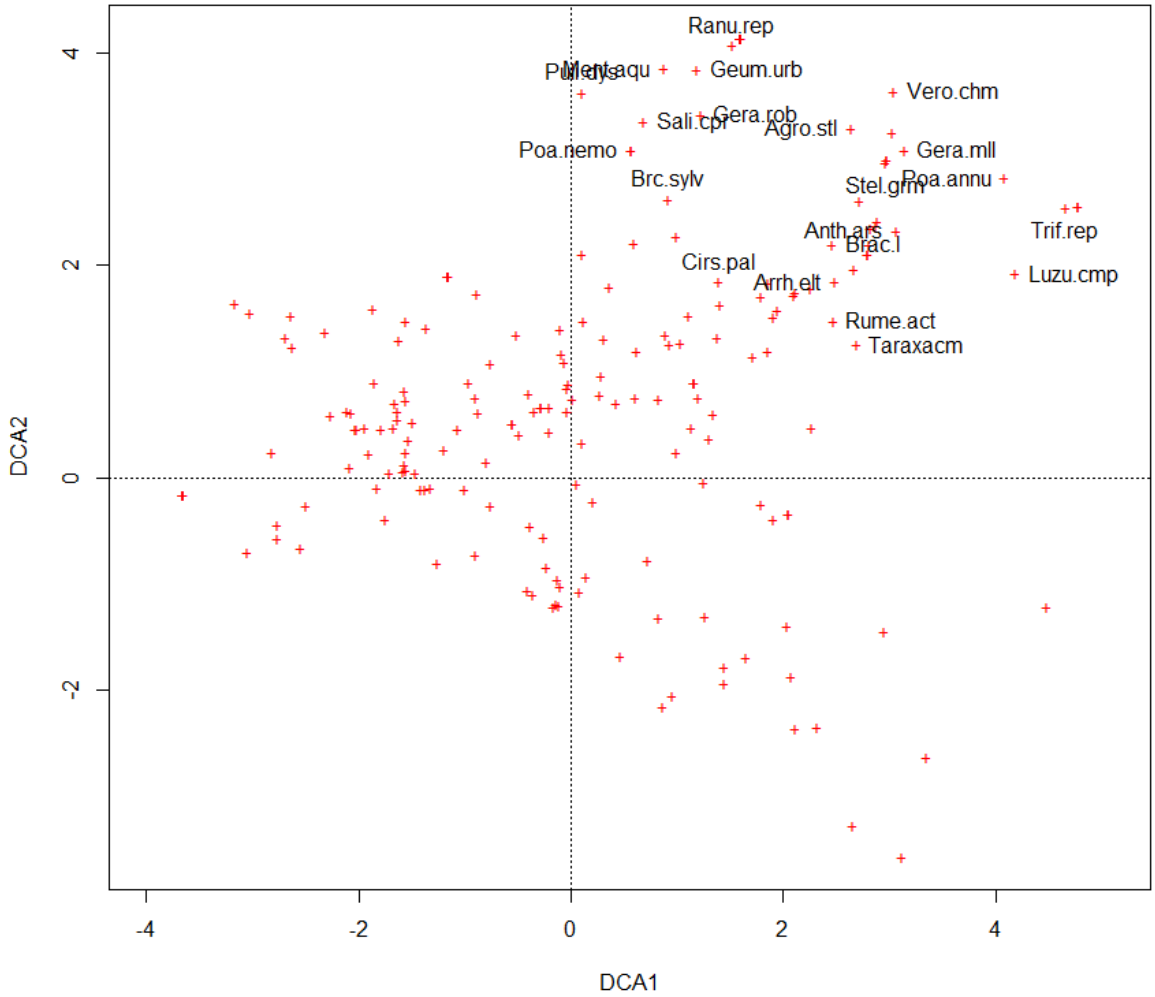

Figure 4.12. Restoration: lowland heathland. For this species ordination, species have been labelled to assist in explaining the contraction in community space between survey phases; other species are indicated by red plus symbols.

xi. Maintenance: woodland

The permutation test for homogeneity of dispersions was marginal (P = 0.09); the PerMANOVA (R^2 = 1.5%; P = 0.001) and multiple linear modelling (R^2 = 0.8%; P = 0.05) both support very small but significant effects. Both axes appear to be at least partly associated with acidity, and possibly nutrient status (Figs 4.13, 4.14). The upper left-hand corner of the larger ordination appears to contain species of more nutrient rich habitats (whether semi-natural or disturbed), with the lower right-hand corner appearing to be associated with drier, more acidic conditions. The move away from the upper left corner of the ordination between surveys may therefore indicate a move towards less disturbed conditions, although the broad distribution of fen species in this area of the ordination may also simply indicate a difference in quadrat locations between surveys (i.e. the area towards the resurvey bounding hull [Fig. 4.13] does not seem qualitatively different from the outlying area of the upper left-hand corner in terms of the types of species present).

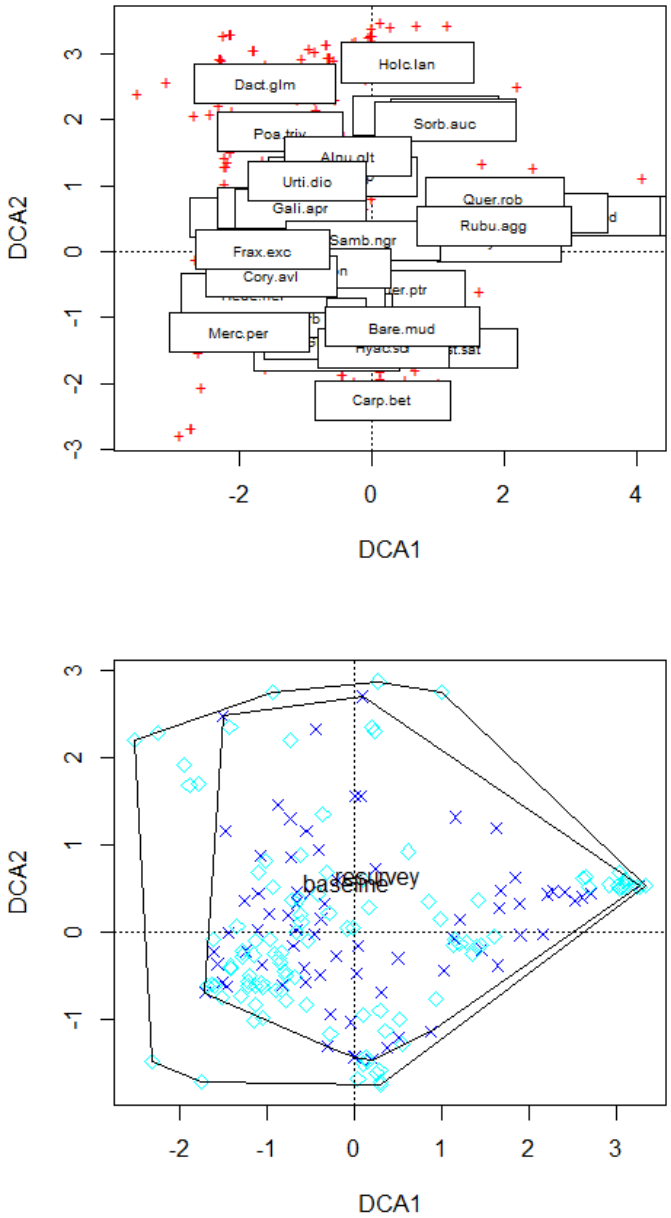

Figure 4.13. Maintenance: woodland. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index). The bottom ordination shows sites, grouped by survey phase.

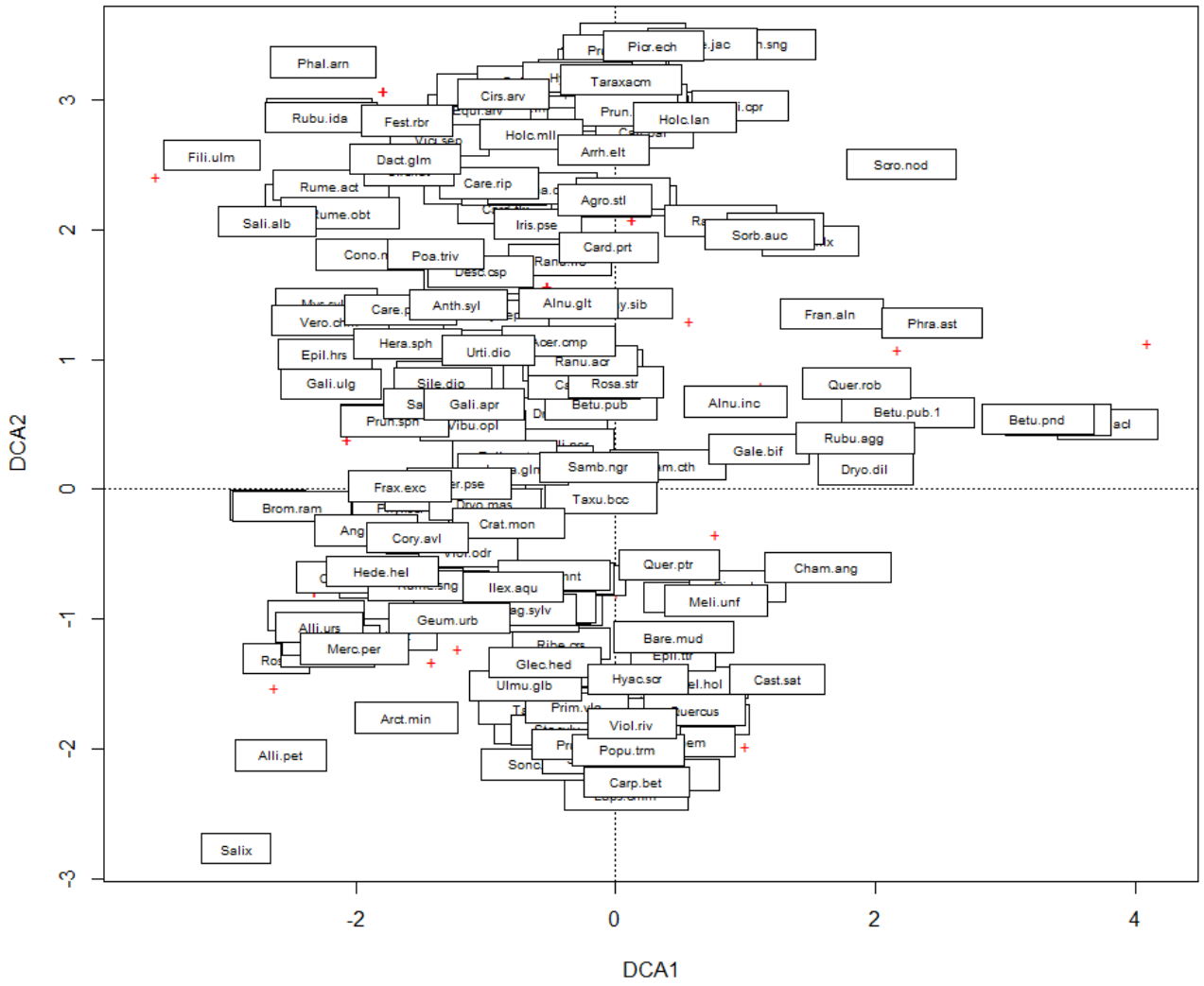

Figure 4.14. Maintenance: Woodland. For this species ordination, species have been labelled to assist in explaining the contraction in community space between survey phases; other species are indicated by red plus symbols.

xii. Maintenance: fen

PerMANOVA provides evidence for a location effect (R^2 = 5.1%; P = 0.001), but dispersions are not homogeneous (P = 0.001). Multiple linear modelling provides evidence for a small, marginal effect (R^2 = 2.0%; P = 0.069). The ordinations (Figs 4.15, 4.16) indicate that DCA axis 1 is related to fertility and soil pH, with axis 2 possibly superimposed on the lower end of axis 1, and indicating the degree of fertility, with the bottom of axis 2 indicated the more eutrophic, and possibly disturbed, sites. Given that the expansion of the ordination space between survey periods is mainly in the upper and lower left-hand quadrants, a move towards higher pH, and also possibly less eutrophic conditions, may be posited.

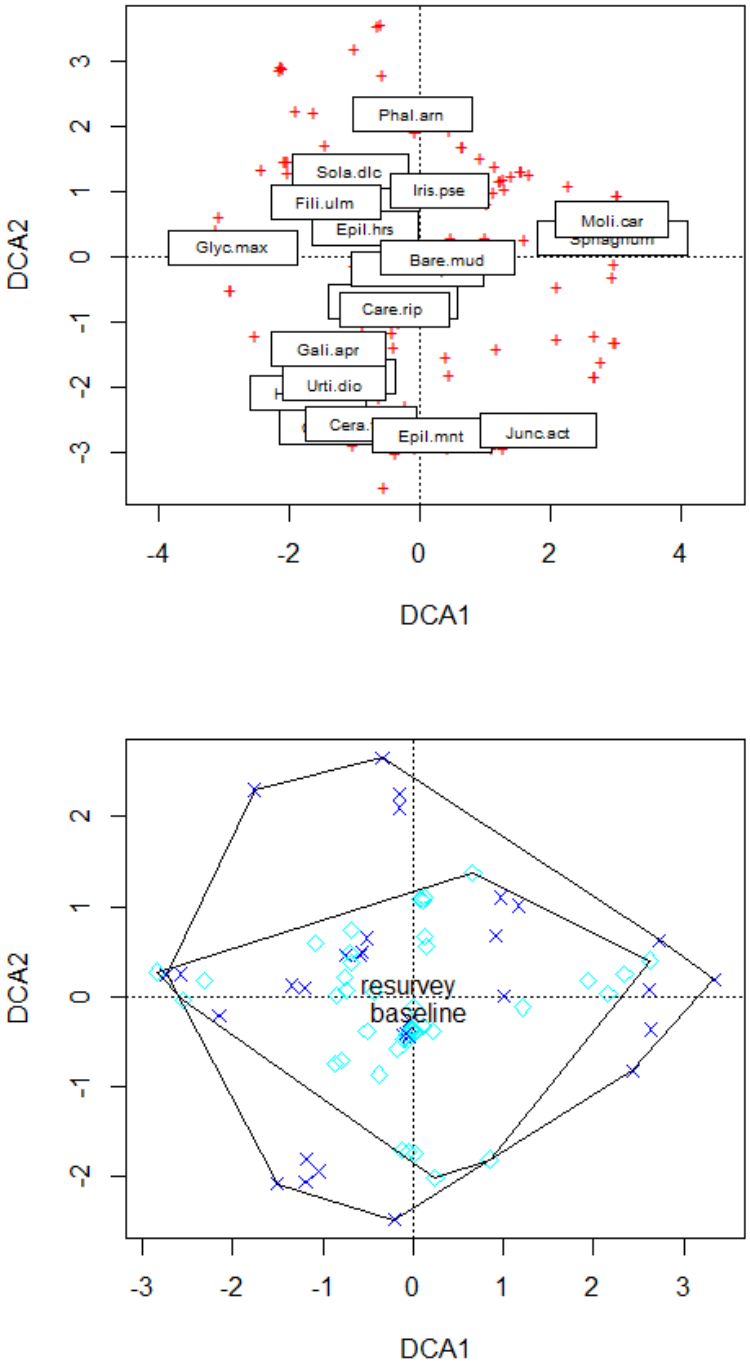

Figure 4.15. Maintenance: fen. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index). The bottom ordination shows sites, grouped by survey phase.

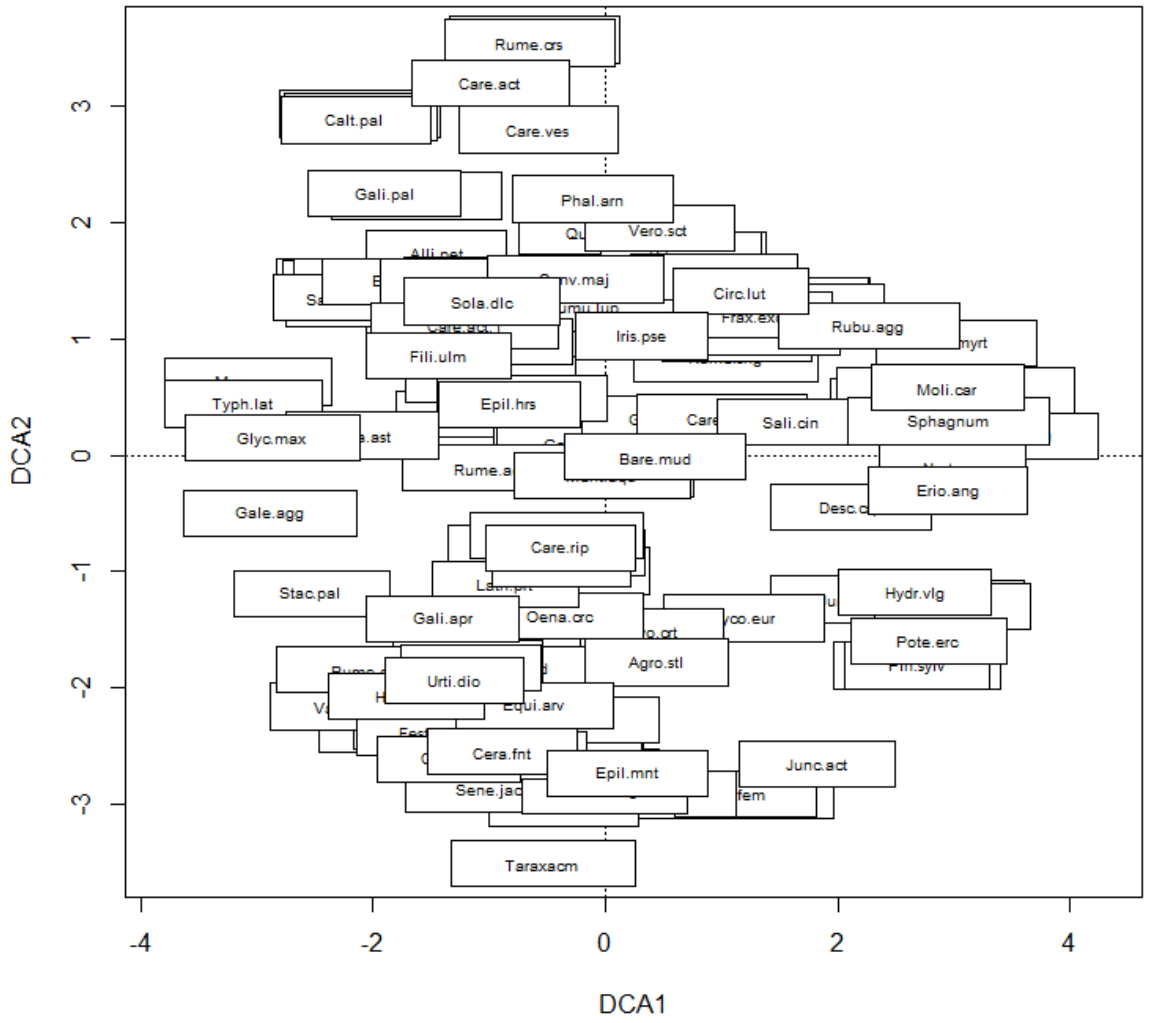

Figure 4.16. Maintenance: Fen. For this species ordination, species have been labelled to assist in explaining the expansion in community space between survey phases.

xiv.i Maintenance: grassland

There was no evidence for change in dispersion between sites (P = 0.384). The PerMANOVA test of location (centroid) change between survey periods indicate a very small, but significant, shift (R^2 = 0.5%; P = 0.001; Fig. 4.17); however, this is likely to be due to the large dataset, and so high power, to detect small differences, and may not be biologically significant. This was is also supported by a standalone analysis of HLS option HK6 (Maintenance of species rich semi-natural grassland; Fig. 4.18).

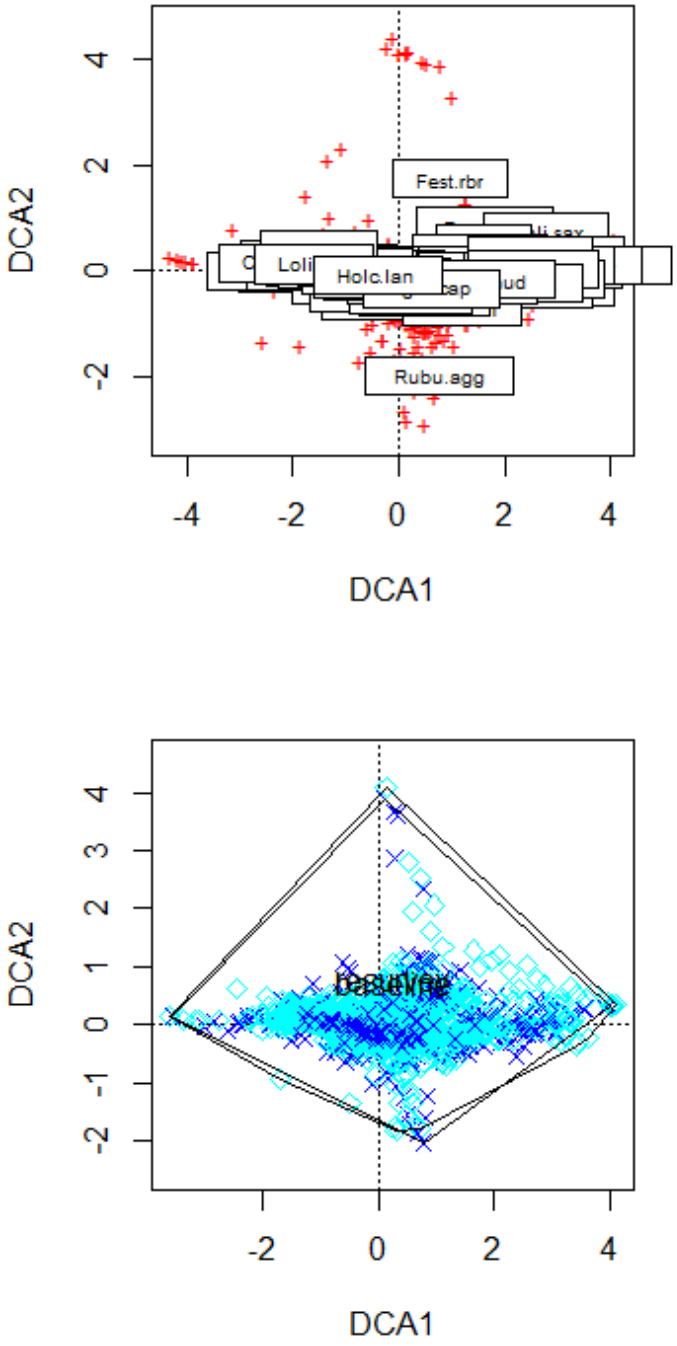

Figure 4.17. Maintenance: grassland. The top ordination show species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index). The bottom ordination shows sites, grouped by survey phase.

xiv.ii Maintenance: grassland, HK6

There was no evidence for change in dispersion between sites (P = 0.363). The PerMANOVA test of location (centroid) change between survey periods again indicated a very small, but significant, shift (R^2 = 0.5%; P = 0.001; Fig. 4.18).

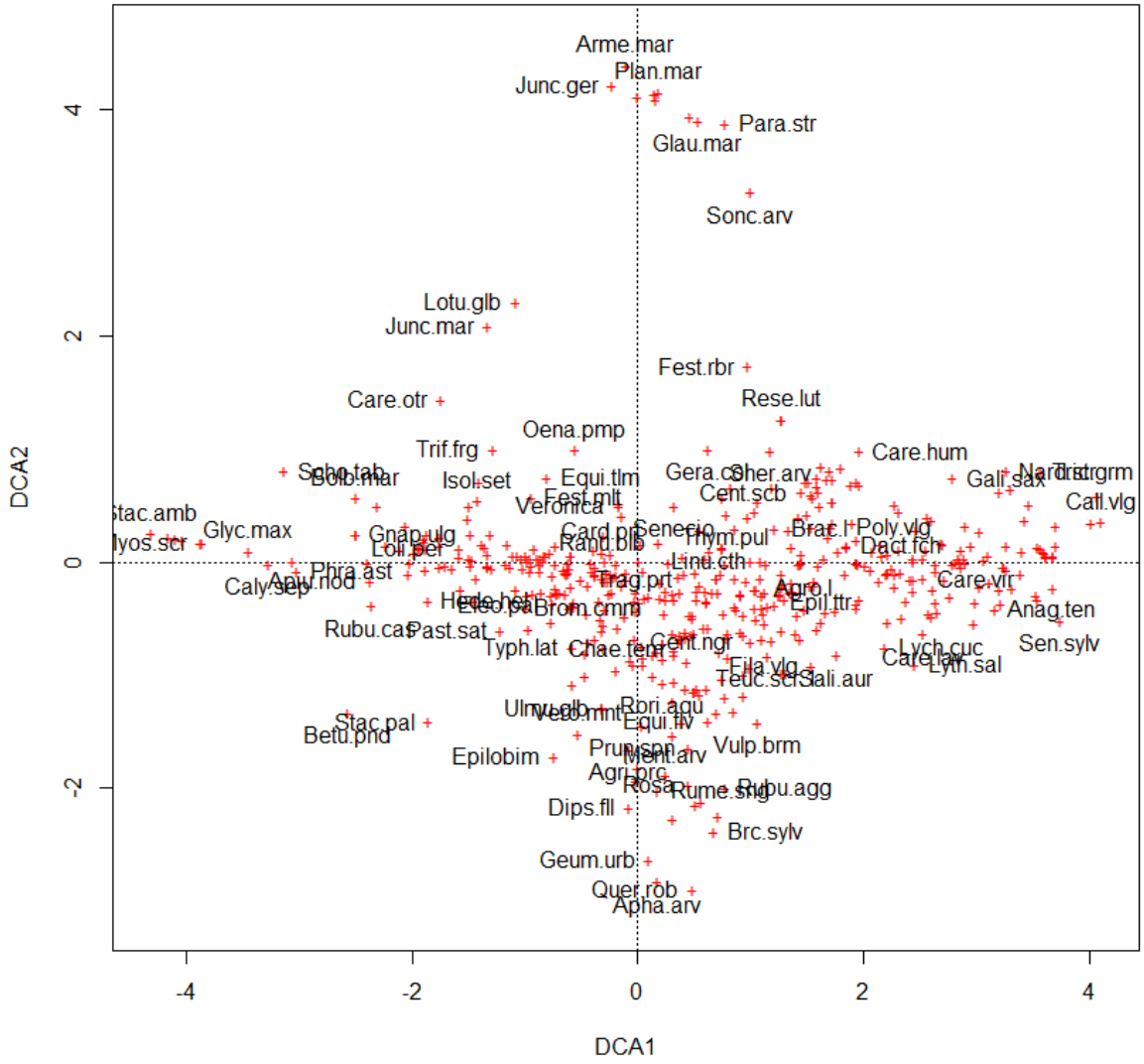

Figure 4.18. Maintenance: grassland, HK6. Species ordination, with selected species labelled, for option Hk6 only; unlabelled species are indicated by red plus symbols.

xv. Maintenance: lowland heathland

There was a marginal difference in dispersion (P = 0.105), and support for difference between phases (PerMANOVA: R^2 = 8.8%, P = 0.002; multiple linear modelling: R^2 = 4.7%, P = 0.030; Fig. 4.19). The main floristic changes (Figs 4.20, 4.21) appear to be a general shift towards heathier communities, and away from woodier, or wetter, outlier quadrats.

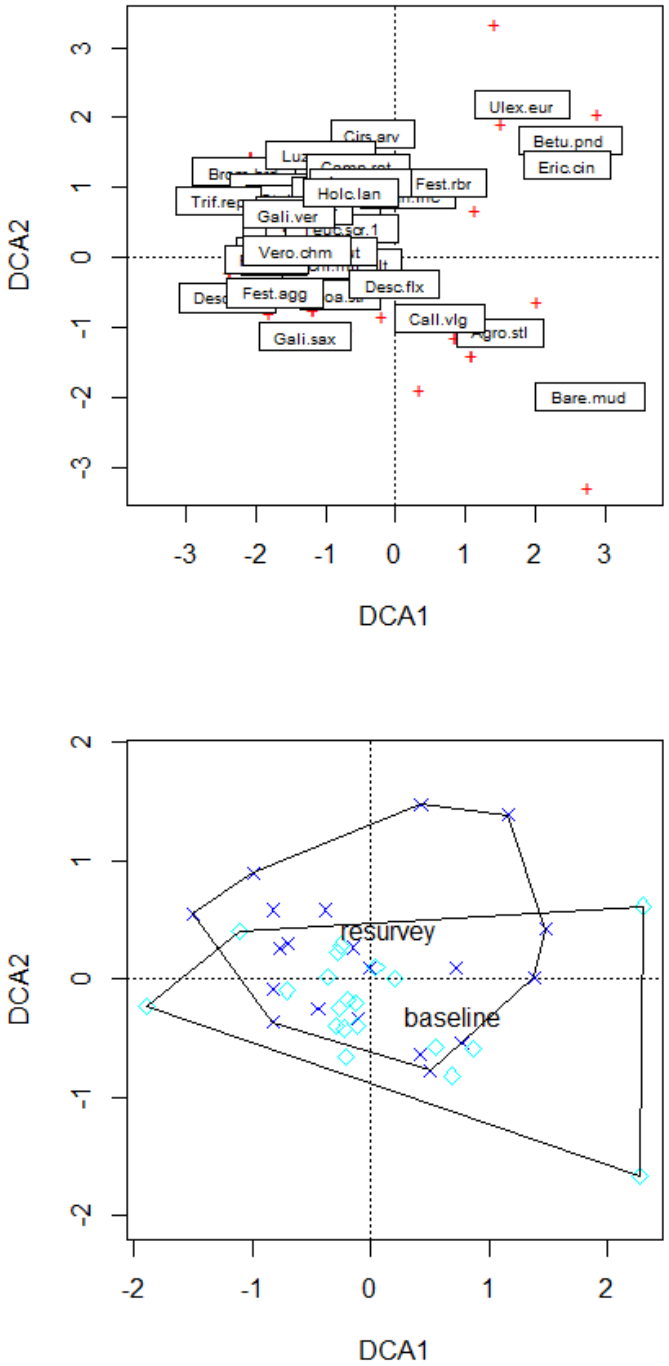

Figure 4.19. Maintenance: lowland heathland. The top ordination shows species; only the most abundant species are labelled, and these are layered in order of relative diversity (using the inverse Simpson index); red plus symbols indicate unlabelled species. The bottom ordination shows sites grouped by survey phase.

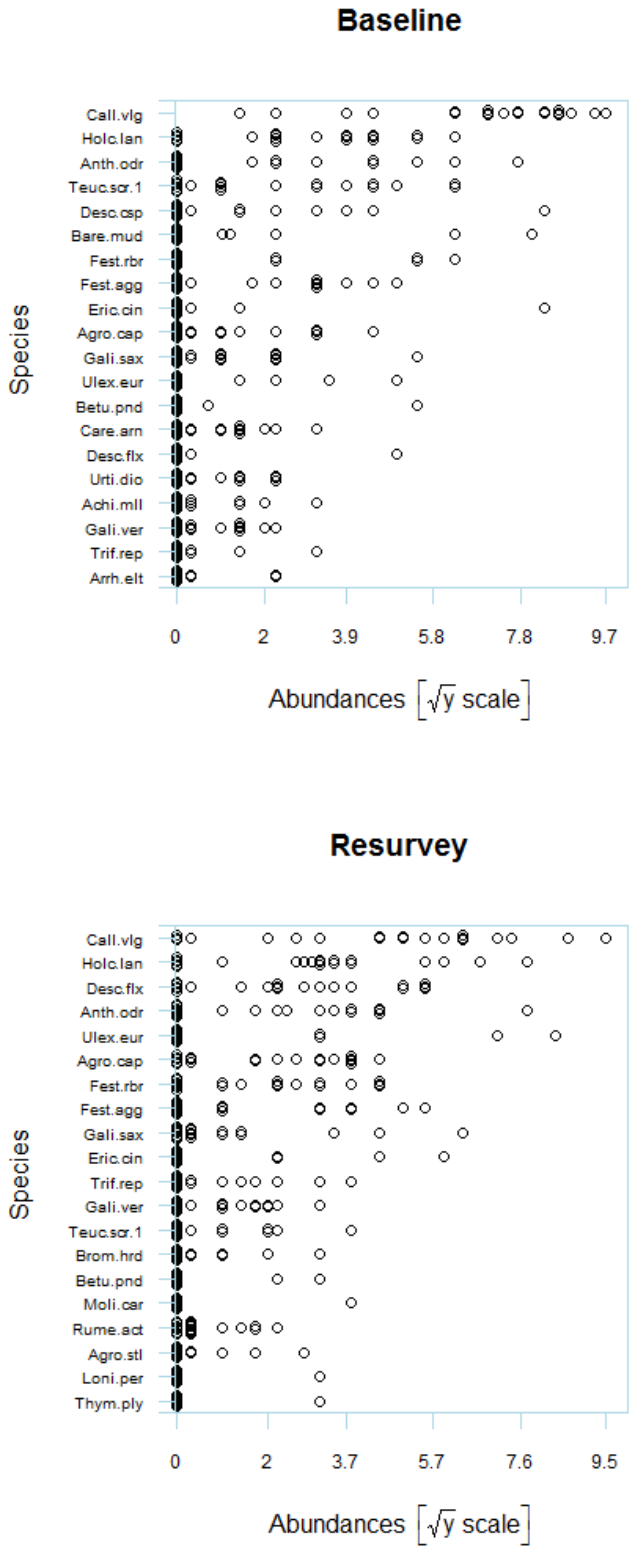

Figure 4.20. Maintenance: lowland heathland. The twenty most abundant species by survey phase.

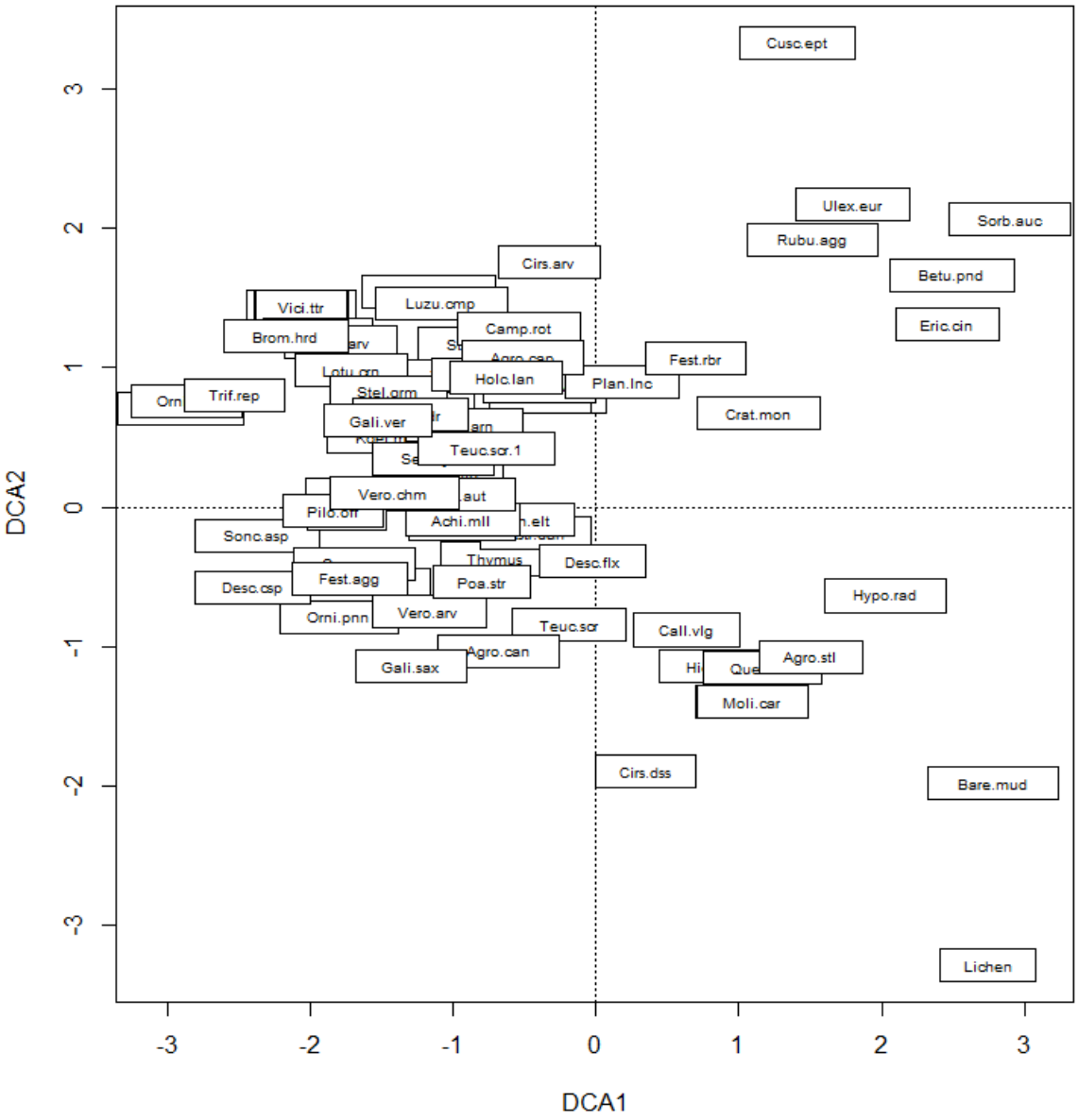

Figure 4.21. Maintenance: lowland heathland: enlarged species ordination

4.2 Multivariate analysis of upland stop data

4.2.1 Data preparation and methods

Initially, all upland 'stop' data were treated as one dataset. Firstly, parcels were removed that did not have stop information in both the baseline (2010, 2011) and resurvey (2016) periods; that is, the current analyses focus on change between paired parcels only. Second, species were removed that did not appear in the HLS habitat-specific recording protocols – this operation was subject to detailed checking on a per habitat protocol basis to ensure that errors due to spelling or other differential formatting did not occur.

Subsequently, within habitats, only parcels with matching protocols between time periods were retained: there were some parcels surveyed in both phases of the project, but using different habitat protocols – this was possibly due to habitat heterogeneity within large parcels, although other possibilities, such as true change, surveyor error, or surveyor subjectivity regarding habitat classification, may also play a part. Note, however, that field surveyors were provided with the GPS locations of baseline stops, in order to focus the resurvey on roughly the same areas as the baseline.

Finally, and again within habitats, only unique species-stop combinations were kept, thus ensuring that data duplicated as a result of one-to-many parcel-to-HLS option relationships in the HLS database were removed. For certain habitat protocols (e.g. the Upland Dry Heath protocol), some parcels for analysis were the result of the merging of smaller fields. For example, within the Upland Dry Heath protocol for parcel 4974, there were stops recorded against a sub-unit named 'Units 139/142/141', however, this sub-unit was only surveyed during the HLS baseline survey. Given that the analysis presented here was being conducted at the agglomerated level of parcel 4974, the stops from Units 139/142/141 were included as representative of the area being examined at baseline, with the resurvey assumed to represent condition over a similar, but not exactly matched, area.

All data preparation and manipulation (with the exception of a small number of checks on, and changes to, taxon spelling and formatting) was carried out in *R* v. 3.3.2 (R Core Team, 2016), and is available as a set of annotated scripts from CEH.

For each habitat protocol and survey phase, the final dataset consisted of a species-by-parcels matrix; cells in the matrix were initially counts of species presence at unique stops according to this breakdown. These were subsequently standardised according to the maximum number of stops per parcel per phase (i.e. the relative frequency of a species within a parcel at either the baseline or resurvey). The subsequent species-by-parcels matrices were used in Non-metric Multidimensional Scaling (NMDS, a type of ordination) and permutation-based Multivariate Analyses of Variance (PerMANOVAs); the PerMANOVAs investigated whether there was strong evidence for a change in species composition between the survey phases. In one case where the optimal NDMS solution was a single axis (the Mires/Wet Heath protocol), a Detrended Correspondence Analysis (DCA) was used instead.

4.2.2 Results and discussion

i. Upland calcareous grassland

Five parcels were surveyed under this protocol at both baseline and resurvey, with 202 unique stop identifiers. All parcels were under option HL10 Restoration of moorland. The NMDS ordinations do not indicate any clear shift over time (Fig. 4.22), neither did the PerMANOVA detect any significant difference between phases (R^2 = 13.7%; P = 0.31).

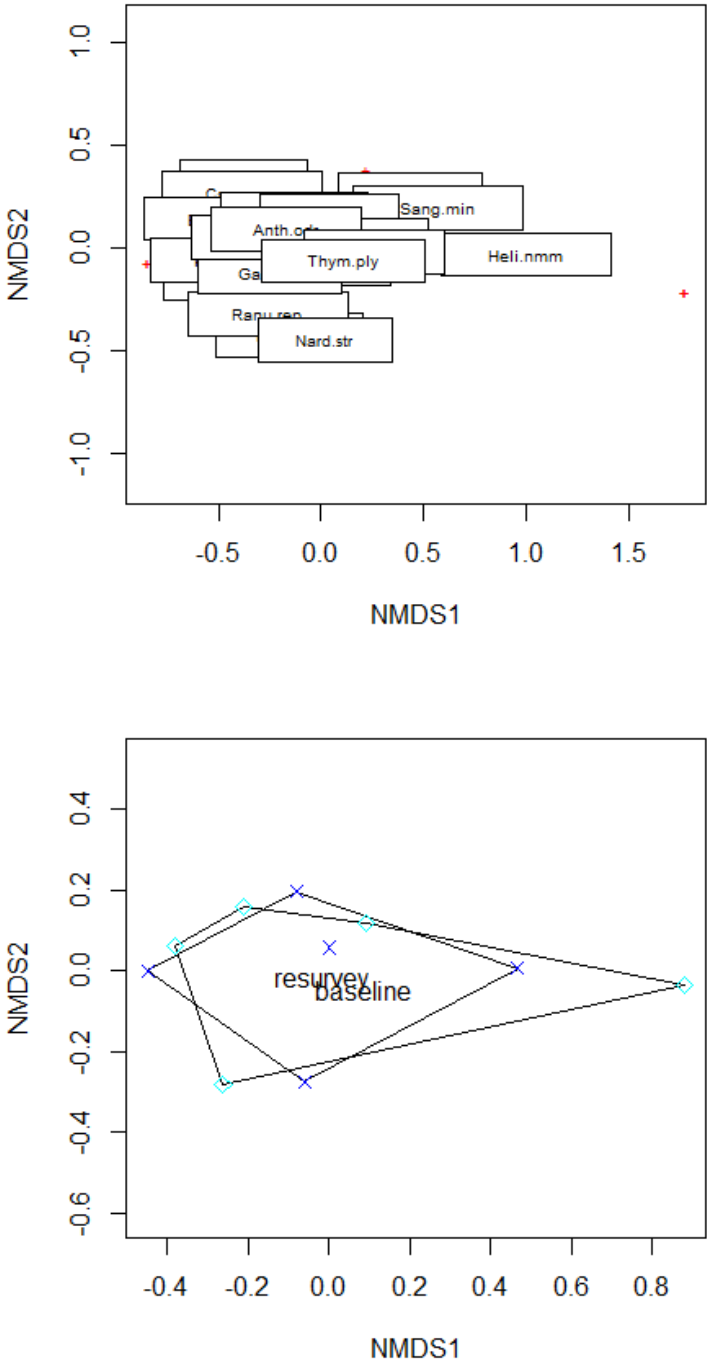

Figure 4.22. Upland Calcareous Grassland. A. NMDS ordination for species. Labels overlap according to relative species diversity as calculated by the inverse Simpson index. The red plus symbols indicate minor species where labels have been suppressed to improve clarity. B. NMDS ordination for parcels; phase labels indicate centroids; bounding hulls circumscribe all parcels within a survey phase.

ii. Dry Heath

Eight parcels were surveyed under this protocol at both baseline and resurvey, with 465 unique stop identifiers. The parcels analysed were approximately evenly split between HL10 Restoration of moorland (6) and HL9 Maintenance of moorland (4). The NMDS showed no clear shift between baseline and resurvey (Fig. 4.23), and the PerMANOVA did not detect any significant difference (R^2 = 5.3%; P = 0.43).

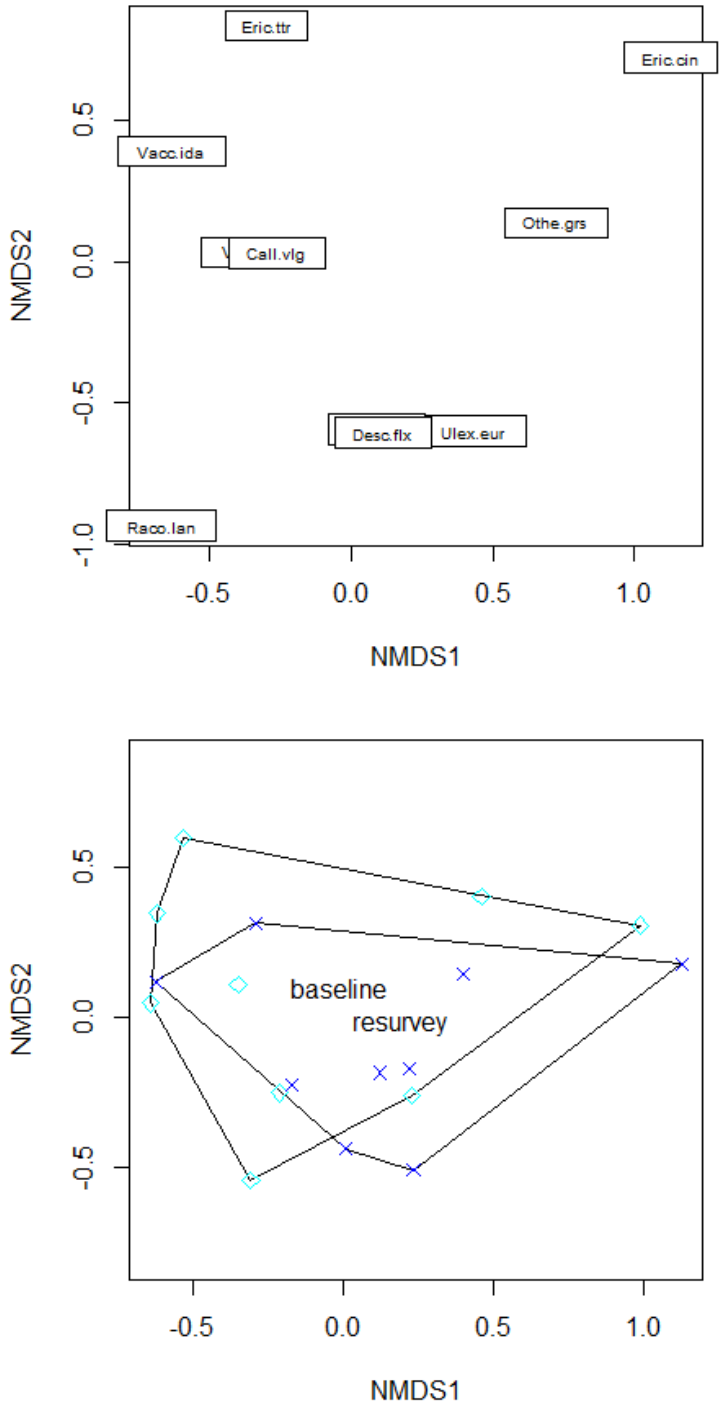

Figure 4.23. Dry Heath. A. NMDS ordination for species. Labels overlap according to relative species diversity as calculated by the inverse Simpson index. B. NMDS ordination for parcels; phase labels indicate centroids; bounding hulls circumscribe all parcels within a survey phase.

iii. Dry / Wet Heath

Thirteen parcels were surveyed under this protocol at both baseline and resurvey, with 732 unique stop identifiers. The parcels analysed were almost evenly split between HL10 Restoration of moorland (7) and HL9 Maintenance of moorland (6). The NMDS showed no clear shift between baseline and resurvey (Fig. 4.24), and the PerMANOVA did not detect any significant difference (R^2 = 2.1%; P = 0.79).

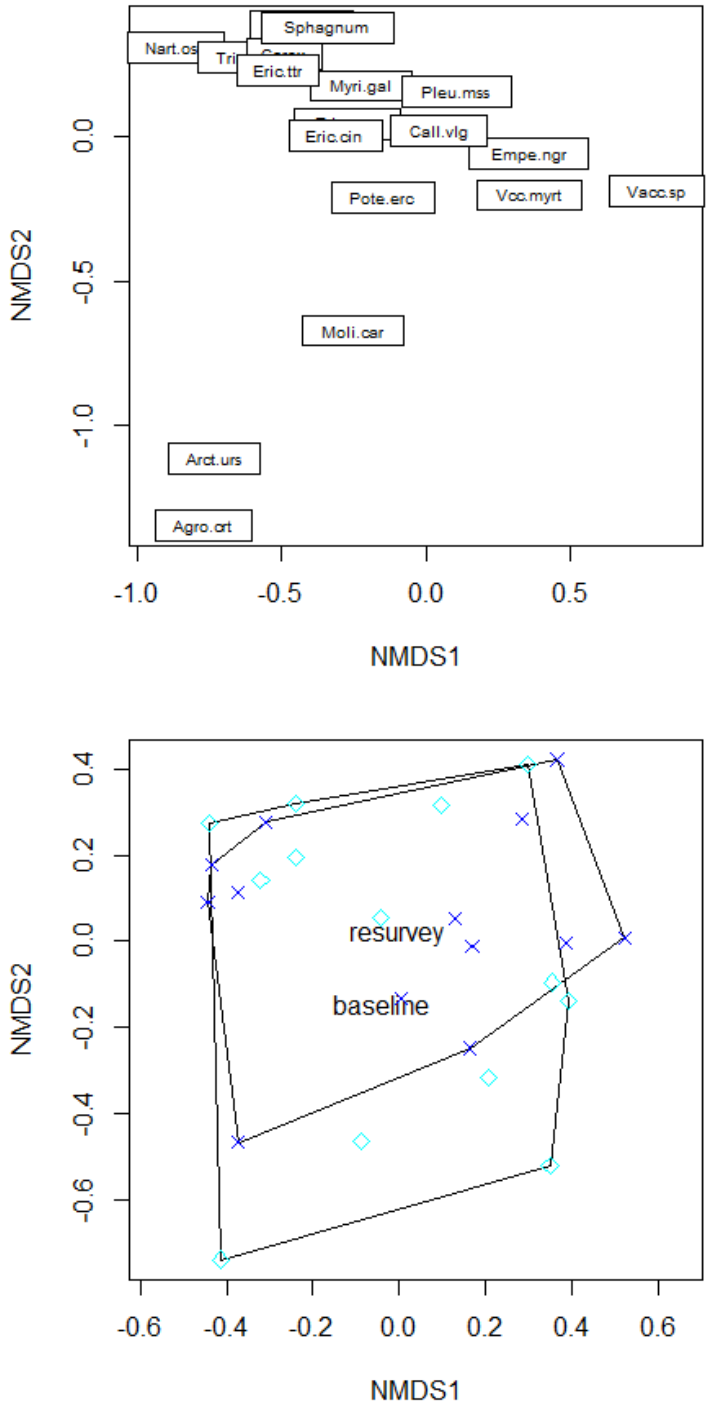

Figure 4.24. Dry / wet Heath. A. NMDS ordination for species. Labels overlap according to relative species diversity as calculated by the inverse Simpson index. B. NMDS ordination for parcels; phase labels indicate centroids; bounding hulls circumscribe all parcels within a survey phase.

iv. Grass Moorland

Nine parcels were surveyed under this protocol at both baseline and resurvey, with 285 unique stop identifiers. The NMDS showed a shift between baseline and resurvey along the second NMDS axis, but not the first (Fig. 4.25). The PerMANOVA did not detect any significant difference (R^2 = 8.7%; P = 0.22), although the low P value provides some evidence that a null test hypothesis of 'no difference' is not well-supported by the data. The parcels analysed under the Grass Moorland protocol were weighted towards restoration options (12), rather than maintenance (2), and this may explain the small shift between phases seen here, particularly when compared to other habitats (e.g. Mires, Dry / Wet Heath) that tended to have a more even split between options types. The slight shift along NMDS axis 2 is not obviously interpretable, but may be related to increased topographical diversity at small scales (based on the close juxtaposition of *Sphagnum*, non-crustose lichens, and *Agrostis vinealis* in the ordination).

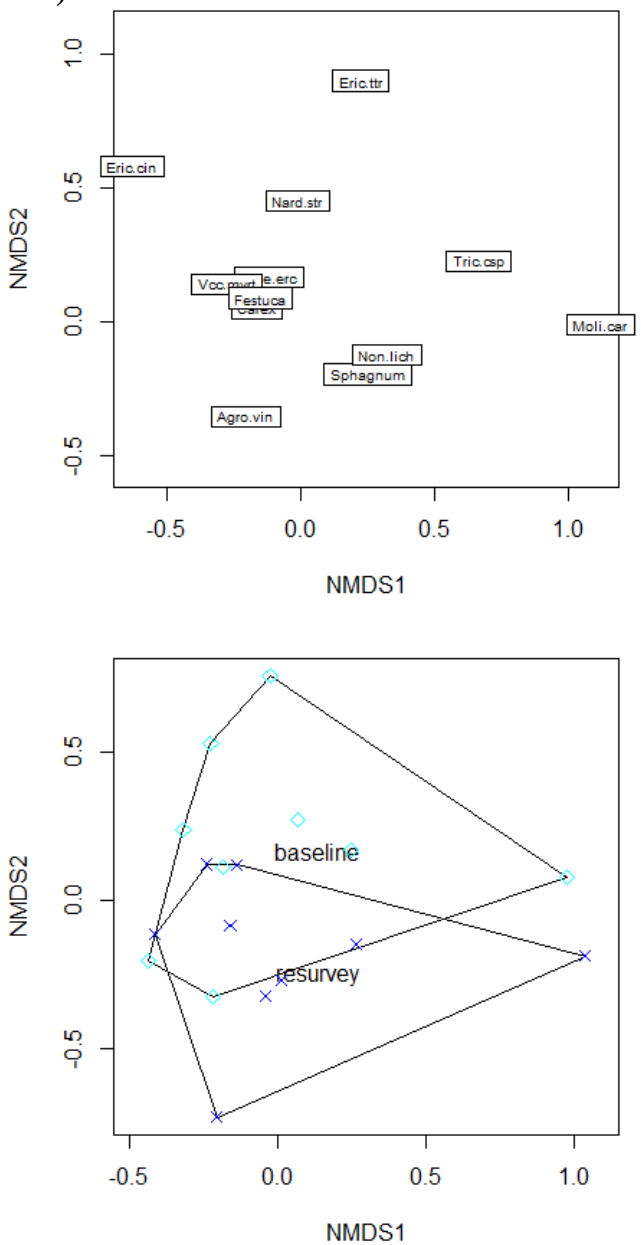

Figure 4.25. Grass Moorland. A. NMDS ordination for species. Labels overlap according to relative species diversity as calculated by the inverse Simpson index. B. NMDS ordination for parcels; phase labels indicate centroids; bounding hulls circumscribe all parcels within a survey phase.

v. Mires

Eight parcels were surveyed under this protocol at both baseline and resurvey, with 211 unique stop identifiers. The parcels analysed were fairly evenly split between HL10 Restoration of moorland (8) and HL9 Maintenance of moorland (6). The NMDS showed no clear shift between baseline and resurvey (Fig. 4.26), and the PerMANOVA did not detect any significant difference (R^2 = 7.4%; P = 0.36).

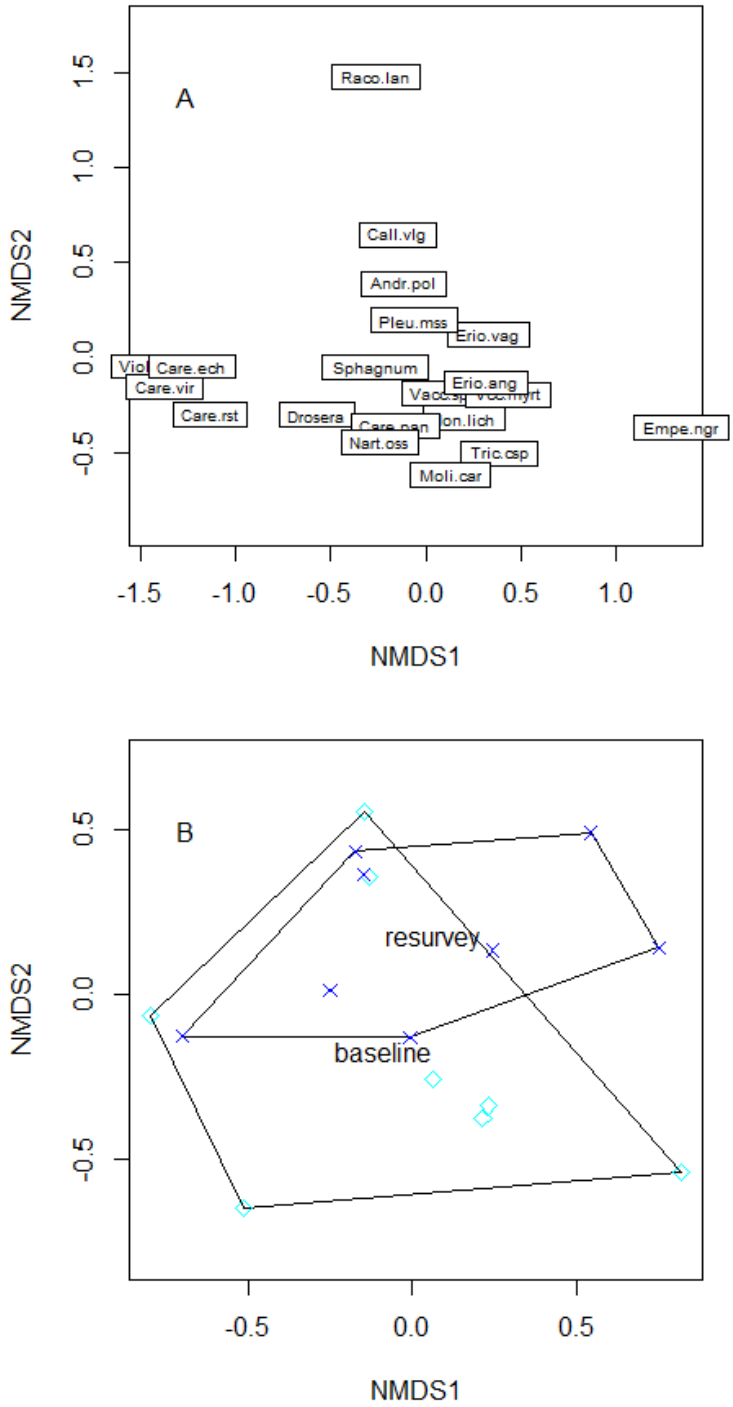

Figure 4.26. Mires. A. NMDS ordination for species. Labels overlap according to relative species diversity as calculated by the inverse Simpson index. B. NMDS ordination for parcels; phase labels indicate centroids; bounding hulls circumscribe all parcels within a survey phase.

vi. Mires / Wet Heath

Four parcels were surveyed under this protocol at both baseline and resurvey, with 257 unique stop identifiers. The only HLS option represented is HL10 Restoration of moorland (3). The DCA showed no clear shift between baseline and resurvey (Fig. 4.27), and the PerMANOVA did not detect any significant difference (R^2 = 7.0%; P = 0.68).

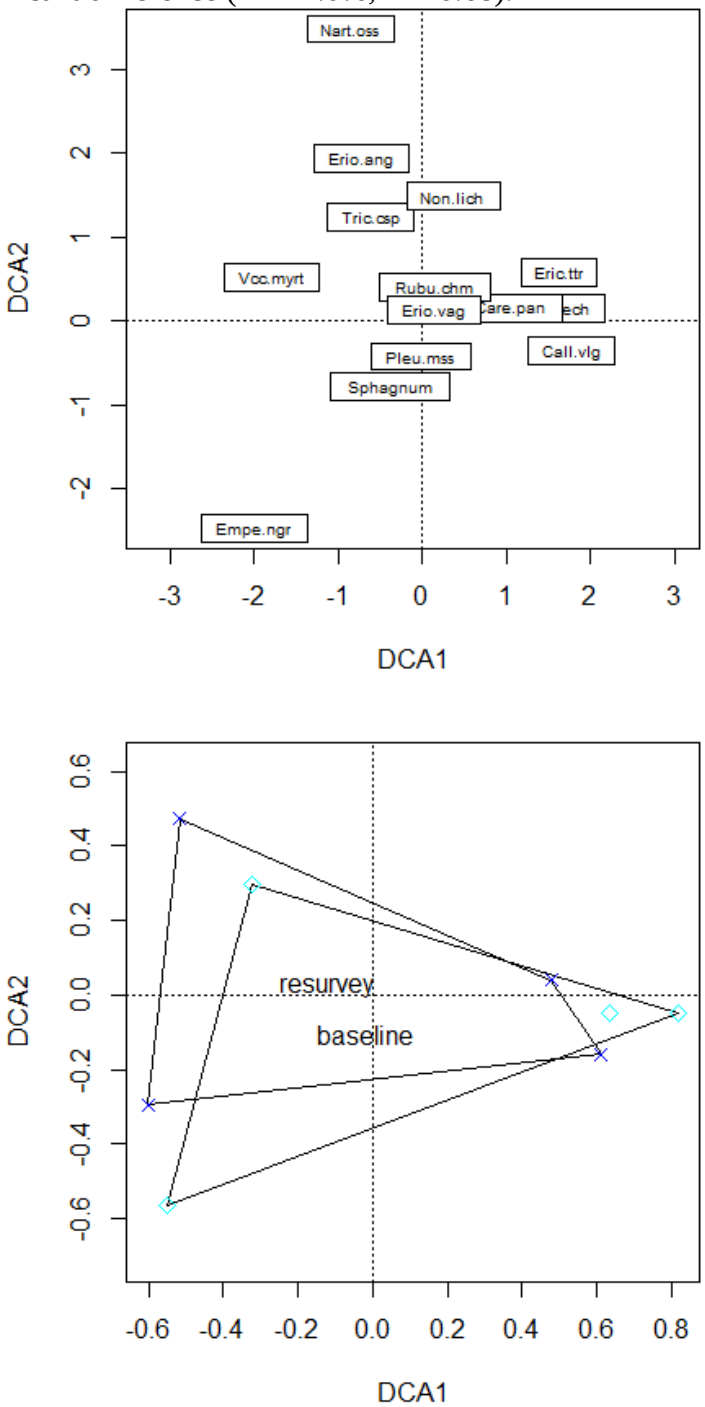

Figure 4.27. Mires / Wet Heath. A. DCA ordination for species. Labels overlap according to relative species diversity as calculated by the inverse Simpson index. B. DCA ordination for parcels; phase labels indicate centroids; bounding hulls circumscribe all parcels within a survey phase.

