START TOMORROW TODAY

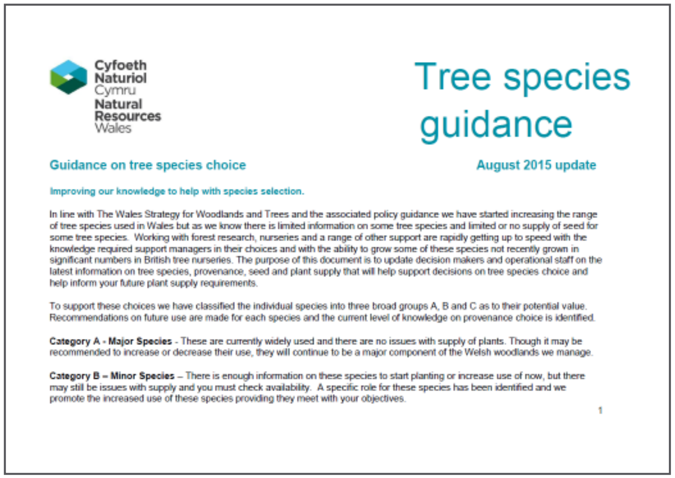
SPECIES CHOICE FOR TIMBER AND BIOMASS

Elspeth Macdonald
Scottish School of Forestry
Inverness College UHI

With thanks to colleagues in Forest Research and Edinburgh Napier University

Species choice in the 21st Century

- Ongoing initiatives aim to increase species diversity



Cyfoeth Naturiol Cymru
Natural Resources Wales

Tree species guidance

Guidance on tree species choice

August 2015 update

Improving our knowledge to help with species selection.

In line with The Wales Strategy for Woodlands and Trees and the associated policy guidance we have started increasing the range of tree species used in Wales but as we know there is limited information on some tree species and limited or no supply of seed for some tree species. Working with forest research, nurseries and a range of other support are rapidly getting up to speed with the knowledge required support managers in their choices and with the ability to grow some of these species not recently grown in significant numbers in British tree nurseries. The purpose of this document is to update decision makers and operational staff on the latest information on tree species, provenance, seed and plant supply that will help support decisions on tree species choice and help inform your future plant supply requirements.

To support these choices we have classified the individual species into three broad groups A, B and C as to their potential value. Recommendations on future use are made for each species and the current level of knowledge on provenance choice is identified.

Category A - Major Species - These are currently widely used and there are no issues with supply of plants. Though it may be recommended to increase or decrease their use, they will continue to be a major component of the Welsh woodlands we manage.

Category B – Minor Species – There is enough information on these species to start planting or increase use of now, but there may still be issues with supply and you must check availability. A specific role for these species has been identified and we promote the increased use of these species providing they meet with your objectives.

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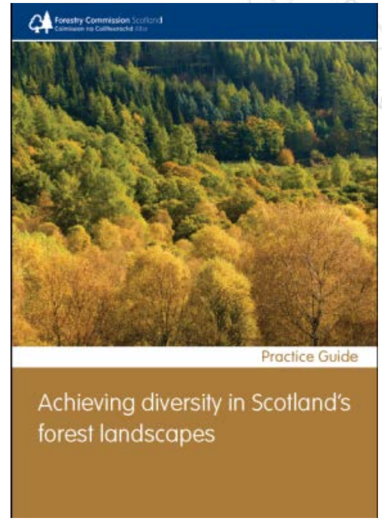


- Factors driving species diversification:
  - Predicted climate change impacts on future species suitability
  - Increasing incidence of damaging pests and diseases – many affecting commercial timber species

Climate change predictions

- Drier, warmer summers → increased drought risk
- Wetter winters
- Increased frequency of extreme weather events


Forestry Commission

Fruiting bodies of *Armillaria gallica*

Research Note

Potential impacts of drought and disease on forestry in Scotland

Sarah Green and Duncan Ray — September 2009

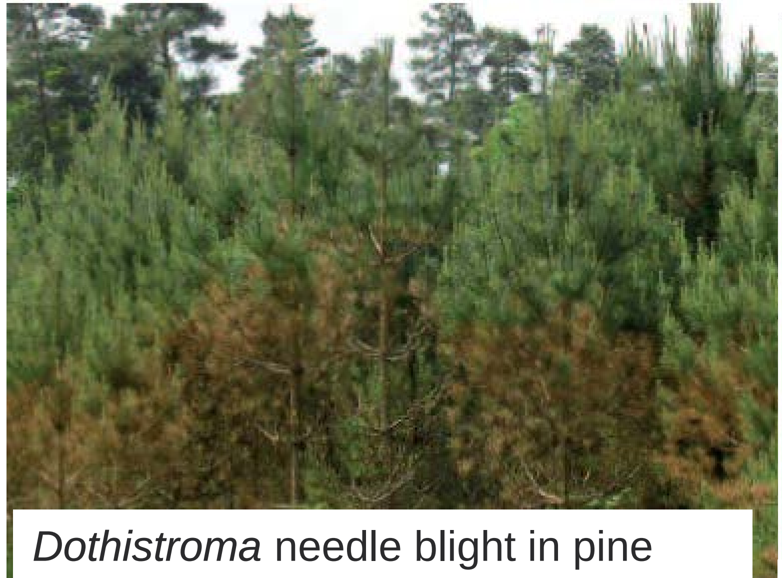
In predictions of future changes in climate, drought is expected to become a more important factor affecting the health of trees in areas of Britain, particularly in the east of the country and including areas of Scotland. Drought may cause direct physiological damage to trees as well as increase their susceptibility to a range of fungal diseases. Although a number of diseases are known to be more aggressive on trees experiencing drought stress, there are uncertainties as to which are likely to increase in frequency and severity in response to future changes in climate. This study used GIS-based modelling to develop 'drought-risk maps' to identify forest sites and tree species in Scotland most at risk by combining past and predicted climatic variables with a range of soils data. Sitka spruce, Scots pine, larch, Norway spruce, mixed broadleaves and Douglas fir were found to be major component species of drought-prone forest sites in eastern Scotland. Results from the modelling study focused a literature review of the potential risks to these species from drought-related fungal diseases. This review identified a number of diseases likely to increase in frequency and severity on drought-prone forest and woodland trees in Scotland. In addition to good silvicultural practice, it is concluded that the potential of damage to trees from pathogens must be factored into future climate change adaptation strategies.

FCRN004 1 Forest Research

(Images: Forestry Commission)

Pests and diseases

P. ramorum in larch



Dothistroma needle blight in pine

Oriental chestnut gall wasp

Forestry Commission

Research Note

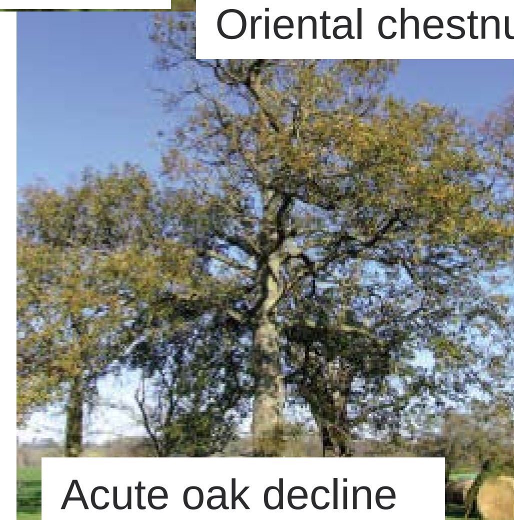
The influence of climate change on forest insect pests in Britain

