Great Western mainline, Wales and Western region

Network Rail State of Nature Summary Report 2023

Contents

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1.1 Document Control

Version number	Date	Description	Prepared by
0.1	May 2025	draft	Neil Strong
0.2	June 2025	Draft	Neil Strong
1.0	August 2025	final	Neil Strong

Foreword

In 2018, the then Rail Minister, Jo Johnson MP commissioned John Varley to review how Network Rail was managing vegetation alongside the railway. At the time there was widespread public concern that Network Rail, in the pursuit of keeping the railway clear of vegetation for understandable reasons of safety, was disregarding the impact on nature and biodiversity next to the railway. The subsequent Varley Report, while recognising that a safe and reliable railway should always be the number one priority, set out how there was a real opportunity to deliver positive outcomes for the natural environment.

Since then, Network Rail has made significant changes to its management of vegetation, using satellite technology to map and measure the biodiversity of habitats across the railway estate. This data is helping Network Rail to establish a baseline against which we can measure progress. It is still very early in the use of this data but it is clear that progress will not be a simple upward trend. One of the key learnings from the various biodiversity trial sites, is that change in nature is variable and certainly does not follow a predictable linear change curve!

However, John Varley in his report highlighted how it would be "human and cultural factors that will determine whether Network Rail can capture and execute this agenda." Upon reading this year's State of Nature report, readers will see from the multitude of case studies and partnerships entered into with conservation bodies across the country that there has been a real and meaningful cultural shift within Network Rail to foster biodiversity, often in the most creative of ways. As is clear from our work to revise our environmental strategy, the organisation is committed to continuing this cultural shift. Nature will be the beneficiary and the data will follow in due course!

David Noyes
Non-executive director and Chair,
Network Rail's Environment
Sustainability Committee
June 2025

2 Introduction

This report, for Network Rail, covers activities that took place in 2023.

It is the fourth annual state of nature report produced by Network Rail. Like previous reports, this document shows the satellite assessment for habitats across the railway estate in Britain. In addition to this summary, there are appendices containing individual reports from each of the five regions of Network Rail (figure 1).

Figure 1: *Network Rail regions and routes*

Throughout previous reports we have stressed that we are seeking to improve not only the data collection methodology, but also the interpretation. Following some additional analysis, we now have some statistical confidence behind our data and the analysis report for this is in full within the appendices to this report.

This same piece of analysis has identified misclassification of habitats was occurring due to the narrow nature of the railway estate, together with the mixed habitats across it. To overcome this, two new categories of 'sparsely vegetated land' and 'grassland' have been created. This does not affect the area of estate, nor the overall unit score (due to similar values).

3 Executive Summary

3.1 Overview

Network Rail's biodiversity units for the network for this report are 254,183.76. The distribution of those units by the five regions are given in Table 1.

Table 1: *Network Rail biodiversity units 2023*

	Units	Area (ha)
Network Rail	**254,183.76**	**51,792.52**
Eastern	74,741.30	15,793.65
North West & Central	53,380.93	11,336.17
Scotland's Railway	38,725.11	7,506.22
Southern	38,846.04	7,831.93
Wales & Western	48,490.38	9,140.37

The proportion of the significant habitat types found across the estate can be seen in Figure 2.

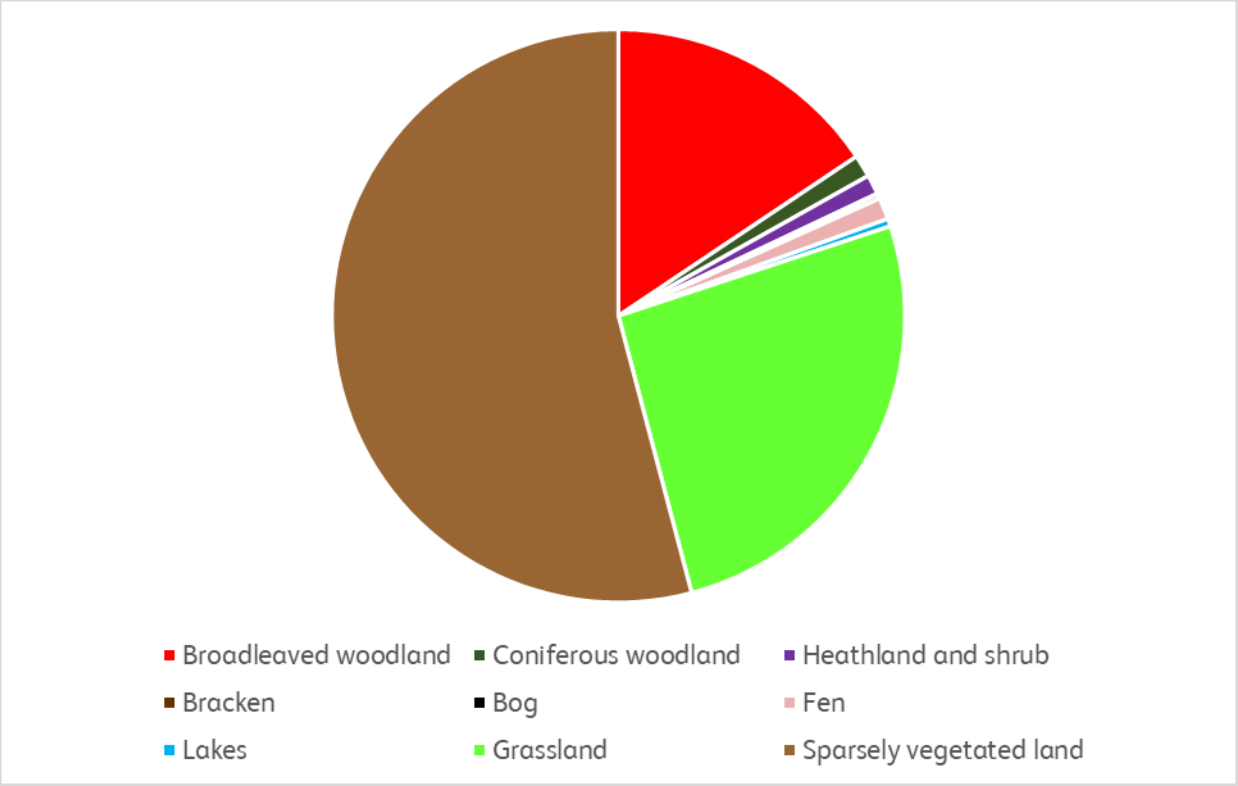

Figure 2: *Proportion of habitat across the rail estate in Britain 2023*

3.2 Five years' data

We reported in the 2022 report that parts of NHS England suggest at least seven data points are needed before trend analysis can be undertaken. Since the publication of the 2022 report, our data supplier, UK Centre for Ecology and Hydrology, has been able to reproduce versions of the UK land cover maps for a period of five years from 2019 to 2023. These additional data (calendar year 2019) together with the existing Network Rail data range (2020-2023) have been subjected to a consistent methodology to estimate the stock of habitats within the railway boundary and assess the locations and nature of land cover change occurring across this period. The methodology is described in Appendix 4.1. Table 2 below shows the biodiversity unit data from 2019 to 2023.

Table 2: *Network Rail biodiversity units 2019 to 2023*

	2019	2020 (baseline)	2021	2022	2023
Network Rail	**258,526**	**255,060**	**255,501**	**260,325**	**254,184**
Eastern	76,346	75,879	75,356	75,715	74,741
North West & Central	54,035	53,002	53,430	55,450	53,381
Scotland's Railway	38,382	38,652	38,140	40,018	38,725
Southern	40,234	38,902	40,714	40,244	38,846
Wales & Western	49,529	48,625	47,860	48,897	48,490

The statistical analysis described in Appendix 4.1 shows that there is no significant change over the period of measurement. This contrasts with previous reports which have shown an apparent decrease in units. However, now that rigorous statistical analysis we have undertaken, we are now confident in the dataset and outputs. The additional work identified that previous versions of the data had differed slightly in is production. The habitat maps for 2019-2021 were reproduced using identical methods to 2022 and 2023 and provides an overall accuracy of approximately 85%.

3.3 Habitat changes

Comparison of the land cover types on the Network Rail estate from 2019 to 2023 show small changes in the extent of habitats. The headline changes in habitat are as follows:

- Increases in broad leaved and yew woodland, coniferous woodland and grassland.
- Reductions in sparsely vegetated, fen marsh and swamp, dwarf shrub heath and rivers and lakes classes.

- Coverage of bog remained broadly similar.

Of these changes, only the increase in broad-leaved woodland (+700 hectares) and the reduction in fen, marsh and swamp (-300 hectares) were found to be statistically significant.

Table 3: *Total area (km^2) of each land cover class for Network Rail land for the reporting periods of 2019-2021 and 2022-2023. Estimates are derived from a statistical model fitted to the data across individual years to enable production of associated confidence intervals and assessment of the significance of change.*

UK-Habitat	2019-2021			2022-2023			Change
	Lower 95% CI	Estimated Area	Upper 95% CI	Lower 95% CI	Estimated Area	Upper 95% CI	
Broad leaved and yew woodland (w1)	72.14	75.26	78.38	78.47	82.30	86.12	Increase
Coniferous woodland (w2)	5.50	6.00	6.49	5.39	6.00	6.60	No Significant Change
Grassland	85.55	110.44	135.33	81.51	111.99	142.48	No Significant Change
Fen marsh and swamp (f2)	7.70	8.76	9.81	4.69	5.98	7.28	Decrease
Dwarf shrub and heath (h1)	5.20	7.25	9.30	5.60	8.11	10.62	No Significant Change
Bog (f1)	0.74	1.25	1.75	1.15	1.77	2.39	No Significant Change
Sparsely vegetated	282.66	304.53	326.40	270.62	297.41	324.19	No Significant Change
Rivers and lakes (r)	1.66	2.60	3.54	1.37	2.52	3.67	No Significant Change

3.4 Summary of future plans for biodiversity management

3.4.1 Eastern

- Strengthening collaboration with infrastructure programs (e.g. TransPennine Route Upgrade).
- Exploring new technologies for habitat and biodiversity monitoring.
- Addressing invasive species, focusing on Japanese knotweed and giant hogweed.
- Expanding stakeholder engagement through Wildlife Trusts-led initiatives.

3.4.2 North West and Central

- Expansion of Habitat Management Plans (HMPs) to improve biodiversity while maintaining operational safety.
- Stakeholder engagement, including partnerships with Natural England and environmental organizations, to enhance biodiversity at a landscape scale.
- Use of NatureSpace licensing to streamline habitat management where protected species, such as great crested newts, are present.

3.4.3 Scotland's Railway

- Scotland's Railway aims to enhance or create at least 500 hectares of habitat by 2029.
- Efforts are underway to integrate HMPs into railway infrastructure projects.

- Strengthening partnerships with groups like Forest and Land Scotland, Forth Rivers Trust, and the Tree Council to deliver biodiversity improvements.

3.4.4 Southern

- Implementation of the Biodiversity Net Gain (BNG) Strategy aiming for no net loss by 2024 and 10 % biodiversity net gain by 2035.
- Expanding HMPs for all lineside areas to integrate biodiversity enhancement with railway operations.
- Enhancing conservation partnerships, including ongoing collaborations with Zoological Society London (ZSL) for biodiversity monitoring innovations.
- Stakeholder engagement in Local Nature Recovery Strategies, aligning conservation efforts with wider landscape priorities.

Figure 3: *Partnerships between regions and external organisations*

3.4.5 Wales and Western

- Expansion of ecology resources to increase support for ecological expertise and recruitment to improve biodiversity management.
- Development of HMPs to align habitat preservation efforts with operational rail priorities.
- Strengthened collaboration with conservation groups through Nature Partnerships and Area Statements in Wales.

3.4.6 National ambition

- We will manage our land responsibly for the benefit of nature, safety and performance

3.5 Summary of conservation actions and achievements

3.5.1 Eastern

- Protection and safeguarding of key species such as peregrines, willow tits, and hazel dormice.
- Partnership with Wildlife Trusts Consultancies to develop biodiversity management plans, including Route Biodiversity Action Plans and HMPs.
- The establishment of pilot areas to explore biodiversity improvement projects.
- Engagement with local conservation groups and stakeholders to enhance habitat connectivity.

Figure 4: *Peregrine falcon in Eastern region*

3.5.2 North West and Central

- The establishment of Habitat Management Plans (HMPs) to align biodiversity preservation with operational needs.
- Case studies demonstrate successes:
    - Goat grazing was trialled to manage invasive species, reducing costs compared to traditional methods.
    - A Stockport partnership project engaged volunteers in Himalayan balsam eradication to restore native biodiversity.
    - The Dutton Triangle project tackled invasive Himalayan balsam growth to protect woodland species

Figure 5: *Goatscaping in Manchester Delivery Unit*

3.5.3 Scotland's Railway

- Bee Bank Installation: A sinkhole repair project in Ayrshire was repurposed into a habitat supporting solitary bee populations.
- Bat Conservation: A diseased ash tree with bat roosts was managed carefully with habitat creation measures, including bat boxes.
- Kestrel Research Partnership: Network Rail ecologists collaborated with Lothian & Borders Raptor Study Group to monitor kestrel populations.
- Community Planting Projects: Volunteers planted hedgerows and fruit trees to enhance biodiversity in Queen's Park and Elder Park, Glasgow.

Figure 6: *Bee bank created next to the railway*

3.5.4 Southern

- Railway Nature Sites: 50 lineside locations designated as biodiversity priority sites for conservation efforts.
- Kent Habitat Management Pilot: Ongoing trials demonstrate positive impacts on plant and invertebrate species richness.
- Great Crested Newt Organisational Licence: Speeds up conservation compliance while mitigating impact on protected species.
- Tree Council Partnership: Planted 45,350 trees across 105 sites with a remarkable 90 % survival rate.
- Hazel Dormouse Protection: Southern is working with Natural England to ensure dormouse-friendly operational activities.

Figure 7: *Wildflower meadow on a Railway Nature Site*

3.5.5 Wales and Western

- Baseline Ecology Surveys: Targeted surveys are informing vegetation management, prioritizing areas affected by Ash Dieback.
- Protected Species Mitigation: Licenses secured for species such as bats, dormice, badgers, and Great Crested Newts.
- Stakeholder Engagement: Collaborations with Natural Resources Wales (NRW), Welsh Government (WG), Transport for Wales (TfW), Royal Society for the Protection of Birds (RSPB), and Wildlife Trusts.

- Invasive Species Management: Large-scale control efforts, including Japanese Knotweed eradication, Rhododendron clearance in North Wales, and ongoing monitoring of Giant Hogweed and Cotoneaster.

Figure 5: *Flood management in partnership with external stakeholders*

3.5.6 National achievements

- We returned to the NEC in Birmingham to engage with thousands of students at the Big Bang STEM event. We planted thousands of saplings (albeit the same ones over and over again) to show the students that getting your hands dirty was OK! The STEM ambassadors at our partners at The Tree Council made music with trees and each student that visited wrote a message for the message tree – this in itself showed a great connection with nature and the younger generations, that organisations like ours need to act upon.
- We held a successful conference with the Forestry Commission in Reading showcasing the Trees and Trains work to identify locations where trees could be planted in England. Over 80 representatives from land managers, forestry companies and environmental charities heard from environment and rail ministers alongside the CEO of the Forestry Commission and the chair and CEO of Network Rail.

Figure 6 (top): *Big Bang STEM event*; **(bottom):** *John Varley chairing the Trees and Trains panel Q&A*

3.6 Further action

3.6.1 Regions

- Eastern
    - Work closer with capital projects and the supply chain to understand how best to work towards common biodiversity goals
    - Explore the creation of an Eastern Region Ecology Framework that will include suppliers from across the Region
    - Establish how to better support local teams implement the Network Rail Biodiversity Standard (NR/L2/ENV/122)
    - Identify and explore new technologies that will help deliver plans for biodiversity at scale
    - Identify new partnerships and stakeholders to help deliver biodiversity initiatives
    - Further work is required to record and treat invasive non-native species
- North West and Central
    - Future plans continue to focus on the implementation of HMPs to improve and increase biodiversity across the Region.

    - Monitor the successes or failures of our demonstration and pilot sites and share and implement learning across the region.
    - Quantify the benefits that biodiversity enhancements, or habitat creation can have on operational performance and resilience, as well as any wider societal benefits, such as flood risk alleviation, or the provision of recreational sites.
    - Further engagement with local stakeholders and organisations, such as the Environment Agency, Natural England, Rivers Trusts and other relevant non-governmental organisations and charities, to deliver biodiversity enhancements that deliver benefits at a landscape scale.
- Scotland's Railway
    - In partnership with Forestry and Land Scotland (FLS), we will deliver an ambitious biodiversity enhancement project which aims to protect, enhance, and expand.
    - Mitigate any unavoidable loss of biodiversity across the region and deliver improved biodiversity through habitat creation and restoration on our estate where possible.
    - Continue to partner with groups such as The Tree Council to deliver community planting schemes.
    - Establish an effective and efficient methodology to produce Vegetation and Habitat Management Plans, as well as developing the Scotland's Railway Climate Action Plan in which Biodiversity is one of five key priorities for the next Control Period.
- Southern
    - Create and publish a wider Land Management Strategy for Southern, to commence from the start of the new Control Period (2024).
    - Establish strategies and organisational arrangements between the Region and Natural England that will permit our workforce to deliver vital maintenance, refurbishment and enhancement of the rail network.
    - Create and start to introduce new, standardised ways of working for Infrastructure Maintenance colleagues where Protected Species are likely to be present.
    - Complete our work on establishing a series of 50 Railway Nature Sites around the Region, high value sites for nature which will be ring-fenced and safeguarded for the benefit of the railway and the communities we serve.

    - Complete our Control Period tree planting programme, in partnership with the Tree Council. Our planting plan for 2023 aims to deliver a further 30,000 trees, to be planted working with local communities, taking us past 100,000 planted trees in total since the partnership began.
- Wales and Western
    - Deliver the demonstration projects to inform future biodiversity and habitat management across the Region, with a focus on a pragmatic approach to sympathetically work with the existing habitats present on site – with the right habitat in the right place.
    - Continue to progress with delivering the ELR ecology surveys on the Wales & Borders route, managed with direct input from the Ecologists in the Delivery Units.
    - Embed requirements to positively manage our assets to 'maintain and enhance' biodiversity and be complaint with external legislation with regard to ecology, including Cultural Change for positive management for biodiversity and ecology.
    - In January 2023, the 'intelligent client' model will be launched in Wales & Western region, with Ecological services being contracted out to six long-term supply chain partnerships for renewal projects. This model aims to support buildings, civils, electrification, and plant project in CP7.
    - Work on procurement of a new Wales & Western Ecology Framework of Suppliers to provide support to the teams on delivery of work.
    - Consult with Natural Resources Wales and Welsh Government to resolve the question around using biodiversity metrics in Wales and meeting the requirements under Net Benefit for Biodiversity on the Railway.

3.6.2 National

- The baseline units estimated using the biodiversity metric would suggest that in order to achieve PR23 final determination targets for Control Period 7 the number of units needs to increase by 10,866 across the network. A further 15,005 would then be required to achieve the ten percent increase by 2035.
    - We will continue to work with our suppliers to determine the statistical analysis that may be required to demonstrate these values have been achieved.
- As we have discussed in previous reports, there are some aspects of biodiversity management that are not demonstrated by changes in biodiversity units. We will work

with biodiversity experts and environmental regulators to develop and utilise methodologies that can show improved biodiversity that may not equate to increased unit scores.

4 Appendix

An Estimate of the Network Rail UK-Habitats Account 2019 to 2023

Prepared for Network Rail

Christopher Marston, Clare Rowland, Peter Henrys, Aneurin O'Neill, Zephyr Orsler, Richard Pywell

Client Ref: PO number 5732428 (8997)
Issue number 2
14.02.2025

Title	An Estimate of the Network Rail UK-Habitats Account 2019 to 2023
Client	Network Rail
Client reference	PO number 5732428 (8997)
Confidentiality, copyright and reproduction	The contents of this report should be treated as commercial in confidence. They remain the copyright of the UK Centre for Ecology & Hydrology until released by the client [Network Rail]
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Date	14/02/2025

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1. Executive Summary

Assessment of the coverage and distribution of UK-Habitats stocks within the Network Rail (NR) land holdings is key to supporting NR in realising its nature conservation objectives. The extensive nature of the rail infrastructure, difficulties in accessing the lineside to undertake ground survey due to safety issues, and the logistics and resources required, means that network-wide ground survey is unfeasible to achieve this monitoring on an annual basis. Here, monitoring habitat stocks via Earth observation using satellite sensors is applied as a practical, repeatable and cost-effective approach to assessing habitat stocks and change in habitats, overcoming many of the limitations of ground-based survey. Here we use reproduced versions of the UK Land Cover Maps (LCM) for a five-year period from 2019 to 2023 using a consistent methodology to estimate the stock of UK-habitats within Network Rail (NR) land holdings and assess the locations and nature of land cover change occurring across this period.

Previous released versions of the UKCEH LCMs have differed slightly in their production methodology under a programme of continuous improvement, introducing some inconsistencies when assessing change over time using these data products. Here, LCMs 2019-2021 are reproduced using an identical methodology to LCM2022 and LCM2023, removing this inconsistency. The overall accuracy of this new LCM series was found to be 83.6% (2019), 84.0% (2020), 84.2% (2021), 86.1% (2022) and 83.0% (2023).

Comparison of the overall stock of land cover types on NR land holdings from 2019 to 2023 indicates small changes in the extent of habitats mapped by the Land Cover Map, including habitats considered to be of high nature conservation value. The headline changes in habitat are as follows: increases in broad leaved and yew woodland (+0.89% of total NR land holdings area), coniferous woodland (+0.08%) and grassland (+2.47%). Reductions were observed in sparsely vegetated (-2.11%), fen marsh and swamp (-0.65%), dwarf shrub heath (-0.39%) and rivers and lakes (-0.27%) classes. Coverage of bog (-0.01%) remained broadly similar. Of these changes, only the increase in broad-leaved woodland and the reduction in fen, marsh and swamp was found to be statistically significant.

It must be noted that the majority of NR's land holdings are linear and less than 20 m wide, containing a heterogeneous mix of land cover and vegetation types. This presents a number of challenges for detection in change of habitats because most of these linear features are below pixel resolution. The rail network also often runs through cuttings and this make the presence of shadows a problem for land cover mapping. These narrow heterogeneous areas are correspondingly at higher risk of misclassification than more homogenous areas typically found in the broader landscape.

Assessment of the capabilities of 10 m land cover classifications to detect known areas of land cover change from trees to non-trees occurring on NR land was performed. Results indicated a 68.8% detection rate in identifying tree loss in the proximity of recorded vegetation management activities conducted on Network Rail land holdings. It was not possible to validate the detection success of other land cover change vectors due to the sparsity of appropriate validation data.

Although a large extent of recorded tree removal has also been identified as changes between LCMs 2019 and 2023, the limitations in using two static land cover classifications to determine change must be acknowledged. This principally is a consequence of misclassification in the earlier and/or later classifications which could falsely be interpreted as real-world change, plus the increased susceptibility of narrow heterogeneous features, such as the NR land holdings assessed here, to misclassification. Accordingly, although the 10 m LCMs can be used to assess broad-scale land cover stocks (acknowledging the limitation above), it is generally not recommended that a time series of 10 m land cover classifications is used to monitor land cover change in this manner.

The 10 m LCMs represented the best available option for satellite land cover mapping in the period 2019-2023. However, the recent advent of widely available, multiband high- and medium-resolution satellite and airborne data potentially offer a better solution to overcoming the issues of mixed pixels on this linear infrastructure. UKCEH has recently explored the capabilities of higher resolution land cover mapping at 3 m resolution using multi-spectral and multi-temporal satellite data which offers improved detection and discrimination of smaller habitat patches. For highly heterogeneous locations such as many of those contained within the NR land holdings, this resolution of pixel (or higher) should offer improved classification performance and increase accuracy in land cover stock and change assessment in the future.

2. Introduction

This report outlines assessment of the coverage of UK-Habitats within the Network Rail (NR) land holdings for a five-year period from 2019 to 2023. Assessment is based upon a series of annual land cover classifications produced for each year within this period based on a similar methodology used to produce the UKCEH Land Cover Map products (Marston *et al.*, 2023). Whereas production methods for the UKCEH LCMs 2019 to 2023 differed under a programme of continuous development, the production methodology here is modified to apply an identical production methodology for all classifications across this time period, removing this potential source of variability. The land cover classification schema is also mapped to the UK Habitat Classification (UKHab) schema. The land cover classifications produced will aid NR in understanding the area coverage and distribution of trackside land cover types in support of NR realising its nature conservation objectives. This document describes this work and details of outputs.

A key factor and limitation in assessment of trackside vegetation is that the majority of NR land holdings are narrow, the trackside vegetation can be heterogeneous, and the frequency of cuttings mean that shade can be a problem. The Sentinel-2 satellite imagery that is the principal input into LCM production has a spatial resolution of 10 m, therefore an individual pixel within this imagery corresponding to a NR land holding location is likely to comprise a mix of different habitat types (Figure 1). Consequently, these mixed pixels have an increased susceptibility to misclassification. When comparing change between two land cover classifications for these mixed locations, the increased likelihood of misclassification in either of the two compared land cover classifications in turn can further reduce the reliability of the mapped land cover changes.

