Forestry Commission

Using natural colonisation for the creation of new woodland

Contents

Summary

Natural colonisation is the process by which trees colonise new ground from existing local sources. This can happen through seed which has been dispersed by birds, mammals, wind or gravity, or by vegetative colonisation where new growth sprouts from the stem or roots of adjacent trees.

This document considers natural colonisation as an option for creating new woodland. For the purposes of this guide, the objective is to establish a closed canopy of woodland trees across at least 60% of a site. While natural colonisation is a key component of rewilding, from which woodland may or may not be the ultimate outcome, this is considered a separate topic and not covered by this guidance.

Evidence on the successes, failures, and potential benefits and drawbacks of using natural colonisation to create a viable new woodland is still relatively sparse and further research is underway. By introducing the range of planning and site factors that influence natural colonisation, this document acts as preliminary guidance to support those who are considering using it to create new woodland, based on current evidence.

Planning factors

A critical first step in any woodland creation project is to identify the management objectives for the site, and these objectives will help determine if natural colonisation is an appropriate method, or not. Management objectives for new woodland can be many and varied but will often involve a major element of biodiversity conservation, timber production, carbon sequestration, or providing access for recreation. Natural colonisation is more likely to be suited to some objectives (particularly biodiversity conservation) than others (particularly timber production and carbon sequestration). The benefits and drawbacks of natural colonisation when compared to planting are listed in Table 1 below.

Successfully establishing new woodland by natural colonisation depends on an array of factors that interact in variable and location-specific ways. In some cases, a dense cover of woody vegetation may be achieved in five years while in other cases, a patchy cover of scrub and trees may take many decades to develop.

It will often be prudent to combine natural colonisation with other establishment methods (primarily planting), especially where diverse management objectives exist across a site or where the range of suitable seeding species is limited. Supplementary planting can be used in advance of,

or in response to, initial colonisation to enrich species composition, provide bird perches to increase seed distribution, and speed up the development of a woodland structure. Natural colonisation can also be included where it develops among planted trees. Combining methods could ensure successful establishment and capitalise on the benefits of each method.

The creation of woodland, including by natural colonisation, is a legal change of land use and subject to the Environmental Impact Assessment Regulations (Forestry). Consent may be required from the Forestry Commission. There is a presumption that woodland is a permanent land use.

Table 1: Benefits and drawbacks of natural colonisation when compared to planting

Benefits of natural colonisation	Drawbacks of natural colonisation
• Trees that establish successfully are likely to be well matched to the current site conditions • Genetic diversity and associated adaptive capacity are promoted • Lower initial costs • Patchiness and scrub structures can create transitional areas between mature woodland and open habitats, which typically has high biodiversity value • Patchy distribution and associated structural irregularity can create an attractive natural appearance • Presence of complex, vegetation mosaics has higher ecological value over the woodland establishment stage than uniform vegetation • Avoids risks to root integrity which are associated with poor planting practice • On highly suitable sites, intensive ground preparation is unlikely to be necessary, in turn minimising ground disturbance and carbon emissions • Avoids using the resources associated with plant production and transport • Eliminates the biosecurity risks associated with plant movement • Plastic tree protection not needed for the initial stage of establishment	• Species composition cannot be pre-determined, and the woodland that results can be poor in species diversity if seed sources are limited, or particular species dominate • Species previously lost from the site cannot be re-established • Limited ability to use southerly provenances (for climate adaptation and/or yield) and improved provenances (for timber form and/or yield) • Successful establishment depends on the interaction of complex and unpredictable processes and will be challenging on some sites • There is limited research and operational experience of successful establishment across the range of possible site conditions • Timescale for succession is unpredictable and establishment costs may continue for many years • Limited control over stocking density, planting pattern and spatial distribution means that management objectives which include a productive element might not be reliably achieved • Can result in scrub rather than woodland habitat in the short to medium term

Site factors

The suitability of the site will determine the potential of natural colonisation to deliver the chosen management objectives, especially if initial establishment is required within 5-10 years. First-hand observation and survey of a site is necessary to understand its suitability for natural colonisation and the management interventions that may be needed to achieve it. Appendix 1 includes questions to consider when surveying a site.

There needs to be sufficient suitable source material (either seed or vegetative growth) arriving on the site and appropriate conditions for germination; this is more reliable on drier and nutrient-poor sites, and sites with exposed soil.

On most sites, management interventions will be needed to help seed germinate, survive, and grow into healthy young trees. On highly suitable sites or where there is already abundant early-stage colonisation, simply reducing browsing and grazing pressure may be enough to achieve establishment. In other cases, ground preparation or vegetation management will be necessary to produce conditions for germination and on-going growth. Some sites may simply be unsuitable for achieving the desired levels of colonisation on acceptable timescales.

On sites that have potential for successful natural colonisation, the requirements for management should be well understood to ensure the skills, resources and time are available to see the woodland through the establishment phase and beyond.

Appendix 2 provides a diagrammatic summary of the planning and site factors to consider.

Section 1. Planning factors

A comprehensive woodland creation plan will be essential for the successful delivery of all projects. Much of the decision-making on establishment methods is likely to take place during the development of this plan and be described within it, along with details of the final approach to be taken.

