UK INDICATORS OF SUSTAINABLE FORESTRY

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Forestry Commission
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Foreword

By the Chairman of the Forestry Commission

All of us depend on forests. We use products made from wood every day. Millions of us visit forests for exercise and relaxation. We take pleasure from the animals and plants that live in our forests, even though we may never see them.

Following many centuries of clearance for farming and settlement, the area of woodland has doubled in the last hundred years, and is still increasing. However, our forest cover is still far below the European average, and nearly all of our original native forests are gone.

From the Earth Summit in 1992, through the European and global agreements reached since, and right up to the World Summit on Sustainable Development in 2002, the UK has been at the forefront of promoting sustainable forestry, both at home and abroad. We take our international commitments seriously, and working with partners we are building them in to our shared objectives for our woods and forests. The Forestry Commission is proud that all the state forests in the UK have been certified as being sustainably managed.

Indicators are for everyone, to know the current status and track trends, so we can act in our different ways to ensure that our forests continue to provide for generations to come. These Indicators of Sustainable Forestry highlight the role of forestry in helping to achieve sustainable development in the UK. The indicators cover the three strands of sustainable development – economic, social and environmental.

Forestry is devolved; all four countries have strategies that reflect their commitment to sustainable forestry. Each country will monitor against its own objectives but we want to be able to consider the UK situation as well.

This publication is the culmination of a long consultative process to which many people have contributed. We are grateful to all those who have helped us develop the indicators, by offering comments or making data available. This indicator set is the start of a journey, not the end, and we will be refining and developing the indicators as our understanding grows.

David Clark

Rt Hon Lord Clark of Windermere

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Introduction

Sustainable forestry

1. Forests provide us with a variety of goods and services including timber, attractive landscapes, wildlife, jobs and income. Managed responsibly, they will continue to enhance our quality of life and the quality of life of future generations. Indicators of sustainable forestry help us measure the contribution of woodland towards our quality of life, and the ability to sustain that contribution into the future.

2. This document contains a set of UK Indicators of Sustainable Forestry. The indicators mostly provide information about the present state, and trends over time, of woodlands and their management, rather than measures of driving forces (pressures) or responses. They will enable the government, non-government organisations, the business community and society to track the contribution that our forests are making to our quality of life. They will inform us about undesirable trends so that we can decide how to act.

3. The indicators have been developed through two rounds of consultation in 2001 and 2002. Selection of the indicators has taken account of an initial set in the UK Forestry Standard (FC, 1998) and the parallel review of pan-European Indicators of Sustainable Forest Management (see MCPFE website). There are many more indicators that we could have included. We have considered the relevance of potential indicators to sustainable forestry in the UK, the current quality of information and the timescale over which it can be improved.

4. This set of indicators covers a wide range of aspects of sustainable forestry in the UK, including some topics currently without suitable data (e.g. loss of woodland). In total there are 40 indicators, grouped under six themes:

- Woodland
- Biodiversity
- Condition of forest and environment
- Timber and other forest products
- People and forests
- Economic aspects

5. Each indicator is presented in a standard format:

Relevance	The relevance of the indicator to sustainable forestry in the UK.
Key points	Trends and key points evident from the statistical information.
Statistics	Statistical information for the indicator, usually presented in a table or chart. If statistics are not available, this outlines the desired information (measures).
Background	Additional information that helps put the trends and key points in context and assists understanding and interpretation.

Future Possibilities for improving the statistical information for the indicator in the future.

6. Where it has been possible, we have included statistics for England, Scotland, Wales and Northern Ireland, to give a comparable overview, as well as for the UK as a whole. Forestry is a devolved matter, so there are no explicit UK targets. In each country, these indicators can be supplemented by indicators linked to specific objectives and actions in the country forestry strategies (FC 1999, FC 2000b, FC 2001c).

7. This set of indicators only includes topics that are appropriate for monitoring at UK or country level. Regional information is not shown in this publication, and is currently only available for a few of these indicators; extending it to others would require much more extensive monitoring. Some other topics may be important at regional or local level – for example forestry's contribution to rural development, or its contribution to enhancing the quality of life in areas of social deprivation and former industrial dereliction. At present, this set does not include indicators on these topics, but it is possible that indicators could be developed in the future, by drawing information from local monitoring.

Links to other processes

8. There are links between the UK Indicators of Sustainable Forestry and a number of other processes that develop and use indicators:

Pan-European Criteria and Indicators for Sustainable Forest Management. Many countries have now published national reports using the indicators adopted by the Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 1998. These indicators were reviewed in 2001-2002. A revised set will be proposed for approval by the MCPFE in 2003 (see MCPFE website). Efforts were made to collect comparable data for most aspects of the Pan-European Criteria and Indicators, through the Temperate & Boreal Forest Resources Assessment (TBFRA 2000). This was published in May 2000, followed by a Global FRA in early 2001. An updated subset was compiled in June-July 2002, in preparation for the MCPFE in 2003.

Indicators of Sustainable Development. Quality of Life Counts indicators of sustainable development were published in December 1999 (DETR, 1999). They include two indicators for forestry in the UK – total area of woodland and area of ancient semi-natural woodland – and a third indicator of forest management to be based on indicator A6 here. A set of 12 headline Sustainable Development Indicators for Wales (see WAG, 2002) was adopted in March 2001 and Indicators of Sustainable Development for Scotland (SEEG, 2002) were published in April 2002. Although forestry is not an explicit topic in these sets, it can contribute to other objectives (e.g. wildlife and biodiversity). A sustainable development strategy for Northern Ireland is being developed.

Country Forestry Strategies. A set of indicators for the Scottish Forestry Strategy was subject to consultation in the spring of 2002, aiming for publication later in 2002. In Wales, a Woodland Forum working group established in 2002 is

developing a draft set of indicators and targets. England has a set of performance indicators for the Spending Review, and plans to adopt the English indicators from this UK set as a supplementary set of indicators. The policies for Forestry in Northern Ireland were the subject of a consultation paper in 2002 (DARD, 2002), but at present there are no draft indicators linked to this strategy.

Certification. There are links between the development of indicators, monitoring at forest management unit level for the UK Forestry Standard, and certification standards such as the UK Woodland Assurance Standard (UKWAS).

Monitoring by NGOs. There is also related work by non-government organisations, particularly the WWF Forest Scorecard, for which the second edition was published in January 2000. This addressed a gap in officially published information, and dealt with the issues perceived to be important by that NGO.

Future reporting

9. This publication is available in the Sustainable Forestry section of the Forestry Commission website http://www.forestry.gov.uk/sfindicators. Supplementary information for the indicators will be made available through this website, and new statistical information will be added as it becomes available. The indicators will also be accessible through the Forest Service website. Major additions or updates may be reported in the annual publication 'Forestry Statistics' or ad hoc 'Indicator Update' publications.

10. At present, about a quarter of the indicators do not contain suitable statistical information. Information from water monitoring (C3 - C6) could not be compiled in time for this publication, but could follow soon after. We hope that other gaps will be able to be partly filled over the following year by current work to develop landscape indicators (A5), assess native woodland condition (B3) and estimate values for social and environmental benefits (F5). New work will be required to monitor loss of woodland (A3) and to develop appropriate measures of community involvement (E4). In addition to addressing these gaps, further work would be desirable to develop many of the other indicators, outlined in the 'future' section for each indicator, but the extent of this work will depend on available resources.

11. It is planned to reassess the full set of UK Indicators of Sustainable Forestry in 2005, to publish the latest information then available for each indicator, and to review the requirements and plans for continued monitoring.

Simon Gillam
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Forestry Commission
October 2002

Indicators of Sustainable Forestry

A. Woodland	A1. Woodland area A2. New woodland creation A3. Loss of woodland A4. Tree species A5. Woodlands in landscape A6. Area of sustainably managed woodland A7. Management practices
B. Biodiversity	B1. Ancient woodland B2. Native woodland area B3. Native woodland condition B4. Abundance of fauna B5. Richness of flora B6. Diversity of woodland within a stand B7. Natural regeneration of woodland
C. Condition of forest and environment	C1. Air pollutants C2. Soil chemistry C3. Water quality C4. Surface water acidification C5. Water yield and stream flows C6. River habitat quality C7. Pollution incidents C8. Crown density C9. Damage by living organisms C10.Other damage (wind and fire)
D. Timber and other forest products	D1. Volume of growing stock D2. Harvesting compared with annual increment D3. Timber production and future availability D4. Home-grown timber as % of consumption D5. Carbon storage
E. People & Forests	E1. Visits to woodland E2. Extent of open public access E3. Public awareness E4. Community involvement E5. Historic environment and cultural heritage E6. Health & safety
F. Economic aspects	F1. Financial return from forestry F2. Value added in forestry F3. Value added in wood processing F4. Employment F5. Social & environmental benefits

A. Woodland

A1. Woodland area

A2. New woodland creation

A3. Loss of woodland

A4. Tree species

A5. Woodlands in landscape

A6. Area of sustainably managed woodland

A7. Management practices

Woodland – Summary

The contribution that woodlands make to our quality of life depends on their total area and their characteristics, which in turn are influenced by the way in which they are managed. The country forestry strategies aim to increase woodland cover with appropriate species in appropriate locations and encourage management practices that will provide the benefits we seek from our woodlands.

The trend in total area over time (A1) is determined by woodland creation (A2) and woodland loss (A3). Information about loss of woodland is a serious gap in our present knowledge. The variety and proportions of tree species in our woodlands (A4) and the number and size of individual woodlands (A5) provide a picture of the overall character of our woodlands at a UK and country level.

The area of sustainably managed woodland (A6) and the management practices applied in our woodlands (A7) tell us about the quality of forest management and the benefits provided by our woodlands.

A1. Woodland area

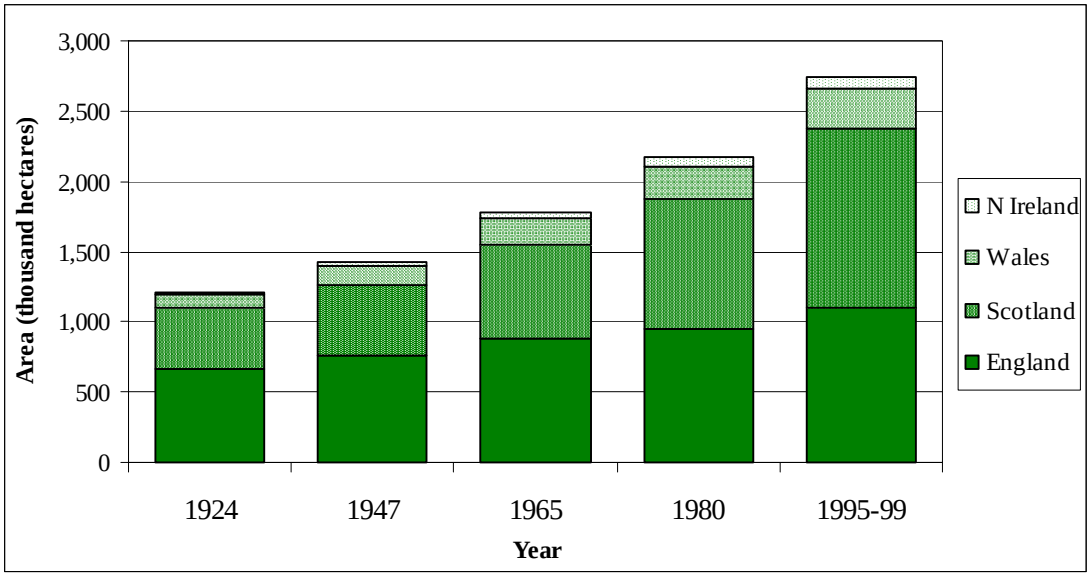
Relevance Woodlands contribute to many sustainable development goals. They have the potential to enhance our landscape and are habitats for wildlife. They are places for leisure and recreation and are an economic resource for timber production, tourism, and local development and regeneration. An expansion of the area of woodland can increase the extent of these multiple benefits.

Key Points The area of woodland in the UK increased through the last century, from around 5% cover at the start of the 20th century to over 11% now. In 2002, woodlands cover 8% of England, 17% of Scotland, 14% of Wales and 6% of Northern Ireland.

UK Woodland area

	Thousand hectares						***% woodland cover***
	1924	**1947**	**1965**	**1980**	**1995-99**	**2002**	***2002***
England	660	755	886	948	1,097	1,104	*8.5%*
Scotland	435	513	656	920	1,281	1,324	*16.9%*
Wales	103	128	201	241	287	288	*13.9%*
N Ireland	13	23	42	66	81	84	*6.2%*
UK	**1,211**	**1,419**	**1,785**	**2,175**	**2,746**	**2,800**	***11.5%***

Sources: GB Censuses of Woodland 1924 to 1980, NIWT 1995-1999, and NI Forest Service
Note: NIWT 1995-99 was carried out as a rolling programme**.** The areas for 2002 are based on the latest GIS data for Forest Enterprise, with private woodland areas projected forward from NIWT with varying base dates in 1995-99, taking account of new woodland creation and other changes.



Sources: GB Censuses of Woodland 1924 to 1980, NIWT 1995-99, and NI Forest Service.
Note: The areas for 2002 are not included in the chart, because the gap since 1995-99 is much shorter than the intervals between censuses.

Background Over previous centuries, there was a gradual loss of forest cover in the UK, which fell to its lowest level of 5% at the start of the 20th century. Today, the area of woodland has more than doubled from that low.

Much of the increase in woodland area during th 20th century came from new commercial conifer plantations in the 1950s to 1980s, especially in upland areas of Scotland. During the 1990s, 15-20 thousand hectares of new woodland were created each year in the UK, mostly by private owners assisted by the Woodland Grant Scheme and other government grants (see Indicator A2).

This is indicator S10 in Quality of Life Counts indicators of sustainable development.

Future To improve the annual updates of woodland area, it will be desirable to take account of estimated woodland loss (see Indicator A3) and obtain better estimates of woodland created without grant aid.

A2. New woodland creation

Relevance New woodland creation contributes to the aim of expanding the woodland area. New woodland that is assisted by grant schemes or created by the Forestry Commission or Forest Service should be located in appropriate areas, which can be informed by land use planning tools such as Indicative Forestry Strategies and Landscape Character Assessments.

Key Points Around 700,000 hectares of new woodland was created in Britain during the last 30 years. Until the early 1990s, most was conifer woodland, and most was in Scotland. Since 1990, more than half has been broadleaved woodland.

New woodland creation – 5 year totals

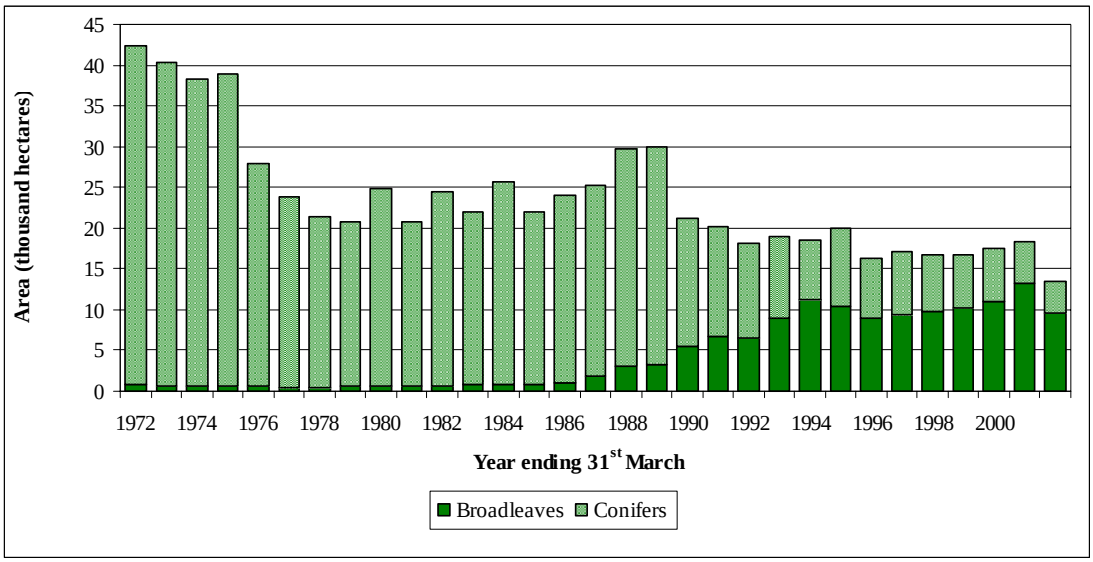
thousand hectares

		5 year period ending 31 March					
		1976	**1981**	**1986**	**1991**	**1996**	**2001**
England	Conifer	18.3	7.0	5.3	3.9	3.2	3.2
	Broadleaved	2.4	1.5	2.3	9.2	21.5	21.2
	Total	**20.7**	**8.5**	**7.5**	**13.1**	**24.7**	**24.4**
Scotland	Conifer	148.6	90.9	100.1	94.6	38.3	27.1
	Broadleaved	0.6	0.8	0.9	9.2	21.0	28.5
	Total	**149.3**	**91.7**	**100.9**	**103.8**	**59.3**	**55.6**
Wales	Conifer	12.9	6.8	5.6	3.0	0.5	0.7
	Broadleaved	0.1	0.2	0.3	1.1	2.0	2.1
	Total	**12.9**	**6.9**	**5.9**	**4.1**	**2.5**	**2.7**
N Ireland	Conifer	5.0	4.3	3.4	4.4	3.9	2.1
	Broadleaved	0.1	0.3	0.4	1.0	1.4	1.5
	Total	**5.1**	**4.6**	**3.8**	**5.4**	**5.3**	**3.6**
UK	Conifer	184.7	108.9	114.3	105.8	45.9	33.0
	Broadleaved	3.2	2.7	3.8	20.4	45.9	53.3
	Total	**188.0**	**111.7**	**118.2**	**126.3**	**91.8**	**86.4**

Sources: WGS and other grant schemes, Forest Enterprise and NI Forest Service

Note: The statistics for this indicator do not include new woodland creation that is not grant-aided. It is estimated that on average around 400 hectares a year are created in this way.

New woodland creation



Sources: WGS and other grant schemes, Forest Enterprise and NI Forest Service

Background This indicator does not explicitly show the main objective of the new woodland creation. The conifer plantations mostly have timber as a main objective. Much of the new broadleaved woodland contributes mainly to environmental or social objectives and can also provide a valuable commercial crop.

The average annual area of new conifer woodland has fallen from more than 30,000 hectares a year in the early 1970s to around 7,000 hectares a year in the 1990s. The average annual area of new broadleaved woodland has increased from around 600 hectares a year in the 1970s and early 1980s to around 10,000 hectares a year in the late 1990s.

Future It will be desirable to supplement these statistics with information on the location and type of land used for new woodland creation. This would show the extent to which new woodland creation has moved to better quality agricultural land, and could also show whether it follows good forestry practice (e.g. avoiding peatlands).

Woodland creation on brownfield sites situated close to areas of high population density can contribute to local economic development by improving the image and environment of the area. Regeneration of derelict land is indicator K1 in Quality of Life Counts indicators of sustainable development. In 2000-01 there was a total of 189 hectares of planting on damaged or reclaimed land in the 12 Community Forests**.**

A3. Loss of woodland

Relevance Woodland can be lost to agriculture, to development, or for restoration of special habitats and landscapes. For sustainable forestry, the first two reasons for loss would generally be viewed as undesirable, especially where the woodland has high environmental or social value, but the latter could be a positive indicator of forestry's wider environmental awareness. There are particular concerns about the loss of ancient semi-natural woodland, which is irreplaceable – see indicator B1.

Key Points This is a serious gap in our current information.

Measures

Loss of:

- Ancient semi-natural woodland (ASNW)
- Other semi-natural woodland
- Plantation (conifer / broadleaved)

To:

- Agriculture
- Development
- Restoration of other habitats
- Open space (e.g. stream-side clearance, larger integral open space)

Available information:

Land Use Change Statistics

Land Use Change Statistics for England (ODPM, 2002) are based on statistical analyses of Ordnance Survey map data revisions. It takes up to 5 years for Ordnance Survey to record rural changes, and there could be a bias towards recording a rounded year of change. For the 10 year period from 1988 to 1997, total change from forestry to other land uses was around 25,000 hectares – i.e. about 2,500 hectares a year. The same source also gives figures for changes from other land uses to forestry.