David Wainhouse and Daegan J.G. Inward

March 2016

Predicting future risks of damage by insect pests is an important aspect of forest management. Climate change has the potential to affect forest pests and their impact on trees through higher temperatures, altered precipitation patterns, and more frequent extreme weather events. Warmer temperatures are likely to have complex effects on insects, influencing, among other things, development rate and the seasonal timing of life-cycle events, while also affecting their host trees and natural enemies. It is not possible to predict the future impact of forest pests with any precision, but some generalisations can be made based on the ecological characteristics of different insect types. The damage caused by aphids and related insects is likely to increase as the climate warms. Higher temperatures will increase their reproductive rate, and drought stress of host trees may increase their susceptibility to aphid attack. The impact of bark beetles and related insects is also likely to increase, due to factors such as increased frequency of windblows, drought stress of host trees and, for some species, a shorter generation time. Effects upon defoliators are more difficult to predict, but the abundance and impact of some species is likely to be influenced by an increase in the number of generations per year and changes in their geographical distribution. Changes in forest management as a response to

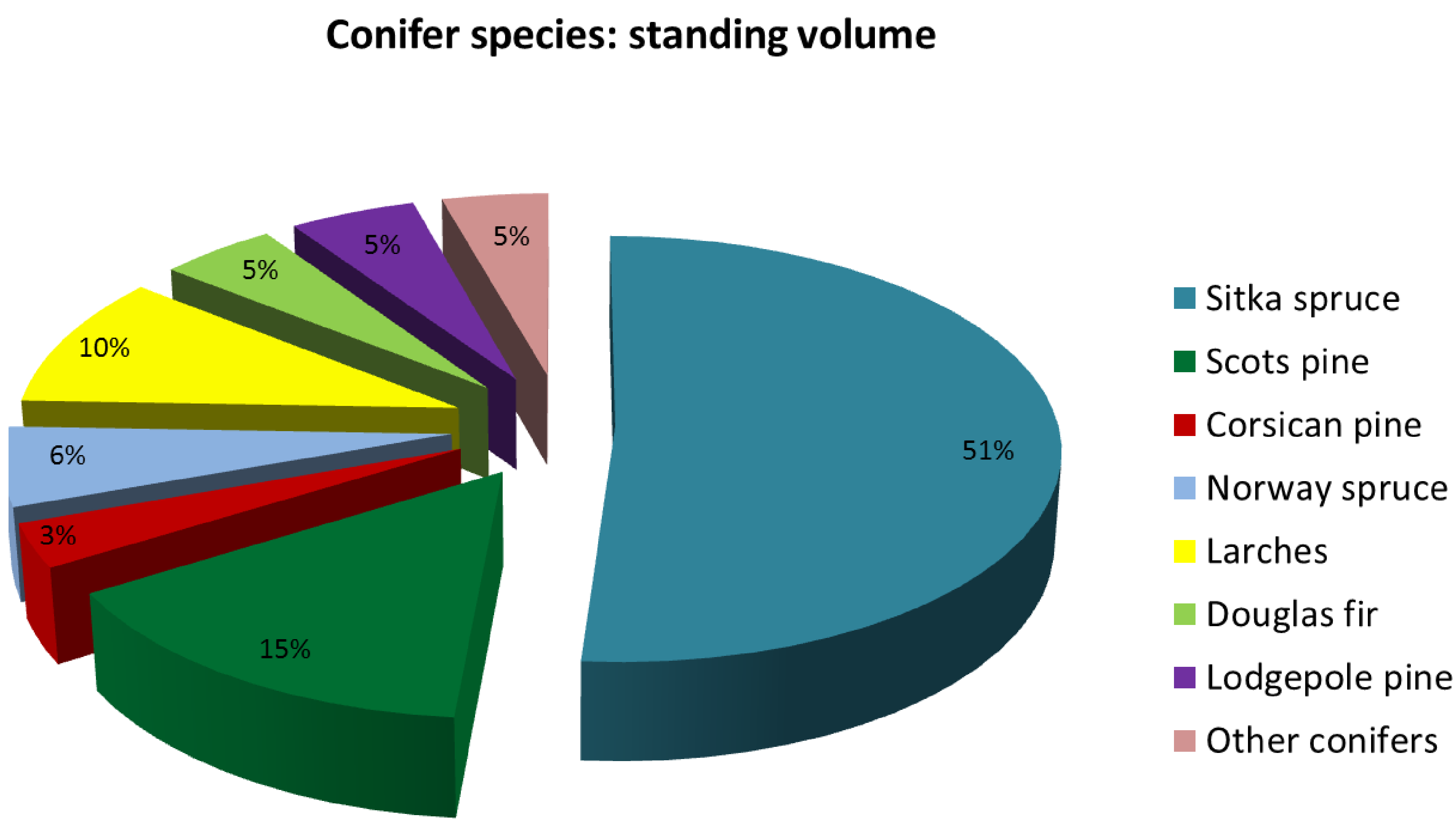
Chalara dieback in ash



Acute oak decline

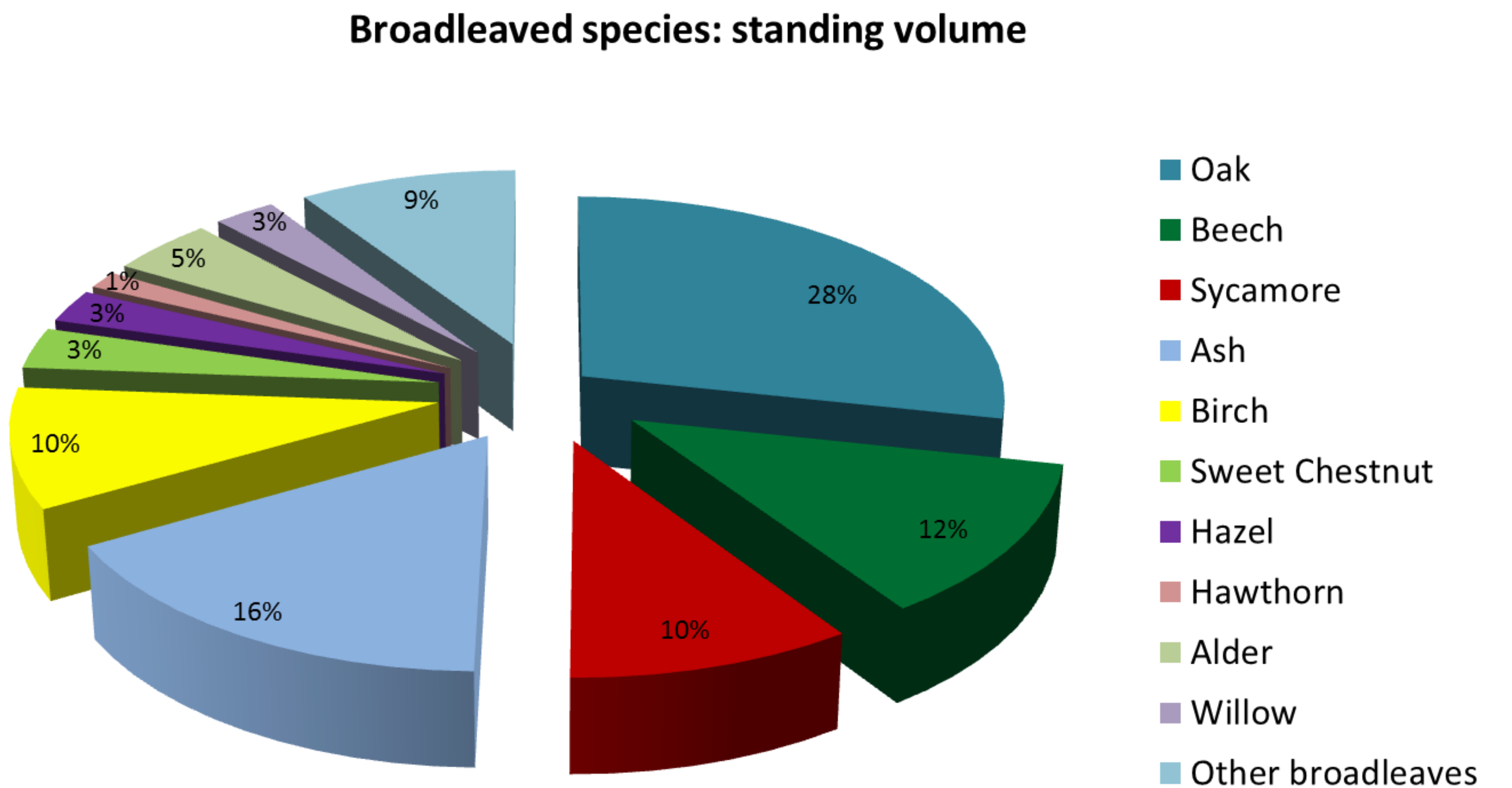
(Images: Forestry Commission)

