Forestry Commission Scotland
Coimisean na Coilltearachd Alba

Scotland's Native Woodlands

Results from the Native Woodland Survey of Scotland

natural scotland
SCOTTISH GOVERNMENT

Right: Birch woodland in spring.
Craigellachie, Cairngorms National Park.
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Acknowledgements

This report was written by Gordon Patterson, Derek Nelson, Patrick Robertson and John Tullis.

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We would also like to acknowledge the contributions from a wide range of other individuals and organisations who helped us to plan and deliver the project including;

- the field surveyors and survey team managers from Forest Research, RPS Group Plc and Haycock & Jay Associates, who were out surveying in all seasons and all weather conditions;
- the very many land owners and managers who co-operated so helpfully with the surveyors on the ground;
- Tim Clifford, Neil MacKenzie, John Rodwell and Ben Averis, amongst others, who helped to develop the methodology and train surveyors;
- members of the Native Woodlands Partnership for Scotland (and later the Woodland Ecosystem Group) who helped steer the project especially in the method development phase;
- and all the staff from the Forestry Commission who were involved.

While o'er their heads the hazels hing
The little birdies bythely sing,
Or lightly flit on wanton wing
In the birks of Aberfeldie.

From The Birks of Aberfeldie
Robert Burns 1759-96

Foreword

Native woodlands were the dominant natural ecosystems in post-glacial Scotland, but they were gradually fragmented and lost, partly through climatic changes but mainly as a result of human action or neglect.

The last three decades have seen a remarkable turn around in the fortunes of Scotland's native woodlands as more and more people have realised how precious they are for biodiversity and the many other benefits they provide.

A wide-ranging effort to protect, restore, improve and expand native woods has gathered momentum since the late 1980s.

Until now this work has not had the benefit of a national picture of the extent and condition of native woods to base it on. Dr. Bob McIntosh, Director of Environment and Forestry, Scottish Government, realised the value of a firm evidence base and he initiated the Native Woodland Survey of Scotland to fill the gap.

Forestry Commission Scotland has worked with Scottish Natural Heritage and a range of other stakeholders to develop the survey. It has proved to be a major effort spanning 7 years, which involved highly trained field surveyors visiting 848,000 hectares of woodlands of which over 40% were surveyed in detail.

The project has produced a wealth of information which is a freely available resource for everyone on the Forestry Commission Scotland and Scotland's Environment websites.

The value of the data has already been seen, for example in the 2012 rapid survey for ash dieback disease (caused by the fungus *Chalara fraxinea*), when the survey data enabled a very quick identification of sites with ash trees for surveyors to inspect.

I very much welcome this national summary report of results from the survey, and I am sure that it will help to make people throughout Scotland aware of the challenges facing our native woods and the many potential ways that the survey data can be used to help to meet them.

Hamish Macleod
Chair of the National Committee,
Forestry Commission Scotland

Left: Sessile oak tree, Sunart oakwoods. Ardnamurchan, Highland.
© Fergus Gill/2020VISION

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For additional information see the
NWSS webpages: www.forestry.gov.uk/nwss

Summary

Native woodlands covered most of Scotland in the post-glacial period. However they have been depleted over thousands of years by the changing climate and unsustainable human use.

Much has been done over the last 25 years or more to protect, restore and expand our remaining native woods, but until now there has not been a reliable national inventory to help plan further action. The Native Woodland Survey of Scotland (NWSS) was carried out from 2006-2013 in order to establish an authoritative picture of Scotland's native woodlands. It used field survey to identify the location, type, extent, composition and condition of all native and nearly native woods, as well as woods planted on ancient woodland sites (PAWS), of at least 0.5 ha in area. The survey has established a national baseline to monitor future changes in area and condition.

This report give a national overview of results and suggests many other intended and potential uses for the data at various spatial scales. Forestry Commission Scotland aims to work in partnership with others to realise this potential.

The area of native woodland in Scotland surveyed by NWSS was 311,153 ha, which is 22.5% of the total woodland area (as at March 2011) or 4.0% of the land area of Scotland. This figure falls between various previous estimates.

Comparison with the existing provisional ancient woodland inventory suggests that significant losses of ancient woodland cover may have occurred over a 40 year period in unenclosed upland areas, but very small amounts of loss have occurred to development or other land uses. However, more work is needed to confirm the precise extent and causes of ancient woodland losses.

Native woodland condition is moderate overall with 46% of the total area in satisfactory condition for biodiversity. Most of the remainder needs only a single key threat to be addressed to achieve satisfactory health. The most widespread threat is from herbivore impacts, mainly through browsing and grazing. Invasive species, like *Rhododendron ponticum,* and non-native tree species are locally important threats to native woodland ecosystems, with climate change and new pests and diseases presenting additional challenges.

The report concludes that although a lot has recently been done to plant and restore native woodlands, the current amount and distribution of regeneration is not yet enough to sustain all of our current native woodland resource in the long term.

Encouraging aspects include the strongly semi-natural characteristics and the high average proportion of native tree species cover in all canopy layers, both of which should help native woodland ecosystems to be resilient provided more diverse, widespread and abundant regeneration can be secured.

The NWSS has established a firm baseline for monitoring change and repeat survey could be considered after 10-15 years, perhaps using partial sampling.

Geàrr-chunntas

Anns na linntean às dèidh Linn na Deighe, bha a' chuid as motha de dh'Alba ga còmhdachadh le coilltean dùthchasach. Chrìon iad, ge-tà, thar nam mìltean de bhliadhnachan tro dhaoine a bhith gan cleachdadh ann an dòighean neo-sheasmhach, agus ri linn atharraichean sa ghnàth-shìde

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Thathas air mòran a dhèanamh thairis air na 25 bliadhnachan mu dheireadh a' dìon, a' leasachadh agus ag ath-leasachadh nan coilltean dùthchasach a tha air fhàgail. Rinneadh Sgrùdadh air Fearann-coillteach Dùthchasach na h-Alba (NWSS) eadar 2006 is 2013 gus eòlas ceart a bhith againn air fìor staid choilltean na h-Alba. Rinneadh sgrùdadh a-muigh sna coilltean fhèin a' dearbhadh làraichean, ghnèithean, meud, staid agus an seòrsa chraobhan a lorgas sna coilltean dùthchasach - no an ìre mhath dùthchasach - air na seann làraichean choilltean (PAWS) san robh co-dhiù 0.5 ha de mheud. Thug an sgrùdadh seo dhuinn tuigse is eòlas air staid nan coilltean a chum mothachadh agus measadh a dhèanamh air na h-atharraichean a thig orra san àm ri teachd.

Tha an aithisg a' toirt dhuinn sealladh nàiseanta air toraidhean an sgrùdaidh; le molaidhean a thaobh nan diofar dhòighean - aig diofar ìrean - sam b' urrainn an dàta seo ga chur gu feum. Tha FCS ag amais air obair ann an com-pàirt le buidhnean eile gus na molaidhean a thoirt gu buil.

B' e meud fearainn-choilltich ann an Alba, a rèir sgrùdaidh NWSS 311,153 ha; 22.5% de dh'fhearann-coillteach na dùthcha gu lèir (aig Màrt 2011) no 4% de dh'Alba. Tha am figear seo eadar na diofar thuairmsean a rinneadh roimhe.

A' dèanamh coimeas eadar toraidhean an sgrùdaidh seo agus na cunntasan a th' againn air coilltean aosmhor Alba ('Ancient Woodland Inventory') tha e a' tighinn am follais gu bheileas air mòran a chall thairis air an dà fhichead bliadhna a dh'aom am measg nan coilltean air talamh àrd, ach chan eileas ach air glè bheag a chall ri linn leasachaidh no chleachdaidhean fearainn eile. Feumas tuilleadh obrach a dhèanamh mas bi dearbhadh againn air na thathas air a chall agus carson.

Tha coilltean dùthchasach Alba gam meas ann an staid mheadhanach math le 46% den fhearann-choillteach ann an staid reusanta math a thaobh bith-iomadachd. Chan fheum sa chòir dhiubh, ge-tà, ach dèiligeadh ri aon dùbhlan mòr ach an toirear gu staid reusanta math iad. Is i a' bhagairt as motha ach beathaichean a bhios ag ithe is ag ionaltradh air lusan. Tha lusan air thighinn a-steach, leithid Rhododendron ponticum, agus craobhan neo-dhùthchasach nan cunnartan ro eag-shiostaman ann an cuid de choilltean; le bagairtean a bharrachd an lùib atharraichean sa ghnàth-shìde, phlàighean is ghalaran ùra.

Ged a tha mòran ga dhèanamh a chum coilltean dùthchasach a chur às ùr agus an toirt air ais, tha an aithisg a' ruigsinn a' cho-dhùnaidh nach eileas a' dèanamh gu leòr fhathast gus na coilltean a chur ann an staid a bhios dha-rìribh seasmhach thairis air an fhad-ùine.

Tro a bhith a' leasachadh nithean leithid feartan leth-nàdarra agus chraobhan dùthchasach am measg cheann-bhrat choilltean aig gach ìre, bu chòir dha seo cuideachadh a thoirt dha eag-shiostaman choilltean a chum a bhith nas treasa agus nas seasmhaiche; le ath-bheothachadh a' tachairt a tha nas sgapte, eadar-mheasgaichte agus nas motha.

Tha an NWSS air dearbhadh staid nan coilltean againn, rud a bhios na bhun-stèidh dhuinne agus sinn a' measadh atharraichean san àm ri teachd, agus 's dòcha gum b' fhiach e coimhead ri sgrùdadh eile an ceann 10-15 bliadhna co-dhiù am measg phàirtean de na coilltean.

1: Silver birch bark.
Abernethy Forest, Cairngorms National Park.
© Mark Hamblin/2020VISION

2: A carpet of wood anemone
(Anemone nemorosa) flowers in May.
© Mark Hamblin/2020VISION

3: Walking in the forest.
Abernethy, Cairngorms National Park.
© Mark Hamblin/2020VISION

1

2

3

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1: Golden eagle foraging in a native pinewood.
© Peter Cairns/naturepl.com

2: Small pearl-bordered fritillary butterfly.
© Gary Servant

3: Mosses on the woodland floor. Barnluasgan, Argyll and Bute.
© Lorne Gill/SNH/2020VISION

4: Red squirrel on Scots pine.
© Peter Cairns/2020VISION

Introduction

Native woodlands have played an important part in Scottish culture, having been used for wood, shelter, hunting and forage throughout our history.

They are particularly important for biodiversity and host a high proportion of our rare and threatened species, perhaps more than any other habitat type of comparable area. Native woods are now recognised for their importance as part of our 'natural capital' (Scottish Government, 2013). They can supply a wide range of benefits, or ecosystem services, to society in addition to their wildlife value, including:

- timber, shelter for livestock and non-timber forest products such as mosses, berries and mushrooms;
- improved water and air quality, carbon sequestration, reduced soil erosion and better flood control;
- enhancing opportunities for recreation and tourism as well as improving physical and mental wellbeing.

Native woodlands have developed and adapted to our changing environment over thousands of years since the last glaciation and have also been heavily influenced in extent, distribution and composition by human activities. Until 5,000 years ago as much as 80% of Scotland was wooded. Then people and a changing climate caused progressive deforestation to a low point of around 4% woodland cover by the 18th century, when significant woodland planting by landowners began (Forestry Commission Scotland, 2008). Native woods today include both self-sown woods and also areas that have been planted with native species at some time. Some native woods are on ancient woodland sites whilst others are of more recent origin.

All types of native woodland are recognised as priority habitats for conservation action in Scottish Government policies and strategies for forestry and biodiversity. Much has been done in the last 25 years or more to protect and enhance them (Forestry Commission Scotland, 2006). However, they remain in a vulnerable state, being subject to pressures such as fragmentation, deer browsing, non-native tree planting and the spread of invasive non-native plants and animals, as well as underlying threats from plant pests and diseases, climate change and atmospheric deposition of pollutants.

Box 1: Native tree and shrub species and native woodland types

Native tree species are those which arrived naturally in Scotland without direct human assistance as far as we can tell. Most of our native tree and shrub species colonised Scotland after the end of the last Ice Age with seeds dispersed by wind, water, and animals. Native tree and shrub species recorded in the survey are listed in Annex 1.

Our surviving native woods have been classified into 6 main habitat types (Forestry Commission, 1994a; Biodiversity Research and Information Group, 2008) which are recognised as UK priorities for conservation*.

Upland birchwoods: Birch-dominated woods on acid upland soils with rowan, hazel, oak, alder, bird cherry, aspen and juniper amongst the associated species. Downy birch is more common in the north and west and on wetter and more exposed sites. Silver birch is more suited to east and central Scotland and to more fertile sites.

Native pinewoods: Mostly Scots pine with pockets of birch, rowan and juniper along with alder and willows in wet areas. Native pinewoods were originally much more widespread in the post-glacial period but they retreated to their current native range in the Highlands by about 4,000 years ago. The planted Scots pine woods in this area are also included as part of this type.

Wet woodland: Alder, willows and birches are the characteristic dominant trees. Found in a wide range of situations, including small woods along river valleys, fringes of bogs and mires and transitions between open water and drier ground. Some wet woods can be transient, but others, such as many slope alder woods, are more persistent.

Lowland mixed deciduous woodland: In lowland regions and penetrating into some straths and coastal areas on upland margins. They occupy a wide range of fertile, moist soils and support a rich flora. Oak, ash, birch, hazel, elm and a range of other native trees and shrubs are common. Introduced species such as beech and sycamore have become widespread.

Upland oakwoods: On free-draining acid upland soils, dominated by oak or birch/oak mixtures, with some rowan and alder and, on richer sites, ash, hazel, hawthorn, blackthorn and bird cherry. In the oceanic western Highlands, oakwoods are part of our Atlantic woodlands which are very important for lower plants, and are sometimes known as 'Scotland's temperate rainforest'. Many upland oakwoods were managed as oak plantations for iron-ore smelting or tan-bark manufacture in the past.

Upland mixed ashwoods: Diverse species-rich woods with ash, alder, hazel, downy birch and oak. Found on moist base-rich soils on lower valley slopes, ravines, river gulleys and on limestone outcrops. Often in mosaics with upland birchwoods or upland oakwoods and merging into lowland mixed deciduous woodland at the lowland margins. This type includes western hazel scrub woods which are now recognised as a distinct type of high biodiversity value, called Atlantic hazelwoods.

* Some subdivisions of these native woodland types are also recognised as priority habitats under the European Union Habitats and Species Directive: see the NWSS webpages at www.forestry.gov.uk/nwss.

Although there have been various surveys undertaken since the 1970s, there has never been a comprehensive national picture of our native woodlands until now. Previous survey work has often focused on specific regions or types of woodland, or relied on maps or photographs without field survey.

The periodic woodland censuses carried out by the Forestry Commission have not mapped native woodland areas as such, although the National Forest Inventory (NFI) (Forestry Commission, 2013a) and its predecessor the National Inventory of Woodlands and Trees (NIWT) (Forestry Commission, 2001) allow statistical estimates to be made.

1. Upland birchwoods
© Mark Hamblin/2020VISION

2. Native pinewoods
© Mark Hamblin/2020VISION

3. Wet woodland
© Gordon Haycock

4. Lowland mixed deciduous woodland
© Forestry Commission photo library

5. Upland oakwoods
© Malcolm Whitmore

6. Upland mixed ashwoods
© Forestry Commission photo library

The aim, outputs and uses of the survey

Aim

The Native Woodland Survey of Scotland (NWSS) was carried out in order to establish an authoritative picture of Scotland's native woodlands. It sought to identify the location, type, extent, composition and condition of all native and nearly native woods, as well as woods planted on ancient woodland sites (PAWS), of at least 0.5 ha in area.

The survey was also intended to be a national baseline to monitor future changes in area and condition.

Outputs and uses

The results are published as a spatial dataset and are available to download free of charge. Results are also summarised in national, local and regional reports (covering each local authority area, both national parks and the Central Scotland Green Network).

The NWSS results can be used to inform national policy and for a wide variety of national, regional or site specific purposes including:

- strategic planning for areas such as national parks, local authorities, river catchments or habitat networks;
- development planning and control;
- environmental assessments;
- targeting incentives for management;
- management planning for individual woodlands.

NWSS data can also be used to assist research, for example in scenario analysis.

NWSS will provide a firm baseline for monitoring future change. Additionally, the data has enabled some comparisons with two previous surveys:

- ancient woodland areas which were first identified in the Scottish Ancient Woodland Inventory (SAWI) (Scottish Natural Heritage, 1997);
- remnant native pinewood areas previously identified in the Caledonian Pinewoods Inventory (Forestry Commission, 1994b).

More information and guidance on uses for the data can be found on the NWSS pages on the Forestry Commission Scotland website (www.forestry.gov.uk/nwss).

Left: Bluebells/Wild hyacinths (Hyacinthoides non-scripta): typical spring flowers of broadleaved native woods.

© Lorne Gill/SNH/2020VISION

Right: Wood ants (Formica aquilonia): a keystone species typical of ancient woodlands.

© Forestry Commission photo library

Box 2: Definitions used in the survey

Woodland: a discrete area of at least 0.5 hectares (ha) with a tree and/or shrub canopy and a minimum width of 20 metres (m), and which is at least 20 m long.

Native species: Tree or shrub species native to Scotland and the region or locality in which a site is situated. In practice Scots pine was defined as native within the Highlands in the 'native pinewood zone' (see Fig 30) whilst other native species were accepted as native throughout Scotland.

Native woods: woodland where over 50% of the canopy (defined as the upper layers present at any part of the site) is composed of native species. Can be on ancient woodland sites or other areas where woodland is of more recent origin.

Nearly-native woods: woodland where between 40% and 50% of the canopy is composed of native species. These woods have the greatest potential to become native woods with appropriate action.

Ancient Woodland sites: the extent of ancient woodland as estimated in the Scottish Ancient Woodland Inventory (SAWI) (see Box 3).

Plantations on Ancient Woodland Sites (PAWS): As recorded in SAWI, ancient woodland where the original semi-natural tree cover on an ancient woodland site had been replaced by planted stands, usually of non native species.

Box 3: Ancient woodlands and the Native Woodland Survey of Scotland

Ancient woodlands usually have a high value for natural and cultural heritage because of their long history of continuous woodland cover. Ancient and semi-natural woods (ancient woods where the current stands appear to be naturally regenerated rather than planted) generally have the highest biodiversity value.

Ancient woodlands were defined in SAWI* as areas where woodland was originally self-sown as far as we can tell, and woodland cover has been continuously present, either since the first surviving modern maps of Scotland around 1750 or since the first Ordnance Survey map series was published in 1860.

Many ancient semi-natural woods were converted to plantations (PAWS, see Box 2) by felling and replanting, mainly between the 1950s and early1980s. Remnants of the original native woodland cover often remain and can be restored. Such restoration work is now underway on many sites.

What was surveyed in NWSS?

All woods that are currently native or nearly-native in composition, plus all other woodlands on areas classed as planted woods on ancient woodland sites, received a full survey**.

The SAWI was published as a provisional inventory as it was based mainly on map records and was not verified by field survey. The NWSS therefore gives us the first national update and picture of the current status of ancient woodlands. It will provide insights into what has changed since the SAWI was compiled, as well as correcting errors.

* See SNH Information and Advisory Note 95, (Scottish Natural Heritage,1997); and 'A guide to understanding the Scottish Ancient Woodland Inventory' (Scottish Natural Heritage, 2011).

** A few areas that were marked as ancient and semi-natural woods on the SAWI will not have been surveyed in full under NWSS. This may be because, at the time the aerial photographs were taken, these areas were not woodland or they had been felled or were awaiting replanting. Alternatively some may have been visited and found by surveyors to be wooded, but with less than 40% native species or with less than 20% canopy cover.

How the survey was done

The NWSS is the most comprehensive habitat survey of its kind ever undertaken in Scotland, and probably also in the UK. This section describes the approach taken. Copies of the full survey plan, processes and procedures are available on the NWSS webpages.

Working with a team of ecological consultants, Scottish Natural Heritage, Forest Research and a range of other stakeholders, Forestry Commission Scotland developed and piloted the methodology during 2004-2006. It then ensured that the field work and data processing was carried out to expected standards with project management overseen by a project board.

After the pilot phase, field survey started in autumn 2006 and continued in all seasons without a break until completion in November 2012. Funding was provided by Forestry Commission Scotland, with a contribution from SNH.

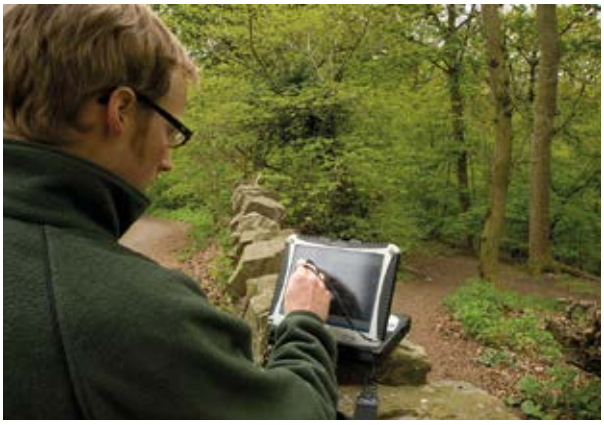
Preparation

To estimate the areas where survey would be needed and to plan the fieldwork, a new digital woodland map of Scotland was produced by identifying woodlands from recent aerial photographs. This was the same digital map that has been used for mapping woodlands in the National Forest Inventory. In most cases photographs were taken between 2003 and 2010 with fieldwork generally taking place within 5 years of the photograph. All areas of woodland in Scotland were assigned an "Interpreted Forest Type" (IFT). Relevant forest types which might include areas of native woodlands were then selected as candidate types for field survey.

The main candidate types were: broadleaved woods, mixed woodlands, conifer woodlands (in the native pine zone only) and all areas of PAWS. See NWSS webpages for more information.

Fieldwork

Whilst every one of these candidate woodlands had to be visited, only those which met the native or nearly native woodland criteria, or were PAWS, were surveyed in full. Surveyors recorded the findings directly into spatial datasets using a laptop computer designed for outdoor use.



The surveyors were also able to map and add into the dataset any native woodland areas which they discovered on the ground which had not been detected from the aerial photography when the digital map was produced.

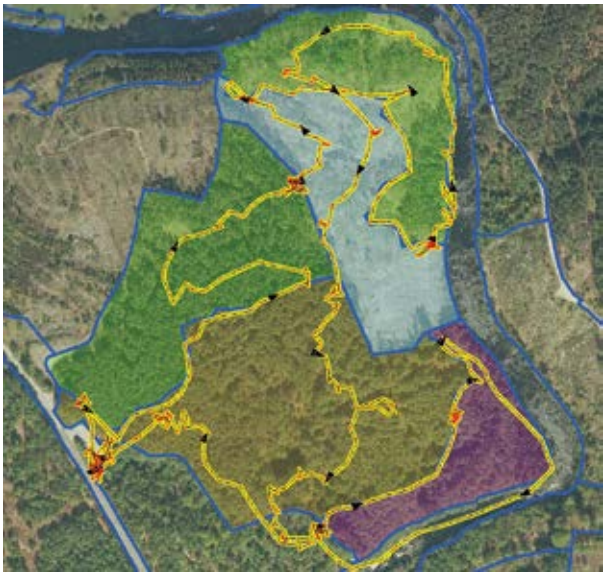
Table 1. Main attributes assessed for each surveyed polygon (see survey protocol on NWSS webpages for more detail)

	Description
Habitat	Priority Woodland Type (PWT) and National Vegetation Classification (NVC) community type, or open habitat type.
Species	Each tree or shrub species was recorded as a proportion of the canopy observed in 5% classes for each structural stage present. Stocking densities were also estimated for each species and structural stage.
Canopy Cover	10% classes of total canopy cover (as if viewed from above) including all tree and shrub species in the polygon.
Native Species	5% classes for the overall share of native species in the total canopy cover (above).
Semi-naturalness	10% classes for the degree of semi-naturalness of the polygon.
Type of polygon	Native, nearly-native, open habitat, PAWS (not-native).
Invasive species	Presence and % of the polygon covered by *Rhododendron ponticum*, Japanese knotweed, snowberry, giant hogweed, Himalayan balsam and a category known as 'Other herbaceous invasive exotics'.
Other Traits	Presence and % cover of various other features in the woodland such as bracken, erosion, dumping, pests and diseases etc.
Structural stages	Veteran, mature, pole immature, shrub, established regeneration and visible regeneration.
Maturity	Overall assessment of the maturity of the woodland based on the structural stages recorded.
Herbivores	The overall recent impact of herbivores in the woodland polygon, assessed in terms of browsing, grazing, bark damage and poaching of soil. The main herbivores thought responsible were recorded where known. Information was later analysed to assign each polygon a herbivore impact rating on a 4 point scale.

Figure 1. Example of the tracks of a surveyor mapped onto an aerial photograph

The survey route selected was critical. It had to allow the surveyor to pick up the full range of the diversity present and ground-truth any canopy variation identified from aerial photographs or Ordnance Survey mapping.

- Surveyor track
- Native Woodland
- Non-native Woodland (PAWS)
- Woodland loss
- Open Habitat



© Getmapping plc.

Surveyors subdivided and mapped the woodlands into polygons (discrete areas) of identifiable priority woodland types (PWTs, see Table 2), each of which was at least 0.5 ha in size, then recorded the attribute data separately for each polygon. Most polygons were actually a mosaic which included small patches of other woodland types below the mappable threshold size. These were recorded as components with an estimated % of the polygon area.

Where possible, each polygon was assigned to both a PWT and a National Vegetation Classification (NVC) community type (see Table 2 plus Annexes 2 and 3). Most polygons contained more than one woodland type and more than one NVC type. When analysing the composition and condition data, polygons were assigned to a 'dominant habitat type' (the type with the largest share) to enable them to be assigned to the best fit priority woodland type.

Table 2. Priority woodland type & related National Vegetation Classification recording options

Priority Woodland Types (PWT) (from UK Biodiversity Action Plan)	**National Vegetation Classification (NVC) communities**
WW: Wet woodland	W1, W2, W3, W4*, W5, W6, W7*
LMDW: Lowland mixed deciduous woodland	W8, W10, W16
UMA: Upland mixed ashwoods	W7*, W9
UO: Upland oakwoods	W4*, W11*, W17*
UB: Upland birchwoods	W4*, W11*, W17*
NP: Native pinewoods	W18
Native woodland scrub communities: juniper scrub, montane willow scrub, hawthorn scrub, blackthorn scrub.	W19, W20, W21, W22

* Some NVC communities can be classified in more than one priority woodland type depending on canopy composition and sub community distinctions.

