RFS
ROYAL FORESTRY SOCIETY

MANAGING FOR RESILIENCE

12 case studies - incorporating All-England Woodland Resilience Award winners

Royal Forestry Society in partnership with

Forestry Commission

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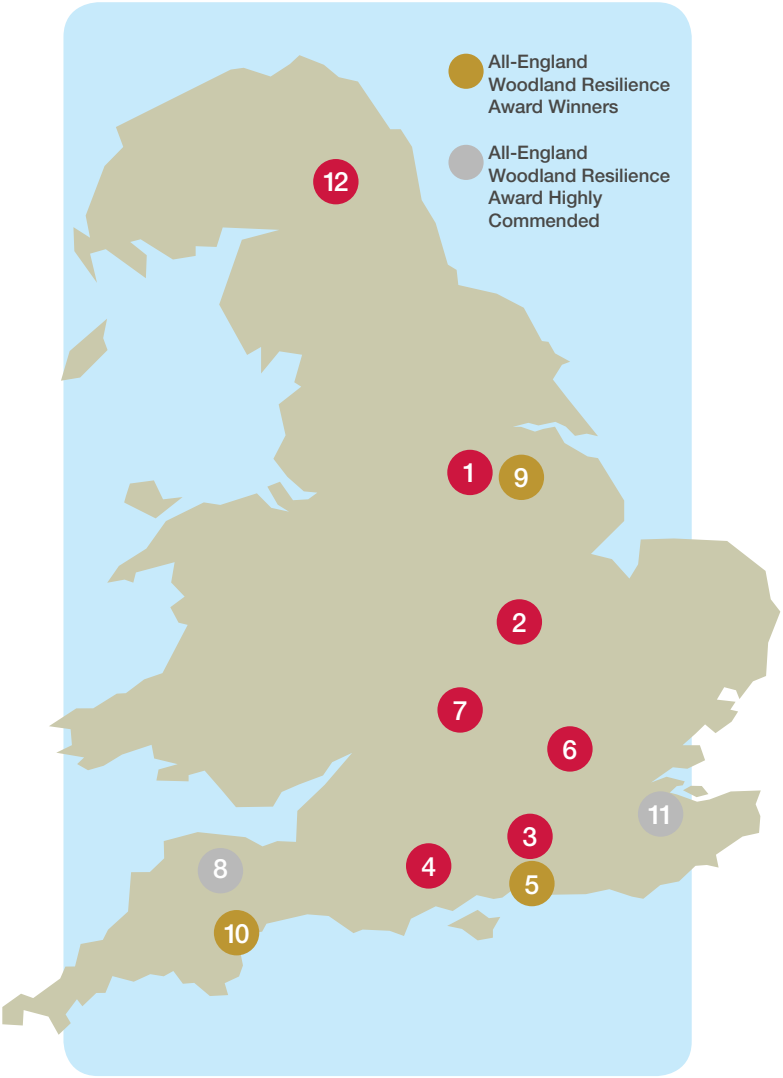

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INTRODUCTION

Climate change and the increased incidence of tree pests and diseases is already putting some of our trees and woods under stress. Predictions for more frequent and extreme weather events could impact woodlands further. Evidence suggests the pace and extent of change may be too great for some woodland systems and species to adapt without human intervention.*

Adapting new and existing woods to unprecedented environmental change requires a re-assessment of our approach to management in order to ensure the continued delivery of the ecosystem goods and services we derive from them. *The Climate Change Accord* sets out guiding principles for adaptation:

- Follow *UK Forestry Standard* (UKFS) guidelines on climate change adaptation. The UKFS emphasises the importance of planning;
- Plan on the basis of climate projections specific for the site for 2080+;
- Base actions on the best available evidence and decision support tools;
- Accept an element of risk. There are no risk-free options or definitive answers;
- Act now, before symptoms of stress and damage are evident. Delay makes the task harder;
- Recognise the diversity of woodland types. Actions will vary with woodland type and management objectives. There is no single acceptable approach;
- Work with nature and natural processes to enable successive generations of trees to adapt to climate change and enhance biodiversity.

The 2020 British Woodland Survey indicates we are making slow progress with the process of adaptation. 70% of survey respondents did not have a UKFS-compliant management plan and 70% were not aware of local climate projections despite observed increases in the frequency of droughts.

This collection of case studies is intended to provide practitioners with insight and inspiration from a number of land managers who are taking action to increase the long-term resilience and health of their woods, consistent with the constraints of the site and their management objectives.

A short companion report *Resources for Managing Woodland for Resilience* contains resources on the aspects of forest management linked to resilience, from climate change impacts and adaptation to surveying and maintenance of the soil resource. These have been adapted from an article in the July 2021 QJF *Forest Resilience Part 2* by: Tew, E., Coventry, R., Fensom, E. and Sorensen, C. (2021).

**Forestry Commission (2020) Managing England's woodlands in a climate emergency. A guide to help foresters and agents implement adaptation actions.*

All-England Woodland Resilience Awards 2021 were hosted by the Forestry Climate Change Partnership as a forestry sector contribution to mark COP26.

Case studies on the winning and highly commended woodlands in the Existing Woodland and Woodland Creation categories are included in this report.

They are:

Existing Woodland: Joint Winners Perridge Estate, near Exeter and the Morton Hall Estate, near Retford; Highly Commended, Moor Wood in Exmoor National Park.

Woodland Creation: Winner, Goodwood Estate, West Sussex; Highly Commended, Pleasant Forest, Kent.

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PLANNING FOR RESILIENCE

The UKFS defines resilience as:

"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."

As illustrated by the definition, resilience is a system property.

Whilst there is an awareness of the current and future stresses faced by our woodland systems, the challenge is turning that broad awareness into a clear picture of what resilience looks like in a forest stand.

Defining the boundaries of the system

These must include not only the geographic and ecological boundaries but the human ones – the objectives of that woodland to deliver particular goods and services, both now and in the future.

Moving forwards

Once the system has been defined, the specific stresses and changes likely to be a threat to its continued functioning can be determined, and their level of significance understood. The potential compound effect of interacting stresses may also become apparent. From there, management to promote a woodland's ability to absorb and adapt can be targeted and prioritised, and innovative solutions sought.

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CASE STUDIES

The following case studies represent a wide range of site types and locations from the heavily gleyed soils of Northumberland, through the sandy soils of north Nottinghamshire, to the chalk of the South Downs.

They also cover a range of management objectives. However, they have some characteristics in common:

- Adaptation to environmental change has been carefully considered in management planning;
- Plans are based on a good understanding of local soil properties and variation;
- Species selection is guided by this knowledge of local soils combined with experience of what species thrive locally, often augmented by predictions from the Ecological Site Classification Decision Support System (ESC-DSS);
- Species diversification is a central objective, typically motivated by both ecological resilience and financial sustainability; and
- Strategies for establishment and maintenance are an integral part of the plan, especially mitigation of deer damage.

Diversifying age structure by adopting a continuous cover approach is central to some case studies and has been considered and rejected by others.

Species choice has, in some cases, been strongly influenced by commercial considerations, with land managers taking advantage of the strong biomass market to widen their traditional selection of hardwood species.

Seed provenance is an important consideration in some but not all case studies.

For others, **biodiversity** and **landscape** are priorities in their approach.

Some case studies also show a greater appetite for measured risk in species selection in relation to future climate conditions. The diversity of approaches to achieve a common goal is in itself an important component of resilience.

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1. BABWORTH ESTATE, NEAR RETFORD, NOTTINGHAMSHIRE

Diversification of a Corsican pine plantation

Owner: **Sir Jack Whitaker Bt**

Forest manager: **Josh Robinson**

Experimenting with radiata pine

Overview

The Babworth Estate is located in north Nottinghamshire near Retford. The estate comprises two blocks of land 15 km apart: the Bawtry block includes 250 ha of forestry previously leased by Forestry England which is 90% conifer; the Babworth block includes 74 ha of primarily broadleaf woodland.

This case study describes the management of the Bawtry conifer woodland.

The current structure of Bawtry reflects key historic events:

- 250 ha leased by the estate to the Forestry Commission in 1929 which over the following two years planted the area with Corsican pine (75%) and Scots pine (25%) The future of the Corsican pine has been heavily impacted by Dothistroma Needle Blight (DNB).
- A major fire in 1953 destroyed over 100 ha. The Forestry Commission restocked mainly with Corsican pine, missing an opportunity for species diversification but creating a more uneven aged forest which has been an asset.
- The estate bought out the Forestry Commission's leasehold interest in 1993, creating a commercial forest estate that supports a forest manager and a professional forestry agent.

Bawtry lies on acidic sandy soils with poor moisture retention and low fertility originating from the underlying Bunter sandstone. Rainfall averages 600 mm a year but frequent spring droughts make establishment of restock sites a challenge.

Management objectives

- Manage a commercial forest enterprise;
- Retain 60% conifer cover to underpin the Estate's forestry cash flow;

Increasing the proportions of eucalyptus on new restock sites

- Restructure the age class distribution from predominantly even age to a diverse age structure to provide a continuous supply of mature conifer in rotation; and
- Diversify the palette of species and provenance within species to increase resilience to pests, disease and climate change, informed by ESC and evidence from other local estates on similar soils, especially the value of Douglas fir.

Delivering change

The estate's management objectives are delivered by:

- Clearfell and restock currently 5-6 ha of mature conifer, mainly Corsican pine, each year which provides a regular cash flow and broadens the age class distribution.
- Restock with alternative species and site suitable provenances within species. In the early phase of delivery (from 2012), the Estate selected three major productive species:
  - Douglas fir: the dominant restock species (50-55%). A provenance from Washington state, South Cascades which has slightly better form and is also more tolerant of drought.
  - Scots pine: (20%). An improved variety which has proven to be more resilient to drought.
  - European larch: (10%). Remains a viable commercial species in the east of England with no evidence of Phytophthora ramorum.

The estate has also experimented with a variety of radiata pine which is reportedly resistant to DNB. This was sourced as seed from New Zealand where it is the staple forestry species, and grown on in a UK forest nursery. It is fast growing with a tendency to topple in years 3-6. Deeper planting to encourage better root growth and structural anchorage is being trialled as a solution.

In the early phase the restock was planted out in lines (3 rows Douglas fir, 3 rows European larch, small blocks of Scots pine) for ease of harvesting. This planting scheme has been replaced with planting in blocks of 100-150 single species.

Widening the palette further

The estate has widened the palette of species, considering that 3-4 species is not sufficient to build strong resilience long term or adequately manage disease and climate risk. The initial palette has been supplemented when restocking following clearfell with Serbian spruce, silver fir, western red cedar, western hemlock and eucalyptus (mainly E. glaucescens). Initially these additional species made up no more than 4% each of the planting mix. ESC indicates they are suitable for current and projected site conditions.

The aim now is to increase the proportion of eucalyptus on new restock sites from 4% to 15-20% and has received approval from the Forestry Commission. This reflects the increase in the size and profitability of the biomass market. Eucalyptus is well suited to site conditions on the Estate and its growth rate makes it an attractive commercial species.

Establishment of conifers is assisted by using plugs in place of bareroot saplings. Plugs establish better in the light soils, minimise damage due to handling and extend the planting season. The saplings are protected by plastic vinewraps and canes, a relatively low cost option which facilitates mechanical weeding and spraying by quad bike, thus keeping costs down on required manpower.

The estate has considered adopting a continuous cover approach in place of the preferred clearfell and restock but has found that gaps in the canopy are rapidly colonised by a dense thicket of silver birch and any conifer regeneration is difficult to spot and expensive to manage. In restock sites birch regeneration is sprayed off.