Current conifer species



(Data: Forestry Commission (2014), 50 year forecast of softwood availability)

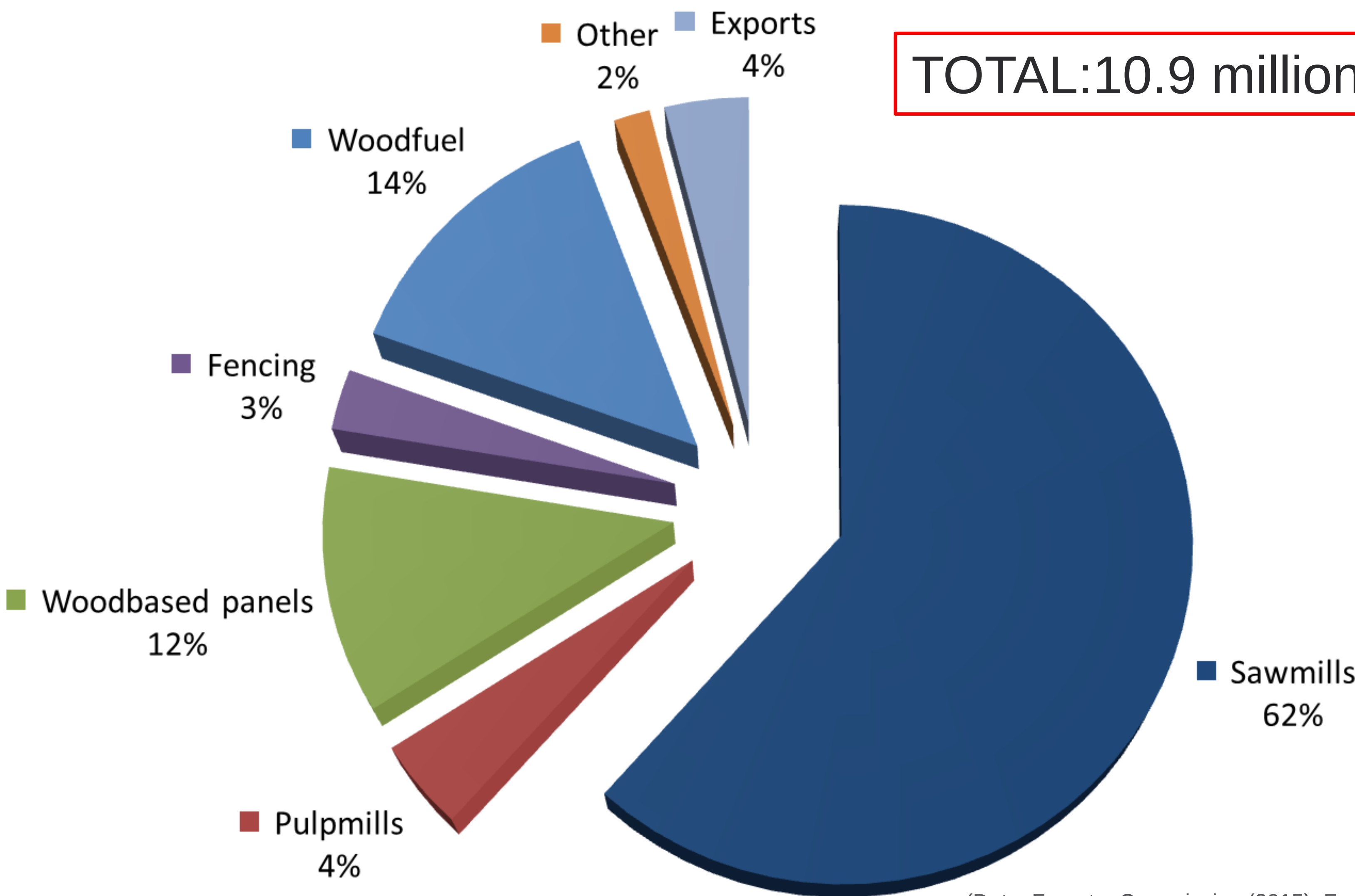
Current broadleaved species



(Data: Forestry Commission (2014), 50 year forecast of hardwood availability)

2014 use of UK timber - softwood

TOTAL:10.9 million tonnes



(Data: Forestry Commission (2015), Forestry Statistics 2015)

2014 use of UK timber - hardwood

TOTAL: 0.5 million tonnes

(Data: Forestry Commission (2015), Forestry Statistics 2015)

Timber and biomass – key properties

- Value of timber affected by:
  - Growth rate (productivity) and survival
  - External features (straightness, fluting, branching and taper) → affect harvesting, transport and processing
  - Wood properties
  - Demand/availability

(Images: Forestry Commission)

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  - **<u>Wood properties</u>**
  - Demand/availability

(Images: Forestry Commission)

Key properties for some end uses

	Biomass/ woodfuel	Woodbased panels	Structural sawn timber	Fencing/ outdoor	Pallets	Joinery
Wood density	✓	✓	✓			
Stiffness			✓			
Strength			✓		✓	
Durability				✓		
Treatability			(✓)	✓	(✓)	
Dimensional stability			✓			✓
Moisture content	✓	✓				
Knottiness			✓		✓	✓
Appearance/ colour			(✓)			✓

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Knottiness			✓		✓	✓
Appearance/ colour			(✓)			✓

Determine net calorific value per m^3

Strength grade determining properties

Species selection - considerations

- Management objectives
- Access to potential markets
- Silvicultural approach:
  - ➢ Single species or mixtures
  - ➢ Clearfelling or continuous cover

  } - Growth rate
  - Shade tolerance
- Site assessment – soils, climate, topography
- What has grown well on the site before? Or locally?
- Use Ecological Site Classification (ESC) to guide species choice and future climate suitability

Using ESC to guide species choice

- Radnor forest, Wales

Forest Research

Enter Grid Reference (e.g. NT090950) SO218658 Go Select decision support tool: Ecological Site Classification

Ecological Site Classification : Amend site/management variables below then click on map for species suitability analysis.