Additionally, the following options could be used when surveyors were unable to identify a specific NVC or PWT at the time of survey:

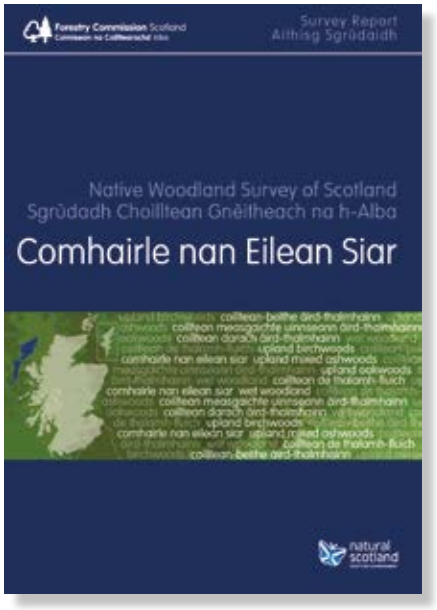
WN - not identifiable to NVC community;
WHN - not identifiable to priority woodland type;
NN - non-native habitat component.

Making data available and help for users

The results of the NWSS are being published and made available in several ways.

Summary reports

Summary local and regional reports are available on the NWSS web pages (see www.forestry.gov.uk/nwss).



Online access to data

The full NWSS dataset is freely available and can be accessed in several ways:

- on the Forestry Commission Scotland Map Viewer: This allows users to look at the components of the survey data for specific woodlands or small areas; or
- from the Forestry Commission's Datadownload site: This allows access to the data to enable reviews of larger areas and/or to carry out specific analysis of the data through geographic information systems (GIS). The spatial data can be downloaded free of charge.
- the data can also be viewed on Scotland's Environment website, SEWeb.

Training and guidance on using the data

The release of NWSS data has been supported by training general users and GIS analysts. Up until September 2013 a total of 136 Forestry Commission Scotland staff and external delegates had attended the training course. This course will continue to be available after publication of the complete dataset.

Guidance on using the data was first published on the NWSS webpages in 2010. It provides further information on the significance and possible uses of the analyses. This guidance will continue to be updated in response to user feedback and suggestions for new analyses.

Box 4: How does the Native Woodland Survey of Scotland differ from the National Forest Inventory?

The National Forest Inventory (NFI) is a record of key information about forests and woodlands in Britain, based on sample plot data. It will provide periodic statistical estimates with confidence limits, at both country and GB levels, of timber production potential and a wide range of other indicators of sustainable forest management.

At a GB level the NFI will sample approximately 15,000 randomly selected plots of 1.0 hectares each. Around 6,500 plots will be in Scotland, based on assessing between 0.3% and 0.4% of the total woodland area. For more information on the NFI see www.forestry.gov.uk/inventory.

The NWSS is a 100% field survey producing a map with linked spatial data that can be interrogated at any chosen scale. It therefore differs from, but complements, the sample plot based NFI, with each set of results having different uses.

Survey results

This report sets out the main findings at national level, together with some examples of the potential questions that can be asked of the data.

Following a summary of key results, Part 1 reports in more detail on area and Part 2 on composition and condition. In each case results for native woodlands and ancient woodlands are distinguished. Part 3 focuses on individual woodland types and scrub communities.

Summary results: area

Native woodlands

- The area of native woodlands in Scotland surveyed by NWSS was 311,153 ha, which was 22.5% of the total woodland area (as at March 2011), or 4.0% of the land area of Scotland.
- A further 13,383 ha was 'nearly-native' woodland, which had between 40% and 50% of native species in the canopy.
- Since survey fieldwork was completed, almost 7,900 ha of additional native woodlands are estimated to have been established up to 31st March 2013.
- The native woodland types with the greatest areas were upland birchwoods, native pinewoods and wet woodlands.

Ancient woodlands

- NWSS found 120,305 ha of woodland to be present on ancient woodland sites, of which 65% was native woodland. Another 2% was nearly-native in composition (40-50% native species in canopy).
- Of this, the woods that are on ancient woodland sites and are both native and highly semi-natural in composition are probably the most important category for nature conservation. These woods totalled 64,130 ha, which was 20.6% of native woods and just 4.6% of all woodlands in Scotland.
- Analysis of differences in areas of ancient woodland between NWSS and SAWI suggests that there is less wooded area now present than was estimated in SAWI. More work is required to understand how much of this difference is a real loss of wooded area, but significant fragmentation and loss of woodland cover may have occurred over a 40 year period in ancient woods in unenclosed upland areas.
- Much smaller apparent losses were recorded from ancient woodland to areas under development, to estate gardens, golf courses and sports fields and to enclosed agricultural use.

Above: Scotland's Atlantic woodlands support a great diversity of lichens and other lower plants. Barnluasgan, Argyll and Bute.

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Summary results: composition and condition

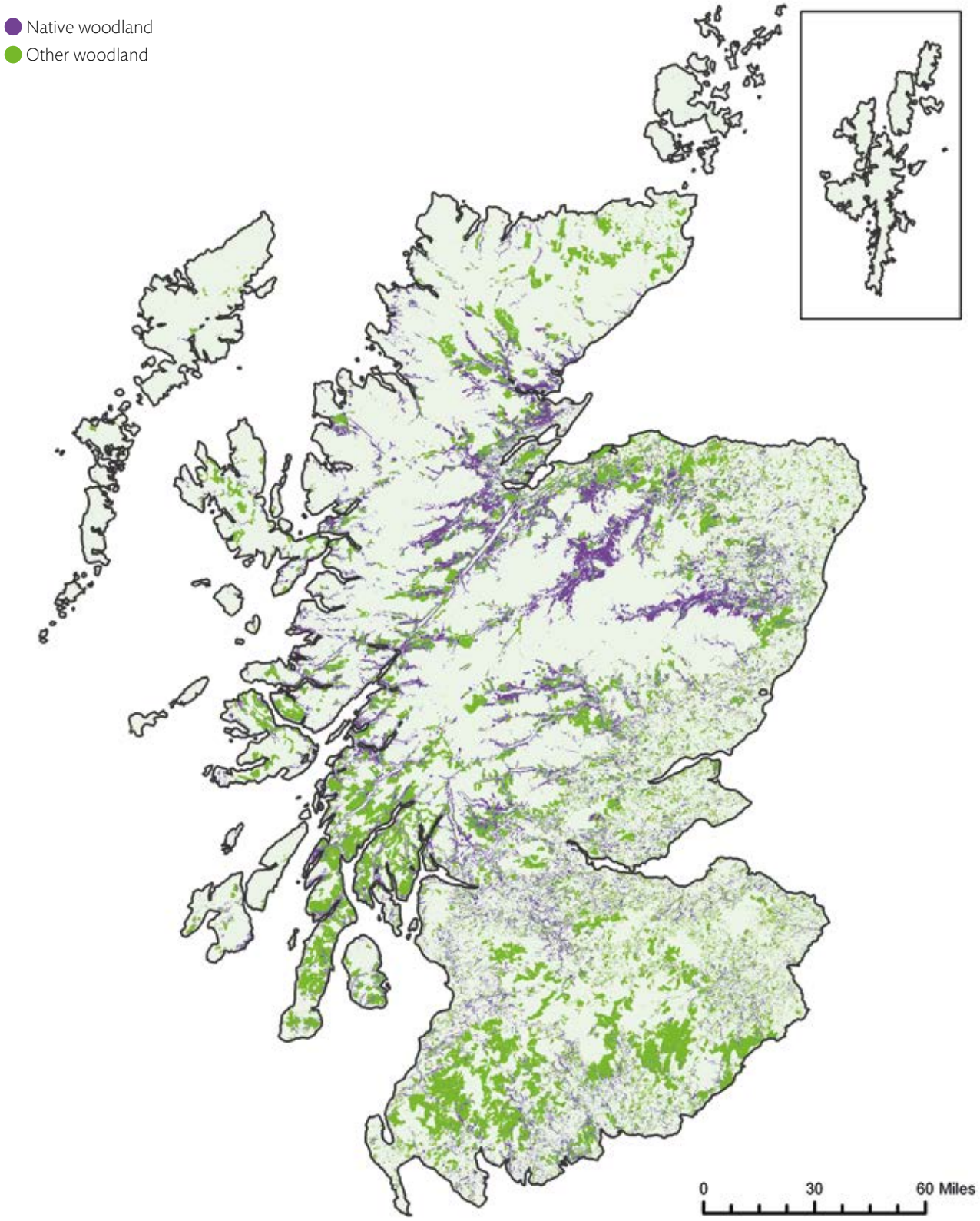
Native woodlands

- Most native woods in Scotland were highly semi-natural in their structure and composition, with 62% of the total area in the 80-100% semi-natural category. Native pinewoods were atypical as they included a large proportion of planted stands of Scots pine.
- The most common native tree species in the upper canopy were Scots pine and downy birch.
- Woodland canopy cover averaged 73% across all native woods. In 92% of native woods canopy cover fell within the range 50%-90% (defined in the survey as desirable for good condition).
- Native species made up 92% of canopy cover averaged across all types of native woodland; individual types ranged from 82% native species in the canopy of lowland mixed deciduous woodland to 95% in native pinewoods and upland birchwoods. In 79% of native woodlands (by area) the desired condition threshold of 90% native species in upper canopy layers was achieved.
- Non-native tree species comprised 6% of the established regeneration stage and 10% of the canopy in mature woodland.
- Estimated deadwood volume averaged 16m^3 per ha.
- Invasive non-native species in the shrub and field layers occupied 1.8% of native woodland areas, with *Rhododendron ponticum* and the category known as "Other herbaceous invasive exotics" being the main threats. Overall, 4.4% of areas did not meet the desired condition threshold because they had at least 10% cover and/or 3 or more species or types of invasive non native species present.
- Native woods in Scotland had 67% of the total area in the lowest two categories of the herbivore impact assessment. The remaining 33% had high or very impacts and so did not meet the desired condition threshold.
- 46% of native woodland was found to be in satisfactory condition for biodiversity, based on the condition index developed for the Native Woodland Survey of Scotland.

Ancient woodlands

- Native ancient woodland areas were highly semi-natural in current composition and structure, with 78% of the area in the 80-100% semi-natural category.
- These ancient highly semi-natural and native woodland areas should, in general, be the most important native woodlands for biodiversity conservation. Of these, 40% had a condition score of 4 (satisfactory). This is a little lower than for native woodlands as a whole. Another 51% had condition score 3.
- Some 35% of areas classed in the Scottish Ancient Woodlands Inventory (SAWI) as planted woods on ancient woodland sites (PAWS) were found to be native woodland, and more than half of this (53%) was currently highly semi-natural in character.
- Sitka spruce was the main component (43%) of the canopy of the non-native stands which occupy the remaining two-thirds of PAWS areas.

Figure 2. Map of all native woodland in Scotland showing native woodland distribution



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Part 1: Area

Native woodlands

The survey found a total of 311,153 ha of native woodland above the minimum size threshold of 0.5 ha. This was 22.5% of the total woodland area in Scotland as at 31st March 2011, which was derived from the digital woodland map used for the National Forest Inventory (Forestry Commission 2013a). Native woodland occupied 4.0% of the Scottish land area. A further 13,383 ha (1.0%) was 'nearly-native' woodland, with between 40% and 50% of native species in the canopy.

Area changes since the fieldwork took place

The survey field work took place between late 2006 and late 2012. Over that period some newly planted native woodlands were not surveyed, mainly because they were established after the field survey had taken place in that area.

The estimated additional area of new woodland which was identified but which was not included in the NWSS data was 7,858 ha up to 31 March 2013 (6,836 ha of grant-aided woodland and 1,022 ha on the National Forest Estate).

We have no record of permanent loss of native woodland since the time of field survey. Because native woodland loss to development is unlikely due to development control policies, and losses to causes such as browsing and grazing are more gradual, it is assumed here that losses of native woodland have been negligible over this short period (see the ancient woods change analysis on page 27 for some evidence on rates of change).

As at 31st March 2013 the estimated area of native woodland was therefore some 319,000 ha from a total woodland area of 1,410,000 ha (Forestry Commission, 2013b), so native woods occupied 22.6% of the woodland area of Scotland.

Box 5: Previous estimates

Figures from NWSS can be compared to previous estimates of the area of native woods.

The UK Biodiversity Action Plan and Scottish Forestry Strategy estimates of areas for each priority woodland type totalled 392,000 ha in 2005 (Native Woodland Partnership, 2005; Forestry Commission Scotland, 2006). These included estimates for areas down to 0.1 ha from a variety of survey and other sources, and it included estimates for native woodland planting and regeneration.

The High Nature Value Farmland and Forestry (HNVFF) Indicator (Scottish Government, 2011) estimated native woodland area at 215,000 ha for 2010.

This was based on analysis of sample plots in the National Inventory of Woodlands and Trees as at 1995, and included woodlands over 2 hectares in size. It did not include unstocked open areas associated with native woods. The uprating of this indicator from 1995 to 2010 values made the assumption that native woodland area had increased in proportion to the total woodland area increase.

Differences in methods help to explain the wide variation between these previous estimates. It appears likely that the UKBAP figures overestimated and the HNV method underestimated the actual amount of native woodland present.

Areas of each native woodland type

The areas of each native woodland type are shown in Table 3 and Figure 3.

Table 3. Summary of native woodland area by type

Native Woodland Type [1, 2]	Area (ha)	%
Lowland mixed deciduous woodland [3]	23,189	8%
Native pinewoods	87,599	28%
Upland birchwoods	91,235	29%
Upland mixed ashwoods	12,353	4%
Upland oakwoods	19,474	6%
Wet woodland	44,742	14%
Blackthorn scrub	152	<0.1
Hawthorn scrub	2,138	1%
Juniper scrub	1,482	1%
Montane willow scrub	10	<0.1
'Other' type [4]	28,779	9%
Total	**311,153**	**100%**

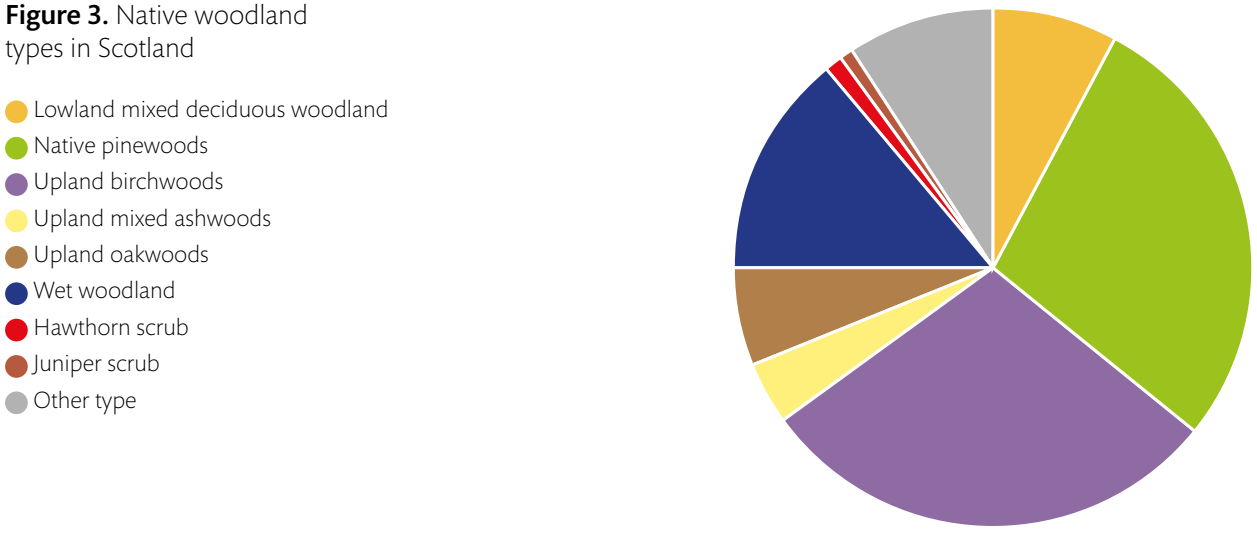
Note 1: The top 6 rows are native woodland types which are priority habitats under the UK Biodiversity Action Plan.

Note 2: 30% of mapped units (polygons) of native woodland surveyed contained a single native woodland habitat type. The remaining 70% consist of mosaics of 2 or more woodland types where no one patch has an area over 0.5 ha.

Note 3: This type is sometimes referred to as lowland mixed broadleaved woodland.

Note 4: "Other" native woodland includes areas that were not attributable in the field to a particular native woodland type.

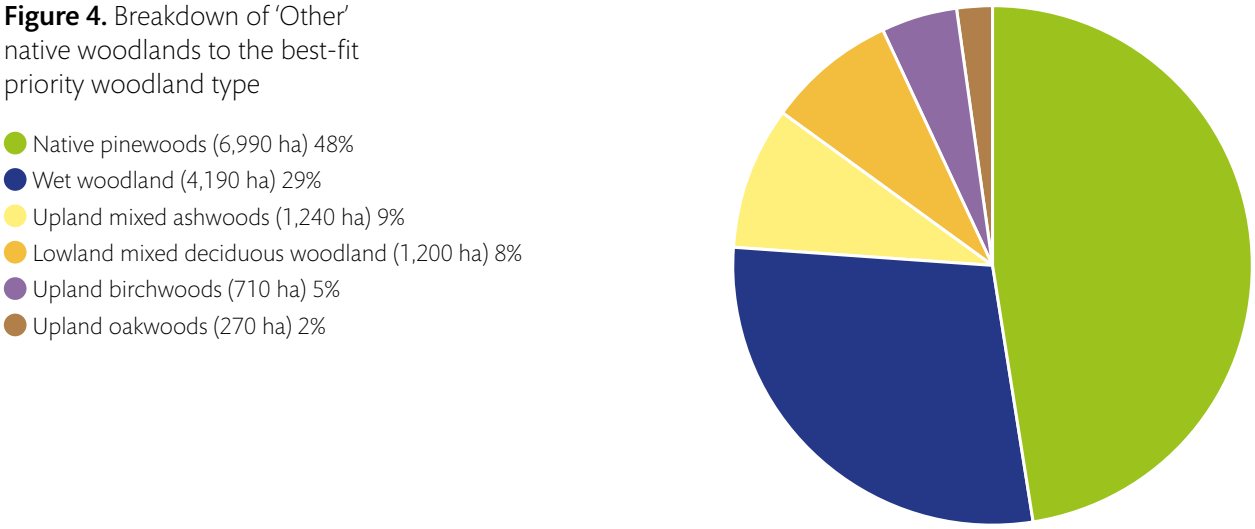
Figure 3. Native woodland types in Scotland



The results of an analysis of each polygon within the 'Other' native woodland type from Table 3 gives a further breakdown of this area into best fit priority woodland types (see Figure 4). These areas have not been used in analyses of PWT characteristics as their identification is less reliable than areas recorded as specific types by surveyors in the field.

Just over half of the area (14,600 ha) can be readily allocated to a priority woodland type based on dominant tree species (and NVC type if known). Native pinewoods and wet woodlands have the biggest shares, but significant areas are also attributable to upland mixed ash woodlands and lowland mixed deciduous woodland.

Figure 4. Breakdown of 'Other' native woodlands to the best-fit priority woodland type



National Vegetation Classification types

The National Vegetation Classification system was used to help define and map the native woodland types (see Annexes 2 and 3). Table 4 (overleaf) highlights the key classifications and shows the areas of each NVC type found across Scotland. Figure 5 gives an example of how the NWSS data can be used to show distribution patterns of NVC types.

Box 6: National Vegetation Classification

The NVC data in NWSS can be used to help understand the ecological patterns in our native woods and how they may change in future. The NVC type can provide an indication of the characteristic suite of trees and shrubs that might be expected in an area of native woodland.

This could be used at various spatial scales to compare expected and observed distributions of tree and shrub species, help plan future management or as a basis for targeting surveys of associated species of plants and animals.

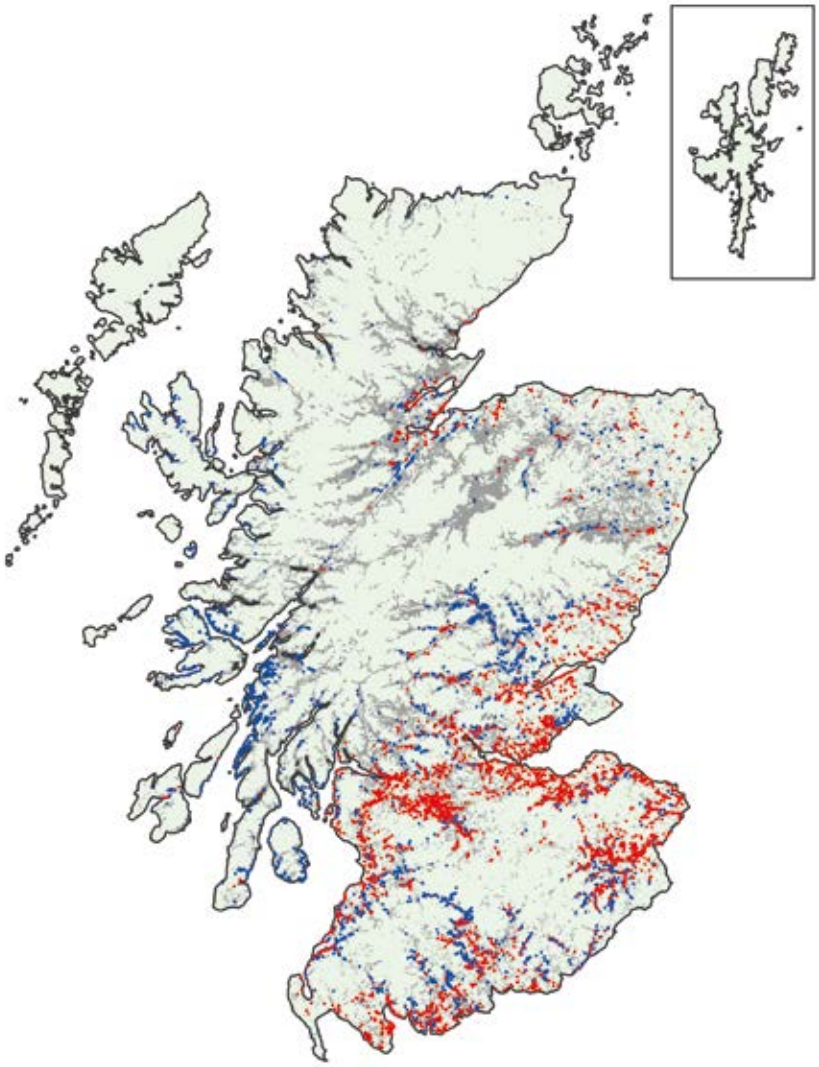
Table 4. Areas of each National Vegetation Classification type surveyed in native woodlands and the relationships to priority woodland types

Priority woodland type	NVC types present*	Area (hectares)	Percentage of total native woodland area (%)	Comments
Native pinewoods	W18	77,978	25	
	WPc	25		
Wet woodland	W7	27,862	9	Some of this type is in upland mixed ashwoods.
	W4	26,268	8	Some of this is in upland birchwoods or upland oakwoods.
	W6	1,322	<1	
	W3	568	<1	
	W2	364	<1	
	W1	274	<1	
	W5	101		
Upland birchwoods/ Upland oakwoods	W11	58,704	19	
	W17	45,983	15	
	(W4)			See wet woodland above.
	WLz	1,652	<1	Some of this is in lowland mixed deciduous woodland see below.
Lowland mixed deciduous woodland	W10	12,878	4	
	W8	6,584	2	
	W16	330	<1	
	(WLz)			See upland birch/ oak above.
Upland mixed ashwoods	W9	8,590	3	
	(W7)			See wet woodland above.
Native woodland scrub	W19 Juniper scrub	1,482	<1	
	W22 Blackthorn scrub	153	<0.1	
	W20 Montane willow scrub	10	-	
Miscellaneous	Wh	167	<0.1	
	Not identifiable as an NVC type**	37,720	12	
Total area		**311,153**		

* Annex 2 gives full names of NVC types (see Annex 3 also).

** Comprised of native woodland that had no discernible NVC type, including young planted woods, small unmappable areas of open habitat and areas of felled trees within native woodland polygons.

Figure 5. Map of distributions of W8 and W9 NVC types



This demonstrates the overlapping pattern of lowland and upland communities.

Note: Map shows the position of polygons where W8 or W9 is the dominant NVC type.

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Ancient woodlands

The total area of ancient woodland that has been surveyed or mapped through NWSS was 120,305 ha, with 65% of this being mainly native in composition. Table 5 summarises the current status (from NWSS and the digital woodland map) of all sites which were identified as ancient woodland in the SAWI.

Table 5. Current status of sites that were recorded as ancient woodlands in the Scottish Ancient Woodlands Inventory (SAWI)

Current status from NWSS	Area (ha)	% of total current area of woodland on ancient woodland sites
Native woodland	77,924	65
Nearly–native woodland	2,370	2
Other woodland (under 40% native species)	40,011	33
Areas surveyed as plantations on ancient woodland sites (PAWS) [1]	*31,896*	
Broadleaved or mixed woods [2]	*3,440*	
Conifer woods [3]	*4,675*	
Total current area of ancient woodland (surveyed or mapped)	120,305	100
Other land [4]	27,848	-
Area of ancient woods in SAWI [4]	148,156	-

Note 1: Areas recorded as planted ancient woods on the SAWI - fully surveyed under NWSS.

Note 2: Areas assessed as under 40% native species in NWSS. Broadleaved species make up at least 20% of cover from the digital woodland map. Not surveyed in detail.

Note 3: Areas assessed as under 40% native species in NWSS. Conifer species make up greater than 80% of cover from the digital woodland map. Not surveyed in detail.

Note 4: The SAWI area and current (NWSS) area of ancient woodland may be different for a number of reasons, including mapping errors or inaccuracies in the SAWI estimates and real changes in woodland area. Some of this "Other land" may also be recorded as felled, under ground preparation, very young trees etc.

Map displacement errors between SAWI boundaries and the newly digitised woodland areas could mean that some areas of ancient woodland were not surveyed in NWSS, so the ancient woodland areas given above may underestimate the true area (see page 27).

Table 6. Current composition of woodlands that were recorded as ancient and semi-natural in the Scottish Ancient Woodlands Inventory (SAWI)

SAWI Category	Current State NWSS Type	NWSS (ha)	%
Ancient and semi-natural 89,080 ha	Native	57,308	64
	Nearly-native	927	1
	Non-native †	716	<1
	Broadleaved/mixed, not native	3,308	4
	Conifer, not native	4,155	5
	Other land	22,666	25
	Total	**89,080**	**100**

† Surveyed as PAWS: area under 40% native species.

Table 7. Current composition of woodlands classed as Planted Woods on Ancient Woodland Sites (PAWS) in the Scottish Ancient Woodlands Inventory (SAWI)

SAWI Category	Current State NWSS Type	NWSS (ha)	%
PAWS 59,072 ha	Native	20,616	35
	Nearly-native	1,443	2
	Non-native†	31,180	53
	Broadleaved/mixed, not native	132	<1
	Conifer, not native	520	1
	Other land	5,181	9
	Total	**59,072**	**100**

† Surveyed as PAWS: area under 40% native species.

Analysis of changes in total ancient woodland areas between SAWI and NWSS

An analysis was made of differences between the two datasets to determine, as far as possible, the extent and reasons for any actual loss of ancient woodland.

The method allocated changes to map errors or to one of four change categories by examining aerial photographs of a statistically valid sample of areas in combination with SAWI & NWSS boundaries (see Annexes 4 and 5). The methodology and more information for individual local authority areas is given on the NWSS website.