Countryside Survey 2000

Woodland loss can also be estimated from the matrix of changes recorded by the Countryside Survey (Haynes-Young *et al.*, 2000). Comparison of sample data for 1990 and 1998 would suggest that about 140,000 hectares of woodland in GB was converted to other habitats – i.e. about 17,500 hectares a year. A similar comparison of sample data for 1984 and 1990 gave an even higher annual rate of conversion. The change matrices from the Countryside Surveys also show a very high level of woodland creation.

Background Monitoring should include the type of woodland lost, and also what it is lost to. At present, there are no statistical systems to monitor woodland loss. Information that has been published gives divergent pictures of the scale of woodland loss. The Forestry Commission's statistics on woodland area imply that there is little woodland loss, and this view is supported by Land Use Change Statistics for England, but the matrix of land-use change in DEFRA's Countryside Surveys suggests much higher levels of woodland loss.

Future In the future, the best single source could be repeated air photography, which could pick up natural extension and loss at forest edges, although this may not immediately show the successor land use. Air photography is now commercially available for all of GB on a 3-year cycle.

Other possible data sources include data from local planning processes, data on land-use change from Ordnance Survey map revisions, estimates from National Inventory of Woodland, and estimates from over 2000 sample 1 km squares used for the survey of Small Woods & Trees.

In the future (but not as presently held) it may be possible to make use of WGS data on felling licences.

A current research project (FOCUS – see Countryside Survey website) is trying to reconcile the Countryside Survey sample data with other sources, and investigate why they show such high levels of conversion to and from woodland. Results of this project (due at the end of 2002) should give a better view of the value of these sources for monitoring trends in the change of land use.

Information on woodland loss in Northern Ireland may become available from a digital air photography programme that is now underway, and a woodland inventory due for completion in 2005.

A4. Tree species

Relevance This gives an indication of the overall makeup and diversity of Britain's woodlands; there is a public preference for more mixed and broadleaved woodland.

Key Points Conifers make up about 60% of woodland in Britain, about half of the conifer area being Sitka spruce. The proportion of broadleaves has been increasing in recent years.

Tree species in GB

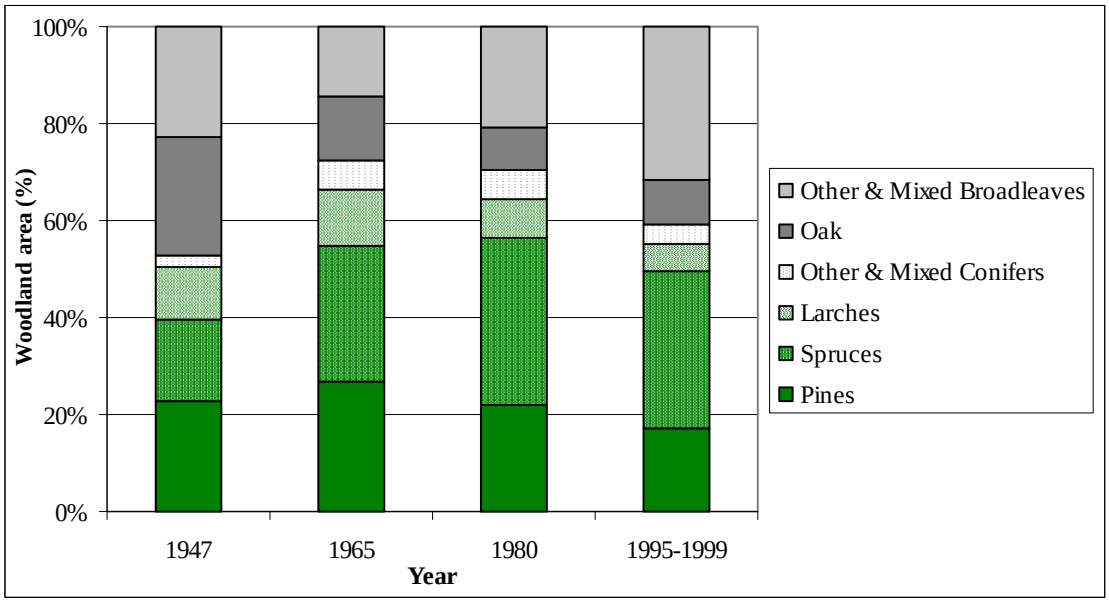
thousand hectares

	1947	1965	1980	1995-1999			
	Great Britain High forest only			GB	Eng	Scot	Wales
Total	**724**	**1,267**	**1,881**	**2,377**	**988**	**1,123**	**266**
Total Conifers	**382**	**917**	**1,321**	**1,406**	**340**	**916**	**149**
Scots pine	147	252	241	227	82	140	5
Lodgepole pine	1	53	127	135	7	122	6
Corsican pine	16	37	47	47	41	2	3
Sitka spruce	68	248	526	692	80	528	84
Norway spruce	54	106	117	79	32	35	11
Larches	79	147	152	134	47	65	23
Douglas fir	15	43	47	45	24	10	11
Mixed & other conifer	3	31	64	48	28	13	6
Total Broadleaves	**342**	**350**	**560**	**971**	**648**	**206**	**118**
Oak	175	166	172	223	159	21	43
Beech	65	66	74	83	64	10	9
Sycamore	23	28	49	67	49	11	7
Ash	34	32	70	129	105	5	19
Birch	27	15	68	160	70	78	13
Mixed & other broadleaves	17	43	127	309	202	81	28

Sources: NIWT 1995-1999 and previous woodland censuses

Note: NIWT areas exclude felled, coppice and integral open space. Previous Census figures also exclude scrub – i.e. high forest only.

Proportion of woodland area by species in GB



Source: NIWT 1995-99 and previous woodland censuses

Background Sitka spruce is suited to producing softwood timber in many parts of Britain. The area of Sitka spruce doubled between 1965 and 1980, and increased by another third by 1995-99.

In recent years the figures also show substantial increases in the area of broadleaves, but some of the apparent increase in 1995-99 is due to the inclusion of a species breakdown for scrub for the first time, and the better coverage of the 1995-99 National Inventory.

The changing species mix has been influenced by changing priorities of forestry policy, with more importance now given to environmental and social objectives. In areas of commercial forestry where timber production is the main objective, Sitka spruce has become more dominant. Indicator A2 shows more clearly the trend toward an increased proportion of broadleaved planting in recent years.

Future Similar information may be available in the future for Northern Ireland, from a planned woodland inventory due for completion in 2005.

A5. Woodlands in landscape

Relevance This is intended to be an indicator for the visual appearance of the landscape. The overall landscape impact of woodland depends on the percentage woodland cover, and also on the extent to which it is broken up. Woodland should be "in keeping" with the overall landscape, and woodland design should meet the landscape guidelines in the UK Forestry Standard (FC, 1998).

Key Points Good indicators of woodlands in the landscape are not yet available, but the National Inventory of Woodland & Trees (NIWT) provides some information about woodland size. About 14% of Britain's woodland area is in woodlands smaller than 10 hectares.

Distribution of woodland size in GB

	England	Scotland	Wales	GB
All woodland				
Number of woods	222,461	82,306	33,036	**337,803**
Total area (thousand hectares)	1,097	1,281	287	**2,665**
% cover	8.4%	16.4%	13.8%	**11.6%**
Woods greater than 100 hectares				
Number of woods	1,315	1,287	357	**2,959**
Total area (thousand hectares)	503	1,053	170	**1,726**
Woods between 10 and 100 hectares				
Number of woods	13,019	5,006	2,644	**20,669**
Total area (thousand hectares)	339	148	71	**558**
Woods between 2 and 10 hectares				
Number of woods	41,351	11,488	6,630	**59,469**
Total area (thousand hectares)	180	52	29	**261**
Woods between 0.1 and 2 hectares				
Number of woods	166,776	64,525	23,405	**254,706**
Total area (thousand hectares)	75	29	17	**121**
Trees outside woodland				
*Tree density per km^2	684	245	738	**539**
Total length of linear features				
*Metres per km^2	736	239	702	**564**

Source: NIWT 1995-99.

Note: Information on woodland size is not available from previous Woodland Censuses.

* Numbers of trees and length of linear features were only estimated for non-urban areas, but the density is calculated by dividing this by the total surface area. Linear features are rows of trees, or narrow strips of woodland up to 50 metres wide.

Background A trend of increasing size may be indicative of reduced fragmentation, but above some limit, which varies by woodland and landscape type, can have a negative impact on the landscape. An increase in the number of small woods can come from new woodland creation, but can also come from fragmentation of existing woods. Linear features and trees outside woodland also contribute to the landscape.

This indicator presents some information that is readily available from NIWT 1995-99, using the digital map to identify woodland sizes down to 2 hectares, and results from the sample survey of smaller woods and trees.

Future This indicator should be developed in the light of new work, taking account of views of stakeholders. It would be desirable to have measures of woodland proximity and density, which are both relevant to connectivity. In the future, changes may be able to be monitored every few years by air photography and/or satellite imagery.

Forest Research have done some work to develop landscape indices which describe the pattern and structure of the woodland landscape. This has been tested on some areas of FC woodland but could possibly be applied to wider areas of woodland in the UK (Ferris *et al.* 2001).

Information about woodlands' contribution to the landscape in England should be available from the Countryside Quality Counts research programme that started in 2002 (see Countryside Quality Counts website).

Indices should also be available from follow-up work for the Countryside Survey 2000. The CS2000 sample data showed an increase in the number of woodland parcels and no significant change in the average parcel size. CS2000 can also provide information about adjacent land, which is relevant to an assessment of woodlands in the landscape.

A6. Area of sustainably managed woodland

Relevance This indicator measures the area of woodland shown to be managed sustainably. This can be demonstrated by certification to the UK Woodland Assurance Standard (UKWAS) under the Forest Stewardship Council (FSC) or another scheme, or the FSC UK standard, but other areas are also managed sustainably. Certified forest is monitored to ensure that good management is continually in practice.

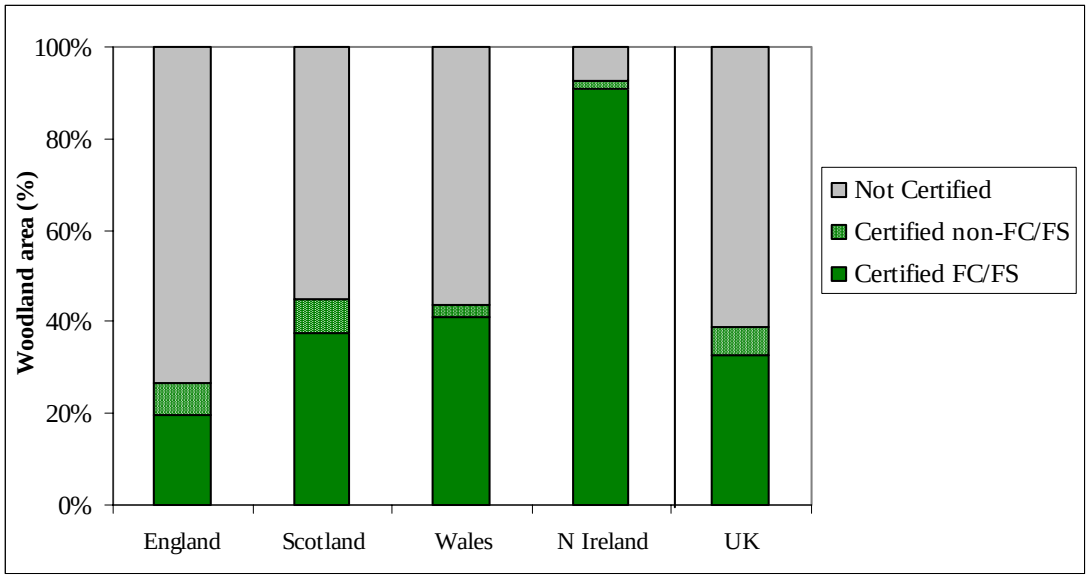
Key Points The FSC began certifying woodland in 1996. Since then over one million hectares (more than one third of the woodland area) in the UK has been certified. The certified area is dominated by Forestry Commission and Forest Service woodland.

Total area certified under FSC in December 2001

	England	Scotland	Wales	N Ireland	UK
Total woodland area (000 ha)	1,100	1,317	289	83	**2,790**
Certified area (000 ha)	291	590	126	77	**1,084**
No. certificates applying to woodland in one country	14	4	3	1	**22**
No. certificates applying to woodland in more than one country					**7**
Total no. certificates					**29**

Source: Forest Stewardship Council (see FSC website)

Proportion of woodland area certified under FSC in December 2001



Source: Forest Stewardship Council (see FSC website)

Background

The UK has two certification standards – UKWAS and the Forest Stewardship Council (FSC) UK Standard. They are recognised as equivalent, and certification against either is recognised by the FSC International scheme. A new scheme has recently been launched – the UK Certification Scheme for Sustainable Forest Management, which will use UKWAS. Certification is credible in the UK if it is carried out by a certification body accredited by UK Accreditation Service (UKAS) or FSC International. The management practices in these woodlands are reviewed annually. Compliance with these standards is also an indirect measure of good management and protection of soils and water in the forest.

There may be sustainably managed woodlands which are not certified, perhaps because of the perceived cost of certification for small woodlands, or because certification may not be important to those who do not produce timber. These are not included in this indicator. When developed this indicator will also feature as indicator S12 in the Quality of Life Counts indicators of sustainable development.

Future

A digital map of all certified woodland in the UK can be produced with help from the certifying bodies as a first step towards developing this indicator.

This indicator could be further developed, by summing the following categories, using GIS to avoid double counting:

- Areas certified against the UKWAS or FSC UK standards by certification bodies accredited by UKAS (UK Accreditation Service) or FSC International;
- Areas with formal management plans or other recognised plans of operation;
- Areas established with grant-aid since 1988, if it can be confirmed that such areas continue to be managed to the standards required by the grant schemes, or any losses can be monitored;
- Estimate for all other woodlands, based on National Inventory data for timber quality and any other relevant data.

There is a concern that the resulting estimates could still exclude a sizeable proportion of the broadleaved woodlands that are sustainably managed for their social and environmental benefits.

This indicator could be extended to break down the certified areas by type of woodland, e.g. conifers/broadleaves, plantation/semi-natural.

Measuring the extent of positive management, including areas where it does not meet the standards for sustainability, would require a supplementary indicator.

A7. Management practices

Relevance Monitoring management practices in all types of woodland helps to assess the extent to which managers are taking actions related to possible management objectives (e.g. timber, public recreation, wildlife management). In some woodland areas, there is an interest in retaining traditional management practices, including coppice and wood pastures. There is also an interest in increasing the area managed under alternative systems to clearfelling, as they produce a more diverse age structure, which is of value to biodiversity, and may improve the landscape visually.

Key Points More than three-quarters of all woodland shows signs of management practices related to timber production. In England, more than a third of the area has practices related to public recreation, and around a quarter has management prctices for game birds and for wildlife/conservation; the proportions applying these practices were smaller in Scotland and Wales. The area of coppice (including coppice with standards) is around 24,000 hectares, mostly in England. The area of coppice has declined, from 40,000 hectares in 1980 to 24,000 hectares in 1995-99. Time series of data are not available for other management practices.

% of clusters where type of management practice was recorded in GB

% of clusters

Type of management practice	England	Scotland	Wales	GB
Timber production	76.9	89.5	75.8	**83.0**
Game birds	28.1	4.0	4.4	**13.7**
Wildlife/conservation	23.9	15.1	12.3	**18.3**
Good forest design	11.3	27.1	6.8	**18.6**
Grazing	5.1	5.4	9.6	**5.7**
Public recreation	37.2	12.3	21.6	**23.3**
Screening or shelter	14.6	7.9	14.0	**11.3**
Unmanaged	16.1	5.5	13.9	**10.7**

Source: NIWT 1995-99

Note: A cluster in NIWT was a group of 1-5 sample squares, spread over a land area of up to 40 hectares, possibly extending over more than one wood and/or more than one ownership.

Coppice area in GB

hectares

	England	Scotland	Wales	GB
Coppice	11,674	554	489	12,717
Coppice with standards	10,710	630	0	11,340
Total	**22,284**	**1,184**	**489**	**24,057**

Source: NIWT 1995-99

Background In areas of coppice, trees are cut near ground level to produce many small shoots that can be harvested for staves, fencing and other products. Coppice with standards includes some trees grown on a longer rotation. The coppice areas for this indicator do not include short rotation coppice, where fast-growing species are grown as an energy crop.

Future At present, Forest Enterprise does not hold information centrally about management practices, but more information should be available later in 2002.

Information will also be required for the following categories:

- Wood pasture: areas of historical, cultural and ecological interest, where grazing is managed in combination with a proportion of open tree canopy cover. Wood pastures include lowland parks, where scattered trees have been planted and allowed to grow very old, as well as other cultural landscapes (often including pollarded trees) and unenclosed upland areas. For the Forest Resources Assessment 2000, it was estimated that wood pastures total 20,000 hectares in the UK.
- Continuous cover: silvicultural systems whereby the forest canopy is maintained at one or more levels without clear felling.
- Minimum intervention: management with only the basic inputs required to protect the woodland from external forces or to ensure succession of key habitats and species.

B. Biodiversity

B1. Ancient woodland

B2. Native woodland area

B3. Native woodland condition

B4. Abundance of fauna

B5. Richness of flora

B6. Diversity of woodland within a stand

B7. Natural regeneration of woodland

Biodiversity – Summary

Biodiversity (short for biological diversity) means the total variety of life. It includes the variety of habitats, species and genes. As a signatory to the Convention on Biological Diversity, the UK is committed to conserving and enhancing biodiversity and has set out objectives, priorities and targets in the UK Biodiversity Action Plan (BAP - See the UK Biodiversity website). Forestry aims to contribute towards the aims and targets of the UK BAP:

- To conserve and where practical enhance overall populations and natural ranges of native species and the quality and range of wildlife habitats and ecosystems within woodlands.
- To help conserve and enhance internationally and nationally important and threatened species, habitats and ecosystems and of natural and managed habitats which are characteristic of local areas.
- To increase public awareness and involvement with woodland biodiversity conservation.

In general the most important woodland types for biodiversity are ancient semi-natural woodlands (ASNW), closely followed by other forms of native or ancient woodlands (B1 - B3), which have native tree and shrub species and/or a long continuous history as woodland. Eight types of native woodland habitats are priority habitats in the UK BAP.

Abundance of animal species (B4) and diversity of plant species (B5) that depend wholly or partly on woodland are important components of biodiversity.

Biodiversity value in woodlands of all types depends upon structural diversity at both stand level (B6) and woodland or landscape scales. Generally, enhancing natural processes in woodlands enhances their biodiversity value. An example is natural regeneration of trees and shrubs (B7), which assists conservation of genetic diversity and natural structures and species patterns.

B1. Ancient woodland

Relevance Maintaining the area of ancient woodland is a key target of the UK Biodiversity Action Plan (BAP). Ancient semi-natural woodlands (ASNW) tend to be richer in plants and animals than other woodland areas, and also have a role in preserving locally native genotypes; they are also important as part of the historic visual and cultural landscape. The area of ASNW has declined over the centuries and the woodlands have become increasingly fragmented.

Key Points The area of ancient woodland in the UK is now estimated to be 508,000 hectares, of which 288,000 hectares is ASNW. ASNW accounts for around 10% of the total UK woodland area and around 1.2% of the total land area.

Area of ancient woodland

thousand hectares

	England	Scotland	Wales	N Ireland	UK
Total woodland 1995-1999[1]	1,097	1,281	287	81	**2,746**
Total ancient woodland[2]	334	119	52	3+?	**508**
ASNW (ancient semi-natural woodland)[2]	193	65	27	3[3]	**288**
PAWS (plantation on an ancient woodland site)[2]	140	55	25	?	**220**

[1]**Source: NIWT 1995-1999**
[2]**Source: Pryor and Smith (2002)**
[3]**Source: Forest Service database**
Note: This is an updated estimate of ancient woodland based on overlaying the NIWT 1995-1999 digital map with ancient woodland inventories. However there remain discrepancies between these new estimates for ASNW and total ancient woodland, and those made previously. These are being investigated further by Forest Research.

Background As there are no reliable records older than 1600 in England and Wales, 1750 in Scotland and 1830 in Northern Ireland, ancient woodlands are defined as areas that have been continuously wooded since those dates. It is therefore impossible for the area to increase, except through reclassification. Ancient woodland can be ancient semi-natural (ASNW) or plantations on ancient woodland sites (PAWS), which may retain some of the native trees, shrubs and ground flora. Of the ASNW present in the 1930s, about 38% was converted to plantations and a further 7% cleared for other land uses. Depletion has now largely ended with the implementation of policies for their conservation.