Currently the adopted silvicultural approach is delivering the estate's objectives and financial performance is encouraging.

Further information

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2. BOUGHTON ESTATE, NORTHAMPTONSHIRE

Diversifying ash oak woodland to increase species diversity and future market potential

Owner: **Boughton Estate, Weekley, Kettering, Northamptonshire**

Forest manager: **Jonathan Plowe - Woodland Operations Manager, Buccleuch Woodlands Enterprises Ltd**

Large oaks left in situ for landscape and ecological benefits

Overview

Boughton Estate in north Northamptonshire includes 935 ha of mostly native woodland located between 80 m and 120 m above sea level. The woods at the Boughton Estate consist of four large woodland blocks, outlying spinneys and smaller woodland areas which all provide important habitats for local wildlife. These smaller areas are a mix of Ancient Semi-Natural Woodland (ASNW), recent plantings of farm woodland plots and larger areas of quarry restorations, park woodland and Sites of Special Scientific Interest (SSSI).

Most of the woodland on the estate is located on glacial tills on the higher ground in the local area with slightly acid to acid loamy soils and varying levels of clay. Where the ground is level, significant waterlogging can occur. The exceptions to this are the extensive old ironstone quarry sites which are generally more acidic and display signs of severe soil compaction resulting from the restoration processes.

Rainfall: The rainfall in the area is approximately 600 mm per year.

A site now in its third growing season

Management objectives and drivers of change

The management objectives focus on improving the resilience of the woodland to pests and diseases by increasing the diversity of species across the estate and support the move towards a more structurally diverse woodland with a mixture of age classes.

Before action was taken to diversify the woodland, it comprised predominately of a high proportion of mature ash and oak. However, the woodland is being heavily impacted by ash dieback (Hymenoscyphus fraxineus) whilst the oak is affected by an emerging disease of oak trees, Acute Oak Decline (AOD).

This has prompted the creation of a new 10-year re-stocking strategy where the management of ash dieback and AOD is a major component. Where the percentage of ash in the individual compartment is higher than 60%, clear-felling and re-stocking with alternative species is the considered option. Below this percentage it is anticipated that there will be enough other species to result in a productive compartment at the end of the rotation. The main objective of the re-stocking strategy is to maximise the economic value of the trees affected whilst limiting the spread of AOD.

The woodlands on the estate are under a higher-level Countryside Stewardship woodland management agreement and Tree Health Restoration Grants have been used to fund restocking of land where trees have been felled due to ash dieback.

Biomass potential

Reducing the exposure of the estate's woodlands to disease is not the only driver for species choice change. The estate is moving towards supplying wood for biomass and away from such a reliance on saw logs as there are very limited markets for hardwood other than for oak. The local biomass market requires large volumes of quick growing timber and so this requirement has been influential when considering the replacement species options. The estate notes that the income from growing for biomass is economically more efficient.

The decision to move towards the growth of timber for biomass is also due to the constraints of the site. The heavy clay soils limit what will grow and the woodlands are very wet and thus difficult to work. Hornbeam and sycamore are seen to regenerate well if there has been a good mast year, but in 80% of the areas where these species are used, vegetation competition and browse pressure from the local deer population limits their establishment despite active management. 30% of the trees which were planted during the winter of 2019-20 failed due to the waterlogged soils experienced in that very wet winter and so the species mixtures have been further diversified to help ensure that there will be successful establishment.

Delivering change

Species selection:

Restock sites (ASNW) – 2018>

In response to the development of AOD across the site, the percentage of oak in restocking mixtures has been steadily reduced and the diversity of species increased to improve resilience to pest and disease threats and provide a supply of timber for the biomass market. Local knowledge of species which perform well on the waterlogged soils, alongside use of the Ecological Classification Decision Support System (ESC-DSS), helped to inform the species composition for restocking mixtures.

Sites restocked two years ago comprised of: 60% oak in single species rows, 30% birch, alder and sycamore in equal amounts. 10% mixed broadleaf trees. The aim of this species mix at the time of restocking was that species other than oak would act as a nurse crop for the oak or would be preferentially thinned out to leave the oak.

Sites restocked one year ago: in response to increasing levels of AOD on the estate the percentage of oak included in the species mix was reduced to lower the estate's exposure to risk - 40% oak, 50% sycamore, alder, birch. 10% mixed broadleaf trees planted in an intimate mix.

A 2020 restock site

2020 winter planting comprised of: 30% oak, 60% sycamore, birch, alder, lime, cherry in equal amounts. 10% other mixed broadleaf trees. Lime and alder were planted in January 2021 across the whole estate to reduce the reliance on oak as they have proven to grow well on the clay soils. The large oak trees are to be left in situ for landscape and ecology benefits.

Where there is ash regeneration which appears to show tolerance to ash dieback, this will be retained. There is a large presence of ash on the estate so natural selection will become evident, and any apparently tolerant trees will be retained and monitored beyond the clear fell areas.

Commercial considerations

As well as considering appropriate species choice, the estate is keen to identify all commercially viable areas within the woodland. The estate managers map these areas when planning restocking operations to increase economic viability by minimising tree failure in areas of the woodland with high commercial value. The site is mulched to ground level to ensure effective maintenance in the crucial first three years and to allow access to maintain the deer fence effectively. The estate is mindful to limit mulching to the planting areas to ensure this doesn't prevent the regeneration of woody species elsewhere.

Where there are mature trees, the estate does not plant new trees under the canopy. A distance of 4-5 m from the mature tree ensures there is sufficient light available for the young trees and enough space to extract the mature trees. In addition to this, no planting takes place within 3-5 m of rides, fences or important ditches to limit maintenance and removal costs in the future. The estate is trying to reduce the non-productive areas to a minimum, even if that means leaving areas free of trees.

In addition to changing the species composition within the existing woodland, the estate also created areas of new woodland 5-10 years ago and have included the use of conifer species in a mixture with oak (50% oak + 50% Norway spruce) as well as a couple of 100% mixed broadleaf areas. The estate plans to plant more new woodland using conifers including western red cedar, Scots pine and Douglas fir in a mix with broadleaf species which can be harvested on shorter timescales to supply the biomass market.

The aim is to make a commercial return but there are considerations; the estate will need to evaluate how the use of non-native species fit within the landscape and grant scheme eligibility.

Future planting will take into account changes in the agricultural grant scheme. The areas of poor-quality land on the estate will form a buffer of new productive planting against the existing woodland, making use of the Woodland Carbon Guarantee scheme.

Management

The estate aims to keep the use of fencing to a minimum. Following very robust deer control over the past five years, deer fencing is not required in the ex-arable areas which are away from the main woodland blocks where more unpalatable tree species (birch, alder, some conifer species) are grown for biomass. Where fencing is utilised in the main woodland blocks, a 3 m gap is retained around the fence line which is always placed on level ground and avoids water courses to allow access for mowing. Regular maintenance is carried out to keep the fence line clear of brambles. This is important when considering the future removal of the fence and the recycling of materials.

As few tree guards are used as possible as the estate do not consider their use to be economic. Tubes are utilised in line with biodiversity requirements and where there are views into the woodland where a fence would impact upon the vista in the areas with public access. Due to the costs associated with planting using 1.8 m tubes, the estate now only uses these where there is an overriding future landscape reason.

Further information

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Photo credits - Jonathan Plowe

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3. DIDLING FARM, SOUTH DOWNS, WEST SUSSEX

Supporting transformation of ash dominated woodland in a SSSI

Owner: **Didling Farm Ltd.**

Forest agent: **Neil Chamberlain, Maydencroft**

Ash dieback is driving change

Overview

The woodland within Didling Farm is around 62 hectares in size and is mostly along a scarp slope of the South Downs, east of South Harting in West Sussex. The woodland falls into several National Vegetation Classifications (NVCs); the predominant is W8 – ash with field maple and dog's mercury, interwoven with W12 – calcareous beech and yew, and W13 – yew woodland.

The age structure is relatively uneven due to storm damage and other natural processes. There has been some planting and enrichment, including a small plantation of even-aged Norway spruce along a less steep section of the site.

The site features very thin lime rich soils over chalk and the altitude ranges from 70 m to 200 m above sea level. It experiences low rainfall but does have a very steep north-facing slope.

The woodland has received less intervention and management than other woodlands on the estate due to its steep slope and its location. As well as being within the South Downs National Park, it is also part of the Harting Downs Site of Special Scientific Interest (SSSI), and has several drovers tracks and Public Rights of Way running through it. It is currently under a Countryside Stewardship Higher Tier woodland improvement grant scheme.

An important interface with chalk grassland

Management objectives

The management objectives are to:

- help increase the woodlands resilience to pest, disease and the effects of climate change by planting principally broadleaf trees grown from seed collected from a wide variety of provenances. These broadleaf trees should be mostly locally native but can include minor elements of exotic but naturalised trees such as Italian alder and Norway maple to help broaden the species mix;
- help diversify the ash dominated woodlands by encouraging the regeneration of all species through regular thinning interventions where practically possible;
- protect the yew groves from falling ash trees as the ash continue to die back and collapse;
- maximise the woodland's biodiversity potential by maintaining the expansive open space, scrubby areas and important interface with the chalk grassland and by ensuring dead and dying trees are retained where they do not pose a risk to the public;
- help ensure a safe environment for walkers and workers alike by adopting a regular tree safety inspection programme;
- reduce the extent of exotic conifer monocultures.

Delivering change

The main driver of change is ash dieback. Ash dominates the woodlands all along this scarp slope and its demise will radically change the woodland landscape. There will be some owners/managers who feel this is an opportunity for other native species or habitats to thrive (this area has some beautiful chalk grassland both above and below the woodlands and species rich shrubby grassland is a very valuable habitat) but probably fewer owners who will try to support woodland through the transformation from ash to something else.

This is the first resilience project the owners have tried on this site. It is currently under a woodland improvement grant, and is also hoping to use the tree health grant available from the Forestry Commission to help subsidise the cost of replanting after removing the dying ash. Using planting instead of relying on natural process allows for the introduction of other tree and shrub species which helps diversify the species mix.

Ash currently dominates the woodland

The Ecological Site Classification (ESC) tool was used extensively to design the restocking proposals.

Site surveys also looked at what was growing well and historical records consulted to find locally important trees including large leaved lime that grows along the scarp in a SSSI. The management plan has not yet been adopted as it is still at the consultation phase.

Sourcing of trees is still on-going as the project is waiting for the approval of the management plan before works commence. The team are considering the use of beech sourced from further south in Europe for its potential to be more resilient to drought. Once the management plan has been approved, small coupes of new planting will slowly be created in the worse-affected areas. Once planted, the trees will be maintained with a mixture of herbicide and hand weeding until the trees are established. The area also has a large number of deer, so all the trees will be tubed, in addition to the deer control already carried out by the estate.

The species list for the replanting is as follows:

Species name	% within mix	Key attributes
Large Leaved lime	10	Thrives locally and historically important
Field maple, whitebeam and hazel	25	Part of the native W8 woodland type
Wild service tree	10	Grows well on chalk slopes (eg Chilterns)
Beech	20	Part of the native W12 woodland type
Crab apple, Spindle and Dogwood	20	Habitat provision
Norway maple and Italian alder	15	Exotic but not invasive. Good on these soils and considered highly suitable in ESC

Red oak and holm oak were considered but rejected after consultation with ESC.

Looking into the future, the estate is planning broadleaf plantations elsewhere on the estate, and the deeper, more neutral soils will be enriched with other native broadleaves to diversify species mix. There are no plans at present to introduce exotics but the estate will look to different provenances to build resilience into their woodlands.