Table 8. Summary of ancient woodland area changes from woodland to non-woodland between SAWI and NWSS

Change from ancient woodland in SAWI	Area change (ha) % change*	Range (ha)**
To open land (unenclosed)	18,543 (12.5%)	17,330-19,757
To agriculture	1,270 (0.9%)	754-1,787
To development	1,030 (0.9%)	597-1,462
To estates/gardens	201 (0.1%)	0-415
Total estimated reduction in ancient woodland area	**21,044 (14.2%)**	**19,928-22,160**
Area reduction attributed to map error in SAWI maps	6,507	5,402-7,611
Area reduction attributed to map error in NFI/NWSS maps	281	56-506
Total gross reduction in ancient woodland area	**27,831 (19%)**	**-**

* Baseline area of ancient woodland estimated in SAWI at 148,136 ha.

** There is a 95% probability that the true value lies within this range.

An overall reduction of 14.2% of ancient woodland area appears to have occurred since the mapping used for SAWI was done using the Ordnance Survey (OS) 1:25,000 second series maps (Ordnance Survey, 1965-1997). The reduced area is concentrated heavily in areas recorded as semi-natural on the SAWI, rather than PAWS. This might be because planted stands that make up PAWS are more likely to have been intensively managed.

Fieldwork for these maps took place over a considerable number of years, with great variation between districts. Taking a reasonable median time of 1970 for this, the maximum rate of loss of ancient woodland can be estimated as 0.35% per annum.

However, this interpretation should be treated with great caution, as there are reasons to indicate that the true loss figure will be less:

- differences in how woodlands were mapped between the OS maps and NWSS/NFI could exaggerate the true loss. For example, if scattered trees were mapped as woodland by OS surveyors when they did not reach the threshold of 20% cover which has been used to define woodland in the NWSS;
- the margins of upland native woods are often naturally dynamic in extent as they regenerate outside the current stands of trees and so may gradually fluctuate in shape around a core area. Any such offsetting of area losses within SAWI polygons by gains outside them could not be detected by this analysis.

The results in Table 8 suggest that policies which have been in place since the late 1980s to prevent the deliberate removal of ancient woodland for development and agriculture have been quite successful.

In contrast, almost 90% of the possible total loss of ancient woodland over the last 40 years has been to unenclosed open land, mainly in the uplands.

More detailed research, including looking into individual cases, will be needed to understand to what extent losses to open land have actually occurred, the causes of these changes and appropriate responses. The most likely causes are some combination of herbivore pressures and poor regeneration capacity of older trees.

1: Scattered old native pines. Cairngorms National Park.
© Mark Hamblin/2020VISION

2: In many upland areas native trees are confined to inaccessible burnsides or cliffs.
© Malcolm Whitmore

3: Aspen (Populus tremula): an uncommon species of high conservation value. Strathspey, Highland.
© Mark Hamblin/2020VISION

Part 2: Composition and condition

Results are presented for several important aspects of native woodland ecosystem health or condition. More information on these and how NWSS data can be used is available in the NWSS guidance notes on the Forestry Commission Scotland website.

Naturalness of native woods

What information does the survey provide and why does it matter?

Native woods are often classified as semi-natural or planted. Semi-natural woods are, strictly speaking, those which have arisen from natural regeneration from parent trees.

Semi-natural native woods are recognised as more important generally for nature conservation than planted native woods because they have a more natural structure and composition and a higher value for genetic conservation. They are especially valuable if they are also on ancient woodland sites.

In most cases, however, it is not possible to be definitive about whether a wood has regenerated naturally because we do not have sufficient historical information.

NWSS therefore assessed semi-naturalness in terms of the current structure and composition of trees and shrubs, recording the degree to which each area of native woodland appeared to have been planted or not, taking account of signs of planting like straight rows or cultivation.

This semi-naturalness measure is expressed as a percentage of the site. It is a continuum since planted native woods can develop a more semi-natural structure and appearance through time. This can occur both through the effects of natural disturbance events such as storms and as a result of management that promotes natural regeneration of native species and the development of an irregular structure. Stands of semi-natural origin can sometimes appear to be planted, for example, where extensive even-aged regeneration has occurred, and vice versa. The NWSS semi-naturalness score therefore cannot be used to show definitively the genetic history of a wood.

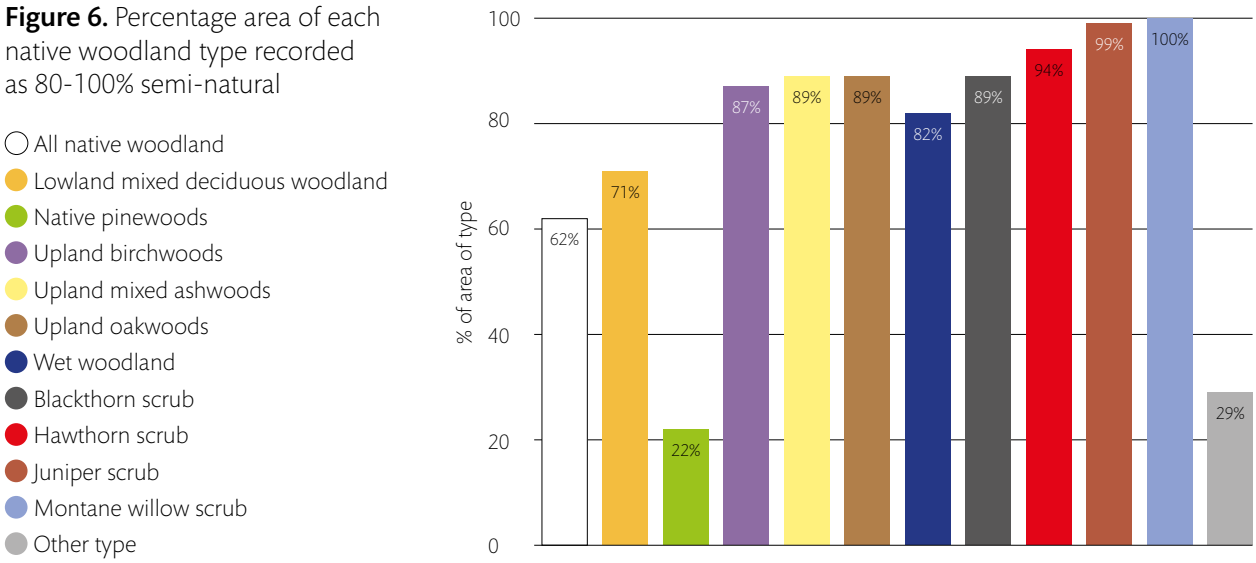
Results

Most native woods were classed as highly semi-natural in appearance (62% of area of native woods was in the 80-100% semi-natural category - see Figure 6) with around a third mainly or entirely planted in character (31% in the 0-20% semi-natural class). Only 7% fell between these extremes. The total area of highly semi-natural woods was 193,200 ha.

Many native woods of planted character are either in recent native woodland planting areas or in older Scots pine woods that are part of planted forests. New native woods were classed as planted if there had been initial cultivation, even if they were irregularly spaced.

Above: Native pinewood in autumn. Rothiemurchus Forest, Cairngorms National Park.
© Mark Hamblin/2020VISION

Figure 6. Percentage area of each native woodland type recorded as 80-100% semi-natural



We can use the semi-naturalness data to help identify from the NWSS those native woods of highest potential nature conservation value, woods that are:

- highly semi-natural in structure;
- native in composition, and
- present on ancient woodland sites.

This category is described in the ancient woodlands results section.

Tree species composition

What information does the survey provide and why does it matter?

The dominant nature of trees and shrubs mean that they largely determine ecosystem processes and also the character and other values of a woodland.

Many plants and animals use or co-exist with non-native trees, but a lot of the rarer and more threatened woodland species are specialists which are adapted to a particular native tree or shrub species. This is partly due to the very long periods of exposure to native trees that have occurred compared to introduced tree species (e.g. Kennedy and Southwood, 1984). Birches, willows and oaks are examples of trees that host many specialist insect species (Patterson, 1993).

Native woodland biodiversity value is usually greater when:

- a wide range of native trees and shrubs characteristic of the site-type are present, which will support a larger community of wildlife, more rare and specialist species and a wider range of ecosystem processes like decomposition and nutrient cycling;
- native species make up all or nearly all of the woodland.

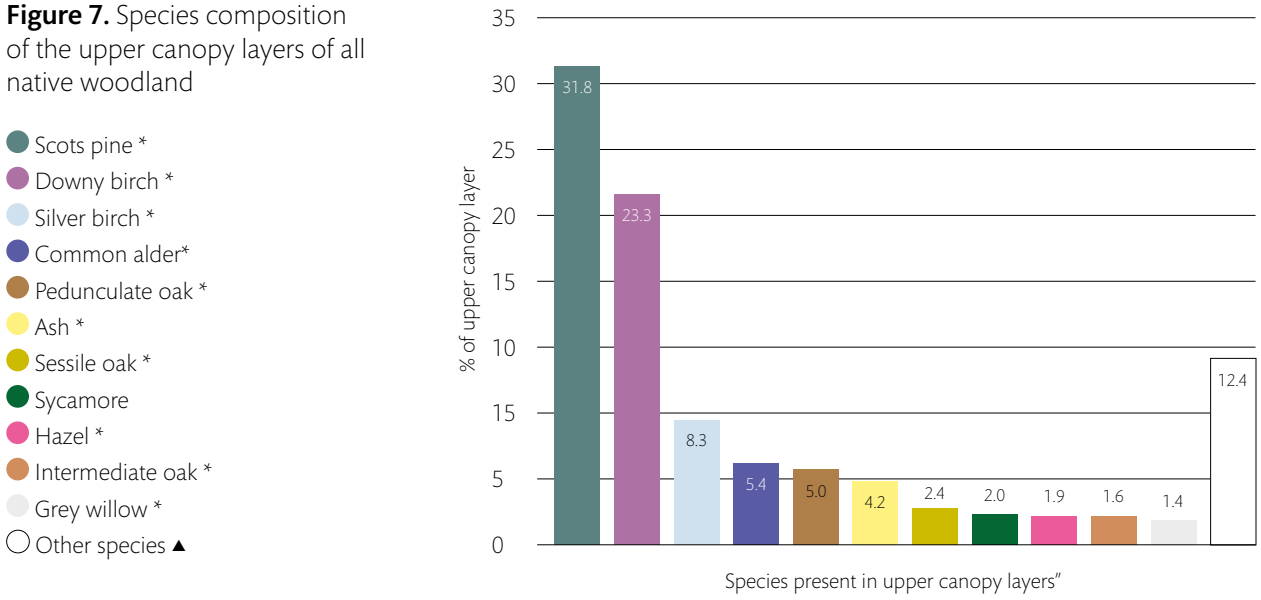
Tree species cover values were combined for the upper canopy layers as they determine woodland character. These consist of the veteran, mature and pole immature stages.

Results

Scots pine and downy birch were the most common native species in the upper canopy layers of native woods nationally (33% and 23% respectively), although it should be noted that most Scots pine are in planted woods.

It can be seen from Figure 7 that many native trees and shrub species are quite uncommon. This probably reflects the results of browsing pressures and past woodland management which are both likely to have reduced woodland diversity below natural levels (Mason et al, 2004).

Figure 7. Species composition of the upper canopy layers of all native woodland

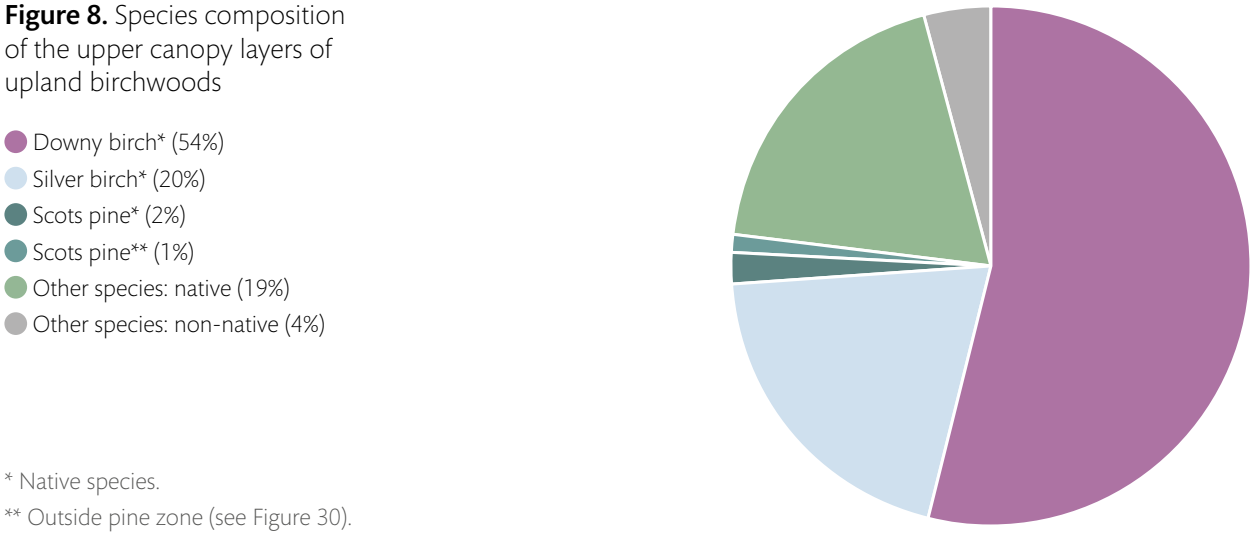


▲ Note: Other species include: grey willow*, rowan*, beech, birch*, goat willow*, Sitka spruce, hawthorn*, European larch, wych elm*, Norway spruce, lodgepole pine, hybrid larch, gean*, aspen *, bird cherry* and Japanese larch.

* Native species.

Figures 8-10 show the species composition of upper canopy layers for the three most extensive native woodland priority habitats in Scotland (from Table 3). These analyses are based on classifying each native woodland unit according to the main priority woodland type present.

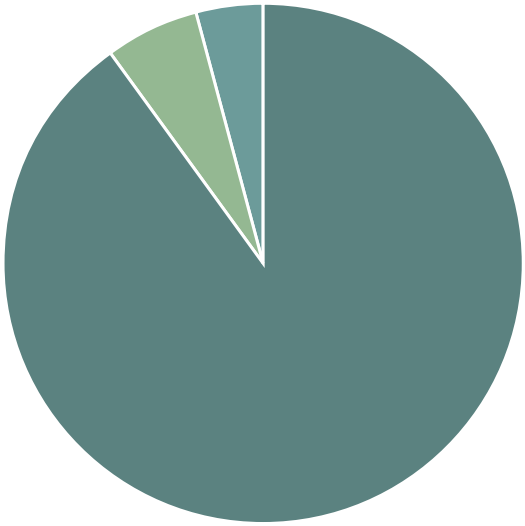
Figure 8. Species composition of the upper canopy layers of upland birchwoods



* Native species.

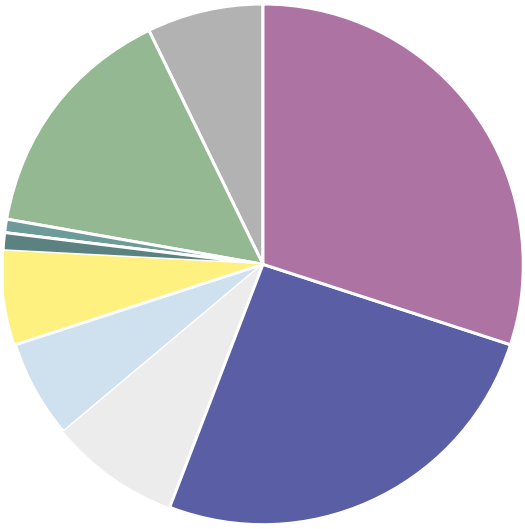
** Outside pine zone (see Figure 30).

Figure 9. Species composition of the upper canopy layers of native pinewoods



* Native species.

Figure 10. Species composition of the upper canopy layers of wet woodlands



* Native species.

** Outside pine zone (see Figure 30).

Information on individual tree species populations

What information does the survey provide and why does it matter?

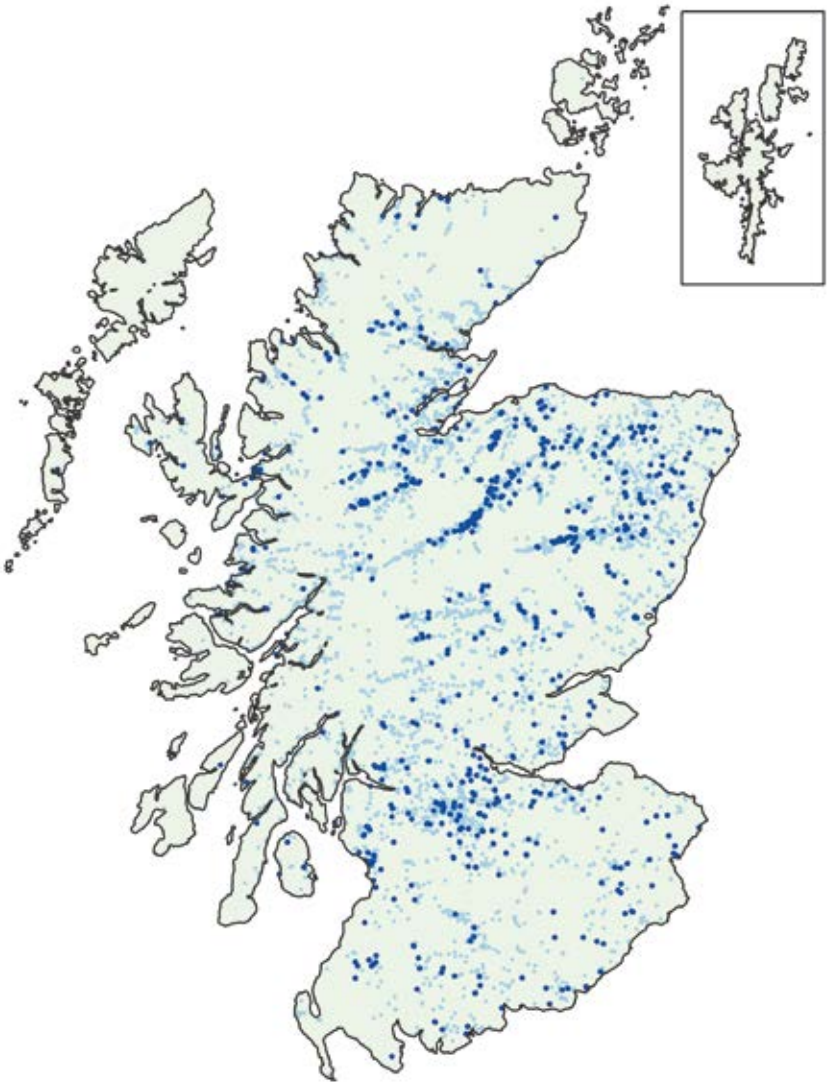
The NWSS data can be used to show the distribution and characteristics of individual tree species of interest, for example rare tree species or species which support flora and fauna of conservation interest.

As an example of this, Figures 11, 12 and 13 show the distribution and structural characteristics of aspen populations in native and ancient woods.

Aspen is relatively uncommon though widely distributed in Scotland. It has high nature conservation value for various lichens (Ellis, 2004), bryophytes (Rothero, 2001) and insects, including the rare aspen hoverfly (Rotheray, 2001). Aspen is highly vulnerable to browsing (Mackenzie, 2010) and it is also a favoured food of the European beaver (Jones et al., 2001), which will be important if this species is re-established.

Figure 11. The distribution of aspen in all woodland surveyed for the NWSS

- Presence of aspen in the polygon
- A minimum canopy cover of aspen (across all structure stages) of 15%.



Note: Map shows the position of polygons containing aspen.

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Figure 12. Occurrence of aspen in each priority woodland type

- Number of occurrences
- Total area of polygons in which aspen is present (ha)

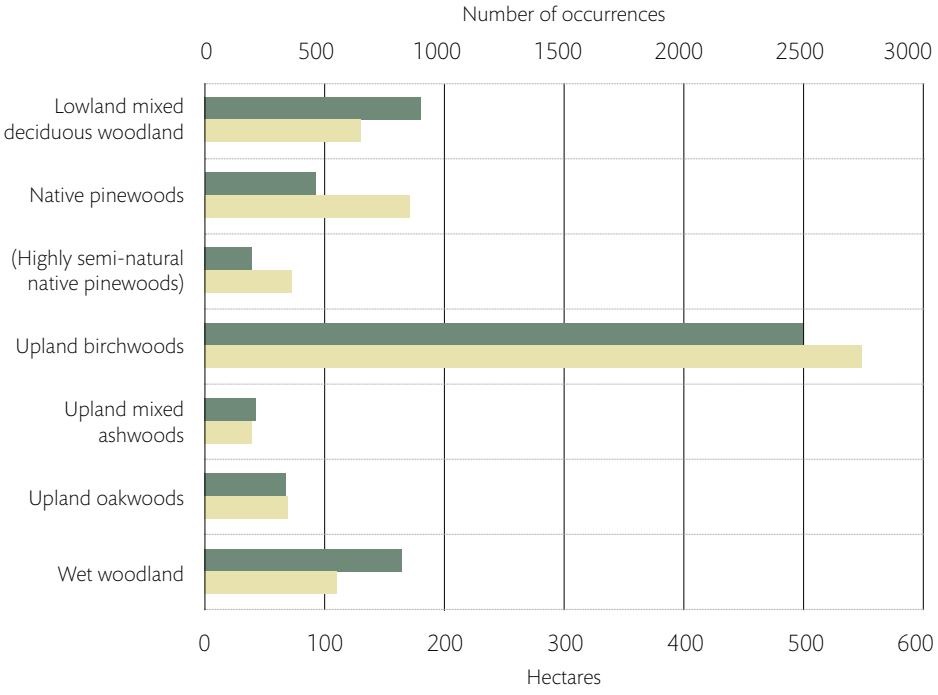
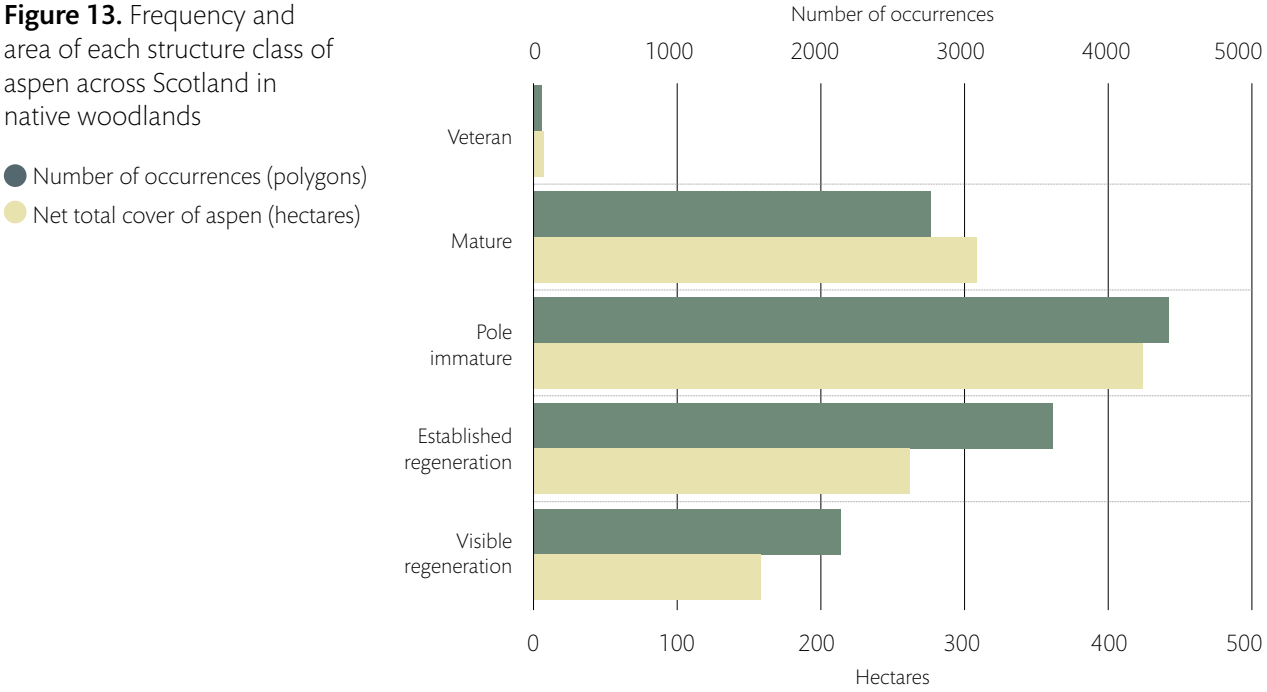


Figure 11 shows that aspen is a widespread species in native woods but that it usually occurs at low levels of cover, which is consistent with its habit of growing in isolated clonal patches.

NWSS data can also show the structural diversity of the population of a tree species at any scale. For aspen there is a good spread of age-classes nationally with a high proportion in the regeneration phase (Figure 13). Spatial analysis could be used to assess how to manage or expand aspen populations in selected areas.

Figure 13. Frequency and area of each structure class of aspen across Scotland in native woodlands



Total canopy cover

What information does the survey provide and why does it matter?

The total canopy cover of all species combined was assessed. In each native woodland unit the surveyor assessed the uppermost layer present at any part of the wood. This included areas of established regeneration or shrub layer where there were no larger trees above them.

Woodland canopy density and structure is an important driver of ecosystem function and the services that woodlands provide. Microclimate, litterfall, soil moisture, nutrient turnover and shading are influenced by canopy cover for example. This in turn shapes the living communities in lower vegetation layers and soil.

Woods with scattered trees and low canopy cover will have less of a woodland character and reduced diversity of woodland-dependent species (although they may be valuable as wood-pasture if they have a history of this form of management).

However, completely closed canopies across the whole woodland are not ideal either as they exclude species associated with edges, glades and open grown trees, and inhibit tree regeneration.

