OFFICIAL

Railway Sustainability Design Guide

Grassland Design and Management Guidance Note

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

OFFICIAL

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/OTK/6202	Protecting railway assets during vegetation work
	Habitat Design and Management Guidance Note

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

OFFICIAL

Contents

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

OFFICIAL

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

OFFICIAL

1 Purpose

The lineside includes a range of grassland habitat types. Effective grassland 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 grassland habitat design and management for Central, Regional, and Route management teams showcasing what good grassland habitat and biodiversity management looks like;

b) Why grassland 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 grassland and lineside constraints;

d) Benefits of the application of this guidance note. including enhanced biodiversity of the lineside, increased stakeholder confidence and improved performance relating to national biodiversity goals and the resilience of lineside grassland; and

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

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

OFFICIAL

2 Scope

This guidance note applies to Network Rail, their supply chain and third parties working on Network Rail owned land. It shows how grassland within the lineside can be created and 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.*

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

OFFICIAL

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 Metric 2.0	Provides a way of measuring and accounting for biodiversity losses and gains resulting from development or land management change.
Biodiversity Net Gain	An approach to development that leaves biodiversity in a better state that before.
Biodiversity Value	The value of a habitat to plants, animals and fungi. The greater number of species a habitat supports, the greater its biodiversity value.
Biosecurity	Procedures or measures designed to protect a population against harmful biological or biochemical substances.
Browsing and grazing	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 regeneration of plants on previously unwooded sites.
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.
Green Infrastructure	A network of multi-functional green space, urban and rural, which is capable of delivering a wide range of

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

OFFICIAL

Term	Definition
	environmental and quality of life benefits for local communities
Green hay	Harvested grasses and wildflowers that are taken from species-rich donor sites and spread on a recipient site that is species-poor.
Habitat condition	The ecological condition of a particular habitat parcel. Condition relates to the standard of a habitat parcel relative to other parcels of that particular habitat type. Habitat condition relates to Natural England's Biodiversity Metric 2.0's habitat condition scores which range from 'Poor' to 'Good' (Natural England 2019a and 2019b). Grassland 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 value	A habitat's value is its relative importance in sustaining socially or ecologically significant wildlife populations and biological diversity.
Habitat mosaics	An area comprised of multiple habitat types.
Hemi-parasite	A parasitic plant which can partially survive by photosynthesizing.
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.
Lineside	The extensive area of land that falls within the ownership boundary.
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.
Overstocking	When there are too many animals in one grazing space.
Plant litter	Dead plant material that has fallen to the ground.

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

NetworkRail

OFFICIAL

Term	Definition
Poaching	Occurs when livestock have stood or walked on grassland during wet conditions for a prolonged period.
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: Transform, Conserve, Restore and Enhance. This is in relation to the Habitat Management Plans (NR/L2/ENV/122 Module 2) only.
Priority habitat	Habitats principal importance listed under Section 41 of the Natural Environment and Rural Communities Act (2006).
Protected species	Species of plants and animals afforded some level of legal protection within the UK. This includes European Protected Species listed under the Conservation of Habitats and Species Regulations 2020.
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.
Soil microbes	Microorganisms that live in the soil e.g. fungi, bacteria, algae and protozoa.
Species-rich	A habitat that is comprised of many different plant species.
SSSI	Site of Special Scientific Interest.
Stepping stones	Patches or islands of semi natural habitat which provide passage the semi natural habitat within the wider landscape for wildlife.

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

OFFICIAL

Term	Definition
Sward	An expanse of short grass.
Unimproved grassland	Usually species-rich grassland that if unfertile and has not been ploughed, fertilised or reseeded in recent years.
Urban setting	Belonging to/relating to a town or city.

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

OFFICIAL

4 Introduction

This document provides guidance on the following:

1. Grassland classification – how to classify grassland into one of three grassland sub-types to help understand the existing grassland and apply relevant best practice grassland establishment and management guidance;
2. Grassland habitat and design – guidance and key considerations for the design of grassland within the lineside estate; this includes suitable site selection, soil analysis and seed specification;
3. Grassland creation and establishment – guidance and key considerations on how to successfully create and establish new grassland in the lineside to maximise its biodiversity and the ecosystem services it supports;
4. Long-term management of grassland habitat – guidance, key considerations and best practice management techniques to enhance established grassland; and
5. Grassland restoration – guidance on restoring grassland which has transitioned to a higher successional vegetation community (e.g. to dense scrub).

Figure 1 – Grassland design and management guidance process

Case studies are included in section 7 to illustrate examples of best practice in the delivery of preferred habitat objectives.

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

OFFICIAL

4.1 Document structure

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

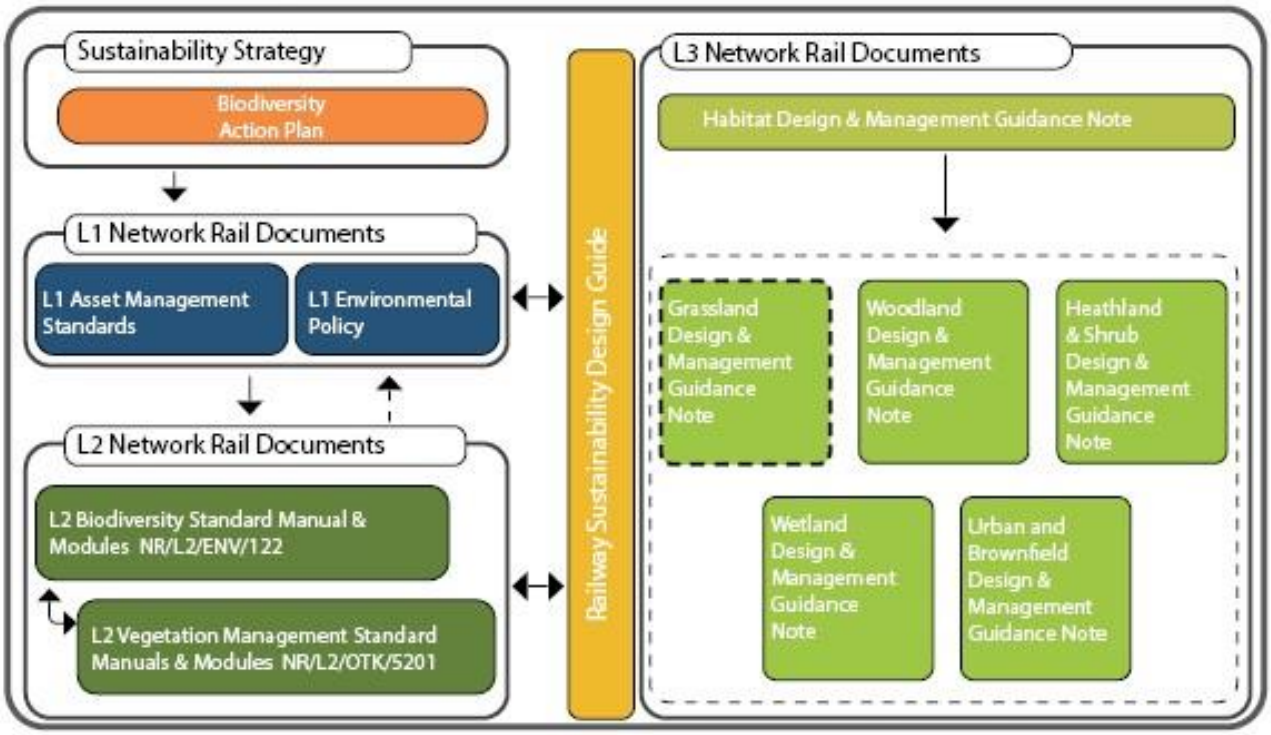


Figure 2 – Document hierarchy

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

OFFICIAL

5 Grassland 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 Grassland (UK Habitat classification code - G)

5.2.1 Definition

Vegetation not on permanently waterlogged soils, with more than 75% cover of herbaceous species (grasses, sedges, rushes and wildflowers). Grassland covers 40% of the UK and grow on soils where scrub and trees are absent or infrequent e.g. on embankments and cutting slopes, pasture, along field margins and woodland edges.

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

OFFICIAL

Figure 3 – Typical grassland found adjacent to the railway

5.2.2 Attributes

The following list of attributes are typical of grasslands:

- Habitat dominated by grasses and other herbaceous plants e.g. wildflowers.
- A well-managed grassland should typically have few trees and no more than 10-25% scrub coverage.
- Typically managed through mowing or grazing.
- Species composition can differ depending on underlying soil type, e.g. chalk, neutral or acid and soil fertility.
- Fertility and nutrient levels within the soil determine whether a grassland can be species-rich. Where fertility and nutrient levels are low, species-rich grassland may thrive (see Section 6.4.2).

Figure 4 – Examples of typical lineside grassland communities

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

OFFICIAL

5.2.3 Classifying grassland habitats

The type of grassland and the species it supports is mostly defined by the soil and underlying geology. Understanding the soil type and geology of a site is essential, as it indicates what type of grassland may be created. Whilst this leads to varying design approaches for acid, neutral and calcareous grasslands, approaches to establishment, restoration and long-term management are the same regardless of grassland type.

Grassland identification is not a simple process and cannot always be accurately determined by the species present. Expertise should be sought from a professional ecologist.

The following information can be used to help further classify grassland habitat into sub-types (UK Habitat Classification, 2018):

G1: Acid Grassland (Level 3)

- Grasses and herbs on a range of lime-deficient soils;
- Derived from acidic bedrock or from superficial deposits such as sands and gravels; and
- Soils usually have a pH of less than 5.5.

G2: Calcareous grassland (Level 3)

- Grasses and herbs on shallow, well-drained soils which are rich in bases (principally calcium carbonate i.e. limestone);
- Formed by the weathering of chalk and other types of limestone or base-rich rock; and
- Soils usually have a pH of above 6.5, however, calcareous grassland communities can occur on soils with a pH as low as 5.

G3: Neutral grassland (Level 3)

- Grasses and herbs on a range of neutral soils;
- Includes enclosed dry hay meadows and pastures, together with a range of grassland which are periodically inundated with water or are permanently moist; and
- Soils usually have a pH of between 5 and 5.5, however neutral grassland communities can occur on soils with a pH as high as 6.

G4: Modified grassland (Level 3)

- Dominant fast-growing grasses on fertile, neutral soils;
- Frequently characterised by an abundance of Perennial rye grass (*Lolium perenne*) and White clover (*Trifolium repens*); and

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

OFFICIAL

- Generally, species poor with less than nine species per m^2.

It is important to check whether existing grassland is a priority habitat, is present within a designated site or supports protected species, as this is likely to have a strong influence on the management objective. This should be recorded as part of the habitat study.

Figure 5 provides guidance on how to determine the key differences between grassland habitat types. The species depicted are examples only and may not be representative of all grassland communities. The pH outlined for each grassland habitat is typical only; in reality, some overlap of preferred pH can occur between grassland communities.

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 Natural England refer to Natural England guidance and the Habitat Design and Management Guidance Note.*

