UK Centre for Ecology & Hydrology

An evaluation of Agri-Environment Scheme impact on hedgerows in England

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1. Executive summary

Hedges are key semi-natural features in agricultural landscapes and increasingly recognised for their contributions to biodiversity and carbon storage, as well as to wider ecosystem services. As a consistent focus of agri-environment schemes (AES) since their inception, it is important to understand how this has impacted on their extent and condition in the context of wider changes in hedge extent and condition. This piece of research addressed the following objectives with the aim of ensuring effective targeting of future AES for hedges:

1.1 Objectives

- *To analyse and compare data from spatially representative field surveys in 2022 and airborne lidar (gathered 2016-2021), to enable an evaluation of lidar use in providing information on current status and changes in hedgerow extent and condition.*
- *To explore geographic differences in the uptake of AES options over time and identify potential drivers of that uptake. This included an exploration of farmer's attitudes and motivations for option uptake and non-uptake.*
- *To put the uptake of hedgerow options in Environmental Stewardship (ES) and Countryside Stewardship (CStew) - by option type and location – into context, taking into account the past and current extent and quality of hedgerows across different landscapes/geographic areas. This included providing data on current extent and quality of hedgerows from a repeat Countryside Survey (CS).*
- *To identify the extent to which AES have contributed to changes in hedgerow length and quality since 2005.*
- *To gain a greater understanding of the priorities for creation, restoration and management of hedgerows, in particular by identifying areas/landscapes where future hedgerow planting, restoration and management could be focused to optimise benefits for the environment and contribute towards Favourable Conservation Status (FCS) of hedgerows*.

The research evolved from a pilot project investigating the potential use of lidar for recording current hedgerow extent and condition and changes in these. Early results showed that there were several constraints to the use of lidar, not least current field data (for calibration and validation) on the extent and condition of hedges.

The pilot project led to a wider project which included a repeat survey of hedges in the GB Countryside Survey squares to update the results from 2007 and provide updated nationally representative information on the current extent and condition of hedges as well as on changes in these since 2007. The survey was also used to provide calibration/validation data for lidar data capturing woody linear features, to inform on what aspects of these features could be reported using lidar data. Overlay of AES information for CS squares enabled an evaluation of the impacts of AES options on hedgerows in CS squares, as compared to hedgerows not under options.

Other aspects of the research aimed at addressing the objectives above included a spatial analysis of Natural England (NE) data on scheme uptake in the context of the current extent and condition of hedgerows and an online farmer/contractor questionnaire.

1.2 Findings

The geographic spread of AES hedge option uptake in relation to the extent and condition of hedgerows in England was investigated at the ITE landclass scale for 4 periods from 2007 to 2022. These analyses show the rise and subsequent fall in Environmental Stewardship (ES) coverage and its replacement by Countryside Stewardship (CStew) which did not contain as many equivalent hedge management options. There was a decrease in the uptake of hedge management options particularly in the east and south of England following the end of Environmental Stewardship. Potentially the inclusion of hedges in AES in these areas had been essential for scoring sufficient points to qualify for scheme entry without losing (arable) cropped area. Aligned with a loss of management options in the east and south of England was a clear increase in hedge planting under Higher and Mid-Tier options and Capital Grant schemes in ES and CStew between 2007 and 2022, particularly in the east and northeast of England. These areas have relatively lower extents of hedges compared to the west and southwest of England, where planting of hedges is limited by the high extent of existing hedges (as reported in the farmer survey). In contrast, restoration options under Higher and Mid-Tier options and Capital Grant schemes were favoured in the west of England where hedge density is highest. These areas are dominated by grassland and livestock farming where hedgerows are valued for retaining stock and providing shelter for animals (as reported in the farmer survey).

Results from an analysis of AES data in the context of CS data from 2007 indicated that hedges entered into AES tended to be in reasonable condition, e.g., the areas with most gaps constituting less than 25% of the hedge (as opposed to more than 25%) were most likely to have a high uptake of planting and restoration options. Results from the farmer questionnaire, showed that planting of hedgerows is not restricted to AES and that many non-governmental organisations (e.g. Woodland Trust) and other organisations provide funding and support for tree/hedge planting.

A repeat survey of the Countryside Survey (CS) squares, last surveyed in 2007, was carried out to provide information on 1) how hedges and lines of trees differ in their extent and quality across landclasses in England, 2) changes in these features since 2007 and 3) the potential role of AES in any differences or changes.

National estimates of the extents of both managed hedgerows (woody unnatural shape) and lines of trees (woody natural shape) showed no significant changes between the current 2022/3 survey and the previous 2007 survey. The longer-term trends for a small decrease in the extent of managed hedges and a small increase for lines of trees was continued in 2022/3. A shift from managed hedges to lines of trees

was consistent across all landclasses in England. Where woody features are already relatively sparse, particularly in the north and the midlands the impact had a proportionally larger effect on remaining lengths of managed hedgerows, hence the increased planting in the northeast found from analysis of the AES data is a positive finding***. There were some positive signs that newer AES are supporting more restoration and planting of hedges. However, overall, our results suggest that between 2007 and 2023 AES did not prevent the deterioration of managed hedges into lines of trees. Hence, they did not contribute to achieving the Favourable Conservation Status goals of increasing the extent of the hedgerow network. As well as insufficient planting of new hedgerows, this is likely to result from a lack of long-term management cycles (restoration) for existing hedges.***

Species composition of managed hedges differed by landclass with hedges in the south dominated by more mixed species than those in the midlands and the north (which are more hawthorn dominated). Hedgerow height increased slightly overall between 2007 and 2022/3, In 2007 most hedges were in the 1-2 m category, in 2022/3 there were more hedges >2 m in height. Overall, the lengths of hedges greater than 4 m in height were considerably higher than those less than 1 m in height for all but 5 of the 21 English landclasses. Hedges under AES options (either management or restoration) in the latest survey were on average 0.2 m taller than those not under AES management. The majority of hedges in 2022/3 were between 1 and 3 m wide, around 10% of hedges in the south-west landclass 6e were over 3 m wide.

The most widespread management recorded for mapped hedges was recent cutting with a flail. This was slightly greater for hedges not in AES (79.7%) than for those under AES management options (71.6%). ***Average woody species richness did not change between 1998 and 2022/3 and was not affected by AES options***. ***Herbaceous species richness (in the hedge base plant community) decreased slightly from 2007 to 2022/3, continuing a longer-term trend from 1990.*** This did not differ between hedges under AES options and those not under AES.

Overall, the results indicated that hedgerow condition improved between 2007 and 2022/3 and that AES had a positive impact on hedge condition. Whilst hedgerows in England fall well short of meeting Favourable Conservation Status for habitat quality (95% of features in good condition), there are positive signs that engagement with AES will help to progress towards this target. Management and restoration to improve quality remain a priority for hedgerow conservation and policy. The percentage of hedges in England meeting structural condition criteria increased by 12% (2007: 43.1%, 2022/3: 55.2%). There was a greater increase in hedges meeting both structural and margin condition criteria between the two surveys, though over half of hedges surveyed still failed to reach good condition in this combined category (2007: 14.4%, 2022/3: 40.2%). ***A greater proportion of hedges under ongoing AES management options were in good structural condition (63.5%) than hedges not in AES (46.8%) in 2022/3.*** This

appeared to be due to increased width under management (and hence crosssectional area) and wider margins. A lower proportion of hedges under restoration options met structural condition criteria (31.6%). This is not surprising given the mapped hedge data showed more than half of these hedges were yet to be restored, and that these options within Countryside Stewardship and Environmental Stewardship target hedges in poor condition. Condition data indicate that AES may be part of the reason for improvements in hedgerow condition. However, it is possible that other initiatives, including the NFU campaign for Net Zero which encouraged farmers to grow wider hedges[1] may have also played a role.

The farmer survey indicated a desire from farmers to maintain their hedges both for farming purposes (to contain stock and improve welfare) and for wildlife. ***Participants with hedges in AES were more likely to manage their hedges with a combination of laying and cutting than those with no hedges in current AES, who were more likely to use a flail.*** Annual cutting of some hedgerows on the farm was the most common management (47%) with annual cutting of all hedgerows at 25%. Participants who were not in current AES were less likely to have restored a hedge than those in AES. ***Farmers reported an ongoing need for adequate financial costs for planting, establishment, restoration and ongoing management of hedges (including labour)***.

The substantial response we had from contractors to the survey highlighted that this group do not get adequately consulted. Contractors have more responsibility for hedge management than any other group (including farmers). They told us that the agri-environment schemes had been designed without their input and reported numerous issues with managing hedges as per prescriptions, including impacts on machinery, time taken, land access issues due to timing and business viability (reduced regular work).

Both surveys highlighted the importance of consultation with the appropriate groups in scheme design including contractors. They also highlighted the potential advantages of investing in farmer or contractor training in hedgerow management or knowledge exchange in line with prescriptions. This could include passing on research evidence and practical guidance from experienced hedge restorers to broaden the knowledge base on hedge rejuvenation and restoration and effective planting and subsequent management. Contractors could play a key role in achieving FCS for hedgerows, thereby sustaining their businesses and enhancing the farmed environment.

The repeat of the Countryside Survey, together with the work carried out to investigate its use alongside lidar data emphasise the key importance of longterm nationally representative datasets. Neither CS hedgerow data collection

[1] National Farmers Union. (2019). *Achieving Net Zero: Farming's 2040 goal*. https://www.nfuonline.com/nfu-online/business/regulation/achieving-net-zerofarmings-2040-goal/

nor lidar collection are currently part of ongoing funded monitoring programmes. Whilst new data will be collected in the England Ecosystem Survey (EES), it's compatibility with CS and its robustness (volume and representativeness of data) are yet to be tested. A strategic monitoring programme combining sample based and national extent data (lidar) is essential to track ongoing changes in hedgerows and in the success of AES in helping to achieve Favourable Conservation Status. ***As well as this, AES databases that can be easily interpreted, queried and integrated with external data are of key importance***.

2. Introduction and project overview

Hedgerows are the most significant semi-natural landscape features in our agricultural habitats; they were listed as a habitat of principal importance for biodiversity conservation under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 (England) and remain one in 2022[2]. As well as providing vital habitats for biodiversity in their own right (Staley et al. 2020), they are also important for the connectivity of landscapes and as a carbon store (both above and below ground, Biffi et al. 2022, 2023). Information on their current status and condition and how they relate to historic status (as measured in Countryside Survey 2007 (CS2007) and previous surveys dating back to 1978) is lacking. Hedgerow structural condition, largely determined by management, is known to be key in supporting a range of plant and animal taxa (Graham et al. 2018), yet CS2007 found nearly half of GB hedges were in poor condition (Carey et al. 2008). Hedgerow management has been a key aspect of agri-environment schemes (AES) since they were first introduced and has attracted high levels of uptake and hence considerable government investment (Hodge et al. 2010, Staley et al. 2012). It is important to understand how this level of investment relates to changes in hedgerow extent and condition at both national and regional scales. The attitudes and motivations of farmers are essential factors influencing hedgerow management, as has been found in previous studies (Britt et al. 2000). Understanding how these may be contributing to change in hedge extent and condition is critical for ensuring positive change in the future.

This project assessed how Environmental Stewardship (ES) and Countryside Stewardship (CStew) have influenced the current extent and quality of hedgerows, within the wider context of English hedgerows. The initial project included a scoping component which explored the efficacy of different approaches for measuring change in the extent and condition of English hedgerows. For many decades the GB Countryside Survey (a field-based survey; CS) has been the only dataset available for tracking changes in hedgerow extent and condition. More recently other possible datasets have emerged, namely those derived from Earth Observation (EO) data. In 2016 a woody linear feature framework for GB was released[3] (Scholefield *et al.* 2016) which used aerial imagery in combination with a spatial framework informed by CS field data. In 2017 a hedgerow data product developed by OS (Ordnance Survey) for the Rural Payments Agency, to enable checks on AES claims was completed. In 2024 UKCEH produced a lidar based product using Environment Agency (EA) lidar data collected up to 2021 for England (Broughton et al. 2024). This project explored the use of both field (CS) and EO data for reporting on hedgerows.

[2] https://www.gov.uk/government/publications/habitats-and-species-of-principal-importance-inengland#full-publication-update-history
[3] https://catalogue.ceh.ac.uk/documents/d7da6cb9-104b-4dbc-b709-c1f7ba94fb16

Task 1 explored the potential use of lidar data for monitoring hedgerows, through comparison with Countryside Survey (CS) field data (Section 3 below). One key constraint of that work was the difficulty of getting adequate coverage of lidar data that were collected at the time of the CS2007 field survey. The release of a new comprehensive England-wide lidar product in 2022, comprising data collected over a short time-period across 2016-2021 and a pilot field survey in 2022 (comprising 37 CS squares) enabled a reasonably concurrent comparison of datasets, reported on here.

Task 2 of the project followed the Task 1 scoping study and involved refining the design and costing for a set of approaches for effectively extending the CS timeline of hedgerow change and gathering data on impacts of AES.

Task 3 involved the implementation of the chosen approaches. The approaches chosen included both i) an initial pilot survey of 37 CS squares containing hedges in England in 2022 and ii) a complete re-survey of all other CS squares with hedges in England (211, making 248 squares in total) in 2023. The pilot study both trialled the field survey (methods and costs) and evaluated the potential of the data collected, alongside lidar data from Task 1, to provide sufficient information to evaluate; 1) contextual change in hedges and 2) the impacts of AES on change (section 5). A field survey of hedges in the remaining squares containing hedges (211) in England took place in summer of 2023. The results of the full re-survey of CS squares, an analysis of state and change in the extent and condition of hedges to 2023 and an evaluation of the impacts of AES on hedgerow change comprised Task 5 (reported in Section 5). To enable the evaluation of the impacts of successive AES on hedgerows between 2007 and 2023, we worked with NE to identify where ES (2005 onwards) and CS (2015 onwards) options were taken up on hedgerows in CS squares (Section 5).

Task 4 of the project explored the geographical extent of AES uptake (historic and current) in relation to the spatial extent and condition of hedges. This included an analysis of uptake data (grouped into management, restoration and planting options) alongside hedgerow extent data as estimated by lidar (Broughton et al 2024) and CS data on hedgerow extents in 2007 (expressed as length per km square).CS 2007 data on hedgerow favourable conversation status condition criteria (height categories and gappiness) were also mapped. This analysis provides spatial data for identifying the factors which influence AES hedgerow option uptake (Section 4).

Task 6 focused on understanding the barriers and motivations to farmers taking up options on hedgerows under AES. This research was carried out through online surveys of both farmers and contractors. Interestingly, although the research originally aimed to target a larger sample of farmers and a smaller sample of contractors, more responses came from the contractors. Co-incidentally, the Council for Protection of Rural England (CPRE) had commissioned a survey through Farmers Weekly to gather information on how farmers view their hedgerows and how they manage them on their farms shortly before UKCEH were about to put out their

survey. The CPRE survey covered over 1000 respondents and aimed to understand how best to incentivise farmers and landowners to enhance hedgerow networks through AES. The UKCEH survey was thus adapted to complement rather than repeat the CPRE survey and to gain a better understanding about the current status of their hedgerows and their management of them, both under AES and outside of them. The CPRE kindly allowed access to their data and therefore, where sensible, survey results are compared (Section 6).

3. Scoping pilot field survey and lidar data

This work was undertaken as part of an exploration of the potential for lidar to provide relevant and adequate information on hedges to inform policy around their management, i.e., the following objective:

- *To analyse and compare data from spatially representative field surveys in 2022 and airborne lidar (gathered 2016-2021), to enable an evaluation of lidar use in providing information on current status and changes in hedgerow extent and condition.*

It followed from a small research project (preceding this contract) which investigated whether lidar could be used to look at changes in hedges between 2005 and 2021. That project concluded that a lack of lidar data for 2007 (when field recording of hedges in Countryside Survey (CS) was last carried out) and a lack of current field data on hedges (with which to calibrate/validate the lidar data) made the use of lidar impractical for this purpose. The repeat of CS, which was part of the contract reported on here, provided an opportunity to explore the potential use of two relatively contemporaneous datasets, one field based and one lidar, to provide national information on hedges.

3.1 Creating a lidar linear woody network for England

3.1.1 Introduction

Between 2016 and 2021 the EA completed a national lidar programme that provides standard 1-m resolution raster products for the whole of England (with some small gaps). This provides a uniform national lidar product at moderate 1-m resolution, derived from a lidar point density of approximately 1 per metre. The vertical resolution of the data is 1 cm, with a reported accuracy of under 15 cm for solid surfaces. The lidar data were collected from an aircraft-mounted platform during mostly leaf-off conditions during autumn and winter, which was optimised for the EA's requirements to observe land surfaces and water channels under minimal obscuration from tree canopies or summer vegetation.

Despite some limitations, these data are by far the best option for integration with a national mapping project such as CS, offering consistent national coverage and supporting the EA's ambition of future re-surveys. The EA lidar data are aligned to the Ordnance Survey spatial framework, so are highly compatible with OS mapping and derived products.

The collection of pilot field data from 37 1 km squares in 2022 (details in Annex 2) enabled an evaluation of relatively closely temporally aligned data from both the CS field data and the Environment Agency (EA) lidar data.

3.1.2 Methods

3.1.2.1 Identifying linear features from the EA lidar data

The full EA lidar coverage for England was obtained as a pre-processed canopy height model (CHM) 1-m resolution raster, predominantly in 25 x 25 km tiles. This required 350 GB of storage of the GeoTIFFS. The CHM is derived by subtracting the digital terrain model (DTM), which depicts the elevation of the ground surface, from the digital surface model (DSM), which depicts the elevation of the features in the landscape, such as vegetation or buildings. The CHM therefore smooths out the ground elevation and leaves the heights of features on a flat plane, such as trees, hedgerows and buildings.

A workflow was developed on a subset of data before scaling up to 37 CS squares that were surveyed in 2022 (Annex 2) and fell within the coverage of the EA lidar. Scaling up the processing required extensive computing power, and the JASMIN supercomputer was utilised for this purpose. The workflow involved a series of standard GIS processes, predominantly buffering and masking, to extract height values from the CHM that were most likely to represent linear woody features.

The existing CS linear framework is not seamlessly compatible with the lidar, due to variable spatial misalignment between CS, EA lidar and Ordnance Survey frameworks. All of these datasets have some inherent spatial inaccuracy (typically in the range of metres) that is compounded when they are combined or compared. A suitable spatial framework that is freely available can be derived from the UKCEH Land Cover Map (LCM, Morton et al. 2021). This framework is ultimately derived from Ordnance Survey data but is sufficiently modified during processing to be a unique in-house product. The LCM framework delineates parcels of different land use classification, typically following natural and anthropogenic boundaries, such as roads, woodland edges, fields and water bodies. As such, the LCM 2020 framework provides a useful base on which to create a woody linear network from EA lidar data, which should not be very dissimilar from the framework used by Countryside Survey.

Due to the ‘noise’ and complexity of features in towns, villages and hamlets, those areas defined as urban or suburban classifications in the LCM 2020 were masked out, to exclude them from analysis. Similarly, polygons classified as woodland in LCM 2020 were also masked. This meant that the lidar analysis would aim to depict linear woody features in rural but non-woodland areas.

Briefly, the processing workflow for extracting linear features from the EA lidar CHM are as follows:

1. CHM height values were filtered to remove values <1 m tall. This removed ground vegetation and noise.

2. Reclassify remaining CHM values into height categories used for CS linear features, as shown in Table 3.1. This filtering and reclassification gave a rough depiction of hedgerows and non-woodland trees in raster format.

Table 3.1. Height categories used to reclassify CHM raster values to match CS.

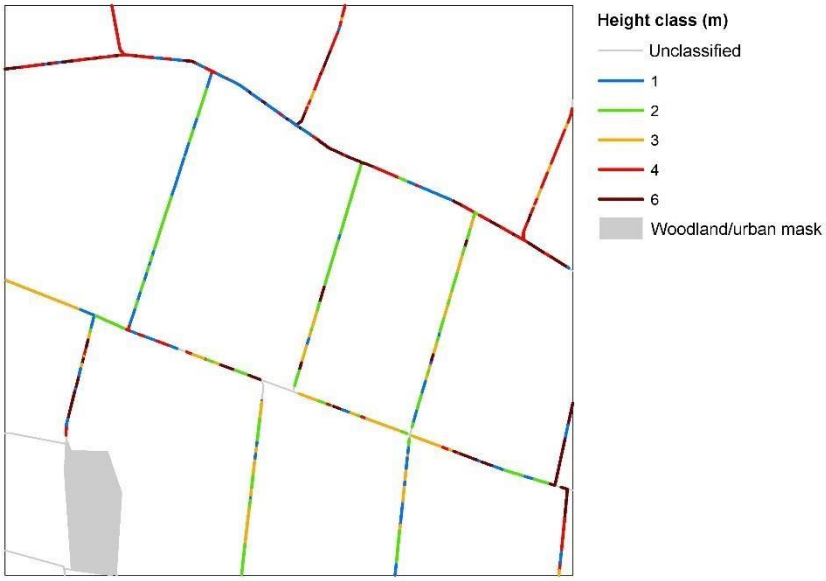
Original height values (m)	New classification
1.00 – 1.99	1
2.00 – 2.99	2
3.00 – 3.99	3
4.00 – 5.99	4
6.00 >	6

3. These data were then converted to vector polygons and smoothed to reduce the complexity.

4. The vector polygons were then snapped to the LCM 2020 linear framework, which acted as a network on which to project the height value polygons. A 20 m tolerance was used around the LCM 2020 framework, to allow for mapping inaccuracy, which essentially reclassified the boundaries in the LCM framework as linear woody features where these occurred coincidentally or close by.

5. The line features in the LCM framework then become segmented into the height classifications (Fig. 3.1).

6. An algorithm estimated whether linear features were single lengths or double lengths (such as a hedgerow on either side of a lane) based on the lidar features. This was applied to the feature attributes and created the final lidar linear woody features (WLF) model.



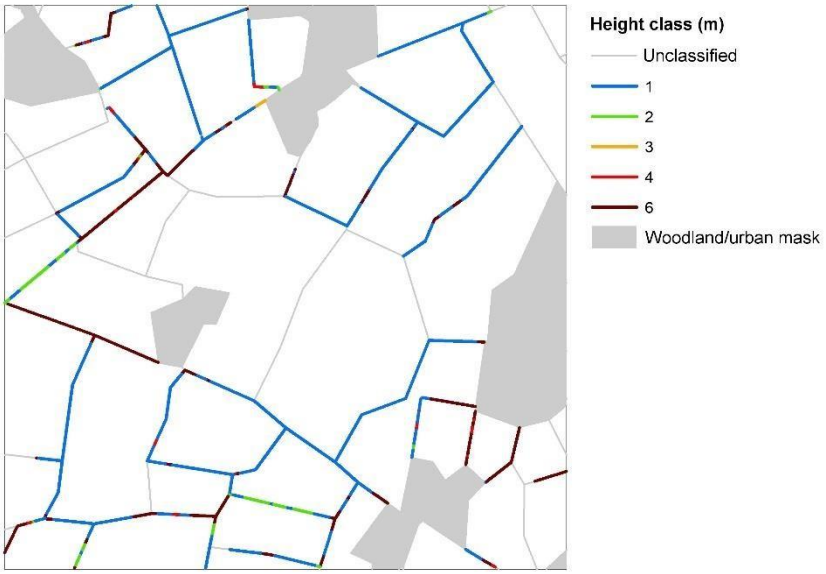


Figure 3.1. Two examples of CS squares with a linear woody features model derived from EA lidar using the LCM 2020 framework. Unclassified linear features are those below 1 m in height. Height classes reflect the minimum height of each class (m).

3.1.3 Results

3.1.3.1 Comparison between lidar woody linear model and Countryside Survey

Feature lengths

To assess the linear woody network of 37 CS squares against the lidar WLF, we used spatial analysis to make a direct comparison of the relative lengths and height classes of features between both datasets. In effect, the CS data were used to 'ground truth' the lidar WLF, although it is important to note the caveats of CS, which has its own inaccuracies, differences and generalisations deriving from its methodology and spatial mapping. Nevertheless, a close agreement between datasets would mean that the lidar WLF model has the potential to complement or replace some CS monitoring.

The comparison was made by designating the CS as the primary data, and then seeing how well the lidar WLF matched it. There was a reasonable agreement between the two datasets, but with some obvious differences (Fig. 3.2). Notably, the CS data contained features that fell within the woodland and urban mask, which was explicitly excluded from the lidar WLF model. Although in CS surveyors are asked not to map features which are in the curtilage of 'urban' areas or those that border woodland, interpretation of this on the ground is clearly different to that from the EO data.

To quantify the agreement between datasets, a 20 m buffer was set around the linear features that were surveyed in 2022 in the CS squares, which acted as the tolerance for a match if any lidar WLF were within that range. Across each of the 37 CS squares, the overall summary length of matching linear features was compared

between datasets. The percentage agreement between summary feature lengths across all squares for the CS and lidar WLF model was generally reasonable, and this was improved if only comparing features from both datasets that occurred outside of the woodland/urban mask (Table 3.2). The discrepancy between datasets was largely due to the lidar WLF model underestimating or not detecting features, rather than over-estimation, and false positives were rare.

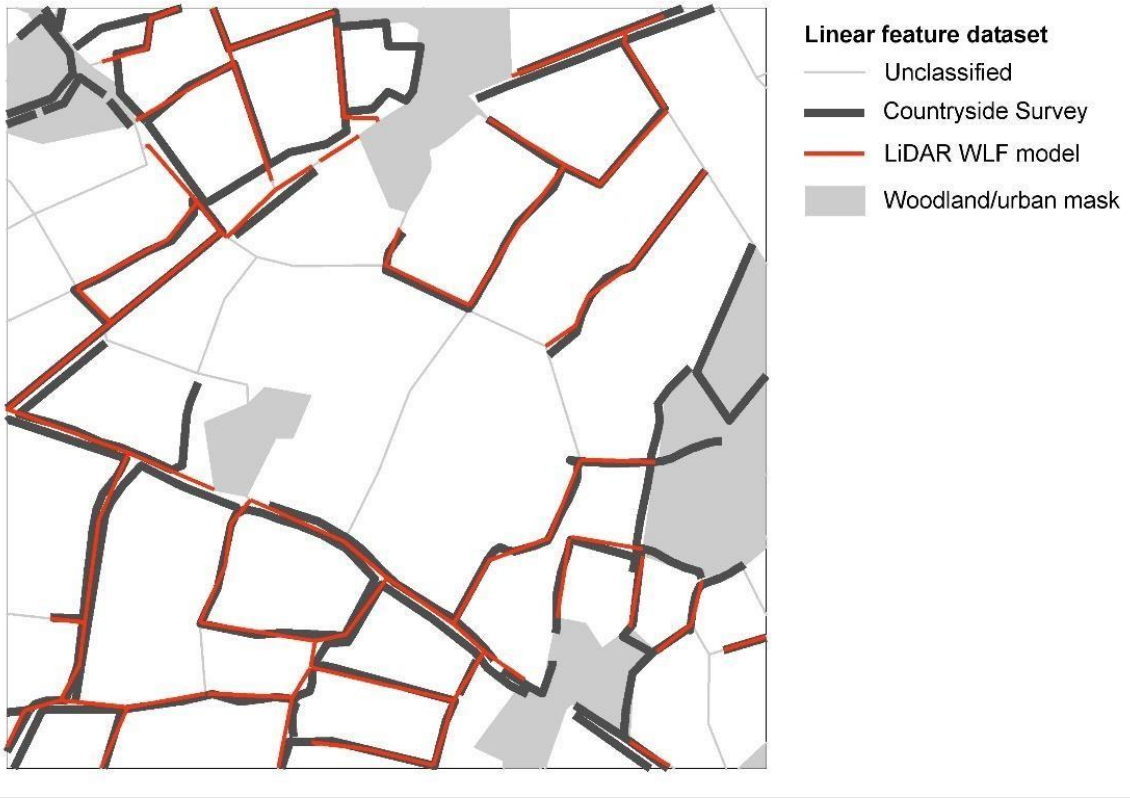


Figure 3.2. A general comparison between woody linear features in the CS and lidar WLF model, showing a general broad agreement across most features. Note the CS features within the woodland/urban mask, which was excluded from the lidar WLF model.

Table 3.2. Comparison between linear feature lengths in the CS and lidar WLF models, summed over 37 CS squares. Values given are the sum lengths of features across all 37 squares, the means with standard deviations, and the percentage agreement of the lengths in lidar WLF model compared to CS (within a 20 m tolerance of CS features). The agreement is corrected for over-estimation by subtracting features in the masked areas.

Length (km)	Countryside Survey	Lidar WLF model	% agreement
All features sum	232851	181683	78.0
Mean (SD)	6004 (2937)	4781 (2611)	75.5 (16.0)

All features (excluding masked areas) sum	213907	181683	84.9
Mean (SD)	5629 (2703)	4781 (2611)	78.7

As can be seen from Table 3.2, the improvement in agreement across all features and squares when comparing only like-for-like areas, i.e., outside of the masked woodland/urban areas, gave good results (Fig. 3.3). A 78-79% agreement in metrics between remote sensing and ground surveys can be considered as successful. Essentially, this showed that the summary lengths of woody linear features could be detected by lidar to a similar, but slightly lower extent as for CS. This would allow a reasonably comparable assessment of the sum length of linear woody features using either method, which could potentially be used to detect broad changes in overall length at a per-square or national scale. It is likely that the lidar assessment would be an under-estimate given 1) that it would (probably need to) screen out areas in which CS does record and 2) it may not capture double features (either close together or co-located, e.g., a line of trees or individual trees above a hedge).

Figure 3.3. A general comparison between woody linear features in the CS and lidar WLF model excluding those CS features within the woodland/urban mask, which gave a significantly better agreement compared to Figure 3.2 (see also Table 3.2).

Feature heights

Height values were more difficult to compare, as the lidar WLF model was at a much greater precision than the CS. In the lidar model, this allowed the depiction of height class variation over short stretches within a longer linear feature, such as taller parts of a hedgerow or small hedgerow trees emerging above the hedge canopy. Variation in a single CS feature (i.e., a woody linear feature in which trees take their natural shape (line of trees) or a woody linear feature in which trees do not take their natural shape (hedge)) would likely be generalised to a single height class for each feature on visual assessment by a surveyor, as the measurement and reporting of this detailed variation would be impractical during a field survey. However, field surveyors would record the presence of these features separately and of individual trees within a hedge, even if they were co-located, so the way in which the data is captured would be different and would provide different information.

Height classes of features were compared by identifying the central point of each separate stretch of classified feature in the lidar WLF model and comparing its height class against that of the corresponding CS feature, i.e., the adjacent line feature within the 20 m tolerance. The timing of data collection varied between CS and the EA lidar, with up to 5 years difference, and so a high proportion of exact matches were not expected. As such, a tolerance of a height class either side of the CS feature's class was also quantified in the lidar WLF model.

The results of the feature height class comparison (Fig. 3.4) show that there was indeed a relatively low rate of exact matches between features (27% overall). The percentage of matches using the class tolerance (accepting one class above or below) was moderate at 60% overall, although all categories had a match better than 50%.

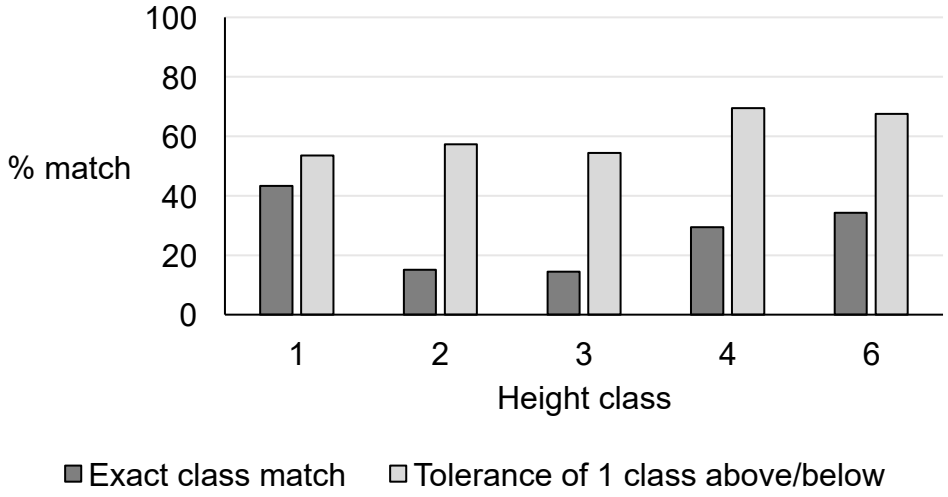


Figure 3.4. The match between the height class of individual segments of linear features in the lidar WLF model compared to the corresponding linear feature in the CS data. Included are an exact match of height classes between features, and also a tolerance of one class above/below for the lidar WLF. Comparisons are for 4846 individual features.

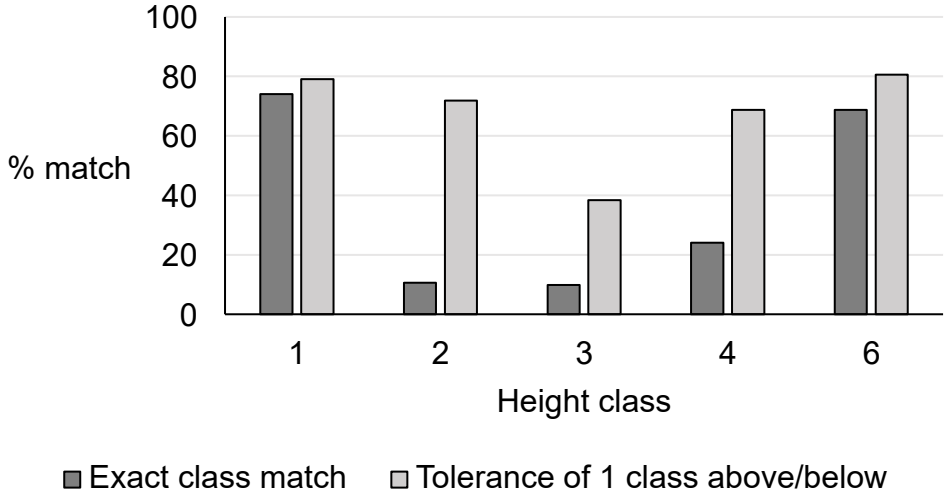


Figure 3.5. The match between the dominant height class of linear features in the lidar WLF model compared to the corresponding linear feature in the CS data. Included are an exact match of height classes between features, and also a tolerance of one class above/below for the lidar WLF. Comparisons are for 1006 individual features.

An improvement in height comparisons were made when the linear features in the lidar WLF model were de-segmented to remove the fine-grained variation, and instead the dominant height class (based on greatest length) among the individual segments was applied to the entirety of each longer feature, similar to the more generalised classification in the CS (see Fig. 3.1). These results (Fig. 3.5) showed the exact match had now improved to 38% overall, with an improved match of 68% where a tolerance of one class above/below was allowed.

In both assessments of height class matching, the best agreement tended to be shorter hedges in height class 1 (i.e., up to 2 m tall), and also in the tallest class 6 (i.e., over 6 m tall). Respectively, these classes would generally correspond to managed farmland hedges of 1-2 m tall and tree lines of 6 m and taller, although together these only accounted for about 40% of all CS features that were assessed.

Other condition metrics

The lidar WLF model was not tailored to assess gappiness in hedgerows, and this was not assessed directly in this trial. However, the results show that the model should be able to achieve a metric of gaps in linear features, if the adequate data queries were set up. Specifically, the high precision of the height classes meant that fine grained variation in height was detectable, which could include gaps greater than approximately 15-20 metres. This does not fit with the <5 m condition criteria for hedges used by the Hedgerow Action Plan (now Hedgelink) group (Staley et al. 2020). Issues regarding the height and type of vegetation between hedge

components and within the 20 m tolerance affect the possibility of assessing gaps <5 m.

Feature width was also not assessed, and this would be unrealistic with the current lidar data that was at 1 m resolution. This resolution would be too coarse to detect width except a very broad categorisation of very wide features (in the tens of metres, such as mature tree lines) and narrow features, such as managed hedgerows. However, these features would be better indicated by the height class in any case, and so deriving width from the current data would be rather redundant.

3.1.4 Discussion

Creating a lidar WLF model presents significant challenges in data handling, storage and processing. The use of large storage capacity and advanced data processing with JASMIN gave the capability for national, high-resolution modelling.

For the assessment of the basic metric of linear feature presence and length, the model had good agreement with the CS field data, at around a 79% match in summary length per 1 km square. On a basic level, this gives strong support for the use of the EA lidar for quantifying the distribution of linear woody features at a national (England) scale.

However, the lidar model had limitations in its coverage within squares, such as the masking of woodland and urban polygons from the Land Cover Map that obscured about 8% of the CS feature lengths. As such, a transition towards using lidar to extend and support field survey would have to involve a re-assessment of which areas and features within existing CS squares could continue to be monitored.

Using a spatial framework of a linear network on which to base the model also means that the lidar is unable to easily handle double hedgerows, such as either side of a road or lane. This was handled in the current model by assigning a ‘double hedgerow’ tag to single linear boundaries, where CS recorded double features in the training data, but this was only partially successful, i.e., in testing, the model was unable to consistently recognise where double features occurred. Further limitations occur where the canopy of double hedges meets to form a single thick feature when viewed from above, or when lines of trees and hedges are co-located. There is no simple way that the current lidar data can overcome this problem, although future availability of high-density point clouds would probably offer a solution (but would dramatically increase the data storage and processing issues).

The height comparisons between CS and the lidar WLF model showed less agreement than for length. This was perhaps predictable to some extent, as there was a time difference between data collection that could have produced real differences due to cutting regimes or growth. However, the height classes were quite broad (several metres), and even giving a wider tolerance of including the class above/below the target still only produced agreement of around 60% on average.

Taller and short features showed the greatest agreement, possibly because their real heights were likely to change the least.

The comparison of height classes encompassed significant uncertainty. Firstly, there was uncertainty in the lidar data, and whether the feature height was adequately represented during leaf-off conditions when the targets present a more diffuse surface. The woody density of closely trimmed hedges would provide a relatively dense surface to intercept the lidar laser pulse, but young trees would be largely invisible at a 1 m resolution if they had shed their leaves.

Furthermore, the CS height data may not have been ideal for ground truthing the lidar model, as single long features tended to be assigned with a single height class for their entire length, reducing the precision and complexity detected with lidar. In this sense, the lidar had more precision than the CS, but it is a matter of debate over which dataset was the more accurate at the time of data collection. Ideally an exercise which directly compared field measurements of hedge height with simultaneous lidar measures should be carried out to better relate these two measures, noting that hedge height changes regularly.

The differences in timing of data collection, detection and recording would have produced additive compounding differences that would have manifested themselves in the apparent mismatch. Despite this, the overall result for feature detection and length summary, and, to a lesser extent, height classification, was perhaps quite promising. However, it is clear that lidar data cannot simply ‘take over’ from the manual CS to produce a seamless continuity. Instead, the metrics and baselines collected would need to be adapted to the strengths and capability of the lidar data and associated modelling, although continuous improvements can likely be expected over time.

Consequently, adoption of lidar based monitoring would also likely involve establishing a new or adapted methodology for CS that diverged from the previous one. The costs and benefits of this, including a loss of retrospective temporal comparisons and a potential increase or improvement of the precision and detail of some available metrics would have to be taken into consideration.

Analyses of change in hedgerow condition will require data for a range of attributes (Staley et al. 2020), some of which require ongoing field survey to collect (e.g., nonnative woody and herbaceous species (see Section 5)). While the analysis above applies to estimates of hedgerow extent and height, and potentially gappiness, lidar data cannot support a full analysis of hedgerow condition.

Finally, although lidar offers substantial benefits for large-scale hedgerow monitoring, field survey remains the only assured repeatable method of monitoring until considerations of repeat lidar surveys are resolved. However, developing the lidarbased approach as a baseline framework, alongside continued field survey, would allow for future calibration, integration and potential transition to new methodologies. It is important to note that lidar is only viable as an ongoing hedgerow analysis tool if there are repeat national surveys by the Environment Agency (EA) on a regular basis (e.g., every 5 years). The EA has ambitions for such a rolling

programme, and there would undoubtedly be demand from a wide user base (e.g., forestry, academic community), but this is dependent on national funding.

3.2 Release of an England lidar-derived hedgerow map since scoping work was undertaken

UKCEH released a map of hedgerows in England in January 2024, derived from Environment Agency lidar data (Broughton et al. 2024). The map data are available here:

https://catalogue.ceh.ac.uk/documents/d90a3733-2949-4dfa-8ac2-a88aef8699be

Initial scoping and method development for the use of these data for mapping hedges was undertaken partly under this project (and under National Capability funding through UKCEH) in 2022, as reported above, and tested against field mapped data from 37 of the CS 1 km squares that were surveyed during a pilot in summer 2022 (see Annex 2 for pilot survey details). The scaling up and processing of lidar data to produce a full national map was then completed under a separate project (see supporting information in Broughton et al. 2024 for full details). Use of the LCM 2020 framework enables any newly created lidar woody linear network to fit seamlessly into the established UKCEH family of spatial products, including the regularly updated time series of Land Cover and Crop Maps.

3.3 Potential future work

Temporal consistency in data is a key challenge to 'ground-truthing' lidar data. Since this scoping work was undertaken with field data from the 37 pilot survey 1 km squares visited in 2022, a further 211 squares had field data collected in 2023. There would be potential to ground truth the national lidar dataset released in January 2024 against this larger dataset of field data from 248 squares surveyed in both 2022 and 2023, to derive more accurate estimates of how closely the lidar and CS mapped hedgerow data agree, notwithstanding the temporal mismatch between the two datasets discussed above.

In addition, if the EA collect national lidar data again in future, there would be the potential to produce an updated lidar map and assess change since 2016-2021 when the existing lidar dataset was collected. Inevitably any such evaluation would need to incorporate uncertainties within the data resulting from survey timings (e.g., time of year and/or time of day).

4. Hedgerow AES option uptake

4.1 Introduction

The aim of this part of the project was to identify the geographic spread of AES hedge option uptake in relation to current extents of hedgerows and, where information is available, to the condition of those hedgerows. In doing so, it aimed to show whether the schemes are addressing a lack of hedgerows or poor hedgerow condition in particular areas.

Contributing to objective:

- *To identify the key drivers behind any geographic differences in the uptake of AES options.*

4.1.1 Hedgerow AES options (2005-2022)

Hedgerow AES options from 2005 to 2022, aimed at improving hedgerow condition were a key biodiversity delivery mechanism of the schemes. The prescriptions and management actions required by farmers for most hedgerow options throughout this time were preserved despite changes from the Environmental Stewardship to the Countryside Stewardship Scheme. Support for management approaches which encourage less frequent cutting on a rotation at times that enhance berry or flower production remained consistent (with only minor changes) across this period.

However, differences in terms of the priorities of the schemes may have impacted on the uptake of hedgerow options in terms of the number of points available for different options and the associated levels of funding.

When Environmental Stewardship was introduced in 2005, there was an overall objective for a unified agri-environment scheme, with a ‘broad and shallow’ tier. This meant that for Environmental Stewardship and especially Entry Level Stewardship (ELS) management prescriptions were designed to allow easy access to schemes and to incentivise participation in them. The widespread adoption of ELS from 2007 which peaked around 2012 included hedgerow options EB1 and EB2 - hedgerow management for landscape (on single or both sides of a hedge).

As part of a 2010 Government spending review and as a result of findings from ongoing monitoring, the Making Environmental Stewardship More Effective (MESME 2013) project was commissioned. It looked at improving the effectiveness of Environmental Stewardship schemes and the outcomes of this were included in schemes agreed from 2013. Specific changes to hedgerow options included (1) a new option for small scale hedgerow restoration (inside and outside the Severely Disadvantaged Area) and (2) a reduction in points for ELS hedgerow management.