Figure 1. Left shows small length of NR land holdings against aerial photography; right against 10m resolution Sentinel-2 data.

3. Methods

Quantification of the area of UK-habitats on Network Rail land is based on the UKCEH Land Cover Map 10 m classified pixel product for 2019, 2020, 2021, 2022 and 2023. A key factor to note is that the methods underlying LCM production have been advanced under a programme of continuous development over a number of years to target identified misclassifications and progressively improve classification accuracy. Consequently, using the published versions of the UKCEH LCMs to assess land cover change is discouraged as differences in methodological production between LCMs could add an additional source of variability into the land cover change analysis. To remove this inconsistency and potential source of error, LCMs for 2019, 2020 and 2021 were reprocessed using an identical methodology to LCM2022 and LCM2023. Section 3 outlines the production methodology of the annual land cover classifications, extraction of land cover statistics for NR land holdings, mapping change in land cover presence, and validation of land cover change.

3.1 Land cover map production

3.1.1 Seasonal Composite Images

Seasonal composite images for classification were derived from Google Earth Engine. Sentinel-2 surface reflectance values were resampled to 10 m pixel resolution and median reflectance was computed for four time periods: January-March, April-June, July-September, and October-December, using ten Sentinel-2 bands 2, 3, 4, 5, 6, 7, 8, 8a, 11, and 12 (after Carrasco *et. al.*, 2019), see Table 1. There were occasional gaps in the seasonal composite images due to persistent cloud in an image compositing period which were represented by null data. Fortunately, these data gaps never occurred at a single location in all four of the seasonal composites, ensuring that at least some Sentinel-2 satellite data were available for classification. The classification algorithm used will tolerate partially complete spectral information, so we were able to produce land cover for the whole of the UK without the need to manually fill gaps.

Table 1. Sentinel-2 spectral bands and spatial resolutions.

Sentinel-2 Band	Central wavelength (µm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation red edge	0.705	20
Band 6 - Vegetation red edge	0.740	20

Band 7 - Vegetation red edge	0.783	20
Band 8 - Near infra-red	0.842	10
Band 8A - Vegetation red edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - Short wave infrared - cirrus	1.375	60
Band 11 - Short wave infrared	1.610	20
Band 12 - Short wave infrared	2.190	20

3.1.2 Context Rasters

Spectral confusion can occur between different land cover types that have similar spectral properties. For example, bare rock in the littoral coastal zone lack significant vegetation, so too do exposed mountain rocks and sealed urban surfaces. Spectrally these surfaces can appear very similar when viewed in satellite imagery, and extra detail is required to differentiate them. We used 10 m context rasters to resolve a range of confusion types. The 10 m context rasters used were:

1. Height, derived from the NEXTMap® terrain product from Intermap® Solutions.
2. Aspect, derived from the NEXTMap® terrain product from Intermap® Solutions.
3. Slope, derived from the NEXTMap® terrain product from Intermap® Solutions.
4. Distance from the nearest building, derived from Ordnance Survey open data.
5. Distance from road, derived from Ordnance Survey open data.
6. Distance from tidal water, derived from Ordnance Survey open data.
7. Distance from freshwater, derived from Ordnance Survey open data.
8. A foreshore binary mask, derived from Ordnance Survey open data.
9. A woodland binary mask, derived from Ordnance Survey open data.
10. A saltmarsh binary mask, derived from Environment Agency, Scottish Government and Natural Resources Wales open data.

3.1.3 Classification Scenes

For Great Britain, a grid of tiles based on a modified version of the Ordnance Survey 100 x 100 km tile grid was created (Figure 2). In total, 32 classification scenes were classified comprising full coverage of the GB land surface. Each classification scene was trained and classified independently. The approximate 100 x 100 km tile size was chosen as this provides a manageable size for processing. Moreover, if regions were much larger, phenological variation due to climatic difference across a classification scene could begin to degrade results. Some tiles such as those encompassing the Western Isles, Orkney and Shetland, and Cornwall and the Scilly Isles are larger. These are intentionally enlarged to avoid a sparsity of training data due to the extensive presence of sea in these tiles. Occasionally where tile extents are modified to include specific areas overlap between adjacent tiles do occur.

Calculation of land cover data for Network Rail land focused on Great Britain only, with no analysis performed for Northern Ireland.

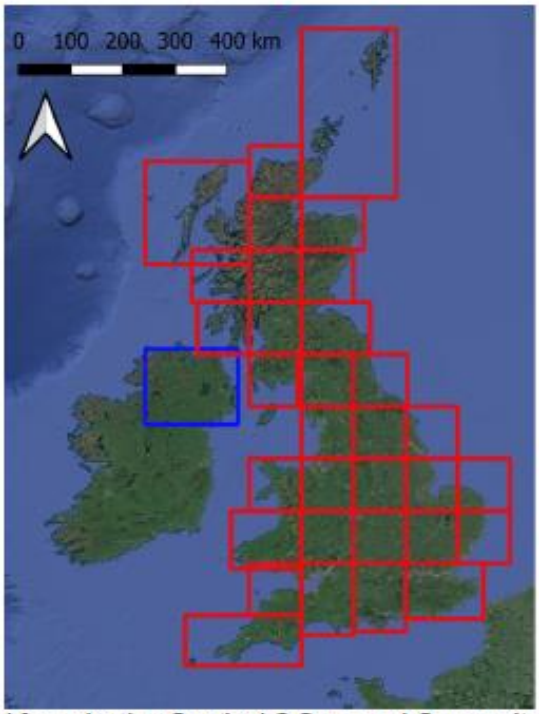

Figure 2. Tiles used for selecting Sentinel-2 Seasonal Composite Images for Great Britain (red) and Northern Ireland (blue).

3.1.4 Bootstrap Training

Bootstrapping is used to refer to a self-starting process that proceeds without external input. UKCEH have developed an automatic training process for land cover/habitat classification that does not require a fresh collection of (expensive) field-gathered data for classifier training, and we have named the process bootstrap training. Land cover and habitat change is usually gradual. Transitions from one land cover or habitat to another typically occurs over a number of years. Therefore recent habitat/land cover maps can be a valuable source of training data for a new map if the original maps are accurate and the update interval of the new map is short relative to target dynamics. When this is true, land cover observations from the historic maps can be used to sample the current satellite image to produce training observations. These can then be used by a Random Forest (RF) classifier to yield a classification result, which contributes to the bootstrap for the next map and so forth. Because the historic maps give wall-to-wall coverage they provide a very large number of training observations, which is the key to learning success. Machine-learning algorithms,

such as RF, rely on the majority signal to assign class membership, so when the bootstrap training set is very large if a minor proportion have changed class (are incorrect) over the refresh interval since these will have little influence on the dominant signal.

The bootstrap training dataset for UKCEH LCM2023, for example, came from UKCEH LCM2020, LCM2021 and LCM2022 classified pixel products. We filtered these land cover products retaining only pixels with >80% probability and which were classified as the same land cover class across all three years. Figure 3 gives an example of a bootstrap training dataset and resulting classification result. Crop rotations resulting in land cover change between arable and improved grassland classes within the preceding three-year period, means that in some areas this method is less well suited to producing training data for these classes. Consequently, training data for arable and improved grassland classes was instead sourced from the UKCEH Land Cover® plus: Crops data for 2023. For each year for which a land cover classification is produced an identical method was applied, with the years from which training data is sourced changed on a rolling basis to harvest training data from the three preceding years.

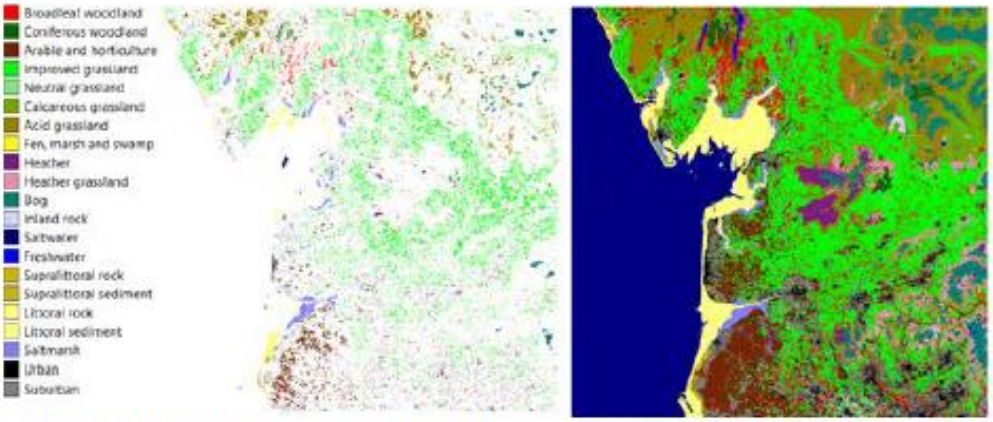

Figure 3. UKCEH Land Cover classes (left), a bootstrap training set (centre) and the resultant RF land cover classification (right).

3.1.5 Random Forest classification

Random Forest (RF) classification (Breiman, 2001) is a supervised learning technique that uses a training set of known observations to derive an empirical relationship which is then used to predict the membership of unknown observations. Bootstrap training pixels were placed into labelled bags and from each bag 10,000 samples, with replacement were drawn to train the RF classifier. The RF classifier subsequently yields the 10 m land cover classification. Sampling with replacement ensures that all land cover classes have an equal number of pixel observations for training the RF, this balances learning. Without balanced learning, the signal of rarer

classes will be weak and susceptible to domination from commoner classes, causing misclassification. The classification software used for UKCEH LCMs is bespoke and was developed by UKCEH scientific staff. It integrates the Weka (Frank *et. al.* 2016) machine learning suite with a PostGIS geospatial database and GDAL tools (https://gdal.org/). These are all open-source technologies.

Once the classifications are generated, a series of minor knowledge-based corrections were applied. These included reclassification of misclassified arable pixels to improved grassland in urban green space areas (as denoted by the OS Open Greenspace data set), and of coastal classes being misclassified inland using a coastal mask.

3.2 Product validation

The accuracy of each land cover classification (2019-2023) was validated using a large set of validation reference points distributed across Great Britain and covering all 21 LCM classes. The reference data is a composite data set, derived from the GB countryside survey, open-source National Forest Inventory data, Rural Payment Agency data and a set of bespoke LCM validation points generated from manual image interpretation and field collection (see Marston *et al.*, 2023 for details). These were intersected with each of the land cover classifications to determine correspondence. The LCM2022 and LCM2023 data used within this project was the full UKCEH LCM releases with accuracy assessment performed on both GB and Northern Ireland, comprising 33,107 validation points. The LCMs for 2019, 2020 and 2021 are LCM versions reproduced for this project to have a consistent production methodology with LCMs 2022 and 2023, with these datasets reproduced only for GB. As such, the validation datasets for 2019-2021 comprised 30,954 validation points as the Northern Ireland validation data is not included. The validation data used is drawn from the full national extent of the LCM and is not specific to only NR land holding areas.

3.3 Translating from UKCEH land cover classes to UK-Habitats

The 10 m pixel LCMs use the UKCEH land cover class schema which are based on UK Biodiversity Action Plan broad habitats (Jackson *et al.*, 2000); these were translated to UK-Habitats (UKHab). UK-Habitats are a hierarchical schema (UK Habitat Working Group, 2018) with direct analogues to UKCEH Land Cover (Table 2). There are three exceptions: (1) UK-Habitats do not have a saltwater class, with this UKCEH LCM class assigned instead to UK-Habitat 'Rivers and Lakes, r'. (2) UK-Habitats do not have a class for a heather-grassland mosaic, with this UKCEH LCM class assigned instead to 'Acid grassland, g1'; (3) UKCEH LCM classes littoral

sediment and saltmarsh and both mapped to UKHabs class t2a (Coastal saltmarsh). Converting the UKCEH land cover product to UK-Habitats is achieved by cross-referencing using Table 2.

Table 2. Conversion of UKCEH Land Cover Map classes to equivalent UK-Habitat classes.

	UKCEH Land Cover	LCM class ID	UK-Habitat	UK-Hab ID
Grassland			Grassland	g
	Acid grassland	7	Acid grassland	g1
	Calcareous grassland	6	Calcareous grassland	g2
	Neutral grassland	5	Neutral grassland	g3
	Improved grassland	4	Modified grassland	g4
Woodland			Woodland	w
	Deciduous woodland	1	Broad leaved and yew woodland	w1
	Coniferous woodland	2	Coniferous woodland	w2
Heath, shrub				h
	Heather grassland	10	No corresponding habitat	g1
	Dwarf shrub and heath	9	Dwarf shrub and heath	h1
Wetland				f
	Bog	11	Bog	f1
	Fen	8	Fen, marsh and swamp	f2
Croplands				c
	Arable	3	Arable and horticulture	c1
Urban				u
	Suburban	21	Built up areas and gardens	u1
	Urban	20	Developed land, sealed surface	ulb
Rivers and lakes				r
	Freshwater	14	Rivers and lakes	r

Sparsely vegetated land				s
	Inland rock	12	Inland rock	s1
	Supralittoral rock	15	Supralittoral rock	s2
	Supralittoral sediment	16	Supralittoral sediment	s3
Marine inlets and tidal				t
	Littoral rock	17	Littoral rock	t1
	Littoral sediment	18	Coastal saltmarsh	t2a
	Saltmarsh	19	Coastal saltmarsh	t2a
	Saltwater	13	No corresponding habitat	r

The land cover classifications are not trained on lineside habitats due to their high land cover heterogeneity and narrow size, instead being trained on areas of homogenous land cover found in the wider landscape outside NR land holdings. Consequently, trackside mixed pixels occurring within NR land holdings which often include areas of low or no vegetation cover such as track bed, along with vegetation in trackside areas, can be misclassified as a number of land cover class typified by a mix of seasonally vegetated and non-vegetated surfaces such as arable and horticulture. To overcome this issue, a new sparsely vegetated class was created which merged land cover classes exhibiting similar low-vegetation characteristics. The classes merged into this sparsely vegetated class are arable and horticulture (c1), inland rock (s1), supralittoral rock (s2), supralittoral sediment (s3), littoral rock (t1), coastal saltmarsh (t2a), developed land, sealed surface (u1b), and built-up and gardens (u1). Similarly, a further grouping of spectrally similar modified (g4), neutral (g3), calcareous (g2) and acid (g1) grassland classes was performed to form a single grassland class. Subsequent analysis utilised these merged sparsely vegetated and grassland classes.

3.4 Regional statistics

Regional statistics describing land cover proportions in both UK-Habs and UKCEH LCM schemas for NR land holdings were generated. The land cover information produced for each of the years from 2019 to 2023 was extracted for each of the 42,696 Maintenance Delivery Units (MDU) areas. This identified for each MDU which land cover types are present within the MDU boundary, and how many pixels of the respective land cover classes are present. These statistics are extracted using the UKCEH LCM classification schema and are then mapped to the equivalent UK-Habs

classification scheme. The results are provided as a series of ESRI shapefiles representing MDU boundaries and an attribute count for each habitat type and have also been summarised in excel files (provided alongside this report, see section 6: Deliverables). Additional attributes are included providing pixel counts for the merged sparsely vegetated and grassland classes.

3.5 Land cover change 2019-2023 validation

Validation of land cover change utilised lineside vegetation management records for works conducted on Network Rail lineside land holdings. This dataset outlined the dates, locations and nature of vegetation works conducted. As the conducted works mainly corresponded to vegetation clearance and removal, validation focused on assessing detection of tree loss from 2019 to 2023.

This data set has some weaknesses, in particular its descriptive nature means there is some uncertainty as to the exact extent and nature of vegetation management within an MDU. In addition, the work locations did exhibit a consistent spatial offset with existing maps of rail locations. A correction was applied to realign the work locations as close as possible to the rail tracks. To mitigate for potential positional inaccuracies in the recording of work location, each work location point was buffered by 150 m. Subsequent assessment of tree loss detection in the 2019-2023 LCMs focussed on these 150 m buffered areas rather than the specific point locations, to introduce a tolerance for potential positional inaccuracies.

The vegetation management dataset was filtered to retain only records where management works was identified as being conducted on trees, with either chainsaw or mechanised felling, though it is accepted this could mean the removal of branches rather than the whole tree. Further filtering was applied to remove all records of small areas of work (<1500m²), any records of work conducted prior to 2020 (2019 was used as a baseline year) or for July 2023 onwards. Points where work was conducted in or after July 2023 were removed as the input satellite imagery used in the production of the 2023 LCM would predominantly include imagery prior to vegetation management occurring, reducing the likelihood of detection. Records where the attribute information indicated the works conducted did not include the removal of

trees were removed. This retained a total of 1574 validation locations across Great Britain (Figure 4).

Figure 4. Validation locations.

A change raster was then produced from the 2019 and 2023 land cover maps describing the vectors of land cover change (the land cover classes for which a location had changed from and to between 2019 and 2023), with this change raster then converted to vector (polygon) format. These polygons were then filtered to retain only polygons intersecting Network Rail land holdings. The area of each polygon denoting land cover change was calculated, and all areas smaller than three 10 m pixels in area (300 m²) were disregarded, retaining only larger change polygons. These larger areas are more likely to correspond to genuine change, rather than pixel misclassification in either the 2019 or 2023 classifications. A further filtering retained only polygons corresponding to changes from trees in 2019 to non-trees in 2023. Further analysis then identified all buffered vegetation management locations where tree removal was recorded which intersected the retained LCM 2019-2023 derived

change from trees polygons. This enabled the detection rate of tree loss in the 2019-2023 change methods to be assessed.

3.6 Quantifying Uncertainty in Estimates

As the areas of habitat derived from the land cover map are the result of a classification model applied to satellite imagery, there is inevitably uncertainty in the classification. Therefore, to enable a robust assessment of change in habitat classes, the uncertainty in the areal estimates produced needs to be quantified. Essentially, this allows separation of what is genuine change from differences resulting from uncertainty. Uncertainty here results from the classification error that arises within each of the land cover maps – where one land class may be incorrectly assigned to another. Whilst the validation and assessment work undertaken shows that the true classification rate is high, and therefore misclassification and error is relatively low, it still exists and could make a difference to total area estimates if ignored. Mechanisms to quantify the uncertainty in the total area estimates are hence needed. To do so relies on making use of some additional information. There are two statistically optimal ways in which additional information could be used to quantify uncertainty.

The first approach is to use associated ground-truth data alongside the classification information within a Bayesian data assimilation approach. This is exemplified in both Henrys and Jarvis (2019) and Levy et al. (2018), whereby all information is combined in a unified model of land use change that allows for each data source to have different characteristics, but that the overall change has to be consistent. This approach is based on the assumption that different data are providing a different view of the same phenomenon observed through different processes with different uncertainty potentially associated with each. In combining the rich information together estimates of habitat extent, along with the associated uncertainty can be derived. The second option makes use of detailed ground-based information to produce a robust classification matrix. This, in turn, can then be used to quantify the error associated with total counts across the different classes. Recent work by Spence et al. (2025) has demonstrated how this approach can be us to quantify uncertainty associated with classification of counts. Fundamentally, this approach relies on the classification matrix and hence good data to provide a robust assessment of this. Both of the statistically optimal approaches therefore rely on robust, extensive and representative ground-truthed data on land use.

In lieu of high quality and extensive ground-truthed information available that could be used in either of the approaches outlined above, an alternative approach is needed. In this case, we use the information across years as the replicated estimates from which uncertainty estimates can be derived. In this approach the information across years 2019-2023 is grouped into two classes: 2019-2021 and 2022-2023. The data across the years is then used to quantify the variability in the areal estimates.

Whilst the number of replicates (years of data) is not large, the number of areal units (MDUs) is large enough to provide a good estimate of the variance in the total area if we assume that this is consistent. The overall estimates derived are therefore obtained by grouping individual years into groups, and using the inter-annual variability as a measure of the overall uncertainty associated with the total area estimates.

4. Results

4.1 Land cover classification accuracy assessment

Accuracy assessment of the land cover classifications produced for 2019 to 2023 was performed using a validation dataset comprising 30,954 validation locations for LCMs 2019-2021, and 33,107 for LCMs 2022 and 2023. The overall accuracies of the classifications are given in Table 3, with full correspondence matrices presented in Appendix 1. Note that these accuracy assessments were performed on the full GB land cover classifications using the UKCEH Land Cover Map classes, not specifically for the classified areas corresponding to the NR land holdings. The overall accuracy for all LCMs is high, ranging from 0.830 in 2023 to 0.861 in 2022.

Table 3. Accuracy assessment of the 2019-2023 land cover classifications.

Year	Overall accuracy (%)	95% confidence intervals (%)	Kappa coefficient
2019	0.836	0.832, 0.840	0.804
2020	0.840	0.836, 0.844	0.809
2021	0.842	0.838, 0.846	0.812
2022	0.861	0.858, 0.865	0.836
2023	0.830	0.826, 0.834	0.799

4.2 Land cover extraction

The number of pixels of each land cover class are extracted for each MDU. These statistics are summarised to give overall land cover figures for the NR land holdings each year from 2019 to 2023. Figures are presented as total area (km²) of each land cover type (Table 4), and as a percentage of the overall NR land holdings area (Table 5 and Figure 5).

Table 4. Total area (km²) of each land cover class for Network Rail land for 2019 to 2023.

UK-Habitat	2019	2020	2021	2022	2023
Broad leaved and yew woodland (w1)	75.20	73.05	77.54	84.83	79.77
Coniferous woodland (w2)	6.03	6.22	5.74	5.52	6.47
Grassland	121.42	116.93	92.98	89.82	134.17
Fen marsh and swamp (f2)	9.64	9.10	7.53	5.67	6.30

Dwarf shrub and heath (h1)	8.13	6.31	7.31	10.13	6.09
Bog (f1)	1.29	1.26	1.20	2.31	1.22
Sparsely vegetated	290.71	300.69	321.93	314.7	279.8
Rivers and lakes (r)	3.67	2.52	1.86	3.11	2.25
Total	516.09	516.09	516.09	516.09	516.09

Table 5. Percentage coverage of each land cover class for Network Rail land for 2019 to 2023.

UK-Habitat	2019	2020	2021	2022	2023
Broad leaved and yew woodland (w1)	14.57	14.15	15.02	16.44	15.46
Coniferous woodland (w2)	1.17	1.21	1.11	1.07	1.25
Grassland	23.53	22.66	18.02	17.40	26.00
Fen marsh and swamp (f2)	1.87	1.76	1.46	1.10	1.22
Dwarf shrub and heath (h1)	1.57	1.22	1.42	1.96	1.18
Bog (f1)	0.25	0.24	0.23	0.45	0.24
Sparsely vegetated	56.33	58.27	62.38	60.98	54.22
Rivers and lakes (r)	0.71	0.49	0.36	0.60	0.44
Total	100.00	100.00	100.00	100.00	100.00

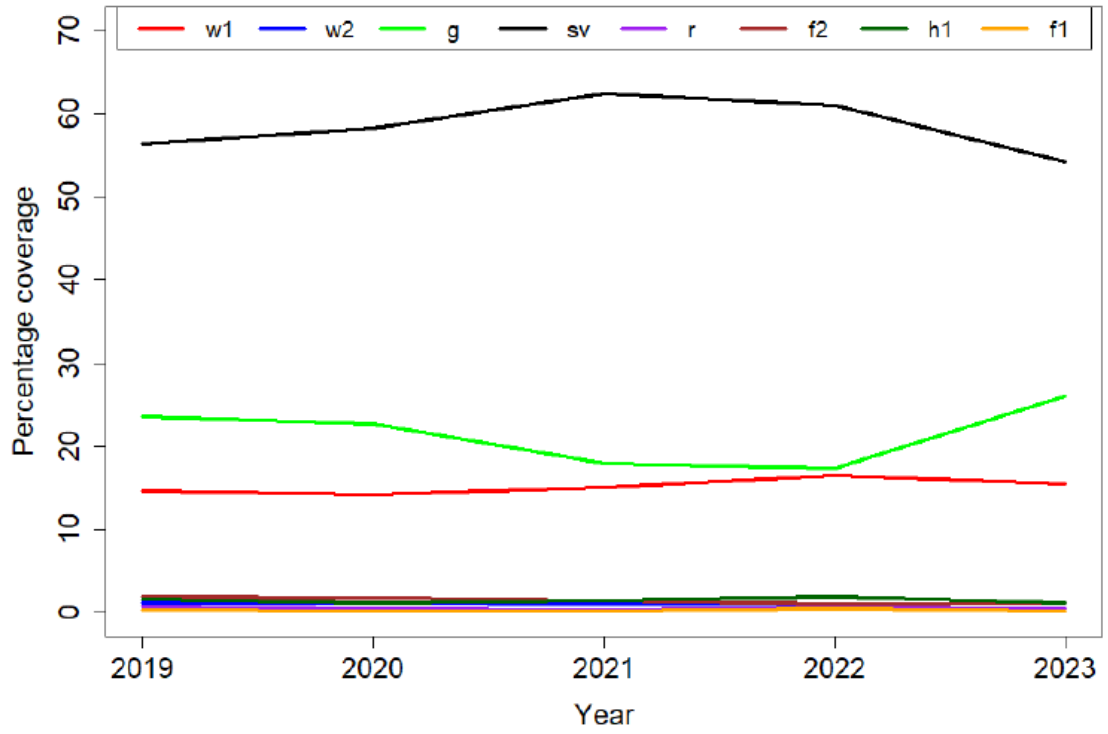

Figure 5. Land cover class coverages from 2019 to 2023 for broad leaved and yew woodland (w1), coniferous woodland (w2), grassland (g), sparsely vegetated (sv), rivers and lakes (r), Fen marsh and swamp (f2), Dwarf shrub and heath (h1) and bog (f1).