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

OFFICIAL

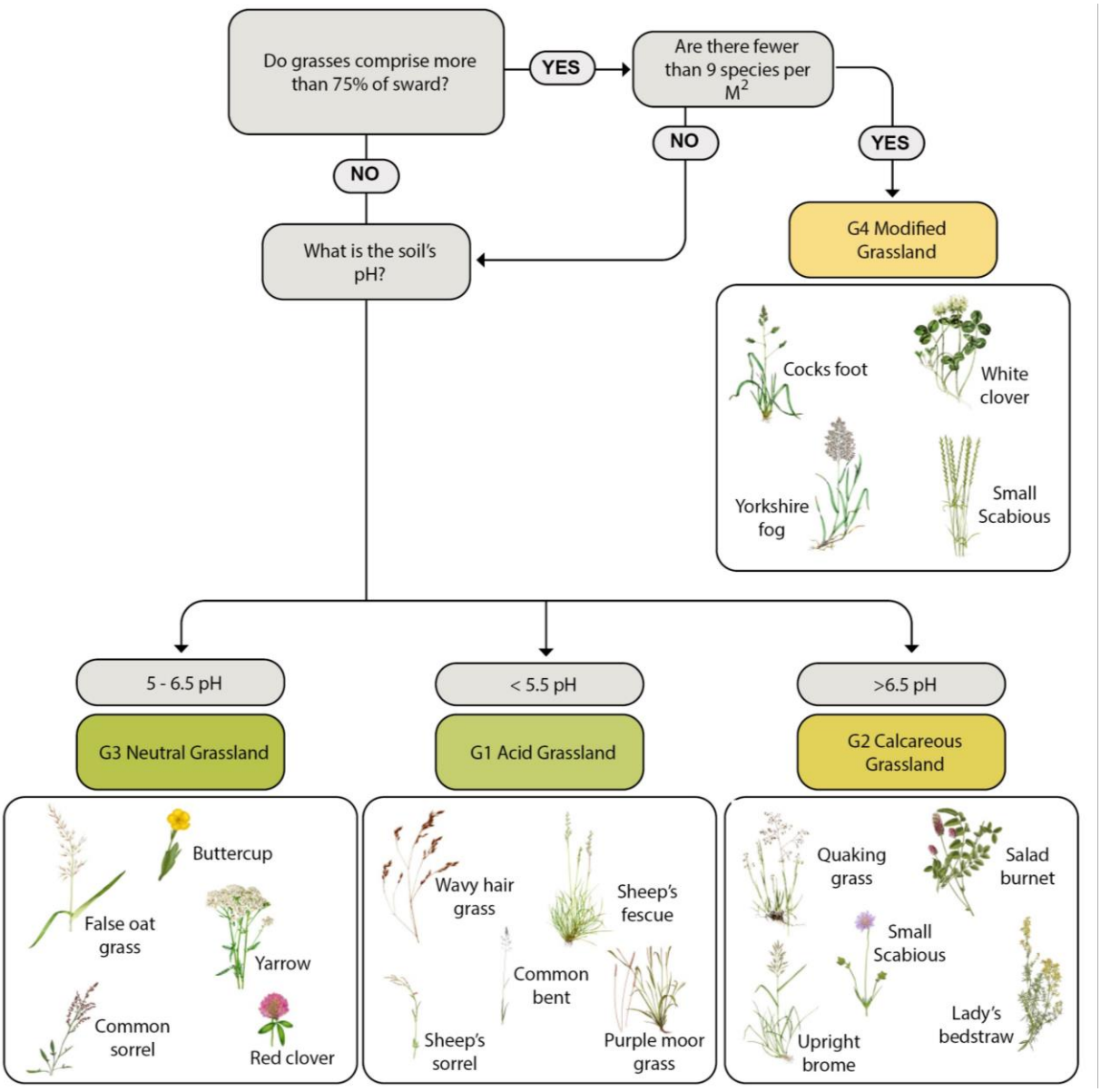


Figure 5 – Visual aid to assist in determining grassland habitat types

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

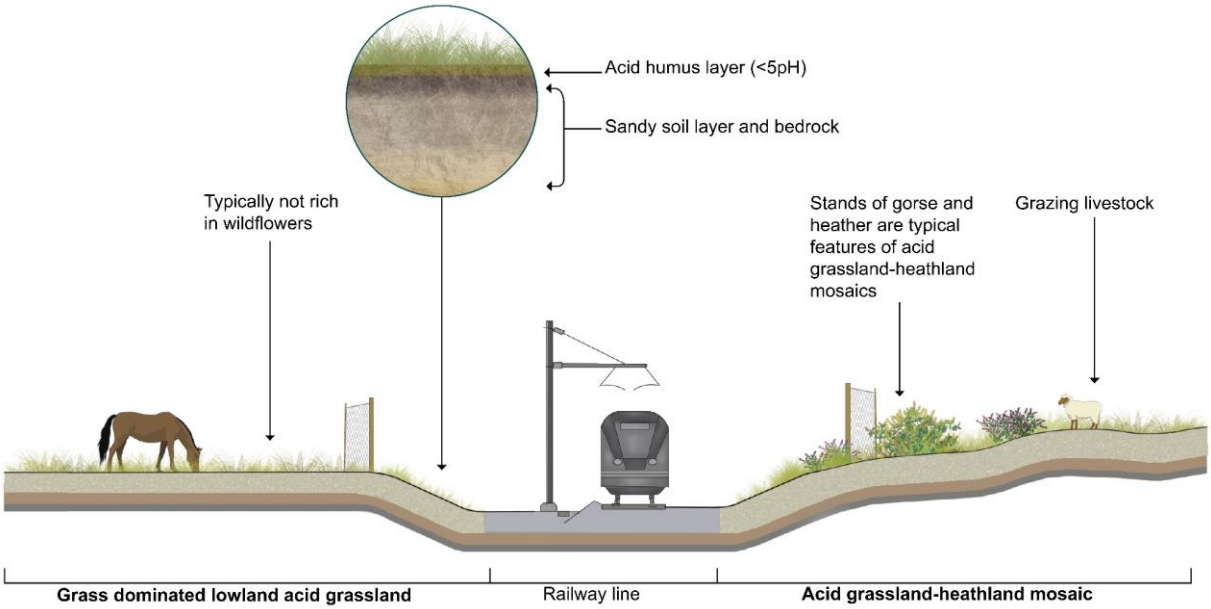
OFFICIAL

5.3 G1 Acid grassland

5.3.1 Attributes:

The following list of attributes are typical of acid grasslands:

- Examples of common species include sheep's fescue (*Festuca ovina*), common bent (*Agrostis capillaris*), bristle bent (*Agrostis curtisii*), wavy hair-grass (*Deschampsia flexuosa*), red sorrel (*Rumex acetosella*), and heath bedstraw (*Galium saxatile*).
- Often found in mosaics with deciduous scrub and heathland communities, such as heather. Over time, acid grassland is susceptible to encroachment by scrub and tree species. Rare grassland plants include heath lobelia (*Lobelia urens*) and pale dog-violet (*Erigonum dasyanthemum*).
- Species-richness is variable but is usually poor compared to calcareous and neutral grassland. Acid grassland species-richness will range from 5 to over 25 species per m^2 (Maddock, 2008).
- Widespread throughout the uplands of England, Scotland and Wales, where it is typically found in conjunction with moorland. Whilst rarer, lowland concentrations occur in, but are not limited to, the Brecklands of Suffolk, the Sandlings in Dorset, the New Forest, the Weald, Dungeness, the south-west coast of England, Shropshire and Powys.
- Traditional management techniques include livestock grazing, burning, sporadic cultivation, ploughing, disturbance.
- If grazed, it is typically stocked with horses, sheep or cattle.



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

OFFICIAL

Figure 6 – Example of typical lineside acid grassland habitat

5.4 G2 Calcareous grassland

5.4.1 Attributes:

The following list of attributes are typical of calcareous grasslands:

- Examples of common species include: sheep's fescue, carline thistle (*Carlina vulgaris*), meadow oat-grass (*Avenula pratensis*), erect brome (*Bromus erectus*), mouse-ear hawkweed (*Hieracium pilosella*), blue moor grass (*Sesleria caerulea*), wild thyme (*Thymus praecox*) and common bent.
- Scrub is often present and includes species such as guelder rose (*Viburnum opulus*), dogwood (*Cornus sanguinea*), hawthorn (*Crataegus spp.*), blackthorn (*Prunus spinosa*) and juniper (*Juniperus communis*).
- Well managed calcareous grassland is typically species-rich in grasses and herbaceous wildflowers. Calcareous grassland species-richness ranges from 9 to over 40 species per m^2 (Forest Research, 2014).
- Calcareous grassland is found on chalk or limestone soils and bedrock. Whilst a relatively rare habitat, calcareous grassland is concentrated in areas where these soils are present.
- A large proportion of chalk grassland is found between Southern England up to the Yorkshire Wolds. Limestone grassland is more widespread, found along the southern and western coast of England, the Mendips and Cotswolds, and up to County Durham (The Wildlife Trust, 2020).
- Traditional management techniques include livestock grazing or cutting.
- If grazed, it is typically stocked with sheep or cattle.

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

OFFICIAL

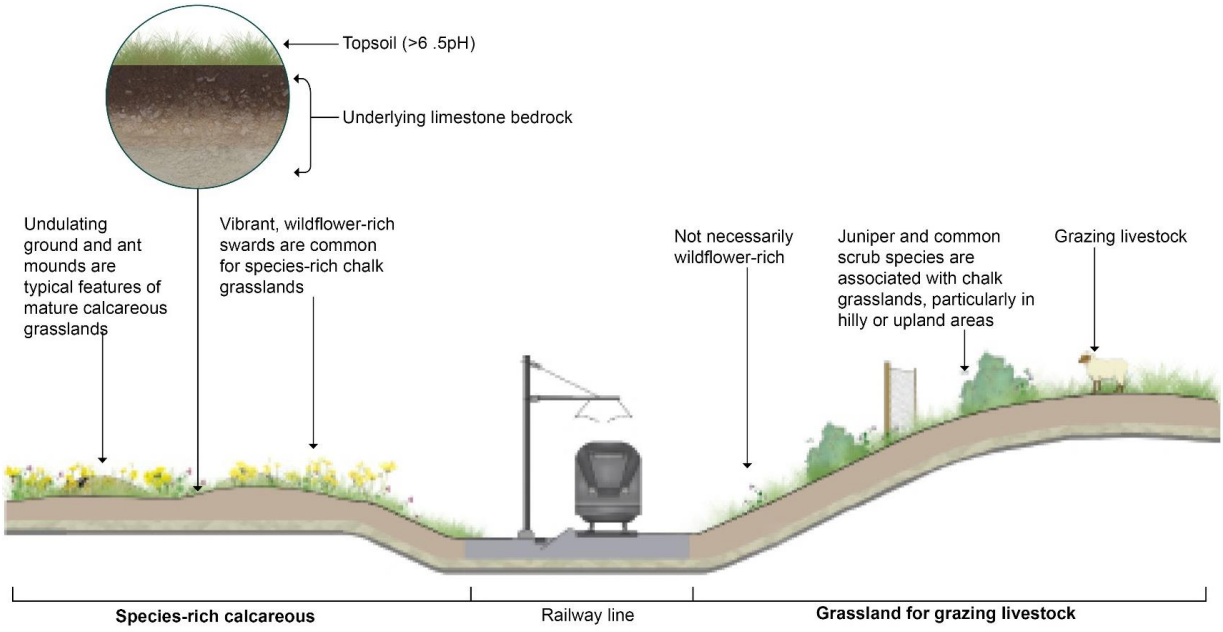


Figure 7 – Example of typical lineside calcareous grassland habitat

5.5 G3 Neutral grassland

5.5.1 Attributes:

The following list of attributes are typical of neutral grasslands:

- Examples of common species include: false oat-grass (*Arrhenatherum elatius*), common knapweed (*Centaurea nigra*), meadowsweet (*Filipendula ulmaria*), red fescue (*Festuca rubra*), crested dog's tail (*Cynosurus cristatus*), cock's-foot (*Dactylis glomerata*), wood cranesbill (*Geranium sylvaticum*), meadow foxtail (Alopecurus pratensis) and marsh marigold (*Caltha palustris*).
- Neutral grassland is more abundant than other grassland habitats.
- Widespread throughout the UK. Suitable soil conditions occur widely over level and slightly undulating ground throughout the British lowlands. 20th century agricultural improvement has meant that unimproved semi-natural neutral grassland is now very scarce.
- Whilst neutral grassland can be species-rich, richness is largely dictated by the fertility and nutrient levels of the soil and surrounding land.
- Range from species-poor to species-rich. Neutral grassland species-richness ranges from 9 to over 40 species per m^2 (Gibson, 1998).
- Traditional management techniques include livestock grazing or cutting.

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

OFFICIAL

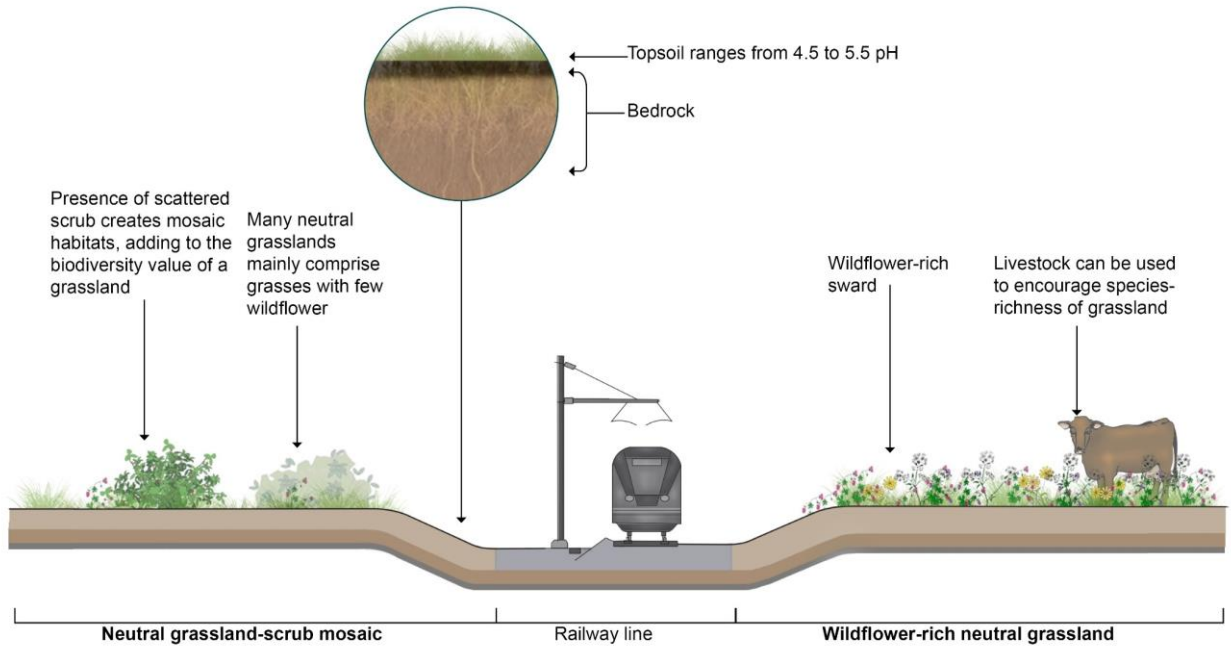


Figure 8 – Example of typical lineside neutral grassland habitat

5.6 G4 Modified grassland

5.6.1 Attributes:

The following list of attributes are typical of modified grasslands:

- Typically dominated by a few species, most notably perennial rye grass (*Lolium perenne*) and white clover (*Trifolium repens*) due to soil enrichment through use of chemical fertilisers and livestock dung.
- Examples of common grasses palatable to livestock include: rye grass (*Lolium spp.*), timothy-grass (*Phleum pratense*), cock's-foot, crested dog's-tail and Yorkshire fog (*Holcus lanatus*). Examples of herbaceous species include white clover, creeping buttercup (*Ranunculus reopens*), greater plantain (*Plantago major*) and dandelion (*Taraxacum officinale*).
- Species poor. Typically, less than 9 species per m^2.
- Widespread throughout the UK.
- Modified grassland provides habitat and food for grazing livestock e.g. cattle, sheep and horses.
- Typically, a product of pasture or by-product of arable land. However, in the context of the lineside is most likely to be encountered where grassland is kept

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

OFFICIAL

very short for amenity, visibility or safety purposes. Also, likely to be found on the lineside adjacent to arable fields where fertilisers are frequently used.

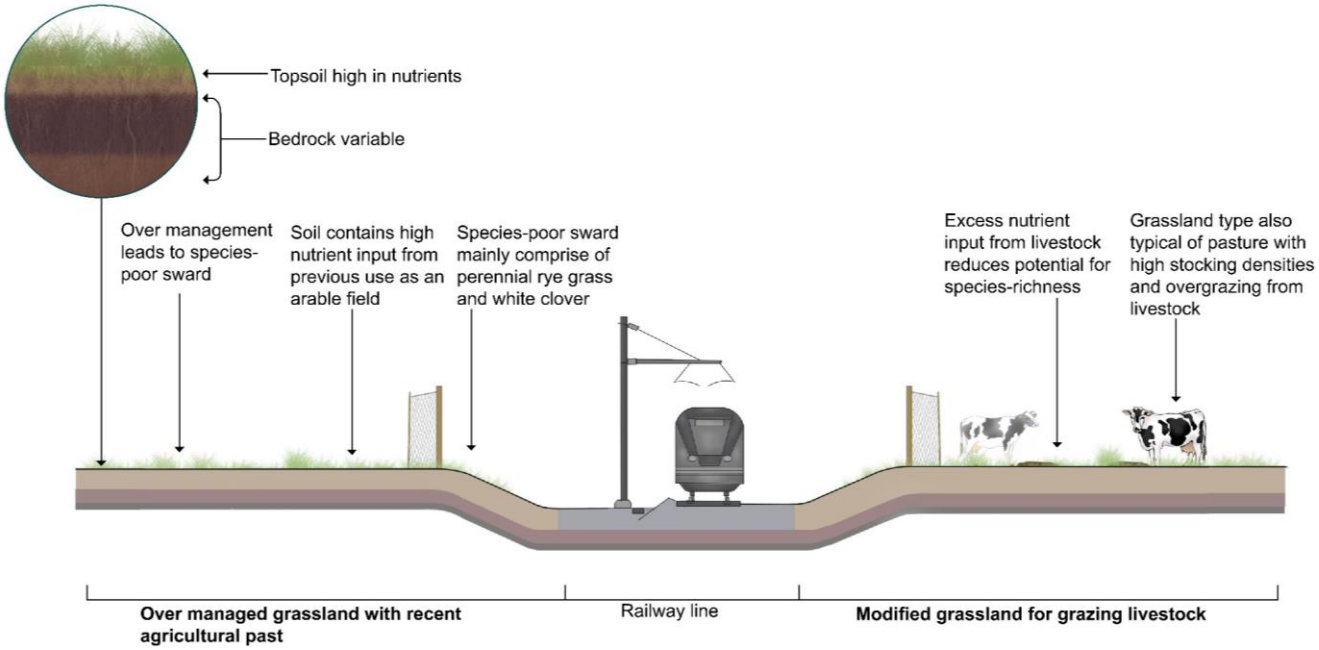


Figure 9 – Example of typical lineside modified grassland habitat

5.7 Grassland development cycle

Figure 10 illustrates the development cycle of grassland which applies to all grassland habitat types. 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 grassland, refer to section 6.4 Grassland Habitat and Design.

