OFFICIAL

Railway Sustainability Design Guide

Heathland and Shrub Design and Management Guidance Note

Published and Issued by Network Rail, 2nd Floor, One Eversholt Street, London, NW1 2DN.

Disclaimer

In issuing this standard/control document for its stated purpose, Network Rail Infrastructure Limited makes no warranties, expressed or implied, that compliance with all or any standards/control documents it issues is sufficient on its own to provide safety or compliance with legislation. Users are reminded of their own duties under legislation.

Compliance with a Network Rail standard/control document does not, of itself, confer immunity from legal obligations.

Where Network Rail Infrastructure Limited has granted permission to copy extracts from Network Rail standards or control documents, Network Rail Infrastructure Limited accepts no responsibility for, nor any liability in connection with, the use of such extracts, or any claims arising there from.

This disclaimer applies to all forms of media in which extracts from Network Rail standards and control documents might be reproduced.

Supply

Copies of standards/control documents are available electronically, within Network Rail's organisation. Hard copies of this document might be available to Network Rail people on request to the relevant controlled publication distributor. Other organisations can obtain copies of this standard/control document from an approved distributor.

Issue record

Issue	Date	Comments
0.1	June 2021	First release in advance of online edition

Reference documentation

NR/L2/ENV/122	Managing Biodiversity
NR/L2/ENV/122/01	Biodiversity
NR/L2/ENV/122/02	Habitat Management Plan
NR/L2/OTK/5201/01	Lineside vegetation inspection and risk assessment
NR/L2/OTK/5201/02	Lineside Vegetation Management Requirements
NR/L2/OTK/5201/03	Route Vegetation Management Plans
NR/L3/OTK6202	Protecting railway assets during vegetation work
	Habitat Design and Management Guidance Note

Contents

1 Purpose

The lineside includes a range of heathland and shrub habitat types. Effective heathland and shrub management will contribute to safe and efficient rail operation and an increase in the natural-capital value of the lineside. This note provides guidance on:

a) Best practice heathland and shrub habitat management operations for Central, Regional, and Route teams showcasing what good heathland and shrub habitat and biodiversity management looks like;

b) Why heathland and shrub management decisions are made in certain situations including important considerations and implications;

c) Risks reduced by the application of this guidance note including, delays and unplanned costs from unforeseen/inadequately considered heathland and shrub and lineside constraints;

d) Benefits of the application of this guidance note including, enhanced biodiversity of the lineside, increased stakeholder confidence and improved relations relating to national biodiversity goals and, the use of green infrastructure solutions to improve resilience of the heathland and shrub lineside; and

e) Associated legislation and control documents that this document helps to achieve compliance with.

2 Scope

This guidance note applies to Network Rail, their supply chain and third parties working on Network Rail owned land. It shows how heathland and shrub within the lineside can be managed, supported by templates; habitat specifications; identification; aids; toolbox talks; and case studies.

The guidance note complies with and supports the following documents:

a) Protecting railway assets during vegetation work (NR/L3/OTK/6202);

b) Biodiversity (NR/L2/ENV/122);

c) Lineside Vegetation Management Standards (NR/L2/OTK/5201); and

d) Habitat Design and Management Guidance Note.

This guidance note informs:

a) The production of habitat management plans; and

NOTE: *Habitat management plans are described in NR/L2/ENV/122 Module 02*

b) The production of route vegetation management plans and sectional asset plans.

NOTE: *Route vegetation management plans and sectional asset plans are described in NR/L2/OTK/5201 Module 03.*

3 Definitions

Table 1 – Terms and definitions

Term	Definition
Biodiversity	Biodiversity is the variety and variability among all forms of life, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part.
Biodiversity Net Gain	An approach to development that leaves biodiversity in a better state than before, abbreviated in this document to BNG
Biosecurity	Procedures or measures designed to protect a population against harmful biological or biochemical substances.
Browsing and browsing	A browser is a type of herbivore which eats leaves, soft shoots, fruits of high-growing plants and shrubs. A grazer feeds on grass or other low vegetation.
Colonisation	Natural establishment of plant communities which start to form a habitat. Colonisation can occur from plants self-seeding by a variety of mechanisms e.g. wind or animal dispersed.
Coppicing	The practice of cutting back a tree or shrub (or hedgerow) to ground level periodically to stimulate growth.
Designated site	A site legally designated for nature conservation. This includes internationally designated sites (e.g. Special Area of Conservation), nationally designated sites (e.g. Sites of Special Scientific Interest), regionally and locally designated sites (e.g. Local Nature Reserve).
Edge habitats	Edge habitats are the spaces between two different types of habitat. For example, the boundary between a woodland and grassland habitat is an edge habitat.
Flushes	Flushes are areas where water from underground flows out onto the surface to create an area of saturated ground.
Friable tilth	Soil which is “easily crumbled”, allowing enough air space for drainage and to trap nutrients.
Green Infrastructure	A network of multi-functional green spaces, urban and rural, which are capable of delivering a wide range of

Term	Definition
	environmental and quality of life benefits for local communities
Habitat condition	The ecological condition of a particular habitat parcel. Condition relates to the value to biodiversity a particular habitat parcel provides relative to other parcels of the same habitat type. Habitat condition relates to Natural England's Biodiversity Metric's habitat condition scores which range from 'Poor' to 'Good' (Natural England 2019a and 2019b). Heathland and shrub habitats will vary in their ecological condition. Factors that affect the condition of a habitat include human disturbance, damage by livestock and presence of invasive non-native species (INNS).
Habitat mosaics	An area comprised of multiple habitat types.
Habitat value	A habitat's value is its relative importance in sustaining socially or ecologically significant wildlife populations and biological diversity.
Haggs	A firm spot in a bog.
INNS	Invasive non-native species (INNS). Species which have been introduced into areas outside their natural range through human actions and are posing a threat to native wildlife.
Laying (hedge)	Hedge laying is the practice of making or maintaining a hedge by cutting branches and laying them horizontally.
Lineside	The extensive area of land that falls within the ownership boundary.
Muirburn	Intentional burning of moorland to remove the top layer of vegetation.
Natural capital	The world's stocks of natural assets. These include geology, soil, air, water and all living things. From this natural capital, people derive a wide range of services, (ecosystem services) such as food production.
Natural regeneration	Natural regeneration is the process by which a habitat is restocked by plants that develop from seeds that fall or are dispersed by wind or animals and germinate *in situ*.
Preferred Habitat Objective	The broad process which will enable an existing habitat to be modified into the preferred habitat type. Habitat Objectives related to one of the following processes:

Term	Definition
	Transform, Conserve, Restore and Enhance. This is in relation to the Habitat Management Plans (NR/L2/ENV/122 Module 2) only.
Priority habitat	Habitats of principal importance listed under Section 41 of the Natural Environment and Rural Communities Act (2006).
Resilience	The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.
Self-sown	A plant sown by itself, typically from seeds dispersed from a neighbouring plant.
Semi-natural	Habitats that have been heavily modified by human activities. Most of the UK's naturally occurring habitats are regarded as semi-natural.
SSSI	Site of Special Scientific Interest.
Statutory Nature Conservation Organisation (SNCO)	The SNCO for England, Wales and Scotland are as follows: England: Natural England Scotland: NatureScot Wales: Natural Resources Wales
Stepping stones	Patches or islands of semi natural habitat which provide passage within the wider landscape for wildlife.
Targeted habitat creation	A management technique of creating loosely geometric grid of cut heather. One of the benefits is increase of grouse numbers and establishment of habitat for numerous species such as hares and waders.
UK Habitat Classification	A system for classify habitats within the UK, devised by the UK Habitat Working Group. UK Habitat Classification is the classification system used within Natural England's Biodiversity Metric.
Urban setting	Belonging to/relating to a town or city.
Wayleaves	A right of way granted by a landowner, generally in exchange for payment and typically for purposes such as the erection of telegraph wires or laying of pipes.

4 Introduction

This document provides guidance on the following:

1. Heathland and shrub classification – how to classify heathland and shrub into one of three sub-types to help understand existing heathland and shrub habitats and apply relevant best practice with regards to creation, establishment and management guidance;

   Parts 2-5 are addressed for the following individual sub-habitat types; *dwarf shrub heath*, *hedgerows* and *dense scrub*.

2. Heathland and shrub habitat and design – guidance on how to design new heathland and shrub within the lineside and key considerations for implementation;
3. Heathland and shrub establishment – guidance and key considerations on how to successfully create and establish new heathland and shrub in the lineside to maximise its biodiversity and the ecosystem services it supports;
4. Long-term management of heathland and shrub habitat – guidance, key considerations and best practice management techniques to enhance established heathland and shrub, and
5. Heathland and shrub restoration – guidance on restoring heathland and shrub and the associated lineside benefits including best practice techniques such as reseeding, replanting or natural regeneration.

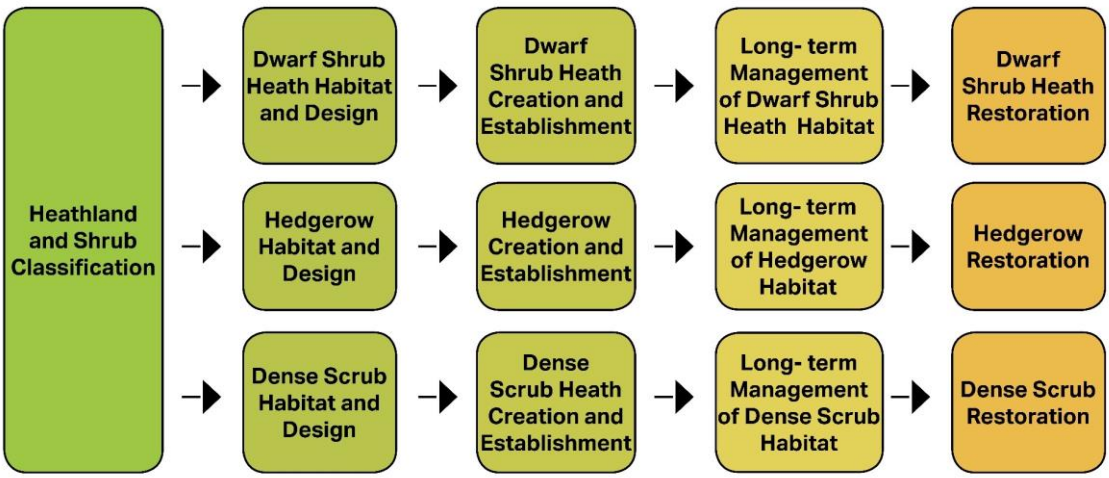


Figure 1 – Heathland and shrub design and management guidance process

Case studies are included in Section X to illustrate examples of best practice in the delivery of preferred habitat objectives.

4.1 Document structure

Figure 2 shows the relationship hierarchy of the Heathland and Shrub Design and Management Guidance Note and other Level 2 and Level 3 Network Rail guidance notes, manuals and modules.

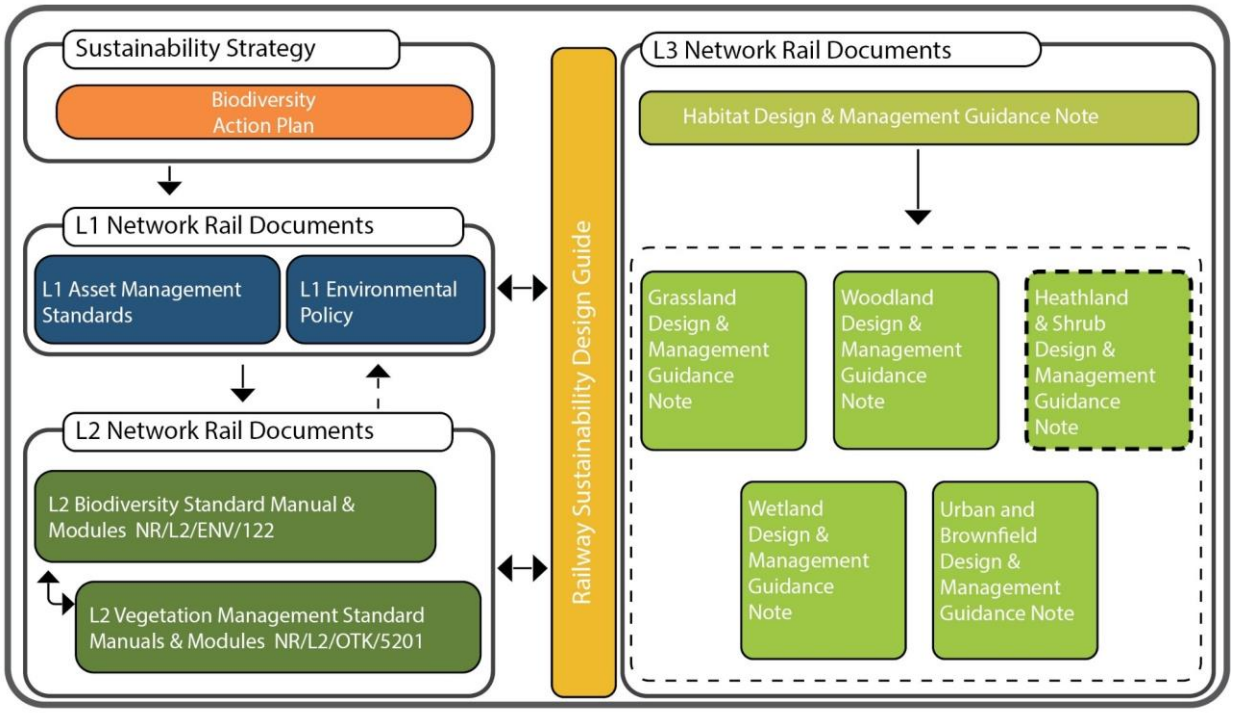
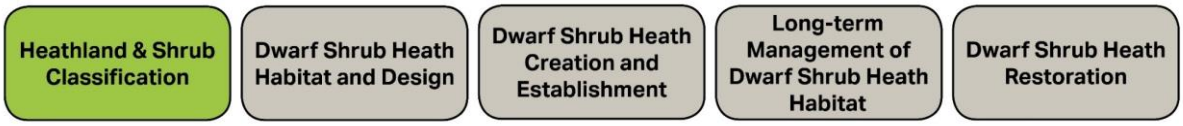


Figure 2 – Document hierarchy

5 Heathland and Shrub Classification



5.1 Introduction

Network Rail has adopted the UK Habitat Classification to describe the habitats within the lineside. These are set out and described in the Habitat Design and Management Guidance Note, which defines five primary habitat types (UK Habitat Classification Level 2) according to which all land within the lineside should be classified:

- Grassland;
- Woodland;
- Heathland and shrub;
- Wetland; and
- Urban.

***NOTE**: UK Habitat Classification documents are available at:*
https://ecountability.co.uk/ukhabworkinggroup-ukhab/

5.2 Heathland and Shrub (UK Habitat classification code - h)

5.2.1 Definition

Vegetation with more than 25% cover of dwarf shrub species (height no greater than 1.5m) or woody species of up to 5m high. Heathland includes vegetation dominated by ericoids (tough leaves like those of heather) or gorse (*Ulex* spp.) species. Shrub is dominated by woody vegetation usually no greater than 5m tall, occasionally with a few scattered trees.

Figure 3 –Typical heathland and shrub habitat found adjacent to the railway

5.2.2 Attributes

The following list of attributes are typical of heathland and shrub:

- Habitat comprises at least 25% cover of woody species.
- Comprises small trees or large shrub species lower than 5m in height. The low height makes them appear 'bushy'.
- Includes hedgerows which are common on field and property boundaries in some parts of the UK.
- Heathland is typically found on nutrient poor, acidic soils.
- Lowland heathland is found in southern England (e.g. Dorset, Hampshire and Surrey) but also scattered in lowland areas in the Midlands, north of England and Wales.
- Moorland is a common term for upland heathland (e.g. Dartmoor, Pennines, Cairngorms, Snowdon).

Figure 4 – Example of lineside heathland and shrub habitat

5.2.3 Classifying heathland and shrub habitats

The type of heathland and shrub can influence the application of appropriate best practice guidance for its design and management.

The following information should be used to further classify the heathland and shrub habitat into sub-types. They are defined by the dominant plant species within them (UK Habitat Classification, 2018):

- **H1: Dwarf shrub heath (Level 3)** is characterised by 25% or greater coverage of heather and dwarf gorse species. Occurs generally on well-drained, nutrient-poor, acid soils in both the lowlands and the uplands.
- **H2: Hedgerows (Level 3)** is characterised by a boundary line of shrubs, with gaps less than 2m, that were once stock proof and more or less continuous. Hedgerows can include features such as an earth bank, wall, ditch, tree or herbaceous vegetation provided its less than 2m from the hedgerow centre.

The UK Hab Classification has the following two sub-definitions for different types of hedgerows:

  - **H2a Hedgerow (priority habitat) (Level 4):** Hedgerow consisting predominantly (i.e. 80% or more cover) of at least one woody UK native species, where each UK country can define the list of woody species native to their respective country.
  - **H2b Other hedgerows (Level 4):** Hedgerows that do not consist predominantly (i.e. 80% or more cover) of at least one woody UK native species.

- **H3: Dense scrub (Level 3)** is characterised by areas of shrubs less than 5m tall with greater than 90% cover. This includes patches with occasional trees greater than 5 metres tall and tree species less than 5m tall.

It is important to check whether existing heathland and shrub habitats have any protected species as this is likely to have a strong influence on the management objective(s). This should be recorded as part of the habitat study.

NOTE: *Refer to Habitat Design and Management Guidance Note for guidance on existing habitat surveys and site data information.*

NOTE: *Protected species licences may be required from the Statutory Nature Conservation Organisation (SNCO); Natural England, NatureScot and Natural Resources Wales; see Sections 7.4.3, 8.4.3 and 9.4.3 Protected Species License and the Habitat Design and Management Guidance Note.*

5.3 H1 Dwarf shrub heath

5.3.1 Attributes

The following list of attributes are typical of dwarf shrub heath:

- Dwarf shrub heath, hereafter referred to as heathland, are split into two categories:
    - **Lowland heath** occurs in areas below 300m Above Ordnance Datum (AOD), such as Staffordshire, Suffolk, Norfolk, the south and west of England from Surrey to Cornwall, south and west Wales and the eastern Scottish Lowlands.
    - **Upland heath** (commonly known as Moorland) occurs in areas above 300m AOD such as Devon, Cornwall, Wales, the Pennines, Lake District and Scotland.
- Both Lowland and Upland heath comprise of shrubs, broadleaf plants, grasses and mosses. Examples of common species include:
    - **Shrubs:** bell heather (*Erica cirecinerea*), bilberry (*Vaccinium myrtillus*), common ling / common heather (*Calluna vulgaris*) and cross-leaved heath (*Erica tetralix*).
    - **Broadleaf plants:** heath bedstraw (*Galium saxatile*) and tormentil (*Potentilla erecta*).
    - **Grasses:** purple moor-grass (*Molinia caerulea*), dwarf gorses (*Ulex* ssp.), western gorse (*Ulex gallii*), sheep's fescue (*Festuca ovina*) and mat grass (*Nardus stricta*).
    - **Mosses:** woolly fringe-moss (*Racomitrium lanuginosum*), red-stemmed feather-moss (*Pleurozium schreberi*), glittering wood-moss (*Hylocomium splendens*), cypress-leaved plait-moss (*Hypnum cupressiforme*), haircaps (*Polytrichum* spp.) and bog mosses (*Sphagnum* spp.).
- Historic locations of lowland heathland in England can be found on the RSPB maps available online https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/advice/conservation-land-management-advice/heathland-extent-and-potential-maps/.
- The majority of heathland in the UK is classified as species poor, found on generally well-drained, nutrient-poor, acid soils.
- Historically man-made habitats created for browsing livestock and sourcing fuel from cut turf (otherwise referred as cut peat).
- Traditional management techniques comprise of manual and machine cutting; browsing and burning. Upland and lowland heathlands are managed similarly.

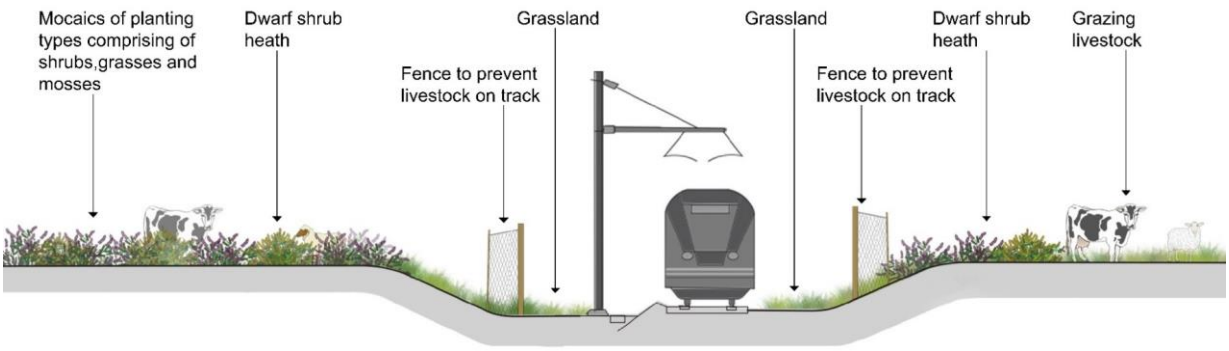


Figure 5 – Examples of lineside dwarf shrub heath habitat

5.3.2 Development phases

Figure 6 illustrates the development phases of heathland. Best practice management techniques and associated operational considerations can be found in the relevant sections of the document as outlined below. For best practice guidance on designing new heathland, refer to Section 7.6.

Pioneer phase  (0-6 years)	Heathland develops from seed into small individual plants which form approximately 10% of vegetation cover which requires ground preparation and aftercare to establish.	Refer to Dwarf Shrub Heath Creation and Establishment in **Section 7.7**.
Building phase  (6-15 years)	Heathland forms a dense, closed canopy creating approximately 90% of vegetation cover.	Refer to Dwarf Shrub Heath Creation and Establishment in **Section 7.1**.
Mature phase  (15 – 25 years)	Plants become woody, with thick stems and fewer green roots. The heathland canopy begins to open, creating approximately 75% of vegetation cover allowing other plant species to increase their cover. Implementing long-term management and monitoring is key to enhancing or conserving the biodiversity value of the heathland.	Refer to Long-term Management of Dwarf Shrub Heath in **Section 7.8**.
Degenerate phase  (25 – 50 years)	The central branches of heathland tend to die off creating larger gaps in the canopy. At this stage heather contributes to approximately 40% of vegetation cover. Without appropriate management scrubland or woodland plants may colonise, and heathland restoration may be considered.	Refer to Dwarf Shrub Heath Restoration in **Section 7.9**.

Figure 6– Development phases of heathland

5.4 H2 Hedgerows

5.4.1 Attributes

The following list of attributes are typical of hedgerows:

- Hedgerows provide connectivity between different habitats.
- Examples common of hedgerow species include: hazel (*Corylus avellana*); hawthorn (*Crataegus monogyna*); blackthorn (*Prunus spinosa*); field maple (*Acer campestre);* purging buckthorn (*Rhamnus cathartica*); dog rose (*Rosa canina*); holly (*Ilex* spp.); and wayfaring trees (*Viburnum lantana*).
- Hedgerows can be species-rich, such as mixed native hedges or species poor such as single-species ornamental hedges. Due to hedgerows being predominantly planted, species richness is largely dictated at the habitat creation stage.
- Hedgerows define boundaries, provide shelter for local wildlife from wind and flooding (via water supply regulation), insect pest control, preventing loss of soil and reducing pollution.
- Hedgerows are traditionally managed by trimming, re-shaping, laying, and coppicing. The majority of these techniques can be done by hand or machine.
- There are types of hedgerow that are only found regionally (see Section 8.6.1.1) these can include Cornish Hedgerows and Devon Hedgerows.
- Hedgerows can have associated features such as banks, specimen trees, laid hedgerows, ditches and margins (see Figure 7 for some examples). These features can increase the ecological value of the hedgerow.

NOTE: *For best practice guidance for Cornish hedgerows refer to the Code of Good Practice for Cornish Hedges, http://www.cornishhedges.co.uk/PDF/code-cor.pdf.*

Feature	Description	Location on site
Hedgerow with ditch 	A ditch adjacent to a hedgerow is a common occurrence, especially in rural agricultural settings, often created as a drainage feature for the surrounding arable fields.	Hedgerows with ditches are likely to be found on arable field margins.
Species-rich hedgerow 	A hedgerow generally comprised of five or more UK native species.	This hedgerow is typical of a countryside setting.
Laid hedgerow 	When a hedgerow requires restoration, 'laying' techniques can be applied. This involves cutting the stem at an angle part way through to allow it to be bent or 'laid'.	A laid hedgerow is typically found in rural settings.
Hedgerow with specimen trees 	Specimen trees are a common feature of a hedgerow which can provide benefits to biodiversity such as food, shelter, nesting sites, song posts for birds, as well as connectivity 'stepping stones' between habitats. If specimen trees are present, they should be considered as part of the hedgerow management plan.	A hedgerow with specimen trees are typically to be found on arable field margins.
Ornamental hedgerow 	A hedgerow comprising ornamental species, i.e. non-native, selected for their foliage and / or flowers and visual amenity. Typically these are single species hedgerows.	This type of hedgerow is usually found in urban environments such as garden boundaries.