Further information

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4. FARNHAM WOODS, RUSHMORE ESTATE, DORSET/WILTS

Transformation to irregular structure selection system

Owner: **The Trustees of the Rushmore Estate**
Forest manager: **Andy Poore**

Enrichment planting following 2017 thinning

Overview

The Rushmore estate is situated in the Cranbourne Chase Area of Outstanding Natural Beauty and on the Dorset-Wiltshire border, 17 miles south west of Salisbury. The estate includes 833 ha of woodlands of which 60% is native semi-natural, 25% is conifer dominated and 15% is non-native broadleaves or other woodland types.

The woodlands lie wholly on the dip slope of a large chalk escarpment, largely on the mid to upper part of the slope between 100 and 180 m above sea level but extending to the top of the escarpment at 260 m. The dip slope is deeply dissected in places but the woodland lies mainly on the plateaus between these deeper dry valleys, and across shallower valleys. The depth of the soil over chalk is highly variable and a clay cap of rather acid loamy soils is present in places.

Rainfall averages 1050 mm per annum. Trees are able to access water from the chalk substrate so the woodland soils are not drought-prone, despite a lack of surface water.

The focus of this case study is compartment B2/3. This is located in Farnham Woods at 110 m above sea level and on the deeper, acid clay loam soil. The stand is currently composed primarily of early-mature Norway spruce planted in 1963, with small proportions of other conifers and oak.

Management objectives

The higher level management objectives for the estate woodland which apply to compartment B2/3 are:

- To create a structure which maintains positive cash flows as far as possible through reducing costs and which seeks, in the long term, to maximise the production of quality sawlogs and where appropriate, larger dimension timber; and
- To create a forest structure and composition which will be resilient to biotic and climatic threats.

The woodlands have been under Andy Poore's management for the last 30 years. Increasing resilience by the introduction of structural diversity, appropriate levels of growing stock and longer-term species diversification has been a goal throughout that time.

Specific silvicultural aims now include the use of:

- Permanently irregular structures;
- Natural regeneration;
- Mixtures of one main species and one to three secondary species;
- Selective harvesting to promote vigorous individuals with disease tolerance and good timber quality characteristics.

The estate receives Countryside Stewardship higher tier funding for the woodlands.

Delivering change

Current and target species composition and species attributes in compartment B2/3

			Key attributes	
Species name	Current % of species composition (>7 cm dbh)	Long-term %	Climate Change Suitability	Other
Norway spruce	93	35	Mod	Established demand. NS will be more resilient to increased temperature if within a mixed spp irregular structure
Douglas fir	<2	40	High	Established demand, incl large sawlogs. Well adapted to irregular silviculture.
Western hemlock	<2	5	Mod	Established demand. Well adapted to irregular silviculture. Accept nat regen rather than planting
Western red cedar	0	10	High	Established demand for larger sawlogs. Well adapted to irregular silviculture
Coast redwood	0	5	High	Fast growing. Developing market. Untried in UK irregular structures.
Oak/other broadleaves	6	5	High	

The silvicultural approach is described below. Cpt B2/3 is currently in Stage 2 - the Regeneration Initiation Phase of transition from an even-aged structure to a permanently irregular one (see box).

Establishment of permanent racks; edge trees marked blue, and trees to remove marked red, 2017

Selection felling

The final structure will be permanently irregular at the sub-compartment / stand element level. When this structure has been achieved the silvicultural system employed can be described as a 'Selection' system. Interventions ('selection fellings') will be on a 4-6 year cycle and will:

- Utilise increment (annual volume growth) and stand structure data (standing volume, diameter and species distribution) derived from the periodic surveying of sample stands to set overall target parameters;
- Maintain the structure and growing stocks by harvesting only the increment. It is envisaged that the target growing stock will vary from around 26 to 34 square metres of basal area per ha for stands dominated by Douglas fir and Norway spruce;
- Retain good quality trees irrespective of position until the target diameter for that species* is reached. After this point the presumption to retain ceases and the stems may be removed. Only a proportion of trees above the target diameter are removed at any one intervention;
- Consider wind loading, seed sources and wider biodiversity objectives (as well as target diameter and quality) in the selection of trees to fell or retain;
- Ensure that the correct amount of regeneration and recruitment into the upper storey is occurring; and
- Regulate competition for light particularly to the lower storeys. This is in contrast to interventions in even-aged stands which are designed to regulate competition for lateral space.

**The target diameter is different for each species and for each main quality grade within species. It is the diameter where the standing value of the tree equals its expectation value.*

Stages of transformation to an irregular selection system

Stage 1. Preparatory Stage (before seeding starts)

- Achieve stand stability to wind loading by maintaining stand volumes near to 'Management Table' (MT) levels but gradually promoting clumpy spatial distribution. Basal Area (after thin) will be between MT + 5% and MT –10%
- Improve phenotypes by the intensive removal of stems with negative characteristics, subject to biodiversity and other non-timber production objectives
- Promote structural diversity by avoiding regular spacing amongst retained stems
- Promote species diversity by intensive retention of secondary and minor species

Stage 2. Regeneration Initiation Stage (when seeding age reached)

- Reduce stand volume somewhat below long-term target to initiate regeneration
- Create small discrete gaps of less than 0.1 ha, if the opportunity arises
- Begin enrichment planting to diversify species as appropriate

Stage 3. Structural Development Stage (when sufficient regeneration established)

- Allow stand volume to increase towards target volume/ basal area.
- Develop full structural and species diversification.
- Relate stand structure to increment to guide structural development.

Regeneration

Within the fully developed irregular structure regeneration will generally be by natural regeneration. However, during the transformation period, often the current species composition in coniferous stands is dominated by one species and structural transformation will be combined with species diversification. This will be achieved through enrichment planting introduced in Stage 2 (see box above) where moderate-sized growing stock is manipulated to produce small gaps of <0.1 ha.

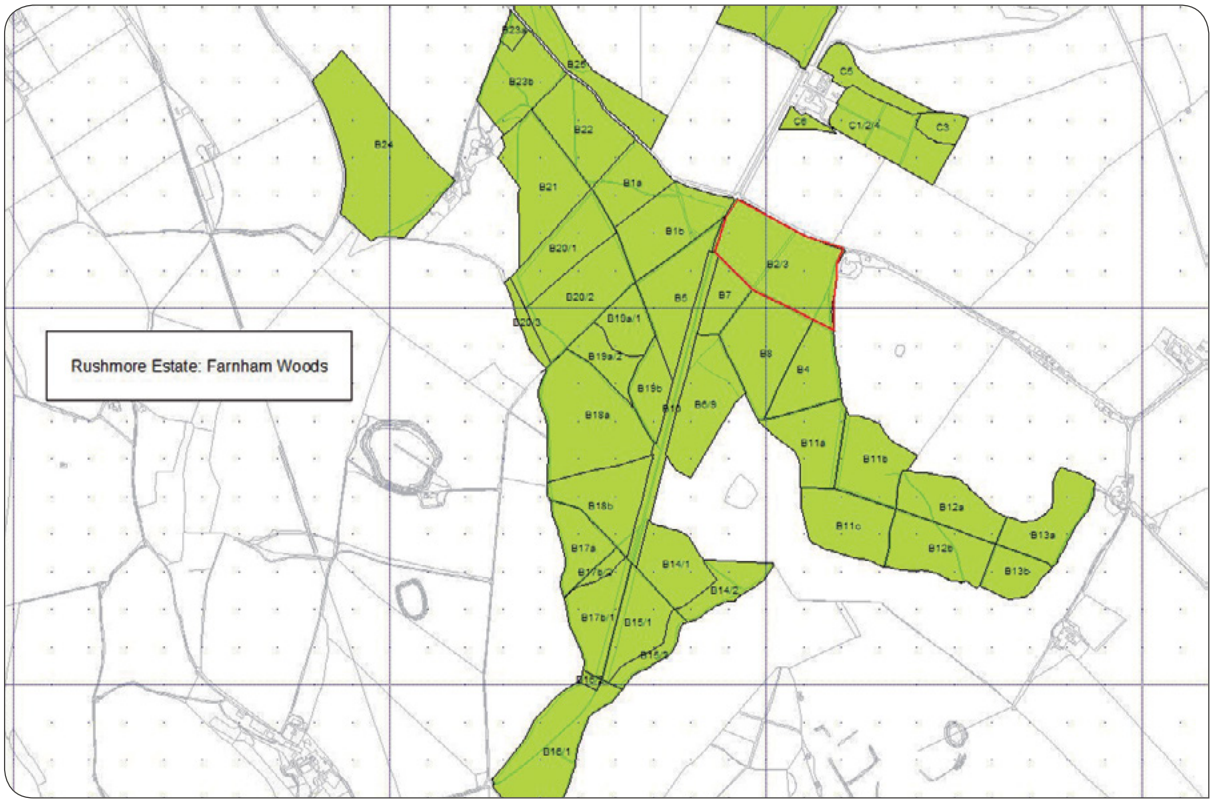
In order to ensure the establishment, survival and recruitment of natural regeneration there must be sufficient seed available, a suitably receptive seed-bed, compatible light conditions and protection from browsing animals, in this case primarily deer. Deer populations have been reduced over the last 10 years and the increased light levels have begun to produce more understory which in combination with bramble should begin to create the conditions which will assure successful recruitment into the sapling stage without fencing. The presumption will be against using fencing.

Compartment B2/3 has been subject to thinnings designed to explore the possibility of obtaining Norway spruce (NS) regeneration, a rarely attempted activity in the UK. The general conclusion of these experiments and advice from European foresters, is that NS starts to produce significant amounts of viable seed from Yr 50 onwards. In the case of B2/3, enrichment planting started in 2017 (age 55) at the same time as permanent extraction racks were installed.

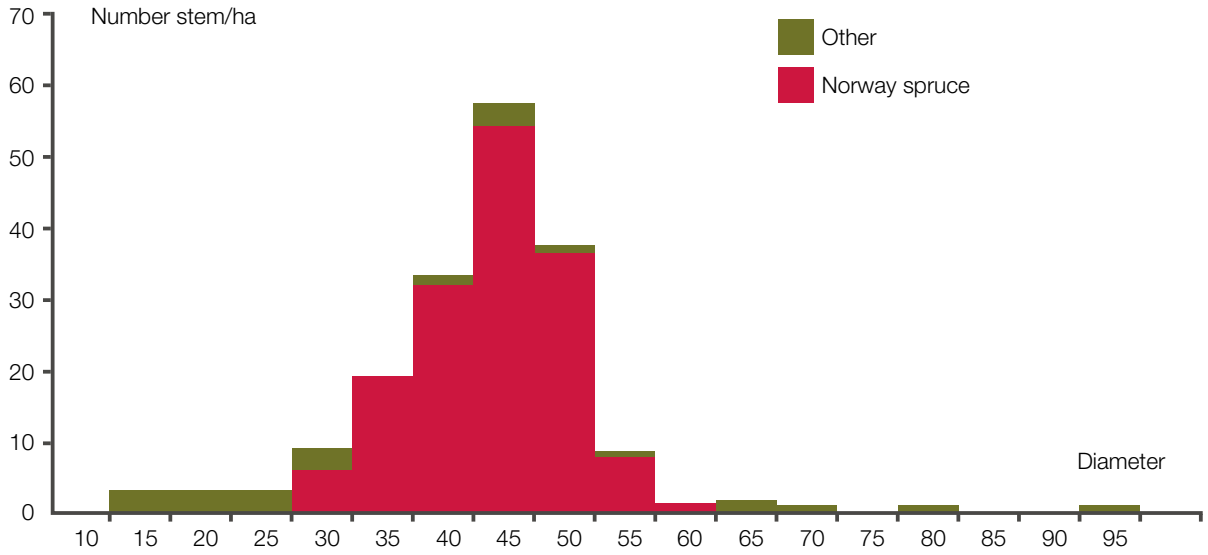
Extraction

Permanent extraction racks will be established at around 26m intervals during the regeneration phase in order to:

- Allow the harvesting of larger trees without significant damage to younger stand elements;
- Reduce the impact of harvesting machinery on the site; and
- Provide a management framework for tending and enrichment planting operations.