The following resources include information on planning, funding and the delivery of woodland creation projects:

- Forestry Commission webpage including template for a woodland creation design plan
- Forestry Commission guidance on new woodland creation: [Please note: the link to this documentation will be added as soon as this becomes available]
- Forestry Commission webpage giving an overview of capital grants for establishing woodland
- Forestry Commission bulletin giving technical advice on creating new native woodlands

1.1. Management objectives

A fundamental first step in designing a new woodland is determining the objectives for its creation and on-going management. From this, a specification can be generated for attributes such as woodland structure, layout, stocking density (the density of trees) and species composition. Natural colonisation can then be tested for its potential to deliver this specification and therefore the management objectives for the site in question.

Where natural colonisation takes place without assistance, it is likely to result in a patchy mosaic of a limited range of species, initially, rather than a uniform colonisation of chosen species. Where timber production or carbon sequestration are leading objectives, greater certainty is desirable, and this will be better guaranteed by planting on all but the most suitable sites for natural colonisation. The longer timescales and lack of control over tree cover density, species and provenance choice associated with natural colonisation are less likely to be appropriate for delivering these management objectives.

Where biodiversity conservation or recreation are the main management objectives, natural colonisation could be an ideal method. The prolonged periods of scrub cover with localised patches of tree development, typically over several decades, can create a range of habitats and food sources suitable for many previously widespread, now declining, species of birds and invertebrates. The variable habitat structure is also likely to offer attractive

surroundings for recreation. In addition, natural colonisation promotes the development of woodland with broad genetic diversity, and this will enhance its ability to adapt to changing environmental conditions in the future. For some species, the conservation of local genetic populations may also be desirable.

1.2. Timescale and costs

The timescale and costs for woodland establishment will also be an important aspect of achieving management objectives.

The timescale for establishing a new woodland by natural colonisation is difficult to predict. The likelihood of success depends on the characteristics of a site, primarily seed availability (Section 2.2), soil type and vegetation cover (Section 2.3), although there can often be variation even within a suitable site. Studies of natural colonisation have shown that where it does not take place within the first 5-10 years – in other words, if establishment is not quick – then it can be extremely slow, taking 30-70 years to develop into a sparse, patchy cover of established trees.

The costs involved are also difficult to determine because they depend on how successful early establishment is, and the intensity of management interventions used. The need for cultivation or vegetation management (Section 2.3) will depend on the site type and the speed at which establishment is required. Management of browsing and grazing animals (Section 2.4) will be necessary on almost all sites.

Comparing costs of natural colonisation with planting

A comparison of potential management interventions over the period of woodland establishment is given in Table 2.

Table 2: The main management interventions associated with establishment by natural colonisation and by planting

Number of years from start		1	2 to 3	4 to 5	5 to 10	10 to 30	30 plus
Natural colonisation	Installation, maintenance, and removal of protection from grazing and browsing animals, and control	Probable	Probable	Probable	Probable	Probable [6]	Possible [6]
	Ground preparation	Possible	Improbable	Improbable	Improbable	Improbable	Improbable
	Vegetation management [1]	Possible	Possible	Improbable	Improbable	Improbable	Improbable
	Advanced or responsive supplementary planting, or remedial planting	Possible	Improbable	Possible	Possible [6]	Probable [6]	Improbable
	Respacing/thinning	Improbable	Improbable	Improbable	Improbable	Possible	Possible
Planting	Installation, maintenance, and removal of protection from grazing and browsing animals, and control	Probable	Probable	Probable	Probable	Improbable	Improbable
	Ground preparation [2]	Possible [5]	Improbable	Improbable	Improbable	Improbable	Improbable
	Vegetation management [3]	Probable [5]	Probable [5]	Possible	Possible	Improbable	Improbable
	Tree Planting	Probable [5]	Improbable	Improbable	Improbable	Improbable	Improbable
	Beating up/replace lost trees[4]	Improbable	Probable [5]	Possible	Improbable	Improbable	Improbable
	Thinning	Improbable	Improbable	Improbable	Improbable	Possible	Probable

Notes:

1. For natural colonisation, vegetation management is unlikely to be appropriate but can be used to achieve higher initial stocking levels in particular circumstances.
2. When planting, ground preparation is unlikely to be necessary for the planting of broadleaves.
3. When planting, the duration/intensity of vegetation management can be reduced with increased stocking density.
4. When planting, losses are often in the region of 10% for the first two years although can be higher, and may require 'beating up (i.e. replacing lost trees).
5. Most costs occur early and are more clearly defined.
6. Costs are less certain but may occur later.

When comparing establishment methods, this should be considered against their ability to deliver particular management objectives (e.g. biodiversity-focused native woodland). Natural colonisation and planting are likely to have similar requirements, and therefore costs, for ground preparation, protection from animals and general monitoring and maintenance. However, if acceptable, a planted scheme can use individual tree guards more easily and this can reduce fencing costs, particularly for long, narrow sites.