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

OFFICIAL

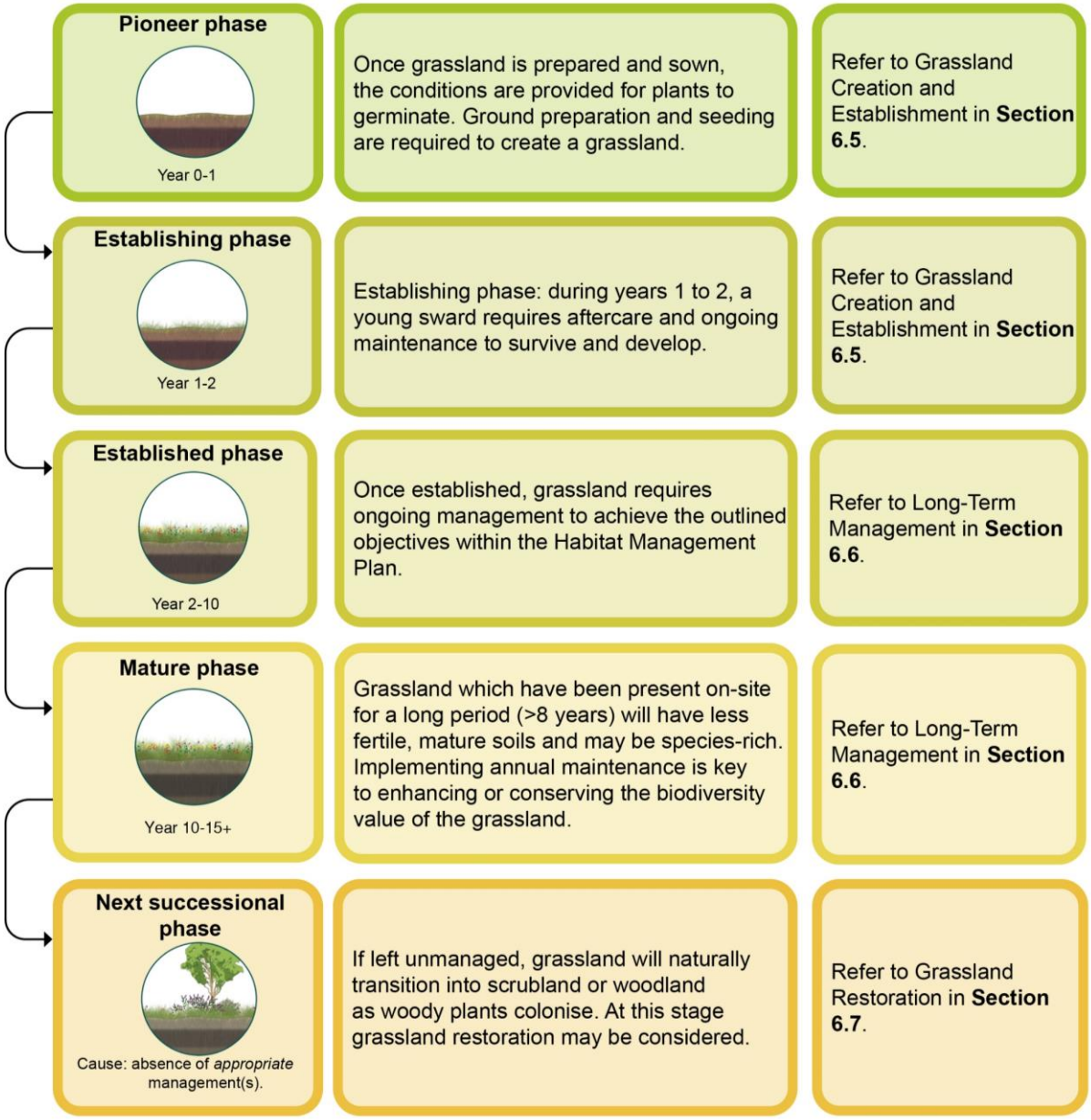


Figure 10 – Phases of grassland development cycle: applicable to all grassland habitat types

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

The remaining parts of section 5 include key considerations pertinent to grassland habitat design for all phases of grassland development.

5.8 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.

OFFICIAL

5.8.1 Designated sites

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

Grassland situated within Special Protection Areas (SPA), Special Areas of Conservation (SAC) and designated Ramsar Sites may also need assessment under the Conservation of Habitats and Species Regulations 2020 before proceeding with works.

5.8.2 Protected species

Many species are protected under UK and European law. Protected animals most associated with grassland include large blue butterflies, reptiles, badgers, great crested newt, and ground nesting birds, such as skylark. Other species indirectly impacted include foraging animals such as wild birds (and their nests and eggs) and bats. Protected plants most associated with grassland include early gentian (*Gentianella anglica*) (Gov.uk, 2015).

5.8.3 Protected species licenses

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 may include consulting the following relevant government bodies prior to the implementation of grassland 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

5.8.4 Other consents

Several types of acid, calcareous and neutral grassland are recognised as habitats of principal importance under Section 41 of the NERC Act (2006), referred to in the Post-2010 Biodiversity Framework. Classifying grassland habitats to Level 4 of the UK Habitat Classification will indicate whether a habitat is classed as a priority habitat.

Where present within the lineside estate, management of these grassland should be prioritised. This is to ensure that management of priority grassland is programmed early due to the appropriate season for management being relatively short. Prioritisation is discussed in greater detail in Section 6.6.1.2.

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

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

OFFICIAL

5.9 Biosecurity

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

5.9.1 Invasive non-native species

Whilst grasslands are typically resilient habitats, those associated with lineside habitat are more likely to be colonised by INNS due to transport corridors transmitting seed and the general greater level of disturbance that occurs. Several INNS listed on Schedule 9 of the Wildlife and Countryside Act (1981) can colonise grassland habitat. Under this Act it is illegal to plant or otherwise cause to grow any plant species listed in the wild. Examples of these are provided in Figure 11. 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.

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

OFFICIAL

Japanese rose
(Rosa rugosa)

Giant hogweed
(Heracleum mantegazzianum)

Monbretia
(Crocosmis x crocosmiiflora)

Giant rhubarb
(Gunnera tinctoria)

Three cornered garlic
(Allium triquetrum)

Variegated yellow archangel
(Lamiastrum galeobdolon subsp. argentatum)

Figure 11 – 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.*

5.9.2 Pests and disease

Whilst pests and disease can impact all habitat types, grassland are generally more robust to attacks. Species-rich grassland is typically more resilient than species-poor grassland, such as modified grassland. As species-poor swards comprise fewer species, pests and diseases may impact the entire sward.

Pests and diseases can affect grassland establishment, yield and longevity. Common pests associated with grassland include frit fly, leatherjackets, chafer, ticks, slugs, and sitona. Pests may also carry diseases that are harmful to humans and can kill plants by eating their roots and stems. Fungal disease can also occur with symptoms such as discoloration of stems (Farming Connect, 2013).

OFFICIAL

Frit fly

Leatherjackets

Grass rust

Figure 12 – Example of pests and disease

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

- referring to the UK Plant Health Information Portal for government guidance on the requirements for plant passports, quarantining affected planting stock, removing diseased areas of grassland and reporting on suspected pest and disease attacks when considering grassland creation or supplementing grassland with new plants (Defra, 2020);
- using locally harvested seed where possible or locally prevalent species (Natural England, 2007);
- If seed cannot be sourced locally, it should be sourced from plants grown within the UK; and
- Establishing biosecurity protocols on site, for example regular cleaning of equipment with disinfectant.

NOTE: *For more guidance on species selection refer to section 6.*4.3.

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.*

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

OFFICIAL

6 Grassland Design and Management

6.1 Introduction

This section provides guidance on:

- General considerations related to the design and management of grassland;
- The design of new grassland habitat;
- Maintenance required to establish new grassland habitat; and
- Restoration of degraded grassland 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 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.*

6.2 Habitat management plans

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

According to the Habitat Design and Management Guidance Note, Habitat Management Plans should incorporate Short to Long-term objectives. Objective periods for grassland differ in relation to other habitats, due to a differing development cycle (see Section 5.7). Objective periods for grassland are likely to be as follows. This is consistent for all grassland habitats.

- *Short-term* (year 0 to 5);
- *Medium-term* (year 6 to 15); and
- *Long-term* (year 15+).

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 6.6.3.).*

6.3 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 on whether grassland is the preferred habitat for the site and how grassland is designed or managed.

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

OFFICIAL

- **Pollination**: supports a wide range of pollinating insects, offering refuge and food resources that can help boost the population of native pollinator species which are essential for wild plant pollination and arable crop pollination.
- **Biodiversity**: supports a wide range of species which provide further ecosystem services such as pollination;
- **Habitat connectivity:** networks of habitat enhance permeability of the landscape for species, greater genetic viability and increased resilience;
- **Water regulation**: can reduce the rate at which water meets waterbodies and watercourses; reducing the occurrence of flash flooding downstream;
- **Carbon sequestration:** carbon sequestration of grassland provide benefits including improved health and protection against climate change;
- **Soil recovery:** associated preservation and renewal of soils provide benefits including a reduction in C02 released from soil, desiccation prevention and recovery of agriculturally important fungal and bacterial soil communities;
- **Health and wellbeing:** access to semi-natural habitats provides physical and mental health/wellbeing benefits to people;
- **Forage production**: crops grown to be eaten by grazing livestock or harvested; and
- **Landscape integration**: 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.*

6.3.1 Lineside design considerations

In addition to ecosystem services, there are other lineside specific design risks and benefits which will help to inform whether grassland is an appropriate habitat within a specific location (Table 2 and Table 3). In some cases, there may be conflict between different objectives, for example reducing fire risk by increasing cutting frequency may reduce biodiversity. The design should therefore provide detail on how competing objectives could be managed, for example, by minimising the areas where grass is cut shorter.

Table 2 – Key considerations for grassland in a railway setting: lineside risks

Design consideration	Key grassland design considerations	Associated grassland management approaches
Fire risk	• Grassland in the urban lineside, in particular, can be a 'high risk habitat' due to increased occurrences of arson.	• Consider location and the associated fire risk in the design phase. To prevent potential for wildfires from drought, cut earlier in the season. This should be

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

OFFICIAL

Design consideration	Key grassland design considerations	Associated grassland management approaches
	• During summer droughts, grassland can dry out and can become prone to wildfires, for example caused by discarded shards of glass or fire spreading from neighbouring land.	prioritised for lineside grassland connected to public spaces where barbeques, bonfires etc may take place. • Consider creating fire breaks by keeping strips of grassland cut to ground level to prevent spread of wildfires. Note that this is likely to conflict with the biodiversity objectives for the site.
Access routes for establishment, maintenance and monitoring	• Grassland may need to be accessed via routes on third party land for creation and maintenance. • Public Rights of Way can improve access and community engagement, where they do not increase safety risks. • Cutting grassland on uneven terrain or where access restrictions are in place may be challenging. • Removing arisings once cut may also be difficult. • Consider if the objective can be achieved if the preferred frequency of management cannot be carried out.	• Whilst Network Rail may have rights to undertake works, it is important to consider local stakeholder engagement when accessing third party land to maintain reputation. In such cases, permissions should be sought prior to grassland creation or maintenance. Refer to the Stakeholder Engagement Guidance Note. • Refer to the Habitat Design and Management Guidance Note, section 6.3.4. • Grassland arisings should be appropriately disposed of once removed, e.g. identify a local green waste recycling centre (if no invasive species material is present in the remnants).
Creation and maintenance of grassland on steep slopes	• Method of management should be determined where grassland is to be created or maintained where slope angles restrict traditional cutting methods.	• Use of innovative or non-traditional cutting methods should be considered (see Section 6.4.1.1 and 6.6.1.1).
Causing spread of invasive species	• Invasive non-native species and some competitive species can present a risk to operation, the welfare of livestock (e.g. ragwort), or biodiversity. • Managing a site can aid the spread of such species if present within the sward.	• Invasive non-native and competitive plant species should be eradicated from site before habitat management commences. • Consider best practice guidance for eradication of the species in question (see Section 5.9.1 and 6.6.1.3).

Table 3 – Key considerations for grassland in a railway setting: lineside benefits

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

OFFICIAL

Design consideration	Key grassland design considerations	Associated grassland management approaches
Landscape setting	• In some locations, grassland can add to the landscape setting and character. For example, within the South Downs National Park, calcareous grassland would be in character with the landscape setting.	• Check the local landscape character to see if grassland is an important feature. • Ensure grassland design is appropriate to the landscape character.
Creation and maintenance of grassland on steep slopes	• Sowing and establishing grassland on steep embankments and cuttings may be favourable due to constraints and issues with other habitats. However, health and safety may be an issue.	• Grassland is an acceptable habitat for such scenarios; however, it is likely to be patchy and species should be selected which can be easily and efficiently managed, limiting the amount of time required for contractors to undertake habitat management.

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

OFFICIAL

6.4 Grassland Habitat and Design

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

Good grassland design should seek to achieve the following:

- Resilient and diverse species mix appropriate to the soil conditions at the site that enhances the biodiversity value of the habitat i.e. provides the conditions for a greater range of plants, animals and fungi inhabit the grassland;
- Appropriate specification for preparation and management to ensure grassland establishment;
- Cost effective management where works are planned and combined to minimise costs associated with site access and operational restrictions;
- Connections to adjacent grassland habitat to create grassland corridors and stepping stones, or in conjunction with wetlands, shrublands and woodlands to create habitat mosaics; and
- Maintain the safety and performance of the lineside.