4.3 Conclusions

Did plant communities change more between the two surveys within parcels under restoration and creation options, compared to maintenance options?

Among lowland habitats, the multivariate analyses show changes in grassland communities under HLS creation and restoration management options. The latter may be explained by a shift towards plant assemblages that are typical of wetter sites or of those with less grazing. Separate analyses of univariate responses (Chapter 5) indicated that sward height increased on average in species-rich semi-natural grassland parcels under option HK7 (restoration), but that Ellenberg moisture attributes did not differ between the baseline survey and resurvey (Section 5.3.1), which suggests that a reduction in grazing may have driven the change in plant assemblages under this option. This difference between the analysis of all grassland restoration options and HK7 in isolation is not unexpected, given that sites managed under options for the restoration of wet grassland are fewer in the HK7 dataset.

The multivariate analyses did not show evidence of change in many maintenance options, with the exception of woodland maintenance (discussed below).

Is there evidence of change in plant communities between baseline and resurvey, within specific habitat types?

For the woodland maintenance option, changes in flora between the baseline survey and resurvey indicate a move towards less disturbed conditions, in addition to the change in grassland communities discussed above. This was accompanied by an increase in species richness between the two surveys for parcels under both woodland maintenance and restoration management options (HC7 and HC8; Section 5.3.4). Lowland heathlands were shown to move towards plant assemblages more indicative of heathlands between the two surveys, under both options for restoration and maintenance.

Is there evidence that plant communities changed more between baseline and resurvey in the lowlands or the uplands?

The multivariate analyses identified more instances of change among lowland, enclosed habitats than upland habitats. This may be partly due to differences in survey methods (quadrats which included percentage cover were used in enclosed surveys vs. stops converted to frequency data per parcel in the upland habitats) and in replication, as more parcels were surveyed in several of the lowland habitats than in the uplands. Due to these methodological differences, no firm conclusions can be drawn from these analyses regarding change in the lowlands vs. uplands.

5. Changes in condition and vegetation variables at option scale

5.1 Introduction and outline of analyses

These analyses tested whether condition and plant community variables changed between the baseline and resurvey, and whether any changes found were affected by agreement holder characteristics and geographical variables, at the scale of options. This provides an assessment of which options are successful (e.g. testing whether condition improved more for restoration than maintenance options), and how other factors may influence this. The number of agreements and parcels surveyed are summarised in Table 2.2 for the most frequent options surveyed during baseline and resurvey. Some additional parcels were surveyed only during the resurvey, e.g. under management options for enhanced wild bird seed mix plots (HF12), floristically enhanced grass margins (HE10), maintenance of wet grassland for wintering waters and wildfowl (HK10) and maintenance of rough grazing for birds (HL7). Analyses were conducted for seven options and option pairs, which cover a range of agricultural habitats: grassland (HK6, HK7, HK15/16, HL7/8), moorland (HL 9/10), woodland (HC7/8) and arable (HF12).

Condition was assessed for each habitat feature within each parcel (Natural England, 2010). For these analyses, a change in condition was classified as a 'success' when a parcel classed as condition A or B in the baseline remained at the same condition or improved (i.e. change of B to A), or a parcel initially in condition C at baseline improved to either A or B. Change in condition was analysed using logistic regression, and included the covariates shown in Table 5.1. Quantitative covariates were standardised prior to their inclusion in models. Condition at baseline was also included, to assess whether the starting condition affected the likelihood of a successful change. Habitat feature was also included, to determine whether condition outcomes differed between habitats. Binomial generalised linear mixed models were used where replication was sufficient to support them (option HK7), and general linear models in other cases, with the binomial response of successful management as previously defined. Multi-model selection was used to assess models with different combinations of the possible covariates on the basis of whole model fit to the data, using the MuMIn package in R (Barton, 2016). The final model in each case is presented in Appendix D, and discussed below.

Vegetation response variables were calculated from quadrat and stop data for all parcels resurveyed, based on species attributes such as Ellenberg fertility defined in PLANTATT (Hill et al., 2004), as detailed previously in Table 2.4. The majority of response variables were calculated as averages across all quadrats or stops in each parcel, while species richness was calculated across all quadrats or stops in each parcel. The difference in vegetation variable (resurvey – baseline) at the scale of parcel was analysed as the response variable. This used a similar approach to the analyses of condition, in terms of use of mixed models where the data were adequately replicated, and in relation to model selection from the large pool of potential models, each with a different combination of covariates. The average site value for each parcel (averaged across baseline and resurvey values) was also included. This was to test whether, for example, sites with a greater Ellenberg fertility attribute were likely to have changed more between the two surveys than those with a lower Ellenberg fertility attribute. The use of a site mean, as opposed to the baseline survey value, avoids potential spurious relationships caused by regression to the mean (Kirk et al., 2010; Smart et al., 2014).

Covariate	Covariate details	Scale of covariate data	Source of covariate data	Option scale analyses which included covariate
Habitat feature	Habitat feature(s) as defined by Farm Environment Plan criteria[1]	Parcel	HLS baseline and resurvey field data	All
Option identity	Identity of each HLS option, where analyses are of data relating to more than one option	Parcel	HLS baseline and resurvey field data	All
Site mean	Mean of baseline and resurvey values for response variable, allows interpretation of change along a gradient of values per site.	Parcel and option	HLS baseline and resurvey field data	Vegetation response variables (not CA)
Survey day difference	Difference in the Julian day (day count since start of the year) of the survey date of baseline and resurvey	Parcel and option	HLS baseline and resurvey field data	Vegetation response variables (not CA)
Area of parcel	Area of parcel under HLS management option	Parcel	HLS resurvey field mapping data	All
Presence of supplementary option	Was a supplementary HLS option also present? (Y/N)	Parcel	HLS agreement documentation	All
Environment zone	Broad grouping of English land classes to three categories. 1 = easterly lowlands, 2 = westerly lowlands, 3 = uplands.	Agreement	Countryside Survey[2]	All
Agricultural land classification	Grading of agricultural land. 1= excellent quality, 5 = very poor quality	Agreement	Natural England[3]	All
Slope	Average slope for quadrats or stops in field survey	Parcel	Digital Terrain Model[4]	All
Altitude	Average altitude for quadrats or stops in field survey	Parcel	Digital Terrain Model[4]	All
Ease of management	How easy or difficult have you found it to carry out the management prescription for each of these options on a scale of 1 - 5? 1 = very difficult, 5 = very easy	Option	HLS resurvey agreement holder (AH) interviews	All
Baseline panel score of option management prescriptions	How appropriate were management prescriptions for option on scale of 1 - 4? 1 = Key elements inappropriate, missing and/or in conflict, making mismanagement of the feature likely. 4 = Specific to site where necessary, effectively delimit acceptable management whilst leaving room for adaptation to address indicators of success	Option	HLS baseline project panel appraisal scores[5]	All

Table 5.1 Covariates used in option scale analyses of resurvey and baseline field survey data. [1]Natural England, 2010, [2]Carey et al., 2008, [3]Natural England, 2014, [4]Interlink Technologies, 2007, [5]Mountford et al., 2013.

5.1.1 Key questions addressed in option scale analyses

Did habitat condition improve between baseline and resurvey?

Do plant community variables (such as species richness, the dominance of species typical of fertile conditions, cover of woody species or sward height) change between baseline and resurvey?

Is there a relationship between an agreement holder's rating of ease of management and change in habitat condition or plant community variables?

Do other factors such as the region of England, the quality of agricultural land, field size or degree of slope relate to changes found in condition or plant community variables?

Did parcels with high panel appraisal ratings for how appropriate management prescriptions were have better outcomes, in terms of improved condition or plant community variables?

Did condition and plant community variables change more between the two surveys on parcels managed under restoration than maintenance options?

5.2 HK7 - restoration of species rich semi-natural grassland

5.2.1 HK7 condition

HK7, all features		RESURVEY A	B	C	Total
BASELINE	A	17	19	1	37
	B	26	23	21	70
	C	5	15	23	43
	Total	48	57	45	150

Table 5.2 Condition at baseline and resurvey for parcels managed under HK7 option, for all habitat features that remained the same between the two surveys. Shaded cells denote outcomes categorised as negative change in condition in analyses.

The habitat under option HK7 had an effect on the likelihood of a positive change in condition between the baseline survey and resurvey (Appendix D, Table D7 for statistical model outputs). A positive change in condition was more likely if the habitat feature was semi-improved grassland (G02), rather than lowland calcareous grassland (G04), lowland meadow (G06) or purple moor-grass and rush pasture (G07). A few parcels containing habitat in other categories (which were too few for inclusion individually) also had a reduced likelihood of success compared to G02. This 'other category' was dominated by species-rich grassland (G03) and lowland dry acid grassland (G05). These results suggest improvement in condition is harder to achieve for BAP habitats than more intensively farmed grasslands (Table 5.3). All ten lowland meadows that were classed in poor condition (C) in the baseline remained in condition C at the resurvey. It may be relatively straightforward to bring about initial improvements to a semi-improved sward, especially with addition of seed, but getting the next step towards a priority habitat in good condition is harder to achieve. This result also reflects the more stringent condition assessment criteria for BAP habitats, compared with condition criteria for semi-improved grassland. For example, condition for the BAP habitat features include a requirement for a certain number of positive indicator species to be present. Results for specific criteria used for feature condition assessments are in Appendix D (Tables D1-D6).

HK7, G02		RESURVEY A	B	C	Total
BASELINE	A	9	3	0	12
	B	9	8	3	20
	C	2	6	1	9
	Total	20	17	4	41

HK7, G04		RESURVEY A	B	C	Total
BASELINE	A		4	1	5
	B	4	2	3	9
	C	1	2	5	8
	Total	5	8	9	22

HK7, G06		RESURVEY A	B	C	Total
BASELINE	A	1	0	0	1
	B	2	3	6	11
	C	0	0	10	10
	Total	3	3	16	22

HK7, G07		RESURVEY A	B	C	Total
BASELINE	A		6		6
	B	5	3	2	10
	C	1	2	3	6
	Total	6	11	5	22

HK7, Other		RESURVEY A	B	C	Total
BASELINE	A	7	5		12
	B	5	7	7	19
	C	1	5	4	10
	Total	13	17	11	41

Table 5.3 Condition at baseline and resurvey for parcels managed under HK7 option, by habitat feature. Shaded cells denote outcomes classified as negative change in condition in analyses. Habitat features: G02 = semi-improved grassland; G04 = lowland calcareous grassland; G06 = lowland meadows; G07 = purple moor grass and rush pasture.

The majority of habitat features were the same at baseline and resurvey (90% for HK7). Statistical analyses of change in condition were carried out only for these majority of habitat features that remained the same at the baseline and resurvey, as condition is defined by different criteria for each feature type. For example, a semi-improved grassland with condition A at baseline might have changed to a BAP habitat with condition B at resurvey, but would be considered a success due to the conversion to a habitat with greater conservation value.

Condition of the remaining 10% of parcels under HK7 management in which habitat changed are reported in Table 5.4. Nine out of 11 parcels classed as semi-improved grassland at baseline improved to grasslands with higher conservation value (G04, G06, G07) at resurvey, as did two of the four species-rich grasslands at baseline.

HK7, change in habitat		RESURVEY G02	G04	G06	G07	G13	Total
BASELINE	G02		1	3	5	2	11
	G03	2		2			4
	Total	2	1	5	5	2	15

Table 5.4 Change in habitat feature between HLS baseline survey and resurvey for management option HK7. Features as for Table 5.3, G03 = species rich grassland; G13 = habitat for wintering waders and wildfowl.

The final analysis for change in condition under HK7 also included parcel size (area) and slope (Table D7). More steeply sloping parcels had a slightly reduced likelihood of a positive change in condition. When the parcel size and slope were included, baseline condition had less effect on the likelihood of a positive outcome for condition, for land managed under HK7.

5.2.2 HK7 plant community changes

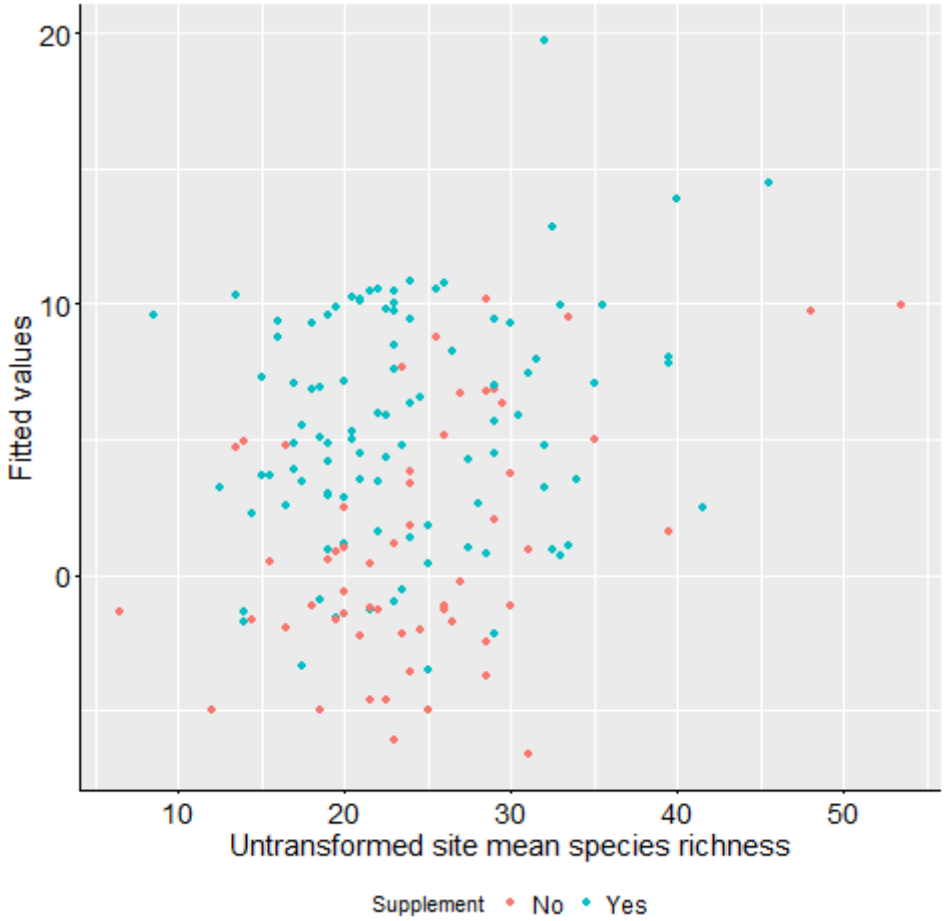

Figure 5.1 Fitted values of difference in species richness (resurvey – baseline) between the two surveys of parcels managed under HK7, plotted against the mean species richness for each parcel across the two surveys. Fitted values are derived from generalised linear mixed model selected through multi-model selection process. Blue dots show parcels with additional supplementary options, red dots show those without supplementary options.

Supplementary options applied with HK7		Number of parcels
Code	**Description**	
HK18	Hay-making supplement	59
HR1	Cattle grazing supplement	62
HR2	Native breeds at risk grazing supplement	41
HR4	Supplement for the control of invasive plant species	3
HR5	Bracken control supplement	2
HR6	Supplement for small fields	40
HR7	Supplement for difficult sites	23

Table 5.5 Frequency of supplementary options applied to parcels surveyed under option HK7 management. Some parcels had more than one supplementary HLS option.

Species richness increased between the two surveys in around two-thirds of parcels under HK7 management (104 out of 160) but decreased in about a quarter of parcels (43). On average 3.85 more species were recorded at resurvey than baseline. The addition of one or more supplementary options was strongly related to an increase in species richness at resurvey, relative to the baseline (Table D29), showing that supplementary options may facilitate more targeted management that improves the botanical outcomes from HK7 (Figure 5.1). In contrast, the presence of supplementary option(s) also had a small effect of increased cover of woody and semi-woody species between the two survey periods (Table D37, Figure 5.2), which may be a less desirable outcome for some features managed under HK7. Both these outcomes could relate to a reduction in the intensity of management (e.g. type or density of livestock used for grazing). The most frequent supplements applied to parcels under HK7 were hay-making, cattle grazing and use of native breeds at risk (Table 5.5).

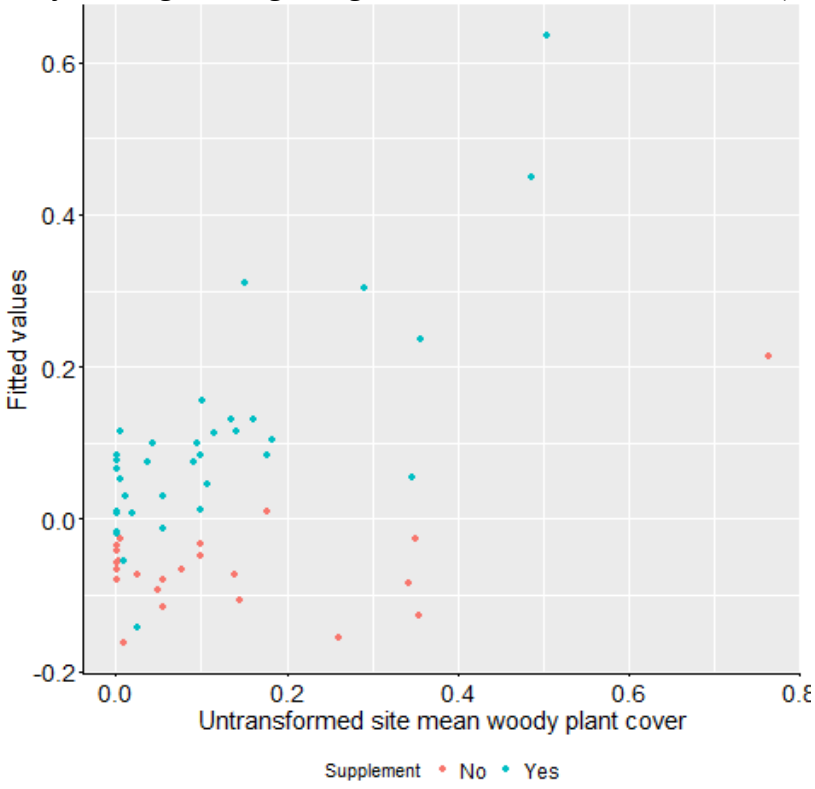

Figure 5.2 Fitted values of difference in cover of woody and semi-woody species (resurvey – baseline) between the two surveys of parcels HK7 management, plotted against the mean cover for each parcel across the two surveys. Blue dots denote parcels with additional supplementary options, red dots show those without supplementary options.

The habitat to which option HK7 was applied affected the change in score for competitiveness between baseline and resurvey (Table D33). This score, which reflects the cover of plant species with more competitive strategies (Grime et al., 2007), was reduced between the two surveys if the baseline habitat was lowland calcareous grassland (GO4), compared to other habitats under HK7 management. Condition was found above to be more likely to have improved if the starting habitat was semi-improved grassland (G02), rather than a conservation priority grassland. Different variables may thus detect positive change in different features, demonstrating the value of looking at a range of response variables. As discussed above, condition assessment for G02 may be less rigorous than for the priority grassland habitats. Hence, whilst lowland calcareous grasslands managed under HK7 may have shown a positive move towards less competitor-dominated plant communities between the two surveys, the change was insufficient to achieve a condition of A on other parameters. A reduction was also found in cover-weighted score for grazing tolerant species for lowland meadows (G06) and purple moor-grass and rush pastures (G07) between the baseline and resurvey (Table D40), perhaps indicating a reduction in grazing pressure.

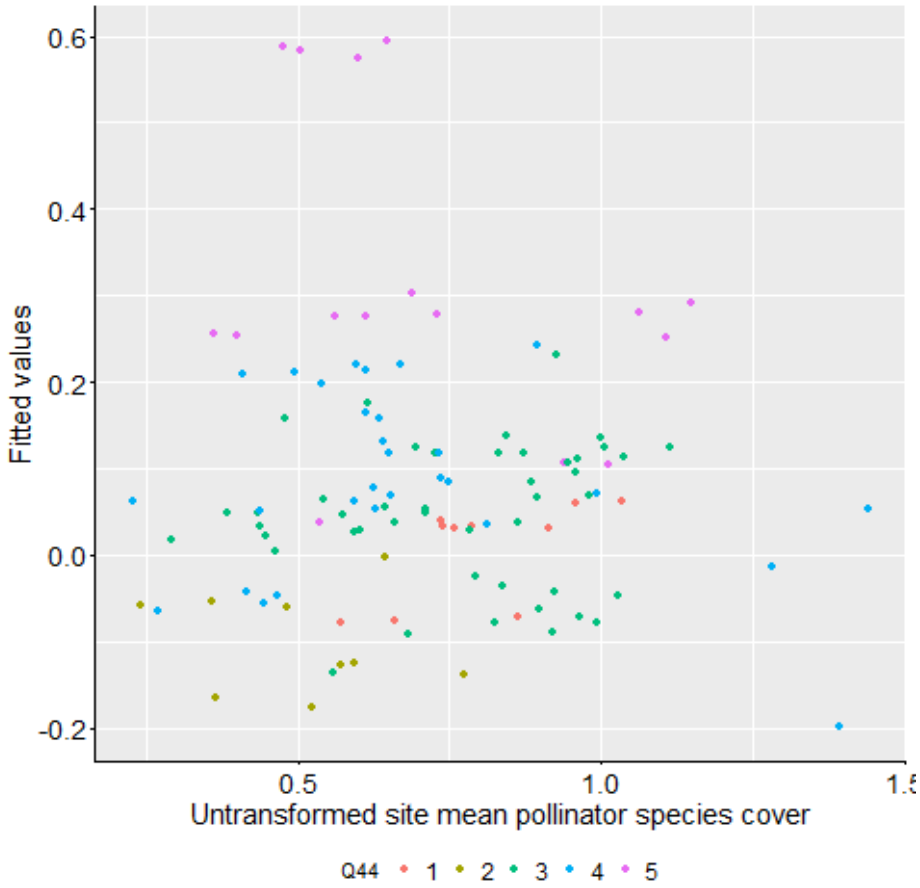

Figure 5.3 Fitted values of difference in cover of pollinator plant species (resurvey – baseline) between the two surveys under HK7, plotted against the mean pollinator plant cover for each parcel across the two surveys. Fitted values are derived from generalised linear mixed model selected through multi-model selection process. Coloured dots denote different answers to the agreement holder interview question 44: "How easy or difficult have you found it to carry out the management prescription for each of these options on a scale of 1 - 5?" 1(red) = very difficult, 5(pink) = very easy.

High agreement holder scores for the ease with which management for HK7 could be implemented was related to an increase in cover of plants for pollinators between the baseline and resurvey (Table D39; Figure 5.3).

Geographical parameters affected the change in several HK7 botanical variables between the baseline and resurvey. The size of parcel under HK7 management had a small effect on the competitive and ruderal scores, with larger parcels more likely to have an increased score for competitors between the two surveys (Table D33), but a decreased score for ruderal species (Table D34). Steeper sloped parcels were also associated with an increased score for competitors (Table D33) between baseline and resurvey.

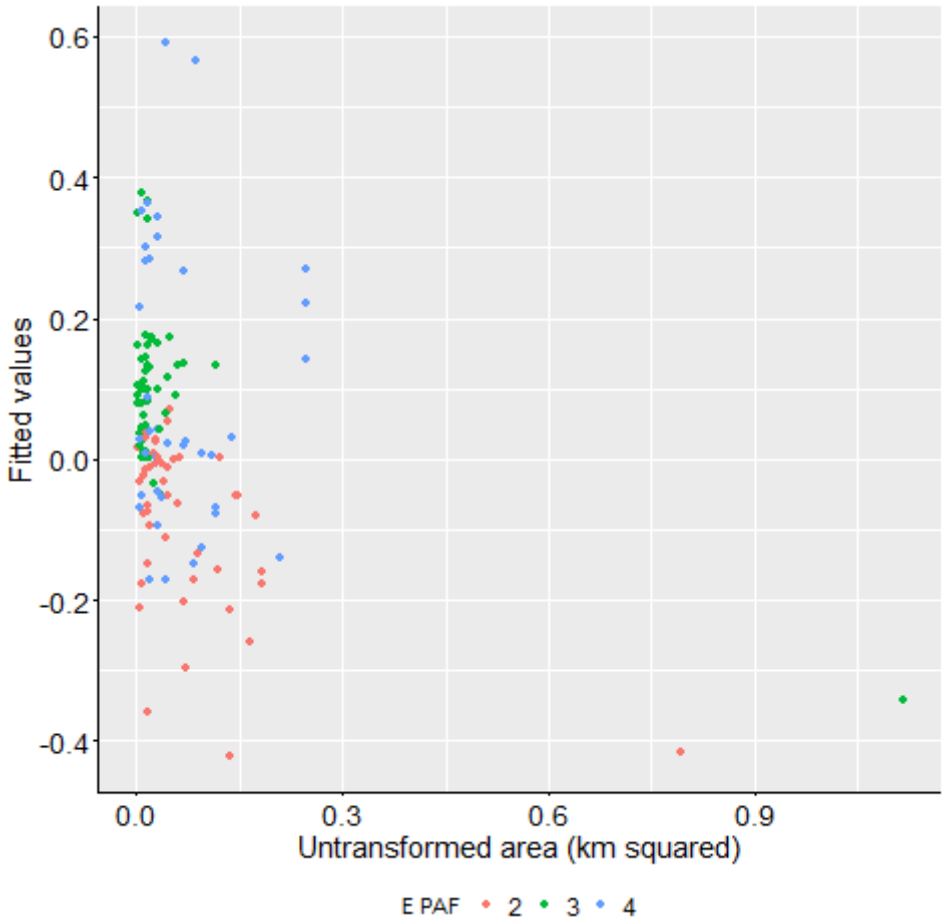

Figure 5.4 Fitted values of difference in cover-weighted ruderal attribute (resurvey – baseline) between the two surveys of parcels under HK7, plotted against the mean ruderal attribute for each parcel across the two surveys. Fitted values are derived from generalised linear mixed model selected through multi-model selection process. Coloured dots denote different scores attributed during the panel appraisal review (criterion E), relating to "How appropriate were management prescriptions for option on scale of 1 - 4?" 2 (red) = prescriptions with risks of internal conflict and/or inappropriate or missing elements that could affect successful management of the feature; 3 (green) = prescriptions mainly generic, but without internal conflict and providing an appropriate framework for management of the feature; 4 (blue) = prescriptions are specific to site when/where necessary and effectively delimit acceptable management whilst leaving room for adaptation to address indicators of success.

The baseline panel appraisal score (for appropriateness of HK7 management prescriptions) was related to several response variables. A panel score of 3 or 4 (vs a score of 2), which indicated more appropriate management prescriptions, was associated with a higher ruderal score at resurvey than baseline (Table D34; Figure 5.4). This might be because some restoration treatments involve creation of bare ground – hence there might be a transitional period when ruderal species respond to this. Higher panel scores were also associated with a reduction in woody plant cover between baseline and resurvey (Table D37), and an increase in grazing tolerance score (Table D40). Parcels with a taller sward showed a greater increase

in sward height between a two surveys (Figure 5.5). More parcels had an increase in sward height than a decrease between the two surveys, and this may reflect a reduction in grazing pressure.

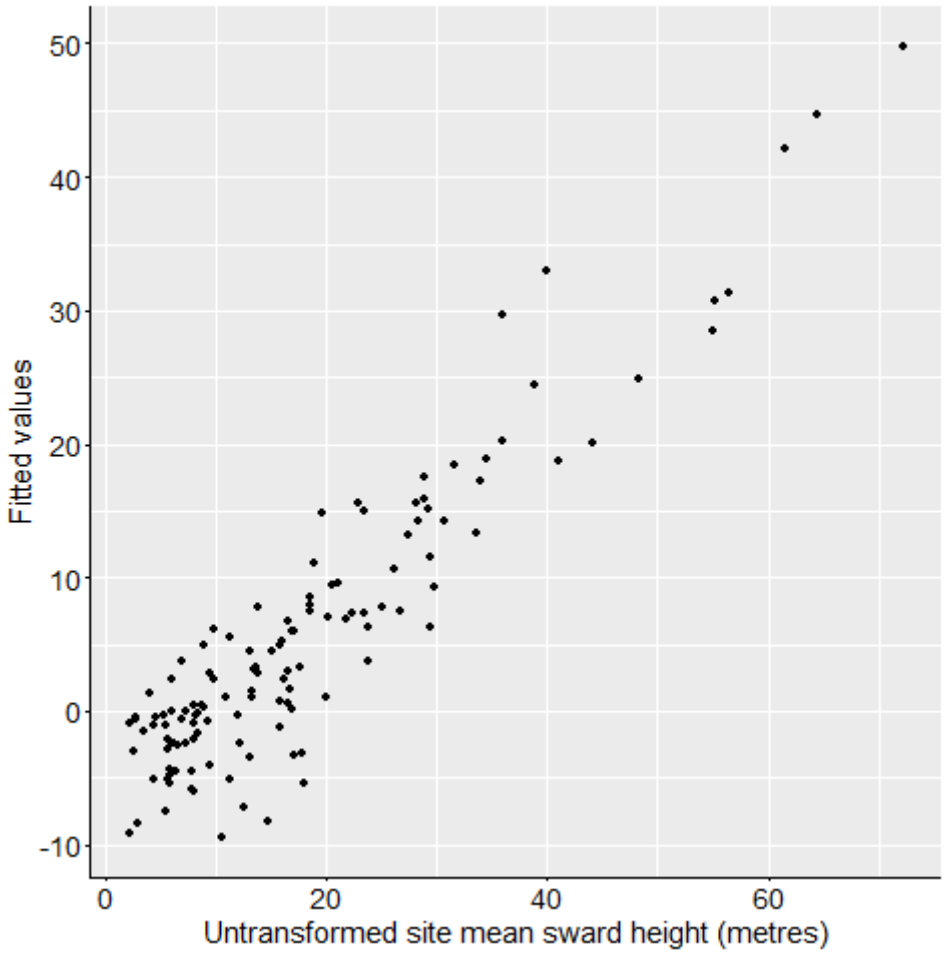

Figure 5.5 Fitted values of difference in sward height (resurvey – baseline) between the two surveys of HLS parcels under management option HK7, plotted against the mean sward height for each parcel across the two surveys. Fitted values are derived from generalised linear mixed model selected through multi-model selection process

5.2.3 HK7 conclusions

- Almost half the parcels (63 out of 150) managed under HK7 remained in the same condition category in both surveys (Section 5.2.1). Condition was more likely to improve for semi-improved grasslands, than for priority grasslands. In addition to condition results discussed where habitats were the same at both surveys, over two-thirds of the parcels where the habitat changed between surveys went from semi-improved to priority grasslands of higher conservation value. Fifteen parcels changed habitat type between the surveys. Eleven parcels were classed as semi-natural grassland at baseline, but had improved to a grassland with higher conservation baseline at resurvey.
- Species richness increased between surveys on more parcels than decreased; statistical analyses showed species richness was more likely to have increased where a supplementary option had been applied in addition to HK7.
- Shifts towards less competitor-dominated communities in lowland calcareous grasslands also indicate a degree of improvement in priority grassland plant communities between the surveys, although the change was insufficient to be reflected in condition class.
- Longer timescales (than elapsed between these surveys) may be required for highly diverse priority grasslands to develop or improve (Mountford et al., 1996). The maximum duration between the baseline survey and resurvey was eight years, and was more commonly seven years. Fagan et al. (2008) concluded that restoration of calcareous grassland sites was achievable but slow, with restored sites often not resembling target ancient grasslands even after several decades. A report into rehabilitating existing priority grasslands from suboptimal to good condition gives a more optimistic timescale of 1-10 years depending on the type of management and starting condition (Shellswell et al., 2016). However, restoration (defined by Shellswell et al., (2016) as improving a site's quality from non-priority to priority condition) is likely to take considerably longer. Recently, modelling plant community responses to AES options designed to promote extensification of grassland as part of a Welsh scheme has indicated that it may take 10 – 15 years for soil parameters such as pH and C:N ratio to be remediated to conditions that would support mesotrophic grasslands such as MG3 or MG5 (https://gmep.wales/biodiversity/glastirimpact/BD031).
- Increases in cover of plants for pollinators at resurvey was associated with the ease of implementing management as rated by agreement holders.
- More parcels had an increase in sward height than a decrease between the two surveys, probably reflecting reduced grazing pressure.
- A total of 36 out of the 55 agreement holders (65.5%) who were carrying out HK7 had been in a previous AES. This may indicate that some restoration management predated their current HLS agreement and so may have progressed further.

5.3 HK6 – maintenance of species rich semi-natural grassland

5.3.1 HK6 condition

HK6, all features		RESURVEY A	B	C	Total
BASELINE	A	17	5	4	26
	B	10	17	5	32
	C	8	10	10	28
	Total	35	32	19	86

Table 5.6 Condition at baseline and resurvey for parcels managed under HK6 option, for all habitat features that remained the same between the two surveys. Shaded cells denote outcomes categorised as negative change in condition in analyses.

The likelihood of a positive change in condition between the baseline and resurvey differed between habitat features for option HK6 (Appendix D Table D8), as it did for HK7. Fewer parcels were surveyed under option HK6, and so there was only sufficient replication to compare individually semi-improved grassland (G02) with G06 (lowland meadows), and a combined category of other species-rich grasslands (mainly G03, G04, G07 and G09, see Table 3.1 for a description of habitat features). Lowland meadows managed under HK6 had a reduced likelihood of a positive change in condition compared to other species-rich grasslands (Table 5.7). Nonetheless, a greater proportion of lowland meadows with condition C improved at resurvey under HK6 than HK7.

HK6, G02		RESURVEY A	B	C	Total
BASELINE	A	6	1		7
	B	1	5		6
	C		1	1	2
	Total	7	7	1	15

HK6, G06		RESURVEY A	B	C	Total
BASELINE	A	3	1	4	8
	B	1	5	1	7
	C	2	5	4	11
	Total	6	11	9	26

HK6, other		RESURVEY A	B	C	Total
BASELINE	A	8	3	2	13
	B	8	9	4	21
	C	6	6	5	17
	Total	22	18	11	51

Table 5.7 Condition at baseline and resurvey for parcels managed under HK6, by habitat feature. Shaded cells denote outcomes classified as negative change in condition in analyses. Habitat features: G02 = semi-improved grassland; G06 = lowland meadows.

The addition of a supplementary option to HK6 also increased the likelihood of a positive change in condition, compared to parcels without supplementary options (Table D8). The most frequently applied supplements were for hay-making and cattle grazing (Table 5.8). As

for HK7, baseline condition did not affect the change in condition by resurvey, once the effects of habitat and supplementary options were accounted for.

Supplementary options applied with HK6		Number
Code	**Description**	**of parcels**
HC11	Woodland and livestock exclusion supplement	4
HK18	Hay-making supplement	23
HR1	Cattle grazing supplement	16
HR2	Native breeds at risk grazing supplement	9
HR5	Bracken control supplement	1
HR6	Supplement for small fields	5
HR7	Supplement for difficult sites	6

Table 5.8 Frequency of supplementary options applied to parcels surveyed under option HK6 management. Some parcels had more than one supplementary option.

Ten parcels under HK6 management changed habitat between the two surveys (Table 5.9). In contrast to HK7, there was not a clear pattern of semi-improved grassland changing to species-rich priority grasslands for the majority of those parcels where habitat changed. Three G03 (species-rich grasslands) did change to BAP grassland habitats, but there were also several parcels which changed from one type of BAP grassland at baseline to another BAP grassland at resurvey (e.g. two parcels changed from upland calcareous grassland to upland hay meadows.

HK6, change in habitat		RESURVEY							
		G02	G03	G05	G06	G07	G09	G15	Total
BASELINE	G02		1						1
	G03	2			2	1			5
	G07			1					1
	G08						2		2
	W08							1	1
	Total	2	1	1	2	1	2	1	10

Table 5.9 Change in habitat feature between HLS baseline and resurvey for management option HK6. Features: G02 = semi-improved grassland, G03 = species rich grassland, G05 = lowland dry acid grassland – BAP habitat, G06 = lowland meadows – BAP habitat, G07 = purple moor grass and rush pastures – BAP habitat, G08 = upland calcareous grassland – BAP habitat, G09 = upland hay meadows – BAP habitat, G15 = coastal and flood plain grazing marsh – BAP habitat

5.3.2 HK6 plant community changes

Species richness increased in the majority of parcels (55 out of 76) under HK6 management between the two surveys, although it decreased in 20 parcels. On average 5.3 more species were recorded at resurvey than baseline. Species richness increased more if the habitat was G06 (lowland meadows) than other habitats (Table D42; Figure 5.6). An agricultural land classification (ALC) of 4 or 5 (poor quality agricultural land) had a negative association with

the change in species richness between baseline and resurvey, compared to higher quality agricultural land classified as grades 2 or 3. Lower ALC gradings may reflect low fertility but also other environmental constraints such as soil moisture. It is also possible some sites with a poor initial species richness may have a reduced capacity to recruit new species.

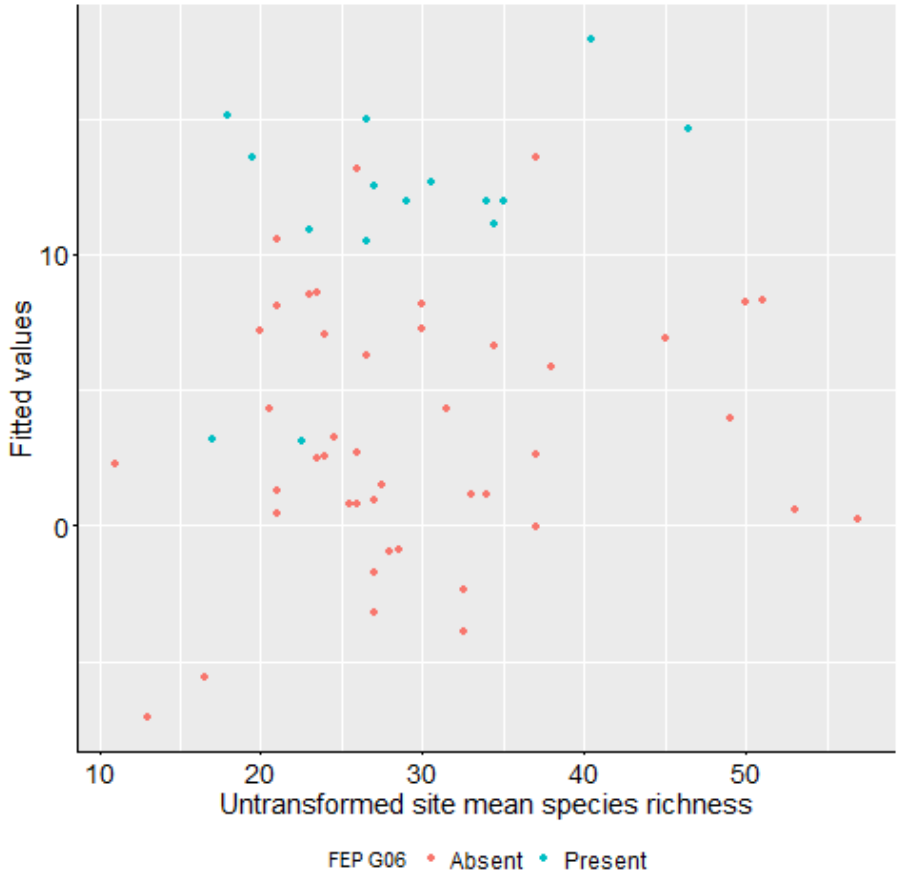

Figure 5.6 Fitted values of difference in species richness (resurvey – baseline) between the two surveys of parcels under HK6, plotted against the mean species richness for each parcel across the two surveys. Fitted values are derived from generalised linear model selected through multi-model selection process. Blue dots denote parcels with G06 (lowland calcareous grassland) present, red dots show parcels without G06.

Ellenberg reaction (R), which indicates a plant community's preference for soil acidity (Hill et al., 2004) was associated with environment zone. Ellenberg R increased between the baseline survey and resurvey for parcels in environment zone 3 (English uplands), compared to those in the English lowlands (zones 1 or 2; Table D44), indicating a small shift towards plant communities more typical of basic soils.

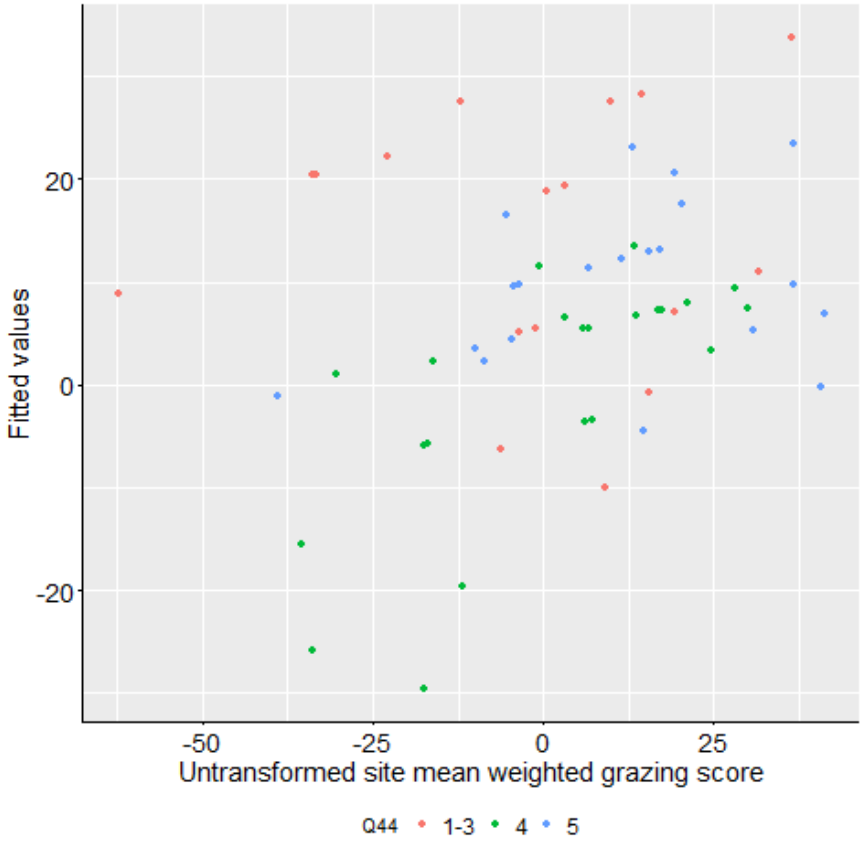

Figure 5.8 Fitted values of difference in cover weighted grazing score (resurvey – baseline) between the two surveys of HLS parcels under management option HK6, plotted against the mean grazing score for each parcel across the two surveys. Coloured dots denote different answers to the agreement holder interview question 44: "How easy or difficult have you found it to carry out the management prescription for each of these options on a scale of 1 - 5?" 1 (red) = very difficult, 5 (blue) = very easy.

Grazing tolerance score increased on average between the two surveys, and was related to agreement holder's rating of ease of management for HK6 (Figure 5.8). A management rating of very difficult, difficult or neutral was associated with a greater increase in grazing tolerance scores between the two surveys, compared with a rating of easy (4). In addition, grazing tolerance score changed less between the two surveys on parcels with lowland calcareous grassland (G06) present (Table D52).

The change in grass to forb ratio for HK6 between baseline and resurvey was negatively related to the site mean value (Table D49); grass to forb ratio decreased more between surveys for those parcels with a higher grass to forb ratio. There was also a positive relationship with slope, whereby grass to forb ratio increased more between the two surveys on steeply sloping land. The cover of negative indicator plant species had a similar relationship with site mean value, as cover decreased more on parcels with higher cover of negative indicators (Table D50). Area of HK6 parcel had a positive relationship with the change in cover of negative indicator species (cover decreased more on smaller fields).

The cover of pollinator friendly plant species increased more between baseline and resurvey on parcels for which the management prescriptions had been classified as 3 or 4 (largely appropriate) by the baseline panel appraisal, compared to those classed as 2 ("prescriptions with risks of internal conflict and/or inappropriate or missing elements that could affect successful management of the feature"; Table D54).

5.3.3 HK6 conclusions

- Few botanical variables showed strong indications of change between the baseline survey and resurvey for parcels under option HK6. This might be expected, as management objectives for this option are aimed at maintaining rather than restoring the grassland feature, so there would be an expectation that land under HK6 should be in reasonable condition at the start of an agreement. However, twenty-eight of the 86 parcels under option HK6 were classed as condition C during the baseline survey, with ten remaining in condition C at the resurvey.
- Species richness increased between the two surveys in the majority of parcels, and was more likely in lowland meadows than other grassland types.
- The degree of change in plant assemblages between baseline and resurvey depended partly on the initial baseline state. Where the grass to forb ratio was initially low there was a reduced chance of a further decrease between baseline and resurvey. Similarly, cover of negative indicator plant species decreased more between the surveys on parcels that had a greater cover of negative indicators at the start.
- The cover of pollinator friendly plant species increased more between the baseline and resurvey on parcels for which the management prescriptions had been classified as 3 or 4 (largely appropriate) during the baseline panel appraisals.

5.4 HK15 / 16 – maintenance / restoration of semi-improved or rough grassland for target species

5.4.1 HK15 / 16 condition

HK15		RESURVEY A	B	C	Total
BASELINE	A	12	7	2	21
	B	14	18	8	40
	C	4	21	16	41
	Total	30	46	26	102

HK16		RESURVEY A	B	C	Total
BASELINE	A	8	3	3	14
	B	1	7	4	12
	C	1	5	1	7
		10	15	8	33

Table 5.10 Condition at baseline and resurvey for parcels managed under HK15 and HK16 options, across all habitat features. Shaded cells denote outcomes categorised as negative change in condition assessment in analyses.

The habitat feature to which options HK15 and HK16 were applied was not linked to the likelihood of a change in condition between baseline and resurvey (Appendix D Table D10). There is weak evidence that the likelihood of a positive change may be greater for HK16 (maintenance) than HK15 (restoration), but fewer parcels under HK16 were surveyed (Table 5.10). The strongest effect observed was of agreement holders scoring the ease of management as 5 (very easy), which resulted in an increased likelihood of a positive change in condition between surveys.

Broadly, HK15 and 16 often require management that would be fairly familiar to land managers, which might help explain the association between an assessment of ease of delivery and the likelihood of a positive change. Agreement holders that found HK15 and HK16 options 'very easy' to carry out stated that implementing the option did not require them to do more than they were already doing and generally had a good fit with existing land management practices, as the following comments from agreement holder interviews illustrate.

> "Takes care of itself." (Agreement Holder 53, Very Easy HK15)
>
> "It fits in with what we are doing anyway. Geared up for it." (Agreement Holder 66, Very Easy HK15)
>
> "It's more or less what we were doing anyway. The option was either cutting hay or grazing, and we've not been able to do grazing because of costs involved in the infrastructure (fencing etc) needed, so stuck with taking the hay and that's continued to work." (Agreement Holder 112, Very Easy HK16)
>
> "The management was successful before entered, we just kept doing the same." (Agreement Holder 105, Very Easy HK15)

There is weaker evidence for the baseline panel appraisal score for appropriateness of management prescriptions affecting the likelihood of a positive change in condition. A score of 'inappropriate' for management prescriptions at baseline was associated with a reduced chance of positive change in condition, compared to better management prescription scores. Habitat features with conditions of B or C at resurvey failed on a range of criteria, including cover of undesirable species, cover of wildflowers and sedges, cover of bare ground and cover of invasive trees and shrubs (Table D8).

There were only three parcels under HK15 or HK16 management in which the habitat feature changed between surveys, compared with 135 parcels where the same habitat was present at baseline and resurvey. Two parcels recorded as G02 (semi-improved grassland) changed to G03 (species-rich grassland) and G05 (lowland dry acid grassland – BAP habitat) respectively, while one G15 (coastal and flood plain grazing marsh – BAP habitat) parcel changed to G02. Far fewer parcels were surveyed under HK16 than HK15, so the fact that habitat feature did not change in any parcel under HK16 management is probably due to this smaller sample size.

5.4.2 HK15 / 16 plant community changes

Species richness of parcels under option HK15 and HK16 increased more between the two surveys in environment zone 2 (westerly lowlands) compared to zones 1 and 3 (Figure 5.9; Table D55). In addition, there was an increase in species richness when the habitat feature present was in the 'other' category, compared to semi-improved grassland (G02) or coastal and flood plain grazing marsh habitat (G15). Individual habitat features in the 'other' category were less frequent than G02 and G15, and included conservation priority BAP grasslands (G03, G04, G05, G06, G07, G08, G09) as well one or two examples of habitat being managed primarily for target species in other taxa (invertebrates and birds).

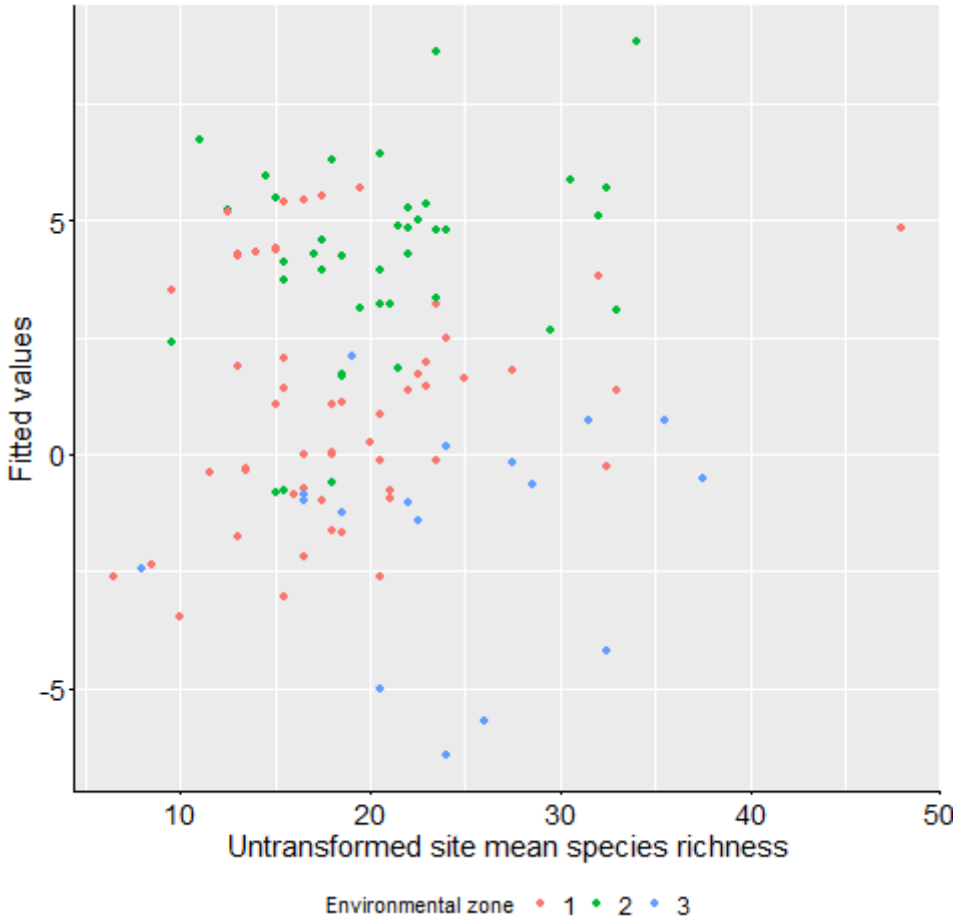

Figure 5.9 Fitted values of difference in species richness (resurvey – baseline) between the two surveys of HLS parcels under management options HK15 and HK16, plotted against the mean species richness for each parcel across the two surveys. Red dots show environment zone 1 (easterly lowlands), green dots = 2 (westerly lowlands), blue dots = 3 (uplands).

The environment zone was also related to changes in Ellenberg fertility and reaction attributes between the two surveys (Tables D56 and D57). Both attributes decreased in the westerly lowlands (environment zone 2), while there was also weak evidence of a decrease in Ellenberg reaction in the uplands (zone 3), relative to zone 1 (easterly lowlands). This may be a feature of the increasing isolation of higher value sites in the eastern lowlands as a result of highly intensive agriculture around them, leading to low capacity to recruit those species that require low fertility. The soils of the eastern lowlands are overwhelmingly neutral to mildly alkaline and so the result for reduced reaction might be expected.

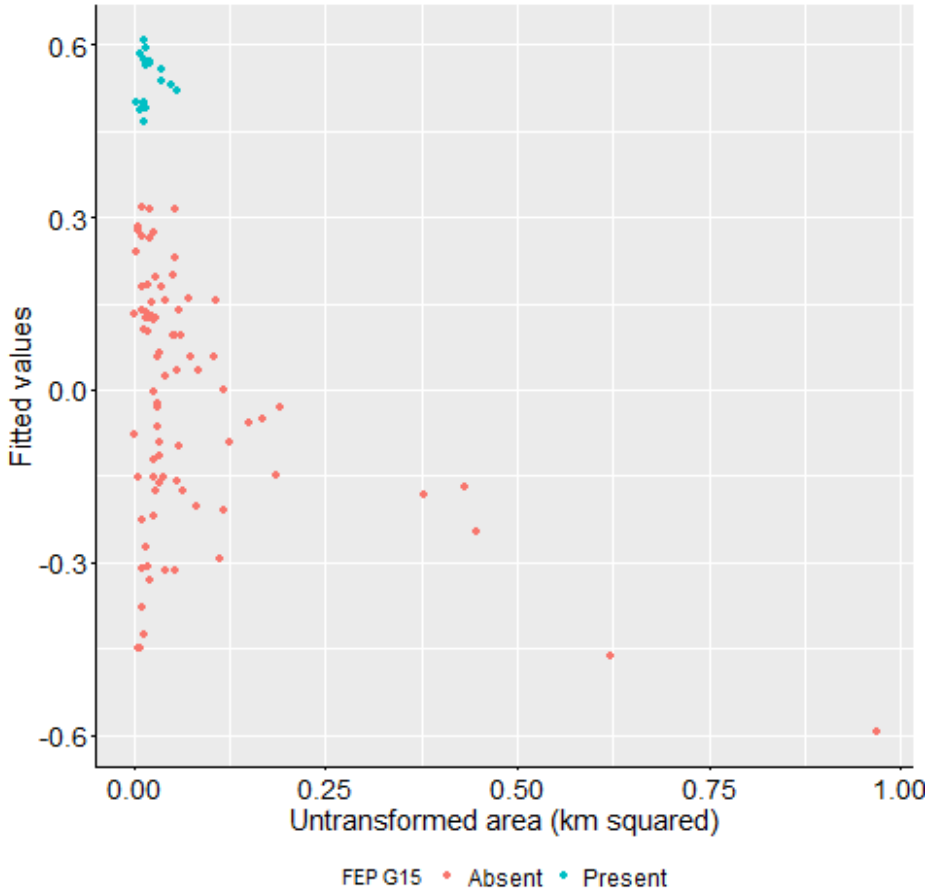

Figure 5.10 Fitted values of difference in cover weighted Ellenberg moisture attribute (resurvey – baseline) between the two surveys of parcels under HK15 and HK16, plotted against the area of each parcel. Blue dots denote presence of habitat feature G15 (Coastal and flood plain grazing marsh).

Change in Ellenberg moisture attribute (F) was related to baseline habitat feature. Ellenberg F increased on HK15 and HK16 parcels containing coastal and flood plain grazing marsh habitat (G15), but not consistently on the other habitat features present (Table D53). There was also a negative relationship with parcel area, whereby larger decreases in Ellenberg F were seen on large parcels, though this may be partly driven by a very few large parcels (Figure 5.10).

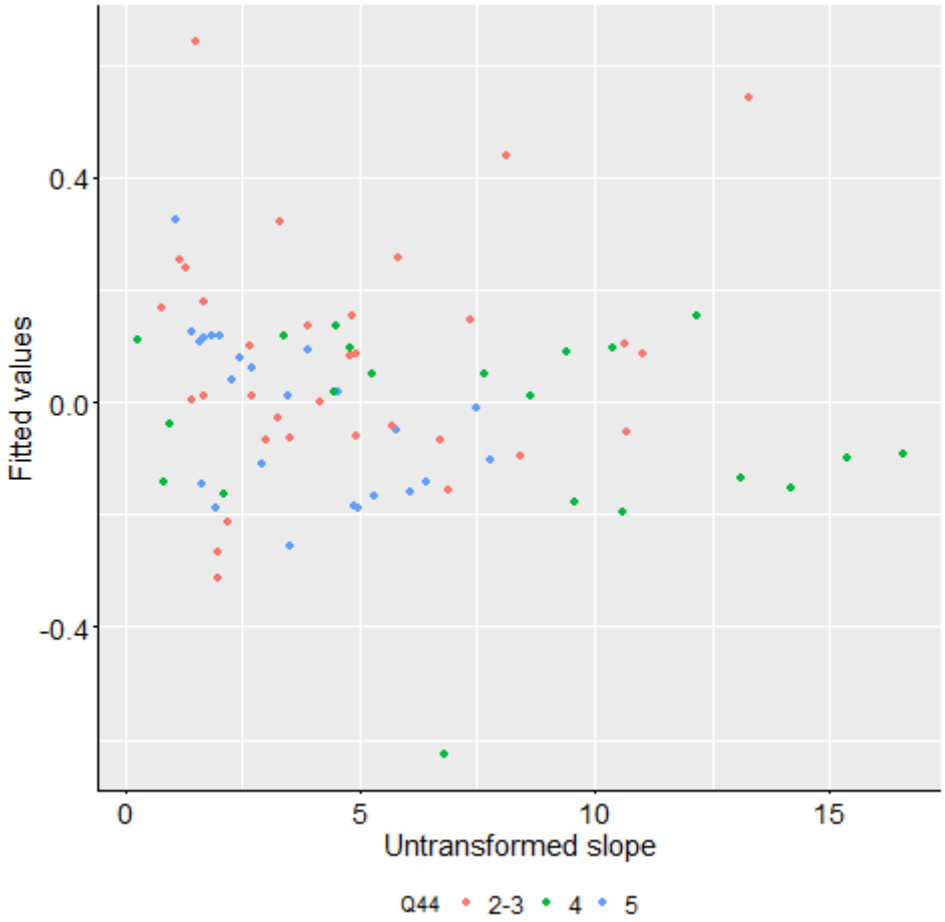

Figure 5.11 Fitted values of difference in cover weighted competitiveness attribute (resurvey – baseline) between the two surveys of parcels under options HK15 and HK16, plotted against the slope for each parcel. Coloured dots show different answers to the agreement holder interview question 44: "How easy or difficult have you found it to carry out the management prescription for each of these options on a scale of 1 - 5?" 1 (red) = very difficult, 5 (blue) = very easy.

Agreement holder ratings for ease of management were present in the final models for all three Grime botanical attributes (Tables D59 – C61). Land managed under HK15 and HK16 on agreements where agreement holders rated the management as easy (score 4) showed a reduced botanical competitiveness attribute between the two surveys, and an increase in stress tolerator attribute (Figures 5.11 and 5.12). This suggests that if agreement holders rate management prescriptions as easy, the plant assemblage under HK15 and HK16 on those agreements is more likely to show a reduction in dominant competitive species over time, and an increase in stress-tolerators, which (although not always the main target of these options) are desirable botanical outcomes.

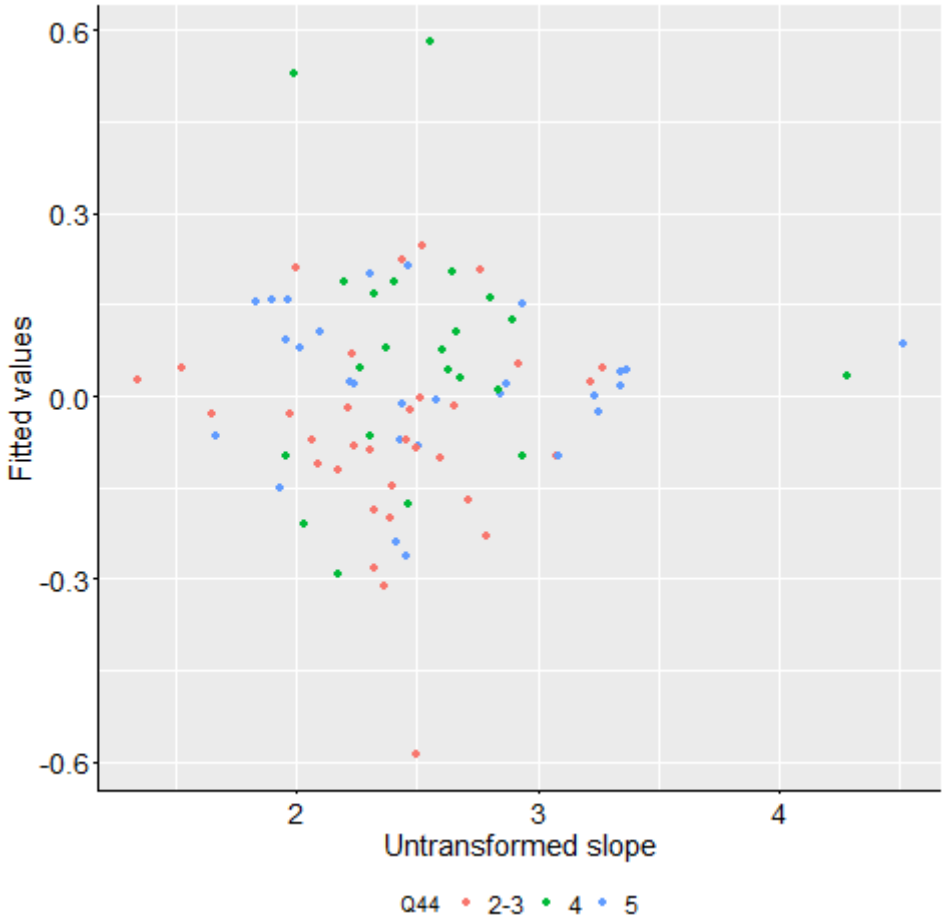

Figure 5.12 Fitted values of difference in cover weighted stress-tolerator attribute (resurvey – baseline) between the two surveys of parcels under options HK15 and HK16, plotted against the slope for each parcel. Fitted values are derived from generalised linear model selected through multi-model selection process. Coloured dots denote different answers to the agreement holder interview question 44: "How easy or difficult have you found it to carry out the management prescription for each of these options on a scale of 1 - 5?" 1 (red) = very difficult, 5 (blue) = very easy.

Scores for how appropriate the HK15 and HK16 management prescriptions were, assessed during the baseline panel appraisal process, were also retained in the final linear models for all three Grime botanical attributes, though their relationship with changes in attributes were largely negative (Tables D54 – C56). Agreements given a high score for appropriate prescriptions (4) for HK15 and HK16 had an increase in the attribute for competition, and a decrease in the attribute for ruderals. Effects of high prescription scores on the change in stress-tolerator scores were not significant, but were also negative. This suggests that predictions of the degree to which management prescriptions for HK15 and HK16 are appropriate relate poorly to these botanical outcomes. However, botanical outcomes are not always the priority for these options, which are often used for management of target species in other taxa.