Figure 7 – Example of hedgerows with features

5.4.2 Development phases of hedgerows

Figure 8 illustrates the development phases of hedgerows. Best practice management techniques and associated operational considerations can be found in the following relevant sections of the document as outlined below. For best practice guidance on designing new hedgerows, refer to Section 8.6

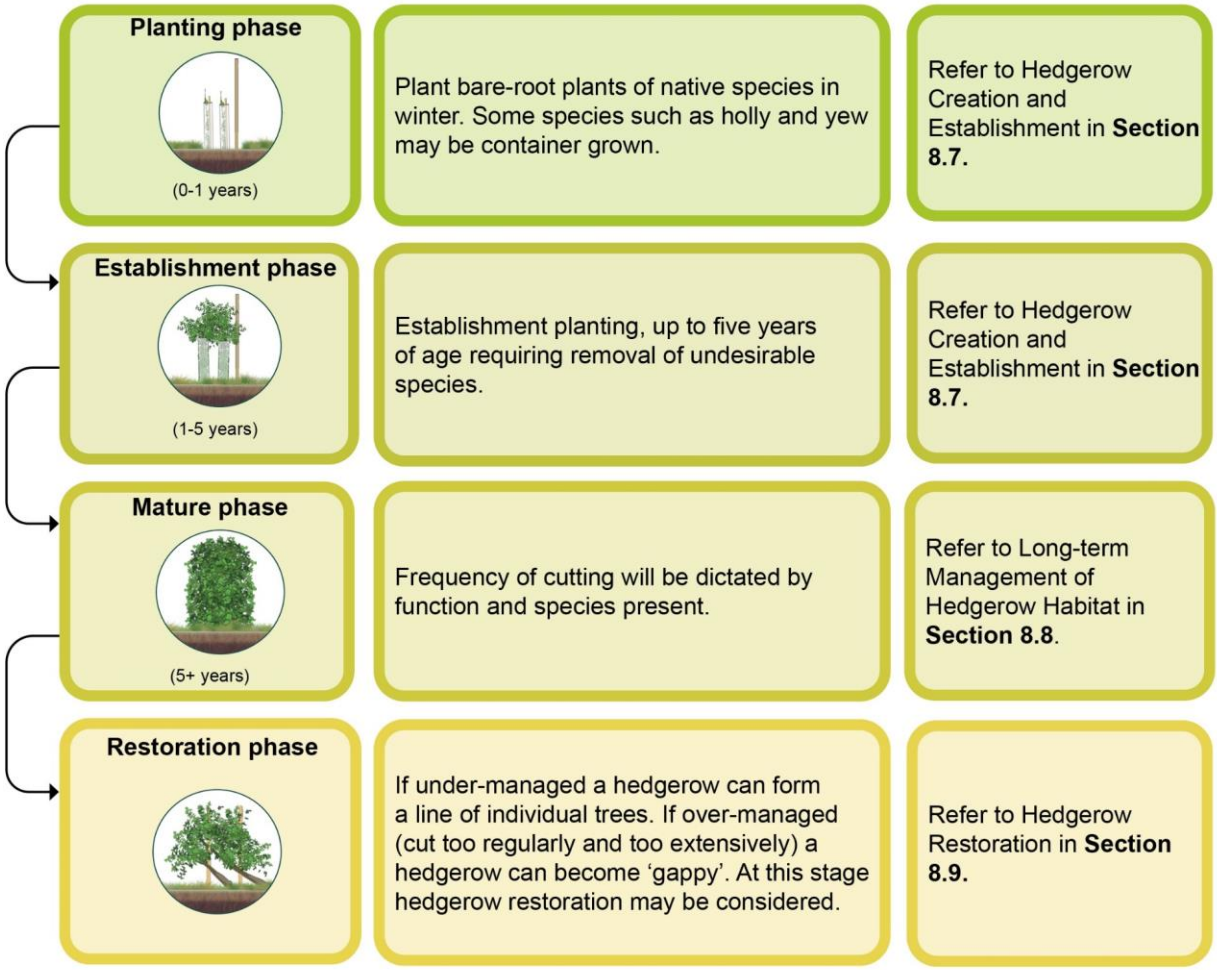


Figure 8– Development phases of hedgerows

5.5 H3 Dense Scrub

5.5.1 Attributes

The following list of attributes are typical of dense scrub:

- Dense scrub, hereafter referred to as scrub, comprises of two layers:
    - **Scrub edge** which can include grassland with a mixture of annual, perennial, herbaceous plants; and
    - **Shrub** which can include scattered or close canopy shrubs with occasional trees;
- Scrub edge is most valuable for biodiversity;
- Scrub is found throughout the UK;
- Scrub should be divided into three types defined by their location: lowland, upland and coastal scrub;
- Scrub can form an importance mosaic element of woodland, grassland, and heathland plant communities;
- Scrub is an essential component of the grassland and heathland priority habitats, as being important for many birds and invertebrates including several priority species;
- If not managed correctly scrub can be invasive, dominating species-rich habitats such as grassland and eventually turning into woodland, and
- Traditional management techniques include browsing or cutting. Herbicide treatment is also a common management technique and maybe required in combination with cutting.

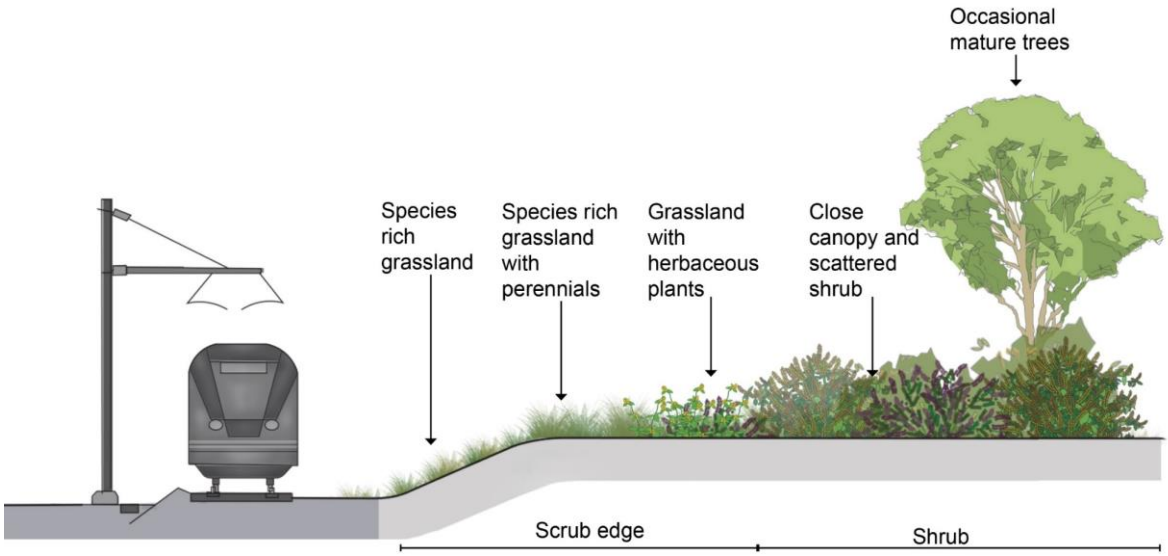


Figure 9 – Example of section through lineside scrub habitat

5.5.2 Development phases of scrub

Figure 10 illustrates the development phases of scrub. Best practice management techniques and associated operational considerations can be found in the following relevant sections of the document as outlined below. For best practice guidance on designing new scrub, refer to Section 9.6

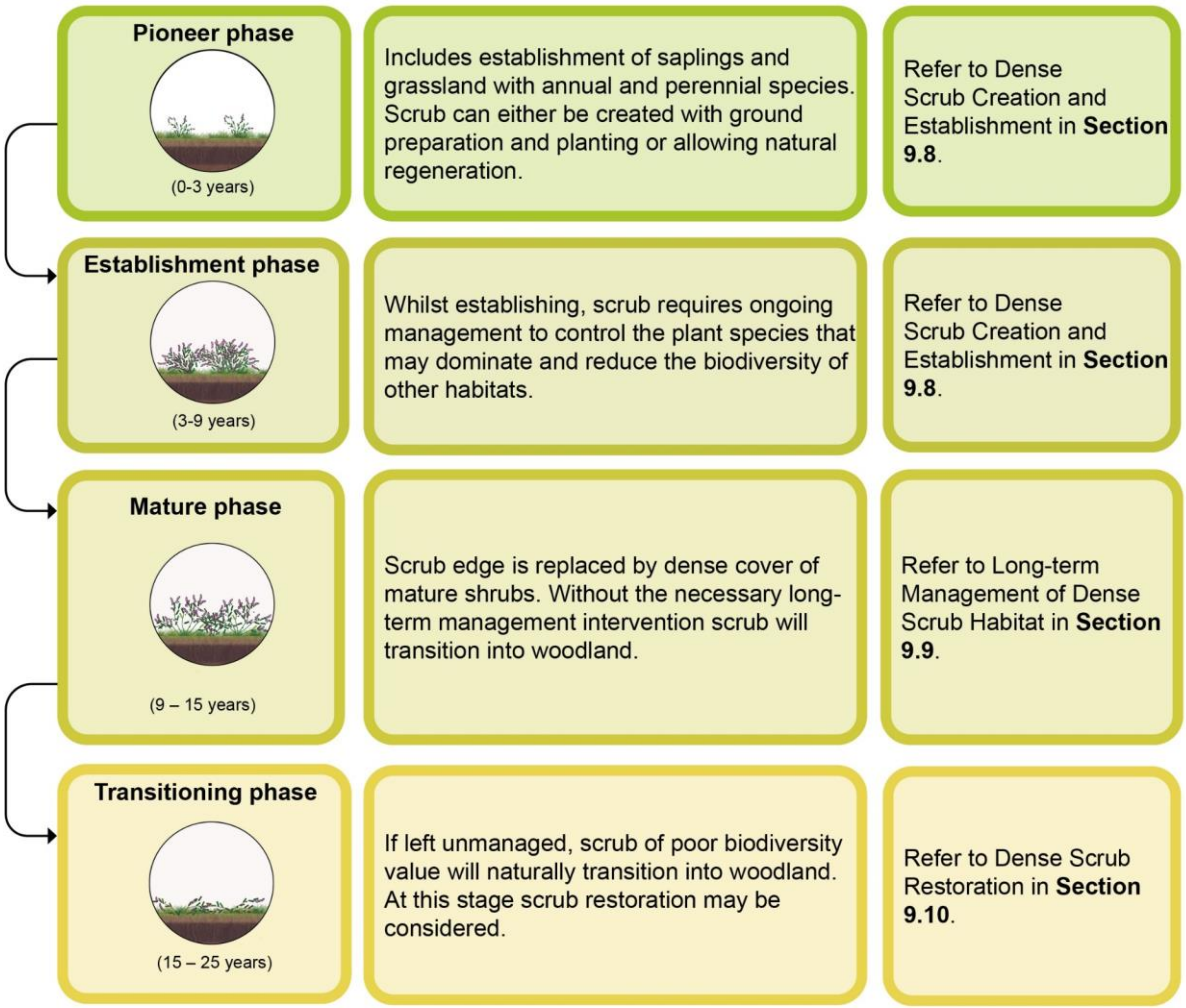


Figure 10 – Scrub development phases

6 Heathland and Shrub Habitat Design and Management

Figure 11 – Heathland and shrub design and management guidance process

6.1 Introduction

The following sections are grouped into the heathland and shrub sub-habitats; *dwarf shrub and heath* (heathland), *hedgerows* and *dense shrub* (scrub).

These sections provide guidance on:

- General considerations related to heathland and shrub design and management;
- The design of new heathland and shrub habitat;
- Interventions required to create and establish new heathland and shrub habitat; and
- Management of established heathland and shrub habitat, including habitat restoration.

Each section includes practical guidance and makes reference to tables in the cost summary folder to understand the budget costs of carrying out work.

Specialist advice can be sought as necessary to inform decision making and implementation. Typically, this may involve the following:

- Ecological advice where protected habitats or species are identified;
- SNCO (Natural England, NatureScot, Natural Resources Wales) advice where dwarf shrub heath management advice is required; and
- Landscape advice for the design, implementation and management advice where required in particular when integration with existing or new landscape elements is needed

7 Dwarf Shrub Heath Habitat Design and Management

7.1 Introduction

This section provides guidance on:

- General considerations related to the design and management of heathland;
- The design of new heathland habitat;
- Maintenance required to establish new heathland habitat; and
- Long-term management of heathland habitat; and
- Restoration of heathland habitat.

NOTE: *Professional expertise should be sought throughout the process. For example, an experienced ecologist should be consulted to determine the Preferred Habitat Objective and objectives set out in the site Habitat Management Plan. In addition, landscape advice should be sought where design, implementation and management advice is needed.*

7.2 Habitat management plans

In addition, Network Rail's requirements for Habitat Management Plans are set out in NR/L2/ENV/122 Module 02.

The process of setting objectives for the Habitat Management Plan is described in the Habitat Design and Management Guidance Note (see Section 7.6).

It is recommended that the Habitat Management Plan sets out short, medium and long-term objectives. These periods, as follows, should reflect the development phases as illustrated in Figure 6:

- *Short-term* (year 0 to 6);
- *Medium-term* (year 6 to 15); and
- *Long-term* (year 15 - 25).

NOTE*: Refer to NR/L2/ENV/122 Module 02 for information on the requirements for Habitat Management Plans.*

NOTE*: Management objectives should be reviewed against data collected via monitoring (see Section 7.8.4).*

7.3 Ecosystem services and design considerations

As outlined in the Habitat Design and Management Guidance Note, an initial site appraisal can help identify ecosystem services present and the potential to expand the range provided by the lineside. This will help inform decisions as to how the heathland is designed or managed.

Heathland within the lineside can provide a range of ecosystem services. These include:

- **By-products:** the existing mosaics of heathland are a valuable source of heather and other heathland seeds, which remain dormant in the soil or can be used as a source for restoration or re-creation of new habitats;
- **Forage production:** heathlands are suitable for browsing livestock and, or by wild herbivores;

- **Pollination:** plants from the heather family offer a food source and shelter for pollinators;
- **Biodiversity:** heathland habitat supports biodiversity which provides further ecosystem services such as pollination;
- **Water regulation:** vegetation can reduce the rate at which water meets waterbodies and watercourses, reducing the occurrence of flash flooding downstream;
- **Air pollution removal:** carbon sequestration of heathland and associated preservation and renewal of soils provide benefits including improved health and protection against climate change; and
- **Landscape integration:** heathland can improve lineside aesthetics and integrate the landscape with the wider setting.

NOTE: *Ecosystem services of the land should be identified when fieldwork is undertaken. This should be determined by an environmental specialist, using professional judgement. Refer to the Habitat Design and Management Guidance Note for more information on ecosystem services.*

7.3.1 Lineside design considerations

In addition to ecosystem services, there are other lineside specific design considerations and benefits which will help to inform whether heathland is an appropriate habitat within a specific location (Table 2). In some cases, there may be conflict between different objectives, for example reducing fire risk by replacing with another habitat type with reduced biodiversity. The design should therefore provide the detail on how competing objectives could be managed, for example, by minimising the areas where heathland should be removed.

Table 2 – Key considerations for heathland in a railway setting

Design consideration	Key heathland design considerations	Associated heathland management approaches
Fire risk reduction measures	• During summer droughts, heathland can dry out and can become subject to wildfires.	• Consider location and the associated fire risk in the management plan. To prevent potential for wildfires from drought, cut earlier in the season. This should be prioritised for lineside heathlands connected to public spaces where barbeques, fires etc. may take place. • Consider creating fire breaks by keeping areas of heathland cut to the ground to prevent spread of fire – this could conflict with habitat connectivity objectives. • Controlled burning should be replaced by cutting to deliver the same management objectives.
Access routes for establishment and maintenance	• Heathland habitat may need to be accessed via routes on third party land for planting and maintenance.	• Network Rail may have rights to access land but local stakeholder engagement is key to gaining access to third party land. Landowner permissions should be sought prior to heathland creation or

Design consideration	Key heathland design considerations	Associated heathland management approaches
		maintenance. Refer to the Stakeholder Engagement Guidance Note.
Maintenance on steep embankments	• Maintenance of heathland on steep embankments may result in health and safety issues.	• Appropriate machinery should be used for cutting. Depending on the gradient of slope, work may be undertaken by flail, mower, swipe (ground level cutter towed by a tractor also known as flail mower) or other suitable equipment. • Browsing animals could be considered with the inclusion of protective fencing to separating browsing animals from the railway.

7.4 License requirements

This section includes the legal requirements and need for licences if designated sites, protected species or priority heathland habitats are encountered within a site.

7.4.1 Designated sites

Sites of Special Scientific Interest (SSSI) are protected under the Wildlife and Countryside Act (1981). Certain habitat management, such as changing a browsing regime or cutting within a SSSI will require consent from Natural England, Natural England, NatureScot or Natural Resources Wales.

Heathland situated within Special Protection Areas (SPA), Special Areas of Conservation (SAC) and designated Ramsar Sites may also need assessment under the UK Habitats Regulations before proceeding with works.

A National Nature Reserve (NNR) and Local Nature Reserve (LNR) protects land under the National Parks and Access to the Countryside Act 1949 or Wildlife and Countryside Act (1981) as amended. Management interventions need to be consistent with the management plan and approved by the managing organisation.

NOTE: *National Parks and Areas of Outstanding Natural Beauty (AONB)(not applicable in Scotland) are landscape designations which aim to protect, conserve and enhance natural beauty, wildlife and cultural heritage. Large extents of British heathland are located within areas covered by these designations and therefore management interventions need to be consistent with the management plan and approved by the governing organisation.*

7.4.2 Protected species

Many species are protected under UK and European law. Protected animals most associated with heathland include smooth snake in southern England only, sand lizard, great crested newt, bats, and natterjack toad. Other notable species include: all other reptile species (adder, grass snake, common lizard, slow worm), badgers, pine marten (uplands), breeding birds and wintering birds. Protected plants most associated with heathland, such as blue heath (*Phyllodoce caerulea*), can be found in Schedule 8 of Wildlife and Countryside Act, (Gov.uk, 2015).

7.4.3 Protected species licenses

Where protected species may be at risk of disturbance or other harm, protected species licences may be required. A professional ecologist can advise on license

requirements and appropriate mitigation. This will include consulting the following relevant government bodies prior to the implementation of heathland creation or management activities:

- Natural England: https://www.gov.uk/guidance/wildlife-licences
- NatureScot: https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/licensing
- Natural Resources Wales: https://naturalresources.wales/permits-and-permissions/species-licensing/?lang=en

7.4.4 Other consents

Upland heathland and lowland heathland are recognised as habitats of principal importance under Section 41 of the NERC Act (2006). Where present within the lineside estate, management of heathland must be prioritised over non-priority habitats in the area.

NOTE: *Budget costs of works to specific areas or management interventions requiring statutory consent are outlined in the cost summary folder.*

7.5 Biosecurity

Biosecurity refers to a set of precautions that aim to prevent the introduction and spread of harmful organisms. With respect to heathland, this can include invasive non-native species (INNS), pests and diseases.

7.5.1 Invasive non-native species

Several species listed on Schedule 9 of the Wildlife and Countryside Act (1981), such as common rhododendron (*Rhododendron ponticum*), shallon (*Gaultheria shallon),* false-acacia *(Robinia pseudoacacia),* japanese rose *(Rosa rugosa)* can colonise heathland habitat. Under this Act is illegal to plant or otherwise cause to grow in the wild any plant species listed. Presence of these species may cause delay or change to the Preferred Habitat Objective.

If non-native species, listed in Schedule 9, or otherwise known to be invasive (see NOTE) are found within a site, a Network Rail ecologist should be contacted, in order to devise a plan in which the plants can be removed and safely disposed of without causing spread. In this instance, the landowner is duty bound to take action to prevent spread of the species.

Common rhododendron *(Rhododendron ponticum)*

Shallon (*Gaultheria shallon)*

Japanese rose (*Rosa rugosa)*

False-acacia (*Robinia pseudoacacia*)

Figure 12 – Example of INNS

NOTE*: Refer to Schedule 9 of the Wildlife and Countryside Act (1981) and gov.uk guidance for a full list of invasive non-native species: https://www.legislation.gov.uk/ukpga/1981/69/schedule/9 and https://www.gov.uk/guidance/invasive-non-native-alien-plant-species-rules-in-england-and-wales#list-of-invasive-plant-species*

NOTE: *Refer to https://www.gov.uk/guidance/prevent-the-spread-of-harmful-invasive-and-non-native-plants for information on removing invasive and non-native plants.*

7.5.2 Pests and disease

The heather beetle naturally occurs within upland and lowland heathland. However, when the population dramatically increases it can cause significant damage to

heather leaves, stripping them bare. In such circumstance's management interventions such as cutting are required to aid heather regeneration.

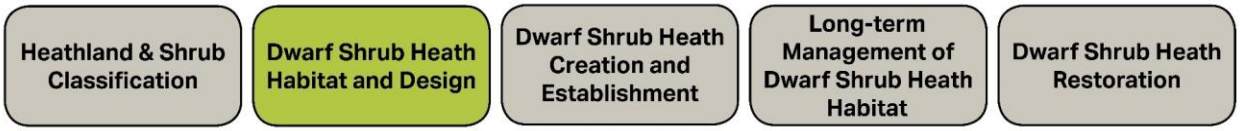
Figure 13 – Example of heather beetle and damage caused to heathland

NOTE: *Population increases of heather beetle is linked to raised levels of nitrogen in the soil and plant tissues which provide the beetle with higher quality of food source. Refer to: The heather beetle: a review (Angus Rosenburgh) for more information.*

By implementing proactive biosecurity measures, the risk of introducing or spreading heathland pests and diseases can be reduced. This can be achieved by:

- A period of review is recommended following a pest attack in order to assess if the pest has been removed and the plants have recovered;
- Proactively planning, monitoring and reporting concerns to identify issues through the UK Plant Health Information Portal; and
- Establishing biosecurity protocols on site, for example regular cleaning of equipment with disinfectant.
- ***NOTE:*** *Anticipated costs of INNS management are addressed in the cost summary folder.*
- ***NOTE:*** *Anticipated costs of disease management are addressed in the cost summary folder.*

7.6 Dwarf Shrub Heath Habitat and Design



This section provides advice on the design of new heathland within the lineside and key considerations for implementation.

Good heathland design should seek to achieve the following:

- Fit within wider landscape context;
- Diverse, well-structured heathland mosaics that improve the biodiversity value of the habitat;
- Strong heathland habitat without emerging plants such as bracken and tree saplings of local species;
- Diverse species mix which is resilient to climate change, pests and disease and appropriate to the soil conditions of the site;
- Cost effective management that takes into consideration the operational restrictions of the lineside;
- Connections to adjacent habitat types to create stepping stones, which may include habitat mosaics of wetlands, grasslands and woodlands; and
- Maintain the safety and performance of the lineside.

NOTE: *The value of heathland habitats is greatly increased if they are linked together and managed as part of a network. This is also true of heathland mosaics, where heathland is found in conjunction with grassland, scrub, woodland or wetlands.*

NOTE: *Anticipated costs of heathland creation are addressed in the cost summary folder.*

7.6.1 Site selection for heathland creation

The suitability of a site for heathland habitat creation should be assessed through habitat studies and site appraisals as part of the baseline studies and align with the Preferred Habitat Objective. This includes consideration of safety aspects of railway operations, habitat opportunities and constraints. Guidance on the process of recording and analysing this data is found in the Habitat Design and Management Guidance Note.

The following may indicate a site is suitable for heathland creation:

- **Physical environmental conditions:** appropriate soil composition, if the soil is not appropriate, heathland will not establish (see Section 7.6.2).
- **Historical context:** the site is within an area known to support heathland in the past and could support heathland restoration (see Section 7.6.2 for historic mapping guidance);
- **Potential for enhancing habitat connectivity:** opportunities to extend or connect with existing open habitats such as grassland to form a continuous or well-connected habitat that allows for sustainable management such as browsing;

- **Local landscape context:** opportunities to remove habitats alien to the wider landscape context, such as a wooded lineside corridor through an open heathland setting;
- **Cost effectiveness:** of heathland creation and implementing management (see cost summary folder;
- **Presence of INNS:** heathland creation after the clearance of pre-existing undesirable species, such as INNS;
- **Safe access:** safe site accessed for implementation and future management interventions that will likely require machinery; and

NOTE: *Refer to NR_L2_OTK_5201 MOD1 Lineside Vegetation Inspection and Risk before undertaking any fieldwork.*

NOTE: *Refer to NR/LN/ENV/122 MOD 01 Biodiversity Section 3.3 regarding field surveys.*

NOTE: *Refer to NR/L2/ENV/122 MOD 01 and MOD 02 regarding data gathering, the identification of existing habitats and species (e.g. SSSI) or protected species recorded on site.*

7.6.2 Soil analysis

Understanding the soil composition of the site is important to establish:

- If heathland is the appropriate habitat to create; and
- The extent of ground preparation required (see Section 7.7.1 ground preparation).

To determine whether soil conditions are initially favourable for heathland creation, desk-based studies should be undertaken first to understand:

- If heathland was historically present in the area, refer to Heathland Extent and Potential Maps https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/advice/conservation-land-management-advice/heathland-extent-and-potential-maps/
- If acidic, poor nutrient soils, exist in the area, refer to Soilscapes Map http://www.landis.org.uk/soilscapes/about.cfm

After desk-based studies, soil samples from the site should be taken to accurately determine soil type, pH, soil fertility and nutrient levels. Understanding these are integral to successfully creating and establishing heathland habitat.

The scope of soil analysis should be determined by a suitable experienced ecologist, botanist or soil scientist. Various companies offer soil testing and analysis which can be purchased online.

The optimal soil conditions for heathland are:

- Low fertility and nutrient levels; and
- Acidic soils between 6.5 – 3.0 pH, ideally 4.5-5.5 pH.

If these conditions are not present the following can be considered:

- **Deep ploughing** allows burying of the topsoil and brings nutrient poor layers of soil to the surface (see Section 7.7.1);
- **Topsoil stripping** helps remove the most fertile soil, this will also remove the existing seedbank (see Section 7.7.1); and

- **Chemical additives:** such as elemental sulphur or other suitable treatments to increase the acidity of the soil can applied.

Due to the invasive nature of these techniques and the associated lineside operational risks another Preferred Habitat Objective may be considered more appropriate.

Once the suitability of the soil condition for heathland habitat has been established, it is important to understand whether a viable seed source is available in the soil. Samples of existing dormant seed banks within the soil should be tested by a suitably experienced botanist to understand the germination rate and ultimate viability of the heathland seed bank. This will determine the approach for either heathland creation or heathland restoration as illustrated in Figure 14. For further guidance on heathland creation is see Section 7.7 and heathland restoration see Section 7.9.

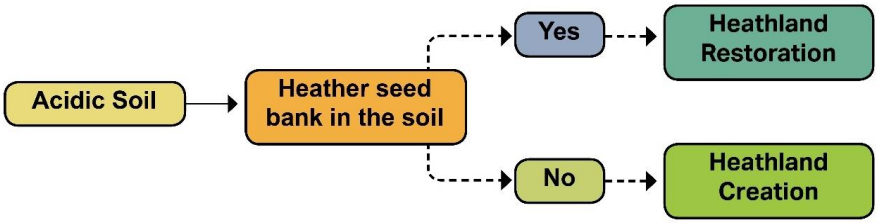


Figure 14 – Heathland restoration and creation decision process

NOTE: *RSPB Heathland Extent and Potential Maps only covers lowland heathland in England. For further assistance with desk studies seek advice from an experienced specialist (e.g. ecologist).*

NOTE: *For design and management guidance on other habitat types refer to Network Rail Woodland / Grassland / Wetland and Urban & Brownfield Design and Management Guidance Note.*

NOTE: *For guidance on the process of establishing the Preferred Habitat Objective refer to the Habitat Design and Management Guidance Note.*

NOTE: *For design considerations for heathland in a railway setting refer to Table 2 in Section 7.3.1.*

7.6.3 Species selection

When specifying heathland the following two typical lineside scenarios should be applied:

- **Heathland creation:** where new heathland habitat creates an extension of existing heathland habitats, National Vegetation Classification (NVC) Survey should be carried out to determine the existing heathland community type; or
- **Heathland restoration:** where a seed bank is present in the soil, the area should be monitored by an ecologist for approx. 2-3 years in order to establish which species are successfully recolonising. This will determine the need to add additional species. Plants should be selected in line with the list of typical species for the appropriate Level 5 sub-habitat type of the UK Habitat Classification.