The removal of trees that are not native to the ancient woodland sites, and restoration of native woodland on some of these ancient sites, is a target under the UK BAP. Areas of ASNW are now highly fragmented; the greatest concentrations are in south-east England, the southern Welsh borders and the central Scottish Highlands. Only about a quarter of ASNW is in designated nature conservation areas.

The area of ASNW in GB is indicator S11 in the Quality of Life Counts indicators of sustainable development. ASNW also forms part of the semi-natural category in the indicator for native woodland (indicator B2). No monitoring system currently exists for the loss of ancient woodland (indicator A3).

Future English Nature and the Forestry Commission are currently looking at ways of updating the Ancient Woodland Inventory in England.

No Ancient Woodland Inventory for Northern Ireland has been undertaken until now, but the Woodland Trust have commenced this inventory in 2002, and areas continuously wooded since 1830 will be included. Results should be available in 2005.

In future, the area of PAWS that is restored to native woodland on ancient woodland sites may be recorded in the Woodland Grant Scheme database and in Forest Enterprise systems. An alternative would be to use NIWT to estimate the proportions of PAWS that are native and non-native.

B2. Native woodland area

Relevance Native woodland is valuable for biodiversity and can have a high concentration of rare and threatened species. It also provides many other environmental and social benefits including amenity, landscape and soil and water protection.

Key Points In the past native woodland had decreased to cover only 2% of the UK land area. Grants are available from the Woodland Grant Scheme (WGS) for creation of new native woodland (including native pinewood). An average of around 1,500 ha of 'new native woodland' has been planted each year since 1997 and has received a first instalment of grant.

Area of native woodland: semi-natural and planted

thousand hectares

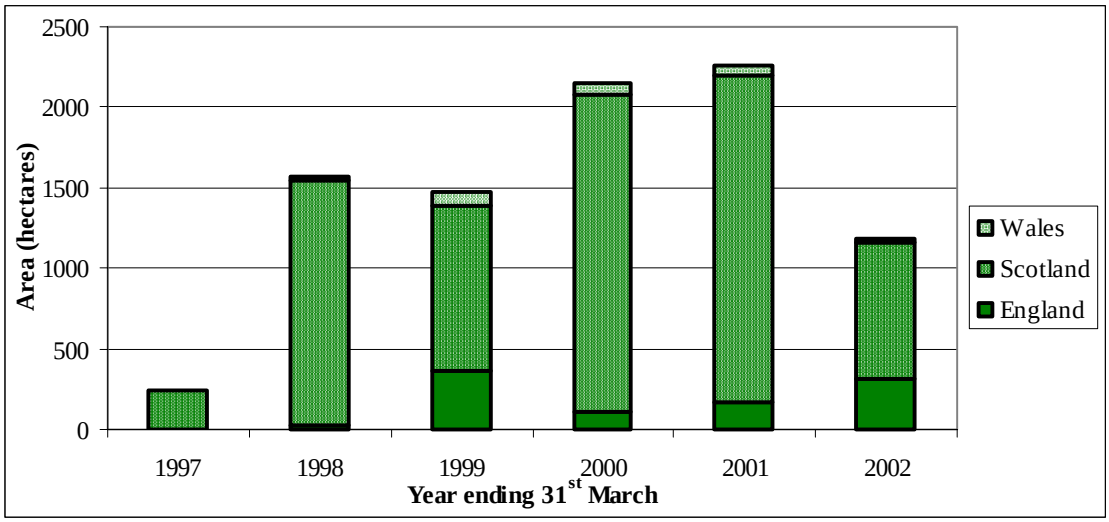
	England	Scotland	Wales	N Ireland	UK
Total woodland 1995-1999[1]	1,097	1,281	287	81	**2,746**
Total native woodland		321[2]			
Semi-natural woodland[4]	416	133	83	~18	**~650**
Planted native woodland					

[1]**Source NIWT 1995-1999;** [2]**Source: MacKenzie (1999).** Includes areas of local and non-local seed origin.

[4]**Source: Pryor and Peterkin (2001).** These estimates are based on reports from the early 1990s. This includes ASNW (from indicator B1) plus other semi-natural woodland.

Note: Native Woodland figures for NI are currently being produced

New native woodland where a WGS grant 1st instalment has been paid[1] in GB



Source: WGS database

[1]Area only includes new planting of 'new native woodland' in non-FC woodlands in GB where the first instalment is paid. It does not include restocking of an area which was previously not native (conversion) or restoration. The second instalment of a grant for 'new native woodland' was first paid in 2001/2.

Background

Native woodland is woodland where at least 50% of the canopy cover is site-native species. Semi-natural woodland is native woodland which is not obviously planted (e.g. it appears to have arisen mainly through natural regeneration). The total native woodland resource includes both semi-natural native woodland and planted native woodland.

The native woodland Habitat Action Plans (HAPs) aim to increase the area of native woodland, through new planting, restoration of plantations on ancient woodland sites (PAWS) to ancient semi-natural woodland (ASNW) and conversion of other woodland to native species. 'New native woodland' is being created using communities of locally native tree and shrub species matched to the site (FC, 1998). It is intended that new native woodlands will increase the area of woodlands with semi-natural characteristics. Nature conservation and protection and enhancement of cultural landscapes are strategic objectives of management of these woodlands. Native woodland can also be created by conversion of existing non-native woodland. Ongoing work is assessing the extent to which native woodland HAP targets are being met (MacKenzie and Worrell, in press).

'New native woodland' is a subset of 'new woodland creation' in indicator A2. No monitoring system currently exists for loss of native woodland (see indicator A3). The semi-natural category in this indicator includes ASNW (see indicator B1). Recorded 'new native woodland' is likely to be an underestimate of the total amount of native woodland that is planted or regenerates naturally.

Future

Estimates of native woodland area are uncertain and work is ongoing to increase the accuracy of these estimates. Estimates of the native woodland area in Northern Ireland will be developed from the NI Countryside Survey.

As more 2nd instalment grants for 'new native woodland' are paid this information will also be shown. It is desirable to include new native woodland that does not receive the 'New Native Woodland' grant.

In future it may be possible to show the expansion of native woodland in total, including conversion and restoration in addition to new woodland creation.

B3. Native woodland condition

Relevance The condition of native woodland contributes to the conservation and enhancement of biodiversity in the UK.

Key Points Although there are measures of the area of native woodland, there are currently no systematic surveys of the condition of all such habitats, but they are being developed. The condition of woodland on Sites of Special Scientific Interest (SSSI) is assessed every six years. Over half of woodland on SSSIs in England is in favourable condition.

Condition of woodland on SSSIs in England, 1997-2002

hectares

Condition	England
Favourable	57,028
Unfavourable recovering	16,395
Unfavourable no change	14,789
Unfavourable declining	4,495
Part destroyed	145
Destroyed	13
Total	**92,865**

Source: English Nature

Note: No similar information is yet available for Scotland, Wales or Northern Ireland

Background

There will eventually be a Habitat Action Plan (HAP) for each of the native woodland types in the UK. The HAP sets out specific targets for the conservation of the habitat and lists key actions that are necessary to achieve these objectives. Progress will need to be monitored at the strategic level (i.e. HAP type as a whole) as well as at the individual site level. A HAP working group is developing sets of measures of condition which could be used at national and UK level.

Some native woodland is part of a SSSI. The condition of each SSSI in the UK is assessed every 6 years. The table shows the results for woodland in England that was assessed between April 1997 and August 2002.

The information about woodland diversity in indicator B6 may also give an indication of the condition of woodland.

Future

Information regarding the condition of woodland in SSSIs will be available for Scotland by the end of 2002. Similar data are also collected in Wales and Northern Ireland.

Condition measures to be used for all native woodland are being developed by the HAP working group. They are likely to be focused on extending existing measures in the National Inventory of Woodland and Trees.

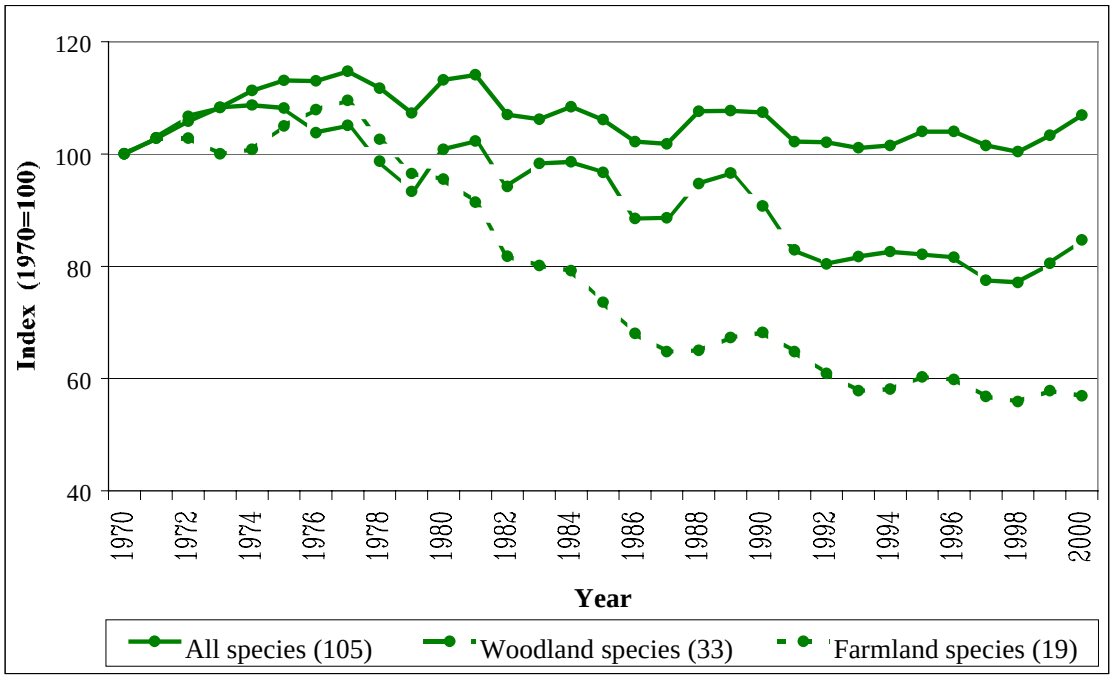
A possible additional measure of condition of native woodland could be the area of native woodland coming into the Woodland Grant Scheme in recent years, both new native woodland and that which receives a management grant.

B4. Abundance of fauna

Relevance Wildlife is valued for its own sake and because it is an integral part of our surroundings and our quality of life. The abundance of fauna is an indicator of the quality of woodland habitats for wildlife. Habitat quality is influenced by woodland management practices. Birds are regarded as good indicators of the broad state of wildlife and the countryside, because they are wide-ranging in habitat distribution and tend to be at or near the top of the food chain. Butterflies and bats are good indicators of diversity in young and mature woodland respectively. Present policies seek to promote management which leads to a more diverse forest.

Key Points Woodland birds are less abundant than they were in 1970. Although populations of the more common woodland and farmland birds have been declining, populations of other birds, such as open water birds and many rare birds, have been stable or rising.

Abundance of woodland birds in GB since 1970, compared with all birds and farmland birds.



Source: Royal Society for the Protection of Birds, the British Trust for Ornithology and DEFRA

Background Many factors affect populations of birds and other wildlife species. These include short-term influences such as the weather and a range of longer-term influences such as changes in farming practices, loss of habitat diversity, urban development, road building, climate change, loss of habitats, changes to food supplies and pollution.

The bird index forms one of the headline Quality Of Life Counts indicators of sustainable development. DEFRA have also published regional bird indices for England. These are available from the UK sustainable development website. More information about individual bird species trends can be found on the RSPB website.

Future The Royal Society for the Protection of Birds, British Trust for Ornithology, DEFRA and the FC plan to examine ways in which bird indices for Scotland and Wales can be developed.

Other information which may be developed includes:

1. Butterfly abundances (all species) at woodland and non-woodland sites are available from the Butterfly Monitoring Scheme and Butterfly Conservation. These will require some work to form a woodland butterfly index. Woodland Species Action Plan (SAP) butterflies are not numerous enough to form a GB index of their abundance.

2. The 130 (fauna and flora) woodland SAP species should be monitored individually by lead partner organisations as part of the UK BAP. Formation of an index of their abundance is theoretically attractive but would require considerable work and time. It may be possible to form an index of the abundance of the smaller group of 'woodland specialists', excluding species that are partially dependent upon woodland.

3. Bat box schemes are managed by Forest Enterprise districts. Basic annual information, including the number of boxes and number of species present, is collated by Forest Research for the Eurobat project.

4. Mammonet, a monitoring network for mammals, is being developed for GB and it may be possible to use information about woodland mammals from this monitoring network.

B5. Richness of flora

Relevance This indicator shows the overall condition and richness of flora in woodland. It tells us about the state of and trends in ecological conditions, and hence whether management is delivering a stable mosaic of woodland types, even though there are natural changes and successions between types. Present policy seeks to promote management which leads to a more diverse forest structure in plantations.

Key Points Between 1990 and 1998 there was a decrease in the species richness of broadleaved, mixed and yew woodlands in England and Wales.

Vegetation richness and condition scores in 1998 and their change since 1990 in GB

Broadleaved, mixed and yew woodland[1]	**1998**			**Change 1990-1998**		
	England & Wales	**Scotland**	**GB**	**England & Wales**	**Scotland**	**GB**
Species richness score	14.13	19.87	**15.27**	-2.40	n.s.	**-2.06**
Light score	5.96	6.29	**6.02**	-0.10	n.s.	**-0.07**
Fertility score	5.21	4.08	**4.98**	+0.14	n.s.	**+0.09**
Conifer woodland[2]	**1998**			**Change 1990-1998**		
	England & Wales	**Scotland**	**GB**	**England & Wales**	**Scotland**	**GB**
Species richness score	8.56	10.79	**10.00**	n.s.	n.s.	**n.s.**
Light score	5.96	6.46	**6.28**	n.s.	n.s.	**n.s.**
Fertility score	3.95	3.13	**3.43**	n.s.	n.s.	**n.s.**

Source: Countryside Survey website. Higher scores indicate more species, and higher levels of light and fertility.

[1] Broadleaved scores are based on 195 sample 'x' plots in CS2000 in GB. Broadleaved change scores are based on the 131 plots that were in the same woodland broad habitat in 1990 and 1998.

[2] Conifer scores are based on 170 sample 'x' plots in CS2000 in GB.

Note: CS2000 did not contain sufficient monitoring plots for Wales to be analysed separately. No similar samples were taken in the Northern Ireland Countryside Survey. n.s. = not significant.

Background The scores in the table are based on plant species recorded in the Countryside Survey 2000 (CS2000) sample plots. Species richness measures the number of species found on each plot, a simple measure of plant diversity. The light and fertility scores are indirect measures of light availability at ground level and soil fertility, based on the plant species present in each plot. The light score reflects changes in the abundance of plants that either tolerate or cast shade through to plants which grow on open ground. The fertility score reflects changes in the abundance of plants that are known to be associated with different levels of nutrient availability.

Broadleaved, mixed and yew woodland

From 1990 to 1998 in England and Wales, there was an overall decline in species richness, and an increase in the frequency of plant species associated with more nutrient-rich conditions (fertility score). There was also a change from species suited to well-lit conditions to those suited to more shaded conditions (decrease in light score). This change in light score is perhaps expected due to a 'successional' change (the woodlands established in 1990 will have developed, and longer established woodlands would have continued to mature), but it could also be due to changes in the nature and intensity of management. There were no significant changes in Scotland.

Coniferous woodland

There was no significant change in the variety of vegetation types (species richness) or the light and fertility scores between 1990 and 1998.

See Haines-Young *et al.* (2000) or the Countryside Survey website for further information.

Future It would be desirable to provide separate results for England and Wales, but Wales-only results are not available from CS2000.

B6. Diversity of woodland within a stand

Relevance In addition to preserving the quality of ancient semi-natural woodland (ASNW) there is also considerable scope to enhance the biodiversity of other woodlands by encouraging the development of natural processes such as the build-up of deadwood. Deadwood is an important habitat for certain species. High degrees of naturalness and variation in woodland structure support high levels of biodiversity.

Key Points 12% of high forest in GB contains some standing deadwood, and 4% of high forest in GB contains some felled and abandoned timber.

Standing and lying deadwood in high forest[1] in GB

		% of high forest area			
Standing deadwood[2]	**No. of pieces per hectare**	**England**	**Scotland**	**Wales**	**GB**
	0	84.5	88.6	98.2	**88.0**
	4/8	8.6	5.2	0.7	**6.1**
	12/16	3.4	3.0	0.2	**2.9**
	20/24	1.4	1.4	0.1	**1.2**
	> 24	2.0	1.9	0.8	**1.8**
		% of high forest area			
Lying deadwood[3] (felled and abandoned)	**No. of pieces per hectare**	**England**	**Scotland**	**Wales**	**GB**
	0	94.9	96.5	99.8	**96.2**
	4/8	2.0	1.0	0.0	**1.3**
	12/16	1.1	0.7	0.0	**0.8**
	20/24	0.7	0.7	0.0	**0.6**
	> 24	1.3	1.2	0.1	**1.1**

Source: NIWT 1995-1999

[1]High forest excludes open ground and coppice.

[2]Standing deadwood is the number of standing trees which have deadwood of more than 15 cm diameter.

[3]Lying deadwood is felled and abandoned timber which is at least 15 cm diameter and 2 m long.

Background

Deadwood is an important habitat for small vertebrates, invertebrates, fish (wood in watercourses), cavity nesting birds, lichens and fungi.

NIWT measures standing deadwood, and it measures lying deadwood in two categories: felled and abandoned timber (logs that have been worked by man to some extent and left to decay) and fallen trees (trees or limbs of trees that have fallen naturally); statistics for the latter are not yet available.

Deadwood is recorded in one quarter of each sample square, so the observed counts are multiplied by 4 to show a count per hectare. For both standing and lying deadwood, the counts are more extreme than would be expected if the distribution of deadwood were random, having more counts showing no deadwood and also more counts showing multiple pieces of deadwood.

NIWT does not cover Northern Ireland, and there is no alternative source of similar data.

Future

Many other measures could contribute to an indicator of diversity of the woodland itself (within a stand).

Other measures of diversity will be available from NIWT. They will include the following:

- fallen trees (number per sample square),
- old forest growth (measure still to be defined),
- within-stand species diversity (no of patches per sample square and/ or number of species (trees, shrubs and bushes) in each sample square),
- within-stand vertical structure (area of forest with given number of layers).

Other measures of diversity may be available from follow-up analysis of CS2000 data (see Countryside Survey website).

B7. Natural regeneration of woodland

Relevance Natural regeneration contributes to the UK's biodiversity objectives by maintaining the diversity of genotype, species composition and structure.

Key Points The amount of woodland, especially ancient semi-natural woodland (ASNW) regenerating naturally has been increasing in recent years. Grants are available for natural regeneration under the Woodland Grant Scheme (WGS). Around 1,500 hectares per year (of which 150 hectares is ASNW) receive WGS 2nd instalment grants for natural regeneration.

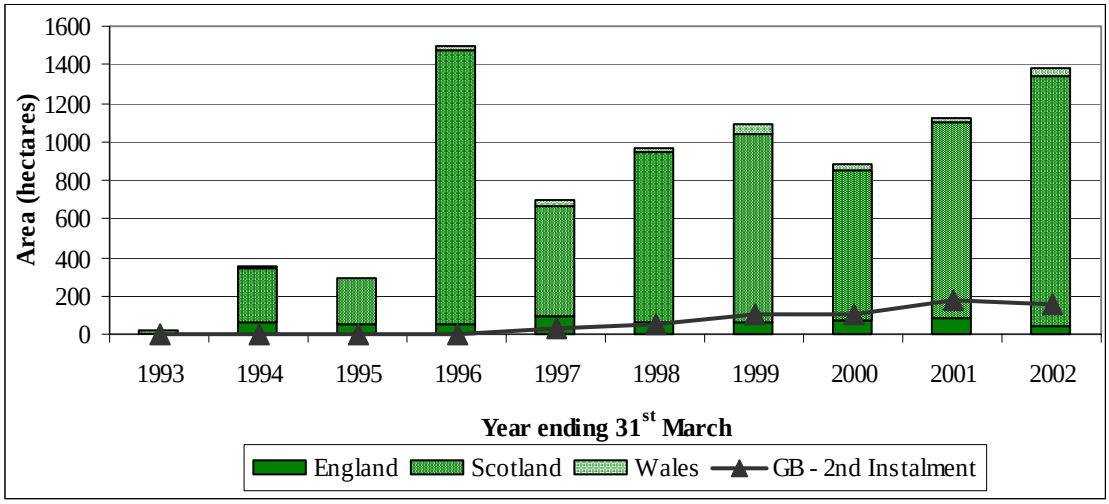
Natural regeneration in GB where a second instalment WGS grant is paid (non-FC)

hectares

Year ending 31st March	Natural regeneration of all woodland	Natural regeneration of ASNW
1995	27	0
1996	206	3
1997	343	36
1998	707	55
1999	1,688	101
2000	1,418	104
2001	1,712	172
2002	1,526	155

Source: WGS database

Area of natural regeneration on ASNW sites in GB (non-FC)



Source: WGS database

Note: WGS 1st instalment is shown in bars and WGS 2nd instalment is shown as a line. 1st instalment grant is paid for ground preparation work. 2nd instalment grant is paid once sufficient trees have successfully established. Includes new woodland creation and restocking.