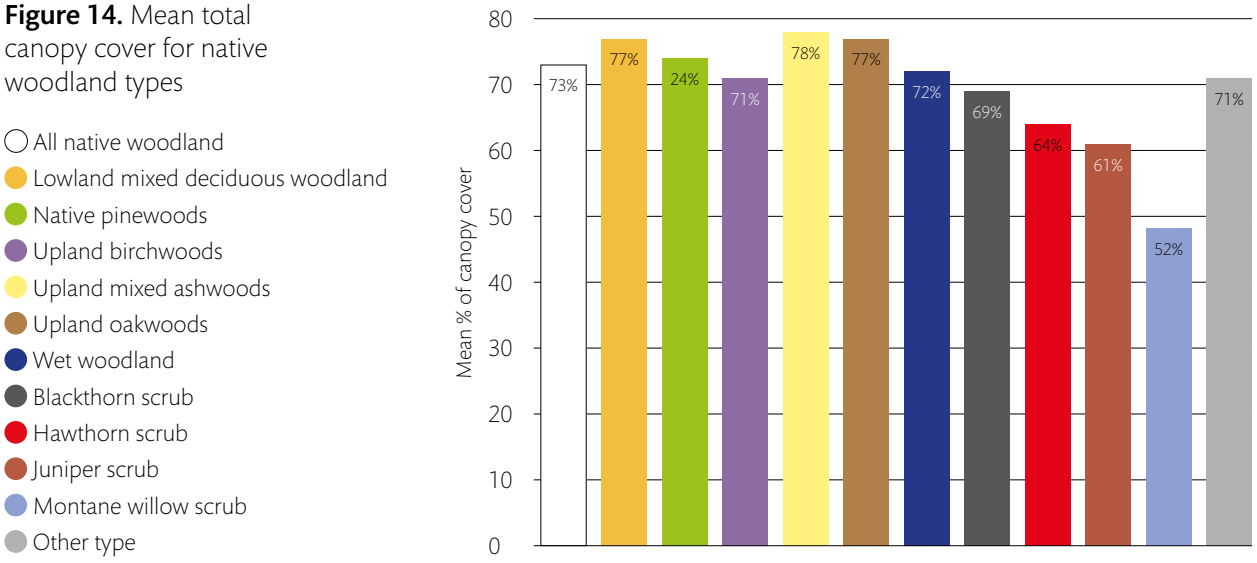
In general, areas within the range of 50-90% canopy cover should have a good balance - a core of woodland interior conditions with some open and edge habitat as well. Canopy cover in the range of 50-90% was selected as one of the four components of the native woodland condition indicator (see page 47).

This range of canopy cover should also be optimal for many other benefits including wood products, a woodland recreational experience, attractive scenery, soil and water protection as well as carbon sequestration.

Results

The national average was 73% total canopy cover in native woods, and for individual types the range was from under 70% in the various scrub woodland types to 78% for upland mixed ashwoods. Only 8% of native woodland areas were outside the range of 50-90% cover.

Figure 14. Mean total canopy cover for native woodland types



Note: Areas are assigned to types according to the proportions of all types present in each native woodland unit.

Percentage of native species in the canopy

What information does the survey provide and why does it matter?

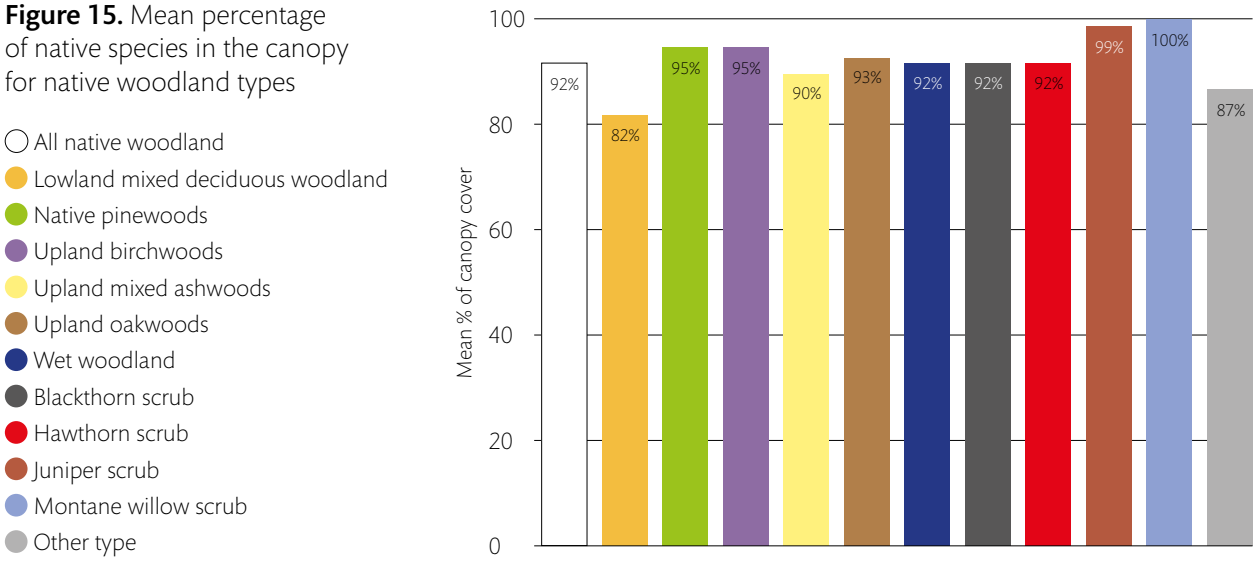
In every native woodland area an estimate was made of the overall percentage cover of the upper canopy which was made up of native species. This was assessed for the uppermost layer present at any part of the wood, which included any areas of established regeneration or shrub layers where there were no larger trees above them.

A value of at least 90% native species in any canopy layer was taken as a reasonable average threshold for good condition for biodiversity and has been included in the native woodland condition indicator (see page 47).

Moving to a more completely native composition is usually preferable for biodiversity. However, sometimes it is not feasible to aim for total removal of non-native species, for example on inaccessible sites. In some situations it can also be better for biodiversity to retain specific mature non-native trees at least in the short term in order to maintain canopy structure and shade or a supply of dead wood and tree holes, especially where the non-native species are not actively regenerating. The various management objectives for a woodland need to be factored in and site management planning should consider what is the best composition of non-natives for each woodland, as well as the pace of change where they are to be phased out.

Results

Figure 15. Mean percentage of native species in the canopy for native woodland types



Note: Areas were assigned to types according to the proportions of all types present in each native woodland unit.

Native species averaged 92% of canopy cover across all native woodland types, with just 21% of the native woodland area having less than 90% of native species.

Structural diversity

What information does the survey provide and why does it matter?

The distribution of cover between structural stages can influence the biodiversity, scenic and recreational value and wood production potential of a woodland.

High structural diversity normally indicates a higher diversity of niches and associated species. Different priority woodland types tend to have characteristic structures. These are partly natural, related for example to typical disturbance patterns and to the degree of shade tolerance of the major tree species, and partly the result of past management practices (Forestry Commission 1994a).

Native pinewoods and upland birchwoods are often relatively extensive and simple in structure, with only one or two size classes over most of the site. Lowland mixed deciduous woodland and upland mixed ashwoods are more complex in structure and usually have smaller stands of trees and patches of regeneration.

The presence and extent of regeneration, which includes both visible regeneration (VR) and established regeneration (ER), is important to the sustainability of the woodland. A wood which is dominated by mature or veteran layers with no regeneration may be at risk and may need intervention to sustain it for the long term.

Veteran trees are usually of high biodiversity value, and each tree species has different potential communities of lichens, bryophytes, fungi and invertebrates.

Above: Diagram highlighting structural diversity in a woodland.
Illustration: Clare Hewitt

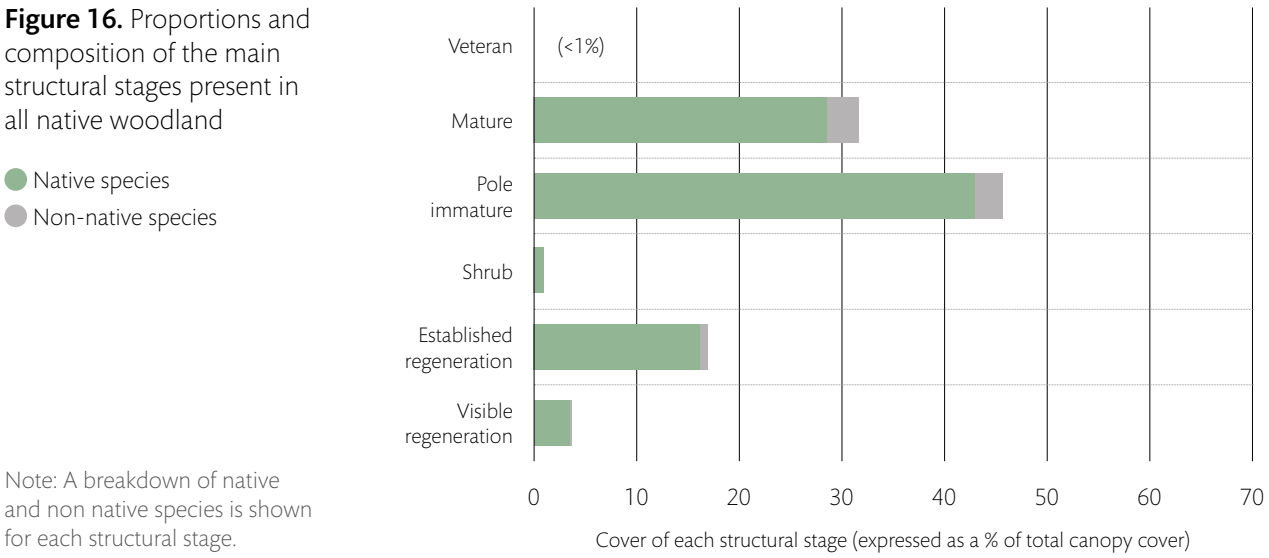
Results

For native woodlands as a whole the weighted mean cover of each structural stage is shown (Figure 16), expressed as a percentage of the total canopy cover. Because structural stages can overlap e.g. regeneration and shrub layers may occur beneath mature trees (see diagram), the combined cover of structural stages may exceed 100% of the total canopy cover.

Overall, native species made up 93% of combined cover of all structural stages in native woods. The figure was very similar for each stage, ranging from 90% for mature trees to 96% for veteran trees.

The proportions of native and non native species in the main structural stages are also shown. Each mapping unit (polygon) was allocated to a priority woodland type based on the dominant type present.

Figure 16. Proportions and composition of the main structural stages present in all native woodland



Note: A breakdown of native and non native species is shown for each structural stage.

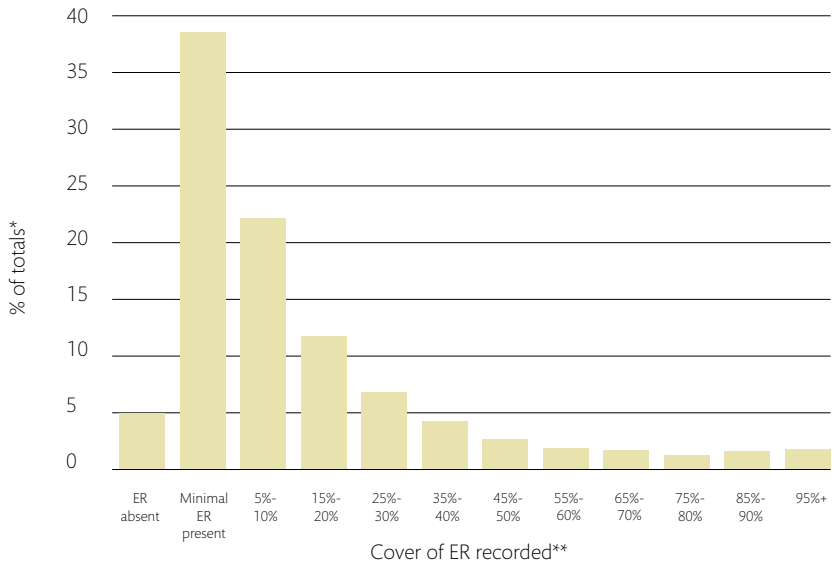
There were more differences in the nativeness of tree species composition between individual woodland types, ranging from 82% overall for lowland mixed deciduous woodland to 96% for upland birchwoods (see Part 3, individual native woodland type accounts).

Overall, in Scotland's native woods 78% of total cover was in the mature and pole immature stages, with 21% in the regeneration stages. Less than 1% is veteran trees and just over 1% shrubs. In the individual woodland types, regeneration cover varied from 11% in upland oakwoods to 26% in wet woodland.

In each type of native woodland the percentage of native species cover in the regeneration layers was similar to or higher than in the mature canopy, which is a good sign for their future development and resilience as native woodland ecosystems.

The distribution of regeneration is important as well as the overall amount. Figure 17 shows this for native woods as a whole, after removing the polygons which were predominantly young planted native woods, so that the data relate to natural regeneration and not planted areas.

Figure 17. Natural Regeneration: frequency distribution of established regeneration cover classes for all native woodlands



Note: Excludes areas of planted Established Regeneration.

* Area in each cover class expressed as a % of total native woodland area.

** Expressed as a % of total canopy cover.

Box 7: Is there enough natural regeneration to sustain our native woods for the future?

It is not possible to answer this question only from data on the current stocking or cover of young trees. We also need to predict the survival and growth rates as these will determine how many saplings can eventually develop into mature trees.

There is little hard evidence to guide us on these points. One recent study that helps was carried out at Glentress Forest in the Scottish Borders (Kerr and Mackintosh, 2012). It analysed survival of individual seedlings over a 19 year period in an area of mixed conifer and broadleaved forest that is being managed to develop continuous cover forest conditions.

Sapling mortality across all conifer and broadleaved species averaged 63% over 19 years and exceeded 75% for some species of broadleaves. The study area contained roe deer with some limited culling, with harvesting damage causing some sapling mortality.

The period of time required for the surviving oak and beech saplings to grow from being 1.3m tall to a height at which the stem diameter reaches 7cm, measured at 1.3m in height, was estimated at 20-25 years. This is closely equivalent to the range of the Established Regeneration (ER) structural stage in NWSS, which is 1.0m height to 7cm diameter.

Extrapolating these results to native woods, a period of 15-35 years may be reasonable for the length of the ER period, allowing for a range of tree species and site quality. If we estimate that 1% of the total native woodland area needs to be recruited each year from established regeneration into the 'pole immature' stage, based on a 100 year average regeneration cycle, then the minimum average cover of ER required to achieve this would be 15-35%, assuming low mortality of saplings.

This is a preliminary and imperfect analysis but it is sufficient to show that the current average amounts of ER observed in native woodland through the NWSS (<17%) will be too low overall to sustain all of our native woodland resource unless very low average mortality and browsing rates can be achieved in future.

In addition, some of the NWSS regeneration stage cover is in planted areas. When these areas are discounted the amount and distribution of *natural regeneration* which is in the established regeneration stage can be calculated (Figure 17). Only a quarter of native woods have 20% cover or more of established natural regeneration.

Taken together these analyses suggest that at present natural regeneration is well below the level required overall to sustain our native woodland resource in the long term.

Deadwood and veteran trees

What information does the survey provide and why does it matter?

Deadwood volumes were estimated from one or more plots in each native woodland unit surveyed. NWSS data can be used to estimate mean total deadwood volume per hectare (standing and fallen aggregated) for each type of woodland nationally or across a local authority area.

The biodiversity value of deadwood varies depending on size and tree species as well as whether it is fallen or standing, but overall volume is a reasonable indication of value across the whole of a region such as a local authority area.

Deadwood is an important component of woodland ecosystems. It supports a range of specialist invertebrates, fungi, lichens and bryophytes as well as several birds and bats which use tree holes for nesting/roosting.

Deadwood and dying wood, and especially large dead trees, are typically under-represented in most Scottish woods compared to what might be expected to have accumulated in unmanaged semi-natural forests. More deadwood is often desirable in order to sustain populations of rare and threatened deadwood species in the long term.

The NWSS allows estimates of mean volume of deadwood per hectare for each type of woodland across a local authority area. Analysis is also possible by size classes of deadwood and fallen or standing categories but not for tree species. Volume estimates at individual woodland level would have required much higher sampling intensity and were judged unacceptably expensive.

NWSS surveyors also collected data on veteran trees (see structural diversity results). These are very important for biodiversity and often have historical importance, for example they may indicate a history of wood pasturage (Forestry Commission Scotland, 2009). Veterans support many of the same species that use dead and dying wood and eventually become large standing and fallen dead wood if left in situ. For this reason information on veteran trees should be considered alongside information on deadwood in management planning.

Above: The great spotted woodpecker (Dendrocopos major) depends on old trees and dead wood.

© Peter Cairns/2020VISION

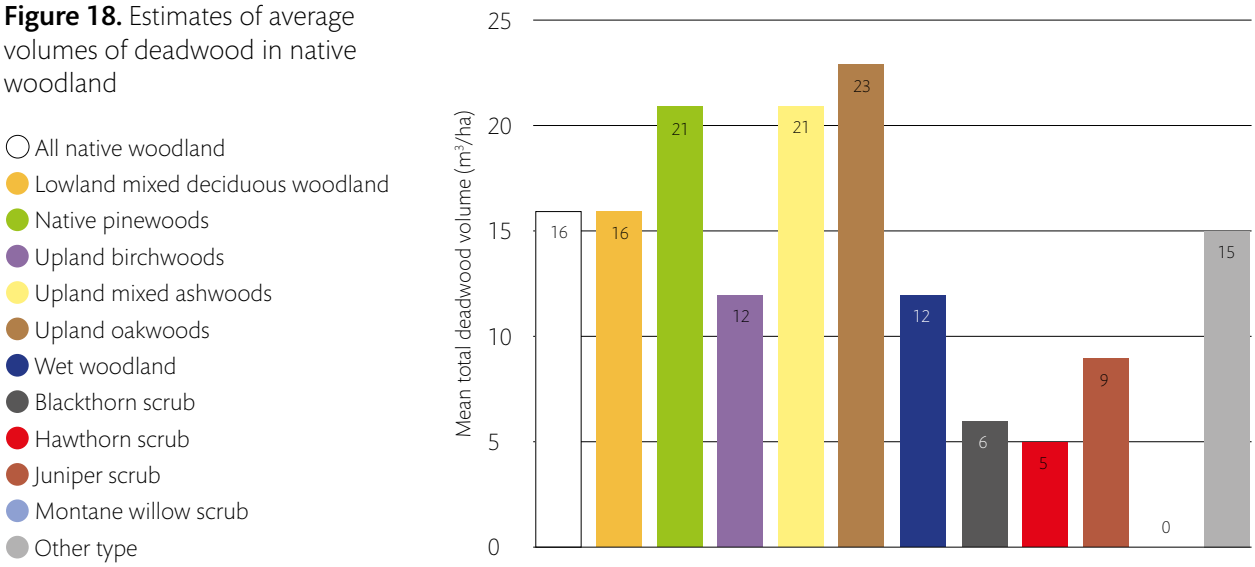
Results

The overall mean deadwood volume in native woods was 16m³/ha (Figure 18).

Average values ranged from 5-9m³/ha in various types of scrub to over 20m³/ha in pine, upland mixed ash woodlands and upland oakwoods. Semi-natural pinewoods had higher amounts (32m³/ha) and ancient semi-natural pinewoods reached 51m³/ha.

The Forestry Commission's guidance on managing for deadwood (Humphrey and Bailey, 2012) suggests that an average of 20m³/ha is desirable for biodiversity in general. The average volume found in the National Inventory of Woodlands and Trees, sampled from 1995-99, was 4.4m³/ha across all woodland types (Forestry Commission Scotland, 2011). On this basis it appears that our native woods have around 4 times as much deadwood as Scottish woodlands as a whole, but some types are not quite at the desired levels.

Figure 18. Estimates of average volumes of deadwood in native woodland



Note: As this data was collected from a limited number of non random plots per polygon it is not possible to apply confidence limits.

Veteran

Table 9. Veteran species records counts and estimated total cover of veteran trees

Habitat category	Veteran Species Record Count*	Estimated Area (ha)
Native woodland	15,770	981
Nearly-native woodland	834	29
PAWS	668	20
Open land habitat	1	-
Total	**17,273**	**1,030**

* The total number of separate species records in polygons, not the total number of trees. A count of 2 for a polygon means 2 species of trees were recorded, each with one or more veterans present.

Table 10. Summary of areas of native woodland with any presence of veteran trees, classed by dominant habitat type

Dominant habitat type	Number of polygons with veterans present	Total Area (ha) of polygons	% area of each type with veterans present
Upland birchwoods	4,517	28,683	35%
Native pinewoods	1,184	19,502	24%
Wet woodlands	1,988	8,416	10%
Upland oakwoods	1,154	7,636	9%
Lowland mixed deciduous woodland	1,447	5,704	7%
Upland mixed ashwoods	754	3,834	5%
Other*	1,175	7,386	9%
Scrub**	76	256	<1%
Grand Total	**12,295**	**81,417**	**100%**

* Other = Unidentifiable Type, Non native, Clear Fell and Acid grassland.

** Native woodland scrub types = Hawthorn, Juniper and Blackthorn Scrub.

Table 11. Veteran species which have a total estimated area exceeding 10 ha across all surveyed polygons*

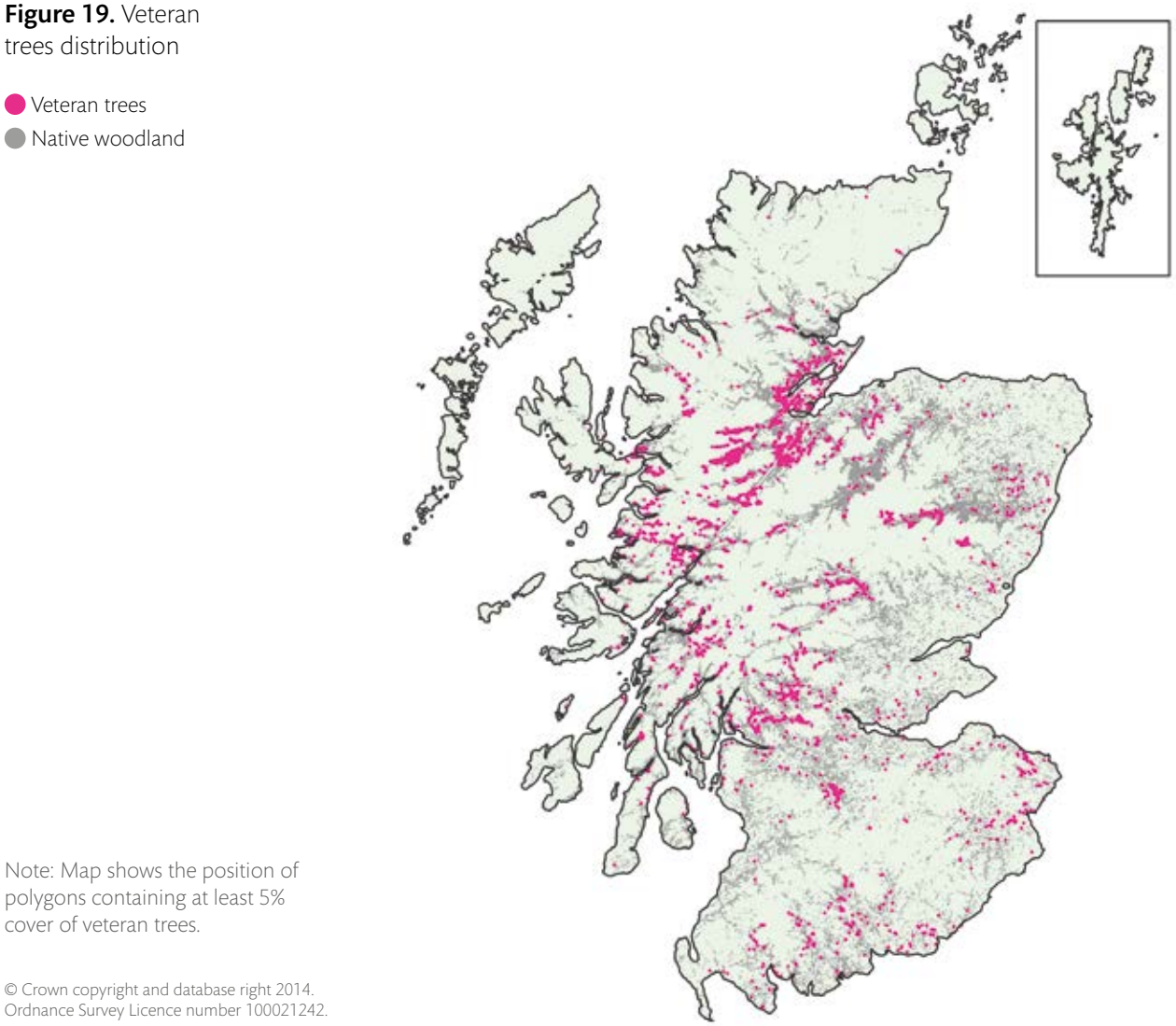
Species	Number of Species Records	Estimated Area (ha)	Percentage of total veteran tree cover
Downy birch	4,839	285	28%
Scots pine	1,726	281	27%
Silver birch	1,558	86	8%
Pedunculate oak	1,379	59	6%
Intermediate oak	590	48	5%
Ash	1,030	44	4%
Common alder	1,215	41	4%
Sessile oak	494	39	4%
Beech	854	28	3%
Birch	162	20	2%
Rowan	695	14	1%
Total	**14,542**	**945**	**92%**
All other species combined	2,731	85	8%
Grand Total	**17,273**	**1,030**	**100%**

* Including native, near-native and PAWS woods.

Table 12. Stocking densities for veteran trees

Stocking Density	Frequency of species records
<100 stems/ha	17,219
100 < 600 stems/ha	46
600 < 1100 stems/ha	8
Grand Total	**17,273**

Figure 19. Veteran trees distribution



Note: Map shows the position of polygons containing at least 5% cover of veteran trees.

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It may be that NWSS has underestimated the number of veteran trees on some of the more infertile sites as the tree diameter thresholds used are perhaps quite high for these slower growing environments (for threshold details, see the survey protocol on NWSS webpages).

Nevertheless, this is the first national stocktake of veteran trees in native and ancient woods. The data will be of considerable value in identifying important areas for conserving species associated with old trees and deadwood, so helping to plan for a future supply of veteran trees. The data can be combined with information on woodland history and data from other inventories, for example those for ancient wood pastures and designed landscapes, to help manage and interpret our historic environment.

Invasive non-native species

What information does the survey provide and why does it matter?

Invasive non-native species (INNS) are a serious potential threat to the biodiversity of native and ancient woods because they exclude native species and, in some cases, may dominate the shrub layer and prevent natural regeneration.

In the survey, data has been collected for invasive non-native plant species in the shrub and field layers. Several individual species which are frequently invasive in Scottish woods are assessed separately: *Rhododendron ponticum*, snowberry, Japanese knotweed, giant hogweed and Himalayan balsam. A category of 'Other herbaceous invasive exotics' has been used for other species encountered.