In addition to these costs, a typical planted area will incur high costs in the first year for plant procurement and planting, with progressively smaller costs in years two and three for replacing lost plants (known as beating-up). Losses are often in the region of 10% for the first two years although they can be higher. Tree protection and maintenance is unlikely to be required after year 10.

In contrast, natural colonisation entails no initial planting costs. Where suitable densities are achieved in acceptable timescales, overall costs can therefore be low. However, where this is not achieved, supplementary planting may be required, alongside an extended period of protection (the service life of a fence is approximately 15 years, with regular maintenance), and in some cases on-going vegetation management. For example, re-spacing (removing tightly packed saplings to encourage a greater diversity of species) may be required in some cases and this operation is generally considered costly.

For both planting and natural colonisation, fencing should be removed at the end of its functional life. Individual tree protection that has been used to protect planted trees will also need removing and there will be additional costs associated with this; this would also apply to guards or shelters used to protect trees following natural colonisation.

Long term management

Any interventions to control vegetation, grazing and browsing will need to be maintained until an acceptable level of natural colonisation has been achieved, which will depend on the management objectives for the woodland. Where colonisation is slow, interventions may need to continue well beyond the 5 – 10 years typically expected for a planted woodland.

Following successful establishment, on-going management is likely to be required for the continued delivery of management objectives on a site. This may include:

- Maintenance of access routes
- Management of rides and open space
- Management of tree safety

- Thinning (removing a small proportion of trees evenly across areas where canopy has closed) may be necessary where high densities of colonisation are achieved, to ensure the development of a healthy stand and ground flora
- Extraction and sale of firewood and/or timber
- Removal of invasive non-native species
- Management of grazing and browsing animals, and grey squirrels

1.3. Combining approaches

Mixing approaches – in other words, creating a new woodland by using both natural colonisation and planting and / or direct seeding (see below) – will bring attributes of each approach and avoid complete reliance on less predictable natural processes and timescales. The balance between approaches will depend on site factors and management objectives.

Where woodland creation schemes include scope for using different methods in different locations, natural colonisation will be best undertaken in areas that are adjacent to existing woodlands and hedgerows, especially where these are of high ecological value. A woodland creation plan can also accommodate space for further natural colonisation once the planted component becomes established, in which case this is likely to be along ride edges, in open spaces and in wetter areas. Substantial open areas between planted sections may be designated as a combination of woodland and open space depending on where colonisation is successful.

Integrating planting into an area of natural colonisation

Where natural colonisation is the dominant method to be used, the addition of planted areas may be advantageous for achieving a diversity of desirable species or may be necessary in areas, or for species, which do not establish on acceptable timescales. Three types of additional planting are described in Table 3.

Table 3: The timing and objective of additional planting in a natural colonisation area

	Timing	Objective
Advanced supplementary planting	Around the time of initiation of natural colonisation (i.e. 0-1 years)	• Enrich species composition where it is apparent, in advance, which species are likely to dominate colonisation, or where desired species are missing or lost from the local seed sources • Add bird perches to improve seed dispersal • Speed up the development of woodland structure
Responsive supplementary planting	Two or more years after natural colonisation processes are initiated (i.e. 2-15 years)	In response to the initial development of natural colonisation: • Enrich species composition • Support the development of woodland structure • In-fill areas of no colonisation (especially those further from the seed source)
Remedial planting	Following unsuccessful natural colonisation (i.e. 5 or more years, depending on objectives)	In response to failure of natural colonisation: • Ensure the site develops to woodland in the required timescale

Supplementary planting in an area predominantly designated for natural colonisation may be best specified in groups of 10-50 trees. The following principles can support group design:

- To ensure trees can be located for maintenance, plant in groups of 10 or more regularly spaced trees. Individual tree protection makes locating trees easier, so regular spacing is especially important if this is not present.
- To minimise vegetation management requirements, plant trees at a spacing of 1 to 2 metres so the canopy closes more quickly, suppressing competitive vegetation.
- To ensure specific species survive, plant single species groups, or groups of one species surrounded by one or more slower growing species. Mixing species more intimately can increase resilience to future pest and disease outbreaks but the more intimate the mixture, the sooner management will be required to prevent faster growing species from suppressing others.

Integrating natural colonisation into an area of planting

Where management objectives will be better met by planting, natural colonisation can still be incorporated. This may be where it exists prior to planting (as germinating seedlings or more established patches which are then not planted), or where it arrives later among regularly spaced, planted trees. Natural colonisation among planted trees (termed supplementary natural colonisation) can increase stocking density (increasing the timber potential of the stand), enrich species composition, and increase genetic diversity. Natural colonisation should only be controlled where it is suppressing trees planted for specific purposes, is a non-native invasive species such as rhododendron, if there is a need to retain open space, or if respacing is needed.

Direct seeding

Direct seeding is a method of establishment that can be used alongside natural colonisation. At present it is only recommended for using on unwooded ex-agricultural or well-restored brownfield (reclaimed or ex-industrial) sites, where it can be very successful. It has primarily been used for broadleaved woodland and as large numbers of seed are required, it may only be feasible for use with common species that are cheap and readily obtainable.