In 2016 Countryside Stewardship was launched; unlike earlier schemes some aspects of the scheme were competitive, and applications were scored against criteria, with not every application being guaranteed success. Countryside Stewardship included Mid and Higher Tier elements alongside 1–2-year capital grants which included small–scale restoration of boundary features like hedgerows to a maximum of £5000. Options that were included in ELS (EB1 and EB2) were subsequently removed from Countryside Stewardship when evidence suggested that they produced no benefits above management as usual (Staley *et al.* 2018).

The time series of data covered here do not capture more recent changes to agrienvironment schemes with the introduction of Environmental Land Management schemes (ELMS) which have incorporated some novel and complex hedgerow management standards into the Sustainable Farmer Incentive programme including annual incremental cutting; leaving hedgerows uncut for longer; assessing and recording hedgerow condition; maintaining existing hedgerow trees or establishing new ones.

Three types (or groups) of options are considered here; a) management, b) restoration and c) planting.

4.1.1.1 Management options

Both Environmental stewardship (Entry and Higher Level) schemes and Countryside Stewardship options encourage rotational management of hedges with a restriction on the frequency of cutting. Cutting is also restricted to periods that do not overlap with the bird breeding season. Management prescriptions of hedgerow with high environmental value encourage management that supports target species of farmland birds, insects or mammals, such as the tree sparrow, brown hairstreak and dormouse. Prescriptions also aim to maintain hedgerows that make a significant contribution to the local landscape character and/or are historically important boundaries.

4.1.1.2 Restoration options

Restoration options cover coppicing, laying hedgerow trees/shrubs (Figure 4.7) and filling in gaps >20 m long in established hedgerows known as gapping up. Restoration is seen as important in providing stock proofing of boundaries, improved connectivity by shortening gaps and structural complexity within individual hedgerows for benefits to biodiversity and carbon sequestration.

4.1.1.3 Planting options

BN11 is the current Countryside Stewardship planting option and is available under Mid Tier, Higher Tier and Capital Grants. Within prescriptions it is said to be available for the following criteria:

- sites of former hedgerows - as shown on historic maps or other records
- sites where creation would extend or link existing lengths of hedgerow
- sites where creation will help reduce soil erosion and runoff
- sites close to slurry or digestate stores, livestock housing or free-range areas for poultry or pigs where creation will help capture ammonia emissions
- can only be used when the applicant has “management control” of both sides of the boundary (Gov.uk BN11).

4.1.2 Data on hedgerows

Data on hedges are used to provide some context around the state of hedges during the period over which these agri-environment schemes have operated. These data include the UKCEH Land Cover Plus: Hedgerows 2016-2021 map (England) (UK Hedgerow Map, see Section 3.2) and data from the CS2007 Countryside Survey. Both datasets are described below (4.1.2).

4.2 Methods

Analysis of NE data on AES agreements was carried out at the landclass level because landclasses underlie the Countryside Survey (CS) stratification and Countryside Survey is one of the key datasets used as context here. In addition, this project includes a full repeat of the CS2007 hedgerow survey in England. Landclasses also provide a manageable number of sub-divisions of England by which data can be viewed. National Character Areas were considered too resolved given data availability. Landclasses are aggregated groups of 1 km squares with similar underlying geophysical conditions. There are 21 landclasses in England (Bunce et al.
2007) although they are not numbered 1-21 for historical reasons (1-13, 15-19 and 22-23 and 25). Data on the extents of features from a national dataset were compared with option level information from the Environmental and Countryside Stewardship datasets.

4.2.1 Contextual data for English hedgerows

Comparisons of extents of woody linear features under AES have been made primarily using the UKCEH Land Cover Plus: Hedgerows 2016-2021 map (England) (UK Hedgerow Map, see Section 3.2). This dataset contains a model of the extent and height classes of woody linear features on field boundaries in England, including hedgerows, tree lines and semi-natural thickets of shrubs and trees. The model was derived from processing of the Environment Agency lidar product (National Lidar Programme), captured between 2016-2021, and the linework is consistent with the polygon boundaries used in the UK Centre for Ecology & Hydrology (UKCEH) Land Cover Map (LCM) (Broughton *et al.* 2024). Further comparisons have been made with the CS2007 survey estimates (see Annex 2).

CS2007 hedgerow data include national estimates of extent and condition (height and gappiness). **N.B.** Direct comparisons between estimates of hedge extent and extents for hedges with different condition measures are not possible due to two key factors: 1) The definition of 'Hedgerows' in CS includes both lines of trees and managed hedges, data on condition criteria below relate to managed hedges only, 2) the use of separate modelling approaches for producing National Estimates of 1) extent and 2) condition measures. Where %'s of hedges with specific condition metrics are shown the proportion refers to the total sample of hedges with condition criteria data, not the overall extent of hedges in 2007.

CS2007 Broad Habitat cover data were also used to visualise regional differences in farming land uses across England. Grassland area (combined covers of Improved Grassland, Calcareous Grassland and Neutral Grassland) and Arable Broad Habitat data were mapped to provide a picture of the wider context of the land uses which may influence hedgerow management and extent.

4.2.2 AES Option data

Data on AES options was provided by RPA for all agreements, both those that are historic (closed agreements) and those that are currently active (live agreements).

Data on all options were provided at the agreement and option level (point data) by Natural England from the data sets entitled All_ESS_OPTIONS_MASTER_as_at_01072022 for closed and live Environmental Stewardship agreements and OPTIONS_MASTER_20220808 for Countryside Stewardship agreements.

Options at the agreement level were provided in spatial layers named: ALL_ESS_APPS_AGREEMENTS_MASTER_as_at_01072022.

Hedgerow options were selected from the data provided at the parcel level where option types were clearly defined and identifiable within the dataset provided.

Data on lengths of hedgerow under options were derived from a combined dataset of both Environmental Stewardship options (including both organic and non-organic options, (O)ELS and (O)HLS and Countryside Stewardship options). The datasets were amalgamated for hedgerow options and associated lengths.

All management, restoration and planting options were included. Management options are annual payments for managing the hedge in a certain way, restoration options include capital payments for laying, coppicing, or gapping up, and planting options include capital payments for creating new hedges. Supplementary options were not included as they have been assumed to be on the same lengths of hedgerow as the main option type. Hedgerow tree planting and tagging options have also not been included in extent of hedgerow options as these are reported in units or individual trees and not in metres. Similarly, hedgerow options that are reported in

hectares (ha) such as hedgerow tree buffer strips have been excluded from the data. Tables 4.1 and 4.2 detail the options that have been included in this section.

Data on length of hedgerow under agreement were taken at a single point in time (1st of July) in each of 4 years; 2007, 2012, 2017 and 2022. This method was used to capture agreements (as far as possible) that were live between Countryside Survey 2007 and 2023.

4.2.3 Approach

4.2.3.1 Hedgerow extent

Extents of hedgerows were mapped using both the UK Hedgerow Map dataset and the CS2007 landclass estimates of woody linear feature extents (incorporating both lines of trees and managed hedges). The UK Hedgerow Map dataset which provides spatially explicit locations of features (as opposed to estimated extents per km square) was used for a spatial analysis of AES uptake in relation to estimates of woody linear feature (hedgerow) extents within the 19 landclasses.

4.2.3.2 Hedgerow condition

Data on specific hedgerow condition criteria have been collected within Countryside Surveys since 1984. Data on height and gappiness are key condition metrics associated with favourable condition of managed hedges. Within AES schemes, minimum heights are required e.g., for Countryside Stewardship Option BE3 there is the requirement that from year 2 onwards, hedges will be at least 2m tall.

Maps of condition metrics collected during CS 2007 by landclass were created from mapped data collected in the field during CS 2007 using similar methods to those outlined in section 5.2.3. and described in detail in Carey *et al.* 2007. These data collected at the hedgerow scale were then processed and incorporated into the National Estimate models (methods described in Scott 2008).

These data provide an ideal and timely baseline for the condition of hedgerows entering into Environmental Stewardship. Height measurements (in categories <1 m, 1-2 m, 2-3 m, 3-4 m, 4-5 m, 5-6 m or >6 m) were combined into the following categories to enable meaningful display on maps: short (below 2 m); medium (2-4 m) and tall hedgerows >4 m. Gappiness measures for managed hedges in categories from <10%, 10-<25%, 25-<50%, 50-<75% or no gaps were combined into three categories 1) gaps < 25%, b) gaps > 25%, c) no gaps.

Hedgerow width data were new to Countryside Survey in 2023 and therefore these have been excluded from this mapping exercise (they do not form a baseline) but are displayed as a demonstration of how these data could be used in the future. Further details on landclass analyses, including differences in condition and extent over time are included in section 5.4.2.

4.2.3.3 Hedgerow options

For any agreement live on the 1st July 2007, 2012, 2017 and 2022 hedgerow options were logged and then summed as a whole for each landclass. For example, if an

agreement started in January 2005 and ran until January 2010 it would have been live on 1st July 2007 and so any hedgerow options would have been part of the data for this date. An agreement that ran November 2007 to November 2012 would not have been live on 1st July 2007 and so would not have been included in 2007 data but would have been included in 2012 data. Any agreement that bridged two time points, for example an agreement running from July 1st, 2017, to July 1st, 2022, would have hedgerows featuring in both 2017 and 2022 datasets.

Broad scale coverage of Environmental Stewardship scheme options especially in Entry Level agreements are included in the 2007 and 2012 data: these included EB1 and EB2 options for hedgerow management which had very wide uptake. The management prescriptions under these options were noted by Staley et al. (2018) to be popular but found to provide relatively little benefit to wildlife above typical management practiced by farmers outside of the scheme. These basic management options were therefore not available following the end of Entry Level Schemes and there was a shift towards cutting once every three years either in autumn or winter, or once every two years in winter under options such as the BE3 Countryside Stewardship option. Definitive hedge lengths under general Countryside Stewardship agreements are not provided with the Countryside Stewardship data (N.B. this includes BE3 options).

Following data extraction and assignment to year and landclass the total estimated lengths under AES, grouped by three aggregated option types a) management, b) restoration and c) planting and by scheme strand were described and mapped by landclass.

Table 4.1. Hedgerow options and code used to extract data on the extent of hedgerows under all Environmental Stewardship (Organic/Entry Level Scheme and Organic/Higher Level Scheme) and Countryside Stewardship hedgerow option types (Mid & Higher Tier & Hedgerows and boundaries grant).

Level of scheme	Code	Description
ELS & HLS	EB1	Hedgerow management for landscape (on both sides of a hedge)
ELS & HLS	EB2	Hedgerow management for landscape (on one side of a hedge)
ELS & HLS	EB3	Hedgerow management for landscape and wildlife
ELS & HLS	EB4	Stone-faced hedgebank management on both sides
ELS & HLS	EB5	Stone-faced hedgebank management on one side
ELS & HLS	EB8	Combined hedge and ditch management (incorporating EB1 Hedgerow management for landscape)

ELS & HLS	EB9	Combined hedge and ditch management (incorporating EB2 Hedgerow management for landscape)
ELS & HLS	EB10	Combined hedge and ditch management (incorporating EB3 Hedgerow management for landscape and wildlife)
ELS & HLS	EB14	Hedgerow restoration
ELS & HLS	UB4	Stone-faced hedgebank management on both sides on or above the Moorland Line
ELS & HLS	UB5	Stone-faced hedgebank management on one side on or above the Moorland Line
ELS & HLS	UB14	Hedgerow restoration
ELS & HLS	UB15	Stone-faced hedgebank restoration
OELS & HLS	OB1	Hedgerow management for landscape (on both sides of a hedge)
OELS & HLS	OB2	Hedgerow management for landscape (on one side of a hedge)
OELS & HLS	OB3	Hedgerow management for landscape and wildlife
OELS & HLS	OB4	Stone-faced hedgebank
OELS & HLS	OB5	Stone-faced hedgebank
OELS & HLS	OB8	Combined hedge and ditch
OELS & HLS	OB9	Combined hedge and ditch
OELS & HLS	OB10	Combined hedge and ditch
OELS & HLS	OB14	Hedgerow restoration
Level of scheme	**Code**	**Description**
OELS & HLS	UOB4	Stone-faced hedgebank management on both sides on or above the Moorland Line
OELS & HLS	UOB5	Stone-faced hedgebank management on one side on or above the Moorland Line
HLS	HB11	Management of hedgerows of very high environmental value (both sides)
HLS	HB12	Management of hedgerows of very high environmental value (one side)
HLS	HR2010	Hedgerow restoration including laying, coppicing and gapping up

HLS	PH	Hedgerow planting – new hedges
HLS	BR	Stone-faced hedge bank repair
HLS	BS2010	Stone-faced hedge bank restoration

Table 4.2. List of Countryside Stewardship hedgerow options

Level of scheme	Code	Description
Mid & Higher Tier	BN11	Planting new hedges
Mid & Higher Tier	BE3	Management
Mid & Higher Tier & Hedgerows and boundaries grant	BN5	Hedgerow laying
Mid & Higher Tier & Hedgerows and boundaries grant	BN6	Hedgerow coppicing
Mid & Higher Tier & Hedgerows and boundaries grant	BN7	Hedgerow gapping-up

4.3 Results

4.3.1 Extent of hedgerows in England

From the UK Hedgerow Map dataset, **total** hedgerow length for all of England (excluding 2 landclasses, as follows) was estimated at 652,556km. Excluded landclasses were landclass 22e - Intermediate Mountain tops/broad ridges, N England and landclass 23e High Mountain summits/ridges, N England. Although the dataset did include hedgerows in these landclasses they have been removed from the dataset because very few hedgerows have been recorded in squares in these landclasses in any Countryside Surveys, and their inclusion produces potentially spurious results. Figure 4.1 shows the extent of hedgerows in (a) the UK Hedgerow Map dataset and (b) for the landclass estimates of woody linear feature extents (incorporating both lines of trees and managed hedges) from Countryside Survey 2007. The census (Lidar) and sample-based approaches produce very consistent results, with both approaches having some limitations, e.g., the lidar data may produce similar results for narrow stone walls and hedges in some landclasses, thereby over-predicting the presence of hedges in walled areas.

Table 4.3. Lengths (km) of hedgerow under management, restoration, and planting options in England. Hedgerow extents are reported for all scheme strands combined (All) and then also per itemised scheme strand (Environmental Stewardship – Higher Level Scheme and (Organic) Entry Level Scheme and Countryside Stewardship hedgerow option types – Mid Tier; Higher Tier; Hedgerows and boundaries grant; and capital grant). (NB there are some limitations to the data which may impact on reported results).

Year under agreement	Scheme strand	Length of hedgerow under management options (km)	Length of hedgerow under restoration options (km)	Length of hedgerow under planting options (km)	Length of hedgerow under (all hedgerow) AES options (km)
2007	All	248442.86	831.64	401.09	249675.59
	HLS	5.64	14.55	0.10	20.28
	(O)ELS	229949.28	0	0	229949.28
	(O)ELS plus HLS	18487.95	817.10	400.99	19706.03
2012	All	360015.16	4611.01	1325.35	365951.52
	HLS	167.00	102.73	20.01	289.73
	(O)ELS	245446.32	7.44	0	245453.76
	(O)ELS plus HLS	114401.85	4500.85	1305.34	120208.03
2017	All	187885.60	6359.36	1642.02	195886.97
	HLS	233.12	176.17	26.25	435.53
	ELS	43328.01	14.99	0.00	43343.00
	ELS plus HLS	132774.15	5260.73	1200.21	139235.09
	H&B	0.00	226.71	0.00	226.71
	Higher Tier	1749.55	198.78	208.03	2156.36
	Mid Tier	9800.77	481.98	207.53	10490.28
2022	All	127732.67	11776.43	4658.59	144167.69
	HLS	119.50	121.42	11.25	252.17
	ELS plus HLS	68259.81	2752.20	530.84	71542.85
	H&B	0.00	383.88	0.00	383.88
	Higher Tier	4758.96	667.74	376.17	5802.87
	Mid Tier	54594.40	7046.58	3407.13	65048.11
	Capital Grant	0.00	804.61	333.19	1137.80

4.3.1

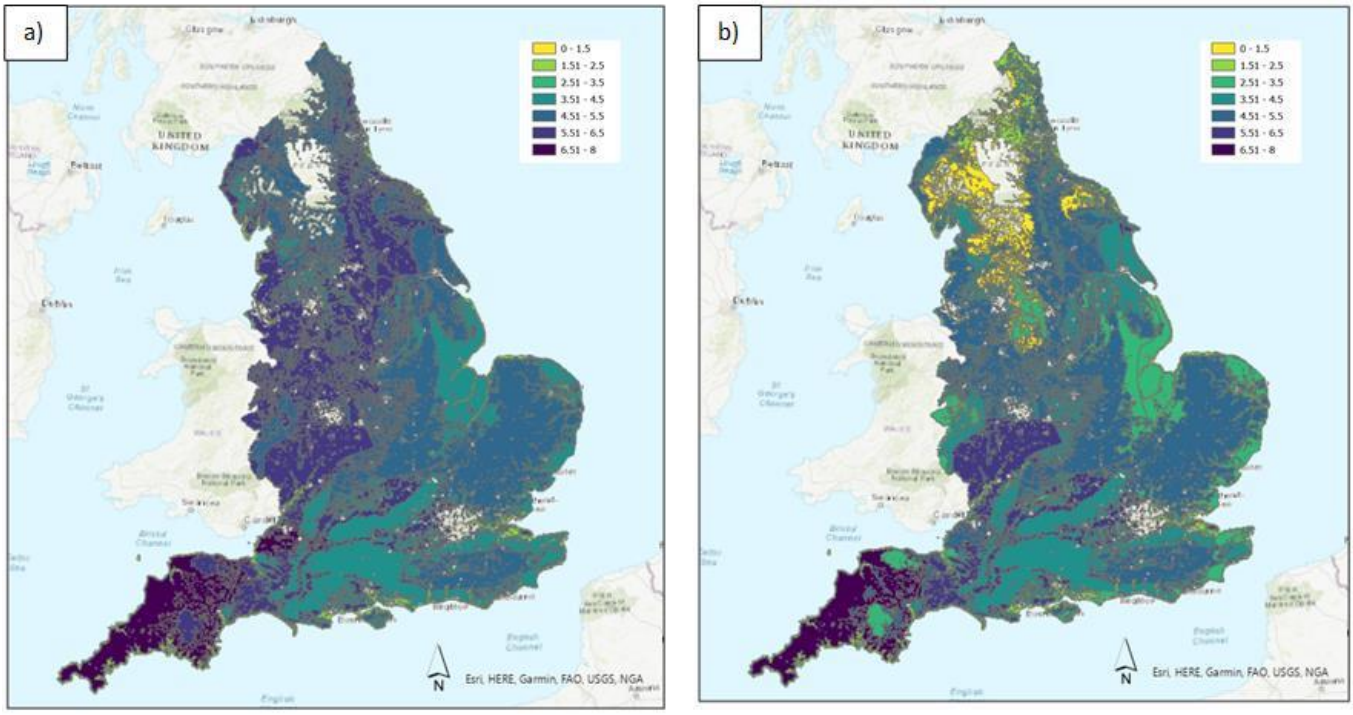


Figure 4.1. a) Hedgerow extent per landclass (km per km^2) in England as estimated by the UK Hedgerow Map dataset derived from lidar (Broughton *et al.* 2024) and **b)** Hedgerow extent per landclass (km per km^2) in England as estimated by Countryside Survey 2007 (mean estimates) (Carey et al. 2007).

4.3.2 Geographical uptake of AES hedgerow options

Total estimated lengths of hedgerows under AES, grouped by three aggregated option types a) management, b) restoration and c) planting and by scheme strand are described in Table 4.3. Maps showing the percentage of all hedgerows in the 19 English landclasses included in the analysis that were under hedgerow options at specific time intervals (2007, 2012, 2017 and 2022) are provided in Figures 4.2, 4.3, 4.4. and 4.8.

4.3.2.1 Management Options

Table 3 and Figure 4.2 show that the extents of hedges under management options increased by approximately a third from 2007 to 2012 under ELS and HLS and subsequently decreased to only around a third of the 2012 extent by 2022, following changes to options and payment rates. The geographical uptake of management options from 2007 onwards shows an easterly trend in early uptake (Figure 4.2). By 2022 hedgerow management AES options were widespread and evenly distributed across English landclasses.

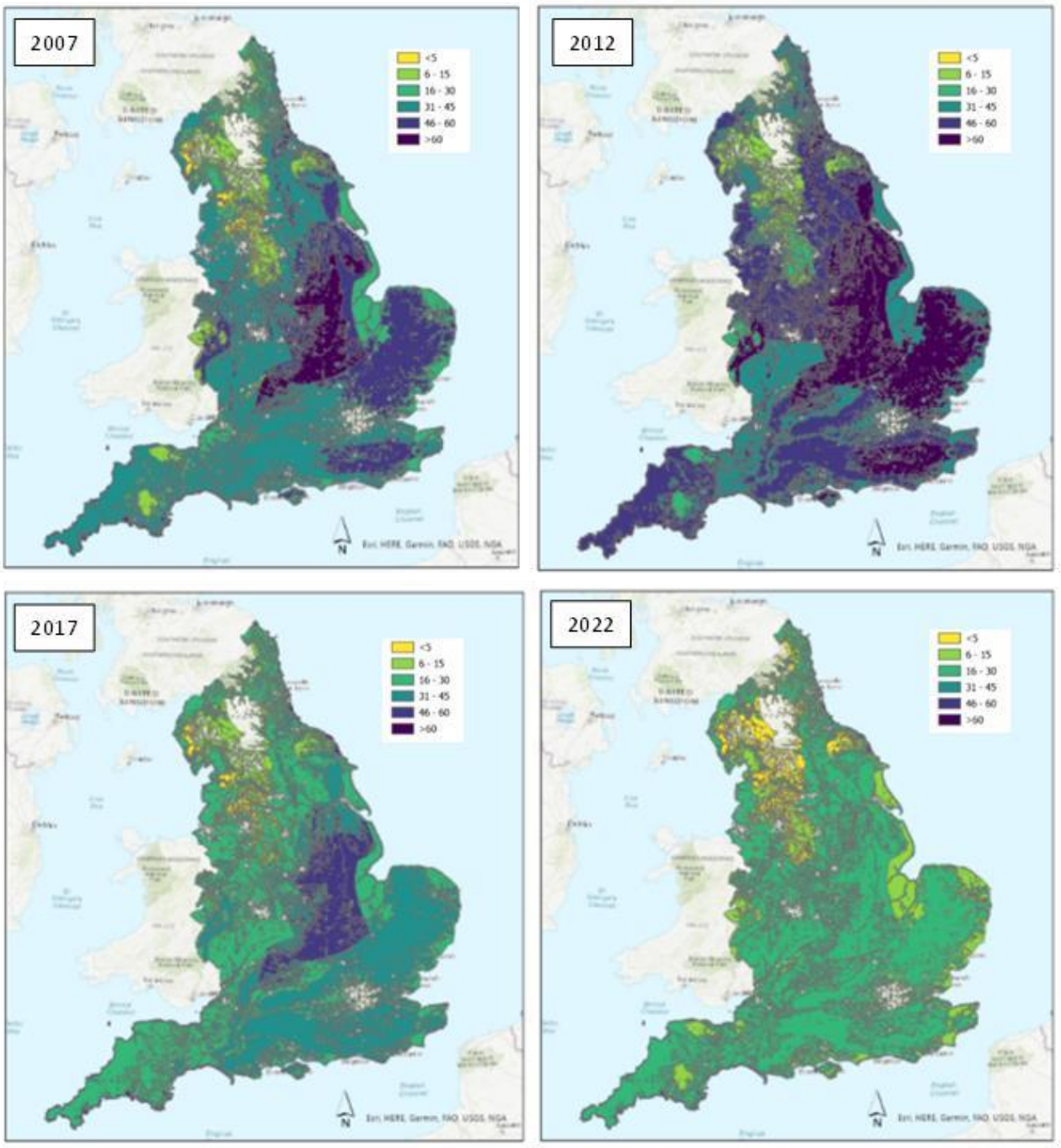


Figure 4.2. The percentage of total hedgerow extent (%) under AES management options on 1st July in 2007, 2012, 2017 and 2022. Total hedgerow extent estimates used the UKCEH Hedgerow Map dataset (Figure 4.1a), see Appendix 2 Figure 4.2**A** for estimates using CS2007 extents.

4.3.2.2 Planting options

The length of hedgerow being planted under options increased tenfold between 2007 and 2022 (from a low base of just over 400km) with the most significant increases coming between 2017 and 2022. These increases were mostly influenced by the

uptake of options under Countryside Stewardship Mid-Tier. Due to the use of a consistent scale in Figure 4.3 it is difficult to see where there are differences in planting extent between landclasses. An additional map for 2022 using a different scale has been produced to make it possible to see differences in the extent of hedgerow planting across England for 2022 (Figure 4.4). Post 2017, there were higher planting extents in the northeast compared to other regions (Figure 4.4). Anecdotally, many newly planted hedgerows are visible in the northeast region and easily recognised due to plastic tree guards (Figure 4.5 & 4.6).

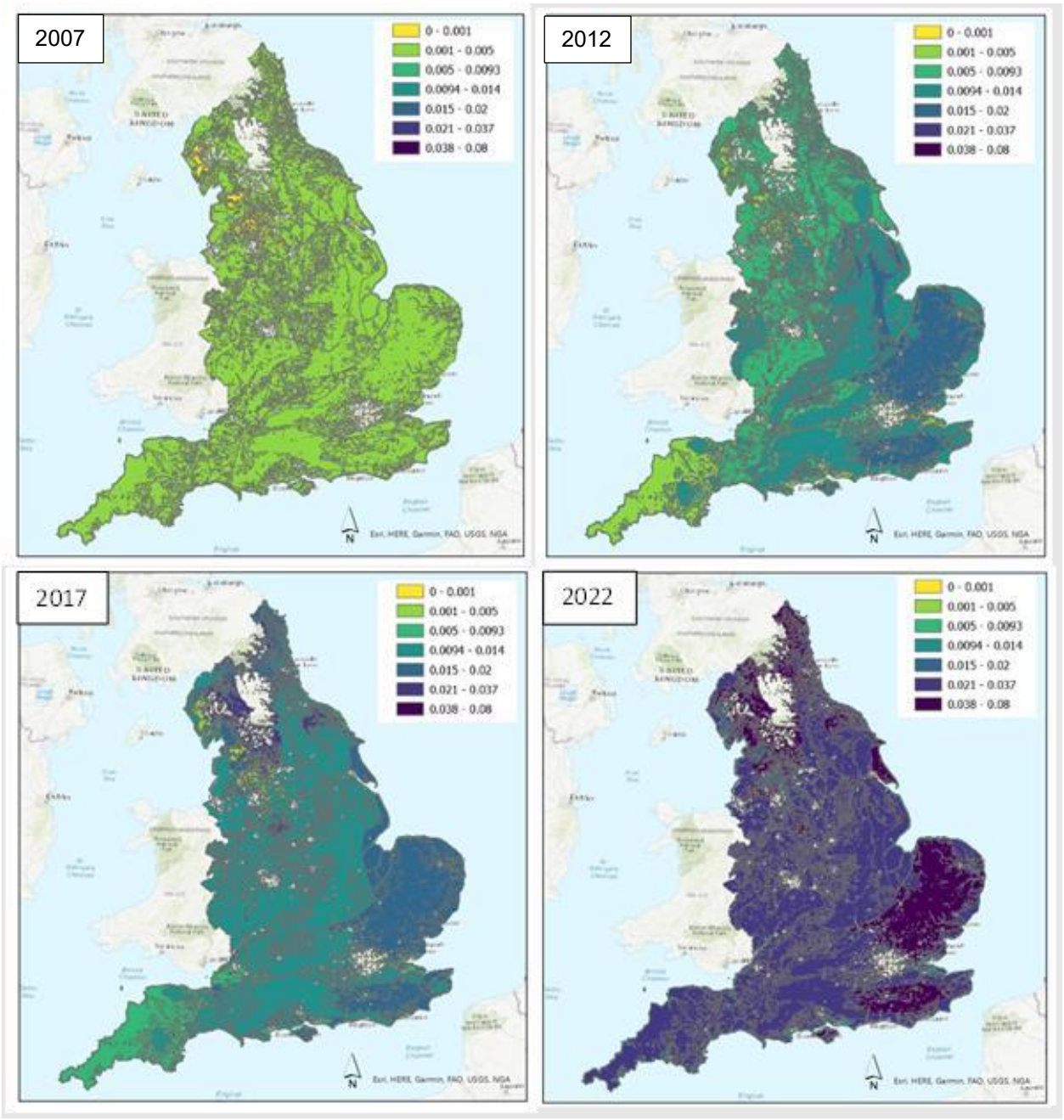


Figure 4.3. Extent of hedgerow (km per km^2) under AES planting options within landclass boundaries on four different time stamps, 2007, 2012, 2017 and 2022 – these maps represent extent along the same scale across the 4 time periods.

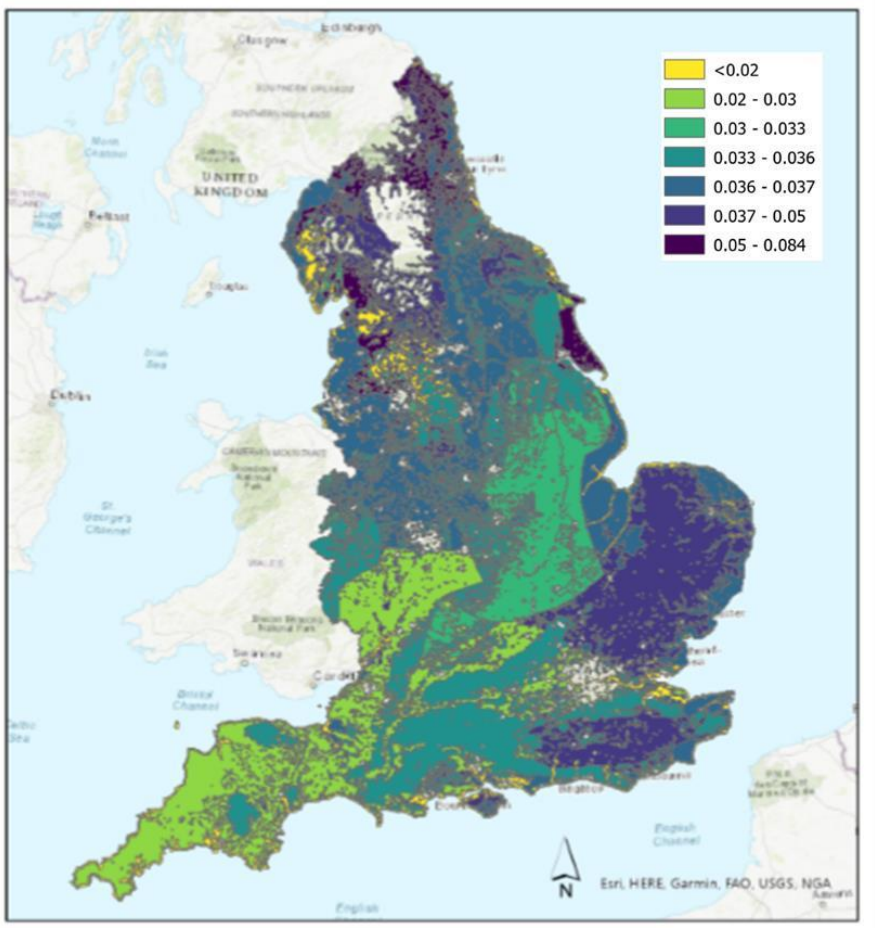


Figure 4.4. Extent of hedgerow (km per km^2) under AES planting options within landclass boundaries in 2022. This displays the same data as in Figure 4.3 but uses different scale to enable better visualisation.

Figure 4.5. Photograph of newly planted hedgerows (2023) in Northumberland; an area identified as having more planted hedgerows in 2022 than other regions in Figure 4.4).

Figure 4.6. Example of recently planted hedgerow (<5 years since planting).

4.3.2.3 Restoration options

The extent of hedgerows under restoration options increased five-fold between 2007 and 2012, under ELS and HLS. Thereafter increases in uptake were less dramatic. Nevertheless, fourteen times the length of hedge under restoration in 2007 was under restoration in 2022 with the Countryside Stewardship Mid Tier options. The geographical uptake of restoration options was broadly more westerly in coverage than management options, with upland landclasses also appearing to have increased uptake (Figure 4.8).

Figure 4.7. Examples of hedgerow restoration - laying. South Oxfordshire.

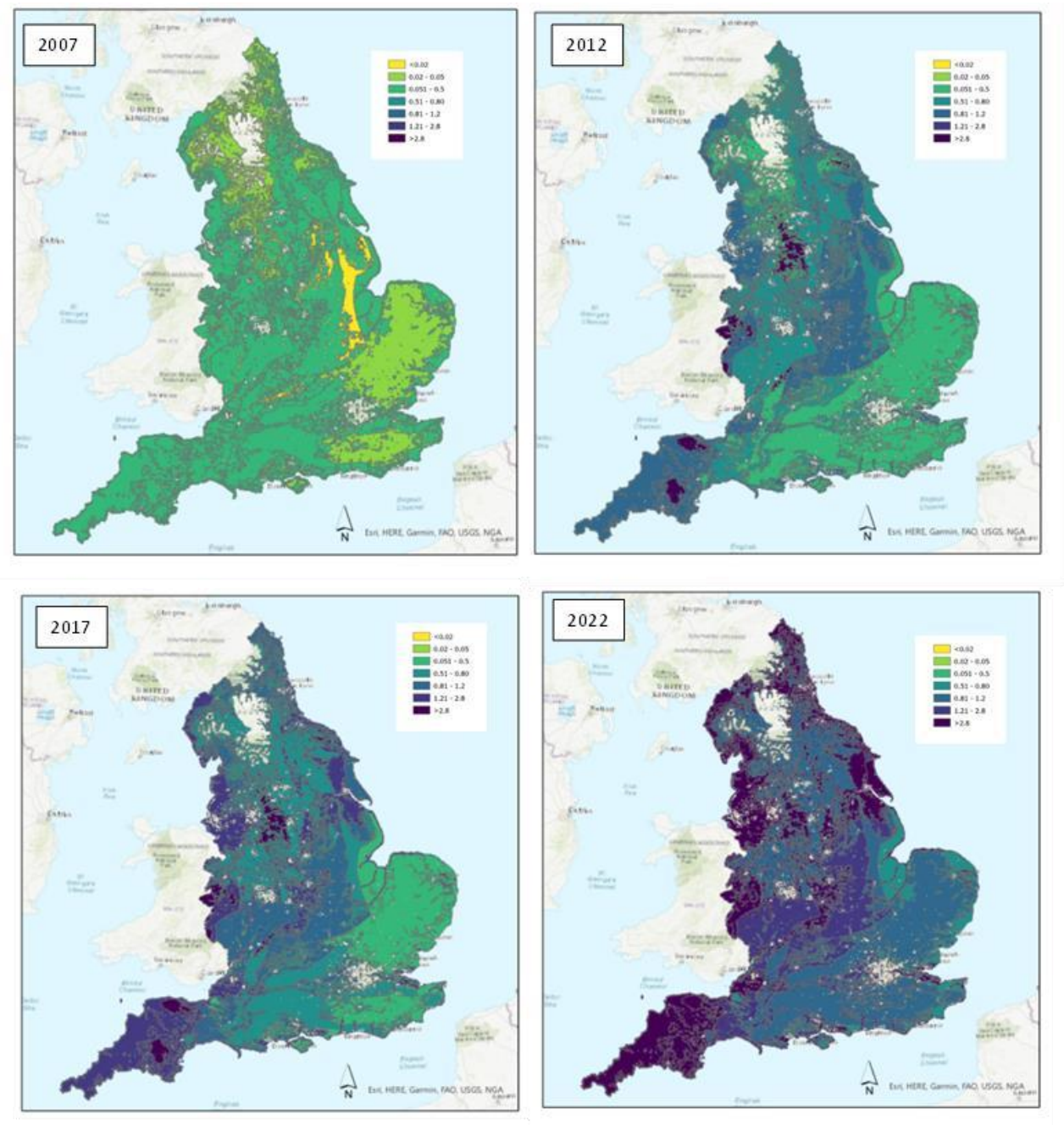


Figure 4.8. The percentage of total hedgerow extent (%) under AES restoration options on 1st July in 2007, 2012, 2017 and 2022. Total hedgerow extent estimates used the UKCEH Hedgerow Map dataset, see Appendix 2 Figure 4.8**A** for estimates using CS2007 extents, together with a re-scaled 2022 map (Figure 4.8**B**) to enable easier viewing of landclass differences.

4.3.3 Condition of managed hedges in England

The following criteria relate to only managed hedges in England, not to lines of trees (which form part of the hedgerow network).

4.3.3.1 Hedgerow height

The results show that in 2007 shorter hedgerows (those <2 m high) were more prevalent in more northerly landclasses, with taller hedgerows more prevalent in the south (Figure 4.9).

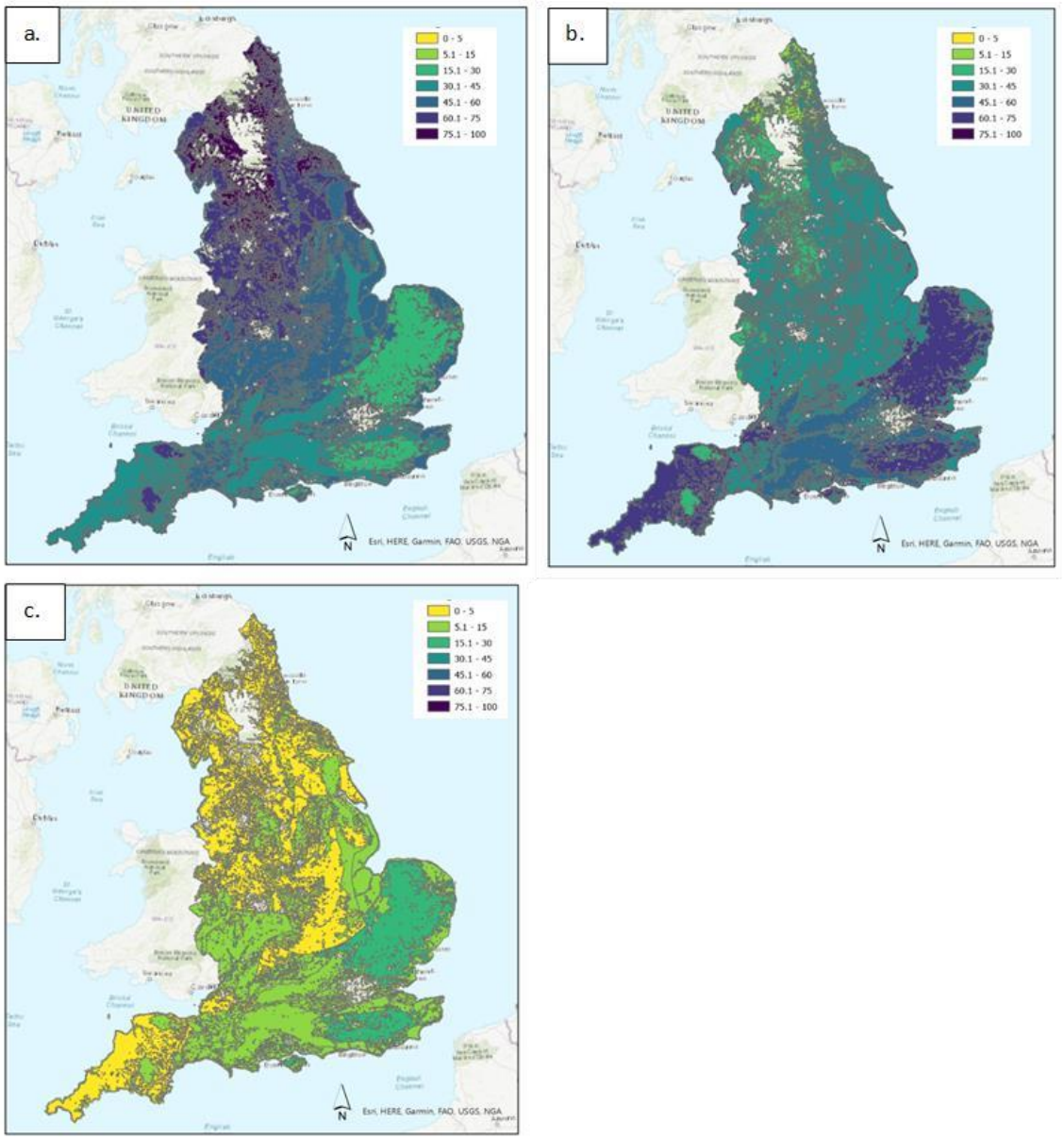


Figure 4.9. a) Percentage of managed hedges in 2007 with height <2 m b) Percentage of managed hedges in 2007 with height 2 m – 4 m and c) Percentage of managed hedges in 2007 with height >4 m.

4.3.3.2 Gappiness

The results indicate that in 2007 the areas of the country with the highest proportion of hedges with gaps (which comprised less than 25% of the hedge) was in the north of England and those with the lowest were towards the south and west. In line with this, the results indicate that the highest proportions of hedges with no gaps occurred in the south and west. The most gappy hedges (with gaps which comprised greater than 25% of the hedge) were in more coastal areas of East Anglia and the southeast. However, overall, the proportion of hedges with large gaps was much lower than that of hedges with smaller or no gaps (Figure 4.10).

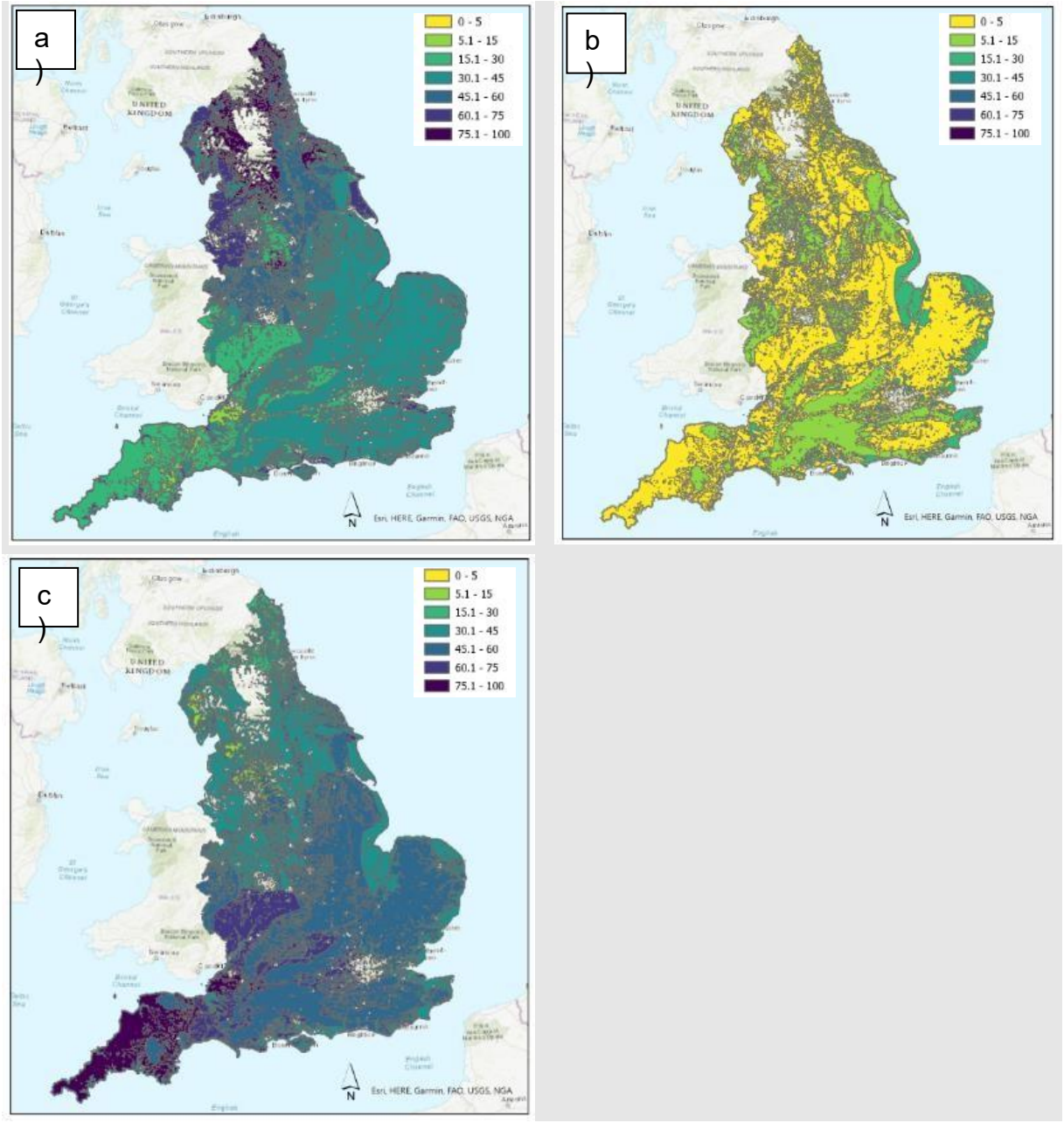


Figure 4.10. a) Percentage of all managed hedges in 2007 with gaps <25%, b) Percentage of managed hedges in 2007 with gaps >25%, c) Percentage of managed hedges in 2007 with no gaps.