Monitoring



Current stem diameter distribution of Norway spruce and other species in compartment B2/3

A Local Research Stand was set up in 2018 using the Irregular Silviculture Network protocol. Re-measurement will take place at 5-10 year intervals to monitor changes in structure and timber increment of the whole stand and its components, and track development of the irregular structure towards a dynamic equilibrium with mixed conifer composition.

Diameter distribution and species composition in 2018 (age 55) is shown in the table and graph above. Stand basal area in 2018 was 27.5 m2/ha and volume 328 m3/ha.

Further information

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Picture credit - Andy Poore

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5. GOODWOOD ESTATE, NEAR CHICHESTER, WEST SUSSEX

Reestablishment coppice with standards and brownfield restoration

Owner: **Duke and Duchess of Richmond**

Forest manager: **Darren Norris**

ALL-ENGLAND WOODLAND RESILIENCE AWARDS
WINNER
WOODLAND CREATION

Heavy and compacted quarry infill has required ditching to reduce standing water

Overview

Goodwood Estate is just over 4,800 hectares in size. It is home to a mixture of forestry and agriculture, as well as being the home to Goodwood racecourse, Goodwood Revival and Goodwood Festival of Speed.

Valdoe Wood was 42 hectares of existing mixed broadleaved ancient woodland, with 10 hectares of alder and poplar planting added in the 1980s. To the south of Valdoe Wood, an area had been originally woodland before being cleared for agriculture, and then subsequently used as a quarry. Part of this area was also used as a compound to store boughs of chestnut and straw bales used on the estate for events.

The quarry was handed back to the estate in 2019, having been filled in with imported soil material. The Duke and Duchess of Richmond took the decision to replant this area as woodland. This planting took place in 2019, extending Valdoe Wood by 19 hectares.

In the new woodland area, the soil conditions and type varies. In the compound area, the soil type is heavy clay with flint which was heavily compacted. Beneath this is hoggin, and sand above chalk bedrock. The quarry area is topsoil, and underneath is a mixture of whatever the quarry company found to infill the quarry. This area is therefore quite boggy and soft.

The site is on a south-facing slope which receives full sun and a south-easterly prevailing wind, which is quite drying. Rainfall averages around 950 mm per year, and can be quite unpredictable, causing drought.

Management objectives

The management objectives for the estate's forestry, and this creation project in particular, are to experiment with species mixes for:

- Resilience;
- Biodiversity; and
- Timber production.

The established woodlands are managed under a Forestry Commission-approved Woodland Management Plan, and are under a Countryside Stewardship Higher Tier woodland improvement grant scheme.

The estate is keen to spread what works across the estate and didn't want it to be a single species boom and bust type forestry. This has been especially highlighted as important by the spread of ash dieback, which has affected planting carried out after the 1987 storm. The majority of that ash has now succumbed to ash dieback.

Ride network in the new woods continues the star shaped pattern from the existing woods

Delivering change

A wide range of species has been chosen within the estate's creation scheme to support its management objectives.

- The timber produced will be used within the estate's existing biomass wood-fuel heating system, as well as fuelling the new biomass boiler which is currently being built and which will heat the house, hotel and some of the cottages. This means a minimal transport footprint as all fuel is generated on the estate.
- A wide range of species has been selected, using the Ecological Site Classification (ESC) tool to inform species choice.
- Species choices within the selection have been picked to deliver a management style of coppice under standards. These include:
  - European beech, over hornbeam coppice, with edge margins of field maple, hawthorn, walnut, and a section of black poplar at the bottom of a dry river bed;
  - 3000 sessile oak and 3000 English oak, separated across the scheme to see how they perform within the plots, mixed with sweet chestnut, field maple and hornbeam, with a handful of tulip tree for aesthetic purposes along the edges;
  - Common alder on the lower slope as another coppice product does well in the damper soils, mixed with oaks and other species, planted in clumps of five;
  - Small-leaved lime higher up the slopes to reflect specimens found elsewhere on the estate, as a coppice product and for wildlife benefit.
  - Wild service tree has also been sprinkled around the scheme, as well as some elm Ulmus 'New Horizon', which is being trialled as resistant to Dutch Elm Disease.
- In addition, some commercial species blocks have been included namely
  - *Douglas fir*
  - *Grand fir; and*
  - *Eucalyptus*
- The eucalyptus has been included as a fast-growing nurse stock, with the intention that at least 50% will be removed by year 10-12.
- Cricket bat willow had also been considered, but due to the complexity of the scheme, it was removed. However, the estate is keen to introduce it in the future.

As well as traditional planting, one section has been left to recolonise naturally, to benefit wildlife and explore a more intimate mix of species. In this area there has already been an increase in wildlife activity observed, such as 15 breeding pairs of lapwings in 2020, up from two pairs the previous year. Bee hives will also be introduced to add an agroforestry element.

Hornbeam has taken well in the new coppice areas

Further information

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Picture credit - Forestry Commission

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6. HOCKERIDGE AND PANCAKE, BUCKS/HERTS BORDER

Oak establishment silvicultural trial

Owned and managed by: **Royal Forestry Society**

Birch scrub to act as a nursery for oak mixes

Overview

The 74 ha Hockeridge and Pancake Wood is an Ancient Semi Natural (ASNW) marking the borders of Hertfordshire and Buckinghamshire, on the edge of the Chilterns. The soil type is predominantly Fresh-Rich (W10) typical brown earth FC type, heavy, stony with occasional gleying, and light podsolization in the upper horizons in the poorer areas. National soil maps indicate argillic brown earths.

Management objectives

Hockeridge and Pancake Wood is managed for its educational value in line with the RFS's charitable objectives. Species choice for the restock sites is generally based on FC ESC analysis and advice, and the RFS attitude to risk. The RFS has a preference for proven productive species with a strong probability of timber value under projected climate conditions.

The wood features more than 20 productive tree species, predominantly planted in intimate mixes (although beech, Douglas fir, western red cedar, Norway spruce, Japanese larch and western hemlock occur in both intimate mixes and in single species stands). The only productive trees not planted intimately with other tree species are the coast redwood, dawn redwood and grand fir, which are planted in three single species stands and the giant redwood, which have been planted as an ornamental avenue. Additional ornamental trees and non-productive species provide structural and age diversity, as well as adding to the biodiversity of the woodland.

The RFS aims to further diversify species mix of both broadleaf and conifer within compartments by applying silvicultural science in the selection of restock species and silvicultural systems and to share those findings with members and more widely.

By diversifying species mixes and overall age structure further, the RFS believes the wood will have a robust structure to better meet future challenges of climate change, pests and diseases while continuing to provide a wooded landscape for people to enjoy.

Delivering change

During 2021/2022 the RFS will restock Compartment 25A which consists of recolonised woodland following a windblow event in 2004.

The compartment had previously been stocked with Norway spruce, black cherry, cedar of Lebanon and Atlas cedar. Pioneers and recolonisers are generally birch but with some Scots pine, beech and oak.

A clearing of approximately 1 ha will be created within the central section of the compartment as a demonstration plot to establish a pedunculate oak plantation using and comparing three different establishment methods. Some of the existing birch scrub will initially be retained as a nursery crop, helping moderate against wind and other local climatic conditions.

Trees will be planted at 2500 stems per ha with varying species compositions:

- pure oak (650)
- 60% oak (400) and 40% Weymouth pine (250)
- 60% oak (400) and 20% each common and Italian alder (125 each)

Oak is an integral part of the woodland and local treescape but is under pressure from climate change, disease and, despite robust control measures, from grey squirrel. This is a common scenario for many RFS members who own or manage woodland and are looking for establishment and management scenarios which will allow the UK to grow oak better into the future.

Species mixes have been chosen with reference to ESC and known soil compositions but also for their compatibility. Weymouth pine has a light branch structure allowing more light to the forest floor and is less susceptible to Dophistroma Needle Blight (DNB) than, for instance western red cedar.

Alder mixes with oak offer a potentially robust broadleaf nursery crop – much used in Germany – while again allowing plenty of light in to the compartment to encourage oak to grow.

The planting plan represents an increase in native species compared to earlier plantings in the compartment. It complies with FC requirements allowing <20% non-natives as long as they are site-suited, non-invasive, any ASNW features are maintained and they will be managed at or below that proportion in the future.

Future management and evaluation

Restocking is being funded by a combination of income from timber and a private grant.

The demonstration plots will be regularly monitored, recorded and evaluated with results published in the RFS's *Quarterly Journal of Forestry.*

The oaks will be planted in 1.2m tree shelters since in addition to grey squirrels, the fat dormouse - Glis glis - found in this wood may cause bark damage. Deer management of both roe and muntjac will also be necessary. Bracken and bramble control will be important in the first few years to aid oak establishment.

Compartment	Species name	Rationale for inclusion
25Ai	Oak	a key component of the wood; timber producing; supports native biodiversity
	Italian alder	Adapted to warmer climates (originating S Italy); capable of thriving in wetter conditions, potential large woodland tree;
	Common alder	Range extends throughout Europe to North Africa; large woodland tree; capable of thriving in wetter conditions;
25Aii	Oak	
	Weymouth pine	Large 5 needle pine (less susceptible to DNB than 3 needle pines); originates from Eastern North America where it is one of the most common and widely used timber for construction lumber.
25iii	Oak	

Further information

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Picture credit - Bryan Elliott

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7. MIDDLETON PARK, OXFORDSHIRE

Conversion of Norway spruce monoculture to resilient productive woodland

Agent: **Adam Todd - Pryor & Rickett Silviculture**

Pre harvesting looking west into NW block

Overview

Middleton Park is in north Oxfordshire, near Bicester. A 14 ha block of woodland at Middleton Park sits on the site of a medieval deer park. It is an undesignated ancient semi-natural site with evidence of old oak and elm butts. The site has probably been at least sparsely wooded since the late 1200s when it was first set aside as a deer park.

In the 1950/60s the site was purchased by the Forestry Commission and planted with Norway spruce (70%) and Scots pine (30%). Five years later it was sold to the father of the current owner. The wood has been regularly thinned but the Norway spruce has not grown well on the site and poor long-term growth and slow recovery from recent droughts may have exacerbated great spruce bark beetle infection (Dendroctonus micans).

The Norway spruce and Scots pine crop was clearfelled in September/October 2020. A buffer strip of spruce was retained on the east side to protect views and provide a wind break and all self-set but established broadleaves within the compartments were left standing.

Soils are predominantly lightly alkaline brown earth overlying limestone bedrock (FC type 12b, calcareous brown earths). There is a deep and well mixed O (organic) and A (surface/topsoil) horizon. Dog's mercury and wild garlic are present on site, both of which like neutral to slightly alkaline soils, however across the majority of the site, there is a distinct lack of fern species or bracken which would indicate acidic soils.

Despite the lower than average rainfall in North Oxfordshire, the site is not prone to drying out and holds a lot of water in the winter.