Soil properties

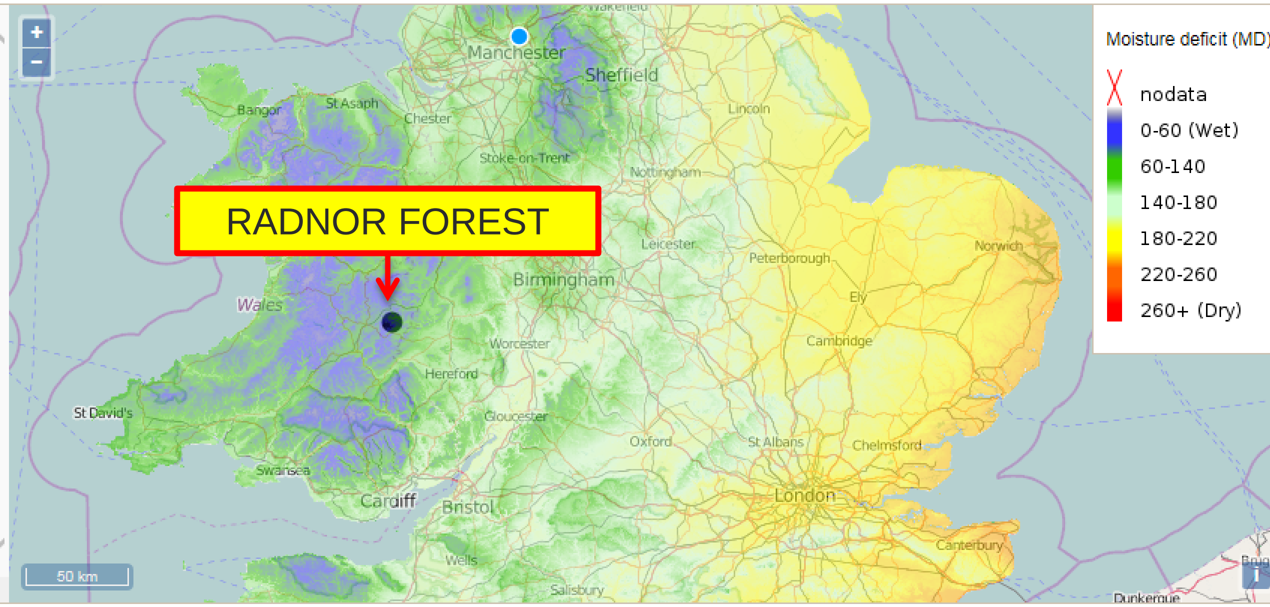
Soil Moisture Regime (SMR): Fresh

Soil Nutrient Regime (SNR): Medium

Site Management [+/-]

Options [+/-]

Update Results



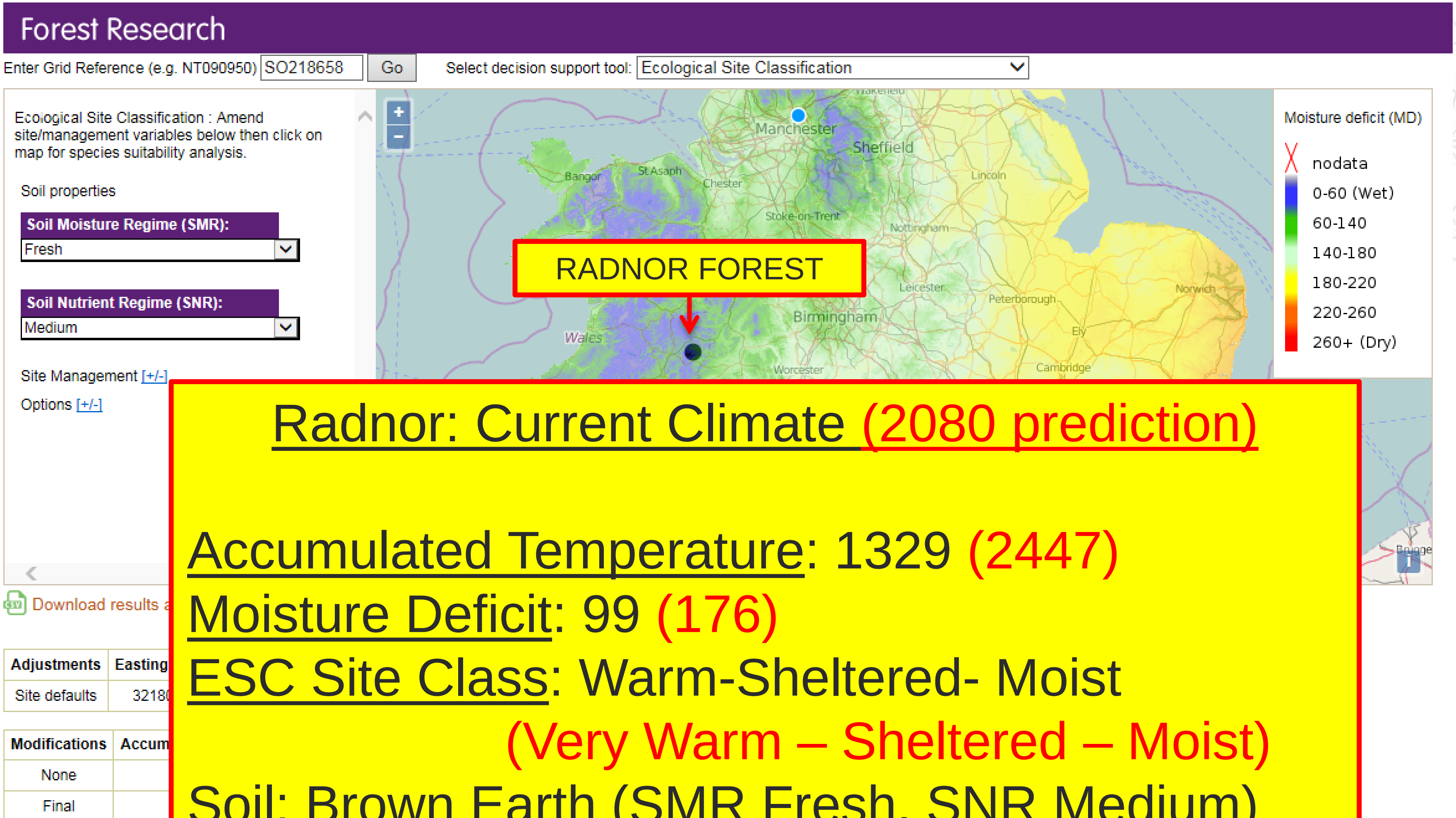
Download results as a CSV file | Download results as a PDF file

Adjustments	Eastings(m)	Northings(m)	Site Grid Reference	Climate Scenario	Site Class	Filter	Brash	Drainage	Fertiliser
Site defaults	321800	265800	SO218658	Baseline climate 1961-1990	Warm - Sheltered - Moist	All species	No brash present	No drainage installed	No fertiliser

Modifications	Accumulated Temperature(AT)	Continentality(CT)	Exposure(DAMS)	Moisture Deficit (MD)	Soil Moisture Regime (SMR)	Soil Nutrient Regime(SNR)
None	1329	9	11	99	5(Fresh)	3(Medium)
Final	1329	9	11	99	5(Fresh)	3(Medium)

Using ESC to guide species choice

- Radnor forest, Wales



Radnor: Current Climate (2080 prediction)

Accumulated Temperature: 1329 (2447)

Moisture Deficit: 99 (176)

ESC Site Class: Warm-Sheltered- Moist

(Very Warm – Sheltered – Moist)

Soil: Brown Earth (SMR Fresh, SNR Medium)

Using ESC to guide species choice

- Radnor ESC species suitability

Suitability key: ● Very Suitable (0.75-1.00) ● Suitable (0.50-0.74) ▲ Marginal (0.30-0.49) ● Unsuitable (0.0-0.29)

