

Indicator name			Version
NF1 Proportion of major timber species on Scotland's National Forest Estate planted in areas likely to be climatically suitable in 2050 (Sitka spruce and Scots pine)			26/03/16
Indicator type:	Risk/opportunity	Impact	Action
	X		
SCCAP Theme	SCCAP Objective	CCRA risk/opportunity	
Natural Environment	N3: Sustain and enhance the benefits, goods and services that the natural environment provides.	FO4b Increase of potential yield of Sitka spruce (and other major timber species) in Scotland FO2 Loss of forest productivity due to drought	

At a glance
<ul style="list-style-type: none"> • With a changing climate, there will be an associated change to the suitability of sites for growing particular species of tree • Changing suitability could impact forest productivity and the sustainability of the forestry sector • Spatial modelling, utilising the Forestry Commission's Ecological Site Classification decision support tool, is applied to climate projections for 2050 with high and low emissions scenarios. This enables the identification of likely changes in tree species suitability • Climate projections indicate that by 2050 the growing season for many species will be longer, temperatures will not have increased nor water availability reduced to an extent that will be detrimental to species suitability; however, the model takes no account of the impact of pests and pathogens

Latest Figure	Trend
The proportion of current forest area projected to increase in suitability exceeds that projected to decline for both Sitka spruce and Scots pine. In 2050, 81-82% of current Sitka spruce forest area is projected to be on sites classified as suitable or very suitable; for Scots pine this is 77-78%.	No trend available. Repeating this analysis in future will enable identification of trends.

Why is this indicator important?

As the climate changes, so too will the suitability of sites for growing particular timber species. Areas currently suitable for a certain species could become unsuitable over the next 40 years and beyond due to climate change. This could have impacts on forest productivity and therefore on the sustainability of Scotland's forest industry. Moreover, areas currently unsuitable for a species could become suitable, presenting an opportunity for increased tree growth and productivity.

This indicator measures the change in the suitability of existing forest area managed by Forestry Commission Scotland, according to the UKCP02 Climate Projections High and Low emissions scenarios for 2050. It uses the Ecological Site Classification method (ESC), which classifies a site as 'Very suitable', 'Suitable' or 'Unsuitable'. It reports the change in suitability class by proportion of forest area by planting decade, for the key timber species Sitka spruce and Scots pine.

In Scotland there are around 1,410,000 ha of forests (18% of land area), of which approximately one third is managed by Forestry Commission Scotland (Forestry Commission, 2014). Detailed data for the location, management and species composition of individual stands is only available for the National Forest Estate, therefore this indicator considers only publically managed forest.

Timber production is an important provisioning service provided by Scotland's forests, and timber production makes a significant contribution to Scotland's economy through jobs in wood processing, forest management, timber haulage and associated industries. The direct Gross Value Added (GVA) of the growth and primary timber processing industry in Scotland is £1 billion (Scottish Forest and Timber Technologies, 2011). The total value of UK wood product exports in 2013 was £1.7 billion (Forestry Commission, 2014). Forestry Commission Scotland (FCS) aims to maximise the economic potential of Scotland's timber resources, sustaining a predictable and stable supply of timber, while delivering a range of social, ecological and economic Ecosystem Services (Forestry Commission Scotland, 2013).

Related indicators:

NF6 Number of uses & users of the Ecological Site Classification (ESC) decision support tool

What is happening now?

Suitability to baseline climate conditions

According to baseline climate conditions (1970-1990), the percentage of current Sitka spruce forest area planted on sites classified as suitable is 53%, as very suitable is 20% and as unsuitable is 25%. For Scots pine at baseline conditions, the current percent of forest area planted on sites classified as suitable is 65%, as very suitable is 13%, and as unsuitable is 20%.

Suitability to 2050 climate projections

Sitka spruce

Under the UKCP02 high emissions scenario, in 2050 82% of Sitka spruce forest area will be classified as suitable or very suitable and 15% as unsuitable; under low emissions scenarios these figures are 81% and 15%.