Slope showed a small positive relationship with increases with competitive species between the two surveys, suggesting steeper parcels are moving towards more competitive plant assemblages (Table D59). This may reflect a difficulty in applying management on steeply sloping fields. The habitat feature also affected changes in the Grime botanical attributes. The attribute for stress-tolerator species increased between the two surveys on semi-improved

grassland (G02), while the attribute for more ruderal plant species decreased on coastal and flood plain grazing marsh habitat (G15).

There was an increase in the stress-tolerator attribute between the baseline survey and resurvey among fields in the westerly lowlands (environment zone 2) compared to those in the east (zone 1; Table D61). Together with the results for Ellenberg attributes in relation to environment zone discussed above, this indicates a move towards plant assemblages typical of less fertile conditions and with increasing cover of species with high stress-tolerance in the westerly lowlands, over time.

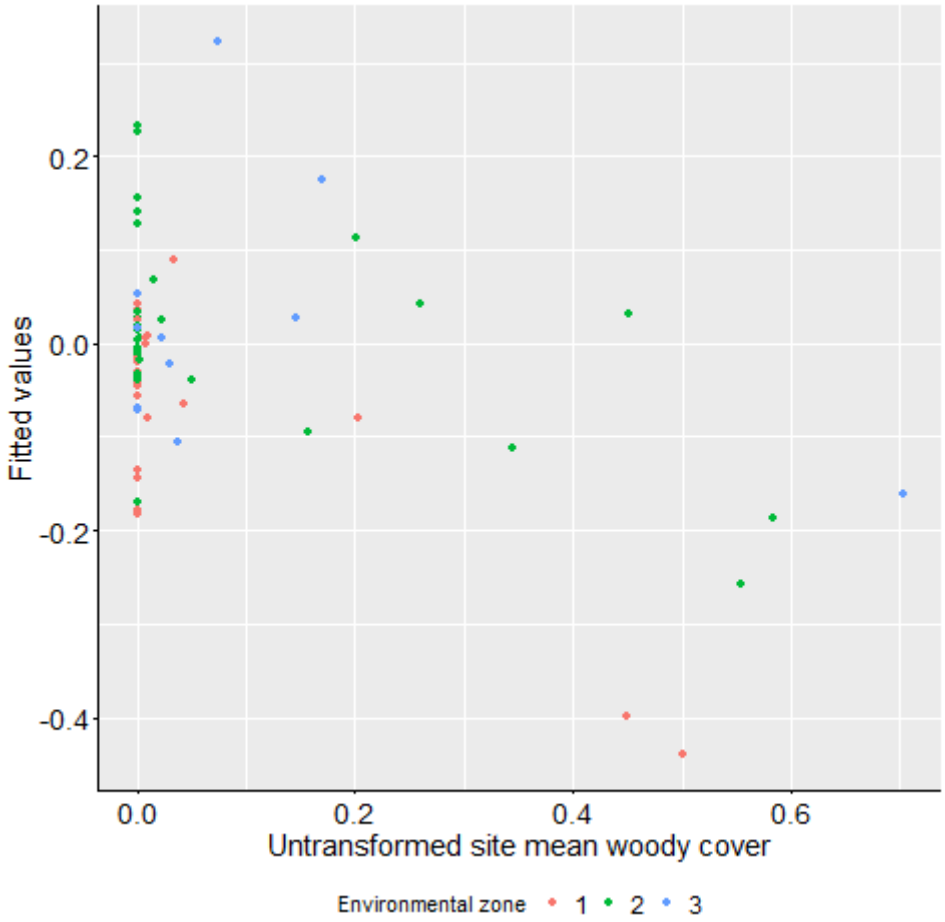

Figure 5.13 Fitted values of difference in cover of woody and semi-woody species (resurvey – baseline) between the two surveys of parcels under options HK15 and HK16, plotted against the mean woody cover for each parcel. Fitted values are derived from generalised linear model selected through multi-model selection process. Red dots = environment zone 1 (easterly lowlands), green dots = 2 (westerly lowlands), blue dots = 3 (uplands).

The cover of woody plant species declined between the two surveys in environment zone 1 (easterly lowlands), but not in zones 2 or 3 (Table D64; Figure 5.13). There was some indication of a relationship with the ease with which agreement holders scored the management of these options, with woody cover increasing very slightly on agreements where management was scored as easy. There was a negative relationship with the site woody cover, whereby sites with high woody cover were more likely to have a reduced woody cover between the two survey dates. Finally, woody cover appears to decrease between the two surveys for low grade agricultural land (agricultural land classes 4 or 5), but there is no evidence of a change on higher grade land (classes 2 or 3). HK15/16 are applied to

a range of features (habitats, species and archaeology), so management aims for these options may be more diverse as a result, compared to HK6/HK7 which are targeted at plant communities.

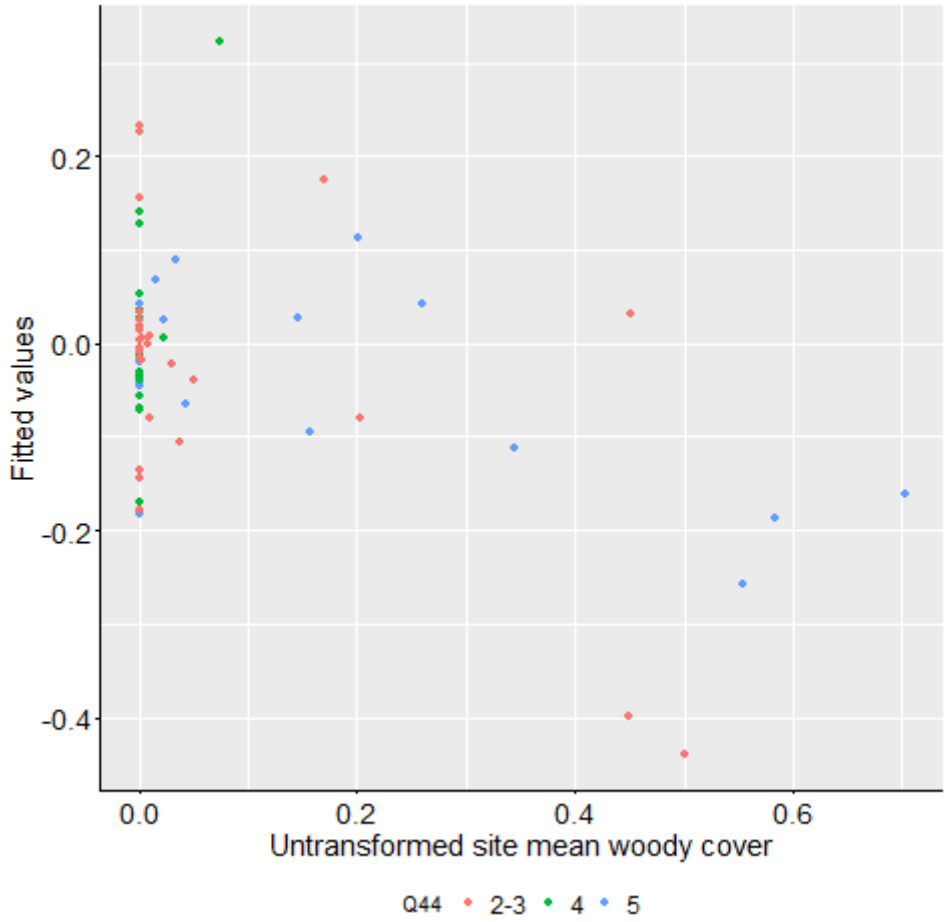

Figure 5.14 Fitted values of difference in cover of woody and semi-woody species (resurvey – baseline) between the two surveys of parcels under options HK15 and HK16, plotted against the mean woody cover for each parcel. Coloured dots show different answers to the agreement holder interview question 44: "How easy or difficult have you found it to carry out the management prescription for each of these options on a scale of 1 - 5?" 1 (red) = very difficult, 5 (blue) = very easy.

Supplementary options applied with HK15 and HK16		Number of parcels		
Code	**Description**	**HK15**	**HK16**	**Total**
HK18	Hay-making supplement		10	10
HL12	Management of heather, gorse and grass by cutting or swiping	14		14
HL15	Seasonal livestock exclusion supplement	14		14
HR1	Cattle grazing supplement	5	18	23
HR2	Native breeds at risk grazing supplement	8	9	17
HR4	Supplement for the control of invasive plant species	6	3	9
HR5	Bracken control supplement	4		4
HR6	Supplement for small fields		8	8
HR7	Supplement for difficult sites		1	1
HR8	Supplement for group applications	2		2

Table 5.11 Frequency of supplementary options applied to parcels surveyed under options HK15 and HK16. Some parcels had more than one supplementary HLS option.

5.4.3 HK15 / 16 conclusions

- The strongest factor linked to habitat condition was that of agreement holders scoring the ease of management as 5 (very easy), which resulted in an increased likelihood of a positive change in condition between surveys. Similarly, where agreement holders rated management prescriptions as easy to implement, then a reduction in competitive species and an increase in stress-tolerator species was more likely to have been seen. Although botanical diversity is often not the primary target of these options, this is indicative of a probable increase in wildlife value.
- The habitat to which HK15 and HK16 were applied did not affect condition, in contrast to the species rich semi-natural habitat options above. Some differences in botanical variables were found between habitat features – for example, species richness increased between the two surveys on a group of features including grassland BAP habitats, but not on semi-improved grassland or grazing marsh. This may reflect the range of target features to which HK15 and HK16 are applied, resulting in different management objectives and outcomes for parcels managed under these options. The success of these options could be more comprehensively evaluated by looking at the target feature in each case, but this was outside the scope of the current contract.
- There was no strong evidence for differences in outcomes between options HK15 (maintenance) and HK16 (restoration), with no effect of options for condition or the majority of botanical variables analysed. There was weak evidence that sward height may have increased more for parcels under HK15, and that parcels under option HK16 had a reduction in grazing tolerance score between the two surveys, but in neither case were the effects significant (Tables D65 and D66). This provides an indication that grazing intensity may have been reduced more on parcels managed under the maintenance option HK15 than the restoration option HK16. In addition, there was weak evidence that Ellenberg moisture attribute decreased slightly between the two surveys for HK16 but not HK15 (Table D56).

5.5 HL9 / HL10 – maintenance / restoration of moorland

5.5.1 HL9 / HL10 condition

The habitat feature to which HL9 and HL10 are applied did not affect the change in condition between surveys, and nor was there any evidence for a difference between the two options (Table D11). A baseline condition of A or B, as opposed to C, was the strongest factor associated with whether condition changed positively between the two surveys. Three-quarters of parcels in condition A at baseline remained in the best condition category at resurvey (Table 5.12). However, the majority of parcels under options HL9 and HL10 with a baseline condition of C remained at C when resurveyed (20 out of 27 parcels). Most surveyor comments relating to parcels in poor condition (C) at resurvey cite failure to reach target thresholds for dwarf shrub heath cover and/or diversity of age structure (Appendix D1.4.1).

HL9		RESURVEY A	B	C	Total
BASELINE	A	4	2		6
	B	6	3		9
	C	2		2	4
	Total	12	5	2	19

HL10		RESURVEY A	B	C	Total
BASELINE	A	8	2		10
	B	6	16	5	27
	C		5	18	23
	Total	14	23	23	60

Table 5.12 Condition at baseline and resurvey for parcels managed under HL9 and HL10 options, across all habitat features. Shaded cells denote outcomes categorised as negative change in condition assessment in analyses.

Similarly to options HK15 / HK16, there is weaker evidence for an effect of a baseline panel appraisal score for appropriateness of management prescriptions on change in condition. A baseline panel appraisal score of inappropriate or poorly tailored management prescriptions relates to a reduced likelihood of positive change in condition between the surveys.

There were only three parcels under HL10 management where the habitat feature changed between surveys, compared with 79 parcels under HL9 and HL10 management where the same habitat feature was the same at baseline and resurvey. One parcel recorded as G08 (upland calcareous grassland – BAP habitat) at baseline was M08 (upland valley mires, springs and flushes) at resurvey, one with a mixture of G02 (semi-improved grassland) and M08 at baseline was recorded as M06 (blanked bog – BAP habitat) at resurvey, and the third was recorded as M06 at baseline but M08 at resurvey. Habitat feature did not change for the majority of parcels managed under these options.

5.5.2 HL9 / HL10 plant community changes

Generally plant communities managed under these options did not change much between the two surveys. Ellenberg fertility attribute was reduced slightly between surveys for those parcels under management option HL9 and HL10 where agreement holders had rated management as easy (score of 4) as opposed to difficult (score of 1 – 3 where 1 = very difficult; Table D79). A similar result was found in relation to the Ellenberg reaction attribute (Table D80). The Ellenberg moisture attribute decreased where a supplementary option was applied in addition to the main HL9 or HL10 option. The cover of negative indicator species did not change between the two surveys for all parcels under management options HL9 and HL10, though there was some evidence of a very small increase in cover of negative indicators on blanket bog (M06).

5.5.3 HL9 / HL10 conclusions

- While the condition of a few parcels improved at resurvey, the majority of parcels that were in poor condition at baseline remained in poor condition at resurvey (20 out of 27) for these moorland options.
- Where panel appraisal scores had indicated poorly tailored or inappropriately used options, this was associated with reduced likelihood of improved condition.

- Relatively few changes were found in the plant community attributes. Ellenberg fertility reduced slightly between the surveys for options HL9 and HL10 where agreement holders had rated management for these options as easy, as opposed to difficult or very difficult. However, whilst the cover of negative indicator species on the options as a whole did not change between surveys, there was weak evidence of a very small increase in the cover of negative indicators on blanket bog.
- No evidence was found that condition or any of the plant community variables changed more for the restoration option HL10 than for HL9.

5.6 HL7 / HL8 – maintenance / restoration of rough grazing for birds

5.6.1 HL7 / HL8 condition

There was no evidence that habitat feature, baseline condition or any of the other covariates related to the likelihood of a positive change in condition (Table 5.13). There was also no indication that change in condition between the surveys differed between options HL7 and HL8 (Table D12). There was just one parcel where habitat feature changed between the two surveys; this was recorded as G02 (semi-improved grassland) at baseline and G14 (habitat for breeding waders - upland) at resurvey. Due to these results for condition, and the lower replication for HL7 and HL8 compared to other options analysed, plant community variables were not analysed further for these two options.

HL7		RESURVEY			
		A	B	C	Total
BASELINE	A	5	2		7
	B	1	4	4	9
	C	1	4	4	9
	Total	7	10	8	25

HL8		RESURVEY			
		A	B	C	Total
BASELINE	A	5	1		6
	B	4	2		6
	C	1	3	1	5
	Total	10	6	1	17

Table 5.13 Condition at baseline and resurvey for parcels managed under HL7 and HL8 options, across all habitat features. Shaded cells denote outcomes categorised as 'negative change in condition' in analyses.

5.7 HC7 / HC8 – maintenance / restoration of woodland

5.7.1 HC7 / HC8 condition

There was no evidence that habitat feature, baseline condition or any of the other covariates altered the likelihood of a positive change in condition, or that this differed between woodland options HC7 and HC8 (Table D14). Nine parcels under HC7 or HC8 management were given the lowest condition of C during the baseline, seven of which had a better condition at resurvey (Table 5.14). Three-quarters of parcels in good condition at baseline were still in condition A at resurvey (15 out of 20 parcels). The most frequently cited criteria against which the condition failed for T08 (native semi-natural woodland) under options HC7 and HC8 in both the baseline and resurvey was lack of a diverse age and height structure.

HC7		RESURVEY A	B	C	Total
BASELINE	A	10	2		12
	B	5	4	1	10
	C		1	1	2
	Total	15	7	2	24

HC8		RESURVEY A	B	C	Total
BASELINE	A	5	2	1	8
	B	9	9	3	21
	C	1	5	1	7
	Total	15	16	5	36

Table 5.14 Condition at baseline and resurvey for parcels managed under HC7 and HC8 options, across all habitat features. Shaded cells denote outcomes categorised as negative change in condition in analyses.

The woodland habitat present changed between surveys in four parcels managed under HC8 and one managed under HC7. In three cases these changes were from T06 (mixed woodland) to T08 (native semi-natural woodland) or vice versa. Both of these woodland habitats can include native and planted trees, and woodlands with >20% non-native species canopy cover can be classed as T06, whereas those with <20% non-native canopy cover can be categorised T08. The difference between these two woodland types may thus be quite small.

5.7.2 HC7 / HC8 plant community variables

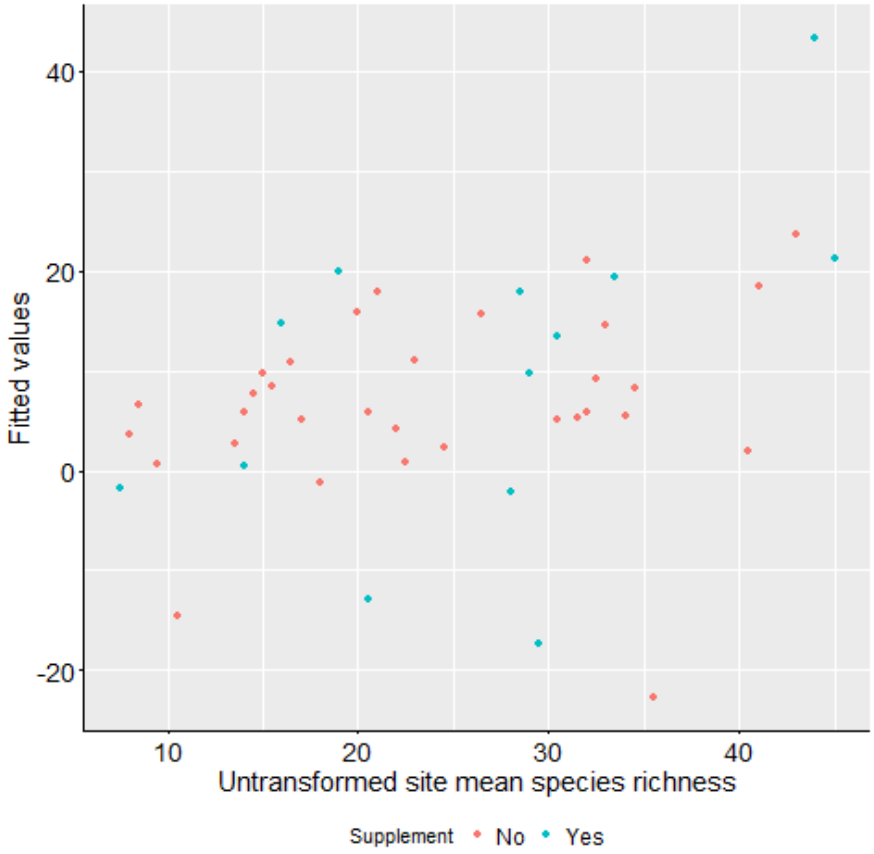

Figure 5.15 Fitted values of difference in species richness (resurvey – baseline) between the two surveys of parcels under options HC7 and HC8, plotted against the mean species richness for each parcel across the two surveys. Fitted values are derived from generalised linear model selected through multi-model selection process. Blue dots show parcels with supplementary management options, red denote those without supplements.

Species richness under options HC7 or HC8 increased between the baseline and resurvey. However, this increase was present only in environment zone 1 (easterly lowlands), and not in either the western lowlands or uplands (environment zones 2 and 3; Table D67). Woodland parcels on which supplementary options were present in addition to HC8 also had a greater increase in species richness between the two surveys than those without supplements (Figure 5.15). The most frequently applied supplementary option to HC8 was for livestock exclusion (HC11; Table 5.15).

Supplementary options applied with HC8		**Number of parcels**
Code	Description	
HC11	Woodland and livestock exclusion supplement	39
HR4	Supplement for the control of invasive plant species	2
HR5	Bracken control supplement	1
HR6	Supplement for small fields	3

Table 5.15 Frequency of supplementary options applied to parcels surveyed under option HC8. Some parcels had more than one supplementary option. No supplementary options were applied to parcels under management option HC7.

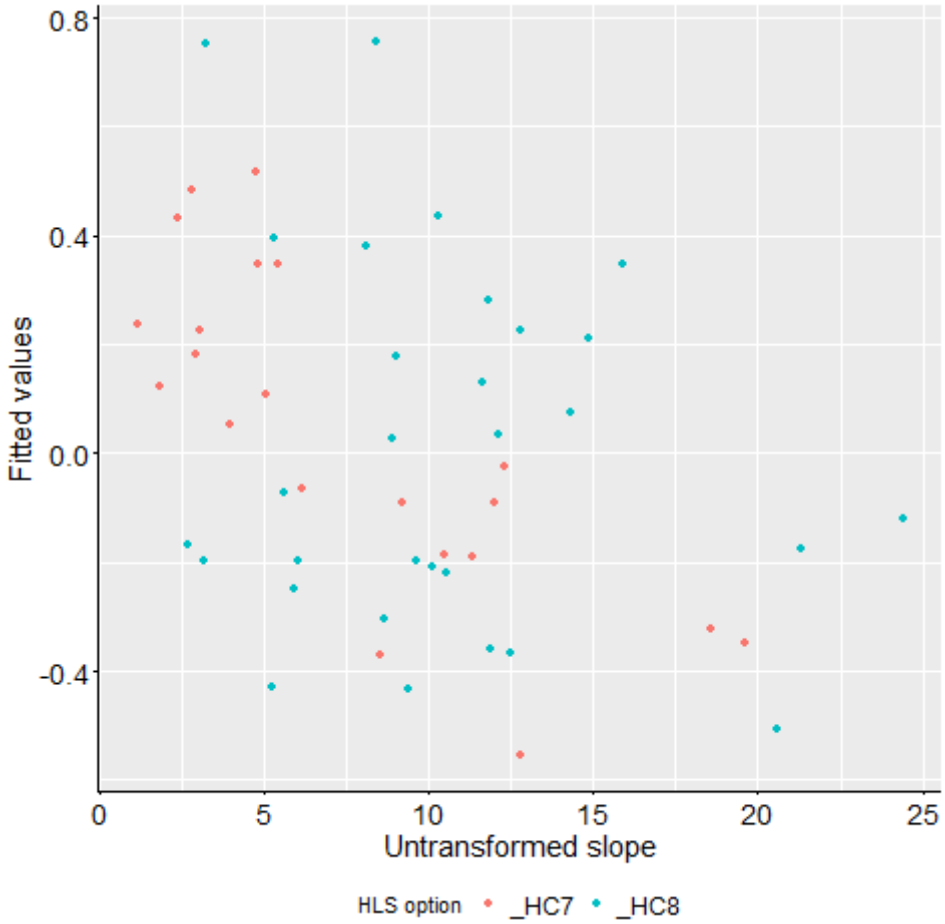

Figure 5.16 Fitted values of difference in cover weighted Ellenberg fertility attribute (resurvey – baseline) between the two surveys of parcels under options HC7 and HC8, plotted against the mean Ellenberg fertility attribute for each parcel across the two surveys. Coloured dots show option.

Agreements where a high score was allocated for appropriate prescriptions for options HC7 and HC8 during the baseline panel appraisal showed a relationship with reduced species richness between the two surveys, compared with agreements for which management prescriptions were scored inappropriate or mainly generic (scores 1, 2 or 3; Table D67). In addition, larger parcels under HC7 and HC8 management had a greater increase in species richness between the two surveys.

Changes in Ellenberg attributes between the two surveys for woodlands managed under HC7 and HC8 were most strongly influenced by geographical variables. Change in Ellenberg fertility and reaction were negatively related to slope, while altitude had a negative relationship with change in the Ellenberg moisture attribute (Tables D68 – D70). The change in Ellenberg fertility between the two surveys was affected by which woodland HLS option was applied (Figure 5.16).

In addition, the agreement holder's assessment of ease of management related to Ellenberg moisture (Table D70). Agreements where agreement holders assessed management prescriptions for options HC7 and HC8 as easy (scores of 4 or 5) showed an increase in moisture attribute between baseline survey and resurvey, indicating a move towards plant assemblages associated with more moist environments. It is possible that a change in Ellenberg moisture attribute may be a response to change in grazing management. Agreement holders who scored these options as easy or very easy claimed the options required little input or where it did require work, the tasks were relatively easy, as illustrated by the following quotes from the interviews:

> "Straightforward management; exclude stock and look after trees; easy!" (Agreement 87, Easy HC7)

> "Requiring little management and intervention." (Agreement Holder 150, Easy HC8)

> "There's not much to do so it's easy to manage." (Agreement Holder 92, Very Easy HC8)

Others reported how the work was akin to what they had already been doing and it was therefore a case of doing what they were already doing.

> "Already doing it, so easy." (Agreement Holder 73, Easy HC7)

> "Runs alongside existing management objectives." (Agreement Holder 20, Very Easy HC7)

> "Fits in with farming system: equipment and contacts." (Agreement Holder 86, Very Easy HC7)

> "Is part of our normal day to day farm management." (Agreement Holder 5, Very Easy HC7)

Although these comments would appear to raise issues regarding additionality it is important to recognise that different individuals will have different perceptions of what is "easy" and what is part of "normal" management. Moreover, in these cases HLS is

playing an important role in supporting and rewarding existing positive environmental behaviour, behaviour that in some cases would not be continued in the absence of HLS. Finally, it should be noted that establishing the degree of additionality is notoriously difficult in social science research given the effective absence of the counter-factual situation.

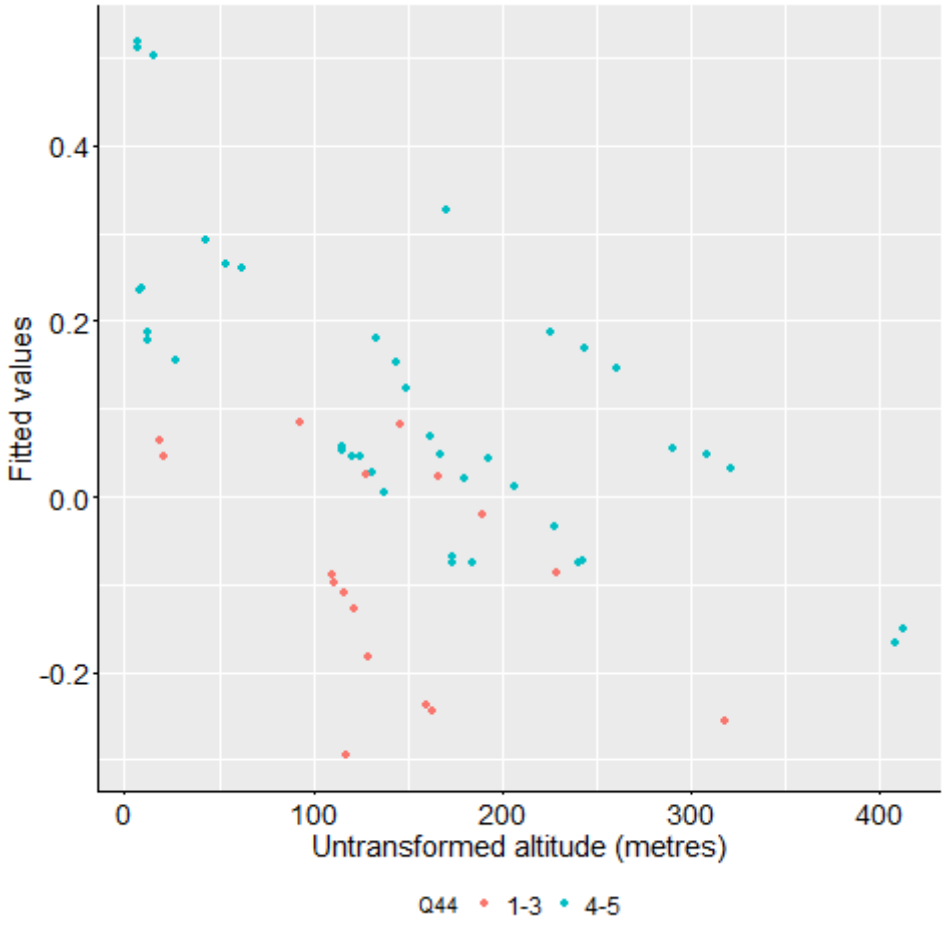

Figure 5.17 Fitted values of difference in cover weighted Ellenberg moisture attribute (resurvey – baseline) between the two surveys under options HC7 and HC8, plotted against the mean Ellenberg moisture attribute for each parcel across the two surveys. Coloured show different answers to the agreement holder interview question 44: "How easy or difficult have you found it to carry out the management prescription for each of these options on a scale of 1 - 5?" 1 (red) = very difficult, 5 (blue) = very easy.

Attributes relating to plant strategies (competitiveness, ruderality, stress-tolerance) were affected by fewer covariates under options HC7 and HC8 than the Ellenberg attributes relating to soil conditions discussed above. There was a decrease in the stress-tolerator attribute in the upland (environment zone 3) parcels surveyed under woodland HLS options between the two surveys, compared to the lowlands (environment zones 1 and 2; Table D68).

Grass to forb ratios decreased between the baseline and resurvey on agreements graded as low quality agricultural land (agricultural land class 5), but not on those graded as good or medium (agricultural land classes 2 or 3; Table D73). Percentage cover of woody and semi-woody species did not differ much between the two surveys (Table D75). The change in cover of positive indicator species (chosen to indicate ancient woodland ground flora;

(Natural England, 2010); Table D76) between the two surveys was weakly related to the cover at that site, in that cover decreased slightly on sites with higher initial positive indicator species cover (Figure 5.18). The cover of pollinator friendly plant species increased slightly between the two surveys for most woodland habitat features, but not for T08 (native semi-natural woodland) under these management options.

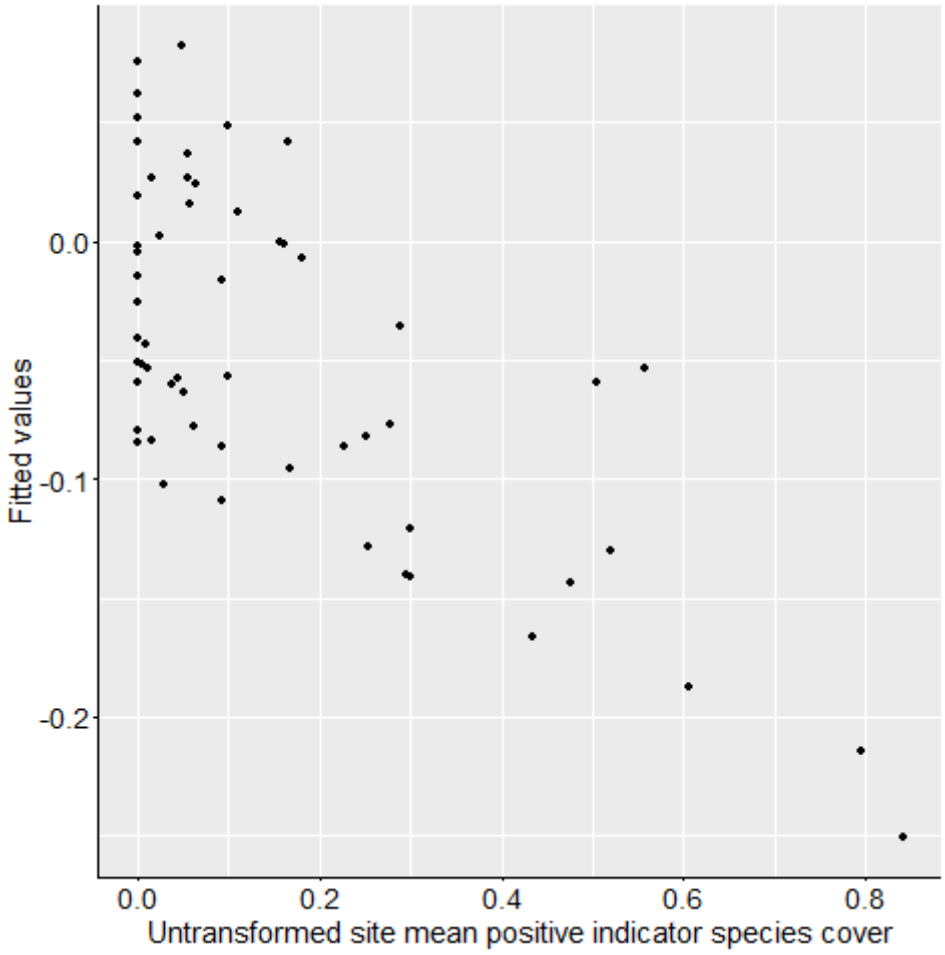

Figure 5.18 Fitted values of difference in cover of positive indicator species (resurvey – baseline) between the two surveys of HLS parcels under management options HC7 and HC8, plotted against the mean positive indicator cover for each parcel across the two surveys. Fitted values are derived from generalised linear model selected through multi-model selection process.

5.7.3 HC7 / HC8 conclusions

- 75% of parcels in condition A at baseline remained in A at the resurvey, while the majority of parcels in condition C had improved to a better condition by resurvey (7 out of 9 parcels). The likelihood that condition improved between the two surveys did not differ between the two woodland management options, and nor did it relate to any of the variables tested (e.g. agreement holder rating of ease of management, panel appraisal score, environment zone).
- The agreement holder's rating of ease of management related to Ellenberg moisture attribute, which may also indicate a change in grazing regime. Multivariate analyses of the plant communities managed under HC7 showed a shift towards plant species

typical of less disturbed conditions (Section 4.1.2), which would be compatible with a reduction in grazing. Species richness increased between the two surveys in the easterly lowlands, potentially also as a result of less grazing disturbance. The combined evidence of change across these plant community attributes suggests that botanical communities managed under HC7 or HC8 are improving as a result of reduced grazing.

5.8 HF12 - Enhanced wild bird seed mix plots

Average percentage cover of sown species in winter bird food plots under management option HF12 was around 16% by autumn / early winter (Figure 5.19). Plots surveyed in winter split between those with no or very little (<1%) cover of sown species, which constituted 11 of the 24 plots surveyed, and the remainder where cover was 25% or greater. Winter bird food plots with <1% of sown species cover were dominated by wheat stubble, nettles, grass or bare ground. Seed availability was closely related to the cover of sown species during autumn / early winter, but by the second visit in January – March the seed supply was very nearly depleted (Figure 5.20). Winter seed provision did not relate to any of the covariates tested (Table D89).

Plant species richness in HF12 plots, assessed during the summer field survey, related both to size of plot and to the score which agreement holders attributed to 'ease of management' for this option (Table D88). The analysis suggests a relationship between lower species richness on HF12 plots on agreements where ease of management had been rated easy or very easy (4 or 5), as opposed to difficult (score of 1 – 3 with 1 = very difficult; Table D88). However, although botanical diversity in summer may indicate an improved weed flora on HF12 plots, it is not the main objective of the option, which is to provide resources for over-wintering birds.

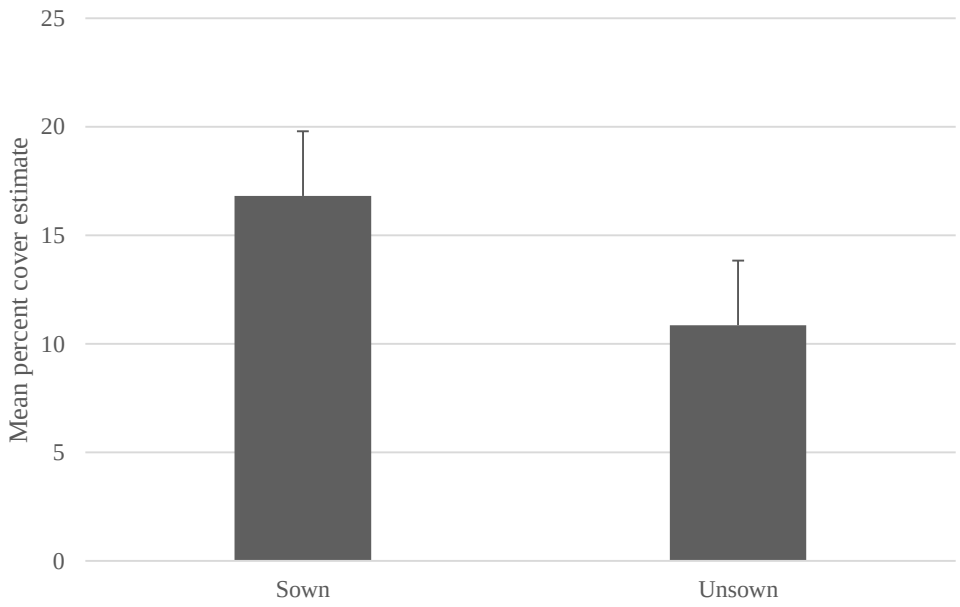

Figure 5.19 Percentage cover of sown and unsown plant species in HF12 winter bird food plots in October – December 2016. Means ± standard error.

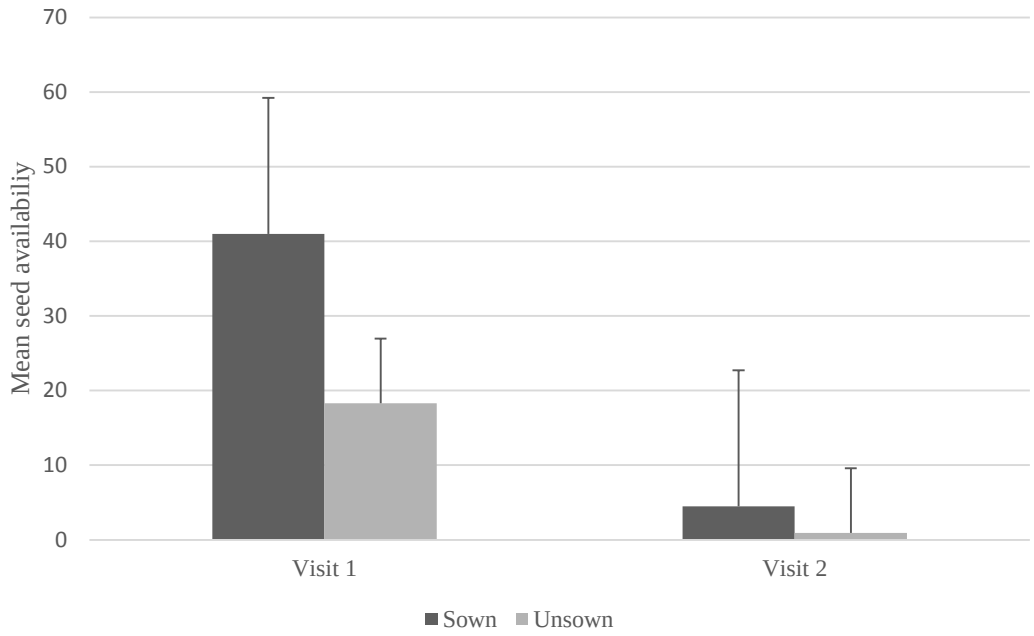

Figure 5.20 Seed availability of sown and unsown plant species in HF12 winter bird food plots during visit 1 (October – December 2016) and visit 2 (January – March 2017). Means ± standard error.

5.9 Habitat condition at baseline and resurvey under options with insufficient replication for analysis

Condition results for other options surveyed, for which there were not enough parcels per option for statistical analysis, are in Appendix D1.7. A few key results are summarised here.

Fifteen parcels were resurveyed under the lowland heathland restoration option (HO2). Seven of the 11 parcels in condition C at baseline were still in condition C at resurvey, and three had improved. The four parcels in conditions A or B at baseline remained in the same condition.

Thirty-three parcels were resurveyed under option HK9 (maintenance of wet grassland for breeding waders). Ten of these were in condition C at baseline, of which four had improved to a better condition at resurvey (Appendix D1.7.2). Eight parcels managed under an option for maintenance of wet grassland for wintering waders and wildfowl (HK10) were resurveyed, of which the two parcels in condition C at baseline had both improved (one to an A at resurvey, one to condition B).

Twelve parcels were surveyed under reedbed restoration or maintenance options (HQ3 and HQ4). One of those in condition C at baseline had improved to a B, two remained in condition C, while all five parcels in condition A at baseline remained in the best condition (Appendix D1.7.4).

Twenty-five parcels were surveyed under options for fen maintenance and restoration (HQ6 and HQ7), twelve of which were in condition C at baseline, half of which improved, mainly to condition B, at resurvey. Four of the five parcels at condition A at baseline remained in the best condition; 1 dropped to condition B (Appendix 1.7.5).

Options for traditional orchard management (HC19, HC20, HC21) were surveyed on 9 parcels. Only one parcel was in condition C at baseline and remained in C at resurvey; three parcels were in condition A in both surveys (Appendix D1.7.7). Eleven parcels were surveyed under options for maintenance and restoration of successional areas and scrub (HC15 and HC16). Five parcels were in condition C at baseline, of which 3 improved, but the two in condition A at baseline deteriorated to a C (Appendix D1.7.8). The criterion on which condition failed at resurvey most frequently was having a good age range of woody species (Table D28).

Hedgerow options (HB11 and HB12) were surveyed on 24 parcels (Appendix D1.7.6). Two hedges in condition C at baseline had improved condition at resurvey, while four of the 14 parcels in the best condition at baseline had deteriorated to a B or C at resurvey. Common reasons for poor condition included hedge gappiness and dimensions, and a lack of higher value ground flora.

5.10 Condition of historic features

Condition was assessed for 47 historic features (Appendix D4). The majority of these were above-ground historic features (H01), of which 10 were in condition B at baseline, and historic water meadows (H06), 10 of which were in condition C at baseline. Of the 24 historic features in these two categories, only two remained in condition C at resurvey. The majority had improved between the surveys (six out of 12 H01 features improved in condition, and nine out of 12 H06 features). Other common historic features were routeways (H03), large-scale archeological features (H04) and relict boundaries of historic importance (H05). Of the six other historic feature types, only one example of each was surveyed (Appendix D4.6).

5.11 Results summary across options and general conclusions

5.11.1 Summary of change in condition and plant community variables between surveys, by option(s)

	HK7	HK6	HK15 / HK16	HL9 / HL10	HL8 / HL7	HC7 / HC8	HF12
Condition of habitat feature	Improved for semi-improved grassland, not for priority grasslands	Improved between surveys, not for lowland meadows. Increase more likely if supplementary option also applied	Improved where AH rated management as easy	Majority at condition C at baseline did not improve. Initial condition related strongly to outcome.	No change	No change	NA
Change in habitat feature	9% of parcels changed habitat; majority from semi-improved to species rich grasslands	10% of parcels surveyed changed habitat; no pattern to changes	2% of parcels surveyed changed habitat	4% of parcels surveyed changed habitat between surveys	Habitat changed on 1 parcel	8% of parcels surveyed changed habitat	NA
Plant species richness	Increased in majority of parcels, more likely if supplementary option also applied	Increase for lowland meadows, increase more likely on higher quality agricultural land	Increased in westerly lowlands and on some priority grassland habitats.	NA	NA	Increase in easterly lowlands, increase where supplement added	Lower where AH rated management as easy
Ellenberg fertility	No change	Decreased slightly on priority and species-rich grasslands	Decreased in westerly lowlands (towards plant communities typical of less fertile soil), decreased on G15 grassland	Reduced where AH rated management as easy	NA	Relates to slope and option identity	NA
Ellenberg reaction	No change	Small shift to plant communities of more basic soils, in English uplands only	Decreased in westerly lowlands (towards communities typical of less basic / more acidic soil)	Reduced where AH rated management as easy.	NA	Increase in northerly uplands, relates to slope	NA
Ellenberg moisture	No change	No change	Increased on G15 grassland	Reduced where supplementary option also added	NA	Increased where AH rated management as easy	NA
Grime competitive attribute	Lowland calcareous grasslands – reduction in competitive species	No change	Reduction in competitive species where AH rated management easy	Increase feature other	NA	No change	NA
Grime ruderality attribute	No change	No change	Decrease on G15 grassland	Decrease AH rated management as easy, also if supplementary option applied, and in blanket bog	NA	No change	NA

	HK7	HK6	HK15 / HK16	HL9 / HL10	HL8 / HL7	HC7 / HC8	HF12
Grime stress-tolerator attribute	No change	No change	Increase where AH rated management as easy, also increase in westerly lowlands and on semi-improved grasslands	Decrease feature other	NA	Decrease in uplands	NA
Grazing tolerance	Reduction in grazer tolerant species in lowland calcareous grasslands and purple moor-grass /rush pastures	Decreased where AH rated management as easy. Decreased on lowland meadows.	Increased where agreement holders categorized management as easy	NA	NA	Data very variable, no clear result.	NA
Grass to forb ratio	No change	Increased on steeply sloping parcels	Increase on G15 grassland	NA	NA	Decrease AC	NA
Negative indicator species cover		Decreased more on smaller parcels	NA	Little change, weak evidence for increase on blanket bog	NA	*Positive indicators relate to baseline; slight decrease where baseline cover high (negative indicators NA)	NA
Woody species cover	Increase related to addition of supplement, decreased where prescriptions rated appropriate in BPA.	No change	Increase where AH rated management as easy, reduced more where woody cover was greater at baseline	*No change	NA	No change	NA
Sward height	Increased, more for swards that were taller at baseline	No change	No change	No change	NA	NA	NA
Cover of pollinator friendly plants	Increase where AH rated management as very easy	Increased where prescriptions rated appropriate in BPA.	No change	NA	NA	Increase between surveys	NA
Cover of sown species	NA	NA	NA	NA	NA	NA	<1% in 46% plots, >>25% in majority,
Maintenance and restoration options differ?	NA	NA	No	No	No	Yes for 1 variable; change in Ellenberg fertility	NA

Table 5.16 Summary of main findings from analyses of changes in condition and plant community variables between the surveys, by option or option pair. Note trends are derived from generalised linear or generalised linear mixed models fitted to data collected in the field. AH = agreement holder. BPA = baseline panel appraisal, G15 = coastal and flood plain grazing marsh habitat – BAP habitat. *Cover of dwarf shrub cover analysed for HK9 / HL10 rather than woody species cover, positive indicator cover analysed for HC7 / HC8 rather than negative indicators. NA = variable not analysed / not applicable for that option / option pair.

5.11.2 General conclusions across all options analysed

Did factors such as the habitat feature, region, quality of agricultural land or degree of slope relate to changes in condition or plant community variables between the two surveys?

- Changes in condition between the baseline and resurvey in grasslands under options for maintaining or restoring species-rich swards were strongly related to the identity of the starting habitat. In contrast, condition outcomes for grasslands under management options that target animal taxa were more strongly linked to agreement holder interview responses and scores for prescriptions allocated at the baseline panel appraisal, and in fewer cases to starting habitat.

- Changes between the two surveys in the condition of upland habitat features under options HL9 and HL10 was most strongly influenced by starting condition, with better outcomes predicted for features with a baseline condition of A or B, vs. C. The likelihood of a positive change in the condition of features under the rough grassland (HL7 and HL9) or woodland options (HC7 and HC8) analysed was less strongly related to the baseline condition.

Do plant community variables change between baseline and resurvey?

- Many botanical response variables showed no change between the two surveys. However, for some options plant community variables showed an improvement between the two surveys, where condition did not. For example, condition of lowland calcareous grasslands under the restoration option HK7 did not improve between the two surveys, but a reduction was found in the dominance of competitive plant species. Condition is assessed on multiple attributes, all of which need to reach a threshold value in order to pass (for example cover of wildflowers > 10%). Small improvements in metrics describing the conservation value of a plant community may not immediately result in a better condition category, if thresholds are not reached, but may be indicative that the plant community is changing in the right direction to meet condition thresholds over a longer time scale.

- In general, where change was found between the baseline and resurvey, response variables derived from the botanical data tended to show positive responses in terms of the conservation objectives (e.g. reduction in Ellenberg fertility score). These changes were often restricted to particular habitats, biogeographical areas (environment zones) or types of agricultural land (agricultural land classification).

Did condition and plant community variables change more between the two surveys on parcels managed under restoration than maintenance options?

- There was little evidence for different outcomes between the restoration and maintenance option in each pair, where change in condition and plant community variables were analysed for paired management options targeting the same habitat.

This may in part have been influenced by poor initial targeting of options: there are many examples of habitat features with a baseline condition assessment of C being entered into a maintenance option, where a restoration option might have been more appropriate. For example, 41 out of 102 habitat features surveyed being managed under maintenance option HK15 had a condition at baseline of C.

Is there a relationship between an agreement holder's rating of ease of management and change in habitat condition or plant community variables?

- The scores for ease of management that agreement holders attributed to specific options related to one or several of the botanical variables derived from habitats managed under each of options HK7, HK15 / HK16, HC 7 / HC8, HL9 / HL10 and HF12. Among grassland, woodland and moorland options, a management rating of easy or very easy was associated with improved botanical outcomes between the two surveys, for those response variables where a relationship existed. Total species richness in summer of the arable option HF12 was lower on agreements where the management had been rated as easy. Plant species richness is not the prime objective of HF12. However, a previous study found that agreement holder confidence was negatively related to ecological outcomes linked to the key objectives of Entry Level Stewardship arable options (McCracken et al., 2015). In contrast, the results found here for grassland, moorland and woodland options, suggest that when management is rated as easy this is linked to better conservation outcomes. Agreement holders may be better at judging the demands of management for some grassland and woodland options, and may be more familiar with management requirements, than for arable options. These results demonstrate that links between social variables and ecological outcomes are complex, and may differ between agricultural habitats. As few of the agreement holder data are option specific, additional research might be required to further understand the influence of agreement holders on these contrasting results

Did parcels with high panel appraisal ratings for how appropriate management prescriptions were have better outcomes, in terms of improved condition or change to plant community variables?

- Following the baseline, the panel appraisal awarded scores for various aspects of agreement design, including how management prescriptions had been applied in relation to specific options. In a few cases, these scores related to change in botanical variables between the two surveys. A high score reflecting appropriate and well-tailored management prescriptions was more likely to be associated with positive botanical change between the two surveys. In one example (HK7) a high panel appraisal score was associated with an increase in ruderal species between surveys, which may reflect a transition in the plant community following the creation of bare ground. Panel appraisals were predictive and relied on expert judgement, only using the evidence available at the time of scoring.

6. Indicators of success and capital works

6.1 Achieving indicators of success

Were indicators of success achieved and how do they differ between options and indicator types?

Surveyors were asked to assess indicators of success (IoS) for all option/parcel combinations for which they carried out a full botanical survey. The responses they gave were Yes (fully met), Partial (partially met) or No (not met at the time of assessment). An assessment of "Could not Assess" was made for 28% of IoS, either because (1) the IoS referred to change but did not provide a suitable baseline (2) the surveyor was present at the wrong time of year (winter or summer specific descriptions); (3) the IoS required more than one visit, was specific to a target feature not addressed through our survey or not seen on the survey (e.g. wintering wildfowl, breeding waders, certain indicator species) or (4) where the IoS were only properly measureable at the very end of the agreement. In total, 4582 individual IoS were assessed during the HLS resurvey. The level of achievement of IoS is outlined in Table 6.1.

% IoS achieved	Number of HLS options achieving	% Options achieving this level
81-100%	22	30
61-80%	20	27
41-60%	17	23
21-40%	8	11
0-20%	6	8
Total	73	100

Table 6.1 Proportion of options achieving IoS in categories of success. Supplementary options are excluded

The numbers of IoS assessed for each HLS option in the resurvey and the percentage of those that were classed as having been achieved are summarised in Table 6.2. Of all the IoS that were assessed, 63% were achieved, 9% were partially met and 28% not met. These headline IoS results are in the same range as found in other recent assessments of HLS IoS, for example Boatman et al., (2014) found 61% of IoS had been achieved, while 21% were classed as unlikely to be achieved in their study on the impact of advice and support on HLS outcomes; Mountford et al., (2013) also found that 61% of HLS options had already been achieved, or if not were thought likely to achieve all their IoS whereas 21% had failed or were expected to fail at least one IoS.

HLS Code	HLS definition	Yes	Partial	No	Not assessed	Total assessed	% achieved
HB11	Management of hedgerows of very high environmental value (both sides)	19	3		10	22	86
HB12	Management of hedgerows of very high environmental value (one side)	30	2	1	11	33	91
HC2	Protection of in-field trees - grassland	1			0	1	100
HC5	Ancient trees in arable fields	3		1	1	4	75
HC7	Maintenance of woodland	81	18	36	35	135	60
HC8	Restoration of woodland	83	36	44	23	163	51
HC10	Creation of woodland outside the LFA	2	3	6	6	11	18
HC12	Maintenance of wood pasture and parkland	2	2		2	4	50
HC13	Restoration of wood pasture and parkland	12	2	6	2	20	60
HC14	Creation of wood pasture	2	1	1	0	4	50
HC15	Maintenance of successional areas and scrub	40	7	9	16	56	71
HC16	Restoration of successional areas and scrub	9	2	15	9	26	35
HC18	Maintenance of high value traditional orchards	9		1	1	10	90
HC19	Maintenance of traditional orchards in production	8			0	8	100
HC20	Restoration of traditional orchards	17	3	5	10	25	68
HC21	Creation of traditional orchards	2		3	1	5	40

Table 6.2. The number of IoS per HLS option falling into three categories (Yes = achieved successfully; Partial = partially met and No = not met at the time of assessment) with the percentage of the total assessed for each option that were classified as being achieved. Total not assessed are those that were classified as "could not assess" in addition to a minority that were not assessed. Supplementary options are excluded. HLS options are ordered alphabetically, continued below.

HLS Code	HLS definition	Yes	Partial	No	Not assessed	Total assessed	% achieved
HD2	Take archaeological features out of cultivation	1			0	1	100
HD4	Management of scrub on archaeological sites			1	0	1	0
HD5	Management of archaeological features on grassland	11		1	3	12	92
HD7	Arable reversion by natural regeneration	7			0	7	100
HD9	Maintenance of designed/engineered water bodies	8	1	2	1	11	73
HE10	Floristically enhanced grass margin	19	6	38	4	63	30
HF4	Pollen and nectar flower mixture	1		4	6	5	20
HF6	Over-wintered stubbles	1			0	1	100
HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)	45	7	53	106	105	43
HF13	Fallow plots for ground nesting birds	11	2	3	6	16	69
HF14	Unharvested, fertiliser-free conservation headland	7	1	2	8	10	70
HG7	Low input spring cereal to retain or re-create an arable mosaic	9	2	4	14	15	60
HJ3	Arable reversion to unfertilised grassland to prevent erosion or run-off	2		4	2	6	33
HJ4	Arable reversion to grassland with low fertiliser input to prevent erosion and run-off	3		1	0	4	75
HJ5	In-field grass areas to prevent erosion or run-off	28	1		6	29	97
HJ6	Preventing erosion or run-off from intensively managed improved grassland	25		7	9	32	78
HD10	Maintenance of traditional water meadows	6			0	6	100
HE3	6m buffer strips on arable land (conventional)	12	3		6	15	80

Table 6.2 continued. The number of IoS per HLS option falling into three categories (Yes = achieved successfully; Partial = partially met and No = not met at the time of assessment) with the percentage of the total assessed for each option that were classified as being achieved. Total not assessed are those that were classified as "could not assess" in addition to a minority that were not assessed. Supplementary options are excluded. HLS options are ordered alphabetically, continued below.

HLS Code	HLS definition	Yes	Partial	No	Not assessed	Total assessed	% achieved
HK1	Take field corners out of management outside the LFA	1		1	0	2	50
HK2	Permanent grassland with low inputs outside the LFA	2			0	2	100
HK3	Permanent grassland with very low inputs outside the LFA	1		1	0	2	50
HK5	Mixed stocking		2	2	0	4	0
HK6	Maintenance of species rich semi-natural grassland	274	42	150	223	466	59
HK7	Restoration of species rich semi natural grassland	418	66	244	339	728	57
HK8	Creation of species rich semi natural grassland	23	3	2	19	28	82
HK9	Maintenance of wet grassland for breeding waders	110	12	32	122	154	71
HK10	Maintenance of wet grassland for wintering waders and wildfowl	36	12	3	20	51	71
HK11	Restoration of wet grassland for breeding by waders	27	3	4	49	34	79
HK12	Restoration of wet grassland for wintering waders and wildfowl	5			4	5	100
HK13	Creation of wet grassland for breeding waders	3			4	3	100
HK15	Maintenance of semi-improved or rough grassland for target species	183	42	81	172	306	60
HK16	Restoration of semi-improved or rough grassland for target species	120	22	35	70	177	68
HK17	Creation of semi-improved or rough grassland for target species	16		1	8	17	94

Table 6.2 continued. The number of IoS per HLS option falling into three categories (Yes = achieved successfully; Partial = partially met and No = not met at the time of assessment) with the percentage of the total assessed for each option that were classified as being achieved. Total not assessed are those that were classified as "could not assess" in addition to a minority that were not assessed. Supplementary options are excluded. HLS options are ordered alphabetically, continued below.

HLS Code	HLS definition	Yes	Partial	No	Not assessed	Total assessed	% achieved
HL7	Maintenance of rough grazing for birds	83	20	102	39	205	40
HL8	Restoration of rough grazing for birds	43	10	13	18	66	65
HL9	Maintenance of moorland	175	8	29	33	212	83
HL10	Restoration of moorland	504	44	151	194	699	72
HL11	Creation of upland heathland	8		12	2	20	40
HN2	Permissive open access	16	2	3	0	21	76
HN3	Permissive Footpaths	7	1	14	5	22	32
HN4	Permissive bridleway/cycle path access	8			0	8	100
HN7	Upgrading CRoW access for cyclists/horses			1	0	1	0
HN8	Educational access base payment	4			0	4	100
HO1	Maintenance of lowland heathland	21	5	21	16	47	45
HO2	Restoration of lowland heathland on neglected sites	97	11	78	34	186	52
HO3	Restoration of forestry areas to lowland heathland	3	3		2	6	50
HP2	Restoration of sand dunes	3		1	2	4	75
HQ1	Maintenance of ponds of high wildlife value <100 sq m	18		2	3	20	90
HQ2	Maintenance of ponds of high wildlife value >100 sq m	39	2	1	7	42	93
HQ3	Maintenance of reedbeds	30		6	10	36	83
HQ4	Restoration of reedbeds	21		11	21	32	66
HQ6	Maintenance of fen	24	2	9	6	35	69
HQ7	Restoration of fen	19	3	16	32	38	50
HQ8	Creation of fen		2	4	1	6	0
HQ9	Maintenance of lowland raised bog	3	1	1	1	5	60
HQ10	Restoration of lowland raised bog	7	7	8	3	22	32
Total		2871	427	1287	1785	4585	63

Table 6.2 continued. The number of IoS per HLS option falling into three categories (Yes = achieved successfully; Partial = partially met and No = not met at the time of assessment) with the percentage of the total assessed for each option that were classified as being achieved. Total not assessed are those that were classified as "could not assess" in addition to a minority that were not assessed. Supplementary options are excluded. HLS options are ordered alphabetically.

Whether IoS were met varied considerably between option categories. For options for maintenance and restoration of species rich grassland (HK6 and HK7 respectively) only 59% and 57% of IoS were achieved. The allocation of inappropriate habitat features to species rich grassland options and in particular the issue of grassland quality being 'inflated' within the Farm Environment Plan were identified in the baseline survey (Mountford et al., 2013), as issues that might affect the success of these options. IoS typically reflect the desired criteria closely for species rich grassland habitats under HK6 and HK7. Boatman et al. (2014) found a significant relationship between the appropriateness of IoS and whether they were achieved.

HK6 and HK7 may have a high number of IoS types that are classed as not appropriate, e.g. referring to lists of positive indicator species and/or target species that were not present or likely to be present, hence making the IoS less likely to be achieved.

A greater proportion of IoS were achieved for moorland options. For both HL9 and HL10, restoration and maintenance of moorland, more than 72% of IoS had been fully met at the time of resurvey and HL8 (restoration of rough grazing for birds) achieved 65% success. However, for option HL7 (maintenance of rough grazing for birds) this was lower with only 40% of IoS fully met. IoS relating to soil moisture were most frequently met, while those relating to sward height fell almost equally into fully met and failed. Where parcels failed this IoS the vegetation was often too short, and short vegetation covered too great a proportion of the area. This suggests a failure to deliver effective grazing management.

IoS for the hedgerow options HB11 and HB12 were often fully met (86% and 91%). This is consistent with results from the analysis of condition assessment evaluations (Chapter 5, appendix D1.7.6) to which IoS are intrinsically linked. More experienced farmers produce better results for agri-environmental outcomes (McCracken et al., 2015); these hedgerow options typically represent management with which agreement holders have prior experience (Chapter 7, section 7.2) and so may be more successfully delivered as a result. The IoS criteria for these options are also very similar to measures of compliance, and agreement holders may find it easier to comply with a prescription than is it to meet an ecological target.

6.2 IoS by type

The detailed requirements and wording of IoS vary between agreements and options but are based on common criteria. Each IoS was given a 'type' to enable them to be summarised across options and agreements, following the IoS categories described by Boatman et al. (2014).

For the majority of IoS types over 50% were met (Table 6.3). These include negative indicator types; a breakdown of IoS of this type by option is in Table 6.3. Only nine IoS types were achieved in under 50% of cases.

Within the 'Woodland management' type 58% of IoS were classed as 'not met at the time of assessment' (Figure 6.1). Jones et al. (2015) included assessments by field surveyors of whether IoS were of an appropriate type, and set at an appropriate level. For woodland options, 33% of maintenance of woodland (HC7) IoS and 41% of restoration of woodland (HC8) IoS were considered to be set at doubtful or inappropriate levels. Mountford et al. (2013) also found that woodland IoS were very general and failed to describe objectives clearly, which may partly explain the relatively high failure levels for woodland management IoS. However, in some cases the management required to achieve desired outcomes had not been delivered. Surveyors often noted that there was no visible sign of woodland management aimed at meeting these IoS, even for those classed as partially met.

IoS type	Yes	Partial	No	Not assessed	Total assessed	% achieved
access	32	3	18	5	53	60
arch/ historic	105	6	14	176	125	84
bare ground	339	21	146	30	506	67
boundary management	1			0	1	100
bracken control	59	3	21	10	83	71
burning	70	5	13	5	88	80
cereal density	5			4	5	100
disturbance	29	1	1	4	31	94
ditch profile	10			0	10	100
erosion	43	2	8	15	53	81
flowering	30	12	25	46	67	45
generic	1			0	1	100
grazing	5	2	3	0	10	50
grazing regime	70	2	11	29	83	84
habitat extent	87	10	33	56	130	67
hedge management	68	3	2	12	73	93
litter	9			5	9	100
margin/ buffer management	4			6	4	100
meadow management	2			0	2	100
moist soil	25	4	3	22	32	78
monitoring				5	0	0
negative indicator species	474	24	96	43	594	80
open water	3			4	3	100
poaching/compaction	16	1	2	0	19	84
pollution	20	1		1	21	95
pond				1	0	0
positive indicator species	330	86	355	117	771	43
priority habitat	2			13	2	100
rabbit management		1		0	1	0
resource protection	4			0	4	100
rides/glades/firebreaks	21	6	23	2	50	42

Table 6.3. IoS results by type: Yes (fully met), Partial (partially met) and No (not met at the time of assessment). % achieved is of those that could be assessed and does not include those that were not assessed. Continued below.