4.3.3.3 Landscape context of hedges

Having a picture of the types of landscapes that hedgerows are located in, and their extent and condition is important in helping to identify how landscape and farming practices relate to regional differences in the uptake of hedgerow AES options. Figure 4.11 shows how different parts of England are dominated by different predominant habitat types. Whilst grassland is present across England it tends to be more concentrated in the north and west a). In contrast arable areas tend to be predominantly in the east and south b). In many areas of England there is a relatively equal distribution of grassland and arable habitats.

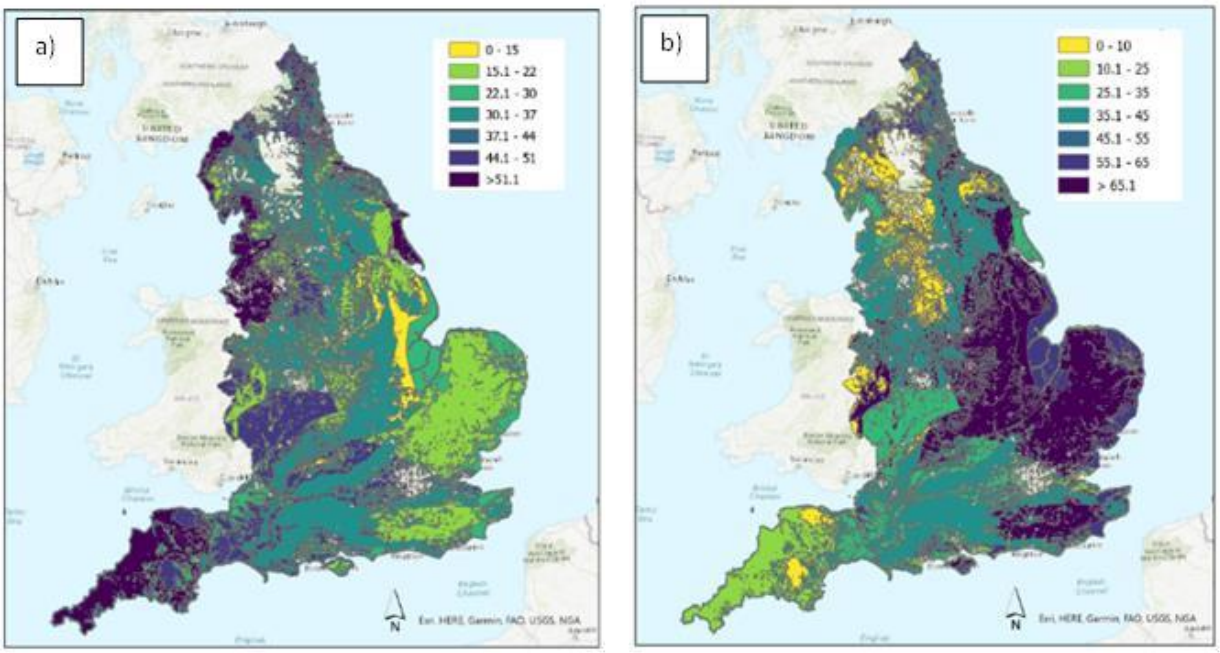


Figure 4.11. a) Percentage of landclass covered by grassland (Improved Grassland, Neutral Grassland and Calcareous Grassland) Broad Habitats (CS 2007) and b) Percentage of landclass covered by the Arable and Horticultural Broad Habitat (CS 2007).

4.4 Discussion

4.4.1 1 AES uptake related to geographical hedgerow extent and condition and habitat type.

A comparison of the maps of Broad Habitat cover (Figure 4.11), hedgerow extent (Figure 4.1) and AES hedgerow extent (Figure 4.2) indicates that management options (Figure 4.8), dominate in the arable east and southeast areas (Figure 4.11b) where hedgerow extents tend to be in the medium range of hedgerow extents, i.e., between 4.5 and 5.5 km per square km.(Figure 4.1). Given that other areas of England tend to have higher extents of hedgerows, this may be unexpected, but farmers in arable areas may have historically needed to include hedgerow management in their scheme applications to score sufficient points to qualify for scheme entry (Norton pers. comm. 2024). Hence under the Entry Level Scheme

large extents of hedges in arable areas went into management options post 2005 and by 2012 (see 4.2.2.1). Farmers in arable areas may have been less likely to enter schemes for intensive restoration options as there is perceived to be less of an agricultural need for in-tact hedges, e.g., for stock proofing, in such areas.

The length of hedgerow (km) under planting options in agri-environment schemes from 2007 to 2022 in each landclass in England (Fig 4.3) showed a clear increase across this period. However, planting option uptake was generally very low across this time period, with the maximum uptake between 0.038 and 0.08 km per square km for any of the landclasses recorded only in the 2022 data. These are labour intensive options and require significant investment in capital and time, so lack of uptake is perhaps not particularly surprising. Payment changes in Countryside Stewardship may have made these options more attractive than they were in the previous scheme. The focus on planting options in the north and east of England is very recent and may reflect recent changes in attitudes towards hedgerows resulting, for example, from changes in drivers including potential carbon payments for hedgerows or increased recognition of their value for other purposes (pollination, pest predators, soil protection). Planting in the east and north is also likely to be related to relatively lower extents of hedgerows in these areas (Figure 4.1), such areas are likely to be good targets for hedgerow planting in the future. Areas in the west of England already have a relatively high density of hedgerows which may preclude additional hedgerow planting in those areas (see comments from farmers in Section 6 around reaching capacity and having no more room for planting new hedgerows). It important to note (See Section 6) that planting of hedgerows is not restricted to agri-environment schemes and many non-governmental organisations (e.g. Woodland Trust) fund hedge planting.

The geographical locations of restoration options (Figure 4.8) appear to differ from those of management (Figure 4.2) or planting options (Figures 4.3 and 4.4). Restoration was uncommon under Environmental Stewardship (ES), although there was an increase between 2007 and 2012 with a few predominantly grassland areas towards the west and south taking up options on >2% of hedgerows. However, most areas had less than 1% of hedgerows in restoration options in 2012. Restoration options, like planting options, are capital and labour intensive and may not be feasible on farms where there is a shortage of labour. Between 2012 and 2017 some more westerly and northerly areas saw an increase in the extents of hedgerows under restoration, potentially in response to the additional restoration options offered under
ES. However, after the advent of the Countryside Stewardship Scheme, between 2017 and 2022, the proportions of hedgerows under restoration increased everywhere with the highest levels in the far west and around northeastern coastal areas. High levels in the west are perhaps to be expected due to high extents of hedgerows in these areas (Figure 4.1). In these grassland (Figure 4.11a) and livestock farming dominated areas managed hedges continue to be important for business and are generally well maintained in terms of their height (Figure 4.9b) and

gappiness (Figure 4.10b). The roles of managed hedges in keeping animals in fields (stock proofing) and providing shade, shelter and browse may result in farmers being more willing to enter these hedgerows into restoration options (Section 6.2.2). High levels of restoration in northeastern areas where hedgerows are less extensive, may be linked to the extents of managed hedges with gaps <25% (Figure 4.10a). This indicates a willingness to restore hedgerows in areas where they are in poorer condition. Managed hedges in these areas are also less tall (<2m) (Figure 4.9a) than in other parts of the country.

Restoration primarily addresses hedgerow gappiness. Hedgerows play an important role in connecting up non-cropped habitats across farmed landscapes. Hedgerows with large, frequent gaps have been shown to disadvantage a range of taxa (Graeme et al. 2018), including bats, other small mammals and some invertebrates (Garratt et al. 2017; Staley et al 2020). They are also likely to be a precursor to the deterioration of managed hedges into lines of unmanaged trees. Restoration of hedges in poor condition is likely to be both good for business as well as for biodiversity and wider ecosystem services. Whilst lines of unmanaged trees have clear ecological value, they may have more limited business value and lack of management is likely to lead to the eventual loss of trees in the landscape.

Additional detailed analysis of AES options, hedgerow height and other condition variables from CS surveys in 2007 and 2022/23 are included in Section 5. These results could potentially be used to highlight further opportunities for AES uptake in the light of drivers to increase the extents and condition of hedges for multiple ecosystem goals including biodiversity enhancement, Net Zero, flooding and animal welfare.

4.5 Conclusions

These data show how AES option uptake has changed since 2005 and provides an indication of how that relates to the existing hedgerow networks across England. It appears that in the first ten years of the period covered management options were widely taken up in areas where hedgerows were already in reasonable condition (height and gappiness), perhaps indicating that the options allowed farmers to gain points for existing management, particularly in the east of England where uptake was highest. Following changes to the schemes, increased uptake of the more pro-active options has occurred, particularly under the CS Mid Tier Scheme. It appears that this uptake has been in areas with more limited extents, or higher gappiness of, existing managed hedges. These are very positive indications for the newer schemes. However, there is a need for ramping up the uptake of restoration and planting options to achieve Net Zero and biodiversity targets.

5. Condition and extent of hedgerows - field resurvey of CS2007 squares

This section describes the resurvey of CS squares in England which was carried out to provide information on changes in the extent and condition of hedgerows between 2005 and 2022/23, including both those under AES and those outside of AES, addressing the following objectives,

- *To put the uptake of hedgerow options in Environmental Stewardship (ES) and Countryside Stewardship (CStew) - by option type and location – into context, taking into account the past and current extent and quality of hedgerows across different landscapes/geographic areas. This included providing data on current extent and quality of hedgerows from a repeat Countryside Survey (CS).*
- *To identify the extent to which AES have contributed to changes in hedgerow length and quality since 2005.*
- *To gain a greater understanding of the priorities for creation, restoration and management of hedgerows, in particular by identifying areas/landscapes where future hedgerow planting, restoration and management could be focused to optimise benefits for the environment and contribute towards Favourable Conservation Status (FCS) of hedgerows*.

5.1 Field survey structure and land access

Countryside Survey (CS) is a long-term national scale survey of the GB countryside which began in 1978 and was repeated five times up to 2007 (in 1978,1984,1990,1998 and 2007). The survey is currently in a rolling programme of vegetation survey which started in 2019 and finishes in 2024. Current surveys do not include hedgerow recording. However, between 1984 and 2007 the survey incorporated hedgerow mapping (of all hedgerows) within 1 km survey squares. Surveys between 1978 and 2007 included plots which sampled vegetation associated with the basal flora of hedgerows (H plots) (Wood *et al.* 2017) and between 1998 and 2007 plots sampling the woody hedgerows themselves were included (D plots). In 2007 surveys were structured to ensure that each GB country could report statistics relating to countryside change separately.

CS squares thus provide a unique record of the extent and condition of a representative sample of hedgerows across England. For this project, a repeat field survey of English squares (with hedgerows previously recorded in CS) took place in 2 stages, a pilot (of 37 squares in England) in 2022 and a full survey of all the remaining squares in England for which we received access permissions (211) in 2023.

UKCEH contracted out the permissions process for survey access to XSG. XSG completed the owner contact lists by December 2021 and contacted farmers and landowners from early 2022 to 2023. Ten full squares were not accessed for the resurvey. These included 2 squares in which urban areas covered the vast majority of the square, other squares in which access was denied to areas with hedgerows and hedgerow plots, and squares where access was denied completely. Access refusals in remaining squares meant that many 1 km squares (all but 20) had some area that was refused or for which we were unable to obtain permissions. On average, across all squares 75% of square area was surveyed, noting that hedgerows frequently border roads or land parcels. Overall, a lower proportion of square area was surveyed than in previous Countryside Surveys due to refusal. Refusal rates were taken into account in analyses to produce national estimates of extent.

5.2 Field survey methods

5.2.1 Surveyor recruitment and training

The pilot survey in 2022 was carried out by experienced (Countryside Survey) UKCEH field surveyors. In 2023 additional external surveyors were recruited, some of whom had worked with UKCEH on surveys before. All surveyors completed an online assessment of species identification skills focused on hedgerow species to ensure their suitability for the survey. All surveyors were trained for a week in late April before going out on survey. Training included health and safety, survey aims and objectives, working with landowners, how to use and look after survey equipment, detailed training on survey protocols and further identification skills. As well as ID testing at interview, training was key to ensuring quality control. It included visiting an actual survey square to ensure that surveyors had a full understanding of what data to record and how they were expected to do it. Surveyors were also provided with digital and printed survey handbooks which clearly stated the protocols that they were expected to follow.

5.2.2 Survey materials and equipment

Surveyors were provided with electronic tablets prepared with the necessary software (ESRI bespoke products SWEET, Surveyor 123 and Collector) and files for survey (including field handbooks) and field equipment. Surveyors were provided with printed and digital plot and square maps for assisting in the relocation of squares and repeat plots. In addition to the repeat plots, surveyors were asked to record plots with hedges which were under agri-environment scheme (AES) agreement. To facilitate this, NE and UKCEH worked closely together to,

1. Locate land within the 2023 Countryside Survey squares with agreements (either open or closed) using publicly available AES option uptake data[4].

2. Once the agreements had been identified by UKCEH, holding information was provided to NE to allow extraction of documentation on the schemes, including option types and agreement maps of the locations of options.

3. These documents were supplied to UKCEH to enable comparisons with CS2007 data to identify linear features under agreement, both to identify a suitable field survey location for an extra plot in each square which was used to record hedgerow condition, and for later analysis.

5.2.3 Habitat mapping

Previous mapping of CS 1 km squares has included mapping the lengths, types, and structural attributes of woody linear features. The term 'woody linear features' (WLFs) has been used to account for the diversity of WLFs to be found in the countryside including everything from a traditionally managed hedge to a planted avenue of trees or a line of old scrub which may at one time have been a managed hedge. WLFs fall into two broad categories based on the extent to which the trees within them take their natural shape.

- (WNS) Woody 'Natural Shape' means unhindered/unmanaged growth for at least a decade. Where trees take their natural shape, the feature will essentially be **a line of trees or scrub** (Figure 5.1).

[4] Environmental Stewardship AES current option uptake data (2023), used to summarise hedgerow option uptake in 40 Countryside Survey squares. https://naturalengland-defra.opendata.arcgis.com/datasets/environmentalstewardship-scheme-options-england

Countryside Stewardship AES current option uptake data (2023), used to summarise hedgerow option uptake in 40 Countryside Survey squares. https://naturalenglanddefra.opendata.arcgis.com/datasets/countryside-stewardship-scheme-2016management-options-england

Figure 5.1. An example of a woody linear feature falling under the category of natural shape). On close inspection this feature shows signs of historic management (with laid stems at its base).

- (WUS) Woody ‘Un-Natural’ Shape - Where trees/scrub has been managed relatively recently the WLF will fall into the **managed hedge** category (Figure 5.2).

Figure 5.2. An example of a woody linear feature falling under the category of ‘unnatural’ shape).

These categories were defined to enable analysis of change between them over time and across national scales.

In the 2022/3 survey, surveyors took out digital maps of feature extents within squares and revisited them to record feature width (for the first time and in 2023 only) and any changes in lengths, management, or structural attributes since 2007. Given the prolonged period between surveys, surveyors were asked to make judgements based on their knowledge and experience of where and how features had changed in the 15 or 16 years since the last survey.

5.2.4 Vegetation plots

Fixed vegetation plots used in CS 2007 were repeated to provide information on 1) plant species composition and cover of woody species and vegetation associated with hedgerow bottoms (1 m x 10 m (managed) Hedge (H) plots) and, 2) woody species, hedgerow structure and condition (30 m Hedgerow Diversity Plots (D) plots). H plots sample from the central stems of the managed hedge out to 1 m and may often be wholly under the managed hedge canopy. D plots span the width of the woody linear feature and are 30 m in length along the canopy. In D plots, in addition to species information, attributes relating to hedgerow (D plots sample both managed hedges and lines of trees) condition are collected (see 5.2.5). These attributes contribute to an assessment of condition that allows progress to be measured against the Definition of Favourable Conservation Status for hedgerows (Staley et al., 2020).

In 2007 CS squares had up to 10 D plots recorded and 2 H plots (each associated with a D plot). In this survey, a smaller number of plots were repeated in each survey square to provide data around changes in the condition of both the structural and hedgerow bottom components of hedgerows. Therefore, only the two D plots with associated hedgerow bottom (H) plots were recorded, and additional D plots were recorded on hedgerows which had been under AES agreement since 2007 where required (i.e., where existing D plots were not already on AES).

5.3 Analysis

5.3.1 Analysis of Mapped Data

Two different approaches for data analysis are outlined below. The first uses the structure of the survey to derive nationally representative data (national estimates), the second uses the actual data collected within squares and analyses the sample surveyed i.e., not scaling to national, to highlight the kinds of changes observed. In both cases, the data is split into managed hedges (referred to below as mapped managed hedges) and lines of trees (which together constitute a wider definition of hedgerows). 1) National Estimates - Data from the 2022 and 2023 field surveys were added to the field survey data from across the CS time series and analysed using the consistent modelling approach developed for the analysis in CS2007 (Scott, 2008). This modelling approach was designed to ensure maximal use of collected data in each survey, including for non-repeated squares. The national estimate analysis is used to analyse areas and lengths (and condition measures associated with them) because it takes account the amount of land surveyed in each square including

where different permissions in each survey impact on changes to the surveyed area, and areas of land that are not surveyable, such as sea. The nature of the model means that exact matches to previous estimates are unlikely. The model provides estimates of hedgerow extent by landclass which are multiplied by landclass areas to provide national estimates of the extents of different woody linear feature types (WUS- managed hedges and WNS- lines of trees) (in '000s km) at national scales in 2022/3. The consistent model has also been used to provide estimates for attributes recorded on the mapped features where the proportion of extent is the underlying metric, including trends in height categories and hedgerow management types.

2) Analysis of mapped data at the square level investigates change within the specific squares surveyed and across the three English Environmental Zones (Figure 5.3) (Haines-Young et al. 2000) and includes the use of:

- A long-term trend model (lme) (consistent model) with mapped indicators as response variables and year as explanatory. The 1 km square was used as a random effect to account for survey structure in this analysis. Before the model was applied exploratory analysis of the data was undertaken to assess normality and distribution.
- A long-term trend model, as above, but with woody linear features either in or out of AES under 'management' or 'restoration' options. **N.B.** ***AES inclusion is only known for 2022/23, we do not know whether woody linear features were in AES in other survey years, the membership of AES scheme has been applied to hedges surveyed in previous years to determine if they were significantly different before being under the current AES.***
- A spatial model for 2022/3 with a similar structure (lme) to investigate locational impacts of AES. These results have been plotted as boxplots.
- Plots of condition attributes (categorical variables) presented as the % of length of hedgerows under each condition.

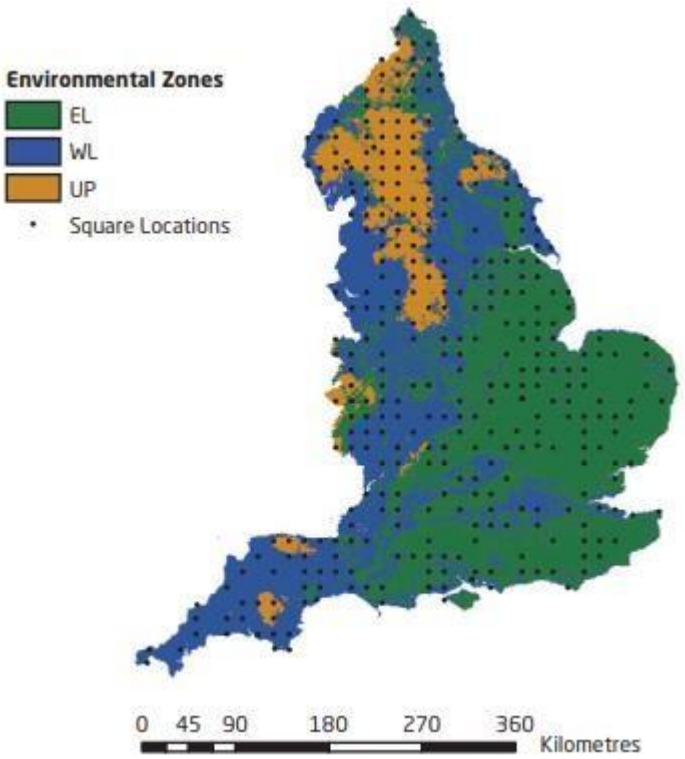


Figure 5.3. The three English Environmental Zones (Easterly Lowlands, Westerly Lowlands and English Uplands).

5.3.2 Hedgerow condition and plot analysis

Most condition criteria for hedgerows are recorded in D plots. H plots provide additional information on the condition of the associated ground flora and always sample managed hedges.

Countryside Survey has always worked closely with Hedgelink (https://hedgelink.org.uk, previously the UK HAP steering group for hedgerows) to identify criteria for hedgerow condition assessment and to enable collection of suitable data to assess whether hedgerows are in 'favourable condition'. Hedgerow condition assessment depends on recording hedgerow 'attributes', such as height and width, to determine whether they meet thresholds to define whether a particular hedgerow is in 'favourable condition' (Staley et al. 2020).

The basic attributes deemed to be indicative of 'favourable condition' include:

1. Structural only
   - height >1 m

- width of the woody component >1.5 m
- cross-sectional area (height x width) >3 m
- the degree of intactness of the hedgerow canopy ○ Vertical gappiness <10% ○ No gaps >5 m wide
- the height above ground at which the canopy starts <0.5 m
- <10% non-native species

2. Structural and margins (width of perennial herbaceous vegetation >1 m)
   - undisturbed ground >2 m adjacent to the hedgerow (all land)

3. Structural and margins (width of perennial herbaceous vegetation >1 m)
   - undisturbed ground >2 m adjacent to the hedgerow (on arable land only)

Plots sampling managed hedges which fulfil the criteria for the three categories, 1) structural, 2) structural and margins (<1 m perennial veg. margin + >2 m undisturbed ground) and 3) structural and margins (<1 m perennial veg. margin + >2 m undisturbed ground) on arable land - were counted, and the proportion of the total number of Hedge Diversity plots in each category calculated.

The trends in hedgerow width were also calculated. Unlike height, width was not recorded in the field mapping data either historically, or in the pilot survey, although it was recorded in the survey in 2023. However, it has been recorded in plots since 1998. Woody diversity (D) plots were first established in 1998 and only three width categories were used (<1 m, 1-2 m, >2 m). In 2007 more detailed categories were introduced (<1 m, 1-1.5 m, 1.5-2 m, 2-2.5 m, 2.5-3 m, 3-4 m, 4-5 m).

In addition, the diversity of woody species in D plots and the species richness of H plots were calculated. The trends over time have been derived.

Vegetation plots have been analysed in R as follows,

- A long-term trend model (lme) (consistent model) with veg plot indicators as response variables and year as an explanatory variable. An independent vegplot ID is included to account for the random effects of having multiple plots within the same square.
- A long-term trend model as above but with either ‘in’ or ‘out’ of AES or AES options (classified as ‘management’ or ‘restoration’).
- A spatial model for 2022/3 with a similar structure lme to investigate locational impacts of AES. These have been plotted as boxplots.
- Plots of condition attributes (categorical variables) presented as the % of plots of hedgerows under each condition metric.

5.3.3 Quality Assurance (QA) surveys

Quality assurance in the survey data comes in part from testing and training surveyors as described in Section 5.2.2. Surveyors were also visited in the field by a senior member of the UKCEH project team, during the early stages of the survey to ensure that data collection was as required. In the early stages of the survey in each year, surveyors were asked to upload square data to the UKCEH database immediately upon completion. This enabled data checks to be conducted to ensure that data was being collected appropriately.

Alongside these quality control measures which seek to limit the variability between surveyors, a formal quality assurance exercise measured the consistency and reliability of the hedgerow survey work. This involved a resurvey of one quarter of each square in a sub-sample of the survey squares (around 7%). The resurvey involved the recording of all plots in the square and mapping hedges in the chosen quarter of the square.

The QA exercise assessed the consistency and quality of the data collected by different surveyors, including:

For plots

- the efficiency of plot relocation
- the reproducibility of species records made by the original surveyors
- the reliability of percentage cover estimates of the principal species recorded in plots.

For mapping data

- the accuracy and consistency of recording linear features in the 1 km squares
- the consistency of recording changes in linear features

The QA process was carried out by senior scientists at UKCEH who are very familiar with CS recording methodologies and the digital soft and hardware and have excellent botanical recording skills.

5.4 Field survey results

5.4.1 National estimates

National estimates for the extents of managed hedges are shown in Figure 5.4 and Table 5.1.

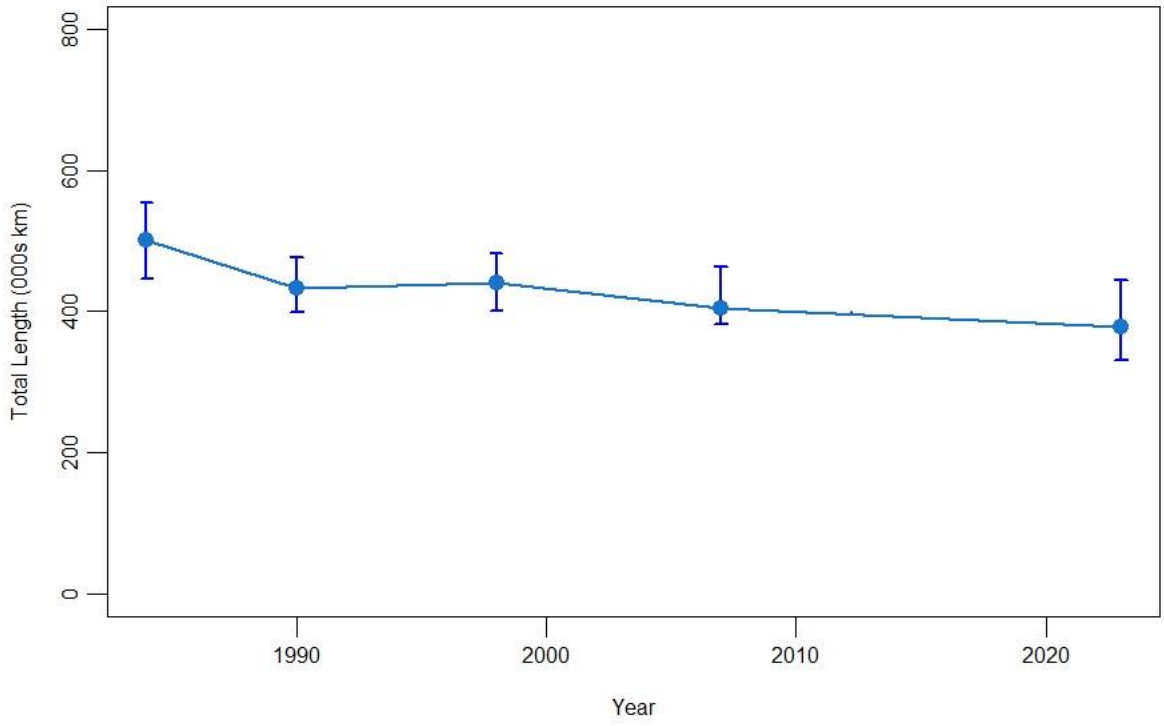


Figure 5.4 National Estimates (with 95% confidence intervals) for changes in the extents (’000’s km) of managed hedges in Countryside Survey between 1984 and 2022/3.

The overall (negative) trend across this period was significant (P< 0.05) but changes between 2007 and 2022/3, whilst still decreasing, were not significant. National estimates for changes in the extents of lines of trees are shown in Figure 5.5 and Table 5.1. The overall positive trend across this period was significant (P< 0.05) but changes, whilst increasing, between 2007 and 2022/3 were not significant. High variability in the estimates in 2022/3 indicated high variability between squares, this higher variability may reflect the influence of unsurveyed/refused access areas in the analysis, but do not invalidate the trend.

Table 5.1. The length (‘000s km) of woody linear features in England, from 1984 to 2022/3.

Year of CS Survey	1984	1990	1998	2007	2022/3
Feature	Length (‘000’s km)	Length (‘000’s km)	Length (‘000’s km)	Length (‘000’s km)	Length (‘000’s km)
Managed hedges	501	432	441	405	378

Lines of trees	55	79	134	156	178
All woody linear features	555	511	574	561	556

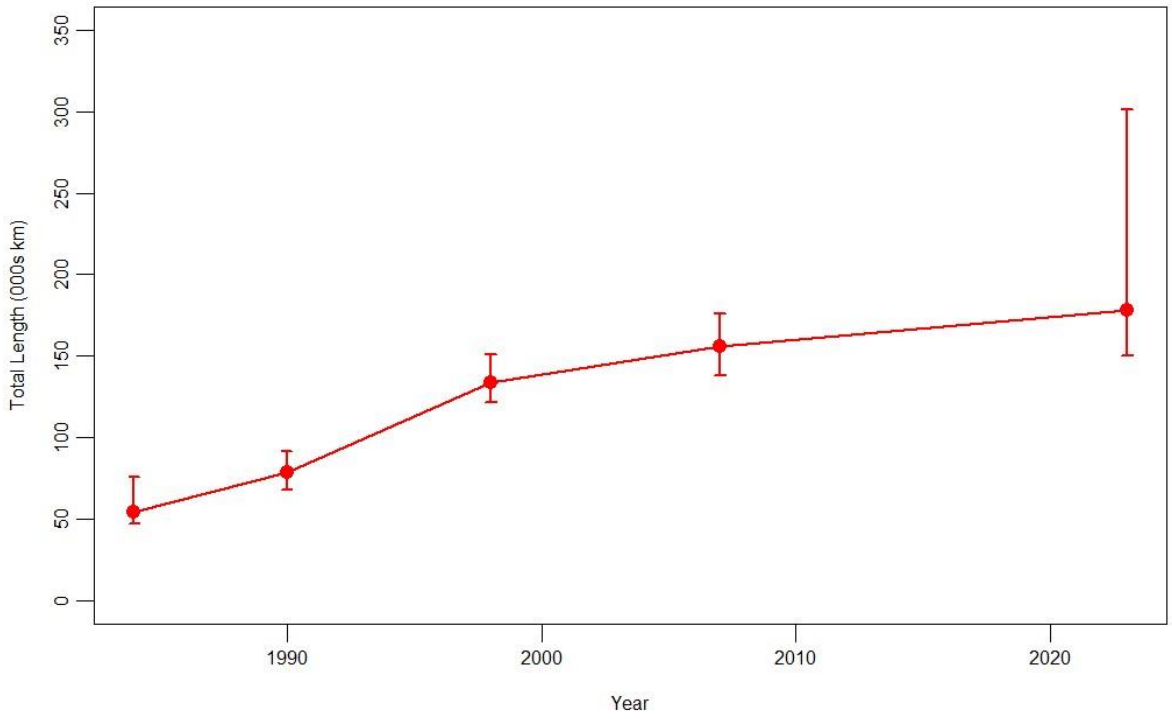


Figure 5.5. National Estimates (with 95% confidence intervals) for changes in the extents ('000's km) of lines of trees in Countryside Survey between 1984 and 2022/3.

Results showing how attributes of mapped hedges changed, include estimates of the proportions of managed hedges in different height categories (Figure 5.6) and the proportions of hedgerows under different management regimes (Figure 5.7).

These results indicate that since 2007 shifts in management of features that still fall into the managed hedge category are towards cutting and flailing every 3 years or more frequently. This change, which indicates a reduction in the extents of features with no management, is confounded by the switch between categories of woody linear feature types - from a reduction in managed hedges to an increase in lines of trees between 2007 and 2022/3. The data show a decrease in the proportion of hedges that have been newly planted which is perhaps surprising given recent policy direction on tree planting and non-governmental initiatives[5]. (A detailed analysis of new features recorded in the survey is included in section 5.4.2.5).

Increasing proportions of larger managed hedges (Figure 5.6) is a more positive signal.

[5] https://www.woodlandtrust.org.uk/plant-trees/trees-for-landowners-and-farmers/morehedges/

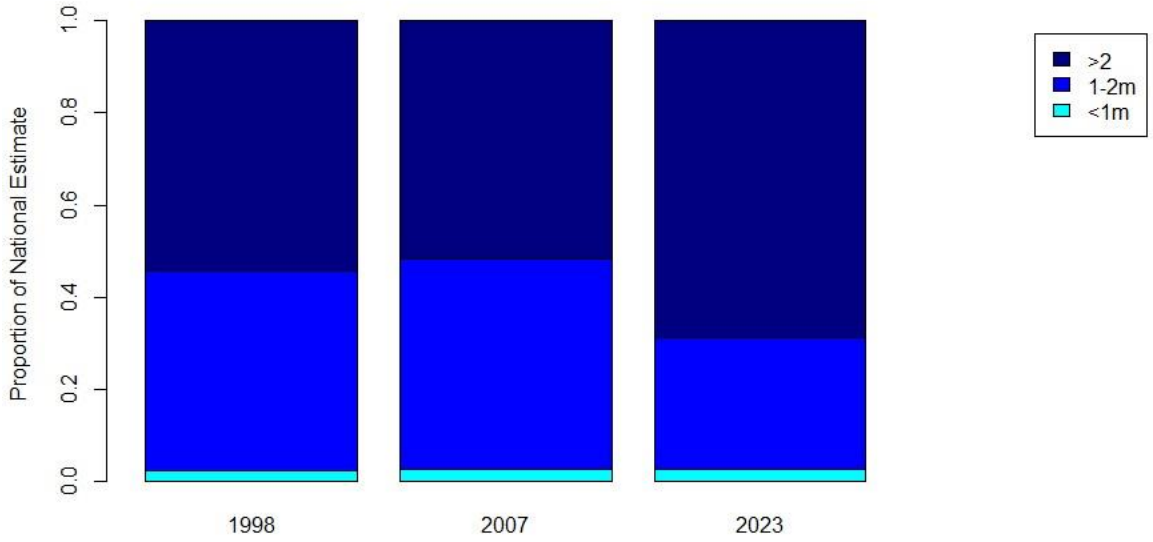


Figure 5.6 National Estimates for the proportions of mapped managed hedges in different height categories in Countryside Survey between 1984 and 2022/3.

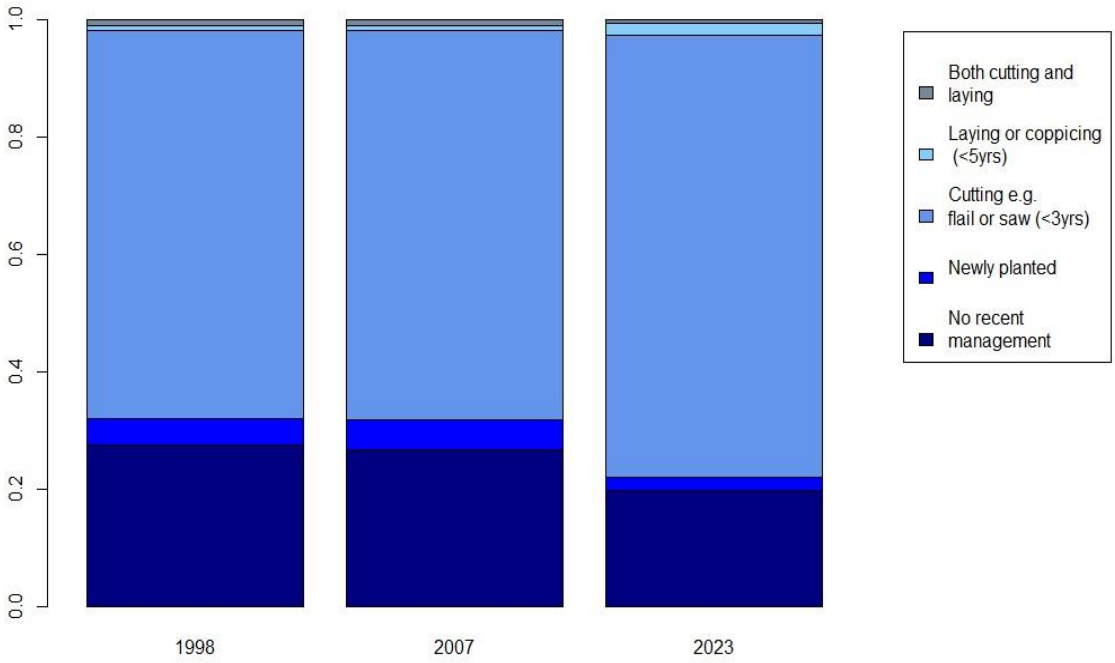


Figure 5.7 National Estimates for the proportions of mapped managed hedges in different management categories in Countryside Survey between 1984 and 2022/3.

5.4.2 National estimates at landclass level

5.4.2.1 Background

UK landclasses form the basis of the sampling structure for Countryside Survey (Figure 5.8). In order to show how landclasses differ in their extents of managed hedges and lines of trees and in the condition of hedges, the results for landclasses are presented here. The rationale of pulling out results at the landclass scale is to try and identify whether there are particular landclass issues relating to the loss of features, or deterioration in their condition, which may enhance any targeting of policy initiatives. A brief description of the landclasses in included in Table 5.2.

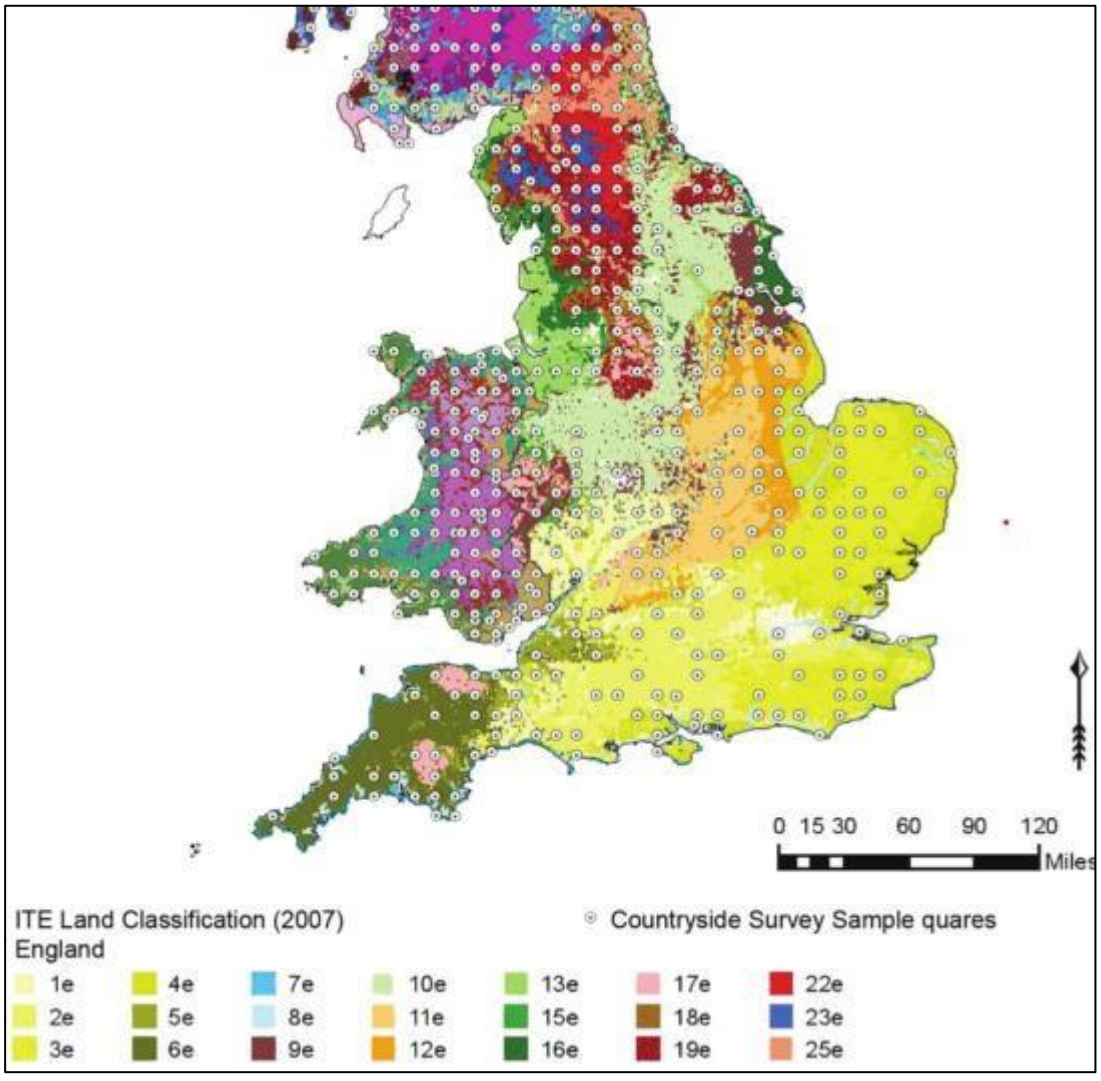


Figure 5.8. Land Classification including all England landclasses.

Table 5.2. Description of English landclasses (Bunce et al. 2007)

Landclass	Description
1e	Undulating country, varied agriculture, mainly grassland
2e	Flat arable land, mainly cereals, little native vegetation
3e	Flat, intensive agriculture, otherwise mainly built-up

4e	Flat, intensive agriculture, otherwise mainly built-up
5e	Lowland, somewhat enclosed land, varied agriculture and vegetation
6e	Gently rolling enclosed country, mainly fertile pastures
7e	Coastal with variable morphology and vegetation
8e	Coastal, often estuarine, mainly pasture, otherwise built-up
9e	Fairly flat, open intensive agriculture, often built-up
10e	Fairly flat plains with intensive farming, often arable / grass mixtures
11e	Rich alluvial plains, mainly open with arable or pasture
12e	Very fertile coastal plains with very productive cropping
13e	Somewhat variable landforms, mainly flat, heterogeneous land use
15e	Valley bottoms with mixed agriculture, predominately pastoral
16e	Undulating lowlands, variable agriculture and native vegetation
17e	Rounded immediate slopes, mainly improvable permanent pasture
18e	Rounded hills, some steep slopes, varied moorlands
19e	Smooth hills, mainly heather moors, often afforested
20e	Mid-valley slopes covered with a wide range of vegetation
21e	Upper valley slopes mainly covered with bogs
22e	Margins of high mountains, moorlands, often afforested
23e	High mountain summits, with well-drained moorlands
24e	Upper steep mountain slopes, often bog covered
25e	Lowlands with variable land use mainly arable

5.4.2.2 Extent of managed hedges

The largest extents (m) of hedges were located in landclasses; 1e (predominantly central southern England), 3e (eastern England towards the south, but north of London), 6e (south-west England) and 10e (eastern and central midlands). As expected, low extents occurred in the mountain and upland landclasses (Figure 5.9). The largest decreases in extents (proportions of existing stock) between 1984 and 2023 occurred in landclasses; 8e (east coast, Suffolk, Essex), 25e (midlands) and 9e (east Yorks). However, there were also losses in areas with large extents of managed hedges (10e, 1e and 3e).

