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Aiming high for hedgerows

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Executive summary

In 2023 the UK Government published its five-year Environmental Improvement Plan (EIP) including the England based target to support farmers to create or restore 30,000 miles of hedgerows by 2037 and 45,000 miles by 2050. How easy will it be to meet these targets? What needs to be done where and what will it cost in terms of time and resources?

These are the questions addressed in this report. Our research objectives were to:

1. Build understanding of the challenges and opportunities of delivering the government's target to plant and restore 30,000 miles of hedgerows by 2037 and 45,000 miles by 2050.
2. Make a strong evidence-based case for where, in terms of landscape character areas, new hedgerows can most cost-effectively be planted and restored, enhancing landscape character and providing local environmental services, and the resources needed to do this.

National Character Areas (NCA) were the framework used to break down the national targets to areas sharing distinct landscape features. The NCA database made available to ORC was interrogated to assess each of the 159 NCAs in terms of priority for hedgerow action and opportunity for hedgerow action. Priority was scored on the basis of (a) the intactness of the historic network, (b) the condition of existing hedgerows, and (c) policy support for new hedgerows as captured in Statements of Environmental Opportunity and Priority. Opportunity was indicated by a GIS analysis of the amount of suitable habitat for hedgerow planting in each NCA. NCA-level hedgerow targets were then calculated on the basis of both priority and opportunity. The results of this analysis can be found in the Excel database that accompanies this research, as well as an online tool.

Key findings

1. We found that 34 NCAs (21.4%) had historically high levels of hedgerow cover which have subsequently been lost and not replaced to a significant degree. These are the priority NCAs for hedgerow action with respect to this criterion. 74 NCAs (46.5%) were categorised as having lost a significant amount of hedgerow, but also having experienced a significant or notable degree of restoration in recent years. Only 51 (32.1%) of the NCAs had largely retained their historic levels of hedgerow cover.
2. 46 NCAs (28.9%) had many of their hedgerows in a poor condition making them targets for restoration efforts. 80 of the 159 NCAs (50.3%) were classed as having hedgerows of predominantly medium condition, whilst only 33 NCAs (20.8%) were found to have the majority of their hedgerows in good condition. The latter were often areas already renowned for their wooded landscapes and many included National Landscapes.
3. Most NCAs (147, 92%) had Statements of Environmental Opportunity or

Statements of Strategic Priority that included a mention of hedgerows. For two thirds of these, hedgerows were a key target. Only 12 NCAs didn't reference hedgerows in terms of this policy support.

4. As a result of our prioritisation, 40 NCAs (25.2%) were classified as high priority for hedgerow action. Eight of these NCAs received the maximum score across all three criteria, being concentrated in the northern half of the country. Trent and Belvoir Vales is the most significant of these NCAs by area. 86 NCAs were classified as medium priority, and 33 as low priority for hedgerow action.
5. 64.2% of NCAs had less than 20% of their hedgerows under management schemes. The low amount of hedgerows managed under these schemes is consistent with only 20.8% of NCAs having hedgerows in good condition. 32 NCAs were found to have between 20–30% of their hedgerows in ES/CS schemes, while only 25 had more than 30% under such management. Locations in these last two categories provide a good opportunity to plant new hedgerows which are then likely to be managed through a favourable management scheme.
6. 40–90% of the land area of most NCAs was potentially suitable for hedgerows and their creation, whilst in a few cases this proportion was as little as 20–30%. Taking these areas and the prioritisation, the indicative NCA-level 2037 hedgerow creation and restoration targets varied considerably, from near zero in the case of three island NCAs to 1,583 km in the case of the South Suffolk and North Essex Claylands. The average was 304 km.

The resources required to meet the targets at NCA level were illustrated by three NCAs of different geographical area and size of hedgerow target. Taking the largest of the NCAs as an example, South Norfolk and High Suffolk Claylands, the target of 1,070 km of planted or restored hedgerow by 2037 would require between 13,740 and 21,230 person days of labour, £3.6 to £3.9 million of capital and be equivalent to between £14.1 and £16.3 million of agri-environment scheme funding. Scaling this up to the national 2037 target, an investment of £636 million will be required, rising to £735 million for our second scenario with a wider range of restoration action.

The NCA profiles were mined for further information relevant to further targeting of action and the specific values of hedgerows that can be employed depending on the environmental context. These factors include the predominant farming type, levels of disturbance and intrusion, and hedgerow ecosystem services that are noted in the NCA descriptions. Ten different ecosystem services that hedgerows provide were noted in these descriptions, with mitigation of water pollution being the most commonly referred to. Habitat and connectivity for biodiversity is an important characteristic of sympathetically managed hedgerows, and this can generate functional and economic benefits for farmers.

The top-down approach to disaggregating the national target and estimating the resource requirements at the NCA level were complemented by case study research within six NCAs from north to south of the country, spanning rural, semi-urban and urban environments and with support through agri-environment scheme (AES) funding and grassroots community involvement. This helped to understand the

sometimes overlooked on-the-ground challenges and also opportunities for delivering hedgerow targets. AES funding has a critical role to play as demonstrated through Farming in Protected Landscapes initiatives in South Devon and the Howardian Hills of North Yorkshire. But so do NGO-led multi-year programmes, such as Hedgerow Hero projects in Hampshire and Suffolk and an orchards project in Manchester, which successfully mobilise a large volunteer workforce. Their coordinators are energetic but their time is finite, often the bottleneck to the scale of action that can be achieved, especially owing to the administrative overhead of working on many small sites. The Solihull Council led Arden Free Tree Scheme (AFTS) experiences similar issues, but ultimately reaches a broad range of stakeholders with many social, environmental and economic benefits.

Recommendations

Drawing together the case study research with NCA level analysis we make eight principal recommendations to help ensure achievement of the national hedgerow targets:

1. Target where action is needed to best deliver the national hedgerow targets in Defra's promised national land use framework. Refine the spatial prioritisation presented in this report with updated Countryside Survey and UKCEH Land Cover Plus hedgerow 2016–2021 data on current hedgerow extent.
2. Use this indicative target setting approach to initiate discussion with local stakeholders on local ambition for hedgerows and the means to more finely tune spatial prioritisation of hedgerow action, including through emerging Local Nature Recovery Strategies.
3. Develop a system for monitoring progress towards the 2037 and 2050 hedgerow targets, encompassing the quality as well as quantity of delivery. Attention to sufficient aftercare of recently planted hedges is needed.
4. Make access to government funding opportunities as straightforward as possible to ensure a high uptake of these offers.
5. Facilitate aggregated approaches (for example through farm clusters) that reduce the administrative overheads of hedgerow action, including access to grant funding.
6. Continue to raise awareness of the many values of hedgerows to urban and rural populations. Those values depend largely on the local environmental and societal context, and in this respect not all hedgerows are equal. Identifying the contributions that hedgerows can make in different parts of a rural landscape or city/townscape can help in targeting and developing support for hedgerow action.
7. Design the right hedge for the right situation, considering the species composition and structure needed to meet the identified local needs and confer long-term resilience to climate change.
8. Address continuing systemic threats to hedgerows through policy support and knowledge exchange, to mitigate and remove ongoing biological, ecological and

cultural barriers to achieving Favourable Conservation Status of England's hedgerow network.

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1. Introduction

Hedgerows are an iconic feature across much of the English countryside. They add immensely to the attractiveness of rural and urban land alike and also provide homes and corridors for wildlife. They help tackle the climate crisis through carbon capture from the atmosphere. Earlier research commissioned by CPRE highlighted the important ecological, economic and societal values of hedgerows and what this would mean if the network was expanded by 40%[1]. Its headline conclusion was that for every £1 invested in hedgerow creation, a return of £3.92 in ecosystem service provision could be returned.

In 2023 the UK Government published its five-year Environmental Improvement Plan (EIP) including the England-based target to support farmers to create or restore 30,000 miles of hedgerows by 2037 and 45,000 miles by 2050[2]. Whilst this falls short of the Climate Change Committee's (CCC) recommendation (2019) that the hedgerow network should be increased by 40% to support the UK government's legally binding target of net-zero carbon emissions by 2050, the Environmental Improvement Plan's target nevertheless represents a considerable level of ambition for tackling the nature and climate crises, welcomed by CPRE[3]. It also represents a significant challenge to meet, requiring a strategic approach to the spatial prioritisation and resourcing of its delivery.

The work reported here aimed to inform a strategic approach, based on the framework of National Character Areas (NCAs) and recognising how hedgerows enhance the character of many of England's landscapes. There are 159 NCA profiles, developed by Natural England, each including key facts and data about the area concerned. Many of the NCA profiles describe where hedgerows are a dominant landscape feature and where there is an opportunity to enhance them. A database of the NCAs was made available to ORC and lists the 'Statements of Environmental Opportunity' that include where hedgerows could be improved[4]. The NCA framework and database was a key resource for undertaking the research.

Our research objectives were to:

1. Build understanding of the challenges and opportunities of delivering the government's target to plant and restore 30,000 miles of hedgerows by 2037 and a total of 45,000 miles by 2050.

2. Make a strong evidence-based case for where, in terms of landscape character areas, new hedgerows can be planted and others restored, enhancing landscape

[1] CPRE & ORC. (2021). *Hedge Fund: Investing in hedgerows for climate, nature and the economy*. https://www.cpre.org.uk/resources/hedge-fund-full-report/
[2] Defra, Natural England & Forestry Commission. (2023). *Ambitious roadmap for a cleaner, greener country*. https://www.gov.uk/government/news/ambitious-roadmap-for-a-cleaner-greener-country
[3] CPRE. (2023). *Huge campaign win as government sets hedgerow targets*. https://www.cpre.org.uk/news/huge-campaign-win-as-government-sets-hedgerow-targets/
[4] Copyright Natural England (2014)

character and providing local environmental services, and the resources needed to do this.

This research was based on:

- Desk research, principally of NCA data but also of supplementary literature and sources.
- In-depth development and analysis of case studies, involving site visits and investigation of relevant local factors that influence outcomes for hedgerows.

The gathering of qualitative data from national stakeholders and relevant stakeholders in the case study areas was important for identifying barriers and potential solutions to delivering the hedgerow target.

The investigation did not seek to update existing information on the extent and condition of the hedgerow network. During the course of the current investigation, the UK Centre for Ecology and Hydrology (CEH) produced a report and dataset on hedgerows based on lidar survey data 2016–2021 (see Annex 2). UKCEH also run the GB Countryside Survey (CS) and associated Northern Ireland CS and were commissioned by Natural England to update the hedgerow element of the survey in England5. The work will provide national estimates of hedgerow extent and condition, and how these have changed since the survey was last carried out (2007) and will explore the role of agri-environment schemes in hedgerow change. The report is expected to be published in 2024 and the current report, with its data and tools, should be used alongside it.

Throughout this report we imply by the term hedgerow[5]:

Any boundary line of trees and/or shrubs over 20 m long and less than 5 m wide, where any gaps between the trees or shrub species are less than 20 m wide, and where England native woody species form 80% or more of the cover. Any bank, wall, ditch or tree within 2 m of the centre of the hedgerow is considered to be part of the hedgerow, as is the herbaceous vegetation within 2 m of the centre of the hedgerow".

We also recognise the interchangeability, for some, of "hedge" and "hedgerow" but mostly avoid using the former term.

[5]Staley, Wolton & Norton. (2020). *Definition of Favourable Conservation Status for Hedgerows*. Natural England, 71pp. https://publications.naturalengland.org.uk/publication/5565675205820416

2. Methods

2.1 NCA hedgerow status

Each of the NCA profiles was studied in relation to the questions set out below. For each question, the NCA was scored using a 1 to 3 ordinal system, with 1 indicating low value/level and 3 a high value/level (see more definitions for each question below).

Intactness: How intact is the historic hedgerow network in the NCA?

This information was found in the summary, description, and landscape change sections of the NCA profiles.

There is no specific date for historical hedgerow levels set by the NCAs, however narrative descriptions of when large amounts of hedgerow and woodland clearances have occurred in the past can be found within the profiles for each NCA. For this analysis, a set of reference dates of hedgerow levels post-agricultural revolution (1700s) and post-WW2/Green Revolution were used[6, 7]. The NCA profiles frequently cover these periods of time in their descriptions and the use of two time periods also allow for identification of hedgerow loss which might have occurred in one but not the other. Each NCA was scored as one of:

1. All or most of the historic network is intact
2. There has been significant loss of hedgerows, but some restoration has already taken place
3. There has been significant loss of hedgerows, and this still needs reversing.

Condition: what is the condition of existing hedgerows?

This information was found in the description and landscape change sections of the NCA profiles.

Condition here refers to gappiness or general structural quality. NCA profiles varied in the level of relevant detail given, but indicators such as gappiness and structural condition related to management (e.g. cases of tightly trimmed hedgerow structures) were registered. Each NCA was scored as one of:

1. Hedgerows generally in favourable condition; they are valued and supported and therefore of least priority for restoring
2. Hedgerows are in medium condition; there is some potential for restoration action

[6] Pretty J.N. (1991). Farmers' extension practice and technology adaptation: Agricultural revolution in 17–19th century Britain. *Agriculture and Human Values*. 8. pp132-148. http://dx.doi.org/10.1007/BF01579666

[7] Brassley, P. et al. (2021). *The Real Agricultural Revolution: The Transformation of English Farming, 1939-1985*. Boydell & Brewer. ISBN: 9781783276356.

3. Most hedgerows are in poor condition; there is significant potential for restoration.

Policy support: Is there already a Statement of Environmental Opportunity (SEO) and AES Countryside Stewardship Statement of Priority that includes reference to hedgerow planting/restoration?

This information was found in the summary and opportunities sections of NCA profiles and also the Countryside Stewardship Statement of priorities, which reliably identify if field boundaries are an appropriate landscape priority in an NCA[8]. Each NCA was scored as one of:

1. No relevant Statement of Environmental Opportunity or Priority
2. Statement(s) exist but are not emphasised
3. Statement(s) exist and are emphasised or strongly encouraged.

Scoring of NCA hedgerow status

The final scores for the values for intactness, condition and policy support were averaged, creating a single score between 1 and 3 which indicated the priority for planting/restoring hedgerows in the NCA.

During the course of our study we recorded an additional attribute at NCA level: the level of management and restoration, derived for 2018 from the Landscape Change Atlas[9]. Specifically, the % of hedgerows managed under ES/CS was extracted. Each NCA was scored as one of:

1. Above 30%
2. Between 20–30%
3. Below 20%

2.2 Prioritisation of NCAs for hedgerow creation/restoration

We scored 159 NCAs across England in terms of low, medium and high priority for hedgerow creation/restoration. For this purpose, we averaged the scores of the NCAs for intactness, condition, and policy support and then generated a prioritisation score as follows:

- Average scores 1.00, 1.33, 1.67 – Low priority
- Average scores 2.00, 2.33 – Medium priority

[8] Defra, Natural England. (2015). Statements of priorities: Countryside Stewardship. https://www.gov.uk/government/collections/countryside-stewardship-statements-of-priorities

[9] Land Use Consultants ltd., Natural England. (2021). Landscape Change Atlas. https://experience.arcgis.com/experience/ff32a2af68de4286b8a760c28c9c7d0a/page/Introduction/

- Average scores 2.67, 3.00 – High priority.

This created what was considered the most suitable apportionment of the NCA network into 33 low priority NCAs, 86 medium priority NCAs, and 40 high priority NCAs.

2.3 Hedgerow plantable area

For each NCA we estimated the available land area suitable for hedgerow planting and restoration through GIS-based analysis. All operations were done in QGIS (3.34.0 Prizren). We sourced Phase 4 habitat survey maps from Natural England[10]. These were downloaded in multiple files due to the large volume of these data. A shapefile of the NCA boundaries was sourced from Natural England[11]. Geometries were fixed in the habitat files, then attributes joined by location between the relevant NCA and each habitat file. The attributes joined to the NCA were "A_pred" (the primary prediction of habitat type) and "shape_area" (the area of the habitat). This was repeated until all the NCAs had been joined by location to all of the habitat files.

The attribute data for each NCA, containing the NCA name, total NCA area, habitat type, and habitat area, were then exported to multiple excel files. Within each excel file the total area for each of the 17 habitat types was converted into km^2. The total area of habitats deemed suitable for hedgerow planting (Table 1) was calculated for each NCA. Only half of the total area for Built-up Areas and Gardens was used to account for unplantable paving/concreted areas. Similarly, only half of the total area for scrub were deemed suitable for hedgerows. As with other potentially valuable habitats such as unimproved grasslands, it is assumed that hedgerows could be planted along field boundaries and roads through mapped areas, although not in all cases for scrub. Unsuitable areas for hedgerows included coastal habitats, wetlands and woodlands. To account for the lack of hedgerows in upland areas the hectarage of upland priority habitat listed in each NCA profile was removed from the suitable planting area.

For each NCA, we thus derived (a) total plantable area (in km^2) and (b) percentage plantable area (dividing (a) by the total NCA land area).

Table 1. Broad habitats considered suitable and unsuitable for hedgerow planting.

Habitat Types Suitable for Hedgerow Planting	**Habitat Types Unsuitable for Hedgerow Planting**
Acid, Calcareous, Neutral Grasslands	Bare Sand
Arable and Horticultural	Bog
Bare Ground	Bracken

[10] Natural England. (2023). *Living England Habitat Map (Phase 4).* https://naturalengland-defra.opendata.arcgis.com/datasets/b3069e7cb3084732b92478b3db51b9c6_0/about
[11] Natural England. (2016). National Character Areas (England). https://naturalengland-defra.opendata.arcgis.com/datasets/Defra::national-character-areas-england/about

Built-up Areas and Gardens	Broadleaved, Mixed, and Yew Woodland
Improved Grasslands	Coastal Saltmarsh
Scrub	Coastal Sand Dunes
	Coniferous Woodland
	Dwarf Shrub Heath
	Fen, Marsh, and Swamp
	Water
	Unclassified

2.4 Disaggregating the national hedgerow creation/restoration targets to NCA level

We broke down the national targets for hedgerow creation/restoration (30,000 miles or 48,280 km by 2037, 45,000 miles or 72,420 km by 2050) to individual NCAs based on their priority for hedgerow action and plantable area. The aim was to create an illustrative scenario, or set of indicative targets, rather than anything more prescriptive. For the purposes of our analysis, we supposed that hedgerow action, on a unit area basis, should be twice as much in medium priority NCAs compared to low priority ones, and three times as much in high priority NCAs compared to low priority ones. Hence, a hedgerow action effort factor (m for 2037, m' for 2050) was calculated according to the formulae:

$$48{,}280 = m(x + 2y + 3z)$$

$$72{,}420 = m'(x + 2y + 3z)$$

where x is the total plantable area of all low priority NCAs, y is the total plantable area of all medium priority NCAs, and z is the total plantable area of all high priority NCAs. The factor m or m' was then multiplied by plantable area for each low priority NCA, two times the plantable area for each medium priority NCA, and three times the plantable area for each high priority NCA, to generate the NCA-specific targets. For example, given a factor m of 0.275, an NCA of priority scoring 2 and plantable area of 205 km^2 will have a hedgerow action target of 0.275 x 2 x 205 = 112.75 km.

The rate of hedgerow action (km length of created or restored hedgerow per year) was also calculated at NCA level based on number of years to reach the 2037 target (14) and 2050 target (27).

2.5 Resource requirements

The rates of required hedgerow creation/restoration (expressed as length [in km] of hedgerow per year) calculated at NCA level (above) to deliver the national target were used to estimate the resource requirements required. For this purpose, we focused on three NCAs: one representing NCAs with a near-average target, one representing an NCA with a relatively low ambition or target, and one with a relatively high target.

The national targets for 2037 and 2050, measured in length of hedgerow, combine hedgerow creation and restoration. To our knowledge Defra has not specified the proportion of the targets which should be met by either planting or restoration, which differ significantly in terms of resource requirements. Moreover, there are different approaches to hedgerow restoration depending on the condition status of the hedgerow. Our exercise was based on the following rationale. A stated goal of the national target is to return hedgerow lengths in England to 10% above the 1984 peak (360,000 miles)[12]. Based on the 2007 network length of 547,000 km, or 339,890 miles, this goal is attained by creating a minimum of 20,110 miles[13]. Half of the 2050 target (22,500 miles) represents a safe option for surpassing that level, so we have opted for a 50:50 creation:restoration split of the 2037 and 2050 targets. In relation to the restoration of hedgerows, this also needs defining (see Box 1). In the absence of specific information at NCA level or guidance at national level, we developed two scenarios: restoration constituting gapping up (with gaps comprising 20% of the hedgerow length being restored), and restoration also including coppicing and laying.

Box 1: What is hedgerow restoration?

The restoration of a habitat such as hedgerows is the process of promoting recovery from a degraded state[14]. In this respect, one can consider two aspects to be important for hedgerows: firstly the restoration of the hedgerow network as a whole towards a defined pre-disturbance level, by increasing its extent or density, and secondly restoring individual hedgerows from poor to good condition. The former involves planting new hedgerows, potentially in positions where they formerly existed, while the latter involves a range of interventions on existing hedgerows to aid recovery. The favourable condition attributes of hedgerows defined by Hedgelink include thresholds for size (height, width and cross-sectional area), gappiness, presence of undisturbed ground and herbaceous vegetation, and lack of non-native species and nutrient enrichment[15]. Further attributes of hedgerow quality were put forward in a definition of hedgerow conservation status, including structural complexity, diversity and connectivity, and plant species composition. To a greater or lesser extent, all of these can be managed or mitigated towards a restored hedgerow.

[12] Defra, Natural England & Forestry Commission. (2023). *Ambitious roadmap for a cleaner, greener country*. https://www.gov.uk/government/news/ambitious-roadmap-for-a-cleaner-greener-country
[13] Staley, Wolton & Norton. (2020). *Definition of Favourable Conservation Status for Hedgerows*. Natural England, 71pp. https://publications.naturalengland.org.uk/publication/5565675205820416
[14] Gann, G. D. et al. (2019). International principles and standards for the practice of ecological restoration. Second edition. *Restor. Ecol.*, Vol 27, S1–S46.
[15] Defra (2007). Hedgerow Survey Handbook: A standard procedure for local surveys in the UK. 2nd edition. Department for Environment, Food and Rural Affairs.

The Environmental Improvement Plan combines creation and restoration into single quantitative targets without additional guidance and definition on the more discrete actions required and the relative amount of effort to be spent across them. From our calculations, the aspiration that these targets are to return hedgerow lengths in England to 10% above the 1984 peak (360,000 miles) (see section 2.5), suggests a near 50:50 split of planting new hedgerows (and in this way restoring the hedgerow network as a whole) and restoring existing hedgerows. But what is involved in the latter?

Natural England's technical note TIN085 on hedgerow restoration illustrate a wide range of actions including changes to the trimming regime to increase the width and height of the hedge, coppicing and laying, planting up gaps, and replacing standard trees[16]. Coppicing and laying is considered rejuvenation management to encourage regrowth from the base; Staley et al (2015) describe agri-environment scheme funding for such actions to support hedgerow restoration through coppicing and traditional hedge-laying[17]. Staley et al (2020) further emphasise how hedgerows in poor structural condition are likely to need rejuvenation of the woody species through coppicing, laying or a comparable approach such as conservation hedging and 'gapping up' (planting new woody species in large gaps) [18]. The hedgerow actions funded under the Sustainable Farming Incentive include coppicing, laying and gapping up[19]. New trees and shrubs planted in gaps can be helped to establish by coppicing or laying the existing hedge next to them, as this reduces shade and competition from the existing hedge. Peer review of the current study has clearly identified the distinction between rejuvenative actions on the one hand and restoration on the other, which should focus on filling gaps. Rejuvenative actions are a normal part of a healthy hedgerow management regime.

We recognise the varying positions on what should be included within the restoration targets. In our analysis of resourcing requirements, we develop estimates for the two scenarios: one in which restoration is restricted to gap filling, and a second in which this is balanced by coppicing and laying in three equal measures. As mentioned, other interventions are also relevant to restoration. What we believe should be commonly agreed is that, whether hedgerow restoration has the narrower or wider focus, restoration should never be considered as a one-off activity. The continued sympathetic, well-informed management through more frequent

[16] Natural England Technical Information Note TIN085: Illustrated guide to hedgerow network restoration. Natural England 2010, 3 pp.
[17] Staley, J.T., Amy, S.R., Adams, N.P., Chapman, R.E., Peyton, J.M. and Pywell, R.F. 2015. Re-structuring hedges: rejuvenation management can improve the long term quality of hedgerow habitats for wildlife. *Biological Conservation* 186, 187-196.
[18] Staley, A. J. T., Wolton, R. & Norton, L. *Definition of Favourable Conservation Status for Hedgerows: Defining Favourable Conservation Status Project*. Natural England, 2020, 71 pp.
[19] https://defrafarming.blog.gov.uk/sustainable-farming-incentive-pilot-guidance-plant-and-manage-hedgerows/

operations such as flailing, and less frequent operations of laying and coppicing, will be required to maintain the habitat in favourable condition.

This exercise was designed to help comprehend the scale of the target delivery in relation to the case studies. Resource requirements were calculated for four essential components of hedgerow action, as follows:

1. Labour: based on case study data supplemented by ancillary data, the NCA targets were translated into person hours for both volunteers and farmers, contractors and project coordinators.
2. Tree stock and other capital items: stipulated planting densities were used to translate the NCA targets into numbers of trees, tree guards, canes and fencing required.
3. Financial cost: the NCA targets are translated into cost using payment rates provided through Countryside Stewardship and the Sustainable Farming Initiative (SFI scheme of ELMs).
4. Number of projects: we compared the NCA targets with data from the case study research on typical farm-scale initiatives, large estate projects, and multi-year programmes. The targets were translated into the numbers of such projects to deliver the targets.

2.6 Database and visualisation

The results of our analysis of the 159 NCA profiles were entered into an Excel database, which can be sorted and interrogated in relation to their characteristics and indicative targets for hedgerow action.

To visualise the data, the NCA shapefiles were loaded in QGIS, along with the excel containing the scores/data described above. The data were reformatted to ensure that data types (numerical, string) were correctly defined. The scoring data were then joined to the NCA shapefile attributes using the NCA name as a common reference.

Maps could then be generated using the various data scores to apply a gradient or colour key across the NCAs. The "QGIS2WEB" plug-in was installed to generate an interactive map for use online[20].