Restocking facing south, main ride visible on left

Management objective

The owner's primarily objective is to maintain a resilient, productive woodland. The ambition is to convert it from 14 ha of monoculture, to a 60/40 split of commercial conifer and diversified mixed broadleaf which is expected to return a profit in the short, mid and long term. The introduction of fast growing species such as Italian alder is expected to provide an early income to help fund woodland maintenance such as cleaning and first thinning which might otherwise be at cost to the owner prior to the conifer crop reaching 25+ years. It is also important to the owner that the wood is aesthetically pleasing and is varied enough to provide a biodiverse habitat.

Day 1 harvesting, cutting an access rack in to keep off of main ride

Harvesting

When harvesting it was decided to rake and windrow the site, providing brash racks every 15 m and a dead hedge around the perimeter. This provided a site with excellent planting conditions. The brash around the perimeter is also expected to deter deer browsing. During harvesting great care was taken to leave standing and undamaged the existing broadleaf trees within the conifer blocks. These were primarily lime, oak and beech that had been drawn up by the conifer. They will provide excellent habitat for birds of prey and owls that will in turn help control vole numbers. A total volume of 2,688 m3 was harvested from the site.

Delivering change

Restock species selection has been driven by the owner's management objectives and site conditions now and in the future. Soil pits were dug, site indicator species assessed, and ESC4 used as a guide. It was interesting to note that the soil pH was less alkaline (pH 7 to 7.5) than indicated by ESC4. In the mid 18th Century acidic soil is reported to have been imported to the site and spread to create a fernery as part of a formal garden. The lower-than-expected pH of the soil may be the result of this operation. On this basis the following principal species have been selected:

- **Conifer: 2 x 2 m - 17000**
  - European larch 4000
  - Douglas fir 13000
- **Short rotation commercial broadleaf: 2 x 2 m - 5000**
  - Italian alder 3000
  - birch 2000
- **Sacrificial squirrel and mid rotation thinning 2.5 x 2.5 m -1500**
  - sycamore 1500
- **Mixed broadleaf (long term/final crop) 2.5 x 2.5 m - 5000**
  - oak (Quercus robur)) 3000
  - hornbeam 2000

The conifers crop will be interspersed with clumps of Italian alder, sycamore, oak, birch and hornbeam.

Norway spruce was not considered for restocking as this species is predicted to suffer from drought stress under future climate conditions. The Scots pine was also ruled out due to poor prior performance on the site.

Douglas fir was chosen as the primary commercial species as it is predicted to provide a consistent return on investment. Douglas fir grows well on neighbouring estates and although it prefers neutral to slightly acidic soils it will tolerate the neutral to very slightly alkaline soil at Middleton Park. It is also considered relatively drought resistant.

Looking NE from halfway up main ride, buffer visible in background, brash windrows

European larch is selected primarily for aesthetic reasons, to break up the canopy and to provide colour in the autumn. It also has commercial value. There is no evidence of phytophthora ramorum in the area and there are no vector species such as rhododendron within the perimeter of the site.

Interestingly ESC4 indicated Douglas fir and larch are unsuitable based on the default setting for the site. Instead of relying on this default setting, when the indicator species gathered from the site survey are entered into ESC4, Douglas fir comes out as very suitable. This illustrates the limitation of the national scale soil maps used in ESC and that local site type information must be used.

Silviculture

Douglas fir and larch will be planted intimately at 2 x 2 m, in a roughly 3 – 1 mixture therefore breaking up the monoculture feel of continuous Douglas fir. The main conifer block itself will be broken up by diamonds of Italian alder, oak and hornbeam. These areas consist of between 25-40 trees at a 2 x 2 m spacing. It is hoped these pockets of broadleaves will provide additional resilience to potential pests and diseases by increasing stand scale species diversity. During autumn and winter the broadleaf elements will allow air to circulate within the woodlands more freely which could potentially help combat fungal diseases. They also bring added biodiversity value to the commercial block.

Along either side of the main north/south ride there is a trial avenue of 2 rows of Italian alder at 2 x 2 m, with a central row of oak at 2.5 x 2.5 m and then two further rows of Italian alder at 2 x 2 m.

The use of Italian alder in this woodland meets two objectives. It will act as a nurse to the hornbeam and oak and will also provide a quick rotation firewood crop at around the same time as first thinning the conifers in years 15-20, providing an additional product alongside chip, bars and fence posts from the conifers.

Around the edges of the main conifer block there is a mixed broadleaf belt consisting of birch, oak, sycamore, hornbeam and Italian alder. They will be planted at a 2.5 x 2.5 m spacing. It has been reported that Italian alder is relatively unpalatable to deer which if proven would provide another species that can be planted without a deer guard in future.

It is hoped that sycamore will act as a sacrificial species as it is normally the species of choice for grey squirrel bark stripping. By planting a proportion of sycamore the objective is to protect the oak and hornbeam which are seen as the climax/high forest species

Establishment

Conifers will be treated with Trico, an emulsified solution of sheep's fat which repels deer. Large scale trials have indicated that deer do not browse the treated shoots. Trico is used neat, and has been successfully used by Pryor & Rickett Silviculture against muntjac, red, roe, fallow and sika deer. This will avoid the need to use plastic guards (shrub shelters) on the conifers, providing both an environmental, cost and aesthetic benefit to the owner and woodland.

Broadleaves trees are protected in 1.2 m tree guards. Deer present are roe and muntjac.

The site will be regularly monitored and where reactive maintenance is required, strimming will be preferred over spraying with Glyphosate to minimise chemical use. Formative pruning of the oak and hornbeam is scheduled to start in year 3-5 depending on growth rates.

Further information

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Picture credits - Pryor & Rickett Silviculture

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8. MOOR WOOD, EXMOOR NATIONAL PARK

Transformation to CCF and species diversification

Owner: **Exmoor National Park Authority**
Forest manager: **Graeme McVittie**

ALL-ENGLAND WOODLAND RESILIENCE AWARDS
HIGHLY COMMENDED
EXISTING WOODLAND

Species section for regeneration

Overview

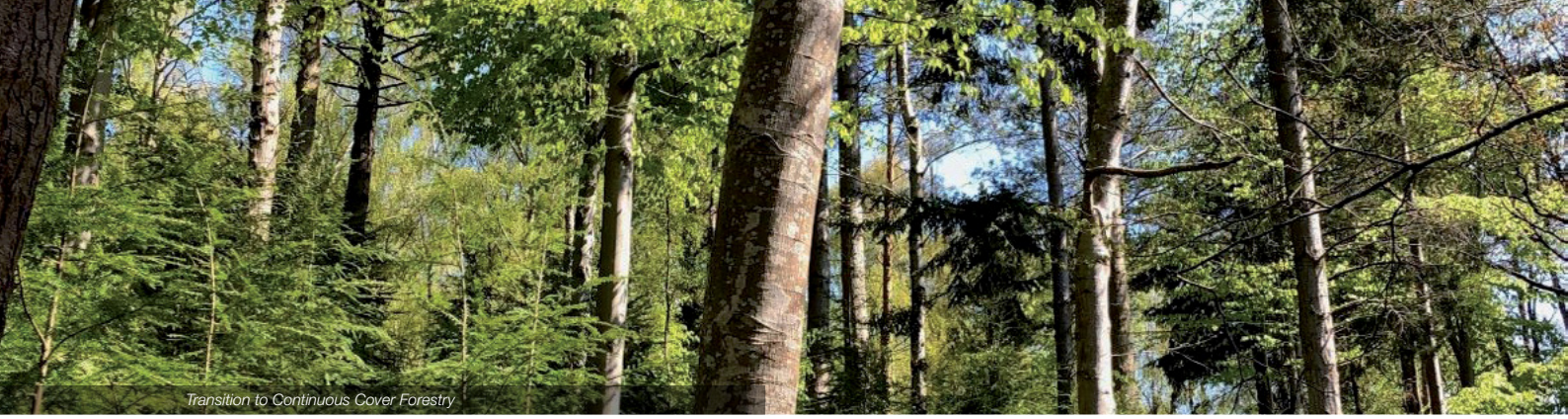
Exmoor National Park is one of the more afforested of the UK National Parks with 9487 ha of woodland (14% of land area) according to the latest National Forest Inventory statistics.

The focus of this case study is on the management of one of these blocks of woodland owned and managed by the National Park itself – Moor Woods near Minehead in Somerset.

The wood covers 16 ha of mainly mixed (deciduous and conifer) woodland. Prior to the last intervention:

- Conifers consisted of Japanese larch, western red cedar, Sitka spruce and Douglas fir with remnants of the 19thC pine plantation;
- Broadleaves consisted mainly of sweet chestnut, sycamore and ash and originated, in the main, after areas were felled for WW2. There is also an important population of endemic whitebeam in the adjacent compartment.There are several “microspecies” of whitebeam known to occur on Exmoor and their conservation is of utmost importance;
- The Sitka and larch has been felled over the past 10 years due to pest and disease outbreaks, Dendroctonus micans in the spruce and Phytophthora ramorum in the larch.

Soils are largely podzolic brown earths with fresher and richer alluvial deposits in the shallow valleys. 120-220 metres above sea level. Rainfall averages 1000 mm a year. The site has a south-easterly aspect but with a strong maritime influence being 0.5 km from the Somerset coast.



Transition to Continuous Cover Forestry

Management objectives

Given its ownership by the National Park and its importance on a biological and landscape level it is no surprise that multiple management objectives exist for Moor Wood. These include:

- To prevent loss of any ASNW and to increase the proportion of native broadleaves within PAWS areas where this does not impact on the high amenity value conifer plantings;
- To increase structural diversity by recruiting multiple age cohorts in each stand and to reduce the need for future clearfells thus maintaining the landscape character and sense of place;
- To maintain and increase biodiversity, particularly the endemic whitebeam, woodland bird assemblages and levels of deadwood;
- To produce a sustainable timber supply and income stream and increase the natural capital of the site;
- To maintain the very high amenity value of the site including keeping conifers beyond their economic rotation age whilst also maintaining open vistas where they currently occur.

Delivering change

The main potential to deliver change came with the spruce and larch clearfells. For the first time on the estate, resilience to future climate change and other threats was at the forefront of the restocking decisions:

Despite some opposition to replacing exotics with more exotics, well-rounded arguments were made for including species such as coast redwood that would complement the already extremely tall and impressive Douglas fir that are a real public amenity resource – a main objective on this site.

The intention was to create stands that could be managed on a continuous cover basis in the future so avoiding the dramatic landscape changes that clearfells can bring.

Allied to this, a move away from monoculture blocks to mixtures was preferred to avoid any future disease and pest clearfells that can affect single species.

The Forestry Commission Ecological Site Classification system (ESC) was initially consulted to check species suitability including for the 2080 climate change projection. From this, species selected were:

- Restocks: Coast redwood (50%), Douglas fir (25%), Japanese red cedar (12.5%), western red cedar (12.5%), plus some occasional Scots pine.
- Elsewhere enrichment and diversification planting were carried out in small gaps with small leaved lime, wild service and Italian alder.

Basal area of the remaining stands was also reduced through targeted thinnings in order to encourage natural regeneration – now clearly evident in these stands.

Overall the National Park believe that the approach at Moor Wood delivers on resilience by choosing species that are well suited to the site both now and in the future, aren't currently affected badly by pests and diseases and that will thrive and regenerate using continuous cover forestry principles.

The use of mixtures allows more options for management to retain canopy cover if pest and disease problems do occur in the future.