The proportion of current Sitka spruce forest area projected to increase in suitability exceeds that projected to decline. For 2050 high and low emissions scenarios 11% and 10% respectively of forest area increase from unsuitable to suitable and a further 8% and 7% increase from suitable to very suitable. In contrast only 0.9% and 0.02% of forest area decline in classification from suitable to unsuitable, and 0% from very suitable to unsuitable.

The ESC classification of the majority of Sitka spruce forest area is projected to remain the same. For high and low emissions scenarios, 43% and 44% remain suitable, 18% and 19% remain very suitable, and 14% and 15% remain unsuitable.

Scots pine

Under 2050 high emissions scenarios, 80% of Scots pine forest area will be classified as suitable or very suitable in 2050 and 20% as unsuitable; under low scenarios these figures are 77% and 21%.

The proportion of current Scots pine forest area projected to increase in suitability exceeds that projected to decline. For 2050 projections (both high and low emissions scenarios), 1% of forest area increases from unsuitable to suitable, and a further 3% increase from suitable to very suitable. 0.6% and 1.2% forest area decline in classification from suitable to unsuitable and 0.4% and 0.7% decline from very suitable to unsuitable.

The ESC suitability classification of the majority of Scots pine forest area is projected to remain the same. For high and low emissions scenarios, 62% and 61% remain suitable, 12% (both scenarios) remain very suitable, and 19% remain unsuitable.

For both species, the differences between the 2050 high and low emissions scenarios are small.

What has happened in the past?

What is projected to happen in the future?

Awareness of the impacts of climate change on species suitability is increasing, as is the use of decision support tools which provide species suitability under future climate projection, such as Ecological Site Classification (Forestry Commission, 2009). Changes to policy and best practice guides mean that plantings on sites classified as unsuitable in 2050 are likely to decrease.

Patterns of change

For Sitka spruce, the total planting area projected to be suitable or very suitable in 2050 increased between the periods of 1970-79 and 1990-99, with a slight decrease in 2000-2009 for both 2050 high and 2050 low emissions scenarios (Figures 1a and 1b).

For Scots pine, the total planting area projected to be suitable or very suitable in 2050 increased from 1970-79 to 1980-89, and decreased in 1990-9 and 2000-2009 for both 2050 high and 2050 low emissions scenarios (Figures 2a and 2b). The proportion of pre-1970's planting that was suitable or very suitable was also high.

Tables giving a full breakdown of the change in suitability class for both species are presented in Appendix 2.