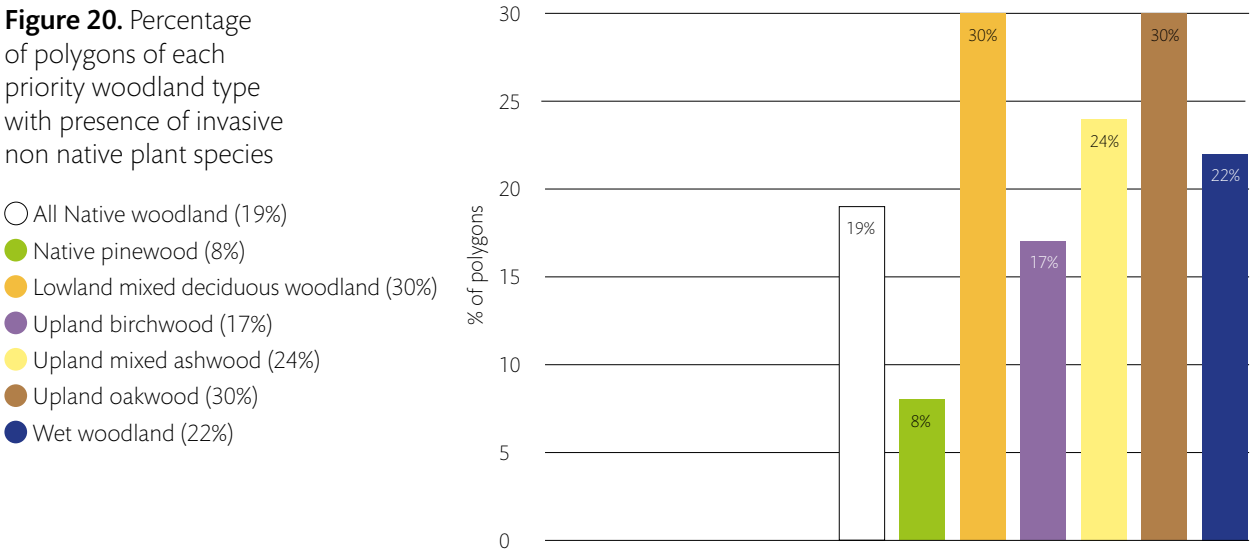
Absence or a low cover (under 10%) of INNS, together with less than 3 species present, is one of the four components of the native woodland condition indicator.

Non–native tree species are not recorded as invasives, but are assessed as part of species composition and structural diversity.

Results

The area of native woodland polygons where some presence of invasive non-native species was recorded totalled 19% of the native woodland area (Figure 20), although invasive species covered just under 2% of the total woodland area (Table 13). The NWSS data allows effort to be targeted to best effect to deal with the threat in local, regional and national planning by revealing the location, cover and size distribution of populations.

Figure 20. Percentage of polygons of each priority woodland type with presence of invasive non native plant species



Some 4.4% of native woodlands overall were outside the desired condition criterion used in the condition index by having over 10% invasives cover **or** 3 or more species/types present.

Table 13. Extent of recorded invasive non-native shrub and field layer species in native woods

Species	Area of invasives (ha)	%	% total native woodland area
Rhododendron ponticum	3,691	65%	1.2
Other herbaceous invasive exotics	1,468	26%	0.5
Himalayan balsam	240	4%	0.1
Japanese knotweed	113	2%	<0.1
Giant hogweed	96	2%	<0.1
Snowberry	46	1%	<0.1
Total	**5,654**	**100%**	**1.8**

Herbivore impact assessment

What information does the survey provide and why does it matter?

The survey recorded overall herbivore impact for each area of native/ancient woodland (see Annex 6). Herbivore impact scores are in four categories: A-low, B-medium, C-high to D-very high herbivore impact in the period leading up to the date of the field work. Symptoms of the more severe impacts can include trampling and/or poaching damage, canopy fragmentation, heavy browsing, bark stripping and the presence of a heavily grazed sward.

Herbivores, especially deer, are an integral part of woodland ecosystems. They are important in influencing woodland regeneration, composition and structure and therefore in shaping woodland wildlife communities.

Some periods with no grazing at all can be neutral for or beneficial for woodland condition, but a long-term absence of herbivores can lead to negative effects for example when dense thickets of young trees develop and shade out ground flora and lower plant species.

However, sustained heavy browsing by deer or sheep prevents woodland regeneration, and this is currently the most widespread threat to the condition of designated woodland features (Scottish Natural Heritage, 2010).

A low or medium level of herbivore impact (i.e. values of A or B) is one of the four required attributes for good ecosystem health in the native woodland condition indicator (page 47).

A low rating (A) indicates that natural regeneration is unlikely to be inhibited by herbivore impact. In general this is the ideal level for optimum woodland condition over the long term. However it may not be desirable in every individual wood.

For example, in some upland oakwoods a moderate level of grazing and browsing is desirable to maintain conditions for woodland bryophytes or lichens. In some native woods managed as wood pasture, moderate or high grazing levels are desirable for most of the time.

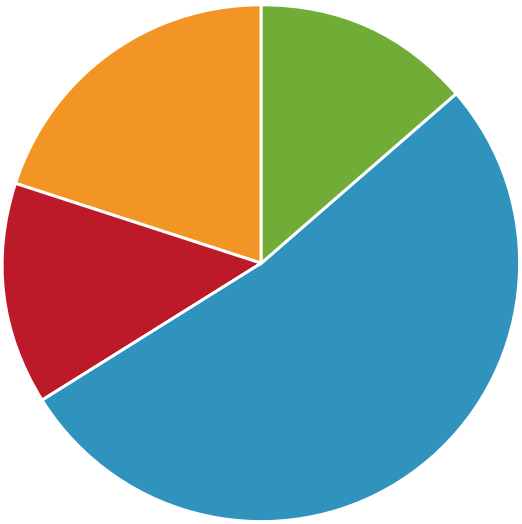
The herbivore impact score is valuable as a general indication, but each site needs to be considered on its merits.

Results

Nationally 33% of native woods were in the high or very high impact categories (C and D), which would be likely to prevent successful tree and shrub regeneration of most species in most cases if the impact were to be maintained at that level (see Figure 21).

Figure 21. Herbivore impact in native woods - the proportion of total area of Scotland's native woods in each category

- Category A Low (14%)
- Category B Medium (53%)
- Category C High (13%)
- Category D Very high (20%)



The medium impact rating (B) was found in just over half of all native woods, meaning that whilst some regeneration will be able to occur, the more vulnerable species may not be able to regenerate in many cases, so the species diversity and the amount of regeneration may be restricted to some extent.

Which herbivores were present?

Surveyors recorded types of herbivore present where this was possible. Deer were recorded as a significant presence (present in at least 5% of the polygon area) in 73% of native woodland areas, livestock in 15%, and rabbits/hares in just 3.5%.

These figures will underestimate true presence as it was not always possible to determine types of herbivore present from field signs.

Above: Red deer stag

© Danny Green/2020VISION

Native woodland condition indicator

What information does the survey provide and why does it matter?

A simple baseline measure from the survey of native woodland condition for biodiversity is helpful for national and regional reporting in relation to the Scottish Biodiversity Strategy (Scottish Government, 2013). Prior to the NWSS there have been no consistent data on extent or condition of native woodlands of any type in Scotland.

A native woodland condition indicator has been developed using measures from the survey that are relevant to every unit area of native woodland, and can indicate ecological health or condition in relation to biodiversity, no matter what the age or type of native woodland.

After testing a variety of measures from pilot study data, four factors were chosen which are critical in influencing biodiversity values and woodland sustainability. These are similar to measures typically used in site condition monitoring for designated woodland features. The four factors are listed with desired values in brackets:

- canopy cover (50-90%);
- percentage of canopy comprising native species (at least 90%);
- herbivore impact (A or B);
- invasive non-native species (not more than 10% cover and less than three invasive species present).

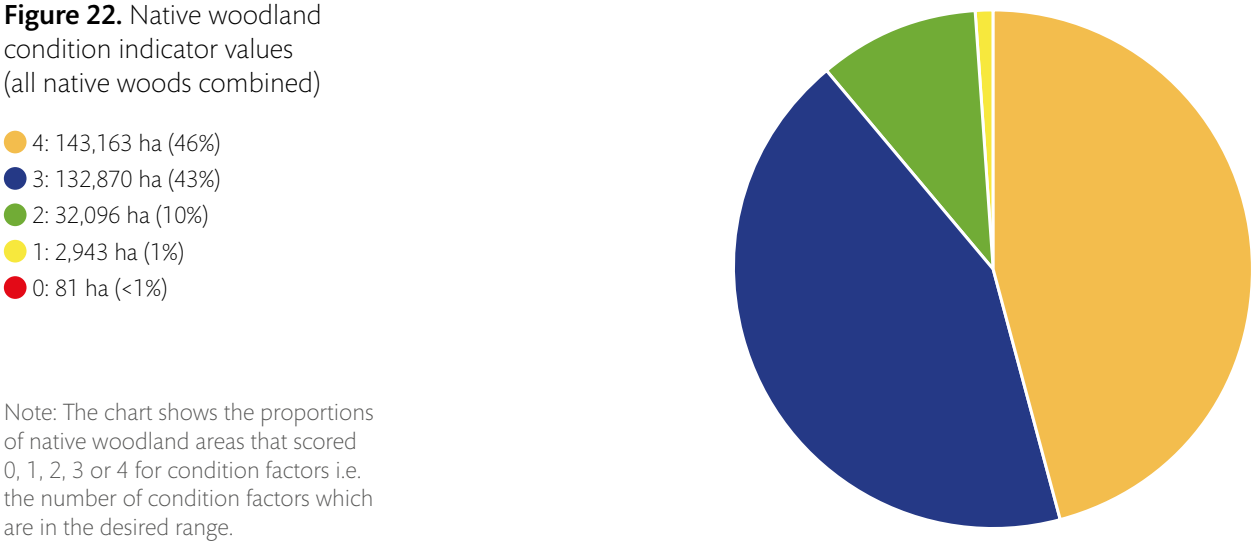
The indicator score is calculated by assessing how much of an area has 0, 1, 2, 3 or 4 attributes in the desired range. This is useful at national and regional level to indicate the proportion of the area of each priority type that is in satisfactory condition for biodiversity and to suggest key issues for action to make improvements.

A generic condition indicator such as this is not very suitable for site assessment because each site is different and the character and management objectives of each site need to be taken into account. More information on the indicator can be seen on the NWSS webpages.

Results

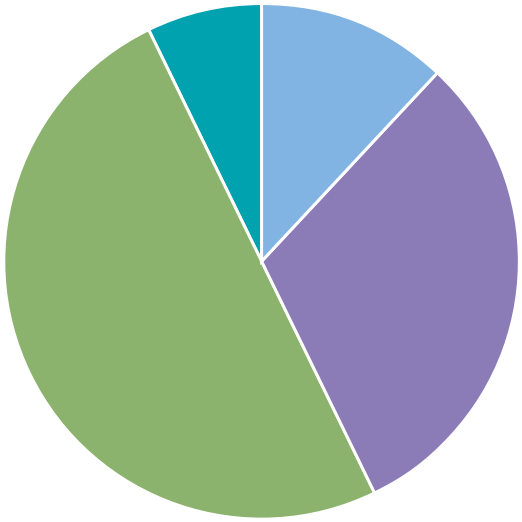
The indicator values showed that 46% of all native woodland area were in satisfactory overall health for biodiversity with an indicator value of 4 (i.e. all condition attributes were in the desired range). A further 43% had an indicator value of 3 and very few areas had two or fewer positive values. Almost 90% of native woods were either satisfactory or could be improved to achieve that by addressing one of the 4 condition factors (see Figure 22 and Annex 7). The most frequent issue to be addressed is herbivore impact, with 33% (103,506 ha) of the total area of native woodlands recorded as suffering high or very high impacts.

Figure 22. Native woodland condition indicator values (all native woods combined)



Note: The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3 or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 23. Breakdown of condition factors which are outside the desired range (all native woods)



Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 22).

Note 2: Some areas are outside the desired range for more than one factor.

Ancient woodland composition and condition

What information does the survey provide and why does it matter?

Because of their long and continuous woodland history, ancient woodlands tend to support a high proportion of rare species, especially the more sedentary ones, as well as having a high cultural heritage value. However, in upland areas the relative importance of ancient woods over more recent woodlands for biodiversity is less than in lowland intensive agricultural landscapes. This is because climate and land use practices in the uplands have created more dynamic woodland boundaries and allow some woodland species to persist in or disperse through unwooded semi-natural habitats.

The current stands of trees on ancient woodlands can be either native species or not, and they can be either semi-natural or planted. Ancient and semi-natural woods are generally the most valuable for conservation, especially where they are still composed entirely of native species.

The survey provides consistent field-based information for the first time on the composition and structure of ancient woods that were identified in SAWI. This information is valuable for planning of work both to improve the condition of current ancient native woods for biodiversity and to restore PAWS areas that are now mainly composed of non-native species back towards native woodland.

Results

The total current area of native woodland on ancient woodland sites (see Table 14) included sites that were formerly estimated in SAWI to be semi-natural as well as areas classed by SAWI as planted. Fig 24 shows the degree of semi-naturalness of all these areas from NWSS data.

The highly semi-natural, native woods on ancient woodland sites found in NWSS might now be considered as the most important native woodlands for nature conservation and likely to have the greatest biodiversity values on average. These can be given the acronym ASNNW (ancient semi-natural native woodland).

Figure 24. Percentage semi-naturalness of ancient woodland surveyed as native woods in NWSS

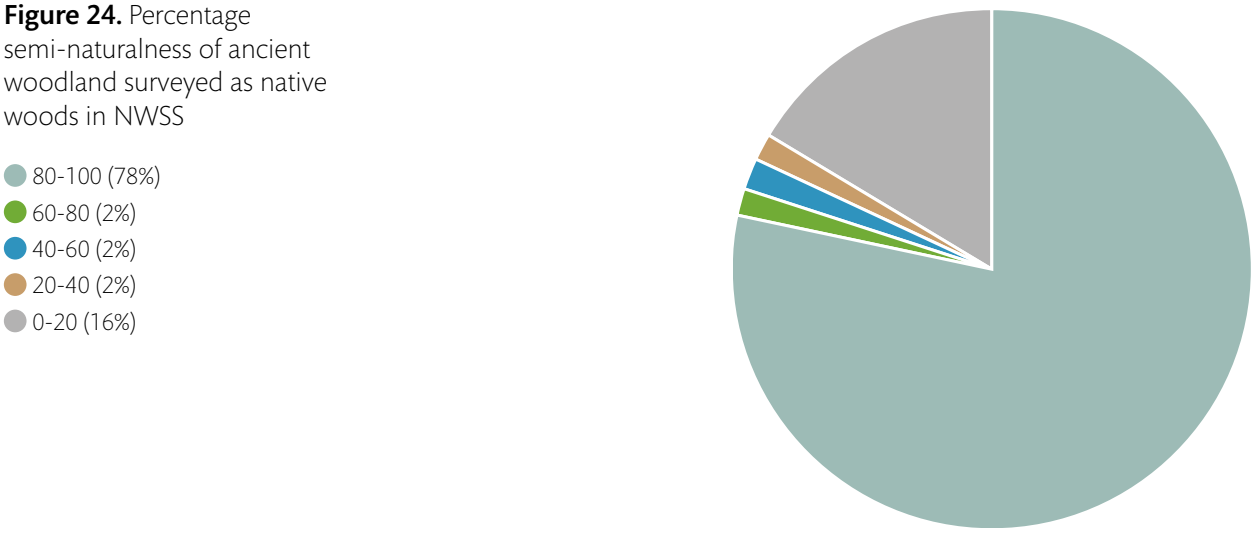


Table 14. Ancient semi-natural and native woodland areas from NWSS data, and their former status in the Scottish Ancient Woodlands Inventory (SAWI)

Status on SAWI	Area of native woodland in NWSS(ha)	Area of highly semi-natural*, native woodland in NWSS (ha) (% of native area)
Ancient, semi-natural	57,308	53,175 (93%)
Ancient, planted	20,621	10,957 (53%)
Ancient total	**77,929**	**64,132 (82%)**

* Highly semi-natural = 80-100% semi-natural class.

Table 15. Condition class summary for ASNNW areas*

Condition class in NWSS	Areas recorded in SAWI as semi-natural (ASNW)	Areas recorded in SAWI as planted (PAWS)	Total area (ha)*	%
0	6	9	15	(-)
1	307	176	483	(1%)
2	3,933	1,599	5,532	(9%)
3	27,146	4,541	31,687	(50%)
4	20,865	4,074	24,939	(40%)
Total	**52,257**	**10,399**	**62,656**	**(100%)**

* This table excludes areas of 'Other' native woods, and scrub which totalled 1,476 ha.

The overall condition of ASNNW, shown in Table 15, was slightly poorer than the average for native woods as a whole (40% is class 4 compared to 46%). This difference is partly explained by the fact that ASNNW excludes planted pinewoods which have higher condition scores than semi-natural pine areas, mainly due to lower herbivore impacts.

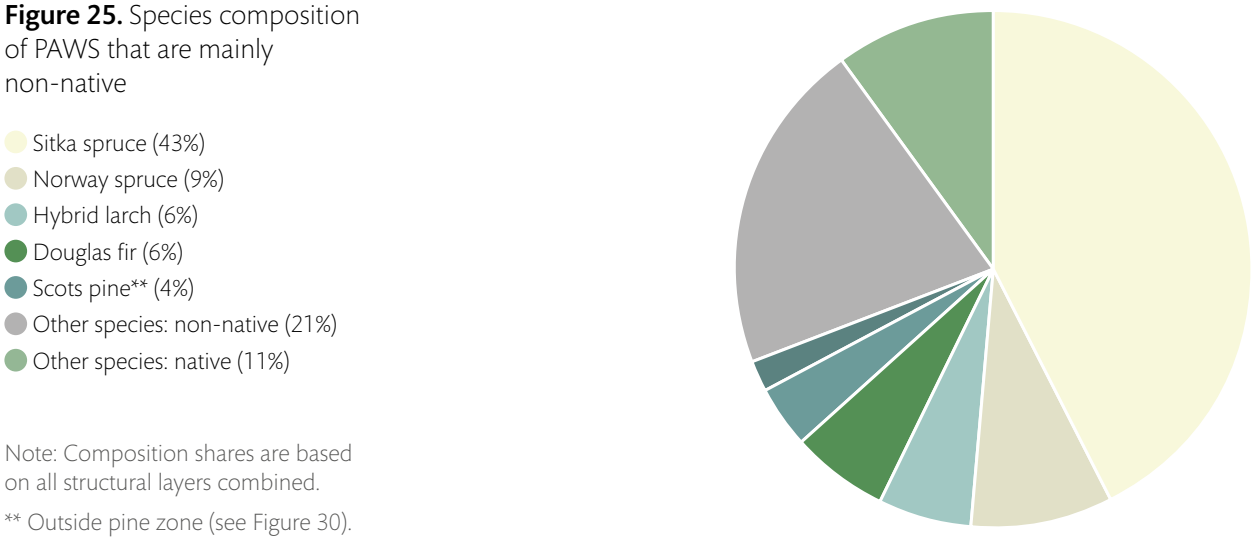
The amount of highly semi-natural native woodland on former PAWS sites is at first sight unexpected. However the SAWI was a provisional map-based inventory without field validation and it has been recognised by Scottish Natural Heritage that areas will have been misclassified because of this (Scottish Natural Heritage, 2009). The results from NWSS could also indicate substantial real changes, including the natural development of some ageing stands and the progress that has been made in protecting and restoring PAWS sites since the 1980s.

Non-native woods on PAWS sites

In the 32,600 ha of PAWS that were fully surveyed in NWSS and were dominated by non-native species, native species made up only 12% of the woodland cover (Figure 25). These woods are likely to be the result of past planting with introduced conifers and broadleaved species. The major species in these non-native woods was Sitka spruce, a heavy shade-casting species which can shade out and suppress the understorey and ground flora.

The PAWS data could be used to identify and prioritise further areas where non-native ancient woods could be restored to native woodland by removing non-native species of trees and invasive shrubs.

Figure 25. Species composition of PAWS that are mainly non-native



Note: Composition shares are based on all structural layers combined.

** Outside pine zone (see Figure 30).

The survey results

Part 3: Native woodland types

This section gives a short account of the area and condition of each of the 6 priority woodland types as well as native scrub woodlands. For further information on the ecology and management of native woodland types see the relevant Forestry Practice Guide (Forestry Commission, 1994a).

Upland birchwoods

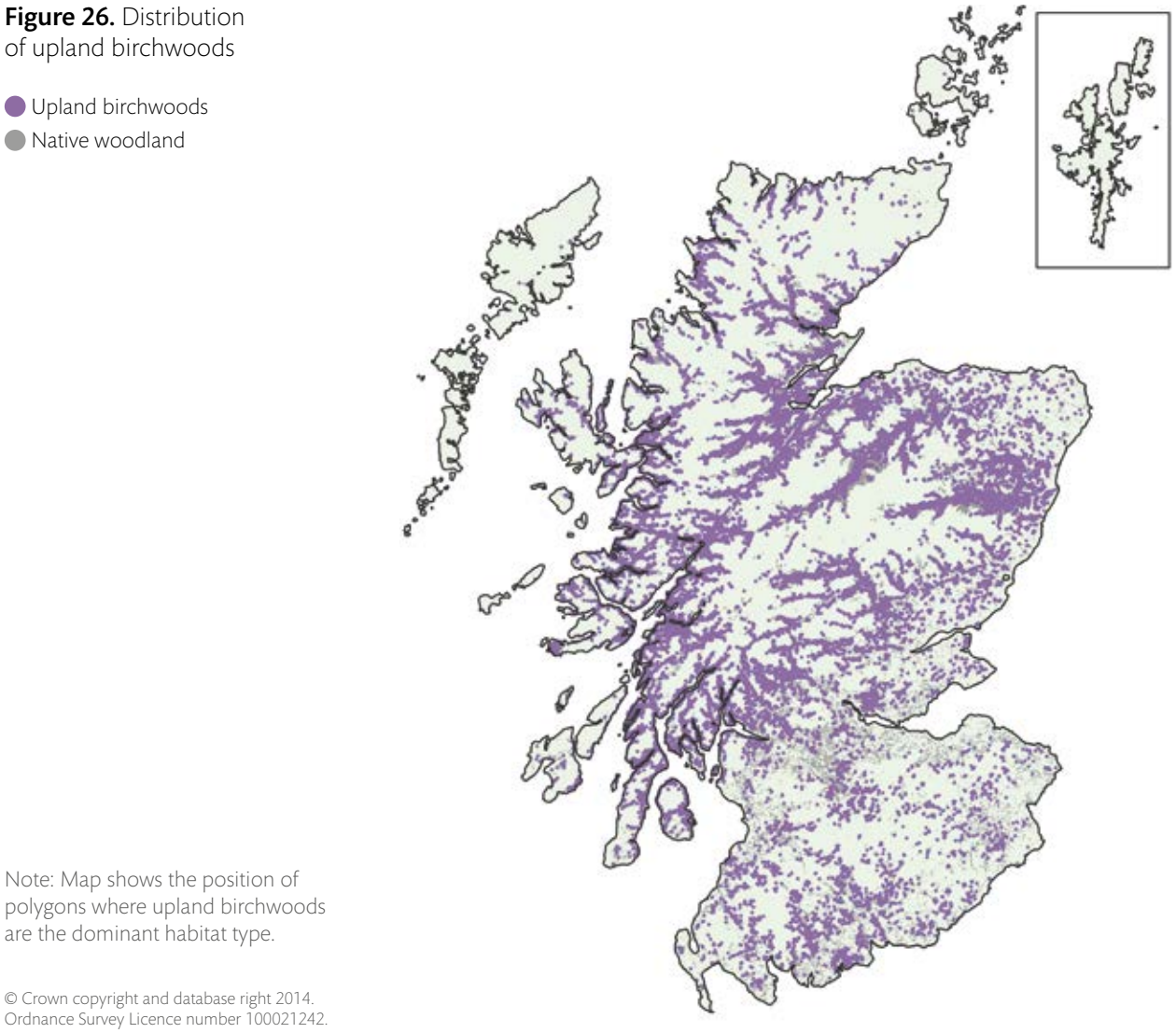
Introduction

Upland birchwoods are found on acid upland soils, (typically above 250 m altitude) including freely draining mineral soils (NVC types W11 and W 17) and some soils with peaty cover. They exclude birch on deeper peat which is classified as wet woodland (most areas of NVC type W4).

This woodland type contains two species of birch as well as rowan, hazel, oak, alder and bird cherry amongst other species. Downy birch *(Betula pubescens)* is hardier and more common in the north and west, and on wet or exposed sites elsewhere. Silver birch *(Betula pendula)* is more suited to east and central Scotland and more fertile sites.

Birchwoods are important for their wildlife and scenic value and can help enrich soil fertility. They range from extensive longstanding tracts to pockets of temporary birch stands in cleared woodland areas. Birches are pioneer species although in parts of the northern highlands birch seems to be a natural dominant and is often the sole species. Elsewhere birch dominance has probably been increased as a result of land management practices leading to fragmentation and loss of other species through overgrazing or burning.

Figure 26. Distribution of upland birchwoods



Note: Map shows the position of polygons where upland birchwoods are the dominant habitat type.

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Area

The area of upland birchwoods identified through the NWSS was 91,235 ha, which was 29% of the total native woodland area, and 88% of birchwoods were highly semi-natural (i.e. recorded as 80-100% semi-natural). Another 700 ha could be added to this from the breakdown of 'Other' native woods in Figure 4.

Previous estimates

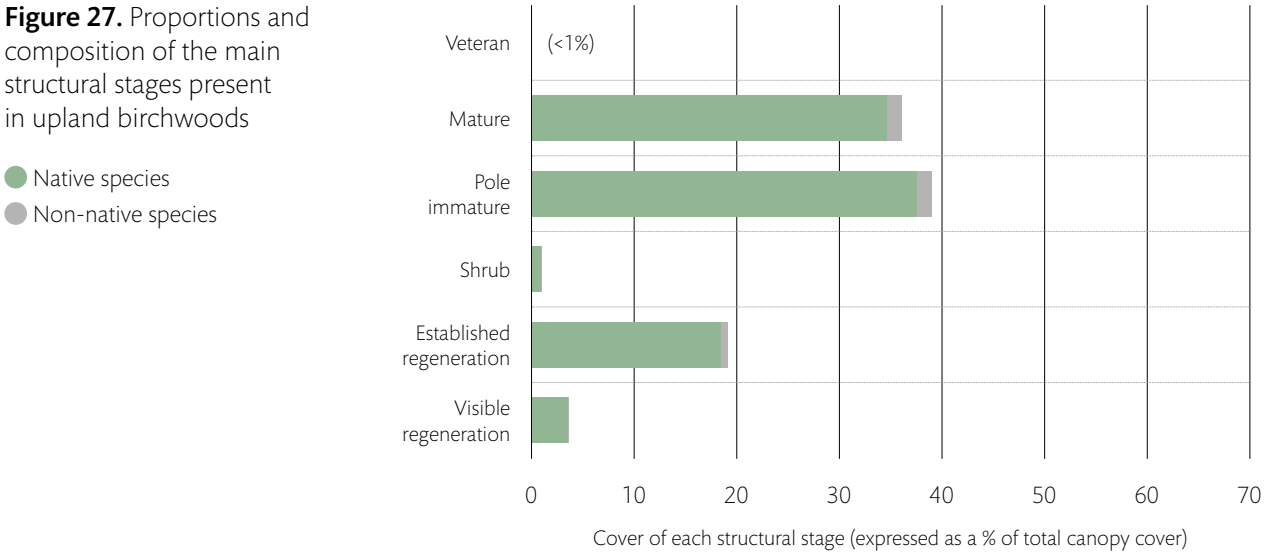
MacKenzie (1999) estimated the area of semi-natural birchwoods to be 64,000 ha. He used data from the National Inventory of Woodlands and Trees (NIWT) and information on planting and other changes up to 1999.