[20] Ordonselli, A. et al. (2023). *QGIS2WEB*. Version 3.17.2. https://plugins.qgis.org/plugins/qgis2web/

2.7 Other information relevant to planning hedgerow creation and restoration

There are factors other than plantable area which affect the opportunity for and targeting of hedgerow action. These include the size of the existing hedgerow network, density of field boundaries and roadsides, and factors that determine particular ecosystem services that hedgerows can contribute to provisioning in the areas concerned (e.g. dominant agricultural systems, urban intrusion). Such information provides context to inform where particular NCAs could benefit from planting or restoration and provide guidance on areas for planting schemes to focus on. Some simple metrics for these factors were generated at NCA level as described below.

Average existing hedgerow density

Existing hedgerow density does not form part of our prioritisation approach but is nevertheless important contextual information. This metric was taken from indicative length data from Table 4/Figure 1 of the report: "Favourable Conservation Status of hedgerows"[5]. The data are only indicative, as Countryside Survey sampling is not designed to provide robust data at NCA level. Data from Table 4 was transcribed into an excel file. The data in the table is binned into the ranges 0–2km, 2–3.5km, 3.5–4.5km, 4.5–5.5km and >5.5km.

It is worth noting that a more detailed dataset for this estimation of hedgerow density was produced by CEH during the course of this study (see Annex 2). In our discussion and conclusions we discuss the potential of these data to inform the targeting of hedgerow action at a range of spatial scales.

Road density

Roadsides represent one important contribution to linear and boundary features that already have hedgerows or could be planted up. A shapefile of UK road data was downloaded from OS open roads[21]. This was clipped to the NCA shapefile in QGIS and total road length was summed for each NCA. Road density (km/km^2) was calculated by dividing road length by NCA total area.

Average size of farms

Farm sizes are correlated with field size, such that smaller farms have a higher density of field boundaries and therefore potential for hedgerows now or in the future[22]. Farm size information was captured from the key facts and data section of the NCA profile. Values were provided in 3 ranges, less than 50 ha (<50), between 50 and 100 ha, or greater than 100 ha (100>).

Dominant agriculture type

This information was taken from the key facts and data section of the NCA profiles and

[21] Ordnance Survey. (October 2023 release). *OS Open Roads*. https://www.data.gov.uk/dataset/65bf62c8-eae0-4475-9c16-a2e81afcbdb0/os-open-roads

[22] Clough, Y., Kirchweger, S, & Kandelhardt, J. (2020) Field sizes and the future of farmland biodiversity in European landscapes. *Conservation Letters*, DOI: 10.1111/conl.12752

is relevant to pollination and natural pest control ecosystem services of hedgerows.

Levels of intrusion

This information was taken from the key facts and data section of NCA profiles. Intrusion is defined by CPRE as noise and visual pollution. "Disturbed" areas are those areas of rural land that have been intruded upon by urban noise and visual pollution. The properties "undisturbed" and "urban" help to understand which benefits of hedgerows should be focused on in planting/restoration programs. For example, hedgerows could have important recreational/health benefits through their amenity value and air quality/noise mitigation functions.

Important ecosystem services

There is further information on ecosystem services in the NCA profiles, found in the description, opportunities, and landscape change sections. These were listed, including services related to climate change adaptation. Specific details of individual ecosystem services varied between each NCA, for example whether key species are mentioned in relation to biodiversity, and so we restricted our recording to broad categories. However, we provide an additional summary on the biodiversity benefits of hedgerows from previous work[23].

2.8 Case studies

To understand the challenges and solutions of hedgerow planting and restoration, six case studies were conducted. The approaches varied per case study, but overall a mixture of online and in-person interviews, site visits, grey literature research, and questionnaires were used to explore each hedgerow planting project.

The six case studies were chosen to achieve a geographical spread across England. The previously calculated hedgerow priority scores were also utilised to identify areas of interest. Furthermore, the case studies were also selected to fit into a series of categories to provide contrasts, for example urban vs rural. A full list of each case study and map can be found in Table 2 and **Figure 1**.

Table 2. Case study characteristics

National Character Area	**NCA number**	**Characteristics**	**Organisation**
South Devon	151	deep rural, protected, southern, low hedgerow priority score, high existing hedgerow cover	South Devon National Landscape

[23] CPRE & ORC. (2021). *Hedge Fund: Investing in hedgerows for climate, nature and the economy*. https://www.cpre.org.uk/resources/hedge-fund-full-report/

South Hampshire Lowlands	128	deep rural, unprotected, southern, medium hedgerow priority score score, low existing hedgerow cover	CPRE
Howardian Hills	29	deep rural, protected, northern, medium hedgerow priority score, medium existing hedgerow cover	Howardian Hills National Landscape
Arden (Solihull)	97	urban fringe, unprotected, midlands, medium hedgerow priority score, high existing hedgerow cover	Solihull Metropolitan Borough Council
South Suffolk and North Essex Clayland	86	deep rural, protected, east England, medium hedgerow priority score, medium existing hedgerow cover	CPRE & Stour Valley Farming Cluster
Manchester Conurbation	55	urban, unprotected, northern, medium hedgerow priority score, low existing hedgerow cover	The Orchard Project

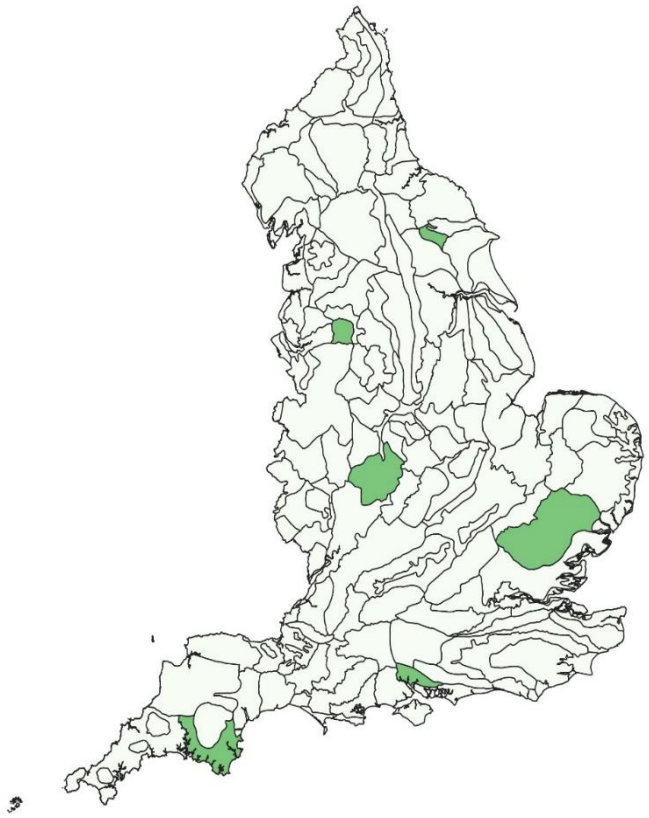


Figure 1. Map of case study locations.

3. Results

3.1 NCA hedgerow status

Intactness: how intact is the historic hedgerow network in the NCA?

74 NCAs (46.5%) were categorised as having lost a significant amount of hedgerow, but subsequently having experienced a significant or notable degree restoration in recent years (**Figure 2**). This was the most common classification and accords with how agricultural policy has changed throughout the years. Beginning with the agricultural revolution and continued by the post-war agricultural boom, the loss of hedgerows has been well documented across England[24]. In recent years the intensity of agricultural policy driving for greater yields and expansion has somewhat slackened, which when combined with a growing industry of hedgerow planting schemes had resulted in some reversal of the loss of hedgerow density. Areas that fall into this category offer a mix of potential for both new planting, some of which could follow historical hedgerow routes,

[24] Robinson, R.A. & Sutherland, W.J. (2002). Post-war changes in arable farming and biodiversity in Great Britain. Journal of Applied Ecology. 39. pp157-176. https://doi.org/10.1046/j.1365-2664.2002.00695.x.

and restoration of existing hedgerows.

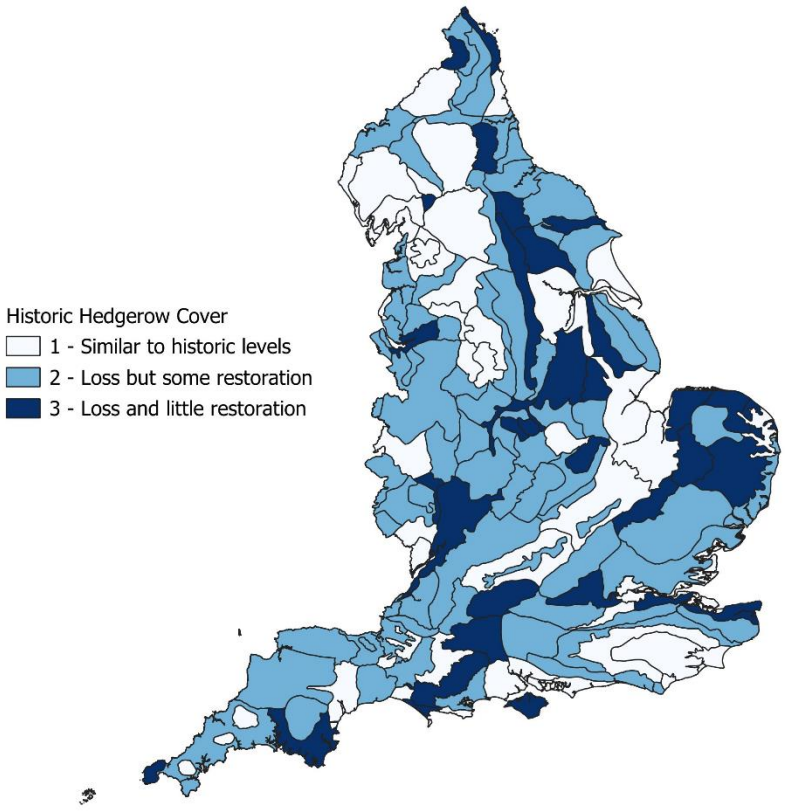


Figure 2. Loss of intactness of the hedgerow network. NCAs that have retained their historic hedgerow cover are given a prioritsation score of 1, those where historic loss has been at least partially reversed by restoration effort a score of 2, and the remaining which have experienced loss with little or no subsequent restoration a score of 3.

Only 51 (32.1%) of the NCAs had largely retained their historic levels of hedgerow cover. Many of the NCAs in this classification are classed as uplands or are located near the coasts. These locations don't have historically high levels of hedgerow, for example stone walls dominate much of the dales and fells, so the uptake and planting of hedgerows has been limited. The result of this is a consistent, low level of hedgerow presence. The other potential incidence fitting into this category is where historic hedgerow cover was and continues to be high. The general trend of hedgerow loss across all environments in England makes this type of location less common, however, in such a case it would be recommended to prioritise restoring/rejuvenating the existing hedgerows over planting additional hedgerows in an already hedgerow rich landscape.

On the opposite end of the spectrum are the 34 NCAs that had historically high levels of hedgerow cover, which has subsequently been lost and not replaced to a significant degree. These locations offer the most potential for hedgerow planting, particularly

following the old hedgerow routes. For example, there is a clustering throughout Norfolk and Suffolk, as well as further north around the Lincolnshire Wolds and Yorkshire Wolds. These are areas of extensive intensive agricultural land dominated by large arable fields.

Condition: what is the condition of existing hedgerows?

80 of the 159 NCAs were classed as having hedgerows of predominantly average condition, with some potential for restoration action. This aligns broadly with the CS2007 finding that 50% of hedges were in good structural condition for height, width and gaps (and non-native species cover). Once again, this result is unsurprising when considering hedgerow management trends. Where hedgerows exist, the standard management method is to flail them in the winter months, often on an annual basis[25]. This approach may alter hedgerow diversity, favouring certain woody species and reducing berry production. However, if done well, this management creates the excellent dense bushy habitat that most hedgerow wildlife favours, from breeding passerines, through dormice, to many invertebrates[26].

Some locations suffer from more damaged or poorer hedgerows compared to others. 28.9% of NCAs had many of their hedgerows in a poor condition making them targets for restoration efforts. As an example, the Southern Lincolnshire Edge is characteristically filled with "tightly cut hedgerows" which are gappy in nature (**Figure 3**).

Only 20.8% of NCAs were found to have the majority of their hedgerows in good condition. These were often areas already renowned for their wooded landscapes, such as the Chilterns, High and Low Weald, and areas around Shropshire (white areas in **Figure 4**). Many of these locations are National Landscapes.

[25] Barr, C.J., Britt, C.P., Sparks, T.H., Churchward, J.M. (2000). *Hedgerow Management and Wildlife: A review of research on the effects of hedgerow management and adjacent land on biodiversity*. https://hedgelink.org.uk/research/hedgerow-management-and-wildlife-a-review-of-research-on-the-effects-of-hedgerow-management-and-adjacent-land-on-biodiversity/

[26] R. Wolton, personal communication.

Figure 3. An example of a damaged or poor hedgerow which provides an ideal opportunity for hedgerow restoration. Photo from South Lincolnshire Edge NCA profile, David Burton/Natural England.

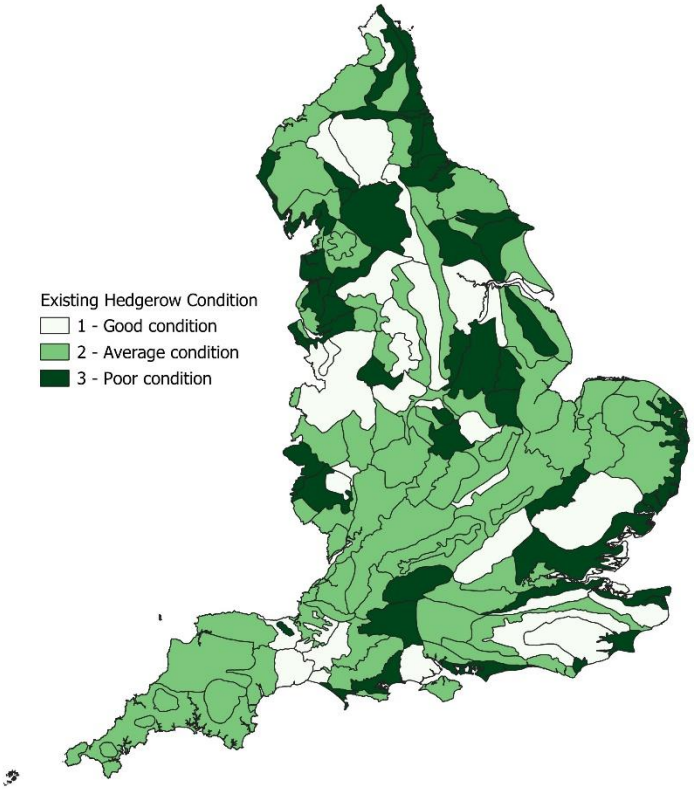


Figure 4. Condition of existing hedgerows within the NCAs. Those with hedgerows in good condition are given a priority score of 1. NCAs with hedgerows in an average condition are given a score 2 and the remaining areas characterised by poor condition hedgerows are scored 3.

Policy support: is there already a Statement of Environmental Opportunity (SEO) and/or AES Countryside Stewardship Statement of Priority (SSP) that includes reference to hedgerow planting/restoration?

147 (92%) of the NCAs had SEOs or SSPs that included a mention of hedgerows (**Figure 5**). Of these, two-thirds explicitly mentioned hedgerow planting and restoration as a key target instead of just being included in a wider general statement. An example is the Mid Somerset Hills NCA whose SEO 2 includes the objective of creating and enhancing corridors of hedgerows amongst other features, including "by the promotion of the maintenance of distinctive ancient farming patterns across the area, including the current field pattern bounded by thick hedgerows with trees", and "maintaining or reinstating hedgerow management". Such examples of strong policy support for hedgerow planting and restoration offer a key opportunity to make significant contributions to the national hedgerow targets.

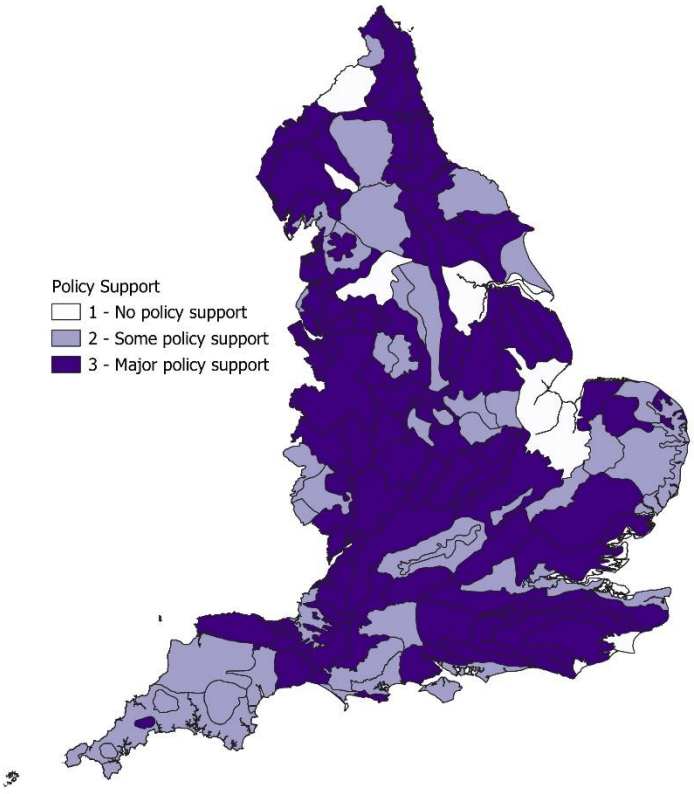


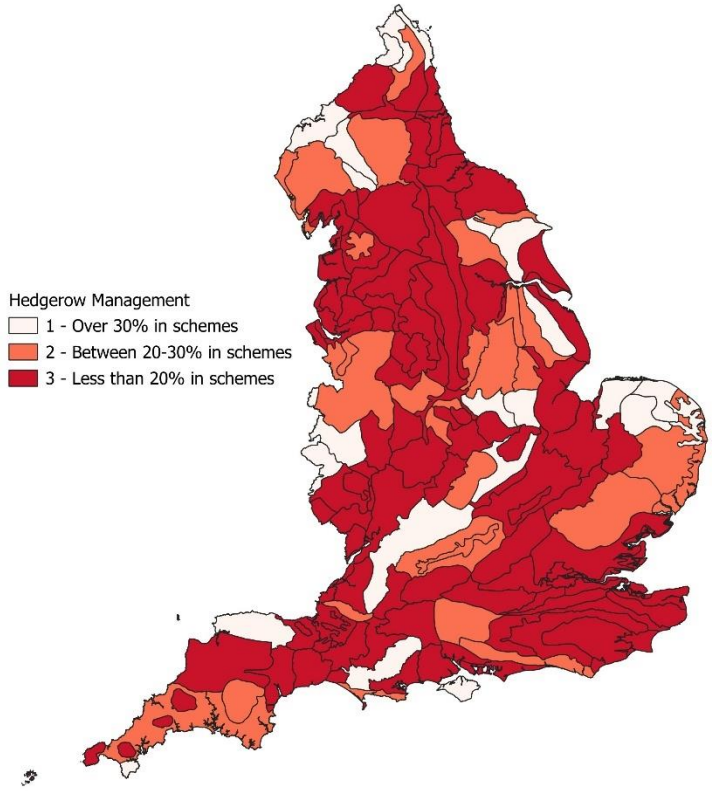
Figure 5. Levels of policy support for hedgerows in each NCA. Where there is strong policy support for hedgerows a priority score of 3 has been given. NCAs that offer some support for hedgerows are scored 2, and the remaining areas with little to no support are given a score of 1.

Only 12 locations didn't mention hedgerows in their SEOs or SPPs. These are Border Moors and Forests (5), Orton Fells (17), Southern Pennines (36), Humberhead Levels (39), Humber Estuary (41), The Fens (46), Greater Thames Estuary (81), Romney Marshes (123), Pevensey Levels (124), Isle of Portland (137), Isles of Scilly (158) and Lundy (159). They are coastal/island, fenland, or upland landscapes where hedgerows

are rare and where ditches, fences, or stone walls are more commonly used as field boundaries. Despite this lack of recognition for hedgerows, planting schemes may still be successful in these areas, however the scale of planting will be limited.

What is the level of management and restoration of hedgerows?

Using data from the Landscape Atlas on percentage of hedgerow managed under Environmental Stewardship and Countryside Stewardship schemes, the majority (64.2%) of NCAs had less than 20% of their hedgerows under these schemes (**Figure 6**). These schemes specify that hedgerows must only be cut once every 2–3 years and the Countryside Stewardship scheme includes additional requirements for gapping up hedges. The low amount of hedgerows managed under these schemes is consistent with only 20.8% of NCAs having hedgerows in good condition. NCAs that have low levels of hedgerow under agri-environment schemes should be key areas to focus



restoration effort.

Figure 6. Percentage of hedgerows in Environmental Stewardship or Countryside Stewardship schemes for each NCA. Those with more than 30% of their hedgerows in such schemes are given a priority score of 1. Those with between 20 and 30% are scored 2, and the remaining locations with less than 20% of their hedgerows in schemes are scored 3. Data from the Landscape Change Atlas (2018)[10].

32 NCAs were found to have between 20–30% of their hedgerows in ES/CS schemes, while only 25 had more than 30% under such management. The NCA with the highest coverage was Clun and Northwest Herefordshire Hills with 83.9%. Locations such as

this provide a good opportunity to plant new hedgerows which are then likely to be managed through a favourable management scheme. In general the level of disparity between the highest percentage coverage (83.9%) and the majority being below 20% highlights the potential for improvement through policy development and uptake of schemes such as Countryside Stewardship with the emerging Environment Land Management Schemes.

3.2 Prioritisation of NCAs for hedgerow action

Hedgerow action priority scoring (1–3) for the 159 National Character Areas is given in Annex 1 and shown in **Figure 7**. There were 33 low priority NCAs (score 1), 86 medium priority NCAs (score 2), and 40 high priority NCAs (score 3).

The scoring was based on loss of intactness, condition and policy support via the National Character Area profile or Countryside Stewardship Statement of Priority. Management was excluded from this final scoring. Eight NCAs received the maximum score across all three criteria, with all aside from one being concentrated in the northern half of the country: Southern Lincolnshire Edge, Trent and Belvoir Vales, Vale of York, Vale of Pickering, North Northumberland Coastal Plain, Howgill Fells, Mersey Valley, and Berkshire and Marlborough Downs.

The Trent and Belvoir Vales, in Nottinghamshire, Lincolnshire and Leicestershire, is the most significant of these NCAs by area. This is a strongly rural but unwooded area whose transition from pastoral to arable farming has been associated with the removal of hedgerows to create larger fields. At the same time, the majority of existing hedgerows were assessed to be in poor condition between 1999 and 2003, whilst planting and restoration activity has been limited. SEO 2 for this NCA is to *Enhance the woodland and hedgerow network through the planting of small woodlands, tree belts, hedgerow trees and new hedgerows to benefit landscape character, habitat connectivity and a range of ecosystem services, including the regulation of soil erosion, water quality and flow*. Within this SEO there is the aspiration to considerably increase the number of hedgerow trees. One standard every 20–40 m is considered necessary for Favourable Conservation Status[27]. With the threat of ash die-back, the predominance of ash trees (alongside oak) as the most dominant hedgerow trees means that this aspect of landscape character is vulnerable. Hawthorn hedgerows traditionally border the fields and are important in creating the character of the area, though less so in the east where their replacement by dykes is part of the more fen-like landscape. This is perhaps one example where spatial prioritisation of hedgerow activity can be important at scales below NCA boundaries.

The very lowest scores were received by NCAs with little precedent and scope for an extensive and healthy hedgerow network, namely Greater Thames Estuary, Humber Estuary, Humberhead Levels, South Pennines and the island of Lundy. Three of these are in the region of Yorkshire and the Humber. The Humberhead Levels is the largest of

[27] Staley, Wolton & Norton. (2020). Definition of Favourable Conservation Status for Hedgerows. Natural England, 71pp. https://publications.naturalengland.org.uk/publication/5565675205820416

these NCAs. Its large, geometric fields are bounded by ditches rather than hedgerows, which get almost no mention in the NCA profile let alone its Statements of Environmental Opportunity. Neither are hedgerows characteristic of the Southern Pennines, whose large-scale sweeping moorlands are enclosed by drystone walls.

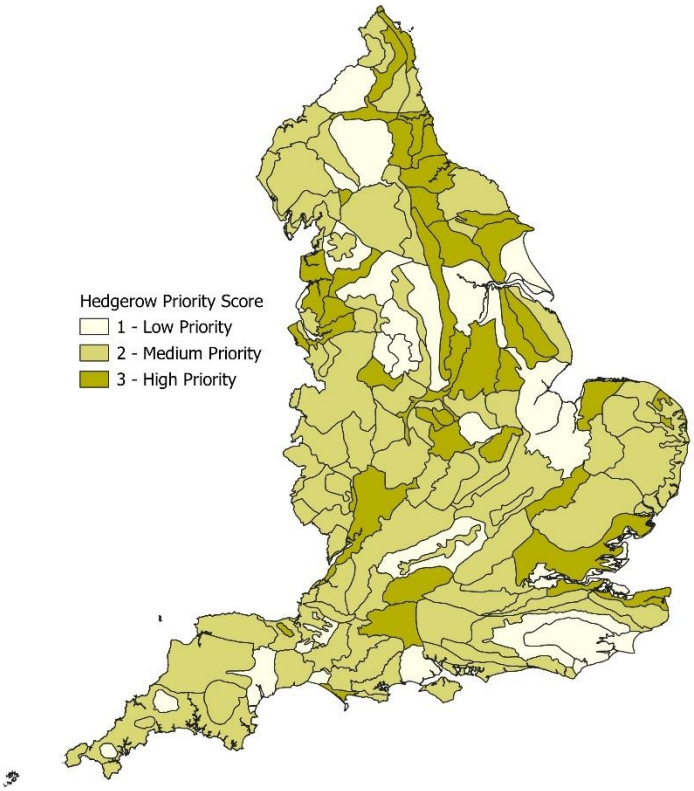


Figure 7. Hedgerow priority score for each NCA. Areas with a higher priority score (3) offer the greatest potential for hedgerow planting and restoration.

3.3 Hedgerow plantable area

The majority of NCAs had between 40–90% of their land as potentially suitable for hedgerows and their planting (**Figure 8**). Many have 80–90% coverage of suitable broad habitats, suggesting that there is a great deal of opportunity for future planting to take place in most areas around England.

There were some significant outliers. At the upper end, the Mid Somerset Hills was the only NCA to have over 90% of its land potentially suitable for hedgerow planting (90.6%). The next group of NCAs had around 88% of land potentially suitable: South Norfolk and High Suffolk Claylands (88.9%), Yorkshire Wolds (88.7%), Lincolnshire Wolds (88.5%), and East Anglia Chalk (88.3%). Despite the high potential planting area in the Mid Somerset Hills, it has a low priority score of 1. Specifically, it has retained historic hedgerow cover and generally maintains it in good condition. The above-listed NCAs with around 88% of their land potentially plantable have priority scores of either

2 or 3, making them particularly strong areas to focus on.