4.3 Incorporating uncertainty

The repeated areal estimates across years were included within a statistical model to estimate the total area in each UK-habitat category across the years 2019-2021 and 2022-2023. Separate models were fitted for each of the UK- habitat categories and the error in habitat area was assumed to be approximately normally distributed – that is, the observed area of each habitat based on the pixel-based classification of each MDU was equal to the true habitat coverage plus some random, normally distributed error centred on zero. The repeats across individual years were used to estimate the standard deviation of this error, but years were grouped to enable separate estimates of extend and an estimate of change. The approach therefore allowed for quantification of confidence bounds on the estimated areas in each of the two periods and therefore an ability to consider the significance of change in areal extent for each of the habitat categories. The results are shown in Table 6 below.

Table 6. Total area (km^2) of each land cover class for Network Rail land for the reporting periods of 2019-2021 and 2022-2023. Estimates are derived from a statistical model fitted to the data across individual years to enable production of associated confidence intervals and assessment of the significance of change.

UK-Habitat	2019-2021			2022-2023			Change
	Lower 95% CI	Estimated Area	Upper 95% CI	Lower 95% CI	Estimated Area	Upper 95% CI	
Broad leaved and yew woodland (w1)	72.14	75.26	78.38	78.47	82.30	86.12	Increase
Coniferous woodland (w2)	5.50	6.00	6.49	5.39	6.00	6.60	No Significant Change
Grassland	85.55	110.44	135.33	81.51	111.99	142.48	No Significant Change
Fen marsh and swamp (f2)	7.70	8.76	9.81	4.69	5.98	7.28	Decrease
Dwarf shrub and heath (h1)	5.20	7.25	9.30	5.60	8.11	10.62	No Significant Change
Bog (f1)	0.74	1.25	1.75	1.15	1.77	2.39	No Significant Change
Sparsely vegetated	282.66	304.53	326.40	270.62	297.41	324.19	No Significant Change
Rivers and lakes (r)	1.66	2.60	3.54	1.37	2.52	3.67	No Significant Change

4.4 Land cover change validation

Of the 1581 tree loss validation locations (150 m buffered area of locations of recorded Network Rail tree removal), a total of 1087 locations recorded change from trees to non-trees between 2019-2023 in the LCM change raster, giving a 68.8% detection rate. We note that due to limited availability of appropriate land cover change data, only change from trees to non-trees could be assessed here.

5. Discussion

The methods described here provide an estimate of UK-Habitats within NR owned land for each year 2019 to 2023. Across all categories, the area coverage of each land cover class varied year to year, with no monotonic increases or decreases observed. Taking the change across the start and end of the LCM series (i.e. the 2019 and 2023 results) shows increases in the coverage of broad leaved and yew woodland, coniferous woodland, and grassland are observed. Correspondingly, reductions were observed for the sparsely vegetated, fen marsh and swamp, dwarf shrub heath, and rivers and lakes classes. However, when the year to year variation is used as a proxy for the associated classification uncertainty within a statistical model, we see that the only significant changes between the 2019-2021 and 2022-2023 periods are an increase in the area of broad leaved and yew woodland and a decrease in the area of fen marsh swamp. Other changes are deemed to be not statistically significant.

The estimated overall accuracies of the five LCMs when assessed as the national level are all high for a 21-class nomenclature, ranging from 0.83 for 2023 up to 0.86 for 2022. These 10 m classifications provide good broad-scale characterisation of habitats and land cover across Network Rail land holdings, however the majority of Network Rail land is characterised by narrow track-side strips with some landscape features being simply too small to be reliably identified with 10 m pixels. A 10 m pixel can potentially include areas of track bed, bankside vegetation (potentially a mix of different vegetation types) as well as extending into adjacent areas outside the Network Rail land holdings which could comprise multiple land cover types depending on location. A consequence of this mixed pixel effect is an increased susceptibility to misclassification. As the majority of Network Rail land holdings are narrow and contain a complex mix of land cover, 10 m pixel land cover maps can achieve a good estimation of assets at regional and national level, but have limitations for more local, direct estimates. For these more local, direct estimates higher resolution satellite imagery or airborne imagery are required to enable improved separation of habitat patches which, at 10 m resolution, can only be observed as mixed pixels (Figure 6). UKCEH are currently investigating the potential of national-scale 3 m resolution satellite data to improve the characterisation and mapping of habitat stocks and of change in these stocks year-to-year. However, in contrast to Sentinel-2, these satellite data are not free, so costs and benefits will have to be carefully considered. The recent acquisition of new multi-spectral high-resolution sensors for the Network Rail helicopter also offers potential for greatly improved mapping accuracy for limited areas of interest.

Figure 6. Comparison of a) 10 m and b) 3 m satellite imagery for a stretch of the West coast main line, Milton Keynes.

Accurately assessing land cover change in the UK remains challenging due to the relatively small area of many UK land cover parcels, and the relatively small scale of much of the change that occurs. Although here the 2019-2021 LCMs have been reproduced to maintain an identical production methodology across the full time series of land cover classifications, removing any influences that may have resulted from differing methodologies, misclassification occurring in both the input land cover classifications still impacts land cover change assessment. The susceptibility of Network Rail land holdings given their small size, heterogeneous nature, (where multiple land cover types comprise the area of a single pixel) and susceptibility to shading further limits the capabilities of this method to detect specific locations of genuine change and identify the nature of that change. These can potentially result in areas of change being incorrectly identified, whereby the change in land cover class identified actually results from misclassification in either of the input classifications. Historically it has been recommended that the UKCEH LCMs are not used for change detection for this reason (Fuller, Smith and Devereux, 2003), and it is important to understand the limitations of these methods and datasets when producing summary statistics for a region, to avoid inferring incorrect conclusions of change occurring whereas this is actually a consequence of false detections.

Given the limited availability of appropriate land cover change ground reference data, validation here focussed on change from trees to non-tree classes. This demonstrated that for 1087 of 1581 validation locations (68.8%) tree loss was detected in the proximity of the recorded Network Rail vegetation management involving mechanised or chainsaw felling of trees. However, this descripted data has limitations and uncertainty in the accuracy with which it described the extent and type of management. It was not possible here to validate other land cover change vectors

due to lack of reference data availability. It should also be noted that while some land cover changes can occur abruptly such as the loss of trees, other change vectors occur over a longer period and are more difficult to detect. For example, change to woodland will only be detected when enough trees have reached a level of maturity that woodland is the predominant spectral signal for the given location in the satellite data. This can depend on woodland type, planting density and the proficiency of woodland management, and may take many years from initial planting. Similarly, some land cover classes are difficult to differentiate in the field and from 10 m resolution EO data, and particularly susceptible to inter-class confusion given their spectral similarity. Consequently, whilst the 10 m land cover classification data are useful in providing an overview of the land cover trends, they are not currently sensitive enough to confidently detect the relatively small levels of change in many land cover classes over relatively short time periods (5 years or less). It is likely that future development of higher resolution 3 m (and higher resolution) land cover classification methods will improve capabilities and accuracies of these activities. Should high quality reference data be available, it would also be possible to undertake a full assessment of the uncertainty in the classification and incorporate this within a unified statistical model of change.

6. Deliverables

Table 7. Data set deliverables.

File name	Description	File size
NR_1km_buffer_clip_LCM2019.tif	LCM2019 rerun clipped to NR land holdings with 1km buffer. EPSG:27700, 10 m pixels, 1 band.	43mb
NR_1km_buffer_clip_LCM2020.tif	LCM2020 rerun clipped to NR land holdings with 1km buffer EPSG:27700, 10 m pixels, 1 band.	43mb
NR_1km_buffer_clip_LCM2021.tif	LCM2021 rerun clipped to NR land holdings with 1km buffer EPSG:27700, 10 m pixels, 1 band.	44mb
NR_1km_buffer_clip_LCM2022.tif	LCM2022 rerun clipped to NR land holdings with 1km buffer EPSG:27700, 10 m pixels, 1 band.	42mb
NR_1km_buffer_clip_LCM2023.tif	LCM2023 rerun clipped to NR land holdings with 1km buffer EPSG:27700, 10 m pixels, 1 band.	42mb
pixel_count_NR_Ownership_MDU_Routes_2019.shp	Zipped MDU shapefile containing extracted land cover statistics for 2019. Includes attributes for the number of pixels of each land cover class for the respective MDU for both LCM and UKHab classification systems.	31mb (.zip)
pixel_count_NR_Ownership_MDU_Routes_2020.shp	Zipped MDU shapefile containing extracted land cover statistics for 2020. Includes attributes for the number of pixels of each land cover class for the respective MDU for both LCM and UKHab classification systems.	31mb (.zip)
pixel_count_NR_Ownership_MDU_Routes_2021.shp	Zipped MDU shapefile containing extracted land cover statistics for 2021. Includes attributes for the number of pixels of each land cover class for the respective MDU for both LCM and UKHab classification systems.	31mb (.zip)
pixel_count_NR_Ownership_MDU_Routes_2022.shp	Zipped MDU shapefile containing extracted land cover statistics for 2022. Includes attributes for the number of pixels of each land cover class for the respective MDU for both LCM and UKHab classification systems.	31mb (.zip)
pixel_count_NR_Ownership_MDU_Routes_2023.shp	Zipped MDU shapefile containing extracted land cover statistics for 2023. Includes attributes for the number of pixels of each land	31mb (.zip)

	cover class for the respective MDU for both LCM and UKHab classification systems.	
NR_MDU_summmary_LCM2019.csv	Summary statistics spreadsheet 2019	47kb
NR_MDU_summmary_LCM2020.csv	Summary statistics spreadsheet 2020	47kb
NR_MDU_summmary_LCM2021.csv	Summary statistics spreadsheet 2021	47kb
NR_MDU_summmary_LCM2022.csv	Summary statistics spreadsheet 2022	47kb
NR_MDU_summmary_LCM2023.csv	Summary statistics spreadsheet 2023	47kb
lcm_style_raster.qml	A QGIS symbology for displaying the revised land cover classification as UKCEH LCM classes.	4kb
ukhab_style_raster.qml	A QGIS symbology for displaying the revised habitat map as UK-Habitats classes.	4kb

7. Acknowledgements

The contribution and historical input of Daniel Morton in the development of in-house software used to produce the land cover classifications, and in the previous mapping of habitat stock on Network Rail track-side areas is acknowledged.

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Appendix 1 – Land cover classification correspondence matrices

Table 8. Classification correspondence matrix for the 2019 land cover classification. Land cover class codes are: 1 = broadleaved woodland, 2 = coniferous woodland, 3 = arable, 4 = improved grassland, 5 = neutral grassland, 6 = calcareous grassland, 7 = acid grassland, 8 = fen, 9 = heather, 10 = heather grassland, 11 = bog, 12 = inland rock, 13 = saltwater, 14 = freshwater, 15 = supra-littoral rock, 16 = supra-littoral sediment, 17 = littoral rock, 18 = littoral sediment, 19 = saltmarsh, 20 = urban, 21 = suburban, UA = Users Accuracy, PA = Producers Accuracy, OA = overall accuracy. Accuracy assessment is performed using the LCM class schema.

	Reference																						
Classified	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**Total**	**UA**
1	1593	133	9	4	1	0	6	1	6	2	1	0	0	1	0	0	0	0	0	0	7	1764	90.3
2	50	569	0	0	0	0	4	0	6	3	0	0	0	0	0	0	0	0	0	0	0	632	90.0
3	18	4	9261	193	6	4	14	7	3	7	17	0	0	1	0	2	1	0	0	15	21	9574	96.7
4	145	5	789	4701	143	149	378	20	19	172	61	1	0	1	3	24	0	0	0	5	104	6720	70.0
5	2	0	4	84	403	2	18	0	0	3	4	0	0	0	0	0	0	0	0	0	3	523	77.0
6	17	0	8	13	2	811	21	0	0	1	0	0	0	0	0	0	0	0	0	0	0	873	92.9
7	1	0	14	56	6	49	894	0	34	129	40	0	0	0	0	0	0	0	0	0	1	1224	73.0
8	9	0	1	5	2	0	0	556	1	1	3	0	0	3	0	0	0	0	1	0	0	582	95.5
9	10	2	3	2	1	2	53	1	809	119	238	0	0	0	0	0	0	0	0	0	1	1241	65.2
10	6	5	5	8	0	15	162	0	45	277	105	0	0	0	0	0	0	0	0	0	0	628	44.1
11	0	1	0	2	0	0	14	0	10	43	634	0	0	1	0	0	0	0	0	0	0	705	89.9
12	1	7	188	17	0	1	20	0	4	3	3	136	0	1	0	1	0	2	0	86	10	480	28.3
13	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	3	0	0	0	51	94.1
14	1	0	0	1	1	0	0	1	0	0	1	0	0	440	0	0	0	3	0	1	0	449	98.0
15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	29	3	7	8	0	1	0	49	59.2
16	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	162	0	17	1	0	0	183	88.5
17	0	0	0	0	0	0	0	0	0	1	0	0	0	1	10	0	77	18	0	0	0	107	72.0
18	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	3	2	185	0	0	0	193	95.9
19	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	3	165	0	0	178	92.7
20	1	0	4	4	0	0	0	0	0	0	0	0	0	0	1	15	0	4	0	2194	492	2715	80.8
21	8	0	5	13	0	0	0	0	0	3	0	7	0	0	0	1	0	0	0	120	1926	2083	92.5
Total	1862	726	10292	5103	567	1033	1585	596	937	764	1107	144	49	449	45	211	87	243	167	2422	2565	30954	
PA	85.6	78.4	90.0	92.1	71.1	78.5	56.4	93.3	86.3	36.3	57.3	94.4	98.0	98.0	64.4	76.8	88.5	76.1	98.8	90.6	75.1	OA =	0.836

Table 9. Classification correspondence matrix for the 2020 land cover classification. Land cover class codes are: 1 = broadleaved woodland, 2 = coniferous woodland, 3 = arable, 4 = improved grassland, 5 = neutral grassland, 6 = calcareous grassland, 7 = acid grassland, 8 = fen, 9 = heather, 10 = heather grassland, 11 = bog, 12 = inland rock, 13 = saltwater, 14 = freshwater, 15 = supra-littoral rock, 16 = supra-littoral sediment, 17 = littoral rock, 18 = littoral sediment, 19 = saltmarsh, 20 = urban, 21 = suburban, UA = Users Accuracy, PA = Producers Accuracy, OA = overall accuracy. Accuracy assessment is performed using the LCM class schema.

	Reference																						
Classified	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total	UA
1	1588	141	10	4	1	0	1	1	5	1	1	0	0	1	0	0	0	0	0	0	8	1762	90.1
2	52	562	0	0	0	0	4	0	6	3	0	0	0	1	0	0	0	0	0	0	0	628	89.5
3	16	7	9411	222	8	11	9	5	6	5	6	0	0	0	0	7	1	1	0	22	23	9760	96.4
4	162	3	573	4679	143	147	375	21	23	202	95	1	0	2	2	25	0	0	0	3	94	6550	71.4
5	1	0	3	75	404	1	14	1	0	3	0	0	0	0	0	0	0	0	0	0	2	504	80.2
6	11	0	5	15	1	800	21	0	0	1	0	0	0	0	0	0	0	0	0	0	0	854	93.7
7	2	1	6	62	4	55	908	0	26	138	42	0	0	0	0	0	0	0	0	0	0	1244	73.0
8	7	0	4	3	2	0	0	556	1	2	4	0	0	3	0	0	0	0	1	0	0	583	95.4
9	9	2	4	1	0	2	48	0	805	115	243	0	0	0	0	0	0	0	0	0	0	1229	65.5
10	3	3	7	11	1	12	173	0	50	262	79	0	0	0	0	0	0	0	0	0	0	601	43.6
11	0	3	0	0	0	4	14	0	10	30	634	0	0	1	0	0	0	0	0	0	0	696	91.1
12	2	4	254	12	0	1	16	0	5	1	2	136	0	0	0	0	0	1	0	73	9	516	26.4
13	0	0	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	6	0	0	0	53	88.7
14	1	0	0	1	1	0	0	2	0	0	0	0	0	440	0	0	0	1	0	0	0	446	98.7
15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	31	4	6	4	0	0	0	46	67.4
16	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	159	0	14	3	0	0	180	88.3
17	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	0	78	24	0	0	0	114	68.4
18	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	2	186	0	0	0	193	96.4
19	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	2	163	0	0	175	93.1
20	1	0	7	3	0	0	0	0	0	0	0	0	0	0	1	12	0	4	0	2196	462	2686	81.8
21	7	0	7	15	0	0	0	0	0	1	1	7	0	0	0	1	0	0	0	128	1967	2134	92.2
Total	1862	726	10292	5103	567	1033	1585	596	937	764	1107	144	49	449	45	211	87	243	167	2422	2565	30954	
PA	85.3	77.4	91.4	91.7	71.3	77.4	57.3	93.3	85.9	34.3	57.3	94.4	95.9	98.0	68.9	75.4	89.7	76.5	97.6	90.7	76.7	OA =	0.840

Table 10. Classification correspondence matrix for the 2021 land cover classification. Land cover class codes are: 1 = broadleaved woodland, 2 = coniferous woodland, 3 = arable, 4 = improved grassland, 5 = neutral grassland, 6 = calcareous grassland, 7 = acid grassland, 8 = fen, 9 = heather, 10 = heather grassland, 11 = bog, 12 = inland rock, 13 = saltwater, 14 = freshwater, 15 = supra-littoral rock, 16 = supra-littoral sediment, 17 = littoral rock, 18 = littoral sediment, 19 = saltmarsh, 20 = urban, 21 = suburban, UA = Users Accuracy, PA = Producers Accuracy, OA = overall accuracy. Accuracy assessment is performed using the LCM class schema.

	Reference																						
Classified	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total	UA
1	1611	146	12	10	1	0	3	1	5	4	0	0	0	0	0	0	0	0	0	1	9	1803	89.4
2	43	559	1	0	0	0	4	0	10	3	0	0	0	0	0	0	0	0	0	0	0	620	90.2
3	19	4	9331	214	9	3	15	8	3	11	2	0	0	1	0	6	0	1	0	10	19	9656	96.6
4	128	2	640	4647	142	120	354	16	18	181	91	1	0	1	2	24	0	0	0	3	66	6436	72.2
5	1	0	6	73	401	1	16	1	0	3	1	0	0	0	0	0	0	0	0	0	1	504	79.6
6	16	0	10	20	2	823	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	893	92.2
7	4	1	14	74	5	75	948	0	24	158	33	0	0	0	0	0	0	0	0	0	1	1337	70.9
8	7	0	5	4	1	0	0	554	0	1	1	0	0	3	0	0	0	0	1	0	0	577	96.0
9	5	3	5	1	0	4	36	1	798	110	220	0	0	0	0	0	0	0	0	0	0	1183	67.5
10	5	0	3	9	0	6	157	0	60	262	100	0	0	0	0	0	0	0	0	0	0	602	43.5
11	0	2	0	1	0	1	11	0	12	27	653	0	0	0	0	0	0	0	0	0	0	707	92.4
12	10	9	255	24	3	0	17	0	7	3	4	137	0	1	0	2	0	1	0	59	14	546	25.1
13	0	0	0	0	0	0	0	0	0	0	0	0	49	0	0	0	0	5	1	0	0	55	89.1
14	0	0	0	1	1	0	0	5	0	0	0	0	0	441	0	0	0	2	0	0	0	450	98.0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	5	8	4	0	0	0	48	64.6
16	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	159	0	12	0	1	0	175	90.9
17	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	0	73	30	0	0	0	116	62.9
18	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	4	183	0	0	0	191	95.8
19	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	1	165	0	0	176	93.8
20	1	0	5	5	0	0	1	0	0	0	0	0	0	0	0	9	2	4	0	2208	422	2657	83.1
21	12	0	5	20	0	0	0	0	0	1	2	6	0	0	0	3	0	0	0	140	2033	2222	91.5
Total	1862	726	10292	5103	567	1033	1585	596	937	764	1107	144	49	449	45	211	87	243	167	2422	2565	30954	
PA	86.5	77.0	90.7	91.1	70.7	79.7	59.8	93.0	85.2	34.3	59.0	95.1	100.0	98.2	68.9	75.4	83.9	75.3	98.8	91.2	79.3	OA =	0.842

Table 11. Classification correspondence matrix for the 2022 land cover classification. Land cover class codes are: 1 = broadleaved woodland, 2 = coniferous woodland, 3 = arable, 4 = improved grassland, 5 = neutral grassland, 6 = calcareous grassland, 7 = acid grassland, 8 = fen, 9 = heather, 10 = heather grassland, 11 = bog, 12 = inland rock, 13 = saltwater, 14 = freshwater, 15 = supra-littoral rock, 16 = supra-littoral sediment, 17 = littoral rock, 18 = littoral sediment, 19 = saltmarsh, 20 = urban, 21 = suburban, UA = Users Accuracy, PA = Producers Accuracy, OA = overall accuracy. Accuracy assessment is performed using the LCM class schema.

	Reference																						
Classified	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total	UA
1	1660	174	5	22	1	0	3	0	4	3	2	2	0	4	0	0	0	0	0	6	11	1897	87.5
2	33	656	0	0	0	0	8	0	6	2	0	0	0	1	0	0	0	0	0	1	0	707	92.8
3	24	7	9655	130	7	0	10	8	2	3	3	2	0	5	0	1	0	1	0	20	10	9888	97.6
4	156	7	710	5095	189	91	274	20	4	149	59	2	0	14	2	24	0	0	0	14	47	6857	74.3
5	11	7	5	154	436	1	16	21	0	3	0	0	0	2	0	0	0	0	0	1	0	657	66.4
6	30	2	5	15	1	886	16	0	1	0	0	1	0	0	0	0	0	0	0	0	0	957	92.6
7	11	4	15	84	9	59	1154	0	13	187	35	0	0	1	0	0	0	0	0	0	0	1572	73.4
8	6	0	3	2	2	0	0	555	1	1	1	0	0	8	0	0	0	0	1	0	0	580	95.7
9	5	3	0	0	1	2	34	1	870	126	193	1	0	0	0	1	0	0	0	0	0	1237	70.3
10	11	2	4	2	0	10	120	0	42	256	49	2	0	1	0	0	0	0	0	0	1	500	51.2
11	0	2	1	1	0	2	8	2	20	40	827	0	0	1	0	0	0	0	0	0	0	904	91.5
12	0	0	2	1	1	1	0	0	0	2	0	166	0	1	0	0	0	0	0	2	0	176	94.3
13	0	0	0	0	0	0	0	0	0	0	0	0	71	0	0	0	0	22	0	0	0	93	76.3
14	8	0	0	2	0	0	1	0	0	0	0	0	0	551	0	0	0	2	0	1	2	567	97.2
15	0	0	0	1	0	0	2	0	0	1	0	0	0	0	40	6	6	4	0	1	0	61	65.6
16	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	174	1	7	0	0	0	184	94.6
17	0	0	0	0	0	0	0	0	0	1	0	0	0	0	15	3	93	26	0	0	0	138	67.4
18	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	5	4	191	2	0	0	213	89.7
19	1	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	4	171	0	0	193	88.6
20	7	0	6	11	2	0	0	0	0	0	0	7	0	2	0	11	1	3	1	2385	290	2726	87.5
21	70	0	8	72	3	0	0	0	1	0	1	1	0	1	0	1	0	0	0	221	2621	3000	87.4
Total	2033	864	10419	5592	654	1052	1646	624	964	774	1170	184	82	592	57	226	105	260	175	2652	2982	33107	
PA	81.7	75.9	92.7	91.1	66.7	84.2	70.1	88.9	90.3	33.1	70.7	90.2	86.6	93.1	70.2	77.0	88.6	73.5	97.7	89.9	87.9	OA =	86.124

Table 12. Classification correspondence matrix for the 2023 land cover classification. Land cover class codes are: 1 = broadleaved woodland, 2 = coniferous woodland, 3 = arable, 4 = improved grassland, 5 = neutral grassland, 6 = calcareous grassland, 7 = acid grassland, 8 = fen, 9 = heather, 10 = heather grassland, 11 = bog, 12 = inland rock, 13 = saltwater, 14 = freshwater, 15 = supra-littoral rock, 16 = supra-littoral sediment, 17 = littoral rock, 18 = littoral sediment, 19 = saltmarsh, 20 = urban, 21 = suburban, UA = Users Accuracy, PA = Producers Accuracy, OA = overall accuracy. Accuracy assessment is performed using the LCM class schema.