- UK Forestry Standard practice guide on creation of broadleaved woodland by direct seeding

1.4. Legislation and regulation

The creation of woodland by natural colonisation is subject to the same regulatory checks for environmental due diligence as woodland creation by planting or direct seeding. Woodland creation, whether by natural colonisation, planting, direct seeding or a mixed approach is governed by the Environmental Impact Assessment (Forestry) (England and Wales) Regulations 1999 (the EIA regulations).

- Forestry Commission webpage on Environmental Impact Assessments for woodlands

Priority habitats, species, and historic environment assets will need to be identified and protected.

- Forestry Commission guidance on additional legislation relating to woodland creation: [Please note: the link to this documentation will be added as soon as this becomes available]
- Forestry Commission guidance on Principles for afforestation on or near priority habitats

- Forestry Commission field guide on Priority open habitats and woodland creation

Woodland is viewed as a permanent land use and the Government's policy is a presumption against removing it. This means there are only specific, defined, reasons for which removing a woodland is permitted.

- Forestry Commission webpage on converting woodland to open habitats

An operational plan will need to be in place before any major forest works begin. Operational site assessments are a useful tool to prepare for successful operations.

- Forestry Commission webpage on operational site assessments

Section 2. Site factors

The successful establishment of a new woodland by natural colonisation relies on many factors. However, there are some general principles which can be used to identify suitable sites and potential management options.

2.1. Site survey

A thorough site survey will help identify likely patterns of natural colonisation and the site-specific factors that might limit it. Typical questions to answer through a site survey are given in Appendix 1.

Creation of small, fenced plots from which grazing and browsing animals are excluded, and observation of a site over multiple years can lead to a fuller understanding of the factors limiting colonisation and the intervention required to support it. Where this is not possible, it may be useful to look at similar projects in the locality, or areas with similar conditions in adjacent field corners, areas of higher human disturbance (with associated reduction in deer browsing pressure), and areas where the previous land use has ceased or been altered. Speaking to foresters, ecologists and land managers with knowledge of natural colonisation on similar local sites will be invaluable too.

Existing colonisation

The presence of existing colonisation is a positive predictor of likely successful future colonisation. This may include tree colonisation or, on some sites, the preceding stages of bramble and thorny shrubs. The species and their development and condition will be a good indication of what the site conditions will offer for a new woodland and may indicate what management intervention will be necessary, if any. However, it is important to remember that deer populations have increased in recent decades, and tree diseases (particularly ash dieback) may affect the future availability of some species.

Existing colonisation that is identified on the site itself can be promoted, irrespective of the dominant establishment method that is later selected.

2.2. Seed availability and vegetative spread

There are two ways by which trees propagate themselves – seeding and vegetative spread.

Vegetative spread can take place through growth of suckers (sprouting from roots or the base of the tree) or less commonly through layering (where

branches touch the ground and then root). Such vegetative spread will be localised initially (typically within 5 m of the hedge or woodland edge) but is nonetheless valuable.

The factors involved in seed availability are illustrated in Figure and described below.

For natural colonisation by seeding to be successful, there needs to be enough fertile seed from appropriate species coming onto the woodland creation site. The seeding characteristics of potential seed trees should be considered when assessing their potential. The seeding characteristics of common native species are given in Table 4.