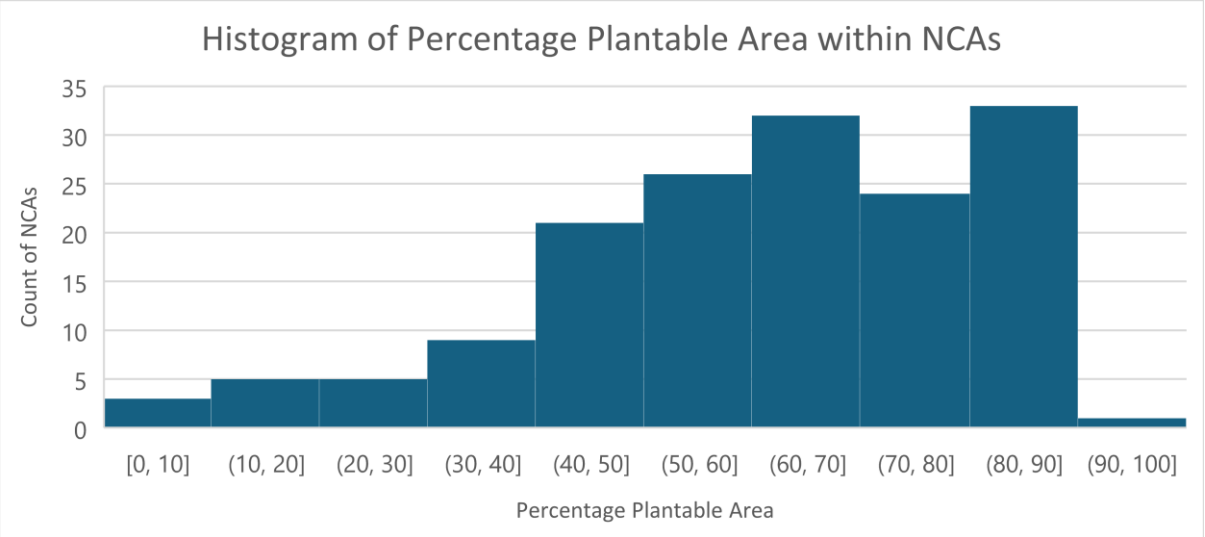


Figure 8. The distribution of NCAs based on their percentage plantable area.

NCAs with little or no suitable areas for hedgerows include the Cheviots (0.3%) and Border Moors and Forests (6.6%), both between Northumberland and Scotland's border, and the two islands of Lundy (12.4%) and Portland (0%) in the south. The Cheviots is largely made up of upland locations with unsuitable habitats for hedgerows. As its name suggests, the Border Moors and Forests NCA has 56% of its land classified as bog or coniferous woodland and therefore unsuitable for planting hedgerows. Urban areas, such as the Manchester Conurbation, Merseyside Conurbation, and Inner London had around 40–50% of their land defined as potentially suitable for planting. For the Manchester Conurbation 64% of the potential plantable land was classed as Built-up areas and Gardens even after subtracting 50% of land in this category. The respective land coverage of built-up areas and gardens potentially suitable for planting was 59% in the Merseyside Conurbation and 72% for Inner London. This emphasises the potential that urban hedgerow and tree planting can have in contributing to these targets.

Taking the actual land areas where hedgerows can be planted (**Figure 9**) there are a number of NCAs that stand out. Offering the most land is the Fens with 3,182.68 km^2 and the South Suffolk and North Essex Claylands with 2,877.70km^2. Despite this high potential, the Fens only has a hedgerow priority score of 1, suggesting that planting on much of this land may be difficult due to other characteristics, in this case a lack of historical precedent and policy support for hedgerows. The tradition for ditches as field boundaries also represents an environmental if not cultural barrier to hedgerow expansion in the area.

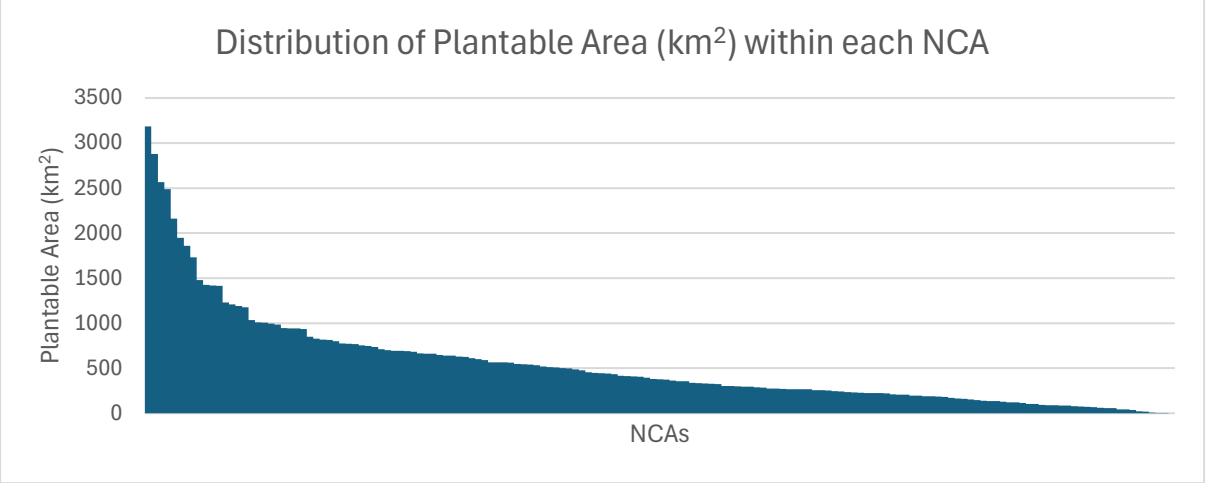
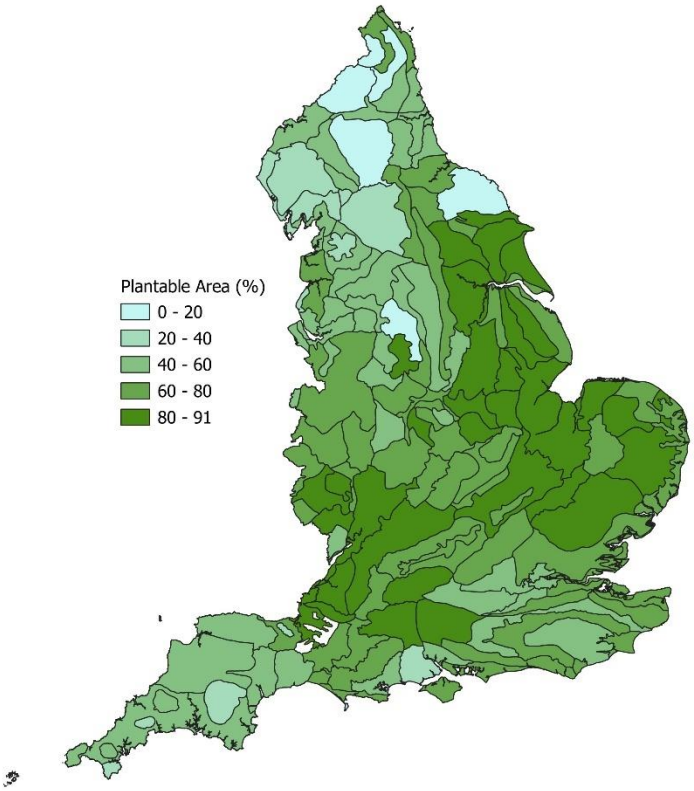


Figure 9. Plantable area in km^2 for all the NCAs, shown as a size distribution in decreasing order. Only 8 NCAs have an extensive plantable area, 1500 km^2 to just over 3000 km^2, whilst 87% of NCAs have areas below 1000 km^2. Each NCA is represented by a single column.

The lower end of the scale is dominated by smaller NCAs which offer a lesser amount of hedgerow action, even in NCAs with high hedgerow priority scores such as the Quantock Hills (19.19 km²) and Howgill Fells (43.03 km²) (**Figure 10**).



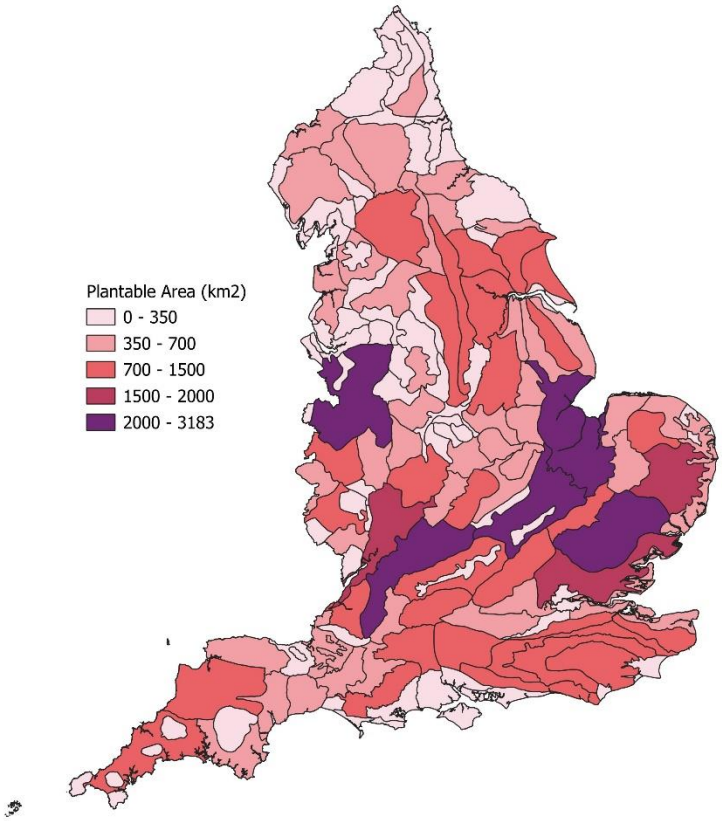


Figure 10. Plantable area percentage (top) and actual area (below) for each NCA.

3.4 Disaggregating the national hedgerow targets to NCA level

Our disaggregation of the national target for hedgerow creation has created an indicative target for each National Character Area. We focus on the 2037 target (48,280 km [30,000 miles] of hedgerow created or restored) for the purposes of presenting this work. To reach the 2050 target, a further 24,140 km (15,000 miles) needs to be planted or restored. With the periods 2024–2037 and 2037–2050 being equal, this implies half the rate of effort on hedgerow action in the second period compared to the first.

The NCA level targets range from near zero in the case of three island NCAs (Isle of Portland, Isles of Scilly, and Lundy) to 1,583.24 km in the case of the South Suffolk and North Essex Claylands (**Figure 11**). The average value is 303.65 km to reach the national 48,280 km target: the median value is 206.93 km. As a consequence of our disaggregation methodology, this implies a density of new/restored hedgerow of 275 m/km^2 (for low), 550 m/km^2 (medium) and 825 m/km^2 (high priority NCAs). The rate of hedgerow creation/restoration in each NCA ranges from zero to 113.09 km per year with an average 21.69 km, or 13.48 miles. The median value is 14.78 km/year (9.18 miles per year), meaning that half (79) of the NCAs have a rate up to this value.

An example of an NCA with a low target is the North Norfolk Coast (No. 77). The plantable area of this NCA is 20.58 km^2 (28.8% of the NCA). It has a 2037 target of 5.66

km, requiring 404 m to be created or restored each year. This narrow, coastal plain is dominated by mudflats, saltmarshes, dunes and beaches, but there are small parts managed for arable and pasture and these are defined by a relatively intact network of hedgerows. Example actions in SEO3 of the NCA profile include to conserve, restore and prevent further loss of hedgerows and hedgerow trees. The gappy nature of the hawthorn-dominated hedgerows in the area is noted elsewhere and is suggestive of gapping up as a priority action to meet this relatively modest NCA-level target.

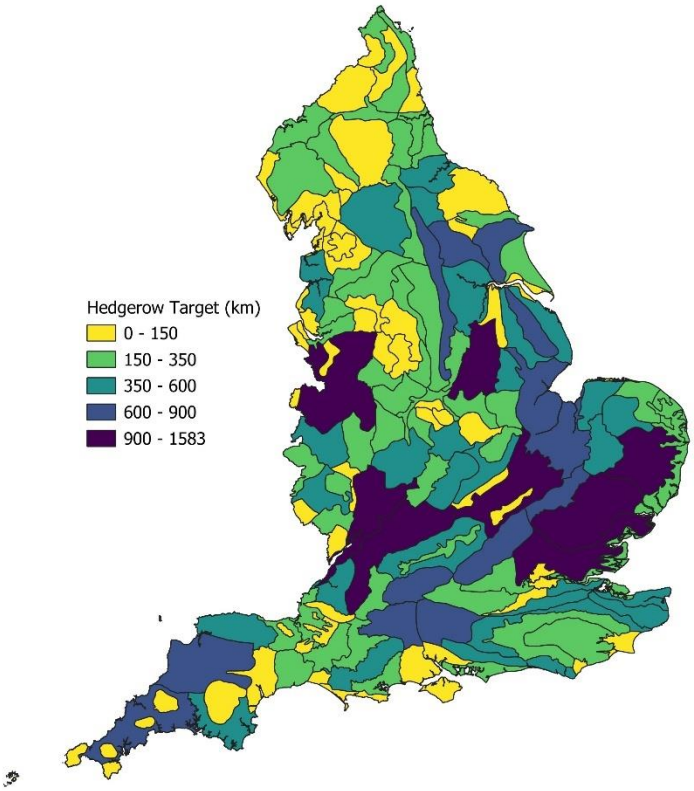


Figure 11. Target hedgerow lengths (km) for each NCA to reach the 2037 hedgerow goal.

The NCA with the highest target is the South Suffolk and North Essex Claylands (No. 83). This is a flat or undulating pastoral landscape with strong field boundaries with well maintained hedgerows, except on narrow sandstone ridges where sandstone walls are more common. The high target is more by virtue of the NCA's large area (366,200 km^2) and high percentage of plantable area (88.9%) than its priority scoring (2). Achieving its target of 1583 km of created or restored hedgerow by 2037 will require 113 km to be achieved each year until that date. How to meet such a target across such an area? Statements of Opportunity 1 and 2 both focus on restoration of hedgerows as a key action, for purposes including benefiting biodiversity and sense of place. Stated considerations include the use of typical species, gapping up, encouraging hedgerow trees, identify existing saplings and shoots to grow on to become hedgerow trees, and adopting appropriate cutting regimes. With small to medium field sizes, and a plentiful network of mature hedgerows, there is the opportunity to meet this target if resources are available.

3.5 Resource requirements

The resource requirements required to deliver the rates of hedgerow creation/restoration (expressed as length km of hedgerow per year) to meet the national target for 2037 were examined with respect to three NCAs representing low, medium and high targets. The following NCAs were selected:

- Marshwood and Powerstock Vales (Dorset) (low target and rate of delivery)
- Trent Valley Washlands, Warwickshire (Staffordshire, Derbyshire, Nottinghamshire and Leicestershire) (medium target and rate of delivery)
- South Norfolk and High Suffolk Claylands (Norfolk and Suffolk) (high target and rate of delivery)

Table 3 presents the assumptions made for the purposes of estimating these resource requirements with respect to person time, tree stock and other capital items, financial cost, and number of projects. Table 4 multiplies these estimates up to NCA level to provide the scenarios of resource demand in relation to the low, medium and high targets. As indicated in our methods, we assume a 50/50 split for the target length of hedgerow created/restored in each NCA. We develop two alternative scenarios in relation to what constitutes restoration, firstly that it is based on gapping up alone, and secondly that coppicing and laying are included and that effort (by length) is evenly apportioned across the three interventions. Other assumptions are detailed in Table 3. We comment on one NCA below. All costings are current, not adjusted for inflation.

South Norfolk and High Suffolk Claylands is by far the largest of the three NCAs and, with a priority scoring of 2, has an ambitious target of 535 km of new hedgerow and 535 km of restored hedgerow by 2037. The NCA profile notes how the landscape has been weakened by hedgerow removal and it prioritises planting hedgerows on previously hedged boundaries as well as restoration, including through planting replacement hedgerow trees (not included in our resources analysis). The scenario we develop for the delivery of the targets in this NCA involves six multi-year coordinated programmes each achieving 15 km of new hedgerow and 15 km of restored hedgerow, 12 large estates with 1 km new and 1 km restored, and 2,165 small to medium sized farms with 200 m new and 200 m restored.

According to the first restoration scenario (Table 4a), farmer and volunteer labour would amount to nearly 12,840 person days with an additional 900 days for coordination of multi-year initiatives. In terms of costs, tree stock, and tree protection would amount to £3.08 million, with an additional £261,888 for fencing and £321,000 for mulch (see Table 3 for assumptions on quantities). The cost in terms of CS/SFI payment rates for the hedgerow creation and restoration would sum to £14,131,490 in this NCA according to our assumptions, which is over £1 million per year. In the case of the second restoration scenario (Table 4b) farmer and volunteer labour would amount to nearly 15,000 person days with an additional 5,350 days of contractor time for hedge laying and 900 days for coordination of multi-year initiatives. In terms of costs, tree stock, tree protection and laying stakes/binders would amount to over £3.4 million, with an additional £261,887 for fencing and £285,333 for mulch (Table 4; see Table 3 for assumptions on quantities). The cost in terms of CS/SFI payment rates for the hedgerow creation and restoration would sum to £16,264,639 in this NCA

according to our assumptions, which is over £1 million per year.

Table 3. Resource demand assumptions.

Resource	Unit	Per 100 m creation	Per 100 m restoration	Sources, notes
People				
Person time	Person days	2	3 (laying) 2 (coppicing) 0.2 (gapping up)	Hants, Devon & Yorks case studies. John Nix (restoration): laying 20–40 m/day, coppicing 100 m/day
Coordinator person time	Person days	0.5	0.5	Large initiatives only
Capital items				
Trees, spiral guards and bamboos/canes	Number	600	60	Gapping up: assume 20 m/100 m
Stakes	Number	-	219	For laying
Horizontal binders	Number	-	160	For laying
Mulch	m^3	2	0.4	Assume 5 cm depth
Fencing	m	100	-	Assume needed for stockproofing on one side on one third of new hedgerows within pasturelands.
Costs				
CS/SFI Planting	£	2297	Laying: 1352 Coppicing: 533 Gapping up: 344	BN11: Planting new hedges £22.97/m BN5: Laying £13.52/m BN6 Coppicing £5.33/m BN7 Gapping up £17.22/m; (assume 20% gaps)

Coordinator time	£	150	150	
Contract labour	£	450	1700 (laying) 850 (coppicing) 45 (gapping up)	John Nix: coppicing assumes by hand with chain saw
Itemised: trees, spiral guards and canes	£	480	48	50p/tree, 25p guard and 5 p cane (information from Yorks and Hants case studies); for restoration assume 20 m of gapping up per 100m
Itemised: Stakes and binders	£	-	380	For laying; assume £1 per item
Fencing	£	700	-	John Nix: Includes labour
Mulch		200	40	Assume £25 per m^3 (ORC Productive Hedges report)
Initiatives				
Small-medium farm	km	200 m	200 m	
Large estate	Km	1 km	1 km	
Multi-year programme	km	15 km	15 km	First 2 phases of Hedgerow Hero project

Table 4. Resource requirements to deliver 2037 hedgerow targets in three NCAs. Two scenarios are presented. Table 4a. is based on gapping up as the main restoration action. Table 4b is based on gapping up, coppicing and laying activities (equal by length) included in restoration.

Table 4a

Resource	**Unit**	**Marshwood and Powerstock Vales NCA**	**Trent Valley Washlands NCA**	**South Norfolk and High Suffolk Claylands NCA**

Plantable area	km^2	102.5	258	1946
Priority score (1=Low, 3=High)		1	3	2
Livestock as % of farming	%	62	22	21
2037 creation target	km	14	106	535
2037 restoration target	km	14	106	535
Resource requirements to meet 2037 target				
People				
Volunteer/ farmer person time	Person days	336	2,556	12,840
Coordinator person time	Person days	0	450	900
Capital items				
Trees, spiral guards and bamboos/canes	Number	100,800	766,800	3,852,000
Fencing	km	2.89	7.80	37.41
Mulch	m^3	336	2,556	12,840
Funding requirement				
Countryside Stewardship/SFI	£	369,796	2,813,091	14,131,490
Coordinator	£	0	135,000	270,000
Itemised: trees, spiral guards and canes	£	80,640	613,440	3,081,600
Fencing	£	20,233	54,615	261,888
Mulch	£	8,400	63,900	321,000
Initiatives				
Small-medium farm	Number	65	280	2,165

Estate	Number	1	5	12
Multi-year programme	Number	0	3	6

Table 4b: gapping up, coppicing and laying activities (equal by length) included in restoration.

Resource	**Unit**	**Marshwood and Powerstock Vales NCA**	**Trent Valley Washlands NCA**	**South Norfolk and High Suffolk Claylands NCA**
Plantable area	km^2	102.5	258	1946
Priority score (1=Low, 3=High)		1	3	2
Livestock as % of farming	%	62	22	21
2037 creation target	km	14	106	535
2037 restoration target	km	14	106	535
Resource requirements to meet 2037 target				
People				
Volunteer/ farmer person time	Person days	392	2982	14,980
Contractor person time	Person days	140	1065	5,350
Coordinator person time	Person days	0	450	900
Capital items				
Trees, spiral guards and bamboos/canes	Number	89,604	681,600	3,423,996
Stakes and binders	Number	17,699	134,545	675,871
Fencing	km	2.89	7.80	37.41

Mulch	m^3	299	2,272	11,413
Funding requirement				
Countryside Stewardship/SFI	£	425,693	3,237,742	16,264,639
Coordinator	£	0	135,000	270,000
Contract labour	£	79,390	603,500	3,031,610
Itemised: trees, spiral guards and canes	£	71,683	545,280	2,739,197
Itemised: Stakes and binders	£	17,699	134,545	675,871
Fencing	£	20,233	54,615	261,888
Mulch	£	7,467	56,800	285,333
Initiatives				
Small-medium farm	Number	65	280	2,165
Estate	Number	1	5	12
Multi-year programme	Number	0	3	6

3.5 Other information relevant to planning hedgerow creation and restoration

The previous sections describe the results of our analysis of hedgerow action opportunity and priority, based on the status of hedgerows and plantable area. There are, however, additional characteristics we can consider in planning and targeting hedgerow action at NCA level, such as average existing hedgerow density, road density, average farm size, dominant agriculture type, levels of intrusion, and important ecosystem services.

Average existing hedgerow density

The source data for existing hedgerow coverage was Table 4/Figure 1 of the report: "Favourable Conservation Status of hedgerows", being indicative only (see methods, section 2.7) and categorised into ranges, e.g. 0–2 km. As a consequence of this, the results produced were also broadly categorised and only show high-level differences between NCAs. A total of 5 bands of existing hedgerow density were identified: 0–2 km,

2–3.5 km, 3.5–4.5 km, 4.5–5.5 km, and 5.5 km+ per square kilometre (**Figure 12**).

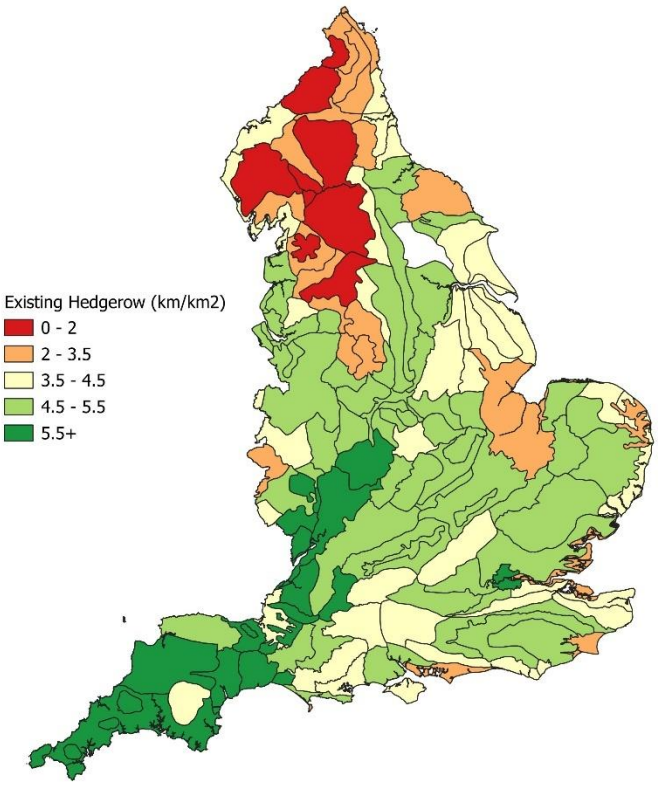


Figure 12. Existing density of hedgerows in each NCA. Areas with a lower coverage may provide more opportunities for new hedgerow planting, while NCAs with higher coverage may offer more potential for hedgerow restoration.

The highest band of hedgerow density was 5.5 km+, however only 24 NCAs were found in this category. The inclusion of Inner London appears anomalous and may be representing the situation in urban parks and gardens, as urban areas were generally excluded in the generation of these estimates and caution should be taken in interpreting this particular result. NCAs included in this category already have extensive areas of hedgerow and thus restoration of poorly managed hedgerows may be more important than new hedgerow creation.

The band of 4.5 to 5.5 km/km^2 was the largest with 61 NCAs, followed by 3.5 to 4.5 km/km^{2}with 39 NCAs. These NCAs may offer some opportunity for both restoration and new planting. The lowest bands of existing hedgerow density, 2 to 3.5 km/km^2 and 0 to 2 km/km^2, represented 24 and 9 NCAs respectively. Many of these areas were uplands, dales, and fells where a tradition of dry stone walls dominates. Data were unavailable for two NCAs.

Road Density

Road density varied from 15.8 km/km^2 in Inner London to 0.51 km/km^2 for the sparse tracks on the island of Lundy (**Figure 13** and **Figure 14**). Across all of the NCAs the average road density was 3.52 km/km^2. As expected, areas of high road density were

normally those containing cities. Hedgerows along roads provide important ecosystem services such as mitigating noise and air pollution[28]. The planting and management of hedgerows in such areas of high road density should keep in consideration these particular functional attributes.