Further information

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9. MORTON HALL, RETFORD, NOTTINGHAMSHIRE

Introducing Continuous Cover Forestry (CCF) to diversify species and stand structure and optimise the potential for timber production

Owner and Manager: **Dr. Bill Mason**

ALL-ENGLAND WOODLAND RESILIENCE AWARDS
JOINT WINNER
EXISTING WOODLAND

Kayes Wood: mixed broadleaves

Overview

Morton Hall comprises woodlands of 78 ha located to the west of East Retford in north Nottinghamshire. The woodland area is situated on predominantly level terrain at 40-50 m asl. Rainfall averages 600-650 mm per year but there can be dry periods in the spring that affect growth of young trees.

The soils are typical of the 'sandlands' of north Nottinghamshire due to the underlying Bunter Sandstone. They range from acidic sandy brown earths to sandy podzols. The Forestry Commission's Ecological Site Classification (ESC) identifies the soils as being of 'medium' to 'poor' soil nutrient regime and 'fresh' to 'moderately dry' soil moisture regime.

The woodland area is divided into three main blocks; (Morton Park, Dunstans Clump, and Walkers Wood) plus a few small outlying woodlands. These woodlands have been in the ownership of the Mason family since the 1850s and originate from plantations on marginal agricultural land dating back to the nineteenth and early twentieth centuries. They are of important value aesthetically, and as a resource for wildlife in an arable landscape.

The management of the woodlands passed to the current owner in the early 1970s, at which point the woods comprised either understocked, mature broadleaved woodlands (pre 1900) which had been affected by war-time fellings or mixed conifer plantations between 15-25 years old, dominated by pine and required thinning. At the time of the last management plan revision (2016) the composition of the woodlands was 48% broadleaf species (oak, sycamore, beech and sweet chestnut) with Corsican and Scots pine comprising around 37%, and mixtures of conifers and broadleaves (including European larch, Douglas fir, red oak, lime) making up the remainder.

Management objectives

Since the 1970s, management objectives have focused on improving the quality of younger planted stands and increasing the stocking of old broadleaved woodlands to maintain and enhance their capital, aesthetic and landscape value. Continuous Cover Forestry (CCF) was introduced to the mature broadleaved blocks in the 1980s and is used wherever practicable to diversify species and stand structure and to optimise the potential of the woodlands to produce quality timber.

Other management aims include; increasing the biodiversity value of the woodlands and conservation of existing ecological features. The management approach includes taking all practicable measures to increase the resilience of the woodlands against the impacts of future climate change and of other threats, including damage from pests and diseases.

The woodlands are currently managed under an EWGS woodland management plan (2007-2027 – revised in 2016) following the UKWAS template and management was supported by an FC Woodland Improvement Grant to improve the habitat for woodland birds. There are no

Categorisation of the Morton Hall woodlands into three broad forest types

Site type	Forest type	Main areas	Main silvicultural system	Main species	Minor species
Brown earth	Old (pre 1900) broadleaved woodlands	Morton Park (cpts 3, 4, 10); Walkers Wood (part) ; Rushey Inn	CCF - Group selection	SOK, SCH, SY, BEto irregular silviculture.	SBI, OBN, WCH, YEW, PRN, SLI,
	Mixed woodlands	Morton Park (other than cpts 1, 3, 4, 10); Walkers Wood (part)	CCF - Group selection, irregular/group shelterwood	CP, DF, SOK, SCH,	SP, EL, ESF, RC, OBN, PRN, SY, ROK, SBI, GF, NS, BE
Podzols	Pine dominated woodlands	Morton Park (cpt 1), Dunstan's Clump; Stevens Clump; Morton Hill clump; Fanny Kayes	Patch clearfelling or strip shelterwood	CP, SP	RAP, MAP, MCP, SBI, SOK, OBN, ROK.

Delivering change

Species Selection

Species selection and the corresponding silvicultural options are based around categorisation of the woodlands at Morton Hall into three main forest types and their corresponding species as shown above:

Species codes are:
SOK – sessile oak; SCH – sweet chestnut; SY- sycamore; BE – beech; CP – Corsican pine; DF – Douglas fir; SP- Scots pine; SBI – silver birch; OBN – Nothofagus obliqua; WCH – wild cherry; YEW – yew; PRN – Nothofagus procera; SLI – small-leaved lime; EL – European larch; ESF – European silver fir; RC – red cedar; ROK – red oak; GF – grand fir; NS – Norway spruce; RAP – radiata pine; MAP – maritime pine; MCP – Macedonian pine.

The focus from the late 1990s onwards was not so much on trialling individual species as trying to be innovative in the way the estate used species on the different site types present in the woodland.

The species diversity within the woodlands at Morton Hall was already well developed, there were over 25 species planted and of the current range of species, most of these were shown in

Kayes Wood in spring

the ESC analysis to be suitable for future climate scenarios provided due consideration is given to soil types, provenance selection, and adequate thinning regimes. For instance, use of ESC highlighted that the podzolic soils could suffer from drought due to warmer and drier summers and so management approaches have paid particular attention to developing mixtures on these soils.

By the time the woodland management plan was revised in 2016, opportunities had already been taken to diversify the woodlands trialling a range of species including Nothofagus spp, radiata pine, bishop pine and Douglas fir. Steps had also been taken to restore the small pinetum in Morton Park which contains over 100 different tree species. Inspection of these trial plantings provides information on the potential suitability of different species for use in the wider woodland area to increase overall resilience to drought and disease. The aim is to have a range of species to create a structure which is varied and allows for natural regeneration, and appropriate deer management to facilitate this.

Silvicultural Systems

The managers of Morton Hall recognise that the costs associated with traditional restocking are not always fully recovered through the income generated from timber sales. Therefore, it is beneficial from a silvicultural and economic perspective to expand the use of the group selection system employed in the older stands across the woodland to encourage natural regeneration (except for the areas on the drier, podzol soils which have the largest pine resource). On the sandy brown earth soils, natural regeneration of a range of species occurs including sweet chestnut, beech, birch, sycamore, yew and grand fir provided adequate deer management is in place. This regeneration offers the chance to develop mixed species stands and irregular structures which should provide stable, robust and structurally diverse habitats. This diversity of species and structure should enhance resilience to an increase in adverse climatic events and biotic threats and provide a sustainable timber resource.

The group selection system creates small gaps of approximately 0.1 ha to allow for natural regeneration or enrichment planting of a range of species. If the vegetation is competitive, spraying will occur during the summer and the young trees will be protected using tree shelters. The estate will monitor the success of the regeneration and the browsing impact to ensure that a range of species are successfully established.

In the pine dominated stands, there is limited natural regeneration occurring due to heavy competition from ground vegetation. In these areas, patch clear-felling or strip shelterwood using coupe sizes of 0.5 – 1.5 ha in combination with supplementary planting to diversify the species mix is thought to be the most logical silvicultural system. This is because the light demanding nature of the pine makes planting or encouraging natural regeneration within small gaps less suitable as the seedlings require very light canopies or areas of open space to achieve adequate growth (Mason et al, 1999). This approach will be implemented in areas where clear felling would typically occur when pine stands reached 60 years old.

Deer management actions include:

- Installation of a network of high seats to aid deer control and seeking to cull a minimum of 10 roe deer a year to reduce browsing pressure.
- Starting to trial other protective measures such as using Trico deer repellent, protecting vulnerable species by using 1 m tubes, and installing plastic deer fencing round vulnerable plantings. Plastic fencing was chosen because of the possibility of moving it to other sites when necessary. Basic monitoring inspections are being carried out to confirm their efficacy.

References: Mason, B., Kerr, G. and Simpson J. (1999) What is Continuous Cover Forestry? Forestry Commission Information Note. Available at *www.forestresearch.gov.uk/documents/6779/FCIN029.pdf*

Further information

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Picture credit - Dr. Bill Mason

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10. PERRIDGE ESTATE, NEAR EXETER, DEVON

Selective thinning and species diversification of mature plantations

Owner: **Sir Harry Studholme Bt**
Agent: **Chris Marrow**

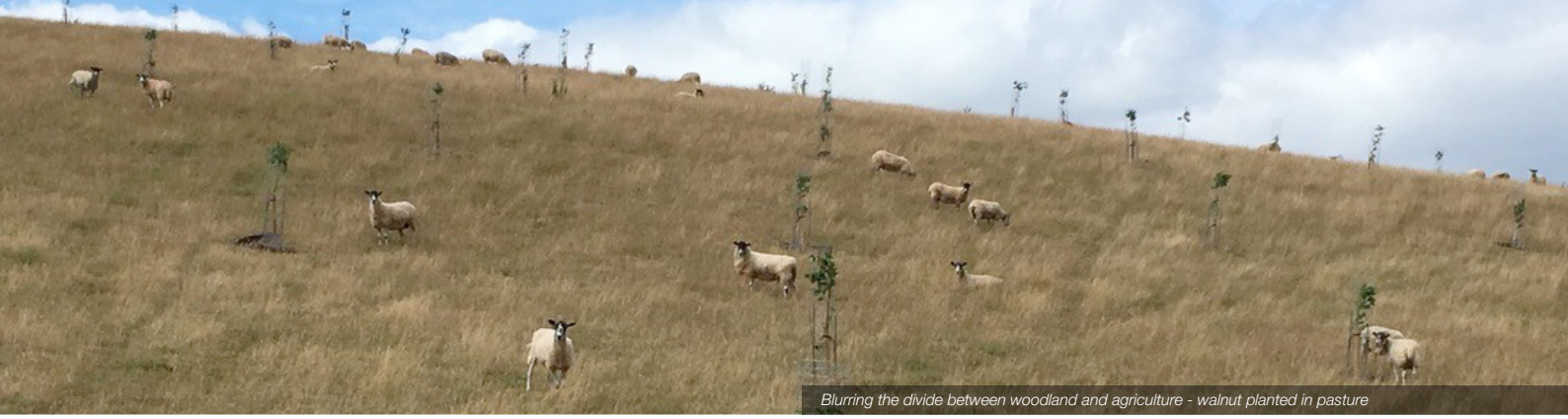
ALL-ENGLAND WOODLAND RESILIENCE AWARDS
JOINT WINNER
EXISTING WOODLAND

Japanese red cedar under radiata pine with larch and Western hemlock in background

Overview

The Perridge Estate in Devon extends in total to 400ha of which the majority, 276ha or 69%, is mixed woodland. Straddling both flanks of a prominent landscape ridge west of Exeter, it lies between 60m and 210m above sea level. The land undulates, steeply in places, running from exposed higher ground to sheltered stream valleys. Most of the woodland grows on clay soils derived from Carboniferous Culm Measure shales. Annual precipitation is around 1000mm and is rising.

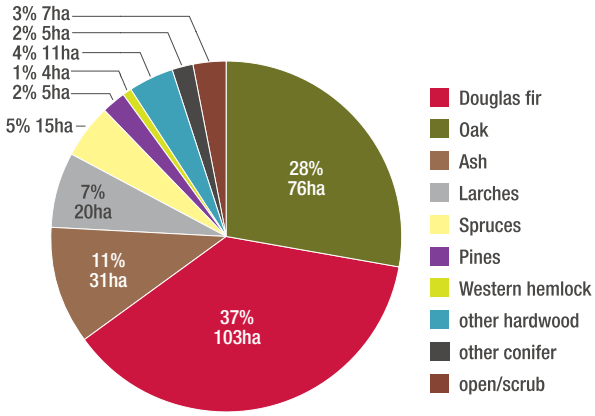
The estate has been in the ownership of the Studholme family since 1905, at which time there was a greater proportion of farmland and the oak-dominated woods were in transition from coppice to high forest. For the period up to 1960 the experience of forestry was characterised by forced felling, with timber requisitioned in the two World Wars, and to pay for death duties. Replanting was limited. Investment in the woods resumed in the 1960s. In areas where the forest would recover naturally from the over exploitations of the war years it was retained. Where it was judged it would not, it was replanted and with it the steepest and most difficult farmland. This planting was mainly coniferous – Douglas fir and larch to meet market demands. At the same time there was experimentation with a range of other conifer species and some hardwoods. The planting was sensitive to soils, elevation and water courses, resulting in an attractive mosaic structure. Further planting on remaining steeper farmland in the 1990s was mainly coniferous and aimed at diversifying the age structure and ensuring long term economic viability.