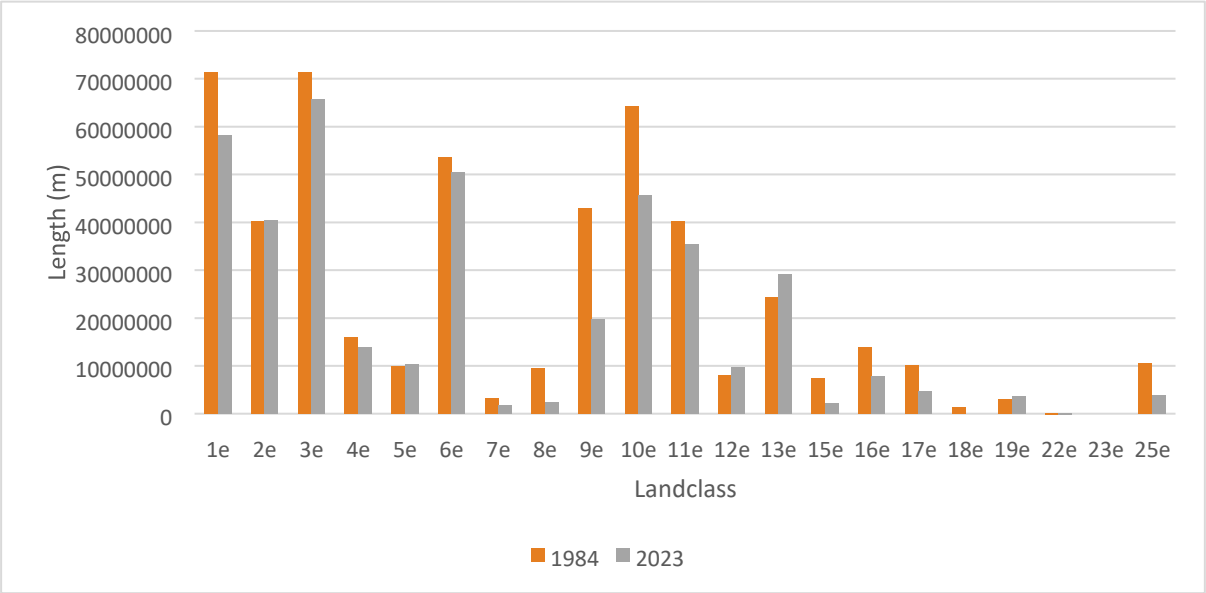


Figure 5.9. Total length of managed hedge (m) by landclass in 1984 and 2023

5.4.2.3 Extent of Lines of Trees

The largest extents of lines of trees (m) were located in landclasses; 1e (central southern England), 2e (Home counties - Surrey, Sussex, parts of Kent, Herefords, Oxfords) and 3e (eastern England south, but north of London) (Figure 5.10). Increases in the lengths of lines of trees between 1984 and 2023 were consistent across all landclasses.

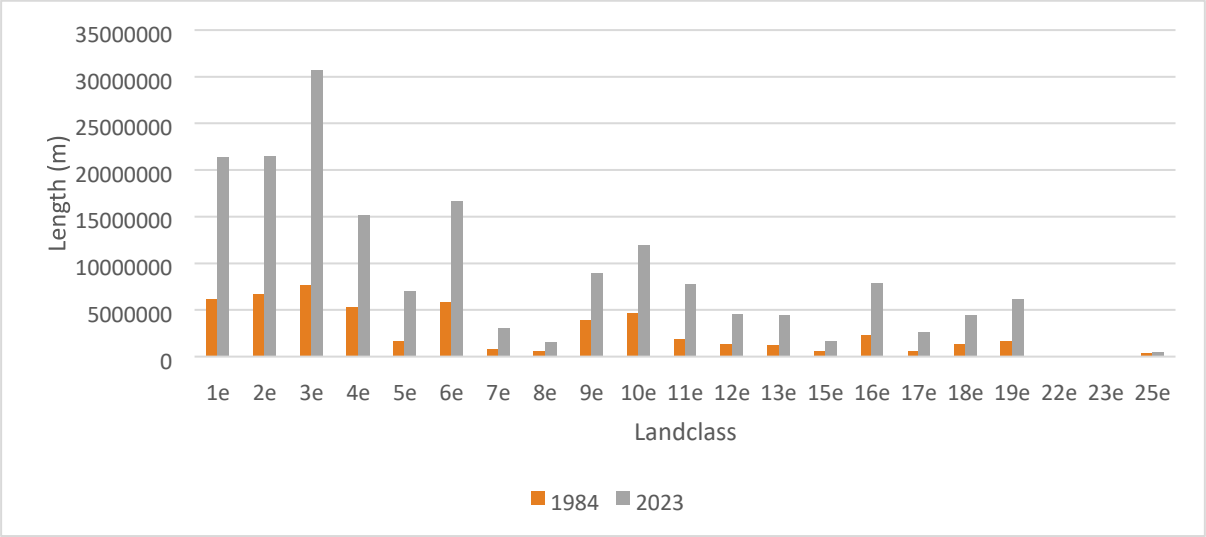


Figure 5.10. Total length of lines of trees (m) by landclass in 1984 and 2023

5.4.2.4 Condition measures (managed hedges only)

The following data provide condition estimates for managed hedges. N.B. Data for different aspects of condition were not collected across all surveys. Direct comparisons between extent (above) and extents for different condition measures are

not possible due to the modelling approach used to produce National Estimates and due to differences between surveys in available data on condition.

- **Species composition**

The species composition of managed hedges was highly comparable between survey years. Whilst differences between 1998 and 2022/3 may, in part, be due to new plantings or to losses of hedgerows through deterioration to lines of trees, they may also be due to differences in access permissions in 1998 and 2022/3 (Figures 5.11 and 5.12).

The data show how hedges differ between landclasses with mixed managed hedges being particularly important in landclasses 1e, 2e, 3e and 6e whilst managed hedges in 9e, 10e, 11e, 12e, 13e and 16e are more dominated by hawthorn (Figures 5.11 and 5.12).

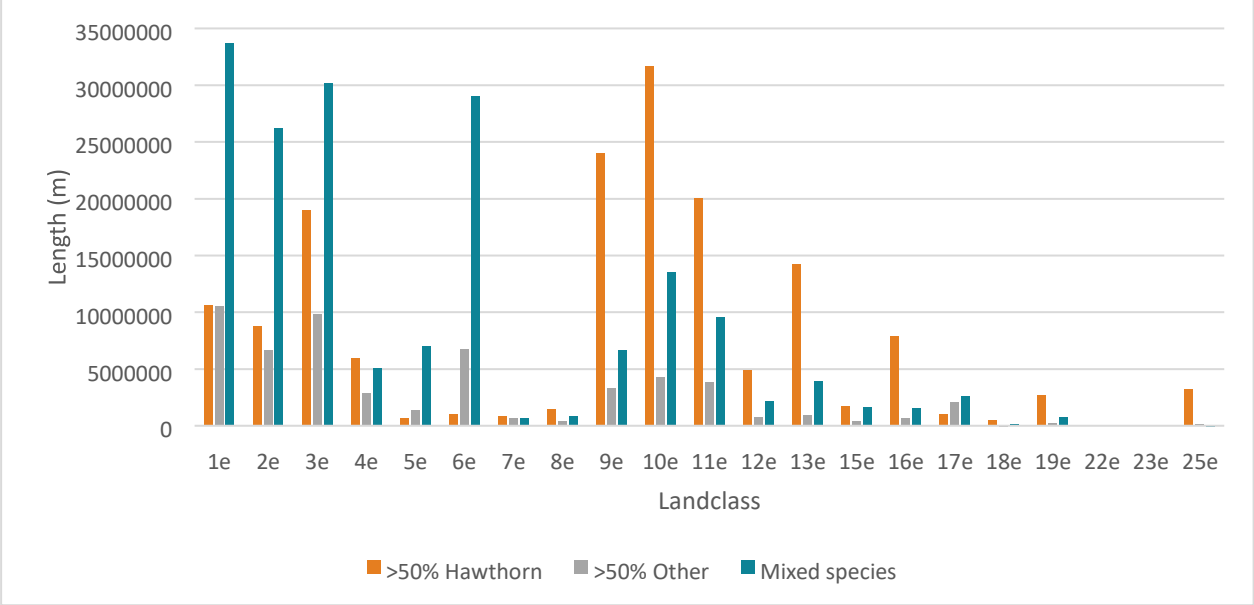


Figure 5.11. Total length of managed hedges by species composition and landclass in 1998.

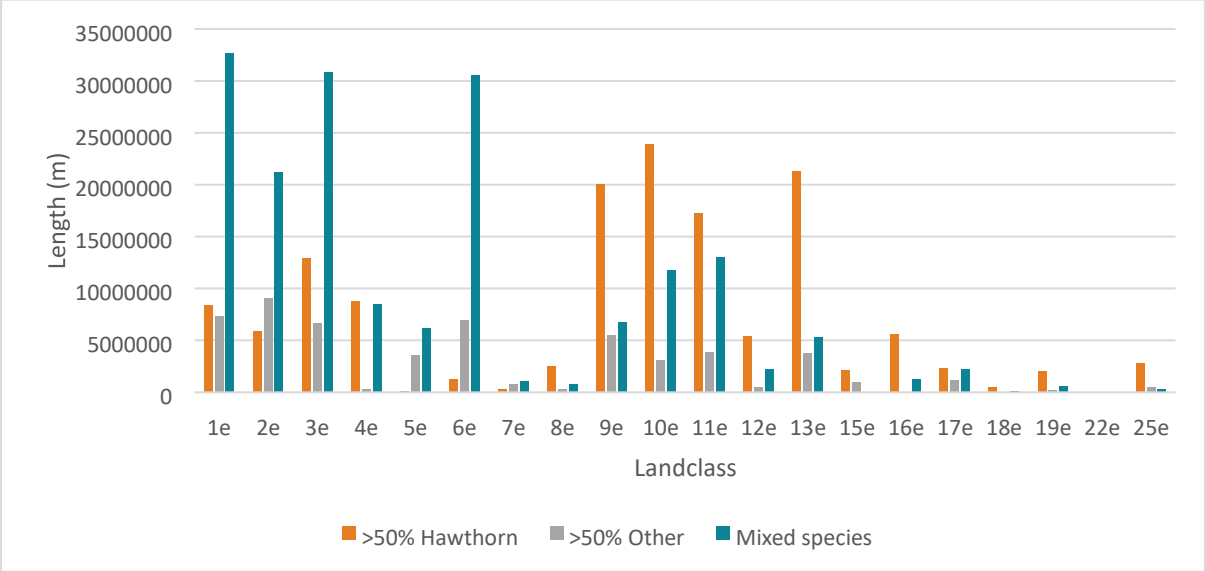


Figure 5.12. Total length of managed hedges by species composition and landclass in 2022/3.

- **Gappiness**

The highest proportions of managed hedges with no gaps were found in the landclasses with the highest lengths of lines of trees and hedges (Figure 5.9 & 5.10), 1e (central southern England), 2e (Home Counties - Surrey, Sussex, parts of Kent, Herefords, Oxfords), 3e (eastern England south, but north of London) and 6e (southwest England and western Wales) (Figure 5.13). For these 4 landclasses, the proportion of managed hedges with no gaps between 1998 and 2003 did not really change but in a couple of other landclasses, with lower extents, the proportion of hedges with no gaps increased, in particular 11e (eastern and central midlands) and 15e (Cheshire, Wirral NW Cumbria). In 11e, this increase was accompanied by a decrease in the overall length of managed hedges (and an increase in the lengths of lines of trees) but in 15e there was also an increase in the lengths of hedges across this period.

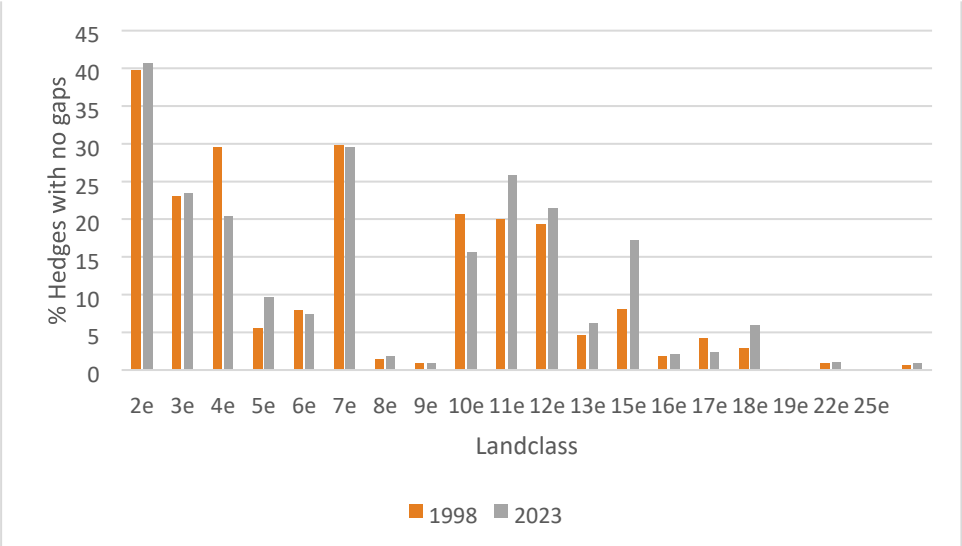


Figure 5.13. Proportion of managed hedges (m) with no gaps in 1998 and 2023 by landclass

The proportion of managed hedges with large gaps (50-75%) was close to or less than 1% for all landclasses in both surveys (Figure 5.14, note Y axis). In general, the landclasses with high lengths of managed hedges and lines of trees and high proportions of managed hedges with no gaps also tended to be those with the slightly higher proportion of managed hedges with large gaps (landclasses 1e, 3e, 9e and 10e). The data show that very gappy managed hedges were more common in some landclasses in 1998 and in others in 2023 (Figure 5.14).

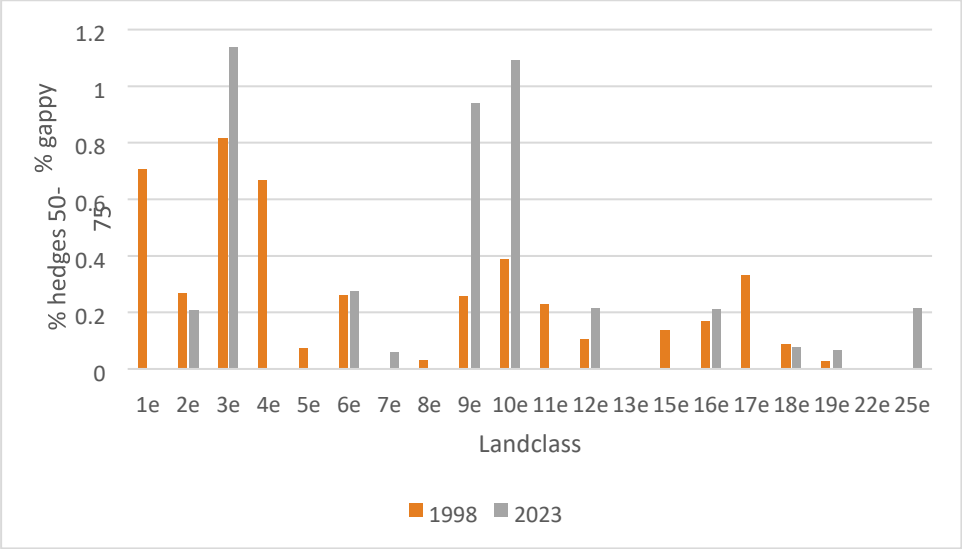


Figure 5.14. Proportion of managed hedges (m) with a high proportion of gaps (50-75%) in 1998 and 2023 by landclass

- **Hedge height**

Extents of the lengths of managed hedges that were less than 1 m high were greatest in landclasses 1e, 2e, 3e, 6e and 10e (Figure 5.15). The data show that estimates for managed hedges less than 1 m were quite high relative to the estimates for total lengths of managed hedges for some of these landclasses (e.g., 4e and 6e in 2023). Due to the modelling approach and slight differences in the numbers of managed hedges with height measures (as compared to extent measures) used to calculate estimates it is not possible to directly compare the data. Whilst for several landclasses the lengths of managed hedges that were <1 m high were greater in 1998, worryingly for 4 of the landclasses (1e, 3e, 4e, 6e) with high extents of managed hedges the lengths of managed hedges which were <1 m high were greater in 2023 than they were in 1998.

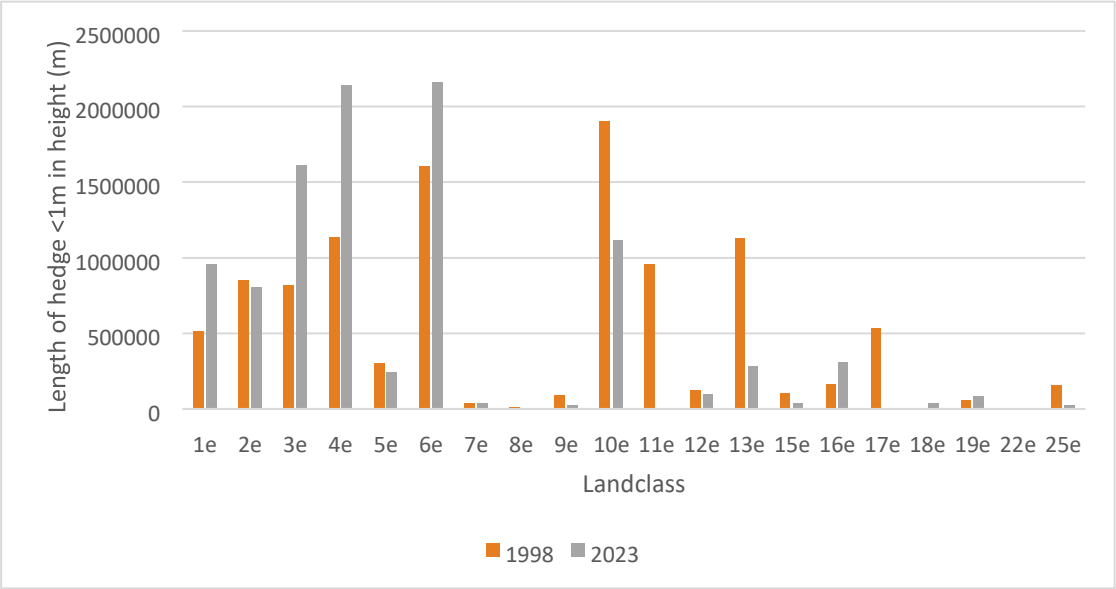


Figure 5.15. Lengths of managed hedges <1m in 1998 and 2023 by landclass

Extents of the lengths of managed hedges that were greater than 4 m high (as for those <1 m) were greatest in the hedged landclasses (1e, 2e, 3e, 6e, 10e) and were overall at least double the proportion of managed hedges <1 m (with some landclasses having over 8,000,000 m managed hedges over 4 m high whilst the 2 landclasses with highest extents of managed hedges <1 m high had marginally higher than 2,000,000 m of these) (Figure 5.16). Whilst the lengths of managed hedges >4 m high declined marginally for two landclasses between '98 and '23, for all other landclasses with a notable extent of managed hedges, the extent of managed hedges >4 m increased, increases were substantial in landclasses 6e (7x) and 10e (5x).

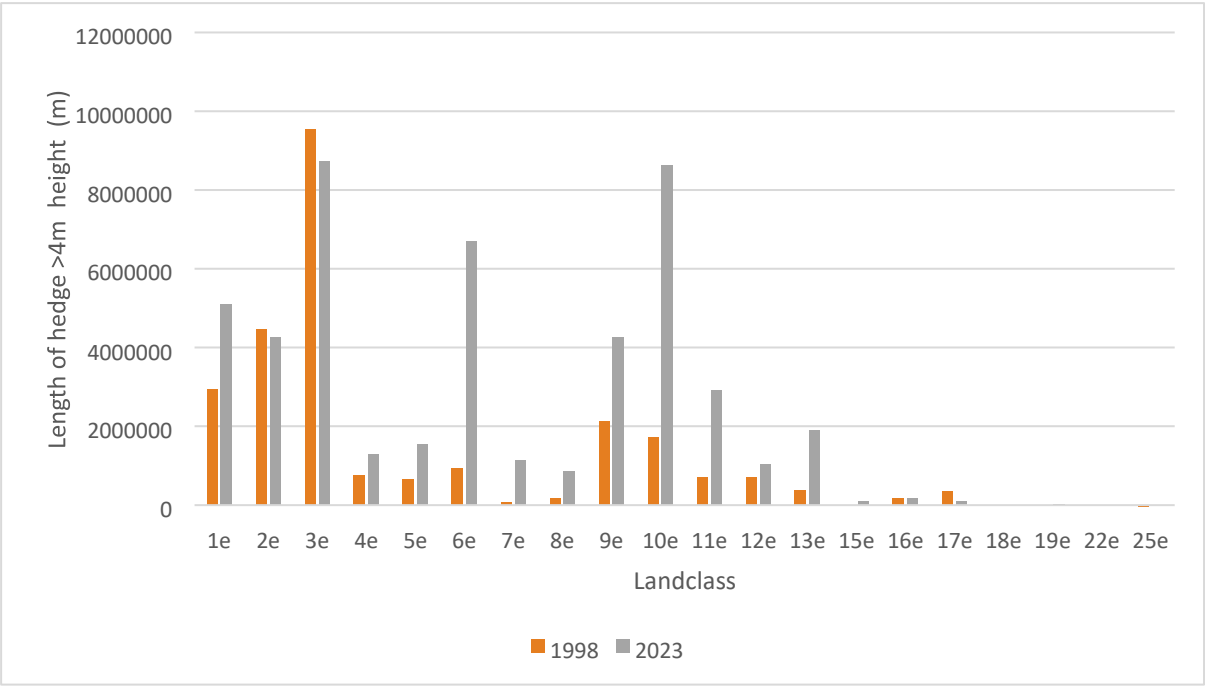


Figure 5.16. Lengths of managed hedges >4 m high in 1998 and 2023 by landclass

- **Hedge width**

Hedge width was measured for the first time in 2022/3. The extents of managed hedges with widths that were either very narrow (<1 m) or wide (<3 m) are shown in Figure 5.17. A higher proportion of managed hedges in the south-west (landclass 6e) are >3 m than for any other landclass, whilst the proportion of managed hedges <1 m is highest in landclasses 3e and 4e in the south-east.

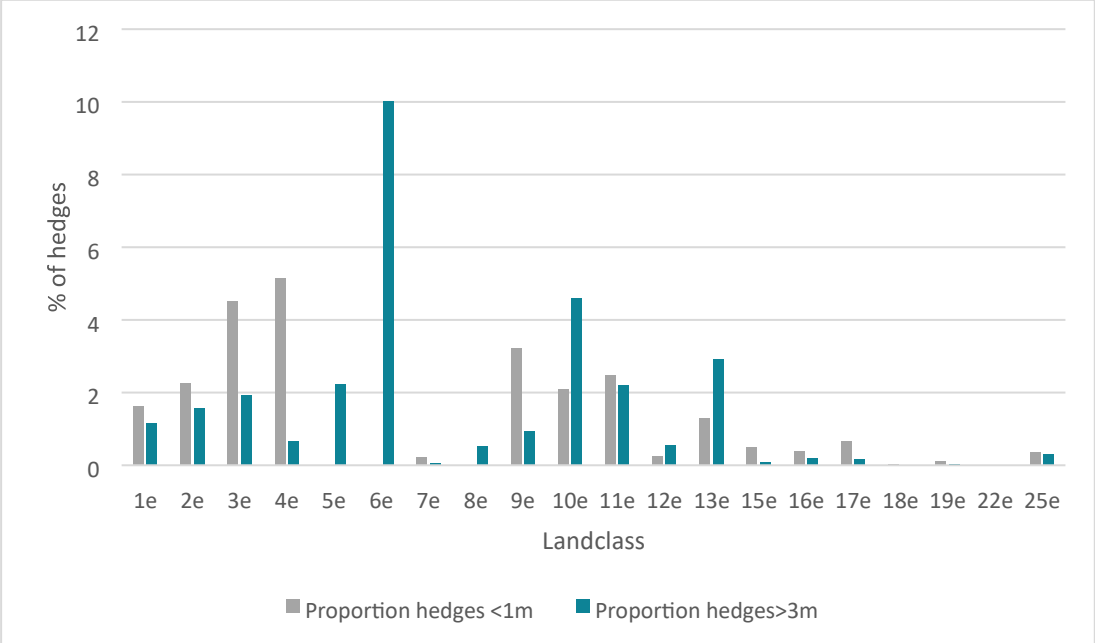


Figure 5.17. Proportion (%) of managed hedges <1 m and >3 m wide in 2023 by landclass.

5.4.2.5 Summary for National and landclass estimates

These results provide information on how managed hedges and lines of trees differ in their extent and quality across England.

1. Changes in national estimates of the extent of both managed hedgerows (woody unnatural shape) and lines of trees (woody natural shape) show no significant difference between the current 2022/3 survey and the previous 2007 survey. The longer-term trends for a small decrease in the extent of managed hedges and a small increase for lines of trees was continued in 2022/3.
2. High variability in the 2022/3 national estimate for the extent of lines of trees (compared to previous surveys) may be linked to more unsurveyed areas, both in terms of access refusals in the squares surveyed and squares that had no woody linear features in 2007 not being included in the 2022/3 survey.

3. A shift from managed hedges to lines of trees was consistent across all landclasses in England. Where woody features are already relatively sparse, particularly in the north and the midlands the impact has had a proportionally larger effect on remaining lengths of managed hedges.

4. Species composition of managed hedges differed by landclass with managed hedges in the south dominated by more mixed species than those in the midlands and the north (which are more hawthorn dominated).

5. Extents of very gappy managed hedges (50-75%) were relatively low, much lower than those with no gaps.

6. Length of managed hedges greater than 4 m in height increased in all but two landclasses (2e and 3e in the south-east of England) between 1998 and 2022/3. Overall, the lengths of managed hedges greater than 4 m in height were considerably higher than those less than 1 m in height for all but 5 of the landclasses.

7. The majority of managed hedges were between 1 and 3 m wide, although around 10% of managed hedges in the south-west landclass 6e were over 3 m wide.

5.4.3 Discussion of National and Landclass estimates

Lack of statistical significance in the increased losses of managed hedges or gains in the lengths of lines of trees since 2007 could be due to a potential slowing up in the neglect of managed hedges over this time period. However, as noted in 5.4.1, high variability in the estimates in 2022/3 (see Figure 5.5, in particular) which indicated high variability between squares may reflect the influence of unsurveyed/refused access areas in the analysis and obscure continuing declines. The landclass level estimates indicate reductions in managed hedges and increases in lines of trees across most landclasses between 2007 and 2022/3 (Figs 5.9 and 5.10) which are likely to be due to long term neglect of hedge management. This shift between feature type is insidious and may be overlooked as a change, especially in the early stages where boundaries still retain some trees (Figure 5.18). However, over time it leads to a loss of woody features from the landscape and a continuation of the longer-term trends identified in the CS time series since 1984. The loss of these features may result from a perceived lack of need for hedges (with fences fulfilling a need for stock retention), lack of time or resources for effective management or lack of interest from the farmer (although see section 6). Management between 2007 and 2022/3 became more focused on cutting and flailing than in previous surveys, with reductions in new planting and in hedges with ‘no management’. It is likely that there is a link between the transition between managed hedges and lines of trees and long-term cutting and flailing regimes. Experienced hedge-layers argue that without a

hedge management cycle[6] (where short-term management is complemented by longer term laying/coppicing) hedges deteriorate and disappear. Similarly, Staley et al. (2015) evidenced the role of hedgerow rejuvenation in improving the long-term quality of hedgerow habitats. Hence, features such as that shown below (Figure 5.18), provide a potential focus for future efforts to restore/replant features, if farmers can be encouraged to do so (see section 6).

Figure 5.18 Line of hawthorn which were formally part of a managed hedge.

Increases in hedge height are a positive sign that where farmers are managing their hedges, they are doing so in ways which benefit biodiversity, carbon sequestration and other ecosystem services. As well as the potential impacts of schemes (see below), this may reflect initiatives by NFU and others to encourage farmers to allow their managed hedges to increase in size[7]. However, it is important to note that neglecting management may also lead to higher hedges, and whilst this may initially provide benefits, if continued, it is likely to result in the eventual loss of hedges as trees shade each other out, leaving gaps. Anecdotally, surveyors noted that hedges tended to be more likely unmanaged on small holdings, potentially reflecting the choice of landowners to manage for environmental or biodiversity benefit. In the longer term, such an approach may be less environmentally beneficial.

5.4.3.1 Conclusions

The results show that although there were no statistically significant changes in the lengths of hedges or lines of trees between 2007 and 2023 there was a continuation of the trend since 1984 for deterioration of managed hedges into

[6] https://www.hedgelink.org.uk/cms/cms_content/files/78_hedgelink_a5_12pp_leaflet_7.pdf
[7] https://www.cfeonline.org.uk/environmental-management/carbon-storage-andsequestration/hedgerows/

lines of trees. This is likely to result from a lack of long-term management cycles for hedges.

5.4.4 Results - Mapped data at the square level (including AES impacts)

5.4.4.1 Mapped hedge height

Managed hedges are features mapped as woody features in which trees do not take their natural shape, as opposed to features in which they do (which get classified as lines of trees). Managed hedges increased significantly ($p < 0.001$) in height between 2007 and 2022/3 (Figure 5.19) and between 1998 and 2022/3 ($p < 0.001$). In 2007

most hedges were in the 1-2 m category, in 2022/3 there were more hedges >2 m in height (Figure 5.20).

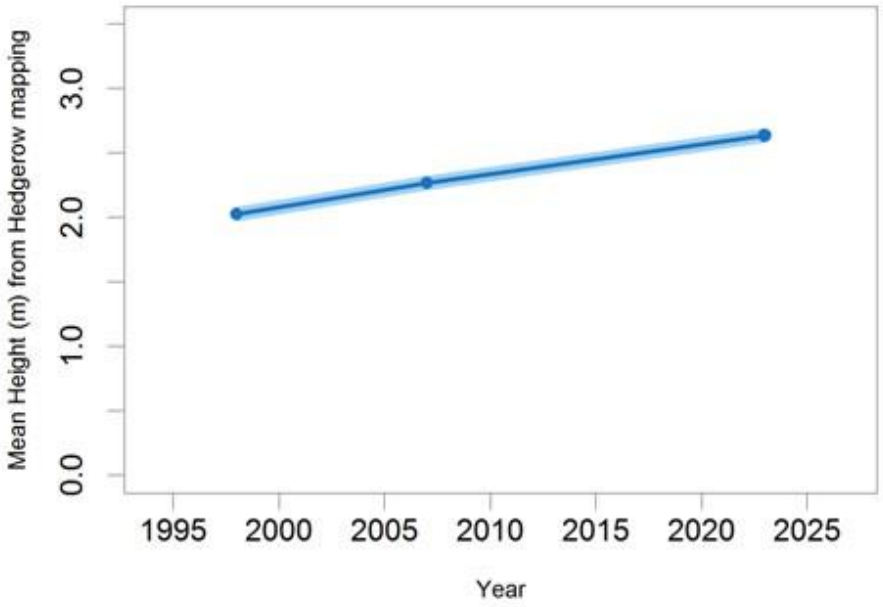


Figure 5.19. Trends in the height of mapped managed hedges in Countryside Survey squares between 1998 and 2022/3. Light blue shading represents 95% confidence intervals.

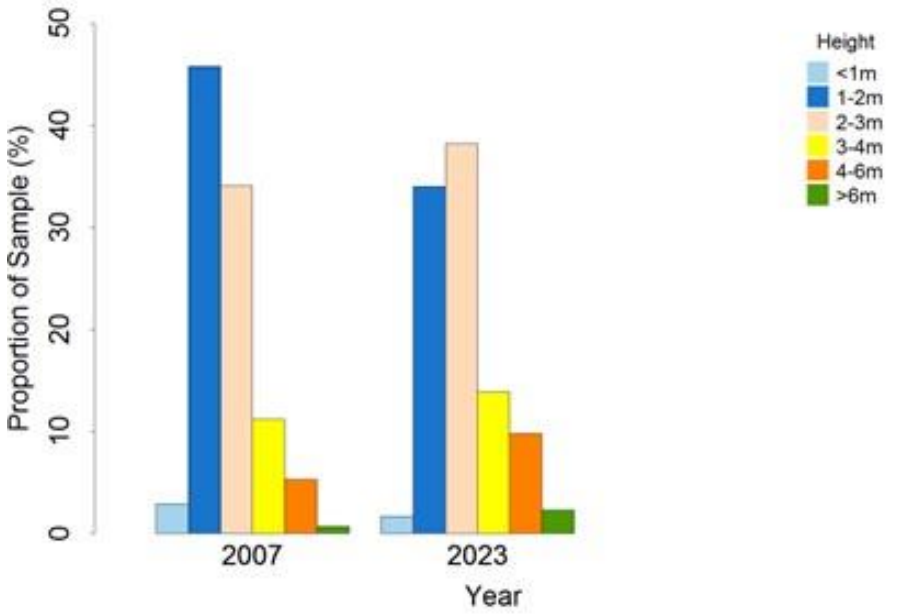


Figure 5.20. Trends in the proportions of mapped managed hedges at different heights in Countryside Survey squares between 1998 and 2022/3.

5.4.4.2 Mapped hedge height under AES

We only have information on which managed hedges were in schemes in 2022/3, analyses were not carried out on 'planted' hedgerows due to insufficient data. Trend analysis (1998-2022/3) indicated that there were small (0.2 m) but statistically significant differences ($P<0.001$) between the mean heights of managed hedges that were in or out of AES in 2022/23 overall (2.8 m compared to 2.6 m) and these were the same as the differences between managed hedges that were under 'management' options in AES (2.8 m) and hedges not under AES (2.6 m) (Table 5.3). When analysis was conducted on the 2022/3 data only, the difference in average managed hedge height was just 0.1 m and not statistically significant (values for 2022/3 in Figure 5.20).

Figure 5.21 indicates the trend in average hedgerow height for managed hedges in the Countryside Survey squares between the CS2000 survey and the 2022/3 survey, differentiated by whether managed hedges were in or out of AES in the current 2022/3 survey and, if in AES, under either 'management' or 'restoration' options (N.B. we do not have information as to whether managed hedges were in or out of AES prior to 2022/3). Hedges in AES under restoration or management options were slightly taller than those not under AES, but trends for increases in hedgerow height over time were the same whether managed hedges were in or out of AES in 2022/3. These trends are in line with those presented for all managed hedges in Figure 5.6 using the national estimates.

Table 5.3. Mean hedgerow heights (m) in the most recent Countryside Surveys (1998, 2007 and 2022/3) for managed hedges in and out of AES in 2022/3. Significance is indicated with an * against the values which are significantly different to one another.

	Not in AES		In AES				
			'managed'		'restored'		
Year	Mean	Lowerupper Est	Mean	Lowerupper Est	Mean	Lowerupper Est	Significance
1998	2.02	1.97-2.08	2.10	2.01-2.18	2.10	1.89-2.30	N/S (p= 0.54, p=0.99)
2007	2.26	2.2-2.32	2.31	2.23-2.38	2.37	2.22-2.53	N/S (p=0.9)
2022/3	2.61*	2.55-2.67	2.78*	2.7-2.85	2.75	2.59-2.92	P<0.001 (p=0.9)

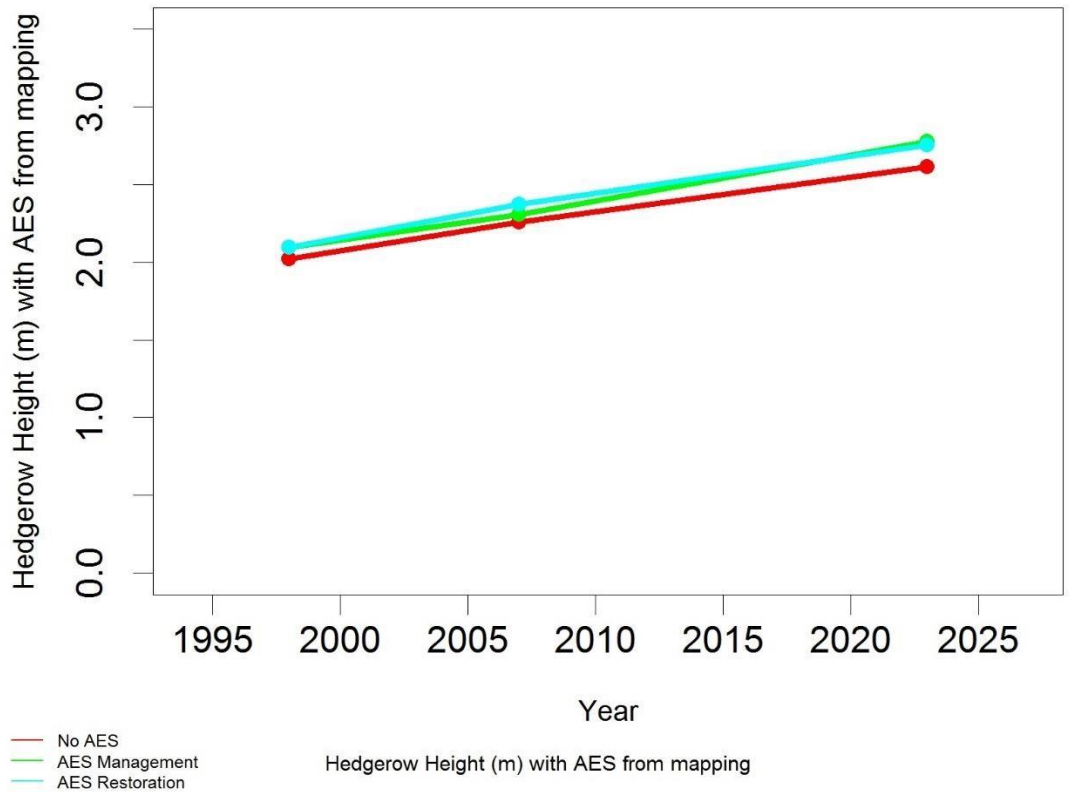


Figure 5.21. Trends in the height of mapped managed hedges in Countryside Survey squares for managed hedges not in AES in 2022/3, managed hedges under AES 'management' options in 2022/23 and managed hedges under AES 'restoration' options between in 2022/3.

Analysis to investigate whether managed hedge heights differed by Environment Zone and inclusion in AES revealed no patterns.

5.4.4.3 Mapped hedge width and AES

Hedgerow width was measured on mapped managed hedgerows for the first time in 2023 (N.B. not 2022). Results for managed hedges not in AES and in AES 'management' or 'restoration' options for England and for the three Environmental Zones (EZ's) are shown in Figure 5.22 and Table 5.4. Analysis showed that there were significant differences (at $p<0.01$ and $p<0.001$) between managed hedges not in AES and hedges under management options in England, EZ's 1 and 2 respectively.

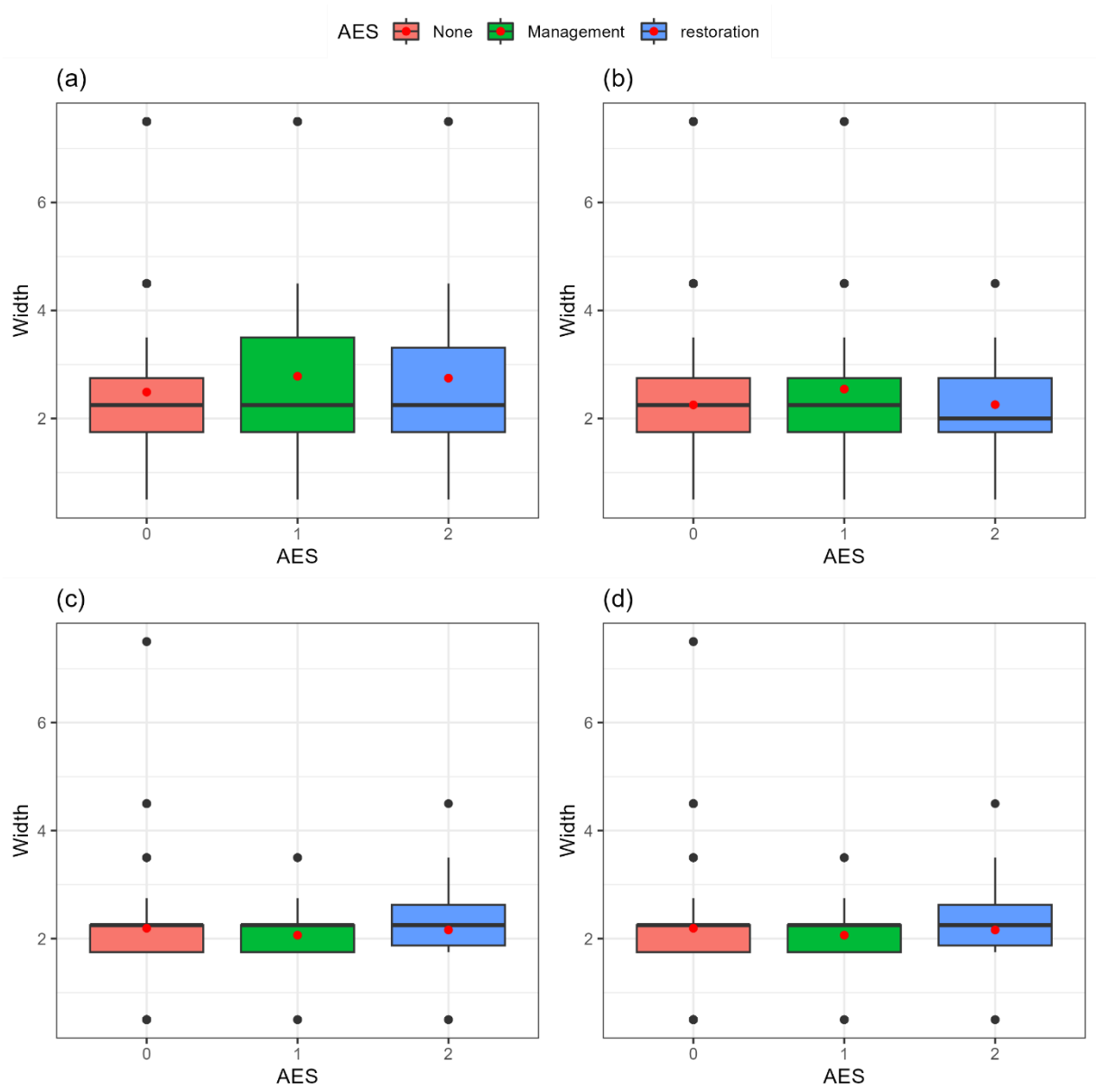


Figure 5.22. The widths of mapped managed hedges in Countryside Survey squares for managed hedges not in AES (None), managed hedges under AES 'management' options (Managed) and managed hedges under AES 'restoration' options (Restored), in a) England; and in Environmental Zones b)1, c) 2 and d) 3 (Fig 5.3) between 1998 and 2022/3. The mean is indicated with a red dot.

Table 5.4. Mean hedgerow widths in the most recent Countryside Survey (2023) per Environmental Zone for managed hedges not in AES, and in hedges in AES management and restoration options in 2023. Significance is indicated with an * against the values which are significantly different to one another ***p<0.001, **p<0.01, *p<0.05.