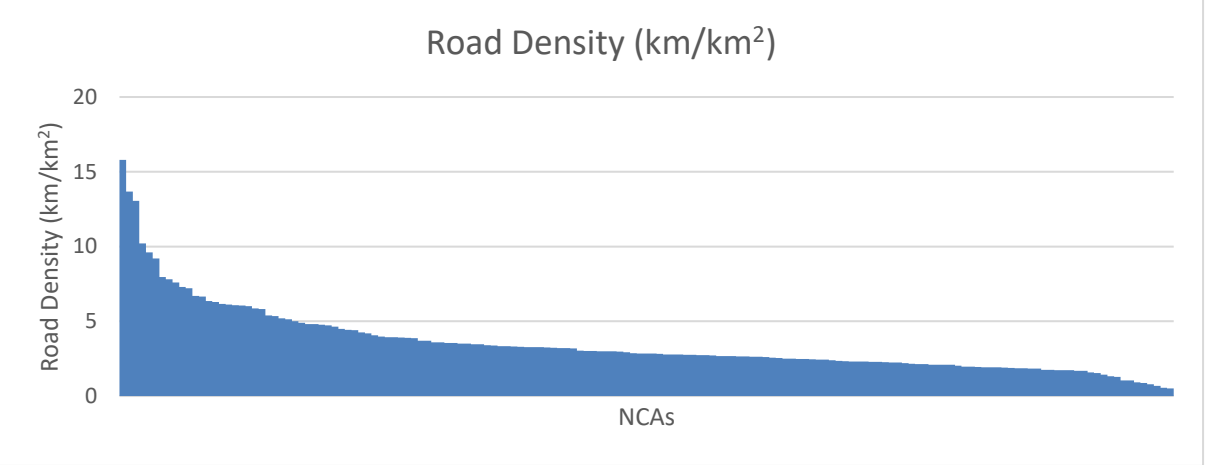
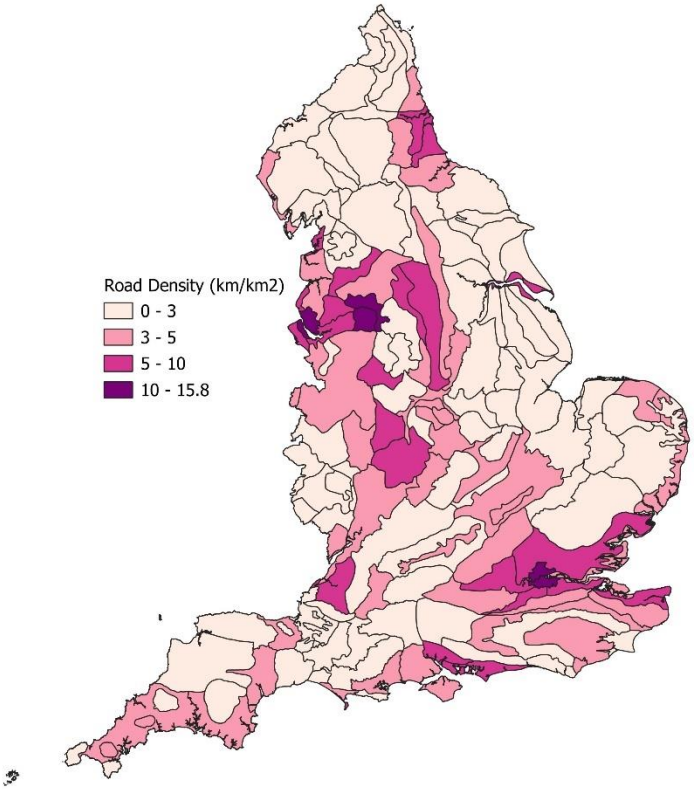


Figure 13. Road density (km/km2) for each NCA. Each NCA is represented by a single column.

Figure 14. Road density across the NCAs.



[28] CPRE & ORC. (2021). *Hedge Fund: Investing in hedgerows for climate, nature and the economy*. https://www.cpre.org.uk/resources/hedge-fund-full-report/

Average size of farms

The listing of farm sizes in the NCA profiles was coarse requiring a broad classification system, in this case below 50 hectares, 50 to 100 ha, and greater than 100 hectares. 52.5% of the farms were greater than 100 ha (**Figure 15**). These larger farms can offer greater lengths of hedgerow planting or restoration for a single project's worth of administrative work. Additionally, once a relationship with the landowner has been established, then larger farms also offer the opportunity for year-on-year expansion and planting of hedgerows. However, smaller farms generally also have smaller field sizes and therefore provide a greater density of field boundaries per area and space for hedgerows[29]. Only 19 NCAs had farms that were classed as being between 50–100 ha, with the remaining 51 NCAs containing farms smaller than 50 ha (**Figure 16**).

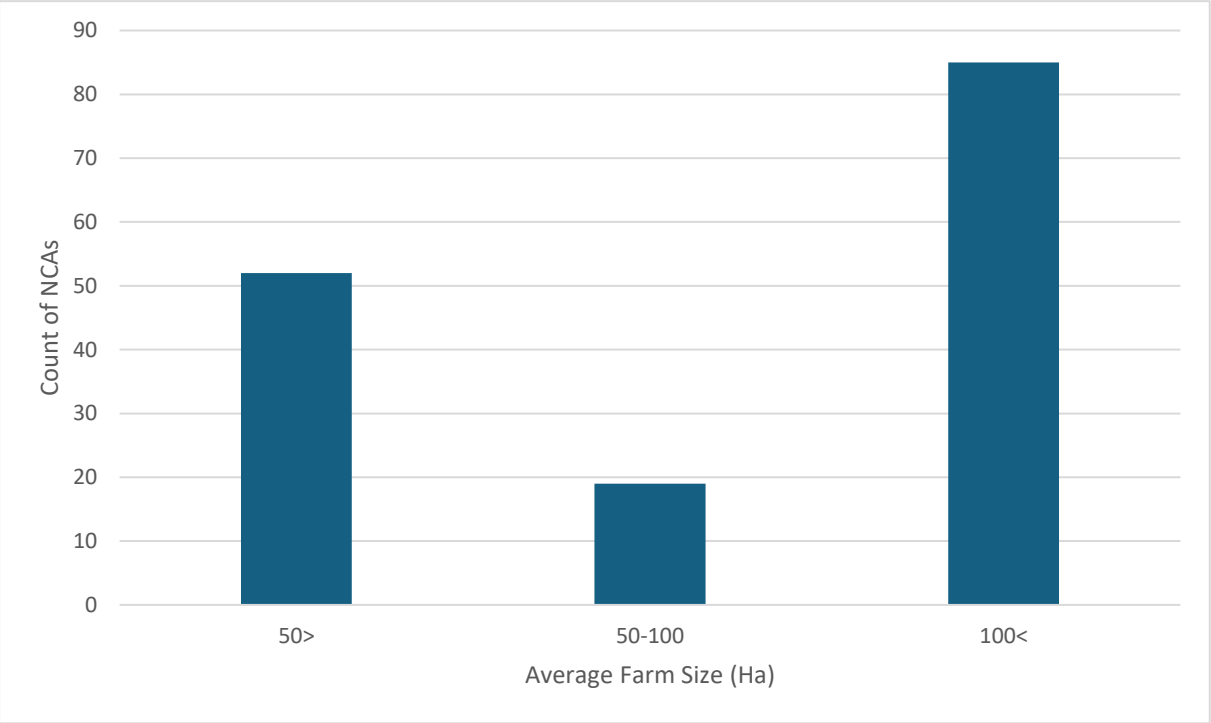


Figure 15. Classification of NCAs by average farm area.

[29] Clough, Y., Kirchweger, S, & Kandelhardt, J. (2020) Field sizes and the future of farmland biodiversity in European landscapes. Conservation Letters, DOI: 10.1111/conl.12752

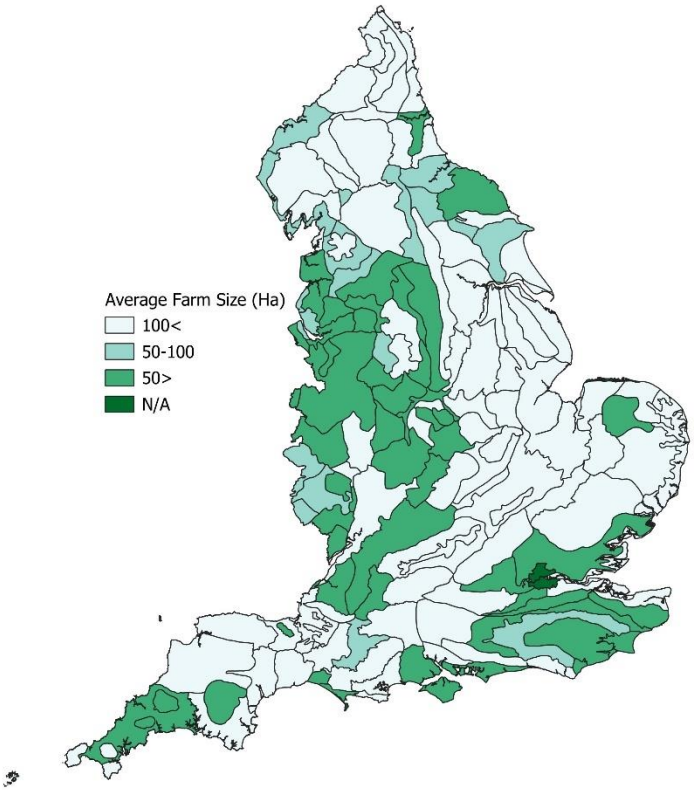


Figure 16. The average farm size for each NCA.

Dominant agriculture type

Pasture was the dominant type of agriculture in 66% of the NCAs (**Figure 17** and **Figure 18**). Hedgerows can offer numerous benefits to livestock, such as shelter and forage, as well as stockproofing of field boundaries. Greater promotion of these qualities will help increase the potential for hedgerow planting on livestock farms. On the other hand, hedges offer numerous benefits in arable areas, such as soil conservation, wind breaks, and a source of pollinators and natural predators of crop pests.

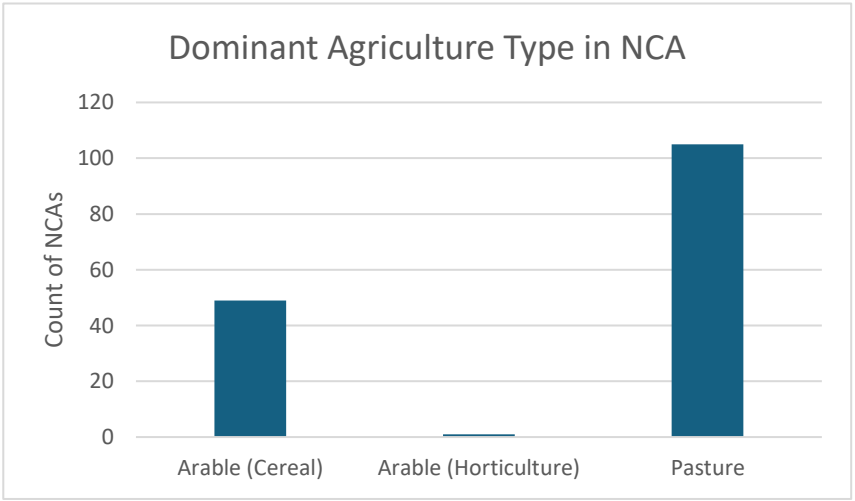


Figure 17. Classification of NCAs by their dominant agricultural type.

Only a single NCA, the Isles of Scilly, was classed as being mostly horticultural arable land. This is due to their southerly location making flower farming economically prosperous. The rest of the arable lands were dominated by cereal farms. These locations can benefit

significantly from the pollinator and pest control opportunities that hedgerows provide[30].

While certain agricultural types were dominant in some areas, in others the split between arable and pasture was near 50/50. Therefore, it is recommended to emphasise the applicability of hedgerows to both farming types, suiting the specific farming benefits and potential wildlife value (see Ecosystem services and biodiversity, below) on a case-by-case basis.

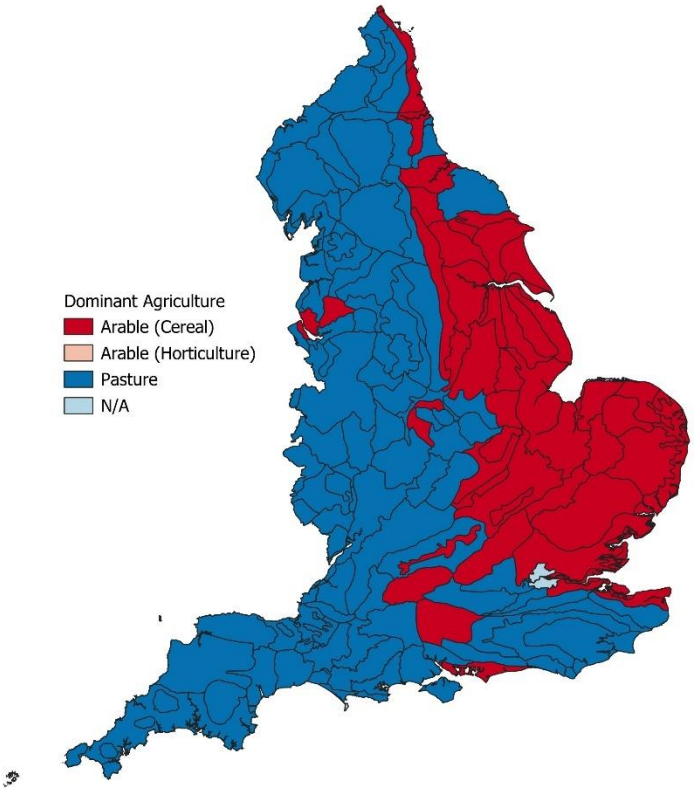


Figure 18. Dominant type of agriculture in each NCA.

Levels of intrusion

When assessing intrusion, land can be classified as either disturbed, undisturbed, or urban. The NCAs with the highest levels of disturbance were Charnwood and Melbourne Parklands, both at 79% (**Figure 19**). These NCAs border each other in the midlands, north-west of Leicester. Charnwood's high level of disturbance is due to expansion from Leicester and Loughborough, alongside the noise and pollution caused by the M1 which runs through the NCA. The Melbourne Parklands NCA contains East Midlands Airport, a major source of disturbance to the surrounding landscape.

The use of hedgerows and trees in these highly disturbed areas can help mitigate the effects of pollution by reducing noise or capturing air pollution. Hedges can also reduce

[30] CPRE & ORC. (2021). *Hedge Fund: Investing in hedgerows for climate, nature and the economy*. https://www.cpre.org.uk/resources/hedge-fund-full-report/

visual pollution, preserving the surrounding SSSIs and picturesque village landscapes.

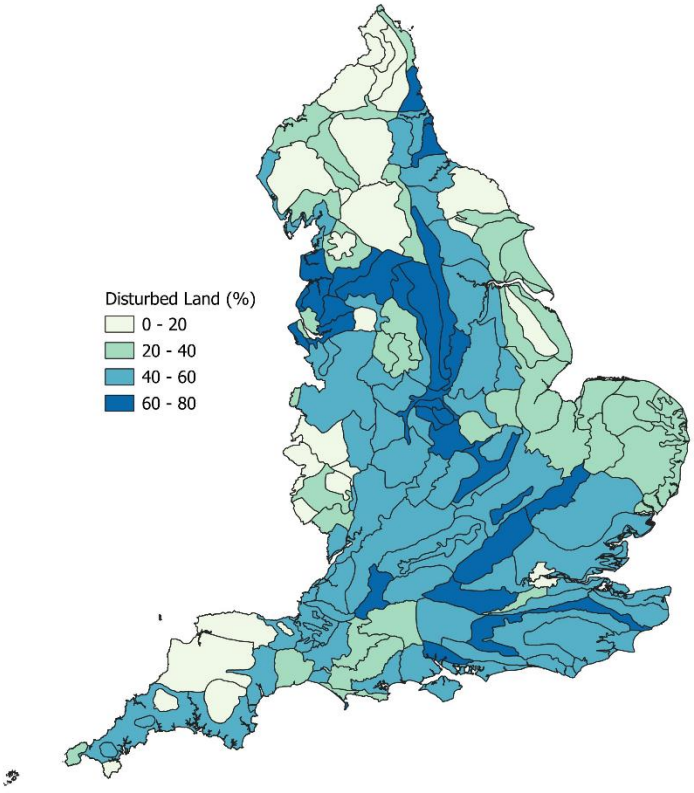


Figure 19. NCAs classified by the percentage of disturbed land they contain.

Border Moors and Forests was the only NCA to have 100% undisturbed land, although it was closely followed by the Bowland Fells and Cheviots, both with 99%. These locations are all in the North of England with Borders Moors and Forests and Cheviots on the border with Scotland, while the Bowland Fells forms the core of the Forest of Bowland National Landscape (**Figure 20**). These sites are renowned for their wildness and beauty, a quality that could be enhanced by appropriately placed hedgerows which can provide much needed habitat for wildlife. Large parts of these NCAs are, however, heathland and conifer forests and thus the area suitable for hedgerow planting may be small.

Unsurprisingly the highest concentrations of urban land are in the NCAs that contain large cities (**Figure 20**). These locations offer a great deal of opportunity for hedgerow planting, especially at the urban-rural interface, where disturbed land is common. Inner London is dominated by urban land, yet hedgerows can still be placed on parklands, gardens, and along some streets. A different approach to that taken in rural situations may have to be taken when designing a scheme to expand urban planting as individual planting projects can be small, creating a significant administrative burden (see Solihull case study). Given the high population density, however, the benefits for mitigating noise, air, and visual pollution will be felt by a larger group and should be key areas to promote.

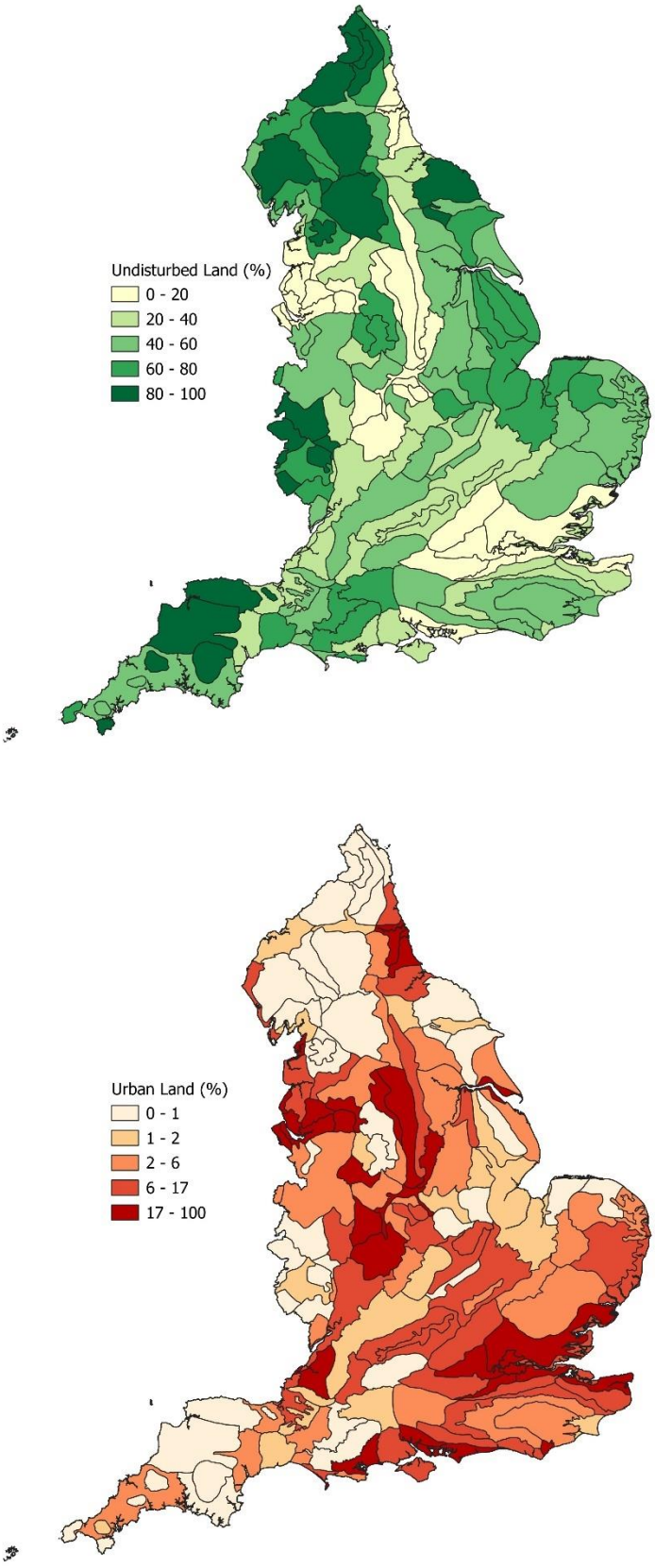


Figure 20. Percentage of undisturbed land (above) and urban land (below) within each NCA.

Ecosystem Services and biodiversity

A total of 10 important ecosystem services were identified that could be support by hedgerow planting and restoration. These were:

- Timber provision
- Climate regulation
- Water flow
- Soil conservation
- Habitat for biodiversity
- Biomass energy
- Water pollution mitigation
- Soil quality
- Pest regulation
- Pollination

The provisioning of these ecosystem services by hedgerows is explored further in the CPRE/ORC *Hedge Fund* report and a summary with respect to biodiversity is given in Box 2[31].

Only three NCA profiles: North Norfolk Coast, Morecambe Coast and Lune Estuary, and Wirral, did not highlight important ecosystem services that hedgerows could support. Whilst hedgerows in these areas will inevitably contribute important services such as climate regulation, coastal erosion, and habitat for biodiversity, the profiles focused on the benefits of non-hedgerow habitats such as bogs, fens, and wetlands.

All other NCA profiles described at least one important ecosystem service that could be supported by the planting of hedgerows. Eight NCA profiles listed seven ecosystem services that could be supported. The most common ecosystem service according to the NCA data was water pollution prevention or reduction (**Figure 21**). Farms in catchment

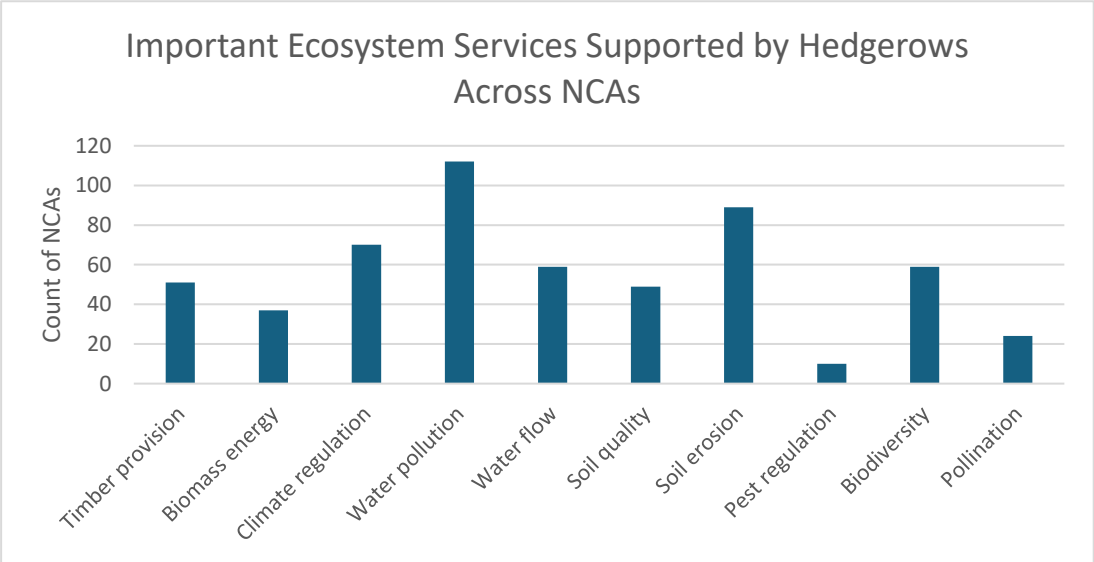


Figure 21. Occurrences of important ecosystem services that can be supported by hedgerow planting.

[31] CPRE & ORC. (2021). *Hedge Fund: Investing in hedgerows for climate, nature and the economy*. https://www.cpre.org.uk/resources/hedge-fund-full-report/

areas are major sources of river and lake pollution, an issue that is further exemplified by the second most common ecosystem service, soil conservation. Hedgerows can provide a barrier to surface water flow, reducing the leaching of nutrients and loss of soil[32]. These benefits could be used in promoting the establishment and restoration of hedgerows in key catchment areas. A full list of the important ecosystem services that can be supported by hedgerows for each NCA can be found at the online tool.

Box 2

Hedgerows and biodiversity

Arguably, we haven't given the biodiversity value of hedgerow the focus it deserves in this report in the context of prioritising new hedgerow planting and restoration. This is largely due to the lack of national scale data on hedgerow value for biodiversity and local prioritisation of hedgerows in biodiversity enhancement strategies. In a previous CPRE/ORC report the value of hedgerows for biodiversity has been covered in detail, but we provide a short primer here[33].

Of the 1,149 UK priority species (those in serious decline) identified by the 2007 Species and Habitat Review, 130 are significantly associated with hedgerows[34, 35]. These include the charismatic hazel dormouse, *Muscardinus avellanarius*, whose decline is associated with aggressive hedgerow management practices adopted in recent years, and the brown hairstreak, *Thecla betulae*, that lays its eggs on blackthorn, which is particularly common in hedgerows[36]. Hedgehogs, *Erinaceus europaeus*, are a species associated with grassland and edge habitats including hedgerows and the deterioration of hedgerow quality and loss has been indicated as responsible for their recent population decline[37].

For land managers functional biodiversity is particularly relevant. Functional biodiversity is a component of overall biodiversity that is agriculturally useful. In an agricultural context pollination and pest management ecosystem services are particularly important.