	Reference																						
Classified	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total	UA
1	1590	175	4	19	2	0	2	2	4	3	1	1	0	3	0	0	0	0	0	1	12	1819	87.4
2	32	652	1	0	0	0	7	0	7	3	0	0	0	2	0	0	0	0	0	1	0	705	92.5
3	23	1	8857	405	2	1	10	3	0	6	23	1	0	5	0	1	0	0	0	15	10	9363	94.6
4	230	10	1014	5223	167	147	389	24	20	192	82	4	0	13	1	34	1	1	0	21	54	7627	68.5
5	10	8	6	240	467	0	5	18	2	2	1	0	0	2	0	0	0	0	0	1	3	765	61.1
6	33	6	7	18	1	832	5	0	6	0	0	2	0	0	0	0	0	0	0	1	0	911	91.3
7	9	4	14	91	4	59	1050	0	19	187	31	1	0	1	0	0	0	0	0	0	0	1470	71.4
8	8	0	2	3	1	0	0	566	0	0	5	0	0	9	0	0	0	0	1	0	0	595	95.1
9	4	3	1	0	0	2	25	0	840	77	190	0	0	0	0	0	0	0	0	0	0	1142	73.6
10	2	4	4	1	0	9	128	1	42	274	93	5	0	3	0	0	0	0	0	0	1	567	48.3
11	0	1	1	0	0	1	21	0	21	28	742	0	0	1	0	0	0	0	0	0	0	816	90.9
12	0	0	5	3	1	1	0	0	1	2	0	164	0	4	0	0	0	0	0	3	3	187	87.7
13	0	0	0	0	0	0	0	0	0	0	0	0	62	1	0	0	0	12	0	0	0	75	82.7
14	8	0	0	2	2	0	1	1	0	0	0	1	0	541	0	0	0	1	0	1	2	560	96.6
15	0	0	0	1	0	0	3	0	0	0	1	0	0	0	44	5	6	12	0	1	1	74	59.5
16	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	166	0	8	0	0	0	177	93.8
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	3	90	35	0	0	0	140	64.3
18	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	5	6	179	2	0	0	212	84.4
19	2	0	0	0	0	0	0	9	0	0	0	0	0	0	0	1	0	7	171	0	0	190	90.0
20	7	0	12	12	2	0	0	0	0	0	0	3	0	5	0	10	2	5	1	2368	303	2730	86.7
21	75	0	9	56	2	0	0	0	2	0	1	2	0	2	0	1	0	0	0	239	2593	2982	87.0
Total	2033	864	9937	6074	654	1052	1646	624	964	774	1170	184	82	592	57	226	105	260	175	2652	2982	33107	
PA	78.2	75.5	89.1	86.0	71.4	79.1	63.8	90.7	87.1	35.4	63.4	89.1	75.6	91.4	77.2	73.5	85.7	68.9	97.7	89.3	87.0	OA =	82.976

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Eastern Region State of Nature Report 2023

Contents

1 Personnel & Document Control

All ecologists should state their membership level of a recognised professional body (e.g. CIEEM, IEMA) alongside their name.

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Position	Environment Manager MCIEEM
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1.1 Document Control

Version number	Approved by Date	Description	Prepared by	Reviewed by	Authorised by
1		Draft Report	Abbie Wood	Alistair Huntly	

2 Foreword

This document is the State of Nature report for the Eastern Region, covering activities that took place in 2023.

It also reviews the state of nature on the Region's estate and explores whether any insights can be made to determine the Region's trajectory to success.

Figure 1 – Eastern Region, broken down into the four different Routes.

This report will highlight achievements made in the Region to improve biodiversity. Examples range from work with habitats and species to improving processes and decision making, resulting in tangible benefits for biodiversity.

The Eastern Region is Network Rail's largest Region, with over 6,000 kilometres of track within 15,688 hectares of land. This extensive estate passes through national parks and areas of outstanding beauty amongst other environmentally protected sites; this includes over 60 sites of special scientific interest (SSSI).

The Region's size poses challenges, but also immense opportunity. The Region is taking steps towards understanding this opportunity and is positioning itself to maximise the benefits for biodiversity, not just within its estate, but across the landscape of which it forms a part.

3 Executive Summary

3.1 Overview

The Eastern Region is the largest region within Network Rail, passing through National Parks, Areas of Outstanding Beauty and environmentally protected sites, including 56 Sites of Special Scientific Interest. There are approximately 76000 biodiversity units across the Region from which we aim to achieve no net loss and then biodiversity net gain by 2035.

A total of 13 habitat types were recorded, two of which were of 'very high' value, including fen and blanket bog.

The most common habitat by area remains 'ruderal ephemeral' at 56%, with 'Modified Grassland' at 28%.

Over the past year the Region has sought to protect and safeguard species including peregrines, willow tits, invertebrates, and hazel dormice; examples are presented in this report.

The Region is now in collaboration with the Wildlife Trusts Consultancies and will deliver ecological support through the partnership. A team structure is in place to embed ecological expertise at both Region and Route levels. A programme of works has been agreed and is underway in which the Wildlife Trust will be/have delivered stakeholder engagement events, a biodiversity inventory, Route Biodiversity Action Plans, Habitat Management Plans and Sectional Asset Plans. These tools will form the Region's plan for its lineside habitats and will help the region in meeting its biodiversity net gain ambitions.

3.2 Summary of ambitions for biodiversity management

We want to be in the position where we understand the biodiversity on our estate. Like all our assets, we want to know what it is, where it is, what health it is in, and we want to have a plan for it. We have started this journey with the help of The Wildlife Trusts by bringing in the resource and expertise to take stock of what we have on our estate and what is around us in the wider landscape. We then want to have systems and processes in place to allow us to make informed decisions and plans for our biodiversity that will lead to meaningful gains. We have started development of our Route Biodiversity Action Plans and Habitat Management Plans created for all four Routes within Eastern Region. Ultimately, this will allow us to be responsible custodians of an important asset, upon which so much depends, at a critical point in time.

3.3 Summary of achievements for biodiversity management

The key to achieving 10 % biodiversity net gain will be in understanding what biodiversity net gain should look like. We have secured funding for the remainder of the control period which we have brought in a team of Wildlife Trust ecologists and Engagement Managers. A programme of works has been agreed and started with a comprehensive and strategic approach to stakeholder engagement and data collection that will lead to opportunity mapping that the Region can benefit from. Feasibility studies have been undertaken to understand what plots of land within our estate that are available for us to deliver biodiversity net gain on, along with approximations of costs of delivery biodiversity net gain.

3.4 What further action will we take?

In addition to furthering the development of the projects, plans and initiatives identified in this report, the Region is now looking ahead to:

- work closer with Capital Programmes Eastern and the supply chain, including large programmes such as the TransPennine Route Upgrade (TRU), to understand how best to work, and track progress towards, common biodiversity goals.
- establish how to better support local teams implement the Network Rail Biodiversity Standard (NR/L2/ENV/122), establish processes to do this and support where needed.
- identify and explore new technologies that will help deliver plans for biodiversity at scale.
- identify new partnerships and stakeholders to help deliver their initiatives and ambitions for biodiversity, wherever possible.
- further work is required to ensure infestations of INNS are recorded in our systems and appropriate treatment plans are agreed and actioned.
- design an integrated approach for vegetation and habitat management that meets the needs of all Network Rail functions and other industry stakeholders through the development of Sectional Asset Plans.

4 State of nature in the Eastern Region

4.1 Biodiversity metric calculation for the region

Network Rail's national biodiversity baseline was captured by the Centre for Ecology and Hydrology (CEH), the methods and results of which were published in the first State of Nature Report 2020/21. This was repeated in 2021 but with an improvement to the way satellite data were interpreted and habitat areas were calculated.

Since the first report was published in 2020, a continuous programme of improvement has changed how data is processed for each new report. As a result, it can be difficult to directly compare findings across different reports. However, each time a change was made, the entire dataset was updated using the same methods. This means that the baseline was adjusted each time, allowing the data within each report to be assessed consistently.

This approach has also been used in the current report. A new and improved method of analysing the data has helped address confusion in how the model previously identified certain habitats. Specifically, 12 habitat types that the model often misclassified, many of which were unique to the railway environment, have now been grouped into just two broader categories: 'Grassland' and 'Sparsely vegetated'. As a result, the total number of habitats reported has been reduced from 27 in earlier reports to 13 in this one.

CEH report the only statistically significant change in habitats between 2019–2021 and 2021–2023 were for '*broad-leaved and yew woodland*' (+7.04 %) and a decrease in '*Fen marsh and swamp'* (-2.78 %*)*. Trends in other habitat areas are not considered statistically significant. It is important to note that the overall accuracy of the 2023 dataset was reported by CEH to be 83.0 % and the data are not accurate enough to confidently detect the relatively small levels of change in many land cover classes over relatively short time periods (5 years or less).

The results for the biodiversity metric calculation are presented in Table 1–2 and Figure 1 below.

4.2 Region habitat types

Habitats are used as a proxy for biodiversity when biodiversity calculations are undertaken. The type of habitat, its condition and its distinctiveness are all considered, together with its significance in the landscape. Certain habitats are known to support more species than others, and it is a habitat's potential to support species (i.e., the biodiversity associated with it) relative to other habitats, which is expressed numerically, as a 'biodiversity unit'. A biodiversity unit is therefore a relative unit of account for biodiversity and not a measure of biodiversity itself.

Habitats are therefore very important to understand the amount of biodiversity likely to be present within a given area and a summary of habitats recorded for the Eastern Region and their associated biodiversity units are presented in Table 1, below.

Table 1: The total areas, Biodiversity Units (BUs) and distinctiveness for each habitat across the time series available.

		2019		2020		2021		2022		2023	
Habitat	**Distinctiveness**	**Area Ha**	**BUs**	**Area Ha**	**BUs**	**Area Ha**	**BUs**	**Area Ha**	**BUs**	**Area Ha**	**BUs**
Other woodland; broadleaved	Medium	1932	15454	1928	15420	2001	16008	2140	17117	2006	16050
Wet woodland	High	20	244	20	243	21	253	23	270	21	253
Lowland mixed deciduous woodland	High	20	244	20	243	21	253	23	270	21	253
Upland oakwood	High	20	244	20	243	21	253	23	270	21	253
Lowland beech and yew woodland	High	20	244	20	243	21	253	23	270	21	253
Upland mixed ashwoods	High	20	244	20	243	21	253	23	270	21	253
Other coniferous woodland	Low	87	349	77	309	71	285	65	259	82	326
Upland Heathland	High	46	556	49	588	46	549	93	1119	13	162
Blanket bog	Very High	5	83	1	23	4	64	14	227	5	78
Fens (upland and lowland)	Very High	295	4722	272	4347	211	3375	135	2165	176	2818
Ponds (Non- Priority Habitat)	Medium	164	1314	128	1026	98	780	135	1082	104	834
Modified grassland	Low	3815	15259	3388	13552	2747	10989	2933	11730	4445	17779
Ruderal/Ephemeral	Low	9347	37389	9849	39395	10511	42042	10166	40664	8857	35427
Total		15794	76346	15794	75879	15794	75356	15794	75715	15794	74741

Table 1 above shows that the reported areas for high-distinctiveness habitats—specifically blanket bog and fen—fluctuate in a way that is unlikely to reflect real changes on the ground. In 2023, blanket bog accounted for just 0.03 % (5 hectares) and fen for 1.1 % (175 hectares) of the total area surveyed in the region. Accurately identifying and classifying these habitats at scale remains particularly challenging when working within the narrow, linear corridors typical of national infrastructure. This supports the conclusion that, although the changes in these habitats appear statistically significant, the model's current accuracy level (83.0 %) is not yet sufficient to have full confidence in the changes recorded for them.

Woodland remains one of the most biodiverse habitat types recorded across our estate. It is also one of the habitats most frequently subject to active management, particularly where vegetation could impact the safe operation of the railway. As such, woodland is where our biodiversity impacts (both positive and negative) are most likely to be observed. While the removal of woodland may initially result in a reduction in biodiversity, this is often offset over time as the cleared areas transition into other valuable habitats, most commonly grassland. In many cases, past vegetation management has allowed natural succession to take place, with these transitional habitats eventually reverting to woodland over several years, contributing to a dynamic and cyclical landscape.

Across the data series, there is a statistically significant 7 % increase[1] in broadleaved and yew woodland (habitat type W1). This trend is broadly supported by Table 1, which shows that woodland cover has remained relatively stable over time, with a slight upward trend notwithstanding some year-on-year variation. However, to confirm these trends with greater certainty, additional datasets and improved model accuracy will be needed.

[1] Marston, C., Rowland, C., Henrys, P., O'Neill, A., Orsler, Z. and Pyewell, R.. (2025). *An Estimate of the Network Rail UK-Habitat Account 2019 to 2023*. Prepared for Netowork Rail. UK Centre for Ecology & Hydrology. Wallingford.

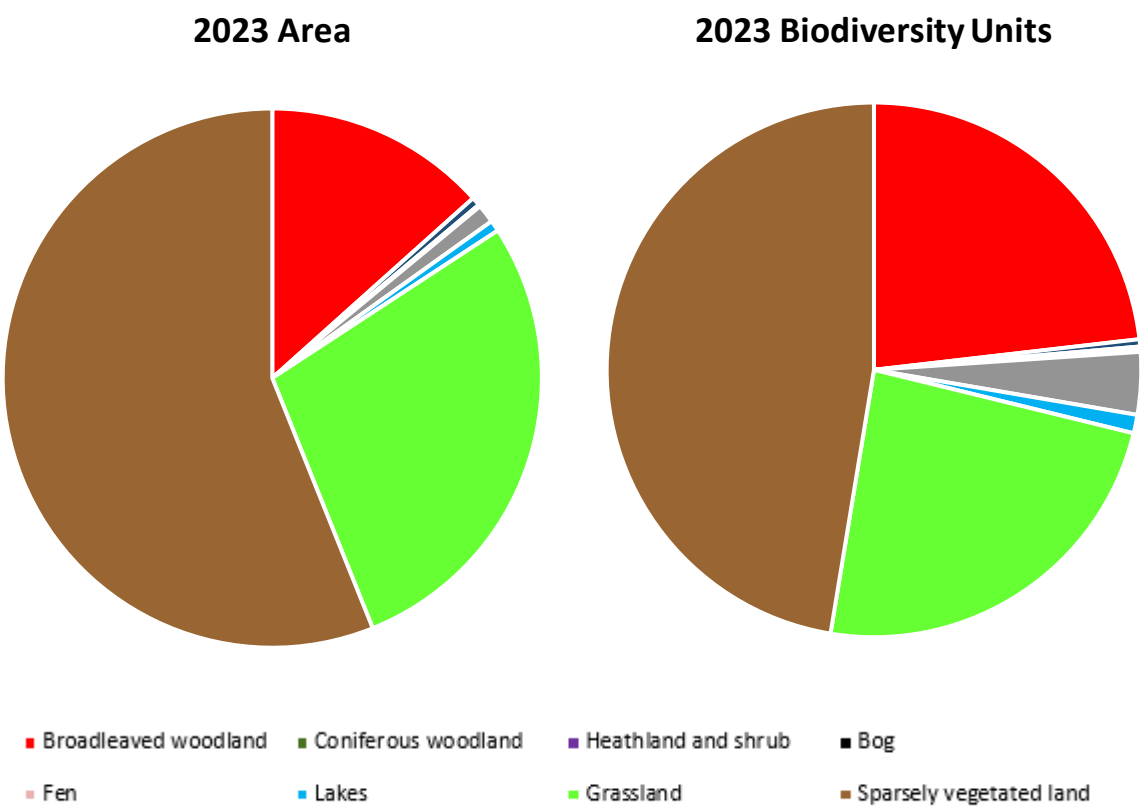


Figure1: *Piechart showing national habitat proportions and their associated biodiversity units*

The model provides a broad-scale overview of three habitat types that together account for 97% of all habitats recorded in the region. These are: Ruderal/Ephemeral habitats (56%), modified grassland (28%), and other broadleaved woodland (13%). Although Ruderal/Ephemeral habitats cover more than half of the total area, they are considered 'low value' in terms of ecological distinctiveness and contribute only 47% of the total biodiversity units. This result highlights a clear opportunity for enhancement. By improving the quality and diversity of these widespread but lower-value habitats, there is significant potential to deliver measurable biodiversity gains across the estate.

Table 2: Number of Biodiversity Units (BUs) and the average BU / Ha for each year from 2019–2023.

Year	BUs	Average BU/Ha
2019	76346	4.8
2020	75879	4.8
2021	75356	4.8
2022	75715	4.8
2023	74741	4.7

While the total area (hectarage) of habitat recorded annually in the region has remained consistent, the associated biodiversity units (BUs) have shown a gradual decline over the time series, with a cumulative loss of 1,605 BUs. Between 2019 and 2022, the average number of biodiversity units per hectare remained stable at 4.8 BU/ha, before showing a slight decrease to 4.7 BU/ha in 2023.

However, the current dataset is limited in both scale and temporal range. The small number of data points and the relatively short time frame make it difficult to draw robust conclusions about long-term biodiversity trends at the regional level. Natural variation and background noise in the data further complicate attempts to identify meaningful trajectories.

Despite these limitations, the need for strategic action is clear. Having a well-informed plan to safeguard, enhance, and reconnect habitats will be essential for meeting the region's biodiversity targets and ensuring future improvements can be measured with confidence.

4.3 Priority species/habitats on the region

The Eastern Region is vast and contains many important species and habitats. Below are some of the important species, species groups and habitats we seek to protect.

Peregrine (Falco peregrinus)

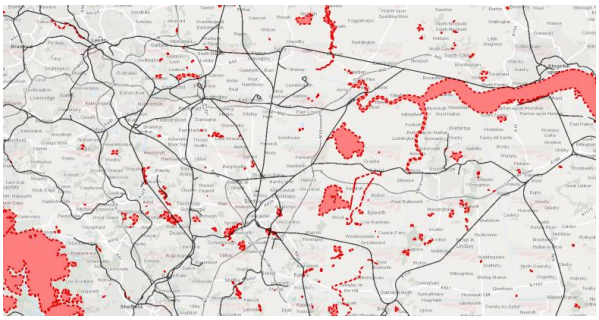
The world's fastest animal calls some of our most iconic structures 'home'. We continue to work with our supply chain, ornithological specialists, statutory agencies, and conservation groups to safeguard these birds, whilst undertaking critical works to maintain our structures.

Invertebrates

Many of our old sidings have developed into Priority Habitats that support National Priority species, such as the dingy skipper (*Erynnis tages*) and small heath (*Coenonympha pamphilus*). We continue to work with conservation organisations and our supply chain to understand how we can safeguard rare butterflies and deliver biodiversity gains in these habitats.

Hazel dormice

The Region continues to work with the Nottinghamshire dormouse group, by facilitating access for surveys to keep track of breeding success and population numbers. This year recorded use of nest boxes by dormice installed in a hedgerow by the group.



SSSIs

The Eastern Region Environment Team continue to work with Natural England to ensure all SSSIs that exist within our estate have up-to date Site Management Statements. We continue to communicate their importance to the wider business.

4.4 Invasive species on the region

The presence of invasive non-native invasive species (INNS) can only be recorded where identified, most commonly through lineside inspection or survey. This means the true extent of areas infested within our estate and their impact on biodiversity is unknown.

Traditional methods of detection and treatment are currently underway, until better alternatives become available. In the Eastern Region, treatment of INNS is currently focussed on Japanese knotweed (*Reynoutria japonica*) and giant hogweed (Heracleum mantegazzianum). Both plants impact biodiversity negatively and giant hogweed presents a particular risk to people because of its blistering effects on skin. Across the region we continue to manage invasive species and record any occurrences.

5 Priorities for biodiversity management on this region

The Eastern Region Sustainability Strategy and Eastern Region Biodiversity Plan support the national, network-wide delivery of the Network Rail Environmental Sustainability Strategy 2020-2050. In support of the ongoing commitment to be fitting and responsible custodians of the land we own, we are focussed on achieving the target of no net loss in biodiversity, which included progressing the following priorities:

5.1 Habitat Management Plans

The Wildlife Trust were onboarded in 2023. They are working closely with Eastern Region's Environment Team to determine the best approach to producing meaningful plans for our habitats, across the Region. Habitat Management Plans define the management required for a given habitat type, and where necessary, outlines changes required to existing habitats. They also establish accountability for the habitat within the Route or Region and support asset management requirements.

5.2 Compliance with standard NR/L2/ENV/122 Biodiversity

Improving biodiversity must start with safeguarding what we already have, including when we carry out routine maintenance and improvements works. One of the most difficult challenges we face, is helping our teams understand when this might be needed. This year, we have been working with maintenance teams and asset management to develop processes that will help detect when impacts might occur, so we can upskill teams and provide ecological expertise when needed.

5.3 Pilot areas

Over the past year we have explored the best way to identify unused plots of land and establish whether they can be used to deliver biodiversity gains. We undertook a feasibility assessment using GIS to identify the best areas to deliver biodiversity gains and screen out the areas that were not appropriate. This is a repeatable assessment that can be done periodically to keep the business up to date with were biodiversity improvement can be delivered. These areas will help the business plan to meet its no net loss and biodiversity net gain requirements.

5.4 No Net Loss by 2024 and Biodiversity Net Gain by 2035

Maintenance Teams and Asset Management teams have worked alongside their supply chains and local conservation groups to embrace new technologies and approaches to vegetation management.

The teams have improved their approach to management of our lineside to attain No Net Loss. As a Region, we are undertaking feasibility assessments to determine where the best places to deliver biodiversity net gain are, and how we can continue to work with other business areas and conservation organisations to help us achieve this.

6 Case Studies

6.1 Stakeholder Engagement

In 2023, as part of the Regional Biodiversity Action Plan (RBAP), a wide-reaching stakeholder engagement programme was launched to draw on local knowledge and involve communities in efforts to protect and improve biodiversity. This engagement was a key part of meeting the RBAP's goals, particularly restoring habitats and improving connections for wildlife along the railway in the Eastern Region.

The process began by identifying and reaching out to relevant stakeholders. This included mapping over 17 Wildlife Trusts and building partnerships with local conservation groups, councils, and ecological consultancies. These connections helped ensure that input came from across the full one-kilometre area surrounding the railway, laying the groundwork for coordinated action.

Webinars played a central role in this process. They introduced the RBAP and its aims to a wide range of participants, encouraged community involvement, and created space for knowledge sharing. These sessions helped foster a spirit of collaboration and shared responsibility.

Collecting and mapping data was another key element. An easy-to-use online survey tool allowed stakeholders to highlight important habitats by marking them on interactive maps. This local input was combined with advanced tools such as satellite images and drone surveys, helping to build a detailed and reliable picture of biodiversity across the region. By combining these sources, a strong base of local and regional data was created to guide future decisions.

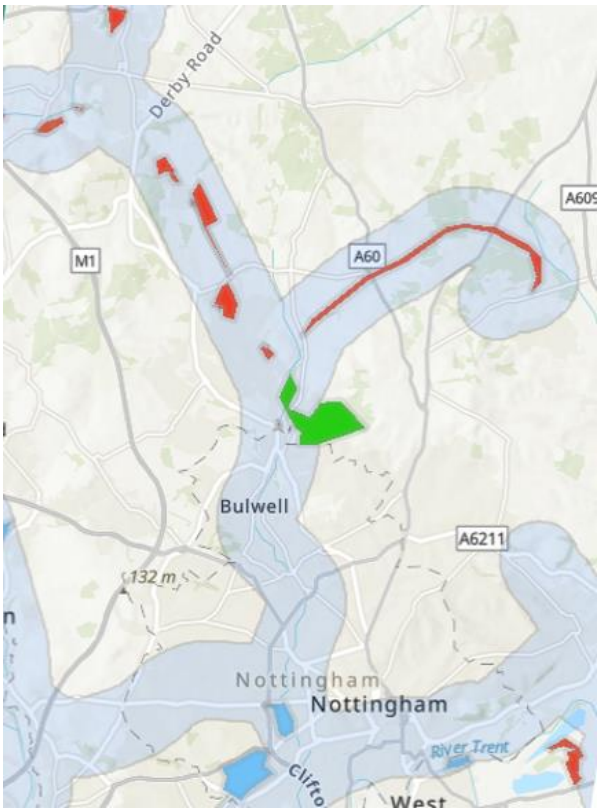


Figure 2: *Example of stakeholder engagement data collected using the online survey tool. Lineside neighbours were able to identify their areas of interest and share their knowledge, ideas and local conservation work.*

Local expertise was particularly valuable in shaping the RBAP. Contributions from groups like the Nottinghamshire Dormouse Group and the Gedling Conservation Trust helped identify opportunities to link habitats and protect vulnerable species, such as the Hazel Dormouse and the Grey Mouse-ear plant. These examples showed how community-led action can play a vital role in tackling environmental challenges.

Network Rail also supported the initiative by sharing specific land parcel data with all Local Nature Recovery Strategies (LNRSs) in the Eastern Region. These areas were identified as having high potential to support biodiversity net gain, and play an important role in reconnecting fragmented habitats across the landscape.

The stakeholder engagement achieved several key outcomes. It built stronger relationships with local communities and conservation partners, helped shape biodiversity plans that reflect local priorities, and provided practical guidance for managing vegetation along the railway. Overall, the initiative highlighted the powerful impact of working together on nature-based solutions—and set a strong example for how large infrastructure projects can support environmental recovery.

6.2 Examples of partnership working

The project at Fen Bog Nature Reserve stands as a strong example of effective partnership working and innovation in action. The team, keen to expand their use of drone technology, were approached by the North Yorkshire Moors Railway and Yorkshire Wildlife Trust with a specific challenge: to help map a remote and inaccessible area of the reserve. Scrub encroachment was threatening the conservation value of the bog, and traditional survey methods were proving difficult. Recognising the opportunity to support a valuable conservation effort while also developing their own technical capabilities, the team stepped up to deliver a tailored solution.