Background Planting has been the favoured method of creating new woodland, but now natural regeneration is becoming increasingly favoured, especially for restoring ASNW or extending woodland to nearby open land, as it preserves the genetic diversity of the ancient and natural forest. The WGS grant for natural regeneration was introduced in 1988, both for new woodland and restocking of woodland. The second instalment of the grant, or a fixed payment, is payable once the trees are established. The success of natural regeneration of woodland is, among other things, dependent upon minimal attack by browsing deer, squirrels and other mammals.

The figures from WGS are likely to be an underestimate of the actual amount of natural regeneration occurring, since they do not include regeneration occurring without grant aid, e.g. in woodland glades or along forest rides.

Natural regeneration is also recorded in Forest Enterprise systems for FC woodland. Cumulative totals for all years up to 2001 are England 62 hectares, Scotland 1391 hectares and Wales 0 hectares. This is also likely to underestimate the actual amount of natural regeneration.

Creation of new woodland by natural regeneration also contributes to total new woodland creation (A2).

C. Condition of forest and environment

C1. Air pollutants

C2. Soil chemistry

C3. Water quality

C4. Surface water acidification

C5. Water yield and stream flows

C6. River habitat quality

C7. Pollution incidents

C8. Crown density

C9. Damage by living organisms

C10. Other damage (wind and fire)

Condition of forest and environment – Summary

Public concern in the 1980s about the growth and condition of European forests was focused on the possible impacts of air pollution on forest health. Although the levels of sulphur pollutants that triggered this concern have declined in recent years, they and other substances still have the potential to affect forests and the soil and water environments that interact with them.

In addition to direct monitoring of pollution input (C1), there are indicators of soil and water quality (C2 – C4). These indicators are also designed to pick up the effects of forests themselves on soil and water. Forest ecosystems are generally robust and may react very slowly to change. It is particularly important to bear this in mind in relation to the indicators of soil and water condition. So important are the potential interactions between forests and water that two further indicators are added: flows in watercourses out of the forest (C5) and river habitat quality (C6). The latter integrates possible impacts on water quality and quantity into their effect on the plants and animals of the freshwater environment.

Forestry operations have the capacity to cause serious pollution of soil and water. Although pollution incidents are generally accidental, they will nonetheless compromise the sustainability of forest management if they happen frequently. Indicator C7 reflects the intention that they remain rare.

The condition of the trees themselves is obviously of prime importance to sustainable forestry, as well as a reflection of the health of the wider forest environment. The remaining indicators (C8 - C10) cover this. Crown density measures the amount and condition of visible foliage and basic indicators of tree condition. The other two indicators are direct observations of the occurrence of serious damage caused by fire, storms, pests or diseases.

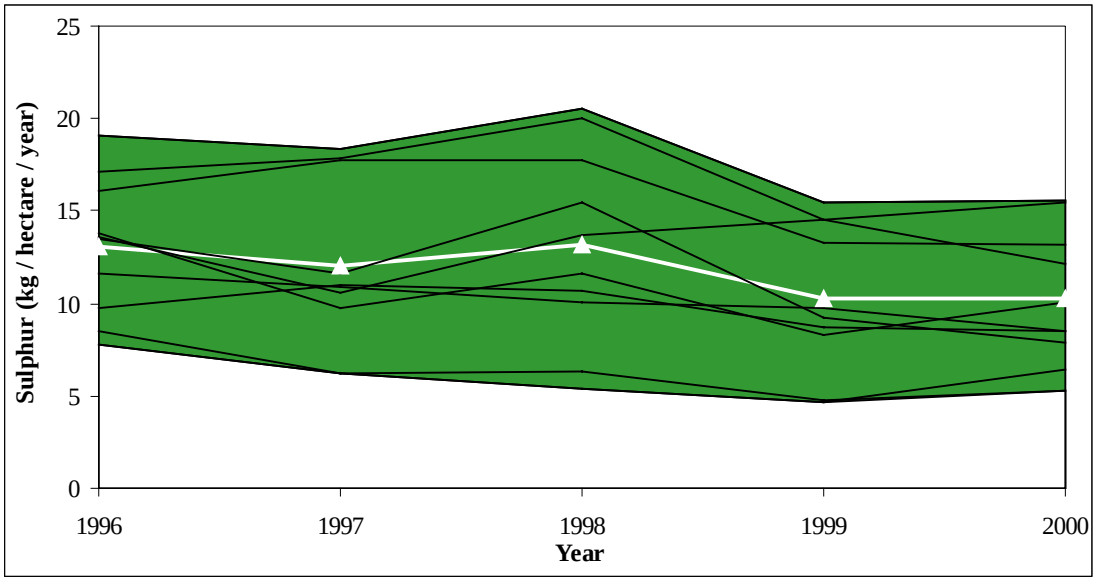
This set of indicators does not include estimates of the extent of protected or protective forest areas. The UK interpretation of the proposed international definitions is still under discussion, and indicators will be developed for pan-European reporting.

C1. Air pollutants

Relevance Air pollution is a potential driver of change in woodland condition. Changes in crown density of trees (see indicator C8) in the UK have not been linked to air pollution. However, other forest health parameters, such as the occurrence of insect damage and needle retention, have (NEGTAP, 2001). Air pollution may also predispose trees to the effects of drought and attack by fungi.

Key Points Emissions of sulphur dioxide have been decreasing since the 1970s and emissions of nitrogen oxides have been decreasing throughout the 1990s (NEGTAP, 2001). As a consequence, deposition of sulphur and nitrogen on woodland in GB has also decreased. Mean sulphur deposition decreased from 13.1 to 10.3 kilograms per hectare per year between 1996 and 2000, and mean nitrogen deposition decreased from 13.2 to 8.5 kilograms per hectare per year.

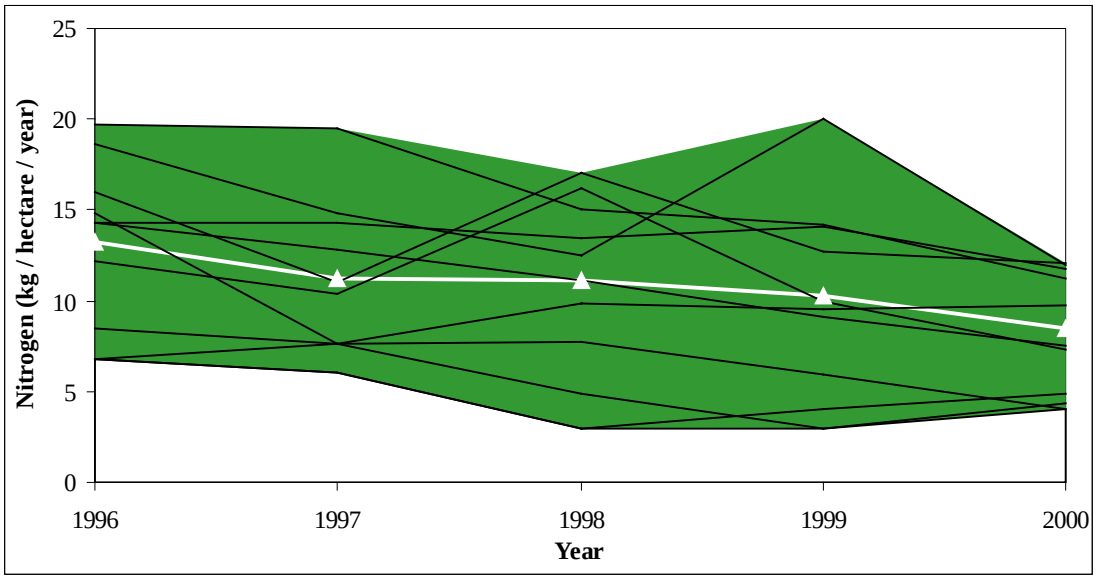
Annual deposition of sulphur at 10 sites in GB[1]



Source: Forest Condition Survey

[1]Shaded area shows the maximum and minimum deposition rates of the 10 sites and the white line with triangles shows the mean of the 10 sites. Individual sites are shown by black lines.

Annual deposition of nitrogen at 10 sites in GB[1]



Source: Forest Condition Survey

[1]Shaded area shows the maximum and minimum deposition rates of the 10 sites and the white line with triangles shows the mean of the 10 sites. Individual sites are shown by black lines.

Background Sulphur dioxide and nitrogen oxides are emitted mainly by burning of fossil fuels and road transport. Once in the atmosphere, these pollutants can be deposited back on the earth's surface either by dry deposition (contact with the ground) or wet deposition (rain). More pollutants can be deposited on woodland than on open land or grassland due to the nature of the land cover. Deposition of pollutants in woodland has implications for the condition of the soil (Indicator C2) as well as acidification of streams and rivers (Indicator C4).

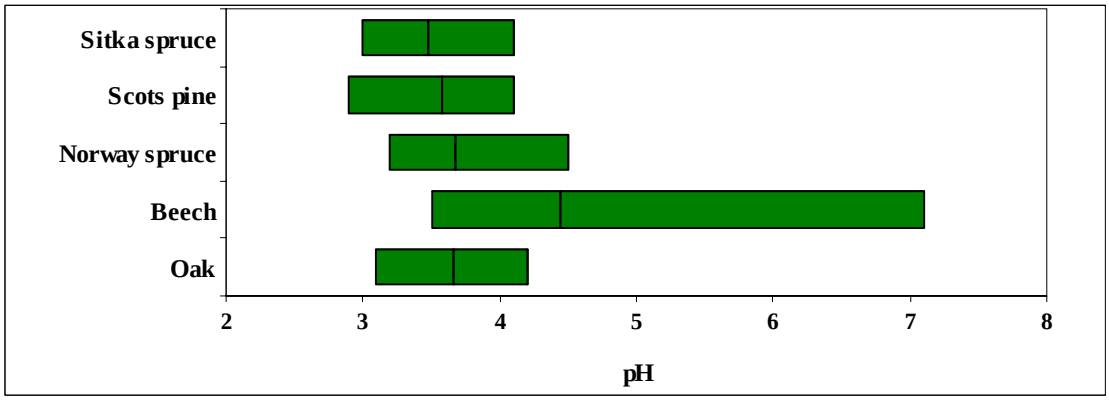
Since mid-1995, air quality and pollutant deposition have been monitored at 10 Forest Condition Survey (FCS) 'level II' plots, mostly in FC forests. These are part of the ICP Forests (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) network (see ICP Forests website), designed for intensive monitoring of forest condition in Europe. The concentrations of several ions (NO_3^-, NH_4^+ and SO_4^{2-}) are measured above and below the forest canopy, to estimate annual deposition (dry and wet) of sulphur and nitrogen to the forest canopy.

C2. Soil chemistry

Relevance Forestry is often beneficial or has no effect on soils, but it can have a negative impact in some situations. Examples of damage are drying of peat, acidification (see indicator C4) and damage from forestry operations – the last includes disturbance, erosion and compaction from harvesting, cultivation and road building. It is important to monitor soil, even if the implications of a particular change are not yet understood.

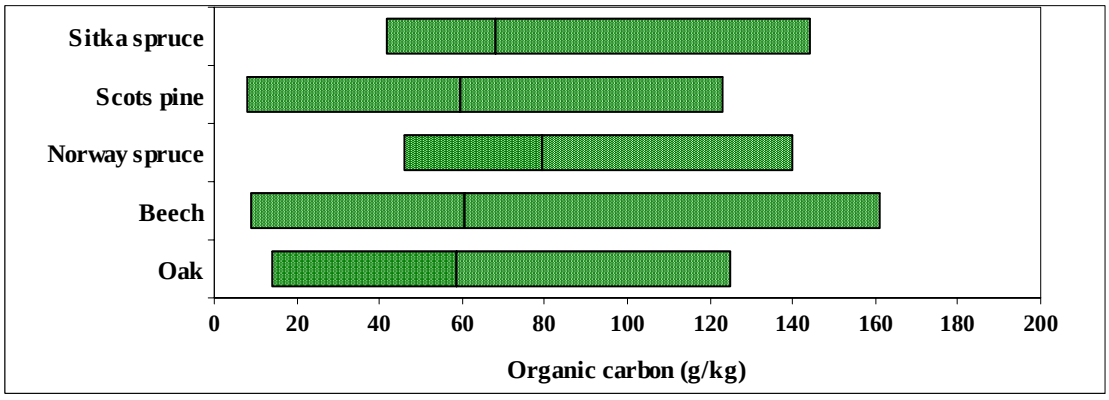
Key Points Soil measurements presented here were taken as part of the Forest Condition Survey (FCS) in 1995 (Moffat *et al.* 1997). Differences between species in soil pH, organic carbon and nitrogen content are likely to be due to a number of factors, including the effect of the tree species itself, and silvicultural decision making at the time of planting where certain species were chosen for certain soil types.

pH of the mineral soil (0-5cm) layer in GB woodland[1]



Source: Forest Condition Survey, 1995, level 1 plots

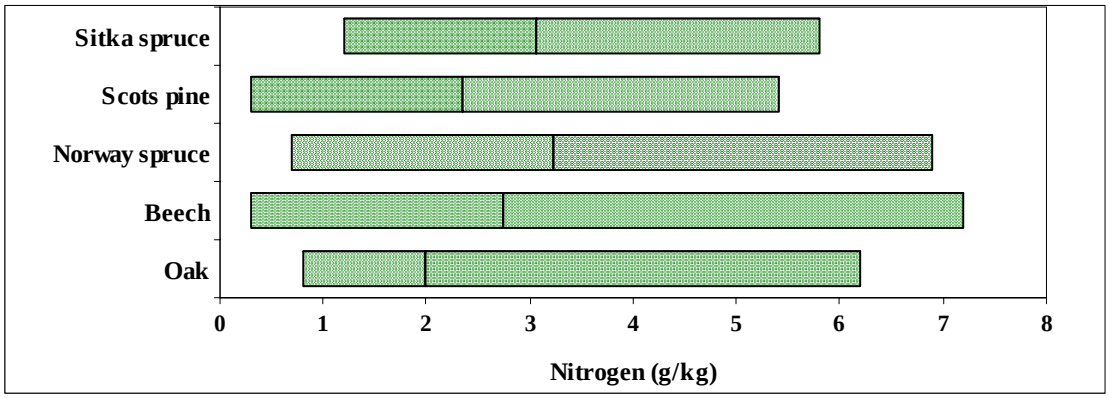
Organic carbon in the mineral soil (0-5cm) layer in GB woodland[1]



Source: Forest Condition Survey, 1995, level 1 plots

[1] In figures, each bar shows the range (minimum to maximum) of values recorded in the survey, with the mean shown by a vertical line.

Nitrogen in the mineral soil (0-5cm) layer in GB woodland[1]



Source: Forest Condition Survey, 1995, level 1 plots

Background Soil properties were measured in 1995 at 67 plots in the FCS Level I network. pH was measured using the Soil Survey for England and Wales $CaCl_2$ method, organic carbon was based on loss on ignition, and nitrogen was measured using the Kjeldahl method. 15 oak, 12 beech, 14 Norway spruce, 12 Scots pine and 11 Sitka spruce plots were included in the figures. These FCS measurements are due to be repeated in 2005. Soil chemistry is also measured continuously as soil solution at 7 FCS level II plots.

pH measures the acidity or alkalinity of soil, which influences its interaction with substances which are added to it. Crop yields, water quality and habitat diversity are all related to the underlying pH of the soil.

Soil organic carbon is an indicator of a number of soil functions and related processes. It is related to the yield of food and fibre and the range and composition of soil-related habitats, among others.

Nitrogen is broad indicator of fertility. Coupled with organic carbon, it has some potential to define nitrogen mobility and potential risk of loss in soil solution.

Future Forest Research have been working with the Environment Agency on the development of a set of soil indicators and hope to include future measurements of soil condition in forests within this framework (Loveland and Thompson, 2001). pH and soil organic carbon are among the Environment Agency's recommended 'minimum indicator set'. Nitrogen and base saturation are also included in their list of biological soil indicators. Base saturation is an indicator of base status. It indicates the 'reserves' left in the soil to buffer against further additions of, for example, acidifying substances.

It may also be possible to access data from the early 1980s, when the National Soil Inventory made measurements in the upper 15 cm of mineral soil, including pH and organic carbon at over 6,000 sites around GB. There were 483 forested sites in England and Wales (209 coniferous and 274 broadleaved) and 332 forested sites in Scotland.

C3. Water quality

Relevance The protection of the freshwater environment is a key requirement for sustainable forestry. Most forest operations can affect the quality and quantity of drainage waters. Benthic invertebrates are affected by a range of chemical and physical impacts and thus provide a good measure of the health of the freshwater environment.

Key Points The diversity and abundance of benthic invertebrates will give an indication of the biological condition of waterways in and downstream of woodland.

Measures Diversity and abundance of benthic invertebrates. Benthic invertebrates are animals without a backbone that live on the bottom of streams during all or part of their lifetime. They include snails, worms, the larvae and nymphs of mayflies and dragonflies, waterbugs and beetles.

Available information

The Environment Agency (EA) and Scottish Environment Protection Agency (SEPA) regularly survey benthic invertebrate populations in a large number of streams and rivers across the UK as part of their River Habitat Survey (RHS). Information for forest sites will be extracted from the RHS database.

The diversity and abundance of the benthic invertebrate population at any given site can be compared with what would be expected on the basis of the natural physical habitat features using the 'River Invertebrate Prediction And Classification System'. This should highlight any physical or chemical impacts resulting from forestry operations.

Background Poor forest management can lead to increased soil erosion, greater water turbidity, nutrient enrichment and sedimentation within watercourses. These can pollute water supplies and damage wildlife and fisheries. The FC's Forests and Water Guidelines (FC, 2000a) provide advice on the best management practices for protecting and enhancing the water resource.

Chemical monitoring can often miss polluting events, which are frequently of short duration and related to adverse weather conditions.

In contrast, the benthic invertebrate fauna remains exposed to all perturbations and provides a better indicator of site disturbance. A wide range of biological scoring systems and indices based on the abundance and diversity of benthic invertebrates have been developed as a means of assessing ecological quality and the impact of water pollution.

This work has been facilitated by the development of the 'River Invertebrate Prediction And Classification System', which uses information on physical habitat characteristics to predict the type of benthic community that could be expected at an unpolluted site. An assessment is based on sampling the benthic invertebrate fauna present in a stream, identifying to species or family level, and counting the number of individuals.

C4. Surface water acidification

Relevance Acidification remains a serious problem in a number of areas of the UK. The primary cause is the deposition of acidic sulphur and nitrogen compounds derived from the combustion of fossil fuels. Forest canopies can significantly increase the capture (scavenging) of some of these pollutants in the atmosphere. This has led to concern that forestry may contribute to further acidification in sensitive areas or delay recovery in response to ongoing emission reductions.

Key Points The individual datasets have not yet been brought together to form this indicator.

Measures Acid Neutralising Capacity (ANC), pH, or aluminium

Available information

Various acid water monitoring networks, including:

- 12 sites (10 forest, 2 moorland) in upland Wales, monitored since 1991 (FC / EA)
- 22 sites (5 forest) in UK Acid Waters Monitoring Network, monitored since 1988 (see Monteith and Evans, 2001)
- 3 / 4 sites (forest and moorland) at Lynn Brianne, Wales, monitored since early 1980s (EA)
- 2 sites (forest and moorland) at Loch Dee, Galloway, monitored since early 1980s (SEPA)
- 7 sites (6 forest) at Loch Ard, monitored since late 1970s (Freshwater Fisheries Laboratory)
- 2 sites (forest and moorland) in NW Scotland, monitored since 1983 (Freshwater Fisheries Laboratory)
- 2 sites (forest and moorland) at Halladale in north Scotland, monitored since 1993 (FC)

Background A number of long-term studies have been established to monitor the response of acidified streams to ongoing reductions in emissions of acid pollutants. Some of the studies involve forested catchments to determine the magnitude of the forest scavenging effect and to assess how this will affect the recovery process.