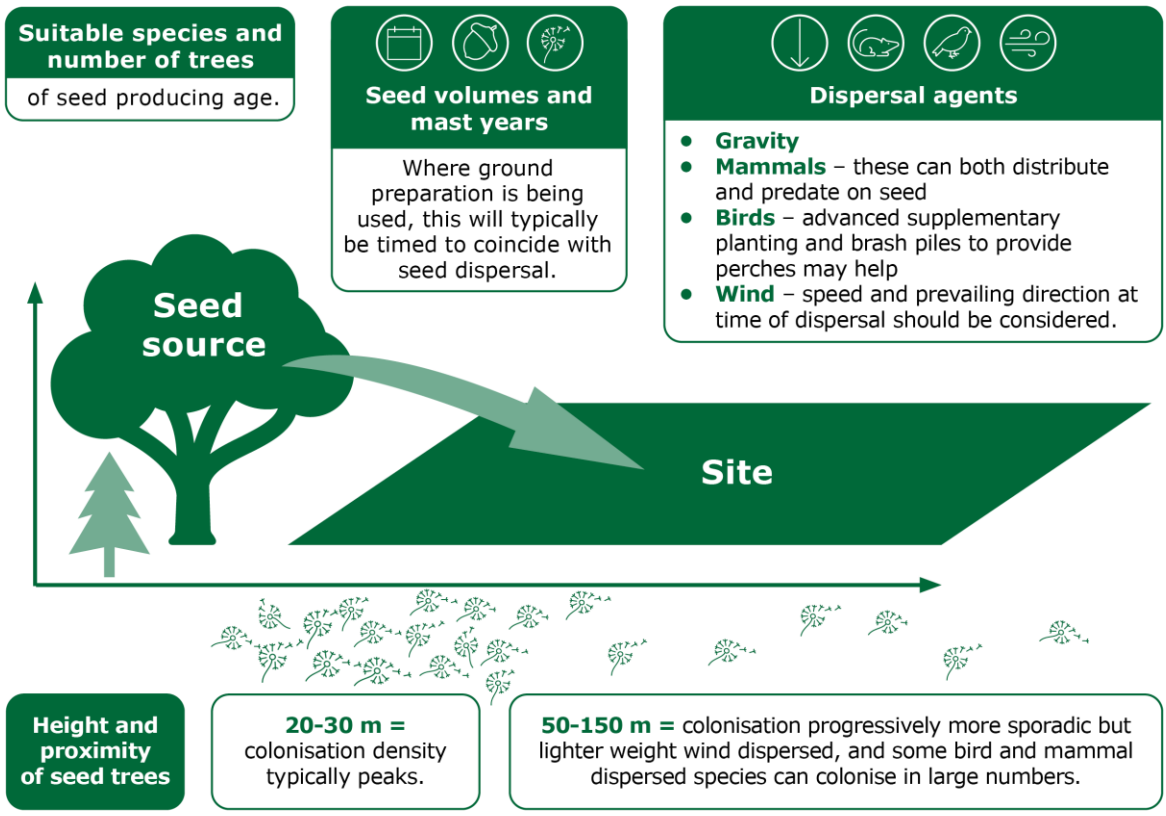


Figure 1: Factors affecting seed availability

Seed volumes

The number, age and health of parent trees will influence their potential as a source of seed for the new woodland, as will the species present. Different species become sexually mature – and later decline in their seed generating capacity – at different ages. Vigorous, healthy trees may produce higher quantities of seed, as may trees in declining health. Some species do not produce heavy seed crops every year, and years where a larger seed crop is

produced are called mast years. Mast years are often determined by climate but are difficult to predict.

Dispersal agents

Depending on the species, seeds can be dispersed by gravity, mammals, birds or wind.

Small mammals such as wood mice and voles can disperse seed that they are attracted to (e.g. beech, cherry and hornbeam) to a distance of around 10 m by carrying and burying them. Seed buried in this way, and not retrieved to be eaten, may be more likely to germinate than those which fall and remain on the surface vegetation.

Birds can disperse seed by digesting berries and excreting the seed (e.g. holly, hawthorn and rowan), or by carrying and burying seed for future consumption (primarily oak). In both cases, seed can be transported over long distances and the addition of perches, brash piles or advanced patches of scrub colonisation may enhance seed dispersal by birds.

For species that rely on wind to disperse their seed (e.g. birch), new woodland sites will need to be down-wind of parent trees according to the prevailing wind direction during the months of seed dispersal.

Table 4: Seed characteristics of native and naturalised trees common in England

Tree species	Maximum distance for colonisation (metres)	Method of seed dispersal	Interval between good seed years	Minimum age to bear seed (years)	Potential for vegetative spread
Oak	20	gravity, mammal, bird	3 to 5	40 to 50	no
Ash	50 to 100	wind	1 to 3	20 to 30	no
Birch	100 to 200	wind	1 to 2	15	no
Cherry	uncertain	gravity, mammal, bird	1 to 3	10	commonly
Alder*	20	wind	1 to 3	15 to 25	commonly

Tree species	Maximum distance for colonisation (metres)	Method of seed dispersal	Interval between good seed years	Minimum age to bear seed (years)	Potential for vegetative spread
Beech	20	gravity, mammal	5 to 15	50 to 60	no
Sycamore	50 to 100	wind	1 to 2	25-30	no
Rowan	uncertain	gravity, bird	1 to 2	15	occasionally
Sweet chestnut	20	gravity, mammal	not known	30 to 40	no
Willows	100 to 200	wind	1 to 2	not known	commonly
Field maple	50 to 100	wind	2	10	commonly
Hazel	20	gravity, mammal	not known	not known	commonly
Aspen	100 to 200	wind	not known	not known	commonly
Small-leaved lime	50 to 100	wind	2 to 3	20 to 30	commonly
Hornbeam	50 to 100	wind, mammal	2 to 4	10 to 30	no
Whitebeam	uncertain	gravity, bird	not known	not known	occasionally
Crab apple	20	gravity, mammal	not known	not known	occasionally
Bird cherry	uncertain	gravity, bird	not known	not known	occasionally
Elms	50 to 100	wind	2	not known	occasionally
Yew	Uncertain	gravity, bird	1	70	no
Scots pine	100 to 200	wind	3 to 5	60	no
Wild service tree	uncertain	gravity, bird	1 to 2	not known	commonly
Holly	uncertain	gravity, bird	2 to 4	20 to 40	no
Blackthorn	uncertain	gravity, bird	not known	not known	commonly

Additional notes:
1. Alder species may also be spread by water (as may other species, in small amounts).
2. For aspen species the production of fertile seed and associated natural colonisation is rare.
3. Where the distance of seed dispersal is uncertain, this is due to birds being able to disperse seed over large distances but there is uncertainty over the exact distance.

Dispersal distance

Where natural colonisation takes place, density will generally peak 20 m to 30 m from the canopy edge of seed trees, declining steadily to 50 m, and becoming more sporadic between 50 m and 150 m. Species with lighter weight seeds that are wind dispersed (such as birch, willow, aspen and Scots pine) or bird dispersed (such as hawthorn and rowan) can readily colonise at greater distances. Heavier seeds are likely to travel much shorter distances, unless moved further by birds.