Figure 3: *Collage of pictures taken during the day working in partnership with external stakeholders.*

Careful and detailed planning was carried out in advance to ensure the safe operation of the drone, including close coordination with RAF Fylingdales due to the site's sensitive airspace. This preparation enabled a smooth and efficient survey, and within just a few hours, the team had captured all the data needed by the partner organisations. The high-quality imagery and insights gathered proved instrumental in helping the Yorkshire Wildlife Trust and North Yorkshire Moors Railway shape their ongoing habitat management plans.

Alongside the technical success, the project delivered important learning for the team. We gained valuable insights into how drone technology can be used not only to map landscapes but to classify habitats, monitor ecological change over time, and support strategic planning for long-term habitat restoration. These lessons have since been brought back into the business and are now helping inform wider biodiversity work across the region. Most importantly, this collaborative effort laid the foundations for strong and lasting relationships. The success of the Fen Bog project has already led to new opportunities for joint working with partners elsewhere in the region, showing how shared goals and mutual support can lead to better outcomes for people, wildlife, and infrastructure. The project is a clear example of how bringing together technical innovation and shared commitment to conservation can deliver practical, positive change on the ground.

7 Future plans

7.1 Habitat management plans

Habitat Management Plans (HMPs) will be the end product of a process the Region will establish. Producing a plan for habitats, with a view to improving biodiversity, will require an understanding of what habitats and biodiversity already exist. It is also necessary to understand local ambitions for biodiversity and wider strategical efforts at a landscape

level (e.g., Local Biodiversity Action Plans, Nature Improvement Areas, Ecosystem Services etc.). This information will be captured through stakeholder engagement and collated into a Biodiversity Inventory that can be used to inform the production of a Route Biodiversity Action Plan (RBAP). The RBAP will be the Route's vision for biodiversity net gain, to be achieved by 2035. HMPs will then be produced supporting this vision, focusing the business' efforts towards realising it, in a way that links in with local and national efforts, and maximises biodiversity benefits at a landscape level. Individual projects can then produce detailed Sectional Plans (SPs) using HMPs and the RBAP, that will capture the project's contribution to biodiversity in detail (e.g., biodiversity calculations, costs, establishment, maintenance). In this way, SPs can be a cohesive way towards achieving a singular vision. SPs can also be used to produced anywhere they are needed but will always reference the same materials and pull together in measure and evaluate the Region's trajectory to biodiversity net gain at ground level and can be the mechanism by which plans are agreed by Asset Management and handed over to the maintainer.

7.2 Stakeholder engagement plans for the next reporting period.

Stakeholder Engagement is at the heart of the Region's plans for biodiversity. The Wildlife Trusts continues to lead this process for the Region, as their charitable position, leading successful conservation efforts for over 100 years, means they are uniquely placed to act as biodiversity 'broker' for the business. Their brand allows them to engage with the grassroots of the conservation movement and link into opportunity mapping that would otherwise be out of reach to the business. The Region's focus over the next reporting period will be to bring in the Wildlife Trusts resource that will facilitate this engagement for the business, whilst continuing to build upon existing stakeholder engagement through the work it undertakes.

Bat box installation on monolith trees in Central Route.

North West & Central State of Nature Report 2023

Contents

1 Personnel & Document Control

All ecologists should state their membership level of a recognised professional body (e.g. CIEEM, IEMA) alongside their name.

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Date	

1.1 Document Control

Version number	Approved by Date	Description	Prepared by	Reviewed by	Authorised by

2 Foreword

This report, for North West and Central (NW&C) region (Figure 1), covers activities that took place in 2023.

It outlines the state of nature on the region's estate and the ambitions and plans we have to protect and maintain its habitats and associated biodiversity. It also highlights key examples of the actions we have undertaken to improve these habitats, and where necessary control undesirable species. The report details how we track this performance and how we are currently performing. Also contained within the report are several case studies and workstreams which demonstrate alignment to our national objectives of achieving no net loss in biodiversity by 2024, and achieve biodiversity net gain of 10% in each Region by 2035, along with a number of projects planned for the coming years.

Figure 1: Map of NW&C Region

3 Executive Summary

3.1 Overview

NW&C is the Backbone of Britain, the low-carbon spine linking London, Birmingham, Manchester, Liverpool and Glasgow. Through our three devolved routes (North West, Central, West Coast South) supported by Capital Delivery we aim to increase our biodiversity alongside delivering a great service to our passengers, customers and neighbours.

In the previous year, 2022 the total area of habitat recorded in NW&C was 11336.17 hectares which equated to 55450.39 habitat units. In 2023 the habitat area remains the same but the biodiversity units drop to 53380.93, representing a 3.7% decrease.

The most notable changes affect the following habitats: broadleaved woodland which has declined, equating to a loss of 1496 biodiversity units from deciduous woodland between 2022 and 2023. The decline in woodland is largely responsible for the overall reduction in biodiversity units in NW&C Region over the last 12 months. Another concerning area of habitat loss is that of heathland and shrub which contributed to a loss 859 habitat units. While conversely, grassland saw notable increases, increasing by 803.2 hectares with an increase of 3,212.16 units A full representation of this, and all other habitat types can be seen in Figure 2, below.

This decline in biodiversity units can likely be attributed to the loss of around 187 Ha of broadleaved woodland, removed or managed by maintenance teams across the region and the increase in around 803.2 Ha of modified grassland.

This apparent loss of deciduous woodland and gain in lower quality grassland habitat needs further investigation. Maintenance teams, via our Internal Delivery Lineside Team, should be undertaking work on woodland habitat where it poses a risk to operational assets. This should however be kept to a minimum and not extend beyond the zone of impact. The loss of heathland and shrub should also be investigated as this is a valuable habitat which poses limited risk to operational assets. As grassland habitat is increasing within the region, further work should be undertaken to assess the biodiversity value of this habitat and the likely loss/ gain from interventions specified in works delivery Vegetation Management Specifications (VMS).

3.2 Summary of ambitions for biodiversity management

The NW&C Region covers 4,500 miles of track, linking our main cities of London, Birmingham, Manchester and Liverpool. This region carries over 246.5m passengers a year and is one of the busiest on the rail network. It passes through some of the most picturesque and biodiverse landscapes in Britain.

In 2021 we published our Regional Sustainability Delivery Plan which outlines our ambitions for a lineside managed sustainably for safety, performance, the environment, our customers and our neighbours.

To support the achievement of these ambitions, NW&C is committed to the Key Performance Indicators (KPIs) of:

- Achieving no net loss in biodiversity on our lineside estate by 2024, and achieve biodiversity net gain of 10% in each Region by 2035 which we will monitor and quantify annually, using remote sensing data, and report findings to the Department for Transport (DfT) in an Annual State of Nature (ASoN) reports, such as this.
- Our natural green infrastructure is viewed as an asset not a hindrance managing our land equally considering operation needs, safety and biodiversity net gain - which we will influence by placing sections of lineside estate under habitat management plans (HMPs), when they are scheduled to undergo vegetation management, to keep them compliant with operational standards and requirements. HMPs will ensure lineside habitat and vegetation management is sympathetic to ecological features and addresses ecological risks, while ensuring operational performance can be maintained or improved using processes such as nature-based solutions to adverse weather and climate change risk.

3.3 Summary of achievements for biodiversity management

There are a number of case studies and demonstration sites that have been undertaken showcasing positive biodiverse improvements that have been made within the Region. This has involved actions to conserve desirable species, habitat creation and restoration for biodiversity net gain and field trials of new management approaches.

3.4 What further action will we take?

Future plans continue to focus on the implementation of HMPs to improve and increase biodiversity across the Region. In addition, we will continue to monitor the successes or failures of our demonstration and pilot sites and share and implement learning across the region. We will continue to quantify the benefits that biodiversity enhancements, or habitat creation can have on operational performance and resilience, as well as any wider societal benefits, such as flood risk alleviation, or the provision of recreational sites. We will also continue to engage with local stakeholders and organisations, such as the Environment Agency, Natural England, Rivers Trusts and other relevant non-governmental organisations and charities, to deliver biodiversity enhancements that deliver benefits at a landscape scale.

4 State of nature on NW&C region

4.1 Biodiversity metric calculation for the region

Table 1 below shows the NW&C Regions habitat data and corresponding biodiversity unit calculations this provides. Within NW&C Region the habitat along the estate is 11,336 hectares in area and equates to 55450.39 biodiversity units.

Table 1: Regional habitat and biodiversity unit data for 2020 to 2023

Habitat type	Distinctiveness	2020		2021		2022		2023	
		Area (hectares)	Total habitat units	Area (hectares)	Total habitat units	Area (hectares)	Total habitat units	Area (hectares)	Total habitat units
Other woodland; broadleaved	Medium	1528.575	12228.596	1625.439	13003.5096	1831.263	14650.104	1644.2664	13154.1312
Wet woodland	High	15.7585	189.102	16.7571	201.0852	18.879	226.548	16.9512	203.4144
Upland oakwood	High	15.7585	189.102	16.7571	201.0852	18.879	226.548	16.9512	203.4144
Upland mixed ashwoods	High	15.7585	189.102	16.7571	201.0852	18.879	226.548	16.9512	203.4144
Other coniferous woodland	Low	99.34	397.36	99.74	398.96	88.86	355.44	115.37	461.48
Heathland and shrub	High	106.1	1273.2	119.19	1430.28	149.94	1799.28	78.39	940.68
Blanket bog	V.High	5.97	95.52	6.76	108.16	72.2	1155.2	19.34	309.44
Fens (upland and lowland)	V.High	6.86	109.76	3.13	50.08	5.62	89.92	3.51	56.16
Ponds (Non- Priority Habitat)	Medium	40.6	324.8	27.21	217.68	48.55	388.4	37.76	302.08
Modified grassland	Low	2206.03	8824.12	1763.42	7053.68	1698.21	6792.84	2501.41	10005.64
Ruderal/ephemeral	Low	7295.42	29181.68	7641.01	30564.04	7384.89	29539.56	6885.27	27541.08

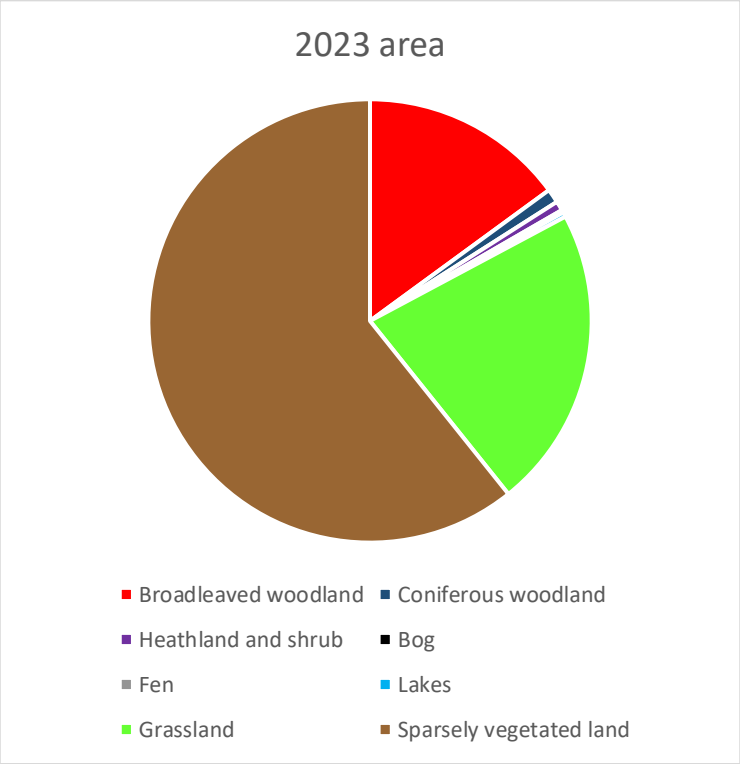

Figure 2: piechart showing 2023 habitat proportions by hectares.

4.2 Region habitat types

Figure 3 presents the composition of habitats on the NW&C estate and shows how the habitat types have changed from 2022 to 2023. It is also supplemented with data from the preceding years to the 2020 baseline as a further point of reference. The built up areas, gardens and urban types are not a priority for NW&C as they are not habitats that we can improve on and provide low biodiversity units.

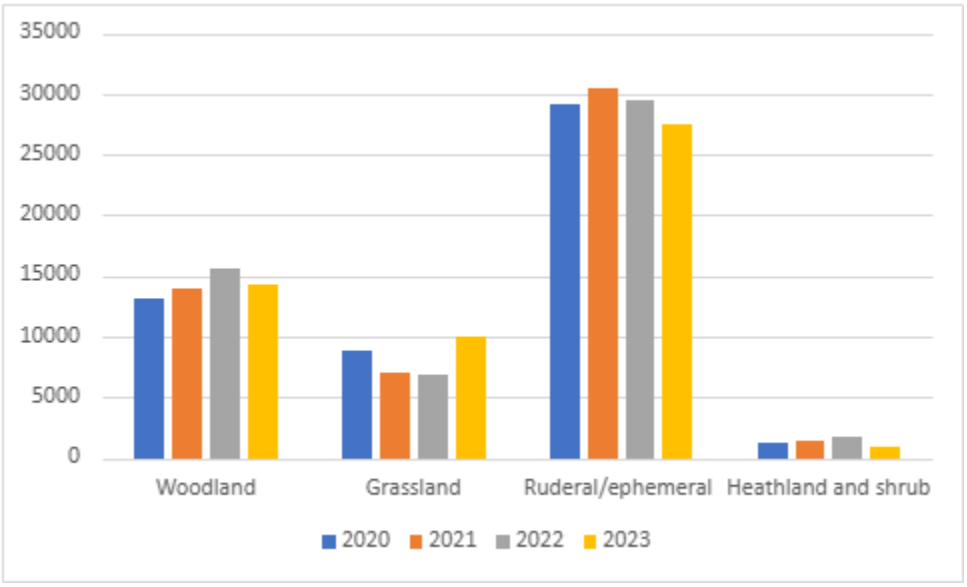

Figure 3: Comparison of 2020-2023 habitat data

This year's habitat data shows that the most dominant habitats on the NW&C estate comprised broadleaved woodland, ruderal (tall herb vegetation such as nettles) and modified grassland, primarily modified. These are broader habitat types with much smaller areas of a further seventeen habitat types making up the overall habitat composition. Our priorities focus on effectively managing broadleaved woodland, which comprises 14.5 % of the regional habitat, while ruderal (60.7 %) and grassland (22 %) make up the more widespread but less distinctive habitat types. We aim to manage the operational risk presented by woodland habitat and create a lineside vegetation structure, containing a more diverse structure of habitats, such as bramble, ruderal and grassland, to increase the resiliency of the infrastructure while increasing biodiversity.

Broadleaved woodland is one of the most dominant, biodiverse, but also operationally problematic habitats on the estate, often striking trains or infrastructure in severe weather or contacting overhead line equipment where it has grown unmanaged. Broadleaved tree species such as sycamore also cause adhesion issues when leaves fall upon the rails, which can result in further adverse operational impacts. For these reasons, broadleaved woodland often requires the most frequent and labour-intensive maintenance. Despite these problems, where broadleaved woodland is allowed to grow in suitable locations, and is suitably managed, it can connect habitats and allow biodiversity to thrive while mitigating other environmental risks such as flooding and landslips. Where woodland is growing in unsuitable locations, often in locations immediately adjacent to

the track or infrastructure, we will often look to replace it, creating larger, improved, and better-connected species rich grasslands or scrub vegetation.

Ruderal has become increasingly dominant since 2020. This likely reflects operational tree felling and the subsequent successional ruderal species establishing. More work is required to understand the biodiversity value of this habitat. Opportunities for post work interventions should be explored with the goal to improve this habitats condition or allow it to transition into a more distinctive habitat quicker.

Between 2022 and 2023 grassland habitat in the region increased by 47 % possibly as a result of succession. The majority of this grassland was made up of lower distinctive modified grassland. Grassland is an operationally low risk habitat and with proper management can benefit a range of species. Areas of new grassland should be surveyed to identify their condition and suggest simple measures that could be used to improve their condition.

In line with the regional approach of conserving and enhancing biodiversity, whilst maintaining or improving operational resilience, through adoption of nature-based solutions, we will adopt a successional approach to the lineside estate, allowing or creating species rich grassland and scrub close to the railway with hedgerows and trees further away. The implementation of this approach, however, will always remain considerate of other sensitive receptors priority habitats and species, designated nature conservation sites such as SSSIs and invasive non-native species (INNS), discussed in sections 4.3 and 4.4, respectively this will help the region work towards the biodiversity net gain agenda increasing the biodiversity of our estate and improving this in the future.

4.3 Priority species/habitats on the region

NW&C Region contains a wealth of priority habitat types which reflect the wealth of habitats through which the regions rail network intersects. The regional estate therefore contains or runs immediately adjacent to a patchwork of marine, coastal, woodland, grassland, and heathland priority habitats. Figure 4, below, displays a representative example of this.

Figure 4: Representative distribution of designated nature conservation sites and priority habitats within NW&C Region

Historically, NW&C Region has had 40 SSSIs, across 7 Delivery Units (DU), which intersect or are located adjacent to the railway estate (Figure 4, above). SSSIs on or adjacent to the NW&C estate are designated for a variety of terrestrial, aquatic, and marine habitats and species, of which the condition varies. We hold site management statements (SMSs) for these SSSIs, which detail arrangements between ourselves and the regulator, Natural England, regarding routine works which can be undertaken without prior assent.

4.4 Invasive species on the region

The region has numerous locations where the lineside is affected by INNS, such as Japanese knotweed, Himalayan balsam, and giant hogweed – see Figure 5 for a representative example of INNS distribution. The presence of INNS present difficulties to internal delivery teams and our supply chain during the undertaking of maintenance and capital works within the region.

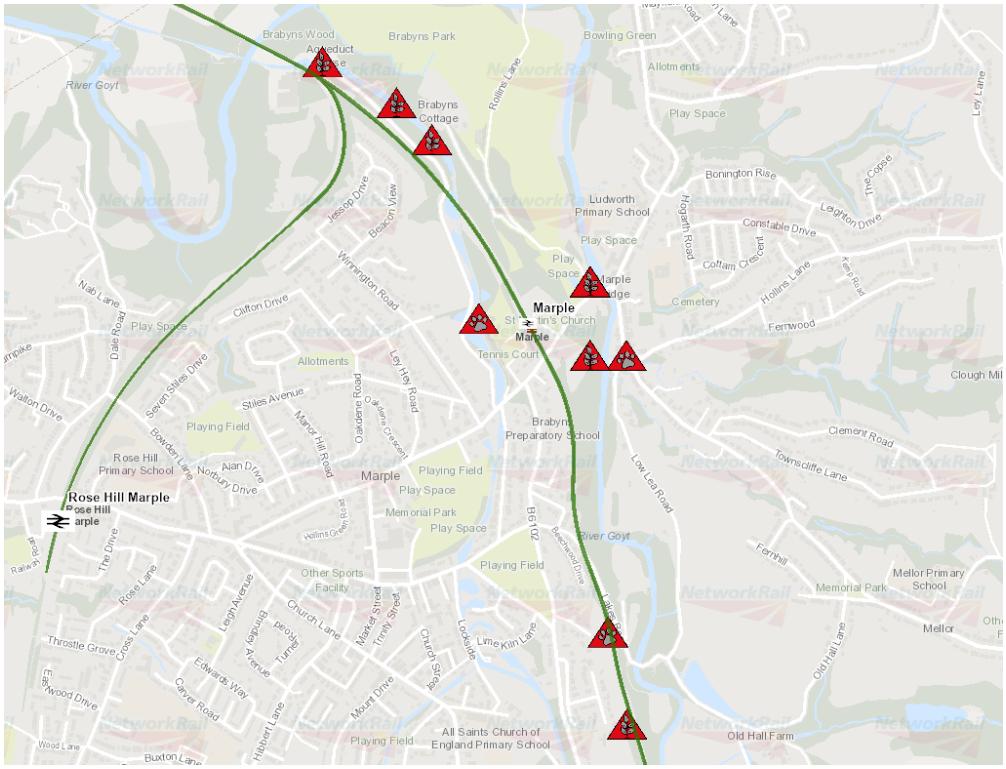

Figure 5: Representative distribution of INNS within NW&C Region

Our regional approach to habitat and vegetation management places emphasis on INNS management. Wherever vegetation management work is planned, an assessment as to the presence of INNS is made. Where INNS are present, and the proposed method of management or habitat structure does not consider them, it is changed accordingly to eradicate or contain the INNS, enabling native vegetation, of the desired type and structure, to establish and thrive.

5 Priorities for biodiversity management on this region

The priorities for managing biodiversity by the end of CP7 is to focus on delivering 4 % net gain in biodiversity. Work will include:

- Managing future work banks to deliver improved operational performance and the amount and quality of biodiversity, simultaneously.
- Work banks are assessed on the following criteria:
    - Designated sites such as Special Areas of Conservation (SAC), Special. Protection Areas (SPA), SSSI, or other local nature conservation designations, and their condition,
    - Protected or priority species and habitats,
    - INNS

  - Weather attributed Schedule 8 delay minutes and payments,
  - Any recorded public trespass incursions.
- Where the proposed vegetation management or habitat structure does not consider the above attributes, it shall be altered to consider and be more sympathetic towards biodiversity while delivering and maintaining improved operational performance, such as the implementation of nature-based solutions to address Schedule 8 delays.
- Producing Habitat Management Plans (HMP) and Vegetation Management Plans to reflect the above and ensure maintenance regimes are implemented to establish and/or maintain any created or managed habitats in compliance with NR/L2/OTK/5201 – Vegetation Management, as well as the objectives of the HMP.
- Working with key local stakeholders to help identify opportunities and work together on delivery.
- Habitat data monitoring - we shall continue to monitor annual habitat data, to better understand how on-the-ground habitats, and other habitat management, is reflected in actual annual biodiversity figures.
- Where we believe this to be incorrect, we shall work to correct and/or supplement them with site specific biodiversity calculations, to demonstrate that our habitat interventions are, in fact, delivering a biodiversity improvement, that through current data collection methodologies, may currently be classified as a biodiversity loss.

6 Case studies

6.1 Examples of best practice habitat management approaches

We have consolidated much of the biodiversity and habitat management work being undertaken, across both the regional business and Capital Delivery, to define the principles of delivering no net loss and net gain of biodiversity and working towards compliance with the biodiversity standard: The below case studies provide some examples of these workstreams.

Vegetation management through goat grazing

In September 2023 goat grazing was trialled as a method of weed control and eradication of invasive species in the Northwest Route.

Manchester Delivery Unit trialled an innovative approach of Goat-scaping as an eco-friendly and cost-effective method of brush/weed and invasive species control. Since goats are browsers, they are especially effective at eating coarser vegetation other grazing livestock would avoid. For this reason the DU stock proofed an area of lineside before releasing goats with the management of a knowledgeable grazier.

The digestive system of the goat's act as an herbicide to prevent the spread of balsam and subsequent re-growth. Their hooves help open the soil in preparation for reseeding.

The delivery unit calculated the cost of using goats to clear the area of weeds and invasives was £800 for 4 weeks. This is significantly cheaper than the conventional approach of flailing and spraying which would have cost at least £2.5k. Subsequent grazing will be utilised to manage the regrowth of invasives.

Lessons were learned from this trial and the region is now looking to permanently stockproof fence suitable assets prior to securing permanent grazing.

Figure 6: Image of grazing goats utilized to manage weeds and himalyan balsam.

Dutton Triangle

This site comprises an unproductive, non-strategic area of land situated within the junction between the WJL1 and CGJ1 lines. The triangle is fenced off from the adjacent public access woodland but provides no access to the track. Habitat within the woodland is dominated by mature broadleaved deciduous woodland, while ground flora is dominated by Himalayan balsam, frequent bracken and occasional patches of native scrub, bluebells, and orchid species, which were being constrained and outcompeted by the dominant and invasive Himalayan balsam (Figure 5). It is proposed that the area may be used for a storage location for spare materials, however the presence of Himalayan balsam, which could contaminate any materials, is currently preventing this.

Figure 6: Mature woodland at Dutton following initial Himalayan balsam removal.

6.2 Examples of partnership working

Stockport conservation volunteer partnership

Members of the civils project team utilised their environment leave days to join forces with Gatley Carrs Conservation Group help eradicate Himalayan balsam which had spread rapidly in the area. There was concern if not eradicated at a catchment scale, balsam would soon return to the rail embankments where it had been removed through the project.

Working with volunteers gave the project team a better understanding of invasive species and the impact they can have on biodiversity allowing. This learning will be incorporated into future projects and designs. By working alongside the local community in Stockport, Network Rail staff were able to visibly demonstrate the importance the local environment has on staff.

Figure 7: Network rail volunteers hand pulling Himalayan balsam in a partnership eradication project.

7 Future plans

7.1 Habitat management plans

In the next reporting period (January 2024– December 2024), we will report further on work undertaken, which will increase the amount of lineside estate under HMPs. This will include the continuation of projects which began during this year, the undertaking of Capital Delivery projects which include vegetation management, or the completion of further pilot projects.