Common name	Species Code	Suitability		YC	Lim	AT	CT	DAMS	MD	SMR	SNR	Suit.	AT	CT	DAMS	MD	SMR	SNR
		Ecological	Timber															
Corsican pine	CP	0.76	0.75	15	AT5	0.76	1	1	0.99	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Lodgepole pine	LP	0.92	0.92	13	MD	1	1	1	0.92	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Macedonian pine	MCP	0.89	0.89	12	MD	1	1	1	0.89	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Maritime pine	MAP	0.63	0.43	6	AT5	0.63	0.79	1	0.68	0.96	1	Suitable	Suitable	Very Suitable	Very Suitable	Suitable	Very Suitable	Very Suitable
Monterey/Radiata pine	RAP	0.39	0.16	3	AT5	0.39	0.79	1	0.4	1	1	Marginal	Marginal	Very Suitable	Very Suitable	Marginal	Very Suitable	Very Suitable
Scots pine	SP	1	1	14	AT5	1	1	1	1	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Weymouth pine	WEP	0.95	0.95	13	AT5	0.95	1	1	1	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Norway spruce	NS	1	1	24	AT5	1	1	1	1	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Oriental spruce	ORS	0.8	0.66	14	AT5	0.8	1	0.95	0.82	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Serbian spruce	OMS	0.8	0.8	18	MD	1	1	0.9	0.8	0.97	0.88	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Sitka spruce	SS	0.99	0.98	27	AT5	0.99	0.99	1	1	0.99	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Sitka spruce(VP)	VPSS	0.99	0.98	30	AT5	0.99	0.99	1	1	0.99	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Douglas fir	DF	0.93	0.91	24	MD	0.98	1	0.94	0.93	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable
Hybrid larch	HL	1	1	16	AT5	1	1	1	1	1	1	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable	Very Suitable

Using ESC to guide species choice

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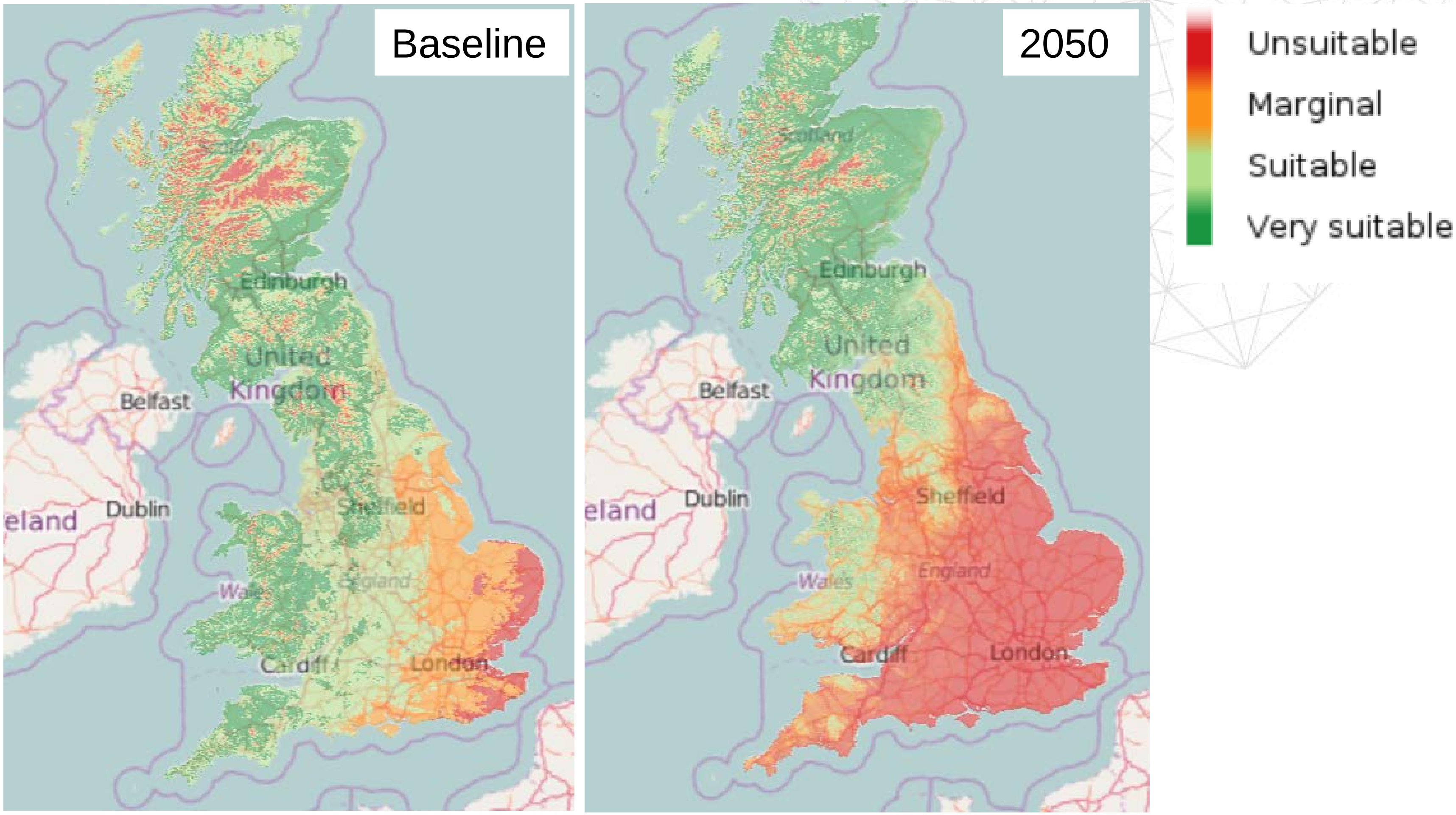
		Ecological	Timber															
Oriental spruce	ORS	0.8	0.66	14	AT5	0.8	1	0.95	0.82	1	1	●	●	●	●	●	●	●

Current species suitability	Number of species	
	Conifers	Broadleaves
Very suitable	25 (21)	18 (18)
Suitable	2 (6)	10 (12)
Marginal	1 (0)	1 (0)
Unsuitable	(1)	1 (0)

- On a site like this – lots of choice
- On more challenging sites – limited number of suitable species