The UK Biodiversity Action Plan estimate for the total area of upland birchwoods in Scotland at 2005 was 90,000 ha, of which 74,000 ha were thought semi-natural and 36,000 ha were estimated to be both ancient and semi-natural (Native Woodland Partnership, 2005; Forestry Commission Scotland, 2006). These figures also included estimates for smaller woods (down to 0.1 ha minimum size), grant-aided woods and Forestry Commission planting and regeneration since 1999.

Table 16. Upland birchwoods: summary profile

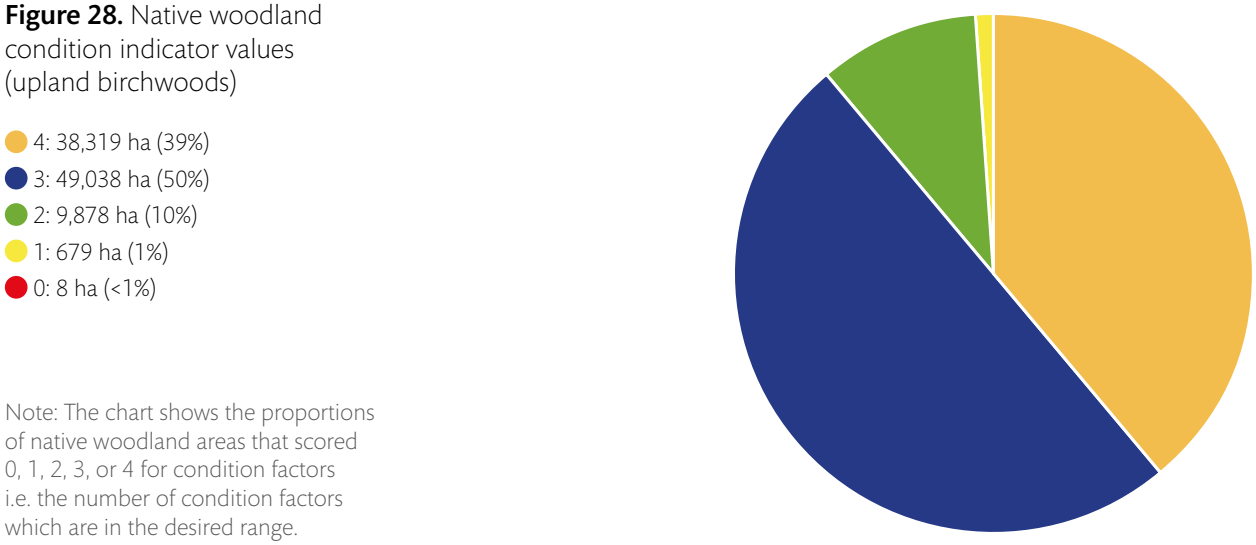
Factor	Values from NWSS	Comments
Area	91,235 ha (29% of total native woods)	700 ha additional area in 'Other' native woods: see Figure 4.
Proportion of highly semi-natural woods (80-100% semi-natural)	88%	
Proportion on ancient woodland sites	31%	
Canopy cover overall	71%	
Native species %	95%	
Top 2 species	Downy birch (54%) Silver birch (20%)	
Structural stage cover (proportions of total canopy cover in each stage) (see Figure 27)	Veteran <1%	More records than any other type; downy birch is the species with most veteran records.
	Mature 36%	
	Pole immature 39%	
	Shrub 1%	
	Established regeneration 19%	Around a quarter of this is planted in new native woods.
	Visible regeneration 4%	
Deadwood	12 m^3/ha	Native woodland average 16m^3/ha.
Invasive plants	Present in 17% of upland birchwoods polygons; overall cover 1,631 ha (1.8% of area)	Rhododendron accounts for 70% of total area.
Herbivore impact	Low/medium 53%	
	High/very high 47%	
Condition scores (see Figure 28)	4 = 39%; 3 = 50%	
Biggest condition issue	Herbivore impact	

Figure 27. Proportions and composition of the main structural stages present in upland birchwoods



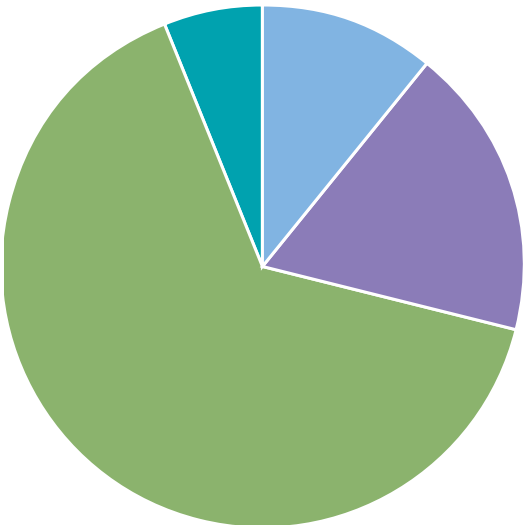
Condition

Figure 28. Native woodland condition indicator values (upland birchwoods)



Note: The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3, or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 29. Breakdown of condition factors which are outside the desired range (upland birchwoods)



Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 28).

Note 2: Some areas are outside the desired range for more than one factor.

Key points

- The birchwood condition score is lower than average. The most widespread problem is herbivore impact for which birchwoods have the greatest proportion of high/very high ratings. This will inhibit future regeneration if maintained.
- Current established regeneration totals are reasonably good, but around a quarter of it is in planted areas (new native woods). The amount of natural regeneration in mature woods is therefore probably too low at present to sustain many of them.
- Canopy cover average seems reasonably healthy given that birch is light demanding and typically regenerates in open glades etc.
- There is a good proportion of pole immature and mature classes and more veterans than in other types. Deadwood volumes are lower than average, perhaps due to the relatively rapid rate of breakdown of birch.
- Invasives, especially *Rhododendron ponticum*, are a significant threat, more than the average for all native woods.

Native pinewoods

Introduction

Native pinewoods are dominated by Scots pine with pockets of birch, rowan and juniper, with alder and willows in wet areas. W18 is the main NVC type with pockets of W4, W7, W11 and W17. The current range accepted for native pinewoods represents the parts of Highland Scotland where they are believed to have been continuously present throughout post-glacial times (Figure 30).

Native pinewoods are listed as a priority woodland type in the EU Habitats and Species Directive where they are described as 'Caledonian pinewoods', and most remnant pinewoods are now designated as Sites of Special Scientific Interest (SSSI's), Special Areas of Conservation (SAC's) or both.

The native pinewoods have been prioritised in policy since the late 1980s following early inventory work in the 1950s (Stephen and Carlisle, 1959) which raised the awareness of the plight of these tiny remnants of a once vast area. Specific grants and guidelines have been in place since 1989 and substantial amounts of work have been done to expand and restore the pinewood area.

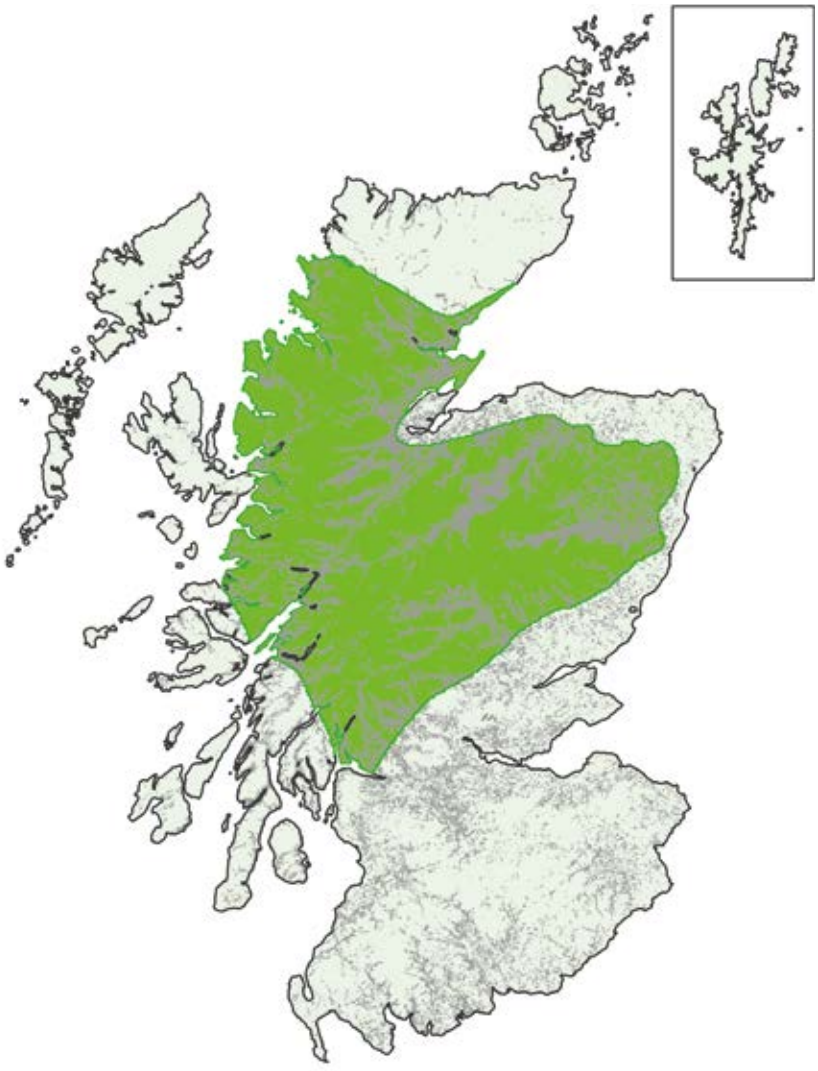


Figure 30. The native pinewood zone used for the NWSS

Based on MacVean and Ratcliffe (1962) and O'Sullivan (1977). For the purposes of the Native Woodland Survey of Scotland a 1km buffer was added and any blocks of Scots pine within the woodland areas allocated to surveyors for field checking which intersected or lay wholly inside that zone were classed as native.

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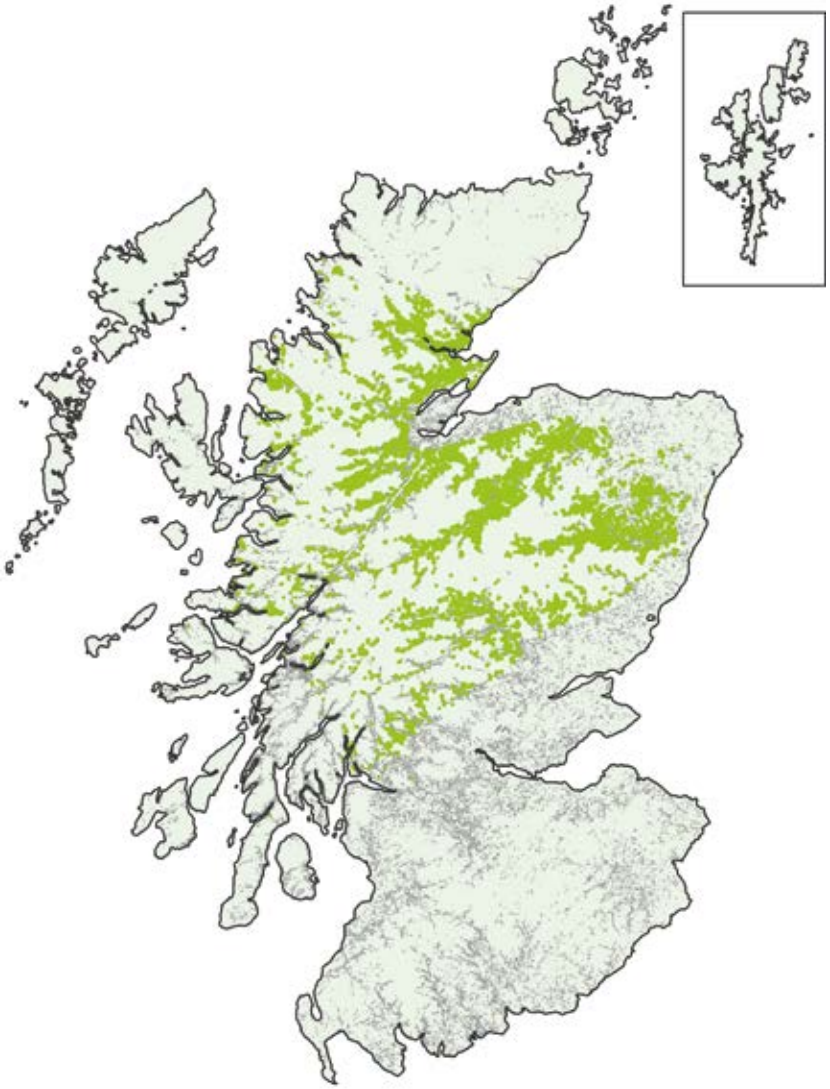
Figure 31. Distribution of native pinewoods

Native pinewoods
Native woodland



Note: Map shows the position of polygons where native pinewoods are the dominant habitat type.

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Total area including semi-natural and planted woods

The area of native pinewoods identified through the NWSS was 87,599 ha which was 28% of the total native woodland area. Another 7,000 ha could be added to this from the breakdown of the 'Other' native woods in Figure 4. The proportion of highly semi-natural pinewood is 22%, calculated from the dominant habitat analysis (80%-100% semi-naturalness classes). Where newly established native woodlands showed evidence of cultivation they were recorded as planted.

Previous estimates

1. The Caledonian Pinewoods Inventory (CPI)

The CPI was a comprehensive inventory of remnant ancient pinewood areas and was initially published in 1994 (Forestry Commission, 1994b). It mapped locations of native pine woodland which were "on the balance of probability genuinely native, that is, descended from one generation to another by natural seeding."

The CPI identified 84 sites and mapped core pinewood areas which appeared to be semi-natural remnants of the original pine forest, surrounded by a "potential regeneration zone" (of circa100m) and then a "buffer zone" (of circa 500m beyond that), within which no Scots pine of non-local origin should be planted. The CPI included areas where the pine appeared semi-natural, averaged 4 trees of at least 2m in height or over per hectare with at least 30 trees in total (although there were exceptions to this for woods of historical, aesthetic or biological significance).

Areas of woodland cover were not assessed as the CPI aimed to map areas of land to protect and expand the remnant pinewoods.

Table 17. Total area of CPI sites (ha)

Pinewood core zone	17,903
Regeneration zone	25,372
Buffer zone	92,045
All zones	**135,320**

Note: These figures show the total land area and not just the wooded area.

2. Native pinewoods as a whole

McKenzie (1999) estimated there were 161,000 ha of native Scots pine in Scotland of which 30,000 ha were estimated to be semi-natural native pinewoods. This estimate was not directly comparable with the NWSS as it did not use pinewood range maps so would have included substantial areas of pine that are outside the native zone, for example along the Moray Firth coast.

The UK Biodiversity Action Plan estimate of total native Scots pine woodland area (above a minimum size of 0.1 ha) was 181,000 ha in 2005. (The Native Woodland Partnership, 2005; Forestry Commission Scotland, 2006). These figures attempted to take into account both small woods from 0.1 ha to 2 ha in size which were largely excluded from the 1999 estimate, and also grant-aided and FC planting and regeneration since 1999.

Previous figures were close to the current NWSS figure for highly semi-natural woods, though there are significant differences between the earlier estimates and NWSS for planted Scots pine stands. It is possible that 2005 estimates did not allow sufficiently for the effect of removing coastal pine when defining the priority woodland type.

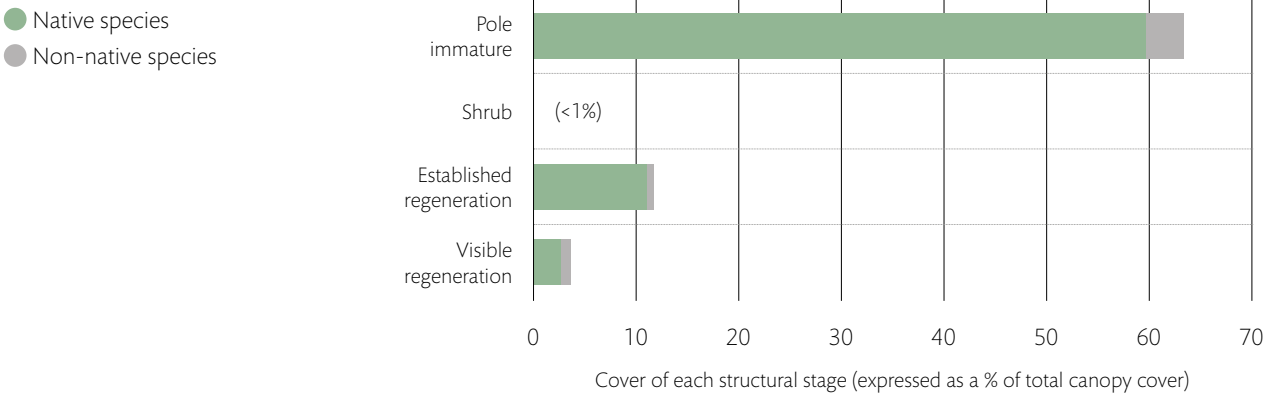
Areas of planted Scots pine forest may also have declined since the 1990s within the pine zone, due to changes in species choice and forest design.

Further work would be needed to explore these issues, including comparisons with National Forest Inventory data.

Table 18. Native pinewoods: summary profile

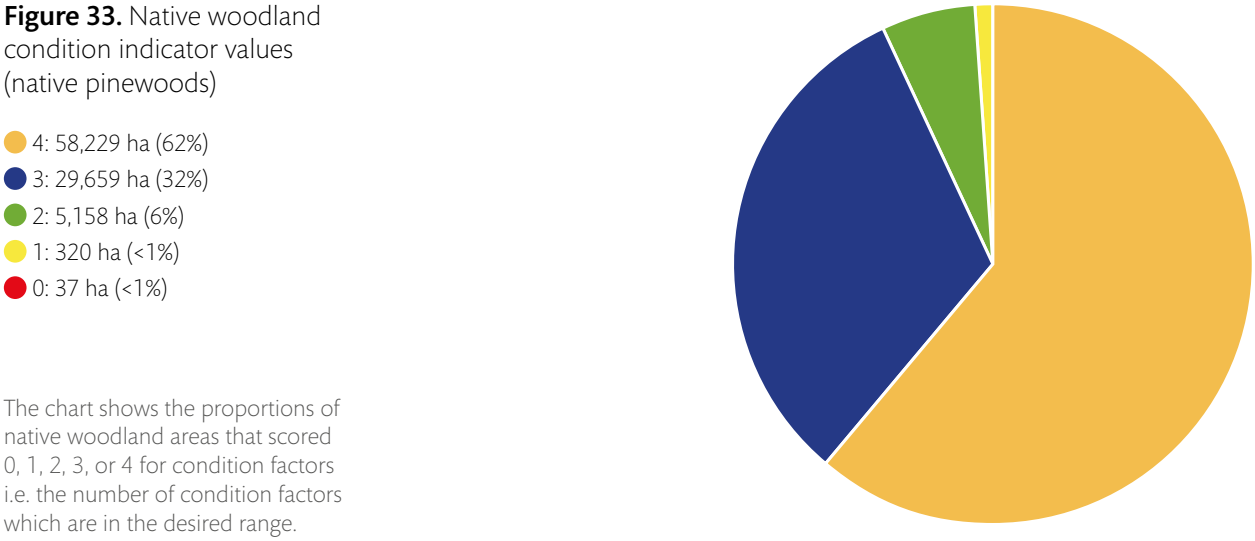
Factor	Values from NWSS	Comments
Area	87,599 ha (28% of total native woods)	7,000 ha additional area in 'Other' native woods: see Figure 4.
Proportion of highly semi-natural woods (80-100% semi-natural)	22%	Many planted stands of SP in older forests and new native pinewood schemes.
Proportion on ancient woodland sites	21%	
Canopy cover overall	74%	68% in semi-natural areas.
Native species %	95%	
Top 2 species	Scots pine 90%, downy birch 2%	Semi-natural areas: Scots pine 88%, downy birch 5%.
Structural stage cover (proportions of each stage) (see Figure 32)	Veteran <1%	Veteran records in 21% of pine wood area Scots pine is 2nd most common veteran tree species in NWSS dataset.
	Mature 19%	Semi-natural areas: 42%
	Pole immature 64%	Semi-natural areas: 44%
	Shrub <1%	Semi-natural areas: 1%
	Established regeneration 12%	Semi-natural areas: 9%
	Visible regeneration 4%	Semi-natural areas: 3%
Deadwood	21 m^3/ha	Semi-natural areas: 32m^3/ha; and 51m^3/ha in ancient semi-natural areas. Native woodland average 16m^3/ha.
Invasive plants	Present in 8% of native pinewood polygons; overall cover 640 ha (0.7% of area)	Rhododendron 57% of total. Higher concentration of invasives in semi-natural areas (1.4% of area).
Herbivore impact	low/medium 78%	Semi-natural areas 65%
	high/very high 22%	Semi-natural areas 35%, rising to 46% for Ancient and semi-natural areas.
Condition scores (see Figure 33)	4 = 62%; 3 = 32%	Semi-natural areas = 52% and 42%.
Biggest condition issue	Herbivore impact	

Figure 32. Proportions and composition of the main structural stages present in native pinewoods



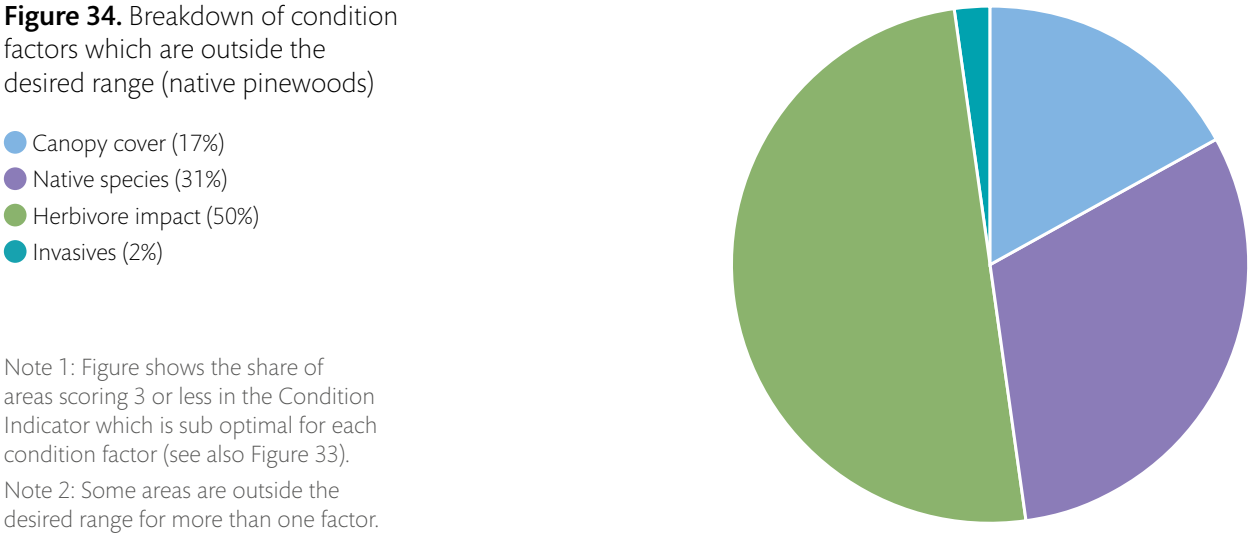
Pinewood condition

Figure 33. Native woodland condition indicator values (native pinewoods)



The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3, or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 34. Breakdown of condition factors which are outside the desired range (native pinewoods)



Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 33).

Note 2: Some areas are outside the desired range for more than one factor.

Key points

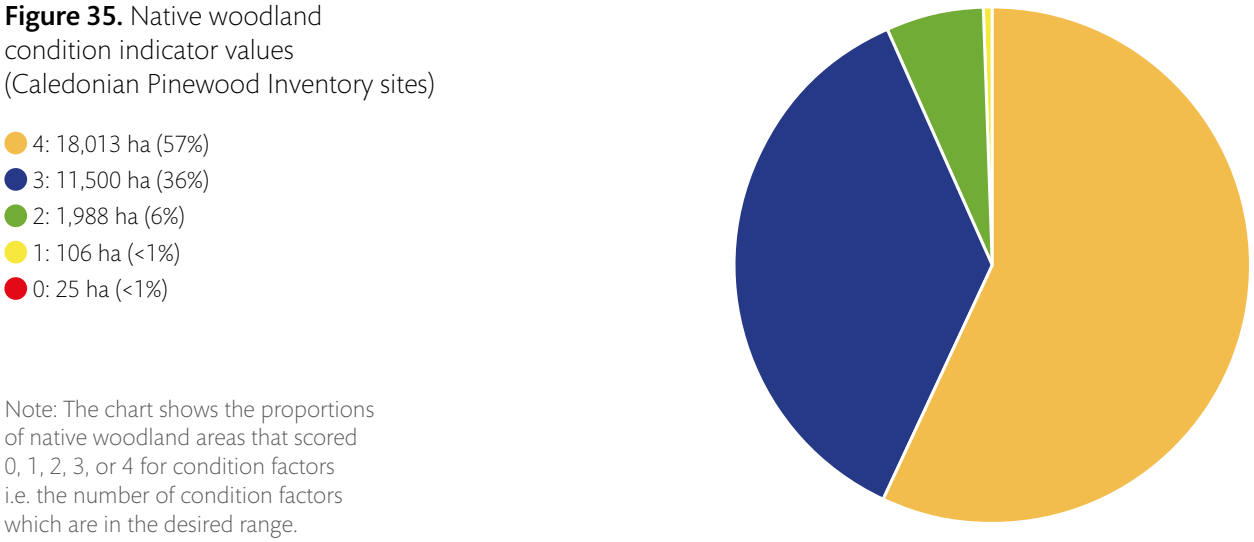
- Low diversity of tree and shrub species even in semi-natural areas. Increasing the proportion of broadleaved species will be important for biodiversity and ecosystem resilience. The need for this is heightened by the current disease threat to pines from Dothistroma Needle Blight (DNB).
- Semi-natural areas are more mature and have much more deadwood, but they also have higher herbivore impacts and are in poorer average condition although still above the overall value for native woods.
- Relatively lower herbivore impact in total figures compared to semi-natural parts may reflect a higher degree of fencing and deer culling in the planted areas, including the new native woods.
- The overall level of established regeneration is low, especially in semi-natural areas. Most of the total is from planted new native woodland areas so natural regeneration is scarce.
- Herbivore impact is the biggest single recorded factor affecting pinewood condition, followed by non-native tree species.

Table 19. Areas of native woodland types in the Caledonian Pinewoods Inventory (CPI) areas within each zone (ha)

CPI Zones	Total land area	Native Woodland area (% of total area)	Native Pine	Upland Birch	Other native woodland types
Core zone	17,903	11,294 (63.1)	9,401	1,243	650
Regen zone	25,372	7,837 (30.9)	5,428	1,649	760
Buffer zone	92,045	12,501 (13.6)	6,986	3,561	1,954
All 3 zones	**135,320**	**31,632 (23.4)**	**21,815**	**6,453**	**3,364**

Note: Native woodland areas in the table exclude native scrub areas which total 293 ha all 3 zones combined.

Figure 35. Native woodland condition indicator values (Caledonian Pinewood Inventory sites)



Note: The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3, or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 36. Breakdown of condition factors which are outside the desired range (Caledonian Pinewoods Inventory sites)

Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 35).