NOTE: *UK Habitat Classification documents are available at:* https://ecountability.co.uk/ukhabworkinggroup-ukhab/

NOTE: *NVC Survey should be carried by a suitable experienced ecologist. Guidance on the survey methodology refer to https://data.jncc.gov.uk/data/a407ebfc-2859-49cf-9710-1bde9c8e28c7/JNCC-NVC-UsersHandbook-2006.pdf*

7.6.4 Seed procurement

The success of heathland establishment can also be influenced by the quality of plant material and the method of procurement.

There are three typical ways in which heathland can be created or restored:

- **Natural regeneration from the soil seed bank:** dormant seeds in the soil have potential for future persistence and survival. Therefore, the longevity of seeds in the soil affects the resilience of plant communities;
- **Seeding of the site with material from local heathland:** An acid grassland nurse sward with heather brash can be sustainably harvested from nearby habitat and spread on the recipient habitat to guarantee local-origin material; and
- **Use of commercial seed:** in cases where there is no source of local material, commercially available seeds can be used; these must be of native species and of British origin.

For methods of applying seed see Section 7.7.2.

NOTE: *For best practice guidance on seed procurement refer to Proceedings of the 11th National Heathland Conference (Natural England, 2016a) and Heathland creation for wildlife (English Nature, 1997).*

7.7 Dwarf Shrub Heath Creation and Establishment

Heathland & Shrub Classification | Dwarf Shrub Heath Habitat and Design | **Dwarf Shrub Heath Creation and Establishment** | Long-term Management of Dwarf Shrub Heath Habitat | Dwarf Shrub Heath Restoration

This section provides guidance on how to successfully create and establish new heathland in the lineside to maximise its biodiversity and ecosystem services provision. This guidance refers to the pioneer phase and building phase of heathland.

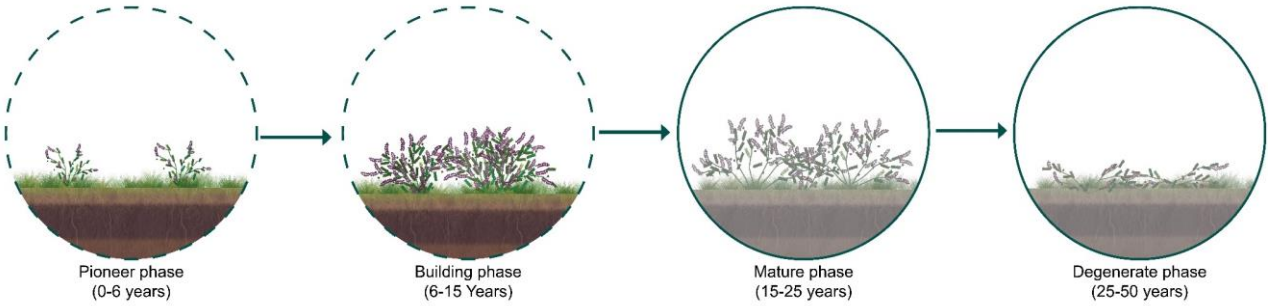


Figure 15 – Heathland development phases: applicable to creation and establishment of heathland

Best practice suggests the following general heathland creation and establishment principles should be applied:

- Undertake ground preparation where necessary;
- Organising toolbox talks for site staff on maintenance protocols, including recording and reporting on suspected cases of pests and diseases;
- Reseed heathland that is dead or fails to thrive at the end of each growing season up to the end of the five-year aftercare period;
- Remove heathland arisings, where possible, once cut to prevent the soil becoming more fertile;
- Control bracken;
- Remove emerging plants and dispose off-site;
- Removing dead or diseased heathland material from site to a licensed green waste recycling facility; and
- Consider fire risks of heathland habitats.

NOTE: *The fire risk of heathland varies according to factors including type and location and should be signposted to NR guidance and / or risk assessment.*

NOTE: *The routine maintenance schedule for heathland, including when to undertake inspections is set out in the schedule folder.*

NOTE: *For guidance on bracken control refer to Moorland Management Guiding Principles (Natural England, 2017) available at: www.publications.naturalengland.org.uk.*

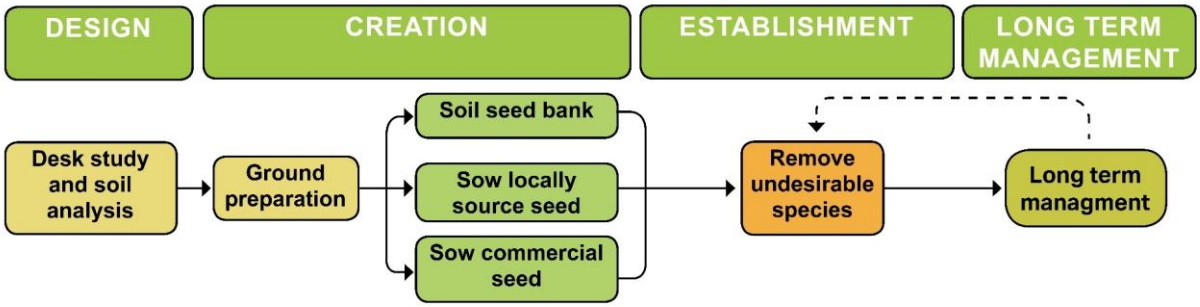


Figure 16 – Heathland creation and establishment process

Figure 16 outlines the process that should be followed when creating heathland and the subsequent actions recommended for successful establishment. Many of these actions are similar to those included in the Grassland Habitat Design and Management Guidance Note.

Methods and considerations relating to ground preparation, heathland creation approaches, and immediate aftercare are outlined within the following subsections. Management interventions and long-term management are discussed in Section 7.8.

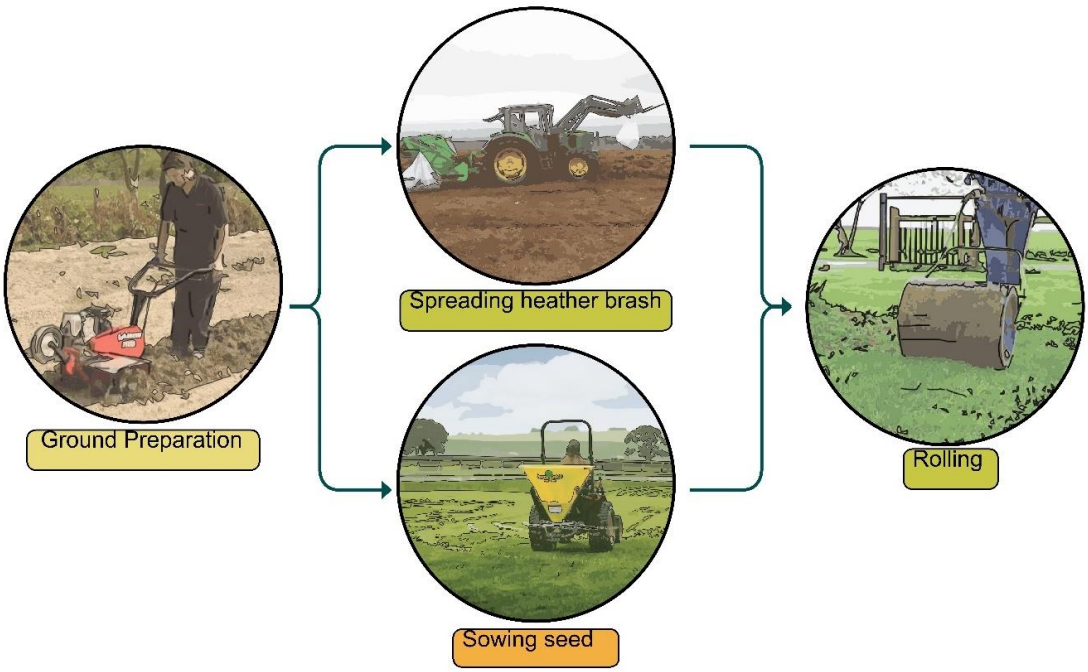


Figure 17 – Ground preparation and seeding or spreading process

7.7.1 Ground preparation

Prior to creating a new heathland habitat, the ground and seedbed must be prepared to encourage seed to germinate and for the plants to successful establish.

Typically, in a lineside context, this will be carried out as follows:

- **Remove pernicious weeds:** remove pernicious weeds grasses, thistles, docks and nettles during preparation and whilst seeds are establishing. This should be done by hand. If weeds persist, spot herbicide treatment can be applied to the weeds; however, this should be undertaken as a last resort if the dominance of weeds threatens the establishment of specified heathland.

- **Dispose of arisings:** all plant material arising from the ground preparation should be removed to a licensed green waste recycling facility as soon as possible prevent nutrient accumulation within the soil.
- **Soil cultivation:** create a weed-free tilth between 6-10cm deep. This should be undertaken when the soil is dry and easily workable. If the site is large enough and access allows, a plough or harrow can be used. Otherwise, cultivation using a rotovator or by hand is preferable.

Many rare, annual plant species are associated with disturbed ground. If these are encountered and identified by an experienced ecologist or botanist, Plantlife should be consulted to advise on actions to conserve the plants.

NOTE: *Threatened arable plants associated with disturbed soils are listed within Plant Life's Threatened Arable Plant Identification Guide (2008):* *https://www.plantlife.org.uk/application/files/2014/8241/1184/Threatened_Arable_Plants_Guide_2008.pdf*

NOTE: *Local Biodiversity Action Plans should also be consulted to determine the importance of the species locally.*

Where existing soils are highly fertile and unsuitable for heathland creation (see Section 7.6.2 soil analysis) but heathland is the Preferred Habitat, the following two remedial interventions can be considered:

- **Topsoil stripping:** using an excavator, or manually if site gradient and access does not allow, strip topsoil to a depth of 20-25cm to remove most of the soil's nutrients. This will also remove the existing seed bank. If necessary, only strip topsoil of patches where fertility is high.
- **Deep ploughing:** using a deep plough, bury the topsoil and bring nutrient poor layers of soil to the surface. This method can be used to depths of up to a metre.

In most lineside scenarios, topsoil stripping and deep ploughing are not practical and therefore an alternative Preferred Habitat Objective may be considered. It may still be appropriate to use these techniques to create heathland in areas of special conservation interests.

NOTE: *If the site contains agriculturally improved grassland the topsoil stripping method will differ slightly. For guidance refer to Grassland Design and Management Guidance note.*

NOTE: *Always consult a suitably experienced ecologist or botanist to determine whether topsoil stripping or deep ploughing is necessary.*

NOTE: *For guidance on defining the Preferred Habitat Objective refer to the Habitat Design and Management Guidance Note.*

NOTE: *Network Rail Geotech department should be consulted before deep ploughing operations are considered to avoid damaging engineering materials within the lineside.*

7.7.2 Seeding and spreading

Once the ground has been prepared, the heathland seed can be sown. The best times of years are:

- **Autumn**: September or October are preferred where warm, moist conditions will enable young plants to establish before winter.
- **Early spring**: March and April provide similar conditions to September and October, although seeds are more likely to face competition from weeds that may dominate the sward.

Seed should be applied using the following methods:

- **Sowing:** commercial or locally imported seed should be sown at the appropriate density, as indicated below, on or just under 1cm of the soil surface. Sowing of a basic acid-grassland nurse sward should be considered where soil needs to be stabilised until the slow growing heathland species have established. This typically occurs on slopes steeper than 1:2.

  Seed can be spread by a conventional tractor and broadcast seed spreader on larger, flatter areas and an All-Terrain Vehicle (ATV) for smaller, more confined or steeper areas. Hand casting is also a common spreading method.

- **Spreading heather brash:** locally sourced heathland brash with heather seed acts as a source of new growth. The brash may be cut from August. However, if a high proportion of seed is desired then cutting should be done during late October through to December, when the seed would set naturally, in order to ensure the highest amount of heather seed is present and spread onto the ground as quickly as possible.

Following sowing of the seed or spreading of the heathland brash, the soil should be rolled if safe to do so. This will assist in making good contact of the seed or brash with soil and help protect the area from erosion by wind and rain.

Depending on the site area and access arrangements, rolling will typically be carried out using similar sized equipment to that used for ground preparation.

Sowing and application rates depend on the form of the seed as follows:

- Fresh cut heather brash material 6,000-10,000kg/ha (refer to spreading heather brash);
- Collected litter from local heather brash 1,000-1,500kg/ha (refer to spreading heather brash);
- Locally sourced brushed seed 15-18kg/ha (refer to sowing); and
- Commercial seed 200-300gms/ha (refer to sowing).

NOTE: *Sowing time should be carefully considered in upper heathland areas, where heavy machinery may not be suitable at all times due to wet ground conditions.*

7.7.3 Natural regeneration

Natural regeneration can also be used in conjunction with seeding. Working on similar principles to grassland, leaving 50% bare ground and sowing the remainder typically provides the best results (Magnificent Meadows, 2020).

Whilst natural regeneration may be cheaper to implement, it is likely to take longer for the heathland to establish and reach the mature phase.

NOTE: *Refer to Grassland Design and Management Guidance note for best practice guidance on grassland natural regeneration.*

7.7.4 Establishment

Once sown or spread, aftercare should be implemented to allow the seeds to germinate and the heathland to establish into the building phase (6-15years).

The immediate aftercare interventions focus on the removal of pernicious weeds and other competing and invasive species including bracken, shrubs and trees (see Section 7.5.1 Invasive non-native species).

The results of regular monitoring of the success of heathland establishment should recorded in accordance with the Habitat Management plan (see Section 7.2).

NOTE: *Habitat Management Plans are described in NR/L2/ENV/122 Module 02*

NOTE: *The routine maintenance schedule for heathland including when to undertake inspections is set out in the schedule folder.*

7.7.5 Protection

Fencing should be erected to protect young plants from browsing for up to 4-5 years until plants have established. Where possible avoid using fencing containing plastic, instead use a biodegradable alternative.

Types of protective fencing considered could include:

- Rabbit and deer fencing; and
- Exclusion fencing for priority woodland species.

Fencing to prevent livestock from entering the railway should be considered where browsing is selected as a maintenance intervention.

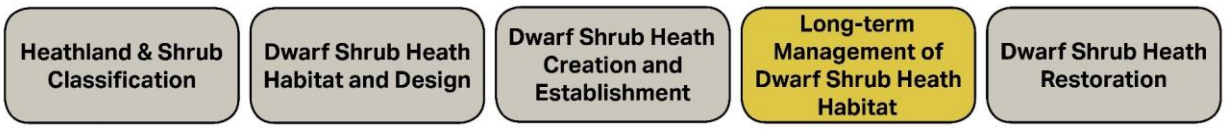
Figure 18 – Examples of heathland protection to achieve successful establishment

NOTE: *Document NR/L3/OTK/6202 provides guidance on protecting railway assets.*

NOTE*: Refer to Woodland Design and Management Guidance note for further guidance on priority woodland species.*

NOTE*: For specification and guidance on Rabbit and Deer fencing refer to FG4: Rabbit fencing supplement: https://www.gov.uk/countryside-stewardship-grants/rabbit-fencing-supplement-fg4 and FG9: Deer fencing supplement https://www.gov.uk/countryside-stewardship-grants/deer-fencing-fg9*

7.8 Long-term Management of Dwarf Shrub Heath Habitat



This section outlines the key considerations for the management of established heathland. The guidance refers to the mature phase of the heathland. It should be read alongside *NR/L3/OTK/6202 Protecting Railway Assets* during vegetation work. Lowland and upland heathland, described in Section 5.3.1, are maintained using the same management interventions.

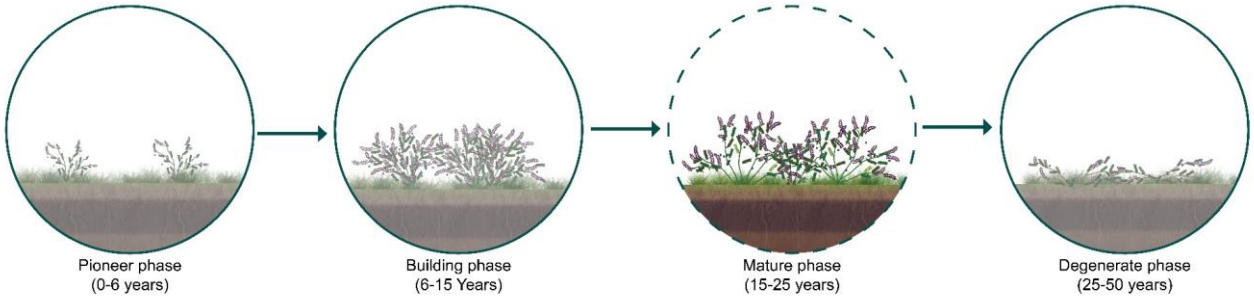


Figure 19 – Heathland development phases: applicable to long-term management of heathland

Best practice suggests the following general principles should be applied:

- Implementing a long-term management regime suitable for the site, soil and heathland e.g. cutting; and
- Monitor and analyse changes in heathland composition and structure to ensure the long-term management regime is appropriate or inform future management decisions.

Once heathland has reached the mature phase, good long-term heathland management should:

- Control encroachment of species including trees, shrubs and bracken by cutting;
- Sustain low level of nutrient in soil;
- Create and maintain micro-habitat features including, scrub and bare ground;
- Maximise species-richness; and
- Reduce the risk of damaging wildfires.

NOTE: *It is important to pro-actively liaise with owners of adjacent heathland outside of the lineside to ensure habitat enhancement opportunities are maximised and objectives are aligned.*

7.8.1 Long-term management interventions

Management interventions should be selected depending on the heather development phase as illustrated in Figure 20. If appropriate management has ceased, habitat restoration may be required (see Section 7.9).

The following subsections outline long-term management interventions for heathland.

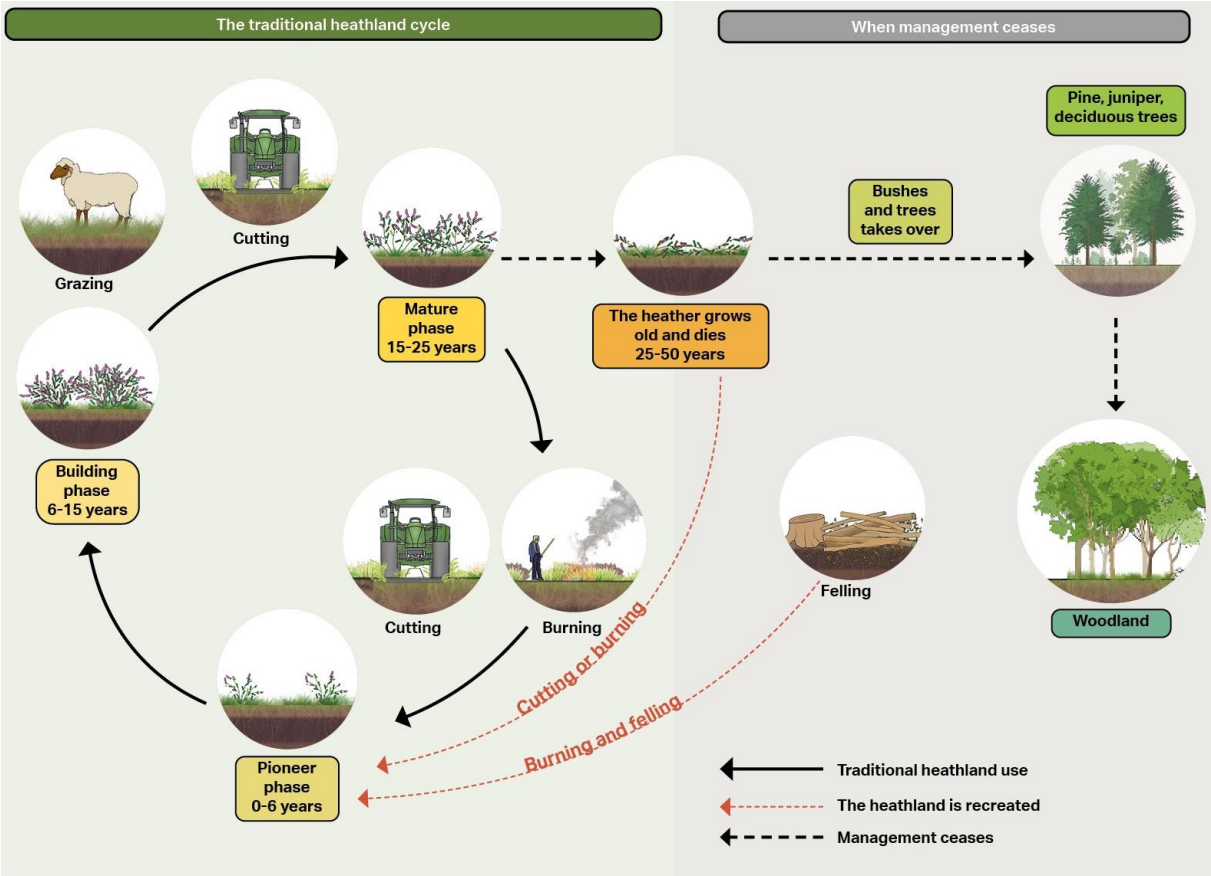


Figure 20 – Heathland development cycle and associated management interventions

NOTE: *Anticipated costs of different stages in heathland management are addressed in the cost summary folder.*

7.8.2 Cutting

Due to the constraints associated with browsing and controlled burning, cutting is the most likely management intervention for the majority of lineside heathland. The purpose of heather cutting is to maintain heather cover and increase species diversity within the heathland.

Before carrying out any work, an assessment of the proposed cutting areas must be carried out to identify areas suitable for cutting and to ensure that there is no risk of damage to: protected sites and species, nesting birds or their eggs and other natural heritage features or features of archaeological or historical value (see Section 7.4.2).

Other sensitive features and non-target areas that cutting should avoid include:

- Flushes and mires including areas around springs, pools, wet hollows and those rich in bog mosses with abundant and or almost continuous cover of *Sphagnum* species;
- Other mosses, liverworts or lichens, where it is likely to damage the interest.
- Areas that contain species which often occur only at a small scale;
- Haggs, erosion gullies and areas of bare peat; and
- Areas where soils are less than 5cm deep or the ground is made up of scree or exposed rock.

NOTE: *Assessments to determine ecologically sensitive features and non-target areas not suitable for cutting should be undertaken by a suitably qualified ecologists prior to any heathland cutting.*

NOTE: *For further detail on sensitive features and non-targeted areas refer to Moorland Management Guiding Principles (Natural England, 2017).*

7.8.3 Implementing a cutting regime

The frequency and timing of cutting plays a significant role in heathland development.

Cutting should be undertaken every 5-10 years, starting in the building phase and continuing throughout the development cycle of heathland.

The extent of the cut will determine when works should be undertaken:

- September: cutting and grubbing up of vegetation to be removed;
- October to February: cutting down to 30cm above the ground level; and
- March to September: further cut to ground level.

To limit damage to the heathland habitat:

- Cutting in cold weather should be avoided as this may have a serious impact on heather recovery; and
- Temporary surfacing (e.g. ground protection mats) to tracked machinery should be considered on wet, boggy soils to avoid machinery getting stuck and unnecessary soil compaction.

7.8.3.1 Machinery

Machinery including mowers, flails, swipes or similar equipment, may be used to create a mosaic or pattern of different-aged heather.

In some lineside scenarios ground conditions may be too soft to use heavy machinery or it may be impractical due to the site having stony outcrops, boulders, steep or uneven terrain or other obstacles. In these instances, the use of manual tools or other management techniques such as browsing or burning should be considered.

NOTE: *To choose appropriate machinery and cutting techniques, refer to Heather Cutting Guidance by Scotland's Moorland Forum Principles of Moorland Management and Information or Advisory Note Number 58: Cutting of heather as an alternative to muirburn.*

7.8.3.2 Browsing

Planned browsing by livestock or by wild herbivores may take place at any time of year.

The benefits of browsing differ according to the livestock and stocking density used:

- Sheep, horses, and ponies are selective grazers and should be used in areas where very close to the ground browsing is required. They can browse saplings preventing new growth. However, they find it harder to graze longer vegetation which is often trampled instead.
- Cattle should be selected when close to the ground browsing is not desired. Due to their wide mouths, cattle do not graze selectively and as a result do not target flower heads and herbage which is important for botanically diverse habitats.

Cattle are able to create their own access into rough areas and the trampling of these areas can also be an important way of controlling scrub.

NOTE: *Refer to Moorland Management Guiding Principles (Natural England, 2017) for further detail on stocking rates.*

NOTE: *All stocking densities should be agreed in discussion with a conservation grazier. Tips on finding a conservation grazier are detailed within Kent Wildlife Trust's (2018) A brief guide to choosing livestock for conservation browsing: https://www.kentwildlifetrust.org.uk/sites/default/files/2018-06/KWT%20Land%20Mgt%20Advice_Sheet%205%20-%20Choosing%20livestock%20for%20conservation%20browsing.pdf*

7.8.3.3 Burning

Burning is a long-established practice to promote the regeneration of heathland. Although there are several positive outcomes to this management intervention, it may not be suitable in the lineside estate because of the reasons listed below. Burning, therefore, should be undertaken as a last resort, where cutting or browsing is not possible or impractical.

- Safety issues to the railway line such as uncontrolled spread of fire towards rail infrastructure, heat and smoke affecting electric cables;
- Public nuisance and perception of regenerating heathland after burning;
- Carbon stored in peat is released to the atmosphere during burning which has a detrimental effect on air quality and Network Rail's target to achieve net-zero carbon emissions by 2050 (and 2045 in Scotland);
- Ash, a bi-product of burning, can pollute watercourses;
- Burning may increase soil erosion in some areas; and
- Risk of uncontrolled spread of fire in proximity to woodland and settlement.

Where burning is the preferred management intervention, the following should be considered:

- By law, burning can only be undertaken, except under licence, between 1 October – 15 April in upland heathland areas and between 1 November – 31 March in lowland heathland areas.
- Inform adjoining landowners and local fire rescue services about the burning including location and timings.
- Burning can be difficult to control safely and therefore should be avoided:
    - In excessively dry conditions (when the moss and plant litter on the ground surface has completely dried out);
    - When the wind is too strong (greater than 15 mph); and
    - If the flames are likely to exceed 10m (this depends on a combination of the weather conditions and the fuel load).

NOTE: *Network Rail's environment target are included in Network Rail Environmental Sustainability Strategy (2020).*

NOTE: *Burning heathland should be defined as a management intervention within the Habitat Management Plan. Refer to the Habitat Management and Design Guide.*

NOTE: *If you intend to burn heathland outside burning season you must apply to Natural England or NatureScot for a licence:*

https://www.gov.uk/guidance/heather-and-grass-burning-apply-for-a-licence

https://www.nature.scot/professional-advice/protected-areas-and-species/licensing/muirburn-licensing

7.8.4 Monitoring and Inspections

Heathland should be inspected by a suitably qualified professional.

- **Monitoring:** determine whether the heathland is developing in-line with the objectives outlined in the site's Habitat Management Plan; and
- **Inspections:** monitor the success of heathland against the specification and inspect for signs of damage and disease.