Hedgerows, pollination, and pest management

Dutch open field strawberries benefit from a woodland-connected hedgerow which

[32] CPRE & ORC. (2021). *Hedge Fund: Investing in hedgerows for climate, nature and the economy*. https://www.cpre.org.uk/resources/hedge-fund-full-report/
[33] CPRE & ORC. (2021). *Hedge Fund: Investing in hedgerows for climate, nature and the economy*. https://www.cpre.org.uk/resources/hedge-fund-full-report/
[34] Biodiversity Reporting and Information Group (BRIG). (2007). Report on the Species and Habitat Review (Report by the Biodiversity Reporting and Information Group (BRIG) to the UK Standing Committee). JNCC, Peterborough. https://hub.jncc.gov.uk/assets/bdd8ad64-c247-4b69-ab33-19c2e0d63736.
[35] Wolton, R. (2009). UK Biodiversity Action Plan: Priority species linked to hedgerows. A report to Hedgelink https://www.researchgate.net/profile/Robert_Wolton/publication/324149813_UK_Biodiversity_Action_Plan_Priority_species_linked_to_hedgerows_A_report_to_Hedgelink/links/
[36] Staley, A. J. T., Wolton, R. & Norton, L. (2020). Definition of Favourable Conservation Status for Hedgerows: Defining Favourable Conservation Status Project.
[37] Graham, L., Gaulton, R., Gerard, F. & Staley, J. T. (2018). The influence of hedgerow structural condition on wildlife habitat provision in farmed landscapes. Biol. Conserv. 220, 122–131.

provisions pollinators[38]. This can increase the value of 100 strawberries by around €6. In Californian oil seed rape, pollinator numbers are boosted by hedgerows as much as 200 m into the crop. The benefits that hedgerows confer to a crop depends on whether a crop is pollinator limited. Pollinator limitation means that providing extra pollen will actually boost fruit yield. In crops that are not pollinator limited, this extra pollen makes little difference. In the UK, pollinator limitation is most strongly indicated in apples, broad beans and oilseed rape so hedgerow planting could be prioritised next to these crops.

Often the flowering understory of a hedgerow is of equal or more use to pollinators than the hedgerow and land managers should not neglect this associated feature of hedgerows[39].

In the context of agricultural pest control, hedgerows and their herbaceous understory provide microclimates for overwintering of beneficial insects and food resources for adult and juvenile beneficial insects[40]. A meta-analysis of 18 studies across North America and Europe suggests that the presence of flower strips improved pest control by 16%, while landscapes with 9% or more of non-crop habitat was found to support enough ladybirds to control aphid infestations[41, 42]. Not all hedgerows are equal, however, and it is likely that the way hedgerow are managed will impact their ability to harbour pest natural enemies[43].

Biodiversity impacts of a 40% expanded hedgerow

We considered what the impacts of a 40% increase in the UK hedgerow network would have for biodiversity. It was concluded that the expanded network would boost biodiversity through improving habitat connectivity and dispersal corridors for organisms contained in high quality habitat patches such as woodland[44].

The provision of extra habitat would also boost biodiversity. A new mathematical model predicted that the earthworms at Elm Farm in Berkshire would increase in local abundance (under the hedgerows) by around 17% as a result of a 40% increase

[38] Castle, D., Grass, I. & Westphal, C. (2019). Fruit quantity and quality of strawberries benefit from enhanced pollinator abundance at hedgerows in agricultural landscapes. Agric. Ecosyst. Environ. 275, 14–22.
[39] Staton, T., Walters, R., Smith, J., Breeze, T. & Girling, R. (2021). Management to Promote Flowering Understoreys Benefits Natural Enemy Diversity, Aphid Suppression and Income in an Agroforestry System. Agronomy 11, 651.
[40] Wolton, R., Pollard, K., Goodwin, A. & Norton, L. (2014). Regulatory services delivered by hedges: The evidence base. Defra Rep. LM0106. Retrieved from https://randd.defra.gov.uk/.
[41] Albrecht, M. et al. (2020). The effectiveness of flower strips and hedgerows on pest control, pollination services and crop yield: a quantitative synthesis. Ecol. Lett. 23, 1488–1498.
[42] Bianchi, F. J. J. A. & Van der Werf, W. (2003). The effect of the area and configuration of hibernation sites on the control of aphids by Coccinella septempunctata (Coleoptera: Coccinellidae) in agricultural landscapes: a simulation study. Environ. Entomol. 32, 1290–1304.
[43] Theves, F. & Zebitz, C. P. W. (2012). Biodiversity of carabid beetles (Carabidae) in field hedgerows-alternative approaches. Mitteilungen der Dtsch. Gesellschaft für Allg. Und Angew. Entomol. 18, 173–176.
[44] Davies, Z. G. & Pullin, A. S. (2007). Are hedgerows effective corridors between fragments of woodland habitat? An evidence-based approach. Landsc. Ecol. 22, 333–351.

in hedgerows[45]. Pipistrelle bats (*P. pipistrellus*) in the vicinity of hedgerows would be likely to increase by roughly the same 17%[46]. The hedgerow-associated population of Lycosid spiders in southern England would be around 35% more abundant and the number of bees would expand by about 5%[47].

Economic impacts of a 40% expanded hedgerow through improved biodiversity

We also demonstrated that the strategic planting of appropriately managed hedgerow next to pollen limited crops such as apples, oilseed rape, and broad beans could generate £1.73 for every £1 spent in hedgerow planting and management. This was due to reduced pest management costs and improved yield through pollination services.

3.6 Database and visualisation

An Excel database of NCA data, including indicative targets for hedgerow action, accompanies this report. Annex 1 also includes key data for each NCA.

To complement this report an interactive online tool was developed to provide access to the data and maps generated (**Figure 22**). This provides a visual guide to understanding where areas of opportunity and priority are located and how planting schemes can be targeted to maximise their influence. The tool can be accessed by going to https://orgrescent.github.io/NCA-map.

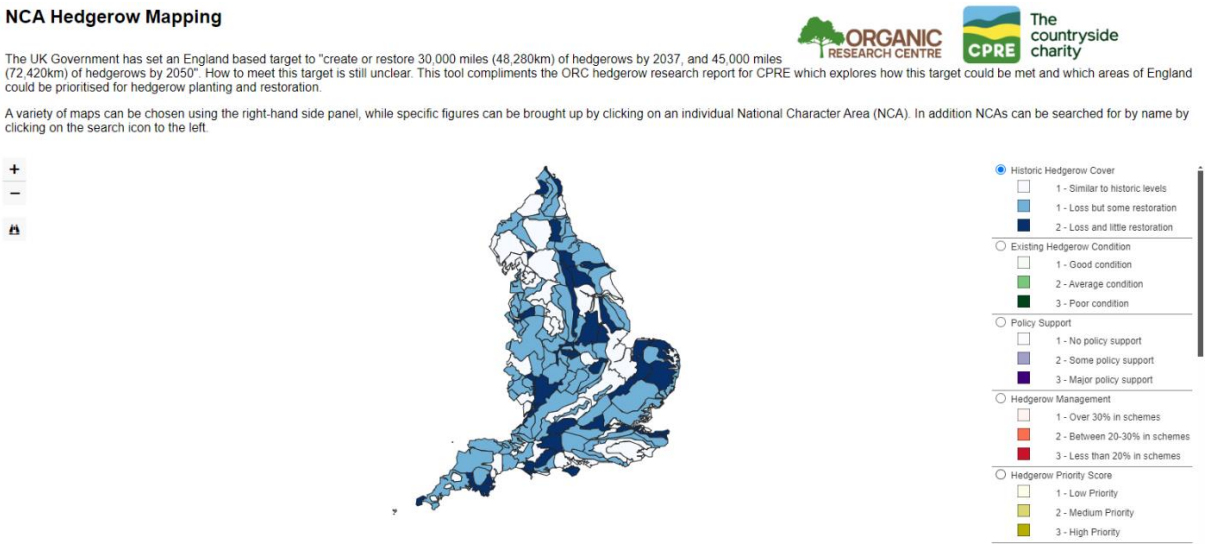


Figure 22. Screenshot of the online tool.

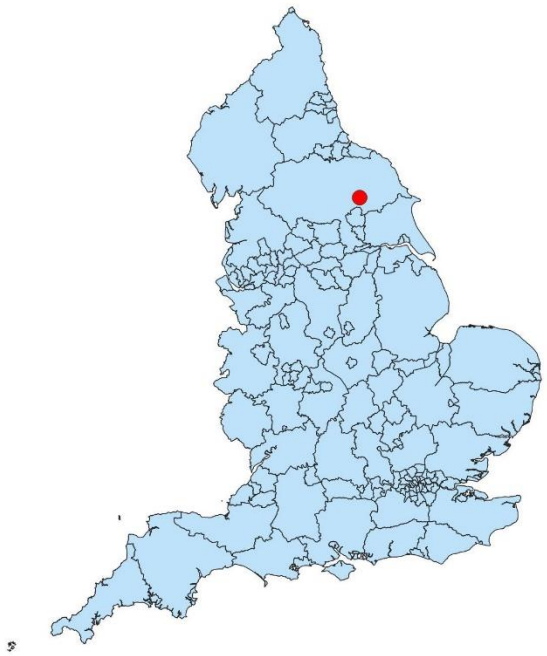
[45] Westaway, S. & Smith, J. (2020). Elm Farm: integrating productive trees and hedges into a lowland livestock farm.
[46] Westaway, S. & Smith, J. (2020). Elm Farm: integrating productive trees and hedges into a lowland livestock farm.
[47] Garratt, M. P. D., Senapathi, D., Coston, D. J., Mortimer, S. R. & Potts, S. G. (2017). The benefits of hedgerows for pollinators and natural enemies depends on hedge quality and landscape context. Agric. Ecosyst. Environ. 247, 363–370.

4. Case studies

Case study 1: Agricultural hedgerow expansion and historic hedgerow maintenance in the Howardian Hills, North Yorkshire

Summary

Two farmers describe their experience of hedgerow creation and maintenance in the Howardian Hills National Landscape. Hedgerow planting in National Landscapes (formerly AONBs) entails special responsibilities such as restoring hedgerows along traditional lines but also brings with it special sources of expertise and funding, such as Farming in Protected Landscapes (FiPL). The farmers interviewed are planting hedgerows to create new rotational grazing paddocks and maintaining traditional hedgerows for nature benefits using Countryside Stewardship funding. These farmers feel well served by current government funding but feel frustrated by the "culture of neatness" surrounding hedgerows in their region where farmers tend to keep hedgerows short and neat.



National Character Area (NCA) Context

The Howardian Hills are often described as "tranquil". Three-quarters of the NCA are within the Howardian Hills National Landscape and the NCA has very low levels of light/noise intrusion. There is only one major road in the NCA and the rest of the area is serviced by a network of minor roads, reflecting a very low (<1% by area) level of urbanisation. Around 82% of the NCA is cultivated, with arable cropping predominant and pockets of pastures on steeper slopes and on the damper valley floors. The NCA has a relatively high woodland cover (15%), with some ancient woodland, often within historic designed parkland associated with large country houses such as Castle Howard.

Most of the hedgerows in the Howardian Hills were established during 17th to 19th century enclosures to produce the relatively small rectangular fields that are characteristic of the area. The Howardian Hills NCA is one of a cluster also including Vale of Pickering, Yorkshire Wolds, and Vale of York. These surrounding NCAs have a high hedgerow priority score, while the Howardian Hills itself scores a mid-range 2 for prioritisation. The following account describes some of the issues and opportunities

associated with hedgerow planting and maintenance in such high potential areas.

Fraser Hugill and Rosy Eaton, Throstle Nest Farm, North Yorkshire

Description of Activity

Fraser and Rosy maintain 6000 m of native mixed species hedgerow under Countryside Stewardship (BE3) on their 177 acre (72 ha) mixed pedigree beef shorthorn and arable farm. Throstle Nest Farm is unusual in that almost all hedgerows and many trees remain in situ as they were in the 1800s (**Figure 23**). This integrity of the hedgerow network attracted Fraser and Rosy to the farm when they took it over in 2012.

Throstle Farm is an excellent example of what can be achieved with a sensitively managed regular trimming regime. Hedges are cut on a 3–4-year rotation with a finger bar and some of the cuttings are left to decompose at the side of the hedgerows to provide structure and microclimates and to feed organisms that depend on decaying wood. Using this management regime large hedgerows of around 5 m width and height can be maintained at their maximum extent (**Figure 24**).

Figure 23. Trees and hedgerows at Throstle Farm in the 1800s and now. Little has changed.

Motivations/Values

While Fraser and Rosy appreciate the value of large hedgerows for animal shelter and welfare, their motivation is principally to promote nature and beneficial insects in particular. They are nature enthusiasts and Fraser is the Yorkshire representative for FWAG (Farm and Wildlife Advisory Group) association. The long cutting cycle ensures several years of flowering and fruiting in hedgerow species and a continuous supply of flowers across most of the growing season.

Enabling Factors and Legacy

Moving into a farm with an historically intact hedgerow network was clearly a huge enabling factor. They have only had to replace 300 m of hedgerows since moving to the farm in 2012. Countryside Stewardship has enabled Fraser and Rosy to spend time managing their hedgerows.

Figure 24. A hedgerow at Throstle farm cut on a four-year cycle and near its full extent.

Challenges/Solutions for success

Fraser and Rosy stress that there are cultural barriers to maintaining nature friendly hedgerows. The "good farmer" is expected to keep his/her hedgerows tightly flailed and "neat" through yearly cutting. Contractors also conform to this ideal of small, neat hedgerows, even if advised by farmers to maintain hedgerows in a different way. For this reason, Fraser and Rosy maintain their hedgerows themselves, which takes time. Their land is wet and cutting with heavy machinery can churn up the land around the hedgerows.

Richard McLane, Lodge Field Farm, North Yorkshire

Description of Activity

Richard McLane is helping his parents at Lodge Field Farm replace historical hedgerows that were removed decades ago when this was incentivised. They will eventually have around 5 km of hedgerows with half of that being new hedgerows and the other half being restored through laying and gapping up (**Figure 25**). They are planting around 500 m of new hedgerow each year with a focus on hawthorn and blackthorn with apple and oak hedgerow trees. Their most recent planting consists of 3 x 100 m lengths splitting a large field into paddocks that they will use to rotationally graze their 80 dairy cross cows (**Figure 26**). They also plan to graze 40–50 sheep. These hedges are heavily guarded by fencing to protect the saplings from deer, rabbits and livestock.

Motivations/Values

Conservation and animal welfare are the principal motivators for hedgerow planting and restoration at Lodge Field Farm. Animals will be rotated on a 45-day cycle in the new paddocks and it is hoped this will reduce the need for worming using agrochemicals. The paddocks will allow the animals to stay out a further three weeks at the start and end of the outdoor season and the hedgerows will improve drainage of the paddock field.

Figure 25. Growth of new shoots from a traditionally laid hedgerow.

Enabling Factors

The McLanes found both the FIPL (Farming in Protected Landscapes) and Countryside Stewardship schemes to be fipladequate to cover all planting costs but they doubt funding is sufficient to attract other farmers who are less motivated by nature restoration. They also had an excellent nursery at Castle Howard that helped with the planting and erected the protective fencing round their paddock strips.

Challenges/Solutions for success

Lack of knowledge was an issue in the first instance. Richard learned how to lay hedges using both the Midland Bullock and Yorkshire styles. They also struggled to find labour to help with the extensive mulching and planting they did and were helped by volunteers. Generally, however, they felt that nothing substantial held them back and that they have been well served by the agricultural grant system. They advise other farmers that the infrastructure round hedgerows (mulch and fencing) need to go in first before the trees. A length of one paddock hedge where there was a gap in fencing was eaten away.

Nick Burrows, Farm Conservation Officer, Howardian Hills National Landscape

Figure 26. One of three new hedgerows at Lodge Field Farm, splitting a single field into a number of grazing paddocks. Note the heavy rabbit and deer fencing.

Nick has overseen both the hedgerow projects described here and others in the Howardian Hills. He emphasises that the FiPL scheme has been extremely enabling for hedgerow projects in the Howardian Hills, especially where the remit has been to restore historical hedgerows. Nick emphasises that hedgerow management is just as

important as new hedgerow planting and that there is much more "management" of hedgerows going on in the Howardian Hills than new planting. Severe flailing of hedgerows, while strictly speaking a "management" activity, is a problem. Nick states that hedgerows and other green infrastructure can help to improve mental health of local people. Plastic spiral trees guards are considered an issue because they crumble and produce microplastics as they age and many farmers are now turning to compostable guards. The general shrinkage of farm labour over the last few decades means that farmers don't have people to manage hedgerows sensitively and so they tend to use rapid but coarse flailing. There is also a need for more skilled hedgerow workers: people that know how to cut hedgerows sensitively and lay them.

Achievements

The farmers at Throstle Farm maintain a network of nature-friendly hedgerows that have been in place since at least the 1800s. 300 m of additional hedgerows have been planted since 2012.

The McLanes at Lodge Field Farm are planting and restoring historical hedgerows to aid conservation and provide new animal grazing areas that will allow them to reduce agrochemical use and improve soil properties.

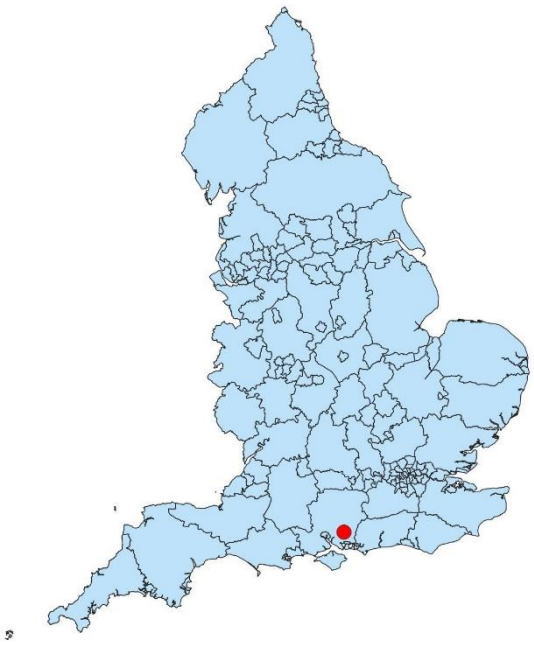
Conclusions and Messages for Policy

A general theme that emerges from this case study is that management of hedgerows is equally if not more important than new planting. There is a "culture of neatness" among farmers in the Howardian Hills that means hedgerows are maintained with little sensitivity to nature. Farmers need to be persuaded that larger, nature friendly hedgerows can be profitable, either through the provision of ecosystem services, or through higher subsidy payment rates for sensitive maintenance so that hedges can "turn a profit".

Case study 2: Hampshire hedgerows

Summary

In the third phase of the Hedgerow Heroes project CRPE Hampshire is aiming to improve around 6 km of hedgerow in semi-rural landscape with the intention of linking up the South Downs and New Forest National Parks with a network of new, restored and managed hedgerows. The focus is on training volunteers, not just in hedgerow planting but other skills such as biodiversity surveying. The project has benefitted from a dedicated project officer and also focuses on long-term maintenance of new hedgerows.



National Character Area (NCA) context

The South Hampshire Lowlands NCA lies between the South Downs to the east and the New Forest to the west. Dominated by the city and port of Southampton, its more rural areas are a mixture of woodland and farmland, mostly pasture. Woodland cover is 18%, half of which is ancient as a legacy of old royal forest status. Protecting, managing and enhancing this wooded character – including through hedgerows – is a key Statement of Environmental Opportunity. This is particularly important in the context of strong local development pressures. The NCA is known for its enclosed field pattern with many small and irregular fields bounded by mixed-species hedgerows or woodland. Oak trees are prevalent in the hedgerows enhancing the wooded character.

Many benefits of restoring the existing hedgerow network and strengthening it through new planting are recognised in the NCA profile. These include biomass provision, linking and strengthening habitats for wildlife, and improving recreational opportunities and sense of place. Preserving the tranquillity of the NCA by buffering major roads with hedgerows is also recognised, as is encouraging the use of wide buffer strips and planting of hedgerows to prevent or reduce run-off. Hedgerows may also improve water quality by reducing the amount of nutrients and silts entering watercourses. Pollination services and natural pest control are further enhancements achieved through a healthier hedgerow network.

Description of activity

The Hampshire Hedges project represents the third phase of hedgerow action spearheaded by CPRE in the county. The Hedgerow Heroes phase 1 project focused on Meyrick Estate in the New Forest (NCA131) and involved planting and laying of hedges, as well as surveying birds, bats, bumblebees, butterflies and soils. The landowner wanted smaller fields and old maps were used to identify historic hedge lines for planting and restoration.

In Phase 2 Hampshire County Farms became involved. There are 33 such farms in the county and two of these on the coast at Fareham (South Coast Plain NCA, 126) was the focus of activity. Volunteers were recruited and trained for surveying, laying and planting hedges. Planting activities involved a wider group of volunteers. Some hazel dormouse surveying was undertaken using footprint tunnels with training given by the People's Trust for Endangered Species (PTES). A number of additional elements were introduced in this phase:

- a community hedge fund pot was created – people could apply for small grants covering the costs of the tree whips, guards and/or for a professional hedge

layer to lay a hedge or train others to do so;

- traineeships – three young people were trained for three months full time to operate chain saws and use PPE. This was supported by a Lantra accredited assessment;
- on-line talks, school visits, and planting on school grounds. Working with three schools, curriculum complementing lessons were given for reception to yr. 6 children;
- 2-day hedge laying courses were offered to a group of seven farmers.

Building on the above, the Hampshire Hedges project was launched in 2023 with the ambitious aim of connecting the South Downs and New Forest National Parks with a stronger network of hedgerows. It again includes many different elements to involve a broad range of actors pulling together towards this aim:

- planting with volunteers on weekly planting days (box 3) and additional weekend days;
- organised planting events with scout groups (very popular) and schools;
- on-line talks and community days;
- three traineeships – each 5 months long;
- wildlife surveys.

A strong emphasis of this project is improving hedgerow management, achieved through training landowners in management and survey. With hedge laying, there is a greater focus on training land managing organisations such as the National Park staff, Sparsholt College, County Councils, Forestry England, and wildlife charities. One-day courses are being organised for the general public.

Motivations/values

The overall objective of The Hampshire Hedge is to link up the South Downs and New Forest National Parks with a network of new, restored and managed hedgerows: nature recovery through increased connectivity. This vision provides something palpable and attractive for public and funding support, with more benefit for overall countryside connectivity and wildlife than specific ecological gains from linking up the protected areas – given that they are so different. Stakeholders of the project will have varied personal motivations that nest within this ambition. For farmers, there can be cost savings by managing hedgerows better for wildlife, for example flailing less often. “Keeping up appearances” can be an important to them, however, and this can be a barrier to achieving hedgerows in favourable ecological condition. There are signs that this is breaking down, with farmers being encouraged to restrict their most intensive management of their hedges to the visible, external facing (e.g. roadside) sides.

Box 3

Volunteer planting day at Itchen Farm, 7 December 2023

Some 12 volunteers joined the Hampshire Hedge project office and CPRE volunteers at this County Farm overlooking the M3 and Hockley Railway viaduct. This was the third of a series of weekly planting days run for volunteers. During the course of the day a field boundary of 200 m was planted up, using tree whips from a nursery in the South Downs. The tree stock was 70% thorns (hawthorn, blackthorn, wild rose) and 30% native broadleaf such as field maple, dogwood and hazel. They were planted in a zig-zag arrangement with about one foot between trees of the same species. Thorns were placed preferentially in the row facing the field. Planting involved creating a slit with a narrow spade, feeding in the roots of the whip into that slit, making sure no roots were exposed, firming in with sole or heel of boot, placing a bamboo cane next to the whip (not in the slit) and then feeding a biodegradable spiral protector over the cane and whip or else wrapping it round from the bottom (necessary for the blackthorn whips which had larger branches that were easily snapped off with the first method).

Most of the volunteers were retired. Two worked for Hampshire Countryside Services and usually did coppicing work. Another signed up to receive a CPRE newsletter at a volunteer fair and heard about the planting day through that.

Enabling factors

Funding for The Hampshire Hedge project comes from multiple sources: CPRE national office through the Hedgerow Hero programme, the National Lottery and a foundation trust.

The Community Hedge Fund launched as part of the Phase 2 Hedgerow Hero project and was considered really successful in reaching a much wider audience and range of actors.

Challenges/Solutions for success

The long-term nature of CPRE's work in the county allows a high degree of learning-by-doing and adapting the programme along the way to achieve higher cost efficiency, better focus, and more achievement. For example, the hedgerow planting was contracted in Phase 1 but it was decided that volunteers could effectively do this work in Phase 2. A group of 12 dedicated volunteers were trained not just in planting and laying but also in biodiversity surveys. Bat and bird surveys and soil sampling were discontinued after Phase 1, as they were considered less useful to the aims of the project.

Achievements

In Phase 1 of the Hedgerows Heroes project, 1.7 km of hedgerow was created and 1.3 km restored through hedge laying and gapping-up. Twenty-six days of volunteer planting were undertaken, involving 85 volunteers.

In the second phase, 3.3 km of hedgerow was planted; over 1 km through the Community Hedge Fund projects; and 2.3 km on a County Farm. 4.3 km of hedgerow was laid from a combination of hedge laying training sessions, Community Hedge Fund projects and three hedge laying traineeships.

The aim of The Hampshire Hedge project is to lay 800 m of existing hedgerow in the project area in 2023/24 and plant 5 km of new hedgerow in the project area. The three planting days held in November/December yielded about 400 m of hedgerow creation.

Conclusions and messages for policy

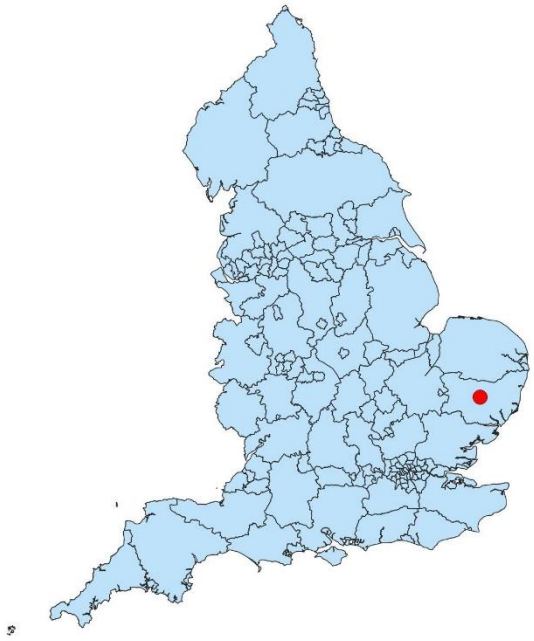
The Hampshire Hedge is an example of what can be achieved through a determined and skilled full-time project officer and the support (funding, a steering group) to mobilise different sectors of the population though a varied range of activities. The limited time of just one project officer is likely the main bottle neck to achieving even more. Sitting outside the National Parks, resources and support from these protected areas is limited.

Projects such as The Hampshire Hedge provide optimism that the national target can be delivered but beyond quantity of restored and created hedgerow, the quality and longevity is also critical: planting the right trees in the right places and ensuring their survival through appropriate aftercare (mulching, watering, management). Have the resources and know-how for this been properly considered in the delivery of hedgerows policies such as CS and SFI actions?