Width	**Not in AES**	**Management**	**Restoration**
England	2.5	2.8**	2.9 *
EZ1	2.4	2.7**	2.9
EZ2	2.7	3.1***	3.1
EZ3	2.4	2.3	3.1

5.4.4.4 Mapped hedge condition measures and AES

The proportions of mapped managed hedges under different management regimes are shown in Table 5.5. Results for all managed hedges for CS2007 are provided for comparison with results for 2022/3. All AES data is for 2022/3. Results broadly reflect the national estimates shown in Figure 5.7. Figure 5.23 shows the results for the proportions of mapped managed hedges under different management regimes within AES and under specific options. It reveals that some hedges under 'restoration' showed no signs of management (as the AES agreements were currently in the 'live' state prescribed management may not have been carried out yet on some hedges; for example, where agreements are still 'live' until 2024/2025)) but that others had clearly already been layed or coppiced.

Table 5.5. Proportions of mapped managed hedge lengths in different AES management categories.

Management	**2007**	**2022/3**	**Not in AES 2022/3**	**Management 2022/3**	**Restoration 2022/3**
No recent management	24.9	17.8	16.2	24.6	20.7
Newly planted	4.6	1.4	1.6	0.8	0.8
Cutting e.g., flail or saw (<3yrs)	68.2	77.8	79.7	71.6	59.6
Laying or coppicing (<5yrs)	1.0	2.1	1.6	2.5	17.5

Both cutting and laying	1.1	0.8	0.8	0.4	1.4

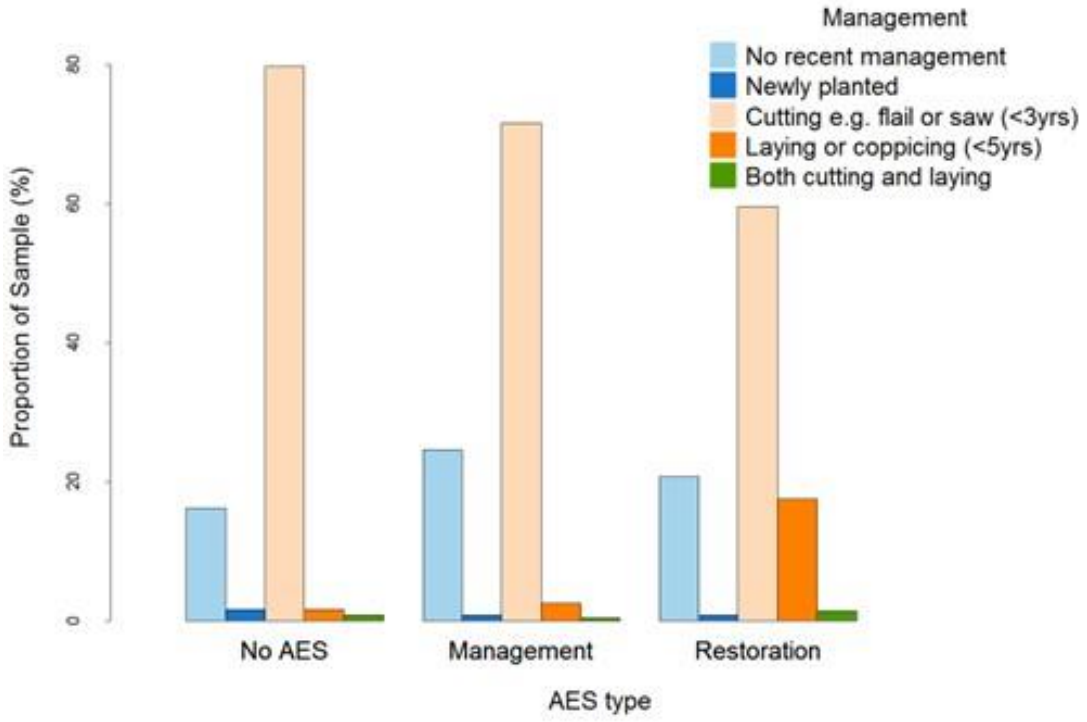


Figure 5.23. The proportions of mapped managed hedges that were either 'not in AES' or in AES 'management' or 'restoration' options (AES data for 2022/3) under different management regimes in Countryside Survey squares in 2022/3.

5.4.4.5 Newly planted features

179 features of total length (19,548 m) were recorded with the Newly Planted code attached. Of this length, 7,606 m (77) were not present in the data in 2007, all of these features were coded as managed hedges. Most features were either less than 1 m or 1-2 m high (80%) and <1.5 m wide (78%), approximately equal proportions were either hawthorn dominated (45%) or multi species (47%) with the remaining managed hedges mainly consisting of another species.

For the remaining length 11,942 m (102) there were features present at the same location in 2007. Features in 2022/3 were coded as either managed hedges (69) or lines of trees (27) and the newly planted code appears to have been used to describe gapping up, with some also including codes for staked trees and tree protectors.

Only two of these features (271 m) appear to have been planted under AES option BN11, a further 7 are in an area which has been under AES hedge management options.

Due to the long period of time since the last survey (>15 years), to investigate whether there were additional new features in the data which had not been recorded in 2007, squares were individually checked.

New managed hedges recorded (where no feature was previously present) and not recorded as Newly planted

N.B. As well as reflecting actual change, these features *may* potentially result from different interpretations of woody features in the mapping, e.g., mapping of belts of scrub (areas) rather than linears previously, or from surveyors in 2007 failing to record these features.

In total 20,439 m (210 features) of managed hedges were recorded in 2023 at locations where they had not apparently been present in the 2007 survey. Of these 28 features (2,360 m) appear to be in an area which has been under AES hedge management options, including 2 under 'gapping up' and 'laying' options. Others may result from hedgerow creation by landowners either under other schemes such as those run by the Woodland Trust or the Tree Council or funded by the landowners themselves.

New lines of trees recorded (where no feature was previously present) and not recorded as Newly planted

N.B. As well as reflecting actual change, these features *may* potentially result from different interpretations of woody features in the mapping, e.g., mapping individual trees (as point features) rather than linear features previously, or from surveyors in 2007 failing to record these features.

In total 7,445 m (87 features) of lines of trees were recorded in 2023 at locations where they had not apparently been present in the 2007 survey. None of these features appear to be in an area which has been under AES hedgerow management options. These may result from planting by landowners either under other schemes or funded by the landowners themselves.

5.4.5 Results - plot data

5.4.5.1 Plot numbers

Numbers of plots surveyed in 2022/3 by plot type and linear feature type are included in Table 5.6. NB plots for 2007 are the plots that were repeated in the 2022/3 survey. Additional plots were added in 2022/3 to cover features under AES.

Table 5.6. Numbers of plots surveyed in 2022/3 and used in the analyses of change between 2007 and 2022/3. WUS= woody linear feature in which trees do not take their natural shape (aka managed hedges) and WNS= woody linear features in which trees take their natural shape (aka lines of trees or scrub).

H plot		D plot					
2007	2022/3	2007			2022/3		
Total	Total	ALL	WUS	WNS	ALL	WUS	WNS
319	471	400	231	169	540	287	248

5.4.5.2 Woody species richness in Hedgerow diversity (D) plots and AES

There was a slight decrease in woody species richness from 2007 to 2022/3 (Figure 5.24). However, there had already been a slight increase from 1998-2007 and over the period 1998-2022/3 there was no significant change (from an average of 5 (1998) to an average of 5.2 (2022/3) species).

There were no significant differences over time between the plots 'in' or 'out' of AES regardless of the AES options they were under. Similarly, an analysis of woody species richness in D plots by EZ and whether plots were 'in' different AES options or not in AES showed no significant results (Table 5.7 & Figure 5.25).

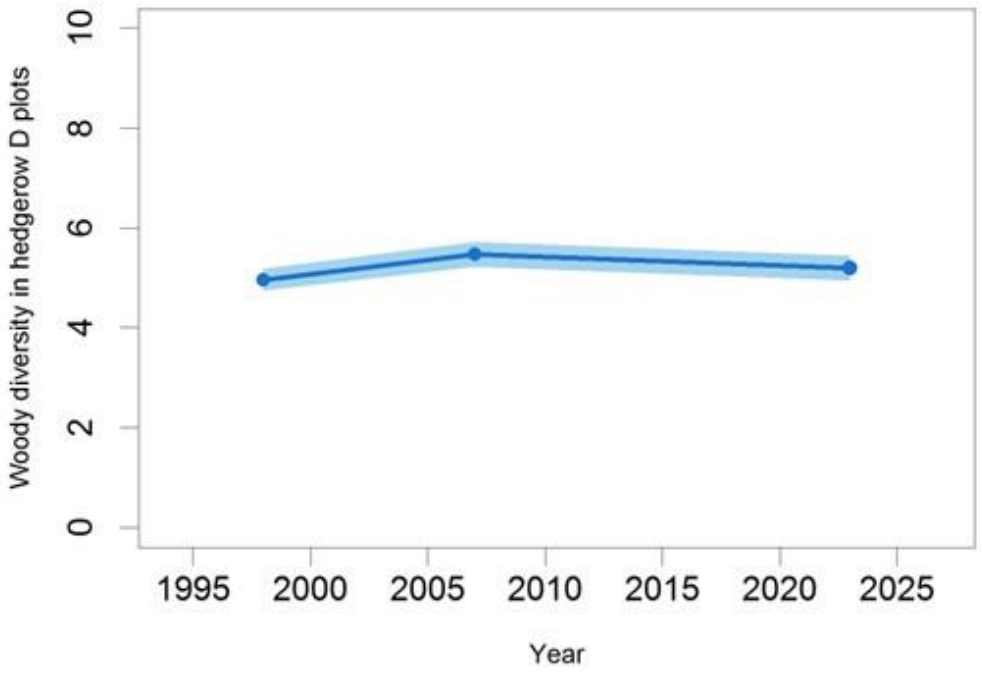


Figure 5.24. Trend in richness of woody species in D plots from 1998-2022/3. Light blue shading represents 95% confidence intervals.

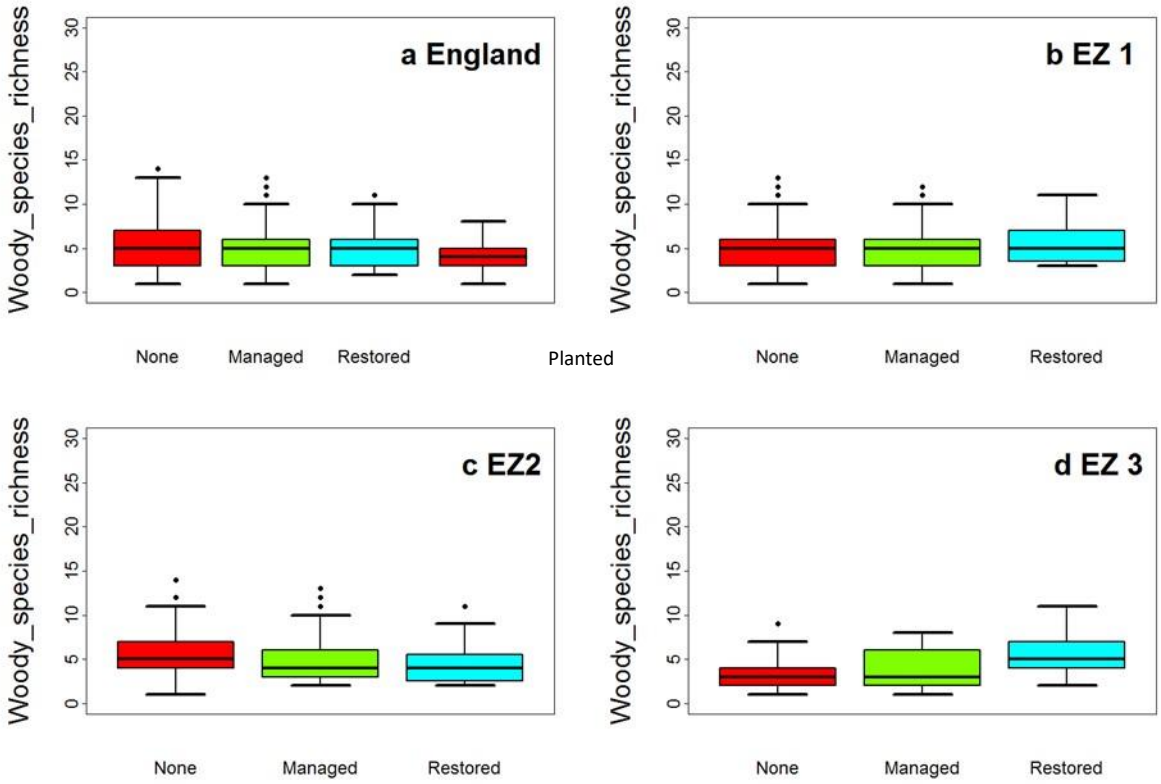


Figure 5.25. Woody species in D plots in Countryside Survey squares in 2022/3 for managed hedges not in AES (None), managed hedges under AES 'management' options (Managed), managed hedges under AES 'restoration' options (Restored) and planted managed hedges (a only), in England and the three Environmental Zones, mean is shown by a red dot.

Table 5.7. Mean woody species richness in the most recent Countryside Survey (2022/3) D plots per Environmental Zone for managed hedges not in AES, and in AES management and restoration options in 2022/3. Significance is indicated with an * against the values which are significantly different to one another ***p<0.001, **p<0.01, *p<0.05.

Woody species richness	**Not in AES**	**Management**	**Restoration**
England	5.2	4.96	4.97
EZ1	5	5.1	5.1
EZ2	5.6	4.9	4.7
EZ3	3.4	4.2	5.5

5.4.5.3 Species richness in Hedge (H) plots and AES

There was a slight decrease in species richness in the ground flora at the bases of managed hedges from 2007 to 2022/3, reinforcing an overall trend between 1998 and 2022/3 (Figure 5.26, Table 5.8).

There were no significant differences in managed hedge ground flora over time between the plots 'in' or 'out' of AES regardless of the AES options they were under. Similarly, an analysis of the species richness of ground flora in H plots by EZ and whether plots were 'in' different AES options or not in AES showed no significant results.

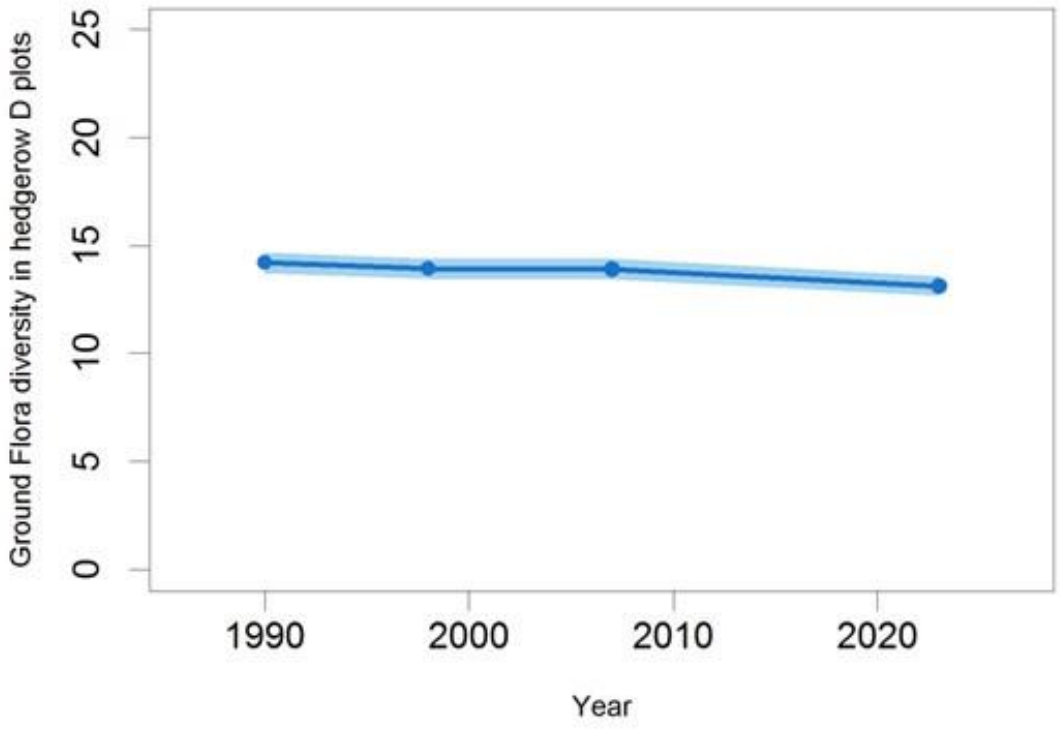


Figure 5.26. Trend in species richness of hedge ground flora in H plots from 19902022/3. Light blue shading represents 95% confidence intervals.

Table 5.8. Changes in ground flora species richness (H plots) between 1990 and 2022/3.

	Mean species richness					
	1990	1998	2007	2022/3	Recent trend 2007-2022	Long term trend (90-22/23)
Ground flora species richness	14.2	13.9	13.9	13.1	p<0.05	P<0.001

5.4.5.4 Hedgerow condition (D) and (H) plots and AES

Hedgerow condition measures as described above (section 5.3.2) were extracted for D plots. D plots used in the analysis are described in Annex 1. We have analysed plots that were managed WUS in both years as well as plots that were managed WUS in 2007 but had changed to lines of trees (WNS) in 2022/3. Figure 5.27 shows

the proportion of D plots for which the hedgerows reached nine condition measures in 2007 and 2022/3 for the plots that were managed hedges (WUS) in both years. Hedges tended to be wider (and therefore had a greater cross-sectional area), fewer had gaps amounting to greater than 10% of the feature but more had gaps greater than 5m. A higher proportion of D plots reached both structural and margin criteria on condition (including on arable land) in 2022/3 than in 2007 (Figure 5.28, values in Annex 1 Table A.2).

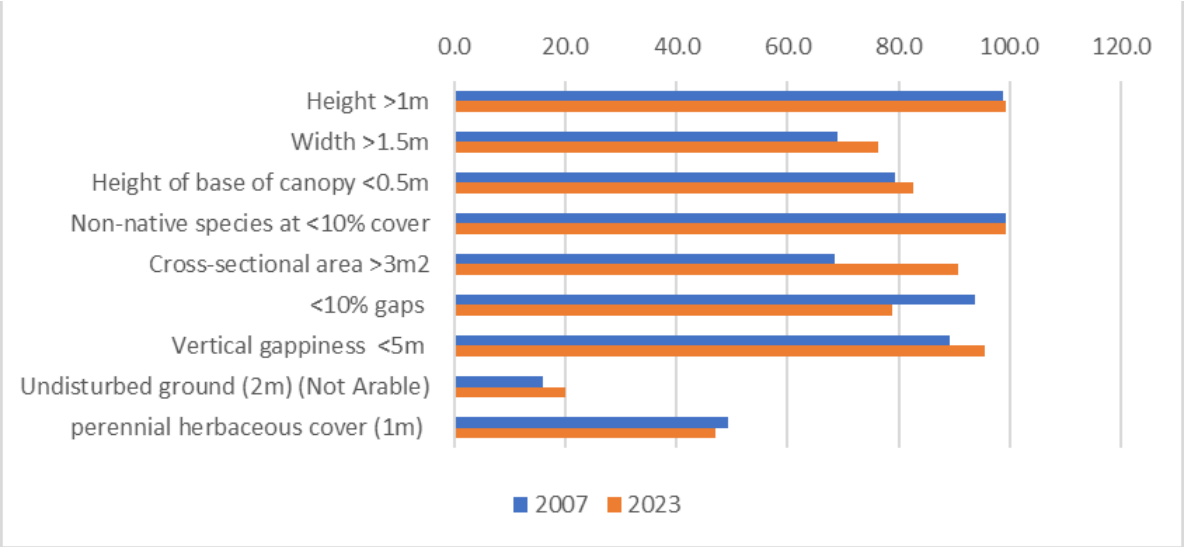


Figure 5.27. The proportion of D plots for which managed hedges reached nine condition measures in 2007 and in 2022/3.

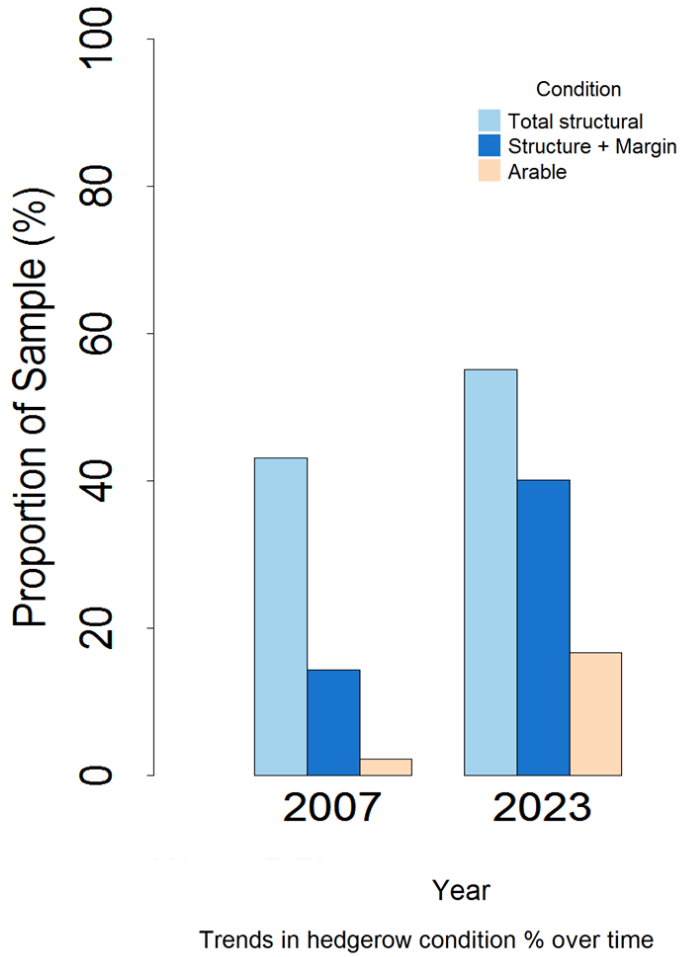


Figure 5.28. The proportion of D plots which reached all structural and margin condition measures on managed hedges in 2007 and in 2022/3. Values in Table A.2.

Figure 5.29 shows the proportion of D plots which reached 9 condition measures in 2022/3 for managed hedges not in AES (None), managed hedges under AES 'management' options (Managed) and managed hedges under AES 'restoration' options (Restoration). Hedges under restoration options (N.B. these may not yet have been restored) tended to be less structurally sound but had wider margins, whilst plots on hedges under management options were wider and had better margins (Figure 5.30).

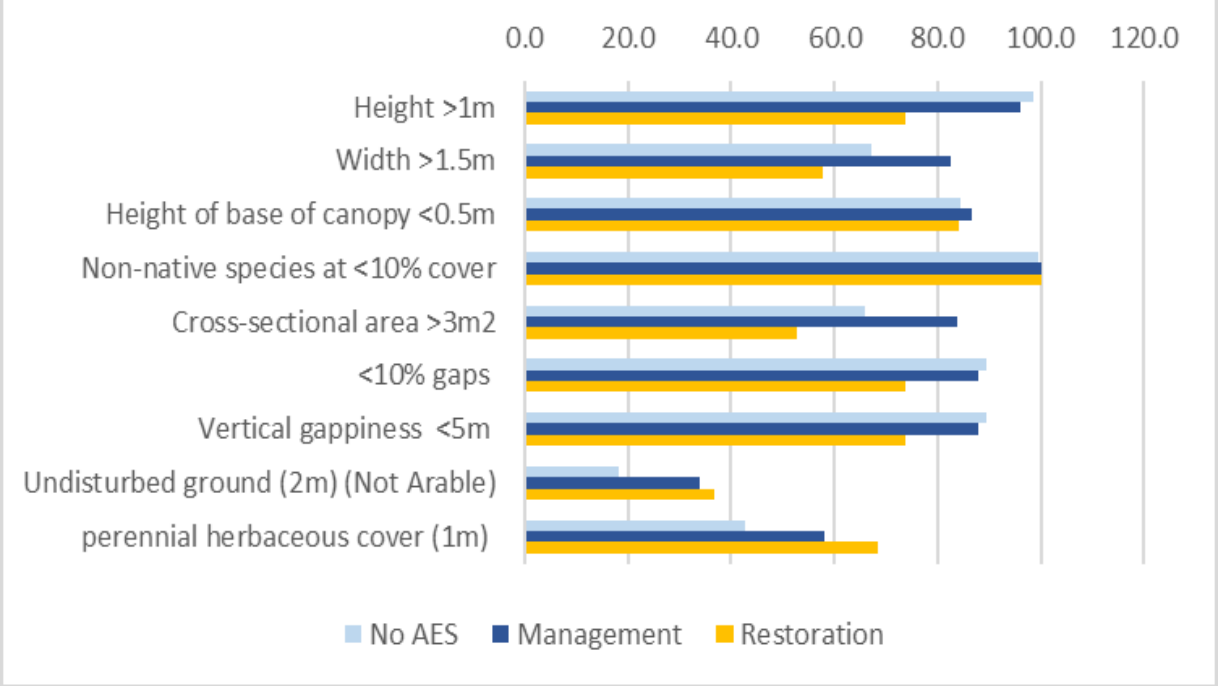


Figure 5.29. The proportion of D plots which reached 9 condition measures in 2022/3 for managed hedges not in AES (No AES), managed hedges under AES 'Management' option and managed hedges under AES 'Restoration' options.

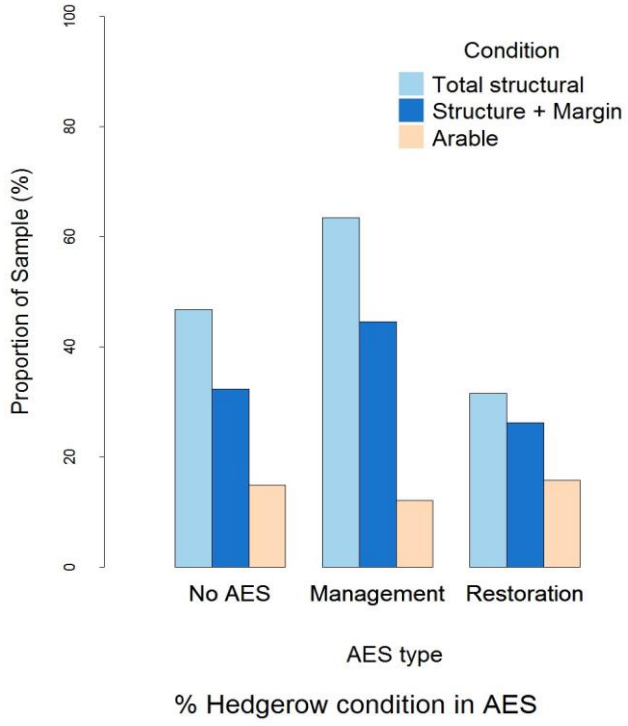


Figure 5.30. The proportion of D plots which reached all structural and margin condition measures in 2022/3 for managed hedges not in AES (No AES), managed hedges under AES 'Management' options and managed hedges under AES 'Restoration' options. Values in Table A.2.

Changes (1990-2022/3) in the combined cover of negative indicator plants (i.e., those indicating high Nitrogen conditions), docks (*Rumex* sp.), cleavers (*Galium aparine)* and nettles (*Urtica dioica*) is shown in Figure 5.31. The trend shows a slight decrease from 2007 to 2022/3 but no statistically significant change. No significant differences were found in the cover of negative species between H plots in or out of AES.

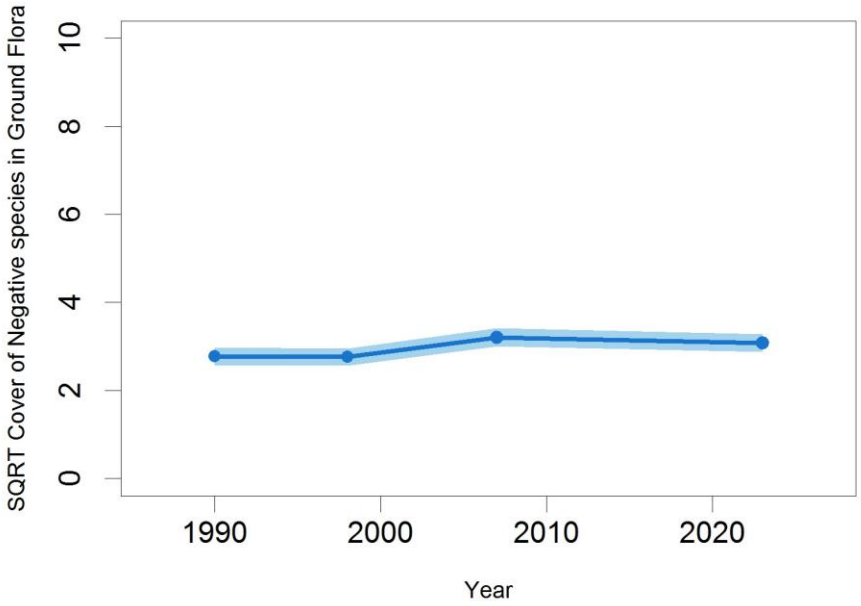


Figure 5.31. Trend (1990-2022/3) for changes in the cover of negative indicators. Light blue shading represents 95% confidence intervals.

5.4.5.5 Summary for square level analyses

1. The mapped hedgerow data shows hedgerow height increased slightly between 2007 and 2022/3. In 2007 most hedges were in the 1-2 m category, in 2022/3 there were more hedges >2 m in height. Hedges under AES options (either management or restoration) in the latest survey were on average 0.2 m taller than those not under AES management.

2. The most widespread management recorded for mapped managed hedges was cutting with a flail in the last 3 years (77.8% in 2022/3), a slight increase from 2007 (68.2%). This was slightly greater for managed hedges not in AES (79.7%) than for those under AES management options (71.6%).

3. More than half (59.6%) of mapped managed hedges under live restoration options had been cut with a flail in the last 3 years, rather than restored. This is not surprising given restoration of a managed hedge is undertaken at one timepoint during a 5 or 10-year AES agreement. This result helps in interpreting the condition results from the D plot surveys.

4. Average woody species richness did not change between 1998 and 2022/3, though there was a slight increase to 2007 followed by a small decrease. Woody species richness was not affected by AES options.

5. Herbaceous species richness (in the base plant community of managed hedges) decreased slightly from 2007 to 2022/3, continuing a longer-term trend from 1990. This did not differ between managed hedges under AES options and those not under AES. This is not surprising, given the prescriptions for hedgerow management options focus on cutting regimes for woody species and not on basal flora management.

6. Hedgerow condition improved between 2007 and 2022/3. The percentage of hedges in England meeting structural condition criteria increased by 12% (2007: 43.1%, 2022/3: 55.2%). There was a greater increase in hedges meeting both structural and margin condition criteria between the two surveys, though over half of hedges surveyed still failed to reach good condition in this combined category (2007: 14.4%, 2022/3: 40.2%).

7. A greater proportion of managed hedges under ongoing AES management options were in good structural condition (63.5%) than managed hedges not in AES (46.8%) in 2022/3. This appeared to be due to increased width under management (and hence cross-sectional area) and in relation to proximity of disturbed land and margins. A lower proportion of hedges under restoration options met structural condition criteria (31.6%). This is not surprising given the mapped managed hedge data showed more than half of these managed hedges were yet to be restored (5.28 above), and that these options within Countryside Stewardship and Environmental Stewardship target hedges in poor condition.

5.4.6 Discussion of Results – Square level mapped and plot data

The results for the change in extent and in mapped measures of condition unsurprisingly echoed the patterns from the National Estimates analysis (5.4.1). ***Despite the negative findings regarding hedge extents (5.4.3.1) at a national level, there were some positive signs that newer AES are supporting restoration and planting of hedges and that planting, and restoration are also happening outside of AES. The issue is that the scale of changes in these is so far insufficient to substantially impact on current extent.*** Changes in the height of hedges overall between 2007 and 2022/3 and within schemes seem to occur for hedges regardless of their starting point (Figure 5.20), i.e., hedges of both 1 m and those of 2-3 m increased in height. In general hedge height (and hedge width) are important for hedge condition, ensuring a greater area of habitat for wildlife as well as storing higher amounts of carbon. Hedge width was also greater across England for hedges under AES, indicating that management prescriptions had a positive effect on hedge condition. More detailed data from the plots provided more evidence of this (below). The mapped information also revealed a difference in management between hedges under AES and hedges not under AES reflecting less frequent cutting as would be expected from the height and width differences recorded. Potentially a legacy of widespread scheme uptake under Environmental Stewardship was a relaxation in the intensity of management; changes could also relate to costs of

management. ***Participants with hedges in AES were more likely to manage their hedges with a combination of laying and cutting than those with no hedges in current AES, who were more likely to use a flail. They were also more likely to have restored a hedge.*** This indicates that those in AES are implementing more effective long-term hedgerow management practices, supported by funding.

The plot results confirmed improvements in hedge structural condition (which relates primarily to height and width). ***A greater proportion of hedges under ongoing AES management options were in good structural condition (63.5%) than hedges not in AES (46.8%) in 2022/3.*** There was also a greater increase in hedges meeting margin condition criteria (width of unmanaged land adjacent to the hedge) between the two surveys, though over half of hedges surveyed still failed to reach both good structural and margin condition criteria. Roadside hedges need regular maintenance for safety reasons and in many cases, this may restrict the potential for them to reach certain structural criteria. Hence there is always likely to be a subset of hedges which do not meet condition criteria, although the proportion currently failing is higher than the proportion of hedges falling into this category.

Average woody species richness did not change between 1998 and 2022/3 and was not affected by AES options. ***Herbaceous species richness (in the hedge base plant community) decreased slightly from 2007 to 2022/3, continuing a longer-term trend from 1990.*** This did not differ between hedges under AES options and those not under AES. Changes in woody species richness are only likely to occur if there is a significant increase in hedge extent resulting from the planting of multi-species hedges. Whilst those planting new hedges are encouraged to use a range of species, the low extents of new planting resulted in no net change across the CS sample. AES do not target the basal flora of hedges, although these plant species may be very important themselves and for a wide range of associated species (Critchley et al. 2013). Hedge bases can become dominated by eutrophic species, although the results here show no change in these between 2007 and 2022/3. A continued decrease in species richness is likely to reflect the increasing dominance of species that can tolerate shady/eutrophic conditions. Further work will be carried out to explore links between structural and species changes and field use to identify possible options to address loss of species in hedge bases.

Overall, the results indicated that hedgerow condition improved between 2007 and 2022/3 and that AES had a positive impact on hedge condition. Whilst hedgerows in England fall well short of meeting Favourable Conservation Status for habitat quality (95% of features in good condition), there are positive signs that engagement with AES will help to progress towards this target. Management and restoration to improve quality remain a priority for hedgerow conservation and policy.

5.5 Quality Assurance (QA) Analysis

5.5.1. Methods

A total of 40 plots were sampled by both the QA surveyor and the hedgerow survey team, with the survey team recording more plots overall in survey squares than the QA surveyor. The survey team were focused on ensuring *both* a repeat of previous survey plots and sampling of plots under AES agreement (where possible). Twenty one of the 40 plots recorded were D plots and 19 were H plots.

5.5.1.1 Plot relocation

Hedgerow plots are generally one of the easiest plots to relocate because they are against a managed hedge (H) or the actual woody feature (D) itself, rather than in the centre of a large polygon and these features tend to be relatively stable in terms of location. The QA team were provided with the same plot photos and plot maps as the hedgerow surveyors to help in plot location (from 2007) and where possible, with the new maps and photos from 2023 surveyors.

5.5.1.2 Species recording

Species recording used a standardised list against which surveyors recorded a % cover. The QA surveyors recorded the plots without reference to the surveyors' data. The simplest comparison between the QA and the surveyors' records was an assessment of species number per plot. A paired sample T-Test was used to test for significant differences between QA assessors and surveyors. Mismatches in the species record were thereafter assessed to ascertain potential reasons for large mismatches. **5.5.2 QA Plot Results**

5.5.2.1 Plot relocation

In most cases the QA team did not record any issues with plot location. However, for a few of the H/D plots there were potential locational issues arising from 1) a change in the position of a gateway impacting on the hedgerow and on the locations of the original plots 2) different interpretations of hedgerow extent due to a woody feature being present behind the hedgerow, 3) missing maps from 2007. These locational issues apparently impacted on the species recorded, see below.

5.5.2.2. Species Recording

For 47.5% of all H and D plots (40 in total), the numbers of species recorded by the surveyor and the QA surveyors were within 1 species.

D plots

The majority of plots with the same or very similar numbers of species were the D plots which only sample the woody component of hedgerows and where the total species numbers recorded were low (between 2 and 12 (Table 5.9)). In 9 of the 21 plots species numbers were the same and in a further 6 they differed by just one species. In the remaining 6 D plots species records differed by no more than 3 with the plots with the highest numbers of species tending to be more variable in numbers

of species recorded. For those plots with lower numbers, and with differences between QA surveyors and surveyors, further investigations revealed potential locational issues. In plot 6, five of the six species recorded by the QA surveyor were also recorded by the CS surveyor, but the species lists and % covers of species present indicate possible locational error (e.g., *Cratageous monogyna* was recorded at 35% by hedgerow surveyor and 1% by the QA surveyor). For plot 14, the species list and cover indicate that the CS surveyor missed some species with very low cover (including *Hedera helix* and *Prunus spinosa*).

Table 5.9. Species richness for QA and CS plots in each of the 21 D plots.

Plots	QA	CS
1	9	8
2	10	10
3	6	8
4	8	9
5	7	9
6	6	9
7	11	13
8	8	10
9	11	12
10	4	5
11	7	8
12	7	7
13	8	7
14	6	3
15	6	6
16	4	4
17	5	5
18	7	7
19	4	4
20	2	2
21	3	3

A paired two-sample T-test comparing the two lists of species counts for the D plots showed no significant difference between the species numbers recorded overall (t (two tailed) 2.08, P >0.10), with the QA Team recording slightly fewer species than the Survey Team.

H plots

Species numbers varied more between the QA surveyors and the surveyors for the H plots, in which there were also higher numbers of species (Figure 5.31). In general,

the QA surveyor recorded higher numbers of species than the surveyors (mean for QA = 18, compared to 16 for the surveyors).

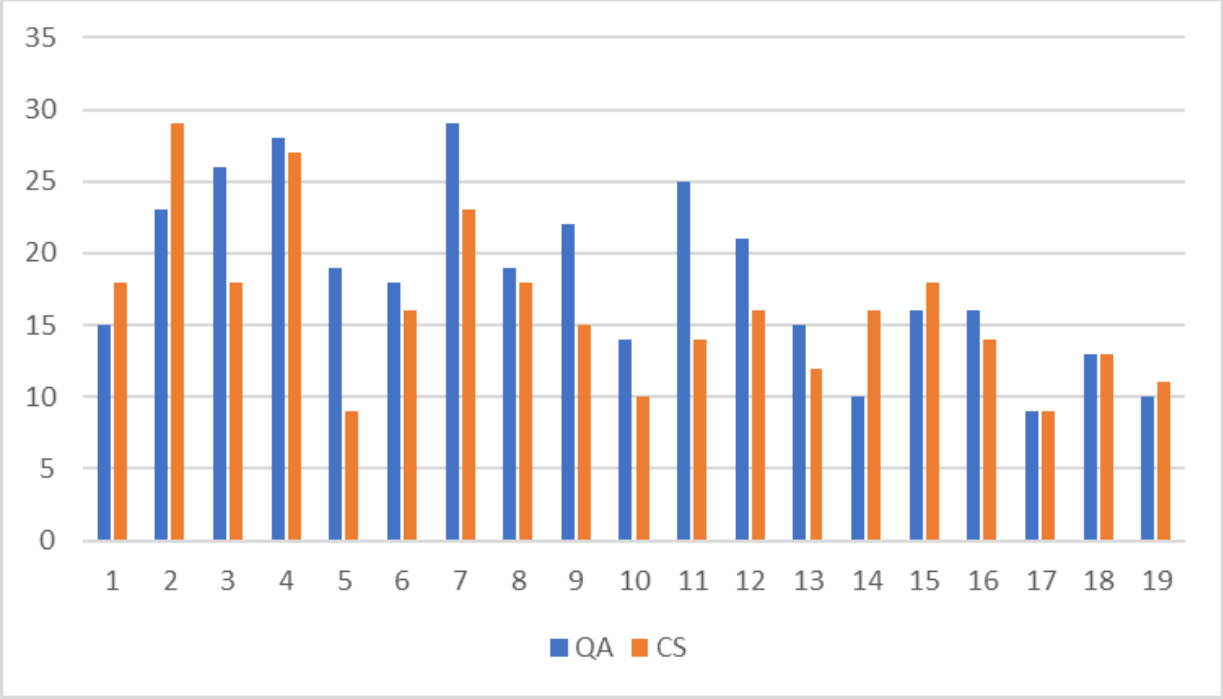


Figure 5.31. Numbers of species recorded in the H plots by the QA surveyor (blue) and by the hedge surveyors (orange).

A paired two-sample T-test comparing the two lists of species counts for the H plots showed that differences between the species numbers recorded by the hedgerow surveyors compared to the QA Team were not significantly different (t (two tailed) =2 .0, P >0.06). In general, the QA surveyor recorded slightly more species than the Survey Team, which is consistent with previous QA results for Countryside Survey.

A closer look at plot differences in the 4 plots where the numbers of species were most different between the QA and the hedgerow surveyor (3, 5, 9 &11, Figure 5.19) indicated possible locational issues in all instances. These were either plots where the surveyor had been uncertain about plot placement, in part due to the position of the hedgerow in relation to an adjoining woodland, plots in a wider hedgerow, or plots with an adjusted position due to changes in features. General guidance for mapping is that hedgerows should not be recorded when they adjoin a woodland, but in cases where they have been recorded there previously, surveyors are advised to continue recording. It appears from the data that in these cases and for other particularly wide hedgerows (3 of 4 plots) the hedgerow surveyors had recorded vegetation further towards the centre of the hedgerow than the QA surveyor had. In those plots, grassland species (grasses and herbs) constituted a higher cover of the QA plots (up to 50%) and <1% of the hedgerow surveyor plot. These differences are of some concern because they indicate a lack of clarity on the plot location for the H plots, but they do not indicate poor recording by the hedgerow surveyors. Potentially the issue

was rather that the QA surveyor did not have the opportunity to refer to the detailed information (collected in the software) from the hedgerow surveyors on plot location issues, due to performing the QA in the same week. This was certainly the case for 3 plots where detailed advice on relocating the plots was included.

5.5.3 Analysis of mapping data

All accessible woody linear features in 9 x 1 km squares were mapped by a QA surveyor using the same protocols as the main survey team. In some cases, due to permissions on the day or time constraints, slightly different areas of the squares were mapped. Results are given for either comparable features mapped in common, or all mapped features, as stated below. A comparison of consistency of mapping for key features from the CS and the QA surveys is provided below.

5.5.3.1 Overall feature length

A comparison of the different linear feature types mapped by length across all squares is given in Figure 5.32. Results are presented for features on lines mapped by both the hedgerow (main) and QA surveyors. Overall agreement is high in terms of the proportions of each feature type mapped. The biggest variations are in relatively uncommon FO (Forestry) features (e.g., belts of trees). This discrepancy may occur where a surveyor has concluded that a woody feature includes more than a single (or two closely planted) lines of trees and is therefore not one of the other feature type (lines of trees or WNS – woody features in which trees take their natural shape and managed hedges or WUS – woody features in which trees have an unnatural shape). Square H shows such a difference between the QA and the hedge surveyor, where the QA surveyor recorded an FO and the hedge surveyor recorded a line of trees. In some squares, a shortfall in mapped lines of trees is compensated by a greater number of managed hedges or vice versa (for example in QA squares B,F,G,H and I) highlighting that there are certain woody linear features which are difficult to categorise as either a line of trees or a managed hedge.