Blurring the divide between woodland and agriculture - walnut planted in pasture

Of the 25 species now present, 65% of the woodland area is represented by just two - oak and Douglas fir. 11% is in ash, 7% in larch, 5% in spruces, 2% in pines with 4% in other hardwood species and 3% in other conifer species.

Species groups by area



Principal management objectives

- maintaining an attractive landscape and a diverse environment
- growing high quality timber to be sustainably harvested thus contributing to the overall estate and its economic viability
- carbon mitigation and developing resilience to climate change and related impacts
- safeguarding and enhancing a range of biodiverse wildlife habitats and features of cultural interest.

Impetus for change

The older plantations are reaching the stage when they could be seen as ready for clear-felling. This maturity provides an opportunity to rethink the forest's future in the light of changing economic, environmental and silvicultural knowledge. There is new awareness of the need for a diversity of species and structure to provide resilience against pests and disease, and to adapt management in the face of a changing climate. Equally, the forest's role as a carbon sink has become important and realising regular income for ongoing support of the wider estate rather than the variable and infrequent revenue from clear-fells has become preferable.

There is no single prescription. A small number of stands are considered either commercial failures or vulnerable to disease. Some 18% of the woodland area comprises ash and larch. Most of the ash is affected by dieback. One stand of larch has been felled due to *Phytophthora ramorum* and the balance remain vulnerable. The need to clear-fell these areas is constantly under review. If felled, they provide potential sites for experimentation and a move to greater species diversity.

In the remaining majority of the forest a closer to nature CCF approach, where the woods are cyclically thinned and older, larger trees will be retained, is providing the best route to developing a more complex structure. This is possible as large-dimensioned timber remains sought-after in the south-west. Markets for quality timber are thought to be unlikely to change and can support the evolution of a forest with a complex rougher canopy and an uneven age structure.

Delivering change

Management objectives are delivered primarily through two ongoing silvicultural thinning programmes, 5 yearly for conifers and 10 yearly for broadleaves.

These are entirely selective, increasingly crown-based and aimed at actively improving the quality of developing stands and the trees within them. A responsive, adaptive approach is taken. As well as improving crop quality and stability, thinnings are being used to manage disease-related issues and to develop ground conditions more conducive to the recruitment of natural regeneration of preferred species.

Early signs are encouraging, although achieving the right balance of shade and light on fertile soils is critical to maintaining suitable conditions. Exclosure plots help monitor the impact of deer. In situations where species continuity is not desirable, under-planting is also used to diversify species as well as structural composition. These approaches recognise the woodland not just as a timber and environmental resource but as a continuing carbon sink as well. They are also expected to provide higher-value management options for the future.

oak Regeneration

Species choice

It remains important that the forest continues to be commercially viable so species that grow marketable timber are preferred. Experimentation with 'minor' or alternative species in the 1960s and 1970s, coupled with improved understanding of provenances, has allowed the planting of species like Western red cedar with confidence, while at the same time rejecting others; larch has not grown well, and Grand fir has proved hard to market. Potential new income streams are being explored with small plantations of Japanese red cedar, black walnut, swamp cypress and tulip tree where conditions are suitable. The heavy soils limit species choice among native broadleaves but alder and cherry grow well. The wider use of some north American hardwoods is being looked at in the context of ash dieback. The divide between woodland and farmland is blurring. Fruiting walnut is being planted in pasture and the intention is, in places, to shelter cattle in established woodlands. A selection of disease resistant elm varieties is being trialled. Trees introduced to the woods are British grown to minimise the risk of introducing disease through imported plants. The best available provenances with more southerly seed sources are chosen, e.g. reinforcement planting in the largely sessile oak woodland with sessile oak of French provenance.

Physical infrastructure and flood mitigation

Both to cope with increasing rainfall and to service the thinnings, improvements to physical infrastructure have been critical – large stacking and loading areas capable of being accessed all year round; wider, more open tracks capable of accommodating modern machinery; good drainage and bigger culverts to cope with the run-off associated with increasingly frequent and heavy deluges of rain. Good infrastructure also helps protect soils. Greater understanding of the significance of mycorrhizal networks in supporting tree growth, health and vigour adds weight to the importance of this and the timing of operations. Contractors are briefed on why close attention to the soil is important.

Tulip Tree – part of an estate history of planting with alternative species

Open space within the woodlands is focussed along the network of tracks and rides, and within overhead powerline wayleaves. These are being strategically developed to improve links between known biodiversity interests and facilitate species dispersal.

Lessons learnt, future plans

Learning is continuous and experimentation fundamental to learning about the specific nature of the forest itself. Current projects include bird ringing to get a better picture of the songbird populations adjacent to the woods and soil carbon monitoring.

Further information

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Picture credit - Perridge Estate

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11. PLEASANT FOREST, NEAR MAIDSTONE, KENT

Delivering high structural and species diversity for sustainable, productive woodland

Owner and manager: **Forestry England (East District)**
Location: **Platt's Heath, Maidstone, Kent**

ALL-ENGLAND WOODLAND RESILIENCE AWARDS
HIGHLY COMMENDED
WOODLAND CREATION

Community tree planting day

Overview

Pleasant Forest is a 118-ha multi-purpose woodland being created on a former arable farm. The woodland design includes a diversity of woodland types to reflect different aims in different blocks. Resilience is key to the long-term delivery of the site's objectives, including sustainable timber production, biodiversity net gain, and increased natural capital value.

The site sits on gently undulating terrain, close to the Kent Downs Area of Outstanding Natural Beauty (AONB). It has mostly freely draining, deep loamy soils that are well suited to woodland creation. Some areas of shallow soils and nutrient poor sandy soils provide excellent opportunities to create a mixed habitat while existing drainage lines offer potential for wet habitats. The land has previously been managed as arable farmland with some rough grazing. The surrounding landscape is mostly arable farming with pockets of ancient woodland.

The site's location in southeast England makes it extremely vulnerable to environmental change and disease pressures. The extreme UK Climate Projections 2018 (UKCP18) high emissions scenario projects 3-5°C increases in summer temperatures and 10-20% winter rainfall increases.

Management objectives

- Create a sustainable, productive woodland which offers a sound financial return
- Meet or exceed UK Forestry Standard (UKFS), UK Woodland Assurance Standard (UKWAS) and Environmental Impact Assessment (EIA) afforestation standards
- Demonstrable increase in natural capital value
- Demonstrable biodiversity net gain
- Provide an informal recreational resource for the local community

Each of the five plots has a particular focus that builds upon its key features: access for all, woodland and the community, peacefulness and nature, sustainable timber production, research woodlands.

Delivering change

Forest resilience has been built into the design of the forest to ensure it can adapt to future environmental conditions. Resilience will be delivered through high structural and species diversity. A total of 21 conifer, 19 broadleaf and 13 shrub species (see Table 1, page 36) were selected through a detailed site assessment, including climate modelling, the Ecological Site Classification tool, soil surveys and consultation with Forest Research. On groundwater-affected soils, species include aspen, common alder and black poplar, whilst species on sandy soils include scarlet oak, Scots pine and maritime pine, selected for drought tolerance. High forest conifer and coppiced broadleaf mixtures, bordered by shrubs, will provide structural diversity whilst open areas adjacent to ancient woodland will encourage natural regeneration.

A portfolio approach to planting includes local provenance seed alongside southerly provenances selected through climate matching analysis. For example, Forestry England has chosen French provenance black walnut, small-leaved lime and hornbeam. Planting in intimate mixtures will allow natural succession of the best-suited species.

Research trials on site will inform proactive management decisions for Pleasant Forest and more widely. These include a Forest Research operational trial of 19 different productive species

Concept design plan

(such as Wellingtonia and coast redwood) and a progeny trial of sycamore in partnership with the Future Trees Trust. A further 4ha broadleaf source-identified seed stand will provide future genetic material for Pleasant Forest and other appropriate woodlands.

To guide nature recovery and maximise the biodiversity value of the site, we are following the Lawton principles of 'better, bigger, more, joined' by creating a diverse matrix of habitats, including open space, high forest, coppice and scrub. Ecological connectivity is being promoted, such as through enhancing existing hedgerow features, creating a stepping-stone network of new ponds, and a mosaic of diverse shrub and nectar-rich grassland corridors. Wildflower areas will be established using green hay from local greensand sites. The effects on biodiversity will be continually monitored, using state-of-the-art techniques like environmental DNA (eDNA). The project will also draw on the expertise of partner organisations and involve local schools to share knowledge and ensure cross-generational collaboration, with the ambition of creating a socially resilient woodland.

Pleasant Forest has been designed with environmental and social resilience at its heart, to create a thriving new woodland that is fit for the future.

Establishment and maintenance

Prior to establishment, a detailed survey of potential browsing pressure was carried out by our Wildlife Rangers.

AFTER

Rabbit fencing has been installed across most of the planted areas to provide protection, although deer fencing was not deemed necessary at present due to a relatively small local deer population. Weekly monitoring of the fences check for badger incursions and install badger gates where required. Where fencing was impractical (such as around footpaths), tree shelters have been used. There is ongoing monitoring of rabbit and deer impacts, and culls will take place if necessary.

A grass sward was established in advance of tree planting. A residual herbicide was then applied in 1.2m-wide strips along the tree lines to suppress grass growth. This will be carefully monitored, with a follow-up spray in spring if necessary to ensure strong tree establishment. The tree lines will be inter-mown for three years.

A beat-up survey will be carried out across the site in summer, including checks for pests and disease. Any necessary replanting will take place during the following planting season.

The rides across the site will be mown throughout the summer, outside the ground nesting bird season. The grass cuttings will be removed to reduce the nutrients on site, with the aim of establishing a diverse grass and wildflower mix.

Broadleaves	
Common name	Percentage planting
Aspen	7.8
Black Walnut	2.3
Common Alder	2.0
Crab Apple	1.1
Hornbeam	6.5
Italian Alder	2.9
Native Black Poplar	2.0
Pignut Hickory	1.4
Red Oak	2.8
Rowan	3.1
Scarlet oak	2.8
Sessile Oak	35.3
Silver Birch	4.2
Small-Leaved Lime	3.6
Sweet Chestnut	6.8
Tulip Tree	1.4
Whitebeam	0.7
Wild Cherry	10.6
Wild Service Tree	2.7

Conifers	
Common name	Percentage planting
Corsican Pine	8.1
Douglas Fir	35.6
European Larch	10.7
Japanese Red Cedar	0.4
Macedonian Pine	10.7
Maritime Pine	8.1
Oriental Spruce	4.5
Scots Pine	6.8
Western Hemlock	7.5
Western Red Cedar	7.5

Shrubs	
Common name	Percentage planting
Alder Buckthorn	6.0
Blackthorn	10.4
Dogwood	6.0
Elder	5.9
Gorse	11.9
Guelder Rose	3.1
Hawthorn	10.3
Hazel	10.4
Privet	5.9
Purging Buckthorn	6.0
Rose	10.4
Spindle	10.5
Willow	3.2

Forest Research trial plot
Common name
Atlas Cedar
Coast Redwood
Douglas Fir
European Silver Fir
Grand Fir
Japanese Red Cedar
Leyland Cypress
Macedonian Pine
Maritime Pine
Noble Fir
Norway Spruce
Oriental Spruce
Pacific Silver Fir
Scots Pine
Serbian Spruce
Wellingtonia
Western Hemlock
Western Red Cedar
Weymouth Pine

Further information

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12 . RUSHY KNOWE PLANTATION, KIELDER, NORTHUMBERLAND

Upland afforestation to increase the natural capital value of the nation's forests

Owner: **Forestry England**
Managers: **Mark Child & Ian Green**

Ground broken with the continuous mounder. Credit: Craig Charters Cinematography

Overview

Rushy Knowe Plantation is a 145 ha area within Kielder Forest in Northumberland where Forestry England have planted just under 100 ha of new woodland which will support a range of habitats. This is the first afforestation project of this scale that Forestry England has carried out for around 20 years. It includes areas of protected open habitat which will create a mosaic of glades and peatlands within the wooded areas.