IoS type	Yes	Partial	No	Not assessed	Total assessed	% achieved
scrub control	108	3	32	14	143	76
seeding	21	5	4	79	30	70
soil characteristics	33	3	10	312	46	72
soil moisture	2			0	2	100
SSSI*	59	13	43	141	115	51
standing water	17	2	15	88	34	50
structure	184	56	86	35	326	56
sward height	81	13	43	74	137	59
target species	62	44	53	304	159	39
tree establishment	11	3	5	8	19	58
tree management	26	1	1	10	28	93
vegetation cover	276	52	139	43	467	59
water levels	35	1	8	34	44	80
wildflower cover	88	33	64	21	185	48
woodland management	4	5	10	11	19	21
Total	2871	427	1287	1785	4585	63

Table 6.3 continued. IoS results by type: Yes (fully met), Partial (partially met) and No (not met at the time of assessment). % achieved is of those that could be assessed and does not include those that were not assessed. Total not assessed mainly comprise those that were classified as "could not assess" in addition to a minority that were not assessed for other reasons. Supplementary options are excluded. Attribution to 'type' of IoS follows Boatman et al. (2014).

* SSSI IoS require SSSI to be in favourable or recovering condition; assessments of this were made using (a) (where specified) criteria outlined in Part 3 of agreement documentation, (b) NE sources i.e. MAGIC or (c) surveyor assessments of individual parcels within SSSI unit. Therefore SSSI assessment within IoS may differ to official assessments recorded through commons standards monitoring approach.

Five other IoS types had poor success with less than 50% achieved. IoS relating to target species were often ambiguous and often could not be properly assessed in a single visit (33% IoS failed). Boatman et al. (2014) included assessments of whether IoS were set at an appropriate level, and concluded 53% of IoS for target species were not at an appropriate level. With many of these, the IoS state that specific species such as dormouse, skylark, stone curlew, snipe etc. should be present and/or should be seen regularly using the plot throughout the duration of the agreement. On some parcels, surveyors saw evidence of one or more of the target species (dormouse nuts, bird calls heard) during the visit, but they were cautious to classify such IoS as being fully met in case such sightings were atypical or did not include all specified species. Where no such signs were visible, surveyors would either class as "could not assess" or as a fail. This illustrates the ambiguity of some IoS wording ('regularly' is open to a range of interpretations). IoS of this type require more frequent monitoring visits throughout the agreement term to accurately assess presence of specific species, and may be more suitable for use by landowners tracking progress than for a one-off assessment.

Despite the additional winter bird surveys undertaken by two ornithologists at the correct time of year, key options targeting wintering birds were often classified as "could not assess". These IoS state that there should be frequent sightings of wintering wildfowl or other target

species often between specific dates. When weather conditions at the time of the survey were not ideal for bird sightings, when birds were seen on one of the two visits or when habitat looked suitable but no birds were seen on the visits, surveyors were cautious with their assessment and often recorded "could not assess", as they felt they did not have sufficient data to categorically state the IoS was met for these specific parcels. Such judgements on ambiguous IoS are subjective and variable.

Boatman et al. (2014) found that IoS addressing the presence of positive indicator species was a common type that was not achieved with 39% missing the target threshold. During the current resurvey, 46% of IoS for positive indicator species were not achieved. Notes provided by surveyors showed that whilst positive indicator species were present on many parcels, they were often at a frequency below that required to meet the IoS target (e.g. the target required three species to be frequent but whilst present these were only recorded as occasional or rare). There were similar comments with IoS for flowering (37% fail) and wildflower cover (35% fail). The number, cover or frequency of a flowering plant often failed to meet IoS targets e.g. an IoS for wildflower cover states that by year 3, cover of wildflowers (excluding undesirables) should be 20-90% with at least 40% of wildflowers in flower May-June, but where surveyors only recorded 10% or 15% cover this would fail to meet the IoS target (also see Appendix D, Table D1 for reasons for failing condition criteria). Jones et al. (2015) found 46% of IoS relating to positive indicators were set at a doubtful or inappropriate level. It is difficult to ascertain if a failure is due to the target within the IoS, or the actual management to deliver the desired outcomes. Table 6.4 shows IoS relating to positive indicator species by option.

HLS Option	Code Description	Yes	Partial	No	Not assessed	Total assessed	% Achieved
HC7	Maintenance of woodland	1		1	1	3	33
HC8	Restoration of woodland	11	4	2	6	22	50
HC10	Creation of woodland outside the LFA		1		1	2	0
HC11	Woodland and livestock exclusion supplement	6		7	7	14	43
HC12	Maintenance of wood pasture and parkland	1			0	1	100
HC13	Restoration of wood pasture and parkland			2	2	3	0
HC15	Maintenance of successional areas and scrub	1			0	1	100
HE10	Floristically enhanced grass margin	5	4	35	39	48	10
HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)	8	1	23	24	41	20

Table 6.4 Positive indicator type IoS by HLS option and levels of achievement.

HLS Option	Code Description	Yes	Partial	No	Not assessed	Total assessed	% Achieved
HF14	Unharvested, fertiliser-free conservation headland	2	1	1	2	4	50
HG7	Low input spring cereal to retain or re-create an arable mosaic			3	3	9	0
HK6	Maintenance of species rich semi-natural grassland	34	15	39	54	100	34
HK7	Restoration of species rich semi natural grassland	89	21	103	124	218	41
HK8	Creation of species rich semi natural grassland	6	1	2	3	14	43
HK9	Maintenance of wet grassland for breeding waders	1	2	1	3	4	25
HK15	Maintenance of semi-improved or rough grassland for target species	9	3	21	24	50	18
HK16	Restoration of semi-improved or rough grassland for target species	15	1	9	10	26	58
HK17	Creation of semi-improved or rough grassland for target species			1	1	1	0
HL9	Maintenance of moorland	28		11	11	42	67
HL10	Restoration of moorland	88	21	76	97	220	40
HL11	Creation of upland heathland			8	8	8	0
HO1	Maintenance of lowland heathland	4	2		2	8	50
HO2	Restoration of lowland heathland on neglected sites	8	4	8	12	22	36
HO3	Restoration of forestry areas to lowland heathland		2		2	2	0
HP2	Restoration of sand dunes	1			0	1	100

Table 6.4 continued. Positive indicator type IoS by HLS option and levels of achievement.

HLS Option	Code Description	Yes	Partial	No	Not assessed	Total assessed	% Achieved
HQ6	Maintenance of fen	7		1	1	9	78
HQ7	Restoration of fen	5	1	2	3	15	33
HQ8	Creation of fen			2	2	2	0
HQ9	Maintenance of lowland raised bog			1	1	1	0
HQ10	Restoration of lowland raised bog	3	2	3	5	8	38
Total		333	86	362	448	899	38

Table 6.4 Positive indicator type IoS by HLS option and levels of achievement.

IoS relating to negative indicator species were much more likely to be achieved than those for positive indicators, with 80% success. These IoS are generally concerned with keeping levels of undesirable, weedy or invasive species at low levels. Table 6.5 outlines results for negative indicator type IoS by option.

HLS Option	Code Description	Yes	Partial	No	Not assessed	Total assessed	% Achieved
HC5	Ancient trees in arable fields			1	0	1	0
HC7	Maintenance of woodland	7	2	3	1	13	54
HC8	Restoration of woodland	10	2	3	2	17	59
HC10	Creation of woodland outside the LFA	1			0	1	100
HC12	Maintenance of wood pasture and parkland	1			0	1	100
HC13	Restoration of wood pasture and parkland	4			0	4	100
HC14	Creation of wood pasture	1			0	1	100
HC15	Maintenance of successional areas and scrub	13	1		0	14	93
HC16	Restoration of successional areas and scrub	5	1		0	6	83
HC18	Maintenance of high value traditional orchards	3			0	3	100
HC19	Maintenance of traditional orchards in production	2			0	2	100
HC20	Restoration of traditional orchards	6		2	0	8	75
HC21	Creation of traditional orchards			2	0	2	0

Table 6.5 Negative indicator type IoS results by HLS option. Continued below.

HLS Option	Code Description	Yes	Partial	No	Not assessed	Total assessed	% Achieved
HD9	Maintenance of designed/engineered water bodies	2			0	2	100
HD10	Maintenance of traditional water meadows	2			0	2	100
HE10	Floristically enhanced grass margin	13	2	3	0	18	72
HF4	Pollen and nectar flower mixture			1	0	1	0
HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)	18		12	11	41	44
HF14	Unharvested, fertiliser-free conservation headland	3		1	0	4	75
HJ3	Arable reversion to unfertilised grassland to prevent erosion or run-off			2	0	2	0
HJ4	Arable reversion to grassland with low fertiliser input to prevent erosion and run-off	1			0	1	100
HJ5	In-field grass areas to prevent erosion or run-off	5	1		0	6	83
HJ6	Preventing erosion or run-off from intensively managed improved grassland	7			0	7	100
HL7	Maintenance of rough grazing for birds	3		2	0	5	60
HL9	Maintenance of moorland	17	1	2	0	20	85
HL10	Restoration of moorland	87		4	8	99	88
HL11	Creation of upland heathland	1		1	1	3	33

Table 6.5, continued. Negative indicator type IoS results by HLS option. Continued below.

HLS Option	Code Description	Yes	Partial	No	Not assessed	Total assessed	% Achieved
HK6	Maintenance of species rich semi-natural grassland	54	3	12	4	73	74
HK7	Restoration of species rich semi natural grassland	88	3	24	5	120	73
HK8	Creation of species rich semi natural grassland	7	1		0	8	88
HK9	Maintenance of wet grassland for breeding waders	13	2	5	0	20	65
HK10	Maintenance of wet grassland for wintering waders and wildfowl	2			0	2	100
HK15	Maintenance of semi-improved or rough grassland for target species	29	2	5	1	37	78
HK16	Restoration of semi-improved or rough grassland for target species	25			5	30	83
HK17	Creation of semi-improved or rough grassland for target species	2			0	2	100
HO2	Restoration of lowland heathland on neglected sites	12	1	1	0	14	86
HP2	Restoration of sand dunes			1	0	1	0
HQ1	Maintenance of ponds of high wildlife value <100 sq m	4			0	4	100
HQ2	Maintenance of ponds of high wildlife value >100 sq m	8	1	1	0	10	80
HQ3	Maintenance of reedbeds	4		2	0	6	67
HQ4	Restoration of reedbeds	3			0	3	100
HQ6	Maintenance of fen	5			0	5	100
HQ7	Restoration of fen	5		3	4	12	42
HQ8	Creation of fen		1		0	1	0
HQ9	Maintenance of lowland raised bog				1	1	0
HQ10	Restoration of lowland raised bog	1		3	0	4	25

Table 6.5, continued. Negative indicator type IoS results by HLS option.

The high failure rate for IoS for rides/glades/firebreaks (46%) identified by Boatman et al. (2014) is consistent with the 42% failure rate from this resurvey. Surveyors observed that the woodland blocks surveyed were often too small to make this IoS viable; 37% of IoS in this category were judged to be of a doubtful or inappropriate type by Jones et al. (2015).

For certain IoS types, assessment was often not possible. For instance, IoS relating to soil physio-chemical characteristics (pH or soil phosphate level) were generally outside the scope of the current resurvey. Those that were assessed related to soil physical characteristics, such as soil moisture levels (e.g. 6-inch nail test). Where IoS relating to soil characteristics could be assessed, 72% were passed. Many IoS relating to archaeological and historic features were also categorised as 'could not assess' (53%). Some of these referred to change or deterioration in a historic or archaeological feature but did not give a baseline condition against which IoS could be judged. Targeted use of photographs could have been beneficial in assessments, but were difficult to use in practice.

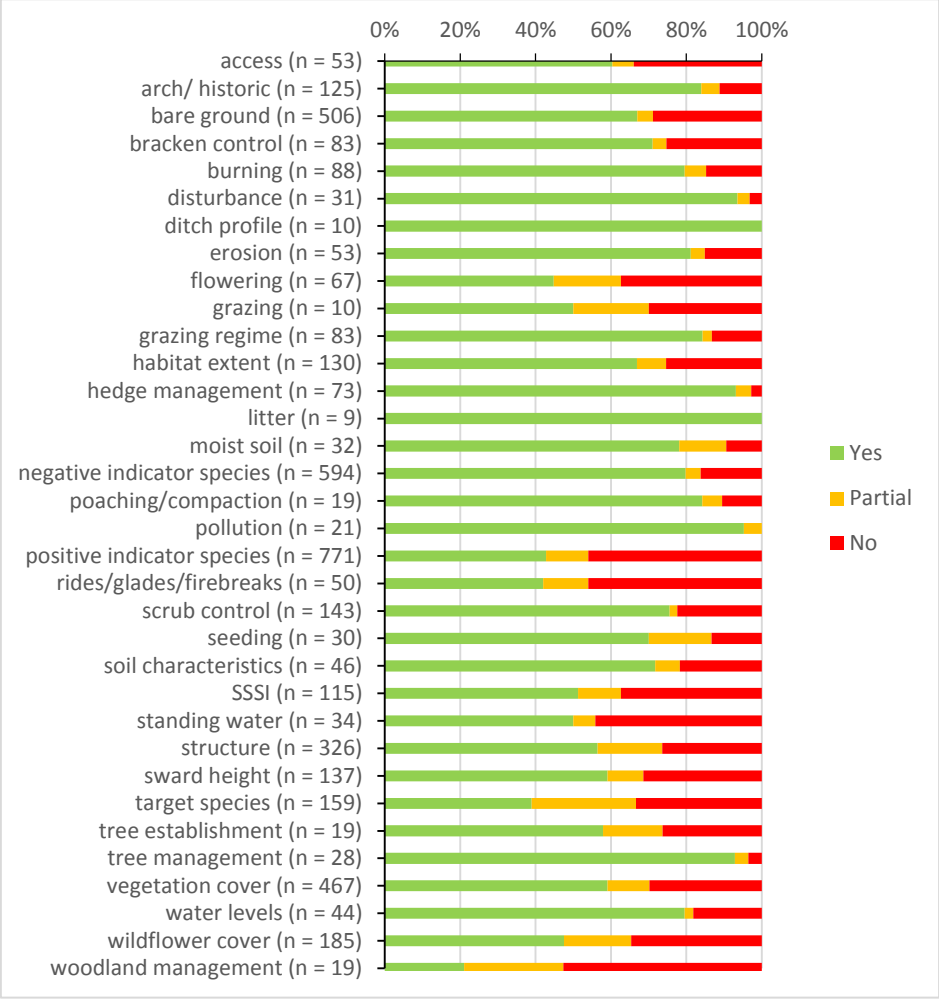

Figure 6.1. IoS achievement by type

Surveyors also found it difficult to assess IoS in the field that described other potential aspects of change such as priority habitat extent and condition or species diversity; although where these could be assessed they were often successful. Changes in area of priority habitats between the baseline and resurvey were recorded as part of the mapping exercise, and for the majority of priority habitats extent did not change between the two surveys (Section 3.0).

6.3 Confidence in achieving IoS per option

Is there any relationship between agreement holder confidence and the achievement of IoS?

Within the agreement holder survey carried out by the CRPR (Section 7), agreement holders were asked "How confident are you that you will achieve your Indicators of Success for the following options in your HLS agreement?" for each option on their agreement. Answers were given in five categories: certain, fairly confident, neither confident/unconfident, not that confident and not at all confident. Option IoS achievement was analysed for each of the following option groupings: maintenance and restoration of species rich grassland (HK6 & HK7), maintenance and restoration of grassland for special features (HK15 & HK16), maintenance and restoration of moorland and rough grazing (HL7-11), maintenance and restoration of woodland HC7 & HC8 and arable (all HF) options. Confidence categories had to be combined in some instances to gain sufficient replicates within groupings for analysis.

6.3.1 Maintenance and restoration of species rich semi-natural grassland - HK6 and HK7

There was a significant relationship between agreement holder confidence and IoS outcome ($\chi^2_{d.f.=4} = 10.54$, $p<0.05$) for management options HK6 and HK7, providing weak evidence that IoS outcome is not independent of the agreement holder's confidence of achieving IoS.

	Certain	Fairly confident	Neither confident/ unconfident	Total
Yes	212	230	83	525
Partial	35	36	8	79
No	109	116	68	293
Total	356	382	159	897

Table 6.6 Agreement holder confidence and IoS resurvey assessment

Forty percent of agreement holders were certain they would achieve the IoS for these options (Table 6.6). Sixty-nine percent of those agreement holders who were certain that all of their IoS would be met had the IoS categorized as 'not met' in the resurvey. For those who were neither confident nor unconfident that the IoS would be met, 48% had IoS that were not fully met.

6.3.2 Maintenance / restoration of semi-improved or rough grassland for target species - HK15 /16

	Certain	Fairly confident	Neither confident/unconfident & combined Not Confident	Total
Yes	200	40	16	256
Partial	31	6	4	41
No	72	10	9	91
Total	303	56	33	392

Table 6.7 Agreement holder confidence in achieving IoS and IoS resurvey assessment.

No significant relationship was found between agreement holder confidence in achieving IoS, and IoS outcome for HK15 and HK16 options ($\chi^2_{\text{d.f.}=4} = 2.8$, p=0.6; Table 6.7). The majority (77%) of agreement holders were certain they would fully achieve IoS for these options.

6.3.3 Maintenance / restoration of moorland and rough grazing for birds - HL7 / HL8/ HL9 / HL10

	Certain	Fairly confident	Neither confident/unconfident & combined Not Confident	Total
Yes	287	181	167	635
Partial	29	24	18	71
No	128	83	31	242
Total	444	288	216	948

Table 6.8 Agreement holder confidence in achieving IoS and IoS resurvey assessment for options HL7, HL8, HL9, HL10 and HL11.

The relationship between agreement holder confidence and IoS outcome was significant for moorland options ($\chi^2_{\text{d.f.}=4} = 19.3$, p<0.001) (Table 6.8). 29% of agreement holders were confident of delivering but did not actually deliver. Many of the IoS in this category (70%) were of the types recorded as having high instances of being set at an inappropriate level or being an inappropriate IoS by Boatman et al. (2014), i.e. positive indicator species, vegetation cover, target species and sward height.

6.3.4. Maintenance / restoration of woodland - HC7 / HC8

There was a significant relationship between agreement holder confidence and IoS outcome of woodland options ($\chi^2_{\text{d.f.}=4} = 18.4$, p=0.001). Confidence in delivering IoS for woodland options was much lower than for other options, 11% of agreement holders were not confident and only 21% were certain that they would achieve the IoS for these options (Table 6.9).

	Certain	Fairly confident	Neither confident/unconfident	Not confident	Total
Yes	34	61	34	9	138
Partial	6	15	18	3	42
No	9	18	17	15	59
Total	49	94	69	27	239

Table 6.9 Agreement holder confidence and IoS resurvey assessment for options HC7 and HC8.

6.3.5. Enhanced wild bird seed mix plots (rotational or non-rotational, Fallow plots for ground nesting birds and unharvested, fertiliser-free conservation headland) - HF12, HF13 and HF14.

There was a significant relationship between agreement holder confidence and IoS outcome for arable options HF12, HF13 and HF14 ($\chi^2_{\text{d.f.}=4} = 33.8$, p<0.001). 33% of agreement

holders were certain they would achieve IoS for these options, however on these agreements 61% of arable IoS were not met (Table 6.10).

	Certain	Fairly confident	Not at all confident combined with not that confident	Total
Yes	16	10	1	44
No	25	8	11	27
Total	41	18	12	123

Table 6.10 Agreement holder confidence and IoS resurvey assessment for arable options HF12, HF13 and HF14.

6.4 Mandatory and non-compulsory IoS

Do mandatory IoS have higher success than non-compulsory IoS?

When an agreement is put together there are mandatory IoS and optional, non-compulsory ones which can be chosen and tailored by the NE adviser. The mandatory IoS introduce a degree of consistency across options and agreements when analysing IoS. Mandatory IoS constituted 36% of the total number of IoS assessed, with 54% of mandatory IoS successful whilst 37% were not. Fewer mandatory IoS were successful than optional IoS ($\chi^2_{\text{d.f.}=2} = 107.6$, $p<0.001$). Optional IoS proved more successful with 68% succeeding (see Table 6.11).

	Resurvey assessment			
	Yes	Partial	No	
Mandatory	900	154	619	1673
Non-compulsory	1971	273	668	2912
	2871	427	1287	4585

Table 6.11 Number of IoS within mandatory and non-compulsory categories across options with resurvey assessment categories.

Agreement holders in consultation with Natural England advisors were more likely to choose options to deliver management of features that were already in place, where they will see increased wildlife or where management was already in place for that feature (Chapter 7, Section 7.3.2). It is possible that Natural England staff and the agreement holder may have more dialogue around optional IoS when setting up an agreement, and they may be better tailored to particular sites and parcels than mandatory IoS. Boatman et al. (2014) comment that mandatory IoS were sometimes irrelevant to the site or parcel for which they were written. This may indicate that in future AES, the use of more site specific and tailored IoS at the individual parcel level would lead to better outcomes.

6.5 Indicators of success: pairing resurvey outcomes with baseline predictions

Can IoS assessments carried out during a baseline be used successfully to predict end of agreement successes?

There were 3645 IoS for which assessments could be matched directly from baseline to resurvey, i.e. using the same field parcel, HLS option and IoS. At baseline agreements were new or in their infancy, so assessment could generally only be made on the potential for the IoS to be met, rather than the actual outcome.

Categories recorded in the baseline were:

- Green - The IoS has already been achieved or it is (almost) certain that it will be achieved within the duration of the agreement, there is no (or minimal) risk that the desired outcomes will not be met.
- Amber - There is some doubt that the IoS will be achieved and a moderate risk that the desired outcomes will not be met. The management prescriptions may appear appropriate but they may be ambitious or require rigorous implementation.
- Red - There is a high risk that the IoS will not be achieved within the duration of the agreement. Site conditions may be such that the IoS is impossible to meet practically or the HLS management prescriptions require complete revision to meet the desired outcomes.
- Could not assess

38% of baseline assessments were classified as "could not assess" (for the same reasons as during the current resurvey), 69% as likely to succeed or already achieved, 23% as outcome uncertain and 8% as at high risk of failure.

		Resurvey			
		Yes	Partial	No	Total Assessed
Baseline	Green	1886	210	445	2541
	Amber	378	108	317	803
	Red	82	23	196	301
	Total Assessed	2346	341	958	3645

Table 6.12 Number of IoS assessed at baseline and resurvey for paired parcels and options.

A significant relationship was found between baseline and resurvey assessment ($\chi^2_{\text{d.f.}=4} = 33.4$, $p<0.001$). Despite the uncertainty of predicting outcomes several years in advance, surveyors appear to have been fairly accurate in their assessments of IoS at baseline, with 74% of those IoS assessed as likely to succeed in the baseline classed at resurvey as having been met. 65% of those categorised as likely to fail at the baseline were confirmed at resurvey as having failed.

However, overall rate of IoS failure was underestimated during the baseline, as 80% of IoS classified as not met at resurvey had been assigned at baseline to either likely to succeed or outcome uncertain - see Table 6.12. This could be due to either or both of (i) over optimism (or benefit of the doubt given) on the part of surveyors during the baseline assessments or (ii) management failing to deliver expected outcomes during the agreement term. This illustrates demonstrates that while predictive assessments of success can provide useful interim proxy metrics, they should not be seen as a substitute for detailed monitoring of targeted futures.

6.6 Capital Items

Have capital items to support the outcome of the agreement been successfully completed?

Capital items (i.e. one-off capital works delivered to support the outcomes of the agreement) are listed in part 4 of the agreement documentation and shown on the agreement map. Progress with these was assessed and categorised;

- After deadline - some works completed
- After deadline - works completed
- After deadline - works not started
- Before deadline - no sign of work
- Before deadline - work started/complete.

In the resurvey 478 capital items were assessed. Where possible, all capital items from both the baseline agreement documentation and the resurvey documentation were considered. A small proportion (8%) of capital items were unable to be assessed. These were generally those that were related to scrub or bracken control, for which surveyors were unsure if work had been completed, or items such as ‘Professional help with implementation plan’ which were impossible to assess without contact with the agreement holder themselves.

The majority (83%) of capital works had been completed on time or had been started by their deadline. Of the agreement holders interviewed, 86% considered capital items as essential or

important (Chapter 7 Table 7.42). There is often an urgency with capital items as they may underpin annual management prescriptions, which may be a motivation for successful completion. Within the panel assessment process undertaken by Mountford et al. (2013), the assessment of capital works programmes judged these as essential to the functioning of annual management options and that 'free standing works' were likely to add value to environmental outcomes. That agreement holders and environmental outcomes both benefit from capital works probably explains the high completion rate.

The most common capital items recorded related to securing field boundaries, enabling effective stock control for grazing management, with sheep fencing, field gates and fencing supplements accounting for 33% of all capital items at resurvey (Table 6.13), this is consistent with other surveys of capital items (Boatman et al., 2014). Of those capital items not implemented by the deadline, wooden field gates accounted for 22%. Surveyors commented that they sometimes found a galvanised metal gate at intended sites which were not with capital works specifications.

6.6.1 Capital items by HLS management option

Twelve HLS options had 100% completion of associated capital works, and all options had a completion rate greater than 66% (Table 6.14). Within the maintenance of species rich grassland option (HK6), 33% of capital works were not complete by the end of the deadline. However, the unfinished capital items were from only 3 agreements. Although 28% of capital works associated with HL10 were not completed, no single capital item stood out as being most frequently not completed. During the resurvey, the surveyors often commented when an item was incorrectly applied or not of sufficient quality. Examples of these comments are given in Table 6.15.

Capital item description	After deadline - some works completed	After deadline - works completed	After deadline - works not started	Before deadline - no sign of work	Before deadline - work started/ complete	Total
Sheep fencing	2	48	7		15	72
Wooden field/river gate	6	22	16		5	49
Fencing supplement – difficult sites	1	20	3			24
Scrub management – 25% to 75% cover		2	4		15	21
Scrub management – base payment	2	10	1		4	17
Chemical bracken control – area payment	2	10	3		1	16
Stone wall restoration	1	9	4		2	16
Stone wall supplement – top wiring	1	7	4		3	15
Hedgerow restoration including laying, coppicing and gapping up	2	6	2		4	14
Scrub management – over 75% cover	5	4			5	14
Timber sluice		7			6	13
Chemical bracken control – base payment	1	8	2		1	12
Mechanical bracken control – area payment	1	3			7	11
Mechanical bracken control – base payment	1	3			6	10
Scrub management – less than 25% cover		7			3	10
Ditch, dyke and rhine restoration	2	6				8
Water trough		2	2	1	3	8
Stone wall supplement – stone from holding		6	1			7
Water supply		3	2	1		6
Deer fencing		5				5
Difficult site supplement for bracken and scrub control		4			1	5
Post and wire		2	2		1	5
Tree removal	1	2	2			5
Hedgerow supplement – top binding and staking		4				4
Pond creation – first 100m2	1	1	2			4
Removal of eyesore		3	1			4
Tree tube and stake		1	3			4
Bench	2	1				3
Creation of temporary ponds – first 100 m		1	2			3
Creation of temporary ponds – over 100 m		2	1			3
Hedgerow supplement – removal of old fence lines		3				3
Livestock handling facilities	2		1			3

Table 6.13 Capital items falling into five categories at resurvey. Deadline refers to the HLS agreement deadline for that particular capital item. Ordered by the total number of capital items. Continued below.

Capital item description	After deadline - some works completed	After deadline - works completed	After deadline - works not started	Before deadline - no sign of work	Before deadline - work started/ complete	Total
Native seed mix		1	1		1	3
Pond creation – over 100m2	2	1				3
Tree and shrub – whips and transplants plus planting		2	1			3
Tree surgery, minor – to include minor pollarding		3				3
Bat/bird box		2				2
Culvert		2				2
Hard standing for disabled paths		2				2
Parkland tree guard – post and wire (wood)			2			2
Planting fruit trees	2					2
Standard parkland tree/hedgerow tree and planting			2			2
Tree surgery, major – to include major pollarding		2				2
Wooden wings for gates		2				2
Bridle gate			1			1
Casting up supplement – hedge bank options					1	1
Construction of water-penning structures		1				1
Coppicing bankside trees					1	1
Earth bank restoration					1	1
Hard standing for car parking		1				1
Hedgerow planting – new hedges					1	1
Kissing gate					1	1
Management of scrub on wet sites					1	1
Orchard tree guard (tube and mesh)		1				1
Permanent electric fencing					1	1
Pond restoration – first 100 m2		1				1
Small mammal boxes					1	1
Soil bund		1				1
Stone wall supplement – difficult sites			1			1
Total	39	234	73	2	93	441

Table 6.13 continued. Capital items falling into five categories at resurvey. Deadline refers to the HLS agreement deadline for that particular capital item. Ordered by the total number of capital items.

HLS option	After deadline - some works completed	After deadline - works completed	After deadline - works not started	Before deadline - no sign of work	Before deadline - work started/complete	Total
HL10	5	36	23		18	82
HK7	1	39	12	2	25	79
HK15		24	3		20	47
HC8	5	35	5		1	46
HK6	1	20	13		5	39
HL7	6	16	6		3	31
HK16		15	4			19
HL9		12			5	17
HL8		13				13
HQ7	3	2	4		3	12
HK10	8	2				10
HO2	8				2	10
HL11		6	3			9
HQ10	2	4				6
HC15					5	5
HK8		3			1	4
HK11		3				3
HQ6					3	3
HK9		2				2
HQ2		2				2
HC7					2	2
Total	39	234	73	2	93	441

Table 6.14 The number of capital items assessed per HLS management option falling into five categories at resurvey (ordered by total number of capital items).

Capital item	Surveyor comments
removal of eyesore	not sure what original eyesore was but a toilet and conifer tree & other vegetation dumped over fence
stonewall restoration	normal wire sheep fencing and no sign of stone wall restoration
bracken control	whilst some bracken looked like it had been sprayed it was only a very small area
hedgerow restoration	hedge was still a bit gappy in places despite laying and new planting

Table 6.15 Examples of comments made by surveyors regarding specific failings of capital items.

6.7 Assessment of SSSI

Resurvey parcels that also had SSSI designation were assessed using a methodology based on generic Common Standard Monitoring (CSM). This involved a structured walk with 20 stops across the parcel, with at least five of these recorded as full quadrats. Assessments of each habitat type were made using different protocols, based on the relevant CSM protocol. Where SSSI units were larger than the parcels or greater than the agreement boundary under assessment, only the land covered by the parcel under general survey was assessed with CSM criteria, likewise if numerous units covered a single parcel the parcel was assessed instead of multiple units. Due to these mismatches of scale, condition assessments made for SSSIs during the resurvey cannot be compared directly to published data on the condition of SSSI units.

Assessments were made on 110 parcels from 64 agreements that had SSSI designation covering 17 habitat types.

Are there any common attributes across SSSIs within agreements that can inform management?

Attributes assessed to assess SSSI condition vary between these habitat types, and so direct comparisons of condition assessed across multiple protocols are not possible. However, there is some commonality between similar habitat classifications e.g. grasslands. These common features include positive and negative indicators.

SSSI condition is often related to presence and frequency of indicator species; for many grasslands at least two positive indicator species should be frequent, and two or three occasional throughout the sward (or at higher frequencies for some habitats). The lists of positive indicator species within each habitat classification may change (see example of lists in Table 6.16) but their presence still contributes towards condition status. Table 6.17 summarises results from the survey across grassland classifications for the average number of positive indicators seen within frequency categories. For four of the habitats SSSI positive indicator thresholds were generally met. The greatest proportion of positive indicator species assessments were in the rare and not present categories (Table 6.17). The nature of such positive indicators is that they are rare within the environment even within SSSIs, but the low frequencies recorded may indicate that although these species can be maintained within a habitat, it is difficult to increase their coverage.

Negative indicator species lists, whilst also tailored to specific habitats have more commonality across them, e.g. *Urtica dioica* and *Cirsium vulgare* occur on all negative species lists. SSSI attribute targets state that no negative indicator species should be more than occasional throughout the sward. Table 6.18 shows the average number of species in frequency categories per habitat type. In all but one habitat type, at least one negative species was recorded as frequent. *Senecio jacobaea* and *U. diocia* were the most frequently recorded negative indicators across all Grassland SSSI units. A high proportions of the listed negative indicator species were however rare or not present on SSSI parcels surveyed.

Positive indicator lists			Negative indicator list		
CG2 Grassland	**MG4 Grassland**	**MG8, MG8-related (south), M22, M23 Grassland**	**CG2 Grassland**	**MG4 Grassland**	**MG8, MG8-related (south), M22, M23 Grassland**
Anthyllis vulneraria	Centaurea nigra	Achillea ptarmica	Cirsium arvense	Anthriscus sylvestris	Cirsium arvense
Asperula cynanchica	Filipendula ulmaria	Berula erecta	Cirsium vulgare	Cirsium arvense	Cirsium vulgare
Campanula glomerata	Filipendula vulgaris	Caltha palustris	Rumex crispus	Cirsium vulgare	Rumex crispus
Cirsium acaule	Galium verum	Cardamine pratensis	Rumex obtusifolius	Rumex crispus	Rumex obtusifolius
Filipendula vulgaris	Lathyrus pratensis	Carex	Senecio jacobaea	Rumex obtusifolius	Senecio aquaticus
Genista tinctoria	Leontodon autumnalis	Cirsium dissectum	Urtica dioica	Senecio aquaticus	Urtica dioica
Gentianella	Leucanthemum vulgare	Eupatorium cannabinum		Senecio jacobaea	
Helianthemum nummularium	Lotus corniculatus	Filipendula ulmaria		Urtica dioica	
Hippocrepis comosa	Oenanthe silaifolia	Galium palustre/uliginosum			
Leontodon hispidus	Persicaria bistorta	Geum rivale			
Leucanthemum vulgare	Primula veris	Hydrocotyle vulgaris			
Linum catharticum	Rhinanthus minor	Lotus pedunculatus			
Lotus corniculatus	Sanguisorba officinalis	Lychnis flos-cuculi			
Pilosella officinarum	Serratula tinctoria	Mentha aquatica			
Plantago media	Silaum silaus	Orchidaceae			
Polygala	Stachys officinalis	Potentilla palustris			
Primula veris	Succisa pratensis	Ranunculus flammula			
Scabiosa columbaria	Thalictrum flavum	Succisa pratensis			
Serratula tinctoria	Tragopogon pratensis	Thalictrum flavum			
Succisa pratensis		Valeriana dioica			
Thymus		Viola palustris			

Table 6.16 Example of positive and negative indicator species lists for CG2, MG4 and MG8, MG8-related (south), M22, M23 Grassland SSSI habitat types.

SSSI Habitat classification	Number SSSI units surveyed	Number Positive Indicator species	Frequent	Occasional	Rare	Not present
CG2 Grassland	3	21	5.00	2.67	7.67	5.67
CG3, 4 & 5 Grassland	10	28	5.60	2.80	6.60	13.00
CG9 Grassland	4	17	1.75	1.00	3.00	11.25
Lowland acid grassland, U1e, U3, U4a, U4c, U4/U20-related (species-rich bracken)	5	21	0.80	1.40	2.20	16.60
M24, M25 Grassland	3	20	4.33	3.67	5.33	6.67
MG3 Grassland	2	9	1.00	1.00	2.50	4.00
MG4 Grassland	9	19	2.89	0.78	3.67	11.67
MG5 Grassland	1	27	4.00	2.00	5.00	16.00
MG8, MG8-related (south), M22, M23 Grassland	2	21	0.50	1.00	4.50	15.00
Species-rich Parched Grassland (CG7a,b,d,e; U1b,c,d,f)	7	19	2.71	1.29	2.00	13.00

Table 6.17 Average number of positive indicator species across different SSSI habitat classifications at resurvey. Presence of species recorded at 20 stops across SSSI parcel; presence in 0= Not present, 1-4 = rare, 5-8 = occasional, 9+ = frequent.

SSSI Habitat classification	Number SSSI units surveyed	Number Negative Indicator species	Frequent	Occasional	Rare	Not present
CG2 Grassland	3	6	0.67	0.67	3.00	1.67
CG3, 4 & 5 Grassland	10	6	0.10	0.30	2.10	2.60
CG9 Grassland	4	3	0.00	0.00	1.25	1.75
Lowland acid grassland, U1e, U3, U4a, U4c, U4/U20-related (species-rich bracken)	5	7	0.40	0.60	1.80	4.20
M24, M25 Grassland	3	6	0.33	0.00	1.00	4.00
MG3 Grassland	2	6	0.00	0.00	0.50	5.00
MG4 Grassland	9	8	0.33	0.22	1.00	1.78
MG5 Grassland	1	10	1.00	0.00	4.00	5.00
MG8, MG8-related (south), M22, M23 Grassland	2	6	1.00	0.50	1.50	0.50
Species-rich Parched Grassland (CG7a,b,d,e; U1b,c,d,f)	7	6	0.57	0.14	1.29	4.00

Table 6.18 Average number of negative indicator species across different SSSI habitat classifications at resurvey. Presence of species recorded at 20 stops across SSSI parcel; presence in 0= Not present, 1-4 = rare, 5-8 = occasional, 9+ = frequent.

6.7.1 Comparison of baseline and resurvey SSSI results

Do SSSI positive indicators change over time?

A comparison between baseline SSSI condition and resurvey is difficult; not all SSSI units within agreements were surveyed using CSM techniques in both surveys, because of time constraints within each survey. The numbers and species within positive and negative lists also changed between surveys in some cases, due to changes in data capture methodologies and in response to expert advice.

Table 6.19 below shows data from comparable SSSI habitat types where species lists were the same in the two surveys, and so differ from the tables above. Not all SSSI habitat types in Table 6.19 were the same, so any conclusions about positive indicators should be treated with caution. Within CG2 grasslands (chalk grassland) between baseline and resurvey there would appear to be a shift in positive indicator species becoming more frequent, but the sample size at resurvey is small. However, this may link to the analysis of change across all habitats under option HK7 (Section 5.2 above), where between baseline and resurvey there was a shift towards reduced dominance of competitive plant species, which might have allowed more positive indicators to spread.

SSSI Habitat classification	Survey	Number SSSI units surveyed	Number Positive Indicator species	Frequent	Occasional	Rare	Not present
CG2 Grassland	BL	13	21	2.69	4.62	6.00	7.69
	RS	3	21	5.00	2.67	7.67	5.67
CG3, 4 & 5 Grassland	BL	9	28	4.11	4.44	6.78	12.67
	RS	10	28	5.60	2.80	6.60	13.00
M24, M25 Grassland	BL	2	14	2.00	4.00	3.50	4.50
	RS	3	14	4.33	3.67	3.67	2.33
MG4 Grassland	BL	1	19	3.00	0.00	4.00	12.00
	RS	9	19	2.89	0.78	3.67	11.67

Table 6.19 Average number of positive indicator species across different SSSI habitat classifications at resurvey and baseline with standardised species lists. Presence of species recorded at 20 stops across SSSI parcel; presence in 0= Not present, 1-4 = rare, 5-8 = occasional, 9+ = frequent. BL=baseline, RS=resurvey.

6.9 Conclusions

Were IoS achieved and how do they differ between options and indicator types?

- Overall, the majority (63%) of IoS were achieved and capitals items completed.
- Results varied between HLS options, with some having a higher proportion of IoS met at resurvey than others.
- Some IoS types appear to have been delivered more consistently than others. Those that were less consistently successful were typically those that have previously been noted in other studies as frequently being set at inappropriate or unachievable levels (Boatman et al., 2014; Jones et al., 2015; Mountford et al., 2013). It is difficult to ascertain if a failure in these IoS was due to the IoS itself, or the actual management to deliver the desired outcomes.

Can IoS assessments carried out during a baseline be used successfully to predict end of agreement successes?

- The results suggest that predictive assessments of whether IoS will be achieved made near the start of AES agreements may offer a more positive assessment of potential to deliver outcomes than the results of assessments made at the end of AES agreements. This demonstrates the importance of repeat ecological surveys in assessing AES outcomes, as opposed to relying on predictions of success alone.

Is there any relationship between agreement holder confidence in achieving IoS and recorded success?

- For those options where a relationship between outcome and agreement holder confidence is significant, agreement holders tend to be too optimistic in their assessment of whether they are able to achieve IoS. Some IoS are very specific about percentage covers and frequencies of species required to achieve success. An agreement holder may see three positive indicator species and so assume success, but not appreciate that frequency or cover of these species within an individual parcel is insufficient to meet the target.
- An IoS may appear on first reading to be straightforward, but may be open to interpretation and difficult to assess even by experts, and certainly difficult for agreement holders without expert advice and ongoing monitoring.
- It may be that agreement holders who believe they have met IoS are less likely to refer back to IoS during the agreement (Chapter 7, 7.4.1) and therefore also less likely to tweak and fine tune management on parcels to bring about the change needed to meet targets. Within conventional farming, assessments of progress within the agricultural production system are routinely made and agreement holders know what they are aiming for and are used to acting to bring about improvements. Designing and implementing agreement holder-friendly indicators, amenable to non-expert assessment, could be beneficial. These would allow agreement holders to judge their

own progress during an agreement and make the adjustments to management that are needed to ensure success.

Have capital items intended to support the outcome of the agreement been successfully completed?

- The majority (83%) of capital works had been completed on time or had been started by their HLS deadline.

Are there any common attributes across SSSI protocols that can inform management?

- Positive and negative indicator species lists can be used to look at commonality across SSSI habitat types. Positive indicator frequencies appear to be within targets for SSSI assessment for some habitat types but not all, and species are more often rare or not present than frequent or occasional within the sward. Management should include a focus on increasing these desirable species cover across SSSI habitat types.

Do changes in SSSI positive indicators change over time?

- Owing to the constraints of survey methodology it is difficult to assess change from baseline to resurvey of SSSI units. The majority of SSSI habitat types appeared to show no difference in the frequency of positive indicator species. There was weak evidence that the frequency of positive indicators increased on some chalk grassland SSSIs, but caution should be applied to this conclusion due to the constraints in the data.

7. Agreement holder interview results: Results from the CRPR survey

This chapter presents the results of the agreement holder survey conducted in 2015-16. It describes the characteristics of the sample and then goes on to consider participants history and experience of agri-environmental management (both informally and as part of formal schemes) prior to their current HLS agreement; their experience of applying for and implementing their HLS agreement; their concerns about HLS and suggestions for changes and plans for the future.

The survey was conducted between October 2015 and August 2016 (with a 4-week break from 27 May-23 June due to 'purdah'). A total of 137 face-to-face interviews were conducted representing an overall response rate of 80.1 per cent (Table 7.1). A total of 15 agreement holders (8.8 per cent) declined an interview; generally these agreement holders claimed to be too busy to be interviewed. A small number (5, 2.9 per cent) were not available when interviewers were in the area. These were added to a 'revisit list' and reviewed in August 2016. Given the geographical spread of these sites, the resources required to visit them and the number of interviews completed by that time, no revisits were arranged. A total of 13 agreement holders (7.6 per cent) could not be contacted, despite successful entry to the sites by the CEH team and multiple and extensive attempts by CRPR team members. Typically, this occurred when a tenant or someone using the land – who was able to grant access to the land for the ecological survey – did not know who the agreement holder was or was unable to contact them. This was more common in the non-farming context and in larger institutions, where agents were initially employed as the agreement holder and had since moved on/retired etc. One site (0.6 per cent), on the Isles of Scilly, was deemed too logistically difficult/expensive to access.

	Frequency	Percent
Interview carried out	**137**	**80.1**
Declined	15	8.8
'Maybe later'	5	2.9
Failed to contact	13	7.6
Logistically difficult	1	0.6
Total	171	100.0

Table 7.1 Breakdown of response rate for agreement holder interviews

The majority of agreement holders surveyed were farmers (108, 78.8 per cent). Of the remaining 29 agreement holders, 22 (16.0 per cent) were Nature Reserves and a further 7 (5.1 per cent) classed themselves as 'Other'.

As above, assurances of anonymity, confidentiality and independence from NE and Defra were central to achieving such a positive response rate. For this reason, direct quotes and references to agreements and agreement holders contained within the following analysis have been reviewed and where necessary, identifiable characteristics such as names, places and/or distinguishing details have been removed or generalised. Agreement holders have been allocated an arbitrary ID and will be referred to using this throughout the analysis, e.g. agreement holder 45.

7.1 Overview of the sample

7.1.1 Land and land use

The mean farm/site size was 345 ha, with a range of 1.00 to 9105.00 ha (Table 7.2). Clearly, this is considerably larger than the typical farm size in England.

	N	Minimum	Maximum	Mean	Std. Deviation
Size	137	1.00	9105.00	345.1	863.5

Table 7.2 Mean farm/site size

The mean size can be misleading (median farm/site size, for instance was 140 ha) and further analysis reveals that nearly 30% of farms/sites were over 250 ha, whilst 25.5% were under 50 ha (Table 7.3). The 'middle' three categories combined (100-149, 150-199 and 200-249 ha), only accounted for 27.1% of the entire sample (see Figure 7.1).

	Farm/site size (ha)					
	<50	50<100	100<150	150<200	200<250	250+
Frequency	35	24	12	13	12	41
%	25.5	17.5	8.8	9.5	8.8	29.9

Table 7.3 Farm/site size distribution

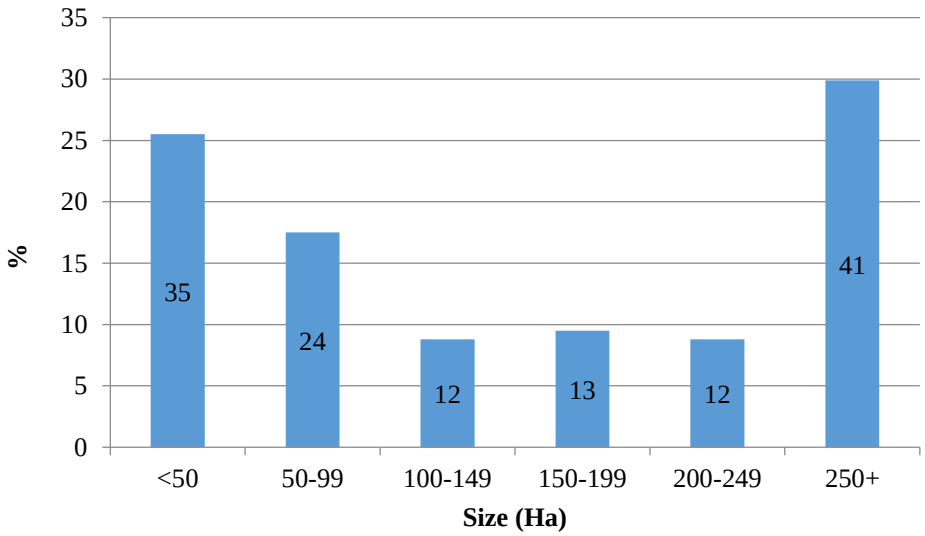

Figure 7.1 Farm/site size distribution

Survey respondents were responsible for managing a total of 47,281 ha. Owned land makes up close to 29,000 ha (61%) of the land in the sample (see Table 7.4 and Figure 7.2). Rented land (under a variety of different tenure arrangements) accounted for just over 8,000 ha (17%). Common land accounted for the smallest area, amounting to just under 4,500 ha (9.5%) of the total area. Other land, which included informal letting/borrowing agreements, accounted for just over 5,500 ha (12.3%).

	Mean	Sum (ha)	%
Total area owned	210.3830	**28822.47**	60.93
Total area rented	59.6220	**8168.21**	17.26
Total common land	32.8388	**4498.92**	9.51
Total other land	42.4702	**5818.42**	12.29

Table 7.4 Land tenure (*n*=137)

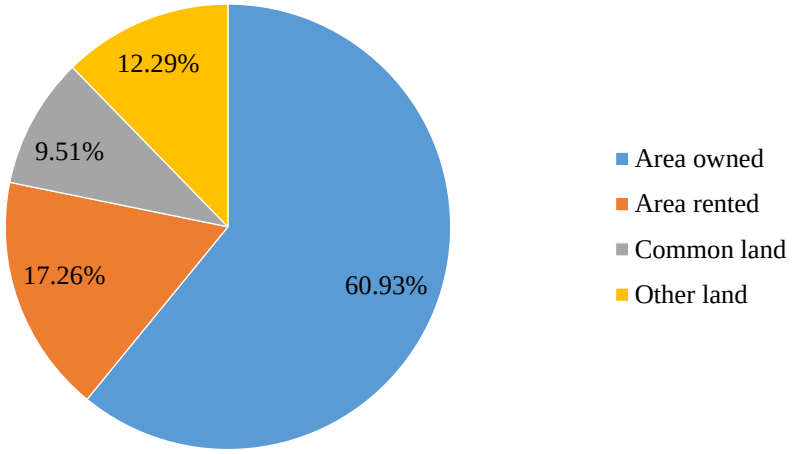

Figure 7.2 Land tenure breakdown

Farms/sites in the sample were **predominantly wholly owned** (45%). Mixed tenure (excluding common land and/or other land) accounted for just over a quarter of the sample (26.27%). Wholly rented, mixed tenure (including common land and/or other land) and sites made up of solely common/other land accounted for just 9.5% of the sample each (Table 7.5 and Figure 7.3).

Occupancy status of farms/sites	Frequency	%
Wholly owned	62	45.3
Wholly rented	13	9.5
Mixed tenure (excl. commons and/or other)	36	26.3
Mixed tenure (incl. commons and/or other)	13	9.5
Commons/other only	13	9.5
Total	137	100.0

Table 7.5 Occupancy status of farms/sites

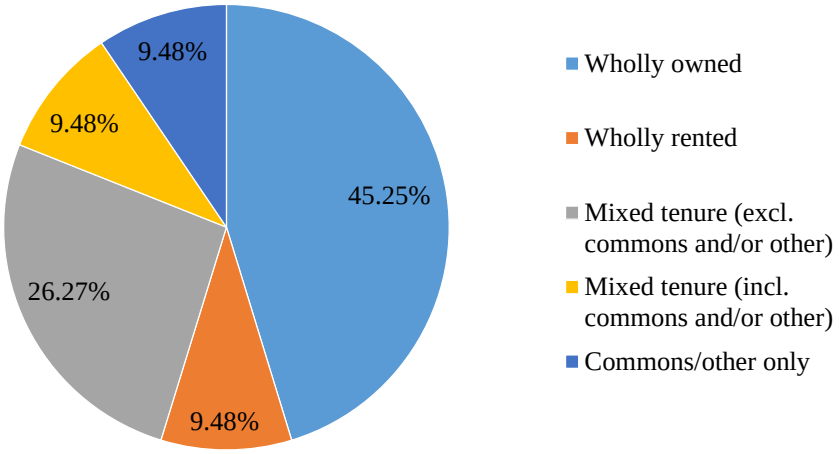

Figure 7.3 Farm/site occupancy categories

The sample captured a reasonably broad spread of main land uses. As Table 7.6 indicates, grassland accounts for just over 28% of the total land area in the sample, with arable land and rough grazing accounting for 21.90 and 22.09% respectively. Nearly 9% of the land in the sample is woodland, and, perhaps not unsurprisingly, just under 5% of land is under temporary grass. The remaining 14% of land is described as 'other' which includes watercourses, ponds, open water, reed beds, buildings, wasteland, orchards, lowland heath, saltmarsh, intertidal salt lagoons, fenland and heathland.

	Mean ha	**Sum**	**%**
		n = 134	
Arable land	74.62	9998.67	21.91
Grassland	96.29	12903.28	28.27
Temporary grassland	16.38	2194.19	4.81
Rough grazing	75.24	10081.69	22.09
Woodland	30.40	4074.19	8.93
Other land	47.72	6393.82	14.00

Table 7.6 Land use

Only 17 farms/sites (12.6%) were registered as organic (Figure 7.4).

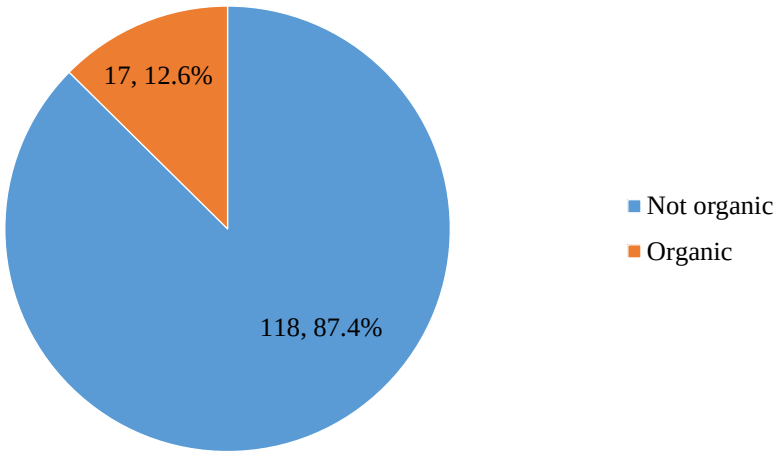

Figure 7.4 Organic status

With reference to the **108 farms** surveyed, the dominant farm type (as defined by respondents) was LFA cattle/sheep (38.9%). Cattle/sheep farming in lowland areas accounted for just over a quarter of the farms (25.0%). Just 4.6% of the farms surveyed were dairy farms (see Figure 7.5). This is not surprising given the potential challenges of combining intensive dairy farming with HLS management requirements.

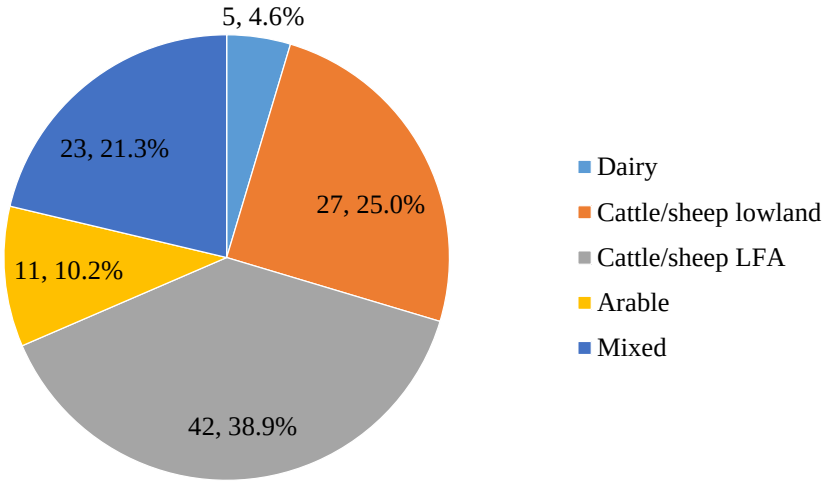

Figure 7.5 Farm type

Of the remaining 29 agreement holders, 22 (16.0% of the total sample) were Nature Reserves. A further 7 (5.1% of the total sample) classed themselves as 'Other' which included, a Country Park, common land only, land used for horses and cut for hay, land used for horses and cereal, parcel of land in valley and a mixture of semi-natural grassland, improved grassland and unimproved SSSI.

Over half (63 per cent) of survey respondents had agreement land which included SSSI land (Figure 7.6).

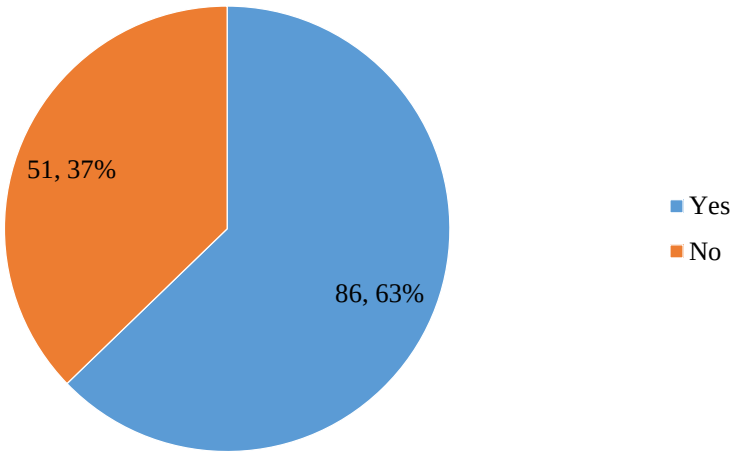

Figure 7.6 Agreement land includes SSSI land (*n* = 137)

7.1.2 The agreement holders

A fundamental hypothesis being tested in this research is that the identity of participants, their characteristics, experience, knowledge and motivations may influence the environmental outcomes of HLS agreements. Given the dominance of farms in the sample it is not surprising that a majority of agreement holders (just over 45%) of those interviewed were in a partnership with a family member, compared with 21.9% who were sole proprietors and 21.2% were directors or managers. The remaining 11.5% classed themselves as 'other', which included administrators, land agents and committee members or chairs (see Table 7.7).

	Frequency	**%**
Sole prop	30	21.9
Partner with family member	62	45.3
Director/manager	29	21.2
Other	16	11.7
Total	137	100.0

Table 7.7 Agreement holders' role in the business/organisation

A total of 86 out of the 108 farm participants were either sole proprietors or in partnership with a family member (79.6%). In contrast, the non-farm participants were typically directors/managers (62.0%; Table 7.8).

	Farm	Non-farm
Sole proprietor	27	3
Partner with family member	59	3
Director/manager	11	18
Other	11	5
Total	108	29

Table 7.8 Agreement holders' role in relation to the agreement by business/holding type. 'Non-farm' refers to those businesses/holding type classed as Nature Reserves or 'Other'

The dominance of farms in the sample influenced the mean age of those interviewed, which was 53.4 years. The minimum age of those interviewed was 23 years and the maximum was 86 years. The mean age for farmers was 54.1 years old, compared with a mean of 50.8 years for non-farmers[1] (Table 7.9).

	N	Minimum	Maximum	Mean
Participants' ages	133	23	86	53.4
Farmers'	105	23	86	54.1
Non-farmers'	28	25	70	50.8

Table 7.9 Age structure of sample

Those in the 45<55 and 55<65 category accounted for 60.1% of the sample (30.8 and 29.3% respectively). Only 8.3% of those interviewed were under 35; similarly, only 13.5% of those in the sample were 35<45 category (Table 7.10).

	Frequency	%
<35	11	8.3
35<45	18	13.5
45<55	41	30.8
55<65	24	29.3
65 and over	24	18.0
Total	133	100

Table 7.10 Age categories of participants

Given the average age of agreement holders it is no surprise that many had been managing their 'agreement land'[2] for many years. This may be taken as a proxy indicator of knowledge of the land management requirements and characteristics of the agreement land, although in the case of farmers, such knowledge may be predominately orientated towards agricultural production. As demonstrated in Table 7.10, the mean number of years participants had been managing the agreement land was 22.34 years. The mean number of years farmers had been managing the agreement land was higher (23.9 years) and this was lower amongst non-farmers (16.5 years).

[1] Independent samples t-test revealed no statistically significant differences between mean ages for farmers and non-farms (p=0.219)

[2] i.e. the land comprising the HLS agreement

	N	Minimum	Maximum	Mean	Std. Deviation
Whole sample	137	1	70	22.34	14.74
Farmers	108	1	70	23.9	15.0
Non-farmers	29	1	47	16.5	12.38

Table 7.11 Agreement holders' number of years managing agreement land by farmer type

As evident in Table 7.12 and Figure 7.7, 46.0% of participants had been managing the agreement land for more than 20 years. An additional 41.6% of participants had been managing the agreement land for 6-20 years. Only 12.4% of participants were relatively new to managing the agreement land, having been managing it for 5 years or less.

	Frequency	%
<5 years	16	11.7
5<20 years	50	36.5
20 years or more	71	51.8
Total	137	100.0

Table 7.12 Agreement holders' number of years managing agreement land, categories

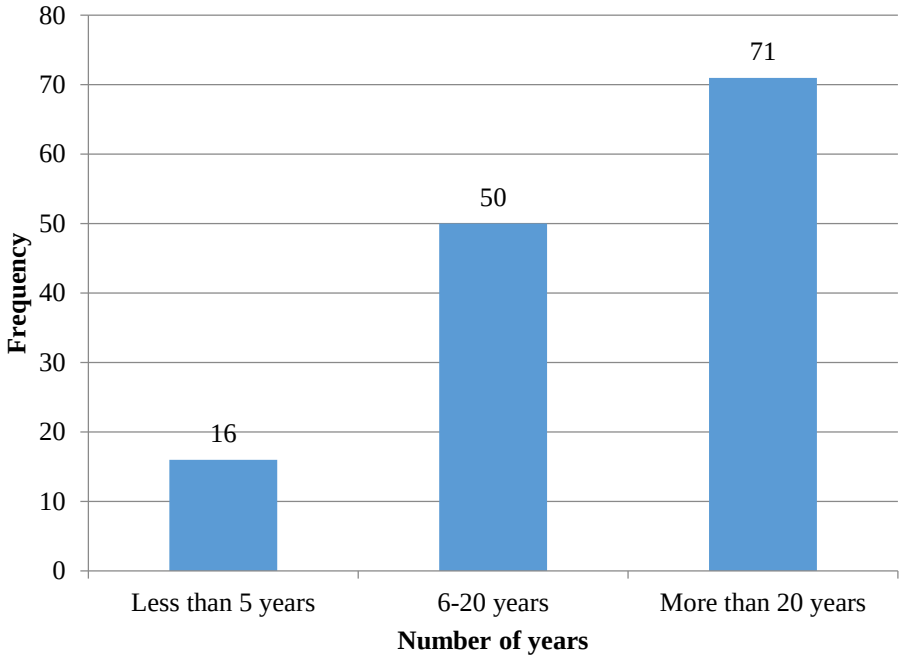

Figure 7.7 Participants' number of years managing agreement – categories

Finally in this section, Table 7.13 presents the educational profile of agreement holders. Survey participants' educational attainment was diverse with notable percentages in every category from leaving school with no qualifications up to obtaining a postgraduate degree. Technical qualifications and undergraduate degrees accounted for more than half the sample combined (26.5 and 25.0% respectively). Those who left school before 16 accounted for 17.6% of the sample, exceeding the number of people with postgraduate degrees (9.6%).

	Frequency	%
School	24	18.3
O-Levels/GCSEs & A-Levels	24	18.3
Technical qual.	36	27.5
Undergraduate & postgraduate degree	47	35.9
Total	131	100.0

Table 7.13 Agreement holders' highest level of formal education

Exactly half of respondents reported that their highest level of formal education was related to agriculture/land management/conservation etc. The remaining half reported it did not relate to any of these areas/subjects.

7.2 Agreement holder history and experience of agri-environmental management

This section considers survey participants' history and experience of agri-environmental management, both informally and as part of AES, prior to their current HLS agreement. It will be demonstrated that many participants have considerable experience of a range of agri-environmental management activities, often over an extended period. This may be taken as a proxy indicator of agri-environmental management knowledge and ability, although as previous research has shown (Lobley & Potter, 1998), participation alone is not sufficient to demonstrate engagement with, and understanding of, agri-environmental management requirements. Rather, it is the 'quality' of such engagement, which may be reflected in motivation, understanding and commitment, which can be important in terms of environmental outcomes.