Case study 3: Utilising the existing Stour Valley Farming Cluster in Suffolk for hedgerow planting and restoration schemes

Summary

Many hedgerow planting schemes focus largely on the funds available, however the importance of trust, lack of administrative burden, and community are highlighted in this case study which is operated through the Stour Valley Farming Cluster in Suffolk and is funded by CPRE. Two participating farmers were interviewed to discuss their experiences of the scheme, along with the central organiser at the farming cluster.



National Character Area (NCA) Context

The majority of the farms in the farming cluster sit within the South Suffolk and North Essex Clayland NCA. Despite containing Stansted airport and the M11, the landscape is dominated by rural scenes. The countryside is marked by ancient hedgerows and woodlands that define the Constable country style and form the core of the Dedham Vale National Landscape that runs through the NCA. Farms across the NCA tend to average about 100 hectares, although this varies and smaller sized farms are particularly common within the Dedham Vale National Landscape.

Around two percent of the existing landscape is covered by hedgerows, however this value would have been higher prior to agricultural expansion after the second world war. This loss of a defining characteristic in the landscape has been recognised by local authorities, as restoration and replanting of hedgerows is widely supported in the Statements of Environmental Opportunity for the NCA. Given the dominance of arable farming in the region, soil erosion is a challenge highlighted in the NCA profile and this is an issue which hedgerows can help address.

Ben Morris, Parrington's Farm

Description of Activity

Ben has planted and restored 1 km of hedgerow on his family farm in Essex using native species. In 2022/23, 200 m of planting was carried out in response to the loss of some existing hedgerows and scrubland from crop residue fires. Where existing hedgerow was damaged by the fire but survived, a coppicing programme has been put in place to support regeneration. An additional 200 m of new hedgerow was also planted on scrubland. In the 2023/24 season there will also be an additional 200 m of planting to gap up hedges, adding up to 600 m of planting in total across the farm. The farm has a mix of arable and livestock.

Motivations/Values

Ben and his brothers took on the family farm from their parents. His mother in particular had a keen eye for hedgerow planting and many of the existing hedgerows stem from her actions. This legacy is one of the key motivations for planting and restoring the hedgerows. Given his background in urban/suburban river conservation, Ben already has an interest in wildlife and the hedgerow scheme offers a new area of learning in which he can expand his conservation skillset. In addition, a local wildlife photographer frequently visits the farm and so they also benefit from the boost in biodiversity provided by the hedgerows, as do local walkers and travellers from further afield who follow the Essex Way which passes by the farm.

Figure 27. Two schemes working together. Woodland planting (left) with hedgerow planting (right).

Tom Dobell, Garnons Farm

Description of Activity

Tom has so far planted a total of 1.9 km and plans an additional 1 km, totalling 3 km of hedgerow across the 187 ha farm. This planting has worked in tandem with other planting schemes, notably 3,600 trees planted in woodland blocks through the Forestry Commission (**Figure 27**). Once again, traditional native species have been used, with the majority being hawthorn and blackthorn, although certain areas have specific species planted, such as in the alder wet woodland. The farm system is mixed arable and livestock.

Motivations/Values

At Garnons farm the picturesque surroundings are vital to the local economy, bringing in numerous walkers along the Stour Valley Path. Enhancing the landscape and creating a traditional feel to the farm is an important driver for Tom. In addition, this style of planting also allows for exploration of income diversification, such as through growing willow which is then sold for making cricket bats. This is becoming increasingly important with the phase-out of the Basic Payments Scheme, meaning many farmers will lose significant amounts of subsidy if they don't take up the incoming Environment Land Management Scheme (ELMS) offers. Hedgerow and tree planting can not only provide alternative incomes, but also meet requirements to qualify for some of these newer schemes.

More widely, the use of hedgerows to provide a community benefit for walkers is a priority, especially considering the network of participating farms within the farming cluster are situated along the Stour Valley Path. This creates a landscape-wide impact,

not just for walkers but also for biodiversity through greater connectivity and semi-natural habitat provision.

Enabling factors

Both farmers agreed that the main enabling factor has been the Stour Valley Farming Cluster itself. Having a central individual whom they trust and can handle the administration has been a welcome relief for them. Furthermore, the use of volunteers to develop and carry out hedgerow surveys for each participating farm provides the farmers with a ready-made report on their existing hedgerow network and areas of opportunity (**Figure 28**).

Funding from CPRE through the farm cluster was useful for Ben in convincing his brothers that the hedgerow planting was viable. Tom, meanwhile, found the funding only covered about 2/3 of the total costs. Despite this shortfall (~£13 per m offered from the CPRE funding compared to the Countryside Stewardship scheme's ~£23 per m), the benefits of working within the farming cluster with a scheme that has significantly less administration makes it a more attractive option.

Figure 28. An example of an opportunity map produced by the volunteers carrying out hedgerow surveys.

Challenges/Solutions for success

Both Ben and Tom were fortunate that the summer of 2023 was wet, removing the requirement for watering that otherwise would have been a major challenge and cost. While Ben has only used rabbit spirals and spraying to manage deer and weeds, these pose a larger challenge for Tom who has required stock-proof heavy duty fencing to try to protect the young trees (**Figure 29**). This, however, has a knock-on effect of allowing the undergrowth to grow without browsing, potentially swamping the young trees.

Tom has invested in a quadbike to make accessing hedgerows on the farm easier to reduce the burden of hedgerow management. The lack of longer-term funding for hedgerow management means that many farmers don't look after the young trees and allow them to be swamped by bramble and nettles. Access to the quadbike makes travelling to and from the hedges with equipment easy and thus increases the likelihood of managing the young hedgerows successfully. This type of support for longer-term management is rarely included in existing hedgerow schemes but providing alternative support such as equipment purchase could be a suitable route to explore in future.

Achievements

In 2022 and 2023, hedgerow projects undertaken in collaboration with Stour Valley Farming Cluster planted a total of 7.65 km of hedgerows, gapped up 1.18 km, coppiced 2 km, and laid 1 km. In 2024 around 1.6 km of new hedgerow was planted and there are plans to restore 500 m, coppice 2.21 km, and lay 300 m.

Volunteers continue to be important in producing hedgerow surveys, walking over 46 km in the summers of 2021 and 2022 to produce the initial surveys from which subsequent plantings have been based.

Conclusions and messages for policy

This case study represents how important factors other than financial support are for ensuring a successful planting scheme with a large uptake. Reducing the amount of administration, having someone well known and trusted by the farmers to organise the scheme, enabling the ongoing management of hedgerows, and offering the resources for support and guidance when required, are all important

Figure 29. Robust fencing required to protect the young trees from deer and livestock.

Farming clusters inherently lend themselves to achieving these goals. As well as allowing individuals to apply for schemes, the use of a trusted farming cluster representative can make such schemes easier for all and develop landscape-wide hedgerow action. As in this case study, the cluster representative can be funded out of the total budget. While this may reduce what can be spent per farm-level project, feedback from the farmers suggests that this is a desirable trade-off.

It can take several years for a farming cluster to bond and trusting relationships to be formed, however, there are around 120 farming clusters across the UK which have

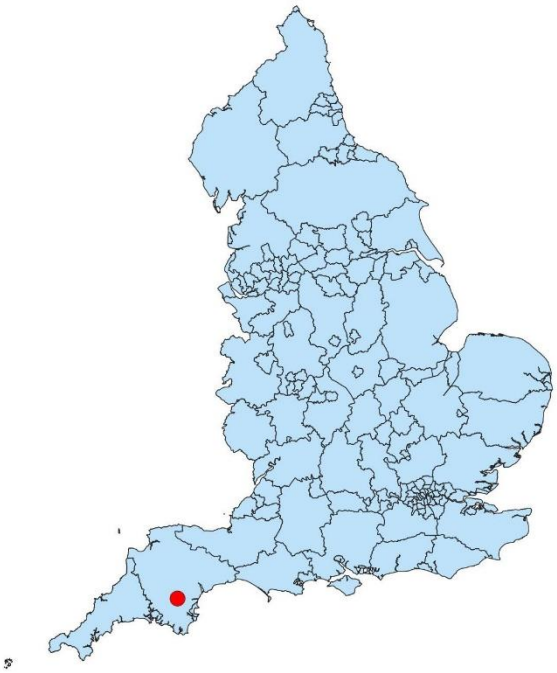
been established for at least 7 years. Utilising these communities will be important in accelerating the expansion of the hedgerow network and achieve the national target.

Case study 4: Hedgerow action in South Devon through Farming in Protected Landscapes (FiPL) and Higher Tier Stewardship funding mechanisms

Summary

The potential of Government funding schemes for hedgerow creation and restoration is explored through the example of South Devon, a region renowned for its species-rich hedgebanks but one where this resource has been in decline for many years. The experience of two farmers receiving hedgerow planting grants through Farming in Protected Landscapes, and an ambitious project of the National Trust funded through Higher Tier Stewardship (Countryside Stewardship), is explored.

National Character Area (NCA) Context



NCA 151: South Devon is a rural area dominated by mixed farming and with many steep valleys and rivers dissecting its landscape. Characteristic Devon banked hedges (earth banks, often faced with stone, topped with bushy shrubs and trees) and narrow winding lanes flank the fields (**Figure 30**). Statement of Environmental Opportunity (SEO) 2 for this NCA includes the ambition to increase the connectivity of habitats by expanding and enhancing the network of traditional, floristically diverse hedgebanks. These provide a stronghold for important, rare species, such as cirl bunting, and foraging grounds for greater horseshoe bats. However, many of these hedgebanks have been lost over time, especially in the 1990s, and many of those that remain are subject to neglect and deterioration.

A key priority in this NCA is to plant new hedgerows, particularly to replace previously removed hedgerows, and in this way restore the historic pattern of the landscape. As well as supporting biodiversity recovery, other ecosystem benefits include soil conservation (by impeding cross land flows) and soil water quality (by reducing sedimentation and nutrient loading of water courses), regulating water flow to reduce flood risk, pollination services and enhancing sense of place and inspiration.

Figure 30. Typical hedgebank flanking a farm lane.

The Farming in Protected Landscapes (FiPL) programme for the South Devon National Landscape is administered by the National Landscape authority and its Farming in Protected Landscapes Officer. Two case examples of grant recipients and their experience are described here.

Woodhouse Farm, West Alvington

Description of Activity

David and Caroline Horton have created 110 m of hedgebank to high specification, planted with a mixture of species: beech, oak, hazel, holly, blackthorn, hawthorn, and a few specimen trees of Lombardy poplar (**Figure 31**). 265 saplings along the hedgebank were counted. The bank was created with material from digging out a ditch to its side. The sides of the bank were turfed and there is also stock fencing for protection. Two adjacent ponds were created when material was removed to create a level profile elsewhere on the farm.

Motivations/Values

The motivation for the project was awareness of the historic loss of hedgerows and desire to put something back. The example of one field that used to be eight different ones was given. Additional reasons for hedgebank creation were to: drain the boggy field so that the cattle don't stand in water and poach the field; create a paddock for the lambs, offering protection from members of the public with dogs; create a barrier to prevent people straying from the public footpath; in the long term, create shelter benefits for livestock; and create an ecological corridor, encouraging birds,

Figure 31. Newly created hedgebank at Woodhouse Farm.

including cirl bunting and yellowhammers seen on the farm.

Higher South Down Farm, South Milton

Description of Activity

Phil Rogers has created 180 m of hedgebank and restored 110 m (**Figure 32**). Planting was in March of 2023. Bank creation used material from digging out a pond and then it took 3–4 people one day to plant the 180 m.

Native Farm Hedging Mix from Mill Farm Trees, suitable for Stewardship BN11 planting, was used and contained a mixture of 65% hawthorn and at least five other native species, to create a traditional farm hedge. (The other five variable species are usually made up of mixes of blackthorn, field maple, dogwood, crab apple, guelder-rose, dog-rose and hazel.) These bare root plants are available from November to April.

Figure 32. New hedgebank at Higher South Down Farm.

1250 plants were ordered and the density of the planting was 6/m. No spiral guards were used as they would blow away in the exposed coastal situation. As a result, the trees were barely visible among the growth of rank grass and weeds on the top of the bank. The FiPL grant covered everything except the time of the farmer.

Motivations/Values

The project was the farmer's own concept. Farming between 700 and 800 cattle on 250 acres at South Milton, the principal objective was to benefit the livestock. The farmer was also aware of the ecological benefits, linking up existing hedges to make a better network.

Enabling factors and Challenges/Solutions for success

The projects at Woodhouse and Higher South Down Farms originated as a result of the recommendation of the local Catchment Sensitive Area (CSA) Officer to get in touch with the AONB (now National Landscape) specialist advisor and find out about the FiPL funding. The farmers have been encouraging others to follow their example. Passers-by have shown interest in the projects, so encouraging community involvement.

South Down Farm near Malborough

Description of Activity

This Farm is part of South Devon National Trust's Salcombe Project and action was funded through a Stewardship Higher Tier grant in 2020 and managed by the Acting

Lead Ranger.

Planted over two winters, a total of 1 km of new hedgebank was created on the boundary of a field, and as parallel lines across it to break the field into smaller ones (**Figure 33**). The planting was in the position of historic hedgebanks. Mostly blackthorn and hawthorn were planted, but a coastal hedgerow pack with salt resistant species including, hazel, guelder-rose, wild privet and dogwood was available. The tree stock was from a plant nursery that has subsequently ceased operating. Alternatives sources of hedge plants are available for the future.

Figure 33. New hedgebank on National Trust estate at South Down Farm.

Planting density was at 8+/m in staggered rows. Spiral guards offered protection and their greenhouse effect was considered to help growth (**Figure 34**). The fact that some of the saplings were lacking this protection perhaps suggested the windswept conditions of the site.

The banks themselves were made from the silt of two silted-up ponds plus scrapings from the arable fields. These fields grow sacrificial crops to create stubble for the birds, so the loss of nutrient rich soil was not a problem.

Figure 34. Detail of the new hedge plants at South Down Farm.

Survival rate was high but in places mortality was up to 20% and replacement planting (beating up) was required. Watering was required just once.

In addition to the hedgebanks, two lines of hedgerow without banking, one beside a bridleway, had been established, and a 200 m gap in a nearby hedgerow had been filled with new planting.

In terms of the longer-term management regime, the hedges are generally slow growing and are not flailed at South Down Farm. They can get leggy, however, and the plan is to have a rotation of laying and coppicing to rejuvenate hedges.

Motivations/Values

The farm's management is balanced for nature, food production and public access through the Land, Outdoors & Nature programme of the National Trust. The main

recognised value of the project was creating ecological corridors and habitat improvement for birds such as cirl bunting.

Enabling factors and Challenges/Solutions for success

There is the intention to do more hedgerow creation on farms to the east and west of South Down Farm. In the west these are grazing lands so there isn't a ready source of local material for the bank creation and the hedges will need to be flat to the ground and protected with double fencing lines.

It is recognised that the creation of new hedgebanks across a field will create inefficiency in the arable operation. At South Down Farm this was somewhat reduced by creating wide gaps (headland) at the ends of the hedgebanks for the farm machinery to pass through easily.

The requirement for material for the banks was satisfied by scraping the field, an option that won't be advisable for most farmers. Indeed, future hedgerow creation on the National Trust estate will likely be without banking because of this lack of available earth material. There was a good contractor who produced a solid, consolidated bank – erosion was avoided and the bank soon greened up.

The National Trust benefit from a volunteer workforce. The labour requirement would be difficult for some private landowners.

Achievements of Statutory Funding in South Hams

Six FiPL funded projects in South Hams have between them created 1470 m of hedgebank. The largest project, on a 5000 acre estate, created 630 m, whilst the others created 100–200 m each. This is within one National Landscape alone. Across five Devon National Landscapes the FiPL funding programme has achieved in years 1 and 2 the creation of 7.6 km of new hedgebank or hedgerow, and management of 19 km.

As another snapshot of what government funding can achieve, the South Devon NCA database notes that, in March 2011, 1,478 km of hedgerows, 155 km of earthbanks and 75 km of stone-faced earthbanks were managed by land managers under Environmental Stewardship.

Conclusions and Messages for Policy

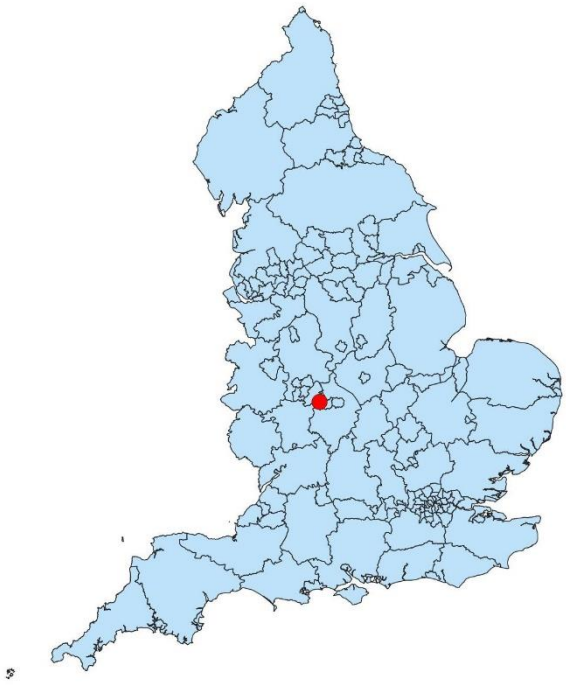
Government funding for hedgerow creation and restoration is a vital factor in being able to achieve its national targets. This case study shows its influence in one locality, with examples of landowners enthusiastically taking up this support. A knowledgeable project officer was important for the achievement of the outcomes, an important consideration for the ELMS Sustainable Farming Incentive hedgerow grants which won't, in general, be accompanied by advisory support.

Certain regions may have structural challenges with regard to contributing to the hedgerow creation and restoration targets. In Devon, a specific practical challenge is that of provisioning the material to build the earthbanks. This was raised by two of the examples in this case study, although across Devon this does not appear to be hindering considerable progress in new bank creation in both pasture and arable land.

Case study 5: Hedgerows in a semi-urban context – Solihull

Summary

Hedgerows can improve environmental quality and human wellbeing in urban and semi-urban areas[48]. This case study explores the Arden Free Tree Scheme (AFTS) in Solihull, covering the successes, struggles, and adaptations that the scheme has had to go through over the past nine years. The information in this case study has been gathered from interviews with scheme organisers and a questionnaire sent out to the participants of the scheme.



National Character Area (NCA) Context

The AFTS is run by Solihull Metropolitan Borough Council and focuses on both the urban Solihull area and wider rural landscape within the Arden NCA. The NCA itself contains the majority of Birmingham city, Coventry, and Redditch. Major roads split the NCA, notably the M42, M6, and M40. Arden also contains the busy Birmingham Airport. Sprawled between these built-up areas is a designated greenbelt, largely consisting of open pasture and parkland landscapes (**Figure 35**). Currently only about 1.77% of the NCA is covered by hedgerows, however many of these mark historical boundaries and hark back to the heavily wooded landscape that used to dominate the NCA.

While many hedgerows are maintained in the rural landscape, the expansion of Birmingham, Coventry, and Redditch has impacted the green landscape in urban and semi-urban areas. This loss has been recognised by the local authorities whose primary aim in the Statement of Environmental Opportunity is to manage and enhance the woodland, hedgerows, and other key boundaries. Other aims are to increase the links between green infrastructure in urban areas and rural landscapes. One of the key reasons for placing such importance on these landscape features is the recognised ecosystem services they provide, most importantly climate regulation, soil quality, and soil erosion protection. Also of importance are wellbeing related services such as recreation, sense of place/inspiration, and tranquility; the latter being vital in a

[48] CPRE & ORC. (2021). Hedge Fund: Investing in hedgerows for climate, nature and the economy. https://www.cpre.org.uk/resources/hedge-fund-full-report/

landscape where 60% of the land is disturbed by noise, air, and visual pollution.

Description of Activity

The AFTS offers a range of pre-selected tree species packages that are tailored towards blending into and supporting the existing species in the landscape. Examples of packs available include multi or single species hedgerows, woodland creation, individual trees, fruit trees, and wet woodland/riparian species (**Figure 36**). Applicants submit a plan of proposed planting in autumn, which is reviewed. At this point the applications are split into those in urban areas and those in the surrounding agricultural landscape. If approved, trees are ordered and delivered to one of two central locations for collection.

Figure 35. Hedgerow planting on one of the farms through the Arden Free Tree Scheme. Photo used with permission from the Arden Free Tree Scheme.

The funding for this scheme, allowing it to provide trees and guards/stakes for free, stems from the expansion of Birmingham Airport. As a result of the creation of this new infrastructure the airport is contracted to offset their carbon emissions. Part of this offsetting is to provide an index linked budget to Solihull Metropolitan Borough Council allowing them to purchase trees and run the AFTS.

Motivations/Values

While the motivations of the funders may be primarily to offset carbon, the participants have a range of reasons for wanting to plant trees and hedges. A consistent theme across all scales of project is the desire to increase biodiversity and landscape connectivity, whether that means hedges between fields or housing estates. People in rural areas also cited benefits to their farms, including shelter for livestock, soil carbon storage, and erosion reduction. Semi-urban and urban applicants focused more on the human wellbeing and spiritual benefits of hedges, emphasising their attractiveness and impact on general enjoyment for local residents.

Hedgerow Pack with oak standard

Contains 50 trees for every 10 metre section.

Latin Name	Common Name	Size (height)	No.
Cornus sanguinea	Dogwood	(40-60cm)	6
Corylus avellana	Hazel	(40-60cm)	6
Viburnum opulus	Guelder Rose	(40-60cm)	2
Malus sylvestris	Crab apple	(40-60cm)	4
Rosa canina	Dog Rose	(40-60cm)	5
Crataegus monogyna	Common hawthorn	(40-60cm)	25
Quercus robur	English Oak	(80-120cm)	1

Accessories	size	No.
Bamboo canes	0.9m	50
Biodegradable spiral tree guards	0.6m	50
Buckle tree ties		1
Vole guards		1
Round tree stakes	1.2m	1

Hedgerow Pack without oak standard

Contains 50 trees for every 10 metre section.

Latin Name	Common Name	Size (height)	No.
Cornus sanguinea	Dogwood	(40-60cm)	6
Corylus avellana	Hazel	(40-60cm)	6
Viburnum opulus	Guelder Rose	(40-60cm)	3
Malus sylvestris	Crab apple	(40-60cm)	5
Rosa canina	Dog Rose	(40-60cm)	5
Crataegus monogyna	Common hawthorn	(40-60cm)	25

Accessories	size	No.
Bamboo canes	0.9m	50
Biodegradable spiral tree guards	0.6m	50

Thornless Hedgerow Pack

Contains 50 trees for every 10 metre section.

Latin Name	Common Name	Size (height)	No.
Cornus sanguinea	Dogwood	(40-60cm)	10
Corylus avellana	Hazel	(40-60cm)	10
Viburnum opulus	Guelder Rose	(40-60cm)	6
Malus sylvestris	Crab apple	(40-60cm)	6
Euonymus europaeus	Spindle	(40-60cm)	7
Acer campestre	Field maple	(40-60cm)	10
Quercus robur	English Oak	(80-120cm)	1

Accessories	size	No.
Bamboo canes	0.9m	49
Biodegradable spiral tree guards	0.6m	49
Buckle tree ties		1
Vole guards		1
Round tree stakes	1.2m	1

Single species Hedgerow Pack

Contains 50 trees for every 10 metre section.

Latin Name	Common Name	Size (height)	No.
Fagus sylvatica	Common Beech	(40-60cm)	50
Carpinus betulus	Hornbeam	(40-60cm)	50
Ilex aquifolium	Holly	(40-60cm)	50

Accessories	size	No.
Bamboo canes	0.9m	50
Biodegradable spiral tree guards	0.6m	50

Figure 36. Examples of hedgerow packs available from the Arden Free Tree Scheme. From the 2023/24 season.

Enabling Factors

Understandably, one of the major enabling factors is that the trees and associated guards/stakes are free. This had been particularly relevant for those on farms who have the capability to plant large stretches of hedges. In these scenarios the costs of trees and guards/stakes can become expensive and prohibitive to the planting process.

Other recipients also cited the advice offered as being important. The scheme provides one-to-one support for planning complex planting designs and all recipients receive general advice and guidance on how to plant and care for their trees. Long-term care of the trees is an important consideration for the carbon offsetting approach being taken, although the contractual agreement between the scheme and recipients doesn't stipulate the lifetime or other restrictions regarding the trees, simply stating that recipients agree to look after the maintain the trees.

While the delivery of trees to a central location poses challenges (see below), some recipients also cited the ease with which they were able to collect these as a key positive.

Challenges/Solutions for success

From an organisational perspective the scheme has had many challenges over the years. For the first few years the scheme only offered trees to those within Solihull's urban and semi-urban area. While there was some uptake, the limited size of land for each application meant that there were a large number of small-scale projects (**Figure 37**). This increased the administrative burden and represented a bottleneck to progress. To solve this a couple of steps were taken.

Figure 37. An example of smaller scale planting that contributed to the admin bottleneck. Photo used with permission from Arden Free Tree Scheme.

In 2019 the scheme was extended in partnership with Warwickshire Wildlife Trust to the wider Arden NCA, with particular focus on the Warwickshire farming clusters. This brought in larger projects where more trees could be planted with reduced administration overhead. This has also increased the total number of trees planted each year. In addition, the scheme originally had a simple checkbox system for indicating which species an applicant wanted. This made identifying the cost of individual projects difficult to assess as each set of trees had to be separately calculated and sent to the nursery for costing. To smooth this process the concept of packs was brought in. This allowed for the scheme organisers to have consistent costings from the nursery for each package. It also made keeping track of numbers of trees easier, particularly for the multi-species applications.

Solihull Council have undertaken a wide range of habitat and nature improvement projects across the borough between 2017 and 2023 with grant-funding from European Regional Development Fund (ERDF). During this time over 300 ha of woodland, grassland, wetland and water quality improvements have been completed and this now means that there are limited opportunities to further enhance Council-owned parks without impacting on other priority habitats such as species-rich grassland.

The funding from the airport will last an additional 11 years, after which another funding source will have to be identified. Due to the success of the scheme to date, a wide range of options are being explored to try and continue to scheme post-2034. Biodiversity Net Gain (BNG) is one option, however householder applications will be exempt from mandatory BNG. Ongoing maintenance costs would also have to be considered with any new planting, further complicating funding requirements.