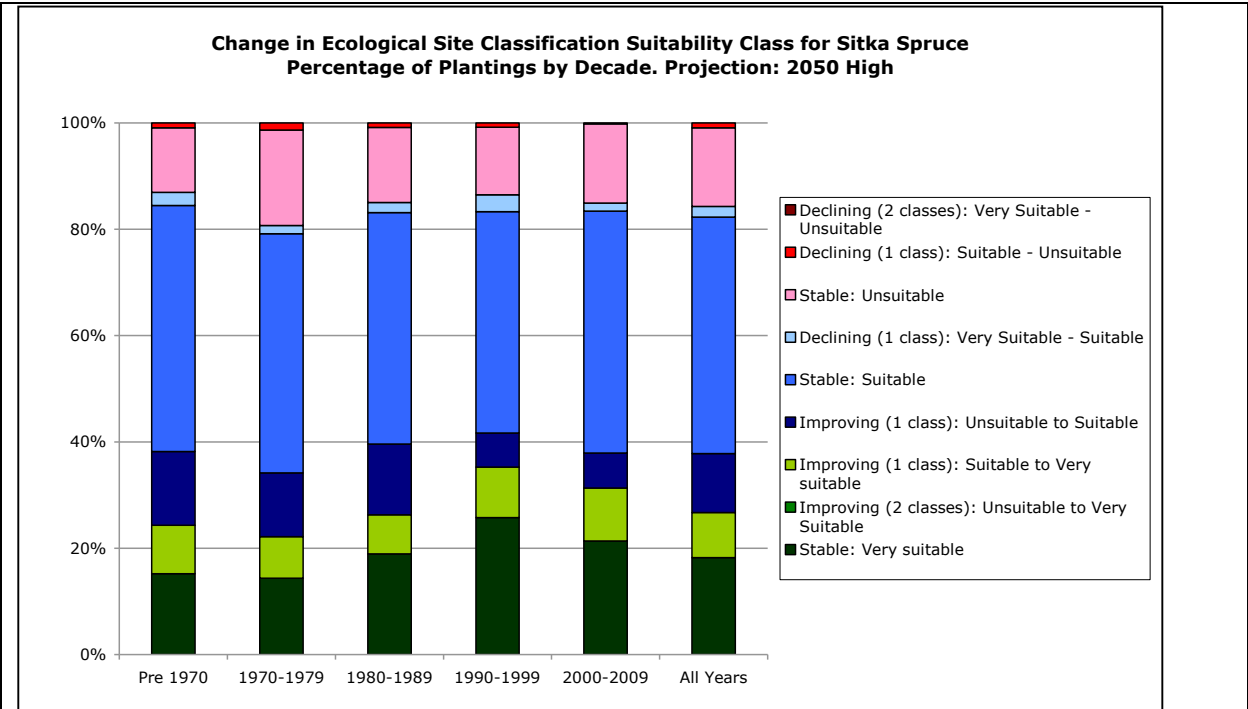


Figure 1a Change in Ecological Site Classification suitability class for Sitka spruce. Percentage of plantings by decade. Projection: 2050 high

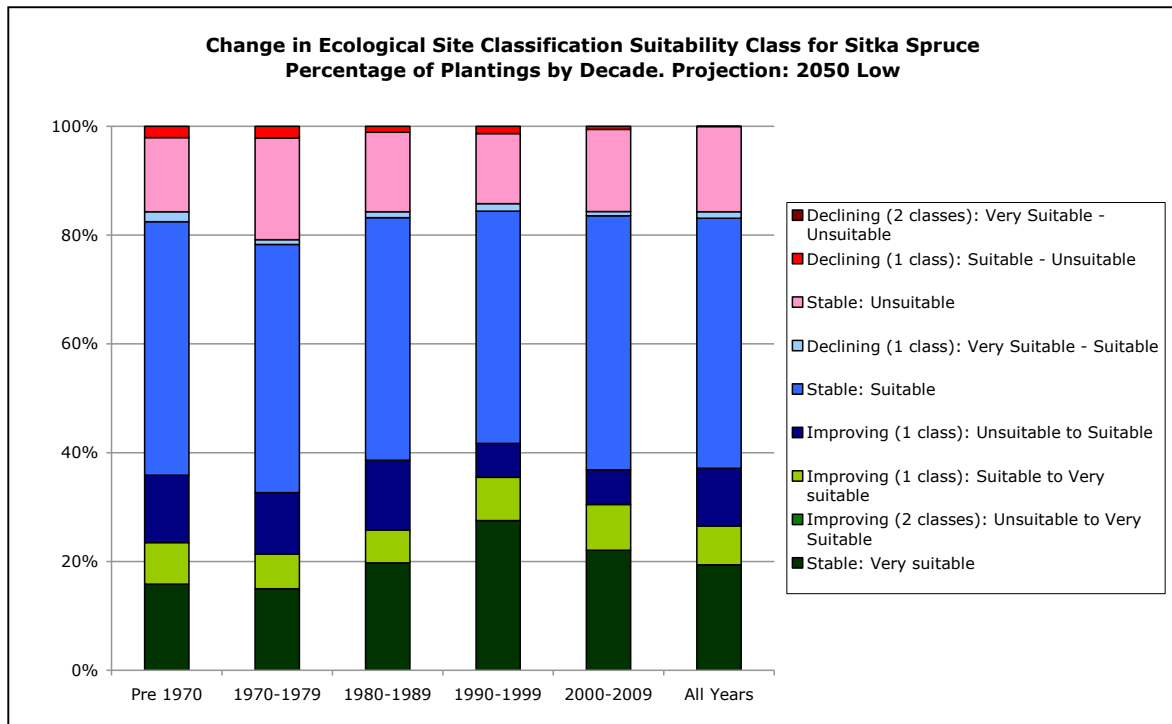


Figure 1b Change in Ecological Site Classification suitability class for Sitka spruce. Percentage of plantings by decade. Projection: 2050 low