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

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

NOTE: *Seek advice from an experienced specialist (e.g. ecologist) where designated sites, protected habitats or species are known to be present on site. Refer to Section 5 to classify grassland habitats and Section 6.4.2 to determine the need for soil tests.*

NOTE: *If grassland creation is being considered within an urban setting, refer to the Urban and Brownfield Design and Management Guidance Note for guidance on design and implementation for urban grassland.*

6.4.1 Site selection and operational considerations

The suitability of a site for grassland habitat 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 that a site is suitable for grassland creation:

OFFICIAL

- **Potential for enhancing habitat connectivity:** whether creating grassland results in an enhanced network of semi-natural habitats. This should be determined during baseline studies;
- **Prevalence of grassland locally:** nearby grassland of the appropriate type with plant species that will naturally colonise the lineside. This should be determined through baseline studies;
- **Presence of protected or notable species:** presence of such species may indicate whether grassland creation is suitable or not. For example, lineside grasslands are likely to be favourable for reptiles. However, grasslands may also encourage species such as barn owl (*Tyto alba*) to forage near to the line, increasing risk of death.
- **Cost effectiveness:** of grassland creation and implementing management (see cost summary folder);
- **Absence of INNS:** is the land free of INNS (see Section 5.9.1)?;
- **Safe access:** can the site be easily and safely accessed for staff and plant? and
- **Physical environmental conditions:** appropriate geology, soil composition (see Section 6.4.2) and terrain (see Section 6.4.1.1);

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.*

6.4.1.1 Physical environmental considerations

The success of grassland creation is likely to be influenced by depth and quality of soil and terrain. Types of grassland that can be created or established across different terrains are outlined in Table 4 and illustrated in Figure 13.

Table 4 – Grassland creation considerations across different lineside terrain

Terrain	Considerations
Flat ground	• Flat ground can support species-rich grassland with high biodiversity value, providing that soil fertility is low, and is managed appropriately. • Flat ground allows for ease of management.
Steeper slopes	• Terrain steeper than 1:3 is generally difficult for machinery to traverse. • In uplands or on steep terrain, where arable land is less frequently encountered, soil fertility is likely to be lower. • Species-rich grassland is possible, but management may be difficult. • Alternative methods of management may need to be considered if grassland creation is to be successful (see Section 6.6.1.1).

OFFICIAL

	• Upland areas may support unique grassland communities and grassland-scrub mosaics e.g. acid grassland – upland heathland.
Steep, narrow, unfertile ground	• Typical of lineside cuttings, which support a limited range of vegetation. • Likely sparsely vegetated and will not resemble a stereotypical grassland. • Lineside cuttings may expose the underlying sub-soil or bedrock, resulting in a nutrient poor habitat which can support a diverse array of grassland species. • Alternative methods of management may need to be considered if grassland creation is to be successful e.g. using robot mowers (see Section 6.5.1.2).

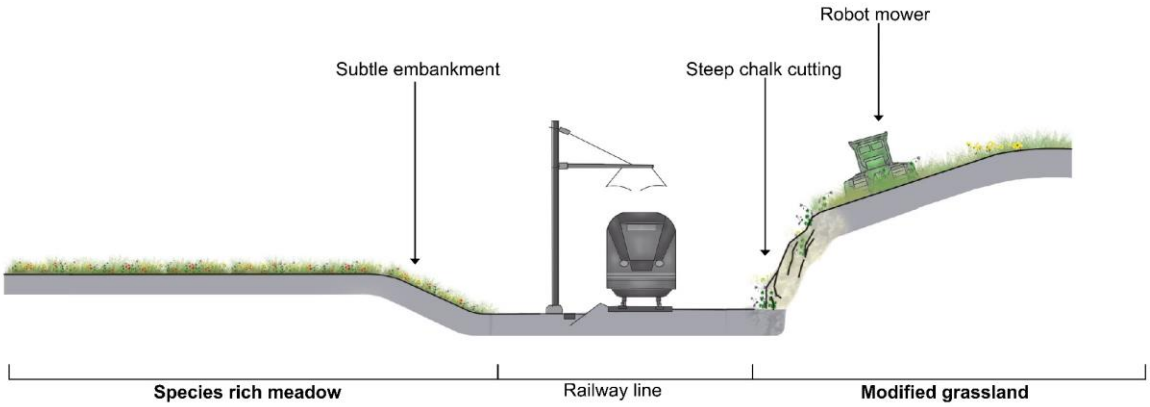


Figure 13 – Examples of grassland found across differing terrains within the lineside

NOTE: *Refer to the Preferred Habitat Objectives and decision process outlined within the Habitat Design and Management Guidance Note to determine whether it is appropriate to create grassland on a site.*

6.4.1.2 Operational considerations for grassland habitats

Creating or enhancing grassland in close proximity to the railway requires consideration of the key site-specific constraints to operational rail use.

Typical operational considerations for grassland may include:

- Flooding;
- Steepness or stability of embankments and cuttings;
- Suitability for animal grazing;
- Lineside width and the proximity to the line;
- Protected species or protected habitats and sites;
- Abundance of competitive or dominant scrub (e.g. bramble) on adjacent land; and

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

- Security, e.g. discouraging public access.

NOTE: *Refer to NR/L3/OTK/6202 Protecting Railway Assets During Vegetation Work for guidance on protecting railway assets.*

6.4.2 Soil

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

- Most appropriate grassland habitat to create; and
- The extent of ground preparation required (see Section 6.5.1.1).

The key components of soil are soil pH, soil type, bedrock, fertility and nutrient levels. Whilst the grassland type is directly related to soil pH (see Section 5.2.3), fertility and nutrient levels determine whether a grassland can become species rich. For example, if nutrient levels are too high, highly competitive, undesirable, ruderal species such as dock (*Rumex* spp.) and thistle (*Cirsium* spp.) are likely to establish and dominate. Dominance of just a few species can indicate high fertility and nutrient levels.

Before creating or restoring grassland, the following should be undertaken:

- **Consult geospatial soil data:** open source data or maps which indicate the underlying soil type and bedrock within the location of a site, should be used to understand what grassland habitat is best suited to the site.
- **Take soil sample on site:** inspecting the site and taking soil samples for analysis is important to accurately determine soil type, pH, soil fertility and nutrient levels. Understanding these is integral to creating an appropriate grassland habitat.

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 local soil type.*

6.4.2.1 Reducing soil fertility

Depending on the outcome of the soil analysis, the following should be considered:

- **High nutrient levels:** fertility levels can be reduced through several years of regular cutting (see Section 6.6.2.1). Alternatively, topsoil stripping may need to be undertaken (see Section 6.5.1.1). Topsoil stripping should only be undertaken if the establishment of a grassland of high distinctiveness on fertile soils needs to be accelerated.
- **Low nutrient levels:** retain topsoil as the existing soil microbial community is important in establishment of the grassland.
- **Cost-effectiveness:** where soil is found to be extremely fertile or contaminated, intensive intervention is likely to be required over several years. In this instance, a different Preferred Habitat Objective may need to be considered, as this may prove to be better for biodiversity and more cost-effective in the long run.

OFFICIAL

- **Retaining/enhancing grassland:** the baseline soil nutrient levels should be used as an indicator to measure the success of management regimes for grasslands being retained or enhanced (see Section 6.6.4).

NOTE: *Always consult a professional ecologist or botanist to determine whether topsoil stripping is necessary.*

NOTE: *Various companies offer soil testing and analysis which can be purchased online. The results should be interpreted by a soil specialist.*

NOTE: *For detailed information on soil analysis and how this applies to creating grassland, refer to the Natural England Grassland Management Handbook (Natural England, 2012b).*

Where soils are highly fertile, topsoil stripping can be used to reduce the fertility. This should only be undertaken if the establishment of a grassland of high distinctiveness on fertile soils needs to be accelerated. The process of undertaking topsoil stripping is outlined for agriculturally improved and non-agriculturally improved grassland below. It is unlikely that agriculturally improved grassland will be frequently encountered within the lineside estate.

6.4.3 Planting specification

When devising a planting specification seek to:

- Select plant species suited to the environmental conditions of the site e.g. soil, aspect, water table;
- Consider specifying specialist species to aid the management process or to provide a source of nectar throughout the year.

Native plant species generally have greater biodiversity value than non-native and ornamental plants, as they have evolved alongside native wildlife. Therefore, only native species should generally be included within grassland specifications.

NOTE: *Proposing non-native grassland/wildflower mixes is only likely to be appropriate in urban amenity settings. Refer to the Urban and Brownfield Design and Management guidance note.*

To encourage suppression of dominant grass species over the first few years, inclusion of yellow rattle (*Rhinanthus minor*) within the seed mix is recommended. Yellow rattle is a hemi-parasite of grasses and can encourage wildflowers to establish. If yellow rattle is included within the seed mix, sowing should take place in autumn to germinate the following spring. Yellow rattle should be sown in managed grassland of low to medium fertility (Emorsgate Seeds, 2020) and may need to be sown over the first few years of grassland establishment to encourage yellow rattle to become abundant in the sward.

NOTE*: Yellow rattle seed should be sown in autumn as they need exposure to cold temperatures in winter to germinate the following spring.*

Bulb planting can be included to provide a source of nectar during early spring. Native and naturalised species to consider include winter aconite (*Eranthis hyemalis*), snowdrops (*Galanthus nivalis*), crocuses (*Crocus spp.*) and snake's head fritillary (*Fritillaria meleagris*).

OFFICIAL

NOTE: *For indicative lists of species suitable for sowing in neutral, acid or calcareous grassland, refer to Chapter 11 of Natural England's Grassland Management Handbook (Natural England 2012b).*

NOTE: *When sourcing seed, consider including species of benefit to pollinating insects. Royal Horticultural Society lists appropriate 'Plants for Pollinators'* *https://www.rhs.org.uk/science/conservation-biodiversity/wildlife/plants-for-pollinators*

NOTE: *If a soil test indicates that soil phosphorus levels are high, avoid introducing legumes, which fix nitrogen, such as clovers or vetches (Natural England 2012b).*

NOTE: *Seek advice from an experienced botanist where grassland creation or management advice is required or where individual botanical species advice is required.*

6.4.4 Grassland creation approaches

6.4.4.1 Commercial seed

Sowing of commercially sourced seed is likely to be the most cost-effective method of grassland creation for the majority of lineside sites. Seed can be flexibly sourced from a range of UK suppliers to create grassland or as a supplement to enhance existing grassland.

Different methods of applying seed can be used. This includes traditional seeding and hydroseeding, which may increase the rate of success on embankments or cuttings (see Section 6.5.1.2).

A sowing or planting rate of 50kg/ha with a ratio of 80:20 of grasses to herbaceous wildflowers; or 10kg/hectare for pure wildflower (British Flora, 2020) can be applied for the creation of new neutral, calcareous and acid grassland.

Seed densities greater than 50kg/ha are likely to result in a dense sward preventing many slower growing wildflower species to establish.

6.4.4.2 Natural regeneration

Natural regeneration is the process of allowing plants to naturally colonise the land from the seedbank or surrounding grassland. Whilst this can be less labour intensive and initially cheaper than other options, the likelihood of a species-rich sward developing is unpredictable (Buglife, 2020) as undesirable grasses or, ruderals such as thistles and common nettle are likely to establish from the existing seedbank.

Natural regeneration can also be used in conjunction with seeding. 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 several years longer for the grassland to establish and reach the mature phase.

6.4.4.3 Other approaches

The following approaches to grassland creation may be suitable in limited circumstances based on professional ecological advice. (Table 5).

Table 5 – Other approaches to grassland creation

OFFICIAL

Approach	Description	Example
Spreading hay	Traditional alternative method to seeding. Hay taken from a local, species-rich grassland is spread across the area and left for three weeks to allow seeds within the hay to fall.	Where a species-rich grassland is present near the site, and in which hay can be quickly and easily transported. Only suitable where the donor grassland is close to the site.
Plug planting	Young plants pre-grown in a nursery that can be directly planted into the soil.	Can be used to supplement seeding or planted into existing grassland where vegetation has become too vigorous (Butterfly Conservation, 2020).
Pre-sown turf	Pre-established turf with grasses and herbaceous plants that is rolled over existing topsoil.	Useful in amenity areas, where immediate results are required.

NOTE: Further guidance on supplying local hay is provided in CIEEM's 'Restoring Native Grasslands Using Local Origin Seed' https://cieem.net/resource/restoring-native-grasslands-using-local-origin-seed/?filter_topic=231

***NOTE:** For information on how to seed using hay refer to: Natural England's Grassland Management Handbook (2012a).*

***NOTE:** Maintenance requirements and aftercare of plug plants and pre-sown turf differs to seeding. For plug plants refer to Butterfly Conservation Management Factsheet on Seeding and Plug Planting for Butterflies https://butterfly-conservation.org/sites/default/files/1.seeding--plug-planting-factsheet.pdf*

6.4.5 Sourcing seed

The success of grassland establishment is influenced by the quality and storage of seed and requires robust procurement processes.

Seeds or plants should be sourced from suppliers that follow government regulations such as the Seed Marketing Regulations 2011. See https://www.legislation.gov.uk/uksi/2011/463/made

***NOTE:** Seed sourced from outside local areas should not be introduced within designated sites, e.g. Special Area of Conservation, or be introduced into existing priority habitats. It would not be appropriate to plug plant of introduce turf into designated sites.*

***NOTE:** The full list of species listed on Schedule 8 can be found at: http://www.ukwildlife.com/index.php/wildlife-countryside-act-1981/schedule-8*

6.4.6 Resilience and adaptability

Including a diverse range of species can help increase resilience to warmer climates and limit the damage caused by pest and disease outbreaks.

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

OFFICIAL

- The National Vegetation Classification (NVC) system can be used as a guideline for devising suitable seed mixes based on different regions and soil types.
- For urban grassland, the Royal Horticultural Society's Plants for Pollinators lists a range of botanical species, native and non-native, which are suitable for planting in urban areas.

NOTE: *RHS Plant for Pollinator Guides can be found at: https://www.rhs.org.uk/science/conservation-biodiversity/wildlife/plants-for-pollinators*

Grassland comprising predominantly hardy, drought-resistant species are likely to be at lower risk of wildfire and should be considered within areas where this risk is particularly high e.g. the lineside Action Zone.

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

6.4.7 Protection

Grassland creation or maintaining grassland can present safety and operational risks, whilst also being at risk of physical damage which is difficult to reverse. Table 6 highlights these risks and associated protection measures.

Table 6 – Protection measures required for lineside grassland

Risk	How	Protection measures
Collisions or operational damage and delays caused by livestock and large wild animals on the railway line.	Livestock, or large wild animals such as deer, grazing on lineside grassland may be able to directly access the railway line.	Installation of exclusion fencing between the railway line and lineside grassland if grazing is the chosen management intervention or if large populations of wild deer are known in the area.
Damage or destruction of habitat within a nature reserve, designated site or habitat of high distinctiveness	Access to the lineside and use of machinery can result in physical damage occurring to important habitat e.g. machinery access.	Markers to indicate habitat of high distinctiveness, nature reserves or designated sites should be erected to ensure care is taken when accessing lineside sites.
Undesirable and invasive species colonise the site.	Ground disturbance caused by machinery or vehicles can create conditions suitable for colonisation by undesirable species.	Reduce the time and general use of heavy machinery where possible.