7.2 Stakeholder engagement plans for the next reporting period.

This final section provides details of work to be undertaken on existing and new projects with partners and stakeholders, with shared objectives to deliver greater biodiversity, often combined with other socio-economic benefits.

Nature Space newt organisational licencing

Following a positive example set by other regions, Nature Space have been commissioned to manage a newt organisational licence for the region. This will streamline the process of completing work where great crested newts are a constraint, allowing us to identify high risk areas and activities before compensating for new habitat creation. We will work with Nature Space and its partners to implement best practice and identify areas for creating compensatory habitat which delivers multiple benefits for biodiversity and weather resilience.

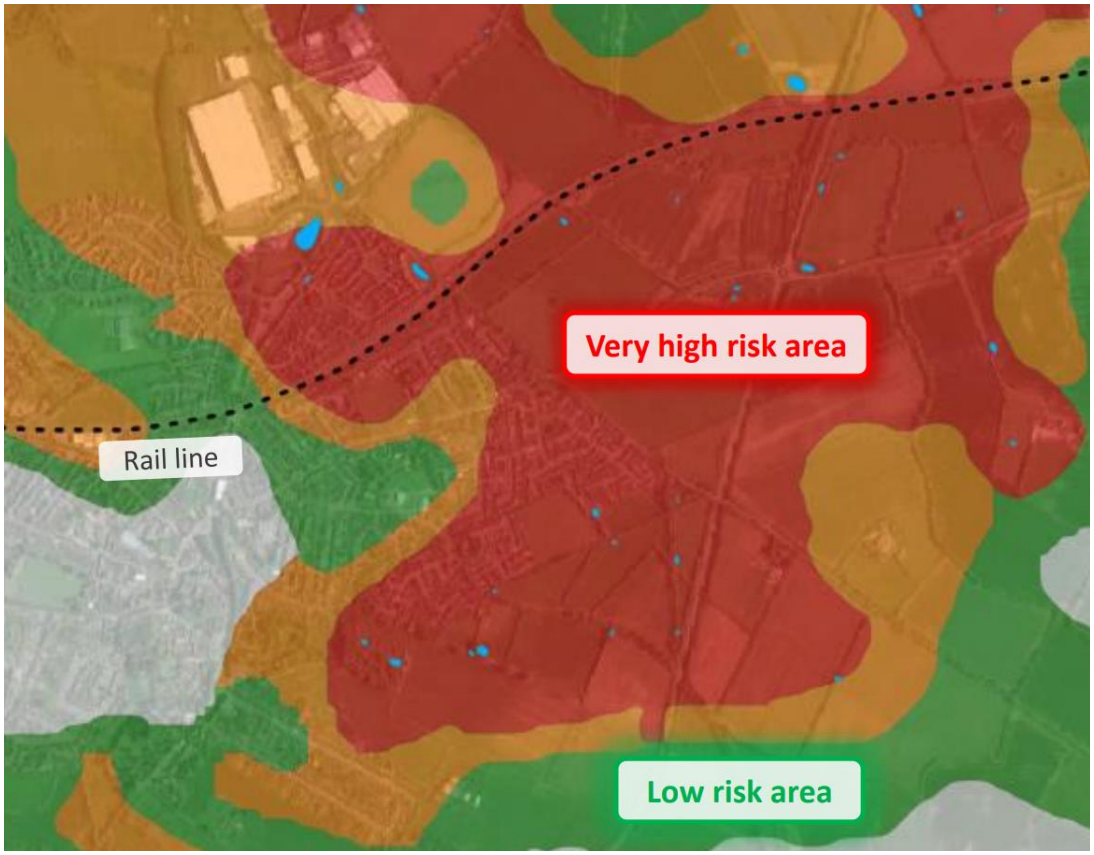

Figure 8: Nature Space risk map showing areas of risk for encountering great crested newts during works.

Network Rail Scotland State of Nature Report 2023

1 Personnel & Document Control

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Date	

1.1 Document Control

Version number	Approved by Date	Description	Prepared by	Reviewed by	Authorised by
1.0		First draft	Laura Ferguson	Keira McLuskey	
2.0		2nd draft	Laura Ferguson	Keira McLuskey	

2 Foreword

This retrospective report, for Scotland region, outlines the state of nature across our estate, covering activities that took place between January and December in 2023. It highlights key examples of the work we undertook to build and enhance existing habitat on our land, and where necessary control undesirable species. The report also details our ambition to further improve biodiversity on Network Rail land and beyond.

Figure 1: *Network Rail Scotland region*

3 Executive Summary

3.1 Overview

Scotland's Railway covers a large geographical area from the Borders to Thurso at the far tip of the Northeast of Scotland.

The Scotland route operates through many nationally and internationally designated sites. This includes two National Parks (Loch Lomond and the Trossachs National Park and the Cairngorms National Park), 91 Sites of Special Scientific Interest (SSSI), 32 Special Areas of Conservation (SAC), 25 Special Protected Areas (SPA), 21 Ramsar sites.

Using the UK-Habitats Classification System (UKHab), a survey of the rail network by the UK Centre for Ecology and Hydrology (UK CEH), shows the Scotland region incorporates a range of habitats including deciduous woodland, arable and improved grasslands, as well as urban areas. These habitat types and designated sites support a range of species from

mammals and invertebrates to plant and fungi, including notable and protected species such as beaver, bats, numerous species of bird, and wildflower species.

Like other regions across the network, Scotland's Railway has the potential to act as a vital wildlife corridor by offering connectivity between habitats. We are therefore taking action to protect and enhance biodiversity within our lineside estate that could contribute to reversing an alarming trend of global biodiversity loss.

Scotland records the highest proportion of deciduous woodland land cover of all the Network Rail regions. This type of habitat support species of bats, birds, but notably in Scotland this type of habitat supports protected species like the red squirrel and pine marten.

Outside of London, Scotland's Railway operates the largest suburban rail network and provides access along busy commuter routes to our seven cities. Often habitats can be fragmented within these built-up areas, however along the railway corridor we find smaller networks of other types of habitats, like woodland and grassland, which form green corridors. These so-called green corridors facilitate the movement of species within these urban environments providing them with access to resources like food and shelter, meaning the railway has an important role in improving habitat connectivity.

3.2 Summary of ambitions for biodiversity management

2023 was our last full calendar year of CP6, when our strategic commitment was to enhance biodiversity across the region. We enabled this through implementing the Network Rail Biodiversity standard NR/L2/ENV/122 within the Scotland region, increasing our biodiversity data and upskilling our workforce on biodiversity.

As we look to the next five-year Control Period, Biodiversity remains a key priority for Scotland's Railway, and is one of the five key themes within the Scotland's Railway Climate Action Plan 2024-2029. Within this plan we have an overarching objective to increase biodiversity across Scotland's Railway which is underpinned by a series of milestones and actions, Further detail can be found in our CP7 Biodiversity Delivery Plan.

3.3 Summary of achievements for biodiversity management

In 2023, we made significant strides in enhancing biodiversity and managing our lineside estate through a range of targeted projects and collaborations. By integrating conservation practices into infrastructure management and fostering partnerships with external stakeholders, these efforts have not only safeguarded habitats but also created

new opportunities for wildlife to thrive. From innovative habitat creation and species protection to community-driven planting initiatives, our achievements reflect a holistic approach to environmental stewardship, demonstrating the positive impact of strategic, sustainable actions across the region.

Some of our achievements include:

- The creation of a bee bank supporting solitary bees alongside a sinkhole repair site. The area was seeded with native wildflowers and linked to BugLife's B-Lines network, enhancing pollinator pathways and increasing habitat connectivity.
- A diseased ash tree with bat roosts was carefully managed to protect the species present, and measures such as the installation of bat boxes and creation of habitat piles were taken to support biodiversity while delivering safety critical works.
- Our Ecologists partnered with the Lothian and Borders Raptor Study Group, to ring Kestrel chicks discovered at one of railway yards, contributing to research on population dynamics for this amber-listed species.
- Community planting projects were delivered by Network Rail volunteers with the Tree Council and local community groups to enhance urban biodiversity, supporting pollinators, and addressing habitat loss in line with local biodiversity action plans.

3.4 What further action will we take?

As we begin a new five-year Control Period in 2024, CP7, our focus will be on fulfilling commitments outlined within the biodiversity delivery plan; part of Scotland's Railway Climate Action Plan 2024-2029.

This includes enhancing or creating at least 500 hectares habitat, producing Scotland's habitat management plans and ensuring data availability to support biodiversity decision making.

4 State of nature on Scotland region

4.1 Biodiversity metric calculation for the Scotland region

In 2020, the UK Centre for Ecology and Hydrology (UKCEH), in partnership with Network Rail, undertook a remote sensing survey of the entire rail network across England, Wales and Scotland. This survey produced a land cover map displaying 21 different habitat types found 1km either side of the rail network. The outputs from this survey were then used to calculate a baseline for Scotland region using the Defra 3.0 biodiversity metric, which utilises data on habitat type to calculate the biodiversity value of a particular area.

The UKCEH seeks to continuously improve how it collects and interprets data and each year there have been improvements in the method applied to calculate biodiversity. However, these improvements in the method have resulted in inconsistencies when comparing figures across different years.

To provide the most consistent and accurate assessment of biodiversity units, the same updated approach has been applied to all data from 2020 to 2023. This method uses advanced satellite sensors and AI technology to monitor the extent and condition of habitats across the railway. This process has an overall accuracy of approximately 84%, based on 31,000 validation points.

One challenge in habitat classification is that some railway habitats are easily confused with similar-looking landscapes in the wider countryside. For example, sparsely vegetated ballast can be mistaken for arable land or inland rock, and different types of tall grassland on railway land can be difficult to distinguish.

To reduce these misclassifications, the UKCEH have refined the approach to habitat classification by grouping certain habitat types into two broader categories:

- Sparsely vegetated (combining classes such as arable land, inland rock, developed land, and coastal habitats)
- Grassland (combining different grassland types, including modified, neutral, calcareous, and acid grassland)

This updated analysis presented the Scotland region with revised baseline figures of a total of 7506.22 hectares of habitat with a value of 38651.73 biodiversity units compared with an original baseline of 7506.23 hectares of habitat with a value of 43,348.18 biodiversity units. The proportion of habitat types found across Scotland are shown in Figure 2.

Since this initial baselining exercise, regional biodiversity units have been provided to the region, from our Technical Authority on an annual basis to identify changes in habitat type, condition and changes in biodiversity units.

The most recent dataset provided for the year 2023 indicates a total of 7,557.70 hectares of habitat (a break down is shown in Figure 3) with a value of 38725.11 biodiversity units. This latest data set indicates a small decrease in biodiversity units compared with the dataset for 2022 (-3.5%), however it indicates an overall increase when compared to the 2020 baseline (+0.2%), as shown in Table 1.

Year	**2020 (baseline)**	**2021**	**2022**	**2023**
Biodiversity Units	38651.73	38140.14	40017.99	38725.11
Total area (Ha)	7506.22	7506.22	7506.22	7506.22
% change **(from 2020 baseline)**	-	-1.3%	-3.5%	+0.2%

Table 1: *Scotland region biodiversity units 2020-2023*

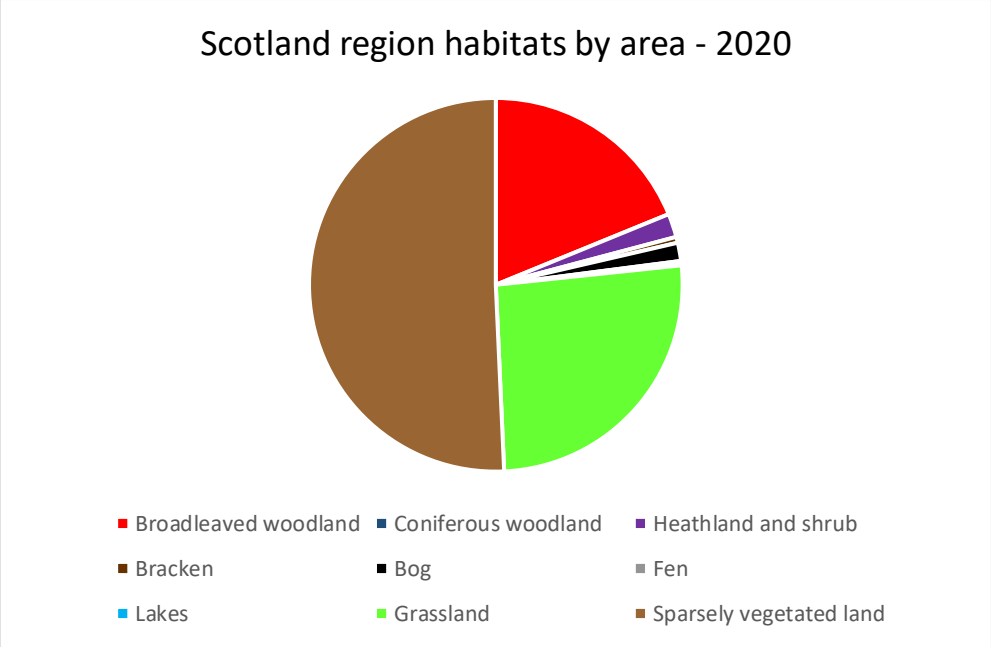

Figure 2: *Proportion of habitat types in the Scotland region in 2020*

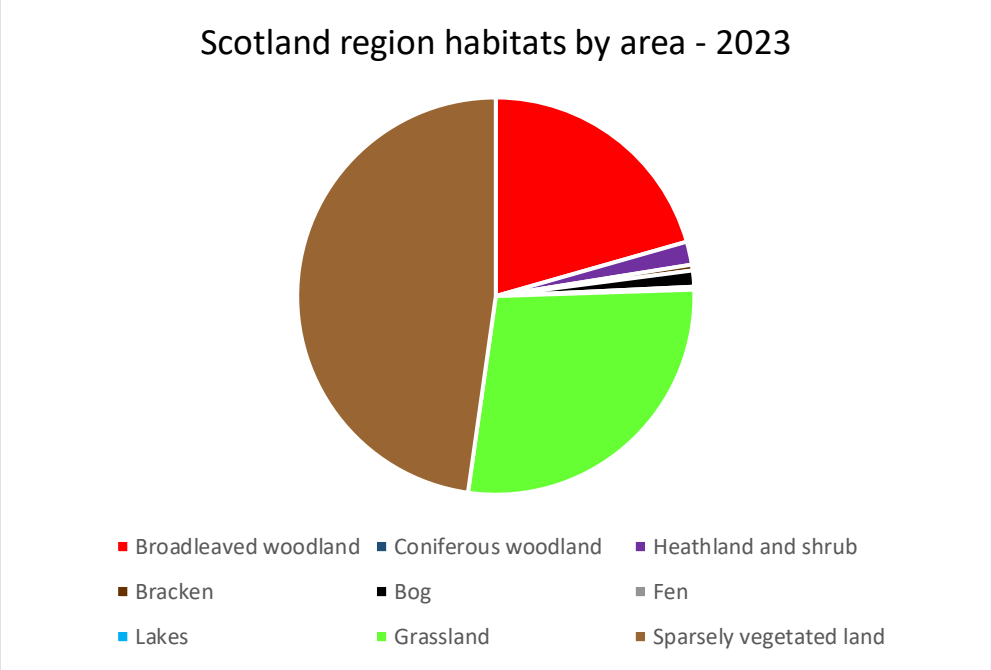

Figure 3: *Proportion of habitat types in the Scotland region in 2023*

4.1.1 Data interpretation and limitations

The updated methodology for 2020-2023 corrects errors from comparing land cover maps across years, which previously caused inconsistencies in habitat classification. It also improves accuracy by consolidating multiple habitat types into two broader categories, aiding the classification of smaller or mixed habitats.

However, limitations remain. The use of 10m resolution imagery—where each pixel represents a 10m x 10m area on the ground— can miss smaller or mixed habitats, making it harder to distinguish vegetation types and key habitat features. Some details can only be reliably identified through field surveys.

Additionally, the inclusion of a 1km buffer of habitats on either side of the railway makes it challenging to determine which habitats fall within the railway boundary and, ultimately, what is within our control to manage and maintain.

We recognise that the data is still in its early stages, meaning we can currently provide only a high-level snapshot and basic analysis. However, as data accuracy improves over time, we expect to conduct more detailed assessments of habitat changes and further evaluate the biodiversity value across our estate in Scotland.

4.2 Region habitat types

In Scotland, the railway network traverses a diverse range of habitats, each with unique ecological significance. In the West Highlands, the railways pass through extensive montane and moorland habitats, characterised by heather, peat bogs, and rocky outcrops. A section of the railway along the West Highland Line can be seen in Figure 4 located in Rannoch, an area which has international importance due to its significant bog habitat. These areas support species such as red deer, golden eagles, and rare plants like the Scottish primrose. The peatlands here are crucial for carbon storage, playing a significant role in climate regulation.

Figure 4: *A section of the West Highland Line located in Rannoch*

Moving eastward, the Central Belt features woodland and grassland habitats. Deciduous forests, dominated by oak, birch, and Scots pine, provide vital habitats for rare and protected species like red squirrels and pine martens. The grasslands are home to pollinators like bees and butterflies, which are essential for maintaining biodiversity.

In the East and North-East, including Aberdeenshire and the Moray coast, our network expands through agricultural and wetland areas. These habitats are important for bird species such as ospreys, waders, and waterfowl. Wetlands are crucial for water filtration and flood control.

The Southern Uplands are characterised by upland heath and grassland habitats, supporting ground-nesting birds like grouse and curlew.

The railway also connects Scotland's major cities and traverse more urban environments where the habitat is more fragmented, limiting the movement of species. An example of this can be seen in Figure 5, where the railway passes through a predominantly built-up, urban area with grassland scattered around with poor connectivity.

Figure 5: *Section of the railway through the town of Linlithgow*

While these areas are fragmented, they do provide essential green spaces for urban wildlife, and like other regions across the network, Scotland's Railway has the potential to act as a vital wildlife corridor by offering connectivity between these habitats through its lineside.

4.3 Priority species/habitats in the Scotland region

Our railway estate provides habitat which supports an array of priority species considered to be of principal importance for biodiversity conservation in Scotland. Examples of these species include Beaver, in which previous efforts to protect this species seen the installation of Beaver pass under the railway (the first of its kind in the country).

Our woodland habitat in the region supports priority and protected species like the pine marten, which can be found primarily in the northwest highlands, and the red squirrel, found across the region in coniferous, broadleaved and mixed woodland areas.

Our lineside also provide favourable habitat and food sources for invertebrate species like the Small blue butterfly, which is known to feed of Kidney vetch found on our lineside in both the southwest and northeast of the region.

4.4 Invasive species on the region

There are many invasive plants and injurious weeds found across the Scotland region and we have a legal obligation to prevent them from spreading or causing a nuisance. Invasive non-native species (INNS) are a growing problem for the region and our strategy is to manage them, rather than try to eradicate them. We collaborate with neighbouring landowners and other stakeholders, like NatureScot, to ensure efforts to manage INNS are effective as possible.

Each of the four maintenance Delivery Units (DU) in the region: Glasgow, Motherwell, Edinburgh and Perth are responsible for controlling INNS within their area. Information collected on the occurrence of INNS indicates Japanese knotweed, giant hogweed and Himalayan balsam are the most prolific across the region, with all three species recorded in every DU.

Japanese knotweed:

Spreads underground by direct growth of rhizomes (roots) and above ground through the transfer of plant fragments to new locations. Above ground stems can grow rapidly, up to 2m in 30 days, and the plant is able to grow through substrates including tarmac and concrete, meaning it can pose safety and operational issues for the railway. It can also impact our lineside neighbours due to issues when selling property within a certain distance of knotweed on Network Rail land.

Figure 6: *Japanese knotweed*

Figure 7: *Himalayan balsam*

Himalayan balsam:

Often found growing along rivers, disused railway lines or in similar linear corridors where it dominates habitats, grows densely and shades out native plants. Plants can produce more than 500 seeds before it dies in the Autumn. When the seed pods are ripe, the slightest touch causes them to burst open catapulting and dispersing the seeds up to 7m away.

Giant hogweed:

Thrives in any habit, but particularly where soil has been disturbed like riverbanks, derelict land, or railway embankments. Its spread

Figure 8: *Giant hogweed*

endangers the survival of native plants, and it can harm grazing animals. This plant also poses a health risk to humans, causing severe irritation, swelling and painful water blisters when skin comes into contact with the sap in sunlight.

During 2022 work was completed to map the spread of INNS across the region and improve visibility of what had been treated. Throughout 2023 we have worked with each Delivery Unit to improve data accuracy in the reporting tool to identify hotspot areas and assist with more targeted approaches to spraying. This work is ongoing and has been identified as a priority workstream as part of the Scotland's Railway Climate Action Plan 2024-2029 (see Section 5).

4.5 Demonstration sites or projects

4.5.1 Bee Bank Installation

In a project that underscores the importance of integrating conservation efforts into infrastructure management, a bee bank was established next to a repaired sinkhole in Ayrshire.

The sinkhole, which appeared near the tracks on the line between Kilmarnock and Barassie, required emergency repairs. Once these critical works were completed, a collaborative effort involving Network Rail and Scottish Woodlands led to the installation of the bee bank to repurpose the otherwise unused space next to the railway into a haven for wildlife.

Figure 9: *Bee bank installed next to railway*

The bee bank has been specifically designed to support solitary bee species, including mining bees, which are known to favour bare, sandy ground for nesting. These bees play a crucial role in pollination, making their conservation important for both local ecosystems and broader environmental health. The structure includes warm, sheltered patches of exposed soil, ideal for burrowing, along with a range of added features such as logs, canes, and rocks. These additional materials provide alternative nesting habitats for other insects and small wildlife, further enriching the site's biodiversity.

To complement the bee bank, the surrounding area was carefully seeded with a native dry meadow wildflower mix. The seed selection, guided by expert advice from Scotia Seeds, was chosen to suit the site's specific conditions and enhance ecological value. This diverse mix of wildflowers aims to create a vibrant habitat that not only supports pollinators by providing

Figure 10: *Bee bank habitat installed*

essential food and shelter but also contributes to the overall health of the local ecosystem.

The project's location near to the River Irvine, a designated B-Line corridor offers strategic advantages. B-Lines, an initiative led by BugLife, aims to create a network of insect pathways across the country, akin to the railway system itself. These pathways link habitats, offering vital refuge and resources for bees, butterflies, and other pollinators. By aligning these kinds of biodiversity projects with the B-Lines network, we enhance connectivity between the railway corridor and surrounding natural habitats.

Projects such as these demonstrate our ability to balance critical works to maintain the safety and operation of our railway, while incorporating measures to enhance local biodiversity.

5 Priorities for biodiversity management on this region

As we entered the final year of the current five-year Control Period (CP6), we completed the final actions set out within the CP6 Biodiversity delivery plan, which formed part of the Scotland Sustainability Strategy 2021-2024. These final CP6 deliverables included establishing a long-term sustainable lineside strategy for Scotland's Railway, which included publishing the CP7 vegetation management strategy and is also captured within the CP7 Biodiversity delivery plan.

Planning for the next Control Period, CP7 also got underway, which included the creation of the Scotland's Railway Climate Action Plan which replaces the Scotland Sustainability Strategy. Like the Scotland Sustainability Strategy, Biodiversity remains a key priority for Scotland's Railway.

The Scotland's Railway Climate Action Plan 2024-2029 was developed through a review of the Scotland Sustainability Strategy, feedback from stakeholders, and benchmarking against public sector best practice. Lessons learned informed significant changes, including reducing the number of themes from 10 to five, of which Biodiversity is one.

Figure 11: *Climate Action delivery plan development workshop*

Detailed delivery plans for each theme were created by subject leads and refined in workshops with over 100 contributors, culminating in final endorsement from the Scotland's Railway's Sustainability Steering Group and Programme Board

The plan aligns with international, national, and internal policies. Key legislative drivers include the Scottish Government's net-zero target by 2045, the UN's Sustainable Development Goals, and strategies such as the National Transport Strategy. This ensures that the plan not only meets regulatory requirements but also contributes to broader climate and sustainability objectives.

Going into CP7 Biodiversity remains a core focus for Scotland's Railway. Unlike CP6, we now have a regulatory target set out within the Office for Road and Rail's Final

Determination of achieving a 4% increase in Biodiversity by the end of CP7. Progress against this target will be monitored by the ORR on an annual basis.

To progress towards this target, our CP7 Biodiversity delivery plan is underpinned by a series of milestones and actions focussed on data availability, habitat creation and enhancement, the training of our workforce and making biodiversity protection and enhancement a "business as usual" activity" across Scotland's railway.

6 Case studies

6.1 Examples of best practice habitat management approaches

6.1.1 Protecting habitats while managing dangerous trees

Thousands of trees of various age, size, species and health can be found on the railway lineside. Some of the trees - particularly large, mature veteran trees - act as homes to many different species of birds, bats, insects, and fungi.

In Dumfries and Galloway, a large mature ash tree with advanced ash dieback (is a serious disease that is killing ash across the UK and Europe) was flagged as a risk to the railway infrastructure and third-party land. As a result, Motherwell Delivery Units, Network Rail Scotland Ecology Team and our supplier QTS worked together to undertake tree safety works in line with Network Rail standards and Wildlife Legislation to reduce the risk the railway and third-party land.