Acid neutralising capacity provides the most robust measure of acid status. It is proposed that the annual mean ANC data for 4 or 5 forest streams will be combined for each of Wales and Scotland and the trend compared with an equivalent number of moorland sites.

Future Long-term trends in ANC for a select number of acid sensitive moorland and forest streams could be compared. This would give a measure of how forestry affects the expected recovery in water quality in response to continued reductions in pollutant emissions.

Alternative measures include the pH or aluminium concentration.

C5. Water yield and stream flows

Relevance Water flows and levels in forested catchments may differ from those in moorland catchments. Forests can help to prevent flooding, but reduced water flows can have environmental effects, and also affect public water supplies. These flows can be monitored to ensure that the presence of a forest does not adversely affect the flow and amount of water in the catchment and further downstream.

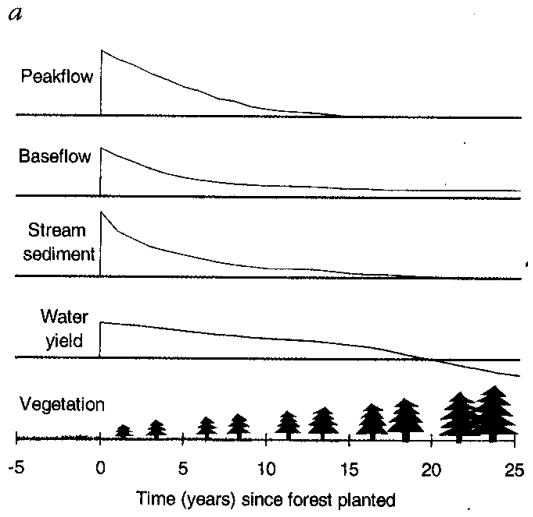
Key Points Overall, research suggests that there may be some 1.5-2.0% reduction of potential water yield for every 10% of a catchment under mature forest. The individual datasets still need to be brought together to formulate this indicator.

Measures Information from the catchment studies can be used to assess the effect of the complete forest cycle on:

- Catchment water yield
- Peak/flood flows
- Summer low flows

The figure is a schematic diagram explaining the trends in water yield and peak and low flows that have occurred since afforestation of the Coalburn catchment in 1972.

Summary of main hydrological changes at Coalburn over time as the forest is planted and grows. Source: Robinson *et al.* (1998).



Background Compared with moorland or grassland, closed canopy conifer forests cause a higher proportion of precipitation to evaporate before it reaches the ground. The quantity of water supplied from catchments containing closed canopy conifer forest may therefore be less than from moorland or grassland catchments. This loss of water in the catchment increases with forest height and canopy development and is greatest in the wetter, upland areas of Britain. There are also concerns that summer low flows will be reduced. Peak flows could be lowered or increased, depending on the scale and nature of forest practices.

There are 3 long-term catchment studies in GB which consider the effects of forestry on water yield and river flows:

- Coalburn, near Kielder, north England (Robinson *et al.,* 1998)
- Plynlimon, mid Wales (Kirby *et al,* 1991)
- Balquhidder, mid Scotland (Johnson, 1991)

The catchment studies were established to quantify the hydrological effects of forestry in upland Britain. These cover different phases of the forest cycle, from pre-planting cultivation and drainage, through establishment and forest growth, to eventual harvesting and restocking. Monitoring is continuing to enable the results for each phase to be compared between sites, as well as to assess the effects of forest restructuring and the second rotation on catchment hydrology.

Measurements include precipitation and stream discharge, covering various stages of forest development and growth. The record for Plynlimon extends back to 1967 and spans the period from forest establishment to clearfelling and restocking. Balquhidder has the shortest record, starting in 1981, and covers the effects of clearfelling and restocking. Coalburn is the only site to include a baseline period (from 1967) of measurements when the catchment was under moorland; the record covers afforestation in 1972 and the subsequent growth of the crop to 30 years age. Both the Plynlimon and Balquhidder studies include neighbouring moorland control sites, although the one at Balquhidder has now been partly afforested.

Future The annual run-off and indices of low and high flows can be plotted to identify the presence of any trend. Background variation in weather patterns can be removed using the data from neighbouring moorland control catchments.

C6. River habitat quality

Relevance The UK Forestry Standard (FC, 1998) and FC Forests and Water Guidelines (FC, 2000a) recognise the high value of the riparian zone for nature conservation, landscape and recreation, and the key role that it plays in protecting the freshwater environment. Forest management should aim to maintain about half the length of streams open to sunlight by creating a mix of mainly broadleaved woodland and open space in the riparian zone. The condition of riparian and river habitat is an indicator of the overall quality of the aquatic environment, while the length of riparian woodland is a useful measure of progress in restructuring the riparian zone.

Key Points River habitat quality scores will give an overall indication of the condition of waterways in and downstream of woodland.

Measures River habitat quality at woodland and non-woodland sites.

Available information

- The River Habitat Survey, carried out by the Environment Agency (EA) and Scottish Environment Protection Agency (SEPA), measures 'habitat quality' on selected stretches of UK rivers. Information can be extracted for wooded sites and could possibly use a habitat modification score to assess change. The initial River Habitat Survey was undertaken during the 1990s and involved over 5,000 sites across the UK.
- CS2000 has several stream bankside plots in broadleaved and conifer woodland. Several scores of vegetation condition are calculated similar to those shown in indicator B5. The 1990-1998 change in condition has been calculated for 230 broadleaved plots. Measures include soil moisture, light score, competitor score, stress-tolerator score, ruderal score, vegetation species richness and butterfly food scores.

Background Riparian woodland is woodland along river and stream banks. Past planting of conifers close to streams resulted in dense shading and the loss of herbaceous riparian and aquatic vegetation. This reduced the biodiversity and productivity of streams and led to increased bank erosion. The felling of first rotation stands presents an important opportunity to reverse these and other effects through restructuring the riparian zone. The wetness of riparian soils and characteristic instability of stream banks mean that the zone is very sensitive to disturbance. Management must aim to protect the zone from the potentially damaging effects of forest operations on the adjacent land.

The River Habitat Survey involves a detailed description of the physical features of the river corridor. This information can then be used to assess the extent of change or damage over time. It may be possible to adapt the habitat modification scoring system that has been developed by SEPA.

Future Riparian zones are not currently identified in the WGS database, Forest Enterprise systems or NIWT.

Work is ongoing to identify riparian woodland (using GIS) for FC woodland, and for all woodland over 2 hectares in NIWT. It should be possible to identify the following:

- Area of FC woodland, and non-FC woodland from NIWT, within 50 metres, say, of a water course
- A breakdown of land use types within this riparian zone
- A breakdown of species present within this riparian zone

Maps of these riparian zones would also be available. With NIWT it should also be possible to identify the sample squares which fall within the riparian zones, allowing more information to be given.

It may be possible to include a riparian marker in future national inventories to allow separate analysis of riparian woodland plots.

C7. Pollution incidents

Relevance Forestry operations have the potential to cause serious soil and water pollution. Sustainable forestry minimises disturbance to soils and water courses and avoids pollution and siltation.

Key Points Pollution incidents to water, air and land due to forestry are a very small proportion of the total number of incidents. This has been the case throughout the last decade.

Pollution incidents: total and those due to forestry operations

Year	England & Wales[1]		Scotland[2]		N. Ireland[3]	
	Total Substantiated	Forestry	Total Substantiated	Forestry	Total substantiated	Forestry
1990					1,623	0
1991					1,959	0
1992					1,845	0
1993		1			1,877	0
1994		20[4]			2,216	0
1995		20[4]			2,380	0
1996		15[4]	2,878		2,055	0
1997		31	3,535		1,823	0
1998		23	2,590		1,641	0
1999	30,922	82	2,588		1,506	0
2000	36,406	113	2,663			
2001	33,723	46				

[1]**Source: EA (2002) and previous years.** Figures for 1999 to 2001 are all pollution events to air, water and land; previous years are water only.
[2]**Source: SEPA (2001).** Pollution events to water only. Data for financial years beginning April.
[3]**Source EHS (2000).** Pollution events to water only. "Total substantiated" is substantiated + unsubstantiated 1990-1995 and substantiated only in 1996 and subsequent years.
[4] Figures are estimated from graph.

Background

The Forestry Commission and Northern Ireland Environment and Heritage Service (EHS) have published guidelines for forest managers aimed at minimising disturbance to water courses and avoiding pollution and siltation (FC, 2000a). Guidelines also aim to keep pollution to soil and air to a minimum.

The EA, SEPA and EHS record all pollution incidents which are reported and which may later be substantiated. SEPA and EHS currently record pollution incidents to water, as did the EA. However in the last 3 years the EA has recorded pollution incidents to water, air and land combined.

In 2001 in England and Wales, there were a total of 33,723 substantiated pollution incidents to water air and land. Pollution incidents due to forestry operations (42) account for 0.1 % of the total number of substantiated pollution events in England & Wales.

EHS are not aware of any pollution events to water due to forestry operations in Northern Ireland in recent years.

Future

In 2000/01 in Scotland there were 2,663 substantiated pollution incidents to water. Forestry is not considered as a separate category by SEPA, suggesting that numbers of pollution incidents due to forestry operations are small. However, this information should be obtainable in future.

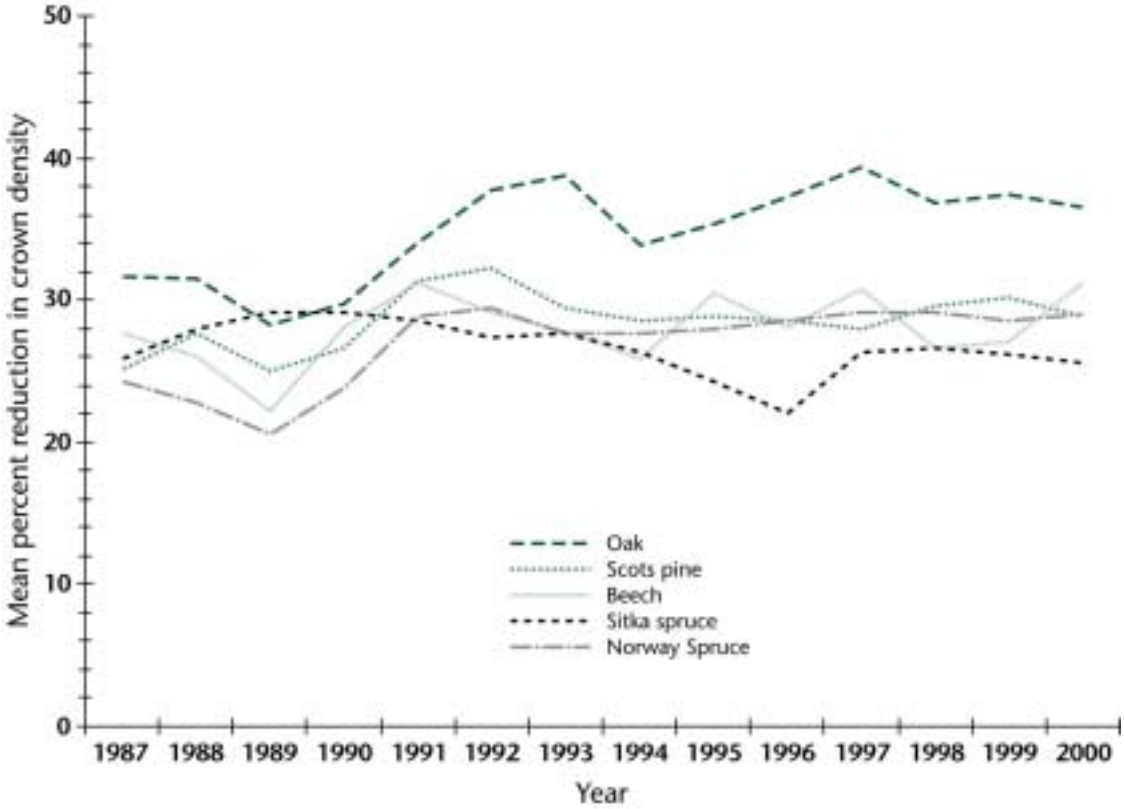
Also available from the EA, SEPA and EHS is the number of breaches of legislation which have resulted in prosecution in the UK. There are understood to be very few prosecutions related to forestry operations.

C8. Crown density

Relevance Sustainable forest management requires the forest itself to be in good health. 'Crown density' is an overall measure of tree condition, indicating the amount of foliage on a tree.

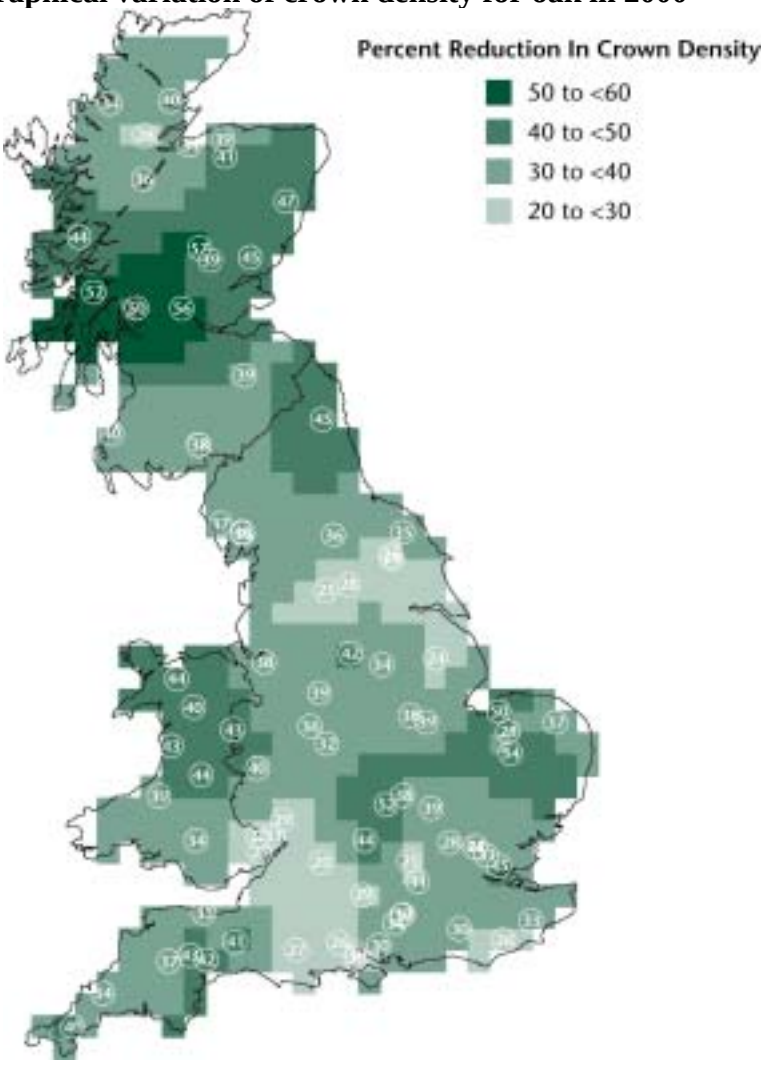
Key Points Oak was in slightly better condition in 2000 than any year since 1995, but is still in poor condition in central Scotland, north-east England, south-west England, north Wales and East Anglia (see map). However, both oak and Norway spruce show slight deterioration from 1987 to 2000. Sitka spruce has improved slightly in recent years probably due to recovery from a severe attack by insects in 1997, but shows no longer-term trend. Beech condition declined significantly in 2000 and shows statistically significant and marked declines and improvements from year to year, with no overall longer-term trend. Scots pine showed a minor improvement in 2000, after little change in condition from 1994 to 1999.

Change in crown density of 5 species in GB.



Source: Forest Condition Survey (Hendry *et al.* 2001)
Note: An upward gradient with time represents a deterioration in condition

Geographical variation of crown density for oak in 2000



Source: FCS (Hendry *et al.* 2001)
Areas of more healthy oak are shown in light green, and those in poorer condition are shown in dark green.

Background

Crown density is measured as part of the Forest Condition Survey (FCS). Since 1987 the FC has annually re-assessed five tree species in FCS 'level I' plots distributed throughout Britain, as part of the ICP Forests (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) network, designed for monitoring of forest condition in Europe (see ICP Forests website).

In 2000 the FCS assessed a total of 8,376 trees in woodland on a total of 349 plots. The density of the tree crown is measured relative to an 'ideal' tree with full (100 %) foliage, hence 'reduction in crown density' is taken as a departure from the ideal. Such reductions are not necessarily due to ill-health - in some years, heavy flowering or seed-set, for example, can lead to a marked reduction in foliation. Further information can be found in Hendry *et al.* 2001.

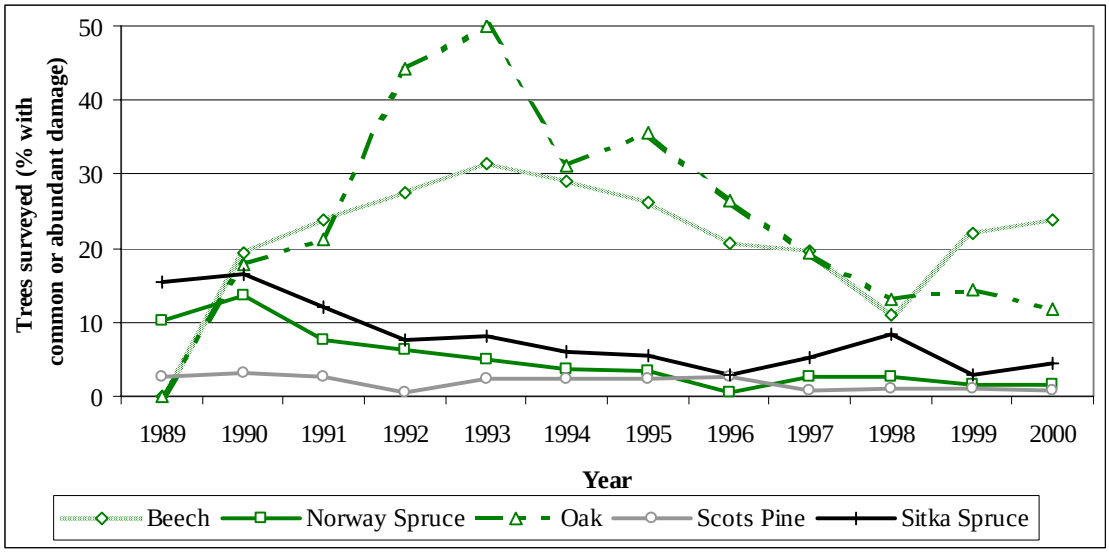
Crown density is monitored across Europe, but the crown density is measured relative to a 'local' tree unlike the data presented here. GB measurements relative to a 'local' tree have also been made since 1993. There are only 3 Sitka spruce plots in Northern Ireland where measurements are taken relative to a 'local' tree, so are not comparable to the results presented here.

C9. Damage by living organisms

Relevance Crown density (Indicator C8) gives an overall measure of the condition of the trees in our forests. Damage by living organisms gives information about some of the reasons for poor condition.