6.4.8 Management approaches

Mowing and grazing are the only two management interventions which should be implemented across lineside grassland.

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

OFFICIAL

Grazing is unlikely to be appropriate for grassland management because most of the lineside is typically narrow and poses potential safety issues. There are, however, a few situations where it may be suitable. For example, where grazing occurs within land adjacent to the lineside. To determine if grazing is feasible, aerial maps and geospatial data should be consulted to understand the site constraints and opportunities at a network level. This will inform the Habitat Management Plans, Route Vegetation Management Plans and Sectional Asset Plans if grazing can be implemented.

Where grazing is possible, it may be the preferred management intervention in order to reduce the need for management by contractors.

Where grazing cannot feasibly be implemented, mowing should be used (see Section 6.6.1).

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

OFFICIAL

6.5 Grassland Creation and Establishment

This section provides guidance on how to successfully create and establish grassland in the lineside to maximise its biodiversity value and ecosystem service provision. This guidance refers to the germination and establishing phase of the grassland development cycle.

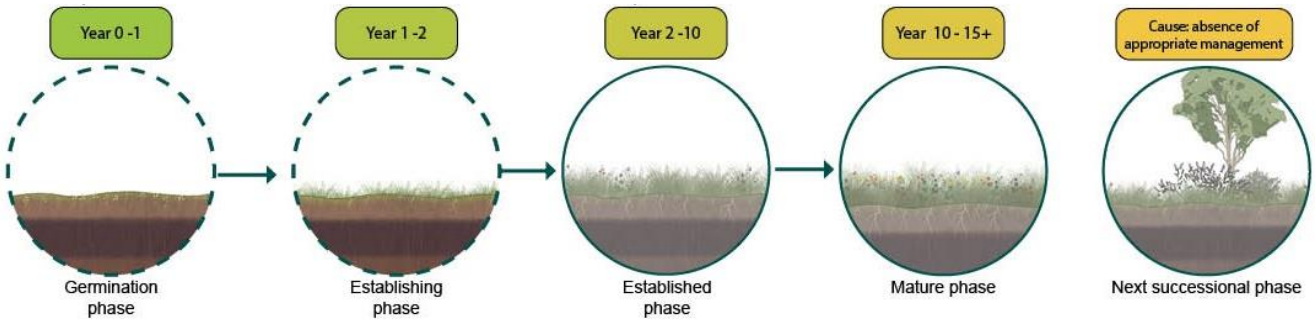


Figure 14 – Phases of grassland development cycle: applicable to grassland creation and establishment

Best practice states the following general grassland creation and establishment principles should be applied:

- Undertake ground preparation where necessary;
- Use the most appropriate seeding method according to environmental and site access conditions;
- Implement an appropriate aftercare programme;
- If possible, remove all arisings once grassland is cut to prevent the soil becoming more fertile;
- Re-seed new grassland which fails to thrive at the end of each growing season up to the end of the five-year aftercare period;
- Remove dead or diseased grass material from site to a licensed green waste recycling facility;
- Disposal of INNS material needs to be considered separately; and
- Consider risks to grassland habitats, for example fire.

***NOTE**: Refer to Natural England's Grassland Management Handbook (Natural England, 2012b*).

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

OFFICIAL

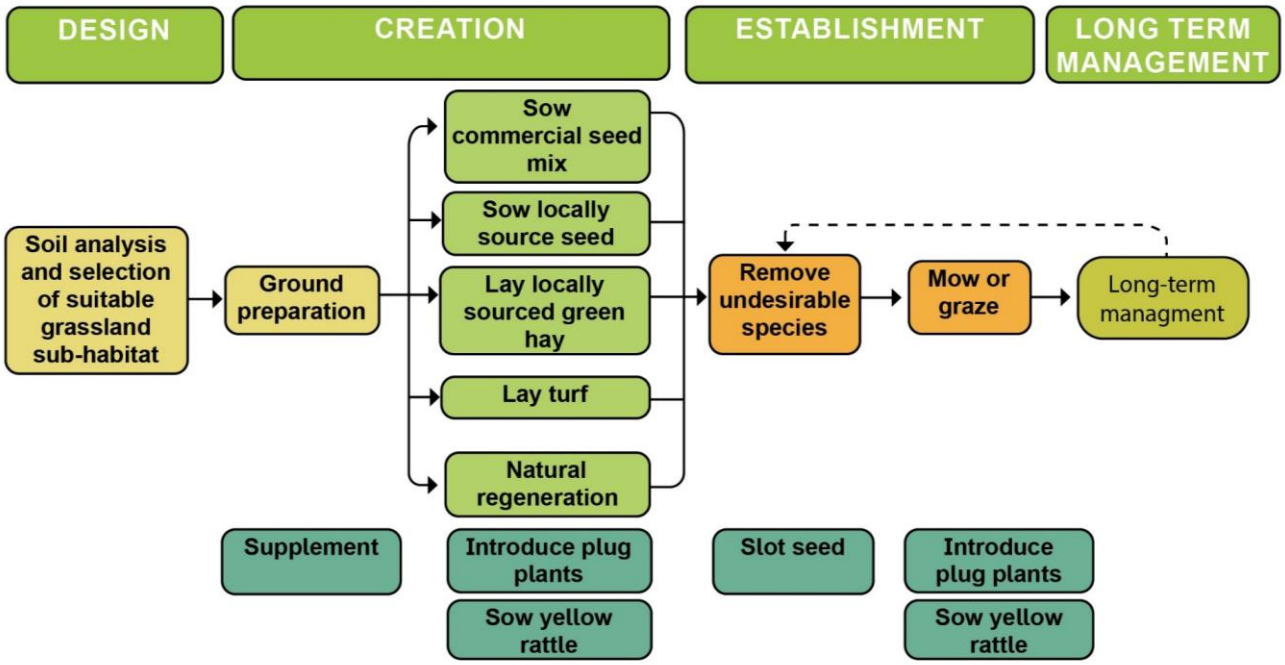


Figure 15 – Grassland creation and establishment process

Figure 15 outlines the process that should be followed when creating a grassland and the subsequent actions recommended for successful establishment. Methods and considerations relating to ground preparation, implementation and immediate aftercare are outlined within the following sub-sections. Management interventions and long-term management are discussed in Section 6.6.

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

6.5.1 Implementing grassland creation

Grassland creation should follow three main processes:

- Ground preparation;
- Sowing seed; and
- Rolling.

The methods of implementation may differ according to the site's environmental and physical conditions. These methods are outlined in more detail below. Whilst plug planting can be considered, in most cases it is likely to be used to supplement a sward whilst seed is establishing or has established. Plug planting can aid the certain species through the establishment process where they may otherwise struggle.

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

OFFICIAL

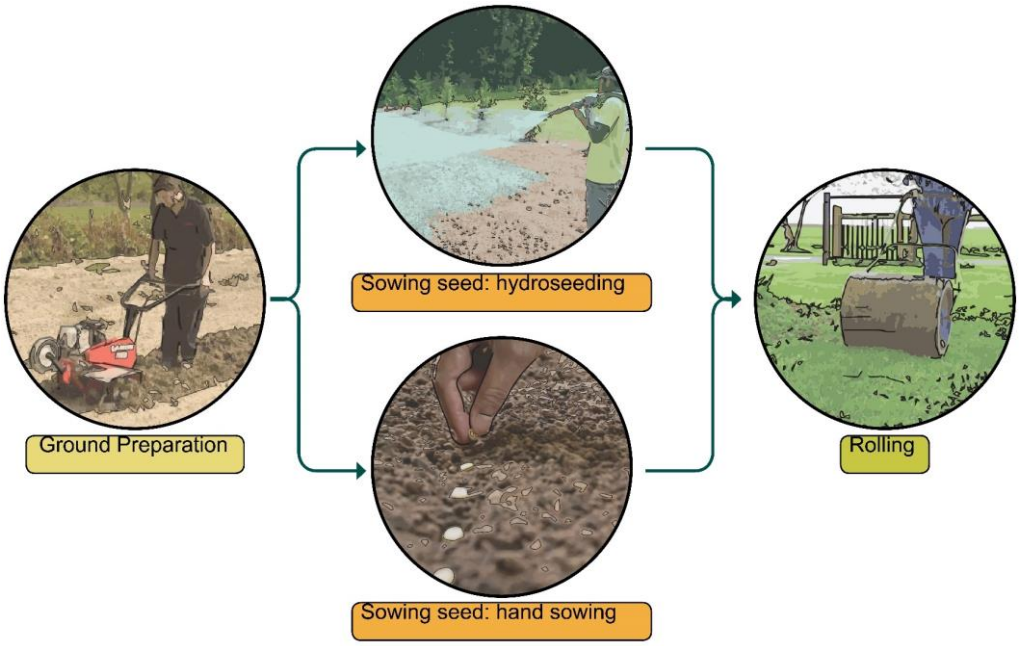


Figure 16 – Ground preparation and seeding process

6.5.1.1 Ground preparation

Prior to creating a new grassland habitat, the ground and seedbed should be prepared to encourage seed to germinate and for plants to successfully establish.

When preparing the soil, the following steps should be undertaken for all grassland creation (Natural England 2012b):

- **Soil condition:** preparation should be undertaken when the soil is dry and easily workable to achieve a weed-free tilth between 6-10cm depth.
- **Soil cultivation:** helps create a workable seedbed and tilth that brings less fertile soils to the top of the soil. Soils can be ploughed or harrowed if the site is large enough and access allows. Otherwise, cultivation using a rotovator is preferable (Plantlife, 2019). Soil should not be over-cultivated as this is likely to release nutrients and moisture encouraging germination of undesirable species.
- **Remove pernicious weeds:** remove pernicious grasses, thistles, docks and nettles within the tilth during preparation and whilst seeds are establishing. This should be done by hand. If weeds persist, spot herbicide treatments can be applied to the weeds, however, this should be undertaken as a last resort, if dominance of weeds threatens the establishment of specified grassland.

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 Plantlife's Threatened Arable Plant Identification Guide (2008):*

OFFICIAL

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 any rare arable plants which may establish once soil is cultivated.*

If topsoil stripping is required, one of the following approaches should be followed according to nutrient richness of the soil:

- **Non-agriculturally improved grassland:** using an excavator, strip topsoil to a depth of 20-25cm to remove most of the soil's nutrients. This will also remove the existing seed bank, which is likely to include undesirable, highly competitive species such as common nettle (*Urtica dioica*), creeping thistle (*Cirsium arvense*) and broad-leaved dock (*Rumex obtusifolius*). To understand whether topsoil stripping is required, see Section 6.4.2. If necessary, only strip topsoil of patches where fertility is high.
- **Agriculturally improved grassland:** on such grassland, remove existing vegetation by stripping the turf and the top 10-15cm of soil, inverting the soil and burying any turf using an excavator (Farm Wildlife, 2020).

6.5.1.2 Seeding

The best times to sow grassland are:

- **August and September:** provides warm, moist conditions that enable young plants to establish before winter. Species which require cold weather for germination will be stimulated to germinate the following spring.
- **Spring:** seed likely to establish but will face competition from fast growing herbs and grasses, which may then dominate the sward

NOTE: *See schedule folder for appropriate seasonal sowing periods.*

Seed should be applied using one of the following methods:

- **Hand sowing:** seed should be sown at the appropriate density (Section 6.4.4.1) on or just under 1cm of the soil surface.
- **Hydroseeding:** a mixture of water, seed and binding agent is sprayed onto the soil. This approach is preferable on steep slopes where erosion is a risk or where ground preparation is not possible (Germinal Amenity, 2018).

NOTE: *Nutrient profile and target plant community should be considered if hydroseeding is used. For example, nutrient rich mulches used as binding agents may be undesirable for the target plant community.*

Following sowing, the soil should be rolled (e.g. Cambridge roller) to press the seeds into the soil. This should be done for hand sown seed, where possible. For hydroseeding, raking should be undertaken instead.

NOTE: *For information on how to prepare the site for natural regeneration refer to Magnificent Meadows (2020):*
http://www.magnificentmeadows.org.uk/assets/pdfs/Restoration_using_natural_regeneration.pdf

OFFICIAL

NOTE: *For information on how to seed using hay refer to: Natural England's Grassland Management Handbook (2012a).*

6.5.2 Establishment

Once sown, aftercare should be implemented to allow seed to germinate and the grassland to successfully establish within the first year or two. The following interventions should be considered:

- **Irrigation:** if sown between drier months (see schedule folder) newly sown grassland may need to be irrigated to aid establishment.
- **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. Pernicious weeds should be controlled following the advice outlined in Section 6.5.1.1 during the establishment phase.
- **Establishment maintenance:** a management regime should be implemented for the grassland to develop to the mature phase, which should include establishment cuts (see below). This is likely to be done via cutting (see Section 6.6.2.1) but grazing may be a viable alternative if lineside conditions allow (see Section 6.6.2.2). Where extremely infertile soils are present, cutting may not be necessary during the first year of establishment.
- **Establishment cuts:** throughout the first year of establishment grassland should initially be cut to a 50 mm, once the grass has reached a height of 100 mm. A second and any subsequent establishment cuts should them be undertaken when it has re-grown to 100 mm.

NOTE: *Refer to DMRB Series 3000 (2001) for information on undertaking establishment cuts.*

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

6.5.3 Lineside management considerations

In most instances large machinery will be required to undertake grassland creation. Physical and operational constraints (see Section 6.4.1) should be considered in the planning phase and before undertaking grassland creation.

Large machinery can cause damage to soil structure which can limit grassland establishment and success. Therefore, using machinery appropriate to the site's conditions is key to the success of the habitat creation and lineside safety. This can be overcome by using non-heavy machinery (e.g. robot mowers) or through non-intensive approaches (e.g. strimming).

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

OFFICIAL

6.6 Long-term management

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

Figure 17 – Phases of grassland development cycle: applicable to long-term management of grassland habitat

Best practice suggests the following general principles should be applied:

- Implementing a long-term management regime suitable for the site, soil and grassland type e.g. cutting; and
- Monitoring grassland to analyse changes in grassland composition and structure to inform future management.

Beyond establishment, the appropriate annual management intervention is similar and applicable to all grassland habitat types.

Once a grassland is established, good grassland management seeks to:

- Maintain grassland cover;
- Conserve, create or enhance micro-habitat features e.g. scattered scrub; and
- Increase species diversity and species-richness.

Typically, there are two management interventions which are appropriate to manage grassland on an annual basis within the lineside: cutting and grazing. Details of each management approach are outlined in the sections below.