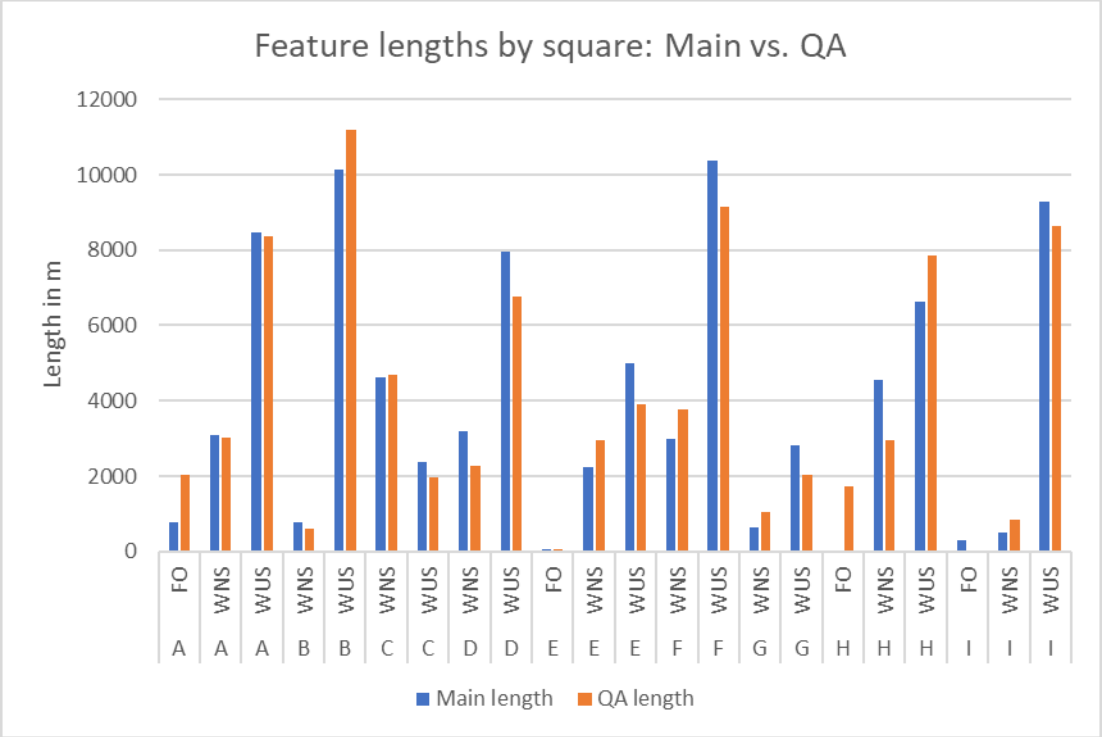


Figure 5.32. Overall agreement of lengths of mapped feature (m) by square (where features were mapped in common by hedgerow surveyors and QA surveyors). FO- Forestry features, WNS- line of trees and WUS- managed hedge. Squares are labelled with letters A-I.

In all QA squares, direct comparisons of existing features (as opposed to the overview of all lines and associated features, including new features above) showed a high correspondence between the QA and hedgerow surveyors (Figure 5.33). There were a small percentage of cases where QA and hedgerow surveyors differed in their interpretation of features as either lines of trees (WNS) or managed hedges (WUS).

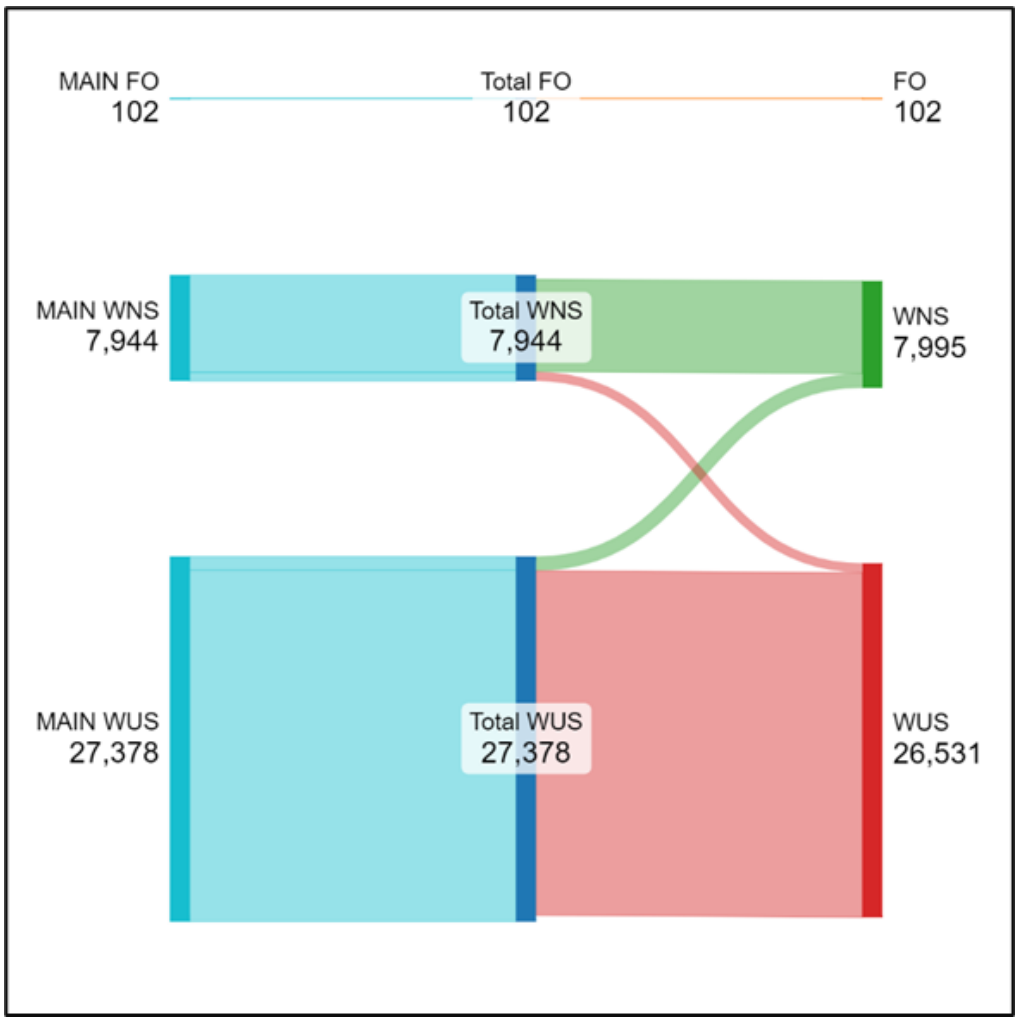


Figure 5.33 Length of features mapped by the Main (hedge) survey (left in turquoise) vs. length and type of those features mapped by the QA surveyors (right, green indicates features mapped as WNS by QA surveyors and red indicates features mapped as WUS by QA surveyors), where features were mapped by both teams.

5.5.3.2 Comparison of condition measures

For the following data, comparisons were made for all features mapped by both the hedgerow and the QA surveyors. Some anomalies may be expected by slight differences in mapping extent, but the expectation is that most features will be common to both datasets.

- ***Height***

A comparison of a variety of different condition measures can be made between the hedgerow surveyors' and the QA data. Height is estimated in the survey rather than specifically measured. Figure 5.34 shows a comparison of the heights of managed hedges and lines of trees in the linear features commonly mapped in both surveys (as in Figure 5.22). Approximately equal amounts of features were allocated to most

of the height categories by both the QA and the hedge surveyors, with only around 10% of features between 1 and 3 m allocated to different height categories.

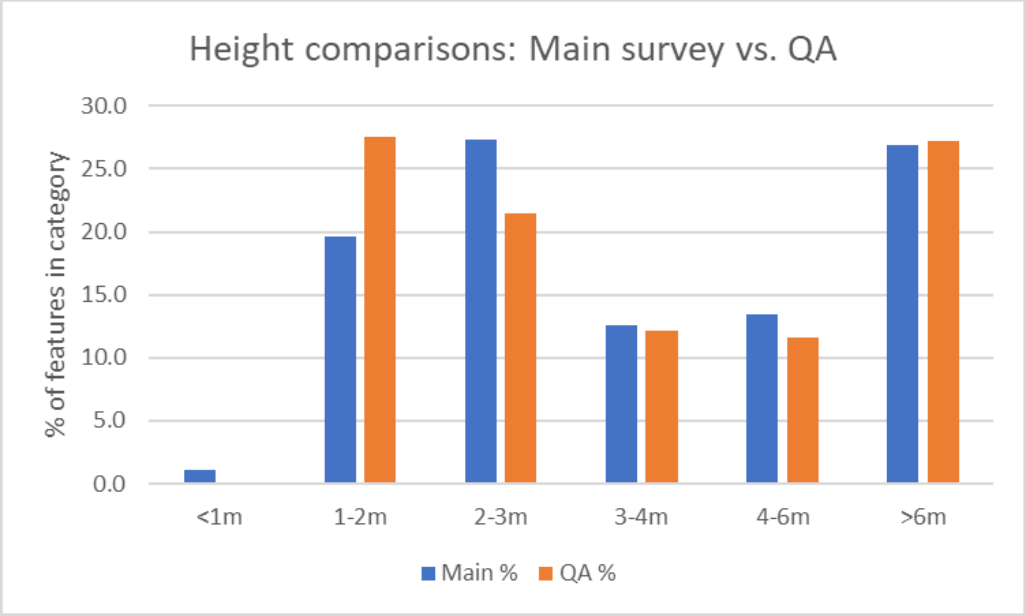


Figure 5.34. Height comparisons between hedgerow (main) and QA surveyors for hedges and lines of trees**.**

- ***Width***

Figure 5.35 shows a comparison of the widths of hedgerows commonly mapped in both surveys. Approximately only 6% of features were allocated to different categories by the QA and hedge surveyors.

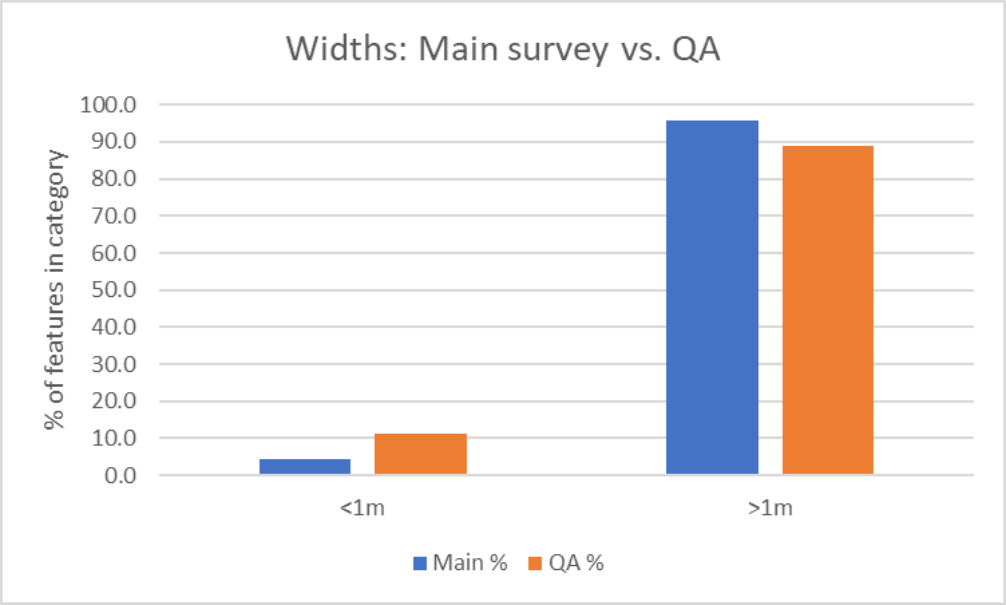


Figure 5.35. Height comparisons between hedgerow (main) and QA surveyors for managed hedges.

- ***% Gappiness***

Figure 5.36 shows a comparison of the recorded vertical gappiness of managed hedges commonly mapped in both surveys. These were highly comparable although the hedgerow surveyors recorded a slightly higher proportion (7.5%) as having no gaps compared to the QA surveyor. Larger gaps, whilst less frequent, were recorded in the same categories by both the hedgerow and QA surveyors.

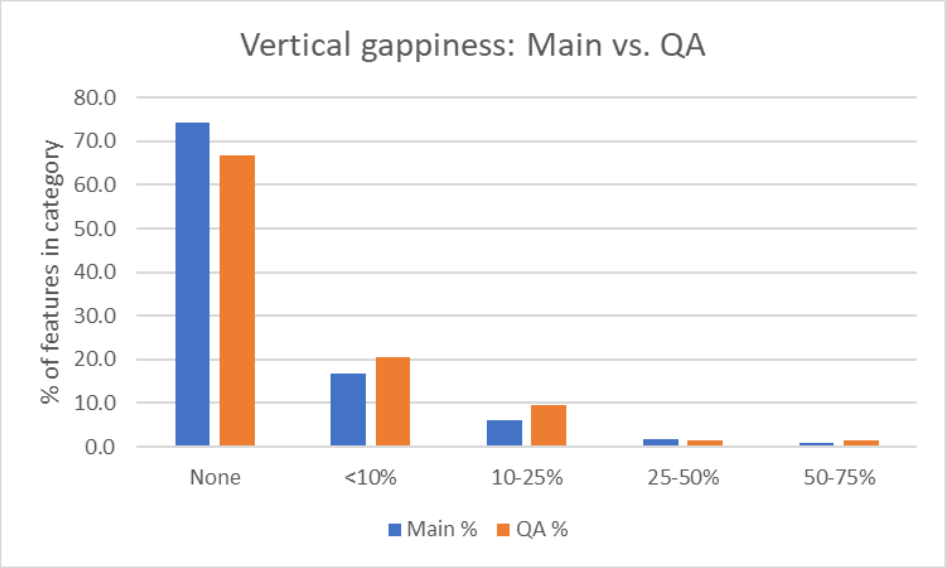


Figure 5.36. '% Gappiness' comparisons between hedgerow (main) and QA surveyors for managed hedges.

- ***Management***

The QA surveyor recorded the management categories 'newly planted', 'laying or coppicing' and 'both cutting and laying' less frequently than the hedgerow surveyors (Figure 5.37). As the incidence of these categories is small, it may reflect the slight variation in features mapped by the teams. The hedgerow surveyors recorded 'no recent management' more often than the QA surveyor, whereas the QA surveyor recorded 'cutting' more often. As previously, this minor variation may reflect slightly different features being mapped.

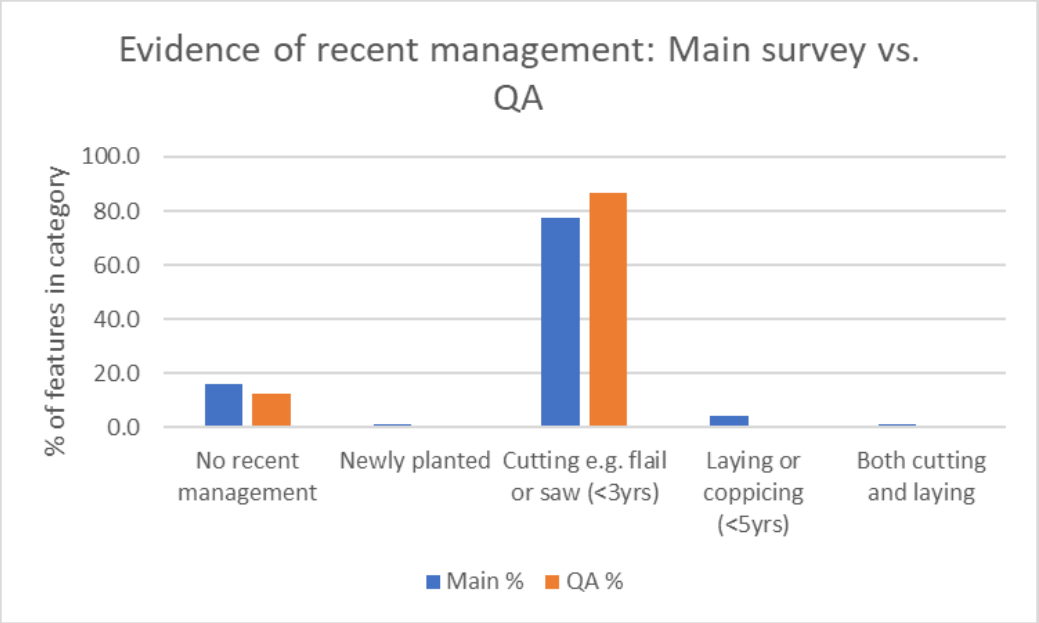


Figure 5.37. 'Evidence of recent management' comparisons between hedgerow (main) and QA surveyors for managed hedges.

- ***Species composition in managed hedges***

Species compositions of managed hedges recorded by the hedge and QA surveyors corresponded well, with a minor difference (~4%) in the '>50% hawthorn' and the 'Mixed species' categories (Figure 5.38).

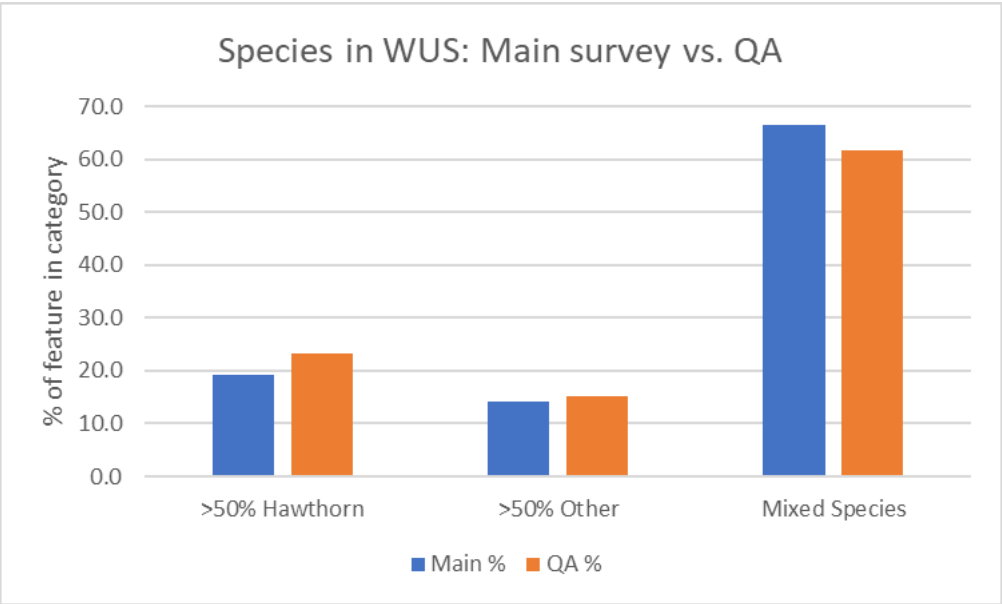


Figure 5.38. Comparison between species compositions recorded for managed hedges by the hedge (main) and QA surveyors.

5.5.3.3 *Tree Species in 'Lines of Trees'*

The top 8 species (with the highest proportion) recorded in lines of trees by both the hedge and QA surveyors are shown in figure 5.39. The top 8 species were the same for both the hedgerow and QA surveyors and proportions were very similar considering that cover is estimated from the ground.

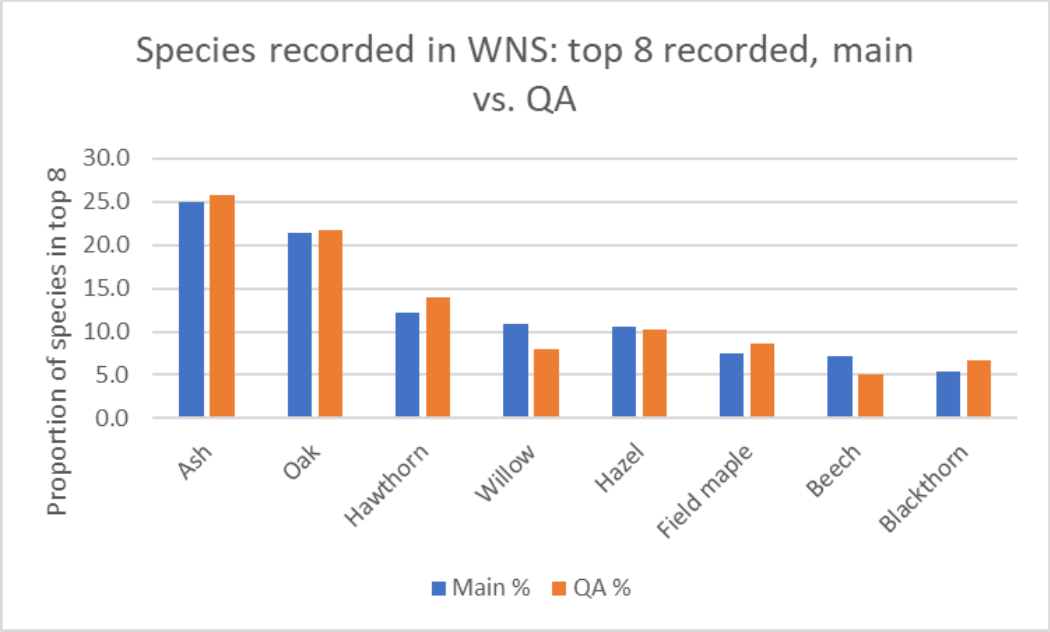


Figure 5.39. Comparison between covers recorded for the eight tree species with the highest cover (%) in mapped lines of trees by the hedgerow (main) and QA surveyors.

5.5.3.4 Quality Assurance (QA) Summary

Overall, the QA exercise provided an excellent validation of the hedgerow surveyor team data. Consistency between QA and hedge surveyors was high for both the plots and the mapping exercise and no statistically significant differences in recording were found. As expected, differences were greatest for the ground vegetation (H) plots containing higher numbers of species. In those, consistency was confounded by locational issues. In being as efficient as possible with the QA survey, the importance of the provision of the current plot information and re-plot placement (including any issues with changes to hedgerows) was overlooked. We know that surveyors did provide detailed information on location for future surveyors, and we have been able to use that information to understand differences between the QA and hedgerow team records.

The surveyors were well-trained and had a good understanding of protocols following a week of intensive training as validated by quality control follow-up in the field for each surveyor early in the survey. Surveyors used a team Whatsapp to communicate with us and each other on any issues which occurred whilst they were in the field. We

are confident that the data collected was of a high quality and have not applied any data alterations (including confidence assessments) as a result of the QA exercise.

6. Farmer motivations and barriers for the uptake of hedgerow options

The aim of this research was to gain more understanding of stakeholders' attitudes and perceptions of hedgerows and hedgerow options under AES. This included investigating the motivations and barriers to landowners taking up hedgerow options in AES and attempting to better understand the role of contractors in hedgerow management in and out of AES.

This work addressed the project objective,

- 'to *explore farmer's attitudes and motivations for option uptake and nonuptake'.*

6.1 Introduction

Much work has been done towards understanding farmer behaviour in engaging with environmental management (Mills *et al.* 2016). Dwyer *et al*. (2007) found that conditions such as finances, time and labour can facilitate or constrain environmental behavioural change. Many other factors also influence a farmer's ability and willingness to participate in AES. Lastra-Bravo *et al.* (2015) list fair payments, lower household dependency on agricultural incomes, age and education levels, the presence of a successor and the ability to make progressive rather than step changes to agricultural activities as important drivers for participation. With both financial incentives and compliance checks, agri-environment schemes can bring about cultural changes, but Mills *et al.* (2021) emphasise the need to extend and investigate socio-cultural factors.

Management of hedgerows forms an integral part of many farm businesses. Policy aimed at improving hedgerow condition and extent need to consider both who is carrying out the management and how it is likely to be carried out. The aim of agrienvironment scheme option prescriptions is to provide both the mechanism and the funding to enable land managers and farmers to adopt healthy hedgerow practices that will bring about these improvements. Schemes will only succeed if farmers and land managers continue to sign up to them and adhere to management prescriptions. Understanding motivations and barriers for taking up specific options is therefore critical for delivering the benefits that AES hedgerow options are designed to provide.

Contractors provide a vital service within the farming community and are often overlooked when considering agri-environment schemes, both in terms of including their views within research and monitoring the effectiveness of their management, but also when targeting advice and knowledge exchange.

Two surveys were commissioned as part of this project to investigate the motivations and barriers to landowners taking up hedge options in agri-environment schemes (AES), and to better understand the role of contractors in hedgerow management in and out of AES. Surveys built on and aligned with previous work on farmers and hedgerow management carried out in 2002 and 2011 (Britt *et al.* 2000 & Britt *et al.* 2011).

Co-incidentally, and as part of a specific focus on the importance of hedgerows in 2022, the Council for the Protection of Rural England (CPRE) commissioned a survey through Farmers Weekly to gather information on how farmers view their hedgerows and how they manage them on their farms. The survey was reported in November (2023)[8]. CPRE's aims, in common with those for this project, were to use this information to understand how best to ensure that farmers and land managers can be properly incentivised to enhance hedgerow networks through well-designed and accessible AES. The CPRE survey included over 1000 farmers and reflected farms with a wide range of enterprises including sheep (50%), cereals (44%), dairy (13%) and vegetables (6%). The CPRE survey questions are in Annex 1.2 below.

The CPRE survey was reviewed and used to adapt the UKCEH surveys (aimed at both farmers and hedgerow contractors), to ensure that the UKCEH surveys gathered different information. Questions were aimed at gaining a better understanding about the current status of hedgerows on farms and how farmers/contractors currently manage them, both under AES and outside of them.

6.2 Summary of CPRE survey findings

The CPRE survey indicated the importance of hedgerows to the farmers who responded, with the vast majority (86%) rating them as important to them and their businesses. The results provided some valuable insights into the motivations and barriers to landowners in terms of hedgerow planting and restoration, as well as helping to enhance an understanding of farmer management and use of AES funding. These are summarised in brief here; an excellent and more in-depth summary is provided in the CPRE report.

Key findings:

- Around 60% of the respondents claimed to have planted hedgerows in the past 10 years.
- The most common length planted was between 100 and 500 m.
- Livestock farmers and farmers with less than 20 ha were more likely to be supportive of hedgerow planting than either arable farmers or those with larger farms.
- Some areas of the country may have more capacity for increases in hedgerows (e.g., southeast) whilst others are more well hedged (southwest).

[8] https://www.cpre.org.uk/wp-content/uploads/2022/12/CPRE-farming-and-hedgrows-report.pdf

- Cost of planting and establishment was reported as the primary barrier to increasing hedgerow lengths (86% of farmers), closely followed by lack of time and money (65%).
- A quarter of farmers felt that hedgerows impacted negatively on farm productivity.
- 56% of farmers had received support for hedgerow planting, primarily from government schemes, 44% had invested their own money into hedge planting and 25% had used some form of private funding (many were a combination of these).
- Farmers said that the key benefits of having hedgerows are to enhance wildlife, provide corridors for nature and enhance the farmed landscape. They also said that they provided useful functions on the farm (e.g., habitats for pollinators and pest control on arable farms and shelter and shade on livestock farms).
- Farmers reported wanting simple, accessible but flexible schemes (e.g., to trim annually to thicken their hedges) and help with long term management. They also said they would like greater advice, more guidance and skills development/training for hedgerow management.
- Most farmers manage their hedgerows in either a rotational 2/3-year cycle or by annually trimming (some will do both depending on hedge location) and two thirds of farmers want to stick with their current practice.

CPRE kindly provided UKCEH with summary data from their survey. Results from the CPRE survey are compared with data from the UKCEH surveys below, as relevant.

6.3 UKCEH surveys

6.3.1 Survey methodology

Two separate surveys were run online from 13th Feb - 7th April 2023 (farmers) and from 13th Feb - 30th April 2023 (contractors). Copies of the surveys are included in Annex 2. The farmer survey aimed to understand what hedgerows farmers had on their land and how that linked to farm type and management decisions. Farmers were specifically asked what would encourage them to create or restore hedgerows on their land. Contractors were asked about their role in hedgerow management including for hedgerow work under AES.

The farmer survey was promoted through the National Sheep Association (NSA). It was felt that following the CPRE survey through Farmers Weekly (FW), it was unlikely that FW would promote a similarly focused survey shortly afterwards. NSA received a small amount of funding to help promote the survey and used online newsletters, social media and personal emails to do so. The farm contractor survey

was promoted through the National Association of Agricultural Contractors and the National Hedgelaying Society.

6.3.2 Farmer Survey

6.3.2.1 General information on participants of the farmer survey

A total of 134 participants carried out the survey covering a wide area of England, the southwest was the region most represented with 39 participants (29% of participants) (Table 6.1). In the CPRE survey most participants were also from the southwest.

Table 6.1. Number of participants in each English Region.

English Region	Number of surveys completed	% of surveys by region
Southwest	39	29
West midlands	20	15
East of England	17	13
Southeast	15	11
Northwest	13	10
Yorkshire and The Humber	12	9
East midlands	10	7
Northeast	6	4
Total	134	100

Most participants (78%) were farmers who owned their own land (Table 6.2). This was similar to the CPRE survey where 76% of those surveyed were farmer owners. Those in the ‘other’ category included small holders, a hobby sheep farmer, a vet and a pensioner (with son farming).

Table 6.2. The number of participants of the survey, per region and their employment

Region	Farmer (tenant)	Farmer (owner)	Farm manager	Other
East midlands	5	4		1
East of England	3	12	1	1
Northeast		6		
Northwest	2	9	1	1
Southeast	3	11	1	
Southwest	1	35	1	2
West midlands	2	15	1	1
Yorkshire and The Humber	1	10		1
Total	17	102	5	7
Proportion%	13	78	4	5

Most famers (73%) were above the age of 56 (Figure 6.1). This is a general reflection of the average age of farmers nationally as shown in Defra statistics[9] which show that 67% of farmers were over the age of 55 (in 2023).

[9] https://www.gov.uk/government/statistics/agricultural-workforce-in-england-at-1-june/agriculturalworkforce-in-england-at-1-june-2023#:~:text=switch%20to%20table,Age%20Group,aged%2045%20to%2054%20years.

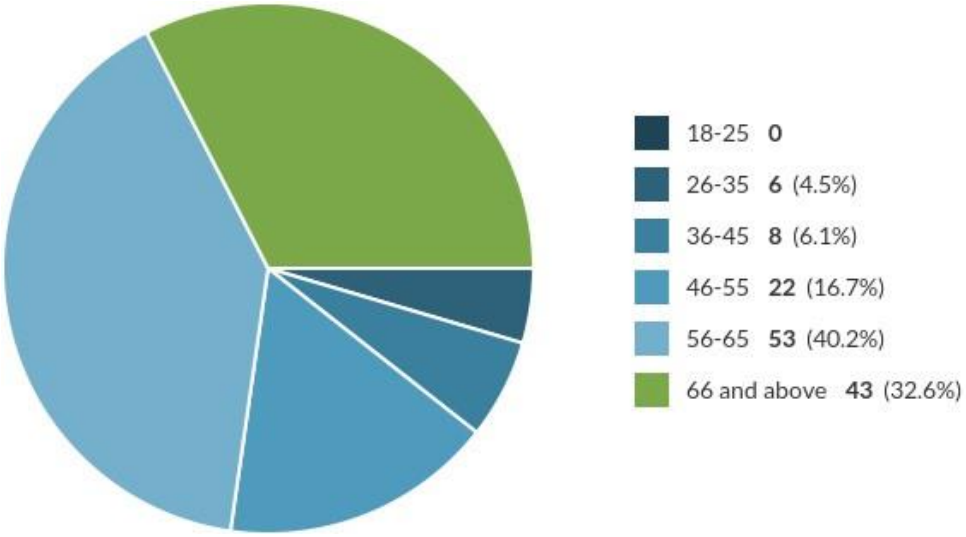


Figure 6.1. Age range of farmers participating in the UKCEH survey. With the number of participants selecting each option (in **bold**) and percentage of total (in brackets).

The size of farm managed by participants also reflected those of the respondents to the CPRE survey; in our survey 21% of participants had farms less than 25ha and 23% had farms over 150ha (Figure 6.2). The size of farm did not impact on whether farms were in AES. CPRE reported that 22% of respondents to their survey owned small farms less than 20ha; and 19% owned farms of over 150ha.

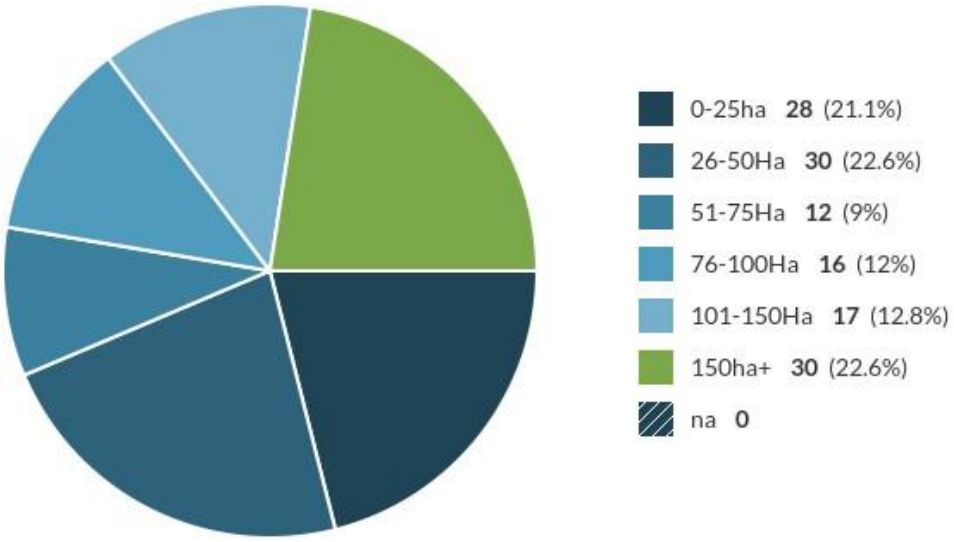


Figure 6.2. The size of farm managed by participants of the UKCEH survey, with number of participants selecting each option (in **bold**) and percentage of total (in brackets).

6.3.2.2 Hedgerow extent and type

The UKCEH survey recognised the fact that farms have different extents and types of hedgerows and that those hedgerows may be managed at different times and in different ways dependent on their location, composition, etc. Participants were therefore asked about the extents of the hedgerows on their farms. Most participants (84 out of 134 (63%)) had managed hedgerows around more than 70% of all fields. 88% of participants had managed hedgerows around more than quarter of all their fields. Two participants did not have managed hedgerows around their fields.

UKCEH Countryside Survey has previously highlighted that neglected or unmanaged hedgerows over time transition into lines of trees (Carey *et al.* 2008). Survey participants were asked whether they had features which could be described as lines of trees around fields (we added the following note: these may have been hedges a long time ago but have not been laid or coppiced for more than a decade).

Most participants of the survey had lines of trees in around a quarter or fewer of their fields (70%), around 14% of those who participated had lines of trees in around more than three quarters of their fields.

Mixed hedgerows, i.e., those containing several species and not dominated by any one species, were more common (69%) within the survey than any other hedgerow type (Figure 6.3). Within the ‘other hedgerow types’ category, farmers listed; Beech (x3 participants) and ‘Ancient hedgerow over 1000 years’ (containing 10 species), the latter fall into the mixed category. Only 20% of hedges were dominated by hawthorn only and 8% were dominated by another single species.

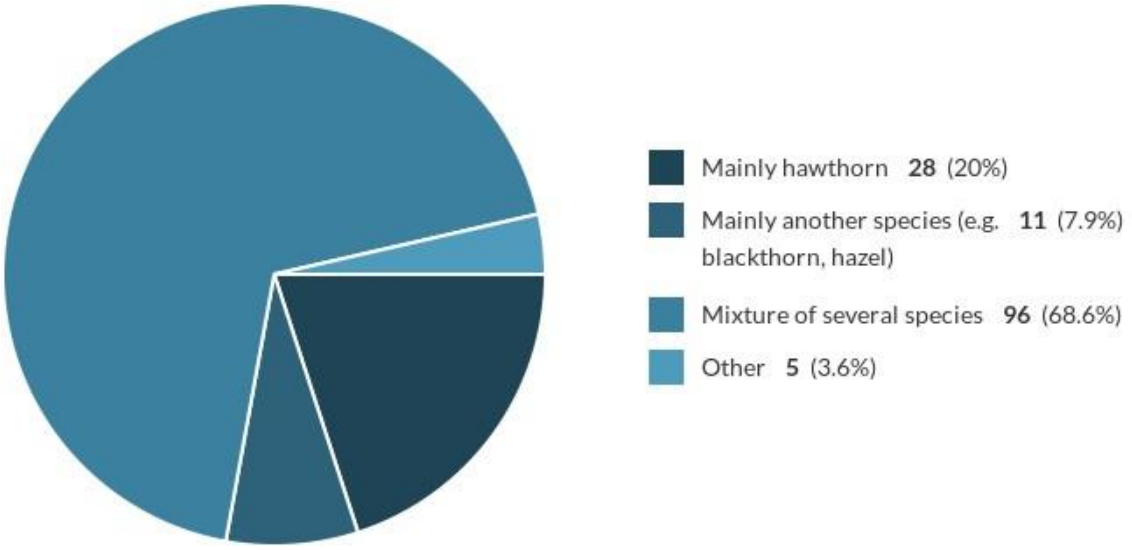


Figure 6.3. Species composition of hedgerows of survey participants. With number of participants selecting each option (in **bold**) and percentage of total (in brackets).

6.3.2.3 Who manages hedgerows on farms?

Hedgerows were primarily managed by contractors (44%) with farmers managing around a third (36%), and 17% managed by a mix of the two. To identify whether 'who' managed hedgerows on farms differed between farms with land under AES and farms without AES, a chi square analysis was performed on the data collected in the survey. Results revealed that there was no statistically significant difference ($p>0.05$) in who managed hedgerows on farms with AES and those without. However, the amount of hedgerow on a farm that was under AES had an impact on who managed them, with higher-than-expected numbers of farmers with all hedgerows in AES cutting these hedgerows themselves ($p<0.05$). In contrast, farmers with above 50% of hedgerows (but not all) in AES had a higher-thanexpected use of contractors. Table 6.3 shows the numbers of participants with differing hedgerow management strategies (who manages them) and relates it to the % of hedgerows on their farm in AES.

Table 6.3. Number of participants with hedgerows under AES and who manages those hedgerows.

Who manages your hedgerows?	Are your hedgerows currently under option in an agrienvironment scheme?			
	Yes, all of them	Yes, greater than 50% of them	Yes, less than 50% of them	No

Farmer does	13	6	6	22
Mostly farmers do, but use a contractor for some	2	1	5	14
Use a contractor for most of them	9	12	7	28
Totals	24	19	19	68

6.3.2.4 What management types are used?

Hedgerow management – within farm variability

Hedgerows in different parts of farms were managed in different ways, 74.2 % of participants stated that they did not manage all hedgerows in the same way. 28% managed roadside hedgerows differently to other hedgerows, 7% managed hedgerows of different species differently and 38.5% adjusted management dependent on location on the farm.

Trimming or cutting with a flail or other implement was the most common form of management (63%). Laying AND trimming and cutting was second most common (23%). Coppicing was the least common management with only 1 participant saying they managed their hedgerows with solely coppicing and 7 responding with coppicing AND trimming. Though the data was collected somewhat differently, the CPRE survey also found that the majority of farmers trim or cut with a flail, while laying and coppicing were less common. The CPRE survey also found that livestock farmers were more likely to lay hedgerows and gap up than arable farmers.

A chi-square analysis showed that having hedgerows in a current AES scheme affected which management was carried out. Participants having any hedgerows in AES were more likely to manage their hedges with a combination of laying and cutting than those with no hedgerows in current AES, who were more likely to use a flail (X^2 = $p<0.05$).

6.3.2.5 Hedgerow trimming - frequency

In the UKCEH survey, when asked how often they cut their hedgerows, annual cutting of some hedgerows on the farm was the most common management (47%) with annual cutting of all hedgerows at 25% (Figure 6.4). Cutting some hedgerows every 2-3 years (28%) was higher than cutting all hedgerows every 2-3 years (13%). 8% of participants hedgerows did not trim their hedges at all.

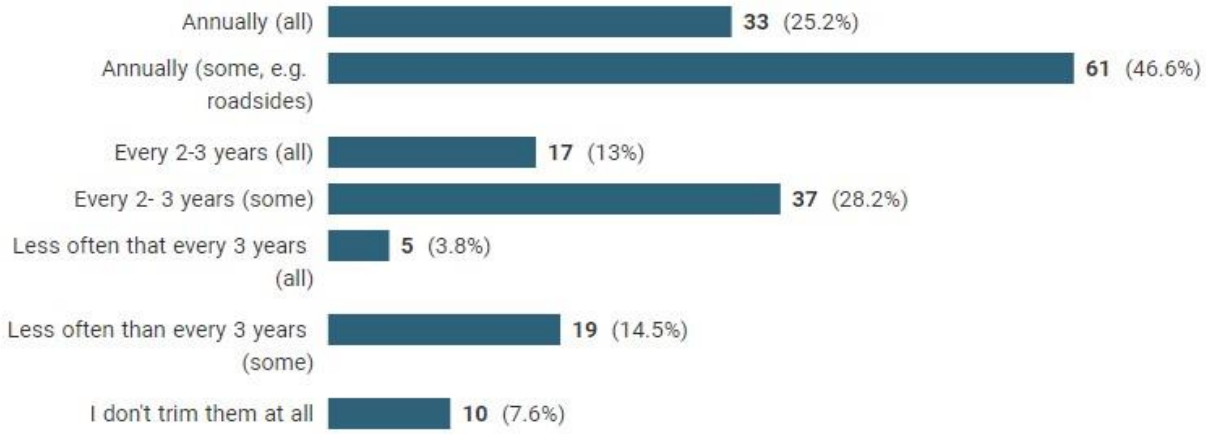


Figure 6.4. Cutting regimes for farmers in the UKCEH survey (2023). With number of participants selecting each option and percentage of total in brackets.

Britt et al. (2000) reported that annual trimming of hedgerows to a box-shape, with a flail, was standard practice for a large majority of farmers, 80% trimmed most of their hedgerows annually (Figure 6.5).

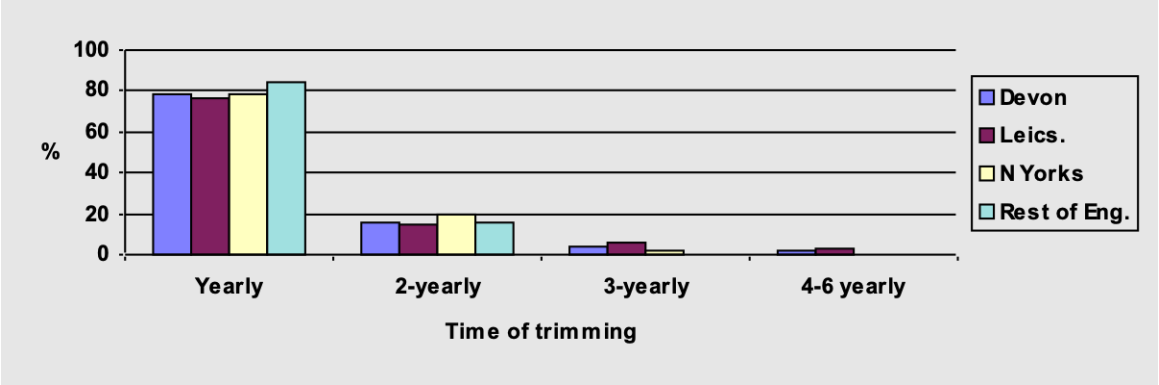


Figure 6.5. Frequency of hedgerow trimming as reported in Britt et al. (2000) shown within 4 regions (reproduced from Britt et al. 2000).