7.8.4.1 Botanical monitoring and assessing biodiversity

To monitor heathland, habitat and botanical surveys should be undertaken for each site. These should be prior to cutting or between April and September if other management interventions are used. Frequency should be in accordance with its development cycle phase as follows:

- Pioneer (0-6 years) – every year
- Building (6-15 years) – every 2 years
- Mature (15-25 years) – every 2 years
- Regenerate (25-50 years) – every 2 years

Using baseline data as a reference for comparison, monitoring should assess change in botanical communities as an indicator for biodiversity. Baseline data collection and monitoring at each site could include the following:

- **National Vegetation Community (NVC):** detailed botanical survey typically undertaken annually, at appropriate times of the year, to assess changes in floral species abundance and diversity;
- **Biodiversity Net Gain (BNG):** data collected from NVC surveys, supported by additional information can be used to undertake BNG assessments. BNG assessments should assess whether the progression of the habitat's condition and distinctiveness is on target to achieve the prediction in line with the time to target condition.

NOTE: *NVC Survey should be carried by a suitable experienced ecologist. For guidance on the survey methodology refer to https://data.jncc.gov.uk/data/a407ebfc-2859-49cf-9710-1bde9c8e28c7/JNCC-NVC-UsersHandbook-2006.pdf*

NOTE: *Surveys, ecological monitoring and BNG assessments must be devised and undertaken by an experienced botanist.*

Following inspections and monitoring, changes to the management regime may be recommended by an experienced ecologist or botanist to enhance or restore the heathland. Inspections are important to:

- Ensure the Habitat Management Plan objectives are being met;
- Report on heather vitality and failures and inform and instruct replanting;
- Assess the health of heathland and identify actions to address biosecurity issues; and

- Report on the condition and effectiveness of plant protection and any remedial action required.

NOTE: *Suitably qualified professionals for undertaking inspections of heathland establishment include Chartered Members of the Landscape Institute or ecologists. Landscape architects can provide assistance with practical issues relating to establishment whereas ecologists can provide detailed technical information.*

7.8.4.2 Inspecting signs of damage and disease

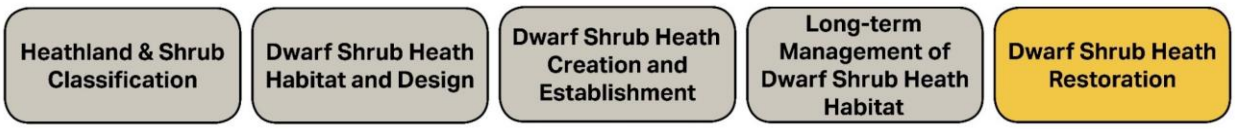
The best time to assess heathland health is in the late summer to the beginning of autumn. Visible signs of ill health include:

- Heather dieback.
- Brown and wilting leaves; and
- Defoliation, resulting from the stripping and browning of leaves.

If symptoms of ill health or pest attack cannot be resolved within a year; phased removal and replacement with an alternative suitable species should be considered.

Figure 21 – Image showing brown wilting leaves of damaged heather

7.9 Dwarf Shrub Heath Restoration



This section provides guidance on how to manage heathland in its degenerate phase to restore the heathland to health.

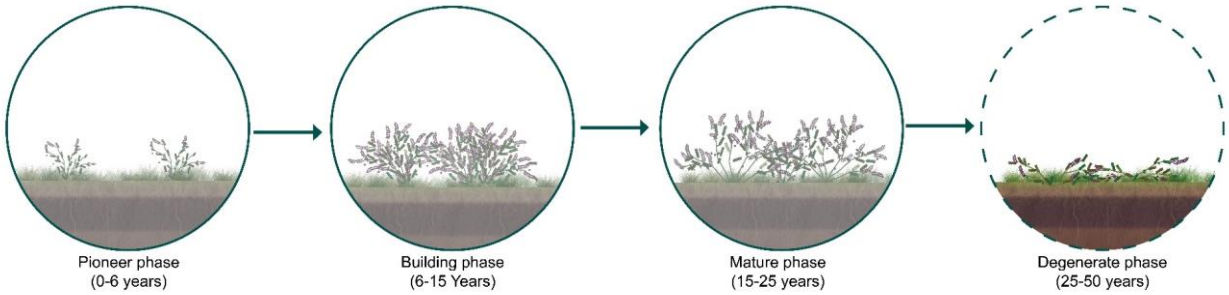


Figure 22 – Heathland development phases: applicable to heathland restoration

Best practice suggests the following general principles should be applied:

1. Undertake removal of scrub and trees where appropriate to restore the heathland or heathland-scrub mosaic;
2. Consider seeding bare ground to accelerate restoration (see Section 7.7.2);
3. Organise toolbox talks for site staff on maintenance protocols, including recording and reporting on suspected cases of pests and diseases;
4. Remove arisings once heathland is cut to prevent the soil becoming more fertile; and;
5. Implement an updated Habitat Management Plan, which ensures the heathland will be maintained and enhanced as a heathland or heathland-scrub mosaic.

7.9.1 Heathland degenerate phase management

Appropriate management interventions are required to prevent heathland degenerating. Typically, this is a cutting regime, using the frequency and techniques established in the mature phase of the heathland development cycle (see Section 7.8.3).

Undertaking management in this stage will assist in the natural regeneration process and can be enhanced by sowing heather seed on bare patches of ground (see Section 7.7.2).

7.9.2 Restoration and transitioning heathland

As illustrated in Figure 20 (see Section 7.8.1) restoration is necessary when long-term management interventions cease, and the next succession phase occurs.

Typically, most heathland will transition into dense scrub and eventually woodland. The rate at which this happens is dependent factors including (Natural England 2012c):

- Presence and proximity of scrub and tree species in the heathland; and

- Soil depth: scrub establishes and grows more quickly on deep, fertile soils opposed to thin, nutrient poor soils.

If scrub has become dominant, all scrub should be cut to the base during winter and removed. However, without further intervention, this can cause scrub to grow back more densely. If consistent annual removal of scrub is not possible, herbicide can be applied to the stem, once cut to ground level and notched.

Once scrub or woodland has been cleared the heathland seedbed can be prepared using the same techniques as for heathland creation (see Section 7.7.1 Ground preparation and 7.7.2 Seeding and spreading).

NOTE: *It is important to establish whether a viable bank of heathland seeds are within the soil on site. Refer to Sections 7.6.2 -7.6.3.*

7.9.3 Historic heathland restoration

Typically, in a lineside scenario, heathland habitat restoration is most likely to be viable on historically open habitats within currently forested land.

The Forestry Commission provides a framework for converting some woodland into open habitats. Suitable sites are where heathland habitat will:

- Extend or buffer high quality habitat;
- Connect high quality habitat;
- Comprise designated areas such as SSSI and NNR;
- Extend or link areas of open habitat to support practical browsing;
- Form a patch of continuous or well-connected open habitat that is significantly more viable in the long-term; and
- Create opportunities for species of conservation concern.

The Forestry Commission defines a 30ha minimum viable size for Lowland heathland. Within the lineside context, this is most likely to be possible where the railway neighbours existing heathland and there are opportunities to support partners in restoring larger areas of adjacent habitat. A minimum viable size for upland heathland has not been set.

NOTE: *Consent to convert woodland to open habitat will be required (with some exceptions). The overarching policy for the sustainable management of forests and woodlands in the UK is a presumption against the conversion unless there is a compelling reason in the public interest for doing so. Compensatory woodland planting will be required.*

NOTE: *Further guidance on consent to convert woodland to open habitat is available on the government website*: *https://www.gov.uk/guidance/get-consent-to-convert-woodland-to-open-habitats#when-you-need-consent.*

NOTE: *Anticipated costs of heathland restoration see cost summary folder.*

8 Hedgerow Habitat Design and Management

8.1 Introduction

This section provides guidance on:

- General considerations related to the design and management of hedgerows;
- The design of new hedgerow habitat;
- Maintenance required to establish new hedgerow habitat;
- Long-term management of hedgerow habitat; and
- Restoration of hedgerow habitat.

Each section includes practical guidance and makes reference to tables in the cost summary folder to understand the budget costs of carrying out work.

NOTE: *Professional expertise should be sought to throughout the process. For example, an experience ecologist should be consulted to determine the Preferred Habitat Objective and objectives set out in the site Habitat Management Plan. In addition, landscape advice should be sought where design, implementation and management advice is needed.*

8.2 Habitat management plans

Network Rail's requirements for Habitat Management Plans are set out in NR/L2/ENV/122 Module 02.

The process of setting objectives for the habitat management plan is described in the Habitat Design and Management Guidance Note.

It is recommended that the Habitat Management Plan sets out short, medium and long-term objectives for hedgerow. These periods, as follows, should reflect the development cycle phases as illustrated in Figure 8:

- *Short-term* (year 0 to 1);
- *Medium-term* (year 1 to 5); and
- *Long-term* (year 5+).

NOTE: *Refer to NR/L2/ENV/122 Module 02 for information on the requirements for Habitat Management Plans.*

NOTE: *Management objectives should be reviewed against data collected via monitoring (see Section 8.8.4.1.).*

8.3 Ecosystem services and design considerations

As outlined in the Habitat Design and Management Guidance Note, an initial site appraisal can help identify ecosystem services present and the potential to expand the range provided by the lineside. This will help inform decisions as to how a hedgerow is designed or managed.

Hedgerows within the lineside can provide a range of ecosystem services. These include:

- **Habitat connectivity:** networks of habitat enhance permeability of the landscape for species, greater genetic viability and increased resilience;
- **Pollination:** hedgerows offer a food source and shelter for pollinators;

- **Biodiversity:** hedgerow habitat supports a wide range of biodiversity which provides further ecosystem services such as pollination;
- **Water regulation:** vegetation can reduce the rate at which water meets waterbodies and watercourses; reducing the occurrence of flash flooding downstream;
- **Air pollution removal:** carbon sequestration of hedgerows and associated preservation and renewal of soils provide benefits including improved health and protection against climate change;
- **Landscape integration:** hedgerows can improve lineside aesthetics and integrate the landscape with the wider setting;
- **Screening:** hedgerows offer visual screening from the railway track; and
- **Noise disturbance reduction:** hedgerows can protect against noise disturbance.

NOTE: *Ecosystem services of the land should be identified when fieldwork is undertaken. This should be determined by an environmental specialist, using professional judgement. Refer to the Habitat Design and Management Guidance Note for more information on ecosystem services.*

8.3.1 Lineside design considerations

In addition to ecosystem services, there are other lineside specific design considerations and benefits which will help to inform whether a hedgerow is an appropriate habitat within a specific location (Table 3).

Table 3 – Key risks and benefits for hedgerows in a railway setting

Design consideration	Key hedgerow design considerations factors	Associated hedgerow management approaches
Fire risk reduction measures	• Lineside vegetation in the urban context can be a 'high risk habitat' due to increased likelihood of arson.	• Consider species selection and location and their associated fire risk in the design phase.
Access routes for establishment and maintenance	• Hedgerows may need to be accessed on both sides via routes on third party land for planting and maintenance. • Mixed species hedgerows require regular trimming to prevent the tree species from transitioning into a row of trees. • Hedgerows require regular trimming to maintain vegetation density at ground level.	• Landowner permissions should be sought prior to hedgerow creation. Refer to the Stakeholder Engagement Guidance Note. • Refer to the Habitat Design and Management Guidance Note, Section 6.3.4. • Confirm the point of access to facilitate regular trimming.
Ground terrain	• Hedgerows are unlikely to establish well and should not be proposed on rocky ground. Consider alternatives, such as walls and fences.	• Consider the terrain when selecting planting location. • Cutting by hand may be necessary, avoiding the use of machinery.

8.4 License requirements

This section includes the legal requirements and need for licences if designated sites, protected species or priority heathland habitats are encountered within a site.

8.4.1 Designated sites

Sites of Special Scientific Interest (SSSI) are protected under the Wildlife and Countryside Act (1981). Certain habitat management, such as cutting within a SSSI may require consent from Natural England.

Hedgerows situated within Special Protection Areas (SPA), Special Areas of Conservation (SAC) and designated Ramsar Sites may also need assessment under the UK Habitats Regulations before proceeding with works.

A National Nature Reserve (NNR) and Local Nature Reserve (LNR)protects land under the National Parks and Access to the Countryside Act 1949 or Wildlife and Countryside Act (1981) as amended. Management interventions need to be consistent with the management plan and approved by the managing organisation.

NOTE: *Hedgerows may also be protected if it forms part of a Scheduled Monument (Ancient Monuments and Archaeological Areas Act, 1979).*

8.4.2 Protected species

A hedgerow may be indirectly protected when it is a habitat for a legally protected species under the Wildlife and Countryside Act 1981, or the Conservation (Natural Habitats etc.) Regulations 1994.

Many species of plant and animal are protected under UK and European law. Those most associated with hedgerows include wild birds (and their nests and eggs), bats (commuting habitat and food source), badger (and their setts), hazel dormouse, great crested newt and pine marten.

8.4.3 Protected species licences

Where protected species may be at risk of disturbance or other harm, protected species licences may be required. A professional ecologist can advise on licence requirements and appropriate mitigation. This will include consulting the following relevant government bodies prior to the implementation of woodland creation or management activities:

- Natural England: https://www.gov.uk/guidance/wildlife-licences
- NatureScot: https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/licensing
- Natural Resources Wales: https://naturalresources.wales/permits-and-permissions/species-licensing/?lang=en

8.4.4 Other consents

The Hedgerow regulations 1997 as amended by the Hedgerows (Amendment) (England) Regulations 2002 must be adhered to when managing hedgerows where applicable. The aim of the legislation is to secure the retention of important countryside hedgerows. The hedgerow regulations “apply to any hedgerow growing in, or adjacent to, any common land, protected land, or land used for agriculture, forestry or the breeding or keeping of horses, ponies or donkeys”

As a Statutory undertaker, Network Rail does not have to apply for consent to remove a hedgerow if removal is needed to fulfil the railway function (see 'The Hedgerows Regulations 1997 – Permitted work'). However, the hedgerow must be replaced following removal (see 'The Hedgerow Regulations 1997 – Replacement of hedgerows') . It is best practice to advise lineside neighbours and adjacent landowners that this will take place in advance of the removal.

The protection of nesting bird season should also be considered. The majority of birds in the UK will nest between February and the end of August but some species breed all year round e.g. wood pigeon or barn owl. Consideration should be given to the potential for nesting birds and checks should be carried out by a suitably qualified professional (e.g. ecologist), regardless of the time of year.

NOTE: *Refer to https://www.legislation.gov.uk/uksi/1997/1160/contents/made for the Hedgerow Regulations 1997 as amended by the Hedgerows (Amendment) (England) Regulations 2002.*

NOTE: *Budget costs of works to specific areas/management interventions requiring statutory consent in the cost summary folder.*

8.5 Biosecurity

Biosecurity refers to a set of precautions that aim to prevent the introduction and spread of harmful organisms. With respect to hedgerows, this can include pests, fungal disease, bacterial disease, and invasive non-native species (INNS) pests and diseases.

8.5.1 Invasive non-native species

Several species listed on Schedule 9 of the Wildlife and Countryside Act (1981), such as three-cornered garlic (*Allium triquetrum*), can colonise hedgerows. It is illegal to plant or otherwise cause to grow any plant species listed. Presence of these species may cause delay or change to the Preferred Habitat Objectives.

If non-native species, listed upon Schedule 9, or otherwise known to be invasive (see *NOTE*) are found within a site, a Network Rail ecologist should be contacted, in order to devise a plan to set out how the plants can be removed and safely disposed of without causing spread.

NOTE*: Refer to Schedule 9 of the Wildlife and Countryside Act (1981) and gov.uk guidance for a full list of invasive non-native species: https://www.legislation.gov.uk/ukpga/1981/69/schedule/9 and https://www.gov.uk/guidance/invasive-non-native-alien-plant-species-rules-in-england-and-wales#list-of-invasive-plant-species*

NOTE*: Refer to https://www.gov.uk/guidance/prevent-the-spread-of-harmful-invasive-and-non-native-plants for information on removing invasive and non-native plants.*

8.5.2 Pests and disease

Typically, the more species rich a hedgerow is, the more resilient it is as a habitat. Hedgerow pests such as aphids, brown tail moth, sawfly, scale insects, and spider mites can affect hedgerows at any stage of the development cycle.

Diseases affecting hedgerows can be split in two:

- Fungal diseases, such as ash dieback (*Hymenoscyphus pseudoalbidus*), powdery mildew (*Golovinomyces orontii*) and honey fungus (*Armillaria*); and

- Bacterial diseases such as bacterial canker (*Pseudomonas syringae*), fire blight (*Erwinia amylovora*) and *Xylella fastidiosa* and algae-like organisms such as Ramorum disease (*Phytophthora ramorum).*

Powdery mildew
(*Golovinomyces orontii*)

Three-cornered garlic
(*Allium triquetrum*)

Figure 23 – Example of disease and INNS

By implementing proactive biosecurity measures, the risk of introducing or spreading hedgerow pests and diseases can be reduced.

This can be achieved by:

- Referring to government legal requirements for plant passports, quarantining affected planting stock, removing diseased sections of hedgerow and reporting on suspected pest and disease attacks (Defra, 2020);
- A period of review is recommended following a pest attack in order to assess if the pest has been removed and the plants have recovered; and
- Establishing biosecurity protocols on site, for example regular cleaning of equipment and machinery with disinfectant.

NOTE: *For advice on proactively planning, monitoring and reporting suspected pest and disease attacks refer to UK Plant Health Information Portal* https://planthealthportal.defra.gov.uk/ *and The Forestry Commission https://www.gov.uk/government/organisations/forestry-commission*

NOTE: *Anticipated costs of INNS management are addressed in the cost summary folder.*

NOTE: *Anticipated costs of disease management are addressed in the cost summary folder.*

8.6 Hedgerow Habitat and Design

This section provides advice on the design of new hedgerows within the lineside and key considerations for implementation.

Good hedgerow design achieve the following:

- Respond to context, reflecting local or regional style;
- Locally appropriate, resilient and diverse species mix;
- Cost effective management where works are planned and combined to minimise costs associated with site access and operational restrictions;
- Connections with adjacent hedgerows and other habitat types such as woodland; and
- Maintain the safety and performance of the lineside.

NOTE: *The biodiversity value of hedgerows is greatly increased if they are linked together and managed as part of a network or habitats.*

NOTE: Anticipated costs of hedgerow creation are addressed in the cost summary folder.

8.6.1 Site selection for hedgerow creation

The suitability of a site for hedgerow creation should be assessed through habitat studies and site appraisals as part of the baseline studies and should align with the Preferred Habitat Objective. This includes consideration of safety aspects of railway operations, habitat opportunities and constraints. Guidance on the process of recording and analysing this data is found in the Habitat Design and Management Guidance Note.

The following may indicate a site is suitable for hedgerow creation:

- **Potential for enhancing habitat connectivity**: opportunities to connect with existing habitats such as scrub and woodland to form a continuous or well-connected habitat network;
- **Defining boundaries:** opportunities to create defensible boundaries within the lineside especially in urban areas where additional security maybe required for example, using thorny plant species to avoid people climbing;
- **Cost effectiveness** hedgerow creation and implementing management (see cost summary folder;
- **Presence of INNS:** hedgerow creation after the clearance of pre-existing undesirable species, such as INNS;
- **Landscape setting**: opportunities to integrate and screen unsightly features of the lineside into the surrounding landscape character. This can be further assisted with the use regional hedgerow styles e.g. Devon Hedgerow (see Section 8.6.1.1);
- **Biodiversity and micro-climate**: Contribution of hedgerows to biodiversity and protection from prevailing winds;

- **Safe access:** safe site accessed for implementation and future management interventions that will likely require machinery; and
- **Physical environment:** appropriate soil composition (see Section 8.6.2) and terrain.

NOTE: *Hedgerows may form defensible boundaries but should not replace the boundary fence or affect the ability to inspect or maintain the boundary. A hedgerow should only act as the boundary measure where it has been assessed by the engineer as appropriate to deter trespass or livestock incursion.*

NOTE: *Refer to NR_L2_OTK_5201 MOD1 Lineside Vegetation Inspection and Risk before undertaking any fieldwork.*

NOTE: *Refer to NR/LN/ENV/122 MOD 01 Biodiversity Section 3.3 regarding field surveys.*

NOTE: *Refer to NR/L2/ENV/122 MOD 01 and MOD 02 regarding data gathering, the identification of existing habitats and species (e.g. SSSI) or protected species recorded on site*

8.6.1.1 Regional styles of hedgerow

There are regional styles of hedgerow throughout the UK. When designing a hedgerow, the appropriate regional style (typically laid hedgerows) should be considered to assist with its integration into the landscape setting. In some instances, replicating these hedgerow styles may not be viable due to the specialist techniques required for creation and on-going management (see Section 8.9.1.3). Where this is the case, common hedgerow features found throughout the UK can be used, as illustrated in Figure 24.

NOTE: *For examples an guidance on regional hedge laying differences refer to* https://www.hedgelaying.org.uk/pg/info/styles.aspx

Semi-mature mixed species native hedgerow with protective fencing

Mature mixed species native hedgerow with specimen tree

Figure 24 – Typical hedgerow features within the UK

8.6.2 Soil analysis

Understanding the soil composition of the site is important to establish:

- The most appropriate plant species to create a hedgerow; and
- The extent of ground preparation required (see Section 8.7.1 ground preparation).

To understand the soil composition a desk-based study should be undertaken. This will indicate the underlying soil type and bedrock within the location of a site.

More detailed, site specific, soil analysis can be carried out with a soil sample analysed within a lab to identify the soil pH and level of fertility.

Hedgerows can be adapted to most soil types. The soil should be reduced to a fine tilth to allow the roots to easily establish with best growth achieved through free draining soil (see Section 8.7.1 ground preparation).

NOTE: *For open source geospatial data which indicate the soil types and bedrock found across the British Isles refer to: Soilscapes Map http://www.landis.org.uk/soilscapes/about.cfm*

NOTE: *The need for soil analysis should be determined by a suitable experienced ecologist, botanist or soil scientist. Various companies offer soil testing and analysis which can be purchased online.*

8.6.3 Species selection

Plant species should be selected that are suited to the environmental conditions of the site e.g. soil, water table. Locally appropriate, UK native species should be used where possible. Native species-rich hedgerows support the most biodiversity but may be supplemented with non-native species to increase resilience to climate change and biosecurity (see Section 8.5).

The Network Rail document: *Recommended planting species, Species Matrix*, includes hedgerow species. This can aid in selecting species which are well-suited to the lineside with the aim of assisting lineside managers to:

- Select ecologically suited species to sites;
- Match key site factors with the ecological requirements of different hedgerow, and tree and shrub species.

For plant species identified as suitable for hedgerows more than 5m and 10m from the line see Appendix 1.

Network Rail guidance also highlights any plant species that should be avoided in the lineside *Action Zone* e.g. deciduous plants that will contribute a large amount of autumn leaf fall.

NOTE**:** *For the full list of species approved by Network Rail refer to the Network Rail document: Recommended planting species, Species Matrix (2015 Tree Council Update).*

NOTE**:** *The Action Zone is defined NR/L2/OTK/5201/02 Lineside Vegetation Management Requirements.*

NOTE**:** *For the full list of species approved by Network Rail refer to the Network Rail document: Recommended planting species, Species Matrix (2015 Tree Council Update).*

8.6.4 Plant specification

The National Plant Specification (NPS) defines criteria for the most commonly specified plant groups. It can provide a useful reference for determining plant sizes,

which can inform stocking densities (CSD Hub, 2020). All plants should comply with the with BS 3936: Parts 1 to 10, BS 8545.

Typically in the lineside, bare root transplants are most appropriate when creating a hedgerow as they are cost effective and easily establish with minimal aftercare. There are, however, other forms of hedgerow plants which can be specified (see table 4).

Table 4 – Different hedgerow specification

	Transplants (0+1) or saplings - approximately 40-60 cm)	**Container grown plants**	**Seed**
Pros	Generally establish easily and quickly. Can establish to form a thick hedge. Suited to deciduous species.	Instant hedgerows can be planted. Can be planted anytime of the year. Suited to evergreen species.	Can develop strong roots and do not require transplanting.
Cons	Takes at least five years to start to form a barrier. Limited time of year to plant (November to March).	Plants are more difficult and expensive to handle and plant than transplants and can need more intensive aftercare, including irrigation during establishment.	Higher likelihood of failure to establish. Less control over the species mix.
Cost	Transplants are cheaper than container grown plants but more expensive than seed.	The most expensive option due to the larger size of the plants and cost of nursery production.	The cost of the seed is cheaper than plants. However, they will require the most protection and more intensive maintenance including weed control to aid establishment.
Example	Long stretches of lineside, within a rural setting, where quick establishment is not required.	Urban environment, where instant boundary definition is needed to screen views. Can also form part of a mix together with bare root deciduous plants.	Future projects, with long lead-in time, requiring large areas of lineside hedgerows. Hedgerows are unlikely to be seeded directly in the lineside.

NOTE: *Further guidance on the specification for trees and shrub refer to BS 3936-1:1992 Nursery stock. Specification for trees and shrubs.*

8.6.4.1 Planting density and layout

The success of hedgerow establishment is influenced by the density and layout of the hedgerow plants when planted. When setting out the plants, it is important to

follow these guidelines, noting the density of plants is dependent on the style of the hedgerow and the size of the plants.

Hedgerows are typically planted in a double staggered rows with 5 plants per linear metre and 40cm between rows. A mixed species hedgerow commonly has individual species grouped into 3's, 5's or 7's.

NOTE: *Timber post and wire fence and other plant protection measures should be installed at the time of planting see Section 8.7.4.*

NOTE: *For more information refer to The Conservation Volunteers; Hedging Handbook.*

NOTE: *Hedgerows may form defensible boundaries but should not replace the boundary fence or affect the ability to inspect or maintain the boundary. A hedge should only act as the boundary measure where it has been assessed by the engineer as appropriate to deter trespass or livestock incursion.*

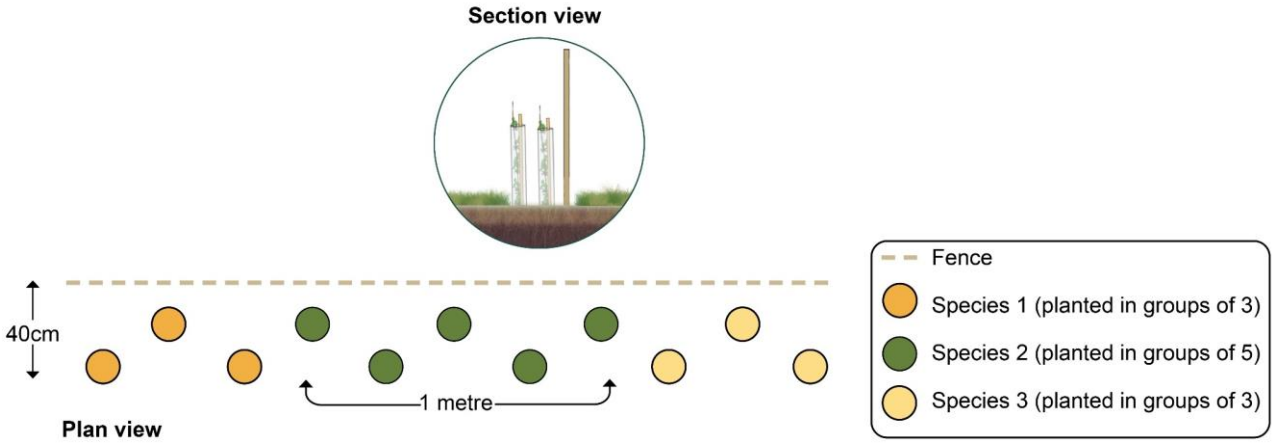


Figure 25 – Typical hedgerow planting layout density

8.7 Hedgerow Creation and Establishment

Heathland & Shrub Classification | Hedgerow Habitat and Design | Hedgerow Creation and Establishment | Long-term Management of Hedgerow Habitat | Hedgerow Restoration

This section provides guidance on how to successfully create and establish new hedgerows in the lineside to maximise the biodiversity and ecosystem services it supports. This guidance refers to the planting phase and established phase of hedgerows.