This work included undertaking bat activity surveys which identified two roosts of two different bat species within the tree. This required a NatureScot bat licence and species protection plan to be put in place prior to works taking place.

An Arborist and licenced bat ecologist worked closely with the teams undertaking the tree safety works to ensure all tree features were checked for presence of bats prior to tree works proceeding,

Figure 12: *Bat boxes installed on retained tree stems*

Tree stems were retained following works and two artisan Kent bat boxes and a multi-chamber woodcrete bat box were sourced and installed on the tree stems to provide a habitat options for bats next season. Arisings were also stacked into large habitat piles within the lineside, providing shelter for invertebrates, small mammals and nesting habitat for a number of birds.

6.2 Examples of partnership working

6.2.1 Road and Rail Ecology Works

During a routine site visit by one of our Ecologists to a railway yard in Midlothian during the summer of 2023, a kestrel (Falco tinnunculus) nest was discovered within a railway overbridge (non-lineside), with three chicks. Our Ecologist reached out to the Lothian and Borders Raptor Study Group to get the chicks ringed.

The joint efforts of Network Rail colleagues, and Raptor Study Group successfully caught two out of the three chicks were caught in a hand-net and they were ringed by an experienced Ornithologist – the third chick flew off and wasn't able to be ringed.

Figure 13: *Kestrel chicks being ringed at railway yard*

Both ringed chicks were healthy males and just about ready to fledge. After ringing they were safely put back into the nest. The third chick was also suspected to be a male.

Kestrels have suffered a population decline of around 40% over the last three decades, making it an Amber-listed Bird of Conservation Concern in UK. Bird ringing provides invaluable information on species dispersal from natal sites, migration and longevity, helping to better understand population dynamics.

6.2.2 FLS and Network Rail Scotland Glenfinnan Project Progress

As mentioned in previous State of Nature reports, Network Rail Scotland is partnering with Forestry and Land Scotland (FLS) to deliver an ambitious biodiversity enhancement project at Glenfinnan which will lead to the protection and expansion of natural habitats and woodland at the site.

This industry-leading pilot project to enhance the natural habitat near the iconic Glenfinnan viaduct is making good progress with the completion of the first phase of work.

During the first phase of work, non-native invasive species were removed, and fencing was installed to protect ancient oak-woodland from grazing animals. Survey work has since been carried out to determine where further planting is required to supplement natural regeneration. In addition, fenced enclosures will be created to protect areas of vulnerable pinewood and access tracks will be created to support future planting, maintenance and wildlife management.

Figure 14: *Glenfinnan biodiversity enhancement project site*

The next phase of the project, expected to conclude in 2024, will include repairs and replacement of fencing to protect a designated Atlantic oak woodland at Kinlochmoidart – part of Scotland's rainforest, planting to native woodland, and continued maintenance and enhancement of wet woodland along Callop River.

6.2.3 Tree Council Community Planting Days

Our partnership with the Tree Council continued throughout CP6 and in 2023, Network Rail partnered with the organisation to deliver biodiversity enhancement through community tree planting projects, including two projects at Queens Park and Elder Park, in the city of Glasgow.

40 volunteers from Network Rail Scotland came together with the Tree Council, Propagate Scotland and the Friends of Elder Park community group and the Queen's Park Community Orchard to deliver enhance the natural features of the two public parks.

At Queen's Park, the community orchard was expanded by planting fruit bearing trees such as apple trees. The fruit trees provide vital shelter as they age quickly, developing features like hollow trunks and rot holes that support invertebrate species. Their blossoms are also an important food source for pollinators, including bees, hoverflies, and butterflies, ultimately benefiting nearby flowering plants.

In Elder Park, over 500 hedgerows were planted. Hedgerows are important habitats, offering nesting sites and protection for birds, small mammals, insects, and other wildlife. Glasgow's Local Biodiversity Action Plan highlights a decline in hedgerows within the city, making this project important for restoring these essential habitats and supporting local biodiversity.

7 Future plans

7.1 Habitat management plans

Network Rail Scotland has obtained a temporary variation against Biodiversity standard NR/L2/ENV/122 Module 2 Habitat Management Plans, which revises the compliance date to the beginning of the next Control Period in 2024.

Work concluded in 2023 on the pilot to produce a joint Habitat and Vegetation Management Plan for approximately 2 miles of our network. The lessons learned from this pilot have helped inform the methodology which will be applied to produce Scotland's Habitat Management Plans.

To produce these plans as efficiently as possible with the resource available, production of the plans will be aligned to delivery of the CP7 Vegetation Management Programme, and we will also seek to embed this required into works being delivered through our Capital Delivery teams. The production of Habitat Management Plans forms a key milestone within the Scotland's Railway Climate Action Plan Biodiversity Delivery Plan, and we will monitor and report on progress throughout CP7. Stakeholder engagement plans for the next reporting period.

7.2 Stakeholder engagement plans for the next reporting period.

As part of the Scotland's Railway Climate Action Plan, we have an ambitious milestone around habitat enhancement and creation. As part of the delivery of this milestone we will focus our efforts on building on the existing relationships and partnerships established during CP7, like with FLS, Forth Rivers Trust and the Tree Council, while also looking to establish new partnerships to deliver biodiversity enhancements that will explore the use of nature-based solutions to benefit not only the railway but Scotland's biodiversity.

In CP7 we are also establishing collaborative forums with our supply chain, aligned to each of the Climate Action Plan themes. This includes a dedicated Biodiversity group which will bring together representatives from our supply chain to discuss key deliverables of the Climate Action Plan's Biodiversity delivery plan, while also providing opportunities to share best practice and discuss biodiversity-related projects across Scotland's Railway.

Southern Region State of Nature Report 2023

Contents

8 Personnel & Document Control

All ecologists should state their membership level of a recognised professional body (e.g. CIEEM, IEMA) alongside their name.

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8.1 Document Control

Version number	Approved by Date	Description	Prepared by	Reviewed by	Authorised by
1	17/01/2025	Draft	HG	SB	SB
1.1	25/03/2025	Final	HG	KS, SB	SB

9 Foreword

This report, for Network Rail Southern Region, covers the period April 2023 to March 2024. Southern Region comprises the Kent, Sussex and Wessex Routes.

It outlines the state of nature on the region's estate and the ambitions and plans we have in place to protect and maintain its habitats and associated biodiversity. It also highlights key examples of the actions we have undertaken to improve these habitats, and where necessary control undesirable species.

Figure 1: *Southern Region*

10 Executive Summary

10.1 Overview

Southern Region owns a total of 7,832 hectares of habitat with a baseline value of 38,902 biodiversity units. Three habitat classes dominate our region: sparsely vegetated land (a new consolidated category including widespread bramble scrub); grassland; and broadleaved woodland. Of these, woodland has particularly high value and potential for habitat connectivity opportunities in the landscape. Southern also has smaller areas of nationally important heathland and wetland habitats.

Southern has direct management responsibility for 221 hectares of Sites of Special Scientific Interest (SSSI) / European protected sites. In addition to this, there are 700 non-statutory protected Local Wildlife Sites wholly or partially in Southern's estate. Biological records have been obtained showing that hundreds of protected or priority species use Southern's lineside habitats. Proactive conservation action is taken in the Region for a number of these species, particularly the hazel dormouse which is uncommonly frequent in the Region's relatively undisturbed railside woodland and scrub.

10.2 Summary of ambitions for biodiversity management

Southern has a comprehensive biodiversity programme, with a range of innovative projects and priority initiatives in place to deliver improvements against biodiversity objectives and targets. Southern's pioneering Railway Nature Sites initiative has so far designated and protected 50 lineside locations as biodiversity priority sites, ringfenced for biodiversity enhancements. Significant resource continues to be invested in the Kent Habitat Management Pilot, which in its fourth year of delivery has begun to yield valuable and insightful results and lessons learned to inform habitat management planning in a railway context.

Research and development continues to be a priority for Southern, with a partnership with the Zoological Society of London delivering lineside wildlife detection, monitoring innovations and insights which earned the project Highly Commended at the annual CIEEM awards. The partnership also provided a Biodiversity Monitoring Framework for Network Rail, which is progressing into the next stage of development.

Delivery against Network Rail's Biodiversity Net Gain (BNG) target is a key priority and performance measure. In 2023, Southern developed a Biodiversity strategy to establish the principles by which the business will plan, implement and measure BNG, and an action

plan for implementation of the strategy including significant business system adaptation requirements.

10.3 Summary of achievements for biodiversity management

Key management and infrastructure activities that have had impacts on biodiversity include Southern's Thanet Parkway station development scheme in Kent, which yielded an impressive 17% BNG. The Kent Habitat Management Pilot monitoring results from 2023 demonstrated that the trials are achieving biodiversity enhancements, with some management techniques emerging as particularly effective. Initial enhancement measures have been carried out in several Railway Nature Sites, with some sites subject to progressive habitat management plans, such as the Wareham and Old Bay site being managed for the rare sand lizard.

Southern has made some extremely important advances in protecting its biodiversity asset, including the establishment of an organisational licence for great crested newts, in a partnership which delivers fast-track works licences and off-site habitat enhancements for this species. Similarly, an agreement with Natural England is being arranged so that Southern can undertake operational activities with dormouse protection measures. A new procurement framework has been established to provide the Region with effective local ecological expertise and support, and externally-sourced biological records for the Region have been obtained.

The ongoing partnership with the Tree Council has this year delivered an incredible 45,350 trees, with Network Rail employees attending 120 days of volunteering. Southern has also worked in partnership with regional train operators including a successful collaboration with South Western Railway to manage a Railway Nature Site at Feltham Marshalling Yard.

10.4 What further action will we take?

A primary focus for Southern in coming years will be the implementation of the biodiversity strategy. A critical component of biodiversity enhancements – and a regional target in its own right – will be the development of habitat management plans covering the whole of Southern's lineside, providing detailed management objectives and options to achieve biodiversity enhancement (and BNG), through systematic integration with Off-Track vegetation management.

Additional Railway Nature Sites will continue to be identified and designated, with enhancements delivered to offset Regional maintenance biodiversity impacts. Southern will continue existing partnerships (such as The Tree Council) and develop its successful R&D partnership with Zoological Society London (ZSL), with a refined scope building on the Monitoring Framework delivered this year. Attention will focus on development of performance measuring methodologies and progression of habitat management trials to understand the impacts of lineside management on wildlife (adaptation of the Kent Pilot).

A major focus of stakeholder engagement for Southern in early CP7 will be engagement with Local Nature Recovery Strategies (LNRS), which will be integrated with lineside habitat management plans provide opportunities for collaborative working with strategic partners and stakeholders.

11 State of nature in Southern Region

11.1 Biodiversity metric calculation for the region

A baseline register of the habitat classes in Southern Region's network and their spatial extent was created through the processing of satellite images in 2020 (by Network Rail nationally). This identified 16 habitat classes in the Southern estate. The 'statutory metric' – a government-developed tool for measuring Biodiversity Net Gain – was used to calculate the value of the habitats present in the Region at baseline (2020), measured in 'biodiversity units'.

Annual re-assessments using updated satellite imagery have been undertaken in subsequent years, and in 2023, all previous years' data were updated following a process of data validation and improvements to reduce uncertainty in the data, which resulted in the original baseline being re-measured. As part of this process, some previously separated habitat classes were consolidated into broad 'sparsely vegetated land' and 'grassland' classifications, resulting in 7 habitat classes in total, shown in Table 1.

At the 2020 (re-)baseline, Southern Region was estimated to own a total of **7,832** hectares of habitat with a value of **38,902** biodiversity units. The breakdown of habitats and their respective values is shown in Table 1 (and Figures 1 and 2, below).

Southern Region 2020 habitats measurement			
	Area (ha)	**Distinctiveness**	**Biodiversity units**
Sparsely vegetated land*	4,112.24	Low	16,448.96
Grassland**	2,106.73	Low	8,426.92
Broadleaved woodland	911.49	Medium - High	7,291.92
Coniferous woodland	290.95	Low	1,163.8
Fen	211.75	Very High	3,388
Heathland and shrub***	147.96	Medium - High	1,775.52
Lakes (ponds)	50.81	Medium - High	406.48
Total	**7831.93**		**38901.6**

* consolidated class including Arable and horticulture, Inland and littoral / supralittoral rock / sediment, Coastal saltmarsh, Developed land sealed surface, Built up areas and gardens.
** consolidated class including Modified grassland, Neutral grassland, Calcareous grassland, Acid grassland.
*** scrub habitats are not included in this figure.

Table 2 Breakdown of habitat types in Southern baseline, 2020

It should be noted that the national data analysis is not sufficiently accurate to inform detailed understanding of Southern's habitats; for example, scrub habitats, which are extremely widespread in Southern, are not differentiated or visible in the national data. However, by applying consistent analysis each year, the data is expected to show a useful indication of likely change.

The Region's key targets, in line with national commitments, are to deliver no net loss in biodiversity by 2024, and biodiversity net gain (of 10%) by 2035, compared to the 2020 baseline. The Southern strategic business plan sets out a timeline of incremental 1% increases towards 10% BNG, as shown in Table 2. In 2023, the re-assessment of habitat satellite imagery measured the value of Southern's habitats as **38,846** biodiversity units; a change of -0.14%, against the target of no net loss (0%) by 2024. This is shown in Table 3.

Control Period	CP7 Y1	CP7 Y2	CP7 Y3	CP7 Y4	CP7 Y5	CP8 Y1	CP8 Y2	CP8 Y3	CP8 Y4	CP8 Y5	CP9 Y1
Year	2024 -25	2025 -26	2026 -27	2027 -28	2028 -29	2029 -30	2030 -31	2031 -32	2032 -33	2033 -34	2034 -35
BNG % increase	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%

Table 3 - Annual Biodiversity Net Gain targets

Performance measure	Target 2023	Actual 2023	Commentary
No net loss in biodiversity	38,901.6	38,846.04	Target is to maintain 2020 baseline.

Table 4 - Performance against Biodiversity Net Gain target

Table 4 shows the annual breakdown of habitats values in biodiversity units.

	Biodiversity Units, per year				2020-23
Habitat type	2020	2021	2022	2023	% change
Sparsely vegetated land	16,448.96	17,297.44	17,954.84	15,719.76	-4.43%
Grassland	8,426.92	6,254.32	5,637.56	8,688.56	3.10%
Broadleaved woodland	7,291.92	9,390.32	9,326.24	8,772.72	20.31%
Fen	3,388.00	3,066.40	1,655.04	2,179.68	-35.66%
Heathland and shrub	1,775.52	3,383.88	4,041.36	1,948.44	9.74%
Coniferous woodland	1,163.80	1,050.68	993.36	1,140.40	-2.01%
Lakes	406.48	271.12	635.92	396.48	-2.46%
Total	**38901.60**	**40,714.16**	**40,244.32**	**38846.04**	**-0.14%**

Table 5 - 2023 habitat values

Figures 1 and 2 display the extent and values of Southern's habitats in 2020 and 2023.

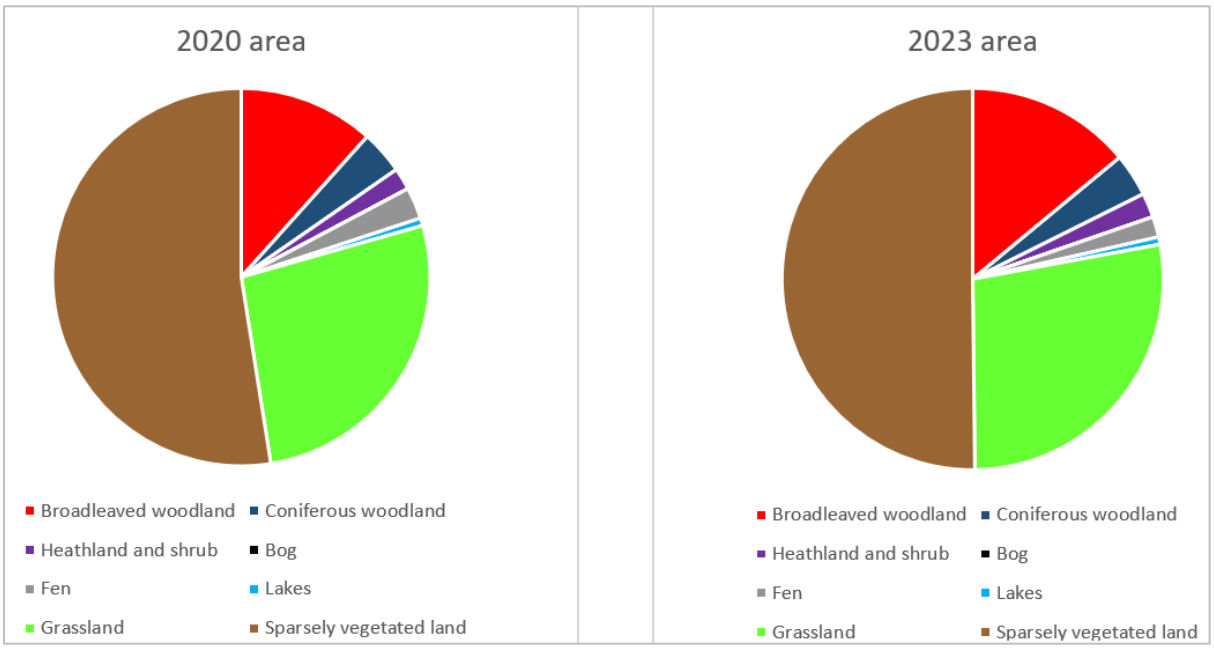

Figure 15 - Regional habitat areas at 2020 baseline and 2023.

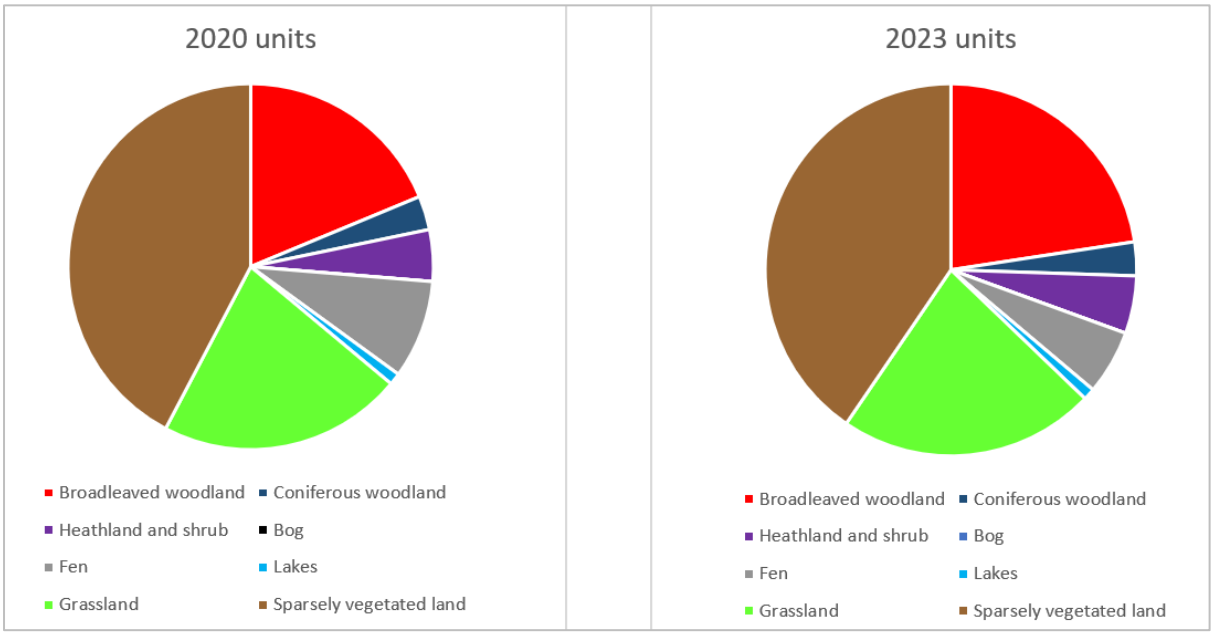

Figure 16 - Regional habitat value in biodiversity units at 2020 baseline and 2023.

The overall (near 0) change in habitat value from 2020-2023 is primarily accounted for by a large (36 %) decrease in fen habitat, balanced by a significant (20 %) increase in woodland and 10 % increase in lowland heathland (scrub is not included in the 'heathland and shrub' category). These changes are difficult to explain, particularly given that the habitat valuations have fluctuated from one year to the next, and it is not possible to interrogate the data to understand where or why this has occurred. It is likely that some figures are the result of classification errors; for example, it seems unlikely that the extent of 'lake' habitats could have changed annually to fluctuate the value from 406 – 271 – 636 – 396 biodiversity units year-on-year.

It is possible that habitats have transitioned, for example grassland and scrub habitats may have matured to classify as woodland, or fen habitats could have dried and transitioned to (wet) woodland. However, data is not available to analyse where changes have occurred, to compare with local knowledge or work records in order to substantiate the findings. The annual fluctuations in the data also make this unlikely.

These difficulties in accounting for the change in habitat types, and limitations inherent in the habitat data, have been considered in Southern's biodiversity strategy development in 2023, which will establish higher-accuracy habitat mapping to support BNG assessments and habitat management plans, and improved data capture of impacts to habitats (positive and negative) by Network Rail activities (see section 4.2).

11.2 Regional biodiversity accounting

In order to provide more detailed understanding of impacts on biodiversity from Southern's activities, a Regional 'biodiversity accounting' process is being established, using detailed assessments completed by Capital Delivery projects and records of maintenance works completed.

For 2023, data available from Capital Delivery projects shows an overall loss of 247 biodiversity units, a 33 % loss from the overall pre-works habitat value, as shown in Table 5. The greatest impact appears to be in the Wessex Route, though data from this Route is less robust than data from Kent and Sussex.

Route	Before Work Units	After Work Units	Unit change	% change
Kent	185.29	144.56	-40.73	-21.98 %

Sussex	146.59	111.34	-35.25	-24.05%
Wessex	425.07	253.89	-171.18	-40.27%
Total	**756.95**	**509.79**	**-247.16**	**-32.65%**

Table 6 - Capital Delivery project biodiversity impacts

Data on the Capital Delivery impacts by habitat type is available for Kent and Sussex Routes, shown in Table 6. This is interesting to compare with the overall habitat change detected in the national satellite data, as Capital Delivery projects are relatively high-impact operational activities, and it would be expected that their impacts might be discernible in the data. For example, a 135-unit loss of woodland biodiversity units was recorded in Kent and Sussex Capital projects, which is a reasonable comparison with the overall 554 woodland units lost between 2022-23, in the national data. Comparison is not possible for other habitats due to lack of consistency in how they have been categorised in the data (the national dataset does not differentiate habitats to the same level as the biodiversity metric used for project accounting, and amalgamates some habitat categories, as explained in section 4.1).

Biodiversity Type	Grassland Modified		Grassland Other		Ruderal		Scrub (various)		Woodland (various)	
	Ha	Units	Ha	Units	Ha	Units	Ha	Units	Ha	Units
Kent change	-0.16	-0.87	4.20	18.10	-0.80	-1.60	1.37	7.04	-4.45	-55.35
Sussex change	-0.01	-0.05	0.00	-1.65	0.31	0.57	0.12	1.41	-4.02	-79.49

Biodiversity Type	Native Hedgerow		Native Hedgerow Species Rich		Line of Trees		Line of Trees Ecologically valuable	
	Km	Units	Km	Units	Km	Units	Km	Units
Kent change	0.32	0.88	0.99	5.07	0.01	0.03	-0.05	-0.44
Sussex change	-0.02	-0.09	0.48	2.65	0.00	0.00	0.00	0.00

Table 7 - Capital Delivery impacts by habitat type

Maintenance records exist, but analysis has proved inconclusive, due to the broadly-themed nature of current task-headings under which vegetation management can be recorded and issues with data robustness (which will be addressed in future plans to improve maintenance biodiversity data). This, coupled with the abstract nature of the current available habitat mapping making it impossible to determine the habitat being impacted by each task, prevents any kind of meaningful interpretation of impacts. Some data does exist for Kent and Sussex Routes (Works Delivery) portfolio of vegetation management, which provides the figures shown in Table 7:

Activity	Kent	Sussex
Plants/Trees Removed	23,341	6,863
Hectares impacted (vegetation re-profiling)	101.54	39
Hectares managed (vegetation maintained)	18.3	3.7

Table 8 - Works Delivery vegetation works

With respect to the data in Table 7, if it is assumed that the 140ha of re-profiled vegetation was woodland encroaching on the railway, this would not be incompatible with the overall 69ha loss of woodland recorded between 2022-23, as not all the re-profiling would be full clearance. However, more detailed analysis of the locations in the two datasets – together with the locations of woodland affected by Capital Works - would be needed to provide more robust conclusions.

11.3 Regional habitat types

According to the national satellite data analysis, three habitat classes dominate across Southern's estate: sparsely vegetated land, which is likely including the widespread bramble scrub habitats, grassland and broadleaved woodland (see Tables 1 and 4 and Figures 1 and 2).