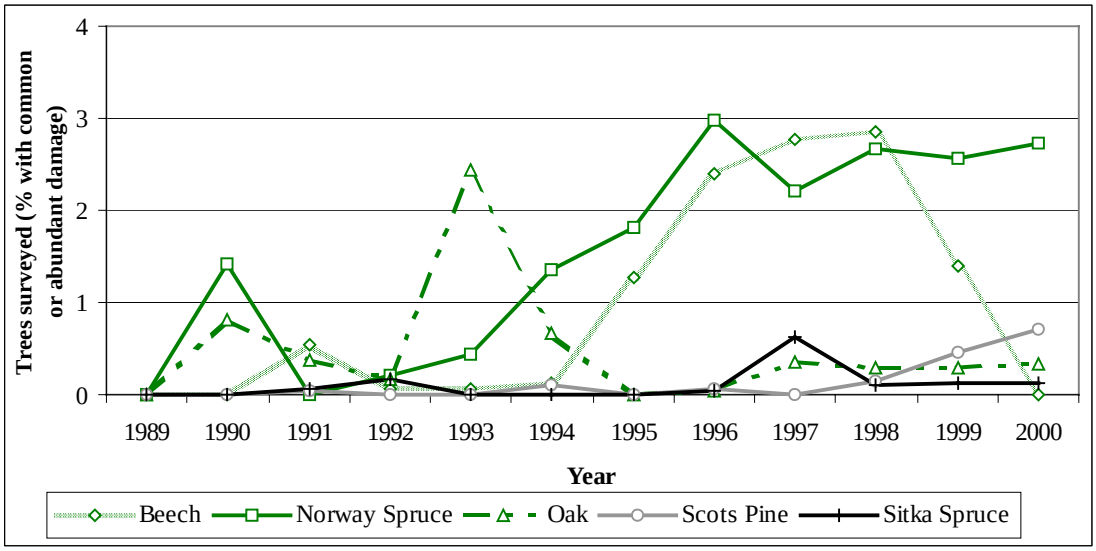
Key Points The main causes of damage reported in the Forest Condition Survey (FCS) are damage by insects and fungi. Mammals such as deer and squirrel can also damage woodland and inhibit natural regeneration. Around 6 % of woodland suffers from browsing by mammals and around 6 % suffers from bark damage.

Common or abundant damage by insects in GB



Source: Forest Condition Survey (Hendry *et al.*, 2001)

Common or abundant damage by fungi in GB



Source: Forest Condition Survey (Hendry *et al.*, 2001)

Mammal[1] damage (bark stripping and browsing) in GB

% of high forest area[2]

	England	Scotland	Wales	GB
Mammal Bark Stripping – Total	**5.2**	**7.2**	**0.9**	**5.7**
< 20 % of trees with bark stripping	2.5	5.6	0.2	3.8
20-80 % of trees with bark stripping	2.1	1.1	0.5	1.4
> 80 % of trees with bark stripping	0.6	0.5	0.2	0.5
Mammal Browsing – Total	**0.9**	**11.0**	**0.1**	**5.7**
< 20 % of trees browsed	0.5	6.6	0.0	3.4
20-80 % of trees browsed	0.3	2.3	0.1	1.3
> 80 % of trees browsed	0.1	2.1	0.0	1.1

Source: NIWT 1995-1999

[1] Mammal damage includes damage from livestock, squirrels, deer, rodents and humans.

[2] High forest is woodland excluding open land and coppice.

Background Damage to trees by insects and fungi are measured as part of the FCS and can be recorded as rare, infrequent, common or abundant. Since 1987 the FC has annually re-assessed 5 tree species in FCS 'level 1' plots distributed throughout Britain, as part of the ICP Forests (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) network, designed for monitoring of forest condition in Europe (see ICP Forests website).

In 2000 the FCS assessed a total of 8,376 trees in woodland on a total of 349 plots. The insect and fungi results represent the percentage of trees of each species that were affected.

Oak has suffered particularly by insect damage, although this has been less of a problem since 1997. Beech also suffered from insect damage in 1999, especially in Scotland. Beech trees are regularly attacked by the beech leaf miner (*Rhynchaenus fagi*), but the actual damage to the health of the tree is only slight. However, attacks of the green spruce aphid (*Elatobium abietinum*) on Sitka spruce can severely damage the health of the tree and the effects are long-lasting - such an event occurred in 1997. Norway spruce plots in north England, Scotland and south west England, suffered from fungal damage in 2000. More information about the FCS can be found in Hendry et *al.* 2001.

Mammal damage is recorded in NIWT. Occurrences of bark stripping and browsing damage are recorded. It can include damage by livestock, squirrels, deer, rodents and humans. In addition to the area damaged, the frequency of damage and severity are also recorded, as is the height of bark stripping.

The FCS also records damage to the bark of a tree, damage by game, pollution, fire, frost & wind and humans. In each case, the proportion of trees damaged is small and has remained so during the last decade.

Future There are only 3 Sitka spruce FCS plots in Northern Ireland – information regarding the condition of these plots could be added.

C10. Other damage (wind and fire)

Relevance Wind damage is a threat to managed forests because it results in loss of timber yield, landscape quality and wildlife habitat. Prediction and prevention of wind damage are important elements of forest management. Damage by fire is not a serious problem in the UK, unlike some other European countries. There is very little natural fire.

Key Points Wind damage is sporadic and occurs when large storms affect the UK. In the NIWT survey, areas of blown woodland which remained uncleared made up 0.2 % of the high forest area in GB, and 6% of the high forest area showed signs of windblow. Fire statistics are only available for FC/FS woodland, in which 540 hectares of woodland per year on average was burned in the 1980s, falling to 360 hectares per year in the 1990s. Both fire and wind damage are likely to be influenced by the climate to a high degree (e.g. 1995 was a drought year and suffered from more fires than previous or subsequent years).

Forest windblown in GB

hectares and % of high forest[1]

		England	Scotland	Wales	GB
Blown woodland which remains uncleared and not regenerated	**ha**	1,140	4,319	48	**5,507**
	%	0.1%	0.4%	0.0%	**0.2%**
Woodland with signs of windblow (e.g. blown trees, cracking around the root plate, trees at unusual angles, trees leaning on other stems)	**ha**	21,950	105,726	6,028	**133,704**
	%	2.4%	9.7%	2.4%	**5.9%**

Source: NIWT 1995-1999

[1]High forest is woodland excluding open space and coppice.

Summary information for catastrophic storms affecting GB since 1945

Date of storm	Area affected by 36 m s^{-1} gusts[1] (hectares)	Maximum gust recorded ($m\ s^{-1}$)	Volume of windthrown timber (million m^3)	Growing stock windthrown in affected area (%)
31 January 1953	37,000	50	1.80	10 – 25
15 January 1968	51,000	52	1.64	15 – 30[2]
2 January 1976	89,000	47	0.96	< 5
16 October 1987	22,000	51	3.91[3]	13 – 24
25 January 1990	69,000	48	1.26[3]	1 – 3

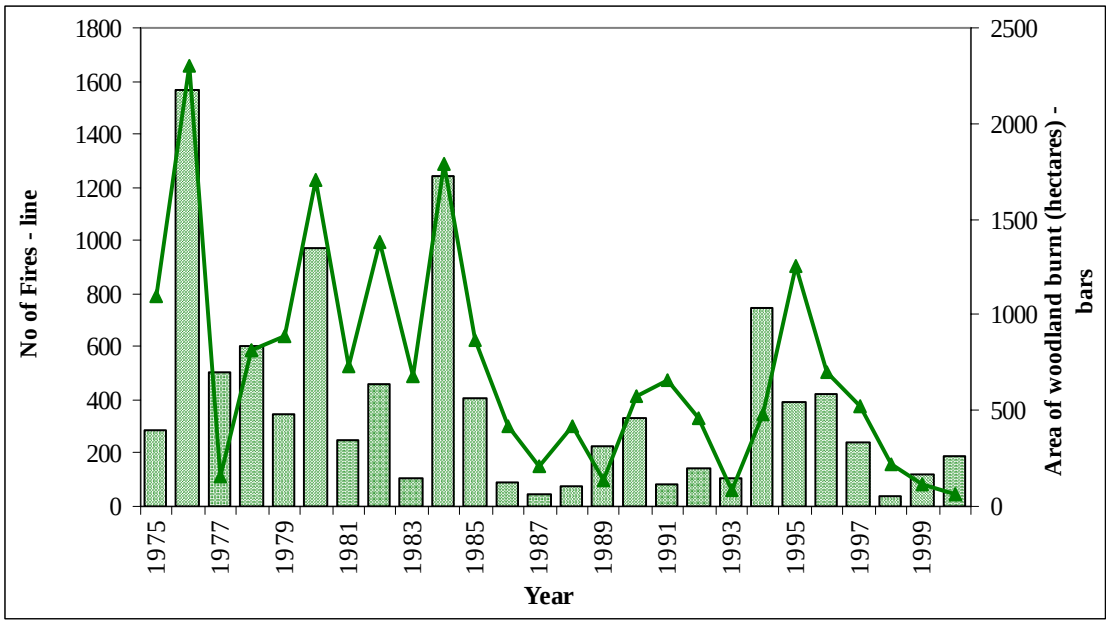
Source: Quine *et al.* (1995)

[1] 36 m s^{-1} (metres per second) is equivalent to 130 kilometres per hour or about 80 miles per hour.

[2] Percentage of crops aged 31 years and over.

[3] Known to include non-woodland trees.

Number of fires and area burnt on Forestry Commission and Forest Service land



Source: UNECE (2001).
Note: Number of fires shown by a line; total area burnt is shown by bars.

Background Windblow includes damage where both stem and roots of the trees overturn (windthrow) and damage where the tree stem breaks above the ground (windsnap). Wind damage normally occurs during a large storm. Some significant damage tends to occur around once every three years. NIWT measures the area of woodland where trees are windblown and remain uncleared, and also measures the area of woodland that shows signs of windblow; these are both shown in the top table. Major damage caused to woodland in GB by the most catastrophic storms is shown in the bottom table.

A large proportion of the fire damage reported here is due to arson or carelessness of woodland visitors. Information on fires is only available for FC/FS woodland. Since there is less public access to private woodland (see indicator E2), it is thought that fire damage is less of a problem in private woodland than in FC/FS woodland.

Future One possible source for the number of fires in private woodland is from the Fire Services.

D. Timber and other forest products

D1. Volume of growing stock

D2. Harvesting compared with annual increment

D3. Timber production and future availability

D4. Home-grown timber as % of consumption

D5. Carbon storage

Timber and other forest products – Summary

The expansion of our forest cover in the 20th century has supported the development of timber processing industries. Although the UK will always be dependent on imports for the bulk of its timber needs, the domestic processing industry makes a positive contribution to employment and national income and reduces our ecological footprint on other countries.

Changes in the stock of timber growing in UK woodlands (D1) are determined by the annual increment and annual volume harvested (D2). The stock of timber and the age of the trees determines how much will be available for harvesting (D3); the actual volume harvested in the future will depend on a number of factors, including the competitiveness of UK manufacturers of forest products compared with manufacturers in other countries as well as prices of forest products, which are set by the international market. The contribution that UK woodlands make to our timber needs is shown in D4.

The volume of growing stock can be used to estimate the quantity of carbon stored in woodland (D5). A full analysis of carbon storage must also consider forest soils and wood products, which have not been included in this indicator.

Forest products also include non-wood goods (e.g. venison, mushrooms and berries) that can be important for commercial or local use, but comprehensive statistics or estimates are not available for the UK. Woodlands also provide social and environmental benefits that are not marketed (see Indicator F5), one of which is recreation (see Indicator E1).

D1. Volume of growing stock

Relevance An increased volume of growing stock provides a reserve of timber for future use by wood processing industries. The figures presented here are limited to growing stock of adequate quality to be harvested as timber, but their value as timber will also be affected by the quality (e.g. straightness), ease of harvesting and other factors.

Key Points The total growing stock of potential timber is around 350 million m^3, of which two-thirds is conifers (softwood). On average at present, the conifers are growing by around 7% a year, and broadleaves by around 4% a year. Growing stock is increasing over time, as annual increment exceeds the volume harvested – see indicator D2.

Volume of growing stock and gross annual increment

	Conifers			Broadleaves		
	Area (thousand hectares)	Growing stock (million m^3)	Annual Increment (million m^3)	Area (thousand hectares)	Growing stock (million m^3)	Annual Increment (million m^3)
England	434	102	4.3	510	88	3.3
Scotland	891	107	10.1	109	17	0.7
Wales	145	21	1.8	61	12	0.4
N Ireland	51	6	0.6	2	0	0.0
UK	**1,521**	**236**	**16.8**	**682**	**117**	**4.4**

Source: Based on NIWT 1995-1999, volumes adjusted from UK to international definitions of overbark standing volume.

Note: This table is based on a summary of data compiled in 2001 for the European Forestry Sector Outlook Studies (EFSOS – see the EFSOS website). It only covers growing stock of timber quality (and Northern Ireland is FS only).

Background These estimates are based on the National Inventory of Woodland & Trees for 1995-99, broken down by species group and age band, using assumptions about conifer yield classes consistent with the forecasts in D3. The Inventory is based on a complete digital map for woodland over 2 hectares, and specified 1-hectare squares for field sampling that should provide a representative sample, so the estimates should be complete and unbiased.

The international definition of timber volume agreed for the Forest Resources Assessment 2000 includes trees of all sizes, all stemwood and large branches (i.e. 0 cm minimum diameter), but excludes the stump. The pre-existing UK definition excludes trees smaller than 7 cm diameter at breast height, excludes the part of the stem that is less than 7 cm diameter, excludes branches (except major forks), but includes the stump. For this indicator, volumes were adjusted from UK definitions to the internationally agreed definitions.

Future Revised figures will be available by the end of 2002 covering a wider definition and based on more comprehensive modelling.

D2. Harvesting compared with annual increment

Relevance This is an indicator of the sustainability of timber production over time. Long run sustainability requires the volume of growing stock to be maintained, so the gross annual increment in growing stock must exceed the volume harvested. The difference must be at least enough to cover the volume of unrecovered natural losses (e.g. fire) and the volume of unrecovered timber left after harvesting; these losses are not recorded in UK statistics, but are both estimated to be relatively small.

Key Points The annual volume of conifer (softwood) timber harvested is around 60% of the gross annual increment in conifer growing stock. Both the annual increment and the volume harvested each year are increasing, as new plantations created in the 1950s to 1970s are approaching the end of their first rotation. The volume of broadleaves (hardwood) harvested is only around 20% of the gross annual increment in broadleaved growing stock.

Comparison of annual increment and 2000 harvest volumes in the UK

million m^3 overbark standing

	Conifers		**Broadleaves**	
	Annual Increment	Harvest 2000	Annual Increment	Harvest 2000
England	4.3	2.3	3.3	0.6
Scotland	10.1	5.7	0.7	0.1
Wales	1.8	1.3	0.4	0.0
N Ireland	0.6	0.3	0.0	0.0
UK	**16.8**	**9.6**	**4.4**	**0.7**

Sources: Increment based on NIWT 1995-1999, adjusted from UK to international definitions. Harvesting from Forestry Statistics 2001 (FC, 2001d)

Note: 0.0 indicates values less than 0.05

Background Other European countries have similar ratios of harvesting to increment (e.g. Germany is around 55%, France around 65%) while Sweden and Finland are both around 75%. This is one of the Environmental Indicators adopted by the UN Commission on Sustainable Development and included in the Eurostat pilot Indicators of Sustainable Development (EC, 1997).

The volume of timber available for harvesting is forecast to increase over the next 20 years (see D3). Annual increment is also increasing, as many plantations are in a period of rapid volume growth during the years before harvesting.

Future Updated comparisons can be compiled after the end of 2002, when revised data for annual increment become available, covering a wider definition and based on more comprehensive modelling.

D3. Timber production and future availability

Relevance The timber production statistics show that UK woodlands have been providing an increasing volume of timber, which has permitted the development of wood processing industries using home-grown logs and small roundwood. The softwood forecast shows that the current woodland area can provide more raw material to these industries in the future.

Key Points The annual volume of softwood harvested in GB has increased steadily, from 2.4 million m^3 in 1970 to 3.4 million m^3 in 1980, 5.7 million m^3 in 1990 and 9.5 million m^3 in 2000. Availability is forecast to increase by more than 60% to 15.5 million m^3 by 2020, but then fall back to little more than the current level by 2050.

Timber production in GB

million m^3 overbark standing

Year	Softwood			Hardwood	GB Total
	FC woodland	Non-FC woodland	Total softwood		
1970	1.49	0.90	2.39	1.30	3.69
1980	2.41	0.98	3.39	1.30	4.69
1990	3.46	2.20	5.66	1.12	6.78
2000	5.53	3.97	9.50	0.72	10.22

Sources: Forestry Statistics 2001 (FC, 2001d) and British Timber Statistics 2001 (FC, 2002a)

Future availability of timber in GB

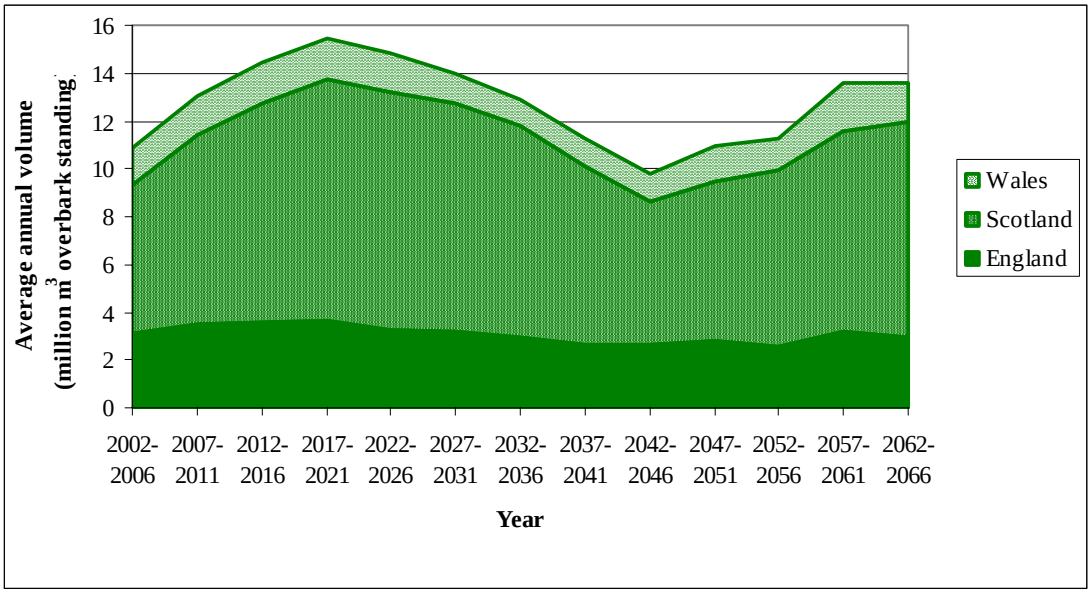
million m^3 overbark standing

annual average in the five years:	Softwood			Hardwood	GB Total
	FC woodland	Non-FC woodland	Total softwood		
2002-2006	5.13	5.75	10.87	1.00	11.87
2007-2011	5.98	7.08	13.06	1.00	14.06
2012-2016	6.24	8.20	14.45	1.00	15.45
2017-2021	6.85	8.63	15.48	1.00	16.48

Source (softwood): Smith *et al* 2001.

Note: The figures for hardwood are a stylised projection - there has been not yet been a comprehensive assessment of the hardwood resource based on NIWT.

Longer term trend in softwood availability for GB



Source: Smith *et al* 2001.

Background Forecasts for non-FC woodland are based on the woodland areas in NIWT 1995-99, using assumptions about average yield classes, rotation lengths and other parameters agreed with advisory groups representing woodland owners and wood processors. The forecasts take account of a broad classification of timber quality in NIWT, but not any detailed quality measures (e.g. straightness). They also do not take account of ease of harvesting or expected economic return.

Forecasts for the Forestry Commission were provided by the planning systems of Forest Enterprise. Hardwood figures are based on the assumption that production will remain at current levels in the foreseeable future, and are not based on availability.

The volumes harvested will depend on felling decisions by woodland owners and market demand. The decline in availability after 2020 may make it difficult to establish long-term industries. For hardwood, future availability is less of an issue; there is a large volume of over-mature timber which could be harvested, but only a small number of suitable markets.

Future A more comprehensive assessment of the hardwood resource based on NIWT should be available in late 2002. The new modelling may also lead to a revision of the softwood availability forecast, at a later date.

Equivalent figures for Northern Ireland can be compiled in the future.

D4. Home-grown timber as % of consumption

Relevance The resource costs of transporting timber for international trade and the impacts of harvesting from forests in other countries (the UK's ecological footprint) are considerations for sustainable development.

Key Points Home-grown timber meets about 16% of UK consumption of wood products (excluding recycled material). The percentage of home-grown timber has risen from around 7% in the 1960s to 10% in the mid-1970s and around 15% in the 1990s. It could rise to around 25% when UK timber availability reaches a peak in the period 2015-2025, if UK timber remains competitively priced compared with imported material.