Surveying the site, or comparable sites in the locality, for evidence of colonisation already taking place can indicate which species are likely to arrive and germinate, especially in areas with no grazing or browsing.

In general, areas within 50 m to 75 m downwind and downslope of existing mature woodlands and hedgerows are more likely to colonise successfully and deliver the associated benefits, especially where patches of colonisation are already present and where grazing and browsing can be controlled.

2.3. Soil and vegetation

In addition to the site being able to receive sufficient volumes of suitable seed, the ground conditions must facilitate both germination and on-going growth. For germination, most tree seeds require access to exposed soil. For on-going growth, seedlings need light, water and nutrients, so adjacent vegetation must not out-compete them.

Soil type

Soils are characterised by their moisture and nutrient availability, depth, and structure (texture). Although different tree species will be better suited to different soil types, the key influence of soil in regard to natural colonisation is on the vegetation that will compete with the colonising tree and shrub species, at both germination and on-going growth stages.

The Forestry Commission’s Ecological Site Classification (ESC) system can help with site characterisation. A soil survey is needed to gather the data to use ESC, and the results will indicate the likely success of colonisation and the management interventions that might be needed to achieve this. ESC is

available as an online decision support tool for species suitability, for a range of commonly used species.

- Forest Research Ecological Site Classification online decision support tool for species and habitat suitability
- Forestry Commission field guide on the Identification of soils for forest management

Table 5 outlines the soil and vegetation types which are likely to support or hinder natural colonisation.

Previous land use

In combination with the soil type, the type and intensity of previous land use will influence both the condition of the soil and the type of vegetation present, and therefore the likelihood of successfully achieving desired levels of colonisation.

For example, brownfield sites[1] may be relatively suitable for natural colonisation, due to the presence of exposed mineral soil, reduced seed banks and less competition from other species. In contrast, highly fertile ex-arable sites are likely to be quickly invaded by competitive vegetation which can hinder the germination and on-going growth of woody species.

While management can mitigate the impacts of site type and competitive vegetation to some extent, as described below, some sites will be inherently difficult. They will be costly or slow to achieve successful natural colonisation on, or efforts to establish a new woodland in this way might fail altogether.

- Forestry Commission Information Note on using natural colonisation to create or expand new woodlands

[1] Many brownfield sites include nationally important priority habitat i.e. 'open mosaic habitat on previously developed ground'. Care is required on such sites to maintain a balance between wooded and open habitats when considering the scope for natural colonisation.

Table 5: Soil and vegetation types likely to support faster or slower natural colonisation

	Colonisation likely to be faster	Colonisation likely to be slower
Soil	Nutrient poor, infertile, acidic, free draining (e.g. lowland heaths and some upland pastures)	Fertile, nutrient rich moisture-retaining clays and loams (e.g. improved pastures and arable fields), in the absence of vegetation management Extremely dry or nutrient poor substrates (e.g. sand dunes)
Vegetation	Slow growing, weakly competitive flora, weak grass swards, small herbs and low growing ericaceous shrubs Patchy vegetation cover with presence of sub-soil or small stony substrates such as gravel and ballast (inc. brownfield sites)	Lush, vigorous, herbaceous vegetation, including dense grass sward or dense bracken cover, in the absence of vegetation management Dense mats of vegetation with no soil or substrate exposed

Ground preparation

Cultivation can be used prior to colonisation to improve conditions for germination, to modify soil properties to support future tree growth and stability, or to bury a seed crop of heavy seed species (e.g. beech or oak). However, the ground disturbance that results can cause soil carbon to be lost from the soil and can lead to erosion on sloping sites. Cultivation should always be limited to the minimum intensity necessary to deliver management objectives.

The presence of a plough-pan (less permeable soil horizon caused by compaction following agricultural use) can hinder drainage, tree growth, and stability. As with other establishment methods, this should be rectified in advance to minimise later problems. The use of a tractor mounted subsoiler or ripper (machinery with tines which break up lower soil horizons without turning

over the soil) can break the plough pan at depths of up to 70 cm and reduce compaction issues.

On poor acidic soils, especially where a deep litter layer or dense grass sward limits germination opportunities, surface ground preparation may be a useful option to generate a seedbed of exposed soil and increase diversity and density of colonising tree species. On nutrient-rich soils the seedbed created is likely to stimulate the growth of competitive vegetation which will subsequently hinder tree germination and growth; in these cases, cultivation should be avoided.

Mechanical scarification (localised scraping away of surface vegetation) is the preferred method of cultivation to avoid excessive soil disturbance and still produce a seedbed. Where high stocking densities are not required, light patch scarification may suffice and minimise disturbance further. Ground preparation will usually be timed for late summer (depending on the target species) and, ideally, to precede seed-fall during mast years. The exception to this is for large-seeded species such as oak and beech in which case the operation will be more beneficial after seed fall, to bury the seed.