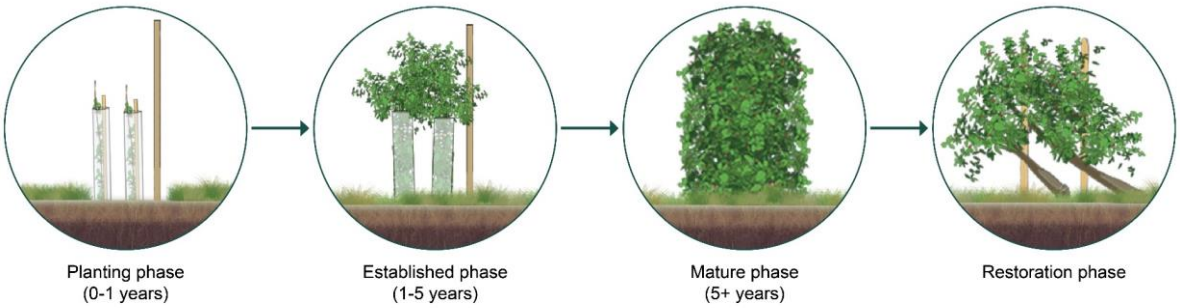


Figure 26 – Hedgerow development phases: applicable to hedgerow creation and establishment

Best practice suggests the following general planting and establishment principles should be applied:

- Undertake necessary ground preparation;
- Organise toolbox talks for site staff on planting and maintenance protocols, including recording and reporting on suspected cases of pests and diseases;
- Use chipped material from other vegetation clearance operations where possible, to assist with hedgerow establishment;
- Protect hedgerows from cold winds during establishment, livestock damage and avoid planting on rocky terrain;
- Install plant protection measures from browsing livestock and wild animals;
- Replace plants that are dead or fail to thrive at the end of each growing season up to the end of the five-year aftercare period; and
- Removing dead or diseased plant material from site to a licensed green waste recycling facility.

NOTE: *The routine maintenance schedule for heathland and shrub, including when to undertake inspections is set out in the schedule folder.*

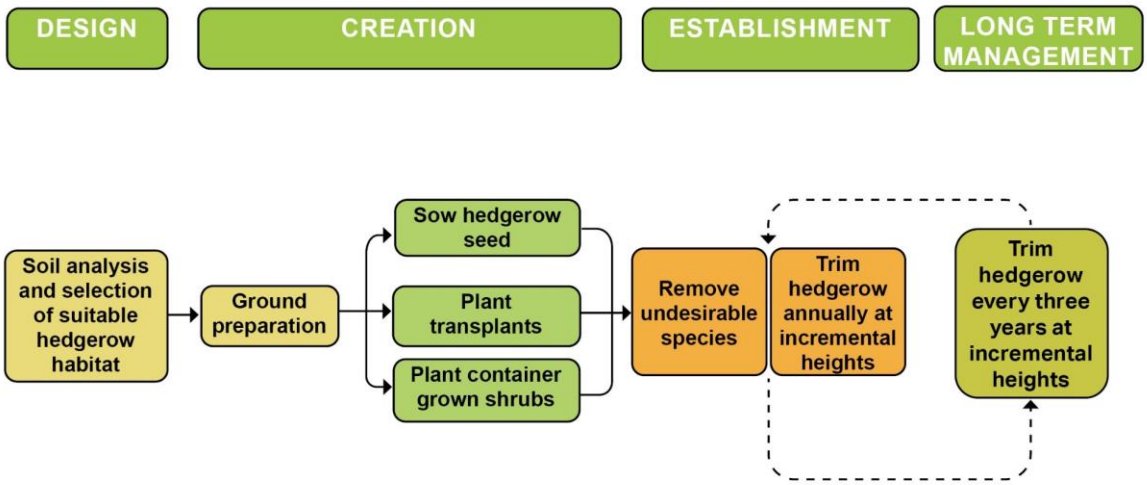


Figure 27 – Hedgerow creation and establishment process

Figure 27 outlines the process that should be followed when creating a hedgerow and the subsequent actions recommended to ensure successful establishment. Methods and considerations relating to ground preparation, hedgerow creation, and immediate aftercare are outlined within the following subsections. Management interventions and long-term management are discussed in Section 8.8.

8.7.1 Ground preparation

Prior to creating a new hedgerow, the ground should be prepared to provide optimal conditions for successful plant establishment.

Typically, in a lineside context, this will be carried out as follows:

- **Soil cultivation:** create a weed-free friable tilth. The best growth will come from free draining soil with a high content of organic matter. This should be undertaken when the soil is dry and easily workable by cutting a strip of turf along the proposed hedge line into grass by machine before cultivating the soil by machine or hand. Soil cultivation should be undertaken just before planting to prevent soil exposure to weeds and erosion.
- **Weed removal:** remove all weeds from the area to be planted and dispose of material to a licensed green waste recycling facility.
- **Plants**: when preparing for planting, make a slot with a spade or appropriate machinery by rocking the clean edge backwards and forwards until a small v-shaped notch has been created.
- **Container grown:** When preparing to plant container grown stock, dig a hole or trench large enough for the pot to fit flush with the surrounding soil.

8.7.2 Planting hedgerows

Once the ground has been prepared, the hedgerow is ready to be planted. Hedgerow planting typically followings these methods depending on the plant specification:

- **Transplants**:
    1. Carefully ease the roots of the plant into the v-shaped notch;

2. Ensure that the roots are well spread and the original nursery mark is flush with the surrounding ground level; and
3. Backfill and gently firm the soil to avoid any air pockets surrounding the root system.

- **Container grown plants**:
    1. Gently remove the plant from pot by turning it upside down and tapping the basis of the plot and gently loosen the roots of the plant;
    2. Place the plant in the pre-dug hole, ensuring the top of the soil level of the plant is flush with the surrounding soil; and
    3. Gently backfill the pre-dug hole to match the existing level to avoid any air pockets surrounding the root system.

In addition to the hedgerow planting techniques, the following general principles should be considered:

- Organic material, such as compost or manure, should not be incorporated at the base of the plant as this may rot and create anaerobic conditions, potentially resulting in plant failure;
- Container grown plants are more susceptible to drought. Therefore irrigation should be provided in transit and storage;
- Roots damaged before planting should be trimmed with a sharp pair of secateurs. If the damage is extensive, the plant should be discarded;
- Water in the plants to field capacity if the soil is dry and no rain is forecast in the next 24 hours; and
- To deter weeds and help retain soil moisture, mulch to a depth of 75mm after planting or use mulch mats made from plant by-products.

NOTE: *Field capacity is the water content of soil 2-3 days after rain or irrigation (Planning and Evaluation of Irrigation Projects, 2017). Field capacity can be estimated by understanding the soil type and conditions see Section 8.6.2 for more detail.*

8.7.3 Establishment - years 0-5

The following principles should be applied during the first five years after planting, to assist the successful establishment of the hedgerow:

- **Irrigation**: in prolonged periods without rainfall, hedgerows may need to be irrigated to reduce the risk of plant failures. Container grown plants are especially susceptible to failure as a result of lack of water.
- **Weed removal:** If specified, mulch should be maintained. Weeds should be removed by hand where possible (see Figure 28 for examples of weed species that should be removed). If weeds persist, spot herbicide treatment can be applied; however, this should be undertaken as a last resort.
- **On-going management:** once established, a management regime should be implemented for the hedgerow to develop to the mature phase. This is likely to comprise of regular (typically annual) hedge cutting at incremental heights until to desired height has been reached. Protection measures such as stock fencing or

guards should be inspected and either replaced or repaired if necessary or removed if plants are being restricted.

Regular monitoring of the success of hedgerow establishment should be reported in accordance with the Habitat Management Plan (see Section 8.2).

Bindweed
(*Convolvulus arvenis*)

Bramble
(*Rubus* spp.)

White byrony
(*Bryonia dioica*)

Black bryony
(*Tamus communis*)

Figure 28 – Examples of weed species that should be removed

NOTE: *For more guidance on preparation, planting and immediate aftercare refer to The Conservation Volunteers; Hedging Handbook.*

8.7.4 Plant protection

To limit damage of newly planted hedgerows, the following best practice principles should be applied:

- Carry out an assessment of the risk of animal browsing as part of habitat studies;
- Either install individual plant shelters and canes which are plant based and break down naturally over time or use recyclable shelters that can be collected up and removed from the site once plants have established;
- Install windbreaks made from living plants or fences with approximately 50-60% porosity made from woven willow or hazel for example; and
- Inclusion of mulch mats made from plant by-products which help retain soil moisture and protect new plants from weeds.

NOTE: *The installation of windbreaks made from semi-permeable screens need to be entirely secured or can pose a safety risk if the windbreak becomes loose.*

NOTE: *Habitat studies should be carried out by a suitable experience ecologist.*

NOTE: *Hedgerows may form defensible boundaries but should not replace the boundary fence or affect the ability to inspect or maintain the boundary. A hedge should only act as the boundary measure where it has been assessed by the engineer as appropriate to deter trespass or livestock incursion.*

8.7.5 Operational considerations in hedgerow habitats

Creating a hedgerow in proximity to the railway requires consideration of the key site-specific constraints to operational rail use.

Typical operational considerations for hedgerow appraisal may include:

- Flooding or lack of water for irrigation;
- Steepness or stability of embankments and cuttings;
- Animal browsing;
- Lineside width and the proximity to the line;
- Protected species or protected habitats or sites;
- Areas where high leaf fall occurs and
- Security, e.g. discouraging public access.

NOTE: *Document NR/L3/OTK/6202 provides guidance on protecting railway assets.*

8.8 Long-term Management of Hedgerow Habitat

This section outlines the key considerations for the management of mature hedgerows. The guidance refers to the mature phase of the hedgerow development cycle. It should be read alongside *NR/L3/OTK/6202 Protecting railway assets* during vegetation work.

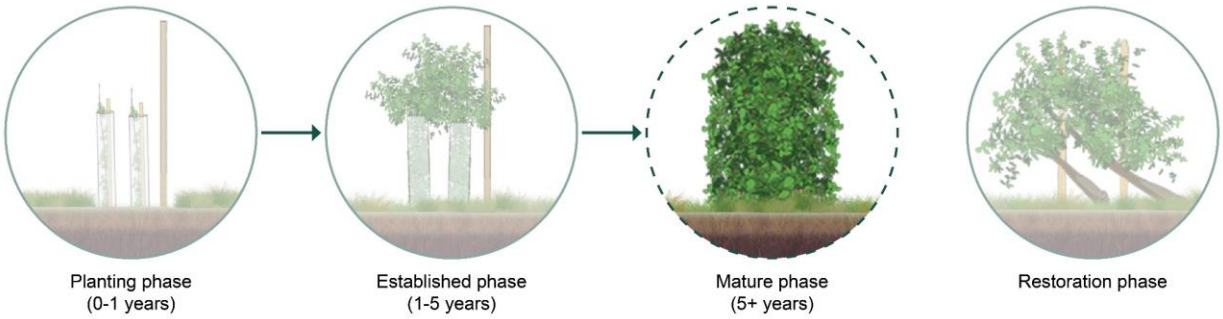


Figure 29 – Hedgerow development phases: applicable to hedgerow long-term management

Best practice suggests the following general principles should be applied:

- Implement a long-term management regime suitable for the site, soil and hedgerow type;
- Analyse changes in hedgerow composition and structure to inform future management; and
- Monitor to ensure the long-term management regime is appropriate.

Beyond establishment, the approach to hedgerow management is similar year on year.

Once a hedgerow has established, good hedgerow management seeks to:

- Remove invasive self-seeded plants (including weeds) to maximise species-richness;
- Maintain the desired height and width to fulfil its boundary function and support biodiversity;
- Reflect regional hedgerow styles in management (e.g. through hedge laying) to contribute to the landscape setting; and
- Conserve, create or enhance micro-habitat features e.g. feature trees, field boundary ditches.

NOTE: *Removal of non-native species is not always appropriate e.g. ornamental hedgerow in urban environments. Refer to the Urban and Brownfield Design and Management guidance note.*

NOTE: *It is important to pro-actively liaise with owners of adjacent grassland outside of the lineside to ensure habitat enhancement opportunities are maximised and objectives are aligned.*

8.8.1 Long-term management interventions

Once hedgerows are established, regular long-term management interventions are required. This will allow the hedgerow to reach and maintain its optimal condition, in accordance with objectives set out in the Habitat Management Plan.

Management interventions associated with the mature phase of hedgerow development cycle, need to be selected depending on the condition of the hedge. When appropriate management ceases habitat restoration may be required (See Section 8.9).

NOTE: *For guidance on producing a Habitat Management plan refer to the Habitat Design and Management Guidance Note.*

NOTE: *Habitat management plans are described in NR/L2/ENV/122 Module 02.*

NOTE: *Anticipated costs of different stages in hedgerow management are addressed in the cost summary folder.*

8.8.2 Cutting

The purpose of hedge cutting is to maintain even plant growth and control the overall structure i.e. height and width. Effective and regular cutting will limit the need for restorative management intervention such as 'gapping up' planting (see Section 8.9.1.1).

Typically in the lineside, hedge cutting will be carried out by machine e.g. a tractor mounted reciprocating bar. Where access for large machinery is not possible, or a more delicate cut it is needed, such as visually prominent areas adjacent to stations, manually operated hedge trimmers should be used.

8.8.3 Implementing a cutting regime

The frequency and timing of cutting plays a significant role in the hedgerow development. This varies, as follows, depending on the age of the hedgerow:

- Years 5-10: annual trimming to ensure the hedge reaches a dense, robust structure; and
- Years 10+: trim to incremental heights of 10-15 cm every three years until the hedge reaches it preferred height.

The preferred times to cut hedgerows are:

- **Deciduous hedgerows:** Trimming is usually carried out in winter. This avoids the nesting bird season which is between February to August each year.
- **Evergreen hedgerows:** Trimming is usually carried out between spring and summer when younger growth is softer and less rigid. Up to three cuts may be carried out annually during summer. Trimming should stop after summer to prevent bare patches.

NOTE: *Most conifers will not re-grow from old wood, so it is important to avoid over trimming.*

NOTE: *An experienced ecologist or ornithologist should be consulted if it is suspected that birds are nesting within the hedgerow.*

8.8.4 Other long-term maintenance interventions

In addition to cutting, the following interventions may be required. Due to the cost, these interventions typically may only be viable in prominent, public facing locations e.g. stations or urban areas.

- **Weed control**; weed growth can be controlled with the use of mulching or removed by hand, and;
- **Irrigation**: hedgerows will require regular watering, especially if the weather is dry for a prolong period of a fortnight or more.

8.8.4.1 Monitoring and Inspections

Hedgerows should be inspected and surveyed annually by a suitably qualified professional to monitor its success against the specification and objectives set out in the Habitat Management Plan. These surveys could include a Hedgerow Survey and Biodiversity Net Gain (BNG):

Following inspections and monitoring, changes to the management regime may be recommended to enhance or restore the hedgerow. Inspections are important to:

- Ensure the management plan objectives are being met;
- Report on hedgerow vitality and failures and inform and instruct replanting process;
- Assess the health of a hedgerow and identify actions to address biosecurity issues;
- Report on the condition and effectiveness of plant protection and any remedial action required;
- Hedgerow surveys should be completed between April and October, June and July are ideal months.
- Hedgerow surveys should be undertaken at similar times of year in order to assess comparable results.
- Hazards such as surveying alongside railways and watercourses, should be considered when undertaking a hedgerow survey.

NOTE: *For guidance on undertaking a Hedgerow Survey refer to* *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69285/pb11951-hedgerow-survey-handbook-070314.pdf*

NOTE: *Surveys, ecological monitoring and BNG assessments should be devised and undertaken by an experienced ecologist of botanist.*

NOTE: *Suitably qualified professionals for undertaking inspections of hedgerows include Chartered Members of the Landscape Institute or ecologists. Landscape architects can provide assistance with practical issues relating to establishment whereas ecologists can provide detailed technical information.*

The best time to assess the condition of a hedgerow is throughout the summer, ideally before any cutting occurs. Visible causes of ill health in hedgerows commonly include:

- Disease;
- Plant breakages; and

- Pests.

If symptoms of ill health or pest attack cannot be resolved within a year; consideration should be given to phased removal and replacement with an alternative suitable species.

Bracket fungus

Vine weevil

Aphids

Figure 30 – Example of a hedgerow disease and pests

8.9 Hedgerow Restoration

This section provides guidance on how to restore hedgerows which have been damaged or become over mature.

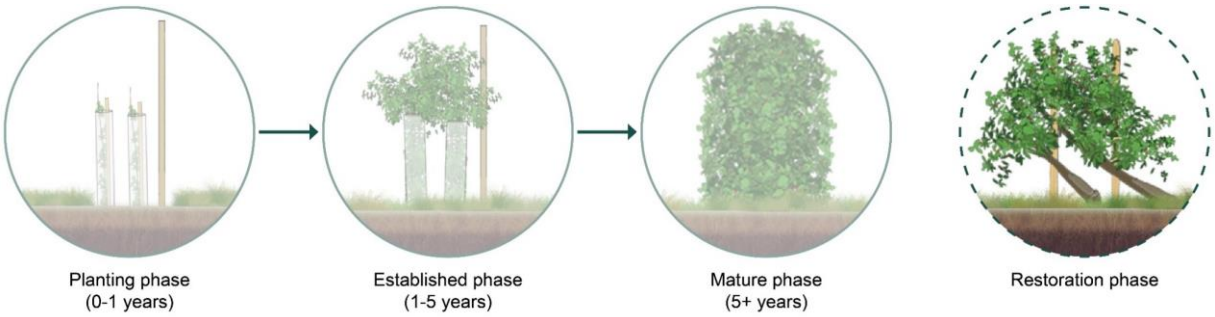


Figure 31 – Hedgerow development phases: applicable to hedgerow restoration

Best practice suggests the following general principles should be applied:

- Undertake removal of undesirable species where appropriate;
- Cut the hedgerow using machinery or hand operated tools
- Lay the hedgerow using hand operated tools;
- Organise toolbox talks for site staff on maintenance protocols, including recording and reporting on suspected cases of pests and diseases;
- Remove arisings unless used as a windbreak; and
- Update the Habitat Management Plan.

8.9.1 Hedgerow restoration

Hedgerow restoration is required when a hedgerow transitions into a line of shrubs or trees from lack of management, or becomes a 'gappy', stunted hedgerow from over-management. A hedgerow can be restored through techniques such as coppicing or laying (see Figure 36).

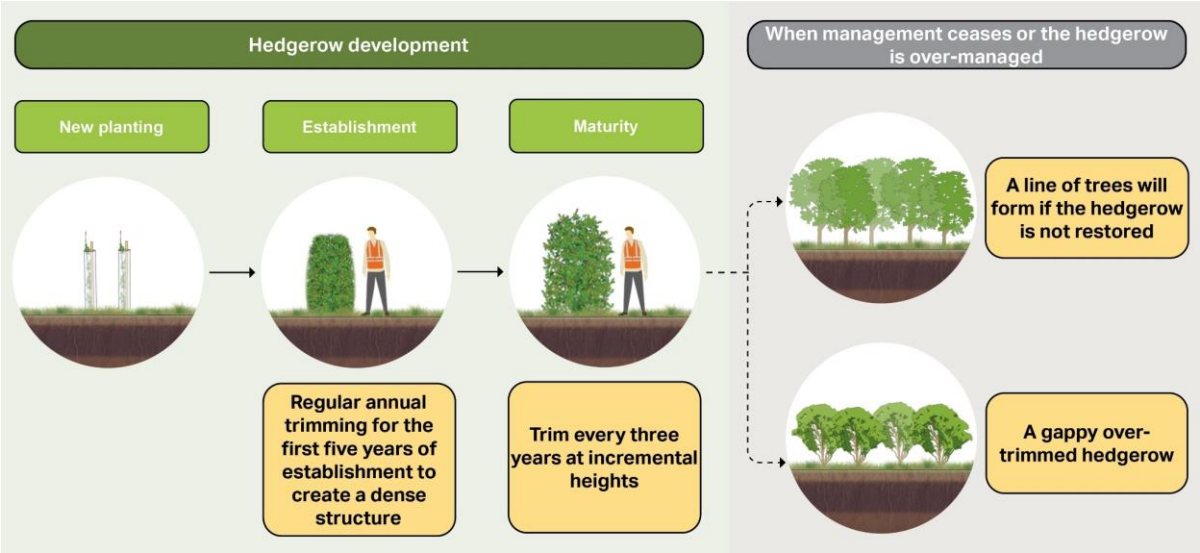


Figure 32 – Mature phase of the hedgerow development cycle and associated management interventions

Figure 32 illustrates the common results of when appropriate hedgerow management ceases. Restorative management approaches are outlined in the sections below.

8.9.1.1 Gapping up

Gapping up is need when plants die or are removed, typically due to over trimming. For native hedgerows this should take place between November and March when the plants are dormant.

Gappy hedgerow Gapped up hedgerow

Figure 33 – Example of hedgerows that is restored using gapping up

The following principles should be applied:

- Prepare the ground to create a weed-free friable tilth (see Section 8.7.1 Ground preparation);
- Species reflecting those of the existing hedgerow should be planted (see Section 8.6.3 Species selection);
- Planting should follow the steps outlined in Section 8.7.2 Planting hedgerows;
- New plants should be protected using fencing if browsing is considered a threat. (see Section 8.7.4 Plant protection).

NOTE: *For further guidance refer to BN7: Hedgerow gapping-up at https://www.gov.uk/countryside-stewardship-grants/hedgerow-gapping-up-bn7*

8.9.1.2 Coppicing:

Coppicing is recommended when a native hedgerow becomes overgrown and transitions into a line of shrubs or trees (Figure 34).

Coppicing involves cutting the hedgerow down to the stump to allow new plant growth.

Coppicing is the preferred approach if the stems have become too thick (+100mm diameter) to lay the hedge. Coppicing is the quickest method of restoring a hedgerow, however hedge laying is likely to be more effective as the barrier formed by the hedge is retained.

The following principles should be applied:

- Copping should be completed during winter;
- Coppicing is usually preferred over hedge laying as the techniques used are commonly practiced and more cost effective
- This method can be completed using a chainsaw or by hand;
- Gapping up can be completed in parallel with coppicing, or the following season when plant failure is clearer; and
- Stumps may not re-grow depending on their vigour and the ground conditions.

Figure 34 – Overgrown hedgerow requiring coppicing and gapping up

NOTE: *Refer to the Network Rail Woodland Design and Management Guidance Note for more information on coppicing.*

8.9.1.3 Laying

Hedgerow laying can be used when a hedgerow becomes overgrown and transitions into a line of individual shrubs or trees (See Figure 35). The main benefit of this approach is that it retains the function of the hedgerow as a physical barrier. Laying should be completed during winter (November to March).

Laying is a traditional hedgerow restoration technique and can be applied in locations of high wind exposure as cut stems from the laying process can be used as a wind break.

Regional variations in hedgerow laying (see Section 8.6.11 Regional styles of hedgerows) can assist with integration of the hedgerow into the wider landscape setting.

The key steps are common to most regional variations as illustrated in Figure 36:

1. Remove lower branches from the stems (referred to as pleachers) of the hedgerow to allow light into the base of the hedgerow, assisting new growth;
2. Cut the pleacher at an angle, typically 35 degrees, just above ground level. The cut should be sufficiently deep to allow the pleacher to bend, but not completely severing the stem;
3. Lay the cut pleachers down along the length of the hedgerow at an upward slant (not horizontally); and
4. Place stakes at 500mm intervals along the hedgerow for support. These should be secured firmly in place; one method is to use flexible hazel rods provided on-site either or from a sustainable source of timber.

Figure 35 – Laid hedgerow

Hedgerow restoration should be implemented on a long rotational basis as set-out in the Habitat Management Plan. This is due to the negative impact on nesting bird opportunities and the recovery of the plants in the first years following the restoration.

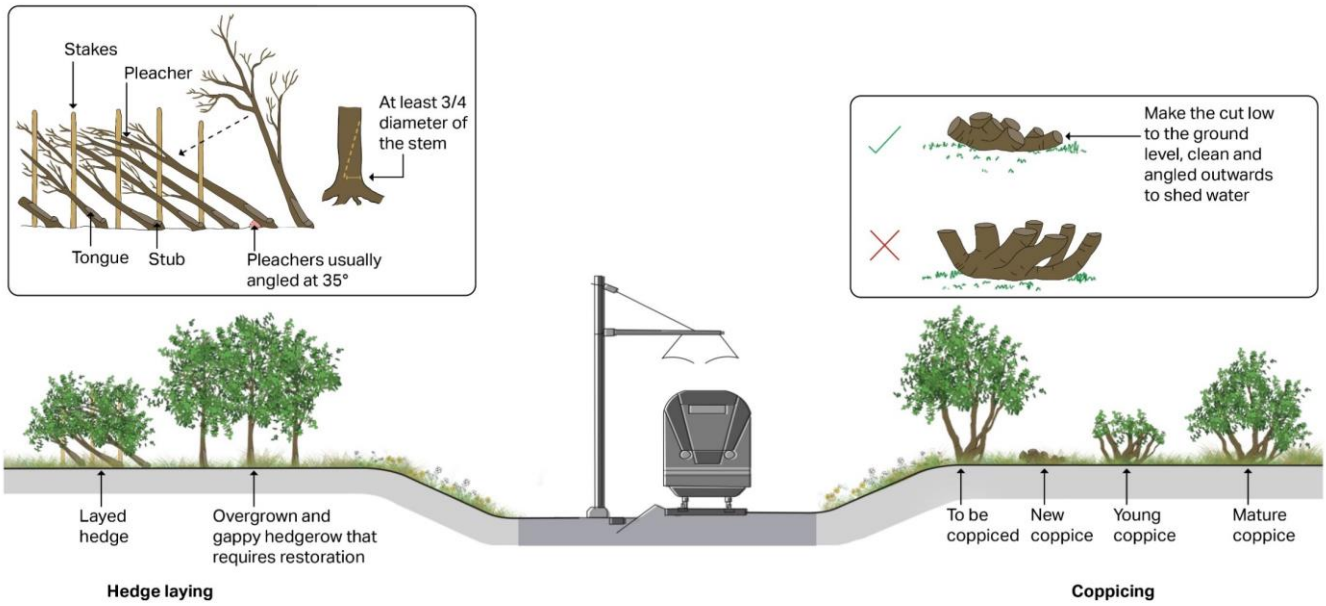


Figure 36 – Examples of hedgerow restoration in the lineside

8.9.2 Lineside management considerations

Physical and operational constraints should be considered before undertaking hedgerow restoration. Use of machinery appropriate to the site's conditions is key in ensuring successful habitat restoration and lineside safety.