The new woodland creation is a mix of broadleaf and conifer phased planting, which began in February 2020. Planting design is based on the technical guidance on 'Robust Species Mixtures' by Kerr. et al, local observation and knowledge of successful species mixtures.

The soils on the site consist of surface water gleys and pockets of deep peat.

Management objectives and planning

Prior to planting, the site was a grazed, agricultural field which formed part of a Natural Capital pilot scheme. Forestry England pioneered a natural capital assessment tool to assess how the habitat data for the site would change under different scenarios (including conversion to woodland) in its ability to meet a range of ecosystem services including; climate regulation (carbon sequestration), timber production, priority habitat protection, recreation and impact on the landscape. The outcome of the pilot was a recommendation to plant the site to blend priority habitat preservation (blanket bog, fen and heathland) with productive carbon sequestration. The area supports half of the red squirrel population in England.

The woodland creation project also links into the aspiration of Forestry England and the Government's 25 Year Environment Plan to increase the natural capital value of the nation's forests to sequester carbon, improve water and air quality, provide recreational and biodiversity benefits and support timber production which is important to the local economy.

Forestry England received funding through the Woodland Carbon Fund for the initial capital costs of the woodland creation in the 1st year.

Delivering change

Designing a project on this scale in an area of open hillside was a very different process to the more routine re-stocking operations. The team marked out the site with GPS units and bamboo canes to identify different planting zones so that, when viewed at a distance, they were able to understand what the forest would look like and how the design needed to be adjusted to account for features of interest such as the view over Kielder Water.

Continuous mounding

This was chosen as the best method of ground preparation because it has minimal impact on the site. The vegetation was able to grow back to simultaneously provide some shelter and competition for the trees. Spot spraying of herbicide was undertaken where vegetation was inhibiting tree growth too much.

After the ground preparation operations had been completed, the contractors marked each mound with the species to be used. This was more time consuming but ensured the results were as stipulated in the design. The 2019/20 planted material came through the drought period in 2020 with the silver birch reaching between with 0.6 -0.9 m. 12,000 trees were used in the beat-up operation in 2021, which equates to less than 10% of the entire site. Some additional conifer and broadleaf planting may be required in 2022 which will be followed up with an application of herbicide to create a weed free area, vole guards will also be used on the thinner barked species such as birch. Forestry England's civil engineering team created a kilometre of new road to allow the team to establish and maintain the woodland into the future.

Forestry England recognised that early engagement with stakeholders was important to provide them with the opportunity to be involved with the project and to ensure that the design of the woodland carefully incorporated their interests.

Species Choice

A mixture of conifer and broadleaf species were chosen for their suitability to the soil conditions and local climate. The design of the species mixtures is based on compatibility information as described in the RFS Quarterly Journal of Forestry (QJF) (Vol. 114 July 2020) guidance on Robust Species Mixtures and on local knowledge of successful species mixtures on the nearby Forestry England site 'Blue Sike' in Kielder which is now on its 3rd rotation. UKFS was used as the starting point and the design exceeded the standard in a number of areas, including the amount of open space and use of native broadleaves.

There are 2 phases of planting to account for a fallow period to limit the effects of Hylobius (weevils):

- Phase 1 (2019/20): 120 ha (80.5 ha planted);
- Phase 2 (2025): 20 ha (16 ha planted);
- Phase 2 planting is to tie in with felling of adjacent forested areas due to be carried out in 2024, the areas of woodland creation and the restocking activities are to take place simultaneously.

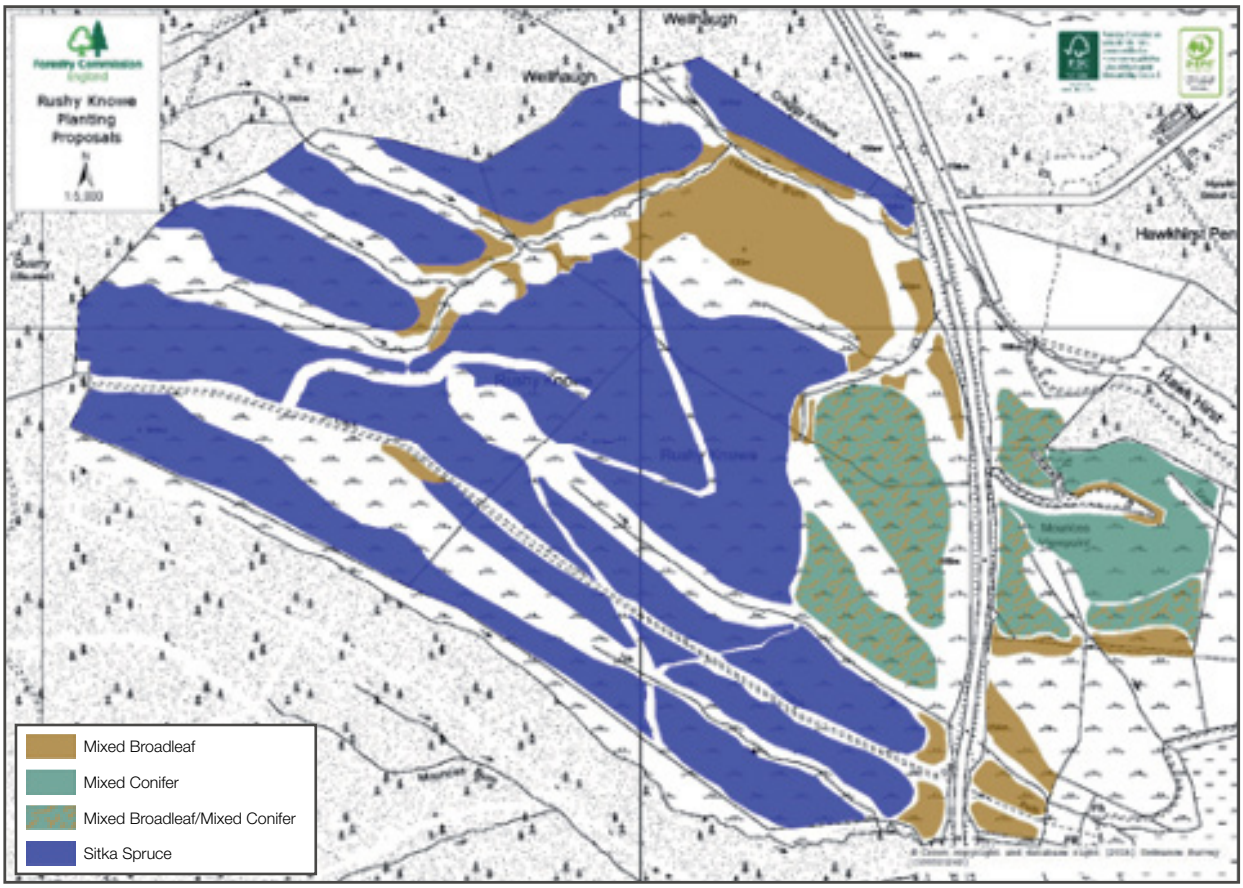
During the planning process, Forestry England carried out additional surveys to identify where deep peat was located and those areas have been left unplanted.

Phase 1 (2019/20) planting:

Sitka spruce (SS) area –this area used 100% improved sitka spruce stock, planted in February 2020, with a herbicide treatment applied in April 2020.

Mixed broadleaf (MB) area – 50% birch, 20% rowan, 20% common alder. The remaining 10% consists of a mixture of hawthorn, cherry, willow and aspen. Improved silver birch was chosen for enhanced timber production and to encourage natural regeneration.

Following further survey work to take account of (*the ancient woodland indicator,)* Forestry England decided to amend the species composition of the mixed broadleaf planting area. Within the silver birch planting there are small nests of oak (20 groups of 10 trees) in recognition of the ancient woodland indicator which was found and for habitat enhancement. The numbers of oak planted were kept low to ensure that grey squirrels would not get a foothold into the red squirrel reserve.



Mixed conifer and broadleaf (MCMB) areas are mainly a W4 mixture on surface water gleys where groups of conifers are interspersed with the broadleaves. The groups vary in size and density, in some parts of the woodland, conifers have been planted in small clumps and in a gradient, with more dense clumps at the back towards the areas of sitka spruce with broadleaves planted in between (picture a dalmatian pattern). Forestry England used local knowledge of successful species mixtures and information on what grows well to inform the conifer choices; Serbian spruce, Norway spruce and Macedonian pine. Further information on conifer mixtures is to be drawn from species trials taking place in Kielder South. Any alterations to the species choices will be made when beat up operations take place.

The area south of viewpoint consists of mixed conifers (MC); Douglas fir, Macedonian pine, western red cedar, Serbian spruce and noble fir. Planted in blocks of 0.5 ha, the percentage proportions were stipulated in the design but decisions on the location and design were made by planting teams (based on the QJF guidance in Resources for Managing Woodland for Resilience).

ESC was consulted when considering the species options, however some of the outputs from ESC required further evaluation using information from nearby sites where exposure was the limiting factor.

Sourcing Stock

Provenance selection was mainly determined by the geographic location of the nursery - southerly provenances of oak were available (southern UK and French). All the planting material used by Forestry England is grown in Britain. In the future, the glass house at Delamere will allow for larger species trials to be carried out which will increase Forestry England's knowledge of species suitability for use in new woodland creation.

First sitka spruce plantings during winter 2019. Credit: Forestry England

Priority Habitats

The areas of priority habitat at Rushy Knowe include areas of blanket bog, fen and heathland. The presence of priority habitat on the site was seen as an opportunity to consult the UKFS and stakeholders to see how Forestry England could incorporate the features of these habitats within the design. The open habitat within the woodland is managed to maintain a vista and to carry out deer control.

Forestry England decided to try to reduce the effect that the existing, non-compliant field drains have on the site by intersecting them with the new drainage network to direct water flow towards the priority habitat areas. The hope is that they will continue to function with the additional water input in different climate change scenarios. 10 m buffers have also been included around the priority habitat areas and the planting areas adjacent are slightly feathered. Forestry England will monitor the condition of the priority habitat over the next five years to evaluate the interventions put in place.

Evaluation

The success of the planting scheme will be evaluated by the survival of the species chosen. Conifers need to achieve 2500 stems per hectare and the broadleaf species 1000 stems per hectare. Forestry England will regularly survey the site to monitor the success of the new planting.

Further land is to be leased for planting in the future, and there will be a review of agricultural land within the nation's forests to evaluate whether the most gains are being achieved for natural capital.

Further information

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For further resources go to:
Resources for Managing Woodland for Resilience

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