Britt et al. (2011) reported that 4% of farmers stated that they did not trim any of their hedgerows. However, the proportion of untrimmed hedgerows in Figure 6.6 indicates that additional farmers left a proportion of their hedgerows untrimmed (around 10% of hedgerows were untrimmed). Other trimming regimes were as shown in Figure 6.6 (reproduced from the Britt report). There was clearly some regional variation, but the highest proportion of participants reported that they annually managed their hedgerows (45%) with 29% managing them 2-yearly and 11% managing them 3yearly.

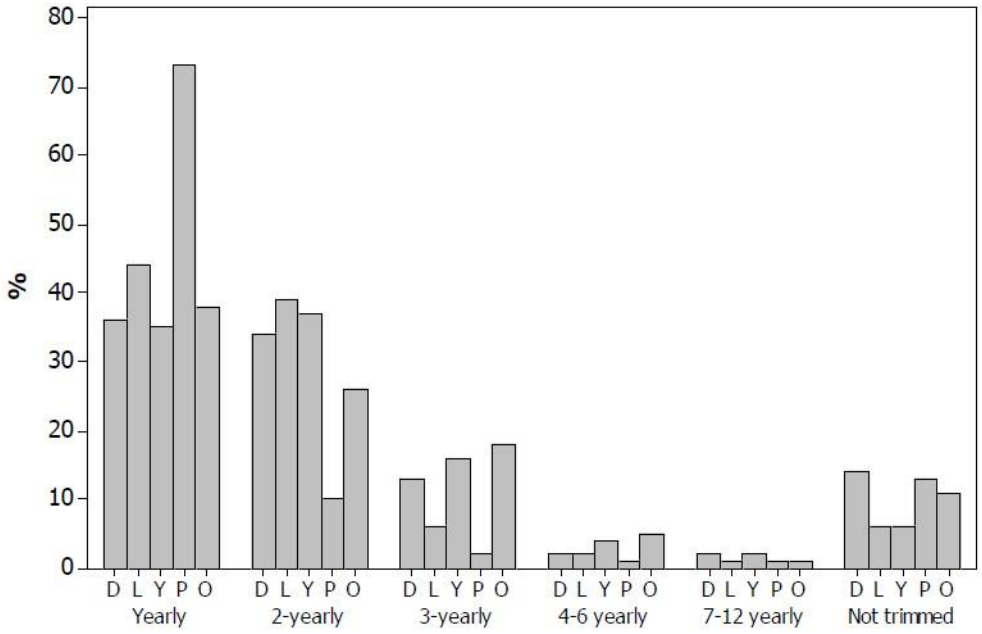


Figure 6.6. Frequency of hedgerow trimming by region (D=Devon, L=Leicestershire, Y=North Yorkshire, P=Powys and O=Other) reproduced from Britt et al. (2011).

In the UKCEH survey regional differences were apparent in the frequency of trimming management (Figure 6.7). Annual trimming (of all or some hedgerows) was most prevalent in the southeast and Yorkshire and Humber, with trimming at longer intervals most prevalent in the east of England. Britt et al. (2000) found a marginally higher proportion of farmers in Leicestershire reporting longer trimming intervals.

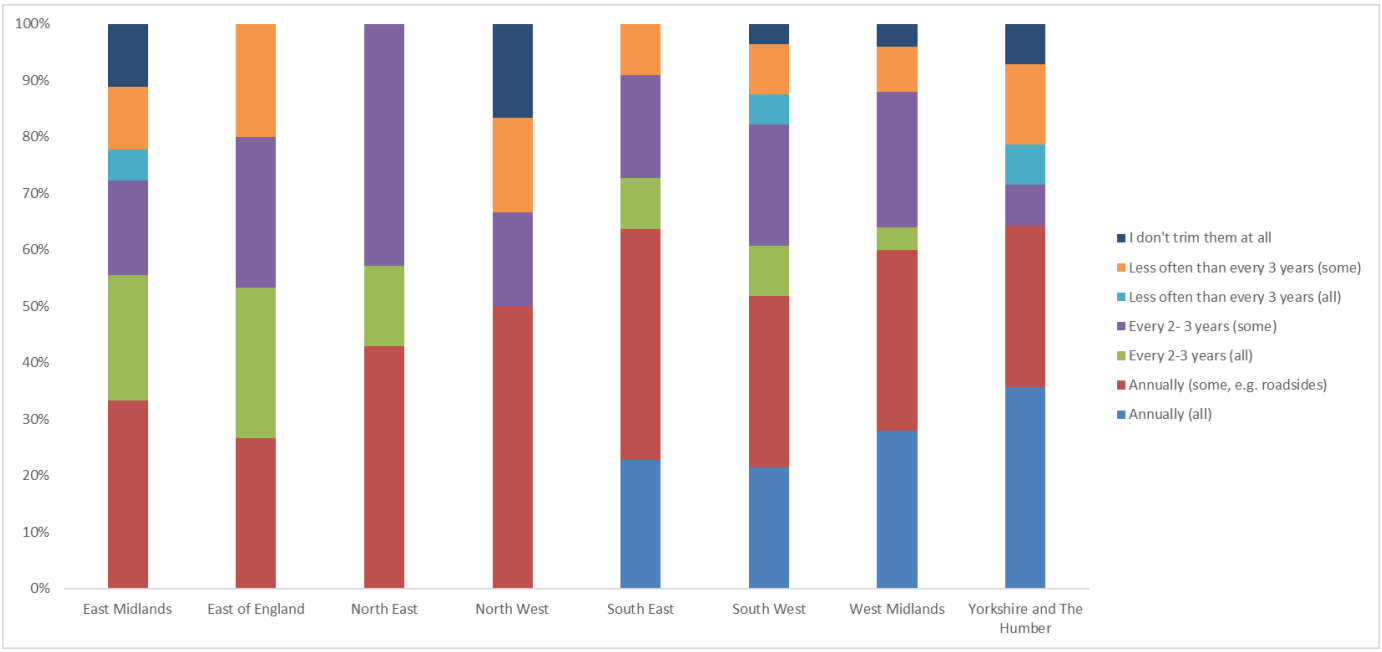


Figure 6.7. Regional differences in the frequency of hedgerow management.

In previous work investigating hedgerow management with farmers (Britt et al. 2000) farms with AES (n = 332), trimmed hedgerows, on average, every 2.1 years compared with an average trimming interval of just 1.5 years on farms with no AES (n = 163). This difference was highly significant ($P < 0.001$).

The UKCEH survey similarly found differences in the frequency of hedgerow trimming between those who had some or all hedgerows under AES and those that did not have hedgerows under AES management ($X^2 = p<0.01$) (Table 6.4). Those with some or all hedgerows in AES were less likely to annually trim than expected but more likely to cut (all or some hedgerows) every 2-3 years. Those not in AES cut hedges annually more than expected and were less likely to cut (some or all hedgerows) at 2-3-year intervals.

Table 6.4. Frequency of hedge trimming and current participation in AES from UKCEH farmer survey.

How often do you trim your hedgerows? (Tick all that are relevant)	Are your hedgerows currently under option in an agrienvironment scheme?	
	Yes	No
Annually (all)	4	29
Annually (some, e.g., roadsides)	34	26
Every 2-3 years (all)	13	3
Every 2- 3 years (some)	27	10
Less often that every 3 years (all)	2	3
Less often than every 3 years (some)	13	6
I don't trim them at all	8	2
Totals	101	79

6.3.2.6 Hedgerow restoration

Participants in the UKCEH survey were asked if they had restored a hedgerow by coppicing or laying. Only one participant had restored a hedgerow by coppicing, all other restoration involved laying.

Most participants in the survey had carried out some restoration of hedgerows in the past (71%). 45% had carried out this restoration within the last 10 years. Some participants (29%) had never carried out any restoration of hedgerows (Figure 6.8).

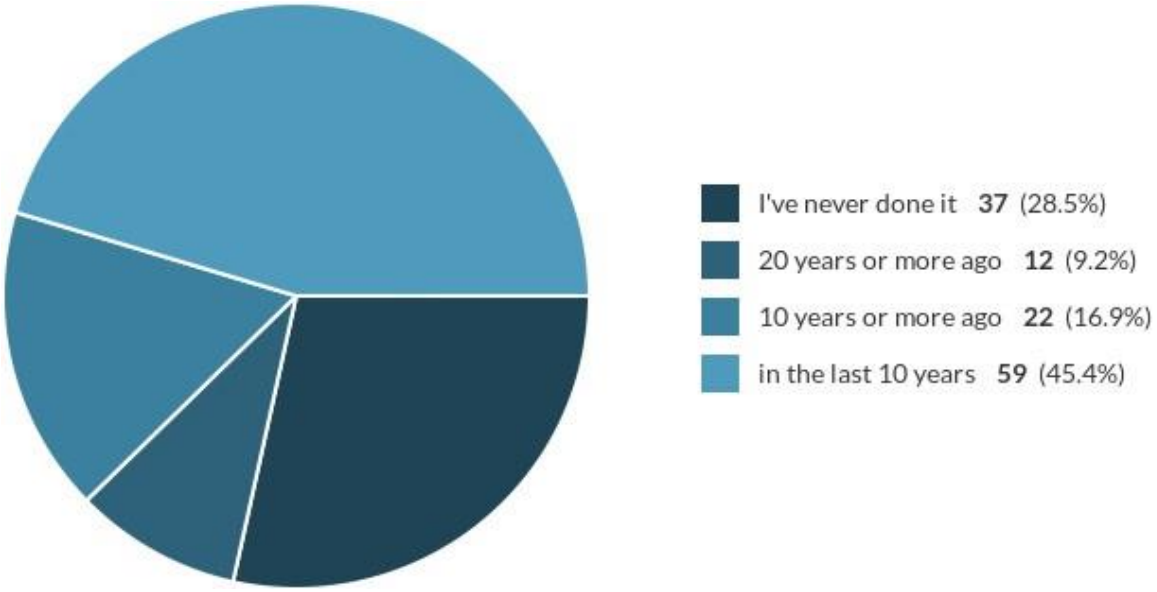


Figure 6.8. Participants carrying out restoration of hedgerows in the UKCEH survey, number of participants selecting each option (in **bold**) and percentage of total (in brackets).

Participants who were not in current AES were less likely to have ever restored a hedgerow than would be expected by chance; conversely those who were in AES currently were more likely to have restored a hedgerow in the last 10 years (X^2 $p<0.01$) (Table 6.5).

Table 6.5. Historical restoration of hedges under AES from UKCEH farmer survey

When did you last coppice or lay any of your hedgerows?	Are your hedgerows currently under option in an agri-environment scheme?	
	Yes (all or some)	No
I've never done it	9	28
20 years or more ago	5	6

10 years or more ago	11	11
in the last 10 years	36	22
Total	61	67

Britt et al. (2000) reported that during the 5 years preceding the survey (1994-1999) over 40% of farmers had planted up gaps to fill in hedgerows and over 40% had laid hedges - in both cases, mainly without grants (including AES).

6.3.2.7 Plans for future hedgerow restoration

N.B. Restoration includes coppicing and laying (rejuvenation) and gapping up, new planting, fencing etc. In the UKCEH survey, participants were asked if they had lines of trees that had been formerly managed as hedgerows which they intended to restore back to managed hedgerows. Most participants were either unsure or did not have plans to restore them, but around 30% said that they planned some restoration in the next 5-10 years (Figure 6.9).

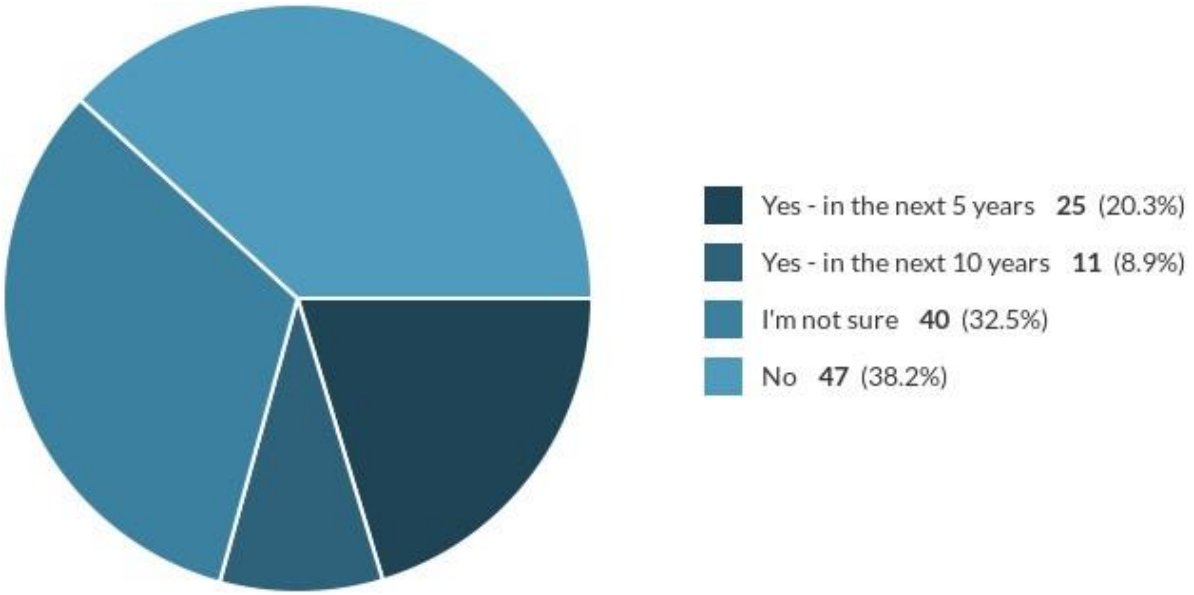


Figure 6.9. Participant responses to the question of whether they intended to restore lines of trees (which had formerly been hedgerows) back to managed hedgerows, with number of participants selecting each option (in **bold**) and percentage of total (in brackets).

Britt et al. (2000) reported that the availability of increased grant-aid would increase percentages of farmers who were “very likely” to carry out further hedgerow coppicing, laying, new planting, gapping up, hedge-bank restoration or fencing to exclude livestock. Similarly, in the UKCEH survey, the need for financial support was highlighted as the primary encouragement for rejuvenation of hedgerows (Figure 6.10). However, there were also participants who already carry out restoration work

either with financial support from government or business or without external financial support. The 6 participants who answered they would not rejuvenate hedgerows/lines of trees were not currently in AES and neither were any of the 22 participants who answered, 'I already do this without support'. The responses in the 'other' category included one participant who had already restored all hedgerows on their property and therefore did not need support for rejuvenation and another who responded that they could not find contractors to do the work.

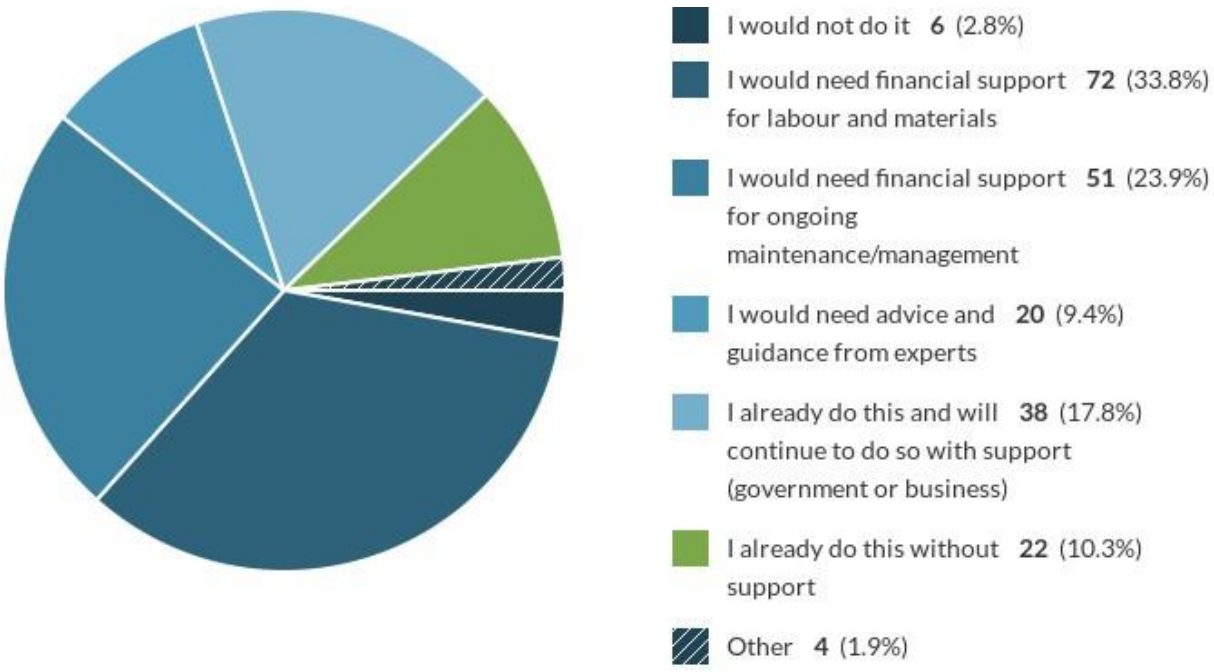


Figure 6.10. Number of participants selecting each option (in **bold**) and percentage of total (in brackets) of responses to the question 'what would be required to encourage you to **rejuvenate** your hedgerows/lines of trees where needed? (e.g., gapping up/laying or coppicing)'.

6.3.2.8 Plans for future hedgerow planting

As for rejuvenation, participants in the survey cited financial support as key to increasing the length of hedgerows on their land; however, many (those with all hedgerows in AES) also stated they had already planted hedges with government or business support (Figure 6.11). Useful feedback from farmers in terms of what may discourage planting included, insufficient payment rates for the skilled work of planting and insufficient funds for protective fencing associated with successful hedgerow establishment. These barriers to hedgerow planting were similar to those found during the CPRE survey, where 94% of respondents reported experiencing barriers to planting hedgerows with the top two being 'cost' and 'lack of time and resources'.

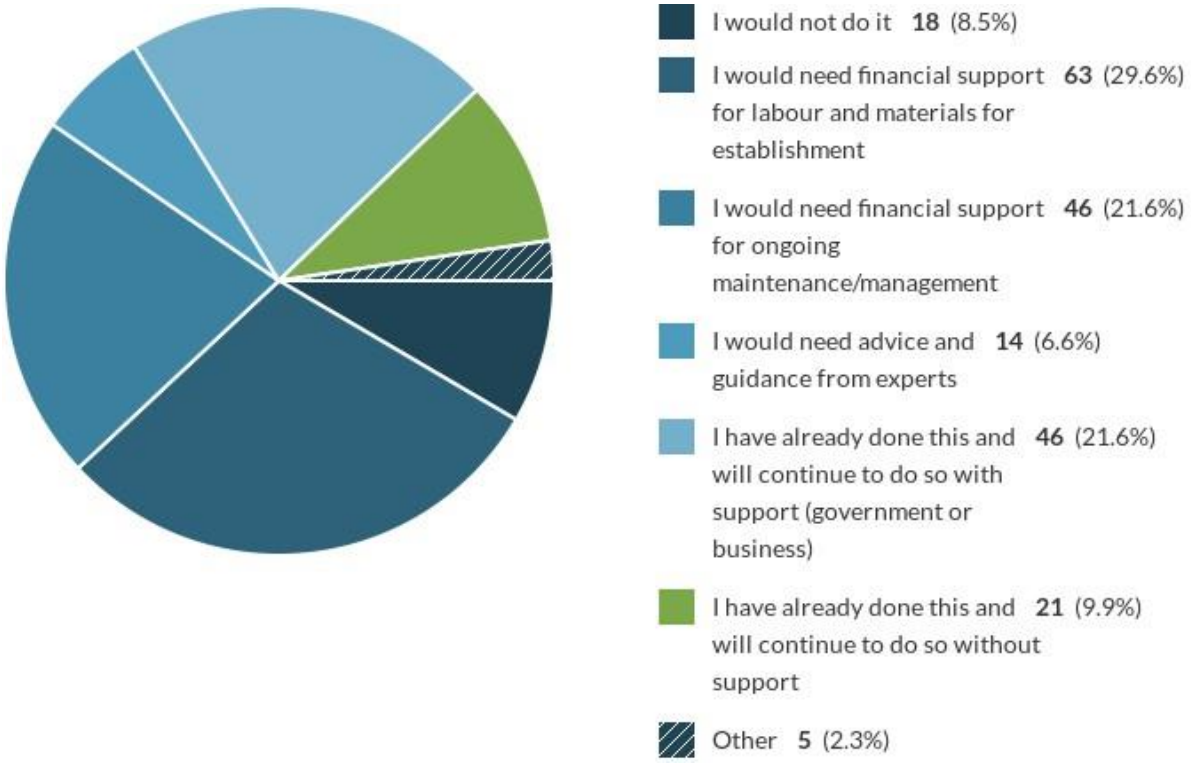


Figure 6.11. Number of participants selecting each option (in **bold**) and percentage of total (in brackets) of responses regarding factors for encouraging hedgerow planting.

6.3.2.9 Attitudes to Agri-Environmental Scheme participation

Most participants in the survey had been in AES at some time historically (63%), the majority of these had been whole farm agreements (88%) with 17% under capital grants. Those that had never been in AES were asked their reasons for not joining. There were a variety of responses falling broadly into 5 categories:

1. Did not know AES on hedgerows was an option (2 responses),
2. Disagree with AES prescription (12 responses, including,
   "*Hedge growth is such that it becomes unmanageable with a flail trimmer and it is too costly to lay hedges"*,
   "*I like to cut annually*",
   "T*hey are attached to schemes which require the grassland to be managed sub optimally which we cannot afford to do*",
3. Not worthwhile (8 responses – including "*too much hassle*", "*easier just to plant hedges yourself*", "*financially not viable*", "*forms too onerous*"),
4. Not applicable (7 responses – reasons included size of property too small or not appropriate for AES, new ownership, 2 responses cited difficulties with accurate mapping from RPA preventing applications being possible),

5. Two participants responded to say it was the landlords' preference not to go into AES.

Further questions explored motivations for not taking up specific AES options. Participants were asked to select (as many reasons as relevant) from a menu of reasons for not taking up options. The principal reason for not taking up hedgerow options was the issue of "*hedges becoming too big and trimmings too difficult to manage if I cut less often than annually,"* followed by "*options not fitting in with farming system*."

For those participants in the survey who had entered into AES the importance of hedgerows for stock welfare (shade & shelter) and the importance for wildlife were primary motivations for taking up AES hedgerow options (Figure 16.2).

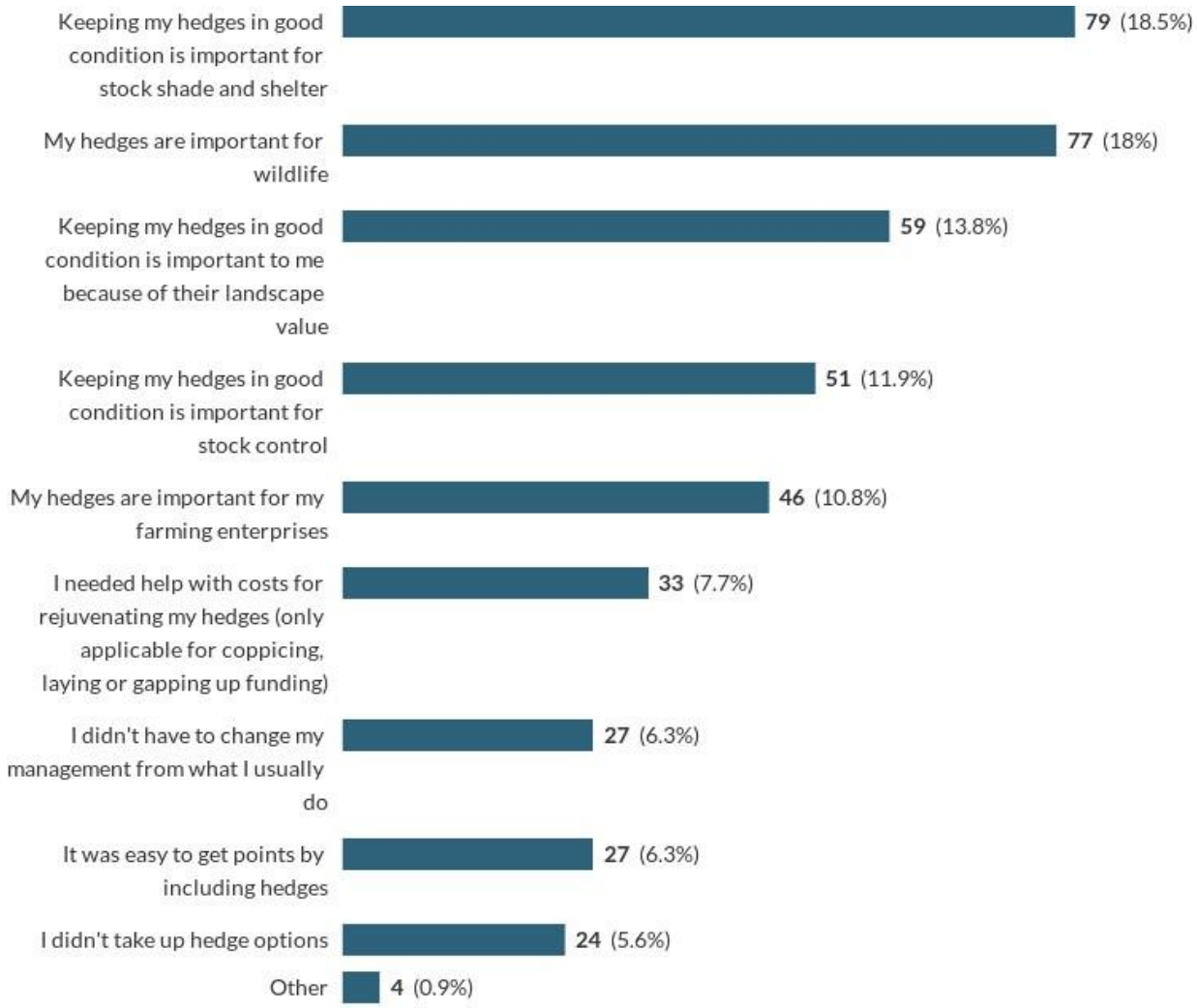


Figure 6.12. Menu of reasons for taking up AES; with number of participants selecting each option (in **bold**) and percentage of total (in brackets).

6.3.2.10 Farmers comments on hedgerows and their management

A voluntary free text response was offered to farmers, 72 participants entered free text responses. These were subdivided into 3 sections for analysis.

1) Farmers who had never been part of AES (historically nor currently),
2) Farmers who had once been part of AES but were not currently,
3) Farmers who had previously been in AES and were also currently in AES.

1) Free text responses from farmers who had never been part of AES

- There were positive perceptions of hedgerows and hedgerow management from this group; hedges appear to be managed favourably without AES; with some participants voicing aspirations of entering into a scheme:

"Hedges are vital on our farm for livestock shelter/browse, biodiversity/wildlife, carbon capture and the cultural heritage of the landscape. I hope to enter schemes to support our management at some point in the future. Our hedges are big, thick and bushy and I want to maintain that. I wanted an option in your Q 'when did you last lay a hedge' for 'about an hour ago!' I love hedges",

"hedges should be managed as it is fairly easy and straightforward with lots of benefits for farm management and the environment",

"I will look into support as I would like to do more",

"owners should be forced to have a minimum size when cut, not allowed to murder to a stick and still claim",

- Three responses mentioned alternatives to government (Environmental or Countryside Stewardship) funding schemes for hedgerow maintenance. These included RSPB's Fair to Nature scheme; Farming in Protected Landscapes (FIPL) scheme and grants provided by UK Power. Participants gave their reasons for adopting these schemes in preference to AES;

"I'm in the RSPB Fair to Nature scheme. Much better options and guidance than DEFRA schemes. Costs me money but far more beneficial to wildlife."

"The FIPL scheme has supported some hedge work, which I have used as it is much more accessible that the CS options and also includes payment towards fencing too."

"The main cost of improving and planting hedges is the need to fence on each side. The cost of this is very high. We have coppiced and planted some 2km in the last 3 years and spent over £30k. We had a grant from UK power."

- Hedgerows are regarded favourably for stock welfare by this group of participants; but with costs of hedgerow maintenance stated as being problematic for continued care:

"Excellent for L/S [livestock] shelter but do cost to maintain, a cost not really reflected in return on (a) small tenanted farm",

"I would lay more hedges if I could afford it"

"Stock fencing is one of the most expensive parts of hedge planting/laying/coppicing"

- Two comments within this group were negative towards hedgerows:

"I have too many hedges already",

"landlord/ landowner not interested in boundary fencing & restoring old hedges unmanaged for over 20 years. Other landlord has new wire fencing but not interested in planting new hedges due to cost of second fence. Neither interested in joining schemes/ stewardship".

2) Free text responses from farmers who had once been part of AES but were not currently

- This group had a generally positive perception of hedgerows but a negative view of AES prescriptions; the most frequently stated problem with scheme prescriptions was the requirement to trim or cut hedgerows on a longer than annual rotation.

"Trimming hedges every year is essential for livestock welfare. When we were on ELMS and had to trim less frequently, we had terrible trouble with lameness caused by large thorns in hedge trimmings. The costs of vet's fees hugely overshadowed the income from hedge schemes. Therefore, we did not renew ELMS and reverted to annual trimming of all hedges.",

"I don't want a situation where I am not allowed to cut the hedges every year",

"I like my hedges to be compact to attract small birds, not magpies and crows",

- The other barrier to continuing with a scheme was cost and inadequate payments through schemes for hedgerow maintenance and planting:

"have laid, replanted and coppiced dykes under standalone scheme but these barely covered the cost of materials and fencing. Did not cover any of my time or contractors time costs",

"We need more financial support for hedge establishment".

3) Free text responses from farmers who had previously been in AES and were also currently in AES.

This group had positive perceptions of hedgerows, of AES prescriptions and were interested in maintaining and planting new hedgerows.

"I am very keen to have big thick hedges for my livestock shade and shelter as well as for bird food and safety from predators.",

"I had no hedges on my farm when I came here 35 years ago but knew of their value particularly on a livestock farm. We have planted many now, and it is my intention to lay them to create 'proper' hedges. This is something I'm very passionate about and

it's rewarding to see not only an enhanced landscape and improved habitat for wildlife but also the benefits to my business.",

"There is no farm business case for frequent flailing of hedges. Instead, they should be managed on a 40-year rotation of laying and coppicing. Even roadside hedges may only need flailing every 3rd year. Since taking on the farm and improving hedgerow management we have seen an increase in wildlife, improved sward, and more browsing for livestock, including use of tree hay.",

"I like the lines of trees, the abundant blossom and fruit, the autumn colours and fungi. I have seen Brown Hairstreak and get winter flocks of roosting Starlings & many Fieldfare and Redwings. These 'overgrown hedges' are very rich in insects, the bees love them. last year I realised how much of the pasture was protected by shading, let alone for the stock.",

Negative perceptions of AES prescriptions within this group of farmers have been aggregated within themes of 'frequency of cutting', 'seasonal timing of cut' and 'cost' and 'policy restrictions for other aspects on the farm'.

Frequency of cutting

"If the hedges aren't cut every two years maximum, they "open out" and magpies steal the eggs of thrushes, robins and dunnocks. Trimming creates a predator-proof "bubble" that predators find it hard to navigate."

Seasonal timing of cut

"Heavy clay soils make keeping to cutting guides almost impossible in wet years.",

"The hedges have been in the ELS scheme and are now in Countryside Stewardship, we would like to see the option of cutting, still on a 2-year basis but during December as well, the rainfall during Jan and Feb often means some soil compaction occurs, even on 4 metre grass margins. Birds are not nesting in December and very prescriptive dates are a bit frustrating for good soil management."

Cost

"Have used a stand-alone agreement to coppice, plant and lay hedges but this did not include covering the cost of the fencing required to protect them!! Am unlikely to do any more"

Policy Restrictions

"We have been told we can't plant hedges due to wading bird sites in upland meadows, to me this doesn't make sense on the ground who's watched wading birds and new chicks have no shelter or cover when hatched to get away from carrion crows and black backed gulls but I guess if it says it in an experts book well it must be true."

- Participants had suggestions for policy changes that they feel would be beneficial for hedgerows:

"To move away from annual trimming requires significant funding to compensate for increased management and machinery wear and tear. Flexibility in trimming, siding but not topping would be useful to prevent lower bramble growth."

"Hedge management is a long-term annual process which requires careful planning, I would suggest that higher payments per meter but more restrictions on overall length of hedge laying/ banking, this would encourage a more staggered approach to laying, encouraging different growth stages on the hedges around the farm giving greater diversity for wildlife as well as lowering annual workload. The current system is encouraging blanket laying of most of the farm and in most cases once the hedge has been layed it will be trimmed in a box like fashion not allowing the hedge to regrow naturally, if the end goal is to have all trimmed square hedges then the current system will work but I believe a mix of different stages of growth should be the aim.

6.3.3 Contractor Questionnaire

6.3.3.1 General information on participants of the Contractor survey

There were 268 responses to the survey from both the National Association of Agricultural Contractors (NAAC) and the National Hedgelaying Society. The majority of responses were from the NAAC (hereafter we refer to the group jointly as 'contractors').

The geographical representation of the contractor participants was different to that of the farmers surveyed (see Table 6.1) with lower numbers from the southwest (23%), and northeast (5.9%) but similar numbers from other areas (e.g., 29% from the midlands) (Figure 6.13).

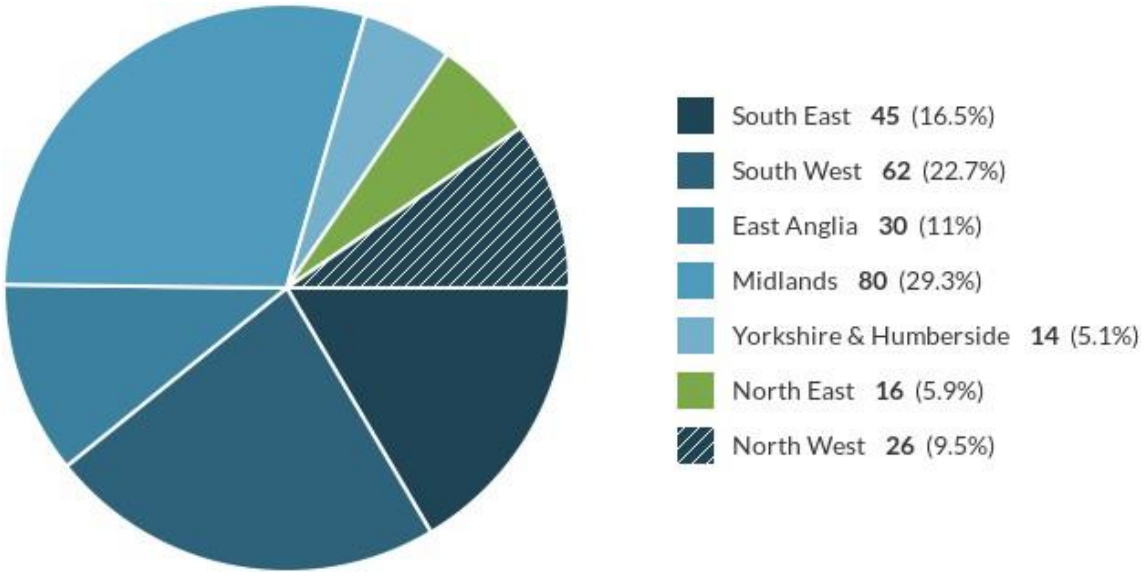


Figure 6.13. Principle regions of operation for contractors participating in the survey, with number of participants selecting each option (in **bold**) and percentage of total (in brackets).

Contractors operated mostly on farms or in rural areas (total of 64% only on farms or in rural areas mostly), with 30% working in all areas listed which also included urban areas or gardens and allotments (Figure 6.14).

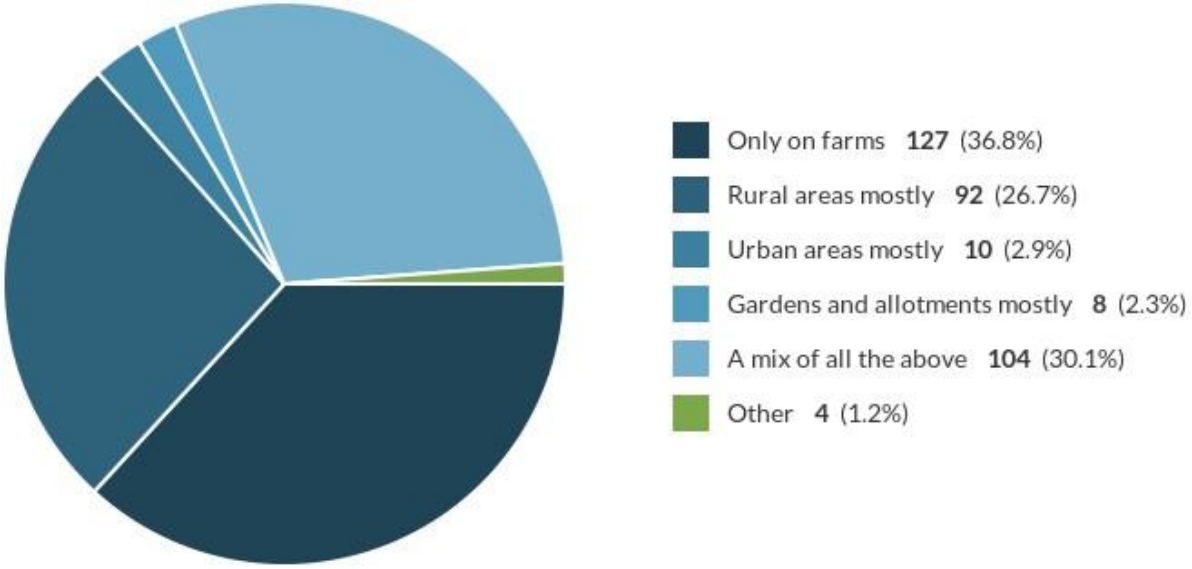


Figure 6.15. The areas where contractor participants carry out most of their work with number of participants selecting each option (in **bold**) and percentage of total (in brackets).

6.3.3.2 Contractor role in hedge management

Responses to an initial question about the extent to which participants in the survey cut, planted or managed hedgerows, showed that 39% did so as a significant part of their work and 11% did it as their sole job. Others who carried out the survey reported that cutting, planting or managing hedgerows was a less significant part of their business (23% as less than 50% of their business and 27% as less than 25%).

Contractors had mostly been operating for over 10 years, with those answering ‘other' operating for over 30 years and one participant operating for 45 years (Figure 6.15).

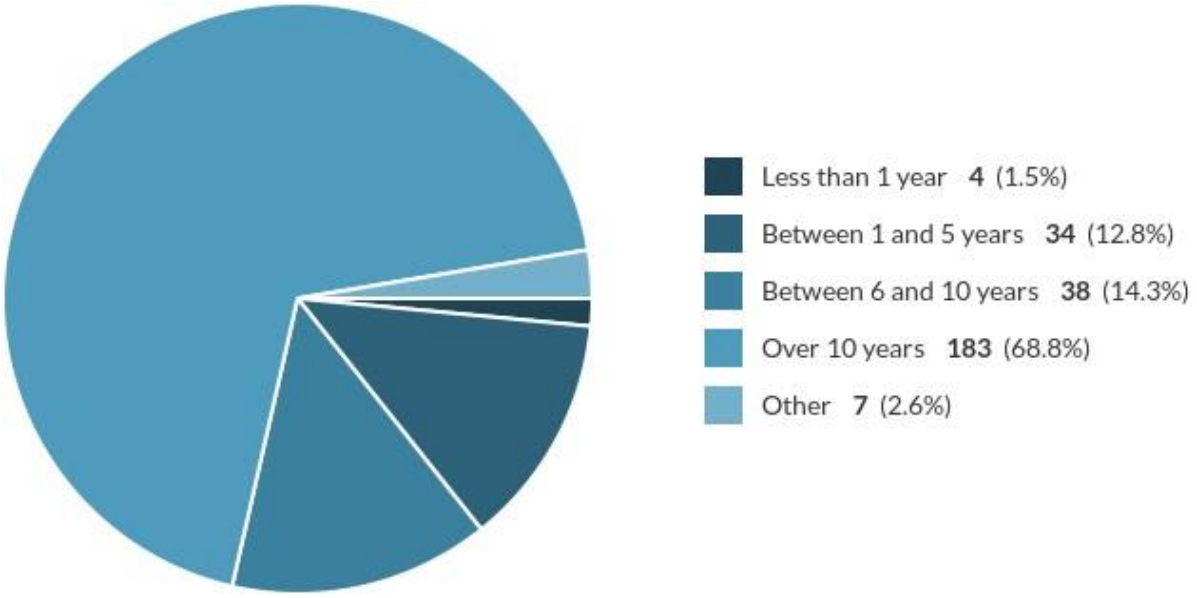


Figure 6.15. The length of time contractor participants had been operating in their current capacity with number of participants selecting each option and percentage of total in brackets.

The majority of contractors who participated in the survey (70%) did not carry out either laying or coppicing of hedgerows (Figure 6.16), and 60% did no gapping up or planting of hedgerows (Figure 6.17).

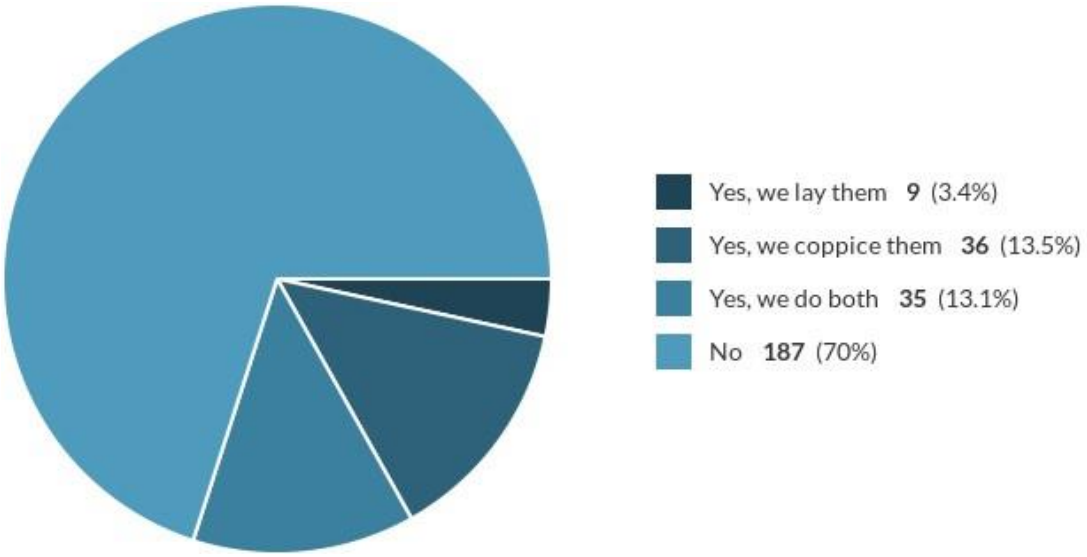


Figure 6.16. Number of contractor participants who carried out laying or coppicing for clients with number of participants selecting each option (in **bold**) and percentage of total (in brackets).