9 Dense Scrub Habitat Design and Management

9.1 Introduction

This section provides guidance on:

- General considerations related to the design and management of scrub;
- The design of new scrub habitat;
- Maintenance required to establish new scrub habitat;
- Long-term management of scrub habitat; and
- Restoration of scrub habitat.

Each section includes practical guidance and refers to tables in the cost summary folder to understand the budget costs of carrying out work.

NOTE: *Professional expertise should be sought to throughout the process. For example, an experience ecologist should be consulted to determine the Preferred Habitat Objective and objectives set out in the site Habitat Management Plan. In addition, landscape advice should be sought where design, implementation and management advice is needed.*

9.2 Habitat management plans

In addition, Network Rail's requirements for Habitat Management Plans are set out in NR/L2/ENV/122 Module 02.

The process of setting objectives for the habitat management plan is described in the Habitat Design and Management Guidance Note (see Section 7.6).

It is recommended that the Habitat Management Plan sets out short, medium and long-term objectives. These periods, as follows, should reflect the development cycle phases as illustrated in Figure 10:

- *Short-term* (year 0 to 3);
- *Medium-term* (year 3 to 9); and
- *Long-term* (year 9+).

NOTE: *Refer to NR/L2/ENV/122 Module 02 for information on the requirements for Habitat Management Plans.*

NOTE*: Management objectives should be reviewed against data collected via monitoring (see Section 9.8.4).*

9.3 Ecosystem services and design considerations

As outlined in the Habitat Design and Management Guidance Note, an initial site appraisal can help identify ecosystem services present and the potential for their expansion within lineside vegetation. This will help inform decisions on whether scrub is the preferred habitat for the site and will influence its management.

Scrub within the lineside can provide a range of ecosystem services. These include:

- **Erosion control:** scrub can help to reduce erosion along railway cuttings and embankments;
- **Pollination**: support a wide range of pollinating insects, offering refuge and food resources that can help boost the population of native pollinator species;

- **Biodiversity:** scrub habitat supports a wide range of biodiversity which provides further ecosystem services;
- **Water regulation:** vegetation can reduce the rate at which water meets waterbodies and watercourses; reducing the occurrence of flash flooding downstream;
- **Air pollution removal:** carbon sequestration of scrub and associated preservation and renewal of soils, provide benefits including improved health and protection against climate change;
- **Landscape integration:** well managed scrub can improve lineside aesthetics and integrate it within the wider landscape setting; and
- **Health and wellbeing:** scrub contributes to clean air, water management and landscape setting for active travel.

NOTE: *Ecosystem services of the land should be identified when fieldwork is undertaken. This should be determined by an environmental specialist, using professional judgement. Refer to the Habitat Design and Management Guidance Note for more information on ecosystem services.*

In addition to ecosystem services, there are other lineside specific design risks and benefits which will help to inform whether scrub is an appropriate habitat within a specific location (Table 5). In some cases, there may be conflict between different objectives, for example reducing fire risk may reduce the extent of scrub. The design should therefore provide detail on how competing objectives will be manged, for example, by extension of scrub edge.

Table 5 – Key risks and benefits for scrub in a railway setting

Design risk	Key scrub design considerations	Associated scrub management approaches
Fire	• Lineside vegetation in the urban context can be a 'high risk habitat' due to increased likelihood of arson.	• Create or mange existing vegetation to create a "buffer" from the edge of the railway line restricted to grassland vegetation and eliminate scrub; • Provide gaps made up of grassland to contain potential fire in isolated locations, and; • Remove hay and wood cuttings from the site.
Access	• Scrub habitat may need to be accessed via routes on third party land for establishment and maintenance; and • Suitable access is also required within lineside.	• Local stakeholder engagement is key to gaining access to third party land; and • Landowner permissions should be sought prior to hedgerow creation. Refer to the Stakeholder Engagement Guidance Note.
Uncontrolled expansion	• Unmanaged scrub habitat can potentially take over other species rich habitats.	• Maintain gaps between the edge of scrub habitats and heathland and wetland habitats to reduce the risk of invasion.

Design risk	Key scrub design considerations	Associated scrub management approaches
Biodiversity	• A landscape element within a larger ecological unit (mosaic habitat).	• Wide scrub edges help to maximise biodiversity;
Alternative to woodland habitats	• Scrub can be considered as an alternative to woodland habitat in locations where woodland will be unsuitable for operational purposes.	• Scrub to be maintained at the mature development phase before it transitions into woodland habitat.

9.4 License requirements

This section details the legal requirements and need for licences or other permissions, if protected species, designated sites or priority grassland habitats are encountered within a site

9.4.1 Designated sites

Sites of Special Scientific Interest (SSSI) are protected under the Wildlife and Countryside Act (1981). Certain habitat management, such as changing a browsing regime or cutting within a SSSI will require consent from Natural England, Natural England, NatureScot or Natural Resources Wales.

Scrub situated within Special Protection Areas (SPA), Special Areas of Conservation (SAC) and designated Ramsar Sites may also need assessment under the UK Habitats Regulations before proceeding with works.

A National Nature Reserve (NNR) and Local Nature Reserve (LNR) protects land under the National Parks and Access to the Countryside Act (1949) or Wildlife and Countryside Act (1981) as amended. Management interventions need to be consistent with the management plan and approved by the managing organisation.

9.4.2 Protected species

Many species are protected under UK law. Protected animals associated with scrub include nightingale, great crested newt, sand lizard and hazel dormouse. Protected plants associated with scrub include species such as common juniper (*Juniperus communis*), common box (*Buxus sempervirens*) and downy willow (*Salix lapponum*). Complete list of Protected Species can be found in Schedule 8 of Wildlife and Countryside Act, (Gov.uk, 2015).

9.4.3 Protected species licences

Where protected species may be at risk, protected species licences may be required. A professional ecologist can advise on license requirements and appropriate mitigation. This will include consulting the following relevant government bodies prior to the implementation of heathland creation or management activities:

Natural England: https://www.gov.uk/guidance/wildlife-licences

NatureScot: https://www.nature.scot/professional-advice/protected-areas-and-species/licensing

Natural Resources Wales: https://naturalresources.wales/permits-and-permissions/species-licensing/?lang=en

9.4.4 Other consents

Some types of scrub such as Mountain Heaths and Willow Scrub are recognised as habitats of principal importance under Section 41 of the NERC Act (2006). Where present within the lineside estate, management of priority scrub habitat must be prioritised. This is to ensure that management of priority scrub is programmed in the appropriate season. Management of priority scrub habitats is likely to take precedent over the management of all other non – priority habitats.

NOTE: *Budget costs of works to specific areas/management interventions requiring statutory consent is outline in the cost summary folder.*

9.5 Biosecurity

Biosecurity refers to a set of precautions that aim to prevent the introduction and spread of harmful organisms. These include non-native tree pests, such as insects, and disease-causing organisms, called pathogens, such as some bacteria and fungi.

9.5.1 Invasive species

Several species listed on Schedule 9 of the Wildlife and Countryside Act (1981), such as common rhododendron (*Rhododendron ponticum*), himalayan balsam (*Impatiens glandulifera*), giant hogweed (*Heracleum mantegazzianum*) and japanese knotweed (*Reynoutria japonica*) can colonise heathland habitat.

Several invasive non-native species (INNS) listed on Schedule 9 of the Wildlife and Countryside Act (1981) can colonise scrub habitat. Under this Act it is illegal to plant or otherwise cause to spread any plant species listed. This duty applies to landowners where these species where identified and is particularly relevant to the management of vegetation along the railway. Examples of these are provided in Figure 37. Presence of these species may cause delay or change to the Preferred Habitat Objective.

If non-native species, listed in Schedule 9, or otherwise known to be invasive (see NOTE) are found within a site, a Network Rail ecologist should be contacted, in order to devise a plan in which the plants can be removed and safely disposed of without causing spread. In this instance, the landowner is duty bound to take action to prevent spread of the species.

Japanese knotweed
(Reynoutria japonica)

Giant hogweed
(Heracleum mantegazzianum,

Common rhododendron
(Rhododendron ponticum)

Figure 37 – Example of INNS

NOTE: *Invasive species such as himalayan balsam, giant hogweed and japanese knotweed should be disposed of in registered landfill sites. For further guidance refer to*

https://www.gov.uk/guidance/prevent-the-spread-of-harmful-invasive-and-non-native-plants for information on removing invasive and non-native plants.

***NOTE**: Refer to Schedule 9 of the Wildlife and Countryside Act (1981) and gov.uk guidance for a full list of invasive non-native species: https://www.legislation.gov.uk/ukpga/1981/69/schedule/9 and https://www.gov.uk/guidance/invasive-non-native-alien-plant-species-rules-in-england-and-wales#list-of-invasive-plant-species*

9.5.2 Pests and diseases

Scrub is generally less prone to pests and diseases in comparison to other habitats due to its species diversity. Pests and diseases that can affect scrub habitats are similar to those found in grassland and woodland habitats.

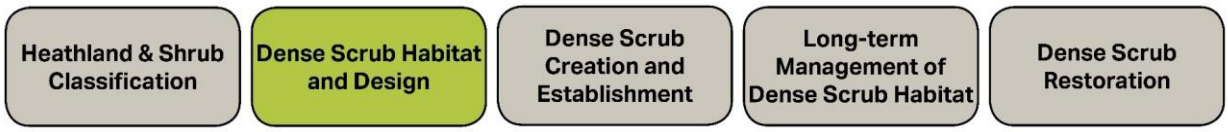
By implementing proactive biosecurity measures, the risk of introducing or spreading scrub pests and diseases can be reduced. This can be achieved by:

- Referring to government guidance on the requirements for plant passports, quarantining affected planting stock, removing diseased vegetation and reporting on suspected pest and disease attacks (Defra, 2020);
- Increasing resistance of plants through appropriate design, planting and maintenance in the context of the existing soil, site aspects and water;
- Using plant material of UK Provenance;
- Proactive planning, monitoring and reporting of concerns to identify issues through the UK Plant Health Information Portal and Forest Research; and
- Establishing biosecurity protocols on-site to include cleaning and sterilisation of hands, PPE equipment, tools clothing; footwear, monitoring the sources of supplied plants, bark, and wood packaging.

***NOTE:** The general principles of pest and diseases relating to woodland refer to Woodland Design and Management Guidance Note.*

***NOTE:** The general principles of pest and diseases relating to grassland refer Grassland Design and Management Guidance Note.*

9.6 Dense Scrub Habitat and Design



This section provides advice on the design of scrub habitat within the lineside and key considerations for implementation.

Good scrub habitat design should seek to achieve the following:

- Resilient and diverse species mix that enhances the biodiversity value of the habitat;
- Appropriate preparation and management to ensure scrub establishment;
- Scrub design to include well-structured mosaics, in most scenarios comprising of scrub edge and shrubs;
- Shrub planting to cover approximately 25% and scrub edge to cover approximately 75% of the site to maximise biodiversity;
- Cost effective management where works are planned and combined to minimise costs associated with site access and operational restrictions;
- Create connections with adjacent habitat types; and
- Maintain the safety and performance of the lineside.

NOTE: *The value of scrub habitats is greatly increased if they are connected and managed as part of a network. This is also true of scrub mosaics, where scrub is found in conjunction with grassland, heathland, woodland or wetlands.*

NOTE: *Anticipated costs of scrub creation are addressed in the cost summary folder.*

9.6.1 Site selection for scrub creation

The suitability of a site for scrub habitat creation should be assessed through habitat studies and site appraisals as part of the baseline studies to identify the Preferred Habitat Objective. This includes consideration of safety aspects of railway operations, opportunities and constraints associated with the habitat. Guidance on the process of recording and analysing this data is found in the Habitat Design and Management Guidance Note.

The following may indicate that a site is suitable for scrub habitat creation:

- **Potential for enhancing habitat connectivity:** opportunities to extend or connect with existing habitat such as grassland to form a continuous or well-connected habitat that allows for sustainable management such as browsing (see Figures 38, 39 and 40);
- **Prevalence of scrub locally:** presence of existing scrub on site, or nearby sites, may indicate that extension of this habitat will be beneficial for local biodiversity. This should be determined through baseline studies;
- **Cost-effectiveness:** of scrub creation and management (see cost summary folder);
- **Presence of undesirable species:** re-vegetation following eradication of the pre-existing undesirable species, such as extensive presence of bramble or INNS;

- **Safe access:** provision or use of existing safe access for implementation and future management interventions that will likely require machinery;
- **Terrain:** safe site access for implementation and future management interventions that will likely require machinery; and

Alternative to other habitats: scrub may be preferred where other habitats e.g. woodland are not suitable due to operational constraints. The scrub design should consider site-specific opportunities and constraints and, where possible, integrate within the wider mosaic of habitats e.g. combining with woodland, grassland and hedgerows as illustrated on Figures 38, 39 and 40.

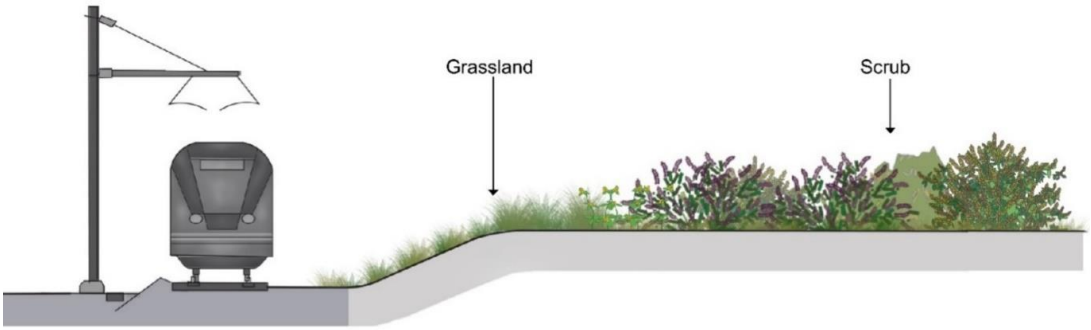


Figure 38 – Example of lineside scrub and grassland mosaic habitats

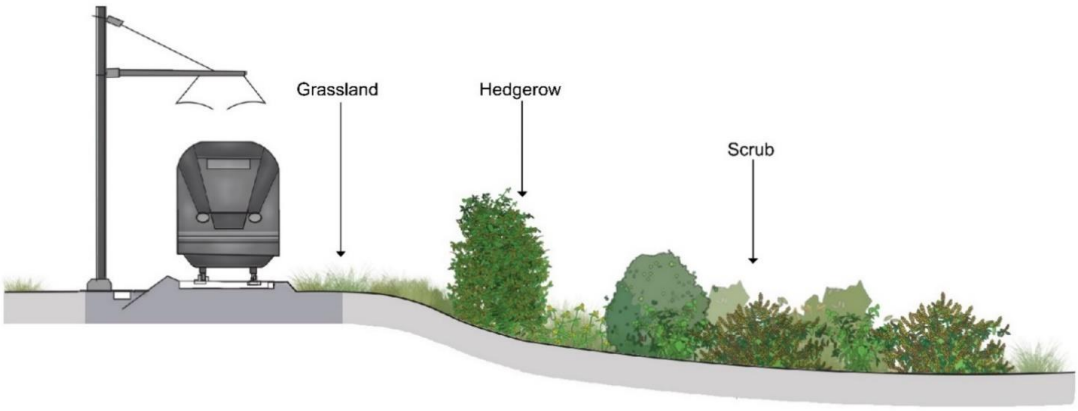


Figure 39 – Example of lineside grassland, scrub and woodland mosaic habitats

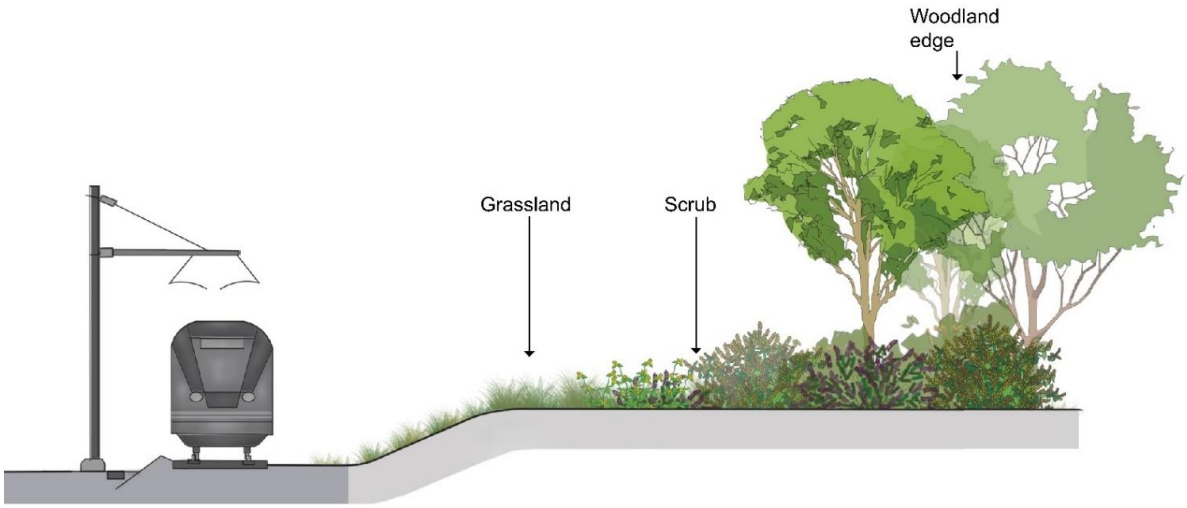


Figure 40 – Example of typical lineside scrub and hedgerows mosaic habitats

NOTE: *Refer to NR_L2_OTK_5201 MOD1 Lineside Vegetation Inspection and Risk before undertaking any fieldwork.*

NOTE: *Refer to NR/LN/ENV/122 MOD 01 Biodiversity Section 3.3 regarding field surveys.*

NOTE: *Refer to NR/L2/ENV/122 MOD 01 and MOD 02 regarding data gathering, the identification of existing habitats and species (e.g. SSSI) or protected species recorded on site.*

9.6.2 Soil analysis

Scrub can be divided into the following three types, defined by geographic location, soil type and its associated properties e.g. bedrock, fertility and nutrient levels. Identifying the scrub type will provide an indication of plant species likely to thrive in a particular location.

- **Lowland dry scrub:** most common in the UK, it occurs on calcareous, neutral and acidic soils;
- **Upland scrub:** occurs above the upper limits of enclosed farmland and in exposed coastal areas of northwest Scotland; and
- **Coastal scrub:** occurs on shingle, sea cliffs, salt marsh and sand dunes.

Before creating scrub the following, more detailed analysis, should be undertaken to confirm appropriate ground preparation and selection of species:

- **Desktop studies:** geospatial data will indicate underlying soil type and bedrock to identify suitable scrub type communities, including pH and fertility;
- **Soil sample:** will accurately determine soil type, pH, soil fertility and nutrient levels to inform the selection of species.

Where there is insufficient depth of topsoil for planting e.g. at locations with chalk bedrock, facilitating natural regeneration should be considered (see Section 9.7.5).

NOTE: *Landis' Soilscapes provides open-source geospatial data which indicate the soil types and bedrock found across the British Isles. This could be used to understand the local soil type.*

NOTE: *The need for soil analysis should be determined by a suitably experienced ecologist, botanist or soil scientist. Various companies offer soil testing and analysis which can be purchased online.*

NOTE: *For guidance on the process of establishing the Preferred Habit Objective refer to the Habitat Design and Management Guidance Note.*

9.6.3 The intrusiveness of scrub

Scrub is an important landscape feature of the countryside. However, when undermanaged, scrub can quickly invade and dominate species rich plant communities such as grassland.

Generally, plants of higher biodiversity value are associated with scrub edges. Areas of mature dense shrub have limited value, often blocking sunlight, using much of the soil moisture and nutrients and therefore limiting the species richness of the ground flora communities. Shrub cover above 50% begins to shade the associated ground flora leading to its eventual loss.

Creation and management of structural and species variety within the scrub edge, as illustrated on Figure 41, can optimise the biodiversity value of scrub.

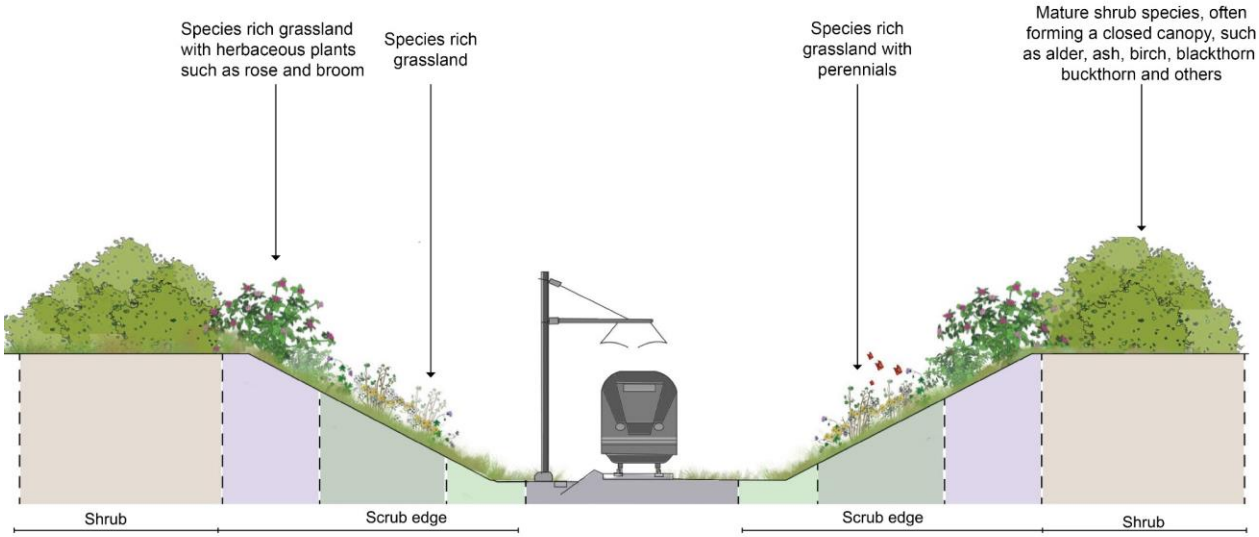


Figure 41 – Design and management of scrub to provide wide scrub edges maximises biodiversity

9.6.4 Species selection

When specifying plant species for scrub habitat it is important use appropriate species suited to the scrub layer that is to be created as illustrated on the Figure 44;

- **Scrub edge:** species rich grassland, species rich grassland with perennials and species rich grassland with herbaceous plants.
- **Shrub:** species to comprise native shrubs with occasional native tree species.

Other considerations when devising a planting specification are:

- Species should be appropriate to soil type, its fertility and pH (see Section 9.6.2);
- Natural regeneration through the exposure of the bare ground, encourages germination from the local seed bank, existing root systems and cut stumps. This may be considered on some sites (see Table 6);
- Many scrub plants e.g. bramble are pioneer species and can colonise open habitats quite rapidly and therefore their inclusion should be carefully considered;
- Shrub and tree species with susceptibility to branch failure or high seasonal leaf fall should be avoided in the Action Zone.

***NOTE*:** *The Action Zone is defined in NR/L2/OTK/5201/02 Lineside Vegetation Management Requirements.*

***NOTE*:** *For the list of species approved by Network Rail refer to the Network Rail document: Recommended planting species, Species Matrix (2015 Tree Council Update).*

***NOTE**: For the selection of grassland shrub and tree species refer to Grassland Design and Management Guidance Note and Woodland Design and Management Guidance Note.*

***NOTE**: Further advice on selecting appropriate shrub species is contained within the following documents:*

- *Tree Species Selection for Green Infrastructure: A Guide for Specifiers (TDAG, 2019);*
- *The Right Trees for Changing Climate Database (Forest Research, 2019);*
- *Urban Tree Manual (Forest Research, 2018); and*

- *Forestry Research Guidance" Raising trees and shrubs from seed" 2007.*

9.6.5 Scrub creation approaches

A combination of seeding and planting is typically used within the lineside to create scrub to reflect the two-layer composition of scrub (scrub edge and shrub). On some sites this approach may not be suitable and therefore natural regeneration (see Section 9.7.5), layering (see Section 9.7.3) and coppicing (see Section 9.9.1.1) may be appropriate.

The benefits and disadvantages of each creation approach are summarised in Table 6. For techniques on creation approaches see Section 9.7.

Table 6 – Benefits and disadvantages of scrub creation approaches

Scrub layer	Method	Benefits	Disadvantages
Scrub edge	**Seeding**		
	• Seeding. • Hydroseeding. • Locally harvested seed.	• Seeding – more predictable results. • Hydroseeding – higher success rate than seeding and suitable for less accessible areas (steep gradient). • Locally harvested seed – reflects local plant species.	• Seeding – requires slopes of suitable gradient, generally slower establishment then hydroseeding. • Hydroseeding – higher cost than seeding, requires more specialist equipment than seeding. • Locally harvested seed – likely to be difficult to source and potentially time consuming to arrange.
Shrub	**Planting**		
	• Notch planting. • Pit planting. • Container planting.	• Instant effect and quicker establishment in comparison to natural regeneration. • Container plants can be planted anytime of the year.	• Notch and Pit planting - limited time of year to plant (November to March). • Container plants - more difficult to handle, time consuming to plant and costly than notch or pit planting will and need intensive aftercare, including watering during establishment.
	Shrub layering		
	• Layering or transplanting shrubs to supplement the expansion of existing scrub.	• Natural expansion of existing scrub.	• Limited to a narrow range of species and suitable for existing scrub. • Faster establishment than natural regeneration.

Scrub layer	Method	Benefits	Disadvantages
Scrub edge and shrubs	**Natural regeneration**		
	• Local exposure of bare ground and monitoring of establishing vegetation.	• Likely to produce a habitat appropriate to local conditions. • Low establishment costs.	• Slow establishment. • On-going management techniques will need to adapt to changes in vegetation to ensure species diversity.

To maximise scrub biodiversity typically only 25% of scrub should consist of shrubs with occasional trees. The remaining area should be scrub edge and should be established by seeding and long-term management.