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.*

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

OFFICIAL

6.6.1 Cutting

The key purpose of implementing cutting is to prevent succession to scrub or woodland, however, cutting also provides the following benefits (Natural England, 2012a):

- Prevents coarse grass species or undesirable ruderal species from dominating the sward;
- Allows slow growing species to establish, increasing species-richness of the sward;
- Restricts growth of scrub and trees; and
- By removing arisings, prevents recycling of nutrients that would naturally occur through decomposition of dead plant matter, lowering soil fertility and allowing for greater species-richness.

6.6.1.1 Implementing a cutting regime

The height, method, frequency and timing of cutting play significant roles in grassland development. Whilst a single annual cut is likely to be sufficient for most grassland, two annual cuts may be required where undesirable species such as dense growth of thistles, nettles or bramble, are dominating a sward.

The frequency of cutting can impact grassland in the following ways:

- Too many cuts will prevent slow growing species from establishing or seeding, ultimately leading to a species-poor grassland; or
- If left uncut, woody species will establish and lead to a natural transition to scrub an eventually woodland.

For details on favourable and unfavourable cutting periods, refer to the schedule folder. The best times to cut grassland are:

- **July:** Most floral species seed before July. Cutting in July allows time for flowers to seed and provides enough time for new plants to germinate prior to winter;
- **August to September:** Less favourable then July. However, once every five years, the annual cut should be undertaken between August to September to allow late seeding species to seed (Natural England 2012a); and
- **Late spring:** If the sward is dominated by coarse grasses or undesirable ruderal species, a second cut may be warranted. The first of the two cuts should be undertaken in spring, followed by a second cut in August to September.

NOTE: *Consult an experienced ecologist or botanist to determine the need for two annual cuts if coarse grasses or undesirable ruderals dominate the sward.*

Cutting can be undertaken using a range of machinery and can be mown, scythed, strimmed or flailed. The method of cutting and machinery used on site will depend on the physical environmental and operational condition (see Section 6.4.1). Where it is difficult or unsafe to use conventional mowing machinery, machinery specialised for

OFFICIAL

cutting grass on sloped terrain, such as robot flail mowers should be considered (Figure 18).

Flail mower | Ride on lawn mower | Robotic flail mower

Figure 18 – Examples of grassland cutting machinery

The following measures should be implemented for mowing grassland to maximise biodiversity:

- **Cutting height:** to prevent harm to reptiles and amphibians, grassland should initially be cut to a minimum sward height of 150mm. Following a check for reptiles and amphibians within the grassland, a grassland should then be cut to 75mm.
- **Structural diversity:** Vary the sward height to provide structural diversity, which is beneficial to wildlife (this should not be implemented if grassland cannot be cut annually);
- **Animal refuge:** Leave a quarter of each grassland uncut as a refuge for animals in each year on rotation (this should not be implemented if grassland cannot be cut annually);
- **Arisings:** Once cut, all arisings should be left for seven days to allow for annual seeds to drop. After seven days, all arisings should be removed from site to prevent nutrient enrichment;
- **Ant hills:** As ant hills introduce varied aspects and exposed soils to a habitat, which can enhance biodiversity, it is important to retain and conserve them as important grassland features; and
- **Ground nesting birds:** Although birds typically finish breeding before July, some species, such as skylark are known to have prolonged breeding periods. An ecologist should check for nesting birds before mowing. If an active bird's nest is found, the nest should be monitored, and mowing should be delayed until the chicks have fledged.

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

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

OFFICIAL

NOTE: *An experienced ecologist should undertake a check for amphibians and reptiles after the initial grassland cut unless a briefing and toolbox talk has been provided to the contractor undertaking cutting.*

6.6.1.2 Prioritisation of grassland cuts

As grassland covers a substantial proportion of the lineside, it is unfeasible for all grassland to be cut during favourable months. Therefore, grasslands listed as a habitat of principal importance under Section 41 of the NERC Act (i.e. priority habitat) and those present within designated sites given the highest importance.

Priority habitats should be identified during the desk study and fieldwork undertaken prior to the Preferred Habitat Objective being determined. Where priority habitat grassland is concerned, the type of management that can be implemented is likely to be constrained by the requirements of the priority habitat type. As priority habitats are of high ecological importance, it is essential that they are cut on an annual basis to ensure the habitat's ecological value is conserved. The level of prioritisation of the grassland habitat should be stated within the site's habitat management plan.

NOTE: *The Habitat Design and Management Guidance Note outlines the process of undertaking desk studies and fieldwork which should be used to identify priority habitats and designated sites.*

NOTE: *Grasslands present within designated sites Special Areas of Conservation, Special Protection Areas and Sites of Special Scientific Interest may have specific management requirements. Grassland cutting should only be undertaking providing it does not conflict with the designated site's requirements.*

NOTE: *Refer to the Habitat Design and Management Guidance Note for more information on Habitat Management Plans.*

Figure 19 outlines a hierarchy for prioritising grassland cuts.

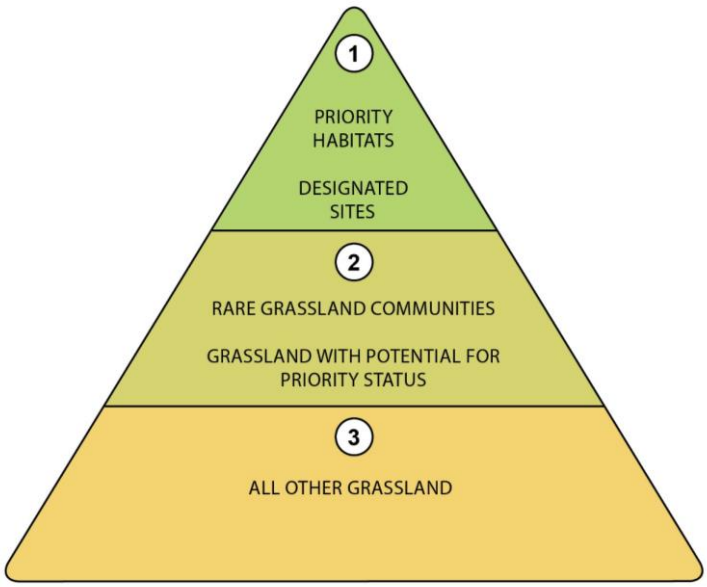


Figure 19 – Grassland prioritisation hierarchy

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

OFFICIAL

6.6.1.3 Supressing dominance of coarse grasses and undesirable species

Dominance of coarse grasses and undesirable herbaceous species within a sward is common where soils are relatively fertile or where management has been absent. Examples of undesirable species are shown in Figure 20.

Where grasses or undesirable species dominate the sward, the following approach should be followed:

- Implement a consistent annual mowing regime or grazing;
- Analyse, through monitoring surveys, whether grass species dominance lowers year-on-year; and
- If dominance of grasses or undesirable species persists, consider:
    - Two annual cuts, one in early spring and one in later summer/early autumn;
    - Sow yellow rattle as per the guidance in Section 6.4.3.

In moderation these species can add to the biodiversity value of a grassland. However, in large numbers they pose a threat to habitat distinctiveness and condition. If inspections or monitoring identify dominance by these species, multiple annual cuts may be required (see frequency in Section 6.6.1.1). Alternatively, hand pulling, or herbicide spot treatment may be considered if cuts prove ineffective (see Section 6.7.2). If considered, this should be undertaken prior to the species' flowering season.

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

OFFICIAL

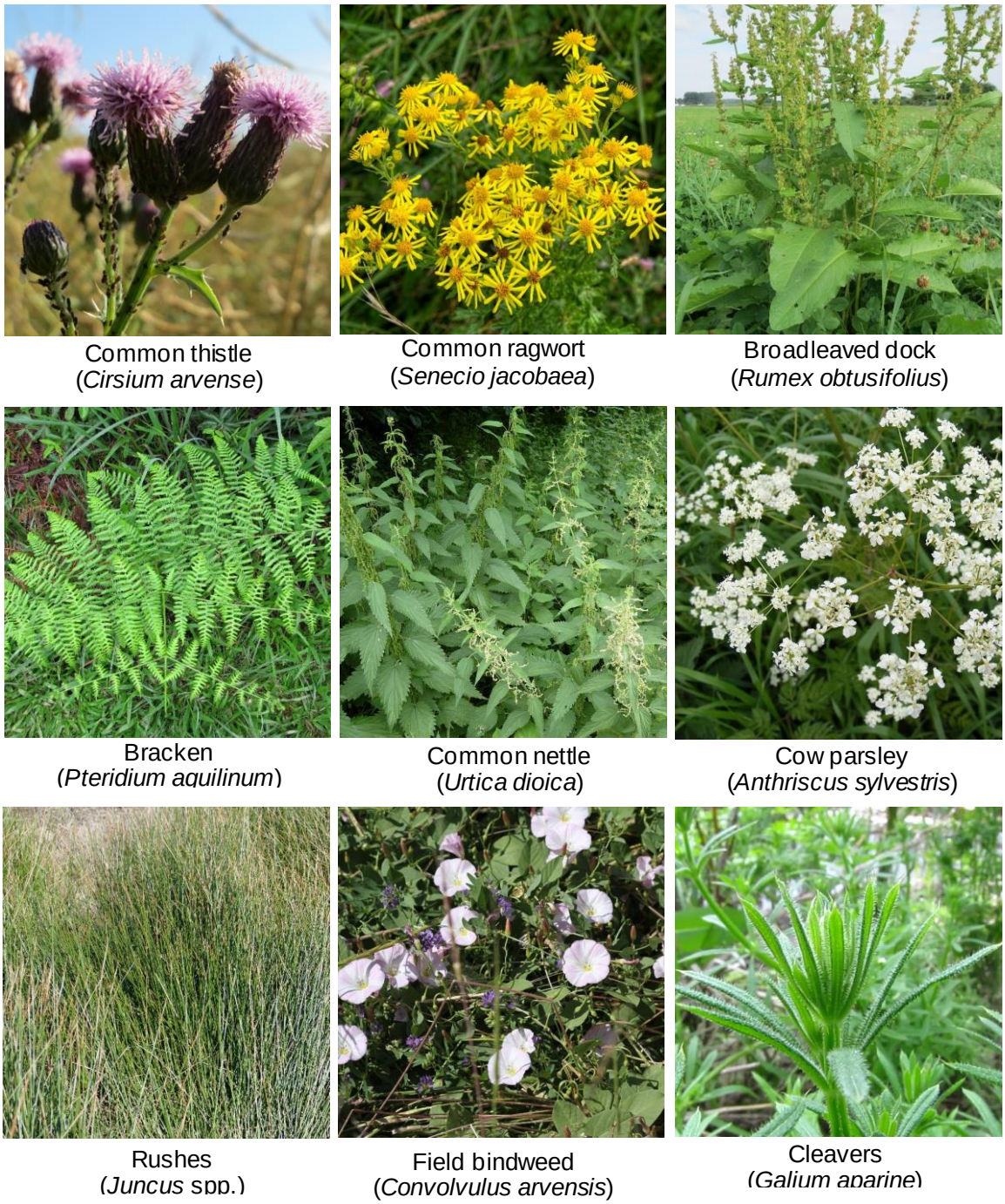


Figure 20 – Examples of undesirable species

Ragwort is a group of yellow flowering grassland herbs (e.g. common ragwort, Figure 20) which are poisonous to cattle and horses if ingested. Where ragwort is abundant within a lineside grassland adjacent to land which supports cattle or horses, all stands of ragwort should be removed from the site to prevent spread onto the grazed land (Scotland Rural University, 2020).

OFFICIAL

Successful control or eradication of ragwort from a site typically requires multiple methods and is likely to take several seasons. The most effective methods include levering out, using a ragwort fork and spot spraying of herbicide or citronella oil at the rosette stage. Control methods should be undertaken before flowering heads mature in early summer.

NOTE: *Refer to The Scottish Government's Guidance on 'How to Prevent the Spread of Ragwort' (Scottish Government, 2008) for detailed information on controlling ragwort.*

6.6.1.4 Restocking/over-seeding established grassland

In situations where species-poor swards persist, supplementing the grassland with new seed or plug plants can be considered by:

- Hand sowing (as detailed in Section 6.5.1.2);
- Plug planting can be considered in conjunction with localised scarifying or topsoil stripping (see Section 6.5.1.1); and
- Slot seeding combined with herbicide spot spraying to prevent fast-growing species from out-competing seedlings (Coulson et al, 2001). This method enables several select species to establish within the sward at a faster rate than natural colonisation.

Over seeding is likely to be more successful in grazed grassland, as livestock create micro habitats for many grassland species to establish e.g. trampling creates patches of bare ground. If cutting is the management intervention, scarifying areas of the grassland should be considered to artificially create these micro habitats.

NOTE: *Refer to DEFRA's TIN064 for information of slot seeding: http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=2RRVTHNXTS.8OFFAUEKWIDU3*

6.6.2 Grazing

Grazing by livestock can take place at any time of year. The benefits of grazing differ according to the type of livestock and stocking density used. Unlike cutting, some plant species within the sward will be absent or reduced in abundance due to their intolerance of grazing (Hopkins, 1990). To most livestock, species that are highly palatable and thus the first to be grazed are typically competitive, fast growing plants which may dominate swards in the absence of management e.g. perennial rye grass (*Lolium perenne*).

NOTE: *The impacts which grazing has on grassland and the benefits and constraints of using sheep, cattle and horses are outlined within Chapter 6 of Natural England's grassland Management Handbook (2007).*

NOTE: *Introducing an appropriate livestock stocking density is integral to the success of grassland management. 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 grazing: https://www.kentwildlifetrust.org.uk/sites/default/files/2018-06/KWT%20Land%20Mgt%20Advice_Sheet%205%20-%20Choosing%20livestock%20for%20conservation%20grazing.pdf*

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

OFFICIAL

6.6.3 Managing scattered scrub

Whilst maintaining the grassland habitat should be the primary goal, the presence of scattered scrub can create a mosaic of habitats and can increase a habitat's biodiversity value. This should be managed on the following basis:

- Limit scrub coverage within an established or developing species-rich grassland to 10-25% where scrub will not result in operational issues; and
- Encourage a range of scrub species and structural diversity and density.

If scrub becomes dominant, outcompeting the grassland, the habitat may need to be restored to grassland (see Section 6.7).

6.6.4 Monitoring and inspections

Grassland should be inspected and monitored at least once a year by a suitably qualified professional.

- **Monitoring:** Determine whether the grassland is developing in-line with the objectives outlined in the site's habitat management plan; and
- **Inspections:** Monitor the success of grassland establishment against the specification and inspect for signs of damage and disease.

Whilst aspirational, it is unlikely that all lineside grasslands can be inspected and monitored annually. Prioritising inspections and monitoring may be required. Section 6.6.1.2 provides more detail on this.

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

6.6.4.1 Soil monitoring

Following the approach outlined in Section 6.4.2, one method of assessing a habitat's development is to assess the soil's fertility and nutrient levels. This is likely to be of greater use if enhancing a modified grassland or grassland that previously had high nutrient levels, but can be used in conjunction with botanical monitoring (Section 6.6.4.2) to gauge at which phase of the development cycle the grassland is in.