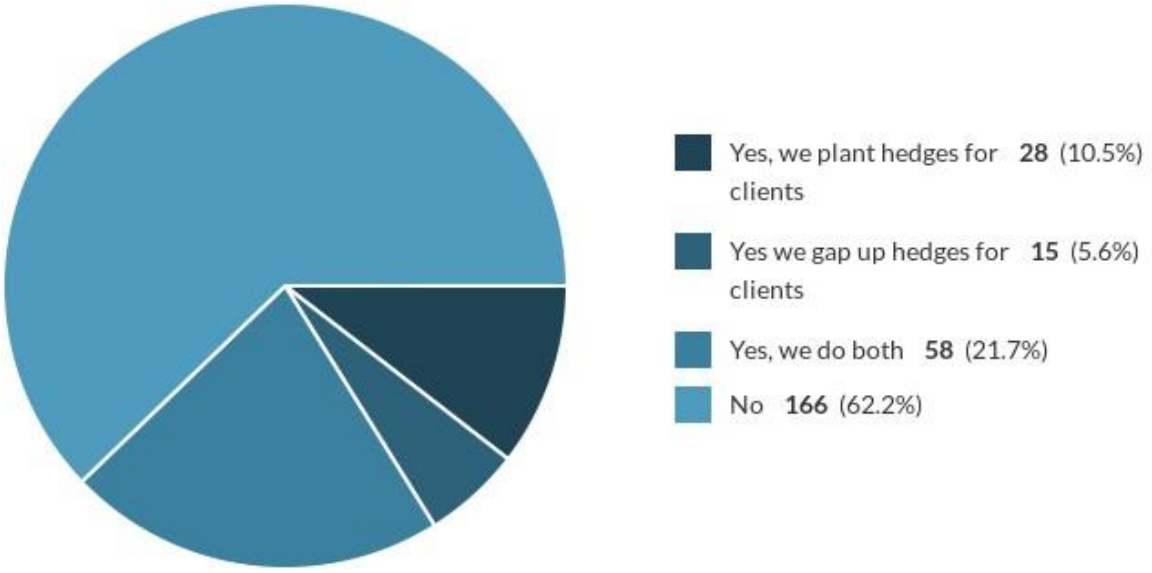


Figure 16.7. Number of contractor participants who carried out 'gapping up' or planting hedgerows for clients (in **bold**) and percentage of total (in brackets).

Contractors being asked to remove hedgerows was uncommon, however 28% of contractors had been asked to remove hedgerows for clients (Figure 6.18), in one case to extend gateways for vehicle access.

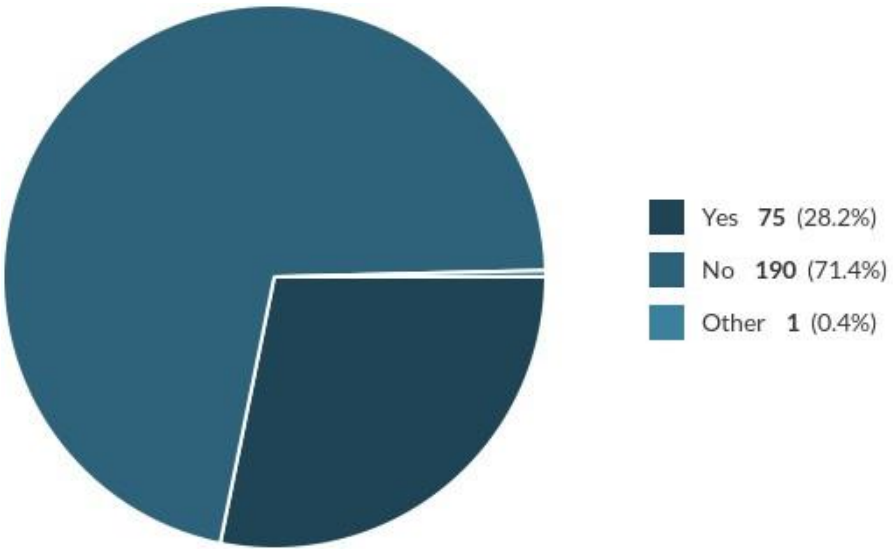


Figure 6.18. Number of participants who answered if they had been asked to remove hedgerows in the last 10 years (in **bold**) and percentage of total (in brackets).

6.3.3.3 Contractor role in hedge management on AES

When asked whether cutting times for hedgerows were in line with clients' AES requirements, 62% said they were and 50% said cutting regimes (types of cut) were carried out in line with clients' requirements. Height and width requirements were decided together with clients (52%) with these height and width requirements meeting AES restrictions (59%).

When contractors were asked how much of the laying and coppicing or gapping up and planting work came through AES, the majority of participants did not know whether AES were the funding mechanism. **6.3.3.4 Changes in management requirements**

Most contractors stated that there had been a change in the last 10 years to how farmers used contractors, with 49% stating a change towards more farmers using contractors, and 24% stating the opposite, i.e., a change towards fewer farmers using contractors; 25% stated no change in the last 10 years.

Contractors had also seen a change to how they were asked to manage hedgerows, with 57% asked to provide taller wider hedges or hedgerows cut at different times (Figure 6.19). In a follow-up question, they were asked whether these changes had had an impact on their business; 87% responded that changes to clients' requirements had impacted on their business. Figure 6.20 shows the ways in which contractors thought their businesses had been impacted by changes to hedgerow management required by those contracting them.

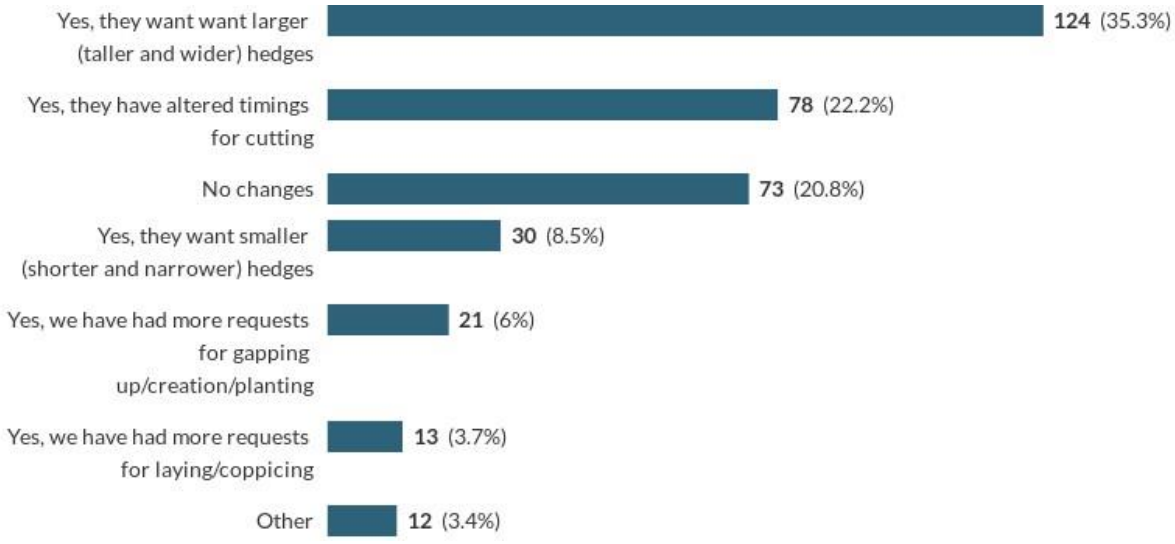


Figure 6.19. Changes to management requests from clients to contractor participants. Number of responses per category (in **bold)** and percentage of total (in brackets).

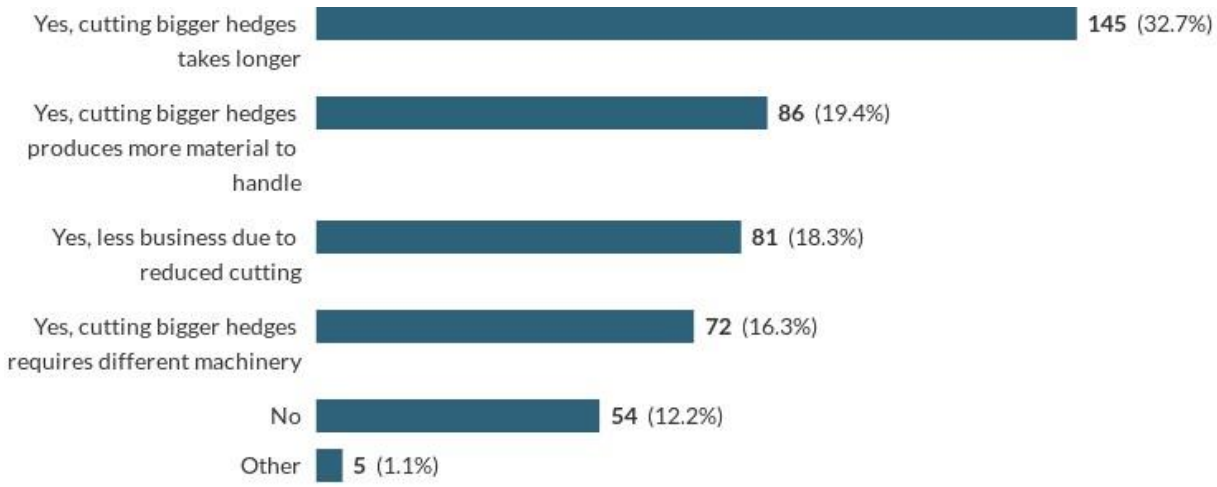


Figure 6.20. The impact on contractors of clients asking for different hedgerow management regimes. Number of responses per category (in **bold**) and percentage of total (in brackets).

6.2.3.5 Contractor's comments on hedges and their management

A voluntary free text response was offered to contractors, 150 participants entered free text responses. To explore these further, text was analysed using AI qualitative analysis software (atlasti*),* which included a line-by-line review and the generation of a contextualised list of themes*.* Responses are summarised under these themes below.

Perceptions of hedgerows

- Contractors' perceptions of hedgerows were positive in relation to hedgerow maintenance required to produce a healthy, good hedge. Many references were made to the beneficial results of hedgerow management for wildlife, biodiversity and hedgerow condition generally. Birds were mentioned in 66 responses: wildlife (preservation/conservation) (48 responses), biodiversity (13 responses) and environmental conservation (26 responses).

"I think a well-maintained yearly trim thickens and enhances a hedge which encourages more birds for nesting etc… hedges left untrimmed start to shade the bottom of the hedge and surrounding area which produces a thinner hedge susceptible to bramble and ivy and self-setting trees taking over the hedge and stifling it eventually killing it".

"A hedge that is cut every year creates a crust on the hedge which birds of prey struggle to get though when trying to reach chicks and eggs that are in nests … hedges which are on a 2-5 year cutting scheme after being cut the hedge is left open

and basically just sticks coming from the ground and leaves nests very vulnerable ... it's common sense".

"More farmers want internal hedges cutting dec-feb to leave the berries and longer hedges for the birds for winter".

- Contractor comments were mainly positive (although, not always) in terms of the beneficial management of hedges for livestock – especially in terms of stock proofing.

"Cutting hedges every 2 or 3 years rather than annually has ruined the structure allowing stock to push through and reducing protection for nesting birds from predators and the weather".

"If landlords let hedges grow over 6 plus years, most are useless against stock which run the banks down, so less birds, wildlife as soil erosion is a problem".

"Hedgerows need trimming to maintain their effectiveness in both their roles as shelter and livestock barriers, and as habitat areas".

"We also have customers complaining that when their hedges are only cut every few years the large thorns are causing problems with their livestock's feet creating a welfare issue".

- Contractors considered hedgerow condition as important, both in relation to the length of time hedgerows took to recover from inadequate management or their feelings towards how certain types of management could be detrimental for hedge condition.

"Hedges have become more open and 'gappy' since we've started 2 or 3 years cutting, after cutting the hedges can take longer to recover because of the thicker material that needs to be removed".

"Trimming rotations over 2yrs has huge detrimental effects on hedges and ruins them."

Perceptions of AES hedgerow management

- A large proportion of the free text comments were considered negative towards AES; 129 out of 150 expressed negative opinions about AES prescriptions. Text was analysed to identify instances where contractors voiced negative opinions on the efficacy of prescriptions laid out in AES hedgerow options. These included quotes containing statements that annual, yearly cutting of hedgerows was either the best way to manage hedgerows or better than 2-3 year cutting. Contractors argued that cutting over 2-3 years or longer intervals had negative impacts on hedgerow condition as opposed to more regular (annual) cutting creating "dense", "tidy" and "neat" hedges. In

other instances, AES, government or environmental bodies were directly criticised within the text.

"Hedges put into upper-level schemes are an absolute nightmare to get done and a right mess when cutting back into shape and are no advantage to birds than hedges cutting annually."

"Hedges have become more open and 'gappy' since we've started 2 or 3 years cutting, after cutting the hedges can take longer to recover because of the thicker material that needs to be removed."

"A well-maintained hedge allows the wildlife to thrive but keeps the hedge under much better conditions. I'm also finding that longer growth hedges let's say 3 years are now thinning out at the bottom. I used to see lovely thick hedges filled out from the ground up. I think a good 60-70% you can now see through for the fact of the hedge putting it's energy into growing taller and not wider. The scheme needs a rethink. Also just to note down, with these gaps now in hedges we find that the public now create footpaths through the hedge lines wherever they please."

"We are commonly seeing that agri-environment schemes generally make it more difficult for farmers to manage hedges in a sustainable way due to a variety if constrains, it is also a common complaint that hedgerow habitat and growth quality suffers for those engaged in such schemes and we often see hedges with no middle or internal growth by delayed or missed maintenance."

"If you insist on paying for such schemes as planting, it needs to be followed up. We're having to deal with hedges now planted 20 years ago on stewardship that have had no maintenance since the money ran out".

To explore the context of these comments with the text analysis software, two core themes relating to the negative perceptions of contractors on AES hedgerow management prescriptions were investigated, 1) Disagreement with cutting regimes and 2) Disagreement on the timings of cutting. Results are shown below:

1) Disagreement with cutting regimes (annual vs longer rotations)

Cutting regimes were considered a problem for several reasons:

A) Belief that it was detrimental to wildlife (birds in particular).

"I believe that leaving hedge for more than 3 years before being allowed to cut is destroying a lot of hedges and wildlife as they are getting too leggy and leaving the hedges open when they are cut."

"Allowing hedges to grow up doesn't benefit wildlife, it makes them thin at the bottom and deer and livestock destroy them. Regular maintenance (trimming) encourages

growth from the base of the hedge. As an operator of a flail I notice nesting is preferred in trimmed hedges with thick cover not a tall wispy hedge with no cover."

"The environmental schemes don't work. Hedges that are cut regularly and repeatedly create a tighter fuller hedge that is better for small birds to nest within". B) Belief that it was detrimental to machinery, health and safety and the land.

"Hedges left two or three years without cutting take a lot more cutting back the following year. This then leaves a hedge that looks a mess and looks butchered. This isn't good for business as these hedges take a lot longer to try to tide up and wear the machinery a lot quicker. You also get larger lumps of material coming of the hedge cutter which are dangerous to me as an operator and anyone else around you (car drivers and cyclists) when cutting on roadsides."

"Cutting a hedge every 2 years is the best for the farmer because the hedge trimmer doesn't have to do lots of passes and compact the ground." C) Belief that it was detrimental to business.

"Nowhere near enough hedges are maintained and are left to get out of control leaving them needing expensive and time consuming cutting down which I find farmer's and landowners are not willing to take on".

"The 2-year rule in my opinion is a waste of time as it takes twice as long to cut which makes no financial savings".

"I believe that cutting hedges annually is farm better for the environment and more cost effective due to there been less material to cut".

Belief that it was detrimental to stock.

"We also have customers complaining that when their hedges are only cut every few years the large thorns are causing problems with their livestock's feet creating a welfare issue".

2) Disagreement on timing of cutting.

This was generally seen to be a problem due to:

A) Ground conditions being unsuitable at the times prescribed. Contractors made recommendation to reinstate august cutting to allow access to hedgerows with drier conditions. Some contractors mentioned the increasing frequency of wetter winters making things more difficult than they used to be.

"Farmers/contractors should be able to have some clout on whether birds are nesting in hedgerows or not. And be able to cut if no nesting birds in hedges etc."

B) Impact on business.

"The start/finish dates have had a serious impact on my business".

"I'm small fry compared to a lot of contractors and a rely on that income each year. It only takes a couple of wet weeks and then panicking about paying my way each month. I feel starting (hedgerow cutting) sooner would give me chance to get some when dry and move onto planting more hedgerows in the wetter winter months."

"I think all hedges should be trimmed side and topped, it keeps contractors busy throughout the winter months, and the start dates should be the end of July to the end of March, as things are now it's not a long enough season especially if we get wet winters".

"Next year my biggest customer is going to every other year hedge trimming for midtier stewardship I will lose a lot of work".

Recommended hedgerow management solutions

Some participants added proposed solutions to assist in positive hedgerow management for wildlife, these included: follow-up for maintenance of planted hedges, improved communication, allowing heterogeneity of hedgerows across farms and encouragement for more restoration management.

"More discussion between contractors and farmers is desperately needed between them and people who dream up these schemes and different types of 'management".

"I would suggest more consultation directly with farmers and more weight being added to their opinions as they are the ones who want to see ... wildlife flourish for the good of ecosystems, the countryside and the environment".

"A lot more hedge laying should be done, almost compulsory".

"There is no right answer. Every farm should have a mix from short to medium to tall".

"Hedgerow management would be greatly improved by a payment reflecting volume/condition etc to discourage the 4ft flat top brigade beating the daylights out their hedges every year thinking it looks smart".

6.3.4 Discussion - Changes in attitudes and perceptions of hedgerows and their management by farmers and contractors

6.3.4.1 Attitudes to hedgerows

Perceptions of hedgerows by farmers appear to have remained consistently positive over time; with both those in and out of AES responding with positive comments and opinions on hedgerows. Britt et al. (2000) and (2011) also reported that farmers displayed a positive attitude towards hedgerows. Our surveys showed that both farmers and contractors recognise the importance of hedgerows at landscape and farm levels for wildlife in general, and more specifically for birds. A key recommendation from Mills *et al.* (2013), was for policy to articulate the benefits of specific scheme options for species that resonate with farmers experiences. Our survey did not try to measure if this recommendation had been followed, but it was clear that farmers and contractors (in 2023) related hedgerow options to birds in particular.

Farmer responses indicated they understand and appreciate the need for the restoration and planting of hedges with many stating they intend to restore hedges within the next 10 years or plant new ones (with financial support). ELMS test trials have already engaged with farmers to enhance AES option prescription criteria for future schemes. These are encouraging signs. Harnessing the willingness of farmers to deliver an improved hedgerow network, alongside providing sufficient financial incentives, knowledge exchange and engagement to support actions are likely to lead to successful outcomes going forward.

6.3.4.2 AES prescriptions and hedgerow management

In 2000, farmers favoured annual cutting, reporting difficulties in dealing with trimmings, inability of machinery to cope with longer stems and unsuitable ground conditions for winter cutting as reasons for their decision. Mills *et al.* (2013) also found that farmers contested AES prescriptions, with some strongly believing that the 2-to-3-year rotational cutting negatively impacted on hedge structure. It was a recommendation of this 2013 report that this issue needed to be explored further as it was seen to be deterring some farmers from not only entering hedges as an option in AES, but also taking up the schemes. There are some indications that attitudes have not changed much. In the UKCEH 2023 survey, those that voiced a preference for annual cutting cited these same reasons and most farmers responding to the UKCEH survey cut most or some hedges on their land annually. Contractors adopted the same position regarding the undesirability of 2-to-3-year rotational cutting but more forcibly than farmers. Despite these findings, AES schemes have clearly influenced cutting frequency (Table 6.4) and although there was a decrease in the number of farmers taking up management options in AES schemes (Figure 4.2), there have been positive signs of a general change in the height of hedges (Figure 5.6). Whilst this cannot be attributed to current membership of a scheme with the data collected here (Figure 5.2), it is possible that the extensive take up of Environmental Stewardship options pre-2015 left a management legacy. Alternatively, farmers may

have signed up to other support mechanisms for managing their hedges or may be responding to other agendas for changes in management.

This research was novel in asking hedgerow contractors their views and opinions of AES. There are limitations to the survey methodology which may bias the sample towards those who had an opinion they wanted to express, but the strength of negative response about AES prescriptions from the contractors who participated in the survey was evident. Approaching contractors across the country by a different mechanism, targeted or at random, may be beneficial to establish if these negative feelings reflect this agriculture sector more broadly. However, given the finding that most farmers use contractors to manage hedges and that there is a dialogue about cutting styles and regimes between farmers and their contractors, there is clear evidence that contractors could be an important, yet overlooked actor influencing the success of hedgerow AES delivery. We encourage future engagement and knowledge exchange with the hedgerow contractor community to enhance relationships and mutual understanding.

Whilst training and knowledge exchange in hedgerow management (in line with prescriptions) did not feature in the UKCEH survey it would be beneficial to consider this recommendation when delivering or passing on research evidence and practical guidance from experienced hedge restorers/rejuvenators to these communities. It will be important to listen to their perspectives and work with them towards the most favourable outcomes for all parties involved in hedge management.

7. Discussion and Recommendations

7.1 AES influence on hedges

The field survey results provide some evidence that hedges under AES options are better quality for wildlife than hedges not in AES. Hedges managed under AES options are slightly taller and a higher proportion of hedges under AES (as compared to hedges not under AES) meet the structural and margin condition criteria. Without information on 2007 live options at the spatial resolution of individual surveyed hedges, it is not possible to know whether this is a result of AES management improving hedge condition over time, or of better condition hedges being more likely to be entered into AES options. The mapped hedgerow height data shows that in 2007 height did not differ between those hedges that went on to be managed under AES options in 2022/3 vs those that did not. This suggests that at least for hedgerow height, the slightly greater increase in height by 2022/3 for hedges under options may have been due to the AES management. However, in contrast, there was also evidence that hedges with gaps <25% in 2007 were more likely to be entered into schemes than those with gaps >25%.

The 2022/3 survey mapped 7,606 m of newly planted hedge, only 271 m of which were under live AES planting options, though other lengths were under broader farm level AES agreements incorporating hedge management. 20,439 m of managed hedges were mapped for the first time in the squares (i.e., these had not been present in 2007), but only 2,360 m of these were in an area under AES options, with two of these agreements including gapping up and laying options. New lines of trees (7,445 m) were recorded for the first time in 2022/3, but none of these lines were under AES options. Whilst AES data show that planting and restoration options are increasing, with uptake considerably higher in 2022/3 than in previous decades (section 4), these data indicate that hedge planting, restoration and gapping may be happening less commonly under AES than under other schemes or at the landowner's own volition.

The longer-term decline in species richness of herbaceous plants growing in the hedge base continued between 2007 and 2022/3. Much of this is likely driven by herbicide use and disturbance (Critchley et al. 2013), but there are evidence gaps around the role of woody species richness, hedge size and connectivity in basal plant communities (Staley et al. 2023). Additional analyses are planned to explore some of these factors using the data collected here and in previous Countryside Surveys.

7.2 Hedgerow extent

Natural England's Definition of Favourable Conservation Status (FCS) for Hedgerows (Staley *et al.* 2020) states that considerable additional hedgerow extent is required for hedges to meet FCS of across 882,000 km in England. National estimates of total woody linear feature extent (556,000km) in this survey showed no significant change

from 2007, with the long-term trends of decreases in managed hedges and increases in lines of trees recorded from previous surveys prevailing. These data indicate that Favourable Conservation Status for habitat extent is not currently being met and that AES between 2007 and 2022/23 were not effective at increasing the extent of hedgerows.

However, AES option uptake data (Section 4.2) and responses to surveys (Section 6) show proportionally large increases in hedgerow planting since 2007, both funded under AES and from other sources. Whilst the planting rates are low relative to the substantial increase in extent which would be required for hedgerows to reach Favourable Conservation Status in England and the large ambition of current government policies (planting and restoring 72,000 km of hedgerows by 2050, Environment Improvement Plan, Defra 2023), they do, at least indicate that the newer schemes are having more of an influence than the previous ones. It should also be noted that many of the planting agreements under AES are fairly recent, and some live planting AES options relate to 5 or 10-year agreements under which planting may not have yet occurred.

7.3 Hedgerow quality

Hedgerow condition has improved in England since last surveyed in 2007, with a 12% increase in the proportion of hedges meeting structural condition criteria in 2022/3, and a 26% increase in the proportion of hedges meeting structural and margin criteria. Whilst this improvement comes from a low starting point in 2007 it does provide some evidence that hedge management is going in the right direction. However, nearly half (44.8%) of hedges in England were in poor structural condition in 2022/3. When margins were included along with structure in the condition assessments, over half of the hedges surveyed in 2022/3 were in poor condition (59.8%) with 83.3% on hedges on arable land failing to reach good condition criteria.

Within the UK, an agreed quality standard for priority habitats to meet Favourable Conservation Status is for a minimum of 95% of the area or extent to be in favourable structure and function (Mousley et al. 2023). Evidence from this 2022/3 survey shows that hedgerows in England do not currently meet Favourable Conservation Status for habitat quality. Management and restoration to improve quality remains a priority for hedgerow conservation and policy.

7.4 Linking motivations and barriers with field survey results

Around 30% farmers who responded to the UKCEH survey had previously planted hedgerows (Section 6.2.2.7), while 60% of the CPRE survey respondents stated they had planted a hedge in the last 10 years. Uptake of AES planting options has increased substantially between 2007 and 2022 (Section 4.2.2), though some of the

2022 planting options within ongoing agreements may not yet have been planted. Despite this, a relatively low proportion of the mapped hedges in the field survey were newly planted. This may indicate that while hedge planting is becoming more popular, the length being planted remains small relative to existing hedgerow extent. It is also likely that the farmer survey results may have been biased towards those who are interested in hedges and actively engaged in restoring or managing them. The surveys tended to attract landowners rather than tenant farmers.

Changes in hedge condition were reflected in survey responses on management with farmers under AES more likely to cut and lay hedges than non-AES farmers and more positive about hedge management prescriptions than those farmers not in schemes. All farmers (in or out of AES) value hedges, with the importance of hedgerows for stock welfare (shade & shelter) and the importance for wildlife being primary reasons for entering AES options. The most commonly stated problem with scheme prescriptions was the requirement to trim or cut hedges on a longer than annual rotation. This problem was very evidently shared by the contractors. Contractors were more commonly responsible for hedge management than owners, but primarily involved in cutting rather than hedge restoration or planting. The use of contractors and the preference of contractors for annual cutting, in their view for wildlife and more dense hedges, as well as for ease of operations probably accounts for the evidence of cutting found in the survey. However, contractors are clearly being asked to cut less regularly and this is a cause of some frustration although it is resulting in improved condition of managed hedges as measured using the standard hedgerow condition criteria. A mismatch between what is good for hedges and what is good for business (for contractors in particular) deserves further focus to identify what roles contractors can play in helping to achieve desired outcomes for hedges.

7.5 Priorities for future hedgerow planting, restoration and management

Despite positive signs of increases in restoration and planting options, CS data clearly show that current approaches for reaching Favourable Conservation Status of hedges are falling short of targets. There is an urgent need for greater uptake of AES options supported by sufficient incentives and advice to ensure the effective restoration of hedges, including planting, gapping up, coppicing and laying as well as subsequent management to maintain condition. Hedgerows and their associated margins in arable areas are a priority for restoration, given the low proportion in good condition (Section 5.4.3). The AES uptake data (Section 4.2.2) shows restoration option uptake is higher in south-west, and parts of the Midlands and north of England, and lower in the east. Uptake of planting and restoration options in these latter areas is positive because in some areas (landclasses) in the north and midlands the extents and condition of hedges are low and there is a real need to address the loss of managed hedges. Increasing the uptake of restoration options (gapping up, laying and coppicing) could be targeted in the east of England, and in arable areas where current uptake is low. Wherever they are targeted it may be

important to consider the extent to which new hedges should reflect existing hedge types or introduce new hedge types.

As discussed above, management of the herbaceous plant community growing in the base of hedges is not part of current prescriptions in AES options. Although a requirement for a 2m strip from the centre of hedgerows with no cultivation or application of pesticides or fertilizers (https://www.gov.uk/government/news/hedgerow-regulations-to-be-brought-into-lawto-protect-wildlife) has recently been announced. This will apply to all rural hedges, but there are no incentives to restore these basal plant communities. Results from CS2007 indicated that previous legislation under cross-compliance to protect these communities was poorly enforced, therefore, it is important that adherence to legislation is monitored and given the ongoing decline in herbaceous plant species richness, restoration incentives are considered under future AES.

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Annex 1. Tables for D plot condition analysis

Table A.1 Numbers of D plots and proportions of plots reaching condition criteria 2007-2022/3 (see section 5.4.3.4). *Data used in Figures 5.14 - 5.17 in shaded columns. 'possible WNS' indicates that features may no longer be managed hedges.*

	Hedges both years		Hedges 2007 repeat 2022/3 possible WNS		All hedges 2022/3		Hedges both years		Hedges 2007 repeat 2022/3 , possible WNS		All hedges 2022/3
	2007	2022/3	2007	2022/3	2022/3		2007	2022/3	2007	2022/3	2022/3
Height >1m	172	173	229	222	275		98.9	99.4	99.1	96.1	95.8
Width >1.5m	120	133	162	174	200		69.0	76.4	70.1	75.3	69.7
Height of base of canopy <0.5m	138	144	182	182	244		79.3	82.8	78.8	78.8	85.0
Non-native species at <10% cover	173	173	229	229	286		99.4	99.4	99.1	99.1	99.7
Cross-sectional area >3m2	119	158	161	180	198		68.4	90.8	69.7	77.9	69.0
<10% gaps	163	137	216	197	250		93.7	78.7	93.5	85.3	87.1
Vertical gappiness <5m	155	166	195	212	250		89.1	95.4	84.4	91.8	87.1
Undisturbed ground (2m) (does not include Arable)	28	35	35	47	67		16.1	20.1	15.2	20.3	23.3
perennial herbaceous cover (1m) from centre line of hedgerow (margins) (all land) (does not include Arable	86	82	111	110	139		49.4	47.1	48.1	47.6	48.4
Total Structured in condition	75	96	99	120	142		43.1	55.2	42.9	51.9	49.5
Total Structured + Margin in condition (includes Arable)	25	70	31	87	99		14.4	40.2	13.4	37.7	34.5

Total structured + Arable	4	29	6	37	40		2.3	16.7	2.6	16.0	13.9
Total plot number	174	174	231	231	287						

Table A.2 Numbers of D plots and proportions of plots reaching condition criteria in the analysis of condition measures for 2022/3 (see section 5.4.3.4)

	No AES	In AES	Management	Restoration		No AES	In AES	Management	Restoration
	2022/3	2022/3	2022/3	2022/3		2022/3	2022/3	2022/3	2022/3
Height >1m	185	92	71	14		98.4	91.1	95.9	73.7
Width >1.5m	126	75	61	11		67.0	74.3	82.4	57.9
Height of base of canopy <0.5m	159	87	64	16		84.6	86.1	86.5	84.2
Non-native species at <10% cover	187	101	74	19		99.5	100.0	100.0	100.0
Cross-sectional area >3m2	124	75	62	10		66.0	74.3	83.8	52.6
<10% gaps	168	84	65	14		89.4	83.2	87.8	73.7
Vertical gappiness <5m	168	84	65	14		89.4	83.2	87.8	73.7
Undisturbed ground (2m) (does not include Arable)	34	33	25	7		18.1	32.7	33.8	36.8
perennial herbaceous cover (1m) from centre line of hedgerow (margins) (all land) (does not include Arable	80	60	43	13		42.6	59.4	58.1	68.4
Total Structured in condition	88	55	47	6		46.8	54.5	63.5	31.6

Total Structured + Margin in condition (includes Arable)	61	39	33	5		32.4	38.6	44.6	26.3
Total structured in Arable	28	12	9	3		14.9	11.9	12.2	15.8
Total plot number	188	101	74	19					

Annex 2. Maps of hedges under AES options using the CS2007 dataset

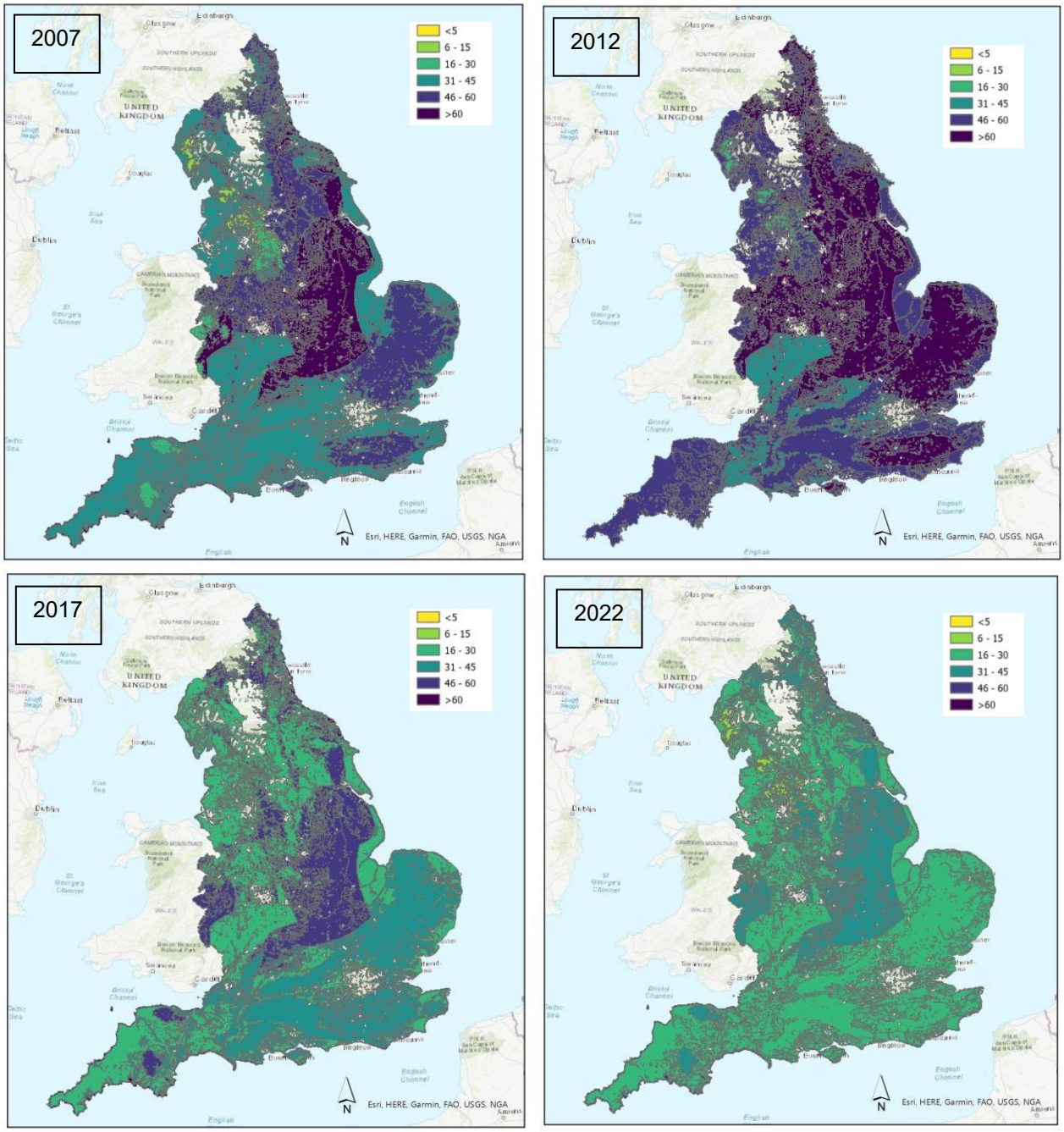

Figure 4.2A The percentage of total hedgerow extent (%) under AES management options on 1st July in 2007, 2012, 2017 and 2022. Total hedgerow extent estimates used the UKCEH Countryside Survey 2007 national woody linear feature length estimates. Legends use same scaling throughout and are consistent with Fig 4.2.

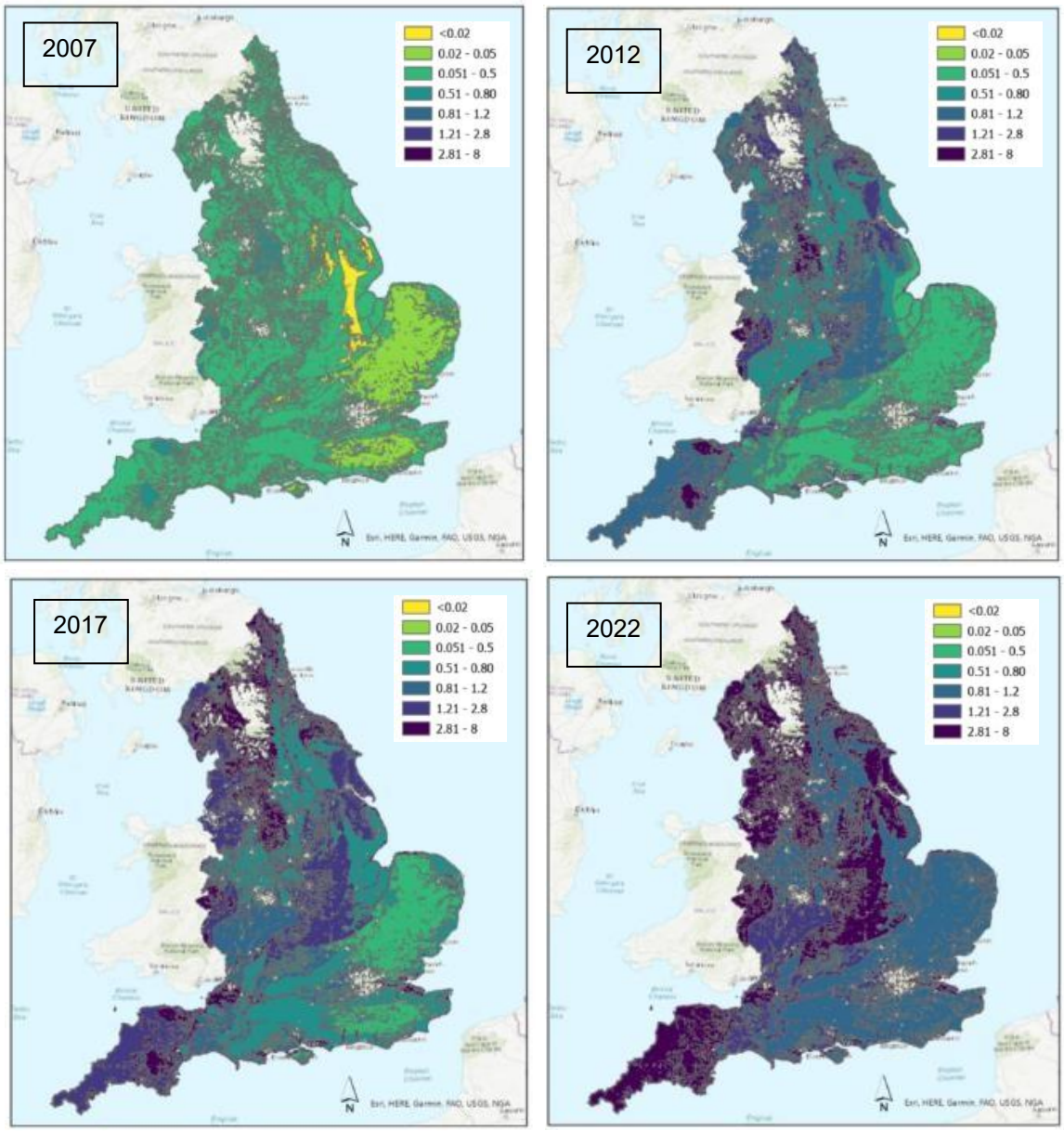

Figure 4.8A. The percentage of total hedgerow extent (%) under AES restoration options on 1st July in 2007, 2012, 2017 and 2022. Total hedgerow extent estimates used the UKCEH Countryside Survey 2007 national woody linear feature length estimates. Legends use same scaling throughout and are consistent with Fig 4.8.

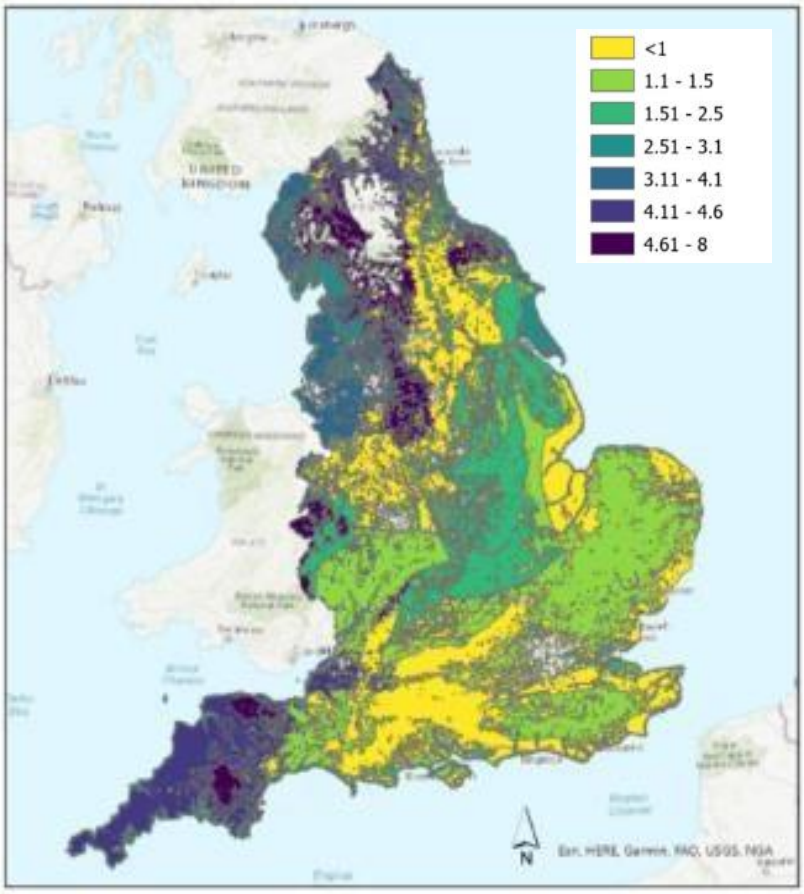

Figure 4.8B. The percentage of total hedgerow extent (%) under AES restoration options on 1st July 2022 (using 2022 scale). Total hedgerow extent estimates used the UKCEH Countryside Survey 2007 national woody linear feature length estimates and have been rescaled to allow better visualisation of landclass differences.

Annex 3. Questionnaires

A3.1 UKCEH questionnaires for farmers and hedgerow contractors

Questionnaire_farmers.pdf

Questionnaire_Contractors.pdf

A3.2 CPRE Hedge survey for farmers

Questions

Which one of the following best describes your involvement in agriculture?

Have you planted any hedgerows in the last 10 years (please select all that apply)

What is the approximate total length of any hedgerows you have planted in the last ten years?

Did you receive any financial or other support when planting the hedgerows? (Please select all that apply)

To what extent are you likely to plant more hedgerows on your farm in the next five years?

How important are your hedgerows to you or your farm business?

Which of the following are the top five benefits of having hedgerows on your farm? (Please select up to five) 2 - rebased to NET by BANNER

What are the top five barriers to planting more hedgerows? (Please select up to five)

Which of the following would encourage you to plant more hedgerows? (Please select all that apply)

In which of the following ways do you currently manage your hedgerows? (Please select all that apply)

Why do you manage them in that way? (Please select all that apply) Would

you like to manage your hedgerows differently?

In which of the following ways would you like to manage them differently?

What are the main barriers to changing your hedgerow management?

What kind of support would you like for hedgerow management?

In which month do you typically cut your hedgerows?

How easy or difficult is it to cut hedgerows in line with the hedge cutting dates set out in cross-compliance (1st September to 31st March)?

Why do you say that?

Are you already in a government / environmental scheme (e g. ELS or CS (ELM) or recently applied to join? (Please select all that apply)

CPRE, the countryside charity is campaigning for a 40% expansion of hedgerows by 2050. Would you support this goal if it was properly funded through ELM or other government policies?

Which of the following enterprise types do you have on your farm? (Please select all that apply)

What is the total land area of your farm?

How old are you?

In which region are you based?

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