- Forestry Commission guidance on cultivation and UKFS compliance for application in England

Sites such as riparian areas, with naturally driven dynamic processes leading to exposed soil, may create ideal conditions for natural colonisation, whatever the soil type; however, competition from other vegetation is also likely on such sites.

Vegetation management

Managing vegetation can help create and maintain good conditions for natural colonisation, potentially leading to increased densities and improved growth rates. A good understanding of the likely future dynamics of ground cover is needed before interventions can be decided on – and a thorough site survey is needed to inform this. Vegetation cover on a site can hinder germination and compete with tree seedlings, leading to their reduced growth and increased mortality. This might be less of a problem on nutrient-poor sites where competing vegetation growth is comparatively weak (especially following cultivation), making it more likely that the colonising tree species can out-compete other vegetation. On nutrient-rich sites where strong vegetation competition is likely (and cultivation is less appropriate), vegetation control might be needed for several years to help the colonising trees species establish more quickly.

The simultaneous phases of natural colonisation limit the options for using herbicides to control vegetation. Applications of herbicide similar to those suggested for direct seeding may be useful but will need to be tailored to local circumstances.

- UK Forestry Standard practice guide on creating new broadleaved woodland by direct seeding

Dense bracken cover will prevent colonisation by woody species and may need appropriate herbicide control during spring and summer until trees are satisfactorily established.

The use of chemical control should always be limited to the minimum intensity necessary to deliver management objectives. Where vegetation control techniques are used, caution should be exercised to avoid damaging any existing colonisation or creating ideal conditions for blanket colonisation by undesirable vegetation.

On some sites, scrub vegetation such as bramble, wild rose, dogwood and blackthorn may begin to dominate. This can include pioneer tree species such as willow or birch and can be considered a natural pioneer phase which is known to support high levels of biodiversity. The thorny shrubs may help to protect slower colonisers such as oak and beech from browsing animals, supporting their establishment over several decades. Management objectives will dictate whether this phase is considered acceptable for the site.

2.4. Browsing and grazing animals

In most instances, grazing and browsing animals (livestock, deer, rabbit, and hare) will have to be closely controlled or eliminated from the site to achieve suitable levels of colonisation. The length of time for which this is needed will depend on the success of colonisation and establishment but, in some cases, it may be required for several decades.

Deer

It is important to determine which deer species are present, and their local abundance, to predict their likely impact on a natural colonisation site. This should be done primarily through expert observation and consultation with local foresters, ecologists and/or deer specialists. The most up-to-date information on deer distribution and population densities should be used including, where available, an indication of local levels of risk.

The most effective way to control deer is through managing a population across a landscape, to limit their numbers to a level that will allow the natural

colonisation of desirable species. This requires adequate resourcing and coordination with adjacent landowners. Frequent culling on site will also reduce numbers and have the effect of making the area "unsafe", thereby reducing pressure on that site by displacement. The potential need to manage deer in the future should be considered in the site's woodland creation plan so that adequate open space is available to enable this.

Where it is infeasible to manage a deer population across a landscape, deer fencing is an alternative. However, it is expensive, does not address landscape-level deer populations, and can result in deer becoming displaced from part of their existing range and so increasing pressure in other areas. Deer fences can be easily breached and to minimise the likelihood of this several smaller areas should be fenced rather than a single large area. Fences will require regular monitoring and maintenance throughout a typical 15-year lifetime to ensure they remain functional, particularly where local deer pressure is high. Fencing should ideally be used in conjunction with population control to prevent local deer densities growing to unsustainable levels.

- Forestry Commission guidance on woodland creation and mitigating the impacts of deer
- British Deer Society deer distribution data

Rabbit and hare

High populations of rabbit or hare can hinder the development of natural colonisation, and these may need to be managed locally through population control or fencing.

- Forest Research webpage giving options for preventing mammal damage to trees and woodland

Livestock

Grazing by livestock is likely to inhibit high densities of natural colonisation and will need to be stopped or closely controlled. However, there is some debate over whether it can also create conditions that support colonisation when at managed densities. Grazing animals can promote the development of a dense sward of finer grasses, which in combination with exposed soil due to trampling, can create suitable conditions for germination. In addition, some livestock are highly selective, and may avoid patches of specific vegetation leaving the woody species among them to establish. The rooting activity of pigs and feral wild boar can also have a positive influence, although they are likely to consume large volumes of seed too.

Tree growth will typically be curtailed by continued grazing, but with careful and consistent reduction in pressure over several years before removing it altogether, some species may germinate and become established. This is a

complex process requiring close attention and careful management and it is important to recognise that grazing and browsing pressure will have to be eliminated or substantially reduced to achieve colonisation on most sites.

- Forestry Commission Information Note on domestic stock in woodlands

Further information

The following resources include information on the creation of new woodland using natural colonisation:

- HARMER, R. (1999). Using natural colonisation to create or expand new woodlands. Forestry Commission Information Note 23. Forestry Commission, Edinburgh.