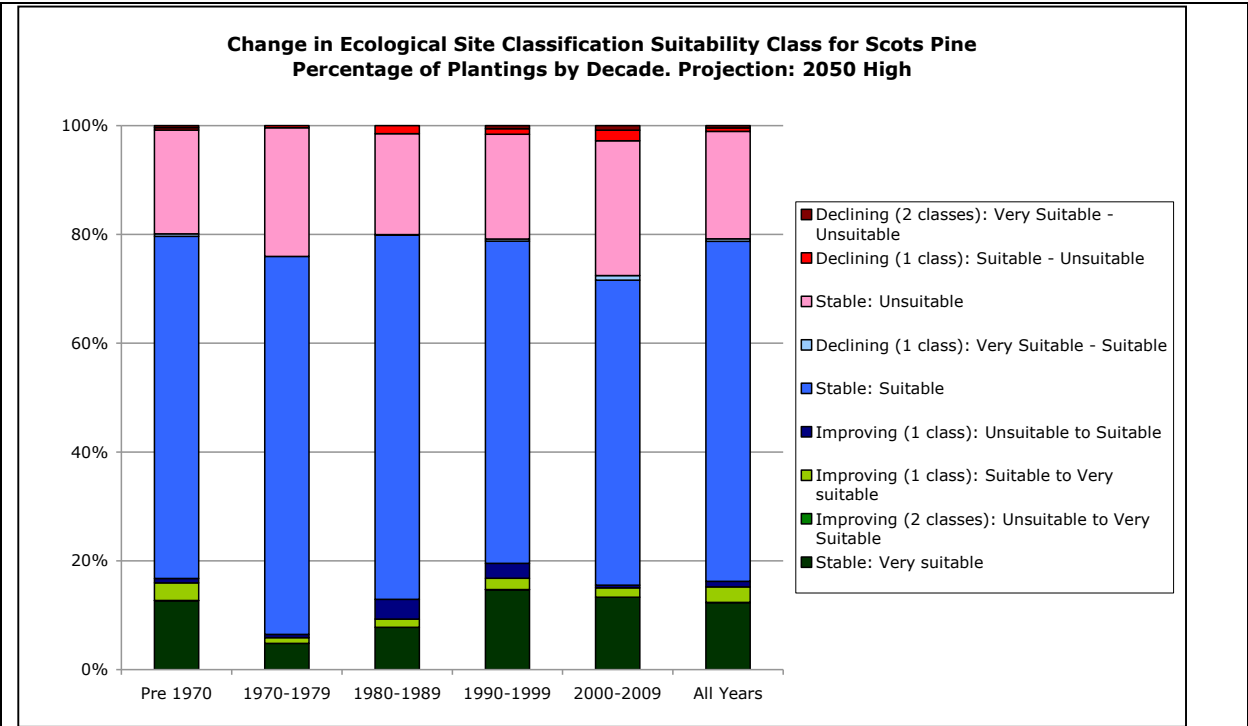


Figure 2a Change in Ecological Site Classification suitability class for Scots pine. Percentage of plantings by decade. Projection: 2050 high