NOTE: *The need for soil analysis should be determined by a suitable specialist, such as an ecologist, landscape architect or soil scientist. Various companies offer soil testing and analysis which can be purchased online.*

6.6.4.2 Botanical monitoring and assessing biodiversity

Habitat and botanical surveys should be undertaken for each site, preferably at least once annually, between April and September, prior to the grassland being cut. Monitoring should assess change in botanical communities as an indicator for biodiversity against baseline data. Baseline data collection and monitoring at each site could include the following:

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

OFFICIAL

- **National Vegetation Community (NVC):** Detailed botanical survey undertaken annually to consistently assess changes in floral species abundance and diversity;
- **Biodiversity Net Gain (BNG):** Data collected from NVC surveys 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: *Surveys, annual ecological monitoring and BNG assessments should be devised and undertaken by an experienced ecologist.*

Following inspections and monitoring, changes to the management regime may be recommended to enhance or restore the grassland. The first few years of establishment are likely to require multiple inspections. Inspections are important to:

- Ensure the habitat management plan objectives are being met;
- Report on grassland vitality and failures and inform and instruct remedial work;
- Assess the health of grassland 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 grassland 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.*

6.6.4.3 Inspecting signs of damage and disease

The best time to assess grassland health is in mid to late spring. Some examples of visible signs of ill health are provided in Table 7.

Table 7 Examples of signs of ill health in grassland

Surface capping: Hard surface crust that forms on the top 1 to 10mm of bare soils. Clay soils that have been cultivated can be at risk of surface capping.	

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

OFFICIAL

Topsoil compaction: A compacted layer known as a 'hard pan'. Can be rectified by using tools with a low positive rake angle (e.g. chisel plough) (Cranfield University, 2001).	
Exposed soil: Areas of bare ground may indicate soil compaction. Too much can be detrimental to a grassland's biodiversity value. However, bare ground which covers 10% or less of the total grassland area can provide micro-habitats for burrowing insects and specialist plant species.	
Severe poaching: Occurs when livestock have stood or walked on grassland during wet conditions for a prolonged period. The compacted areas reduce grassland growth and allow weeds to colonise (Farm Advisory Service, 2020).	
Poor sward quality: Result of lack of reseeding and poor grazing management e.g. overstocking leading to overgrazing can result in patchy growth and/or species-poor swards.	

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

OFFICIAL

Dried out plants and wilting leaves: Caused by draught stress or periods of heat and lack of moisture. If the entire plant is brown and brittle before late summer, reseeding may be required. If the crown at the base of the grass is green, then brown grass may be dormant. Dormant grass can be revived through intensive watering (RHS, 2020). Disease and pests may also attack foliage which can result in the stripping and browning of leaves.	

If symptoms of ill health or pest attack cannot be resolved within a year, cutting back the infected vegetation and cultivating the soil to kills the roots is an effective method of combating certain grass diseases.

NOTE: *Scotland's Rural College (2020) outlines an effective method of combatting grass diseases, pests and undesirable species such as ragwort: https://www.sruc.ac.uk/directory_record/3187/grassland*

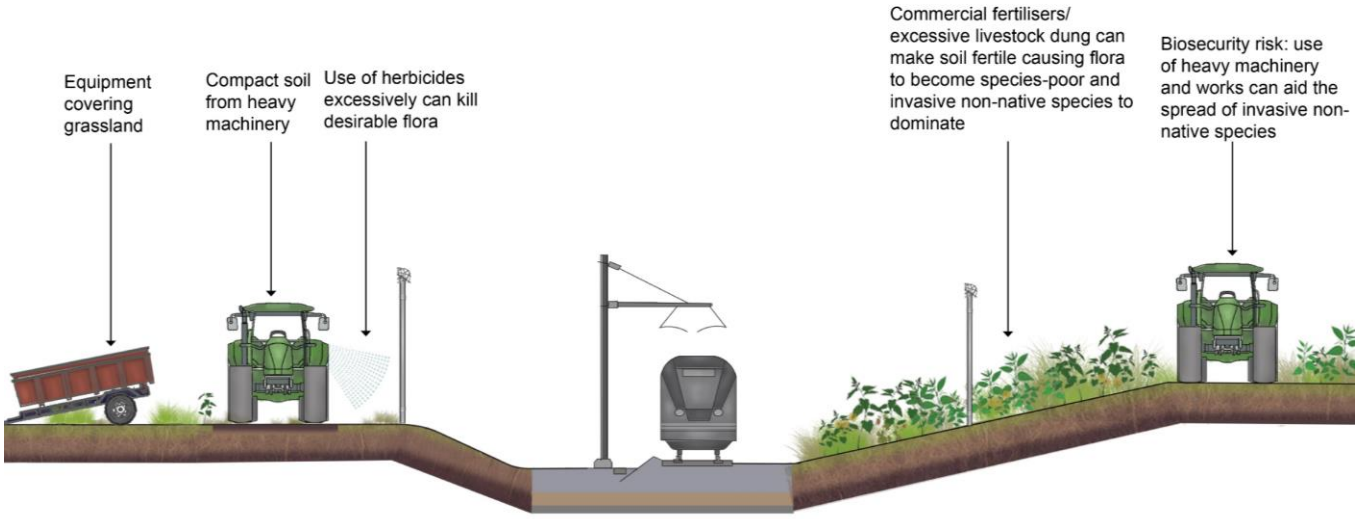


Figure 21 – Section illustrating typical causes of damage or ill health in grassland

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

OFFICIAL

6.7 Grassland Restoration

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

Figure 22 – Phases of grassland development cycle: applicable to next successional phase of grassland habitat

Best practice suggests the following general principles should be applied:

- Undertake removal of scrub and trees where appropriate to restore grassland or grassland-scrub mosaic;
- Consider seeding or plug planting to accelerate restoration, if appropriate;
- Organising toolbox talks for site staff on maintenance protocols, including recording and reporting on suspected cases of pests and diseases; and
- Remove all grassland arisings once grassland is cut to prevent the soil becoming more fertile.

NOTE: *For best practice guidance on grassland restoration, refer to Chapter 11 and 12 of Natural England's Grassland Management Handbook (2012b).*

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

OFFICIAL

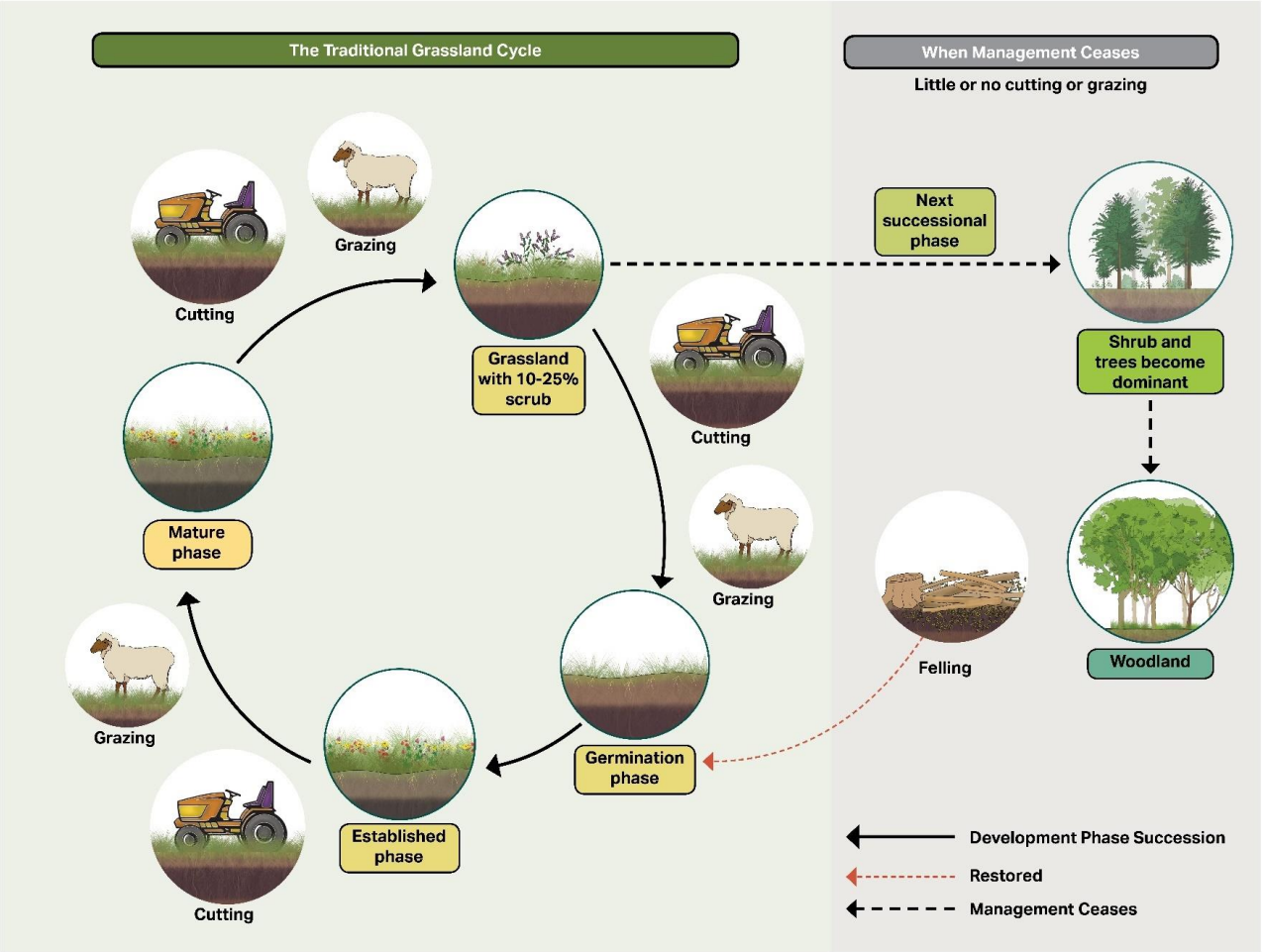


Figure 23 – Phases of the grassland development cycle and restoration process

6.7.1 Restoration approaches

Figure 23 illustrates the process that happens when appropriate long-term management interventions cease and the next succession phase occurs. If grassland has reached this this point restoration measures should be applied.

Restoration involves reversing the process of succession to bring grassland back under management and to maintain or enhance the habitat's distinctiveness and condition.

It is important that grassland restoration is only undertaken if 'Restore' is the Preferred Habitat Management Objective. If 'Transform' is the Preferred Habitat Objective, ground preparation is likely to be required; under this circumstance, the approach outlined for grassland habitat creation in Section 6.5 should be followed.

Grassland is typically restored under the following two scenarios:

- **Rank grassland:** grassland which has been left completely or infrequently managed which has become dominated by coarse grass and undesirable

OFFICIAL

herbaceous species. For information on supressing grass or undesirable species dominance, refer to Section 6.6.1.3.

- **Transitioning grassland:** following the process outlined above, the conditions provided by the grassland allow for woody species to establish, transitioning over time into scrubland or woodland (see Section 6.7.2).

Decisions on grassland restoration should take into consideration the following:

- The existing nature conservation value of the site;
- The ecological and management history of the site;
- Whether a change in management regime will improve or reduce the conservation value of the site;
- The current nutrient levels of the soil and the type of grassland the site may be able to support;
- The costs and resources associated with achieving management goals and objectives; and
- Use of fertilizers on nearby fields.

6.7.2 Restoring a transitioning grassland

If left unmanaged, most grassland will transition into dense scrub, which will eventually transition into woodland. The rate at which this happens is dependent on the following (Natural England 2012c):

- Presence and proximity of scrub and tree species to the grassland;
- Tall grasses and herbaceous plants: decaying matter turns into leaf litter, which can inhibit establishment of scrub); 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 removed using machinery (e.g. flail) and should be cut to the base during winter. However, without further intervention, this can cause scrub to grow back more densely. Annual removal of scrub is costly. Either the stumps can be removed by mechanical means or herbicide can be applied to the cut stem, once cut to ground level and notched.

Where scrub has become dominant, a risk assessment should be carried out to establish the appropriate method for removal. For example, phased removal may be required to minimise the impact on wildlife and consider access and operational constraints.

NOTE: *For information of scrub management within grassland, refer to Chapter 12 of Natural England's Grassland Management Handbook (2012c) and the Network Rail Heathland and Shrub Design and Management Guidance Note.*

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

OFFICIAL

7 Sources of further information

7.1 References

British Flora (2020). *Wildflower meadow creation and management guidelines.* Available at: http://www.britishflora.co.uk/wp-content/uploads/2014/04/BF-WILDFLOWER-MEADOW-CREATION-AND-MANAGEMENT-GUIDELINES2.pdf. (Last accessed 12th November 2020).

Buglife. (2020) *Wildflower-rich Grassland Creation.* Available at: https://cdn.buglife.org.uk/2020/04/Sheet-3-Wildflower-rich-grassland-creation.pdf. (Last accessed 12th November 2020).

Butterfly Conservation (2020). *Seeding and plug-planting for butterflies. Management Factsheet.* Available at: https://butterfly-conservation.org/sites/default/files/1.seeding--plug-planting-factsheet.pdf. (Last accessed 12th November 2020).

Cranfield University (2001). A guide to better soil structure. National Soil Resources Institute. Available at: https://www.landis.org.uk/downloads/downloads/structure_brochure.pdf

Coulson, S.J., Gregory, S.J., Tofts, R. (2001). A 12-year grazing experiment on species-poor grassland: vegetation responses and correlation with plant traits. *Journal of Applied Ecology,* 38: 253-267.

Defra. (2020) *Plant Health Controls.* Available at: https://www.gov.uk/guidance/plant-health-controls. (Last accessed 12th November 2020).

DMRB. (2001) *Specification for Highways Works. Series 3000 Landscape and Ecology.* Available at: https://www.standardsforhighways.co.uk/ha/standards/mchw/vol1/pdfs/series_3000.pdf (Last accessed 18th March 2021).

Emorsgate Seeds. (2020) *Using yellow rattle to increase species diversity.* Available at: https://wildseed.co.uk/page/using-yellow-rattle-to-increase-species-diversity. (Last accessed 12th November 2020).

Farm Advisory Service. (2020) *Poaching.* Available at: https://www.fas.scot/downloads/poaching-information-document/. (Last accessed 12th November 2020).

Farming Connect. (2013) *Pest and Disease Control in Grass and Forage Crops.* Available at: https://orgprints.org/32589/6/2013-pest-and-disease-control.pdf. (Last accessed 12th November 2020).

Forest Research (2014). Lowland Calcareous Grassland. Creation and management in land regeneration. Available at: file:///C:/Users/Ashley.Welch.NA/Downloads/BPG_18.pdf (Last accessed 12th November 2020).