- HARMER, R. and KERR, G. (1995). Creating woodlands: to plant trees or not? In: The ecology of woodland creation (ed. R. Ferris-Kaan). John Wiley & Sons, 113 –128. https://www.forestresearch.gov.uk/documents/6783/FCIN023.pdf

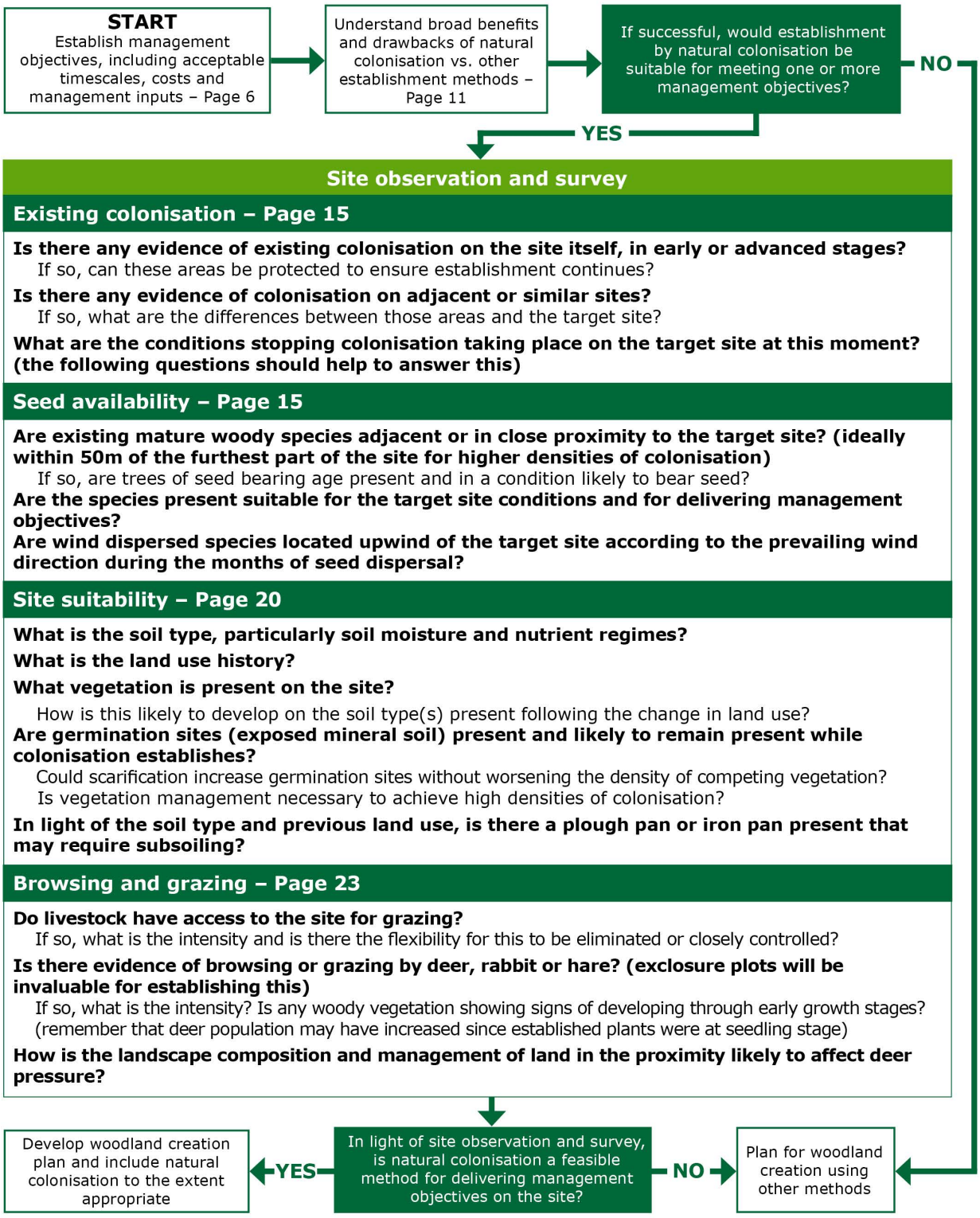
- HARMER, R., KERR, G., and THOMPSON, R., (2010). Creating new broadleaved woodland. In: Managing native broadleaved woodland. Forestry Commission Handbook 3. The Stationery Office, Edinburgh. https://www.forestresearch.gov.uk/research/managing-native-broadleaved-woodland-2/

- HODGE, S (1995). Creation and management of woodlands around towns. Forestry Commission Handbook 11. HMSO, London. https://www.forestresearch.gov.uk/research/archive-creating-and-managing-woodlands-around-towns/

- RODWELL, J. and PATTERSON, G. (1994). Creating new native woodlands. Forestry Commission Bulletin 112. HMSO, London. https://www.forestresearch.gov.uk/research/archive-creating-new-native-woodlands/

- THOMPSON, R. (2004). Predicting site suitability for natural colonisation: Upland birchwoods and native pinewoods in Northern Scotland. Forestry Commission Information Note 54. Forestry Commission, Edinburgh. https://www.forestresearch.gov.uk/research/archive-predicting-site-suitability-for-natural-colonisation-upland-birchwoods-and-native-pinewoods-in-northern-scotland/

Appendix 1 – Decision making and site survey overview



Appendix 2 – Factors involved in utilising natural colonisation for woodland establishment