Note 2: Some areas are outside the desired range for more than one factor.

Key points

- The CPI sites are considered the most important historic areas of pinewood but the actual woodland area within the 84 sites is a small proportion of the total native pinewood resource.
- The NWSS has shown that native woodland (mostly pine but some birch and wet woods) occupies 63% of the core zone and 23% of the total CPI area, including regeneration and buffer zones.
- Most of the pinewood in the CPI sites is actually outside the core zones, which emphasises the importance of a holistic approach to managing all three zones in each site.
- 57% of CPI sites have a condition rating of 4, which is similar to other pinewoods and above the overall rating for native woods. Herbivore impacts and low canopy cover are the main factors affecting condition ratings. Invasives and non-native species are at low levels.

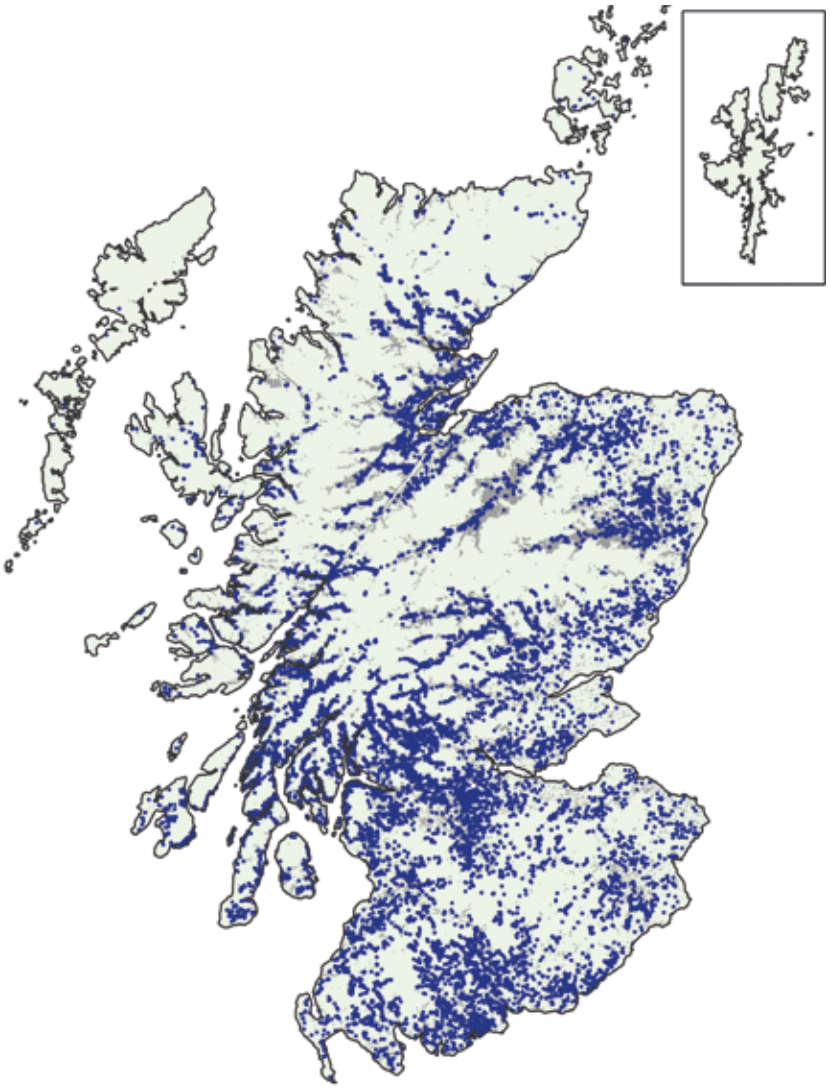
Wet woodland

Introduction

Wet woodland is a category that includes a diverse range of communities on wet sites of different characteristics, and includes 7 main NVC types (W1, 2, 3, 4, 5, 6 & 7). Sub-community W7f is excluded as it is included in upland mixed ashwoods.

Alder, willows and birches are the characteristic dominant trees with pockets of ash, oaks and in places elm, according to the type.

Figure 37. Distribution of wet woodland



Note: Map shows the position of polygons where wet woodland is the dominant habitat type.

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Area

The area of wet woodland identified through the NWSS was 44,742 ha, which was 14% of the total native woodland area, with 82% highly semi-natural (80-100% semi-natural). Another 4,200 ha could be added to this, from the breakdown of 'Other' native woods in Figure 4.

All seven NVC types associated with wet woodlands were found. Most common were W7 and W4, followed by much smaller amounts of W6, W3, W2, W1 and W5 (see Table 4).

Previous estimates

MacKenzie (1999) estimated semi-natural wet woods at 12,000 ha.

The UK Biodiversity Action Plan estimate for the total area of wet woodland in Scotland at 2005 was 21,000 ha, of which 14,000 ha were thought to be semi-natural and 7,000 ha planted (Native Woodland Partnership, 2005; Forestry Commission Scotland, 2006). These figures attempted to take into account both small woods down to 0.1 ha in size and also grant-aided and Forestry Commission planting and regeneration since 1999. Differences in how the W4 NVC community was divided between birchwoods and wet woodland could partly explain the increased area found in NWSS, as well as planting of areas of birch on peaty soils in new native woodland schemes.

Table 20. Wet woodland: summary profile

Factor	Values from NWSS	Comments
Area	44,742 ha (14% of total native woods)	4,200 ha additional area in 'Other' native woods: see Figure 4.
Proportion of highly semi-natural woods (80-100% semi-natural)	82%	
Proportion on ancient woodland sites	19%	
Canopy cover overall	72%	
Native species %	92%	
Top 2 species	Downy birch (30%)	
	Common alder (26%)	
Structural stage cover (proportions of each stage) (see Figure 38)	Veteran (<1%)	Veterans present in 23% of wet wood areas; downy birch and alder are the commonest species.
	Mature 33%	
	Pole immature 39%	
	Shrub 2%	
	Established regeneration 22%	
	Visible regeneration 4%	
Deadwood	12 m^3/ha	Native woodland average 16m^3/ha.
Invasive plants	Present in 22% of wet woodland polygons; overall cover 7,334 ha (1.6% of area)	Rhododendron 50% and 'Other herbaceous invasive exotics' = 30% of total.
Herbivore impact	Low/medium 70%	
	High/very high 30%	
Condition scores (see Figure 39)	4 = 46%; 3 = 43%	
Biggest condition issue	Herbivore impact	

Figure 38. Proportions and composition of the main structural stages present in wet woodlands

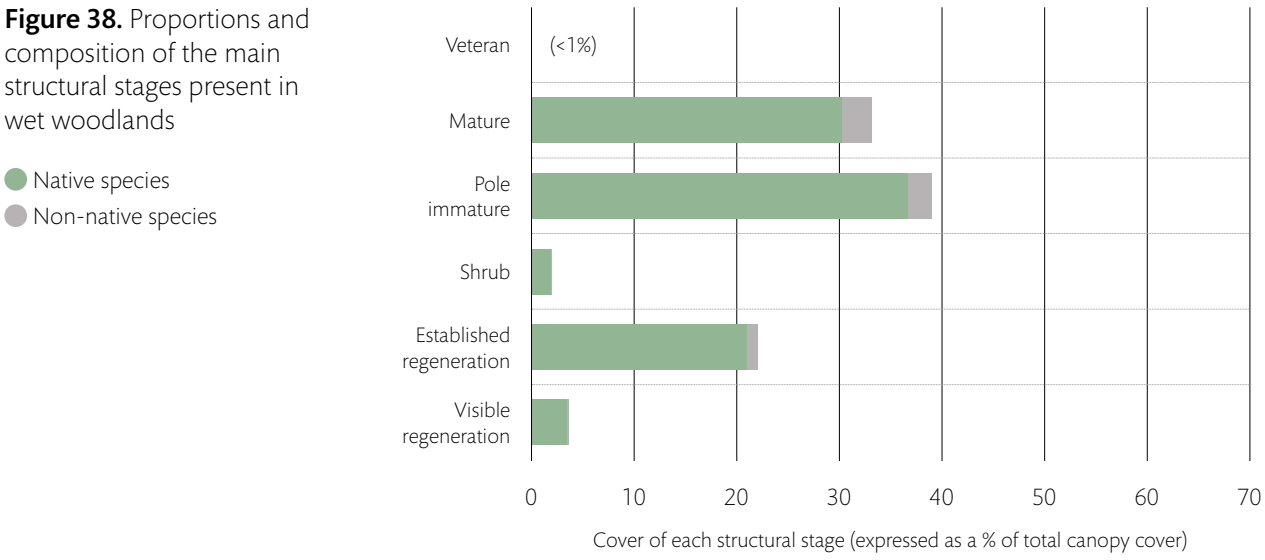
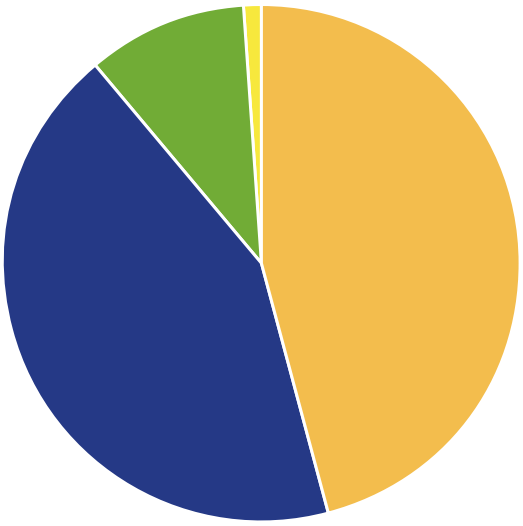
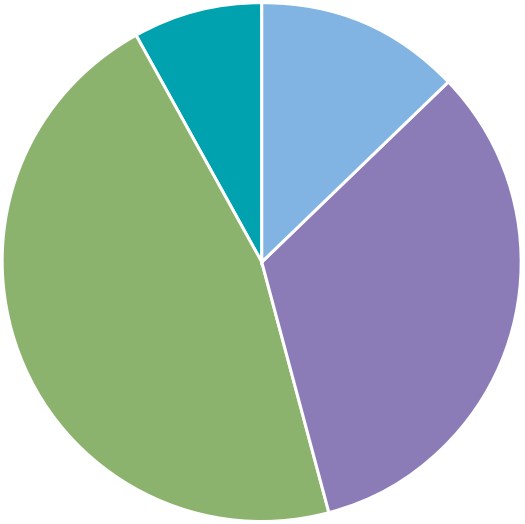


Figure 39. Native woodland condition indicator values (wet woodland)



Note: The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3, or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 40. Breakdown of condition factors which are outside the desired range (wet woodland)



Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 39).

Note 2: Some areas are outside the desired range for more than one factor.

Key points

- Wet woodland has quite an even spread of structural stages and higher than average cover of established regeneration, though some of this will be from planting in new native woods and may not reflect rates of natural regeneration.
- Herbivore pressures are significant but less than the overall native woodland value.
- The proportion of invasive species is higher than for native woods as a whole, with rhododendron and the category of 'Other herbaceous invasive exotics' being the major threats.
- This woodland type is a complex of several quite distinct ecological sub types, each with distinctive site requirements and character. Further analysis could be helpful in understanding how well each of these subtypes are doing and the issues facing them.

Lowland mixed deciduous woodland

Introduction

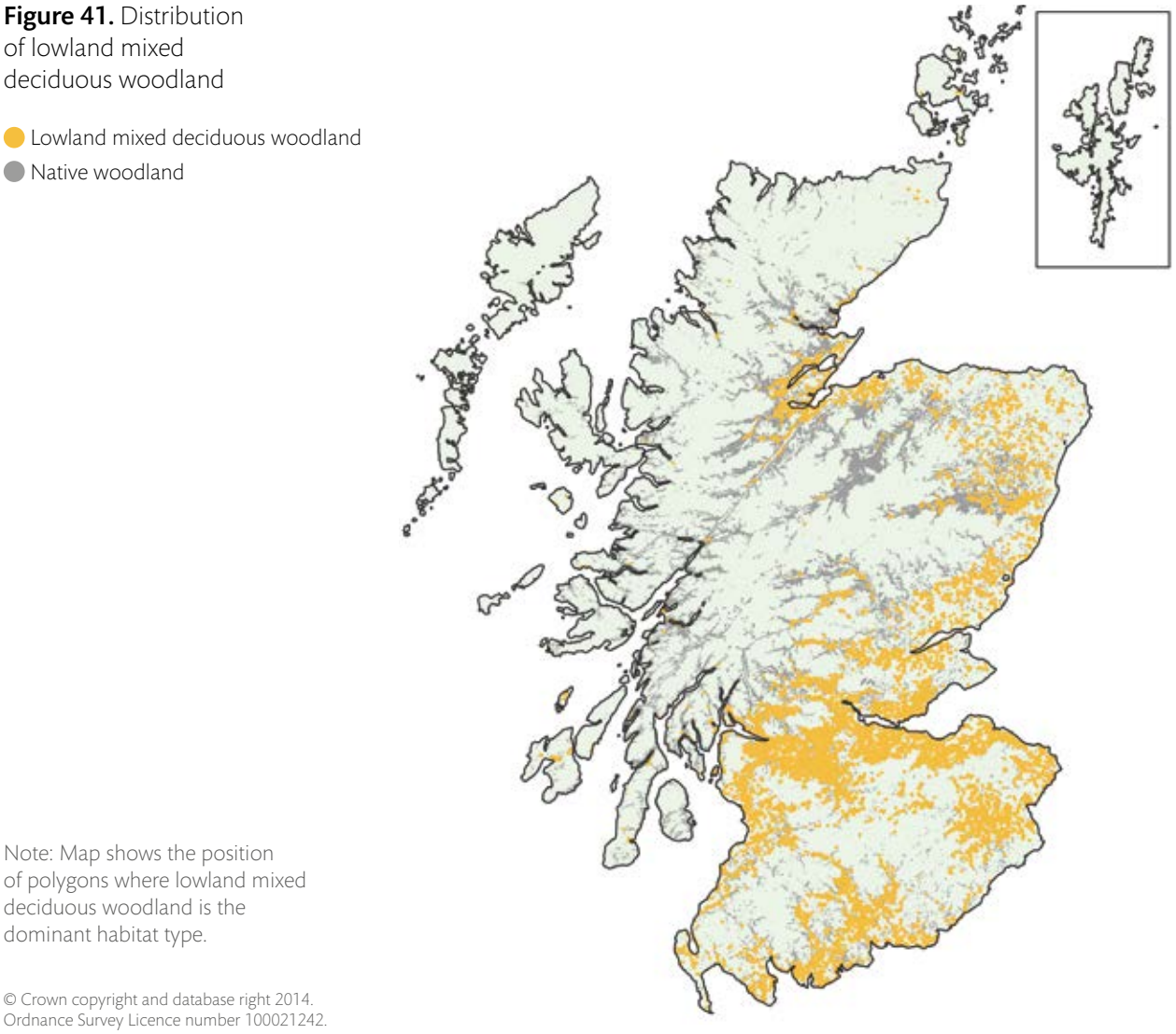
This woodland type is found in lowland regions and penetrating into some straths and coastal areas in upland/lowland margins.

It is a diverse type found on freely drained soils, both base rich and acid. The main NVC types are W10 and W8 with a small amount of the W16 and WLz types.

In Scotland older relics of this type are largely confined to the more inaccessible lowland areas not suitable for agriculture and development, often in river valleys. Some are also found in policy woodlands and parklands where they are often strongly modified by felling and replanting, or by wood pasture management.

A number of woodlands have recently been planted in amenity or farmland settings.

Figure 41. Distribution of lowland mixed deciduous woodland



Note: Map shows the position of polygons where lowland mixed deciduous woodland is the dominant habitat type.

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Area

The area of lowland mixed deciduous woodland identified through the NWSS area was 23,189 ha, which is 8% of all native woods. The type is less strongly semi-natural in character than other broadleaved woodland habitats, but even so 71% of it was in the highest category (80%-100% semi-natural). Another 1,200 ha could be added to the area from the breakdown of 'Other' native woods in Figure 4.

Previous estimates

MacKenzie (1999) estimated semi-natural lowland mixed woods at 3,000 ha.

The UK Biodiversity Action Plan estimate for the total area of lowland mixed woods in Scotland at 2005 was 28,000 ha, of which 10,000 ha were thought semi-natural (Native Woodland Partnership, 2005; Forestry Commission Scotland, 2006). These estimates attempted to take into account both small woods and grant-aided woodlands, as well as Forestry Commission planting and regeneration since 1999.

Table 21. Lowland mixed deciduous woodland (LMDW): summary profile

Factor	Values from NWSS	Comments
Area	23,189 ha (8% of total native woods)	1,200 ha additional area in 'Other' native woods: see Figure 4.
Proportion of highly semi-natural woods (80-100% semi-natural)	71%	
Proportion on ancient woodland sites	13%	Less then any other woodland type.
Canopy cover overall	77%	
Native species %	82%	
Top 2 species	Ash (16%) Pedunculate oak (14%)	Ash is vulnerable to ash dieback *(Chalara fraxinea)*.
Structural stage cover (proportions of each stage) (see Figure 42)	Veteran < 1%	
	Mature 39%	
	Pole immature 40%	
	Shrub 1%	
	Established regeneration 19%	>40% of this in planted areas. Natural regeneration is approximately 11% of overall cover.
	Visible regeneration 2%	
Deadwood	16 m^3/ha	Native woodland average 16m^3/ha.
Invasive plants	Present in 30% of LMDW polygons; overall cover 903 ha (3.9% of area)	Rhododendron 56% of total; other herbaceous species 24%.
Herbivore impact	Low/medium 79%	
	High/very high 21%	
Condition scores (See Figure 43)	4 =27%; 3 = 50%	The lowest % scoring 4 of all the priority woodland types.
Biggest condition issue	Proportion of non-native species	

Figure 42. Proportions and composition of the main structural stages present in lowland mixed deciduous woodland

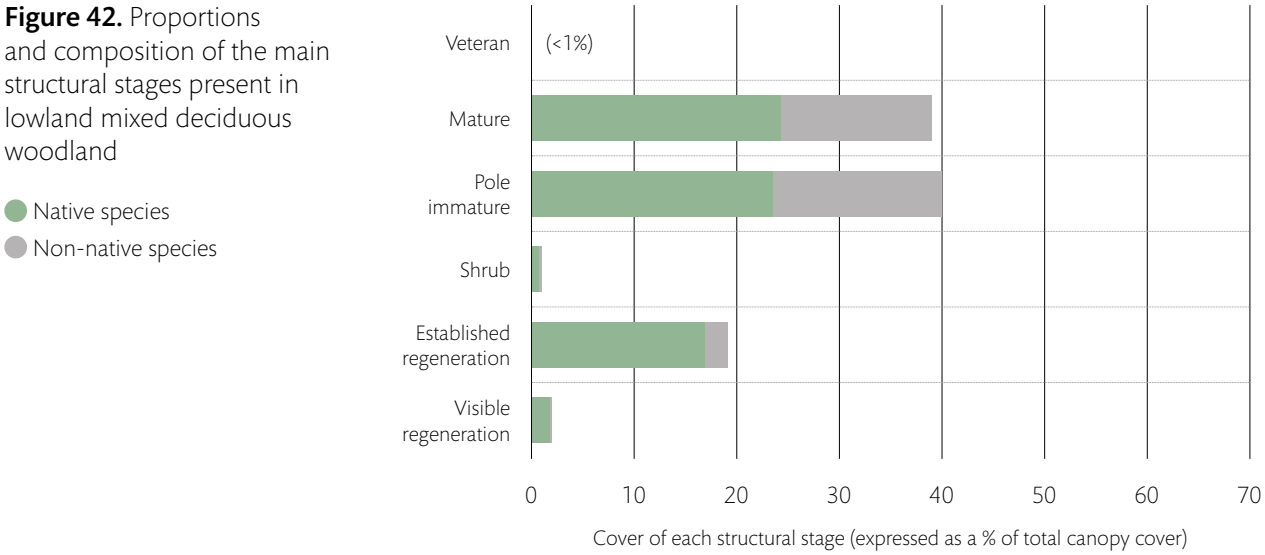
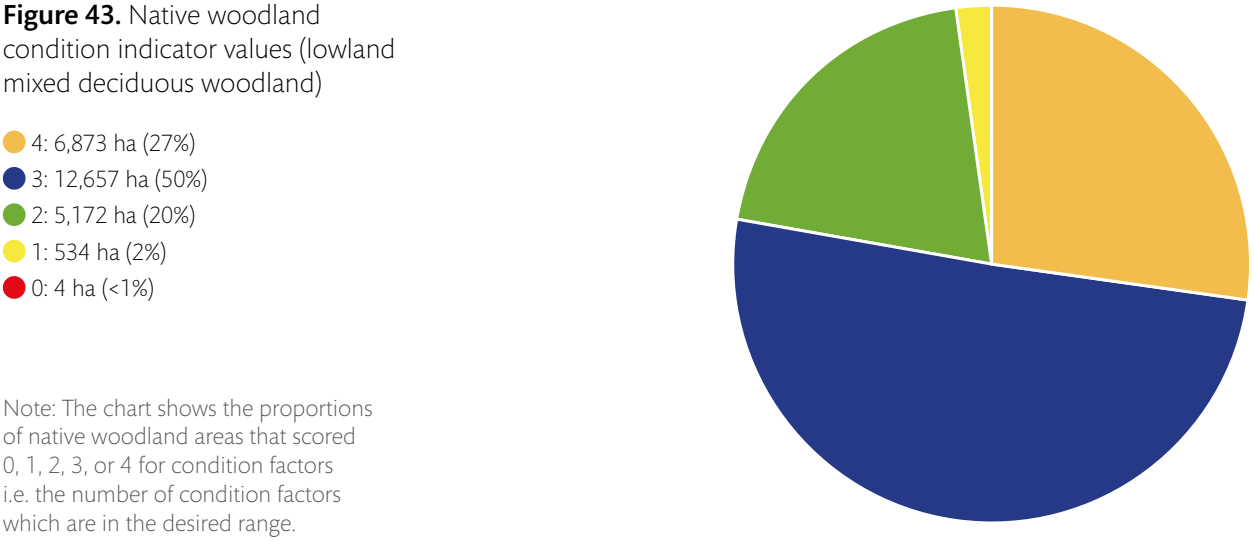
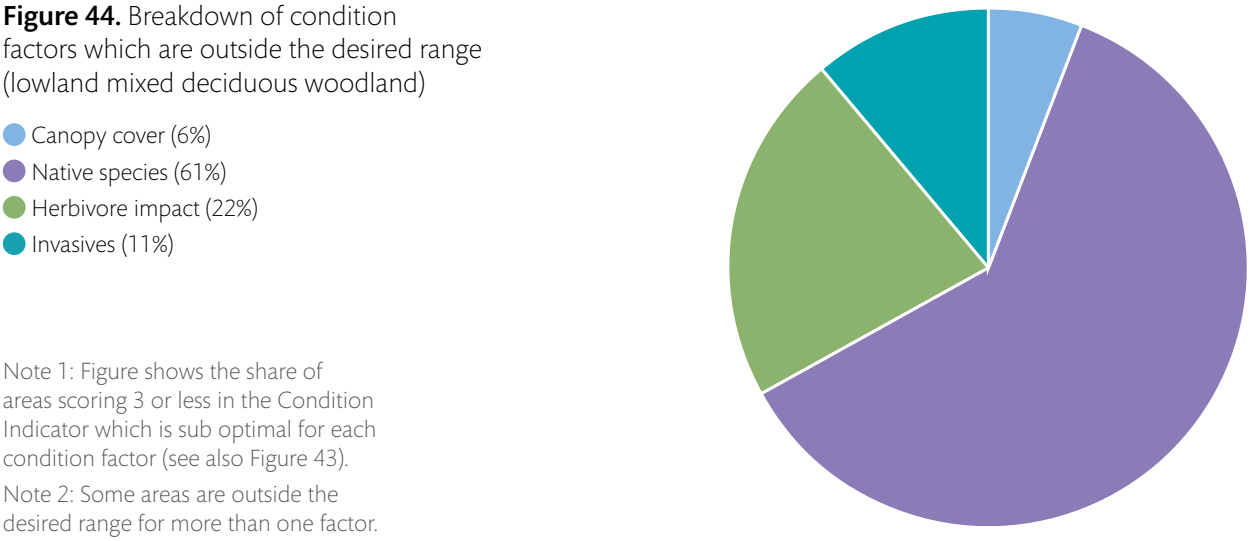


Figure 43. Native woodland condition indicator values (lowland mixed deciduous woodland)



Note: The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3, or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 44. Breakdown of condition factors which are outside the desired range (lowland mixed deciduous woodland)



Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 43).

Note 2: Some areas are outside the desired range for more than one factor.

Key points

- Lowland mixed deciduous woodlands (LMDW) have the lowest proportion of ancient woods, are less semi-natural than other types (except pinewoods) and have the highest proportion of non-native species (18%) and invasive problems (present in 30% of the area).
- These factors reflect their history of management and planting as well as proximity to human settlements, which act as sources for the spread of non-native and invasive species. However, lowland mixed deciduous woods are still largely semi-natural in character overall.
- Overall condition is the lowest of all native woodland types, with just 27% scoring 4. The presence of non-native tree species is the most frequent reason for this.
- Herbivore pressures are less severe than for most other types with just a fifth in the high/very high categories. However, the current spread of deer in lowland Scotland could increase pressure in future.
- The amount of established regeneration is about average for all native woods, but much of it is in recently planted woods and natural regeneration cover is low. Established regeneration is more strongly native in composition than the canopy, which is a positive sign.
- Although rhododendron is most abundant on acid upland sites, it has still established in a lot of lowland mixed deciduous woods, possibly spreading from estates and gardens, and is by far the most widespread invasive species.

Upland oakwoods

Introduction

The upland oakwoods priority woodland type is defined as areas of NVC types W11 or W17 where oak exceeds 30% of the canopy, or has the potential to do so in young stands. Upland oakwoods are typically dominated by oak and birch/oak mixtures often with a component of rowan and alder, and on richer sites ash, hazel, hawthorn, blackthorn and bird cherry. Both pedunculate oak and sessile oak, as well as intermediate forms, are found.