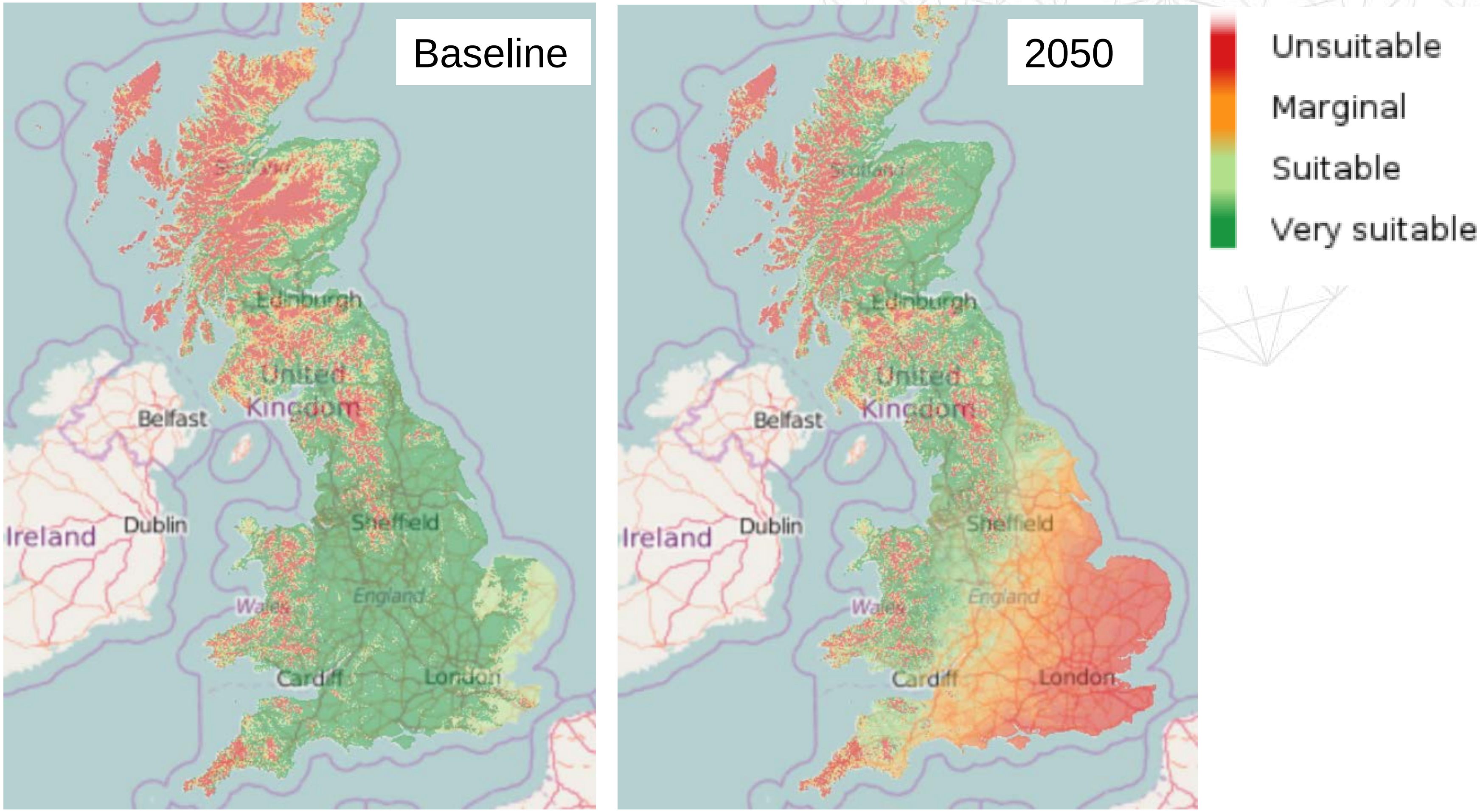
Using ESC to guide species choice

- Changing climate suitability – Sitka spruce



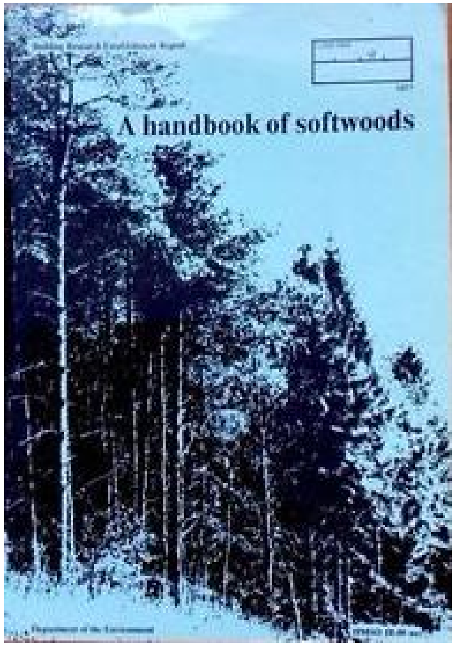
Using ESC to guide species choice

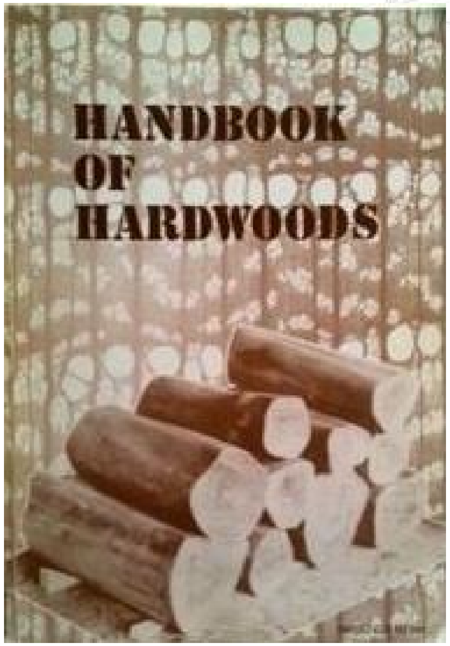
- Changing climatic suitability – sessile oak

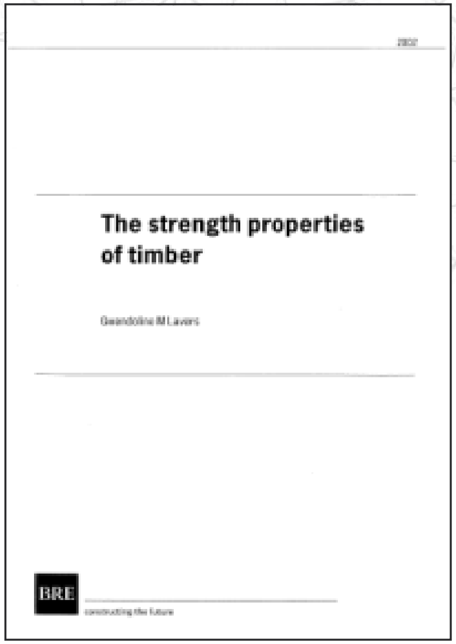


Timber information for species choice

- Early research on UK timber: BRE







Timber information for species choice

- Early research on UK timber: BRE
- More recent research has focused on 4 softwood species (~80% of standing volume):
  - ➢ Sitka spruce
  - ➢ Scots pine
  - ➢ Larch
  - ➢ Douglas fir

Collaborative projects with industry support, many through SIRT network (Forest Research, Edinburgh Napier, Glasgow, Aberdeen and Bath Universities)

- Research has aimed to
  - ➢ Link timber properties and performance to site conditions and silviculture
  - ➢ Investigate variation in properties

Timber data: commercial softwoods

Average values (from UK data)	Sitka spruce	Scots pine	Larches (JL/HL/EL)	Douglas fir
Wood density (kg m^{-3})	387	418	494	455
Bending stiffness (MOE) (kN mm^{-2})	8.3	9.3	9.6	9.2
Bending strength (MOR) (N mm^2)	32.7	44.5	39.1	34.1
Basic strength class	C16	C18 – C20	C22	C18 – C20
Durability (1 = Very durable → 5 = Not durable)	4 - 5	3 - 4	3 - 4	4
Net calorific value (kWh green $tonne^{-1}$)	1705	2233	2653	2596