Achievements

Since its inception the scheme has been increasingly successful (**Figure 38**). In 2022 a total length of 1740 m of hedgerow was planted across projects. Preliminary figures suggest that 1520 m will be planted this year. A wide range of applicants are also applying, in part due to the rural and urban nature of the scheme. When it comes to planting the trees there are numerous approaches, many of which involve the community. Corporate Social Responsibility days have been used, while a number of schools in the local area have ordered trees, adding an element of natural learning into an increasingly nature-sparse urban upbringing.

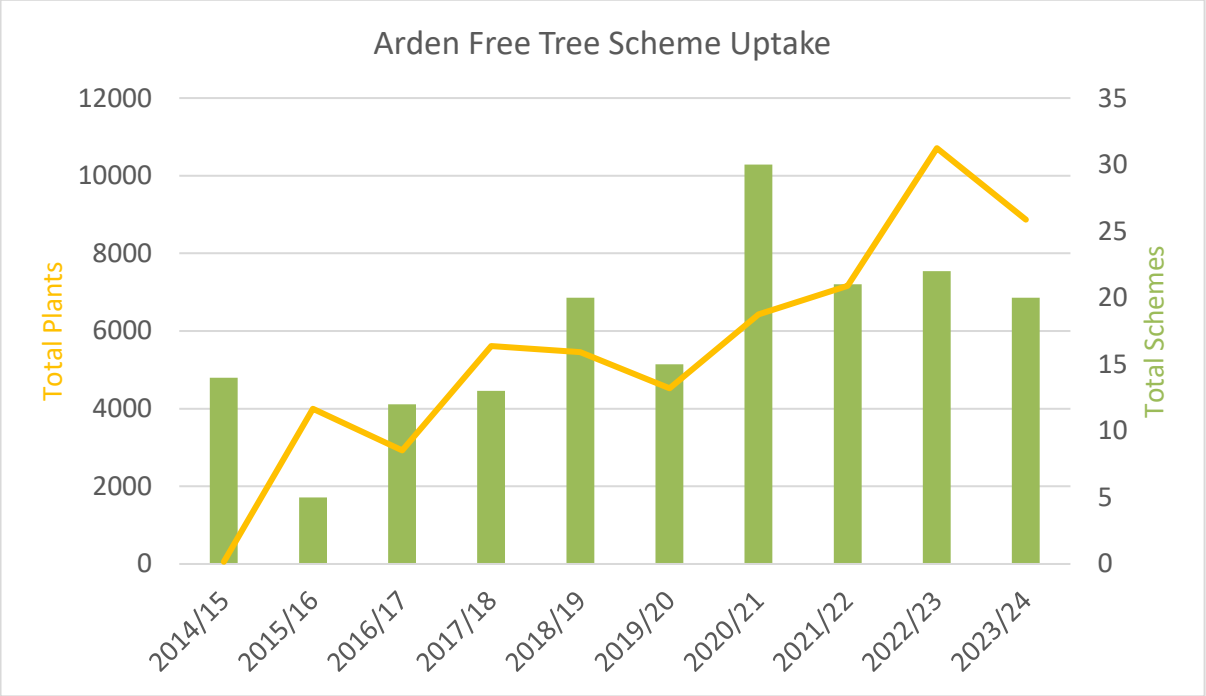


Figure 38. Total number of plants ordered (Orange line) and total number of schemes funded (green bars) per year by the Arden Free Tree Scheme. Data for 2023/24 are preliminary.

Conclusion and Messages for Policy

This scheme shows that while urban and semi-urban areas offer significant opportunities for hedgerow planting, there are unique challenges to delivering such a scheme. The appetite for this scheme from applicants is encouraging, but the administrative burden is of particular concern given the scale of individual projects. This is something that should be addressed in future urban hedgerow planting projects.

When recipients were asked about key messages that could be learnt from this scheme, they concluded that communication of schemes to local landowners, builders, and stakeholders has been poor. There was frustration that potentially suitable land was not being planted on due to a lack of awareness that schemes such as this are available. While the scheme organisers do act to spread the word through local magazines, social media, and community events, this work should be written into the budget and knowledge of such schemes shared with those who deal with planning applications and land ownership.

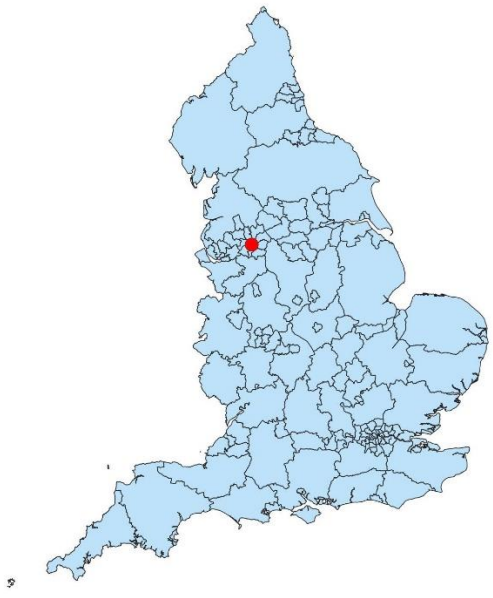
The scheme organisers recommend that the current way of setting tree and hedgerow planting targets should be addressed. Rather than stating a target and then trying to find ways to reach it, policy makers should first explore what opportunities exist for planting i.e. available land, funding sources, logistical challenges, then from this draw up a planting target. The development of new tools and apps, such as the tree equity score (https://www.treeequityscore.org/) should be used to aid this planning.

In addition, developing a national policy landscape where this type of scheme can operate without funding from new infrastructure offsetting will increase its relevance and applicability to other urban and semi-urban locations. For the near future, however, this scheme represents a unique way of increasing hedgerows in urban environments from which lessons can be learnt and achievements celebrated.

Case study 6: Multifunctional hedgerows for urban orchards in inner-city Manchester

Summary

The Orchard Project charity is creating new urban orchards with local volunteers in Manchester and other major cities in the UK. At their new orchard at East Road Park in the Longsight area of inner-city Manchester they are partly surrounding an orchard with very diverse fruit hedgerows for privacy and foraging. Consultation with the local community has been key in hedgerow design.



National Character Area (NCA) Context

The Longsight area of Manchester is contained within the Manchester Conurbation NCA. The NCA contains a number of river valleys forming important corridors of semi-natural habitats linking urban centres with open countryside, but the NCA is overwhelmingly urban, with 82% of its area in this classification.

The Manchester Conurbation NCA profile gives little profile to hedgerows and where they are mentioned it is in the context of the relatively small number of agricultural holdings in the NCA. Discussions with The Orchard Project officer for the East Road Park project indicates that hedgerows predominantly occur around houses; they can be found most extensively, often grown out, in some urban estates in the south of the city such as Fletcher Moss park and Highfield Country Park.

The Statement of Environmental Opportunity 1 of the NCA prioritises the creation of multi-functional green spaces and trees, with a focus on quality of life for city residents who lack access to spaces of tranquillity. It is in this context that the orchard creation

project at East Road Park occurs (**Figure 39**).

Figure 39. The area of bare security fence to be covered by hedgerow. Small tree whips can be seen at the base of the fence on close examination.

Description of Activity

An unused bowling green in East Road Park has been transferred to community management by the local council, under the administration of The Orchard Project charity. In this area a food orchard is being created containing fruit trees and herb beds, which will be available to the local community for recreation and food foraging. All planting and site development activities are undertaken by local volunteers managed by a part-time project officer of The Orchard Project. A 50 m mixed native species hedgerow with some edible fruit species has been planted along one side of the orchard. The hedgerow was planted in October 2023 and took 12 volunteers four hours to plant. The hedgerow contains small whips of hawthorn, elder, hazel, crab apple, guelder-rose, dog-rose, holly, sea buckthorn, and redcurrant. Whips were spaced at 5 per metre and were mulched at planting but grow unprotected and without support.

Motivations/Values

The hedgerow was planted to provide further opportunities for community foraging but also to provide privacy, tranquillity, and shelter from wind within the new orchard. It was also perceived that the hedgerow would increase biodiversity of the park and provide a habitat for birds. The high diversity composition of the hedgerow could also potentially increase interest in the structure among the public.

Figure 40. Project officer, Elsa Little, examines newly planted hedgerow whips.

Enabling Factors

A large part of the success of the hedgerow and wider orchard planting is down to the project officer. She is responsible for all aspects of management of the project, including advertising events, purchasing and transporting plants, mulch and compost and ensuring equipment is available for volunteers (**Figure 40**).

Hedgerow and orchard planting at East Road Park depends on a sizeable voluntary

labour pool. The project officer states that planting events held on weekends can attract up to 100 people. There appears to be no shortage of volunteers for tree and hedgerow planting. This may be where one benefits of urban planting projects located in areas of high population density. Planting days appear to be popular with local women.

The hedgerow and orchard project is funded by the Greater Manchester Environment Fund created by The Wildlife Trust for Lancashire, Manchester and North Merseyside, and The Greater Manchester Combined Authority.

Challenges/Solutions for success

The project's officer states that her biggest challenge in planting the hedgerow was plant availability from the nursery. While the plants were ordered in good time, they were delivered with only one a day to spare before planting. The nursery stated that there had problems with availability due to the unusual weather causing problems with tree growth, and this type of availability issue may become more common with climate change. The project officer advises other organisers of tree planting events to order trees and whips well in advance and be in regular communication with the nursery prior to the planting day.

There is a lack of volunteer knowledge about how to plant trees and what the purpose of the planting is. Basic training is provided to all volunteers by the project officer prior to planting.

There may be constraints on where hedgerows can be placed in urban parks. In particular, local councils and many local people do not like areas to be completely enclosed by hedgerows as this is perceived to encourage anti-social behaviour. Hedgerow planting may, therefore, need to be carefully sited. This constraint on planting due to anti-social behaviour is also evidenced by damage inflicted on some trees, guards and stakes.

It is worth noting that the bowling green area containing the hedgerow is now under community control and no longer managed by the council. This requires funding to allow community events to be organised in the area in the long term and acquiring funding for such long-term action is a major focus of The Orchard Project.

The project officer advises that the local community should be involved in all aspects of decision making in planting projects. For example, the local community decided that they wanted a mixed species hedgerow with some edible species they could forage. This type of engagement will increase investment of the local community in the project and ensure the resultant green infrastructure meets their needs.

Achievements

Some 50 m of partly edible mixed species native hedgerow have been planted in East Road Park in inner city Manchester. This will provide shading, privacy, tranquillity, and a foraging source for the local community and will greatly enhance the functionality of the larger urban orchard project that contains the hedgerow. While The Orchard Project would like to plant more hedgerows in Manchester city parks the suitability of

hedgerows would be assessed on a case-to-case basis. Only where there is a clear need for hedgerows would they be planted.

Conclusion and Messages for Policy

There appears to be no shortage of voluntary labour for tree and hedgerow planting projects in inner-city Manchester. Hedgerow and tree planting projects benefit from dedicated project manager. Clearly, paying a manager from a project's funding will increase the amount of time they can spend on the project but it is possible (if less well proven) that a dedicated voluntary manager could fulfil such a role. Involvement of the local community, who will also form the majority of volunteers, in all stages and in most aspects of the project is considered essential to increase utility of the new green infrastructure and long-term commitment to the project. Schemes such as the Greater Manchester Environment Fund are facilitating urban hedgerow and tree planting in Manchester. This hedgerow planting project has experienced issues with supply from tree nurseries.

5. Discussion: challenges and opportunities

5.1 What will it take to meet the national target?

Achievement of Favourable Conservation Status (FCS) for England's hedgerow network requires both an increase in the quantity of hedgerows but also improved condition of existing hedgerows. The definition of FCS for hedgerows sets out the need for an extra 335,000 km of rural hedgerow, a 61% increase attaining an average density of 10 km/km^2 and the connectivity benefits[49]. At the same time, 95% of hedgerows need to have the right structural and functional requirements for provision of quality habitat and other ecosystem services.

The EIP hedgerow targets that are the focus of the current study make some headway towards this ambition and were welcomed when announced in January 2023. 30,000 miles (or 48,280km) of hedgerow are to be restored or planted by 2037. A further 15,000 miles (or 24,140 km) are to be created and restored by 2050. Whilst only a little over one fifth of the ideal, it nevertheless represents a challenging agenda for hedgerow action in the next 25+ years. The required rate of restoration or planting to meet these targets is almost 2,700 km per year. In comparison, the Environmentally Sensitive Areas scheme (ESAs) from 1987 and Countryside Stewardship Scheme (CSS) from 1991 supported restoration and planting of new hedgerows at an average rate of over 1,000 km a year[50].

Quite what target delivery means when spread across suitable habitats and priority landscapes in England is the subject of the current study using the framework of 159 National Character Areas. We have presented an approach of scoring NCAs in relation to intactness, condition, and policy support which, when taken with the distribution of suitable habitats, or "plantable area", has allowed us to suggest NCA level targets for hedgerow planting and restoration. We stress that these NCA targets are indicative to explore what national target attainment will require in terms of actions at local level; NCA data should not be the only evidence used for spatial targeting (Box 4).

Box 4

A note on National Character Areas

The National Character Areas (NCAs) profiles were created in 2014 based on the previous 'Joint Character Areas' (JCAs), themselves derived from English Nature's Natural Areas and the Countryside Agency's landscape character mapping. The NCAs integrate environmental evidence, giving prominence to landscape character and

[49] Staley, Wolton & Norton. (2020). Definition of Favourable Conservation Status for Hedgerows. Natural England, 71pp. https://publications.naturalengland.org.uk/publication/5565675205820416
[50] CPRE & Farmers Weekly. (2022). Farming and Hedgerows: stretching the boundaries. https://www.cpre.org.uk/resources/farming-and-hedgerows-report-december-2022/

how this is shaped by biodiversity, geodiversity, soils and the historic environment. Their contextual supporting evidence and guidance help promote more integrated approaches to nature recovery.

The preparation of the NCA profiles in 2012–2014 involved consultation with a range of stakeholders in the public sector, local authorities at county level, Defra bodies, NGOs, NFU, CLA and local Natural England staff. The NCAs are mapped at a scale of 1:250,000 and so inform advice commensurate at that scale, leaving important scope for local evidence to have a role at a finer resolution. Local evidence in local landscape character assessments and local knowledge amongst regional stakeholders can play a role in refining and sometimes challenging the evidence. This current research project has identified where there may be scope for more hedgerows, but there needs to be an accompanying process for ensuring the planting of appropriate species in the right place with the appropriate management that fits with the landscape character and ecological context.

Targeting what hedgerow action is required where also needs to take into account potential ecosystem delivery, with associated economic benefits. This was the subject of an earlier report[51]. In the current study we have extracted and comment on relevant NCA data that highlight ecosystem services important at this scale.

All of this contributes to the need stated in the FCS report to consider where increases in hedgerows, their extent and density, may be most appropriate. As well as consolidating on the NCA-level of analysis demonstrated in this current work, the establishment by the Environment Act 2021 of Local Nature Recovery Strategies (LNRS) is a major opportunity. LNRS will identify and target the best places for nature recovery including creating, enhancing and restoring habitats such as hedgerows. Once developed, a LNRS will also better equip local planning authorities to incorporate nature recovery objectives into local plans and development decisions. Upcoming Countryside Survey data providing a more current picture of the current hedgerow network will be a tool to aid this work, for example to explore where conversion of bushy hedgerows to lines of trees is occurring, or where landscapes might benefit from the increased habitat and connectivity provided by hedges. The recently published UKCEH Hedgerows 2016–2021 dataset (Land Cover Plus) is also a key resource[52]. Another contribution to the spatial targeting of hedgerow action is a current research project by the University of Hull called 'Mapping the Gaps', which aims to identify the location and size of hedgerow gaps within East Yorkshire[53].

Building on our spatial prioritisation of hedgerow action, we have been able to start to explore what resources will be required to deliver the NCA level targets, whether

[51] CPRE & ORC. (2021). Hedge Fund: Investing in hedgerows for climate, nature and the economy. https://www.cpre.org.uk/resources/hedge-fund-full-report/

[52] Broughton, R.K.; Burkmar, R.; McCracken, M.; Mitschunas, N.; Norton, L.R.; Pallett, D.W.; Patton, J.; Redhead, J.W.; Staley, J.T.; Wood, C.M.; Pywell, R.F. (2024). UKCEH Land Cover Plus: Hedgerows 2016-2021 (England). NERC EDS Environmental Information Data Centre. https://doi.org/10.5285/d90a3733-2949-4dfa-8ac2-a88aef8699be

[53] https://www.hull.ac.uk/work-with-us/research/institutes/energy-and-environment-institute/our-work/hedgerows-mapping-the-gaps

people, time, tree stock, or funding. This was explored through three example NCAs, of different size and priority scoring and with 2037 targets for created or restored hedgerow ranging from 28 to 1070 km. In this latter case of South Norfolk and High Suffolk Claylands NCA and under the scenarios we present, between 13,740 and 21,230 days of labour and between 3.42 and 3.85 million trees and associated tree guards would be needed. According to the current CS and SFI funding offer, the length of hedgerow being created or restored equates to an investment of between £14.1 and £16.3 million in the South Norfolk and High Suffolk Claylands NCA. Scaling this up to the national 2037 target, this means £636 – £735 million will need investing to deliver the EIP target.

In our analyses, we have needed to make assumptions about how much hedgerow needs to be created and how much restored, and what restoration actions are needed depending on the structural condition of the hedgerows concerned. Many need rejuvenation through coppicing or laying, others will be gappier than the FCS criterion of <10% of their length and will need gapping up; still others will need the planting of new standard trees to achieve the required frequency of one every 20–40 m hedgerow length. The FCS report estimates that some 22 million new standard hedgerow trees are needed to achieve FCS, a 14-fold increase in the current estimate of 1.6 million standard hedgerow trees. A key requirement for delivering the target will be the knowledge and practical experience to guide what restoration action is required where.

Not considered within the hedgerow targets and our analysis of them are two factors that will be critical to achieving favourable conservation status for England's hedgerow network. The first is the quality, not just quantity, of the hedgerows that are planted and restored. The right species composition, planting densities and structural attributes, for any one geographical area, are important at the design stage, and the right planting methods at the point of establishment. Afterwards, appropriate aftercare and longer-term management regimes to ensure the health and good condition of the maturing or restored hedgerows are important. Spring droughts have been one factor in the high mortality rates of planted trees and shrubs in the landscape in recent years. Replacing dead trees ("Beating up") may be required in some instances. A hedgerow creation target is not truly met unless a healthy, mature hedgerow is the long-term end result.

The second factor is consideration of the systemic threats to hedgerows which may be partly responsible for the decline of the hedgerow network in recent years or a risk to achievement of the network's expansion. These threats may relate to biology and ecology (for example in relation to plant diseases) but also management and culture (attitudes to hedgerows). One example is the damage to hedgerows resulting from eutrophication and often evidenced by nettles or goosegrass dominating the marginal flora. Solutions to such threats can be undertaken at the hedge level (e.g. not spreading fertilizers into hedge margins or bases) but often require action in the wider countryside.

Statutory instruments, such as the 1997 Hedgerows Regulations (which protect most important rural hedgerows from removal) and funding through Environmental Stewardship, Countryside Stewardship and Farming in Protected Landscapes (FiPL, see Devon and Howardian Hills case studies), and Biodiversity Net Gain legislation, are

vital to meet the national hedgerow targets and manage the hedgerow network as a whole. There are a range of actions eligible for financial support under Countryside Stewardship and the Sustainable Farming Incentive and these are likely to prove attractive to many landowners. They include managing hedgerows and hedgerow trees and, importantly, assessing and recording hedgerow condition. Access to this funding must be as straightforward as possible to ensure high uptake.

Ultimately there is a huge diversity of mechanisms available for delivering the national hedgerow targets, depending on the local environment (especially urban vs rural), objectives and funding sources. Successfully achieving the targets will require individual farmers and other landowners and managers, as well as coordinated campaigns and grassroots action by community groups, to play a part in conserving and restoring England's hedgerows network.

5.2 Developing successful hedgerow planting projects: messages from case studies

The diversity of available mechanisms for delivering the national targets was apparent from our case study research, which revealed successful examples of hedgerow action across rural (protected and unprotected), urban and peri-urban contexts. The case studies show that there is no single pathway to success with respect to funding, organisation and implementation.

Funding can be through nationally accessible agri-environmental or Environmental Land Management Scheme funding such as Countryside Stewardship and Sustainable Farming Incentive, schemes specific to areas such as National Landscapes, statutory carbon offset funding that created the Solihull Council led Arden Free Tree Scheme (AFTS) (case study 5), and philanthropic and non-governmental funding support. Awareness raising of these funding opportunities is critical, as highlighted in Solihull where the communication of a scheme was perceived to be poor and represented a missed opportunity to establish more hedgerows on land that had been identified to be suitable.

Projects can be from small to large, conceived and delivered by individual farmers, larger estates and their teams, or as a facilitated initiative with a coordinator working across a number of land properties and their owners/managers. Facilitators can have an important catalytic role, as with the Hampshire Hedge initiative (case study 2) where a dynamic full-time project officer mobilises different sectors of the population though a varied range of activities. Another model is of more background support to farmer-led initiatives, as in Devon (case study 4) where a knowledgeable National Landscape project officer has been instrumental in farmers applying for funding and implementing quality schemes. Farm clusters, as in the Stour Valley (case study 3) represent one important opportunity for a coordinated effort at landscape level with some cost efficiencies and an easier route to funding. It can take several years for a farming cluster to bond and trusting relationships to be formed, however, there are around 120 farming clusters across the UK which have been established for at least seven years. Utilising these communities will surely be important in maximising the spread of hedgerows and progress towards the national target.

Implementation in the countryside often relies on individual farmers. The volunteer workforce can be mobilised in both rural and urban environments, as demonstrated by the case studies in the countryside of Hampshire (case study 2) and inner-city Manchester (case study 6). Specialist contractors (for hedge laying) are required in many cases but there are examples of where training in such rural crafts increases the available workforce going forward. But social norms also come into play, exemplified by the culture of neatness detected in areas such as the Howardian Hills (case study 1), where farmers need to be persuaded that larger, nature-friendly hedgerows can be worthwhile functionally and even economically, either through the provision of ecosystem services, or through higher subsidy payment rates for sensitive maintenance. In this way an important message is that hedgerows are not just about policy-support with associated funding but an asset that brings different value (aesthetic, economic and certainly ecological) to landscape and society.

Long-term management is important. Projects such as the Hampshire Hedge provide optimism that the national target can be delivered but beyond quantity of restored and created hedgerow, the quality and longevity is also critical: planting the right trees in the right places and ensuring their survival through appropriate aftercare (mulching, watering, management). Have the resources and know-how for this been properly considered in the delivery of hedgerows policy?

6. Conclusions and recommendations

Our investigation has sought to identify, quantitatively and qualitatively, the challenges to deliver the hedgerow target from national to local levels. We have shown how strategic information on landscape character be used to identify where hedgerow planting and restoration could be focused, as well as how different geographical contexts influence hedgerows ranging from deep rural to urban fringe, protected and unprotected landscapes, northern and southern regions.

Below are our key conclusions set against the research questions addressed by this investigation.

How can strategic information on landscape character be used to identify where hedgerow planting and restoration could be focused? How do different geographical contexts influence hedgerows?

Our approach

We have broken down the national EIP targets to NCA level, presenting a hedgerow action potential map that helps to focus on NCAs with most need and opportunity. This

was based on interrogation of the NCA database and categorisation of NCA-level hedgerow creation and restoration priority to allow comparison across different geographies. In this way we demonstrated a strategic approach to disaggregating the national targets, ground-truthing the NCA analysis with perspectives and information gathered from case study areas. Peer review of our work has helped to examine the validity of the strategic NCA level approach and identify the further steps that need taking.

Main findings

- 34 NCAs (21.4%) had historically high levels of hedgerow cover which have subsequently been lost and not replaced to a significant degree. These are the priority NCAs for hedgerow action with respect to this criterion. 74 NCAs (46.5%) were categorised as having lost a significant amount of hedgerow, but also having experienced a significant or notable degree of restoration in recent years. Only 51 (32.1%) of the NCAs had largely retained their historic levels of hedgerow cover.

- 46 NCAs (28.9%) had many of their hedgerows in a poor condition making them targets for restoration efforts. 80 of the 159 NCAs (50.3%) were classed as having hedgerows of predominantly medium condition, with some potential for restoration action. Only 33 NCAs (20.8%) were found to have the majority of their hedgerows in good condition. These were often areas already renowned for their wooded landscapes, such as the Chilterns, High and Low Weald, and areas around Shropshire. Many of these locations are National Landscapes.

- Most NCAs (147, 92%) had Statements of Environmental Opportunity or Statements of Strategic Priority that included a mention of hedgerows. For two thirds of these, hedgerows were a key target. Only 12 NCAs didn't reference hedgerows in terms of this policy support.

- 40 NCAs (25.2%) were classified as high priority for hedgerow action. Eight of these NCAs received the maximum score across all three criteria, with all aside from one being concentrated in the northern half of the country: Southern Lincolnshire Edge, Trent and Belvoir Vales, Vale of York and Vale of Pickering, North Northumberland Coastal Plain, Howgill Fells, Mersey Valley, and Berkshire and Marlborough Downs. The Trent and Belvoir Vales is the most significant of these NCAs by area.

- 40–90% of the land area of most NCAs was potentially suitable for hedgerows and their creation, whilst in a few cases this proportion was as little as 20–30%. Taking these areas and the prioritisation, the indicative NCA-level 2037 hedgerow creation and restoration targets varied considerably, from near zero in the case of three island NCAs to 1,583 km in the case of the South Suffolk and North Essex Claylands. The average was 304 km, implying a rate of average 21.7 km per year.

Recommendations

1. Target where action is needed to best deliver the national hedgerow targets in

Defra's promised national land use framework. Refine the spatial prioritisation presented in this report with updated Countryside Survey and UKCEH Land Cover Plus hedgerow 2016–2021 data on current hedgerow extent.

2. Use this indicative target setting approach to initiate discussion with local stakeholders on local ambition for hedgerows and the means to more finely tune spatial prioritisation of hedgerow action, including through emerging Local Nature Recovery Strategies.

What are the challenges nationally and locally to deliver the hedgerow target and how can they be addressed? What policy change, monitoring and resources are needed to achieve the EIP hedgerow target?

Our approach

We presented scenarios for implementing the disaggregated NCA-level targets in three example NCAs, showing what resources are required. We used data from the Landscape Atlas to report on percentage of hedgerow managed under Environmental Stewardship and Countryside Stewardship schemes. Through our case study research we assessed practically what delivering the targets will mean at the project level, hearing from key stakeholders in different contexts what challenges are faced at the local level and what solutions they are independently coming up with.