9.6.6 Shrub specification

The National Plant Specification (NPS) defines criteria for the most commonly specified plant groups. It can provide a useful reference for determining plant sizes, which can inform stocking densities (CSD Hub, 2020). All plants should comply with the with BS 3936: Parts 1 to 10, BS 8545.

Typically in the lineside, bare root transplants are most appropriate when creating a hedgerow as they are cost effective and easily establish with minimal aftercare. There are, however, other forms of hedgerow plants which can be specified (see table 9).

The size and form of shrubs at planting stage varies, typically 1-3ltr container grown stock or 1 year seedlings will be appropriate for scrub creation.

NOTE: *For guidance on specifying and the process of establishing shrubs, refer to Woodland Design and Management Guidance Note.*

NOTE: *The height range of saplings/transplants available will depend on the species and growth habit but is likely to be in the range 40-60cm or 60-80cm.*

9.6.7 Species rich grassland specification

The species rich grassland specification should include a mix of species with botanical and common names and sowing rate to inform seeding density.

The sowing rate of any grassland mix will depend on the species mix selected and is typically defined as kg/ha or g/ha.

NOTE**:** *For guidance on specifying and the process of establishing grassland, refer to Grassland Design and Management Guidance Note.*

NOTE: *The National Plant Specification (NPS) defines criteria for the most commonly specified plant groups. It can provide a useful reference for determining plant sizes, which can inform stocking densities (CSD Hub, 2020).*

9.6.8 Planting density and layout

The density and layout of shrub planting within scrub habitat can vary according to site specific conditions. Generally, irregular, wide spacing is preferred as it encourages natural infill of other plant species and a diverse vegetation structure.

Typically, planting will comprise of transplants in single species groups of 3,5, and 7 planted at 2-2.5m centre spacing. Species groups and spacing will depend on the

size of the site. Increased planting densities can be considered on sites where higher plant failures are expected due to exposure to drought and intense competition of weeds.

Lower densities generally result in slower establishment and areas of open habitat and varying species.

Below is a guide on the quantity of wooded shrub species or trees that are required for different planting densities:

- Planted at 3-metre centres – 1,111 shrub species or trees per hectare.
- Planted at 2.5-metre centres – 1,600 shrub species or trees per hectare.
- Planted at 2-metre centres – 2,500 shrub species or trees per hectare.

9.7 Scrub Creation and Establishment

Heathland & Shrub Classification | Dwarf Shrub Heath Habitat and Design | **Dwarf Shrub Heath Creation and Establishment** | Long-term Management of Dwarf Shrub Heath Habitat | Dwarf Shrub Heath Restoration

This section provides guidance on how to successfully create and establish new scrub habitat in the lineside to maximise the biodiversity and the ecosystem services it supports. This guidance refers to the pioneer and establishment phase of scrub.

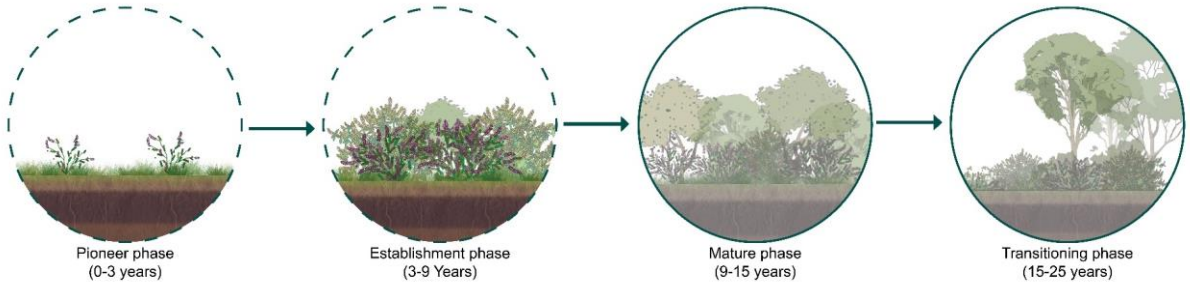


Figure 42 – Scrub development phases: applicable to scrub creation and establishment

Best practice suggests the following principles should be applied:

- Undertake ground preparation where necessary;
- Organise toolbox talks for site staff on maintenance protocols, including recording and reporting on suspected cases of pests and diseases;
- Use the most appropriate scrub creation method according to environmental, site access conditions and to relevant the scrub layer (scrub edge and shrub);
- Implement an appropriate aftercare programme;
- Control expansion of the scrub and emerging weeds;
- Incorporate plant protection measures if necessary to support establishment; and
- Replace plants that are dead or fail to thrive at the end of each growing season up to the end of the five-year aftercare period.

NOTE: *For the selection of scrub management techniques refer to The Scrub Management Handbook: Guidance on the management of scrub on nature conservation sites published by The Forum for the Application of Conservation Techniques.*

NOTE: *For a summary of scrub management refer to RSPB guidance note Scrub Management (creating, restoring and maintaining scrub for wildlife).*

NOTE: *The routine maintenance schedule for scrub, including when to undertake inspections is set out in the schedule folder.*

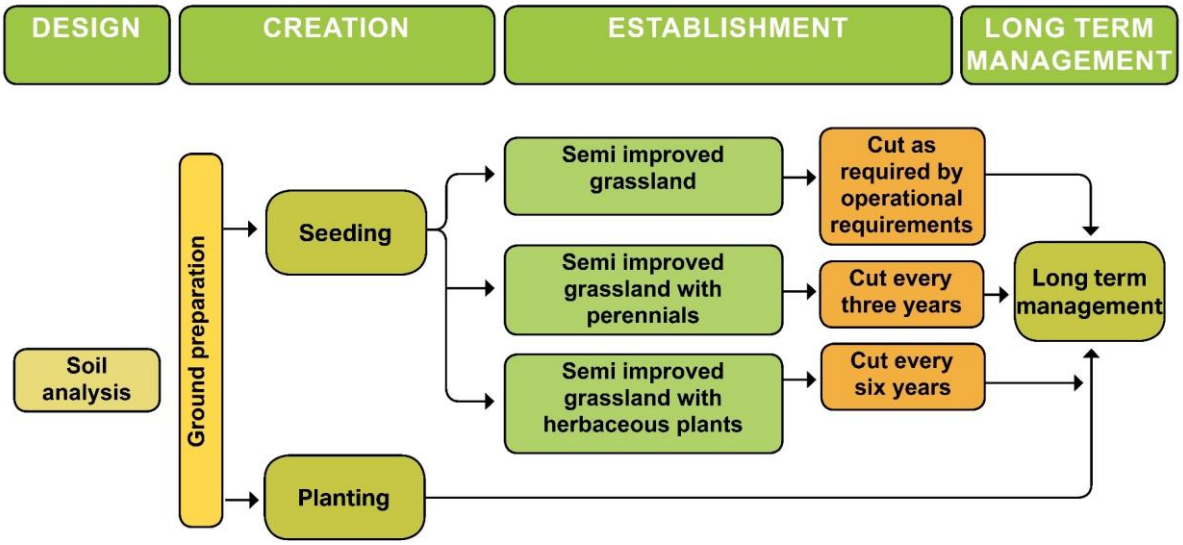


Figure 43 – Scrub creation and establishment process

Figure 43 outlines the process that should be followed when creating scrub habitat and the subsequent actions required to ensure successful establishment. Due to the composition of scrub, some of these actions relate to best practice techniques included in the Grassland and Woodland Habitat Design and Management Guidance Notes.

Methods and considerations relating to ground preparation, implementation, and immediate aftercare are outlined within the following subsections. Long-term management is discussed in Section 9.8.

9.7.1 Ground preparation

Scrub creation typically requires a combination of two different forms of ground preparation:

- For seeding species rich grassland (scrub edge layer); and
- For planting of shrubs (shrub layer).

For details of ground preparation for seeding, refer to Grassland Habitat Design and Management Guidance Note. For ground preparation for shrubs refer to Hedgerow Creation and Establishment (see Section 8.7.1).

9.7.2 Planting – (shrubs)

For best practice principles, techniques and considerations for shrub planting refer to Hedgerow Creation and Establishment (see Section 8.7.2).

9.7.3 Layering – (shrubs)

Layering is a propagation technique that can be applied where minor extensions to the existing areas of scrub are needed. Although limited to certain species that can have stems and or branches bent down to ground level, it may be a cost effective and beneficial approach on some sites.

Layering is undertaken by pegging branches of shrubs or trees into the soil. At the point of contact create a 2.5cm-5cm incision on the underside of the branch approximately 30cm from the tip of the nearest shoot using a knife or billhook. Roots

can form usually after a period of three months. When the strong roots have developed, the layered branch can be severed from the parent plant.

NOTE: *For best practice guidance on layering refer to Royal Horticultural Society (RHS) official website: https://www.rhs.org.uk/advice/profile?pid=358*

NOTE: *For further detail regarding the planting of shrub and tree species refer to Woodland Design and Management Guidance Note.*

NOTE: *BS 8545:2014 Trees: from nursery to independence in the landscape (BSI, 2014) provides recommendations of the planting of trees and shrubs.*

9.7.4 Species rich grassland

Once prepared, the ground is ready to be sown. The following principles apply to seeding of species rich grassland:

- **Timing**: August to September (preferred) or April to May;
- **Method**: Hand sowing (seed mix may sometimes be applied with fine, dry sand to bulk out the mix and make it easier to sow) or hydroseeding (a mixture of water, seed and binding agent sprayed onto the soil). Hydroseeding is preferable on steep slopes or in less accessible areas; and
- **Sowing rate:** Seed should be sown at the appropriate density (in accordance with supplier's recommendation) on or just under 1cm of the soil surface.

Following sowing, the soil should be rolled to press the seeds into the soil. This should be done for hand sown and hydroseeded seed, where possible.

NOTE: *For further detail regarding sowing methods and rates of grassland refer to refer to Grassland Habitat Design and Management Guidance Note.*

9.7.5 Natural regeneration

Natural regeneration is the process of allowing plants to naturally colonise the land. This can occur where there is a ready source of seed, where scrub has previously been cut down to ground level or suckers (new growth on existing plants that develops under the ground from the root or the main stem), from existing scrub. Whilst natural regeneration may be cheaper to implement than other methods of creation, it is likely to take longer for the scrub to establish and reach the mature phase. The results, including species composition, can also be less predictable.

The key considerations for natural regeneration:

- Natural regeneration can be effective when expanding existing scrub;
- Naturally regenerating scrub species can reflect the local flora;
- Limited control over the structure and species diversity of new scrub areas. Without appropriate long-term management, one or two species may dominate.

NOTE: *The routine maintenance schedule for Dense Scrub, including when to undertake inspections is set out in the schedule folder.*

9.7.6 Establishment – years 0-9

Once implemented, immediate aftercare and establishment techniques should be applied to allow a varied structure of the scrub edge and shrub layers of scrub to develop. The following interventions should be considered to assist the successful establishment of the scrub, dependant of the scrub layer.

Scrub edge:

- **Removal of pernicious weeds:** many undesirable ruderal species, such as thistles or docks, are likely to colonise and establish quickly, and if left uncontrolled could dominate the sward.
- **Ongoing management:** An alternating cutting regime should be applied to species rich grassland to encourage a varied scrub edge structure (see Section 9.8.2)

Shrub:

- **Weed control**: either maintain 1m diameter circle clear of weeds around the base of each plant and apply organic mulch or lay mulch mats made from plant by-products to supress weed growth;
- **Plant protection**: check, and if deemed necessary, adjust plant protection (see Section 9.7.7) during establishment at least twice a year;
- **Pruning:** broken or damaged branches should be pruned as soon as possible after each inspection; and
- **Plant replacements:** replace plants that are dead or fail to thrive at the end of each growing season up to the end of the five-year aftercare period.

Young plants may need irrigation in prolonged periods without rainfall to avoid plant failures. Container grown plants are especially susceptible to failure in the early years of establishment as a result of lack of water.

NOTE: *The routine maintenance schedule, including when to undertake inspections is set out in the schedule folder.*

NOTE: *The Forest Research 'Herbicide Advisor' provides a suitability index for each herbicide and further details on crop sensitivity to overall sprays and secondary weed susceptibility.*

NOTE: *For detailed information on grassland aftercare and management, refer to Chapter 11 of Natural England's Grassland Management Handbook (Natural England, 2012b).*

9.7.7 Plant protection

Plant protection should be considered in the context of the selected method of creation. If natural regeneration has been selected, protection from damage by browsing mammals such as deer, rabbits and squirrels is less likely to be required (Forest Research, 2020).

Planted areas can be protected from browsing by the following methods:

- Install individual plant shelters and canes which are plant based and break down naturally over time;
- Inclusion of mulch mats made from plant by-products which help retain soil moisture and protect new plants from weeds;
- Installation of rabbit and deer fencing;
- Installation of exclusion fencing for priority woodland species; or
- Denser planting to deter access.

NOTE: *Where possible, avoid using plastic materials for protection measures. Instead opt for a biodegradable alternative, which break down naturally over time.*

NOTE: *Protection measures for planted areas refer to Section 8.7.4 Plant protection*

NOTE: *Protection measures for seeded areas refer to Grassland Design and Management Guidance Note.*

NOTE: *Further guidance on plant species less susceptible to deer and rabbit browsing can be found at the RHS official website.*

9.7.8 Operational considerations in scrub habitats

Creating scrub in proximity to the railway requires consideration of the key site-specific constraints to operational rail use.

Typical operational considerations for a scrub appraisal may include:

- Flooding or lack of water for irrigation;
- Steepness or stability of embankments and cuttings;
- Likelihood of animal browsing;
- Lineside width and the proximity to the line;
- Protected species or protected habitats or sites;
- High vegetation degradation (leaf fall) areas; and
- Security, e.g. discouraging public access.

NOTE: *Document NR/L3/OTK/6202 guides protecting railway assets.*

9.8 Long-term Management of Dense Scrub Habitat

Heathland & Shrub Classification | Dense Scrub Habitat and Design | Dense Scrub Creation and Establishment | Long-term Management of Dense Scrub Habitat | Dense Scrub Restoration

This section outlines the key considerations for the management of established scrub. It should be read alongside NR/L3/OTK/6202 protecting railway assets during vegetation work.

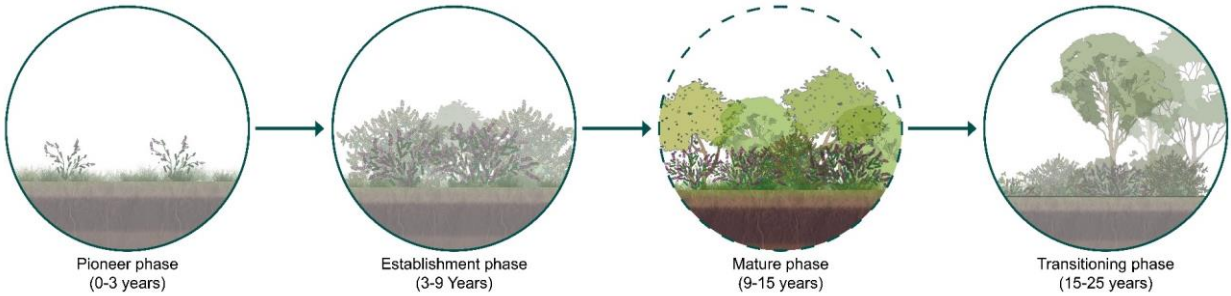


Figure 44 – Scrub development phases: applicable to long-term scrub management

Best practice suggests the following general principles should be applied:

- Implementing a long-term management regime suitable to the development phase of scrub and site-specific constraints or the site;
- Analysing changes in scrub composition and structure to inform future management; and
- Monitoring to ensure the long-term management regime is appropriate.

Good long-term scrub management should:

- Maintain a mosaic of scrub and other habitats;
- Monitor composition of scrub layers and adjust management techniques to maximise structural variety and biodiversity benefit;
- Control expansion of the shrub layer to maintain approximately 25% coverage of the scrub area;
- Remove invasive self-seeded plants including weeds; and
- Increase species diversity and species-richness.

NOTE: *It is important to pro-actively liaise with owners of adjacent land outside of the lineside to ensure habitat enhancement opportunities are maximised and objectives are aligned.*

9.8.1 Long-term management interventions

Once scrub has established, regular long-term management interventions are required. This is important to prevent spread to other areas and reduce the dominance of more aggressive species, which could lower biodiversity. It will allow the scrub to reach and maintain its optimal condition, in accordance with objectives set out in the Habitat Management Plan.

When appropriate management ceases habitat restoration may be required (see Section 8.9).

NOTE: *For guidance on producing a Habitat Management plan refer to the Habitat Design and Management Guidance Note.*

NOTE: *Habitat Management Plans are described in NR/L2/ENV/122 Module 02.*

NOTE: *Anticipated costs of different stages in scrub management are addressed in the cost summary folder.*

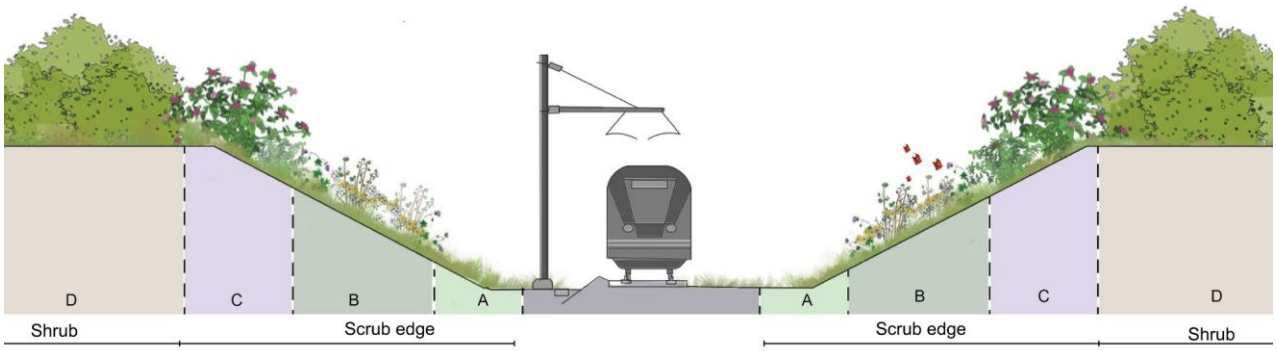
The following two key management techniques can be applied to mature scrub:

- Cutting, followed by removal of cut material or chipping where appropriate (see Section 9.8.2), and;
- Herbicide treatment to control regrowth from cut stumps (see Section 9.8.3)

Cutting may need to be complemented by grubbing up, stump removal or herbicide treatment within areas of mature shrub (see Section 9.9.1). Thinning may require herbicide treatment to stumps and subsequent vegetation that will establish following thinning.

9.8.2 Cutting

Scrub can be managed for biodiversity through a long-term cutting regime. The main purpose of cutting is to create structural diversity and promote species-richness. Figure 45 illustrates the optimal cutting regime for the composition of scrub.



Type of vegetation	Species rich grassland D	Species rich grassland with perennials B	Species rich grassland with herbaceous plants C	Mature shrub D
Cut area	Entire area	Entire area	Half of the area	1/4 of the area
Rotation of cutting	Every year	Every three years	Every six years	Every twelve years

Figure 45 – Long-term management cutting regime of scrub

Other considerations for long-term cutting of scrub are:

- Cutting most species of scrub encourages re-growth, this is useful for maintenance and restoration;
- Cutting small patches approximately 2-5m2 helps diversify scrub structure;
- Cutting can be programmed to take account of site and lineside constraints to create the desired layout;

- Cutting can be used to reduce or eradicate scrub, with the potential need for follow-up treatment that may require repeated cutting, mowing, removal of stumps or herbicide treatment; and
- It is preferable to retain arisings on site if possible. Chipping and spreading of woody arisings to a maximum depth of 75mm and diameter of 1m as a mulch maybe appropriate if vegetation removal is not practical. If arisings include invasive species or the quantity of material cannot be safely accommodated on site, it should be removed to a licensed green waste recycling facility.

NOTE: *For wood chippings arising left on site refer to Lineside vegetation management requirements NR/L2/OTK/5201/02*.

NOTE: *An experienced ecologist or ornithologist should be consulted if it is suspected that birds are nesting within the hedgerow.*

NOTE: *The nesting bird season should be avoided, which is considered to be between February – August although some species breed all year round e.g. wood pigeon or barn owl. Consideration should be given to the potential for nesting birds at a location and checks implemented where appropriate, regardless of the time of year. which is between February and the end of August.*

NOTE: *For details on long-term mowing regimes refer to Grassland Design and Management Guidance Note.*

9.8.3 Herbicide treatment

Where cutting is not viable, herbicide treatment can be considered to control the extent of the scrub or eradicate unwanted species.

Best practice suggests the following general principles in relation to scrub habitats:

- Chemical weed control may be necessary if alternatives (for example hand weeding or mulching) are not viable e.g. when controlling bramble;
- Herbicide can be applied direct to regenerating foliage or onto freshly cut stumps to reduce or eradicate unwanted scrub, and
- Some scrub species and herbicides may require more than one application in a growing season, and some may require follow-up operations the following year to ensure that all regeneration is killed.

9.8.4 Monitoring and Inspections

Scrub should be inspected and surveyed annually by a suitably qualified professional to monitor its success against the specification and objectives set out in the Habitat Management Plan. These surveys could include National Vegetation Community and Biodiversity Net Gain (BNG):

Following inspections and monitoring, changes to the management regime may be recommended to enhance or restore the scrub. Inspections are important to:

- Ensure the management plan objectives are being met;
- Report on plant and seeding failures and inform the replanting process;
- Assess the health of a scrub and identify actions to address biosecurity issues; and
- Report on the condition and effectiveness of plant protection and any remedial action required.

NOTE: *Surveys, ecological monitoring and BNG assessments must be devised and undertaken by an experienced ecologist or botanist.*

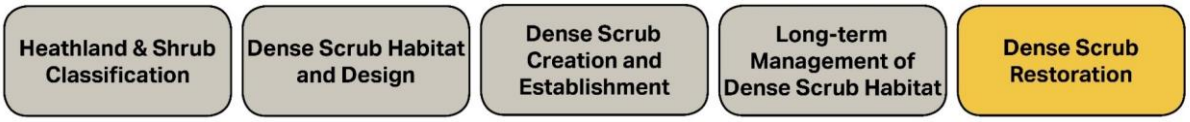
NOTE: *Suitably qualified professionals for undertaking inspections of scrub include Chartered Members of the Landscape Institute or ecologists. Landscape architects can provide assistance with practical issues relating to establishment whereas ecologists can provide detailed technical information.*

The best time to assess scrub health is throughout the summer, ideally before any cutting occurs. Visible causes of ill health in scrub commonly include:

- Disease;
- Plant breakages; and
- Pest Insects.

If symptoms of ill health or pest attack cannot be resolved within a year; consideration should be given to phased removal and replacement with an alternative suitable species.

9.9 Dense Scrub Restoration



This section provides guidance on how to successfully restore scrub in the lineside once it has reached or is starting to transition next successional phase of the development cycle.

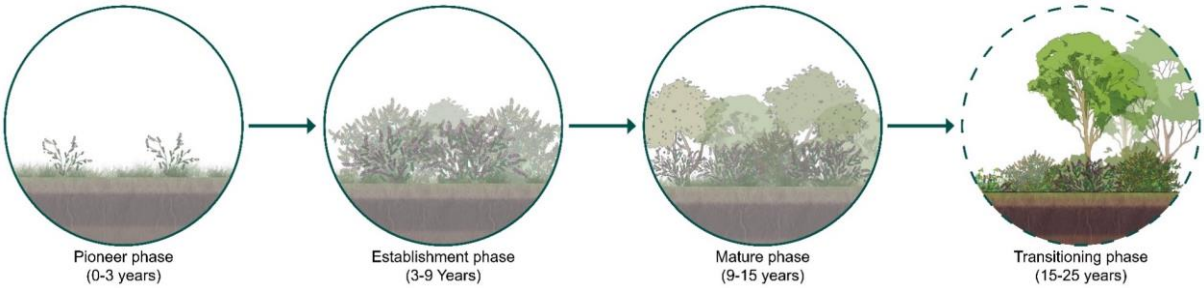


Figure 46 – Scrub development phases: applicable to scrub restoration

Best practice suggests the following general principles should be applied:

- Undertake removal of undesirable species where appropriate;
- Undertake cutting of part or the entire area of closed canopy mature shrub and trees then apply follow up with the application of long-term management techniques;
- Undertake herbicide treatment to eliminate intrusive weeds and other unwanted species;
- Remove arisings following completion of cutting on the site; and
- Implementation of habitat management plan aiming to restore the scrub.

9.9.1 Scrub restoration

Restoration of scrub is a process of managing the recovery of habitat that has been degraded, damaged, destroyed or has naturally transitioned into woodland. The need for restoration arises in situations where scrub habitat has been neglected or damaged through inappropriate management as illustrated in Figure 47. It is important that scrub restoration is only undertaken if 'Restore' is the Preferred Habitat Management Objective.

Restorative management approaches are outlined in the sections below.

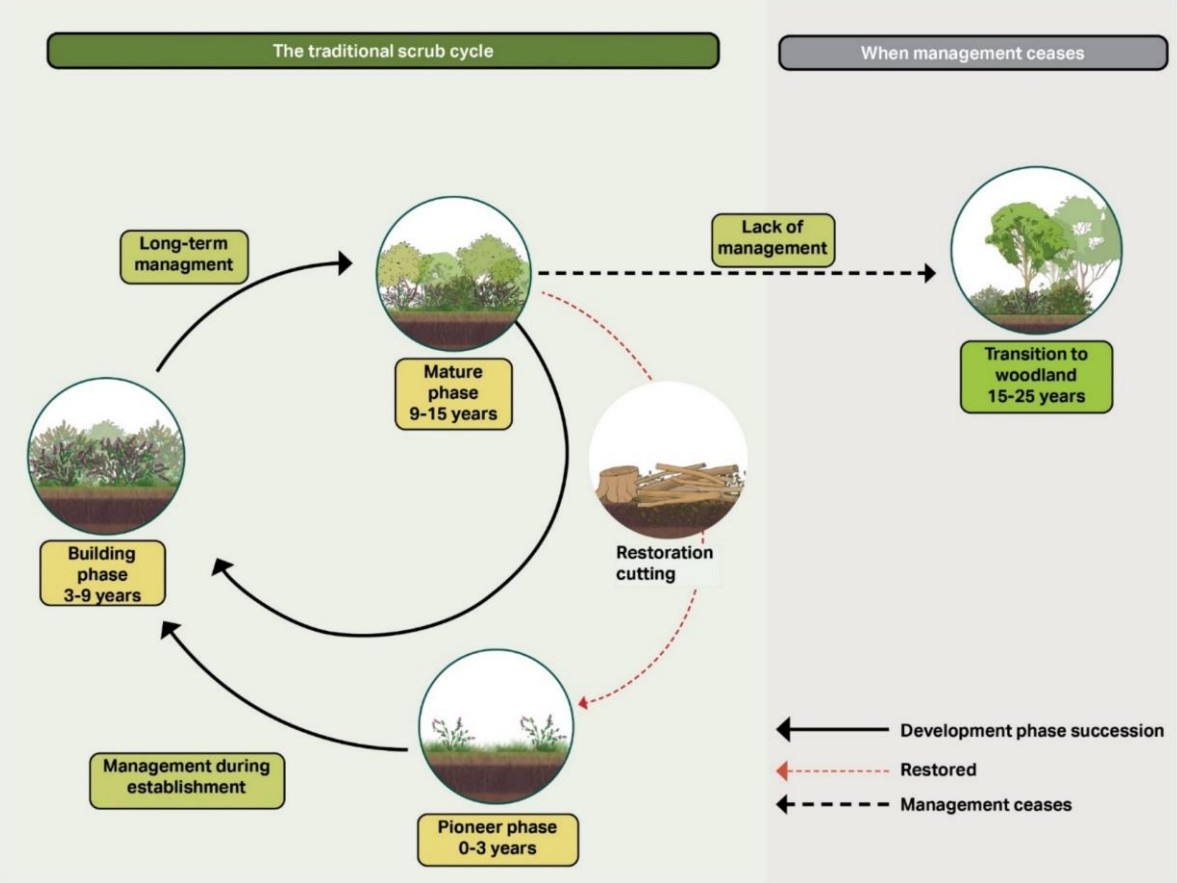


Figure 47 – Scrub development cycle and restoration process

A typical lineside scrub restoration scenario is when the shrub layer of scrub is transitioning into woodland. An indicator of this is when 80%+ of the scrub area comprises of shrub with closed canopy as illustrated in Figure 48.