7.2.1 Informal agri-environmental management

The majority of participants (65.0%) had carried out environmental work/practices independent of an AES, compared with just 33.6% who had not (Table 7.14).

	Frequency	%
No	46	34.0
Yes	89	66.0
Total	135	100.0

Table 7.14 Had agreement holders previously undertaken any informal agri-environmental management work?

As Figure 7.8 indicates, interviewees had undertaken a broad range of informal agri-environmental management with 'Boundary restoration and management (e.g. hedgerows, stonewalls) being the most common (78.4%). 'Manage and/or establish woodlands for conservation', 'creation or maintenance of wildlife meadows, heathland, parkland or common land' and the 'creation of new and/or management of existing water features' were also undertaken by over 50% of the sample (56.8, 55.6 and 51.1%, respectively).

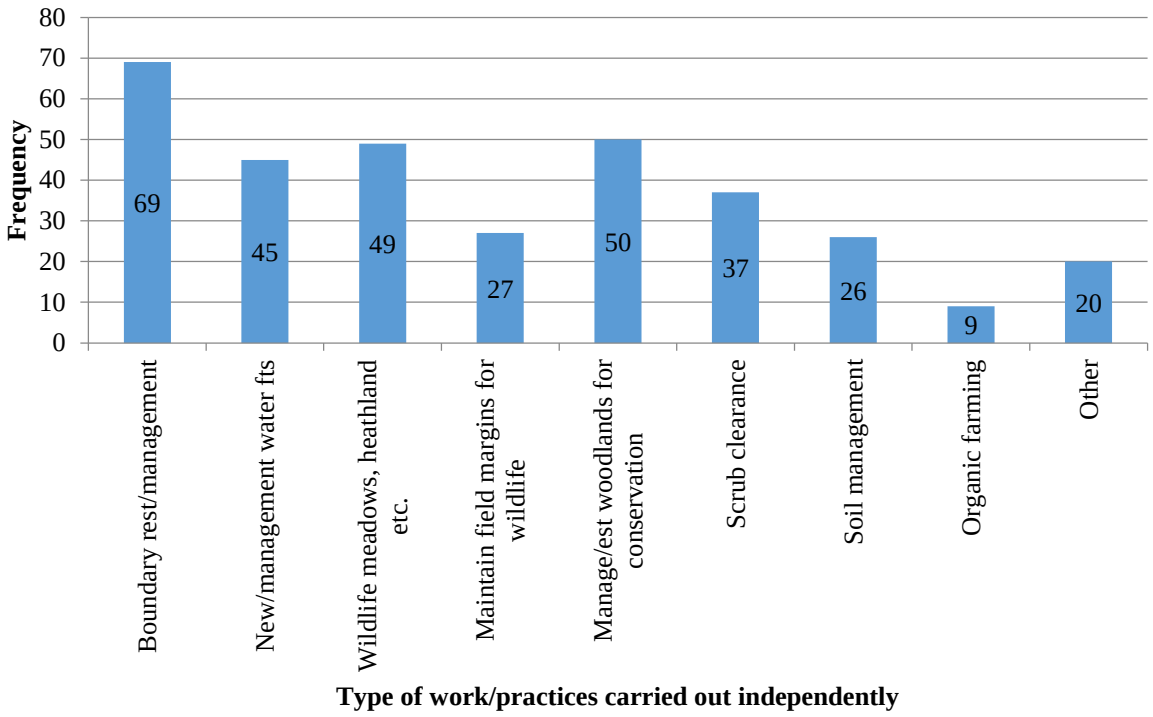

Figure 7.8 Types of environmental work/practices carried out independent of AES (*n*=88)

Examples of 'Other' environmental work/practices include: skylark plots, bird nest boxes, bat conservation, sustainable harvesting of wood products for fuel, nitrogen limitation on arable crops, restoring gravel pits into lakes and re-wetting sites that were previously drained.

Table 7.15 breaks down these independent environmental practices according to business/holding type. Some key differences between farms and non-farms participating in different types of independent environmental work/practices are:

- 82.6% of interviewees on farms who had previously undertaken informal/independent environmental work/practices had undertaken 'Boundary restoration and management (e.g. hedgerows, stonewalls)', compared to 63.2% of those on non-farms.
- 69.4% of interviewees on non-farms who had previously undertaken informal/independent environmental work practices had undertaken the 'Creation of new or management of existing water features', compared with less than half of those on farms (46.4%).
- Nearly three-quarters (73.7%) of interviewees on non-farms, compared with only half on farms (50.7%) had undertaken the 'Creation of/maintenance of wildlife meadows, heathland, parkland or common'.
- Just under 79% of interviewees on non-farms who had previously undertaken informal/independent environmental work practices had undertaken scrub clearance, compared with only 31.9% of agreement holders on farms.
- Scrub clearance aside, this analysis suggests that, as might be expected, it is the non-farming participants' who have previously been engaged in what might be considered 'more demanding' agri-environmental management.

	Farmer (*n*=69)	Non-farmer (*n*=19)
Boundary restoration & management	82.6% (57)	63.2% (12)
Creation of new/management of existing water features	46.4% (32)	68.4% (13)
Creation of/maintenance of wildlife meadows etc.	50.7% (35)	73.7% (14)
Maintaining field margins for wildlife	29.0% (20)	36.8% (7)
Manage &/or establish woodlands for conservation	56.5% (39)	57.9% (11)
Scrub clearance	31.9% (22)	78.9% (15)
Soil management plan	37.7% (26)	0.0% (0)
Organic farming	13.0% (9)	0.0% (0)
Other	20.3% (14)	31.6% (6)

Table 7.15 Types of environmental work/practices carried out independent of AES by agreement holder type

Many survey participants had previously undertaken multiple agri-environmental management activities. As Table 7.16 indicates, over half the agreement holders (68.2%, *n*=60) had previously undertaken a 'low' number of independent environmental work/practices (1-4). Just over 30% had undertaken a 'high' number (7-9). As is evident in Table 7.17, agreement holders carrying out a high number of independent agri-environmental practices are associated with larger land holdings (which arguably offer more opportunity for a range of environmental management activities) and, compared to those who had undertaken a low number of practices, are more likely to be a Director or Manager rather than a partner in a family business. Just under 60% were educated to at least degree level compared to 24% of those implementing a low number of environmental management practices.

	Frequency	%
Low (1-4)	60	68.2
High (5-9)	28	31.8
Total	88	100.0

Table 7.16 Number of independent environmental work/practices undertaken. Categories represent the number of independent environmental work/practices undertaken by agreement holders where low equals 1-4 of the work/practices listed in Table 7.15 and high equals 5-9.

	Low		High
FARM/SITE SIZE		%	
<50	26.7		14.3
50<150	25.0		28.6
150<250	16.7		14.3
250+	31.7		42.9
ORGANIC STATUS[1]		%	
Not organic	94.9		75.0
Organic	5.1		25.0
AGREEMENT TYPE		%	
Farm	80.0		75.0
Non-farm	20.0		25.0
AGREEMENT HOLDER'S ROLE		%	
Sole proprietor	21.7		17.9
Partner with family member	48.3		28.6
Director/manager	20.0		35.7
Other	10.0		17.9
NO. YEARS IN CHARGE OF AGREEMENT[2]		%	
<5	15.0		10.7
5<20	23.3		53.6
20+	61.7		35.7
EDUCATIONAL ATTAINMENT		%	
No qualifications	22.4		7.4
O-Levels/GCSEs & A-Levels	15.5		18.5
Technical qualification	37.9		14.8
Undergraduate & postgraduate degrees	24.1		59.3
HIGHEST LEVEL OF EDUCATION …		%	
Related to agriculture/land management	48.3		42.3
Not related to agriculture/land management	51.7		57.7

Table 7.17 Characteristics of agreement holders carrying out high numbers of independent environmental work/practices

[1]The association between organic status and number of independent work/practices category is significant when $p<0.05$

[2] The association between agreement holders' number of years in charge of the agreement and number of independent work/practices category is significant when $p<0.05$

The independent agri-environmental management uncovered by the survey was informed by information and advice from a variety of sources. As can be seen from Table 7.18, the most common source of information guiding independent agri-environment work/practices were conservation organisations (44% of the 84 agreement holders who answered this question). Neighbours/friends/relatives, farming/scientific literature and NE advisers were also a significant source of information (34.5% of the 84 agreement holders used these sources of information). In contrast, only 3.6% and 2.4% respectively of respondents used farming websites or online forums.

#	Source of information	Frequency	% of sample
1	Conservation organisation	37	44.0
2	Neighbour/friend/relative	29	34.5
	Farming/scientific lit	29	34.5
	NE adviser	29	34.5
3	Agronomist or adviser	18	21.4
	'Other'[1]	18	21.4
4	Course/conferences/workshops	15	17.9
5	Defra	13	15.5
6	Gamekeeper, GWCT etc.	12	14.3
7	Farming websites	3	3.6
8	Online forums	2	2.4

Table 7.18 Ranked sources of information (*n*=84).
[1]Examples of 'Other' include: farming radio, other farming schemes, e.g. CSF and authorities/charities, e.g. CLA, own knowledge/personal experience and word of mouth.

7.2.2 Previous agri-environment schemes

Just over 72% of agreement holders had previously participated in an agri-environment scheme (AES). A total of 60 agreement holders out of 95 (63.2%) had previously participated in the Countryside Stewardship Scheme (Figure 7.9). Participation in Entry Level Stewardship (ELS) and Environmentally Sensitive Area (ESA) schemes was also notable (with 29.5 and 25.3% of agreement holders participating respectively). Clearly, as almost all HLS participants have to be in ELS these figures refer to ELS participation before HLS was considered as an option.

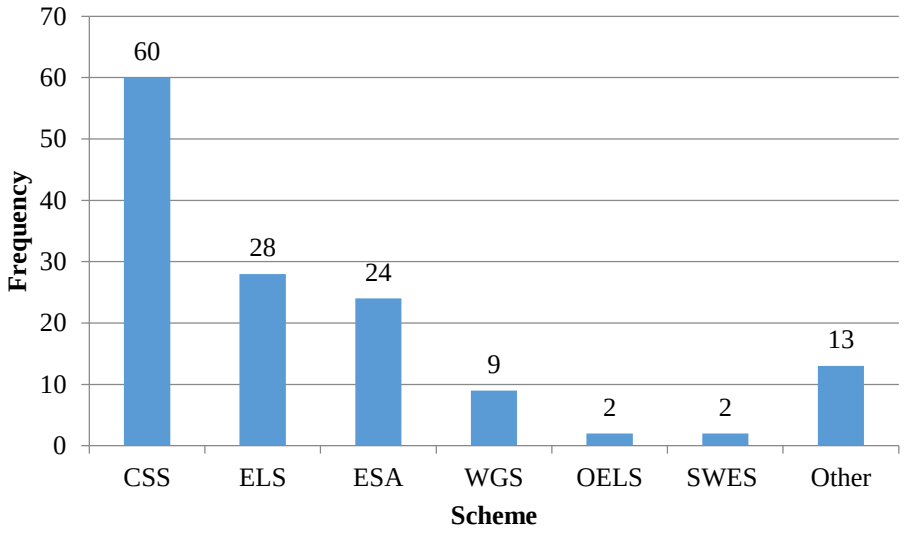

Figure 7.9 Agreement holders participation in previous schemes (*n*=95). 'Other' includes, Wildlife Enhancement Scheme, Catchment Sensitive Farming, Organic Farming Scheme, Hedgerow Restoration, Traditional Breed Scheme and Reserves Enhancement Scheme.

Participation in previous schemes had been motivated by a variety of factors although financial motives dominated. As Figure 7.10 illustrates, the most popular motivation for adopting previous schemes was 'financial support' (just over 80% of agreement holders

identified this as one of their 'top 3' reasons for participating in previous AES). The significance of financial motives reflects the findings of much previous literature on AES adoption (see Brotherton, 1989; Buller et al., 2000; Morris & Potter, 1995; Riley, 2011; Wilson, 1996; Wilson & Hart, 2000). An 'interest in wildlife and/or the environment' and the fact it 'fit with the pre-existing farming system' were also particularly significant motivating factors (mentioned by 51.0 and 45.6% of survey participants' respectively).

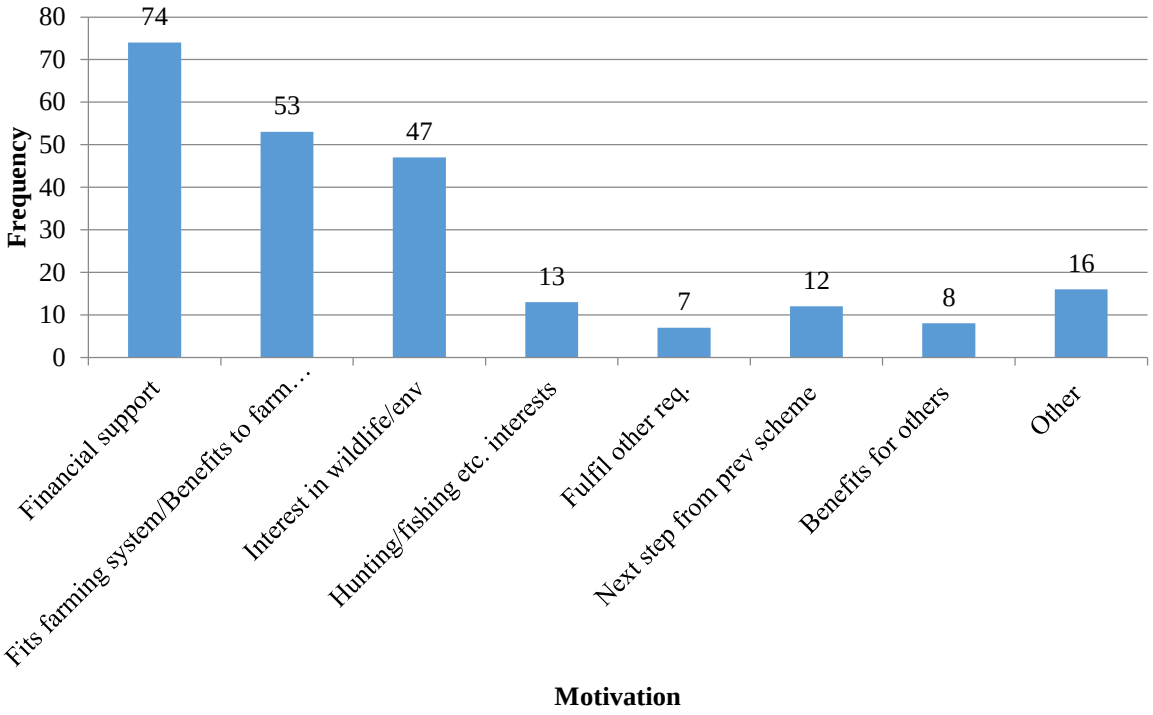

Figure 7.10 Motivations for participating in previous schemes (*n*=92). 'Other' motivations included, the land already being in an AES when the participant arrived or inheriting the agreement with the land, to produce healthy and nutritious food, poor commodity prices, helped to structure management plan, as well as a general organisational interest.

There were some differences in motivation between farm and non-farm agreement holders with the former being more likely to be motivated by financial support and fit with farm system (see Table 7.19).

	Farmer	Non-farmer
Financial support	58.3%	37.9%
	63	11
Fits farming system/Benefits to farm system	49.0%	20.7%
	53	6
Interest in wildlife/env	33.3%	37.9%
	36	11
Hunting/fishing etc. interests	9.3%	10.3%
	10	3
Fulfil other req.	6.5%	0.0%
	7	0
Next step from prev scheme	8.3%	10.3%
	9	3
Benefits for others	4.6%	10.3%
	5	3
Other	11.1%	13.8%
	12	4

Table 7.19 Motivations for previous AES by agreement holder type

Nearly 50% of agreement holders saw 'significant environmental benefit' from their previous AES. Only 12.6% saw no or little environmental benefit (Table 7.20).

	Frequency	%
I saw no/little environmental benefit	12	12.6
I saw a slight environmental benefit	24	25.3
I saw significant environmental benefit	47	49.5
I am not really sure	12	12.6
Total	95	100.0

Table 7.20 Perceived outcome of previous schemes

Generally, those that claimed to have seen **no/little environmental benefit** from previous schemes suggested it was because they had already been maintaining the environment. It is important to note, these agreement holders were not critical of the previous schemes and their capabilities, but felt they did not elicit any environmental benefit beyond what they were already doing.

> "In terms of what we have done with the land there has been no major change ... We have maintained the environment that was here. Most environmental schemes were trying to prevent environmental things being destroyed. We cannot say we have had an environmental benefit because it's the same." (Agreement Holder 12, farm)

> "Don't think we did see any benefits to Countryside Stewardship to be honest. But I can tell you why I think that's the case.... Basically […] the fact that we don't use and have never used any pesticides, insecticides or artificial fertilisers. That's massive, that's like a bedrock - because it means you're not taking out all

the start of the food web. That is really significant." (Agreement Holder 70, farm)

"We didn't see an improvement as such because we were doing it all anyway, so there was no difference." (Agreement Holder 28, farm)

Those reporting **slight** or **significant environmental benefit** were typically able to quantify their reasoning; evidence for environmental benefit in this context was visually quite obvious – involving an increase in wildlife or tangible changes or manual tasks.

"Otters which had come back ... Increase in birds particularly on the SSSI [which the previous occupiers] used to shoot regularly before we came here … More unusual plants growing on the ground ... Been round with a lot of people looking - they throw down these octagonal things on the ground and you look yourself and you can see perhaps five or six plants and they'll find perhaps twenty. That makes you realise you know how things are improving ... We've also had some beetle groups come and they've been absolutely astonished at the number of beetles they've found." (Agreement Holder 30, farm)

"Cirl bunting numbers doubled from 2 to 4 pairs." (Agreement Holder 5, farm)

"We did some capital schemes e.g. digging ponds which clearly has [had] significant impact." (Agreement Holder 7, farm)

"The capital works have improved the area and the wildlife in the area has had a significant benefit; there are definitely more barn owls now!" (Agreement Holder 139, farm)

"Repaired historical landscape features - stone dykes and saw traditional plants begin to grow on/in them." (Agreement Holder 159, farm)

The reasoning of agreement holders who claimed to be **unsure** about the environmental benefit of previous schemes was varied. One agreement holder attributed their uncertainty to such benefits being long-term goals that may not have been realised yet.

"I think there's a cultural thing when you start bringing things into conservation … it's a long-term thing, so it's a little bit hard to say." (Agreement Holder 36, farm)

Another claimed he was not sure how to measure environmental benefit, with specific reference to identifying different species.

"To be fair I wouldn't know these different species if they poked me in the eye!" (Agreement Holder 121, farm)

Like those who claimed there had been 'no/little environmental benefit' a number of 'uncertain' agreement holders claimed to have been doing that kind of work anyway and therefore felt unable to attribute them to the schemes, specifically.

> "There are environmental benefits that may have been achieved anyway - we have managed to get funding to do works we would have done anyway. We cannot say if the benefits are down to environmental stewardship schemes. The funds do make the works more likely to happen." (Agreement Holder 113, non-farm)

Others were unable to comment having not been involved in the farm or site prior to the scheme and were unable to comment.

7.2.3 Overview of previous experience

As we have seen, many participants in the survey have considerable experience of agri-environmental management. Indeed, over half of participants (53%) had participated in both (1) environmental work/practices independent of AES and (2) formal AES. A notable minority (12.9%) had done neither. There was a relatively even split between those who had carried out solely independent work and those that had participated solely in formal schemes – 14.4% and 19.7% respectively (see Table 7.21).

	Frequency	**%**
None	17	12.9
Just independent work	19	14.4
Just formal schemes	26	19.7
Both independent work and formal schemes	70	53.0
Total	132	100.0

Table 7.21 Previous experience of agri-environmental management

Table 7.22 explores the association between previous agri-environmental management experience and a range of other characteristics. It can be seen that those who are most likely to have engaged in formal AES and informal work are more likely to have an under graduate or post-graduate degree, whereas 46% of those whose experience extends to formal scheme participation only either left school before 16 or attained the equivalent of O-Levels (compared to 32% of the sample as a whole). There is also an interesting farm/site size dimension. Those undertaking both formal and informal agri-environmental management are associated with the largest land holdings. This may be a reflection of the additional opportunities afforded by more extensive areas of land. In contrast, those who had previously either never undertaken any agri-environmental management or had done so on an informal basis only, are associated with the smallest land holdings. This may reflect the 'hassle factor' of scheme participation on a small area which, by definition, offers little direct financial reward but which still requires compliance and exposes the participant to a new inspection regime. The operator of the following large farm has size as an advantage:

> "We are better placed than most farmers when you consider the cost of this versus income, the value of the scheme may be outweighed by admin. Now we would question if it is worth it, it no longer a 'no brainer', it may not be worth it for anything complex or smaller parcels." (Agreement Holder 113, large non-farm site, 1380ha)

	None	Independent only	Formal only	Both
AGE		%		
<35	17.6	16.7	0.0	7.4
35<45	17.6	11.1	19.2	10.3
45<55	11.8	27.8	50.0	27.9
55<65	29.4	27.8	26.9	30.9
65 and over	23.5	16.7	3.8	23.5
EDUCATION LEVEL		%		
School, left before 16	11.8	16.7	26.1	17.6
O-Levels/GCSEs/A-Levels	17.6	22.2	30.4	14.7
Technical qualification	29.4	38.9	17.4	27.9
Undergraduate & postgraduate degree	41.2	22.2	26.1	39.7
TOTAL AREA (HA)		%		
<50ha	47.1	36.8	19.2	20.0
50<150	17.6	36.8	30.8	22.9
150<250	17.6	10.5	26.9	17.1
250+	17.6	15.8	23.1	40.0
FARM/SITE TYPE		%		
Dairy	0.0	0.0	7.7	4.3
Cattle/sheep lowland	29.4	36.8	15.4	15.7
Cattle/sheep LFA	35.3	21.1	34.6	31.4
Arable	5.9	0.0	3.8	12.9
Mixed	17.6	15.8	26.9	14.3
Nature Reserve	5.9	15.8	7.7	17.1
Other	5.9	10.5	3.8	4.3

Table 7.22 Previous experience of agri-environmental management by (1) age categories, (2) educational attainment, (3) total area and (4) farm/site type

7.2.4 Agri-environmental experience: a typology

Drawing on the information collected on agri-environmental management experience, agreement holders have been allocated to one of four 'experience' groups as follows:

Group 1: Extensive experience (24.1%)
Agreement holders in this group have undertaken multiple formal schemes, as well as informal work. They are the most committed to environmental work on their land. Conditions:

1. Experience of both formal and informal work … *AND* …
2. More than 1 previous schemes

Group 2: Low level engagers/'burgeoning environmentalists' (40.9%)
Agreement holders in this group have less formal AES experience than counterparts in Group 1 but are on a trajectory towards more formalised environmental working practices. They may have been conducting informal work only, or may have some experience of both formal and informal work, but experience of formal schemes will be limited to no more than 1 project at this stage. Conditions:

1. Have carried out informal work only … *OR* …
2. Have experience of both informal and formal work but have limited experience of formal schemes (no more than 1 project prior to HLS)

Group 3: Formal experience only (20.4%)
Agreement holders in this group have only undertaken formal environmental work i.e. AES. They have not participated in any environmental work independently. Conditions:

1. Have only undertaken previous formal work

Group 4: No previous experience (14.9%)
Agreement holders in this group have no experience of either formal or informal work. Conditions:
No previous experience of either formal or informal work

As can be seen from Table 7.23 a majority (40.9%) of survey participants can be considered to be Low level engagers/'burgeoning environmentalists', suggesting that the transition to HLS reflects a 'step up' in the agri-environmental management career which may bring with it new and unfamiliar management challenges. A significant proportion of the sample (24.1%) are considered to have extensive experience of both formal and informal agri-environmental management, whilst a minority (14.9%) had no experience prior to the ELS agreement generally required for HLS entry.

	Frequency	%
Extensive experience	33	24.1
Low level engagers/'burgeoning environmentalists'	56	40.9
Formal experience only	28	20.4
No previous experience	20	14.9
Total	137	100.0

Table 7.23 Experience typology

Of those that had no previous experience, 40% were associated with very small farms/sites (<50ha), 75% were farms (as opposed to non-farms), and 55% were partners with family members. Over half (52.7%) of those with no experience were over 55 years old, and exactly half had over 20 years of experience managing the agreement land. This suggests those with no previous experience are quite a distinct group of small scale, family orientated farm businesses, which have, up until this point, not been predisposed to be involved in formal AES and work. This links in part to the difficulty small holdings might face in complying with formal schemes, but also, given the family orientation of this group, the desire for autonomy and independence, as has been widely observed in the family farming literature (e.g. see Gasson, 1973).

7.2.5 Deciding on Higher Level Stewardship

The majority of participants reported that they had been very keen to participate in HLS with 80% of agreement holders stating that HLS was something they 'definitely wanted to do' (see Table 7.24). Of the remainder, 19.2% claimed to be indifferent and one agreement holder (0.8%) claimed to have not wanted to join when first learning about HLS. He went on to explain how his initial view changed when his adviser outlined the benefits:

> "I was advised of the benefits for the environment and the financial help it would give me tidying up the farm. Farm at the time had got a bit untidy. Taking land out of growing crops, just leaving some of it fallow, did look very good so I thought it was a good way of a) tidying up the farm b) improving the environment and c) getting a small bit of an income." (Agreement Holder 144)

	Frequency	%
Definitely wanted to do it	104	80.0
Indifferent about it	25	19.2
Did not want to do it	1	0.8
Total	130	100.0

Table 7.24 Attitude towards HLS before participation

There were 4 main motivation types (also see Table 7.25):

Financial (30.6%)
Agreement holders in this group were either solely or chiefly motivated by financial reward associated with HLS.

Practical fulfilment or fit with existing systems (22.4%)
Agreement holders in this group tend to be motivated by more practical motivations/factors and HLS was necessary for them to fulfil other things/meet other demands. They may have been persuaded by a 3rd party of the benefits of the scheme, or it may have supported work they were already doing/planned to do. They may have joined HLS because of the good fit with their existing management system, approach or farm/site conditions/environs and might have claimed that it did not require additional work or change to their practice.

Continuing environmental work (29.1%)
Agreement holders in this group saw HLS as an opportunity to continue work done previously (both independently and as part of a scheme such as the Countryside Stewardship Scheme). Their motivation was less about the environmental benefits of HLS per se, but more about continuing previous works so previous efforts would not have been wasted. HLS offered an often logical next step for these Agreement Holders, many of whom saw HLS as a more robust and comprehensive scheme that would allow them to develop what they had begun with previous work.

Altruistic (17.9%)
Agreement holders in this group were motivated by benefits to either/or (i) the environment (ii) wildlife and (iii) other people (whether through education or public access). They may have referenced money, but they stipulated money allowed them to facilitate wider benefit.

	Frequency	**%**
Financial	41	30.6
Practical or fit with existing system	30	22.4
Continue environmental work	39	29.1
Altruistic	24	17.9
Total	134	100.0

Table 7.25 Main motivation for participating in HLS. Note 3 Agreement holders who ‘inherited’ their agreement have been removed.

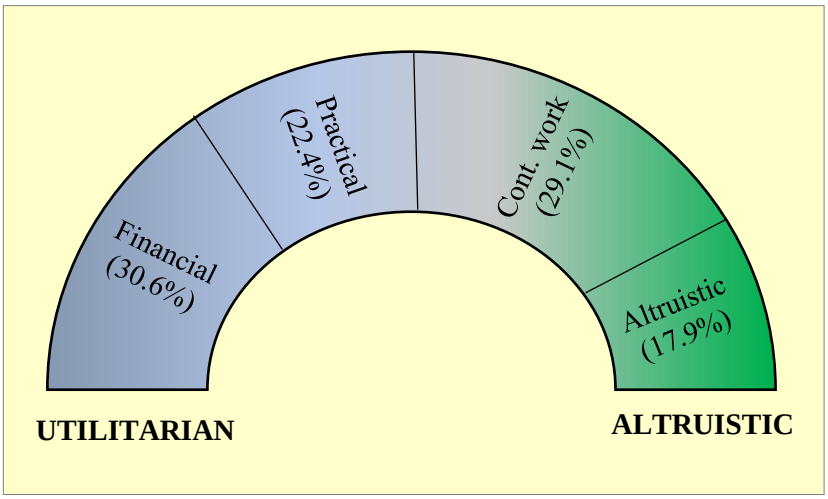

Figure 7.11 Motivation continuum (segments reflect relative percentages)

As demonstrated in Figure 7.11 (above) the motivations are positioned on a continuum which extends from utilitarian to altruistic orientations (left to right).

Despite HLS being a higher level, more demanding scheme aimed at managing more complex environmental areas, it is significant to note that as research into the uptake of lower tier environmental schemes observed (see Buller et al., 2000; Riley, 2011; Wilson & Hart, 2000, 2001; Wilson, 1979), financial motivations were the most common motivation (30.6%), whilst altruistic motivations such as concern for the environment or wildlife, were the least common.

Although, as evident in Table 7.25, in comparison to research into motivations for AES participation, financial motivations were far from being the dominant type, with agreement holders distributed throughout the motivation types. This is likely to reflect the more complex and demanding nature of HLS. Similarly, in their comparison of ESA and CSS participation Lobley and Potter (1998) suggested the balance between financial and conservation orientations was dependent on the nature of the scheme, with ESA holders tending to be motivated by financial gain, and CSS farmers tending to have more clearly defined conservation motives. The increasing prominence of more altruistic motivations could more generally reflect how farmers and land managers are increasingly acknowledging the environmental benefits associated with scheme participation (see Wilson & Hart, 2000).

Moving through the continuum, **practical reasons**, which included the goodness of fit with existing systems, accounted for 22.4% of the sample.

Wanting to **continue to do environmental work** in order to carry on from previous schemes was a clear motivation for 29.1% of agreement holders.

The smallest percentage of agreement holders were motivated by entirely **altruistic** thinking (17.9%). In some ways this was perhaps the most dedicated and committed group – motivated entirely by benefits to others, wildlife and the environment.

Exactly half of the agreement holders who prior to their agreement claimed to be **indifferent** or **didn't want to do HLS** were primarily motivated by **financial** rewards associated with participation, compared to only 26.5% of those who claimed they **definitely wanted to join HLS** (Table 7.26). This highlights the influence of financial reward amongst those who were initially undecided or ambivalent about undergoing the scheme. In contrast, agreement holders that **definitely wanted to do it**, were more equally distributed across the different types of motivation.

	Financial	**Practical/fit with system**	**Continue good work**	**Altruistic**	**TOTAL**
Definitely	26.5	28.4	20.6	24.5	100.0
Indifferent & no interest	50.0	26.9	11.5	11.5	100.0

Table 7.26 Attitude before agreeing to do HLS by motivation type

As evident in Table 7.27, the oldest agreement holders (those over 65), were least likely to be financially motivated (only 12.5%). In contrast, the youngest agreement holders were most likely to be financially motivated (40.0% of those under 35), although a notable 30.0% of the youngest cohort were driven by altruistic motivations. The oldest agreement holders were most likely to be driven by altruistic motivations (33.3%), but their slightly younger counterparts (55<65) were least likely to be (12.5%).

	Financial	**Practical/fit with system**	**Continue good work**	**Altruistic**	**TOTAL**
<35	40.0	30.0	0.0	30.0	100.0
35<45	23.5	29.4	23.5	23.5	100.0
45<55	31.7	22.0	22.0	24.4	100.0
55<65	36.8	39.5	10.5	13.2	100.0
65+	12.5	25.0	29.2	33.3	100.0

Table 7.27 Age categories by motivation type

As Table 7.28 shows, there is an interesting statistically significant association between land holding size and the motivation to join HLS. Not only were the smallest farms/sites the least likely to be associated with a strong financial motivation, they were also the most likely to be motivated by the practical fit of HLS requirements. Given that the total financial return will be limited on small areas of land, the 'goodness' of fit with the existing systems is probably particularly important. Conversely, the operators of the largest land holdings were more likely to be strongly motivated by either financial concerns or highly altruistic factors, reflecting the greater financial gains associated with larger agreements, but also an acute awareness amongst agreement holders on larger farms/sites of the potentially significant environmental impact of their work/practices. In contrast, farms/sites of 150<250ha were least likely to be driven by altruistic motivations (only 4.0%) and most likely to be driven by potential financial gains. This perhaps reflects the greater financial gains associated with larger agreements (as above), but also a lesser association with the negative environmental impacts than their 250+ha counterparts.

	Financial	Practical/fit with system	Continue good work	Altruistic	TOTAL
<50	18.2	45.5	9.1	27.3	100.0
50<150	30.6	25.0	16.7	27.8	100.0
150<250	48.0	32.0	16.0	4.0	100.0
250+	30.0	17.5	27.5	25.0	100.0

Table 7.28 Farm/site size, by motivation type. The association between motivation type farm/site size is significant when $p<0.05$

As demonstrated in Table 7.29, although farms were more likely to be motivated by **practical** or **goodness of fit** type motivations and **financial incentives**, farms were more broadly evenly distributed across the different motivation types in comparison to non-farms.

Motivations for non-farm agreement holders were more polarised at either end of the continuum. Nearly three-quarters of the sample were either motivated by **financial reward** (37.0%) or **altruistic motivations** (37.0%). The centrality of altruistic factors to the non-farming cohort is probably easiest to explain. Made up of organisations that typically have wildlife, environmental and community interests at the heart of what they do, it is not surprising that 37.0% have altruistic motivations to undertake HLS. The dominance of financial motivations for this group required further analysis and revealed an intense reliance on HLS funding amongst these non-farming respondents and their corresponding organisations. As the following quote in particular demonstrates, this appears to have been exacerbated lately in relation to wider funding cuts and austerity.

> "In the context of local authorities, it's [funding has] become more important than ever before … it could have been that when we entered these agreements ten years ago, we may have been able to struggle on … if we had no agri-environment funding now, we'd have to drastically cut what we do and probably staffing as well." (Agreement Holder 38, Nature Reserve)

> "It's a very good way of either fully funding or part funding or match funding work that we want to do but especially being a local authority [we] don't have the funds to do." (Agreement Holder 110, Nature Reserve)

> "[We are] a relatively small site with no other funding - need schemes so that the area can continue to be maintained, improved & managed (Agreement Holder 75, Nature Reserve)

> "The bottom line is the money helps us do that. It's particularly important for a local authority in the current financial circumstances - if we haven't got that money coming in I don't know what we're going to do" (Agreement Holder 112, Nature Reserve)

> "For the financial support provided which gives councils an incentive/ability to carry out environmental work" (Agreement Holder 150, Nature Reserve)

	Financial	Practical/fit with system	Continue good work	Altruistic	TOTAL
Farm	29.0	32.7	19.6	18.7	100.0
Non-farms	37.0	14.8	11.1	37.0	100.0

Table 7.29 Agreement holder type by motivation type

As demonstrated in Table 7.30, there is a notable statistically significant association between agreement holders' highest level of educational attainment and main motivation for participating in HLS.

	Financial	Practical/fit with system	Continue good work	Altruistic	TOTAL
No qualifications	37.5	37.5	20.8	4.2	100.0
O-Levels/GCSEs & A-Level	20.8	20.8	25.0	33.3	100.0
Technical qualification	40.0	34.3	17.1	8.6	100.0
Undergrad & postgrad	24.4	28.9	11.1	35.6	100.0

Table 7.30 Agreement holders' highest level of educational attainment by motivation type. The association between agreement holders' highest level of educational attainment and motivation type is significant when $p<0.05$

Firstly, those with no formal qualifications were least likely to be driven by altruistic motivations, whilst those with either an undergraduate or postgraduate qualification were most likely to have reported altruistic motivations. Ellis et al. (1999) similarly observed how farmers with higher levels of formal education are more likely to be conscious of the environmental consequences of their farming practices. Exactly three-quarters of those with no qualifications were motivated by *utilitarian* motivations, i.e. both financial and practical/fit with system (see Figure 7.11, above). If we look more closely at those with no qualifications, they appear to be a distinctive group of predominantly family farmers, i.e. nearly 96% of agreement holders with no qualifications were on farms and 87.5% were either sole proprietors or in a partnership with a family member (Tables 7.31 and 7.32). This is likely to reflect how those with no qualifications were 'born to be farmers' – leaving school without any qualifications, with a firm intention to farm the family farm (Chiswell, 2018). It is possible that these agreement holders' motives align with more 'traditional' or productivist farming motivations (financial or practical as opposed to altruistic; see Ward, 1996).

	Farm	Non-farm	TOTAL
No qualifications	95.8	4.2	100.0
O-Levels/GCSEs/A-Level	91.7	8.3	100.0
Technical qualification	86.1	13.9	100.0
Undergrad/postgrad	57.4	42.6	100.0

Table 7.31 Agreement holders' highest level of educational attainment by motivation type. The association between agreement holders' highest level of educational attainment and agreement holder type is significant when $p<0.05$.

	Sole prop	Partner with family member	Director or manager	Other	TOTAL
No qualifications	29.2	58.3	4.2	8.3	100.0
O-Levels/GCSEs & A-Level	25.0	75.0	0.0	0.0	100.0
Technical qualification	22.2	47.2	30.6	0.0	100.0
Undergrad &/ postgrad	10.6	25.5	36.2	27.7	100.0

Table 7.32 Agreement holders' highest level of educational attainment by participants' role in relation to the agreement. The association between agreement holders' highest level of educational attainment and participants' role is significant when $p<0.05$.

7.3 Agreement design and application

Before going on to consider agreement holders' experience of implementing and managing their agreement, this section explores their experience of the application process, including who was involved in developing the application, resources used, and motives for the selected options and so on.

7.3.1 Parties involved in the design and application process

Just over half (52.8%) of agreement holders reported that they were initially approached by NE regarding an HLS application. Regardless of this however, only a minority (14.1%) of agreement holders made their HLS application mostly independently (Table 7.33).

The most popular means of submitting an application was through an agent or other 3rd party (40.0% of agreement holders). Similarly, 30.4% reported having designed the agreement with someone else from outside the business and an additional 8.1% of agreement holders stated that someone else within their business completed the application. As can be seen from Table 7.34, farmers were significantly more likely to use an agent or other 3rd party to design and submit their application.

	Frequency	%
Independently	19	14.1
Myself with others from outside the business	41	30.4
Someone else within the business made the application	11	8.1
Agent or other 3rd party designed and submitted application	54	40.0
Other	10	7.4
Total	95	100.0

Table 7.33 Parties involved in HLS design and application.

	Farm	Non-farm
Independently	12.1	21.4
Myself with others from outside the business	32.4	21.4
Someone else within the business made the application	4.7	21.4
Agent or other 3rd party designed and submitted application	44.9	21.4
Other	5.6	14.3
Total	100.0	100.0

Table 7.34 Parties involved in HLS design and application, by agreement holder type
The association between agreement design and application and agreement holder type is significant when $p<0.05$.

In addition to help with designing and submitting their applications, agreement holders (and/or those helping them in the application process) drew on other resources in designing the agreement. As can be seen from Table 7.35 and Figure 7.12 the HLS handbook and Farm Environment Plan (FEP) were most frequently employed in the design of the agreement.

	Not at all	Somewhat	A lot
EIP	34.3%	35.8%	29.8%
	23	24	20
FEP	17.9%	2.8%	58.2%
	12	16	39
Target Statements	28.3%	34.3%	37.3%
	19	23	25
Handbook	9.0%	25.4%	65.7%
	6	17	44
Technical notes	31.3%	35.8%	32.8%
	21	24	22
Other sources	77.6%	9.0%	13.4%
	52	6	9

Table 7.35 Resources used in designing HLS agreement (*n*=70).

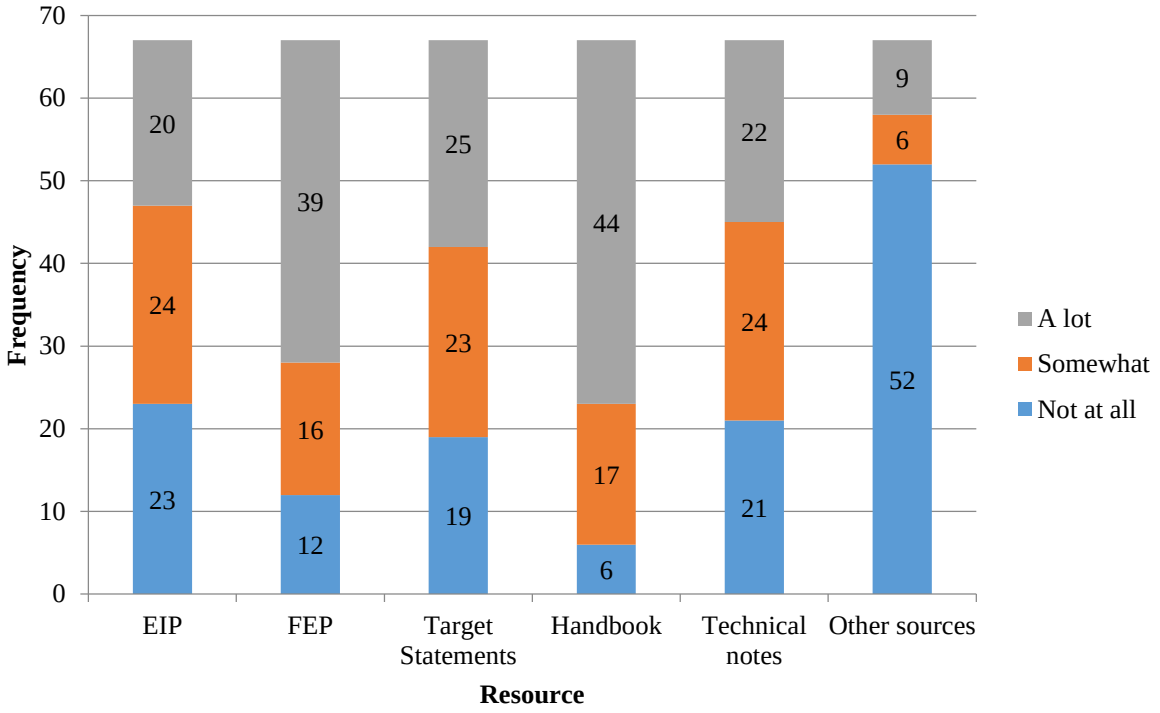

Figure 7.12 Resources used in designing HLS agreement

7.3.2 Reasons for choosing HLS options

Agreement holders were presented with a list of possible reasons for selecting HLS options and were asked to select the 'top 3' that applied to them. From Table 7.36 it can be seen that 'the features were already in place' and 'options would enable us to increase the wildlife' were the most popular reasons for choosing HLS options, identified by 76.5% and 75.7% of participants respectively (Table 7.65). Also identified by more than half of participants, was 'the management was already in place' and 'the options would enable us to protect the landscape features' (61.8% and 53.7%). This indicates that a combination of 'ease of fit' (i.e. features and/or management already in place) and a desire to protect and enhance the environment were the predominant motives in option selection. The improvement of shooting was a relatively low priority (only identified by 19 participants, 14.0%). There were some differences between farm and non-farm respondents (see Table 7.37), but both groups chose the same top 3 motives (although in slightly different orders). The emphasis on increasing wildlife amongst non-farms (top ranked reason) is unsurprising given the nature and purpose of many of these institutions. Easier crop management ranked lowest for both farms and non-farms. Interestingly, 'other' reasons ranked 12th for farms and 6th for non-farms. This is attributed to an increased emphasis on delivering public goods such as access and education amongst non-farming institutions.

#	Reasons	Frequency	% of sample
1	Features already in place	104	76.5
2	Increase wildlife	103	75.7
3	Management in place	84	61.8
4	Protect landscape features	73	53.7
5	Protect historic features	65	47.8
6	Reduce pollution & soil erosion	51	37.5
7	Chosen features were in FEP	50	36.8
8	Increase gross margins from poor areas	41	30.1
9	Fulfil other requirements	38	27.9
10	In NCA target statement	24	17.6
11	Other reasons	20	14.7
12	Improve shooting	19	14.0
13	Easier crop management	8	5.9

Table 7.36 Ranked reasons for choosing options. Note: agreement holders could choose up to 3 reasons.

	Farmers			Non-farmers		
Reasons	**Rank**	**Frq (*n*=107)**	**% farmers**	**Rank**	**Frq (*n*=29)**	**% non-farmers**
Fts already in place	1	84	78.5	2	20	69.0
Management in place	3	65	60.7	3	19	65.5
Increase wildlife	2	79	73.8	1	24	82.8
Protect historic fts	=4	59	55.1	7	6	20.7
Improve shooting	11	18	16.8	12	1	3.4
Protect landscape fts	=4	59	55.1	4	14	48.3
Reduce pollution & soil erosion	6	48	44.9	=10	3	10.3
Fulfil other requirements	9	34	31.8	=8	4	13.8
Increase gross margins from poor areas	8	38	35.5	=10	3	10.3
Easier crop management	13	8	7.5	13	0	0.0
Chosen fts in FEP	7	41	38.3	5	9	31.0
Chosen fts in NCA target statement	10	20	18.7	=8	4	13.8
Other reasons	12	13	12.1	6	7	24.1

Table 7.37 Ranked reasons for choosing options by agreement holder type

7.3.3 Agreement holders' perceived control over agreement design

Previous research suggests that a sense of ownership and control of agreement design can be associated with greater commitment and understanding. As evident in Figure 7.13, nearly half of participants (47%) felt they had 'considerable control' over the agreement and a further 17% claimed they felt they have had 'complete control'. A notable 9% claimed to have had 'not much control'.

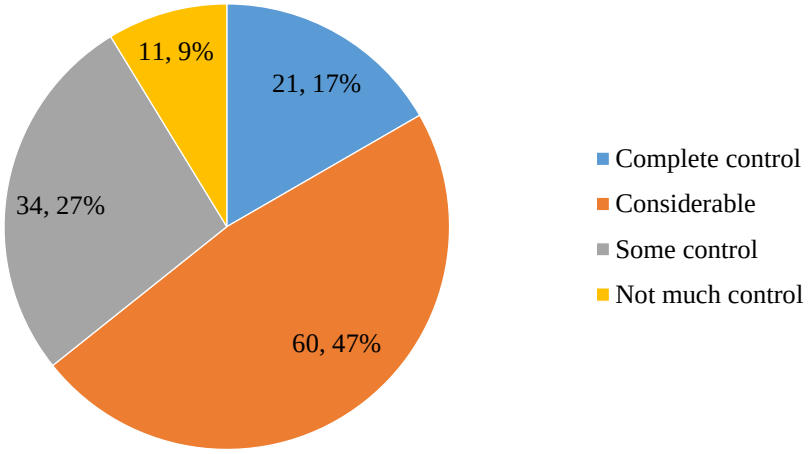

Figure 7.13 Perceived control over agreement design (*n*=126)

A number of agreement holders who felt they either had **complete** or **considerable control** over the agreement design (64% overall) saw themselves as holding the power and seeing the agreement as something that should work for them – as one participant attested "[it] was not about control - it was an agreement; we didn't have to sign it if we didn't want to; it suited us". Others described a similar approach to their agreement design. This was very much about *their* attitude towards the agreement; a staunch belief that it should work for them, and the conviction to walk away from specific options, or even the agreement as a whole, if it did not fit their circumstances.

> "We would have said no otherwise. Lot of guidance from our NE adviser as to best way to put it together and how that would work with us. But ultimately [we] had control. If we did not like a particular option we left it out." (Agreement Holder 12)

> "[We] didn't feel pushed into doing things and would not have signed up if didn't feel to be in control of agreement." (Agreement Holder 146)

The role of the NE advisor was critical in agreement holders' perceived control over agreement design. Amongst those who felt they had **complete** or **considerable control**, agreement holders described the role of the advisor as simply that – 'advisory' – and felt the relationship with the advisor was equal and reciprocal. The ability of the advisor to be flexible was key to the perceived degree of control.

> "It was negotiated with the NE advisor - he was flexible, sensible. We were one of first ones. There was no pressure on us to go into it, it was a two-way thing and there have never been any disputes, it's always been reasoning." (Agreement Holder 1)

> "All negotiable. I think I knew my area pretty well and I knew what would work best really." (Agreement Holder 15)

> "Natural England did have an input but did not manipulate the agreement." (Agreement Holder 20)

One agreement holder described **"the art of a good advisor"** as "making you feel like you've got full control" (Agreement Holder 4). Others simply referred to the fact agreement design was largely limited due to the nature or simplicity of the farm or site. For this reason, the details of the agreement were easy to decide on and the associated agreement holders felt in control.

> "Only scheme option that would suit this simple grassland site/area." (Agreement Holder 75)

> "The features were already there; the land dictated." (Agreement Holder 172)

A minority of agreement holders – all of which felt they had considerable control – attributed this to NE wanting the farm or site in the scheme. They described how NE's desire to secure agreements on these farms or sites meant they felt they held the power and utilised this as a bargaining tool to shape the agreements in the ways they wanted.

> "They (NE) wanted me to join basically. They (NE) approached me to enter into the agreement. They desperately needed one of sites, or desperately required it because it was supposed to be some mammoth portion of the world's population of southern damsel fly, something like a quarter I think it was of the world's population in my one stretch of river. So hence they wanted to get it signed up into an HLS agreement. Basically whatever I would have asked for I think I would have got." (Agreement Holder 54)

In contrast to some of the very positive comments above about NE staff, agreement holders who felt they had less control – **some** and **not much control** – often attributed it to what they perceived as an overbearing or in one specific case, a difficult, NE advisor. For these agreement holders, the lack of control was a source of contention:

> "They (NE) set it up to fit in with what they wanted, so I was not given a lot of say - they set the stocking rates and said which areas I could and could not top - it all came as a package." (Agreement Holder 80)

> "They come to you with it really, and you've got to fit in with their plan. A lot when they came 'round here was the over grazing." (Agreement Holder 136)

> "Natural England stipulated what they wanted on our farm and if we did not agree they would have forced us to do the options anyway due to their environmental importance." (Agreement Holder 141)

> "Our NE adviser was so dominant in what he said. He did not suggest ... he told me that I was going to do things and they had to be done in his manner and his time. He did not seem to appreciate that I was the farmer, it's on my land and that things have to fit in with my system.... Adamant that what he said was right. Made life very difficult for me to be perfectly honest. If I had been dealing with a different person the whole system would have been a lot, lot easier." (Agreement Holder 86)

In an extreme case, one agreement holder reported feeling "bullied" into their agreement design.

> "The agreement we came up with, well I felt bullied into it because it included arable options, which were a complete disaster, we should never have done them and it was only for some tick box that they wanted some arable, and I thought well I've got to have an agreement so I better just go with whatever you tell me I should have" (Agreement Holder 3)

In addition, a number of agreement holders reported feeling 'forced' or 'pressured' into including additional options that they did not necessarily want to include. Sometimes this reflected the need to meet the points threshold for acceptance, although the agreement holders appear to be less aware of the implications of HLS being a 'competitive' scheme.

> "[I] had to include additional options as part of the scheme in order to reach the points target, options I wouldn't have chosen to do myself." (Agreement Holder 14)

> "All as I thought it should be with one exception. Having to put in a small orchard. Went to lot of trouble choosing some trees and I was told I could not have them because they were a Somerset variety. Had to choose from list of Devon apples which I knew from past experience would get problems here because we're just where the rain starts coming in. And sure enough had a lot of scab on them. But I couldn't find an apple that was completely resistant. That's rather a sore point." (Agreement Holder 30)

> "We entered at a time when one had to get quite a lot of points - one gets the impression that over the course of the scheme there's been various times of demand to join it and therefore the points are adjusted depending on that. So we joined at a time where you really needed an awful lots of points to do it, and one of the difficulties was there was a number of nationally important conditions that we met, but locally weren't considered important, so that aspect was a bit of a struggle." (Agreement Holder 47)

Aside from the role of the NE advisor, some agreement holders who claimed to have only felt to have had **some** or **not much control**, attributed this more broadly to the perceived inflexibility of the scheme and the options.

> "I was guided through the process rather than steering it myself. The NE advisor was very helpful but it was an established process I was trying to fit into. It was a nightmare - really hard to understand the process and get to the final point where

> we had an agreement in place. I felt like the NE advisors understood the process very well but I didn't, so I allowed them to guide me through. I felt the options are just off the shelf, not necessarily bespoke and designed for the site. Which is not how management regime should be." (Agreement Holder 112)

Others simply felt their land only lent itself to certain options, limiting their control over the agreement design.

> "Simple site with grassland and very few options that could be selected." (Agreement Holder 51)

> "Area is designated as a SSSI so not a lot of choice." (Agreement Holder 81)

> "The moors fit into a specific category of agriculture, it chooses you so there's not a lot of choice. No shaping of the agreements, especially on the moorland. If you wanted to be in, that was it, the agreement was brought here, the sporting tenant wanted their input. It was a case of take it or leave it." (Agreement Holder 130)

Despite some of the comments above regarding the suitability of certain management prescriptions, the majority of participants (60%) felt that the management prescriptions *were* suited to their land and a further 36% considered them to be 'partly' suited. Only 4% said they did not suit their land (Figure 7.14).

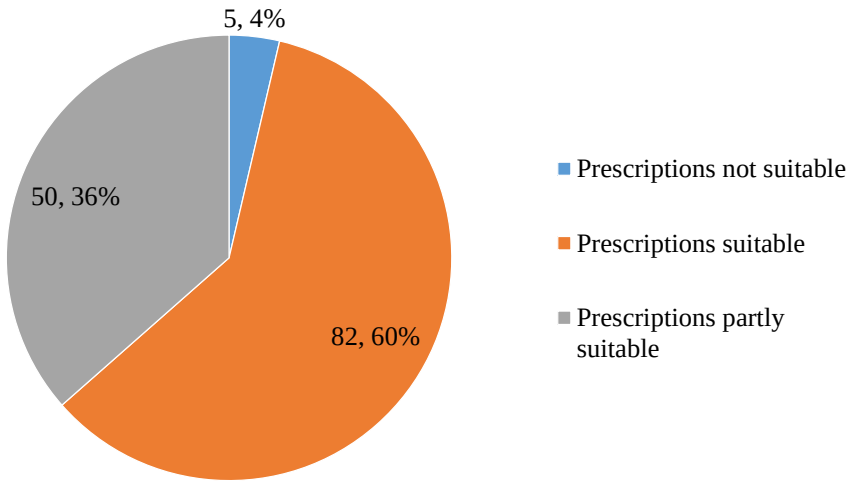

Figure 7.14 Perceived suitability of management prescriptions (*n*=137)

Those who claimed the management prescriptions were suitable for their land attributed it to it aligning closely with what they were already doing:

> "Extremely similar to what I was doing to start with." (Agreement Holder 54)

> "We've not really had to change way we were managing the ground. We've had to tighten up a little bit on our grazing periods and we don't top the ground like we perhaps used to. It's been pretty easy for us to carry it on." (Agreement Holder 68)

> "They fit in well with our vision for both sites, and help us to maintain the species of interest." (Agreement Holder 82)

> "Suits way of farming very well. The secret is to get the right animal to utilise the system you are in. If kept with commercial breed would not have suited this land at all. Devons been around a long, long time." (Agreement Holder 104)

> "They're ok for the land, we haven't had to do much." (Agreement Holder 108)

> "They do not inhibit anything we do, so therefore it works." (Agreement Holder 124)

> "It works. We're not doing anything different to make it work. It fits into our agenda. We are working with what we already do with some fine tuning." (Agreement Holder 130)

> "[I] cannot fault the options and management prescriptions. HLS seems to fit well with the farm." (Agreement Holder 146)

Where the management prescriptions did not align with what was already happening on the farm or site, agreement holders reported notable difficulty. The following response illustrates this disparity and the significance of an alignment between existing practices and the overarching goals of the agreement to the suitability and ease of applying the management prescriptions.

> "They don't particularly fit in with what we are doing on the rest of the farm. So there are too many silly little rules or cut-off dates or whatever on the different schemes that get forgotten because you've got 2ha you're meant to have cultivated by 1st of April or whatever it is. It's very easy to forget. Some of these 6 m margins, floristically enhanced things, are a nightmare to keep going. I appreciate they make sense in themselves and I appreciate we're being handsomely paid to do them but I rather wish we hadn't got involved in a lot of them in retrospect. I think we can achieve much the same thing in different ways." (Agreement Holder 66, partly suitable)

Others who claimed management prescriptions were suitable attributed this to a degree of flexibility when it came to the application of the prescription:

> "We had some choice on which fields were in the scheme fields so we could work it to suit the way we farm." (Agreement Holder 8)

> "They fit really well and what I like about the HLS is you know, you can be steered by the agreement but you can tailor it to whatever is on the ground … there's a degree of flexibility." (Agreement Holder 36)

> "There is flexibility in the management prescriptions so they can move with fluctuations in farming practices." (Agreement Holder 122)

In contrast, those who claimed management prescriptions were either unsuitable or only partly suitable attributed it to an acute lack of flexibility. Lack of flexibility was a source of

significant difficulty for these agreement holders and generally, when an agreement was not going well or where there had been specific difficulties with an agreement, it was rooted in the lack of flexibility with the management prescriptions.

> "The prescriptions don't always allow flexibility and we often have to apply for derogations e.g. for grazing management as these stipulate set dates and in the event of a wet spring or drought in summer then grazing has to be adjusted accordingly." (Agreement Holder 26, partly suitable)

> "Sometimes there is no flexibility for any changes or alterations due to unexpected circumstances. The condition of hedges is not always good." (Agreement Holder 46, partly suitable)

> "The management prescriptions are too inflexible for some of the situations. While they are manageable I question as to whether they actually deliver the benefits. Some are rather too generic and not site specific enough. Some local knowledge is far better than theoretical standards dreamt up in a central office. (In particular regarding stocking rates and regimes, as in when stock should be on or off and feeding sites." (Agreement Holder 55, partly suitable)

> "Needs to be more flexible and not dictated to, not getting letters through the post saying you can't do this or you've done this wrong …" (Agreement Holder 59, partly suitable)

> "Some prescriptions are not suitable for this farm, but still have to be done e.g. plant and encourage holly rather than ash." (Agreement Holder 101, partly suitable)

> "The clue's in the name - they shouldn't be prescriptions - it's the wrong thing. Guidelines fine, but once it's prescriptive it's not available to change. But if its wrong its wrong. Everywhere is different, you can't say well I'll do that because it works in Norfolk - it may not work here. you can't say it works that side of the river, it will work this side of the river - it doesn't work like that. You need to be, the whole thing needs to be far more flexible - the new scheme's even worse e.g. grazing restricted to certain times of year - but there are benefits of companion grazing and so forth. Should be outcome based!" (Agreement Holder 3, not suitable)

One agreement holder felt the restrictiveness of the management prescriptions was actually undermining efforts to improve the land. Others even felt that in some cases it meant the management prescriptions were actually doing damage to the environment.

> "Too restrictive. They are restricting us to improve the land." (Agreement Holder 92, unsuitable)

> "Our Case Officer for my agreement is very forceful in his way of doing things … It's very clear cut, it's by the rules by 100% rather than what is physically possible to do. It still has to be done exactly as the agreement rules state whereas when we're dealing with the Culm grassland, and the wet area that it's in, we can only do certain things at certain times of the year and at some points, especially

with the weather - climate changing - management, like coppicing and clearing of the marshland at a specific date is not very constructive. It does more damage rather than giving some leeway. It does more damage to the environment than what it protects. That's my biggest gripe" (Agreement Holder 17, partly suitable)

"Our land is very heavy and suffers from a high weed burden, some of the prescriptions don't encourage weed management and this is actually proving much more detrimental to general biodiversity than when pesticides and fertiliser were used." (Agreement Holder 14, partly suitable)

7.4 Experience of HLS

7.4.1 Implementing the agreement

This section considers agreement holders' experience of implementing their HLS agreement. Analysis is first presented at the whole agreement scale before delving into detailed analysis at the option level. Assuming an agreement has been designed correctly for given objectives, successful implementation requires an understanding by the agreement holder of what the agreement is trying to achieve; motivation and commitment to achieve agreement objectives, and the knowledge and ability to meet agreement objectives (backed up with further contact and support from NE where appropriate).clearly there are a number of other important factors including the management of surrounding land and events that are beyond the control, of individual agreement holders.

Perhaps a fairly basic starting point is familiarity with what the agreement is trying to achieve; quite simply, would the agreement holder know what success looks like? As a proxy for measuring the extent to which agreement holders were aware of what success would 'look like' for their agreement they were asked how often their referred to the IoS for their agreement. Only 22.6% of participants 'regularly' referred to IoS and while a majority reported 'occasionally' referring to their IoS, just a third of survey participants claimed to not refer to them at all (see Table 7.38). In a study of the effect of advice and support on the environmental outcomes of HLS agreements, Boatman et al. (2014) found 25% of agreement holders consulted their agreement documentation regularly (at least once a year), and 55% occasionally, which are comparable to the results found here.

	Frequency	**%**
Not at all	45	32.8
Occasionally	61	44.5
Regularly	31	22.6
Total	137	100.0

Table 7.38 Frequency of reference to IoS

Of those that did not refer to their IoS at all, 4 attributed this to delegating this task to an agent or another 3rd party such as an advisor or employee.

> "Don't refer to IoS - but advisor frequently visited the farm so he was doing it for us really." (Agreement Holder 1)

> "My sheep farmer knows what needs to be done […] He's regulating when to move sheep around etc. Occasional input." (Agreement Holder 19)

> "She (bookkeeper) tells me what needs to be done and where to." (Agreement Holder 104)

> "Managed by 3rd party who visits every week." (Agreement Holder 90)

A number of the agreement holders who reported not referring to their IoS at all claimed to have their own means of monitoring their success (6). This varied from those that integrated the HLS prescriptions into their bespoke and rigorous management plans, to those that simply did entirely their own thing on a more informal basis.

> "We have a separate management plan for the site, which was already in place - we adapted the work programme to make sure we were doing the HLS prescriptions, so what we look to achieve is what's in that work programme, not necessarily what's in the agreement. But we do have [name of Wildlife Trust] come out and look at the site every year, so we're constantly monitoring progress but doing it in our own way." (Agreement Holder 112)

> "Don't refer to IoS as such, don't go around measuring or anything, but do read through the agreement every now and then to remind myself of what we're trying to do." (Agreement Holder 160)

> "I just look round and see what I see." (Agreement Holder 175)

One agreement holder in the **not at all group** stated, "I'm not sure what IoS actually are" (Agreement Holder 153). Reference of IoS is only meaningful if, in turn, it has an influence on the actions of agreement holders. However, of those referring to the IoS **occasionally** and **regularly**, 22 explicitly stated that they **did not** influence management of the agreement, or were yet to.