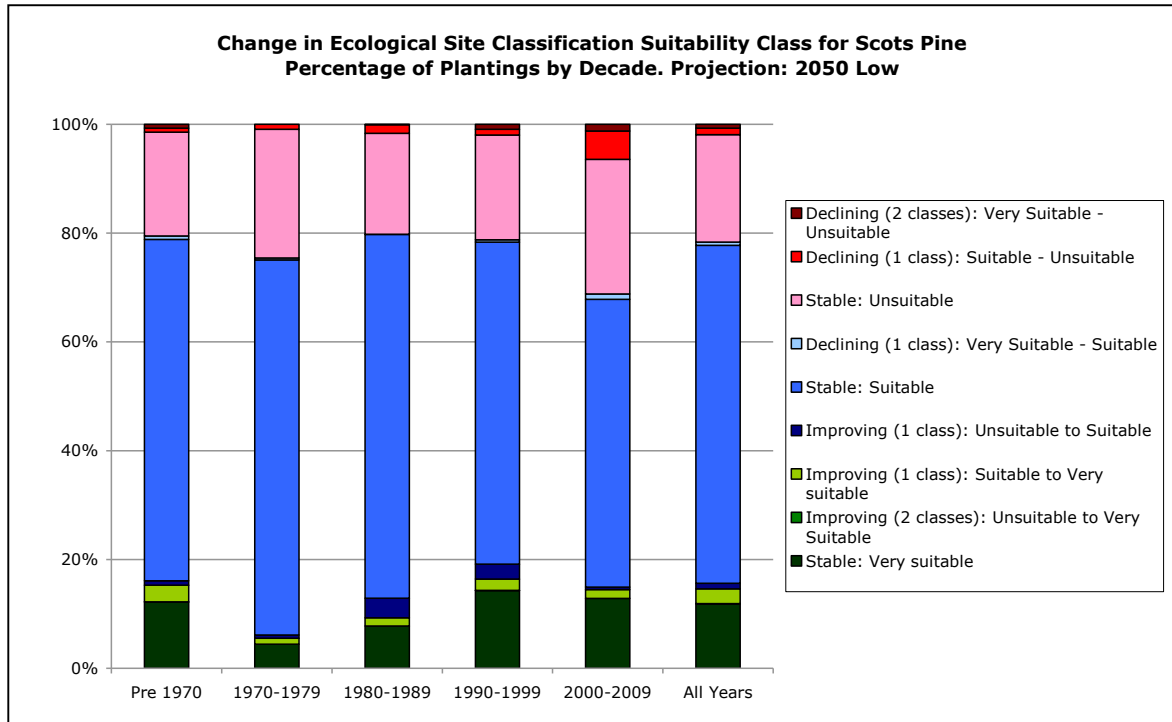


Figure 2b Change in Ecological Site Classification suitability class for Scots pine. Percentage of plantings by decade. Projection: 2050 low

Interpretation of indicator trends

The potential increase in species suitability is due to the projected increases in accumulated temperature, which by 2050 is not projected to be high enough to reduce overall suitability. Changes in water availability don't widely constrain suitability under UKCP02 scenarios. This results in the majority of forest area for both species increasing in suitability or remaining suitable/very suitable.

The 15-21% of forest area for each species likely to be on sites classified as unsuitable in 2050 could still have a significant effect on productivity in certain regions.

Interpreting the changes between planting decade is more difficult, although the increase in plantings on sites classified as unsuitable in 2050 in 1990-99 to 2000-2009 is potentially concerning. It is hoped that with the introduction of projected future species suitability into the ESC decision support tool, that plantings on sites classified as unsuitable will decrease.

Limitations

This indicator only covers forests which form the National Forest Estate managed by Forestry Commission Scotland. Privately owned woodlands are not included. Around one third of Scotland's forests are managed by Forestry Commission Scotland (Forestry Facts and Figures, 2014). Results for forests managed for timber production by the private sector are likely to be similar.

Suitability maps have been generated using UKCP02 projected climate data for 2050. No account has been taken of the impact of extreme events on tree species. Future analysis may be based on UKCP09 or 11-member RCM climate data. 2.5% of Sitka spruce forest area and 1.7% of Scots pine forest area lie outside the coverage area of the UKCP02 projected data.

Potential impacts of pests and pathogens are not included.

The accuracy of ESC is limited by the detail contained within the available soil maps for Scotland.