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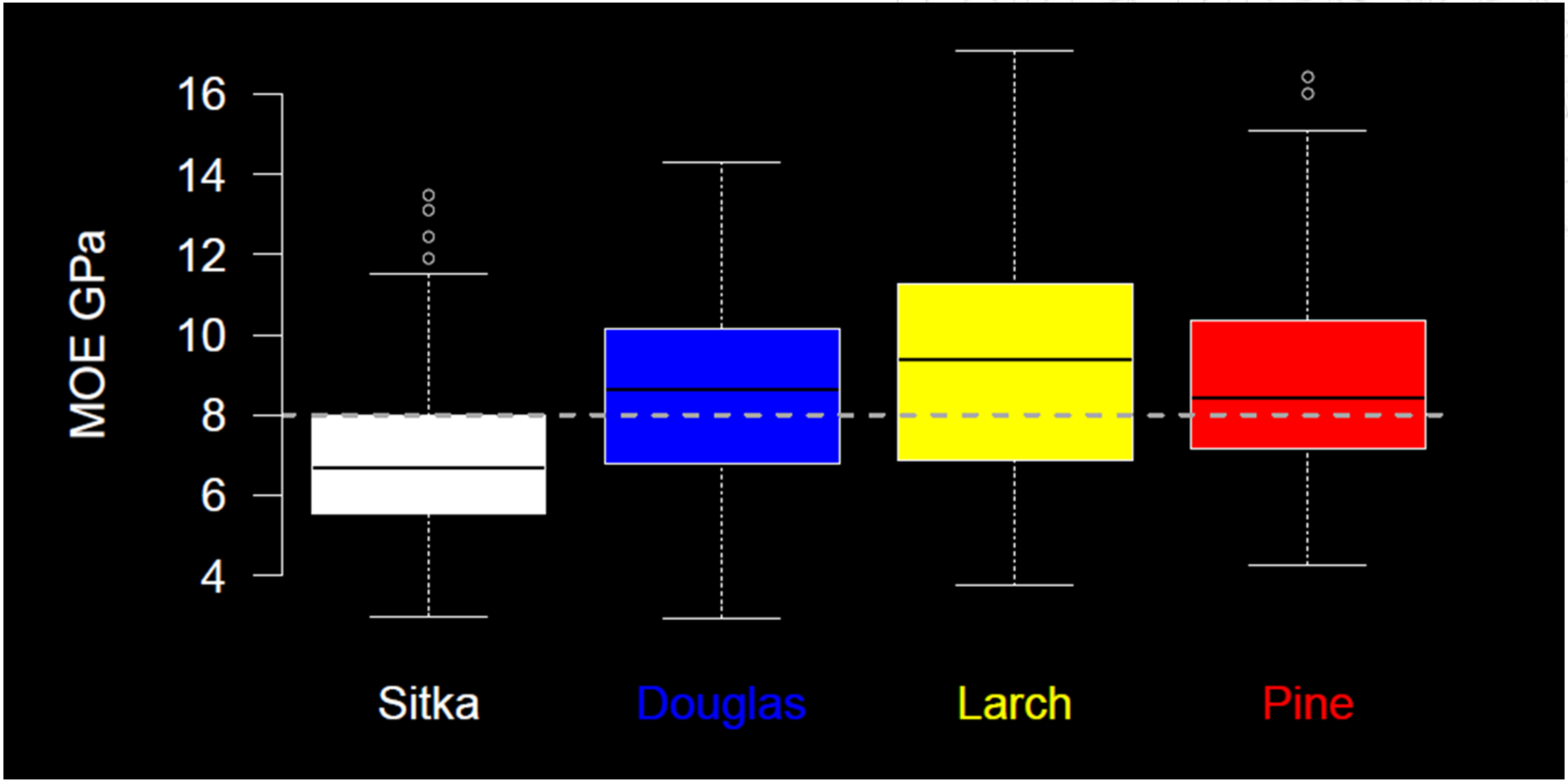
For biomass **productivity** must be considered, as well as net calorific value

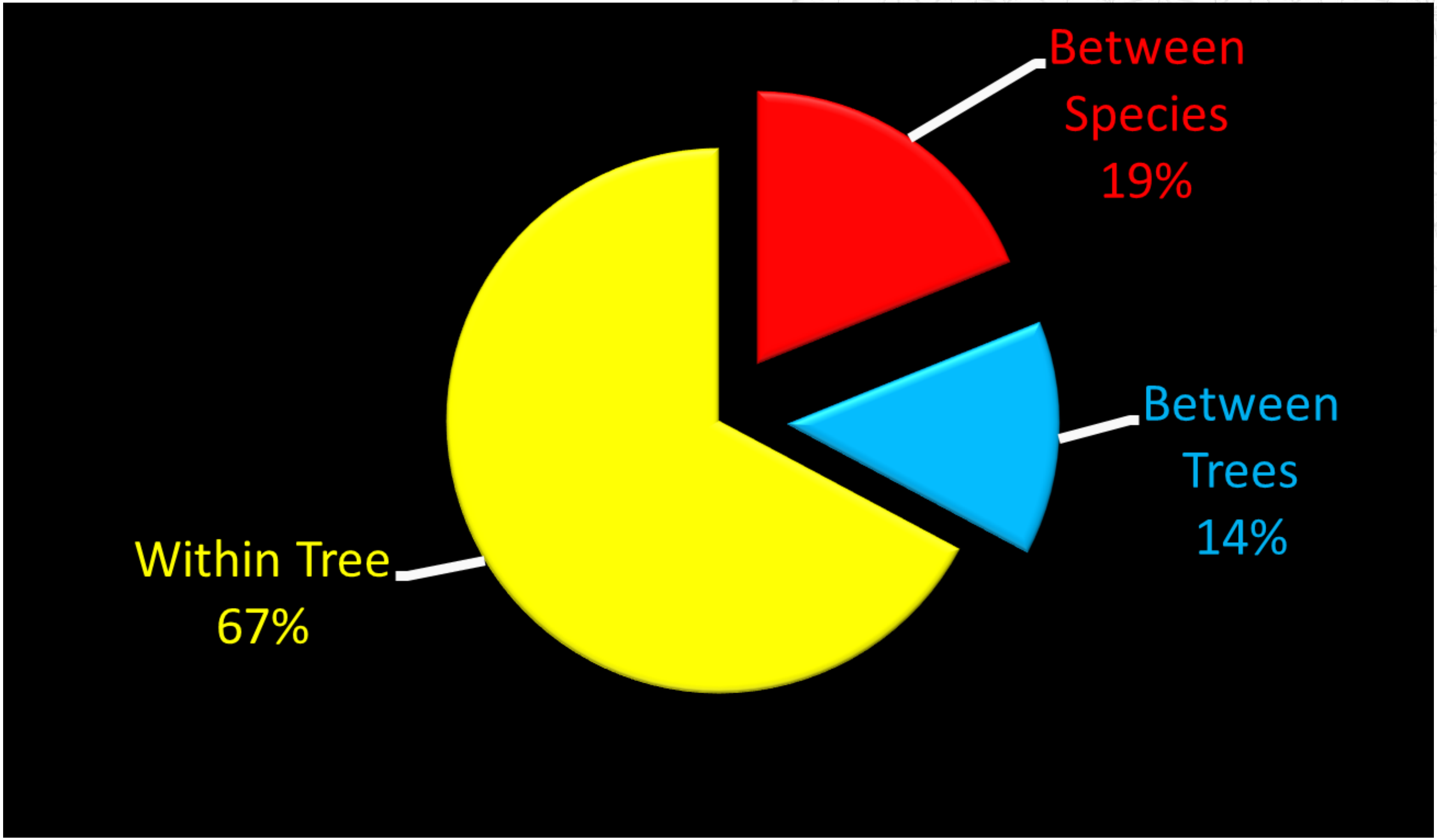
Variation between species

- Wood stiffness variation – UK commercial species



(Data: Forest Research)

Sources of wood stiffness variation



(Data: Forest Research)

Other softwood species

- David Gil-Moreno, PhD student (Edinburgh Napier University and Forest Research) is investigating wood properties of 4 species:
  - Norway spruce
  - Western hemlock
  - Western red cedar
  - Noble fir

Samples from 3 sites for each species (England, Wales and Scotland)

- Project is funded the Scottish Forestry Trust, FC Scotland and Natural Resources Wales

Timber information

Average values	Sitka spruce	Norway spruce	Western hemlock	Western red cedar	Noble fir
Wood density (kg m^{-3})	387	378	444	358	365
Bending stiffness (MOE) (kN mm^{-2})	8.3	8.55	8.33	7.71	7.44
Bending strength (MOR) (N mm^{2})	32.7	31.4	34.5	31.1	30.1
Basic strength class	C16	C18	C18	C14	C14
Durability (1 = Very durable → 5 = Not durable)	4 - 5	4	4	2	5
Calorific value (kWh green $tonne^{-1}$)	1705	1787	2040	1755	

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Estimated C16 yield of > 90%

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Durability (1 = Very durable → 5 = Not durable)	4 - 5			2	5
Calorific value (kWh green $tonne^{-1}$)	1705			1755	

Natural durability offers potential for external applications

Further softwood species

- Edinburgh Napier University and Forest Research are also testing samples of:
  - European silver fir
  - Grand fir
  - Pacific silver fir
  - Nordmann (Caucasian) fir
  - Serbian spruce
  - Japanese cedar

Research considerations

- Limited number of suitable sample stands
- Logistics of extracting sample logs
- Processing, drying and testing all take time….and money….