> "Does not really influence management." (Agreement Holder 8)

> "It doesn't influence the way I manage it really, just about checking." (Agreement Holder 23)

> "IoS - very insignificant really." (Agreement Holder 54)

> "It hasn't influenced it yet, but the IoS are looked at on an annual basis as a measure to assess the current management of the site." (Agreement Holder 49)

A further 16 suggested that the IoS were only influential at the beginning of the agreement. These agreement holders claimed that having adjusted their management to fit the agreement at its inception, they had subsequently had very little influence.

> "In the early years it does, however hardly at all now." (Agreement Holder 25)

> "I don't think it changes the management. [We] changed the management when went into it. We've more or less stuck with the amount of stock we've put in there. Seasons change. You get one particularly cold wet spring, you get one very warm moist one. You've got to stock it accordingly." (Agreement Holder 145)

Those agreement holders for whom IoS seemed to be influential talked very generally about the IoS as a means of keeping their agreement 'on track' and targeting or identifying work priorities. Although not the primary function of IoS – which are intended to monitor and measure the success of an HLS option in a particular parcel of an agreement – a secondary function, as evidenced here, is for the agreement holder to use the IoS as a measure of whether they are achieving or moving towards the desired outcome.

> "So we can make sure things are going right." (Agreement Holder 133, occasionally refers to IoS)

> "Some areas have to be grazed down to a certain level at certain times of year, some areas have to be soft enough to put 6 inch nails in it. So they just remind me of what should be there at certain times of year." (Agreement Holder 65, occasionally refers to IoS)

> "Keeps me on the right lines." (Agreement Holder 10, occasionally refers to IoS)

> "They can target what work gets done in what year." (Agreement Holder 60, occasionally refers to IoS)

> "See what is required and check things are being done as per the agreement." (Agreement Holder 75, occasionally refers to IoS)

> "It is more to refresh the mind for when we clear the meadows so as not to break the agreement. We just use it to check up on things." (Agreement Holder 155, regularly refer to IoS)

There was some suggestion by a minority of farmers (3) that IoS had more of an influence at particular times of the year.

> "Not really. Certain times of year when it does. It affects how you manage. We accepted that was what was going to happen." (Agreement Holder 12)

> "They do to a certain degree - just times of year for stocking grassland with cattle, how long for." (Agreement Holder 17)

Only a minority of agreement holders claimed IoS had a significant influence on their practice. These agreement holders saw meeting IoS as a way of demonstrating compliance.

> "We know that we've got to work to the letter and it's good to have something to refer to make sure we comply - or try and comply." (Agreement Holder 6)

> "It totally influences the management, they are constantly referred to ensure complete compliance with the agreement." (Agreement Holder 119)

There was some suggestion from agreement holders that the IoS were only referred to when it came to communication with NE.

> "We only consult the IoS when NE come to us about it, but we are conscious of them." (Agreement Holder 69)

The frequency with which agreement holders make reference to their IoS varies according to a number of factors. Farming agreement holders were the most likely to not look at their IoS at all and the least likely to look at them on a regular basis (Table 7.39). In addition, the oldest agreement holders (most of whom were farmers) were most likely to never refer to their IoS (Table 7.40).

	Farm	**Non-farm**
Not at all	39.8	6.9
Occasionally	40.7	58.6
Regularly	19.4	34.5
TOTAL	100.0	100.0

Table 7.39 Frequency of reference to IoS, by agreement holder type. The association between frequency of reference to IoS and agreement holder type is significant when $p<0.05$

	<35	**35<45**	**45<55**	**55<65**	**65+**
Not at all	9.1	33.3	31.7	33.3	41.7
Occasionally	81.8	27.8	48.8	43.6	33.3
Regularly	9.1	38.9	19.5	23.1	25.0
TOTAL	100.0	100.0	100.0	100.0	100.0

Table 7.40 Frequency of reference to IoS, by agreement holder age

Frequency of reference to IoS also varies by motivation and experience. Those participating for largely altruistic reasons are more likely to check their IoS on a regular basis (Table 7.41), as are those with extensive experience of agri-environmental management (Table 7.42); 33.3% of those with extensive experience reported regular referring to their IoS compared to just 15% of those with no previous experience. It is possible that those with much greater experience are more aware of the need to frequently check their IoS as a means of gauging progress.

	Financial	**Practical/fit with system**	**Continue good work**	**Altruistic**
Not at all	26.8	43.6	41.7	20.0
Occasionally	58.5	35.9	37.5	40.0
Regularly	14.6	20.5	20.8	40.0
TOTAL	100.0	100.0	100.0	100.0

Table 7.41 Frequency of reference to IoS, by motivation type

	Extensive experience	Low level engagers	Formal experience	No experience
Not at all	24.2	37.5	39.3	25.0
Occasionally	42.4	44.6	35.7	60.0
Regularly	33.3	17.9	25.0	15.0
TOTAL	100.0	100.0	100.0	100.0

Table 7.42 Frequency of reference to IoS, by experience type

7.4.2 Capital works

82.2% of surveyed agreement holders had capital works as part of their agreement. Of these, 81.8% reported having completed capital works as originally planned.

The majority of surveyed agreement holders with capital works as part of their agreement reported that they had been chosen because they were essential to the delivery of agreement objectives or were beneficial to the farm (see Table 7.43). A significant minority (37.5%) reported that they were going to do the capital works anyway. This raises questions about the amount of additionality secured in these cases although further in-depth case study work would be required to explore the implications.

	Frequency	%
Necessary to deliver objectives	88	73.3
Benefits farm management	86	71.7
Going to conduct work anyway	45	37.5
Attractive payment rate	34	28.3
Other	24	20.0

Table 7.43 Reasons for choosing capital works (n = 120). 'Other' included personal interest, enhancing student experience, improving the aesthetics of the farm, to provide a better environment for livestock and to improve visitor infrastructure

Nearly 50% of participants with capital works thought that they were 'essential' to their agreement with a further 36.1% considering them to be 'important' (Table 7.44).

	Frequency	%
Essential	59	49.6
Important	43	36.1
Not very/not at all important or unsure	17	14.3
Total	119	100.0

Table 7.44 Importance of capital works to the delivery of options

Reference to capital works was mixed. A number of agreement holders commented on the value and generosity of the funding, enjoyment of the work and the benefit of the associated work as clear.

> "There was no funding constraints on what we wanted to do, we actually got more than we expected in terms of capital works." (Agreement Holder 25)

> "Capital works one big hit and more enjoyable component. More satisfying than annual work. From my point of view I can see far more significant benefits from items delivered under capital scheme. Those bits can really make a huge difference." (Agreement Holder 110)

> "The ability to carry out capital works on the farm which has benefited the look of the farm. Hill ground has improved overall and the livestock looks good." (Agreement Holder 118)

There was some criticism that capital works only provided a (small) contribution towards the price of the work, although many agreement holders still recognised the benefit of the work.

> "We probably spent £14-15,000 but the capital works payment only came to £2,000. So huge expense - the capital works were great but the payment didn't touch the sides." (Agreement Holder 89)

> "We would do more with a scheme - particularly capital works, that makes a real difference - it's only ever a contribution, it's not nearly enough money, so we are helping to fund it, but if you have to pay the full amount with no financial help at all, if it's a difficult farming environment like it is at the moment you just don't do it do you." (Agreement Holder 47)

> "It's mainly to do with the reality of it all - monitoring, pricing - how are prices/payments arrived at for capital works? The money is not high enough in terms of the percentage contribution, especially when employing external contractors." (Agreement Holder 115)

With specific reference to the planting of trees and tree guards, one agreement holder recognised the generosity of capital grants, they were clearly concerned about how the money was being used and whether it was being used for the right reasons.

> "It was quite frightening how much money they (NE) would pay for capital works on things which I don't really think were a necessity or even that the environment was going to gain a great deal from it." (Agreement Holder 54)

The overwhelming suggestion regarding capital works related to flexibility and, linked to that, the ability to spread the associated work throughout the duration of the agreement.

> "There needs to be flexibility with capital works grants - it is difficult to make changes once the agreement has started if circumstances change." (Agreement Holder 46)

> "We did have problems with the weather regarding capital works - being able to change the timetable needs to be addressed." (Agreement Holder 73)

“Spread capital works throughout the duration of the scheme; consult more with farmers about which options will and won't work on each farm.” (Agreement Holder 101)

“More flexibility of capital works to help achieve outcomes, e.g. need to spend time clearing weeds - no money for this.” (Agreement Holder 31)

“Payments for capital works could be better, more flexibility in the time period for delivering the capital works (more than 3 years).” (Agreement Holder 31)

7.5 Implementing the agreement: options level analysis

7.5.1 By option type

So far the analysis has focused at the agreement level. Individual agreements however, can differ significantly. This section therefore focuses on specific options or, to be more precise, groups of options. The utility of analysis of individual options was limited due to the combination of a large number of options and often few participants in any one option. In order to overcome this and facilitate further analysis, options have been grouped in to broad categories of 'maintenance', 'creation', 'restoration' and arable option groups (see Section 2 for an explanation of how these grouping were derived). Options are also presented by habitat feature in Section 7.5.2 (below).

7.5.1.1 Confidence of achieving IoS

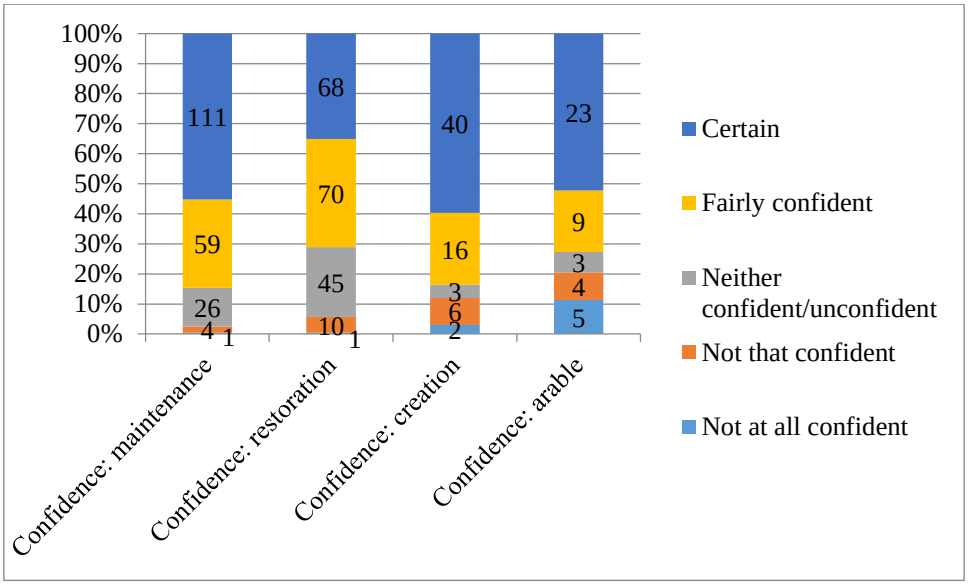

Figure 7.15 Overall confidence by option type

(i) Maintenance options

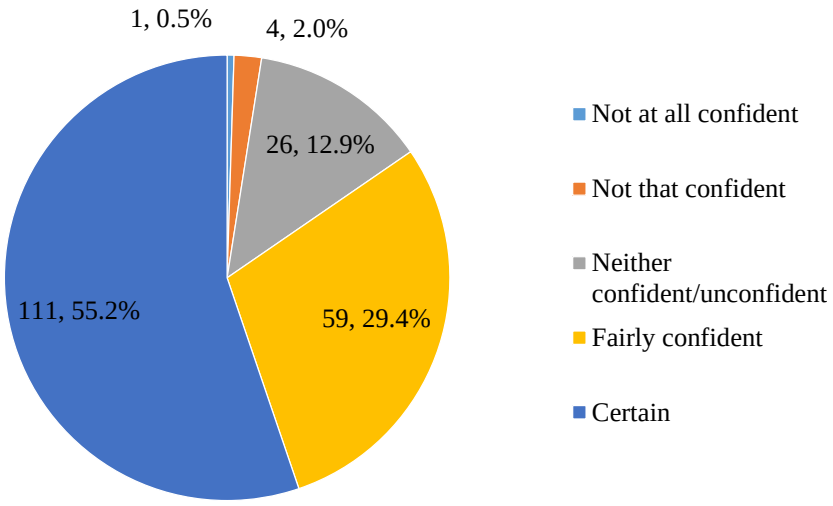

Figure 7.16 Confidence of achieving IoS for maintenance options

As evident in Figure 7.16, over half the sample (55.2%) were **certain** about achieving their maintenance options, with a further 29.4% claiming to be **fairly confident**. The confidence levels of agreement holders with regards to achieving maintenance options, appears to be attributed to the nature of the maintenance options which (as the name suggests) requires 'more of the same' rather than doing anything new or significant. Agreement holders talked about maintenance options as being straightforward and not requiring change.

> "Straight forward option: maintaining what is already there." (Agreement Holder 18, certain)

> "Doesn't require us to anything too different to what we have been and would have continued doing anyway. Did not have to change the policy of the farm or style of the farming." (Agreement Holder 63, certain)

> "Nothing will change, it will stay as it is" (Agreement Holder 117, certain)
> "There is not much for us to do so it's easy to achieve IoS." (Agreement Holder 133, certain)

> "The farming management lends itself to those prescriptions, the stocking is set at a level so there is no over or under grazing, it works, it is easy." (Agreement Holder 155, certain)

> "The woodland area is relatively low impact, it looks after itself and there have been no huge changes so we will be maintaining the feature there." (Agreement Holder 76, fairly confident)

In addition to being straightforward in nature, agreement holders' levels of confidence about achieving the IoS for maintenance options stemmed from the obvious and tangible ways of measuring or recognising success, such as increases in the bird population or improvements in grassland. It appears that being able to recognise success or progress for themselves,

increases confidence levels amongst agreement holders. This highlights the importance of IoS being accessible for agreement holders.

> "Absolutely wonderful for all sorts of birds. Not just pheasant but hedgerow birds (never used to have), spotted woodpeckers, green woodpeckers, buzzards, red kites. So much wildlife in that wood from bits and pieces that have been tidied up. Cut fallen trees down but leave a lot of ivy, leave bits of wood for insects etc." (Agreement Holder 86, certain)

> "There has been an obvious population increase of birds on the farm that we have seen." (Agreement Holder 29, certain)

> "I look at the grassland and see it improving all the time, so I'm quite certain about that." (Agreement Holder 39, certain)

> "Hitting targets for Cetti's warbler population. Cover of scrub species is as prescribed/required. Happy with structure of scrub as well. We've definitely got ragwort and creeping thistle firmly under control." (Agreement Holder 60, certain)

> "I've seen a huge increase in wildlife ... hedges are looking better." (Agreement Holder 15, fairly confident)

> "[It] looks tidy, lot of birds, woodpeckers in the dead trees, it grew apple trees and more wildlife as a result." (Agreement Holder 105, fairly confident)

A minority of respondents were **not at all confident** and **not that confident** that they would achieve the IoS for their maintenance options (0.5% and 2.0% respectively). The lack of certainty surrounding achievement of their IoS seemed rooted in specific problems.

> "This option was originally included but the NE project officer and the landowner and myself agreed that it was not suitable and we shouldn't do it, therefore it was not done." (Agreement Holder 50, not at all confident)

> "The time element involved is huge. I can't afford to spend a lot of time doing it and can't afford to pay others, especially because the charity's funds have got to run the whole of the farm" (Agreement Holder 7, not that confident)

> "Is difficult to find appropriate staff to do the work." (Agreement Holder 5, not that confident)

(ii) Restoration options

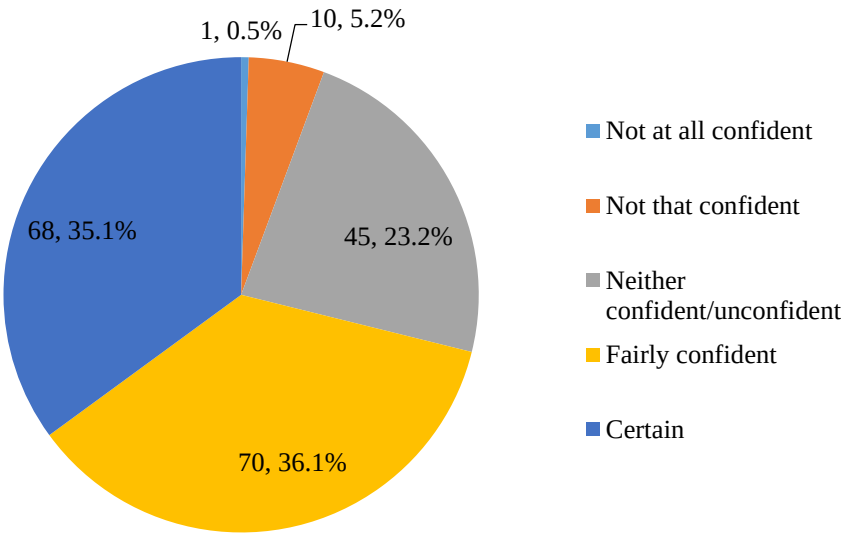

Figure 7.17 Confidence of achieving IoS for restoration options

In comparison to other types of options, agreement holders were less confident about achieving the IoS for restoration options – only 36.1% claimed to be **certain** (compared to 55.2% who reported that they were certain of achieving IoS for maintenance options) with an additional 36.1% reporting that they were **fairly confident** (Figure 7.17).

A total of 23.2% felt **neither confident nor unconfident** and a further 5.2% felt **not that confident**. Although the majority (72%) of agreement holders were either **certain** or **fairly confident** of achieving restoration IoS, analysis indicates that restoration options have been harder for agreement holders to implement and that obvious signs of success have been less visible. When asked about the difficulty and uncertainty around achieving IoS for restoration options, agreement holders attributed it in part to restoration options demanding change and 'upheaval' of what they were already doing. Generally, restoration options presented more of a challenge for agreement holders and required more and sometimes significant action, often working to rectify years' worth of damage and destruction.

> "This involved a change in farming practice - and this may or may not have resulted in the expected outcomes - achieved success" (Agreement Holder 129, neither confident nor unconfident)

> "Struggling a bit for the indicators - the problem with that one, a problem with the isolated sites is if you can't introduce the species, then they're not gonna find their own way there … it's an ex-gravel pit site, it was murdered, soil mixed up … so there's some interesting things but they don't tend to be the things that we are supposed to have" (Agreement Holder 27, neither confident nor unconfident)

> "It is difficult, we are short of flowers and things but we are trying hard but it isn't easy; you've got grassland, it's grazed … it's difficult to restore, you know, I'm not quite sure what they call species rich semi-natural grassland …" (Agreement Holder 39, neither confident nor unconfident)

Restoration also appeared to be quite unpredictable and to some extent, out of the agreement holders' control and some of the outcomes can be diverse.

> "It is out of your control what grows - it is species rich but you cannot guarantee that different species will come back." (Agreement Holder 124, neither confident nor unconfident)

The diversity of the outcomes for restoration options versus a "prescriptive" and "narrow" perception of the IoS was a source of contention for some agreement holders.

> "I think the IoS are very specific and appear to focus entirely on tree species, whereas I consider there to be much broader IoS e.g. increase in number of species and numbers of animals and birds, and there's absolutely nothing about that. For example, we've seen a very obvious increase in our brown hare population, which we are really delighted by, but at no point has that been an indicator for us. We've also seen an enormous increase in the number and diversity of wildflowers that we have in our woodland and wood pastures, but that again is not in the IoS. Even in orchard getting things like harebells, which we'd never seen before but it must have been in the ground and because it's being less intensively managed it's coming back, which is lovely. So the indices are very prescriptive and very narrow and very demanding – they want an awful lot of one thing, which seems strange to me." (Agreement Holder 47, neither confident nor unconfident)

> "On this one, one of the indicators of success is wintering geese or swans should be present which on reflection, I'm not sure why that's in there ..." (Agreement Holder 27, neither confident nor unconfident)

Some agreement holders claimed to be unable to see any progress with their restoration options. There are several potential explanations for this. It is possible that IoS are not being delivered or that it is more difficult to recognise success for restorations. Equally, it may reflect poorly drafted IoS or that restoration is difficult to achieve within the span of an agreement.

> "I can't see it working - we're 6 years in and it's not happening; the management prescriptions don't work." (Agreement Holder 161, neither confident nor unconfident)

> "At the moment, restricting stocking has made no difference to the wildlife." (Agreement Holder 132, neither confident nor unconfident)

> "Moorland has not changed since the scheme started so not sure if IoS will be achieved." (Agreement Holder 135, neither confident nor unconfident)

(iii) Creation options

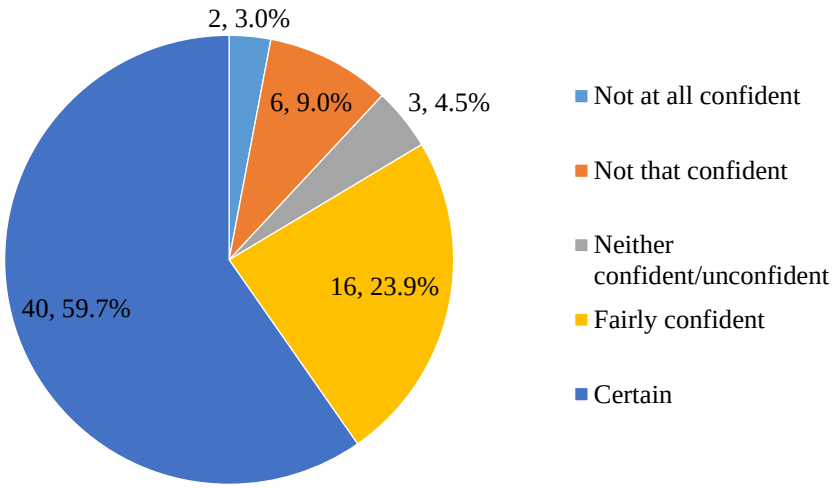

Figure 7.18 Confidence of achieving IoS for creation options

As demonstrated in Figure 7.18, nearly 60% of agreement holders were certain about achieving IoS for creation options, and a further 23.9% claimed to be fairly confident. Like maintenance options, creation options were seen as achievable by many agreement holders just by doing what they would be doing anyway[3]. This was often conveyed as being a normal part of 'good farming/land management' or a case of building on what they were already doing.

> "Because we're doing a great job even though the management can be difficult at times; everything is going right with the option." (Agreement Holder 160)
>
> "Because we are good farmers." (Agreement Holder 104, certain)
>
> "Restoration and creation all in the same area. One bit just drilled, but the area of creation and restoration are next to each other - the difficulties are similar for each. Restoration was a bit easier because the seed bank was still there." (Agreement Holder 4, certain)
>
> "Already established woodland, building on previous success." (Agreement Holder 25, certain)
>
> "All we have to do is plough it up and put the seed in - it's easy." (Agreement Holder 161, certain)

It was also felt that success was easy to identify, therefore agreement holders were able to say quite confidently where the IoS was being achieved.

[3] Although at first this may appear counterintuitive, much probably depends on the starting point and what is being created. This is an area that would benefit from further detail case study investigation.

"All of trees have survived and grown really well. All flowered and fruited. Bees live in the orchard which produce great honey. Tangible - can see what's being created." (Agreement Holder 77, certain)
"We've had no run-off, no great gullies running down it." (Agreement Holder 91, fairly confident)

Lower levels of confidence were attributed to specific problems occurring such as weeds and pests.

"Been slow; lots of weeds, coarse grasses. Never previously seeded land, the first things that come up are weeds really ... so vulnerable to weeds." (Agreement Holder 34, not that confident)

"The business of drought, pests, weeds has made it the most difficult bit of the part of the scheme…it isn't as simple as grass." (Agreement Holder 6, not that confident)

(iv) Arable options[4]

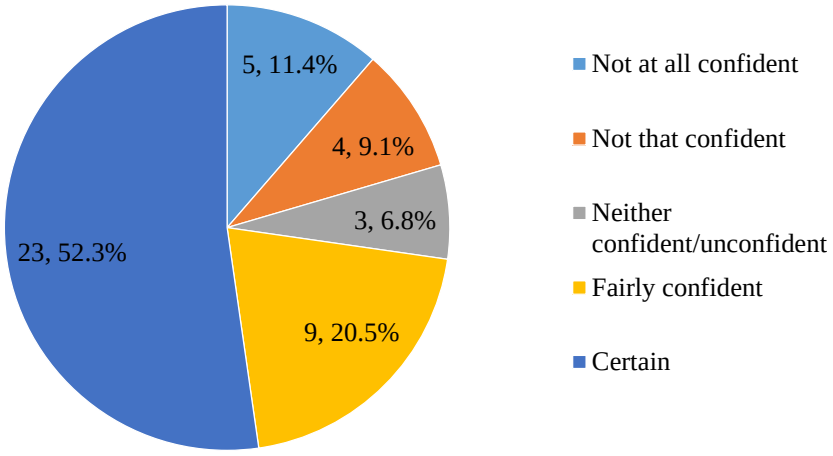

Figure 7.19 Confidence of achieving IoS for arable options

Figure 7.19 shows that over half of agreement holders undergoing arable options were certain they would achieve associated IoS and an additional 20.5% claimed to be fairly confident. Just over one-fifth of respondents (20.5%) were concerned about achieving IoS for arable options.

[4] No qualitative responses for arable options. This is due to qualitative responses being collected for 'Focus Options' only (see Section 2 in the Method chapter). No arable options were listed as focus/priority options, therefore only quantitative data exists for these options.

7.5.1.2 Ease of achieving IoS

In addition to exploring agreement holders' confidence in achieving their IoS we also explored how **easy or difficult** they thought this would be. Maintenance options clearly emerge as those most likely to be perceived as easy or very easy to implement. On the other hand, for restoration and creation and arable options sizeable minorities (21.7%, 19.6% and 23.3% respectively) felt that implementing the options would be difficult or very difficult.

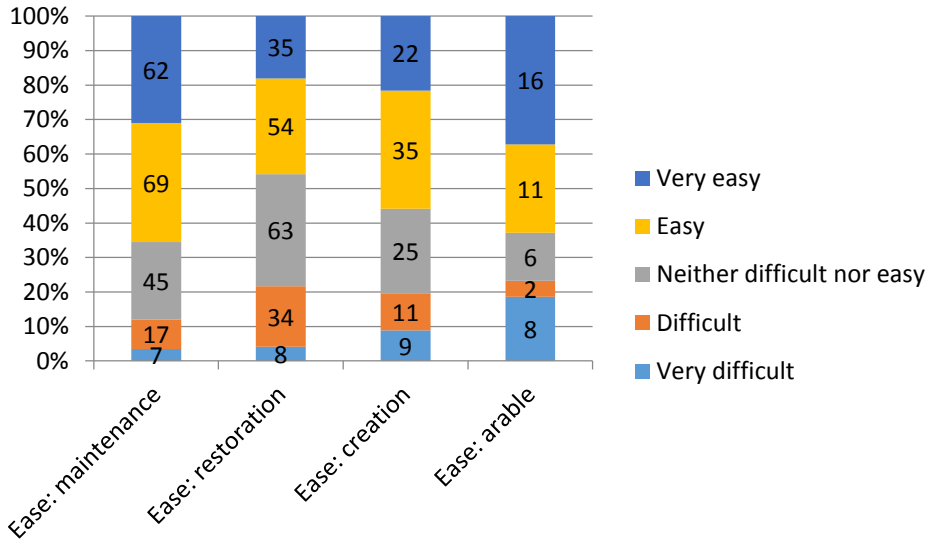

Figure 7.20 Overall ease, by option type

(i) Maintenance options

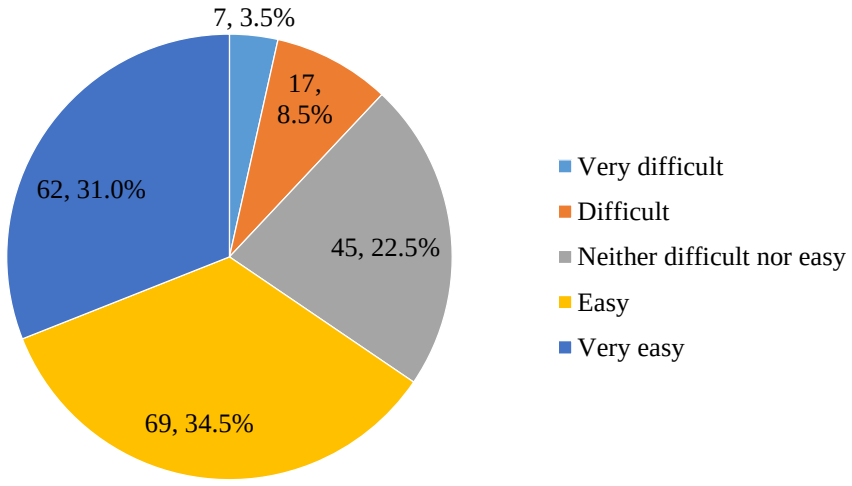

Figure 7.21 Ease of achieving IoS for maintenance options

As demonstrated in Figure 7.21, more than 65% of agreement holders found maintenance options either very easy or easy. Only 12% found carrying out the maintenance options difficult or very difficult (8.5% and 3.5% respectively). Over a fifth (22.5%) of agreement holders described their maintenance options as neither difficult nor easy to carry out. Like

confidence levels associated with achieving IoS for maintenance options, a high percentage of very easy and easy responses are reflected in the fact doing the work generally required agreement holders to continue doing what they are doing. Where it did require work, it was considered to be straightforward and typically low input.

> "Straightforward – easier than growing crops. Only problems initially was with timings – getting contractors in at the right time, but once the system got going it worked well." (Agreement Holder 1, very easy)

> "We are doing it anyway." (Agreement Holder 20, very easy)

> "It was easy to carry out because the option prescriptions were not difficult for us to do." (Agreement Holder 29, very easy)

> "I have been doing them for 70 years." (Agreement Holder 37, very easy)

> "Takes care of itself." (Agreement Holder 53, very easy)

> "Has not changed from what we were doing. Normal routine." (Agreement Holder 54, very easy)

> "You can fence it off, and leave it to itself … you do have to maintain it though, every now and again you have to bring it back into line, bough lopping you know …" (Agreement Holder 116, very easy)

> "We do not have to do many things for this option, so it's easy." (Agreement Holder 133, very easy)

> "Doesn't need much doing to it, the woodland and the option are very low input, except for clearing fallen trees from boundary fences." (Agreement Holder 26, easy)

> "[It] is work that we would normally do – traditional management." (Agreement Holder 50, easy)

Difficulty delivering maintenance options stemmed from them being quite labour intensive. Agreement holders talked exclusively about the physical demands of delivering the options, including issues of access, as opposed to the complexity of the options themselves.

> "Not an easy job – land very hilly so access has been difficult (had to make new track)" (Agreement Holder 85, neither difficult nor easy)

> "It is outside the grazing compartment, it needs cutting and baling but is a small strip next to a road, so it's more to do with the logistics" (Agreement Holder 82, neither difficult nor easy)

> "On the established woodlands, access isn't easy and the timeframe within which the work needs to be done is a bit of a constraint. Especially when you consider that we have shooting interests too – so really you've only got the months of late

January, February and early March in which to do it." (Agreement Holder 100, neither difficult nor easy)

"Sometimes the process of burning heather can be difficult in the areas agreed. Stopping fires can be difficult so we often need to provide more resources to achieving the management prescriptions." (Agreement Holder 107, neither difficult nor easy)

Linked to the sometimes labour-intensive nature of maintenance options, two agreement holders reported finding it difficult to find appropriately skilled labour.

"[It] is not easy to find people with the skills required willing to come and do the work." (Agreement Holder 5, difficult)

"The labour and machinery have got to be decent" (Agreement Holder 7, very difficult)

The issue of flexibility of management prescriptions emerged again here, with a number of agreement holders struggling with strict date and time parameters.

"Dates/timings the scheme allows you to carry out management operations are the problem, the specified timings don't suit this farm." (Agreement Holder 126, difficult)

"Some prescriptions are too generic for specific sites and livestock conditions, and this is particularly hard for the sheep farmers in the agreement area." (Agreement Holder 55, difficult)

Others attributed difficulty to inherently difficult agreement sites.

"One of the most challenging sites, if not the most challenging site that The Trust manages." (Agreement Holder 40, very difficult)

"Due to the wet land conditions and changes in tides." (Agreement Holder 8, difficult)

One agreement holder suggested how an issue out of their control – trespassing – made delivering the options successfully a challenge.

"We've had trouble with trespassing. Walkers aren't too bad, but because it's on the river we have a problem with river gypsies and illegal moorings – it's a pain to get them to move on. Jeopardising the banks and walking around on the site." (Agreement Holder 69, neither difficult nor easy)

(ii) Restoration options

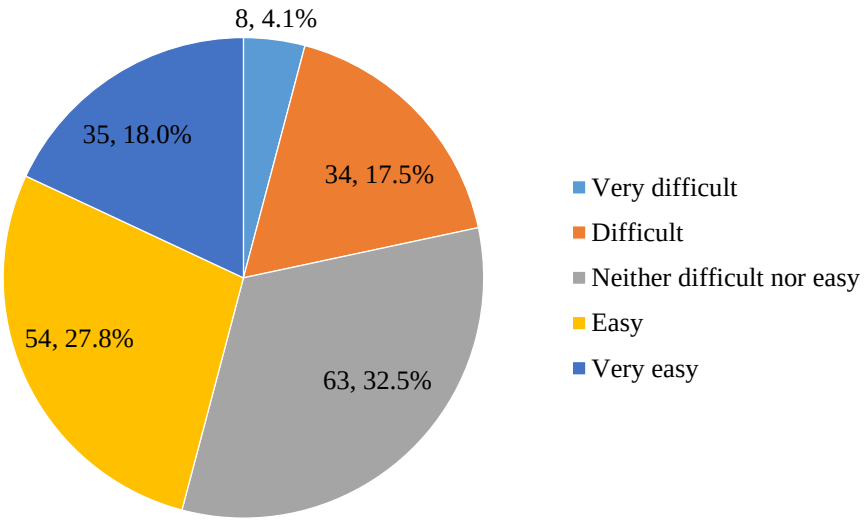

Figure 7.22 Ease of achieving IoS for restoration options

As demonstrated in Figure 7.22, nearly a third of agreement holders (32.5%) found restoration options neither difficult nor easy.

Given that nearly one third of respondents described this as 'neither difficult nor easy' we have drawn on their qualitative responses to the follow up question 'explain this level of difficulty' to explore this response further. Generally, it was where participants found parts of the restoration options easy, e.g. having their own labour but another part of the work being difficult or complex, being unfamiliar with the management prescriptions or small difficulties that were dealt with but ultimately hampered progress.

> "I was unsure of the management prescriptions and had no support in managing this option" (Agreement Holder 93)

> "It wasn't difficult but we had to use all our own labour - difficult because so wet, just couldn't get on the land" (Agreement Holder 102)

> "Ragwort and thistles made it difficult. We spot sprayed, topped, everything - in the end the sheep cured it because they eat the ragwort when it's young. I haven't had to take any ragwort out since they've been there" (Agreement Holder 4)

Under half of agreement holders claimed to find restoration options either very easy or easy (45.8%), compared with nearly two-thirds of agreement holders (65.5%) in relation to maintenance options, 55.9% of agreement holders in relation to creation options and 62.8% of agreement holders in relation to arable. This suggests that restoration options have not been as easy as maintenance, creation and arable options. As above, this reflects the demanding nature of restoration options. As agreement holders reported, restoration options presented more of a challenge, requiring significant physical/manual input, and changes to sometimes longstanding practice to restore areas or features that have been damaged or changed significantly.

> "Getting over the initial difficulty of bringing a site into management that hadn't been managed for many years." (Agreement Holder 128, difficult)

> "It's an ongoing battle, but it's not an unreasonable objective." (Agreement Holder 131, difficult)

> "None of us getting younger […] Drain on energy to physically do it." (Agreement Holder 162, very difficult)

> "Have to manually insert and remove ditch barrier plugs to regulate water flow … lot of hassle and difficult to remove plugs sometimes" (Agreement Holder 176, neither difficult nor easy)

> "[It] wasn't simple to erect fences on the site, but this was a one off difficulty." (Agreement Holder 77, neither difficult nor easy)

> "Have to use manual labour to manage a difficult and inaccessible site." (Agreement Holder 176, neither difficult nor easy)

Some agreement holders commented on how restoration options were time intensive to implement and outcomes/results were not instantaneous.

> "Due to the timescales involved – regrowth is slower than anticipated. Also due to non-target species growing after conifer removal, e.g., birch, that we then had to remove." (Agreement Holder 172, neither difficult nor easy)

> "Takes time to create woodland and manage it." (Agreement Holder 101, neither difficult nor easy)

Because of the gradual nature of the outcomes associated with many restoration options, it is possible that agreement holders did not have the results to affirm the easiness of achieving the options.

Access was a great source of difficulty for agreement holders undertaking restoration options.

> "The access, it is on a steep bank, working with chainsaws etc. is difficult. Everything needs to be carried manually from the roadside." (Agreement Holder 72, difficult)

> "Access to the site for management is the problem, it involves travelling across hay meadows when the grass is long and the actual site is steep and difficult to get around." (Agreement Holder 126, very difficult)

> "Access for modern farm vehicles on some sites is a problem." (Agreement Holder 31, difficult)

> "It's on a hillside so difficult to carry the chainsaw and knapsack sprayer." (Agreement Holder 72, neither difficult nor easy)

> "Difficult to access site with machinery due to wet ground conditions, no road access and generally awkward ground conditions." (Agreement Holder 138, neither difficult nor easy)

There was also some suggestion that work associated with restoration options was particularly vulnerable to adverse weather conditions and weeds which presented an extra challenge. The latter two examples (Agreement Holders 30 and 91) show the value of flexibility offered by NE in being able to overcome these unpredictable and uncontrollable influences.

> "Weather and occasional ragwort have to get in and top." (Agreement Holder 68, neither difficult nor easy)

> "Weather is main difficulty re: making hay in wet summers." (Agreement Holder 157, neither difficult nor easy)

> "Ragwort and thistles." (Agreement Holder 4, neither difficult nor easy)

> "Trees are there, growing but [a] lot of scab. Crab apple, fertilising one, is absolutely fine. Trees miserable really – very miffed about that. Had to design special guards, quite a job really. I voluntarily got an arborist in as I did not like look of them – seems it's a scab you get in this area, very prone to it, basically nothing you can do unless you cut them all down, burn them all and replant. Fortunately there were some walnut trees in there and I did persuade them [NE] to let me keep them as part of the orchard and they're alright. Also a sweet chestnut. So I think there's four trees in there that are quite good!" (Agreement Holder 30, difficult)

> "Because we're not allowed to spot spray out the brambles and nettles, suddenly all the orchids etc. are struggling to compete. We did try to negotiate to be able to spot spray some things out and more intensively manage it – not with fertilisers etc., but being able to go in and say, those brambles need to come down, or make sure they're kept at bay. But we can't." (Agreement Holder 91, neither difficult nor easy)

Even agreement holders who found carrying out the options easier recognised how even when restoration options were followed, the outcomes were not always as expected.

> "Given the prescriptions, provided they were followed, which has been the case, the results should follow – however sometimes the ecology doesn't follow the expected route." (Agreement Holder 129, easy)

Stock management elements of restoration options were perceived as easy by agreement holders.

> "Easy to do; stock management only." (Agreement Holders 135, very easy)

> "It wasn't hard to do, just keeping less stock on the land." (Agreement Holder 132, very easy)

"Grazing is a good way of maintaining the prescriptions, livestock numbers are okay, access is good so we can also mow. The sites are relatively compact so it can be difficult for machinery access." (Agreement Holder 76, easy)

"The stock do it for you – the cattle prefer not to graze there when there's plenty of better grass elsewhere easy." (Agreement Holder 131, easy)

(iii) Creation options

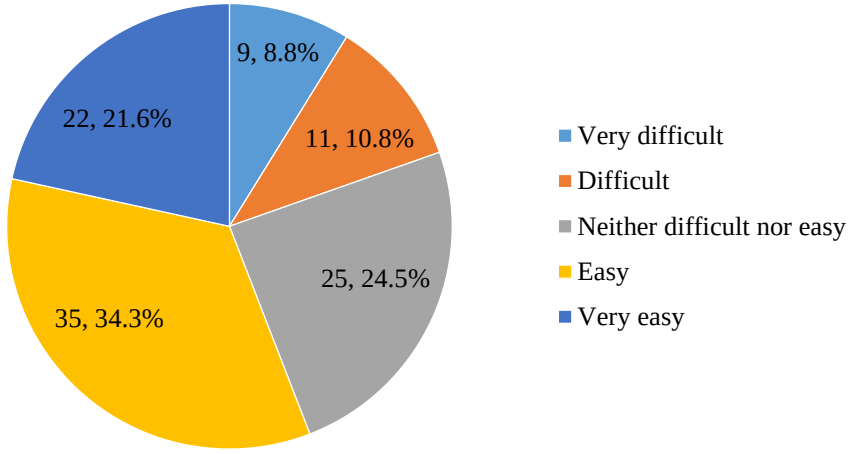

Figure 7.23 Ease of achieving IoS for creation options

Nearly 56% of agreement holders found creation options either very easy or easy and yet a notable almost one-fifth (19.6%) found creation options either difficult or very difficult. Just under a quarter claimed creation options were neither difficult nor easy (Figure 7.23).

Positive responses (very easy and easy) tended to be very generic and as with the confidence in achieving IoS for creation options, seemed to relate to the idea of good farming/land management.

"We know what to do; the management to achieve the prescriptions is basic." (Agreement Holder 141, easy)

"No issues – new trees planted and growing." (Agreement Holder 23, very easy)

"It was straight forward but we did need to divide areas up into plots even though it was already in one plot." (Agreement Holder 25, easy)

"Woodlands are fenced off, we can get in to do management when required. It's fairly straightforward and the trees are growing well." (Agreement Holder 46, easy)

As was the case with other types of options, external factors such as the influence of the weather and vulnerability to weeds hindered progress with creation options.

"Adverse weather conditions can be a problem." (Agreement Holder 141, difficult)

"Been slow; lots of weeds. Never previously seeded – so vulnerable to weeds." (Agreement Holder 34, difficult)

"Trying to control thistles and ragwort is also very time-consuming and not terribly straightforward." (Agreement Holder 100, difficult)

"Establishment, weed control, pests." (Agreement Holder 6, difficult)

"It's purely down to the weeds and flooding." (Agreement Holder 109, neither difficult nor easy)

"Normally it is easy to do but tidal restrictions can cause problems when wanting to carry out work on the land." (Agreement Holder 8, neither difficult nor easy)

(iv) Arable options[5]

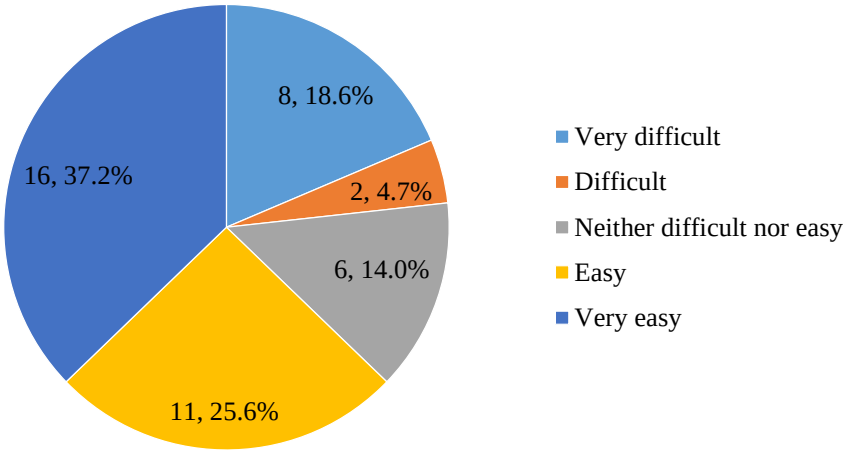

Figure 7.24 Ease of achieving IoS for arable options

Figure 7.24 shows a mixed response. Although 37.2% of agreement holders undergoing arable options found them very easy and an additional 25.6% described them as easy, almost one-fifth (18.6%) found them very difficult and a further 4.7% described them as difficult.

[5] No qualitative responses for arable options. This is due to qualitative responses being collected for 'Focus Options' only (see Section 2 in the Method chapter). No arable options were listed as focus/priority options, therefore only quantitative data exists for these options.

7.5.2 By habitat feature[6]

The findings above are largely confirmed when looking in greater detail at particular habitat features within the broad option groups. As Figure 7.25 indicates, respondents with maintenance options for boundary features were highly confident in their ability to achieve the requirements of the options and generally there were few concerns in meeting the options for other habitat features. Agreement holders expressed less certainty in their ability to meet the requirements of restoration options, with least confidence in achieving wetland restoration options.

7.5.2.1 Confidence of achieving IoS by habitat feature

(i) Maintenance options

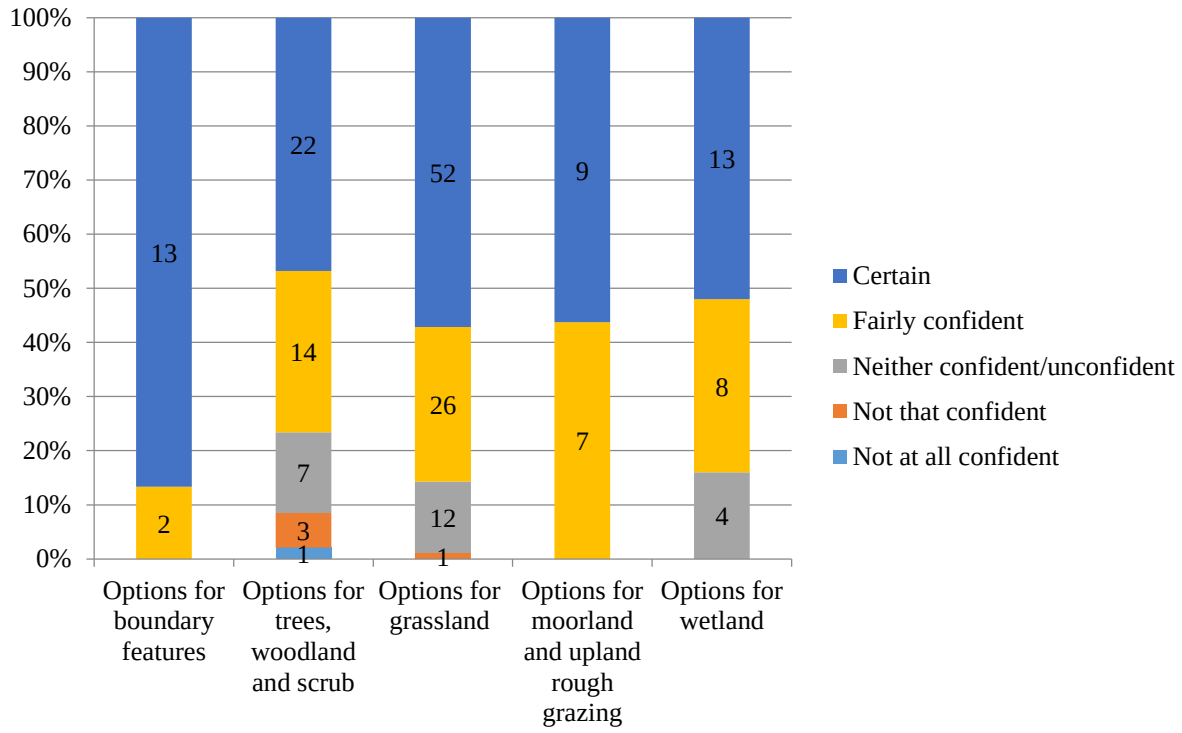

Figure 7.25 Confidence of achieving maintenance options, breakdown by habitat feature type

[6] For anonymity reasons, the following analysis excludes habitat features where the total number of agreement holders for any habitat feature was less than 5

(ii) Restoration options

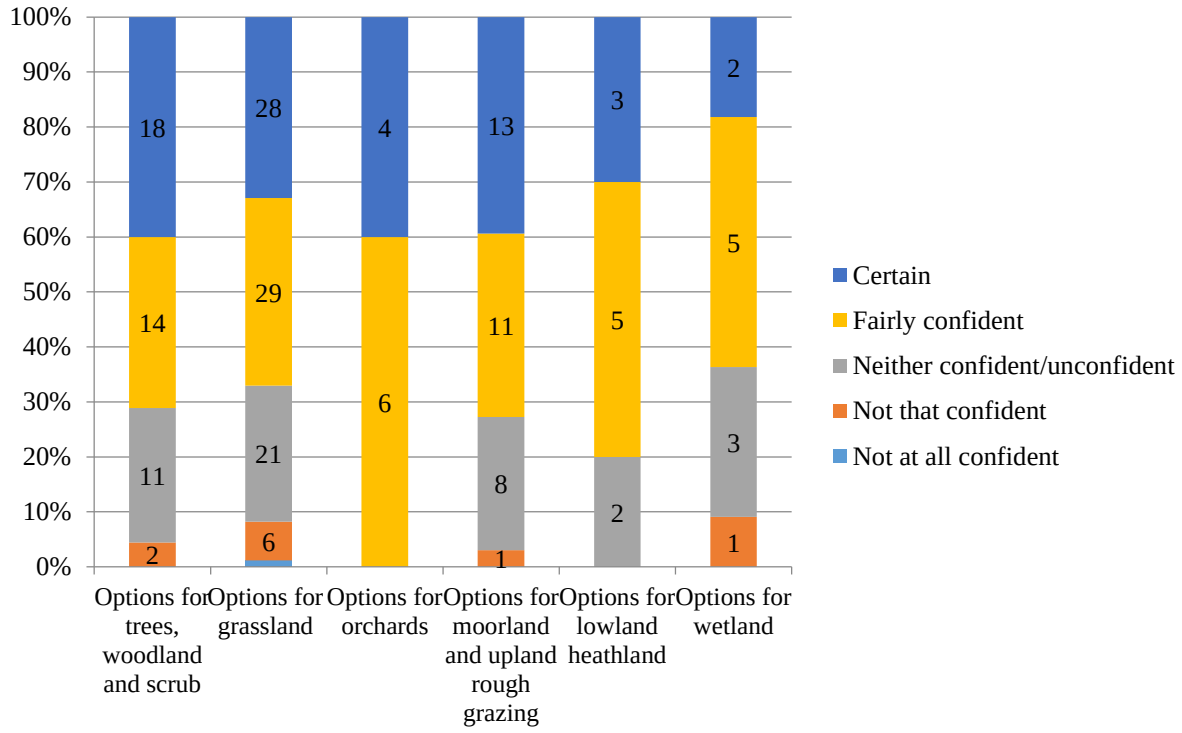

Figure 7.26 Confidence of achieving restoration options, breakdown by habitat feature type

(iii) Creation options

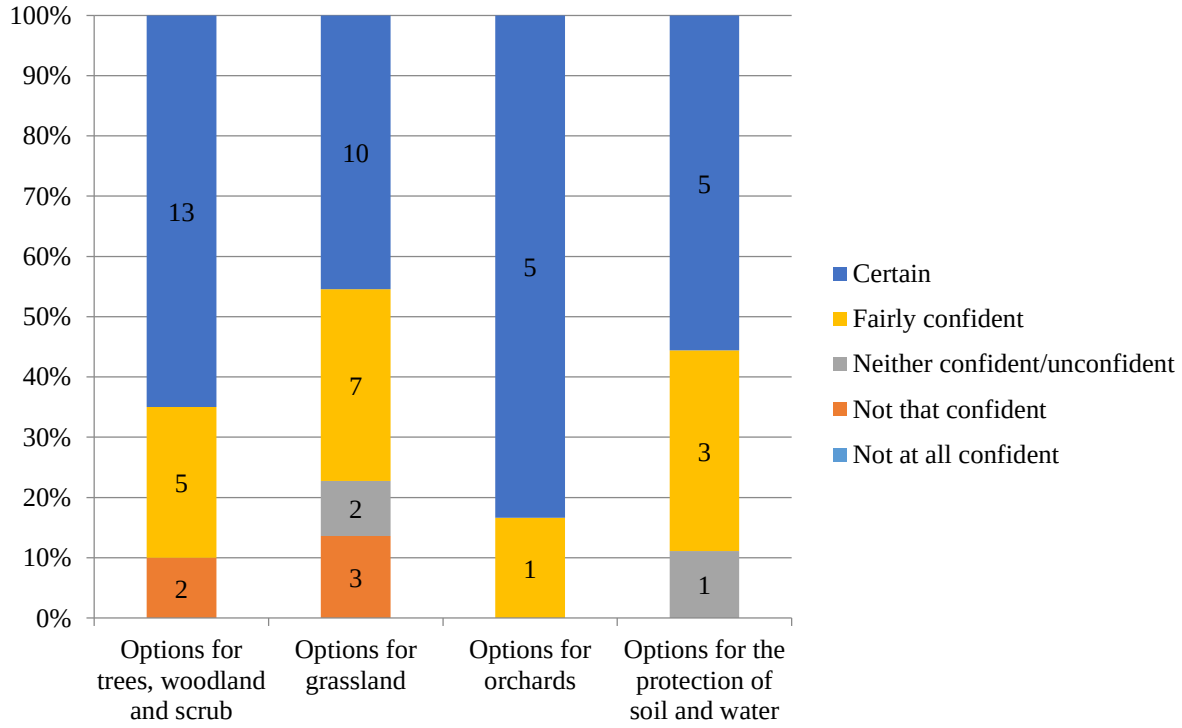

Figure 7.27 Confidence of achieving creation options, breakdown by habitat feature type

7.5.2.2 Ease of achieving options by habitat feature

In terms of the perceived ease or difficulty associated with different combinations of option type and habitat feature, most habitat features within maintenance options were perceived as easy or very easy to manage although wetland options were seen as more problematic. As with the previous analysis, restoration options were generally seen as more challenging, with wetlands and orchard management perceived as most difficult. Options for orchards were also seen to be most difficult by those with creation options.

(i) Maintenance options

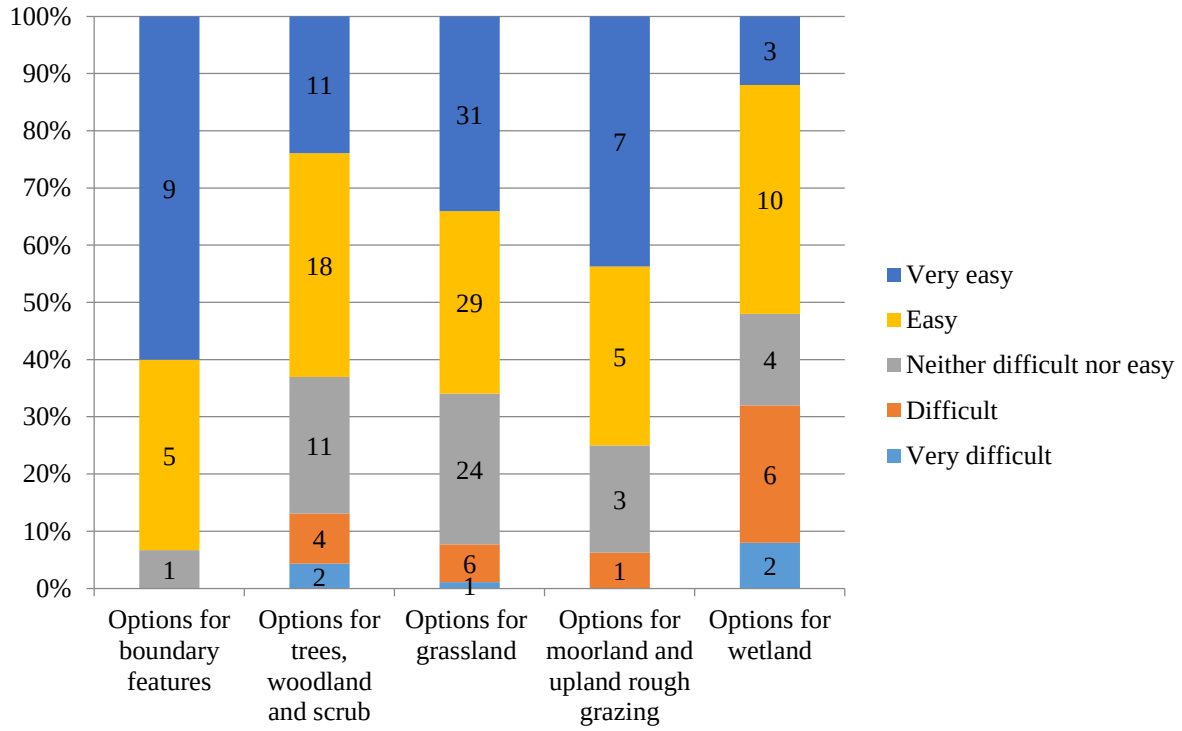

Figure 7.28 Ease of achieving maintenance options, breakdown by habitat features

(ii) Restoration options

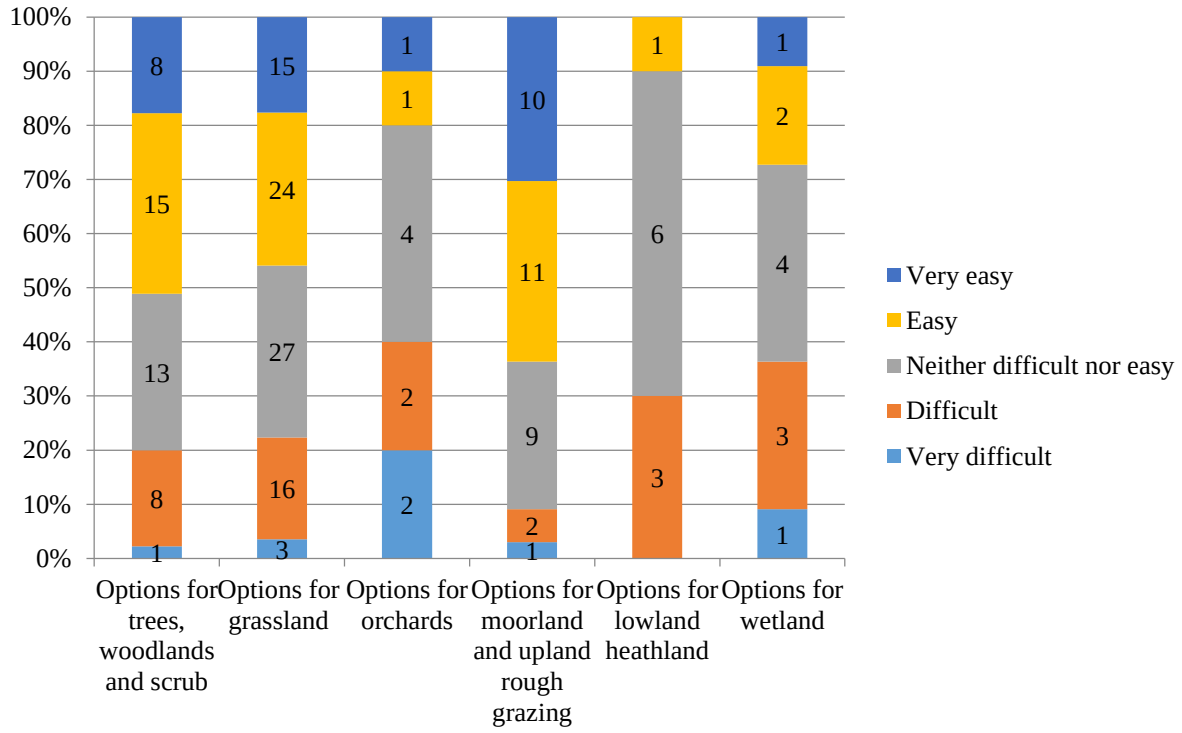

Figure 7.29 Confidence of achieving restoration options, breakdown by habitat features

(iii) Creation options

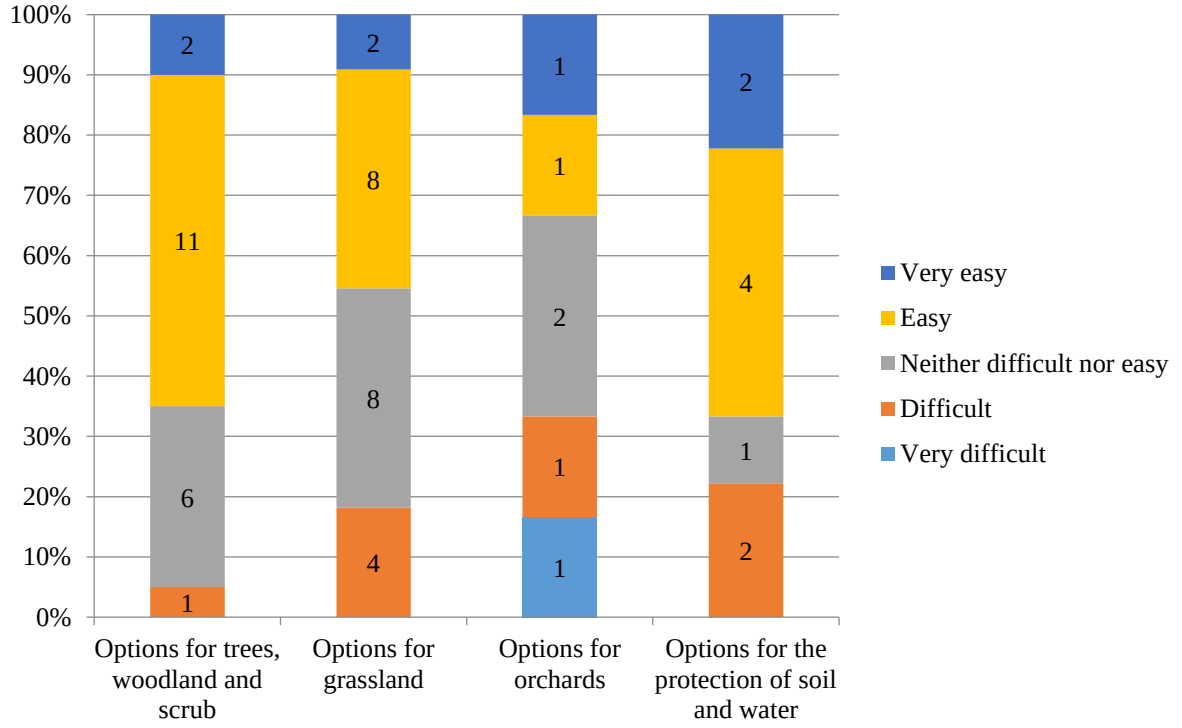

Figure 7.30 Confidence of achieving creation options, breakdown by habitat features

7.6 Perceived impact of the HLS agreement

Survey participants were asked for their perceptions of the impact of their HLS agreement. A range of positive impacts were identified (also see Table 7.45):

- Nearly 72% of participants reported that their HLS agreement had either 'some' or 'a lot' of impact on wildlife.
- A total of 64.3% stated their agreement had either 'some' or 'a lot' of impact on landscape character.
- 53.7% of participants felt their agreement had 'no' or only a 'small amount' of impact on flood risk management
- 58.5% of participants claimed their agreement had 'no' or only a 'small amount' of impact access for farm work. In contrast, 55.4% of participants recognised 'some' or 'a lot' of impact on farm access for the public (this encompasses more than just the provision of access as part of the agreement and reflects improvements to the 'access experience' as a result of HLS management).