References

Forestry Commission (2014) *Forestry Facts and Figures*. Available at: www.forestry.gov.uk/forestry/inf-d-7aqf6j

Forestry Commission (2014) *UK Wood Production and Trade: 2013 provisional figures*. Available at: www.forestry.gov.uk/forestry/inf-d-9hxecv

Forestry Commission Scotland (2013) *The role of Scotland's National Forest Estate and strategic directions 2013 – 2016*. Available at: www.scotland.forestry.gov.uk/images/corporate/pdf/FES-strategic-plan.pdf

Scottish Forest and Timber Technologies (2011) *Roots for Future Growth: A strategy for Scotland's Forest and Timber Industries 2011–14*. Available at: www.forestryscotland.com/media/101263/rffg%20lower%20res%20web%20version%202.pdf

Further information

Ecological Site Classification tool: www.forestry.gov.uk/fr/esc

Climate change adaptation and species suitability in Scotland:
www.forestry.gov.uk/fr/climatechangescotland

Acknowledgements

Kate Beauchamp, Forest Research, who completed the analysis underpinning this indicator. Philip Taylor, Forest Research, who calculated species suitability using UKCP02 data and ESC.

Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	Proportion of major timber species planted in areas likely to be climatically suitable in 2050
Indicator contact: Organisation or individual/s responsible for the indicator	Ruth Monfries, RBGE
Indicator data source	Ecological Site Classification and FCS Sub-Compartment Database
Data link: URL for retrieving the indicator primary indicator data.	N/A

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	Decadal coverage from Pre 1970 - 2009. Records date back to 1661 for some stands, with the majority of plantings occurring from the 1940s.
Frequency of updates: Planned or potential updates	Yet to be determined. None currently planned.
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	2.5% of Sitka spruce forest area and 1.7% of Scots pine forest area lie outside the coverage area of the UKCP02 projected data.
Spatial resolution: Scale/unit for which data is collected	UKCP02 2050 data is available at 5km ² resolution. ESC calculates species suitability at 250m ² resolution. This is applied to component level data in the Forestry Commission's Sub-Compartment Database
Categorical resolution: Potential for disaggregation of data into categories	By species, by planting decade
Data accessibility: Restrictions on usage, relevant terms & conditions	Available on request from Forest Research.

Indicators and trends – NF1 Proportion of major timber species on Scotland's National Forest Estate planted in areas likely to be climatically suitable in 2050 (Sitka spruce and Scots pine) 8

Table 3 Contributing data sources

Contributing data sources
Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
Ecological Site Classification – Version 3. www.forestry.gov.uk/fr/esc
FCS Sub Compartment Database – 2013. http://data.gov.uk/dataset/forestry-commission-sub-compartments1
UK Climate Projections, Met Office. UKCP02 projected climate data for 2050 high and Low emissions scenarios. http://ukclimateprojections.metoffice.gov.uk/

Table 4 Indicator methodology

Indicator methodology
The methodology used to create the indicator data
Baseline data (1970-1990) and UKCP02 projected climate data for 2050 high and low scenarios were used to populate the Ecological Site Classification model and produce spatial maps of species suitability for Sitka spruce and Scots pine.
The Forestry Commission’s Sub Compartment Database (SCDB) was subset separately for components containing Sitka spruce and Scots pine in Scotland.
Species suitability maps and the SCDB subsets were overlaid, providing baseline and future suitability classifications (Very Suitable, Suitable, Unsuitable) for each component. The data were grouped according to the change in species suitability classification from the baseline to 2050 projections. The percentage of forest area in each group was calculated by planting decade. Analysis was carried out in ArcGis v10.0, and R v2.15.2. Data in the SCDB were collected in 2013.