Species not yet tested

- There are a number of other conifer species potentially of interest for productive stands:
  - Macedonian pine
  - Maritime pine
  - Radiata pine
  - Weymouth pine
  - Oriental spruce
  - Coast redwood
  - Leyland cypress
  - Wellingtonia

Processing and utilisation

- Limited UK experience of processing minor species….and understandable uncertainty about prospect of increasing supply
- Edinburgh Napier University is planning a survey of sawmillers' experience to build up a database of knowledge – watch this space…
- Work in the Wood Product Innovation Gateway project (WoodPIG) included tests of some minor species in the production of cross-laminated timber

(Image: Edinburgh Napier University)

What about hardwoods?

- Small volumes harvested, but locally important
- Woodfuel is a key market – opportunity to improve timber quality of stands
- Future Trees Trust: working to improve broadleaved trees

- Initiatives through Grown in Britain to increase hardwood timber utilisation (e.g. WoodStock)

Grown in Britain
WoodStock

- Testing of sycamore and birch underway by FR/Edinburgh Napier

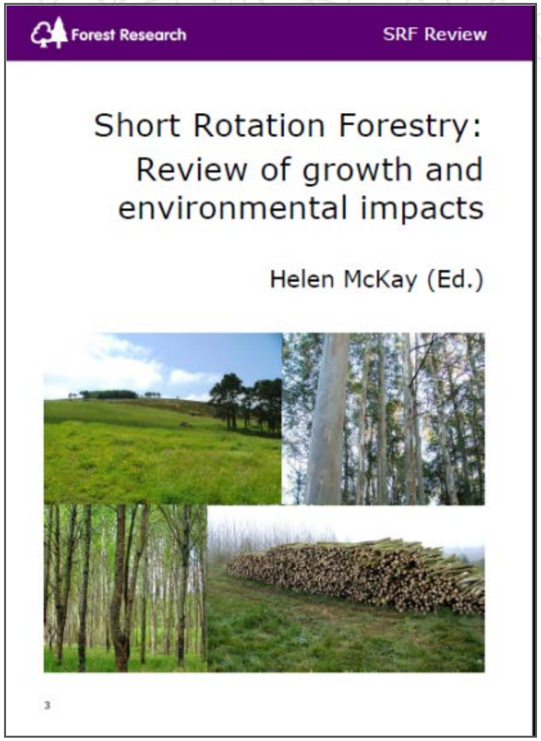
Growing for biomass

- Marginal upland sites – recent work on the potential for mixtures of downy birch and aspen as a woodfuel crop (Scott Wilson)

Growing for biomass

- Marginal upland sites – recent work on the potential for mixtures of downy birch and aspen as a woodfuel crop (Scott Wilson)

- More fertile sites (lower grade agricultural land) - Short Rotation Forestry for biomass production



Growing for biomass

- Marginal upland sites – recent work on the potential for mixtures of downy birch and aspen as a woodfuel crop (Scott Wilson)
- More fertile sites (lower grade agricultural land) - Short Rotation Forestry for biomass production
- Ongoing trials on six sites in Scotland to evaluate biomass potential of several species

Species	Height ranked across sites	Mean % survival ranked across sites
Hybrid aspen	1	4
Red alder	2	9
Hybrid larch	3	3
Common alder	4	7
Silver birch	5	5
Italian Alder	6	9
Sitka spruce	7	6
Ash	8	2
Sycamore	9	1
Sweet chestnut	10	8

(Data: Stokes (2015) Short Rotation Forestry Trials Report)

Species choice: a recent (ish) example

- Lodgepole pine (*Pinus contorta*): native to western North America
- Timber used in construction and joinery

(Photo: www.flickr.com/photos/bryanto/)

Photo: www.naturallywood.com

Lodgepole pine in the UK

- Widely planted in uplands during 1960s-1980s

Inland (Terrace) – good form, slow growing

South coastal (Longbeach) – poor form and stability, fast growing

(Images: Forestry Commission)

Lodgepole pine: pests & diseases

Pine beauty moth (*Panolus flammea*)

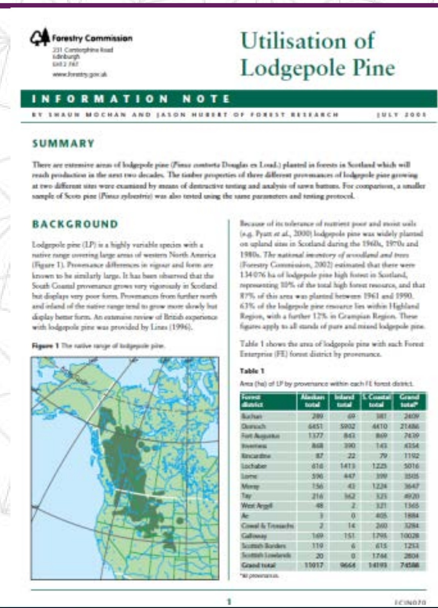
Dothistroma needle blight

(Images: Forestry Commission)

Lodgepole pine: timber properties

- Problems reported by end users – brittle failure of fence posts and pallets in service
- Study tested timber from 3 provenances:
  - ➢ Alaskan – similar properties to Scots pine
  - ➢ Inland – variable properties
  - ➢ South coastal – low impact strength and prone to brash failure

Planted for timber – now harvested mainly for chipwood and biomass (but still planted as a nurse species)


Forestry Commission

Utilisation of Lodgepole Pine

INFORMATION NOTE

BY SHAUN MOCHAN AND JASON HUBERT OF FOREST RESEARCH JULY 2005

SUMMARY

There are extensive areas of lodgepole pine (*Pinus contorta* Douglas ex Loud.) planted in forests in Scotland which will reach production in the next two decades. The timber properties of three different provenances of lodgepole pine growing at two different sites were examined by means of destructive testing and analysis of sawn battens. For comparison, a smaller sample of Scots pine (*Pinus sylvestris*) was also tested using the same parameters and testing protocol.

BACKGROUND

(Images: Forestry Commission)

Lodgepole pine: what might we learn?

- Fast growth does not necessarily deliver a good financial return
- Provenance (seed origin) can be **really** important
- Introduced species may be susceptible to damage by indigenous pests which do not affect native species (e.g. Pine Beauty Moth)
- The value of long-term research trials
- The need for tree improvement through selection and breeding

Conclusions

- Diversifying species choice for timber and biomass:
  - Will it grow and survive? (current and future site and climate suitability; potential pest and disease threats)
  - Is it suited to the planned silvicultural system?
  - Is guidance on provenance available? If so, follow it.
- Since there is a large overlap in many timber properties between (softwood) species – **what** you grow is only part of the story….**how** you grow it (silviculture) and **what you do with it** (processing) may be just as important

Further information

- Forestry Commission, Natural Resources Wales and Forest Research web pages and publications
- Silvifuture website www.silvifuture.org.uk/
- Using alternative conifer species for productive forestry in Scotland

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