Most agreement holders thought that overall their agreement was successfully meeting its environmental objectives (see Table 7.46) with only 3 agreement holders stating that their agreement had not been environmentally successful.

	Not at all/small amount	**Neither/nor**	**Some/a lot**
Impact on water quality	34.0% (32)	20.2% (19)	45.7% (43)
Impact on wildlife	9.6% 13	18.5% 25	71.9% 97
Impact on landscape character	18.6%) (24)	17.1% (22)	64.3% (83)
Impact on historic features	21.9% (23)	22.9% (24)	55.2% (58)
Impact on flood risk management	53.7% (44)	15.9% (13)	30.5% (25)
Impact on access for farm work	58.5% (48)	11.0% (9)	30.5% (25)
Impact on public access	31.5% (29)	13.0% (12)	55.4% (51)

Table 7.45 Impact of HLS agreement

	Frequency	**%**
Very successful	33	24.1
Successful	86	62.8
Neither/nor	15	10.9
Unsuccessful	3	2.2
Very unsuccessful	0	0.0
Total	137	100.0

Table 7.46 Success of HLS in meeting environmental objectives

The 3 agreement holders who felt their HLS agreements had been 'unsuccessful' in meeting its environmental objectives were able to offer an explanation. For example, one agreement holder thought their agreement had not been flexible enough to allow it to succeed:

> "[Natural England needs to] understand and believe in the good intention and sincerity of the people who are trying to comply with their requirements." (Agreement Holder 39)

With specific reference to the birds on their agreement land, another suggested:

> "[I] haven't seen any birds using it. Done all the right things but doesn't seem to have made a difference. Generally disappointed with the difference the HLS has made to birds on the farm." (Agreement Holder 65)

The final example of perceived failure was explained in terms of HLS not making much difference to an already extensive system:

> "More or less does itself really because we are not intensive – already doing it" (Agreement Holder 136)

Perceived lack of success is more likely to be associated with financial motivations for HLS participation (Table 7.47). Furthermore, agreements that were perceived to be successful were more likely to be those where the agreement holder felt they had complete or considerable control over the design of their agreement (Table 7.48). In turn, this suggests a greater understanding and 'ownership' of the agreement which may be associated with greater effort and care in its implementation. This is a significant finding in the context of future schemes and broadly suggests that agreements are more likely to be perceived successful from the perspective of the agreement holder when they have had good levels of control or ownership when shaping/designing their agreement. However, designing and submitting the application independently is not necessarily the best model for this. As evident in Table 7.49, it was actually designing the agreement with others from outside the business (97.6% very successful & successful) and delegating the task to someone else within the business (100.0% very successful & successful) that seemed most conducive with successfully meeting environmental objectives (from the perspective of the agreement holder). Again this is a significant finding in the context of future schemes.

	Financial	**Practical/fit with system**	**Continue good work**	**Altruistic**	**TOTAL**
Very successful/ successful	26.5	30.8	17.9	24.8	100.0
Neither/nor	57.1	21.4	21.4	0.0	100.0
Unsuccessful/very unsuccessful	66.7	0.0	0.0	33.3	100.0

Table 7.47 Success of HLS in meeting environmental objectives, by motivation type

	Complete or considerable control	Some control	Not much control	TOTAL
Very successful/ successful	67.6	25.9	6.5	100.0
Neither/nor	40.0	33.3	26.7	100.0
Unsuccessful/very unsuccessful	66.7	33.3	0.0	100.0

Table 7.48 Success of HLS in meeting environmental objectives, by level of control over agreement design

	Independent	With others from outside the business	Someone else within the business	Agent or other 3rd party	Other
Very successful/ successful	84.2	97.6	100.0	77.8	90.0
Neither/nor	15.8	0.0	0.0	20.4	0.0
Unsuccessful/very unsuccessful	0.0	2.4	0.0	1.9	10.0
TOTAL	100.0	100.0	100.0	100.0	100.0

Table 7.49 Success of HLS in meeting environmental objectives, by who designed the agreement

7.7 Evaluation and future plans

7.7.1 Contact with NE

As evident in Table 7.50, a significant proportion (44.5%) of participants reported frequent advice/feedback from NE since the start of their agreement (more than 3-5 times). Notably, 10.2% claimed not to have any form of advice/feedback during this period. Interestingly, despite some of the difficulties and concerns revealed during the option level analysis, 71.5% of participants felt no more support was needed to manage their agreement (Table 7.51).

	Frequency	%
None	14	10.2
1-2 times	27	19.7
3-5 times	35	25.5
More frequently	61	44.5
Total	137	100.0

Table 7.50 Frequency of advice/feedback from NE since start of agreement

	Frequency	%
No	99	71.5
Yes	39	28.5
Total	137	100.0

Table 7.51 Is more support needed to manage agreement?

Those who reported requiring more support tended not to have much agri-environmental management experience. For instance, 38.5% had not previously carried out any independent agri-environmental management. In addition, 47.4% had used a 3rd party to design and submit their HLS application which might suggest less 'ownership', familiarity and understanding of the objectives of the agreement. Those that claimed to need more support generally felt this could be addressed by more contact with NE.

> "It would be beneficial to both parties – myself and Natural England – to review the scheme on an annual basis – not an inspection, just a general review – and see what is and isn't working and adjust the scheme options and management accordingly, or not at all." (Agreement Holder 14)

> "Visiting more frequently at different times of year to gauge if things are working and IOS are happening and suggest management improvements." (Agreement Holder 137)

> "Checks to see if doing things correctly and extra help to understand agreement & options. Meet new NE advisors/officers and keep in regular contact." (Agreement Holder 159)

> "Like someone to come out and look at the wildflowers when they're in flower. That's an indicator of success. I would like to know if I am doing the right thing at the right time. Just to boost my own security about it." (Agreement Holder 144)

> "More feedback on whether prescriptions are delivering (desired outputs for NE) would be helpful. If objectives/IoS are not being met, advice on best practice in achieving the objectives." (Agreement Holder 129)

> "People start off and they forget what they are doing, so NE coming out more." (Agreement Holder 110)

Underlining this was the need for the contact with NE to be in a supportive/positive/feedback capacity rather than in the form of a formal inspection.

> "More feedback would help us to keep on track; more advice rather than inspections to make sure we are doing the job right." (Agreement Holder 8)

> "A regular visit to determine if any improvements are being made, we need to get feedback." (Agreement Holder 80)

Linked to the desire for more contact with NE, some Agreement Holders offered some practical suggestions for improvement:

> "Direct phone line - I hate computers, much easier to get an answer." (Agreement Holder 53)

> "Positive support - rewarded/praise for doing things right; tips, ideas and practical guides of how to do things and how not to do things on the website e.g. how to identify pests/early warning signs of disease Ash Dieback." (Agreement Holder 90)

> "One point of contact, one number to ring - felt had that in CS but not in this." (Agreement Holder 84)

7.7.2 Concerns and suggestions for improvement

Agreement holders raised a range of concerns about the operation of HLS and in doing so, frequently made suggestions for improvement. Agreement holders have been categorised according to the main concerns they expressed (see also Table 7.52).

Group 1: Lack of flexibility and opportunity for flexibility (29.9%)
Agreement holders in this group were chiefly concerned with the lack of flexibility the scheme offered and were concerned that the scheme doesn't always work at certain points in time (e.g. during periods of bad weather) or in certain locations (e.g. certain topographies, soil types etc.). They may feel that NE need to trust them (more) to make decisions/interpret management prescriptions and felt the scheme might have worked better if they were able to do so.

Group 2: More contact with NE needed (28.5%)
Agreement holders in this group felt more feedback or easier communication with NE advisors was needed. They may have experienced difficulty in accessing consistent and clear advice from NE and may have reported a lack of consistency following a high turnover of NE advisors. In addition to a lack of consistency, they may have felt NE advisors were not sufficiently knowledgeable.

Group 3: Administration and application problems (26.3%)
Agreement holders in this group reported difficulties with the ways in which the scheme was administered. This was often described as 'red tape' or 'bureaucracy'. They may have experienced some problems with the amount of payment and the organisation of payment (i.e. late payment dates) and may be generally dissatisfied with the way in which the scheme is run/administered and/or may have had specific problems associated with management prescriptions.

Group 4: No concerns (15.3%)
Agreement holders in this group were broadly happy with their agreement and had no areas of concern or suggestions for improvement.

	Frequency	%
Lack of flexibility	41	29.9
Lack of contact with NE	39	28.5
Administration problems	36	26.3
No concerns	21	15.3
Total	137	100.0

Table 7.52 Concerns typology

As demonstrated in Table 7.52, just over 15% of respondents reported having no concerns at all with the operation of their HLS agreement. Further breakdown of the data (see Table 7.53) revealed that these agreement holders were not particularly familiar with their IoS so it is possible that for some at least, a lack of concern reflects a lack of knowledge.

	Lack of flexibility	Lack of contact with NE	Administration problems	No concerns
Regularly	24.4	25.0	28.2	4.8
Occasionally	43.9	36.1	56.4	38.1
Not at all	31.7	38.9	15.4	57.1
TOTAL	100.0	100.0	100.0	100.0

Table 7.53 Frequency of reference to IoS, by concern types. The association between frequency of reference to IoS and dominant concern types is significant when $p<0.05$

It was the largest farms/sites that were most likely to have suffered from a perceived lack of contact with NE (35.9%). This is perhaps understandable when we consider how larger agreement sites may require more input from NE. Similarly, over a third (36.3%) of the largest farms/sites that were surveyed suffered from a lack of flexibility associated with the agreement, although it was small farms/sites (50<150ha) that were most commonly concerned with a lack of flexibility.

Smaller holdings (under 50ha) were more likely to have experienced difficulties/issues with the administration and application processes associated with HLS than any other issues. As discussed in *Section 2.3 Overview of previous experience* this is likely to reflect the 'hassle factor' of scheme participation on a small area, i.e. compliance with HLS regulations and administration demands is more problematic or demanding for small farms.

> "Current schemes have too much red tape, too much admin and are too complicated" (Agreement Holder 51, 3ha)

> "I'd like to see them kept somewhat simpler […] They need to make admin simpler and bureaucracy far less" (Agreement Holder 75, 6ha)

42.9% of agreement holders with no concerns were from the smallest farms/sites (<50ha) and only 9.5% of those with no concerns were from the biggest farms/sites (250+ha). This is perhaps linked to the complexity of larger agreements and the scale of the work required and scope to go wrong/experience difficulties (Table 7.54).

	Lack of flexibility	Lack of contact with NE	Administration problems	No concerns
<50ha	14.6	20.5	33.3	42.9
50<150	39.0	15.4	25.0	23.8
150<250	9.8	28.2	13.9	23.8
250+	36.6	35.9	27.8	9.5
TOTAL	100.0	100.0	100.0	100.0

Table 7.54 Farm/site size by concern types. The association between farm/site size and concern types is significant when $p<0.05$.

As Table 7.55 demonstrates, agreement holders on farms were most likely to have been concerned with a lack of flexibility associated with their agreement, whilst nearly half of non-farms (44.8%) were concerned about administration problems. This may be a reflection of the different nature of the two groups; farmers are used to working independently and making decisions based on a combination of experience and site/weather conditions on a given day. Operating under a more overtly rule-governed system of an agri-environmental contract can easily be perceived as lacking flexibility. The greater incidence of administrative problems reported by non-farming agreement holders may simply reflect the reality of working for a larger organisation where several individuals may be involved in the agreement and in communicating with NE.

	Lack of flexibility	Lack of contact with NE	Administration problems	No concerns	TOTAL
Farm	33.3	17.6	24.1	25.0	100.0
Non-farm	17.2	6.9	44.8	31.0	100.0

Table 7.55 Agreement holder type by dominant concern type. The association between agreement holder type (farm or non-farm) and dominant concern type is significant when $p<0.1$

As demonstrated in Table 7.56 it was those with the least number of years' experience in charge of the agreement land that were most likely to have no concerns about their agreement. Those with the most experience were most concerned about a lack of flexibility associated with their agreement; this is unsurprising as it is perhaps the more experienced agreement holders that have been doing things a certain way for a longer time period that might have found strictly imposed rules and regulations harder to comply with or adopt.

	Lack of flexibility	Lack of contact with NE	Administration problems	No concerns	TOTAL
<5	25.0	18.8	18.8	37.5	100.0
5<20	24.0	10.0	36.0	30.0	100.0
20+	35.2	18.3	25.4	21.1	100.0

Table 7.56 Agreement holder's number of years in charge of agreement land, by dominant concern type.

Table 7.57 shows how agreement holders concerned about a lack of flexibility had a range of levels of educational attainment. Over 40% of those concerned with a lack of contact with NE had an undergraduate and/or postgraduate degree. An additional 30.8% had a technical

qualification. It is unsurprising that those with higher level training or education (such as a degree or technical qualification) would see the benefit of regular contact with NE. Agreement holders with no concerns were least likely to have a technical qualification (15.8%) and most likely to hold a degree (31.6%).

	Lack of flexibility	**Lack of contact with NE**	**Administration problems**	**No concerns**
No qualification	23.7	12.8	14.3	26.3
O-Levels/GCSEs & A-Levels	23.7	15.4	11.4	26.3
Technical qualification	28.9	30.8	28.6	15.8
Undergrad & postgrad	23.7	41.0	45.7	31.6
TOTAL	100.0	100.0	100.0	100.0

Table 7.57 Agreement holder's highest level of educational attainment, by dominant concern type.

Table 7.58 reveals how, perhaps surprisingly, 71.4% of agreement holders with no concerns held a qualification unrelated to agriculture.

	Lack of flexibility	**Lack of contact with NE**	**Administration problems**	**No concerns**
Unrelated	63.2	35.9	38.9	71.4
Related	36.8	64.1	61.1	28.6
TOTAL	100.0	100.0	100.0	100.0

Table 7.58 Highest level of educational attainment related to agriculture, by dominant concern type. The association between highest level of educational attainment related to agriculture and dominant concern type is significant when $p<0.05$.

As evident in Table 7.59, there is an interesting, statistically significant, relationship between experience type and dominant concern type. Notably, over 50% of those concerned with a lack of flexibility were low level engagers/burgeoning environmentalists, as were over 66% with no concerns. A total of 36.1% of agreement holders concerned with administration issues were those with extensive experience.

	Lack of flexibility	Lack of contact with NE	Administration problems	No concerns
Extensive experience	22.0	25.6	36.1	4.8
Low level engagers / burgeoning environmentalists	51.2	35.9	19.4	66.7
Formal experience only	17.1	23.1	22.2	19.0
No prior experience	9.8	15.4	22.2	9.5
TOTAL	100.0	100.0	100.0	100.0

Table 7.59 Experience type, by dominant concern type. The association between experience type and dominant concern type is significant when $p<0.05$.

Key concerns

1. Lack of flexibility

A key concern expressed by agreement holders was the flexibility of the agreement and associated options. These suggestions tended to relate to specific problems agreement holders had experienced in implementing their agreement options. Concerns often related to the timings and dates allowed for specific tasks such as hedge-cutting and grazing. Agreement holders often highlighted the importance of local conditions and differences, and the failure of management prescriptions to take these into consideration.

> "It's all about getting the right balance.... one big issue is that the hedge-cutting rules/ dates have been moved – that's right isn't it? Don't think we can cut hedges until September now. Problem is once soil starts to get wet it's a vicious circle. If we don't cut the hedges because there isn't time to cut the hedges obviously the soil doesn't get compacted ...but the hedges get bigger and create more shade and the crops don't grow and therefore your headlands end up being waterlogged. (A crop growing in the ground will remove water from the ground). If we try and go if it's a wet autumn in September on our headlands cutting hedges we're compacting the ground and it has a job to recover from it. The loss of hedge-cutting in August is a big deal." (Agreement Holder 6)

> "There isn't currently any flexibility to do something that isn't in the handbook e.g. cattle-handling facilities. Need to be able to handle cattle - all part of grazing." (Agreement Holder 23)

In turn, the suggestions for improvements from this group tended to emphasise the need for greater flexibility and to listen to the voice of the farmer.

> "Listen to the farmers more. What's right for this farm is not right for a farm one mile down the road. It needs to be more specific to every single farm." (Agreement Holder 17)

> "Less rigid framework with regional variation in options & management prescriptions; use farmers knowledge to engineer options for individual farms/areas; more of a farm level approach to the scheme to get more positive environmental impact." (Agreement Holder 16)

> "By all means issue some guidelines if you assume that some people don't know what they're doing, but there needs to be flexibility. And there needs to be more of an element of cooperative goodwill between all the powers that be - not just Natural England and agreement holders but between other bodies as well including Defra and the government - so that it actually has a reasonable fighting chance of achieving what you want it to achieve." (Agreement Holder 3)

2. Lack of contact with NE

Those that claimed to need more support generally felt this could be addressed by more contact with NE.

> "Rarely get feedback. Only time I seem to speak to NE is to argue about the RPA." (Agreement Holder 7)

> "Always the case that sometimes they're not easy to get hold of …" (Agreement Holder 38)

Not surprisingly, these agreement holders wanted contact with NE to reassure them they were on the right track.

> "Don't leave the farmers alone. The AES is a contract to do XYZ, but I am not skilled to measure the outcome - how am I able to say if it's working or going in one particular direction - are the right birds here?" (Agreement Holder 115)
> "More ongoing connection with Natural England officer to make sure you are on the right lines of meeting objectives." (Agreement Holder 46)

One agreement holder suggested HLS would benefit by going back to the 'early days' of the scheme, characterised by a more personal relationship with their NE advisor and more timely visits.

> "Recreate 'early days' of scheme; good relationship with NE advisor, more personal relationship needed/consistency, NE visits need to come out at the right times, i.e. spring to see good work." (Agreement Holder 59)

As well as a perceived lack of supportive input from NE, agreement holders highlighted a lack of consistency in terms of NE advisors allocated to them. The frequent reallocation of new advisors to existing agreements was a clear source of contention for agreement holders and prompted a key suggestion for improvement.

> "There seems to be a trend, I know it's not the local [NE] team's fault - it's a restriction on time and resources but it is vital, that discussion with local advisors. What is tending to happen … we never know to one week to the next what NE advisor we are going to have. What happens, whenever an NE advisor changes, it

precipitates a site meeting where they come out and want to familiarise themselves with the site and then in a few months' time, the same thing happens - you can't call that an efficient use of resources, can you? More visits and not so overstretched." (Agreement Holder 40)

"Consistency with advisors - huge issue that needs to be resolved. Positive feedback needed when things have gone right - too many people visiting and you never hear." (Agreement Holder 90)

3. Administration problems

A number of agreement holders criticised the administrative burden associated with HLS.

"The amount of paperwork and changes are frustrating." (Agreement Holder 73)

"I've just put an application in for a filter where we wash the sprayer, and the questions that were asked, the level of detail, was beyond me and even my advisor - it's unnecessary" (Agreement Holder 102)

A reduction in the amount and complexity of associated paperwork, particularly with regards to the initial application process, was also a common suggestion for improvement.

"Form filling initially wants to be much simpler." (Agreement Holder 86)

There were also some noteworthy concerns amongst agreement holders regarding the accuracy and consistency of payments, and difficulties of dealing with the RPA.

"Claiming - annual capital claim system is quite complicated and not very transparent. Changes to claim dates confusing. Traceability of claims is practically non-existent." (Agreement Holder 60)
"Dealing with the RPA can be a problem." (Agreement Holder 51)

"It all got messy last year with the adjustments of payments - have to trust someone has worked it out properly." (Agreement Holder 23)

"Payment date delays are a problem." (Agreement Holder 73)

Suggestions for improvement emerging from the analysis:

- More regular and timely 'positive interactions' with NE
- NE advisors allocated on a long-term basis where possible
- Open up channels of communication, i.e. contact advisors directly or talk to someone on the phone rather than email or letter
- Reduce complexity of application and subsequent processes
- Make payments more transparent
- Ensure a consistent payment schedule

7.7.3 Future plans

Likelihood of ...	entering similar scheme in the future		continuing environmental work in the **absence** of such scheme	
	Frq.	%	Frq.	%
Definitely	65	47.8	45	33.3
Quite likely	40	29.4	44	32.6
Unsure	19	14.0	27	20.0
Unlikely	9	6.6	15	11.1
Definitely not	3	2.2	4	3.0
Total	136	100	135	100.0

Table 7.60 Future plans

Looking to the future (Table 7.60) nearly half (47.8%) of participants stated that they would 'definitely' enter a similar scheme after the end of their current HLS agreement. On the other hand, only one third of participants reported that they would 'definitely' carry on such work **in the absence of a formal scheme**. This differential indicates that a lack of funding for formal AES in the future would be associated with lower levels of environmental management. In line with this, the percentage of agreement holders who claimed they 'definitely would not' or were 'unlikely' to undergo environmental work in the absence of a formal scheme totalled 14.1%, compared to only 8.8% of agreement holders who claimed they 'definitely would not' or were 'unlikely' to undergo a similar scheme in the future.

Understanding positive responses towards future schemes

The importance of the financial reward associated with the scheme emerged again, with 41 of the 105 agreement holders saying that they would **definitely** or **quite likely** join a similar scheme referencing financial reasons (potentially alongside other reasons).

> "It's been successful and happy with the finance" (Agreement Holder 1)
> "Reliance on funding … [it's] massively important for us" (Agreement Holder 27)

> "A relatively small site with no other funding - need schemes so that the area can continue to be maintained, improved and managed (Agreement Holder 51)
> "Provides financial support for nature conservation in a farming system." (Agreement Holder 60)

> "We do need all the help we can get, financially." (Agreement Holder 62)

> "For the financial support provided which gives councils an incentive/ability to carry out environmental work." (Agreement Holder 150)

Financial motivations were often also cited alongside other motivations such as a desire for continuity (18).

> "Financial reasons but also to provide continuity; it would be pointless to stop the good work previously carried out." (Agreement Holder 153)

> "I've got this far with it and would like to carry it on. Of course, there's a bit of financial help as well." (Agreement Holder 15)

> "It would be a shame for all the work done to be (possibly) disbanded, we want to continue to improve the quality of water, plant life and wildlife." (Agreement Holder 46)

> "So we can continue the projects which have been started. Would be a shame if we had to stop if didn't get stewardship help - all this work would go to waste." (Agreement Holder 85)

> "We want to continue in what we have done already from the ESA scheme and the HLS scheme." (Agreement Holder 142)

> "A continuation of the time and effort the farm has done for 20 plus years is important so we would definitely enter into a similar scheme." (Agreement Holder 148)

Another influential factor amongst those **definitely** or **quite likely** to enter a similar scheme in the future was having had a generally good overall experience of HLS. A total of 24 out of the 105 **definite** and **quite likely** agreement holders referenced a generally positive experience on the scheme.

> "Been quite happy with the one I've been in." (Agreement Holder 61)

> "It's been successful and I'd want to carry on." (Agreement Holder 102)

> "Works perfectly for the farm." (Agreement Holder 118)

> "I've got on very well with HLS and CS … It's never caused me any problems and I hope I've done a bit of benefit to the countryside." (Agreement Holder 17)

There was a strong sense amongst those that were **definitely** and **quite likely** to continue a similar scheme that environmental work was inherent to what they do and the way they work (15; 13 farms, 2 non-farms), therefore they would naturally want to continue.

> "I'd do it anyway probably because that's what we do." (Agreement Holder 7)

> "It's now come part of the way we run the farm; it's second nature to us." (Agreement Holder 8)

> "Benefit to the environment." (Agreement Holder 16)

> "We are heavily involved in it here [at name of a National Park], so yes" (Agreement Holder 154)

Enthusiasm for future schemes was also often rooted in the observed environmental and wildlife benefits as a result of HLS.

"It has improved the environment and […] now I'm 'retired' I've got more time to do some things like this." (Agreement Holder 86)

"Because it generates excellent environmental, financial and wildlife benefits (even without the financial benefits)." (Agreement Holder 119)

"HLS has worked well and [we've] seen the benefits on the site." (Agreement Holder 36)

"To maintain the progression of the improvement of the environment of the farm. As we get older I think we all take more notice of wildlife and species. You see birds and you look to identify them and take notice of what's there." (Agreement Holder 145)

"[I] would like to continue what we've done. Vital for environment and from a public perspective - they actually see what we're doing and I think they are very much in favour of the environmental work we're doing from the feedback we get from the general public." (Agreement Holder 162)

Notably, as Table 7.61 shows, there is an interesting statistically significant association between the perceived success of HLS in achieving its environmental objectives and the likelihood of undergoing a similar scheme in the future, i.e. agreement holders that recognised the environmental success or benefit of their agreement were more likely to want to carry on a similar scheme in the future than those who deemed HLS as neither successful nor unsuccessful, unsuccessful or very unsuccessful (79.8% vs. 58.8%). These are some of the most committed agreement holders, who perceive the benefit of their agreement and are more likely to participate in future schemes. In turn, this suggests that helping agreement holders to recognise the environmental benefits of their work has the potential to increase interest in future/successive schemes. Farmers, in particular, will be very good at recognising agricultural success but may be less well placed to recognise environmental success.

	Very successful & successful	**Neither/nor & unsuccessful & very unsuccessful**
Unsure & unlikely & definitely not	20.2	41.2
Definitely & quite likely	79.8	58.8
Total	100.0	100.0

Table 7.61 Likelihood of participating in a similar scheme in the future, by perceived overall success of HLS in meeting its environmental objectives. The association between agreement holders' perceived overall success of HLS in meeting its environmental objectives and likelihood of undergoing similar schemes in the future is significant when $p<0.10$

Understanding negative responses towards future schemes

Reasons for more negative responses (unsure, unlikely and definitely not) were more varied than the positive responses. Issues of flexibility and complexity of rules and regulations of HLS put off a number of agreement holders.

> "It's too distracting – there's always a feeling in the back of your head that you're meant to have done something. Too prescriptive and I think I can have far more impact in terms of making the world a better place by concentrating on the rest of my land." (Agreement Holder 66, unlikely to participate in future scheme)

> "It is nice to get money for something you would do anyway, but you lose flexibility e.g. needing to wait to cut the hay meadow - you could fill in a derogation but why can you not use your own judgement especially when employing a contractor. Creating more long grasses in the future - I would be unsure as there is no monitoring of how successful the scheme is. There is no reward for removing bracken which is not benefitting the productivity of the farm. It's not free money." (Agreement Holder 115, unsure about future scheme)

> "Depends upon how restrictive the scheme is in the future to the way we want to farm." (Agreement Holder 141, unsure about future scheme)

> "Need to ask permission to sneeze on your own land." (Agreement Holder 90, definitely not wanting to participate in future scheme)

> "It would have to be more flexible for me." (Agreement Holder 59, unsure about future scheme)

> "Depends on the structure of the scheme (10 years is too long on some options, 5 years would be better). Flexibility on timing of options would be helpful. We're not sure what the future holds in relation to stewardship schemes." (Agreement Holder 73, unsure about future scheme)

> "I think we would, as long as they don't make us cut it (cattle numbers) anymore - because you can't graze as much as you like. It boils down to the money really." (Agreement Holder 108, unsure about future scheme)

A small but nonetheless notable number of agreement holders felt they were unlikely to participate in a similar scheme in the future because of their personal circumstances – namely their age.

> "Hopefully. Age catching up with me. Always keen on all these schemes. Farming in a traditional way. If health keeps going. So long as I can keep farming I'll farm this way." (Agreement Holder 30, unsure about future scheme)

> "I am unlikely due to age, but my son may well do what he thinks is best for the farm." (Agreement Holder 134, unsure about future scheme)

> "[I'm] 60. May not stay here. Would be nice for someone to take over who has more knowledge who could enhance it for the future. Quite stressful trying to abide by all the rules. Would like to do other things. If was younger would definitely do it." (Agreement Holder 144, unsure about future scheme)

As evident in Table 7.62 (below), there is a notable statistically significant association between future plans and number of years managing the agreement land; nearly two thirds (74.2%) of negative responses (unsure, unlikely and definitely not) were from agreement

holders with over 20 years' experience. Also note that all agreement holders under the age of 35 were quite likely and definitely planning to continue a similar scheme in the future.

	Unsure, unlikely & definitely not	Definitely & quite likely
FARM/SITE SIZE		
<50	25.8	25.7
50<150	22.6	26.7
150<250	19.4	18.1
250+	32.3	29.5
AGREEMENT HOLDER TYPE		
Farm	87.1	76.2
Non-farm	12.9	23.8
AGE		
<35	0.0	10.8
35<45	13.3	13.7
45<55	23.3	32.4
55<65	46.7	24.5
65+	16.7	18.6
NO. YEARS IN CHARGE[1]		
<5	0.0	15.2
5<20	25.8	40.0
20+	74.2	44.8
HIGHEST QUALIFICATION		
No qualifications	30.0	14.0
O-Levels/GCSEs & A-Levels	13.3	20.0
Technical qualification	33.3	26.0
Undergraduate & postgraduate	23.3	40.0
EXPERIENCE		
Extensive experience	22.6	24.8
Low level engagers/burgeoning environmentalists	32.3	43.8
Formal experience only	29.0	17.1
No experience	25.0	14.3

Table 7.62 Likelihood of entering similar scheme in the future, by agreement holders' characteristics (multiple)
[1]The association between agreement holders' number of years in charge of the agreement and likelihood of entering a similar scheme in the future is significant when $p<0.05$

Understanding positive responses towards environmental work in the absence of schemes

> "I don't want to harm the environment, as our farm *is* the environment!"
> (Agreement Holder 134, unsure)

As demonstrated in Table 7.63, low level engagers/burgeoning environmentalists emerge as most likely to continue environmental work in the absence of a formal scheme. As outlined in the description of the agreement holder typologies (see Section 2) agreement holders in this group were fairly new to formal environmental work, but were on a trajectory towards

more agri-environmental management. It is therefore unsurprising that they emerged as most likely to continue such work in the absence of a future scheme.

	Unsure & unlikely & definitely not	Definitely & quite likely
Extensive experience	30.4	20.2
Low level engagers / burgeoning environmentalists	21.7	51.7
Formal experience only	28.3	15.7
No prior experience	19.6	12.4
TOTAL	100.0	100.0

Table 7.63 Experience type, by likelihood of continuing environmental work in the absence of a formal scheme. The association between agreement holders' experience and likelihood of continuing environmental work in the absence of a scheme is significant when $p<0.05$

Committed, low level engagers/burgeoning environmentalists agreement holders tended to reference the efforts they made so far and a desire to keep going so their efforts were not in vain. Relatively new to formal environmental work (in comparison to their counterparts), it is possible that the changes in practice and associated benefits are fresh in the minds of these agreement holders, thus motivating them to continue.

> "I'd like to keep it ongoing really. Got this far with it. Would like to see it carry on." (Agreement Holder 15, definitely & low level engager/burgeoning environmentalist)

> "To protect what is here – [we] were handed the farm and features and want to maintain these and hand them on to the next generation." (Agreement Holder 16, definitely & low level engager/burgeoning environmentalist)

> "Not having a scheme will not stop us from doing environmental management but it will be harder and take longer." (Agreement Holder 20, definitely & low level engager/burgeoning environmentalist)

> "Would just carry on the same, if we made any changes it would just undo all of the benefits." (Agreement Holder 72, definitely & low level engager/burgeoning environmentalist)

As evident in Table 7.64, there was a notable statistically significant relationship between agreement holder type (farm or non-farm) and likelihood of continuing environmental work in the absence of a formal scheme. Over 82% of non-farm agreement holders were definitely and quite likely continue such work, compared to only 61.3% of farm agreement holders.

	Farm	Non-farm
Unsure & unlikely & definitely not	38.7	17.2
Definitely & quite likely	61.3	82.8
TOTAL	100.0	100.0

Table 7.64 Agreement holder type, by likelihood of continuing environmental work in the absence of a formal scheme. The association between agreement holder type (farm or non-farm) and likelihood of continuing environmental work in the absence of a scheme is significant when $p<0.05$.

It is perhaps unsurprising that organisations such as National Parks and nature reserves claimed they would remain committed to environmental work and practices, in the absence of schemes. Such agreement holders explained how environmental work was simply inherent to their nature.

> "At the core of what we do." (Agreement Holder 27, Nature Reserve)

> "This is what the trust does, we will always carry out environmental work." (Agreement Holder 26, Nature Reserve)

> "We can't do anything on the land other than provide environmental advantages." (Agreement Holder 67, Nature Reserve)

> "We will continue to do it, regardless of a scheme because we are a Wildlife Trust." (Agreement Holder 82, Nature Reserve)

Understanding negative responses towards environmental work in the absence of schemes

Ultimately, responses to this question highlight the potentially significant reduction in environmental work should AES no longer exist. This equates to a potential loss of environmental practices on 13,541ha or 28.64% of the survey area (Table 7.65).

	Area (ha)	**%**
Definitely & quite likely	33,019	69.84
Unsure & unlikely & definitely not	13,541	28.64
Unanswered Q65[1]	721	1.52
Total	47,281	100.0

Table 7.65 Area of land by plans to continue environmental work in the absence of such schemes. [1]2 survey respondents failed to answer 'How likely are you to continue environmental work in the absence of such schemes?'

Overwhelmingly, negative responses were rooted in the implications resulting from loss of financial support to conduct environmental work.

> "[We] won't be able to afford to do so." (Agreement Holder 40, definitely not)

> "Without funding or payment there is no incentive to give the time to doing it, unless it is financially beneficial." (Agreement 124, unlikely)

> "If there is no financial incentive we can't do environmental management." (Agreement Holder 135, unlikely)

> "Not sure if the Trust could afford to continue environmental work." (Agreement Holder 75, unsure)

> "It's all to do with the finance. So if they're going to take the money off and not do the schemes I probably wouldn't do it. At the end of the day it's the finance that's the carrot to encourage you to go for it." (Agreement Holder 121, unsure)

> "It's all down to economics." (Agreement Holder 151, unsure)

Agreement holders often perceived that land in HLS was actually or effectively taken out of production (particularly for arable options) or at least diverted from more agriculturally productive uses and without the funding to compensate for that, they would be forced to utilise the land in a productive capacity, regardless of the environmental implications (within regulatory limits), to allow them to remain financially viable. Financial viability emerged as the bottom line for many agreement holders.

> "We're not against the environment, but we cannot afford to leave areas bare. The economics in the absence of such a scheme means we cannot afford to do it at our own expense." (Agreement Holder 81, definitely not)

> "If we weren't getting paid we'd want to put corn there. Wouldn't do fallow plot or hedge cutting every other year. We'd do some things maybe, but we would drill everything we could because we would need the crops and money - can't afford to leave uncropped without being subsidised" (Agreement Holder 105, unlikely)

> "Because I couldn't live out of the extensive cattle and sheep farming I'd be left with. Income would be just about zero." (Agreement Holder 60, unlikely)

> "[I] would have to farm more intensively to gain the same financial return as is offered by scheme membership." (Agreement Holder 164, unlikely)

> "Because of the financial impact of losing income from the schemes we would need to increase stocking to compensate for this fall in income." (Agreement Holder 153, unsure)

> "Because at the end of the day 7% of our land is taken out of production and is under environmental schemes which is a big area of our business. And depending on the economic climate - if it's not financially viable then it would have to come back into arable production. That's the main criteria - would be financial which is sad. But we would have to give it some serious thought. There are obviously some aspects of the farm which are very difficult to farm which we would continue what we're doing but we have got some prime arable land which is under the ELS/HLS scheme which would probably have to come back into production. A lot of those would be the six metre margins which we've got in those fields which are well-established and I think it would be a shame if we ploughed them up. So I just hope the environmental schemes will continue." (Agreement Holder 162, unsure)

Other agreement holders suggested that although they would try to ensure past environmental efforts were not undone and may try to 'do the basics' or keep up environmental efforts as best as possible, they ultimately would not be able to do further environmental work at the same kind of level in the absence of such schemes.

> "If there is no financial incentive to do it we would be not likely to do much environmental work however we would not want to destroy the environment and the place where we work." (Agreement Holder 142, unlikely)

> "Couldn't do as much without the financial support gained from an AES. I view the scheme as another crop/income so couldn't do the same level of environmental work without a financial return, however I would still do some things." (Agreement Holder 14, unlikely)

> "Unlikely because of the cost - we would try our best but it would be very difficult." (Agreement Holder 85, unlikely)

One agreement holder operating a Nature Reserve agreement felt they would be forced to cease agri-environmental work in the absence of financial support.

> "We would do our best to continue the work, but realistically … the problem would be, if the financial support was withdrawn it wouldn't be my decision in a sense. Higher management in the local authority would look at the sites that we own and think 'oh these are a financial drain on the authority' ... they are a drain now, but they are a relatively small drain because of the support that you get from HLS ... so if that was withdrawn, a lot of local authorities would ... and [name of local authority] is a relatively well-off local authority ... certainly some local authorities elsewhere would look at their assets and think we just can't afford to keep it. So it's fairly unknown, but in the landscape these days of local authority funding ... we'd struggle to justify keeping the place like this" (Agreement Holder 38, unsure)

> "We would still do the basics, but we would struggle financially. We may have to cut back on some of the quality of what we do, e.g. reed bed management - we cut reeds every other year - we cut one half one year and the other half the next, and that includes taking all the rhizomes away so you're not building up a thatch - and that's quite expensive because you have to pay for someone to take it all away and I don't know how we'd pay for that, so we might not be able to do that." (Agreement Holder 112, unsure)

> "[I] will definitely look after habitats etc. that we've got, but won't create any more." (Agreement Holder 123, unsure)

> "Need financial support to be able to carry on managing environmental features of the farm, although some of them will maintain themselves." (Agreement Holder 71, unsure)

Tenant agreement holders claimed that a lack of financial support in the absence of formal schemes would be particularly difficult for them.

> "Not financially viable for a tenant farmer; the costs are too high to carry our environmental management." (Agreement Holder 141, unlikely)

> "[The] farm is mainly rented so need to get agricultural production from it, cannot act as a charity, but will not go and rip out hedges, fences and woods etc." (Agreement Holder 146, unlikely)

One agreement holder described exactly how his behaviour would change in the absence of a formal scheme. His description encompasses the behavioural changes that might be witnessed at an aggregate scale; a reversion to practices that threaten the environment.

> "If it wasn't for the scheme you wouldn't do it. I think if you didn't have the scheme you would do what you thought was necessary to maintain your farm business which would not necessarily mean you would do things which people thought were environmentally best. Would want to keep farm as it is. Wouldn't do dormice bit. Why would you bother to restore woodland because you know perfectly well it's too small a piece which you can't extract timber from? So you wouldn't do it. Would keep [the] hedges up. Would harrow land if you wanted to at a particular time of year you went and did it. If wanted to put more fertiliser on a piece of ground you'd put some more fertiliser on. If you didn't want to top the bracken you wouldn't top the bracken. It's that sort of thing." (Agreement Holder 12, unlikely).

Entering similar scheme in the future: summary of agreement holders (Table 7.62)

- Nearly a third of negative responses were from farms/sites over 250ha and just over a quarter were from smallest farms/sites (<50ha)
- Notably though, farms/sites over 250ha were more likely than any other farm/site size category to have responded positively (29.5% said 'definitely' and 'quite likely')
- Nearly 90% of the agreement holders that responded negatively were farms
- Just over two-thirds of the agreement holders that responded positively were farms
- Nearly half of agreement holders (46.7%) that responded negatively were aged 55<65
- Just over 10% of agreement holders who responded positively were <35, compared to 0% negative responses in that category
- There is a notable statistically significant association between future plans and number of years managing the agreement land. Specifically, nearly two thirds (74.2%) of positive responses were from agreement holders with over 20 years' experience
- 30.0% of negative responses were agreement holders with no qualifications. Inversely, positive respondents were most likely to have either an undergraduate or postgraduate degree (40.0%)
- 43.8% of positive responses were from low level engagers/burgeoning environmentalists
- Negative respondents were generally well distributed through the different experience categories

Continuing environmental work in the absence of such scheme: summary of agreement holders (Table 7.66 below)

- Nearly 40% of negative responses were from very large farms/sites (250ha+)
- Just under 90% of negative responses were from farm-type agreement holders
- Over half (54.4%) of negative respondents were over 55
- Nearly a quarter (24.7%) were under 45
- 65.2% of negative responses were agreement holders who had been in charge of the agreement land for more than 20 years
- 42.9% of positive responses were from agreement holders with either an undergraduate or postgraduate degree
- Over 50% of positive responses were from low level engagers/burgeoning environmentalists
- 30.4% of negative responses were from those with extensive experience, suggesting they had perhaps exhausted their interest?

	Unsure, unlikely & definitely not	Definitely & quite likely
FARM/SITE SIZE		
<50	19.6	29.2
50<150	19.6	29.2
150<250	26.1	14.6
250+	40.0	27.0
AGREEMENT HOLDER TYPE[1]		
Farm	89.1	73.0
Non-farm	10.9	27.0
AGE		
<35	2.2	11.8
35<45	15.2	12.9
45<55	28.3	31.8
55<65	37.0	24.7
65+	17.4	18.8
NO. YEARS IN CHARGE[2]		
<5	2.2	16.9
5<20	32.6	39.3
20+	65.2	43.8
HIGHEST QUALIFICATION[3]		
No qualifications	28.9	11.9
O-Levels/GCSEs & A-Levels	17.8	19.0
Technical qualification	28.9	26.2
Undergraduate & postgraduate	24.4	42.9
EXPERIENCE[4]		
Extensive experience	30.4	20.2
Low level engagers/burgeoning environmentalists	21.7	51.7
Formal experience only	28.3	15.7
No experience	19.6	12.4

Table 7.66 Likelihood of continuing environmental work in the absence of such scheme by agreement holders' characteristics (multiple)

[1]The association between agreement holder type (farm or non-farm) and likelihood of continuing environmental work in the absence of a scheme is significant when $p<0.05$
[2]The association between agreement holders' number of years in charge of the agreement and likelihood of continuing environmental work in the absence of a scheme is significant when $p<0.05$
[3]The association between agreement holders' highest educational attainment and likelihood of continuing environmental work in the absence of a scheme is significant when $p<0.05$
[4]The association between agreement holders' experience and likelihood of continuing environmental work in the absence of a scheme is significant when $p<0.05$

7.7.4 Commitment levels

Agreement holders have been categorised according to their levels of commitment to environmental schemes (see also Table 7.67).

Group 1: High commitment (19.5%)
Agreement holders in this group are the most consistently committed. They expressed a clear desire to undergo HLS and a clear desire to carry on such work in the future both with and without formal/similar schemes in place.
Conditions: Positive responses across all questions: Q24 Attitude before HLS, Q63 Likelihood of continuing a similar scheme & Q65 Likelihood of continuing work in absence of a scheme TOTAL 3 POINTS

Group 2: Intermediate commitment (35.9%)
Agreement holders in this group are not as consistently committed as those in the previous group.
Conditions: Two positive responses across questions: Q24 Attitude before HLS, Q63 Likelihood of continuing a similar scheme & Q65 Likelihood of continuing work in absence of a scheme TOTAL 2 POINTS

Group 3: Low commitment (44.5%)
Agreement holders in this group are the least committed.
Conditions: No or only one positive responses across questions: Q24 Attitude before HLS, Q63 Likelihood of continuing a similar scheme & Q65 Likelihood of continuing work in absence of a scheme TOTAL 1 or 0 POINTS

	Frequency	**%**
Low commitment	25	19.5
Intermediate commitment	46	35.9
Highest commitment	57	44.5
Total	128	100.0

Table 7.67 Agreement holder level of commitment to AES.

Based on their attitude to HLS and likelihood of continuing similar schemes and continuing environmental work/practices in the absence of such schemes, just over 44.5% of agreement holders were highly committed to AES. Only 19.5% had low levels of commitment.

As evident in Table 7.678 notably, half of the highly committed agreement holders had either an undergraduate and/or postgraduate degree, compared with only 5.6% with no qualifications. Conversely, 36% of those with the lowest commitment levels had no formal qualifications. Nearly 40% of agreement holders with intermediate commitment had a technical qualification. The association between commitment level and educational attainment is statistically significant.

	Low commitment	**Intermediate commitment**	**High commitment**
No qualifications	36.0	25.6	5.6
O-Levels/GCSEs & A-Levels	20.0	11.6	22.2
Technical qualification	24.0	37.2	22.2
Undergraduate & postgraduate degrees	20.0	25.6	50.0
	100.0	100.0	100.0

Table 7.68 Commitment level by highest educational attainment. The association between Agreement Holders' commitment level and educational attainment is significant when $p<0.05$

There is also an interesting statistically significant association between commitment level and agreement holder type (farm or non-farm; Table 7.69). Non-farms were the most committed, whereas farms were more evenly spread throughout the different commitment categories.

	Low commitment	**Intermediate commitment**	**High commitment**	**TOTAL**
Farm	22.8	41.6	35.6	100.0
Non-farm	7.4	14.8	77.8	100.0

Table 7.69 Commitment level by agreement holder type. The association between agreement holders' commitment level and agreement holder type (farm or non-farm) is significant when $p<0.05$

7.8 Summary

Although the survey of agreement holders included both farmers and non-farmers, it should be noted that 79% of respondents were farmers and that of these 64% were livestock farmers. Regardless of type, most agreement holders had a long history of agri-environmental management both formally, as part of a scheme, and informally. Excluding ELS, which is a prerequisite for HLS participation, most had been participants in previous schemes (typically the original CSS or an ESA). Based on their agri-environmental management history it was possible to place each agreement holder in to one of four categories (Extensive experience; Low level engagers/'burgeoning environmentalists'; Formal experience only; No previous experience). A majority (40.9%) of survey participants can be considered to be Low level engagers/'burgeoning environmentalists', suggesting that the transition to HLS reflects a 'step up' in their agri-

environmental management career, which may bring with it new and unfamiliar management challenges.

Agreement holders chose to apply to HLS for a variety of reasons. The largest group (30.6%) were largely or solely motivated by financial concerns but many were motivated by varying degrees of environmental concern. Motivation varied according to agreement holder characteristics. The oldest agreement holders (those over 65) were the least likely to be motivated by financial concerns. The same applies to those managing the smallest areas of land. The most popular reasons for choosing particular HLS options were because the feature(s) was already in place and to increase wildlife, indicating that a combination of 'ease of fit' (ie features or management already in place) and a desire to protect and enhance the environment were predominant motivations.

Many agreement holders reported being approached by NE to apply to HLS and 64% reported a sense that they had complete or considerable control over agreement design. These agreement holders tended to talk about the role of the NE Advisor in terms of being flexible and discussed relationships that they perceived to be equal and reciprocal. On the other hand, those reporting a feeling of little control over scheme design talked in terms of the scheme being virtually imposed on them and in a few cases language such as "bullied", "forced" and "pressured" was used to describe interactions with NE staff.

When it comes to implementing their agreement, only 22.6% of agreement holders reported regularly looking at their IoS and a third claimed to not look at them at all. This has implications for the ability of agreement holders to assess their management and the performance of their agreement. On the other hand, those agreement holders for whom IoS seemed to be influential talked in terms of IoS as a means of keeping their agreement 'on track' and targeting or identifying management priorities.

The frequency with which agreement holders make reference to their IoS varies according to a number of factors. Farmers were the least likely to look at their IoS on a regular basis, or at all. The same applies for the oldest agreement holders. This raises issues regarding the appropriateness of IoS for agreement holders, something which we return to in the final chapter.

We also discussed with agreement holders how confident they were in achieving their IoS and how easy or difficult they thought it would be. Their responses were explored by option type (ie maintenance, creation or restoration) and by broad habitat feature. Not surprisingly, maintenance options were associated with high levels of confidence in achieving IoS. Interestingly though, agreement holders were more confident in their ability to achieve IoS for creation options than restoration options. This is due to a combination of the perception that woodland planting, for instance is straightforward whereas restoring sites that had become severely degraded over a

period of years and which sometimes presented access challenges was harder to achieve. Analysis of ease of achieving IoS confirmed this pattern: IoS for maintenance were regarded as very easy or easy to achieve, while restoration IoS were perceived as harder to archive than those for creation options. These findings were generally confirmed when looking at broad habitat feature. Respondents with maintenance options were confident in their ability to achieve their IoS but less so for restoration options and wetland restoration in particular.

Agreement holders generally perceived their HLS agreement to be having a desirable impact with 72% reporting 'some' or 'a lot' of impact on wildlife and 67% stating that overall, they thought their agreement had been 'successful' or 'very successful' in meeting its objectives. Agreements perceived to be successful were more likely to be those where the agreement holder they had complete or considerable control over the design of the agreement at the same time as working with someone else over agreement design.

Looking to the future nearly half (47.8%) of participants stated that they would 'definitely' enter a similar scheme after the end of their current HLS agreement, although only one third reported that they would 'definitely' carry on such work in the absence of a formal scheme. This differential indicates that a lack of funding for formal AES in the future would be associated with lower levels of environmental management. It seems reasonable to assume that a lack of funding would also be associated with less attention to detail in terms of agri-environmental management.

Agreement holders who recognised the environmental success or benefit of their agreement were more likely to want to carry on a similar scheme in the future than those who deemed HLS as neither successful nor unsuccessful, unsuccessful or very unsuccessful (79.8% vs. 58.8%). These are some of the most committed agreement holders, who perceive the benefit of their agreement and are more likely to participate in future schemes. In turn, this suggests that helping agreement holders to recognise the environmental benefits of their work has the potential to increase interest in future schemes.

Finally, agreement holders raised a range of concerns about the operation of HLS and in doing so frequently made suggestions for improvement. Concerns frequently related to a perceived lack of spatial and temporal flexibility and a desire for more local and agreement level flexibility around management decision making. Others expressed concerns regarding communications with NE, including the impact of a high turnover of advisors which means relationships have to be established again, trust developed, etc. A number of agreement holders were also critical of the administrative burden associated with HLS. Typically, this referred to the amount of form-filling required and difficulties with the RPA.

Suggestions for improvements included more regular and timely interactions with NE with advisors in post for longer periods; improved ability to talk to advisors directly via the phone rather than through websites, emails and letters, and a reduction in the complexity of the application process and also subsequent processes.

8. Assessing relationships between ecological outcomes and agreement holder variables across all HLS agreements surveyed

8.1 Analyses across all HLS agreements surveyed

Change in condition between the baseline and resurvey, indicators of success (IoS) at resurvey and four vegetation response variables calculated from the quadrat data were used in analyses across multiple options and agreements, to identify which covariates affected the outcomes of the HLS AES (Table 8.1). The aim of these analyses was to test whether agreement holder characteristics were linked to changes condition and plant community variables, and to IoS outcomes, across all options and agreements surveyed.

8.1.1 Key questions addressed by agreement scale analyses

Does starting habitat and condition affect whether condition improved between the two surveys?

Did key plant response variables change between the two surveys, across all agreements and options surveyed?

Do agreement holder characteristics affect changes in condition and plant variables between survey, or the proportion of IoS met at resurvey, across all agreements and options?

Did the baseline panel appraisal ratings of use of options across each agreement relate to condition, IoS or plant response variables?

8.1.2 Response variables

Condition was defined at the scale of habitat feature within each parcel. As for the option scale analyses (Section 5.1), change in condition was analysed using the baseline and resurvey condition data to classify 'success' for those parcels which had been classed as A or B in the baseline survey and remained at the same condition or improved, and those classed at C which improved. Indicators of success at or towards the end of agreements, which were assessed during the current resurvey, were analysed across all agreements at the scale of parcel using the number met analysed as a proportion of the total number of IoS assessed.

Species richness and cover-weighted Ellenberg fertility, reaction and moisture attributes (Hill et al., 2004) were calculated for each quadrat recorded during the baseline and resurvey, with the baseline dataset restricted to data for those options that were a priority for resurvey. Broad habitat, which had been recorded as part of the mapping surveys, was included in these analyses due to the differences in habitat type between agreements, which were likely to strongly affect these vegetation responses. Unlike the analyses of vegetation response variables in the option analyses (Section 5.3), for these global analyses across all agreements the responses were not calculated as change. This was because broad habitat was attributed at the level of quadrat, but quadrat locations were not matched between the baseline and resurvey.

8.1.3 Agreement holder characteristics

The typologies relating to experience, motivation, concern and commitment developed from agreement holder interview responses (Section 7) were included in all agreement scale analyses. In addition, data directly from the interview were included as covariates, including agreement holder type, education, the perceived success of HLS in meeting objectives, frequency of referring to IoS and confidence in achieving IoS. Further details of all the covariates used in the agreement scale analyses are given in Table 8.1 below.

8.1.4 Statistical analyses

Binomial generalised linear mixed models (GLMMs) were used to analyse indicators of success and change in condition, with agreement included as a random effect to account for the clustering of data within agreements. Multiple covariates were of interest (17 for condition assessment, 16 for indicators of success, Table 8.1), and there were too many covariates to run them all together through the multi-model selection software. To reduce the number of covariates, a series of GLMMs were run for each response variable, with each model containing just one covariate. The results of these single covariate GLMMs were used to narrow down the number of covariates for each response variable to ten. Habitat feature group was simplified to contain fewer groups for the multi-model selection, by combining groups that were not shown to differ significantly from each other in these single covariate GLMMs (Appendix E, Table E1 for details of FEP feature groupings). Details of the initial covariates assessed, and the reduced covariate set that was used in the multi-model selection process, are given in Table 8.1.

Multi-model selection was used to assess models with different combinations of the possible covariates on the basis of whole model fit to the data, using the MuMIn package in R (Barton, 2016). The final model, and those subsequent models which provide a fit to the data which was fairly close to that of the best model (where delta BIC < 5) are summarised in Appendix E (Section E1 for condition, E2 for indicators of success) and discussed below.

Poisson GLMMs were used to analyse species richness, and linear mixed models (LMMs) to analyse Ellenberg fertility, reaction and moisture. In addition to assessing covariates using single covariate regression models and multi-model selection as described above, an analysis of the interaction between broad habitat and survey (baseline vs. resurvey) was conducted for each response variable. Summaries of these interaction models and the final model for each response variable from the multi-model selection process are given in Appendix E, Sections E3 – E6 and discussed below.

Covariate	Covariate details	Scale of covariate data	Source of covariate	Response variable[1] analyses for which covariate was included: initial regression variable	Response variable[1] analyses for which covariate was included: multi-model comparison	Reference level used in analyses [2]	Abbreviation in analyses (Appendix E)
Option group	Management option, grouped according to creation, maintenance, restoration or arable options (Table 2.3)	Parcel	Baseline and resurvey field data	C, IoS, SR, N, R, F	C, IoS, SR, N, R, F	Maintenance option group	hls_group2
Area of agreement	Total area of agreement	Agreement	Agreement documentation	C, IoS, SR, N, R, F	C, IoS, SR, N, R, F		area_cs
Altitude	Average altitude for quadrats or stops in field survey	Parcel	Digital Terrain Model[3]	C, IoS, SR, N, R, F	C, IoS, SR, N, R		alt_cs
Protected area status	Does the agreement include land designated SSSI? (Y/N)	Agreement	Agreement documentation	C, IoS, SR, N, R, F	C, IoS, SR	No	sssi
Environment zone	Broad grouping of English land classes to three categories. 1 = easterly lowlands, 2 = westerly lowlands, 3 = uplands.	Agreement	Countryside Survey[4]	C, IoS, SR, N, R, F	IoS, SR, N, R, F	1	env_zone
Agricultural land classification	Grading of agricultural land. 1= excellent quality, 5 = very poor quality	Agreement	Natural England[5]	C, IoS, SR, N, R, F	C, N, R, F	2 and 3 combined	agri_class
FEP feature group	Habitat feature(s) as defined by Farm Environment Plan criteria, grouped according to target taxa and conservation status (Table E1)	Parcel	Baseline and resurvey field data	C	C	Grassland plants (GP)	fep_group2
Baseline condition	Condition assessment given at HLS baseline survey	Habitat feature	Baseline survey field data	C	C	A	cnd_bas
Survey	HLS baseline survey vs. resurvey	Quadrat	Baseline and resurvey field data	SR, N, R, F	SR, R	baseline	survey
Broad habitat	Broad habitat classification collected during habitat mapping, based on Countryside Survey classifications (Table 2.4)	Quadrat	Baseline and resurvey field data	SR, N, R, F	SR, N, R, F	Neutral grassland	broad_ habitat
Baseline panel score for use of options across agreement	How well does allocation of options match feature on a scale of 1 - 4? 1 = Serious mismatches likely to result in adverse environmental outcomes; any arable and resource protection options poorly sited with little potential to produce benefits. 4 = All features under management in appropriate options; any arable and resource protection options well chosen, sufficient	Agreement	Baseline project panel appraisal scores[6]	C, IoS, SR, N, R, F	C, IoS, N, F	1 and 2 combined	C_PAF

Table 8.1 Covariates used in analyses of resurvey and baseline field survey data (Sections 4, 5 and 8), continued below. [1] C = condition, IoS = indicator of success, SR = species richness, N = Ellenberg fertility, R = Ellenberg reaction, F = Ellenberg moisture. [2] Reference used to compare other levels for categorical covariates in analyses (Appendix E). [3]Interlink Technologies, 2007, [4]Carey et al., 2008, [5]Natural England, 2014, [6]Mountford et al., 2013.

Covariate	Covariate details	Scale of covariate data	Source of covariate	Response variable[1] analyses for which covariate was included: initial regression variable	multi-model comparison	Reference level used in analyses [2]	Abbreviation in analyses (Appendix E)
Agreement holder type	Farmer vs non-farmer (conservation organisations etc)	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F	C, IoS, SR, R, F	1 (farmer)	ah_type
Experience	Typology derived from interview data, see Section 2.2. 1 = extensive experience, 2 = low level engagers / burgeoning environmentalists, 3 = formal experience only (e.g. AES), 4 = no experience	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F		1	exper
Motivation	Typology derived from interview data. 1 = financial, 2 = altruistic, 3 = practical fulfillment or fit with existing systems, 4 = continuing environmental work, 5 = inherited agreement	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F		1 and 5 combined	motiv
Concern	Typology derived from interview data. 1 = lack of (opportunity for) flexibility, 2 = no concern, 3 = more contact with NE needed, 4 = administration and application problems	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F	N	2	concern
Commitment	Typology derived from interview data. 1 = high, 2 = intermediate, 3 = low	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F	F	1	commit
Agreement holder education	What is your highest level of formal education? 1 = Left before 16, 2 = O-levels/CSEs/GCSEs, 3 = A levels, 4 = Technical qualification (e.g. BTEC), 5 = Undergraduate degree, 6 = Postgraduate degree, 7 = Other, 8 = prefer not to disclose	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F		1	educ
Perceived success of HLS in meeting objectives	Overall, how successful do you feel the HLS agreement has been at meeting its environmental objectives? 1 = very successful, 2 = successful, 3 = neither successful nor unsuccessful, 4 = unsuccessful, 5 = very unsuccessful.	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F	C	1	perc_succ
Frequency of referring to IoS	How often do you refer to the Indicators of Success for your agreement? 0 = not at all, 1 = occasionally, 2 = regularly	Agreement	Resurvey AH interviews	C, IoS, SR, N, R, F	C, IoS	2	consult
Confidence achieving IoS	How confident are you that you will achieve your Indicators of Success for the following options in your HLS agreement? 1 = not at all, 5 = certain	Agreement	Resurvey AH interviews	IoS		1 and 2 combined	Q43

Table 8.1 continued. Covariates used in analyses of resurvey and baseline field survey data, from agreement holder interviews. [1] C = condition, IoS = indicator of success, SR = species richness, N = Ellenberg fertility, R = Ellenberg reaction, F = Ellenberg moisture. [2] Reference used to compare other levels for categorical covariates in analyses (Appendix E).

8.2 Change in condition assessment

All FEP feature groups		RESURVEY A	B	C	Total
BASELINE	A	121	49	15	185
	B	92	131	57	280
	C	28	76	102	206
	Total	241	256	174	671

Table 8.2 Condition at baseline and resurvey for all parcels under HLS management where habitat features that remained the same between the surveys. Shaded cells denote outcomes categorised as 'negative change in condition assessment' (deterioration in condition or failure to improve from baseline condition C) in analyses (Section 8.1).

The four best-fitting regression models (delta BIC < 5) all included condition at baseline as a covariate (Appendix E, Section E1.1). Parcels which were at condition A or B at the baseline had a greater likelihood a successful outcome for condition than those initially given a C (Sections E1.2 – E1.5), as these parcels were in better condition at the start of the agreements.

a) BAP priority grasslands		RESURVEY A	B	C	Total
BASELINE	A	14	16	5	35
	B	16	22	25	63
	C	11	17	40	68
	Total	41	55	70	166

b) Grassland plant FEP features		RESURVEY A	B	C	Total
BASELINE	A	32	12	4	48
	B	16	43	13	72
	C	5	30	16	51
	Total	53	85	33	171

c) Other FEP feature		RESURVEY A	B	C	Total
BASELINE	A	75	21	6	102
	B	60	66	19	145
	C	12	29	46	87
	Total	147	116	71	334

Table 8.3 Condition at baseline and resurvey for all parcels under HLS management where habitat features that remained the same between the two surveys. Shaded cells denote outcomes categorised as 'negative change in condition' (deterioration in condition or failure to improve from baseline condition C) in analyses (Section 8.1). Habitat features divided into three groups according to whether conservation interest was in a) BAP priority grassland plants, b) grassland plants or c) other taxa.

The habitat feature group was also retained in the first and third best-fitting regression models (Section E1.1). Where the habitat feature was a BAP priority grassland (e.g. G04, Lowland calcareous grassland), the likelihood of a successful change in condition was reduced

compared with other grassland habitats (e.g. G02, semi-improved grassland; Table 8.3; Appendix E Sections E1.3 and E1.5 for statistical output). This finding is similar to the difference in outcome for condition between G02 and BAP priority habitat features found specifically for options HK6 and HK7 (Sections 5.2.1 and 5.2.2), and may be partly driven by the dominance of the HK6 and HK7 options in the condition data (256 conditions were made for HK6 or HK7 out of a total of 671 condition recorded for habitat features at both baseline and resurvey). As for option scale analyses, these condition analyses use data recorded for parcels where the habitat feature was the same at the baseline and resurvey (as condition assessment criteria vary with habitat feature). These were the majority of data relating to condition, as only a minority of habitat features changed between surveys (between 2% and 10% depending on option, Table 5.16).

The only other covariate which was retained in the third and fourth best-fitting models was agreement holder type (Section E1.1). In both models the confidence intervals for the agreement holder parameter estimates span zero (Sections E1.4 and E1.5), indicating low confidence in the explanatory power of this variable, and thus this result should not be attributed undue importance.

8.3 Indicators of success at HLS resurvey

Indicators of success (IoS) were analysed across all HLS agreements, using the number of IoS which were met at the HLS resurvey as the response variable along with the total number of IoS assessed on each agreement. The four best-fitting regression models (delta BIC < 5) differed in terms of the identity of covariates that were retained in each model. The best fitting model contained no covariates (Section E2.2 for analytical output).