Appendix Two

Sitka spruce: Change in Suitability class. Percentage of forest area by planting decade and all years						
Projection 2050 High	Pre 1970	1970-1979	1980-1989	1990-1999	2000-2009	All Years
Stable: Very suitable	14.87	13.90	18.42	25.34	20.94	17.78
Improving (2 classes): Unsuitable to Very Suitable	0.00	0.00	0.00	0.00	0.00	0.00
Improving (1 class): Suitable to Very suitable	8.92	7.56	7.14	9.33	9.76	8.28
Improving (1 class): Unsuitable to Suitable	13.55	11.64	12.95	6.31	6.45	10.81
Stable: Suitable	45.28	43.58	42.35	40.97	44.62	43.38
Declining (1 class): Very Suitable - Suitable	2.41	1.48	1.84	3.09	1.48	1.97
Stable: Unsuitable	11.86	17.39	13.72	12.50	14.59	14.40
Declining (1 class): Suitable - Unsuitable	0.90	1.30	0.83	0.81	0.18	0.89
Declining (2 classes): Very Suitable - Unsuitable	0.00	0.00	0.00	0.00	0.00	0.00
NA	2.20	3.15	2.75	1.65	1.97	2.50
Projection: 2050 Low	Pre 1970	1970-1979	1980-1989	1990-1999	2000-2009	All Years
Stable: Very suitable	15.50	14.52	19.19	27.06	21.65	18.61
Improving (2 classes): Unsuitable to Very Suitable	0.00	0.00	0.00	0.00	0.00	0.00
Improving (1 class): Suitable to Very suitable	7.47	6.18	5.91	7.82	8.23	6.88
Improving (1 class): Unsuitable to Suitable	12.09	10.94	12.47	6.14	6.23	10.16
Stable: Suitable	45.59	44.18	43.35	41.98	45.78	44.16
Declining (1 class): Very Suitable - Suitable	1.78	0.85	1.07	1.36	0.77	1.14
Stable: Unsuitable	13.32	18.08	14.20	12.67	14.81	15.05
Declining (1 class): Suitable - Unsuitable	2.04	2.08	1.06	1.32	0.54	0.02
Declining (2 classes): Very Suitable - Unsuitable	0.00	0.01	0.00	0.00	0.00	0.00
NA	2.20	3.15	2.75	1.65	1.97	2.50

Scots pine: Change in Suitability class. Percentage of forest area by planting decade and all years						
Projection 2050 High	Pre 1970	1970-1979	1980-1989	1990-1999	2000-2009	All Years
Stable: Very suitable	12.45	4.78	7.62	14.37	13.20	12.11
Improving (2 classes): Unsuitable to Very Suitable	0.03	0.00	0.00	0.05	0.00	0.03
Improving (1 class): Suitable to Very suitable	3.17	1.07	1.48	2.03	1.72	2.82
Improving (1 class): Unsuitable to Suitable	0.80	0.58	3.54	2.69	0.46	1.00
Stable: Suitable	61.76	69.03	65.59	58.03	55.64	61.46
Declining (1 class): Very Suitable - Suitable	0.44	0.00	0.07	0.39	0.87	0.44
Stable: Unsuitable	18.73	23.49	18.17	18.85	24.59	19.40
Declining (1 class): Suitable - Unsuitable	0.41	0.40	1.43	1.03	1.89	0.63
Declining (2 classes): Very Suitable - Unsuitable	0.39	0.00	0.01	0.54	0.86	0.41
NA	1.39	0.02	0.10	0.11	0.07	1.70
Projection: 2050 Low	Pre 1970	1970-1979	1980-1989	1990-1999	2000-2009	All Years
Stable: Very suitable	11.97	4.42	7.60	14.00	12.75	11.67
Improving (2 classes): Unsuitable to Very Suitable	0.03	0.00	0.00	0.05	0.00	0.03
Improving (1 class): Suitable to Very suitable	2.99	1.07	1.48	2.03	1.60	2.67
Improving (1 class): Unsuitable to Suitable	0.80	0.58	3.54	2.69	0.46	1.01
Stable: Suitable	61.63	68.52	65.48	57.99	52.48	61.06
Declining (1 class): Very Suitable - Suitable	0.62	0.36	0.02	0.41	0.96	0.60
Stable: Unsuitable	18.73	23.49	18.17	18.85	24.59	19.40
Declining (1 class): Suitable - Unsuitable	0.71	0.91	1.54	1.07	5.17	1.18
Declining (2 classes): Very Suitable - Unsuitable	0.69	0.00	0.07	0.88	1.21	0.69
NA	1.39	0.02	0.10	0.11	0.07	1.70