Volume of imports, exports, and home-grown wood and wood products

million m^3 WRME underbark

Year	Imports[1]	Exports[1]	Home-grown	Apparent[2] Consumption	Home-grown %
1960	36.0	0.8	2.7	37.9	7.1%
1965	39.1	0.8	3.0	41.3	7.3%
1970	40.3	1.2	3.2	42.3	7.6%
1975	30.9	1.0	3.4	33.3	10.2%
1980	34.7	2.3	3.9	36.3	10.7%
1985	37.5	2.3	4.7	39.9	11.8%
1990	48.4	4.7	6.5	50.2	12.9%
1995	44.3	6.0	7.6	45.8	16.6%
2000	48.6	7.7	7.5	48.5	15.5%

[1]**Source: HM Customs and Excise, 2001 and previous years, and conversion factors**

[2]Apparent consumption = imports – exports + home-grown. It excludes recycled wood and waste paper of UK origin.

WRME is wood raw material equivalent, the volume of felled timber (measured without bark) required to produce these wood products.

D. Timber and other forest products

Background Total consumption of wood products has tended to increase with economic growth. However it is driven more strongly by specific requirements for construction timber and by the product life cycles for particular products. The growth in apparent consumption is less rapid, because of the increased use of recycled wood and waste paper, resulting in no net increase through the 1990s.

Future An alternative approach would be to estimate the volume (wood raw material equivalent) and/or value of apparent consumption for each category of products, and to estimate the proportion of each coming from UK timber. This would give a lower percentage share for UK timber, because the denominator would include products from recycled material (especially waste paper). An initial estimate (from work for Scottish Forestry Strategy indicators) suggests that home-grown timber produced about 10-11% of wood product consumption by quantity and 8-9% of wood product consumption by value for the UK in 2000.

It would be desirable to supplement this with information about the proportions of UK and imported material that comes from forests certified as being sustainably managed. However, this information is not currently available.

D5. Carbon storage

Relevance Plants absorb carbon dioxide (CO_2) and store the carbon, so they can help to reduce the CO_2 concentration in the atmosphere. Processes that lock up carbon are known as carbon sequestration. Although the main aim of the Kyoto Protocol to the UN Framework Convention on Climate Change is to secure agreement on reducing emissions of greenhouse gases at source, it also recognises forestry as a way of helping to reduce concentrations. The value of offsetting emissions by sequestration is controversial, but there is widespread international agreement that the store of carbon represented by forest ecosystems should be protected and enhanced.

Key Points The amount of carbon in tree wood varies with the volume of growing stock and tree species; the rate of carbon take-up by woodland depends upon the species and age of trees. The growing stock has been increasing in recent years (see indicator D1). There is currently around 140 million tonnes of carbon stored in UK woodland, with a net addition of 2 million tonnes of carbon each year.

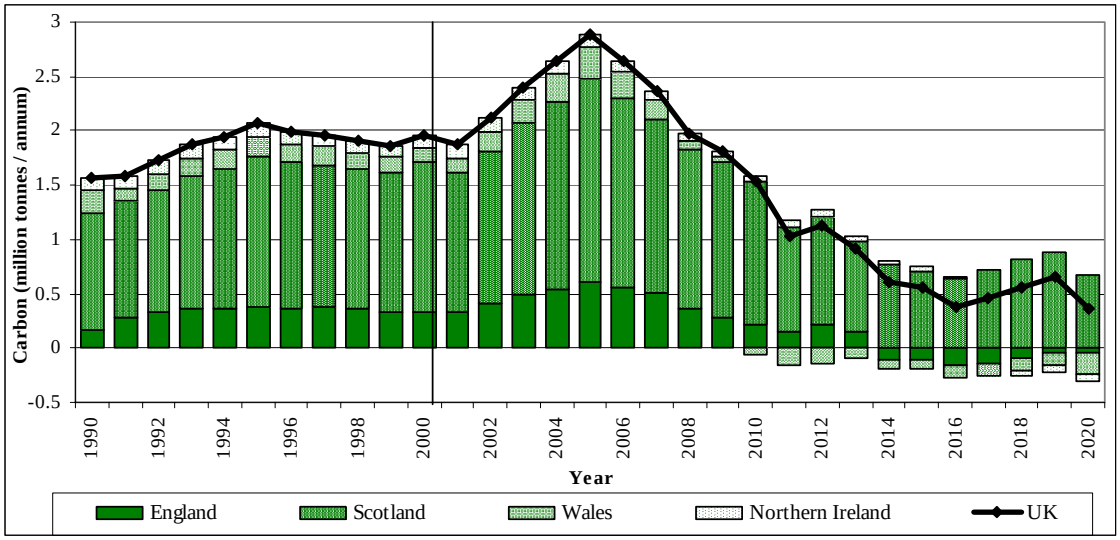
Biomass of trees and shrubs and mass of carbon stored in UK woodland

million tonnes

	Conifer	Broad-leaved	Total
Oven-dry biomass			
Trees in forest	102	97	199
Trees outside forest			27
Other woody biomass (shrubs/ bushes)			5
Stumps & roots			44
Total			**275**
Carbon			
Trees in forest	51	49	99
Trees outside forest			13
Other woody biomass (shrubs/ bushes)			2
Stumps & roots			22
Total			**136**

Notes:
Carbon is estimated as half of oven-dry biomass. Oven-dry biomass is estimated by multiplying the standing volume of timber by the following factors: conifers 0.43 and broadleaves 0.83.
Standing volume of trees in forest is based on NIWT 1995-1999 adjusted to international definitions (total above stump, including branches, not just stem - see indicator D1); others are estimates compiled for Forest Resources Assessment 2000.

Net annual change in mass of carbon in UK woodlands



Source: CEH (2002)

Note: Future predictions of carbon uptake assume that commercial conifer plantations will be replanted when felled, and that planting of new woodland will continue at the same rate as in 2000.

Background The global atmospheric concentration of carbon dioxide (CO_2) has increased since industrialisation and it is now widely accepted that human activity has been the principal reason. Although much of the increase has been due to emission of CO_2 from burning of fossil fuels, a significant proportion has come from the clearance of forests especially in the tropics. CO_2 is released not only from burning or rotting of felled trees but also from the disturbance and subsequent mineralisation of the forest soil. Cultivating moorland for forestry can produce CO_2 emissions greater than subsequent carbon storage in trees. Protection of the carbon store in existing forests is a principle of sustainable forest management. Increasing the terrestrial carbon store through planting new forests is also encouraged by international agreements such as the Kyoto Protocol.

The amount of carbon stored in UK woodlands planted since 1920 was modelled by the Centre for Ecology and Hydrology (CEH, 2002). The amount of carbon sequestered by woodland (and other terrestrial ecosystems) does not increase continuously. At maturity, the carbon taken up by plant growth is balanced by losses from the decay of litter. Clearly harvesting also reduces the carbon stock, but only temporarily assuming replanting occurs. Because of the age structure of UK woodlands, the net rate of carbon uptake is predicted to peak in 2005 and to decrease over the following decades.

In addition to carbon stored in the woodland it is estimated that at present around 0.6 million tonnes are transferred to ‘stores’ in forest soils and litter each year, and 0.3 million tonnes are transferred to ‘stores’ in forest products.

E. People and forests

E1. Visits to woodland

E2. Extent of open public access

E3. Public awareness

E4. Community involvement

E5. Historic environment and cultural heritage

E6. Health & safety

People and forests – Summary

This group of indicators includes recreation & access, health & safety, public awareness and community involvement in forest management. Many of the benefits of forestry for society are linked to the direct use that individuals make of the forest, and may be quantified to give valuable information. They include recreational use of woodland (E1), which is influenced by the extent of open public access to woodland (E2). Increasing the provision and uptake of recreational opportunities in woodland is an objective of the countries' forestry strategies.

Two other objectives are to increase public awareness of forestry and to raise the level of participation by communities in forest management and use. These aspects of sustainable forestry are less amenable to a quantitative approach. Public awareness of forestry (E3) is assessed by a biennial survey of Public Opinion of Forestry. Many aspects of community involvement (E4) could be assessed, but there is little quantitative information at present.

Forest management plays a role in conserving our historic environment and cultural heritage (E5). Little information is currently available for this indicator and more may be added in a future report.

An indicator for health & safety (E6) has been included because of the relatively high rate of accidents to forest workers compared with workers in other sectors.

E1. Visits to woodland

Relevance Recreation in woodland contributes to quality of life. This indicator shows the number of people who are making use of the woodland recreation opportunities that are available.

Key Points It is estimated that there are around 350 million leisure day trips from home to woodland in GB each year. 38% of adults had made a leisure day visit from home to woodland in the past year. The wider measure in the Public Opinion survey shows that 72% had visited in the last few years.

GB day visits to woodland

millions of day visits from home in year

Survey year	journey starting point			
	England	Scotland	Wales	GB
1994	273	18	12	**303**
1996	308	26	11	**346**
1998	321	22	11	**355**

Source: UK Day Visits Surveys

% of adults who had made a "day visit from home" in last year

Survey year	journey starting point			
	England	Scotland	Wales	GB
1994	37	32	32	**36**
1996	40	39	31	**37**
1998	39	34	31	**38**

Source: UK Day Visits Surveys

% of adults who had visited in last few years

Survey year	journey starting point			
	England	Scotland	Wales	GB
1995	73	59	61	**71**
1997	75	78	61	**75**
1999	68	60	63	**67**
2001	73	62	70	**72**

Source: Public Opinion of Forestry surveys

Background The reported number of day trips to woodlands increased from 300 million in 1994 to 350 million in 1998. There is no clear trend in recent years in the two alternative measures of participation. Consistent data are not available for a longer time period, but reports from local managers (e.g. in Benson & Willis, 1992) indicate that visits to woodland have increased since the 1960s.

There have been three comparable UK Day Visits Surveys (UKDVS) in 1994, 1996 and 1998 (NCSR, 1999). The UKDVS estimates the total number of leisure day visits to woodlands from home, the demographic profile of visitors, and attributes of the visits including duration, distance and the perceived woodland ownership. The next Day Visits Survey is being carried out during 2002-03.

The Public Opinion of Forestry survey (Heggie, 2001b) is carried out every two years, and includes a set of questions about visits to woodland.

Future Similar statistics could be collected in the future for Northern Ireland.

There are no statistics at present on the number of non-leisure visits or trips made by holidaymakers, although information about holiday visits is being collected in the 2002-03 Day Visits Survey.

The Visitor Monitoring Trends Index compiled by the Forestry Commission gives year on year changes in the numbers of visits to FC woodlands, but due to unreliability of some of the counts and lack of information for most small sites, this is not recommended as an accurate source. A current project aims to develop an improved methodology for estimating the number of visitors to FC woodlands, by country and type of visitor.

A more comprehensive set of indicators could include information on the demographics (including gender and ethnicity), duration of visit, means of transport, type of visitor (local, day-tripper, holiday-maker) and visitor satisfaction.

E2. Extent of open public access

Relevance Open public access provides opportunities for social enjoyment of the forest through walking; it does not imply that the area is available for other recreational activities. The indicator is related to the potential benefits, but does not indicate the possible costs of management for access, possible effects on the capital value of the land, or possible environmental effects. The public benefit from access depends on its location (proximity to communities) and provision of walking routes, as well as the total area.

Key Points Opportunities for public access to woodlands have been increasing, through the creation of community woodlands and through incentives to provide access (including management grants and the Walkers Welcome package introduced in 1994). The extent of access provision will be affected by Countryside and Rights of Way legislation and the Land Reform (Scotland) Bill.

Measures Open access beyond rights of way has been estimated to exist for 281,000 hectares of woodland in England and 114,000 in Wales (of which 153,000 and 97,000 respectively is FC woodland).
Source: Countryside Agency, 1999.

Northern Ireland has 65,000 hectares of open access woodland.
Source : Forest Service

In Scotland, there has been a tradition of mainly unrestricted access to the hills, but access near towns is poorly provided for in many areas. The main proposal in the Land Reform (Scotland) Bill is for a new public right of access for open-air recreation and passage. People would be required to exercise their rights responsibly, as guided by a new Scottish Outdoor Access Code.

Background There are a number of reasons why public access can be limited. Many woodlands are difficult to reach or pass through; woodland could be surrounded by land not belonging to the owners (e.g. arable land); concerns about damage to property; conflicts between user groups; concerns about wildlife; and loss of privacy. There may also be temporary closure, for public health reasons (e.g. foot & mouth disease), forest operations or sporting activities. Woods with open public access may not be accessible by all (e.g. those with special mobility needs).

Future Further work has been commissioned by the Forestry Commission and Woodland Trust to compile a provisional dataset of woods that are open and welcoming to the public. This provisional dataset should be available by the end of 2002.

This dataset can then be analysed alongside population data to estimate the extent of open public access in relation to where people live. A possible indicator would be the population with adequate woodland access close to their homes (e.g. within 10 km), or in some form of index (proximity index). It would also be possible to produce a map, showing the distribution of woodland compared with population distribution.

Another possible measure is the area for which recreation infrastructure exists. This could be supplemented with information about provision for cycling, horse-riding, etc.

E3. Public awareness

Relevance Sustainable development depends on people understanding how, individually and collectively, their activities impact on the environment. Education in its broadest sense – raising awareness – is being given greater prominence. Sustainable forestry requires that woodland creation and management take account of the needs of the public, so it is necessary to measure the public's awareness of forestry and their attitudes.

Key Points About two-thirds of the public are aware of forestry issues in the media. Despite the fact that the area of conifer and broadleaved trees has continued to increase in the last two decades (see A1 and A2), a large proportion of the public still perceive that the area of woodland in GB is decreasing.

People who had heard or read about British forests, woods and trees in the media in the last 12 months

% of all respondents

	Survey year			
	1995	**1997**	**1999**	**2001**
Respondents who have seen or read about British forests, woods or trees on the TV, radio or in the newspapers.	73	71	64	62

Source: Public Opinion of Forestry surveys

Public perception of the change in area of conifer and broadleaved woodland in Britain over the last 20 years

% of respondents who gave an opinion

Conifer			Survey year	Broadleaved		
Increasing	Staying the same	Decreasing		Increasing	Staying the same	Decreasing
48	8	44	**1995**	13	11	76
47	22	36	**1997**	14	26	60
41	16	39	**1999**	14	22	64
40	15	35	**2001**	13	20	67

Source: Public Opinion of Forestry surveys

Background Awareness and perception can be assessed through a combination of quantitative and qualitative techniques. However, these methods depend very much upon the questions used having clear relevance to the policy theme being addressed.

Public awareness of forestry has been assessed since 1995, through the biennial Public Opinion of Forestry survey of 2,000 households in GB (Heggie, 2001b).

Future A Public Opinion of Forestry survey is planned for 2003. The Forestry Commission is currently overhauling its surveys of public attitudes and perception to target them more effectively on sustainable forestry as it is expressed in the forestry strategies for England, Scotland and Wales.

E4. Community involvement

Relevance Sustainable forestry requires that woodland creation and management take account of the needs of local communities, and involve the communities in decision making. This can include improving public awareness and access to information, as well as increasing active participation in decision making. There is an emerging recognition that community involvement can be an end in itself, not just a means to other ends. The interpretation and approaches to community involvement and participation can vary between the four countries of the UK, depending on their strategies and priorities.

Key Points In Scotland, it is estimated that around 50 community groups are involved in managing woodland, and the area of woodland that they manage is around 22,000 hectares. Similar estimates are not available for England, Wales or Northern Ireland. Community involvement in woodland management is perceived to be growing, but there are no statistics on the trend.

Measures This indicator can include quantitative measures of:

- involvement of local people in decision making for local woodlands,
- active participation in voluntary activities related to local woodlands,
- the extent and quality of local consultation (e.g. on forest management plans).

Qualitative aspects to consider include:

- the existence of effective and accessible participatory processes that are appropriate to the type of decision being made, and standards and rules to support those processes;
- management of those processes in compliance with these standards and rules; and
- the effectiveness of these processes in meeting their overall purposes.

Estimates of the number of community groups that are involved in managing woodland, and the area of woodland that they manage, were included in the draft Scottish Forestry Strategy Indicators, and were revised in 2002 by Reforesting Scotland. There are proposals to compile similar information for England and Wales.

Background

Where forestry affects the interests of individuals and communities they should be given a voice in decision making and planning. Communities can be identified in terms either of locality or of shared interest, and are likely to change according to the scale at which particular decisions apply. The key concern is not that everyone should participate, but that everyone has the opportunity to participate and be heard when they want.

The extent of involvement and participation depend on the opportunities offered and interest in exploiting the opportunities, which in turn are affected by awareness of the opportunities and capacity to exploit them. To get a complete picture, it is necessary to monitor all of these variables, but it may be easier to count the numbers that take up whatever opportunities are offered.

Future

It may also be possible to measure the extent of individuals' involvement in community forestry through questions in a household survey like Public Opinion of Forestry, or by targeted surveys in areas where there have been community initiatives. Possible measures include:

- Percent of respondents who have spent more than X days a year doing paid or voluntary work in a woodland.
- Percent of respondents who have commented on a FE design plan or WGS proposal.
- Percent of respondents who wanted to have undertaken paid or voluntary work in woodland (within x miles of their home) and who have been unable to do so.
- Percent of respondents who feel that their views have not been taken into account in the management of (their local) woodland.

The number of local responses to WGS applications could also be monitored, but this would not distinguish how much was due to local interest and how much to the quality of the WGS applications.

Qualitative measures could include the existence of consultation processes and guidelines, demonstrating that those who want to be involved have appropriate opportunities, without requiring all to participate.

Development of this indicator should take account of the Audit Commission's indicators on Measuring Community Involvement (Audit Commission, 2002), as some of their proposed indicators for local authorities could have equivalents for community involvement in forestry.

It will also be desirable to maintain awareness of the activities of Rural Development Forestry (RDF) groups, predominantly in Scotland (see e.g. SNH, 2001). Many of them have community control or varying levels of community involvement.

E5. Historic environment and cultural heritage

Relevance Sustainable forestry must take account of the cultural heritage of woodlands. Important heritage features should be protected and due account taken of cultural, historic or desirable landscapes. In part, this can be measured by monitoring of Scheduled Ancient Monuments (SAMs) in woodland, many of which relate to earlier land-uses. Conservation of other archaeological sites and features associated with the history of woodland management may be equally, or more important.

Key Points There are many SAMs in woodland, some of which have agreed management plans. There are a number of designations that aid the recognition of elements in the historic environment, but of these SAM is the only one with UK coverage. The number of SAMs with agreed management plans is increasing through a number of initiatives.

Measures There is little monitoring information for SAMs or other ancient monuments. Available information on the number of sites is shown below, to indicate the extent of monitoring that would be required. Monitoring changes in the number of sites would also give some indication of the effectiveness of agencies and managers in identifying ancient monuments that were previously not identified, a possible precursor to their conservation.

There are reported to be around 1000 SAMs on FC/FS land (559 in England, 348 in Scotland, 101 in Wales and 46 in Northern Ireland). The total number of SAMs in all woodland (FC/FS and non-FC/FS) are reported to be 2682 in England, 1418 in Scotland and 999 in Wales (within 50 metres of woodland), with no total yet available for Northern Ireland.

There are no estimates of the total number of ancient monuments in woodland in GB (including those which are not scheduled). For Northern Ireland, the reported total is 385 ancient monuments (source: Environment & Heritage Service), of which 339 are on the Forest Service estate (source FS).

Background

The landscape of the UK is a record of thousands of years of human activity. Insensitive woodland management or poorly located new planting can adversely affect the historic environment and associated features and the understanding and appreciation of future generations.

The conservation of SAMs in woodland can be measured by noting agreements between individual owners and the relevant heritage agency. Some of the heritage agencies (e.g. Historic Scotland) are currently developing heritage indicators. In addition many SAMs lie in woodland covered by WGS agreements which will address issues where woodland management is an issue.

Future

Other data relevant to this topic:

- New woodland creation on land with important relict land uses.
- Number of monuments with management plans.
- Of those SAMs with agreed management plans specifying action, proportion where that action has been undertaken. This will involve close co-operation with the relevant national heritage agencies.
- Other cultural and heritage sites in woodland (or woodland itself as a cultural or heritage site) – these may also be visitor attractions.
- Recovery of lost sites when woodland felled/restructured.
- Areas of forest operations for which archaeological survey took place (area in ha, and as % of forest operations), sites identified, % with positive management put in place.

E6. Health & safety

Relevance There is concern about the high rate of accidents among forestry workers relative to other industries. Safe working practices should be promoted as part of sustainable forestry.