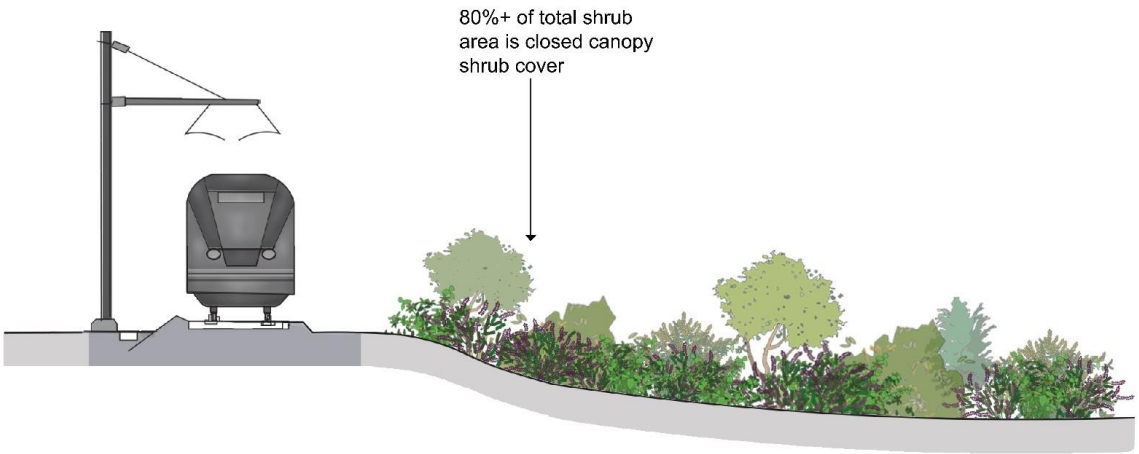


Figure 48 – Sites with shrub coverage of over 80% need restoration

9.9.1.1 Coppicing

Coppicing is a traditionally used to manage woodland and is also suitable for scrub management. Coppicing comprises of rotational cutting of scrub over several years to allow it to regenerate. Key considerations of coppicing are listed below:

- Mature shrubs are cut close to ground level by bow saw, chainsaw or clearing saw;
- Coppicing is likely to result in regrowth from the base of shrubs and trees;
- Coppicing can be used to rejuvenate, diversify and maintain existing scrub area;
- Coppicing is based on cutting defined areas of scrub annually, or periodically; and
- Coppicing carried out sequentially will increase structural and species diversity of scrub.

NOTE: *For guidance on coppicing, refer to the Woodland Design and Management Guidance Note and Section 8.9.1.2 of this document.*

9.9.1.2 Cutting

Cutting is a most common restoration management technique to stop the transition of scrub into woodland. The key considerations of cutting removal are listed below:

- Cutting can be carried out using many types of operation and equipment according to the terrain, type of scrub and its condition;
- Cutting results in regrowth and therefore may require use of other management techniques e.g. herbicide treatment;
- Careful cutting or trimming can maintain vigour and thicken subsequent growth especially along scrub edges leading to increased habitat value; and
- Cutting is also used as a long-term management technique to maintain existing scrub within site parameters.

9.9.1.3 Stump removal

Stump removal can be used to prevent the regeneration of shrubs or to remove obstructions to allow follow-up operations (e.g. mowing) after scrub removal. The key considerations of stump removal are listed below:

- Stump removal is a slow process but may be considered to limit the requirement of repeatedly treating re-growth from stumps;
- Stumps may be important habitat therefore consideration should be given to them before their removal;
- Stump removal is unlikely to be appropriate on sites of archaeological interest;
- Stump removal eliminates the need to return and repeatedly cut re-growth; and
- Rhododendron is a common species of shrub where stump and root removal are required to prevent repeated regrowth.

NOTE: *Network Rail Geotech department should be consulted before stump removal operations are considered to avoid damaging engineering materials within the lineside.*

9.9.1.4 Grubbing out

Removing scrub with mechanical excavators can be quick and cost effective, for large areas of dense scrub. Key considerations of grubbing out are:

- Safe access for use of excavators is required;

- Excavators may not be appropriate where there is a scrub edge that requires conservation and would be more appropriate for manual operations; and
- Scrub clearance using excavators takes a site back to bare ground, leaving the site ready for regeneration of the target habitat.
- After grubbing out the site will likely require remedial works to clear debris and prepare the soil for habitat creation,

NOTE: *Due to the invasive nature of grubbing out another restorative management approach may be considered.*

NOTE: *Network Rail Geotech department should be consulted before grubbing out operations are considered to avoid damaging engineering materials within the lineside.*

9.9.1.5 Herbicide treatment

Herbicide can be used to help eradicate unwanted scrub through application onto freshly cut stumps. Key considerations of herbicide treatment are listed below:

- Certain scrub species and herbicides may require more than one application in a growing season,
- Some herbicides may be used the year after the first application to ensure that all regeneration is killed;
- Mixed scrub may be particularly difficult to eradicate due to varying susceptibility of the shrub species to herbicide;
- Stumps should be treated immediately after cutting as pores are open and herbicides treatment is more effective, and
- Wet and cold weather reduce the effectiveness of herbicides treatment.

9.9.2 Lineside management considerations

Typically in the lineside, large machinery will be required to undertake restoration and to remove vegetation from site. Physical and operational constraints should be considered before undertaking scrub restoration. Use of machinery appropriate to the site's conditions is key in ensuring successful habitat restoration and lineside safety.

10 Sources of further information

10.1 References

10.1.1 Dwarf Shrub Heath

C. H. Gimingham. (1996) *The lowland heathland management booklet*. Hampshire: English Nature. 1-60.

Cranfield Soil and Agrifood University. (2020). *Soilscapes.* Available at: http://www.landis.org.uk/soilscapes/. (Last accessed 18th November 2020).

DEFRA. (2018) *Get consent to convert woodland to open habitats.* Available at: https://www.gov.uk/guidance/get-consent-to-convert-woodland-to-open-habitats#when-you-need-consent. (Last accessed 5th November 2020).

English Nature. (1997) *Fact sheet 2: Heathland creation for wildlife*. London: English Nature. 1-16.

English Nature. (2005) *The importance of livestock browsing for wildlife conservation*. London: English Nature. 1-20.

Exmoor National Park Authority (2020). *The Graze the Moor Project*. Devon: Exmoor National Park Authority. 1-35.

Gov.uk. (2014) *Heather and grass burning: rules and applying for a license*. Available at: https://www.gov.uk/guidance/heather-and-grass-burning-apply-for-a-licence (Last accessed 27th November 2020).

Gov.uk. (2018) *Get consent to convert woodland to open habitats.* Available at: https://www.gov.uk/guidance/get-consent-to-convert-woodland-to-open-habitats#when-you-need-consent (Last accessed 27th November 2020).

Gov.uk. (2020) *Invasive non-native (alien) plant species: rules in England and Wales.* Available at: https://www.gov.uk/guidance/invasive-non-native-alien-plant-species-rules-in-england-and-wales#list-of-invasive-plant-species. (Last accessed 12th November 2020).

Gov.uk (2015, updated 2020) '*FG9* Deer fencing supplement. Available at: https://www.gov.uk/countryside-stewardship-grants/deer-fencing-fg9 (Last accessed 26th May 2020).

Gov.uk (2015, updated 2021) '*FG4: Rabbit fencing supplement*'. Available at: https://www.gov.uk/countryside-stewardship-grants/rabbit-fencing-supplement-fg4 (Last accessed 26th May 2020).

Joint Nature Conservation Committee (2009). *Common Standards Monitoring Guidance for Lowland Heathland*. London: Joint Nature Conservation Committee. 1-48.

Kent Wildlife Trust. (2018) *A brief guide to choosing livestock for conservation browsing. Kent Wildlife Trust Land Management Advice Series.* Available at: https://www.kentwildlifetrust.org.uk/sites/default/files/2018-06/KWT%20Land%20Mgt%20Advice_Sheet%205%20-%20Choosing%20livestock%20for%20conservation%20browsing.pdf. (Last accessed 12th November 2020).

Legislation.gov. (1981) *Wildlife and Countryside Act 1981.* Available at: https://www.legislation.gov.uk/ukpga/1981/69/schedule/9. (Last accessed 12th November 2020).

London Biodiversity Partnership. (2006) Heathland Conservation in London. Available at: https://www.yumpu.com/en/document/read/11783438/best-practice-guidance-for-heathland-managers-london-. (Last accessed 5th November 2020).

Magnificent Meadows. (2020) *Restoring species-rich grassland by natural regeneration and colonisation.* Available at: http://www.magnificentmeadows.org.uk/assets/pdfs/Restoration_using_natural_regeneration.pdf (Last accessed 27th November 2020).

Natural England (2007).*The Heather and Grass Burning Code*. London: DEFRA. 1-5.

Natural England (2008). *Impact of heathland restoration and re-creation techniques on soil characteristics and the historical environment*. Sheffield: Natural England. 1-98.

Natural England. (2016a) *Proceedings of the 11th National Heathland Conference.* Available at: http://publications.naturalengland.org.uk/publication/5304504412012544 (Last accessed 27th November 2020).

Natural England. (2017)*Moorland Management Guiding Principles*. London: Natural England. 1-86.

Nature Scot. (2020) *Muirburn licensing*. Available at: https://www.nature.scot/professional-advice/protected-areas-and-species/licensing/muirburn-licensing (Last accessed 27th November 2020).

Network Rail (2020) Environmental sustainability strategy 2020-2050. Available at: https://www.networkrail.co.uk/wp-content/uploads/2020/09/NR-Environmental-Strategy-FINAL-web.pdf (last accessed 26th May 2021)

Plantlife. (2008) *Threatened Arable Plants: Identification Guide.* Available at: https://www.plantlife.org.uk/application/files/2014/8241/1184/Threatened_Arable_Plants_Guide_2008.pdf (Last accessed 27th November 2020).

Plantlife. (2016) *Rehabilitation of existing priority lowland heathland*. Wiltshire: Plantlife. 1-25.

RSPB. (2008) *Heathland Extent and Potential (HEaP) Maps.* Available at: https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/advice/conservation-land-management-advice/heathland-extent-and-potential-maps/. (Last accessed 5th November 2020).

Save Sandlings Forests campaign. (2012) *Deforestation in England to create heathland: is this what we want, or is there a better way?* Available at: http://saveourwoods.co.uk/get-involved/local-campaigns/deforestation-in-england-to-create-heathland-is-this-what-we-want-or-is-there-a-better-way/. (Last accessed 5th November 2020).

Scotland's Moorland Forum. (2018) *Heather Cutting Guidance*. Lochmaben: Scotland's Moorland Forum. 1-10.

Scottish Natural Heritage (1996).*Information and Advisory Note Number: 58. Cutting of heather as an alternative to muirburn.* Edinburgh: Scottish Natural Heritage. 1-6.

Bargmann. T. (2015). *Life after fire: the impact of fire on species composition and diversity in coastal heathlands*. Bergen: University of Bergen. 1-47.

Angus Rosenburgh (2016) The heather beetle: a review. Available at https://www.researchgate.net/publication/304571759_The_heather_beetle_a_review (Last accessed 26th May 2021).

The Heather Trust. (2020) *Heather and Moorland Managemen* Available at: https://www.heathertrust.co.uk/heather-management. (Last accessed 5th November 2020).

The UK Habitat Classification Working Group (2018).*The UK Habitat Classification, Habitat Definition*. London: The UK Habitat Classification Working Group. 1 - 515.

Welsh Assembly Government (2008) *The Heather and Grass Burning Code for Wales*. Cardiff: Welsh Assembly Government. 1-26.

Wildlife Trust Wales. (2020) *Lowland Heathland.* Available at: https://www.wtwales.org/wildlife/habitats/lowland-heathland. (Last accessed 5th November 2020).

10.1.2 Hedgerow

Buckingham Nurseries. (2020) *Planting a new hedge*. Available at: https://www.hedging.co.uk/acatalog/new_hedges.html#:~:text=To%20prepare%20the%20soil%20for,diameter%20of%20grass%20and%20weeds. (Last accessed 20th November 2020).

Cheviot Trees. (2020) *A guide to Successful Hedge Planting*. Available at: https://cheviot-trees.co.uk/images/A%20Guide%20to%20Successful%20Hedge%20Planting.pdf. (Last accessed 20th November 2020).

Cornwall.gov.uk. (2020) *Field hedge management.* Available at: https://www.cornwall.gov.uk/environment-and-planning/trees-hedges-and-woodland/hedges/field-hedge-management/. (Last accessed 20th November 2020).

Cranfield Soil and Agrifood University. (2020). *Soilscapes.* Available at: http://www.landis.org.uk/soilscapes/. (Last accessed 18th November 2020).

CSD Hub. (2020) CS Design Software: National Plant Specification. Available at: https://www.csdhub.com/national-plant-specification/what-is-the-nps/.

DEFRA. (1997) *The Hedgerows Regulations 1997: A guide to the law and good practice.* Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/438652/hedgerow__guide_part_1.pdf. (Last accessed 20th November 2020).

DEFRA. (2007) *Hedgerow Survey Handbook: A standard procedure for local surveys in the UK*. Available at:

http://www.hedgelink.org.uk/cms/cms_content/files/89_hedgerow-survey-handbook.pdf. (Last accessed 20th November 2020).

Raveendra Kumar Rai,Vijay P. and Singh,Alka Upadhyay (2017) *Planning and Evaluation of Irrigation Projects (chapter 17 soil Analysis)* (Copyright © 2017 Elsevier Inc. All rights reserved.) Available at: https://www.sciencedirect.com/science/article/pii/B9780128117484000170 (Last accessed 27th May 2021).

Gov.uk. (2014) *Stop invasive non-native plants from spreading.* Available at: https://www.gov.uk/guidance/prevent-the-spread-of-harmful-invasive-and-non-native-plants (Last accessed 27th November 2020).

Gov.uk. (2014) *Countryside hedgerows: protection and management.* Available at: https://www.gov.uk/guidance/countryside-hedgerows-regulation-and-management. (Last accessed 20th November 2020).

Gov.uk. (2020) *Invasive non-native (alien) plant species: rules in England and Wales.* Available at: https://www.gov.uk/guidance/invasive-non-native-alien-plant-species-rules-in-england-and-wales#list-of-invasive-plant-species. (Last accessed 12th November 2020).

Hedgelink. (2020a) *About hedgerows: hedgerow components.* Available at: http://www.hedgelink.org.uk/index.php?page=22. (Last accessed 20th November 2020).

Hedgelink. (2020b) *The complete hedge good management guide.* Available at: http://www.hedgelink.org.uk/cms/cms_content/files/30_complete_good_hedge_management_guide_leaflet.pdf. (Last accessed 20th November 2020).

Hedgelink. (2020c) *About hedgerows: importance of hedgerows.* Available at: http://hedgelink.org.uk/index.php?page=17. (Last accessed 20th November 2020).

Hedges Blog. (2019) *Popular pests and diseases to look out for.* Available at: http://www.hedgesblog.co.uk/popular-pests-and-diseases-to-look-out-for#.X6PrBWj7Q2x. (Last accessed 20th November 2020).

Hedge Nursery. (2020) *Planting guide for bare root plants.* Available at: https://www.hedgenursery.co.uk/advice/hedge-planting-advice/planting-guide-for-bare-root-plants#:~:text=It%20is%20unlikely%20that%20100,soil%20type%20and%20weather%20conditions. (Last accessed 20th November 2020).

Legislation.gov. (1981) *Wildlife and Countryside Act 1981.* Available at: https://www.legislation.gov.uk/ukpga/1981/69/schedule/9. (Last accessed 12th November 2020).

Legislation.gov.uk. (1997) *The Hedgerow Regulations 1997.* Available at: https://www.legislation.gov.uk/uksi/1997/1160/contents/made (Last accessed 20th November 2020).

National Hedgelaying Society. (2020) Regional styles. Available at: https://www.hedgelaying.org.uk/pg/info/styles.aspx (Last accessed 27th November 2020).

RHS. (2020a) *Hedges: planting.* Available at: https://www.rhs.org.uk/advice/profile?pid=377. (Last accessed 20th November 2020).

RHS. (2020b) *Hedges: selection.* Available at: https://www.rhs.org.uk/advice/profile?pid=351. (Last accessed 20th November 2020).

RHS. (2020c) *Windbreaks and shelterbelts.* Available at: https://www.rhs.org.uk/advice/profile?pid=624. (Last accessed 20th November 2020).

RSPB. (2020) *Farming for wildlife: Hedgerow management.* Available at: http://ww2.rspb.org.uk/Images/Englishhedgerows1_tcm9-133255.pdf. (Last accessed 20th November 2020).

TCV. (2020) *Wildlife hedgerow.* Available at: https://treegrowing.tcv.org.uk/grow/planting/hedge#:~:text=Alder%20(Alnus%20glutinosa)-,Planting,in%20one%20or%20two%20years. (Last accessed 20th November 2020).

The Guild of Cornish Hedgers. (2019) *Code of practice for Cornish hedges*. Available at: http://www.cornishhedges.co.uk/PDF/code-cor.pdf (Last accessed 27th November 2020).

The UK Habitat Classification Working Group (2018). *The UK Habitat Classification, Habitat Definition*. London: The UK Habitat Classification Working Group. 1 - 515.

10.1.3 Dense Scrub

BTO. (2020) *Managing scrub for nightingales*. Available at: https://www.bto.org/our-science/publications/conservation-advice-notes/managing-scrub-nightingales. (Last accessed 20th November 2020).

Forest Research. (2007) *Raising trees and shrubs from seed*. Available at: https://www.forestresearch.gov.uk/research/raising-trees-and-shrubs-from-seed/ (Last accessed 20th November 2020).

Kent Wildlife Trust. (2020) *Scrub, its vale for wildlife and how to manage it*. Available at: https://www.kentwildlifetrust.org.uk/sites/default/files/2018-06/KWT%20Land%20Mgt%20Advice_Sheet%207%20-%20Scrub%20-value%20for%20wildlife%26mgt.pdf. (Last accessed 20th November 2020).

London Assembly. (2012) *On the right lines? Vegetation management on London's Railway Embankments*. Available at: https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Embankments%20Final%20Report%20AB%20190112.pdf. (Last accessed 20th November 2020).

Natural England. (2006) *The Scrub Management Handbook: Guidance on the management of scrub on nature conservation sites*. Available at: http://publications.naturalengland.org.uk/publication/72031. (Last accessed 20th November 2020).

Natural England. (2019) *The effects of trees and scrub on ecosystem services and biodiversity in the UK uplands: a scoping review*. Available at:

http://publications.naturalengland.org.uk/publication/6474135515693056. (Last accessed 20th November 2020).

RSPB. (2020) *Scrub*. Available at: https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/farming/advice/managing-habitats/scrub/. (Last accessed 20th November 2020).

Suffolk Wildlife Trust. (2020) *Grassland and scrub.* Available at: https://www.suffolkwildlifetrust.org/conservationadvice/meadows-and-grassland/grassland-and-scrub. (Last accessed 20th November 2020).

Woodland Trust. (2016) *Keeping rivers cool: shade for climate change adaption*. Available a: https://www.woodlandtrust.org.uk/publications/2016/02/keeping-rivers-cool/. (Last accessed 20th November 2020).

10.2 Figure references

Figure 3 –Typical heathland and shrub habitat found adjacent to the railway

Railway north-west from Great Ayton Station © Trevor Littlewood, 2017 (CC BY-SA 2.0) https://www.geograph.org.uk/photo/5610433

10.2.1 Dwarf Shrub Heath

Figure 12 – Example of INNS

Ibsley Common, south of Mockbeggar, New Forest © Jim Champion, 2007 (CC BY-SA 2.0) https://www.geograph.org.uk/photo/315168

Gaultheria shallon in PAN Botanical Garden in Warsaw © Krzysztof Ziarnek, Kenraiz, 2016 (CC-BY-SA-4.0)
https://commons.wikimedia.org/wiki/File:Gaultheria_shallon_kz1.jpg

Japanese rose © Robin Webster, 2019 (CC BY-SA 2.0).
https://www.geograph.ie/photo/6253701

False-acacia (Robinia pseudoacacia)
Robinia pseudoacacia 001 © H. Zell, 2009 (CC-BY-SA-3.0)
https://commons.wikimedia.org/wiki/File:Robinia_pseudoacacia_001.JPG

Figure 13 – Example of heather beetle and damage caused to heathland

Lochmaea sp.© S.Rae, 2016 (CC-BY-2.0)
https://commons.wikimedia.org/wiki/File:Lochmaea_sp._-_caprae_or_suturalis_-_Flickr_-_S._Rae_(1).jpg

Brown heather on Brown Clee Hill © Philip Halling, 2019 (CC-BY-2.0)
https://www.geograph.org.uk/photo/6278103

Figure 21 – Images detailing typical ill health symptoms in heathland

Brown heather on Brown Clee Hill © Philip Halling, 2019 (CC-BY-2.0)
https://www.geograph.org.uk/photo/6278103

10.2.2 Hedgerow

Figure 23 – Example of disease and INNS

Powdery mildew © Evelyn Simak, 2017 (CC-BY-SA 2.0).
https://www.geograph.org.uk/photo/5521062

Three-cornered garlic © Anne Burgess, 2020 (CC-BY-SA 2.0).
https://www.geograph.org.uk/photo/6495146

Figure 28 – Examples of weed species that should be removed

Convolvulus arvensis © MurielBendel, 2015 (CC BY-SA 4.0).
https://commons.wikimedia.org/wiki/File:Convolvulus_arvensis_flowers.JPG

Rubus spp. © Jonathan Billinger, 2007 (CC BY-SA 2.0).
https://commons.wikimedia.org/wiki/File:Bramble_patch_by_a_redundant_byway_-_geograph.org.uk_-_513866.jpg

Tamus communis © Andy Potter, 2006 (CC BY-SA 2.0)
https://www.geograph.org.uk/photo/258749

Bryonia dioica © Evelyn Simak, 2017 (CC BY-SA 2.0)
https://www.geograph.org.uk/photo/5438420

Figure 30 – Example of a hedgerow disease and pests

Bracket fungus © Richard Dorrell 2010,(CC BY-SA 2.0)
https://www.geograph.org.uk/reuse.php?id=2032880

Vine weevil © M J Richardson 2020, (CC BY-SA 2.0)
https://www.geograph.org.uk/photo/6481892

Aphids May 2010 © Alvesgaspar (CC-BY-SA-3.0)
https://commons.wikimedia.org/wiki/File:Aphids_May_2010-2.jpg

Figure 33 – Example of hedgerows that is restored using gapping up

Gappy hedgerow © James Dee.

Gapped up hedgerow © James Dee

Figure 34 – Overgrown hedgerow requiring coppicing and gapping up

Hedgerow requiring coppicing and gapping up © James Dee

Figure 35 – Laid hedgerow

Laid hedgerow © James Dee.

10.2.3 Dense Scrub

Figure 37 – Example of INNS

Japanese Knotweed, Radipole Lake Nature Reserve, Weymouth © Brian Robert Marshall, 2010 (CC BY 2.0) Japanese Knotweed, Radipole Lake Nature... © Brian Robert Marshall cc-by-sa/2.0 :: Geograph Britain and Ireland

Giant hogweed © Scottish Invasive Species Initiative, 2018 (CC BY 2.0).

https://www.flickr.com/photos/sisi-project/48917447233/in/photolist-2hwEGND-2hwJyqT-2hwHxcX-2hwEHtX-2jvx9wm-2hwJtN6-2hwHskx-2hwHrFX-AYACoK-286Aeg2-6oMjTF-6oMjux-6oRtWE-6wW7zH-fHZaXB-6wW2aZ-TmKNK7-RJAia6-fHZ8dt-2fv1wPg-qyXSHT-fJgFiu-6wW6bK-6x1aCu-6wW4Mp-24TrDjP-csDYH1-5qWcYo-5qWdpA-asB1pv-89ms73-2h6tjJ9-2e77v1e-fHZ9LH-fsMDPx-2ep3h61-TmKGvy-24TrUpZ-fa6mtj-fa6kQw-daYB3Q-6wqJBX-2jf9jUn-2jh3dLS-5o7oQc-daYzQx-ft31FU-ft31q9-fa6m9S-6wuR1m

Rhododendron ponticum in Spring Wood © Alan Murray-Rust, 2017 (CC BY-SA 2.0).

https://www.geograph.org.uk/photo/5533528

11 Appendix 1 Hedgerow species included in the Network Rail Species Matrix Document

Species line in the document include:

- Dogwood (*Cornus* spp);
- Hazel (*Corylus avellana*)
- Midland thorn (*Crataegus laevigata*);
- Common hawthorn (*Crataegus monogyna);*
- Alder buckthorn (*Frangula alnus*);
- Sea buckthorn (*Hippophae* spp.);
- Blackthorn (*Prunus spinosa*);
- Buckthorn (*Rhamnus* spp.);
- Field rose (*Rosa arvensis*);
- Dog rose (*Rosa canina*);
- Elder (*Sambucus nigra*.);
- Wayfaring tree (*Viburnum lantana*); and
- Guelder rose (*Viburnum opulus*).

Species identified as suitable for hedgerows more than 10 m from the line in the document include:

- Hornbeam (*Carpinus* spp.);
- Beech (*Fagus* spp.);
- Holly (*Ilex* spp.);
- Yew (*Taxus baccata*); and
- Wych elm (*Ulmus glabra*).