Southern has direct management responsibility for 221 hectares of the 125 nationally designated Sites of Special Scientific Interest (SSSI) within or adjoining the estate boundaries. 56 % of these sites are in Wessex Route, with 25 % and 18 % in Kent and Sussex Routes respectively. 101ha of these sites are also designated as European Special Areas of Conservation and Special Protection Areas. 44 % of the SSSI areas for which Southern is partly responsible are in Favourable Condition, and 55 % are in Unfavourable Condition (in most cases the majority of the SSSI is not in Network Rail's ownership). In addition to this, there are 700 non-statutory protected Local Wildlife Sites wholly or partially in Southern's estate.

Scrub, an extremely prevalent habitat in Southern's lineside, is a transition state between grassland and woodland and provides vital food and shelter to a diverse range of animals and pollen and nectar sources for insects.

Lowland deciduous woodland is widespread in the Southern estate and is a UK priority habitat providing many crucial ecosystem functions, supporting a large range of

species including priority species such as bats and hazel dormouse. Deadwood and veteran trees support many species. According to habitat connectivity analysis undertaken by Network Rail, woodlands along Southern's railways offer significant value for improving habitat connectivity in the landscape, as shown in the map below.

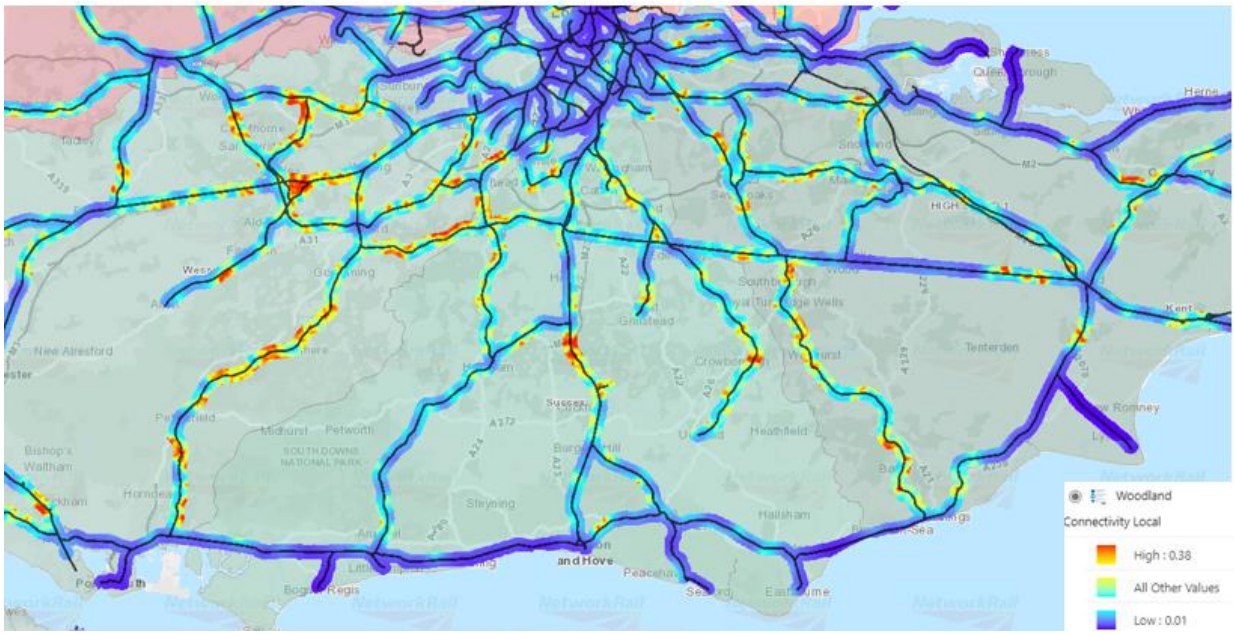

Figure 17 - woodland habitat connectivity potential

Railside grasslands are home to a wide variety of plants and animals and provide important connectivity and habitat 'mosaic' functionality for wildlife. Almost half of all the protected sites in Southern's estate are (partly) designated for their grassland habitats.

Lowland heathland is another UK priority habitat in Southern, primarily in the Wessex Route in nationally protected areas such as the New Forest National Park and Dorset Heaths. Southern also has small areas of important priority wetlands, particularly fen and marsh habitats in the Kent Route, in the Dungeness, Romney Marsh & Rye Bay and Stodmarsh protected site areas.

11.4 Priority species in the region

Many legally protected species are present in Southern's lineside, with biological records for over 20 mammal species, including otters, polecats, hazel dormouse, water vole, hedgehog and at least 11 species of bat, 126 bird species, 80 insect species and

12 reptile and amphibian species. Additionally, over 260 species which are priorities for conservation are currently known from biological records to utilise the estate of Southern Region, including 63 species of bird and 198 insects. Southern has engaged in work to benefit a range of these, and other priority species, including re-introduced or re-establishing species such as pine martens, birds threatened by population declines and habitat loss such as turtle doves and nightingales, and pollinating insects.

In Southern Region, one of the most iconic species is the hazel dormouse, which despite being internationally protected due to population decline (75 % in the UK in recent decades) and habitat loss, is frequently found in Southern's estate, with their distribution strongly correlated with woodland habitat: see map below. This demonstrates the importance of the relative abundance of undisturbed woodland and scrub habitats alongside the railways, compared to other areas.

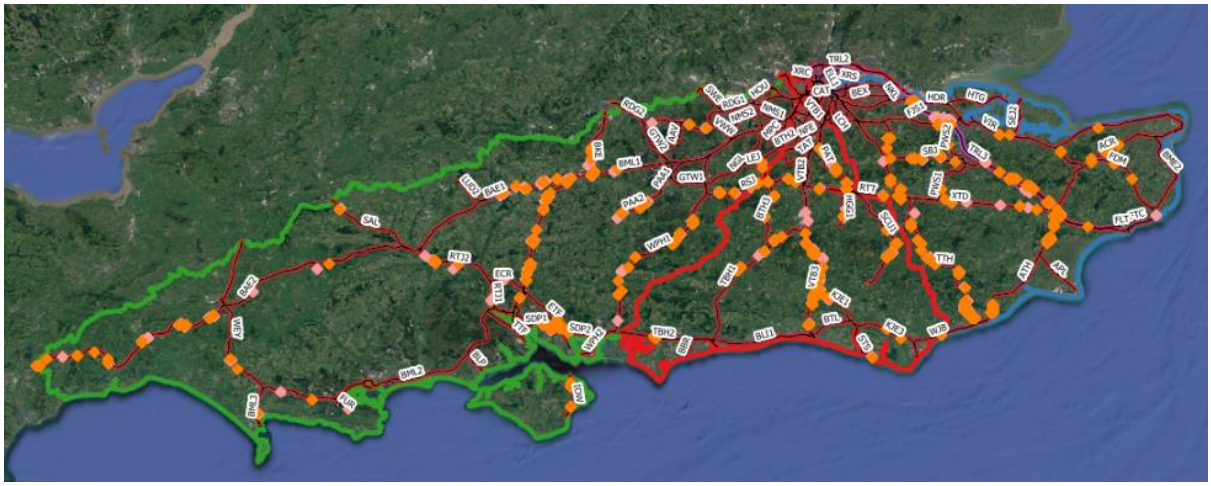

Figure 18 - Hazel dormouse distribution, 2023 (orange diamond symbols)

11.5 Invasive species in the region

Invasive non-native species of plants and animals are found throughout the Region and pose a significant challenge to biodiversity and operational management. There is a legal requirement to not facilitate the spread of such species, but the majority found on the railway are widespread and complete eradication from the Southern estate is not feasible.

In Southern the principal plant species of concern and control effort for biodiversity protection are Japanese knotweed, Himalayan balsam, rhododendron and buddleia, which are all invasive non-native species which out-compete other plants and pose

threats to wildlife and the safe management of the railway. Additionally, giant hogweed and ragwort are managed as harmful or 'injurious' species respectively (ragwort is native but is deemed to require control as a threat to farming productivity). During 2023, Southern's lineside maintenance plan delivered cutting and herbicide treatment of approximately 27,7585m² (28ha) of these invasive plants.

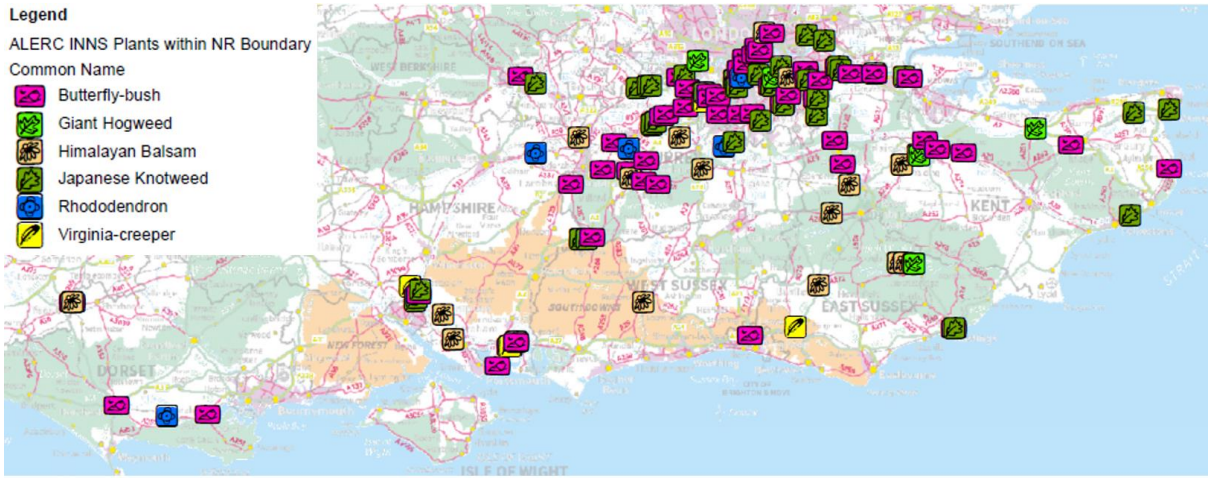

Figure 19 - Records of problematic invasive plants in the region (from Local Environmental Records Centre biological records)

There are many non-native animal species known to inhabit Southern's lineside: externally-sourced biological data shows 1320 records of non-native species including grey squirrel, muntjac deer, American mink, ring-necked parakeet, Chinese mitten crab, signal crayfish and marsh frog. Southern's ecology team engages with efforts to control yellow legged hornets. However, the only invasive animal under significant control in Southern is the oak processionary moth (OPM), regulated as a quarantine pest, which was first identified in London in 2006 and has spread to surrounding counties. Treatment on hundreds of infected oak trees has been undertaken across Kent [28 trees spread between15 locations], Sussex (50-75 trees affected across 5 sites) and Wessex Inner (11 locations; approx. 10 trees per location) during 2023, involving mechanical herbicide application or via manual suction removal. Wessex Outer is currently unaffected by this species. Control appears to be required annually as the caterpillars have been found to return post-treatment.

Figure 20 - OPM warning sign on a site in Wessex

11.6 Demonstration sites or projects

11.6.1 Kent Habitat Management Pilot

Southern's flagship demonstration project is the Kent Habitat Management Pilot, in which a series of Habitat Management Techniques (HMTs) are being trialled on 69 lineside sites. Trials have been implemented since 2020, with 'tranches' of sites added each year. Monitoring of effects has been undertaken each year, with detailed botanical and invertebrate surveys. 2023 was the first year in which sufficient data was available for any significant trends and findings to be detected with reasonable confidence, due to the staggered trial timelines. Although this is still too soon to detect significant effects, and there are inherent limitations in the study methodology, with three years of data the following findings and emerging trends were reported:

- There has been a positive effect of the Pilot overall, towards increased botanical and invertebrate species richness.
- Several HMTs had distinct effects on species abundance measures:
    - HMT 3 (enhance scrub) gave the widest range of benefits to biodiversity across the trial sites.
    - HMT 8 ('business as usual', or limited management) previously had not been observed to produce any effect, but in 2023 showed small positive impacts on species richness.

- Where site seeding was undertaken, the following results were apparent:
    - Seeding success was generally poor and highly variable across sites (0-47 % of species sown found growing).
    - Overall seeding success was low, with sites seeded in Tranche 3 and 2 showing 23 % and 24 % success respectively (1-2 years post-seeding).

Figure 21 - examples of Kent Habitat Management Pilot trial site transitioning to grassland habitat.

The report on the 2023 monitoring made some useful conclusions and recommendations:

- The 'business as usual' HMT yielded a comparable response to other HMTs which had a clear positive impact on plant and invertebrate species richness by 2023, indicating that delivery of a single cyclical maintenance cut (note – most lineside areas are *not* yet routinely managed in this way, whilst the business focuses resource to achieve a safety-compliant vegetation state) may achieve limited biodiversity improvements even in the absence of additional interventions.
- Cutting of vegetation in grasslands, woodlands and scrub have created structural changes with a more open, diverse structure and community composition, including on sites undergoing the 'business as usual' HMT. There has been a general shift from species-poor scrub communities towards species-rich grassland communities.

- Sites with woodland were shown to be moving towards a more species-rich community, due to enhancements in glades and edges, but lacked the dramatic changes seen where scrub was removed and grassland created / enhanced. Changes to woodland habitats take time and are not likely to be detected in a few years; this is one of the overall key findings of the Pilot: biodiversity takes time!
- Structural vegetation changes may not be beneficial to all species groups, but techniques where a mosaic of habitats is created, such as those co-locating tussocky and wildflower rich grassland alongside scrub, are likely to be the most effective at maintaining and enhancing biodiversity.
- Dense ivy ground cover should be retained, creating a desired mosaic of habitats with grassland and scrub. A learning from the study is that reptiles particularly may be impacted by ivy removal – a habitat type that doesn't score highly on the BNG Metric but was still found to be valuable.
- Targeting particular performance measures may fail to capture species-specific impacts of management particularly when habitat structure is changed, or habitat mosaics are not achieved. An example is transforming species-poor tussocky grassland into a more open, species rich grassland, but this destroys structural habitat (tussocks) depended upon by many animals including priority species. It could be possible to enhance tussocky grasslands through over-sowing, instead.
- The study recommends a list of plants for seeding in railway sites, based on those that were found to be more successful in the trials so far. It also recommends a list of species suitable for over-sowing in tussocky grassland.
- Grassland enhancement, rather than creation from other habitat types, is recommended, due to the low success of seeding trials.

12 Priorities for biodiversity management in this region

Southern's strategic priority is to deliver against the objective of delivering no net loss in biodiversity by 2024 and achieving biodiversity net gain by 2035. Aligned to these outcomes, our delivery priorities over 2023 included:

- Addressing the significant challenge of Network Rail's BNG target, Southern's BNG Strategy has been prepared and agreed in 2023. The Strategy sets out how the Region has applied the BNG framework in the context of a large linear infrastructure statutory body (as opposed to the development and legislative Planning context that it was designed for), and the comprehensive steps it plans to take to implement measures towards achieving the BNG targets.

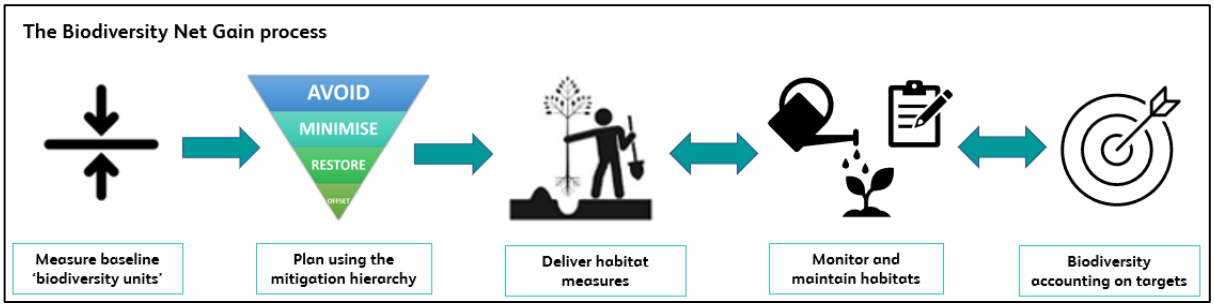

Figure 22 - Network Rail Southern Biodiversity Net Gain process

- 50 Railway Nature Sites have been created – areas of lineside or underutilised land with existing or potential value for biodiversity and/or community use. All 50 sites have been secured with Business Strategy Clearance, and signage installed to inform railway employees. Habitat management to achieve BNG or other objectives will be planned and implemented in CP7, towards the Regional BNG target; a number of sites have already been subject to works to remove invasive species.

Against its underlying commitment to protect and enhance biodiversity, Southern has prioritised the following ecological management deliverables in 2023:

- Establishment of a bespoke new procurement mechanism – the Ecology Services Framework – to ensure access to adequate, skilled and experienced ecological expertise to support the Regional Sustainability team. This Framework is being finalised for use in CP7.

- Regional biological data has been procured from the Association of Local Environmental Record Centres (ALERC), to improve the business' understanding of its biodiversity asset, reduce risks and improve efficiencies in works planning.
- Southern has established a regional great crested newt organisational licence, to ensure mitigation to conserve this protected species and to substantially reduce delays and costs to the business when undertaking works that might impact it. Through a partnership with Nature Space, licences will be quickly processed and off-site enhancement works will be delivered to offset railside impacts. In the year since the organisational licence's inception, Southern made 20 enquiries for Nature Space to assess project licensing requirements and received 6 licences delivering a total of 300m² terrestrial habitat mitigation.
- In a similar initiative, Southern is also working to establish a hazel dormouse 'Ways of Working' agreement with Natural England, in acknowledgement of the unusually high frequency of dormice in the Southern estate and the need to undertake railway management whilst also ensuring appropriate conservation of this species.
- Southern is committed to training staff in biodiversity management and recording and is producing a user-friendly 'ecology checklist' and guidance handbook for operatives to identify and avoid impacts to habitats and species.

13 Case studies

13.1 Examples of best practice habitat management approaches

13.1.1 Wareham sand lizards

Actions to conserve desirable species (no net loss) and control undesirable species are part of many routine activities in the Region, but a specific example is enhancement works to benefit sand lizards - one of the UK's rarest reptiles, now confined to a few sites – which have been implemented at Southern's 'Wareham and Old Bay' Railway Nature Site, in Wessex, based on detailed and ongoing surveys informing a habitat management plan.

In the Railway Nature Site, a total of 267 reptile individuals of five species were recorded during survey effort in 2023 (see images below), with the sand lizard population remaining stable from previous years. For the Old Bay Platform area, the 2023 data show a marked increase in reptile numbers compared to 2022, reflecting the habitat management work that has been undertaken. In particular, sand lizard records increased dramatically, up from seven in 2022 to 20 in 2023. Of note is the sighting of six hatchlings born in summer 2023, demonstrating that successful breeding took place in 2023. The slow-worm population also appears to be increasing significantly.

Figure 23 - reptiles (grass snake and sand lizard) found during surveys at Wareham and Old Bay RNS

13.1.2 Thanet Parkway Capital Works project

As part of Network Rail's Thanet Corridor Enhancements Programme, Kent's first new railway station in eight years, Thanet Parkway, opened in 2023, bringing the capital closer to the coast with high-speed trains and additional peak services. The project undertook habitat creation and restoration, achieving a total 17.63 % BNG through enhancement of existing habitats on the rail embankments and roadside verges and planting of species-rich hedgerows providing connectivity, and habitat creation in formerly arable land. Thanet Council has the lowest percentage of tree cover in Kent, so to support the local tree strategy the project planted 350 whips and 32 trees around the local area, working alongside Cliffsend Parish Council and local volunteers.

Figure 24 - Thanet Parkway tree planting

13.1.3 ZSL research and development partnership

The use of new technologies and research and development to support biodiversity management is a priority for Southern. Since 2022, a partnership with the Zoological Society of London (ZSL) has yielded important insights into the use of acoustic detectors and remote cameras to record lineside wildlife, including dormouse and other small mammals which are typically under-detected using traditional survey methods. The study deployed 'Mostela' boxes and camera traps and found that when placed together, these methods detected more mammal species than either method alone. Acoustic monitoring results illustrated the need for further work to improve accuracy of identifications of small mammals using this relatively new technology. Several practical lessons learned were also made by the study, for application to future lineside surveying methodologies including for

dormouse, which would be highly valuable for protection of this species which tends to frequently inhabit lineside habitats and is very difficult to detect. The Southern Sustainability Team received Highly Commended at the recent CIEEM awards for this work; see image below.

Figure 25 - ZSL partnership dormouse monitoring and CIEEM awards

In 2023 ZSL also produced a detailed Monitoring Framework recommending priorities and methodologies for measuring Network Rail's biodiversity performance alongside the existing BNG metric; a long-term monitoring plan; and a research and development plan. This will be developed in coming years.

13.2 Examples of partnership working

13.2.1 Tree Council

Southern has engaged in a highly successful partnership with the Tree Council to deliver a programme of community tree planting, since 2020. In 2023, the partnership worked at 105 locations to plant an incredible 45,350 trees, with Network Rail employees attending 120 days of volunteering. An audit of trees previously planted found a survival rate of 90%, which is incredibly high (planting scheme survival is normally 50-75%). This is very encouraging for the extension of similar initiatives more generally in lineside management, where trees can be safely grown. The distribution map of the existing partnership locations is shown below.

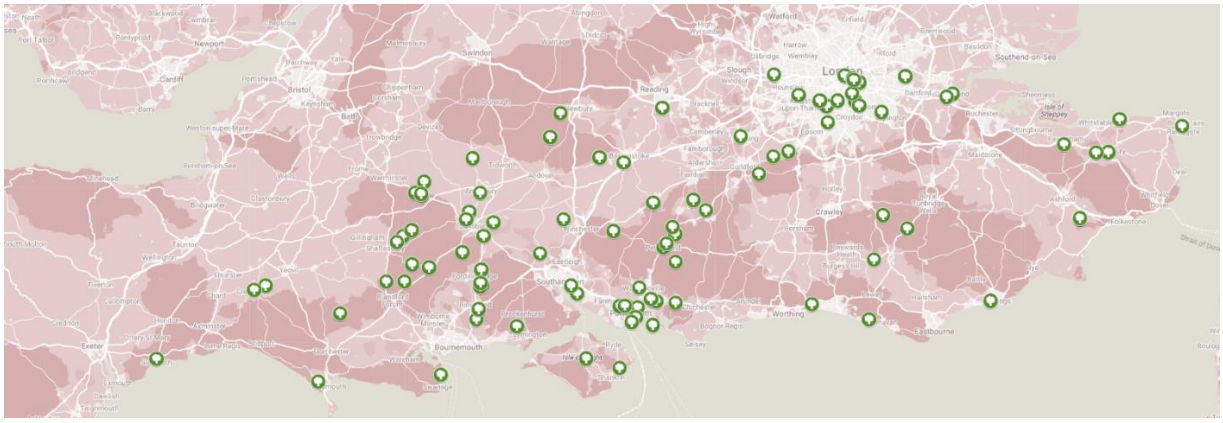

Figure 26 - Distribution of partnership tree planting locations

13.2.2 Feltham Marshalling Yard

75 % of this Railway Nature Site is leased to our train operating partner, South Western Railway, who have been enhancing the woodlands and grasslands of the site (image below) and carrying out species monitoring programmes since 2019. Under new collaborative arrangements, the remaining 25 % of the RNS (under Network Rail control) will be included in ongoing site assessments and a habitat management plan for the RNS will be prepared. Similar partnerships to manage other Railway Nature Sites in partnership with TOCs will be developed on the basis of this successful initiative.

Figure 27 - wildflower meadow at Feltham Marshalling Yard Railway Nature Site

14 Future plans

14.1 Biodiversity Net Gain and habitat management plans

A primary focus for Southern will be the implementation of the BNG strategy, which requires significant work and systemic change to establish and embed business tools and processes for the planning, measurement and monitoring of BNG, and to safeguard biodiversity enhancements for the requisite minimum 30 years. The delivery of BNG will also require considerable financial investment, and detailed planning is necessary to ensure that this is achieved in line with core business priorities and budget commitments, as well as with external stakeholder and wider landscape conservation priorities.

A critical component of BNG delivery – and a regional target in its own right – will be the development of habitat management plans covering the whole of Southern's lineside, providing detailed management objectives and options to achieve biodiversity enhancement (and BNG), through systematic integration with Off-Track vegetation management. Plans will be produced for priority areas in CP7 years 1-2, with remaining areas in a phased programme throughout the control period.

14.2 Biodiversity enhancements

Additional Railway Nature Sites will continue to be identified and designated. Habitat management plans will be developed for all sites and enhancement works will be delivered to achieve BNG and other objectives. Outside these sites, lineside habitat management plans will improve habitat-specific routine maintenance and provide strategic habitat enhancement options for capital projects to deliver to offset impacts and achieve BNG targets.

14.3 Partnerships

Southern will continue existing partnerships (such as The Tree Council) and develop its successful R&D partnership with ZSL, with a refined scope building on the Monitoring Framework delivered this year. Attention will focus on development of performance measuring methodologies and progression of habitat management trials to

understand the impacts of lineside management on wildlife (adaptation of the Kent Pilot in line with ongoing study findings and ZSL's input).

14.4 Stakeholder engagement plans for the next reporting period.

A major focus of stakeholder engagement for Southern in early CP7 will be engagement with Local Nature Recovery Strategies (LNRS) being prepared by Local Authorities. Strategy priorities will be integrated with lineside habitat management plans and engagement with working groups will ensure collaborative working with strategic partners and stakeholders.