Key Points The main statistics on work accidents are reports to the Health & Safety Executive (HSE), which should cover all accidents resulting in at least 3 days absence from work. However comparisons with the responses to the Labour Force Survey suggest that less than a half of all reportable accidents (less than a third in agriculture and forestry) are actually reported (see HSE, 2001).

Each year in the late 1990s, about 160 accidents to workers in forestry and related services were reported to the HSE, of which about 50 were classified as major accidents. The reported rate for all forestry accidents is about double the rate for all employees, and for major accidents is more than three times the rate for all employees.

Accidents reported to Health & Safety Executive
Annual averages for 4 years 96/97 to 99/00

	Major accidents	**Total reported accidents**
Forestry & related services (SIC 0201 & 0202)		
▪ Number of reported accidents	50	**162**
▪ Rate/1000 employees	4.5	**14.7**
All sectors		
▪ Rate/1000 employees	1.2	**7.0**

Sources: HSE, 2001 and HSE tables provided for MCPFE
Note: Rate/1000 for forestry uses an estimate of 11,000 for forestry employment (based on the Annual Business Inquiry), so may differ from other compilations.

Background It is difficult to obtain accident statistics that cover all work in woodlands, because of under-reporting and the difficulty of identifying all forestry activity in the Standard Industrial Classification (e.g. accidents during work on farm woodlands could be recorded in agriculture).

Accident statistics are also available for FC employees, showing a similar rate of around 15 reported accidents per thousand employees. They may not be directly comparable with the HSE statistics for forestry, because they may be increased by better reporting, but decreased by including office employees working in the government department of forestry (for whom accident rates are not a similar concern). Systems for recording FC accident statistics are likely to change so future figures are not likely to be comparable. FC also collects statistics for accidents involving members of the public, but these will not cover all accidents, as they rely on members of the public reporting the accidents. Equivalent statistics are available for the Forest Service in Northern Ireland.

A Safety Survey was carried out for the former Forestry and Arboriculture Safety and Training Council, on two occasions during the 1990s. Based on interviews with forestry workers, this survey reported on awareness of safety issues and implementation of safe working practices.

Future It would be desirable to compare the results for forestry with those for other primary industries (agriculture, fishing). The published Health & Safety Statistics (HSE, 2001) show that for the period 1998/9 to 2000/1 the major accident rate for the whole agricultural sector (including hunting, fishing and forestry) was 2.1 per 1000 employees, about half the rate for forestry. However, published figures are not readily available for total reported accidents or for the matching time period.

It would also be desirable to look at accident rates for the manufacturing of wood and wood products. These will be compiled for the pan-European Indicators of Sustainable Forest Management, using the same sources as used for this indicator.

F. Economic aspects

F1. Financial return from forestry

F2. Value added in forestry

F3. Value added in wood processing

F4. Employment

F5. Social and environmental benefits

Economic aspects – Summary

The economic contribution that forests make to our quality of life can be looked at from the point of view of the forest owner, the forest sector (forestry and wood processing), or the whole economy and society. This set of economic indicators measures economic aspects of forestry at a national (UK) level.

Much more extensive data collection would be required for a comprehensive set of local and regional indicators. Such indicators could demonstrate the contribution of forestry to rural development, including local and regional economic impacts, as well as the development of social capital arising from the sharing of information, skills and resources through community and business networks.

The most tightly focused measure is woodland owners' financial returns from commercial forestry (F1). This can be broadened to the forestry sector in the National Accounts (F2), where wages and salaries in forestry are part of Gross Value Added; similar information is available for wood processing (F3). In addition to financial measures, economic assessments normally look at employment numbers (F4).

Most social and environmental benefits of forestry are not marketed, so are excluded from the financial measures in F1 - F3. There has been progress in measuring and valuing some of these benefits (F5) but it is still difficult to assign accurate values to them that would inform us about trends in the economic contribution of forestry over time.

F1. Financial return from forestry

Relevance To attract long-term investment in forestry, it is necessary for forest owners to receive returns competitive with other investments, or to receive non-financial returns (e.g. enjoyment from living, recreation or countryside pursuits in woodland).

Key Points For comparison with other asset classes, the financial returns from forestry are expressed as an annual equivalent rate over a 3-year period. For forest owners of commercial Sitka spruce plantations, the nominal three-year annualised return has declined from a positive return of almost +10% in 1993-1996 to a negative return below –5% in 1998-2001, mainly because nominal timber prices have fallen by more than 50% since the mid-1990s.

3-year rolling annualised returns from forestry in GB
(Nominal three year annualised return for private sector Sitka spruce plantations)

3-year period	Total return (% pa)
1992 to1995	4.4%
1993 to1996	9.9%
1994 to1997	7.9%
1995 to1998	4.5%
1996 to1999	-3.0%
1997 to 2000	-5.2%
1998 to 2001	-5.4%

Source: IPD, 2002

Background

Returns to the forest owner are made up of sales of timber (standing or felled), sales of other goods and services, increases in the value of the woodland (from annual increment or market factors), and the net income from subsidies (e.g. planting grants) less taxes. The owner's costs are made up of employment costs and other purchases. Official survey information is not yet available to monitor this for a representative sample of all woodlands.

Estimates of the overall return from commercial Sitka spruce plantations are produced annually in the Investment Property Databank (IPD) UK Forestry Index, which is calculated from a sample of private sector plantations in mainland Britain (see IPD website). Sitka spruce makes up about half of the total area of conifers, and is chosen because it can be planted on a wide range of soils and produce a large yield of timber suitable for UK wood processing industries.

This indicator may not provide a good guide to the financial return from other forests and species. Returns over a relatively short period like 3 years may attract new investors to forestry, but existing private owners are likely to look at a much longer cycle and be aware of the value of woodland for personal wealth retention and its taxation benefits. The indicator only gives the financial returns for Sitka spruce plantations; similar estimates are not compiled for other species.

Future

To measure the financial return from forestry, the pan-European indicators propose to include a measure of the net revenue of all forestry enterprises in SIC 02 (see indicator F2), which would be calculated from income and expenditure in a year (including subsidies less taxes), rather than the return on an asset. The pan-European indicators also propose indicators of the marketed values of roundwood, non-wood goods and services. Reliable UK data are not currently available for these proposed pan-European indicators.

In addition to measuring financial return, it is possible to assess the financial health of forestry businesses by a questionnaire survey. An initial survey was carried out in 1999, but suffered from poor response rates. Plans are now being drawn up for a further survey in 2003.

F2. Value added in forestry

Relevance From the national viewpoint, an increasing value added from forestry contributes to economic growth (Gross Domestic Product or now Gross Value Added). In the National Accounts, forestry is covered by Division 02 of the Standard Industrial Classification (SIC92).

Key Points Forestry's contribution to the national economy (gross value added at basic prices) in 2000 was just under £300 million, equivalent to 0.04% of the UK economy. Forestry's contribution to gross valued added at current prices did not increase during the 1990s, as increases in wood harvesting were offset by falling timber prices, so forestry took a falling share of the UK economy.

Gross value added (GVA) at basic prices for SIC 02 (forestry, logging and related services)

Year	SIC 02 GVA (£ million)	% of UK total GVA
1992	289	0.05%
1993	308	0.05%
1994	346	0.06%
1995	344	0.05%
1996	333	0.05%
1997	307	0.04%
1998	283	0.04%
1999	276	0.03%
2000	298	0.04%

Source : Office for National Statistics (ONS), UK input-output analyses for National Accounts data (see National Statistics website)

Note: Initial results for 2000 from the Annual Business Inquiry indicate a slightly lower level of £270 million GVA for SIC 02 (source ONS).

Background

In the UK National Accounts, the forestry sector is called 'forestry, logging and related services' and classified as Division 02 in the Standard Industrial Classification (SIC92). Earnings from employment are counted as part of the value added by forestry, rather than a cost to owners (which they were in F1). In measuring the net economic contribution of forestry to the economy, it is desirable to subtract subsidies (grants) and add taxes, to get the value added at 'basic prices'. Values are in current prices (i.e. actual prices for each year), because figures at constant prices are not calculated by the Office for National Statistics for individual sectors.

At present, UK National Accounts data for forestry are based on estimates. The Annual Business Inquiry, which is used by the Office for National Statistics to collect data for most sectors, was extended in 2001 to collect data from the forestry sector, with the first data being for 2000. Initial results for 2000 are reasonably close to the previous estimates (slightly lower), and the Annual Business Inquiry should provide a better basis for future monitoring.

Future

Scottish figures for 1998 are in the Scottish Forestry Strategy indicators, but similar figures are not yet available for England, Wales or Northern Ireland.

The statistics in this indicator only measure part of forestry's contribution to the economy. Forestry may also lead to value being added in wood processing industries that are established because of the available timber (see indicator F3), value added in suppliers to forestry or through spending forestry income (multiplier effects), and value added through spending by tourists and other forest visitors. Multiplier effects and tourism impacts have been the subject of recent and ongoing research (see FC website). Forestry also produces social and environmental benefits that are not marketed (see indicator F5).

F3. Value added in wood processing

Relevance This measures the contribution of forest products to economic growth. It is not wholly related to the outputs of UK forests, because the processing includes use of imported and recycled material, but the increasing availability of UK timber has resulted in substantial new investments in this sector. The importance of wood processing to local economies is beyond the scope of this national set of indicators.

Key Points In 2000, primary wood processing (of wood products and pulp & paper) generated £1.7 billion gross value added (GVA), representing 0.2% of the UK economy. The manufacture of other products made from wood (e.g. joinery) and from paper and paperboard generated a further £4.7 billion GVA, bringing the total to 0.6% of the UK economy. This covers all wood and paper processing in the UK, not just the processing of UK timber. In recent years growth in wood and paper processing has not been as rapid as in the total UK economy.

Gross value added (GVA) at basic prices

Manufacture of wood and wood products (SIC 20)

	GVA £ million (current prices)				As % of UK total GVA	
Year	Primary SIC 20.1	Primary SIC 20.2	Other SIC 20	Total SIC 20	Primary 20.1 + 20.2	Total SIC 20
1995	310	317	1,351	1,978	0.10%	0.31%
1996	277	274	1,379	1,930	0.08%	0.28%
1997	318	350	1,550	2,218	0.09%	0.31%
1998	341	311	1,618	2,270	0.09%	0.30%
1999	399	291	1,411	2,101	0.09%	0.26%
2000	398	246	1,660	2,304	0.08%	0.27%

SIC 20.1 = Sawmilling and planing of wood, impregnation of wood
SIC 20.2 = Manufacture of veneer sheets, manufacture of plywood, laminboard, particle board, fibre board and other panels and boards
Other SIC 20 = manufacture of builders' carpentry and joinery, wooden containers, and other products of wood, straw and plaiting materials

Manufacture of pulp, paper and paper products (SIC 21)

	GVA £ million (current prices)			As % of UK total GVA	
Year	Primary SIC 21.1	SIC 21.2	Total SIC 21	Primary 21.1	Total SIC 21
1995	1,420	3,222	4,642	0.22%	0.50%
1996	1,215	3,189	4,384	0.18%	0.47%
1997	1,201	3,038	4,239	0.17%	0.42%
1998	1,177	2,837	4,014	0.15%	0.37%
1999	1,257	2,730	3,987	0.16%	0.34%
2000	1,014	3,061	4,075	0.12%	0.37%

SIC 21.1 = Manufacture of pulp, paper and paperboard
SIC 21.2 = Manufacture of articles of paper and paperboard
Source (both tables): Office for National Statistics (ONS) Annual Business Inquiry (see National Statistics website).

Background These statistics for gross value added in wood processing are taken from the Annual Business Inquiry; similar statistics are available from the input-output tables that are the basis for UK National Accounts. Values are in current prices (i.e. actual prices for each year), because figures at constant prices are not calculated by the Office for National Statistics for individual sectors. At present these data are not available broken down by country or region, although a separate set of input-output tables and accounts exists for Scotland.

The pan-European indicators intend to use a wide definition of the wood processing sector that includes all wood and wood products (SIC 20), pulp, paper and paperboard (SIC 21.1) and the manufacture of products of paper and paperboard (SIC 21.2). However estimates for the processing sector in the UK (e.g. employment in indicator F4) are often limited to primary wood processing, which only consists of SIC 20.1, 20.2 and 21.1. This indicator presents figures for primary processing and also for the wider definition.

Future Scottish figures for 1998 are in the Scottish Forestry Strategy indicators, but similar figures are not yet available for England, Wales or Northern Ireland.

Estimates of the value added through primary processing of UK timber (in England, Scotland and Wales) should be available from the UK forestry multiplier study, due to be published in 2002-03, and these will supplement this indicator.

F4. Employment

Relevance Employment provided by forestry contributes to sustaining rural economies. Although the total employment provided directly by forestry and wood processing is relatively small, it can be of great importance in some localities.

Key Points Total employment in forestry and the primary wood processing industries in 1998-9 was around 30,000 full-time equivalents. Employment in forestry decreased during the 1990s, mainly because of productivity improvements in harvesting. In forestry, almost all direct employees and more than half of contract workers live within 20 miles of their place of work.

Employment in forestry and primary wood processing in GB, by activity 1998/9

full-time equivalents

	England	Scotland	Wales	Great Britain
Forest nurseries	421	201	2	624
Establishment	1,088	1,189	252	2,529
Maintenance	1,680	1,304	380	3,364
Harvesting	2,330	1,947	493	4,770
Road construction	181	179	47	407
Other forest	466	372	144	982
Total forest	**6,166**	**5,192**	**1,318**	**12,676**
Haulage	326	593	142	1,061
Processing	5,952	3,083	2,192	11,227
Other non-forest	2,295	1,826	447	4,568
Total non-forest	**8,573**	**5,502**	**2,781**	**16,856**
Total	**14,739**	**10,694**	**4,099**	**29,532**

Source: Forest Employment Survey 1998/9 (Heggie, 2001a)

Percentage of forestry workers travelling less than 20 miles to their place of employment in GB

% workers

	England	Scotland	Wales	Great Britain
Direct workers	97	98	80	96
Contract workers	56	54	55	55
Total	**72**	**68**	**68**	**71**

Source: Forest Employment Survey 1998/9

Background

The scope of the 1998/9 Forest Employment Survey was wider than previous years, to encompass local authorities, research organisations, woodland associations and other woodland initiatives, mostly shown in the other non-forest category. The 1998/9 survey aimed to include small scale activity, such as coppice working, but the lack of a complete sampling frame made it difficult to achieve complete coverage.

There have been three Forest Employment surveys that give the breakdown of employment by activity (1998/9, 1993/4 and 1988/9). Each survey used a different sampling frame and the results are not fully comparable.

Forestry can also generate employment outside the sector, through purchases of supplies (indirect multiplier), spending of forestry incomes (induced multiplier) and encouraging recreation and tourism (positive externalities), but these are outside the scope of this indicator.

Future

At present comprehensive information is not compiled on the demographic attributes of the forest workforce, how long staff have been in the industry, the level of education, training and skills of the workforce, or other aspects of the quality of employment associated with forestry.

It would be desirable to identify how much of the forestry employment is in rural areas, and to break down between commercial conifer plantations and other woodlands, but these breakdowns are not currently available from the Forest Employment Survey.

At present, little regional information is available, although some regional estimates from the 1998/9 survey are available on the FC website.

F5. Social and environmental benefits

Relevance Social and environmental benefits of forestry include recreation, biodiversity, landscape, carbon sequestration and pollution absorption. These non-market benefits are important outputs from forestry activity, and this importance is recognised in the objectives of sustainable forest management. These benefits can be available from all types of forests, to varying extents. They are mostly not captured in market processes but their values can be estimated using economic methods. These estimated values indicate people's preferences, and can be used to inform policies for both public and private forests and woodlands. Adding the value of these benefits to revenues from timber and other forest-related products and services demonstrates the total economic value of forestry.

Key Points The values of social and environmental benefits are not estimated on a regular basis so there is no firm information available on trends over time. Previous studies have estimated the values of various benefits but, since a range of methodologies have been used and are undergoing further development and improvement, any comparisons have to be treated with caution. A recreation value of over £1 per visit has been accepted as a basis for supporting forestry by public expenditure.

Measures The Forestry Commission has commissioned a study to estimate the values of social and environmental benefits of forestry across Britain, but final results from this source will not be available until 2003. The study is examining the following forestry-related benefits:

- Biodiversity – forests support a wide variety of habitats and species;
- Landscape – forests contribute to landscape quality in rural and urban areas;
- Recreation – forests provide sites for a range of recreational activities;
- Carbon sequestration – photosynthesis associated with tree growth absorbs carbon dioxide (one of six key greenhouse gases) from the atmosphere.

The study also examines benefits (and costs) relating to water quantity and quality (see also indicators C3 and C5), air pollution absorption and archaeology, although further investigation may be needed to develop a fuller understanding of these issues.

Background

Social and environmental benefits can be categorised into different types of value. They may be valued for their actual use by consumers, for example recreational visits. They may also be valued for their mere existence and/or option to be used in future, for example biodiversity and landscapes which many people may value even though they do not currently experience them first-hand. Thus, these forest-related benefits are said to comprise both use and non-use values. A variety of economic methods have been used to estimate these values and are the subject of ongoing critical debate.

These economic values do not present a complete picture, as they do not take account of the distribution of benefits – there may be a higher social value in providing benefits in areas of high deprivation.

The provision of social and environmental benefits from forestry is dependent on the nature of forest management regimes. Inappropriate forest design and management can generate costs rather than benefits.

Future

Given the current status of scientific knowledge and economic methodologies to assign values to social and environmental benefits, it may be preferable to use a mixture of quantitative and qualitative evaluations of these benefits.

It would be desirable to extend future investigation to include forestry's contribution to benefit people's physical and mental health. Information relevant to forestry can also be obtained from wider studies valuing biodiversity or the environment.

In addition to the benefits and costs described above, forestry may generate externalities affecting other activities. These may be positive (e.g. supporting tourism) or in some cases negative (e.g. timber traffic affecting roads and other road users). There is limited information on the extent of such externalities, although current research commissioned by the Forestry Commission is examining the role of forestry in supporting tourism across GB.

A full cost-benefit analysis of forestry (including social and environmental benefits) or an assessment of the exchequer costs compared with the benefits would be beyond the scope of this set of indicators (and beyond what can be achieved with current information).

Acronyms

ANC	Acid Neutralising Capacity
ASNW	Ancient Semi-Natural Woodland
BAP	Biodiversity Action Plan (see also HAP and SAP)
CO_2	Carbon Dioxide
CS2000	Countryside Survey 2000
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EHS	Environment and Heritage Service (Northern Ireland)
FC	Forestry Commission
FCS	Forest Condition Survey
FE	Forest Enterprise
FR	Forest Research
FRA	Forest Resources Assessment
FS	Forest Service (Northern Ireland)
FSC	Forest Stewardship Council
GIS	Geographic Information System
GVA	Gross Value Added
HAP	Habitat Action Plan (part of the BAP process)
HSE	Health and Safety Executive
IPD	Investment Property Databank
MCPFE	Ministerial Conference on the Protection of Forests in Europe
NIWT	National Inventory of Woodland and Trees
NGO	Non-Governmental Organisation
ONS	Office for National Statistics
PAWS	Plantation on an Ancient Woodland Site
SAM	Scheduled Ancient Monument
SAP	Species Action Plan (part of the BAP process)
SEPA	Scottish Environment Protection Agency
SSSI	Site of Special Scientific Interest
TBFRA	Temperate and Boreal Forest Resources Assessment
UKDVS	UK Day Visits Survey
UKWAS	UK Woodland Assurance Standard
UN	United Nations
WGS	Woodland Grant Scheme
WRME	Wood Raw Material Equivalent
WWF	World Wide Fund for Nature

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Forest Service (Northern Ireland)	http://www.forestserviceni.gov.uk
Forest Stewardship Council	http://www.fscoax.org
Forestry Commission	http://www.forestry.gov.uk
▪ **Sustainable Forestry Indicators**	http://www.forestry.gov.uk/sfindicators
▪ **Economics and Statistics**	http://www.forestry.gov.uk/statistics
ICP Forests	http://www.icp-forests.org
Investment Property Databank Limited	http://www.ipdindex.co.uk
MCPFE	http://www.mcpfe.org
National Statistics	http://www.statistics.gov.uk
Royal Society for the Protection of Birds	http://www.rspb.org.uk
Scottish Environment Protection Agency	http://www.sepa.org.uk
UK Biodiversity Action Plan	http://www.ukbap.org.uk
UK sustainable development	http://www.sustainable-development.gov.uk