OFFICIAL

Germinal Amenity (2018). Sowing of wildflower mixtures. Available at: https://germinalamenity.com/guides-advice/sowing-of-wildflower-mixtures/ (Last accessed 12th November 2020).

Gibson, C.W.D (1998). South Somerset SSSIs: A study of neutral grassland succession. English Nature Research Reports, No. 266. Peterborough.

Gov.uk. (2015). *Plants: surveys and mitigation for development projects.* Available at: https://www.gov.uk/guidance/protected-plants-protection-surveys-and-licences. (Last accessed 12th 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).

Hopkins, J.J. (1990). British meadows and pastures. *British Wildlife*, 4: 202-215.

Kent Wildlife Trust. (2018) *A brief guide to choosing livestock for conservation grazing. 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%20grazing.pdf. (Last accessed 12th November 2020).

Landis. (2020) *Soilscapes.* Available at: http://www.landis.org.uk/soilscapes/. (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).

Legislation.gov. (2006) *Natural Environment and Rural Communities Act (NERC) 2006.* Available at: https://www.legislation.gov.uk/ukpga/2006/16/contents. (Last accessed 12th November 2020).

Maddock, A (2008). *UK Biodiversity Action Plan; Priority Habitat Descriptions. Lowland Dry Acid Grasslands. BRIG.* Available at: https://data.jncc.gov.uk/data/902cafcb-578f-43de-8a99-7143f00d79a2/UKBAP-BAPHabitats-26-LowlandDryAcidGrass.pdf. (Last accessed 12th November 2020).

Magnificent Meadows. (2020) *How can I restore or create a meadow?* Available at: http://www.magnificentmeadows.org.uk/advice-guidance/section/how-can-i-restore-or-recreate-a-meadow. (Last accessed 12th November 2020).

Natural England (2012a). *Lowland Grassland Management Handbook (Second Edition). Chapter 5 – Grazing.* http://publications.naturalengland.org.uk/publication/35034. (Last accessed 12th November 2020).

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

OFFICIAL

Natural England (2012b). *Lowland Grassland Management Handbook (Second Edition). Chapter 11 – Grassland creation.* http://publications.naturalengland.org.uk/publication/35034. (Last accessed 12th November 2020).

Natural England (2012c). *Lowland Grassland Management Handbook (Second Edition). Chapter 5 – Scrub management.* http://publications.naturalengland.org.uk/publication/35034. (Last accessed 12th November 2020).

Natural England (2012dc). *Lowland Grassland Management Handbook (Second Edition). Chapter 7 – The control of grassland weed species.* http://publications.naturalengland.org.uk/publication/35034. (Last accessed 12th November 2020).

Natural England. (2007) *Lowland Grassland Management Handbook (Second Edition).* Available at: http://publications.naturalengland.org.uk/publication/35034. (Last accessed 12th November 2020).

Plantlife (2008). Threatened Arable Plant Identification Guide. Available at: https://www.plantlife.org.uk/application/files/2014/8241/1184/Threatened_Arable_Plants_Guide_2008.pdf. (Last accessed 12th November 2020).

Plantlife (2019). *Managing grassland road verges. A best practice guide.* Available at: https://www.plantlife.org.uk/application/files/3315/7063/5411/Managing_grassland_road_verges_Singles.pdf. (Last accessed 12th November 2020).

Pywell, R.F., Bullock, J.M., Hopkins, A., Walker, K.J., Sparks, T.H., M.J.W. Burke., S. Peel. (2002). Restoration of species-rich grassland on arable land: assessing the limiting processes using a multi-site experiment. *Journal of Applied Ecology*, 39:294-309.

RHS (2020a) *RHS Plants for Pollinators.* Royal Horticultural Society. Available at: https://www.rhs.org.uk/science/conservation-biodiversity/wildlife/plants-for-pollinators. (Last accessed 12th November 2020).

RHS (2020b). Lawns: dead patches. Royal Horticultural Society. Available at: https://www.rhs.org.uk/advice/profile?PID=421 (Last accessed 12th November 2020).

Scottish Government (2008). How to Prevent the Spread of Ragwort. Edinburgh, 2008. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2009/12/scottish-government-guidance-prevent-spread-ragwort/documents/0090932-pdf/0090932-pdf/govscot%3Adocument/0090932.pdf (Last accessed 8th January 2021).

Scotland's Rural College (2020). Grassland. Available at: https://www.sruc.ac.uk/directory_record/3187/grassland (Last accessed 12th November 2020).

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

OFFICIAL

The Wildlife Trusts. (2020) *Lowland calcareous grassland.* Available at: https://www.wildlifetrusts.org/habitats/grassland/lowland-calcareous-grassland. (Last accessed 12th November 2020).

UK Hab. (2020). *UK Habitat Classification.* Available at: https://ukhab.org/. (Last accessed 12th November 2020).

7.2 Figure References

Figure 3: Typical grassland

Railway, Apsley Manor Farm © Rob Farrow, 2006 (CC BY-SA 2.0). https://commons.m.wikimedia.org/wiki/File:Railway_near_Apsley_Manor_Farm_-_geograph.org.uk_-_163278.jpg

Figure 11: Example of INNS

Giant hogweed © Scottish Invasive Species Initative, 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

Monbretia © James Emmanus, 2015 (CC BY-SA 2.0). https://www.geograph.ie/photo/4683534

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

Giant rhubarb © Albert Bridge, 2018 (CC BY-SA 2.0). https://www.geograph.ie/photo/5840828

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

Variegated yellow archangel © Patrick Roper, 2017 (CC BY-SA 2.0). https://www.geograph.org.uk/photo/5340899

Figure 12: Example of pests and disease

Frit fly © Katja Schulz, 2018 (CC BY 2.0). https://www.flickr.com/photos/treegrow/40135435610/in/photolist-FY6Di5-

TB8fDd-2apuQNm-pdU9W7-TtgXZM-249CAH9-249CAQJ-249CAUw-pSU5kD-b8Ujbx-ccKGS9-249CASN-9Eiivk-249CAMC-6xFzMY-LEZeKD-o3WH4k-X38s8-6v82Ye-o2ajpk-TCuAc-9nJTKX-muw3zL-9nMTKQ-9nMUgb-kX2c2E-T5HtoJ-9nMSYU-9nJS6B-9nJRE2-9nMSzw-2iRevsR-9nMXKG-9nMVXQ-9nJUmk-9nJQsT-9nMVyf-gKxC6b-F3r9rn-gyadyw-dx3DNE-2jj8Z8K-dwXag4-2jj7MJU-2jj4PBK-2jj4PBp-2jj7MHX

Leatherjacket © Simon, 2015 (CC BY 2.0).
https://www.flickr.com/photos/137246163@N04/23679288519

Fungal disease © M J Richardson, 2009 (CC BY-SA 2.0).
https://www.geograph.org.uk/photo/1410180

Figure 18: Examples of grassland cutting machinery

Flail mower © Zabdiel, 2008 (CC BY-SA 3.0)
https://commons.wikimedia.org/wiki/File:Talyllyn_Flail_mover.JPG

Ride on lawn mower © Tod Baker, 2005 (CC BY-SA 2.0)
https://www.flickr.com/photos/todbaker/9298639/in/photolist-PEan-8bESEA-8vigKV-a5Giyy-2jdw4wx-2jn6u51-26oatWt-fXVLLP-dzYQA-eDX55w-rwBVDF-kUEya-nJvGbG-bt1db1-NunYaq-f5be5-eDX4U3-5xwnGV-2jN6ZZQ-Gr867n-eDQWMX-eDX569-Paw4BN-GmXf7a-pLpov4-6qWmTE-Scy6CJ-4NnfoQ-6LfeV3-2iGoo7j-7KpcR3-qczmuV-wM8FmH-4NneyJ-cGEy39-2hswjDy-GmNLa5-7YUXvo-bs1gRD-aUfbJF-6w1ACN-4wJV24-dUPcoR-ezz24-5DE3U5-fppoNe-8dzSio-9QN9LJ-4mudJf-9QN8fU

Robo flail © With the sound of music, 2011 (CC BY 2.0)
https://www.flickr.com/photos/86426405@N00/6038867030/

Figure 20: Undesirable species

Cirsium arvense © Andreas Rockstein, 2016 (CC BY-SA 2.0).
https://www.flickr.com/photos/74738817@N07/27341852613/in/photolist-HE79cX-2bDmn4G-NAXhHT-LN94cL-WkYNQ5-28eCnUn-LXqp8r-MHGhqA-LRWPCi-25nRvg5-UT7HzT-Kb4QjG-CVvT66-WJBXFr-MUZ1zM-MHGfSA-UQjFb9-Jn8Tbb-N33t66-27QnNgj-HRDECj-LRWQzZ-28cdzqn-MsSecq-JKYPgs-2bDmnij-28tHscE-2c2U2eJ-2b1pSe1-2jh5nhZ-Y4PRdx-29yZbgZ-28cdFKM-29HNnuE-BYYcws-29yZ9qz-2hzPFjq-8zkst4-8zks8V-8zkrER-8zkrUt-8zkptp-8zoxXY-89AE6U-2945EP1-f7ARHG-2ju3A6g-8zoASA-ffgmNt-bFG8vk

Senecio jacobaea © Steve Slater, 2012 (CC BY 2.0).
https://www.flickr.com/photos/wildlife_encounters/9615975746/in/photolist-fDJozh-9X7bPh-qqFyfD-a4Aasb-eiMAZ8-vKLdiU-bV3hkP-vQis8M-fB7uFs-wGMFWZ-eKB1gW-CcaSY5-58ePZ2-cconxE-wEtDkf-wEtmCC-8BMjF4-68o5g2-akKNBm-8inpd4-8inoYT-8iqCFA-6PbJ9f-cconpm-PQebHg-8iqCJ9-

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

OFFICIAL

Rzs4wt-eQhqTC-M75Vr9-aQhkkn-3MSk5i-QmWmVL-8bbXvw-ab9Cpo-6Xkbjq-abJJgv-25yQABw-4uUosz-8iqCXU-KRvnQv-8bbXcY-o7hsGY-eQfjXX-a7Ejda-o7iQ8Q-KBb2bK-ZtXVrr-G36mZq-oxyUfR-wmeAa5

Rumex obtusifolius © Andreas Rockstein, 2016 (CC BY-SA 2.0).
https://www.flickr.com/photos/74738817@N07/28626878885/in/photolist-KBEeKk-Kbuugh-JF62CU-29BpXyx-TBhwo1-XnYTNM-JFbA6D-VHKsPS-TK7r9z-26RywrQ-PX7ZGC-T5SxyQ-TK7uFe-MNaL28-N59qz6-PX83iQ-28exQ76-WeQwHt-TK7xNB-NS1ZK3-25Kvrg9-NS25Dw-24uMbsQ-NMsve3-24yHuCk-29xcEnh-MtJ8tu-NS22Mu-24uM7Js-PHZsta-NTJGjd-MC9rKh-2c5TAAr-SvfY1t-234sLrq-Va6n2q-SvALz3-TAE3fV-29xcsRw-234sP6o-N5rW93-WndquJ-KaKUue-WrreBn-MNaGui-Xo82L1-DJArdF-22KjWW2-TN7E9V-2c1sNTC

Pteridium aquilinum © Forest and Kim Starr, 2011 (CC BY 2.0).
https://www.flickr.com/photos/starr-environmental/24476886223/in/photolist-DhWrvH-DinC5z-E35Eny-DtDvFm-DoPL8n-XiP7Ak-DPq8Yq-EhgmKQ-Em1THS-DnzhPA-Eo3T3B-DR8Y19-Dm9M76-E74QXe-D98u85-EeP45c-LHHa82-DMGsnD-CFgmGn-Dvms8e-DAfFAR-CU5D3u-DE4JoT-DP2yRw-DrjyQs-DtxvZS-Eo3wYt-E5qqSe-DU1Eeu-DVKKxr-CWHdcG-Dx9pNi-EsHJtk-Dq9Avg-DegdgG-D6ycSM-DciWEE-DRRKap-D7FwkU-Dnh4jR-DiQrT5-DWcgvi-CYmZ2z-Eb4nVP-D2HToB-Ehwyfx-DAwqER-DTrhxd-DH2pZm-EfU9oN

Urtica dioica © Joan Simon, 2007 (CC BY-SA 2.0).
https://www.flickr.com/photos/simonjoan/2483371451/in/photolist-4MrVPa-bt5rrp-4KY9Fo-aMXkwe-4KTUon-K7Y5YB-4VMCo4-4KTU8r-4KYao5-4KTUz2-c4U7JS-4KY9VG-b2aLJD-bZ8TJs-b2aKFk-cVavcW-Wos5NV-cVbMMG-cUBhvh-d3xkKq-4MsaYK-K9BFSo-4KYacy-6mu6po-4Ah65H-AmBEyt-pAM9tk-2iXCiEi-4JnXop-4SPejs-MKGaz1-MKGajS-278s5bE-ai2znu-arDokK-9WwF8h-9WtPSv-9WwEZh-9WwF3s-2aA3h7j-278s4Wm-PxMvX1-2jtZN9H-716gZL-nSbQeX-4GzquuqATNVL-GrrPRu-4Woj2k-4Woj28

Anthriscus Sylvestris © Adrian Cable, 2009 (CC BY-SA 2.0).
https://commons.wikimedia.org/wiki/File:Cow_Parsley_in_Station_Road_-_geograph.org.uk_-_1296289.jpg

Juncus spp. © Derell Licht, 2019 (CC BY-ND 2.0).
https://www.flickr.com/photos/derelllicht/40703893773/in/photolist-251S7ge-251S6vX-2VmaP7-2VgPgx-q7fCCt-2gQFQ4n

Convolvulus arvensis © Andrey Zharkikh, 2009 (CC BY 2.0).
https://www.flickr.com/photos/zharkikh/6660111143/in/photolist-b9wP1t-25hLtiR-b9wRdc-X42fxo-X42gVU-VsG9qE-W1ZFaC-VTubKe-27Bahf6-JWx6xS-27wJdRC-WWvYR5-HSmBfD-uzS1G9-LcKxVs-Jr5c8w-JWx84h-

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

OFFICIAL

269AJfX-WnEYe3-29ym2gQ-27wJcqm-VvRsrc-WnF739-26qsUpd-XrjLHx-UtPDZD-VbfqNC-VFPUwX-KpfE5f-26qsWDy-U4ZhYe-VumnFe-KrVKEm-VqLCvz-XzmW9E-USzbgE-J6xLFG-J35kR8-28xgF8Y-KdeLWZ-VwHqmw-LJpjv5-HTbwua-Jz5hki-267frLS-KwcSmW-UxRz8g-VpdsPm-ekzxBP-27teCCV

Galium aparine © Unknown, 2020 (CC0 1.0).
https://commons.wikimedia.org/wiki/File:Galium_aparine.png

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