Main findings

- For South Norfolk and High Suffolk Claylands, the 2037 target of 535 km of new hedgerow and 535 km of restored hedgerow that could be delivered in the NCA involves six multi-year coordinated programmes each achieving 15 km of new hedgerow and 15 km of restored hedgerow, 12 large estates with 1 km new and 1 km restored, and 2,165 small to medium sized farms with 200 m new and 200 m restored.
- Additionally for this NCA the scenario focusing on gapping up as the restoration intervention, farmer and volunteer labour would amount to 13,740 person days. In terms of costs, tree stock and tree protection would amount to £3.08 million, with an additional £261,888 for fencing and £321,000 for mulch (current prices).
- Again under this scenario, the cost in terms of CS/SFI payment rates for the hedgerow creation and restoration would sum to a total of £14,131,490 in this NCA, which is over £1 million per year.
- Scaling this up to the national 2037 target, an investment of £636 million will be required, rising to £735 million for our second scenario with a wider range of restoration action.

- Ongoing management also requires considerable investment. Planting tree whips is just the first step of hedgerow creation and good support and advice is needed on raising and establishing a good hedge. According to 2018 data, the majority (64.2%) of NCAs had less than 20% of their hedgerows managed under agri-environment schemes (AES). 32 NCAs were found to have between 20–30% of their hedgerows in ES/CS schemes, while only 25 had more than 30% under such management. The NCA with the highest coverage was Clun and Northwest Herefordshire Hills with 83.9%.

Recommendations

3. Develop a system for monitoring progress towards the 2037 and 2050 hedgerow targets, encompassing the quality as well as quantity of delivery. Attention to sufficient aftercare of recently planted hedges is needed.
4. Make access to government funding opportunities as straightforward as possible to ensure a high uptake of these offers.
5. Facilitate aggregated approaches (for example through farm clusters) that reduce the administrative overheads of hedgerow action, including access to grant funding.

Where can hedgerows be targeted to maximise specific environmental and social benefits?

Our approach

We drew information from the NCA database and GIS analysis, supplemented with findings from the *Hedge Fund* report, to show NCA-level benefits of hedgerows to society and the environment opportunities. We used the case studies to discuss local priorities in respect to the values of hedgerows.

Findings

- With the demise of mixed farming, much of the country is dominated by either livestock or arable production systems. Hedgerows have different values in each, providing benefits to livestock (e.g. shelter, browse) and their management (stockproofing field boundaries).
- In all rural areas they can help to reduce soil erosion and leaching. Water pollution prevention was the most commonly referred to ecosystem service in the NCA profiles.
- In urban, peri-urban and intruded areas, hedgerows can help mitigate noise and air pollution, and create features that can be enjoyed, through the beauty and tranquillity, and foraged.
- Many species of conservation concern use hedgerows as habitat for at least part of their life cycles. Hedgerows not only create habitat but also important

corridors for movement. Hedgerows are additionally important for functionally important agro-biodiversity, providing habitat and places of shelter for natural predators of crop pests and pollinators.

- In these respects, not all hedgerows are equal, and seeking out specific opportunities to benefit local communities and rural environments are needed.
- These values and functions of hedgerows can be degraded by ongoing systemic threats, such as poor hedgerow management and nutrient pollution.

Recommendations

6. Continue to raise awareness of the many values of hedgerows to urban and rural populations. Those values depend largely on the local environmental and societal context, and in this respect not all hedgerows are equal. Identifying the contributions that hedgerows can make in different parts of a rural landscape or city/townscape can help in targeting and developing support for hedgerow action.
7. Design the right hedge for the right situation, considering the species composition and structure needed to meet the identified local needs and confer long-term resilience to climate change.
8. Address continuing systemic threats to hedgerows through policy support and knowledge exchange, to mitigate and remove ongoing biological, ecological and cultural barriers to achieving Favourable Conservation Status of England's hedgerow network.

Annex 1: National Character Areas: hedgerow prioritisation and targets

Number	Name	Historic precedent	Condition	SEO	Management/ restoration	Prioritisation Score	Hedgerow target (km)	Area of NCA (ha)	Plantable area (km2)	% of plantable in NCA
1	North Northumberland Coastal Plain	3	3	3	1	3	221.67	37700	268.60	68.91
2	Northumberland Sandstone Hills	2	3	3	2	3	100.01	72700	121.19	16.03
3	Cheviot Fringe	2	1	3	1	2	185.86	51600	337.82	63.03
4	Cheviots	3	2	2	1	2	0.55	36500	1.00	0.27
5	Border Moors and Forests	1	2	1	3	1	23.24	127200	84.49	6.57
6	Solway Basin	2	2	3	1	2	244.53	98400	444.46	44.64
7	West Cumbria Coastal Plain	1	3	3	2	2	107.00	49300	194.48	38.38
8	Cumbria High Fells	1	2	3	2	2	227.76	199000	413.98	20.38
9	Eden Valley	2	1	3	1	2	216.42	81000	393.37	47.16
10	North Pennines	1	1	2	2	1	99.81	214600	362.81	16.63
11	Tyne Gap and Hadrian's Wall	2	3	3	3	3	171.57	43400	207.89	45.68
12	Mid Northumberland	2	2	3	3	2	206.93	63700	376.12	57.24
13	South East Northumberland Coastal Plain	1	3	3	3	2	141.89	43700	257.90	57.49
14	Tyne and Wear Lowlands	2	3	3	3	3	185.55	46400	224.83	46.68
15	Durham Magnesian Limestone Plateau	2	3	3	3	3	220.91	45300	267.69	57.50

16	Durham Coalfield Pennine Fringe	3	2	3	3	3	247.69	66100	300.14	44.10
17	Orton Fells	1	3	1	1	1	36.87	29300	134.02	43.82
18	Howgill Fells	3	3	3	3	3	35.51	10400	43.03	38.63
19	South Cumbria Low Fells	1	2	3	3	2	138.65	69100	252.00	35.25
20	Morecambe Bay Limestones	1	3	2	3	2	104.37	40000	189.71	47.39
21	Yorkshire Dales	1	3	2	3	2	455.49	240000	827.91	34.00
22	Pennine Dales Fringe	2	1	3	3	2	308.88	87300	561.42	61.89
23	Tees Lowlands	2	3	3	3	3	548.28	102200	664.37	63.69
24	Vale of Mowbray	3	2	3	3	3	409.58	60600	496.31	79.63
25	North York Moors and Cleveland Hills	2	2	2	3	2	123.89	165900	225.19	13.43
26	Vale of Pickering	3	3	3	2	3	307.70	43100	372.85	83.07
27	Yorkshire Wolds	2	3	3	1	3	833.49	111400	1009.97	88.68
28	Vale of York	3	3	3	2	3	699.78	102100	847.95	81.18
29	Howardian Hills	2	2	3	1	2	101.74	24000	184.92	72.94
30	Southern Magnesian Limestone	3	2	3	3	3	828.84	136800	1004.33	70.74
31	Morecambe Coast and Lune Estuary	2	2	3	3	2	36.85	13200	66.98	49.35
32	Lancashire and Amounderness Plain	2	3	3	3	3	547.08	98600	662.91	65.94
33	Bowland Fringe and Pendle Hill	1	2	2	3	1	121.48	74100	441.61	56.80
34	Bowland Fells	1	2	3	2	2	48.38	37400	87.94	22.48
35	Lancashire Valleys	2	3	3	3	3	268.02	55400	324.77	56.51
36	Southern Pennines	1	1	1	3	1	181.88	119700	661.18	53.94
37	Yorkshire Southern Pennine Fringe	2	2	2	3	2	166.17	58500	302.03	49.48
38	Nottinghamshire, Derbyshire and Yorkshire Coalfield	2	1	2	3	1	273.70	169800	994.94	57.31
39	Humberhead Levels	1	1	1	3	1	392.05	171800	1425.16	81.62
40	Holderness	1	2	2	3	1	202.31	87300	735.44	82.92
41	Humber Estuary	1	1	1	3	1	51.49	28000	187.19	62.45

42	Lincolnshire Coast and Marshes	2	2	3	3	2	381.93	88200	694.19	76.95
43	Lincolnshire Wolds	2	3	3	1	3	636.39	84500	771.14	88.54
44	Central Lincolnshire Vale	3	2	3	2	3	572.09	81900	693.22	81.56
45	Northern Lincolnshire Edge with Coversands	1	1	3	2	1	114.47	50100	416.13	79.46
46	The Fens	1	2	1	3	1	875.52	382600	3182.68	81.74
47	Southern Lincolnshire Edge	3	3	3	2	3	421.48	57000	510.72	86.59
48	Trent and Belvoir Vales	3	3	3	2	3	1220.25	177600	1478.62	81.68
49	Sherwood	2	3	3	2	3	249.86	53500	302.76	54.20
50	Derbyshire Peak Fringe and Lower Derwent	2	2	3	3	2	150.82	37800	274.12	69.62
51	Dark Peak	1	1	3	3	1	37.39	86600	135.92	15.26
52	White Peak	1	1	2	3	1	123.04	52900	447.29	81.53
53	South West Peak	1	2	2	3	1	60.49	42600	219.90	50.08
54	Manchester Pennine Fringe	1	2	3	3	2	108.56	39300	197.32	47.92
55	Manchester Conurbation	2	2	3	3	2	80.17	34200	145.72	41.14
56	Lancashire Coal Measures	2	3	3	3	3	188.23	40600	228.08	54.31
57	Sefton Coast	1	2	2	3	1	9.62	9000	34.98	36.60
58	Merseyside Conurbation	2	2	3	3	2	67.30	28700	122.33	41.19
59	Wirral	2	3	3	3	3	61.19	16500	74.15	43.27
60	Mersey Valley	3	3	3	3	3	193.50	44700	234.47	50.37
61	Shropshire, Cheshire and Staffordshire Plain	2	1	3	2	2	1367.77	366200	2486.06	67.01
62	Cheshire Sandstone Ridge	2	1	3	2	2	70.17	22000	127.55	54.93
63	Oswestry Uplands	2	2	3	1	2	31.74	10000	57.70	56.56
64	Potteries and Churnet Valley	2	3	3	3	3	223.03	53100	270.26	49.28
65	Shropshire Hills	1	2	3	1	2	447.00	108000	812.47	73.83
66	Mid Severn Sandstone Plateau	2	2	3	3	2	346.83	88800	630.39	69.22
67	Cannock Chase and Cank Wood	2	2	3	3	2	194.85	72800	354.15	47.38
68	Needwood and South Derbyshire Claylands	2	1	3	2	2	343.48	81500	624.30	74.58

69	Trent Valley Washlands	3	2	3	3	3	212.93	39400	258.02	60.50
70	Melbourne Parklands	2	1	3	2	2	62.69	15000	113.94	71.59
71	Leicestershire and South Derbyshire Coalfield	3	2	3	3	3	114.69	20500	138.98	64.67
72	Mease Sence Lowlands	2	2	2	2	2	150.39	32400	273.34	80.84
73	Charnwood	3	3	2	3	3	85.86	17500	104.04	57.00
74	Leicestershire and Nottinghamshire Wolds	2	2	2	1	2	299.06	64100	543.57	81.52
75	Kesteven Uplands	2	3	2	1	2	325.66	69000	591.92	83.13
76	North West Norfolk	3	2	3	1	3	564.78	80100	684.37	82.89
77	North Norfolk Coast	1	1	2	1	1	5.66	6200	20.58	28.77
78	Central North Norfolk	3	2	2	1	2	310.53	72000	564.42	76.07
79	North East Norfolk and Flegg	3	2	3	2	3	184.49	24700	223.55	82.40
80	The Broads	1	3	2	1	2	208.60	56300	379.15	63.27
81	Greater Thames Estuary	1	1	1	3	1	175.61	83700	638.37	72.49
82	Suffolk Coast and Heaths	2	3	2	2	2	301.97	82200	548.86	64.92
83	South Norfolk and High Suffolk Claylands	3	2	2	2	2	1070.65	214500	1946.01	88.92
84	Mid Norfolk	2	2	3	1	2	440.75	90900	801.11	85.86
85	The Brecks	3	2	2	3	2	380.41	101900	691.44	66.04
86	South Suffolk and North Essex Clayland	2	1	3	2	2	1583.24	329000	2877.70	86.26
87	East Anglian Chalk	3	3	2	3	3	634.24	83900	768.53	88.26
88	Bedfordshire and Cambridgeshire Claylands	1	2	3	3	2	1189.73	260600	2162.46	80.76
89	Northamptonshire Vales	2	2	3	1	2	384.53	90400	698.93	73.91
90	Bedfordshire Greensand Ridge	2	2	2	3	2	112.77	27300	204.98	70.70
91	Yardley-Whittlewood Ridge	2	1	3	3	2	147.31	33800	267.76	73.99
92	Rockingham Forest	3	2	3	3	3	292.86	51000	354.86	67.45
93	High Leicestershire	1	1	2	3	1	139.49	56900	507.08	86.29
94	Leicestershire Vales	2	3	3	3	3	465.73	71800	564.35	76.15
95	Northamptonshire Uplands	2	2	3	2	2	415.50	101100	755.21	72.80

96	Dunsmore and Feldon	2	2	3	3	2	285.58	70600	519.07	71.04
97	Arden	2	2	3	3	2	518.49	143400	942.41	64.35
98	Clun and North West Herefordshire Hills	2	3	2	1	2	267.82	62600	486.80	76.64
99	Black Mountains and Golden Valley	2	2	2	3	2	116.29	26000	211.37	79.81
100	Herefordshire Lowlands	2	3	2	3	2	410.48	88700	746.09	81.66
101	Herefordshire Plateau	2	1	3	3	2	158.51	34600	288.11	80.75
102	Teme Valley	3	1	3	3	2	84.88	19300	154.27	75.48
103	Malvern Hills	3	2	3	3	3	50.89	8300	61.66	68.37
104	South Herefordshire and Over Severn	1	2	3	3	2	238.87	51100	434.18	82.81
105	Forest of Dean and Lower Wye	1	2	3	3	2	94.50	31400	171.76	53.66
106	Severn and Avon Vales	3	2	3	3	3	1533.39	210300	1858.06	86.45
107	Cotswolds	2	2	3	1	2	1412.46	288200	2567.29	87.41
108	Upper Thames Clay Vales	1	2	2	2	1	390.51	189000	1419.57	72.29
109	Midvale Ridge	2	2	2	2	2	183.84	44500	334.16	69.74
110	Chilterns	2	1	3	3	2	648.06	164100	1177.92	70.34
111	Northern Thames Basin	2	3	3	3	3	1429.12	251000	1731.71	67.01
112	Inner London	1	2	2	3	1	44.73	33000	162.59	46.90
113	North Kent Plain	3	3	2	3	3	466.66	84800	565.47	63.78
114	Thames Basin Lowlands	1	3	3	3	2	100.29	32800	182.28	52.15
115	Thames Valley	3	2	2	3	2	262.96	86100	477.96	53.86
116	Berkshire and Marlborough Downs	3	3	3	3	3	780.63	111000	945.91	83.23
117	Avon Vales	2	2	3	3	2	250.59	64300	455.47	68.38
118	Bristol, Avon Valleys and Ridges	2	2	3	3	2	392.16	84300	712.79	82.36
119	North Downs	2	1	3	3	2	517.81	137400	941.17	66.12
120	Wealden Greensand	2	2	3	3	2	450.43	145800	818.70	53.78
121	Low Weald	1	1	3	3	1	328.01	182400	1192.39	63.26
122	High Weald	1	1	3	3	1	271.20	174900	985.85	55.28
123	Romney Marshes	1	3	1	3	1	81.48	36700	296.20	77.11

124	Pevensey Levels	1	3	1	3	1	19.53	9600	70.98	69.77
125	South Downs	2	2	3	2	2	426.56	101900	775.32	73.75
126	South Coast Plain	1	3	2	3	2	182.72	52200	332.11	61.89
127	Isle of Wight	3	2	2	1	2	134.97	38000	245.33	64.63
128	South Hampshire Lowlands	1	2	3	3	2	128.26	38600	233.13	58.11
129	Thames Basin Heaths	2	2	3	3	2	336.32	118500	611.30	50.26
130	Hampshire Downs	2	2	3	2	2	676.13	148900	1228.93	80.94
131	New Forest	1	1	3	3	1	77.90	73800	283.19	37.96
132	Salisbury Plain and West Wiltshire Downs	3	3	2	3	3	853.49	122300	1034.20	82.47
133	Blackmore Vale and Vale of Wardour	1	2	3	3	2	275.62	78400	500.97	61.27
134	Dorset Downs and Cranborne Chase	3	2	2	1	2	515.28	116900	936.58	77.69
135	Dorset Heaths	2	3	2	3	2	162.49	61700	295.34	46.42
136	South Purbeck	1	2	3	2	2	46.75	11900	84.97	69.10
137	Isle of Portland	1	3	1	3	1	0.00	1100	0.00	0.00
138	Weymouth Lowlands	3	3	2	2	3	74.65	13300	90.46	64.84
139	Marshwood and Powerstock Vales	1	1	3	3	1	28.20	15900	102.50	61.98
140	Yeovil Scarplands	2	1	3	3	2	297.87	78600	541.42	66.86
141	Mendip Hills	2	2	3	2	2	146.92	30300	267.04	84.13
142	Somerset Levels and Moors	2	2	2	3	2	331.15	65800	601.89	86.64
143	Mid Somerset Hills	1	1	3	3	1	112.85	42100	410.24	90.60
144	Quantock Hills	2	3	3	3	3	15.84	7600	19.19	23.29
145	Exmoor	2	2	3	1	2	352.44	130400	640.60	48.66
146	Vale of Taunton and Quantock Fringes	2	1	3	3	2	179.87	48400	326.94	64.67
147	Blackdowns	2	1	3	3	2	222.79	80800	404.94	49.28
148	Devon Redlands	1	2	2	3	1	146.68	97400	533.22	53.57
149	The Culm	2	2	2	3	2	778.44	283100	1414.89	49.53
150	Dartmoor	2	2	2	2	2	132.76	87400	241.30	27.11
151	South Devon	3	2	2	2	2	355.79	121100	646.69	52.71
152	Cornish Killas	2	2	2	2	2	664.41	222100	1207.63	53.64

153	Bodmin Moor	1	2	2	3	1	43.62	28600	158.58	53.58
154	Hensbarrow	1	2	3	3	2	22.99	11900	41.78	33.41
155	Carnmenellis	1	2	2	3	1	21.35	14300	77.60	51.83
156	West Penwith	3	2	2	3	2	50.14	20200	91.13	44.69
157	The Lizard	2	2	2	1	2	31.44	14700	57.15	38.53
158	Isles of Scilly	1	3	1	3	1	1.79	1600	6.50	39.94
159	Lundy	1	1	1	3	1	0.14	500	0.52	12.36

Annex 2: Relevance of the UKCEH Land Cover Plus: Hedgerows (2016–2021) England data set to this report

Writing of this report coincided with the release of a new digitised map of woody linear features across England: UKCEH Land Cover Plus: Hedgerows (2016–2021) England data (Broughton et al 2024), predicting a total length of woody linear features in England of 437,000 km compared to the 547,000 km figure produced by the 2007 countryside survey (Staley et al 2020). We have not used this new data asset as a principal source for the current study, but in Figure A1 below we compare NCA hedgerow extents predicted by this new data set to the older data set. Figure A2 is a hedgerow density map using the dataset.

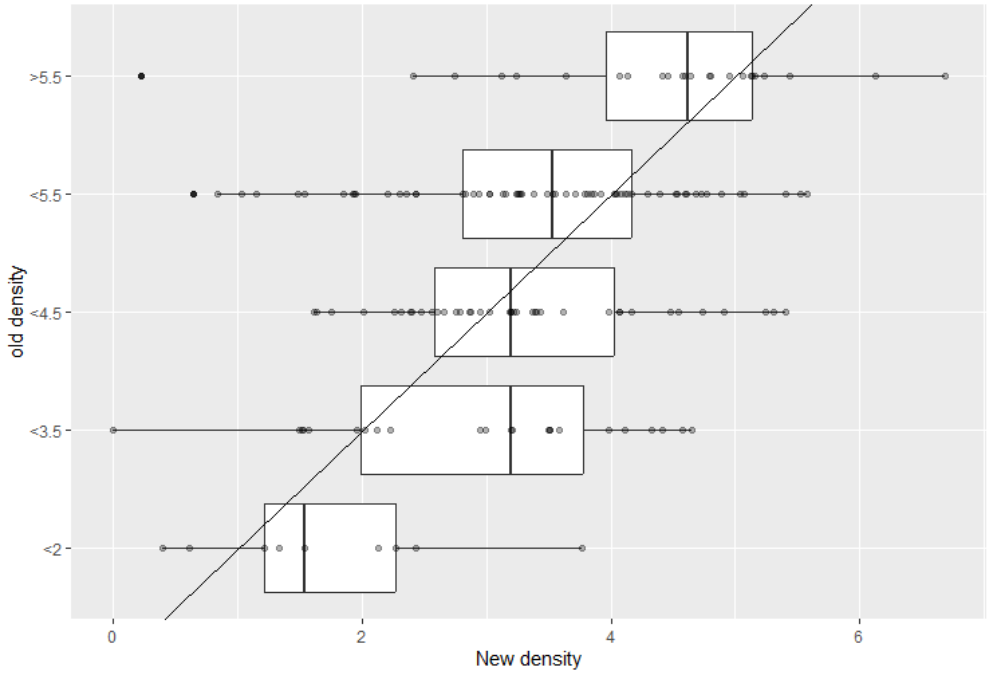


Figure A1. Comparison of NCA hedgerow extents predicted by this new data set and Staley et al (2020).

Data in the UKCEH Land Cover Plus: Hedgerows (2016–2021) England data set was

produced by airborne laser scanning of the English landscape combined with various computational filtering assumptions. Each continuous stretch of hedgerow (21 million of them by our calculations) is represented as a geotagged vector (line) so the dataset can be visualised on a map in a GIS package. Each hedgerow fragment is also tagged with size class (6 classes from 0.5 to 6 m high), whether it is a double (parallel) feature, whether it lies next to a road, its length, and the likely nature of the feature (hedgerow or tree line for example).

From this description of the data set we can see how it could potentially be used in future work to supplement the current report. An obvious application is in the assessment of hedgerow condition. "Gappiness" is a key metric of hedgerow condition, as continuous hedgerow is assumed to provide a better dispersal corridor for animals and plants, and gappiness should approximate to the number of hedgerow fragments in each NCA. Size class of hedgerow fragment could also give some indication of hedgerow condition, with small, gappy hedgerow representing the poorest class of condition. Size class is also potentially useful information in intersection with predominant agriculture type. Large hedgerows are typically considered a superior resource for beneficial organisms such as pest natural enemies in the agricultural landscape, and those planning hedgerow network expansion may wish to prioritise areas with a low density of this type of desirable hedgerow. Proximity of hedgerow to road could potentially be used for hedgerow network expansion with pollution control in mind but in this respect it is worth noting that the UKCEH Land Cover Plus: Hedgerows (2016–2021) England data set does not cover urban and suburban areas. Finally, overall density of existing hedgerow in in each NCA can, of course, be assessed using this new data set and this represents another factor that planners could consider during hedgerow network expansion.

Broughton et al (2024) note that the model behind the new dataset could not distinguish well between woody linear features and other solid field boundaries, such as drystone walls. This is a source of error, albeit one that was mitigated by excluding moorland and mountain land covers. Similarly, field boundaries composed of tall non-woody vegetation, such as nettles, reeds and bracken, could not be distinguished from hedgerows or shrubs. Most of these misclassified features will be captured in the lower height classes of 1a and 1b (below 1.5 m tall), and these can be filtered for removal if required. Misclassification of taller features potentially includes bridges, solar panels and other large infrastructure, although these are less likely to be coincident with polygon boundaries. Manual data cleaning to correct such errors was not attempted, and users are recommended to inspect the model data for their area of interest to remove known error features if possible or appropriate.

Remote assessment of landscape is clearly the future of landscape feature quantification and while there appears to have been heavy human supervision of the interpretation of remote images to produce the UKCEH Land Cover Plus: Hedgerows (2016–2021) England data set, almost certainly this will be done more rapidly and probably more effectively by artificial intelligence in the near future.

References

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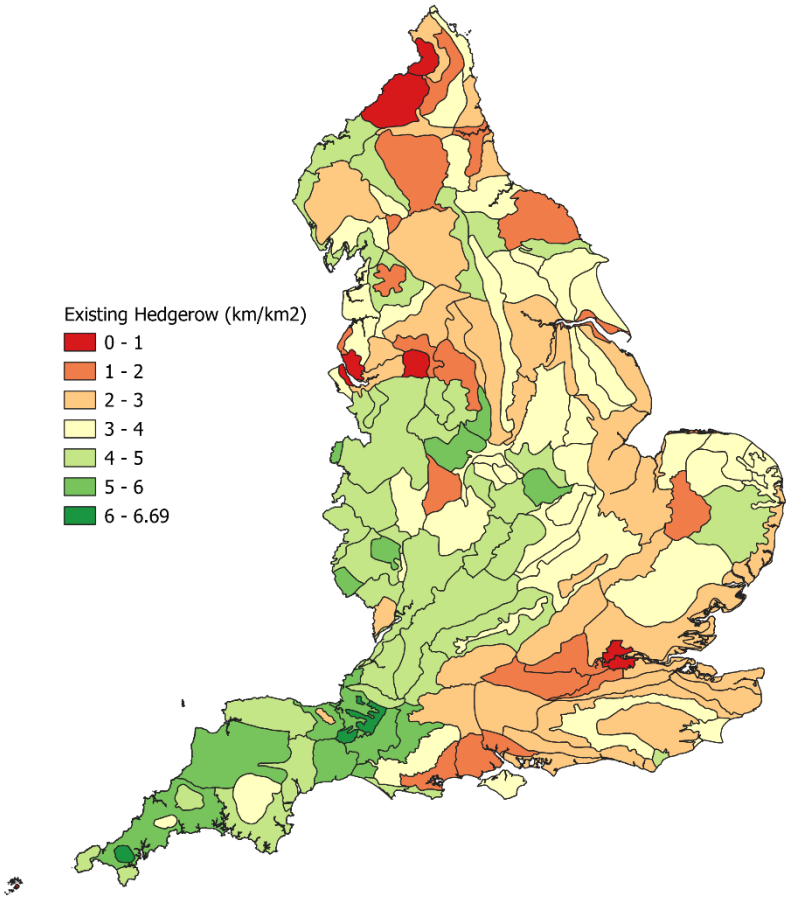

Figure A2: Hedgerow density at NCA level predicted by the new UKCEH Land Cover Plus: Hedgerows (2016–2021) dataset.

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