Baseline PAF score	Number of HLS agreements	Proportion of IoS met	Number of IoS assessed
1 or 2	76	0.56	28.92
3	68	0.64	32.16
4	22	0.67	26.91
No score given	5	0.61	22.8
All agreements	171	0.61	29.77

Table 8.4 Proportion of IoS assessed as met during the resurvey (average per agreement), for each category of panel appraisal score for how well options matched features, attributed following the baseline. PAF scores: 1 = Serious mismatches likely to result in adverse environmental outcomes; any arable and resource protection options poorly sited with little potential to produce benefits; 4 = All features under management in appropriate options; any arable and resource protection options well chosen, sufficient and well positioned. Only four agreements had a score of 1, so these were combined with scores of 2 for analyses. Number of IoS assessed = average per agreement.

The second best-fitting model had very similar explanatory power to the first (delta BIC = 0.41, Section E2.1), and included a score attributed to each agreement during the baseline for how well the allocation of options matched features (Table 8.1). A score of 1 or 2, indicating a mismatch between options and features, reduced the likelihood of IoS on that agreement

being scored as met at resurvey, compared to a score of 4 which indicated all features were under management in appropriate options (Section E2.3). This shows that agreement design, as scored during the baseline survey, had an effect on outcomes observed 5-6 years later at resurvey. The third best-fitting model included a covariate to define whether SSSI designated land is present on the agreement (Table 8.5). Agreements with a SSSI present had a slightly greater likelihood of IoS being met than those without a SSSI present (Section E2.4 for analytical output).

SSSI present?	Number of HLS agreements	Proportion of IoS met	Number of IoS assessed
Yes	103	0.64	31.51
No	67	0.57	27.30
Not known	1	0.56	16.00
All agreements	171	0.61	29.77

Table 8.5 Proportion of IoS assessed as met during the resurvey (average per agreement), for agreements with (Yes) or without (No) SSSI designated land. Number of IoS assessed = average per agreement.

The fourth best-fitting model included agreement holder type as a covariate (Section E2.5). However, as for the analysis of change in condition above, the confidence intervals for the agreement holder type parameter estimates span zero, indicating low confidence in the explanatory power of this variable.

8.4 Vegetation response variables recorded at baseline and resurvey

8.4.1 Species richness

Species richness differed between the two surveys. In neutral grassland (the reference broad habitat used for analyses Table 8.1) and the majority of broad habitats, it was on average higher at resurvey than at the baseline (Figure 8.1). There were significant interactions between survey (baseline vs. resurvey) and broad habitat. On arable habitats the species richness did not increase between the two surveys; however this may be due to the low coverage of arable habitats in the baseline (15 parcels vs. 74 arable parcels assessed during the resurvey), and thus should not be interpreted as meaning that HLS management does not drive change in species richness in arable habitats. Species richness was also shown not to differ between the two surveys for calcareous grasslands; the same was found in the analyses of management options HK6 and HK7, with the exception of parcels under HK7 management to which a supplementary option had been applied (Section 5.3.1). These are the two options under which the majority of calcareous grassland parcels surveyed were likely to be managed.

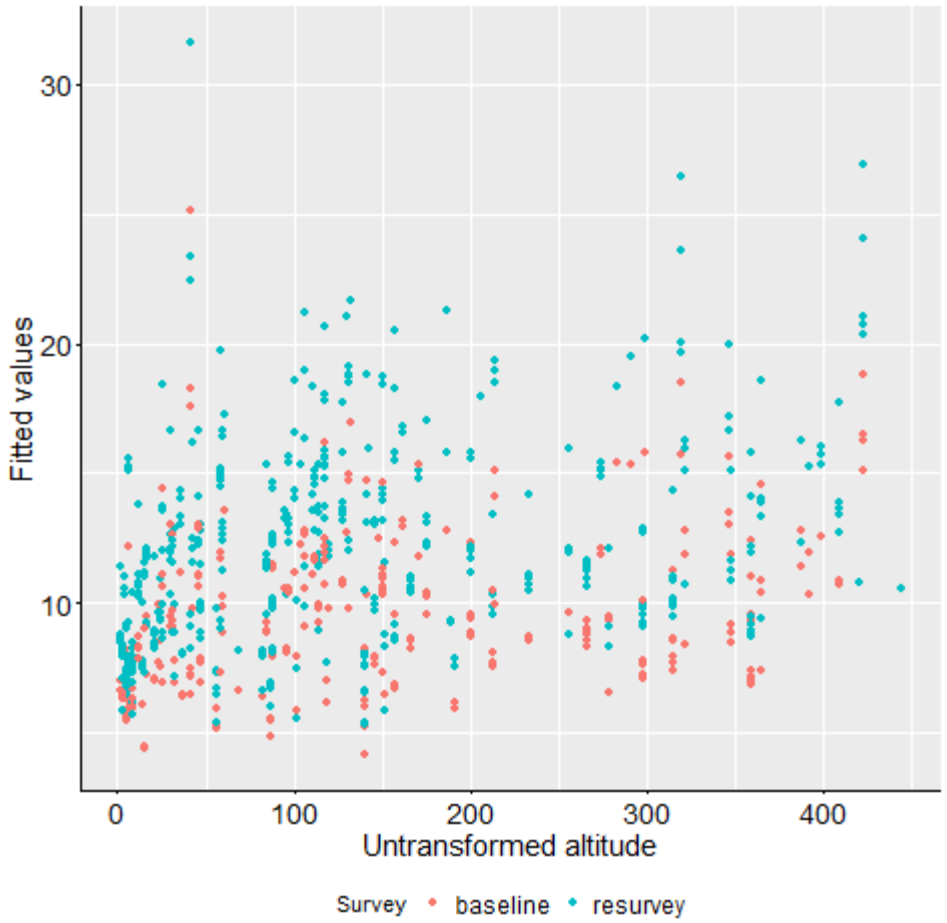

Figure 8.1 Fitted values of species richness for the baseline (red dots) and resurvey (blue dots) plotted against the altitude. Fitted values are derived from generalised linear mixed model selected through multi-model selection process (Section E3.2).

The final model chosen through the multi-model selection process included altitude and the option group, as well as broad habitat and survey (Figure 8.2). Parcels managed under options in the creation and arable options groups had lower species richness than those managed under maintenance or restoration options (Section E3.2 for statistical output). The objectives for arable options are often to provide resources for other taxa, rather than necessarily to increase plant species richness. For example, the most frequently surveyed arable options were HF12 wild bird seed plots and HE10 floristically enhanced grass margins, for which the goal is to increase bird food and habitat and foraging areas for invertebrates and birds respectively (Table 5.1 and Natural England, 2013). Creation options are applied to create higher value from initially low value habitats (for example HK8 aims to create species-rich grassland on former arable land, ley grassland or set-aside; Natural England, 2013), and so a lower species richness in parcels under creation options is not surprising in the early stages. The lack of difference in species richness between maintenance and restoration options supports the results of the detailed option analyses, in which few differences were found between pairs of restoration and maintenance options applied to similar habitat types (Section 5.3).

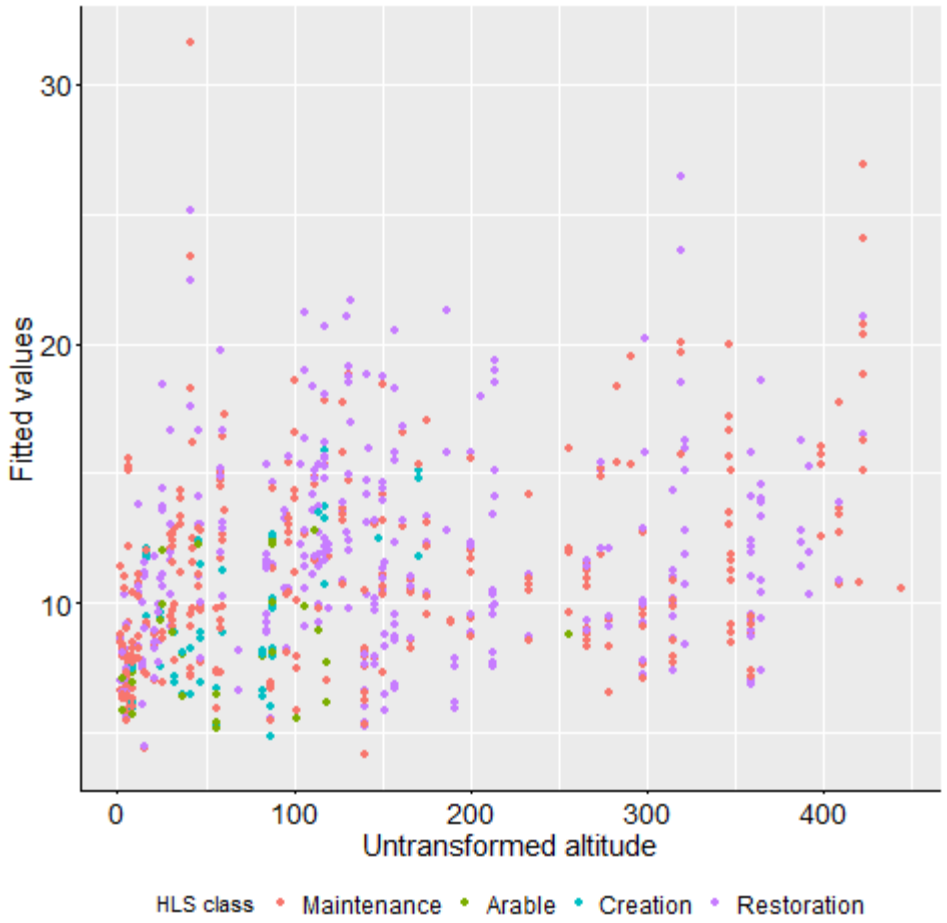

Figure 8.2 Fitted values of species richness for the baseline and resurvey plotted against the altitude. Fitted values are derived from generalised linear mixed model selected through multi-model selection process (Section E3.2). Coloured dots show groups of options ('HLS class'), red = maintenance options, green = arable options, blue = creation options, purple = restoration options.

8.4.2 Ellenberg fertility

Average Ellenberg fertility attribute (weighted by percentage cover) was slightly lower at the resurvey compared to the baseline, for the reference broad habitat which was neutral grassland and in woodland, dwarf shrub heath, arable and improved grassland habitats (Appendix E, Section E4.1 for statistical output). Woodland, arable and improved grassland habitats had slightly higher Ellenberg fertility attributes than neutral grassland, whilst dwarf shrub heath, bog, calcareous grassland and acid grassland had slightly lower Ellenberg fertility attributes. There was an interaction between survey and broad habitat: in bog, calcareous grassland and acid grassland the Ellenberg fertility attribute at resurvey did not differ from those of the baseline; while in fen marsh and swamp a reduction in Ellenberg fertility attribute was found between the two surveys that was greater than for neutral grassland.

The final model from the multi-model selection process contained broad habitat, area of agreement, option group and the agreement holder concern typology (Section E4.2). Ellenberg fertility attribute was greater on parcels under arable and creation options, compared to maintenance options, and reduced on restoration options (compared to maintenance). Agreement holder concern was retained as part of the best-fitting model, but confidence intervals for the parameter estimates of this covariate included zero, indicating little evidence that they differ from the reference level of 'no concerns'. In addition, this final model included fitted values that were outside the range of the data (Ellenberg fertility minimum fitted value = 0.447), unlike the model discussed above with the broad habitat × survey interaction, so this model output may not represent the Ellenberg fertility attribute data well.

8.4.3 Ellenberg reaction

Ellenberg reaction attribute (average weighted by percentage cover) differed with broad habitat: it was lower in dwarf shrub heath, bog and acid grassland compared to the reference neutral grassland habitat, but higher in arable habitat. Ellenberg reaction attribute did not differ between the baseline and resurvey for the neutral grassland reference habitat and the majority of other broad habitat categories, but there was a significant interaction between broad habitat and resurvey (Section E 5.1). Ellenberg reaction attribute reduced between the two surveys for the fen, marsh and swamp broad habitats, indicating a change towards more acidic soil conditions, but increased in bog and acid grasslands.

The final model from the multi-model selection included broad habitat, area of agreement, type of option and agreement holder type. As for Ellenberg fertility, the Ellenberg reaction attribute was higher on parcels under creation and arable options compared to maintenance options, but slightly lower for land under restoration options. Although both agreement holder type and area were retained in the final model (Figure 8.2), confidence intervals for the parameter estimates for both of these covariates included zero.

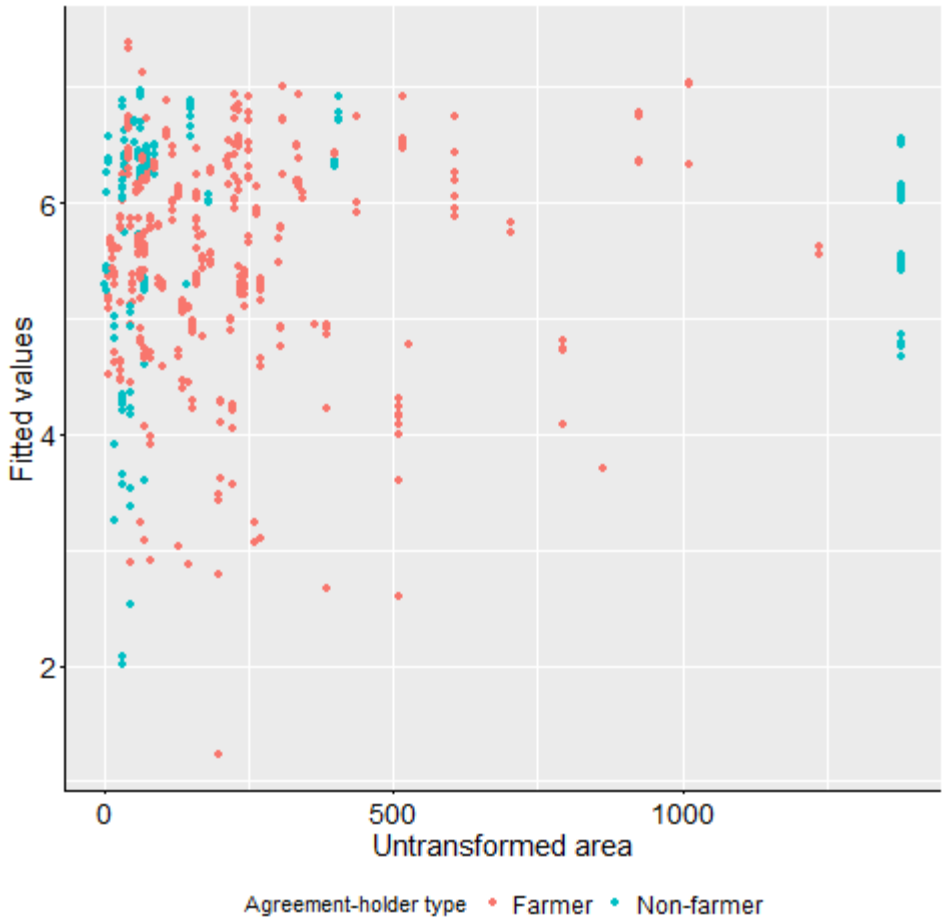

Figure 8.2 Fitted values of Ellenberg reaction for the baseline and resurvey plotted against the agreement area. Fitted values are derived from generalised linear mixed model selected through multi-model selection process (Section E5.2). Coloured dots denote type of agreement holder: red = farmer, blue = non-farmer. One agreement is not shown on the graph, as its area was over 9000 ha and this extended the x axis to the extent that the spread of other points were not visible (data not shows were from 95 quadrats across 4 habitats - neutral grassland (55), acid grassland (27), dwarf shrub heath (12) and 1 for which the broad habitat mapping data could not be linked to quadrat location).

8.4.4 Ellenberg moisture

The Ellenberg moisture attribute was higher in several broad habitats compared to neutral grassland: dwarf shrub heath; fen marsh and swamp; bog and acid grassland. It was lower in calcareous grassland compared to neutral grassland (Section E6.1). Ellenberg moisture did not differ between baseline and resurvey for most of the broad habitats that were assessed, but was reduced between the two surveys for fen, marsh and swamp and acid grassland.

The final model (selected from a multi-model comparison process) included broad habitat, option group, agreement area, agricultural land classification and environment zone (Section E6.2). Ellenberg moisture attribute was lower on land under arable and creation options, compared to maintenance options. In the westerly lowlands (environment zone 2), Ellenberg moisture attributes were higher than in the easterly lowlands (environment zone 1 reference

level), indicating wetter sites. Agreements with land classifications denoting poorer quality agricultural land (4 or 5) had slightly higher moisture attributes than those with a classification of 2 or 3.

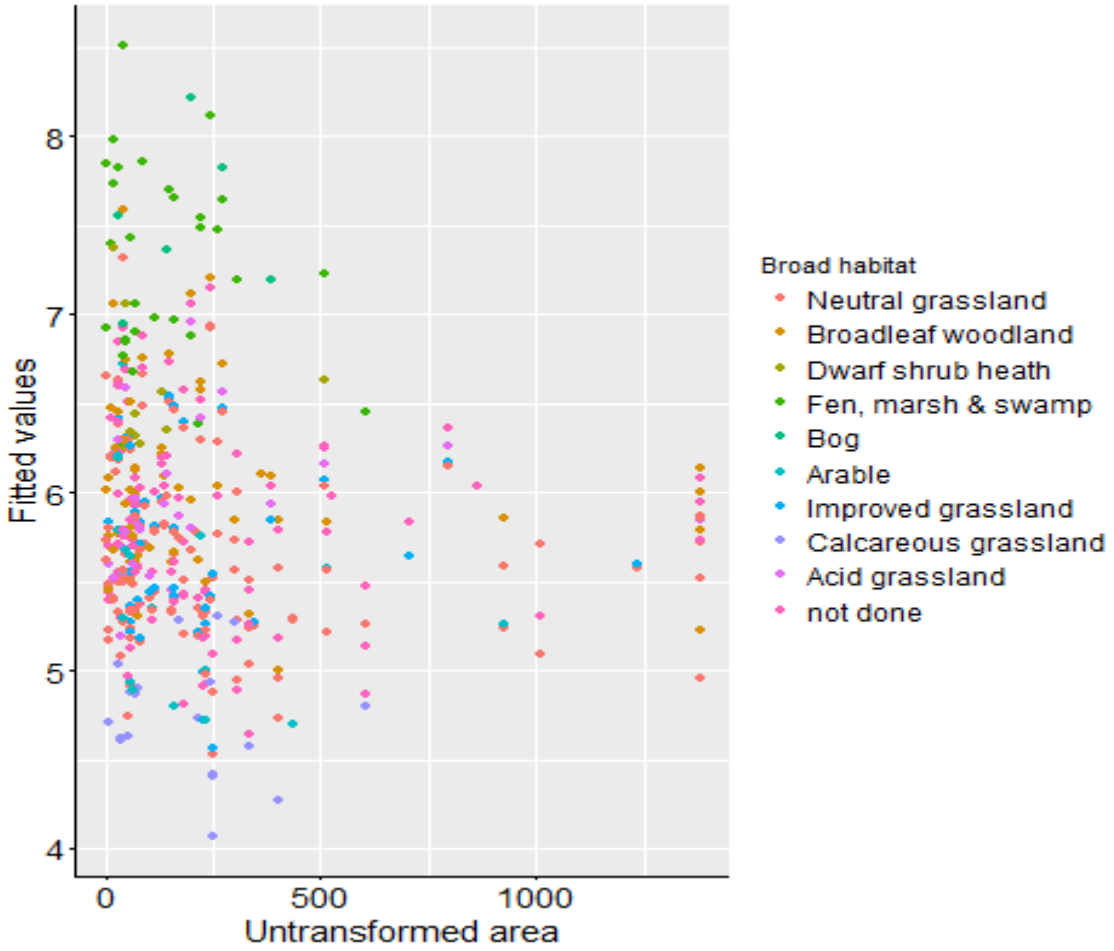

Figure 8.3 Fitted values of Ellenberg moisture for the baseline and resurvey plotted against the agreement area. Fitted values are derived from generalised linear mixed model selected through multi-model selection process (Section E6.2). Coloured dots denote broad habitat. One agreement is not shown on the graph, as its area was over 9000 ha and this extended the x axis to the extent that the spread of other points were not visible (data not shows were from 95 quadrats across 4 habitats - neutral grassland (55), acid grassland (27), dwarf shrub heath (12) and 1 for which the broad habitat mapping data could not be linked to quadrat location).

8.5 Conclusions

Does starting habitat and condition affect whether condition improved between the two surveys?

The analyses across all agreements reported above provide a broad scale assessment of the agreements surveyed, both in terms of whether response variables vary between the two surveys, and which covariates have affected the extent of these changes. Analyses of change in condition between the baseline and resurvey have shown that starting condition and habitat

feature group at baseline are the main drivers of a successful outcome. Priority grasslands with a baseline condition of C were less likely to improve in condition than semi-improved grasslands. This could be interpreted as demonstrating the importance of effective targeting of management. However, as discussed in the Section 5.3.1, timescales required for grassland restoration, i.e. to achieve priority grassland status may be greater than the interval between the two surveys.

Did key plant response variables change between the two surveys, across all agreements and options surveyed?

This larger scale analyses of vegetation response variables demonstrate that plant communities have changed between the baseline and resurvey, and that these changes either relate to, or are greater in, specific broad habitats. The increase in species richness since the baseline across several broad habitat types including neutral grassland, suggests that HLS management is working in those habitats to deliver plant assemblages with improved conservation value. The slight reduction in Ellenberg fertility found between the baseline and resurvey for the majority of broad habitats assessed, also suggests a move towards plant communities that are typical of slightly less fertile soil conditions. Results for the Ellenberg reaction attribute showed less consistent changes between the two surveys across broad habitats, with a reduction only for fen, marsh and swamp.

Do agreement holder characteristics affect changes in condition and plant variables between survey, or the proportion of IoS met at resurvey, across all agreements and options?

The analyses above showed little evidence of links between environmental variables and the agreement holder interview data or typologies at this whole agreement scale. Boatman et al. (2014) drew a similar conclusion from their study of HLS, finding 'no significant correlations between agreement holder characteristics and outcome indicators'. However, results from the option scale analyses did indicate complex effects of an agreement holder variable on botanical outcomes, with effects differing between habitat and options types (Section 5.4). Detailed analyses of specific options may thus be required to tease out these subtle effects, and it is possible that the broad scale of the global analyses has obscured some of the intricate relationships between agreement holder variables and ecological outcomes. This is likely if these relationships work in opposing directions in different habitats, as indicated by analyses summarised in Section 5.

Did the baseline panel appraisal ratings of use of options across each agreement relate to condition, IoS or plant response variables?

The likelihood that IoS were met towards the end of the agreements was affected by whether the agreement included SSSI land, and the score given for use of options (a proxy for effective targeting) during the baseline panel appraisal. In combination with the results for change in condition, the latter result shows the importance of agreements being well set up at the outset. The criteria by which condition is judged differs between habitat features (Appendix D1.1 and 1.2), and in part is linked closely to IoS. As discussed in Section 6.2 and Boatman et al. (2014), some requirements (e.g. for percentage cover of positive indicator species) may be set at inappropriate or unachievable levels.

9 Assembly and analysis of a counterfactual dataset for HLS resurvey: Summary of the results

9.1 Introduction

Why is a counterfactual analysis needed and where did the counterfactual data come from?

Assessing the performance of the HLS scheme is made more robust if change between the HLS baseline and repeat surveys can be contrasted with vegetation change over a similar time interval derived from a dataset representing vegetation outside higher level AES. Previously, for the HLS baseline the Countryside Survey (http://www.countrysidesurvey.org.uk/) offered an opportunity to obtain this (Mountford et al., 2013) but in the absence of Countryside Survey data from later than 2007 we had to find an alternative dataset. The NPMS (http://www.npms.org.uk/) provided such an opportunity through the availability of plots from the 2015 and 2016 surveys that could be used alongside equivalent plots from CS2007. Differences in plots size across these projects rendered a unified analysis of CS, NPMS and HLS unfeasible (Table 9.1). However it was possible to contrast change between CS and NPMS and compare these results with the separate analysis of change in HLS plots. With careful interpretation we aimed to be able to infer performance of HLS relative to the differences between the CS and NPMS counterfactual. Interpreting differences between CS and NPMS as vegetation change over time requires that other factors do not influence differences between the two survey datasets. Put bluntly, survey type is confounded with year of survey, yet this will only matter if the methodological differences between the two surveys obscure vegetation change. There are indeed methodological differences between CS and NPMS but it does not automatically follow that these will significantly influence species recording in quadrats. Important questions centre on whether equivalent, or at least comparable, plant assemblages can be assumed to have been sampled in the CS and NPMS surveys.

- How might subjectivity in the choice of sampled NPMS locations have resulted in species-compositional differences from locations that could have been sampled in equivalent habitats if based on CS methods?
- A bias in the choice of representative patches with a higher incidence of NPMS indicator species (see the NPMS website for lists of indicator species), could render NPMS samples more species-rich than a stratified random sample such as CS2007
- Preferentially locating plots on publicly accessible land may also reduce the likelihood that such areas of habitat are subject to the range of management associated with an unbiased sample. If these effects are important then differences between the surveys may become difficult to interpret purely as reflecting the absence of HLS intervention.

These issues were approached in this analysis by first attempting to construct like-with-like datasets from both schemes. Interpretation of differences between the surveys then considered both the effects of survey method as well as possible detection of real vegetation change.

What were the major constraints on the interpreting change between the counterfactual data versus the change analysis of the HLS data?

Ideally analysis of a counterfactual time series alongside analysis of the HLS data (from baseline and resurvey) need only be based on equivalence in habitat type among the baseline plots in both datasets. If necessary, any plots where vegetation change shifted sufficiently to register a change in habitat type could be analysed separately from the stable cohort, While this could be done for the HLS plots with reference to the common polygon or field that defines a temporal set of repeats, the CS and NPMS plots were recorded in different places so there is no sense in which the vegetation of a CS plot in 2007 could be directly matched to an NPMS plot in 2015. Some degree of like-with-like comparison therefore needed to be applied to the CS and NPMS plots, to increase confidence that unbiased measures of condition were made between the different plots in 2007 and again in 2015 in similar habitats. Clearly though, the definition of the habitat used to group CS and NPMS plots cannot be too narrow otherwise this mitigates against detecting vegetation change. In the comparison of the HLS baseline *vs* CS plots the broad habitat was selected as a compromise, and was used in the current agreement scale analyses of change in quadrat data between baseline and the HLS resurvey (Section 8). These coarse units have also been used repeatedly in analyses of CS data (Norton et al., 2012; Smart et al., 2003) and so we adopted broad habitat again here. This means that the comparison is unable to detect any larger magnitude shifts between vegetation types, for example where calcareous or acid grassland has become dominated by bracken (e.g. Stevens et al., 2016).

Survey	**Linear features**	**Area features**
CS	1 × 10m, 1 × 1m in M plots in field margin strips, 1 × 1m central plot in arable field margins.	Nested X plots that include 1 × 1m, 5 × 5m and 10 × 10m sizes.
NPMS	1 × 25m	5 × 5m, 10 × 10m in woodland, 2 × 12.5m on slopes, screes and in some wetlands and water bodies.
HLS baseline survey and resurvey	1 × 1m plots in arable field margins only. No other linear features surveyed.	1 × 1m in all habitats except 4 × 4m (bog, dwarf shrub heath, fen marsh & swamp) and 10 × 10m in woodland.

Table 9.1 Plot sizes in CS, NPMS and HLS surveys.

9.2 Summary of the counterfactual analysis results

Were there any differences between surveys and did these differ between broad habitats?

Significant differences between schemes and by broad habitat arose for all response variables apart from Ellenberg F (wetness; Appendix F Figure F3; Table F2). Neutral grassland was the broad habitat least likely to exhibit a significant difference between surveys. Directions of the

difference were consistently in the same direction for Ellenberg R, (soil reaction), N (fertility) and indicator richness with higher estimated means for each response variable seen in the NPMS plots. Hence, indicator richness was significantly higher in 2015/16 NPMS plots than 2007 CS plots in neutral grassland, fen, marsh & swamp, dwarf shrub heath, bog, arable and acid grassland relative to broadleaf. Plots in broadleaved woodland were less rich in indicators in 2015/16 NPMS plots than in 2007 CS plots (Appendix F Figure F3).

Were differences between CS and NPMS likely to reflect temporal changes in vegetation condition in the wider countryside in the absence of HLS intervention?

The plausibility of the differences between the 2007 CS and the 2015/16 NPMS surveys being attributable to real vegetation change, methodological differences or recording effort, can be assessed in a number of ways. The higher indicator richness in NPMS is not likely to be due to under-recording or biased recording in CS2007. Three lines of evidence supported this contention:

1. If quadrat data from the same plot sizes in the same broad habitats but *within the same year or only a year apart* are compared from the NPMS and Glastir Monitoring and Evaluation Program (GMEP) in Wales then similar patterns are seen (Appendix F4). Despite being near contemporary in their recording year, GMEP recorded somewhat lower indicator richness in bog, dwarf shrub heath, acid grassland, fen, marsh & swamp and arable habitats, and higher richness in broadleaved woodland, the same pattern as seen in the English analysis. Moreover, the same tendency for mean Ellenberg values for N and R to be higher in NPMS and lower in GMEP plots was also clearly apparent (Appendix F4). These differences are however based on graphical exploration only.
2. The CS v HLS baseline comparison showed no evidence that CS2007 plots were consistently less species rich than the HLS baseline, which ought to have been the case if CS deviated significantly from another survey of the same habitat types carried out within 3-4 years of CS. CS2007 plots did however have significantly lower mean Ellenberg R and N scores for a number of broad habitats compared to baseline HLS plots.
3. The QA analysis for CS2007 initially appeared to indicate that there had been an increase in the proportion of over-looked species in the survey and these were more likely to be sedges and then grasses. However, two exhaustive statistical analyses of the QA and CS replicate plot data concluded that "Once cryptogams are removed statistical modelling shows no significant differences in the level of under-recording across surveys - See http://www.countrysidesurvey.org.uk/sites/www.countrysidesurvey.org.uk/files/QA_PLOTS_3.pdf)."

Higher fertility, pH and richness may reflect the intentional bias within NPMS for sampling flushes and generally higher quality priority habitat patches. It may also reflect geographic and ecological biases in the locations of sampled monads in CS versus NPMS. Certainly NPMS fen, marsh & swamp, dwarf shrub heath and acid grassland plots are represented by monads dispersed across the south and east of England to a greater extent than CS monads (Appendix F4). Monads appear more equally dispersed for broadleaved woodland and neutral grassland, and while there is reasonable overlap for monads containing arable plots, it is

possible that a higher proportion of NPMS plots are located in the chalk and limestone areas of Wiltshire, Oxfordshire and Gloucestershire (Appendix F3).

If we further assume that between survey differences are representative of real vegetation change then we might expect the size of the differences in response variables to be similar to other temporal analyses of vegetation surveillance data from the same broad habitats over previous or contemporary time intervals. When compared to recent findings the differences reported here, expressed in common units of the rate of change in a response variable per year, are unusually large suggesting that methodological differences were possibly a more likely explanation than real vegetation change. The two habitats where effect sizes are approaching comparability are arable and broadleaved woodland. These are also the two habitats where we see much more geographical overlap in the distribution of survey monads. Thus, particularly in broadleaf woodland it could be that the comparison between CS and NPMS is less affected by survey differences such that the detected reduction in indicator richness may be picking up ongoing effects of drivers that have been associated with reduction in understorey species-richness in many broadleaved woodlands in Britain probably since the end of WWII (Kirby et al., 2005; Smart et al., 2014).

The analyses of HLS survey data across all HLS agreements showed that in five of the nine broad habitats assessed (neutral grassland, improved grassland, acid grassland, broadleaved woodland, bog), species richness increased between the baseline survey and resurvey. The lack of a corresponding result for in-scheme squares from the counterfactual analysis implies that differences between the CS and NPMS survey methodologies may be obscuring any signal of HLS management in the counterfactual dataset, and illustrates the importance of structured ecological resurveys of the same locations using consistent methods, in order to assess change over time. Indicator species richness was greater in the NPMS than CS datasets for six broad habitats, but as discussed above this may be due to methodological differences rather than real vegetation change, with the possible exception of arable and broadleaved woodland habitats. A comparison of change in species richness between the HLS surveys and this counterfactual is not possible due to the low numbers of arable parcels surveyed in the HLS baseline survey (Section 8.4.1). The decrease in broadleaved woodland species richness found in this counterfactual analysis, to a similar extent as found in other studies, does suggest that woodland management under HLS is successfully increasing the species-richness of the woodland ground flora relative to the trend apparent across the wider countryside.

9.3 Concluding remarks

What are the options for carrying out more robust counterfactual analyses of English higher-level trier performance in the future?

Given the long time-scales required to create and restore habitats a longer time-interval would be desirable both in terms of scheme impacts monitoring and across the equivalent counterfactual. Options include the following:

- Given the uncertainty associated with scheme design post-Brexit, it might be timely to consider a large-scale test of the effectiveness of extensifying agri-environment options going back as far as possible in time. A hypothesis might be that contemporary Earth Observation products such as MODIS NDVI could detect above-ground productivity differences between habitat exposed to long-term AES management versus areas never exposed. This would rely on being able to assemble a sufficiently accurate record of long-term uptake data. It would also require work to match options across schemes with similar expected impacts i.e. reduced stocking and fertiliser application. Being able to link these areas to contemporary quadrat data from scheme monitoring programs, NPMS and CS would also allow any differences in NDVI to be additionally characterised in terms of their plant species composition. This would be a novel research question pitched at detecting evidence for a long term cumulative impact of 30+ years of AES intervention. It would therefore not be restricted to HLS but would acknowledge the long-timescales over which changes in fertility and species composition might be expected to arise.
- Revisiting selected subsets of CS plots would update a time series of fixed and re-locatable measurements of species composition going back to 1990 and in a minority of cases to 1978. The major advantages are that many plots have matched soil data and repeat recording in fixed locations means analyses are sensitive to gross shifts in broad habitat unlike a comparison of spatially unpaired data as trialled here. Disadvantages are cost of repeat survey and under-sampling of rarer Priority Habitats.
- The lengthening NPMS time-series constitutes a growing capacity for reporting on changes among rarer Priority Habitats. The HLS counterfactual analysis has shown how NPMS plots can be filtered to exclude those in higher-level schemes. With further thought it may be possible to explore further options for joint analysis of CS and NPMS datasets. For example, assembling subsets of plots from both schemes that were in close spatial proximity and sampling the same habitat type could be a way of minimising the influence of geographical and ecological biases that are likely to have influenced the results presented here. A clear advantage of NPMS is the low cost of scheme implementation.

10. Discussion and recommendations

10. 1 The environmental effectiveness of HLS

The results and conclusions presented in the previous chapters show that the effects of HLS management on habitats and plant communities are complicated. Detailed analyses of a range of drivers (including agreement holder characteristics, geographical characteristics and agreement design and set up), at different scales and on multiple response variables, were required in order to explore and characterize these complex effects.

The baseline survey provided a broadly positive assessment of HLS and its potential to deliver desired outcomes and this reflected the use of more targeted management than had been available through the foregoing classic schemes. The baseline report flagged up some problem areas in relation to HLS agreements; these are discussed in relation to the resurvey results in more detail below.

Did the extent or type of broad and priority habitats change under HLS management?

Overall, the extent of most habitat types did not change substantially between the baseline and resurvey. Most priority and broad habitat categories showed little or no change in mapped habitat extent between the two surveys, or small positive changes that were consistent with the objectives of HLS management. Within broad habitat categories, changes to the extent of mapped habitats were larger under restoration and creation options than under maintenance options (for example, a shift from bare ground and improved grassland to neutral grassland). This corresponds with the broad objectives of these option groups, as creation and restoration options are applied where larger changes are required to meet HLS goals.

There were some small losses in the extent of two types of priority habitat (lowland dry acid grassland and lowland meadow) between the two surveys. The baseline survey identified some lowland dry acid grassland as being in poorer condition at the start of HLS agreements than typical of the wider countryside (Mountford et al., 2013). A failure to improve this poor starting condition may have contributed to the small decrease in extent of this priority habitat. Overall, the extent of most priority habitats surveyed under HLS management remained the same at resurvey as it had been at baseline.

Did the condition of habitats under HLS management improve between baseline and resurvey?

Analyses of habitat condition at the option scale showed that drivers of change between the two surveys differ between grasslands under species rich semi-natural options (including conservation priority grassland habitats), and those grasslands under management that primarily targets other taxa (e.g. birds, invertebrates). Change in condition for species rich semi-natural grasslands related most strongly to the identity of starting habitat, and condition was less likely to improve between the baseline and resurvey for these grasslands. However, evidence was found that some attributes of priority grassland communities had improved (e.g. reduced dominance of competitive species) between the two surveys, but not to the extent of

meeting the threshold for a higher condition rating. Previous studies have shown much longer timescales are required for priority grassland restoration than the 6-7 years that elapsed between the baseline and resurvey, or probably the 10 year duration of HLS agreements (Fagan et al. 2008; Shellswell et al., 2016). Change to the condition of grasslands that were managed under options to target other taxa were linked more strongly to agreement holder interview data (perceived ease of management, discussed below) and to the scores attributed by panels after the baseline on appropriateness of management prescriptions.

The baseline survey identified exaggerated quality of semi-natural grasslands in the FEP as a problem in the setting-up of HLS agreements, as it led to inappropriate option choice. Other monitoring work has also flagged up grassland options as a group for which similar problems occurred more frequently than for other option types; for example, incorrect FEP features were allocated leading to questionable option choice for 18% of grassland options (Boatman et al., 2013). Mountford et al. (2013) concluded that in some instances HLS management (including that aimed at maintenance) was being applied to semi-improved features with limited potential value for restoration under the proposed management. The resurvey found that the majority of semi-improved grassland parcels under the restoration option HK7 that were in condition C at baseline improved to a condition of A or B at resurvey, but only one parcel had developed into a species rich grassland habitat with higher conservation value. This may be due to the long timescales required for semi-improved grasslands to change to priority grasslands with high conservation status, discussed above.

For the majority of options, there was no evidence that the condition at baseline affected the likelihood that condition would improve at resurvey. The exceptions were the moorland maintenance and restoration options (HL9/10), for which a poor starting condition reduced the chance of achieving a moderate or good condition at resurvey. The majority of parcels under HL10 management in condition B or C at baseline remained in the same condition at resurvey. Little evidence was also found that changes in condition between the two surveys varied between pairs of restoration and maintenance options applied to similar habitats.

Analysis of change in condition across all agreements and options confirmed that habitat type and baseline condition were the strongest drivers of whether a positive change was observed between the two surveys. This latter result may reflect the dominance of options for species rich semi-natural grassland options (HK6 and HK7) in the dataset, and shows that option specific analyses were needed to tease out the detail of different drivers operating across different habitats and management options.

Evidence for changes in plant communities between the baseline and resurvey

Multivariate analyses of the plant communities found little evidence of change between the baseline and resurvey in the majority of habitats, including all the upland habitats surveyed. Changes that were detected in lowland habitats included a shift to plant communities typical of wetter or less grazed conditions under grassland restoration options, and towards semi-natural grassland communities under creation options. These link to the changes recorded in mapped habitats from bare ground and improved grassland to neutral grassland under these options.

Many of the botanical response variables showed no change between the baseline and resurvey at the option scale, especially for grasslands under species rich semi-natural management options. Where changes did occur between the baseline and resurvey, plant response variables showed positive responses in terms of conservation objectives (e.g. reduction in Ellenberg fertility score). In addition, where changes were demonstrated these often related to particular conditions or geographical areas. For example, species richness under option HK7 (restoration of species rich semi-natural grassland) increased if a supplementary option was also applied, and under maintenance option HK6 increased on lowland meadow habitats and higher quality agricultural land. Ellenberg fertility attribute decreased for parcels under management to maintain or restore rough grassland for target species between the two surveys in the westerly lowlands, but not in the easterly lowlands. This may reflect differences in the nature and intensity of farming in the two regions, with more intensive arable farming dominating in the east.

As discussed above, for some options plant response variables showed an improvement between the two surveys, where condition did not. For example, whilst the condition of lowland calcareous grasslands under the restoration option HK7 did not improve on average between the two surveys, there was a shift towards reduced dominance of competitive plant species. This shows positive change under HLS management, but at a slow rate, which may in this instance be due to the long timescales needed for priority grassland restoration (Fagan et al. 2008; Shellswell et al., 2016).

Some of the changes shown through multivariate analyses link with changes to related univariate botanical response variables between the two surveys. For example, sward height increased on average in species rich semi-natural grassland parcels under option HK7 (restoration), but Ellenberg moisture attributes did not differ between the baseline and resurvey, suggesting that a reduction in grazing may have driven the change found in plant assemblages under this option, rather than wetter conditions.

There was some indication from the multivariate plant community analyses of a shift to less disturbed conditions in woodlands under maintenance options. Species richness also increased under woodland options in the easterly lowlands and in parcels with a supplementary option present. These changes are probably linked to reductions in grazing. An apparent shift was also observed in lowland heathlands under restoration and maintenance options towards plant communities with more characteristic species.

Larger scale analyses of data from multiple options across all agreements showed an increase in species richness in five of nine broad habitats assessed and a reduction in the Ellenberg fertility attribute in six broad habitats. The difference in results for species richness when analysed at this larger scale may be due to the inclusion of more data, from parcels under management options that were not replicated well enough to be included in the individual option-scale analyses, for example creation options. These two factors (increased species richness and reduced Ellenberg fertility) may have been the drivers behind the modest increases in condition found in some instances between the two surveys – for example, the increase found for semi-improved grasslands managed under HK7, and for grasslands managed under HK6 if supplementary options were also applied.

Were Indicators of Success (IoS) achieved at resurvey?

Overall, between 61 and 100% of IoS were met for the majority (57%) of the parcels surveyed in the resurvey. This rate is in line with other studies; for example Boatman et al. (2013) found 64% of IoS had been met in their survey of 100 HLS agreements. The proportion of IoS met varied with option type. A lower proportion of IoS were met for options for species rich grassland management (HK6 and HK7), possibly due to some grasslands being categorised as the wrong habitat feature in the FEP or longer timescales being needed, as discussed above. A larger proportion of IoS were met for moorland and hedgerow management options. A low proportion of IoS (43%) were met for wild bird seed mix option HF12. Eleven of the 24 HF12 plots surveyed had <1% cover of sown species. These plots were only surveyed over one autumn/winter season, so it is possible that where plots failed, these were re-established in subsequent years.

46% of IoS relating to positive indicator species were not met. In many cases positive indicator species were present, but not at the frequency required in the IoS. This provides further evidence that realistic timescales for restoration of some species rich grasslands may be greater than the time that elapsed between baseline and resurvey, or the length of an HLS agreement. IoS relating to the control of negative indicator species were more often met (in 80% of cases) than those relating to positive indicator species.

During the baseline panel appraisals, IoS were judged to be the most frequently deficient element in agreement building. Generic indicator suites were frequently used, which did not provide a clear framework to assess progression, were often not tailored to site condition, and in some cases were not amenable to objective measurement (Mountford et al. 2013). The resurvey finding that fewer mandatory IoS were achieved than non-compulsory IoS may support the baseline criticism of generic indicator suites, as the non-compulsory IoS may be selected with more reference to specific parcels under HLS management.

Analyses of IoS across all agreements showed that if the baseline panels had judged that options were well allocated (i.e. well-tailored to the features present), the IoS were more likely to have been met. This reinforces the importance of tailoring HLS options to the right features when the agreement is set up, as it plays a key role in determining success. In addition, the presence of SSSI land within an agreement increased the likelihood that IoS were met by the resurvey; HLS targets are therefore met more frequently on agreements with land that has higher conservation value. This may in part be due to the statutory management requirements for SSSI land resulting in better conservation management, or greater knowledge of the site.

In a separate report, Jones et al. (2015) comment that in the absence of overarching objectives for an agreement, IoS formed the basis against which HLS agreements were judged. However, field surveyors found IoS were too technical to be of value to most agreement holders (Jones et al., 2015). Boatman et al. (2013) also concluded that IoS were 'a particular problem area' in agreement establishment, and in particular were often set at inappropriate levels (5% of IoS were assessed as set at an inappropriate level, with a further 19% questionable). Less than a quarter of agreement holders reported regularly referring to IoS in the current HLS resurvey (Section 7). Many IoS were considered to be set at too high a level,

or not to be measurable. The finding that many IoS were too technical to be of value to agreement holders (Jones et al., 2015) may be an additional reason why few agreement holders refer to them regularly.

Despite these problems with IoS as currently defined and used in HLS, there is a risk that a drive towards much simpler, more achievable IoS could decrease their value in characterizing environmental quality. The development of meaningful IoS to set rigorous targets that are realistic within the timescale of an agreement and discriminate sites on the basis of environmental quality, while being readily measured and understood by agreement holders, is a critical area for attention in the development of future higher-tier AES. The potential to develop a "payment by results" AES, whereby payments to landowners depend on conservation outcomes rather than on applying management prescriptions, is currently being discussed and piloted in some areas of England (Vicky Robinson, Natural England, pers. comm.). In this context, the urgent need for further development work on IoS or alternative approaches to setting realistic but robust AES targets is even more pertinent.

Did the condition of historic features under HLS management improve between baseline and resurvey?

Too few historic features were surveyed to support a statistical analyses of these data, in contrast to the results discussed above for condition of habitat features. The majority of the two most frequently surveyed historic features improved in condition between baseline and resurvey (Section 5.10 above).

10.2 Discussion and conclusions from HLS agreement holder interviews

A number of important findings and themes emerge from the analysis of the agreement holder interviews.

Diversity amongst agreement holders

The majority of agreement holders surveyed (65%) had previously implemented agri-environmental management independently of formal scheme participation. Often this was 'entry level' activity such as hedgerow management but nevertheless, it marked the start of an 'agri-environmental journey' leading to HLS participation. Excluding ELS, which is almost always a prerequisite for HLS participation, most had also been part of previous schemes (typically the original CSS or an ESA). Based on their agri-environmental management history it was possible to place each agreement holder in to one of four categories (Extensive experience; Low level engagers/'burgeoning environmentalists'; Formal experience only; No previous experience). A majority (40.9%) of survey participants were considered to be Low level engagers/'burgeoning environmentalists', suggesting that the transition to HLS reflects a 'step up' in their agri-environmental management career, which may bring with it new and unfamiliar management challenges. In other words, different agreement holders are at different stages in their agri-environmental career and this in turn suggests that their experience of delivering the same agreement options may differ from others (i.e. what is a challenge to one may be relatively straightforward to another) and that they may have

different understandings of the requirements of their agreements as well as different support needs.

Indeed, a key finding from the research relates to recognising the heterogeneity of agreement holders. This extends beyond the obvious distinction between farmers and non-farmers and includes 'within group' variation as well. In some instances this relates to structural characteristics such as farm/site size and in others it reflects socio-demographic differences. In still others, it is based on experience, motivations and attitudes. The important point being that a 'one size fits all' approach to implementation, support and communication will have limitations. In turn, this points to the need to provide advisors with the means and ability to improve agreements by tailoring them to the needs of the individual agreement holder to a greater extent. This is not the same as only paying agreement holders for what they want to do but is about encouraging greater ownership and tailoring agreements at the local level accordingly.

The importance of relationships

The results point to the importance of developing strong and trusting relationships between NE delivery staff and agreement holders. Those agreement holders who felt that they had control of agreement design talked in terms of 'negotiating', and appreciated project officer flexibility. One agreement holder tellingly referred to "the art of a good advisor". Delivering advice on agreement design is not just a question of translating scientific knowledge. The relationship between agreement holder and advisor is important in and of itself. Where possible these should be long term relationships in order to avoid perceived problems associated with the frequent turnover of staff. An important part of such relationship development is the ability to provide informal feedback and to provide an additional nudge in cases where this is required.

Although recorded in only a minority of cases, to have agreement holders report feeling "bullied", "forced" and "pressured" suggests a need to re-examine the training and development provided for advisors. Advisors need to recognise the asymmetrical power relations between themselves and HLS applicants (which may become more pronounced in a future of less public funding for agriculture) which means that 'force' and 'pressure' may be easily perceived even when not intended.

Understanding motivations

Since the introduction of AES in the late 1980s, considerable research effort has been devoted to understanding the factors affecting farmers' participation in formal AES (e.g. Morris and Potter, 1995; Lobley and Potter, 1998; Wilson, 1996; Wilson and Hart, 2000; 2001; Siebert et al., 2006; Burton, 2014). In common with such research, analysis of the agreement holder survey points to a 'motivation continuum' ranging from financial motivation; a practical fulfilment or fit with existing systems; the desire to continue environmental work and finally, a more altruistic set of motives which prioritises benefits to the environment and other people. The largest single group of agreement holders were those primarily motivated by financial factors; further analysis revealed that those who had been more ambivalent towards HLS were more strongly motivated by financial factors. Motivations amongst non-farm agreement

holders tended to be polarised towards either final factors or altruistic factors. The latter is fairly easy to understand but the former results from a sometimes intense reliance on HLS funding amongst these non-farming respondents and their corresponding organisations; something which appears to have been exacerbated lately in relation to wider funding cuts and austerity.

Turning now to agreement holders experience of and engagement with their HLS agreement, the majority (60%) of survey participants felt that the management prescriptions were suitable for their land (a reflection of the importance of 'goodness of fit' reported above). Many reported that the fit was so good that the HLS agreement had made little or no difference to their management. Although this may raise concerns regarding additionality, in those cases where HLS monies are supporting and reinforcing existing positive management this could be appropriate (and may be at risk in the longer term if financial support was withdrawn – see below).

Clearly though, the perception of many agreement holders was that the fit between HLS prescriptions and their land could be improved. This leads us into a contentious area. If it is assumed that the environmental science behind the prescriptions is correct then that might be considered what is technically feasible under perfect conditions. However, what is socially, culturally and financially feasible could be somewhat different, suggesting a need for negotiation and compromise if agreement holders are to be more fully 'on board' and align themselves with HLS management prescriptions.

If it is assumed that an agreement has been designed correctly for given objectives and that the prescriptions are suitable for the land to which they will be applied, successful implementation requires an understanding by the agreement holder of what the agreement is trying to achieve, alongside motivation and commitment to achieve agreement objectives, and the knowledge and ability to meet agreement objectives.

Familiarity with what the agreement is trying to achieve is a fairly basic starting point here; quite simply, would the agreement holder know what success looks like? IoS would seem to be important in determining this but relatively few (22.6%) agreement holders reported regularly referring to their IoS, with just under one third not referring to them at all. Various reasons were offered for not referring to IoS much or at all, such as they had little influence or were only relevant in the early days of the agreement. As with management prescriptions, IoS are driven by ecological and environmental science and are not necessarily couched in terms that are familiar and accessible to agreement holders (particularly farming agreement holders). IoS that are more relevant to agreement holders might be more likely to be referred to, understood and monitored on an informal basis in order to inform management adjustments.

Confidence in achieving IoS and perceptions of the ease of achieving IoS varied. Not surprisingly, maintenance options were associated with high levels of confidence in achieving IoS. Interestingly though, agreement holders were more confident in their ability to achieve IoS for creation options than restoration options. This is due to a combination of the perception that woodland planting, for instance is 'straightforward' whereas restoring sites that had become severely degraded over a period of years and which sometimes presented

access challenges was harder to achieve. Analysis of ease of achieving IoS confirmed this pattern: IoS for maintenance were regarded as very easy or easy to achieve, while restoration IoS were perceived as harder to achieve than those for creation options.

Agreement holders were also asked about their perceptions of the success of their agreement. Our results indicate that a perceived lack of success of an agreement by an agreement holder is more likely to be associated with financial motivations for HLS participation. Agreements that were perceived to be successful on the other hand, were more likely to be those where the agreement holder felt that they had complete or considerable control over the design of their agreement. In turn, this suggests a greater understanding and 'ownership' of the agreement which may be associated with greater effort and care in its implementation. This is a significant finding in the context of future schemes and broadly suggests that agreements are more likely to be perceived successful from the perspective of the agreement holder when they have had good levels of control or ownership and influence when shaping/designing their agreement.

Concerns

Agreement holders raised a range of concerns regarding the operation of HLS and in doing so often made suggestions for improvement. Concerns frequently related to a perceived lack of spatial and temporal flexibility and a desire for more local and agreement level flexibility around management decision making. Clearly there can be a tension between 'giving back control' and simply paying farmers and other land managers for what they wanted to do anyway but if there is ever to be an improvement in local level ownership then greater flexibility to tailor management to local situations will be important. Agreement holders would still need to be accountable for the use of public funds and this suggests that further work on local level agri-environmental governance would be useful.

Other participants expressed concerns regarding communications with NE, including the impact of a high turnover of advisors which means relationships continually have to be re-established, trust developed, etc. A number of agreement holders were also critical of the administrative burden associated with HLS. Typically, this referred to the amount of form-filling required and/or difficulties with the RPA undertaking compliance monitoring. These are not unfamiliar criticisms. A certain amount of paperwork and form filling is inevitable but options for reducing the administrative burden could form part of a review of agri-environmental governance.

Suggestions for improvements included more regular and timely interactions with NE with advisors in post for longer periods; improved ability to talk to advisors directly via the phone rather than through websites, emails and letters, and a reduction in the complexity of the application and subsequent agreement management processes.

The Future

Looking to the future nearly half (47.8%) of participants stated that they would 'definitely' enter a similar scheme after the end of their current HLS agreement, although only one third reported that they would 'definitely' carry on such work in the absence of a formal scheme.

This differential indicates that a lack of funding for formal AES in the future would be associated with lower levels of environmental management. It seems reasonable to assume that a lack of funding would also be associated with less attention to detail in terms of the agri-environmental management delivered.

Agreement holders that recognised the environmental success or benefit of their agreement were more likely to want to carry on a similar scheme in the future than those who deemed HLS as neither successful nor unsuccessful, unsuccessful or very unsuccessful (79.8% vs. 58.8%). These are some of the most committed agreement holders, who perceive the benefit of their agreement and are more likely to participate in future schemes. In turn, this suggests that helping agreement holders to recognise the environmental benefits of their work has the potential to increase interest in future schemes. Farmers, in particular, will be very good at recognising agricultural success but may be less well placed to recognise environmental success. This provides further evidence to support increased local ownership of schemes as well as perhaps some basic training in monitoring techniques. This could be particularly important if AES move towards greater use of a payment by results basis following the current NE pilot projects.

10.3 The relationship between agreement holders and environmental outcomes

The association between agreement holder characteristics and agreement outcomes is complex to say the least. Our analysis has revealed evidence for some habitat level associations between agreement holder characteristics and environmental outcomes. Links were found between environmental outcomes and the agreement holder's rating for ease of management for specific option(s). These relationships differed with habitat type (grassland and moorland vs. arable options). Analyses at option scale also showed a tendency for agreement holders to be overconfident about achieving IoS, many of which have been shown in previous research to be set at levels that might be considered inappropriate or challenging (Jones et al., 2015).

Our analysis did not indicate an association between agreement holder characteristics and agreement outcomes at the overall agreement level. Given the habitat-specific associations discovered, it is possible that the agreement holder effect is diluted in analyses across agreements covering a range of habitats. Nevertheless, given that agreement holders by definition are responsible for delivering the agreement, they should be included in assessments of current and future schemes. These relationships require further exploration through interviews with agreement holders to capture more habitat or option specific information. This is particularly important if schemes become more locally responsive and/or include an element of results-based payment.

10.4 How effective were the monitoring and analytical approaches used?

The scope of this project was to assess changes over 6-7 years in habitat and plant communities under HLS management. In addition, winter bird use of a limited number of options was surveyed to increase the number of IoS that could be assessed, and condition of a

small number of historic features were assessed (see Section 10.1 above). HLS is a multi-objective AES; for example objectives include positive management of landscapes and public access, in addition to wildlife. Some of these broader objectives were not addressed as they are outside the scope of this project.

The main drawback of the monitoring used in this study was the lack of a linked counterfactual, without which a direct comparison of change over time between the farmland surveyed under HLS management, and farmland not in AES management has not been possible. The baseline survey was conducted a couple of years after the 2007 Countryside Survey (Carey et al., 2008), which was used to enable a comparison of habitats surveyed in the baseline with equivalent habitats in the wider countryside. This showed farmland under HLS management differed to the wider countryside, but that these differences varied with habitat. Most habitats under HLS at baseline tended to be more species-rich, to have fewer ruderals and fewer indicators of fertile conditions as well as a greater component of stress-tolerant species. Habitats with such attributes included woodland, improved and neutral grassland, bracken and arable land, and one could broadly define these attributes as being characteristic of land of higher environmental quality. However, three habitats (acid grassland, bog and fen/marsh/swamp) appeared to show the opposite pattern, with HLS vegetation reflecting more fertile situations where competitors and ruderals have higher cover (Mountford et al. 2013). A separate tailored counterfactual was not conducted in conjunction with the baseline survey, as the assumption was that Countryside Survey would continue to be commissioned at regular intervals and provide a robust counterfactual comparison with any future resurvey of HLS and other AES (as this was one of the key objectives of Countryside Survey).

In the absence of Countryside Survey data collected at a similar time to the resurvey, a detailed and rigorous analysis was conducted here to test the potential to use other, more recent botanical datasets covering the wider countryside (e.g. NPMS; Section 9). This analysis has highlighted the difficulty with using wider countryside data from two time points that are collected with slightly different methods and assumptions, and at different survey sites, for a counterfactual. A unified analysis of HLS, NPMS and Countryside Survey data was not possible. Conclusions have been drawn in relation to counterfactual trends in comparison with the HLS resurvey data in broad-leaved woodlands, but this was less possible for the other, more widespread habitats managed under HLS and surveyed here.

The detailed botanical survey and habitat mapping monitoring approaches used here have been successfully applied to quantify change in habitat extent, habitat condition and plant community composition and attributes between the baseline and resurvey. In addition, changes between the two surveys have been rigorously tested statistically and attributed to a range of drivers, including agreement holder characteristics, geographical characteristics and agreement design and set up. For some options and habitats, small positive changes were detected in botanical attributes, but these changes were not sufficient to meet a threshold required to result in a change in habitat condition or an IoS being met. In addition, positive change between the surveys was sometimes shown in particular areas (e.g. eastern lowlands) or under particular conditions (e.g. when a supplementary option was also applied). Previous recent surveys of HLS have reported results in relation to IoS and habitat condition that are underpinned by botanical data (Boatman et al., 2014; Jones et al. 2015), but did not include

more detailed analyses of botanical data or a range of drivers. The current study demonstrates the value of conducting these more detailed analyses, especially in the context of higher-level AES such as HLS where improvements to some habitats are likely to be slow, and the tailored nature of agreement design and targetting can result in change under some conditions but not others.

With the exception of winter bird surveys, more detailed surveys of the animal taxa that were targeted under some HLS options were not within the scope of this project, which focused on quantifying trends across a large sample of HLS agreements using consistent methods. Options such as HK15 or HK16 are designed to target a range of taxa on different agreements, and these target taxa are better assessed with bespoke monitoring which can be tailored to the target taxa across specific agreements.

Fewer changes were detected in upland unenclosed habitats than in lowland habitats. The monitoring methods used in the uplands differed as a more rapid method built around recording a limited number of attributes at 'stops' was used in unenclosed parcels, while more detailed quadrat data were recorded on all enclosed habitats. Sample sizes were also smaller for the upland unenclosed habitats, which may have reduced the ability to detect change in these habitats. It is therefore difficult to determine whether differences between observed responses in enclosed and unenclosed habitats were due to sample size, sampling method, or a true reflection of differences in the degree of change among the plant communities under HLS management.

10.5 Recommendations

Design and targeting of future higher tier AES schemes

The current project, and other recent surveys of HLS (Boatman et al., 2014; Jones et al. 2015), have in common highlighted the need for better targeting of management options, in particular some grassland options. This has been shown by the number of parcels found to be in condition C at baseline despite entry into maintenance options. The baseline finding that in some cases the quality of semi-natural grasslands had been exaggerated in FEPs was a driver of this (Mountford et al. 2013). New CS higher-tier options have single management options rather than restoration vs maintenance options, but there is still a need for management prescriptions and targets to be defined that are relevant to the starting condition of the habitat entering AES management and provide for progress along the route towards the desired objective.

There is a need for further development of IoS, in terms of setting objectives that are consistently measurable, are more achievable within the timescale of HLS, and can potentially be assessed more readily by agreement holders. Assessments of AES outcomes that can be carried out by agreement holders may be particularly relevant in the context of 'payment by results' as a potential future AES model. However, there may be a tension between the difficulties highlighted with some IoS in the current project, and the need to set IoS that define the ambitious targets necessary to ensure the successful delivery of outcomes

on farmland with high conservation value. This project has also reinforced our understanding of the longer timescales required for restoration of some priority grassland habitats. Consideration of a longer duration for higher tier AES (for example 20 years in four 5-year sections, with reviews and the potential for opt-outs at each stage), might make the achievement of complex environmental outcomes more realizable. There is clearly further development work to be done in this area.

During the agreement holder interviews, the high turnover of NE advisors was frequently raised as an issue. This was also highlighted in the agreement holder interviews reported in Boatman et al., (2014). Regular follow up visits and feedback from NE advisors are valued by agreement holders and should be important aspects of the relationship between agreement holders and NE. Finally, training in AES objectives and the management techniques required to deliver them might support an improvement in outcomes from higher tier AES. Over 40% of the agreement holders we surveyed were classed as Low level engagers/'burgeoning environmentalists', for whom the transition to HLS reflects a 'step up' in agri-environmental management and which may bring with it new and unfamiliar challenges; this group in particular may benefit from training in AES.

Future monitoring of higher tier AES schemes

The indicative finding that links between agreement holder characteristics and environmental outcomes may be habitat / option specific is novel to this project, but needs further exploration. The majority of agreement holder variables tested in this study were not specific to habitats or types of options, as this result was not predicted. The use of generic agreement holder variables, mainly gathered to cover the whole experience of HLS, may have reduced the power to explore potential habitat or option specific links in more detail. Future multidisciplinary research could usefully focus more on agreement holder confidence, perception and experience in delivering specific options or groups of options.

This project has clearly demonstrated the need for a tailored counterfactual to provide a comparison between change under higher tier AES and trends in the wider countryside, given the difficulties summarized above and in Section 9.

Panel predictions made as part of the baseline assessment related positively to many botanical outcomes observed at resurvey, across a range of options. In addition, the baseline panel appraisals of agreement design and set up provided useful explanatory variables in analyses of change between baseline and resurvey, for several HLS options. However, there were instances where the predictions made at baseline were not borne out by the resurvey; for example, assessments of the likelihood of IoS being met that proved over-optimistic, albeit the reasons for this might be complex. This demonstrates the need for repeat surveys to quantify AES outcomes through rigorous analysis of empirical data, rather than an over-reliance on predictive assessments.

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