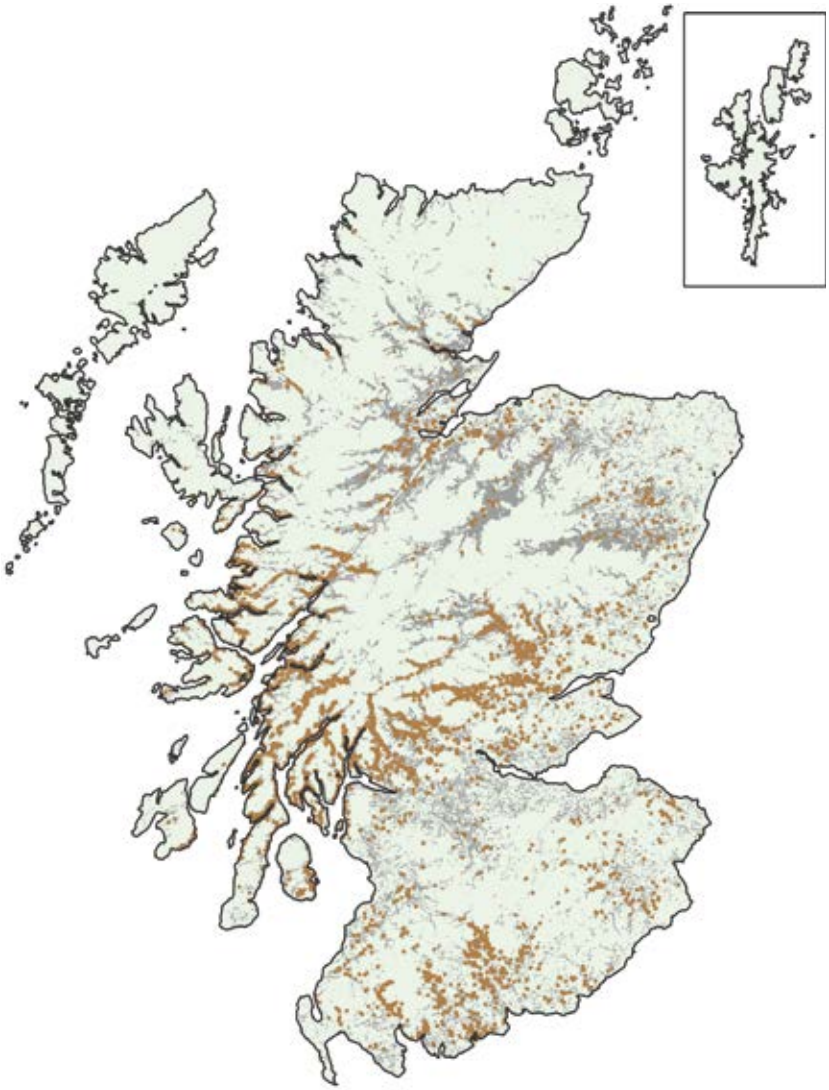
Upland oakwoods are important for biodiversity especially where they form part of the Atlantic woodlands of western Scotland with their internationally important lower plant assemblages. 'Old Sessile oakwoods with Ilex and Blechnum' are recognised in the EU Habitats and Species Directive as a priority type.

Until the mid 20th century upland oakwoods were frequently managed for charcoal production and for tan bark, so many were planted or enriched with oak and had other species removed.

As a result, the current oak dominance evident on many sites is probably not a natural state. Oak does not regenerate prolifically under its own canopy.

Figure 45. Distribution of upland oakwoods

Upland oakwoods
Native woodland



Note: Map shows the position of polygons where upland oakwoods are the dominant habitat type.

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Area

The area of upland oakwoods identified through the NWSS was 19,474 ha, which was 6% of all native woods. Of this 89% was classed as highly semi-natural in current appearance, even though we know that many of the current stands were planted or coppiced. Another 300 ha could be added to this from the breakdown of 'Other' native woods in Figure 4.

Previous estimates

MacKenzie (1999) estimated semi-natural oakwoods at 30,000 ha.

The UK Biodiversity Action Plan estimate for the area of upland oakwoods in Scotland at 2005 was 50,000 ha of which those of semi-natural origin were estimated at 35,000 ha and the planted area at 15,000 ha. (Native Woodland Partnership, 2005; Forestry Commission Scotland, 2006). These figures attempted to take into account small and grant-aided woodlands as well as Forestry Commission planting and regeneration since 1999.

Table 22. Upland oakwoods: summary profile

Factor	Values from NWSS	Comments
Area	19,474 ha (6% of total native woods)	300 ha additional area in 'Other' native woods: see Figure 4.
Proportion of highly semi-natural woods (80-100% semi-natural)	89%	Many known to be planted in 18th/19th century but are now semi-natural in structure.
Proportion on ancient woodland sites	52.%	More than any other woodland type.
Canopy cover overall	77%	
Native species %	93%	
Top 2 species	Pedunculate oak (30%), Sessile oak (19%)	
Structural stage cover (proportions of each stage) (see Figure 46)	Veteran <1%	Collectively oaks are the third most numerous type of veteran tree in all native woods. A third of upland oakwood area has veteran trees present.
	Mature 62%	
	Pole immature 26%	
	Shrub 0%	
	Established regeneration 9%	A fifth of this is in planted areas. Established natural regeneration is around 7%.
	Visible regeneration 2%	
Deadwood	23m^3/ha	Equal highest woodland type. Native woodland average 16m^3/ha.
Invasive plants	Present in 30% of Upland oakwood polygons; overall cover 849 ha (4.4% of area)	Rhododendron is 86% of total.
Herbivore impact	Low/medium 54%	
	High/very high 46%	
Condition scores (see Figure 47)	4 = 36%; 3 = 50%	
Biggest condition issue	Herbivore impact	

Figure 46. Proportions and composition of the main structural stages present in upland oakwoods

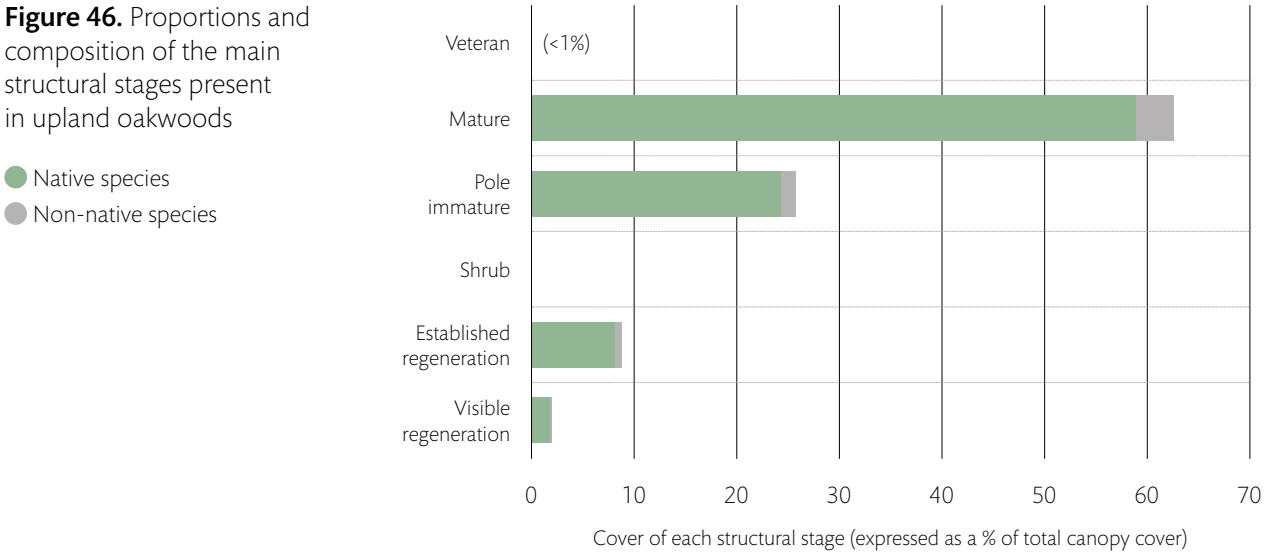
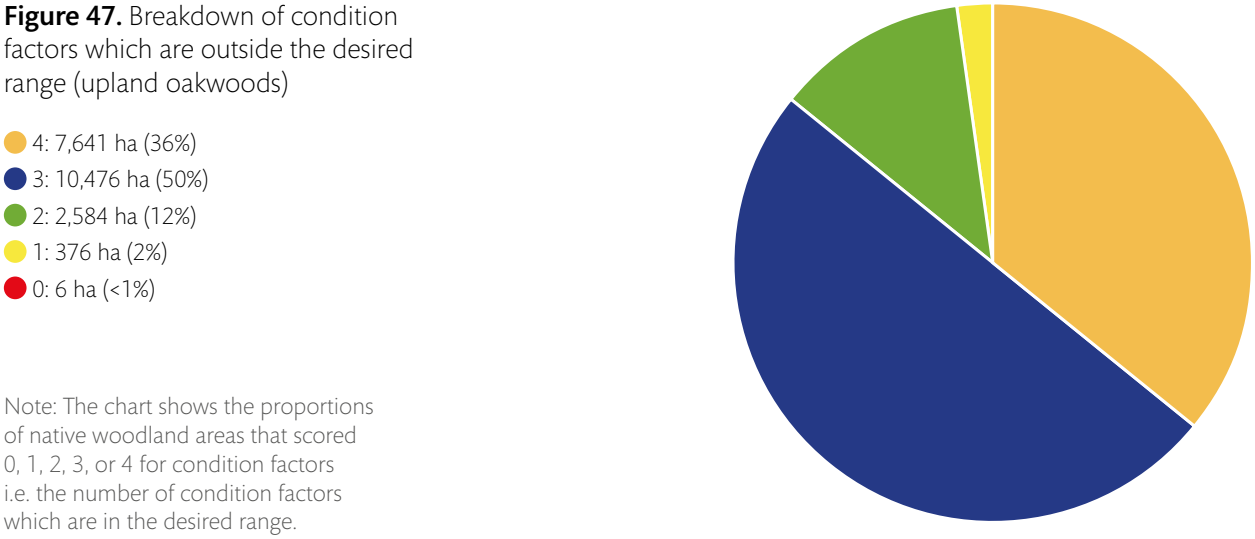
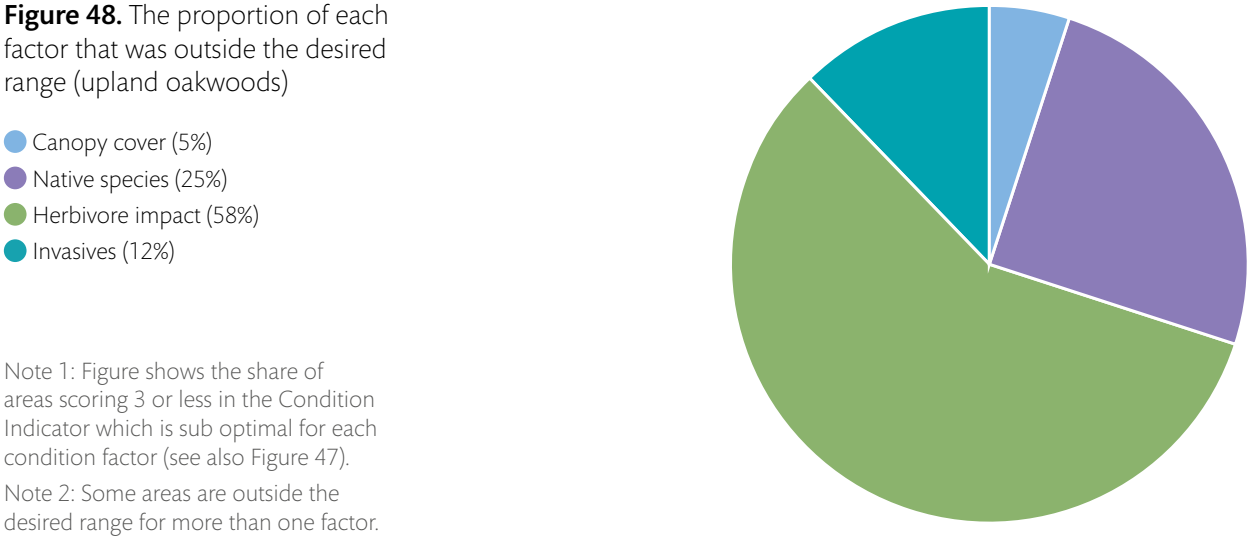


Figure 47. Breakdown of condition factors which are outside the desired range (upland oakwoods)



Note: The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3, or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 48. The proportion of each factor that was outside the desired range (upland oakwoods)



Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 47).

Note 2: Some areas are outside the desired range for more than one factor.

Key points

- Upland oakwoods are significantly less abundant than previously estimated and their condition is relatively poor with only 36% achieving condition score 4. By addressing one factor however, a further 50% could be improved to this rating.
- Herbivore impact is the biggest overall threat but non-native species are also important, as well as the high cover and extent of invasive species, particularly rhododendron.
- Although some regeneration and expansion by planting has occurred in recent years, the high proportion of mature stands and very low level of natural regeneration (around 7% of stocked area) are threats to future sustainability,
- Climate change might add pressures, for example if it favours the spread of rhododendron and increases the interval between good seed-years.
- Deadwood volumes are high compared to other types, which fits with the typically mature canopy and this is good for biodiversity values.

Upland mixed ashwoods

Introduction

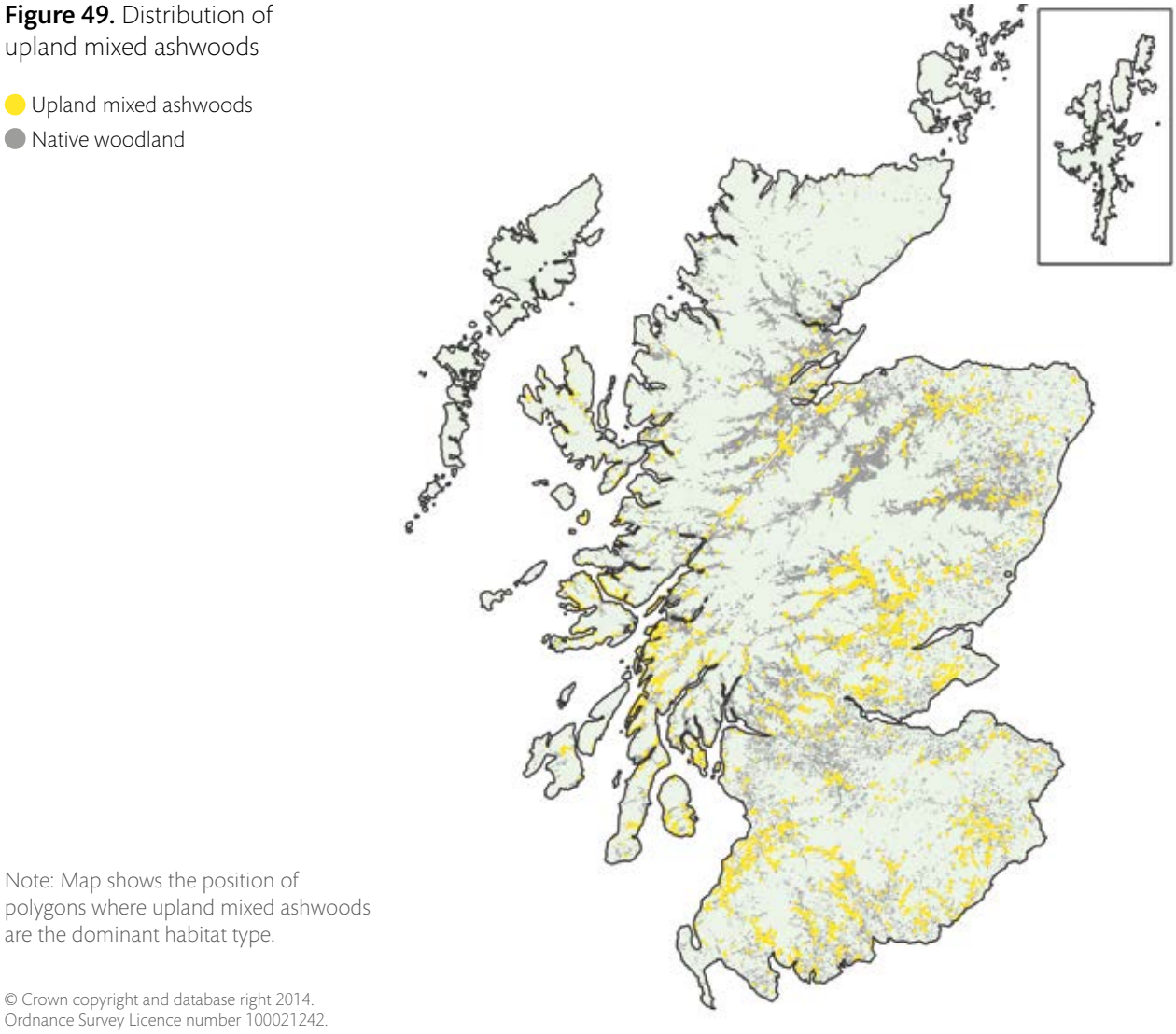
Upland mixed ashwoods (UMA) are found on base rich soils in upland regions throughout the British Isles.

In the NWSS this type included NVC types W9 as well as W7c, with all of NVC type W8 being included in with lowland mixed deciduous woodland. Upland mixed ashwoods are closely related to the EU priority type: 9180 Tilio-Acerion forests of slopes, screes and ravines.

Upland mixed ashwoods are found on moist base-rich soils, typically on lower valley slopes, ravines, river gulleys and on limestone outcrops. They are often found in mosaics with upland birchwoods or upland oakwoods, merging into pockets of lowland mixed deciduous woodland in areas at the upland-lowland interface, for example in the Clyde Valley. They are species-rich for trees and shrubs and also associated wildlife (Worrell, 2013).

As they are found on lime-rich geology, upland mixed ashwoods are often adjacent to good quality agricultural ground which makes expansion difficult.

Figure 49. Distribution of upland mixed ashwoods



Note: Map shows the position of polygons where upland mixed ashwoods are the dominant habitat type.

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Area

Upland mixed ashwoods are the rarest of the six main types of native woodland, with 12,353 ha, or just 4% of all native woodlands identified by the NWSS. They typically occur in small areas associated with areas of wet woodlands or upland birchwoods. Another 1,200 ha could be added to this from the breakdown of 'Other' native woods in Figure 4.

Previous estimates

MacKenzie (1999) estimated semi-natural upland mixed ashwoods at 1,200k ha.

The UK Biodiversity Action Plan estimate for the area of upland oakwoods in Scotland at 2005 was 21,000 ha of which those of semi-natural origin were estimated at 14,000 ha and the planted area at 7,000 ha (Native Woodland Partnership, 2005; Forestry Commission Scotland, 2006). These figures attempted to take into account small and grant-aided as well as FC planting and regeneration since 1999.

Table 23. Upland mixed ashwoods: summary profile

Factor	Values from NWSS	Comments
Area	12,353 ha (4% of total native woods)	1,200 ha additional area in 'Other' native woods: see Figure 4.
Proportion of highly semi-natural woods (80-100% semi-natural)	89%	
Proportion on ancient woodland sites	37%	
Canopy cover overall	78%	
Native species %	90%	
Top 2 species	Ash 25%, Common alder 13%	Ash is at risk from ash dieback *(Chalara fraxinea)*.
Structural stage cover (see Figure 50)	Veteran <1%	A third of the area has some veterans present.
	Mature 43%	
	Pole immature 39%	
	Shrub 1%	
	Established regeneration 15%	Around one tenth of the established regeneration was planted.
	Visible regeneration 1%	
Deadwood	21 m^3/ha	Native woodland average 16m^3/ha.
Invasive plants	Present in 24% of polygons; overall cover 230 ha (1.9% of area)	Rhododendron 53% of total, other herbaceous/invasive exotics = 30%.
Herbivore impact	Low/medium 56%	
	High/very high 44%	
Condition scores (see Figure 51)	4 = 34%; 3 = 46%	
Biggest condition issue	Herbivore impact	

Figure 50. Proportions and composition of the main structural stages present in upland mixed ashwoods

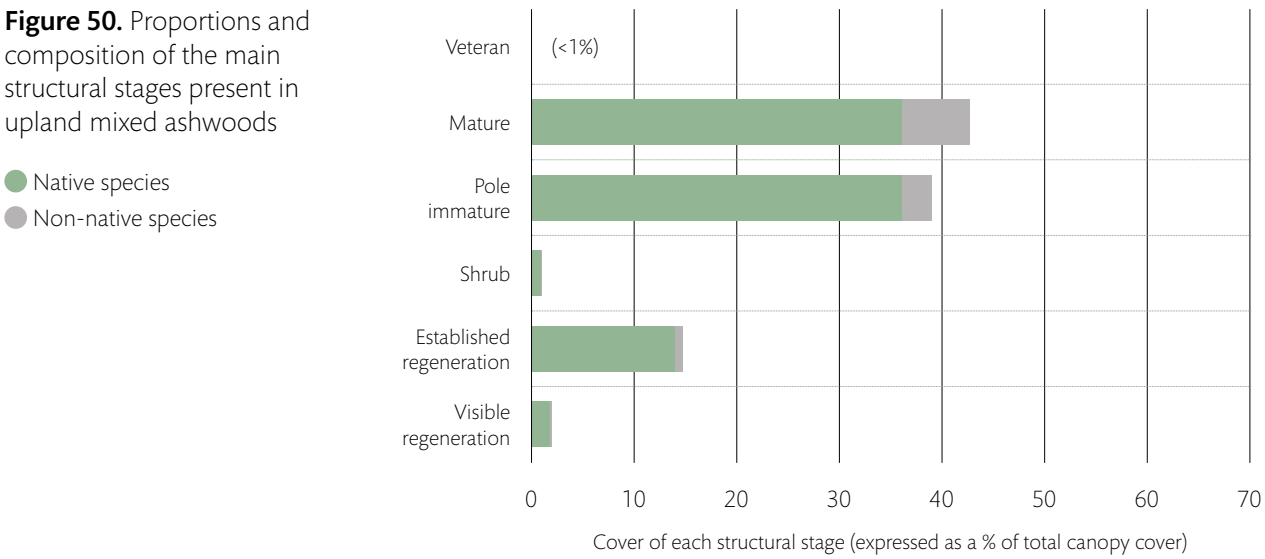
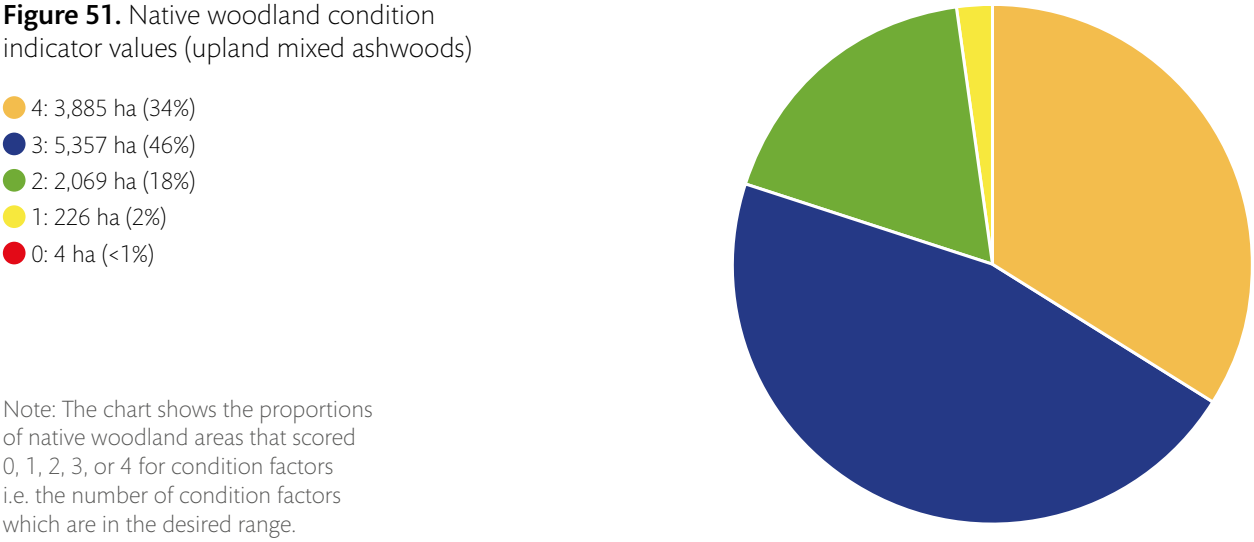
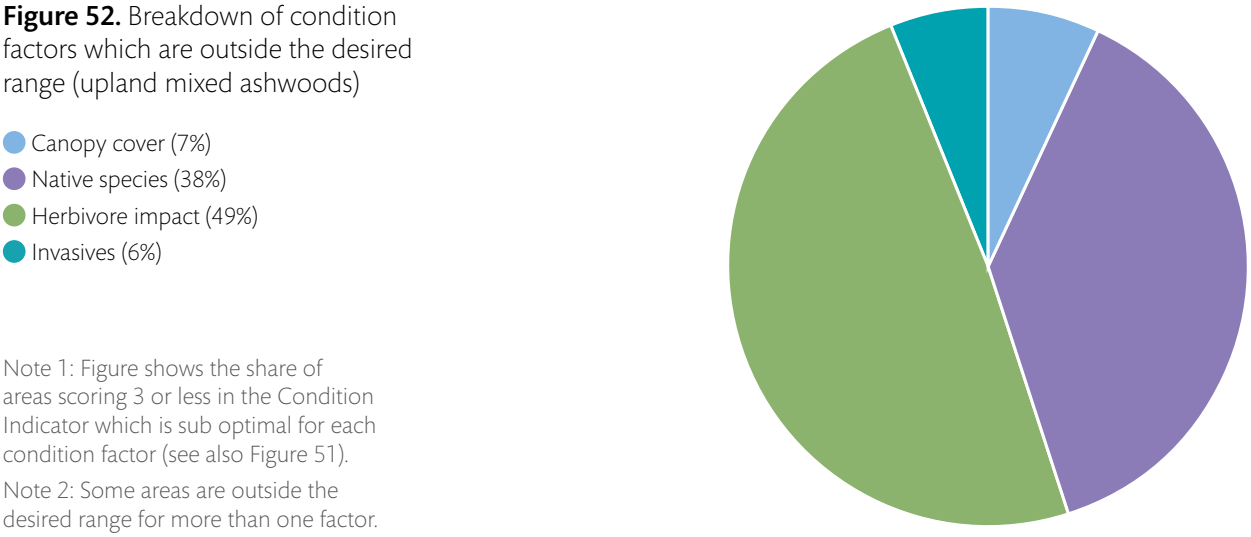


Figure 51. Native woodland condition indicator values (upland mixed ashwoods)



Note: The chart shows the proportions of native woodland areas that scored 0, 1, 2, 3, or 4 for condition factors i.e. the number of condition factors which are in the desired range.

Figure 52. Breakdown of condition factors which are outside the desired range (upland mixed ashwoods)



Note 1: Figure shows the share of areas scoring 3 or less in the Condition Indicator which is sub optimal for each condition factor (see also Figure 51).

Note 2: Some areas are outside the desired range for more than one factor.

Key points

- The condition of upland mixed ashwoods is below the native woodland average, with only 34% having a score of 4, although another 46% could be enhanced to this level by addressing one factor.
- Herbivores and non-native tree species are both important threats, with invasive species also widely distributed.
- Almost all the established regeneration phase cover appears to be from natural regeneration, but the present amount of natural regeneration may be too low to sustain the current area in future.
- Losses of ash from ash dieback *(Chalara fraxinea)* could remove most of the ash, which is currently occupying 25% of cover overall. Further analysis could assess which woods are particularly vulnerable and which have good prospects for other native species that are characteristic of this woodland type to replace ash.
- A strategy for expansion and restoration of this rare woodland type using the full range of associated trees and shrubs could be particularly important to offset potential losses of ash caused by *Chalara fraxinea*.

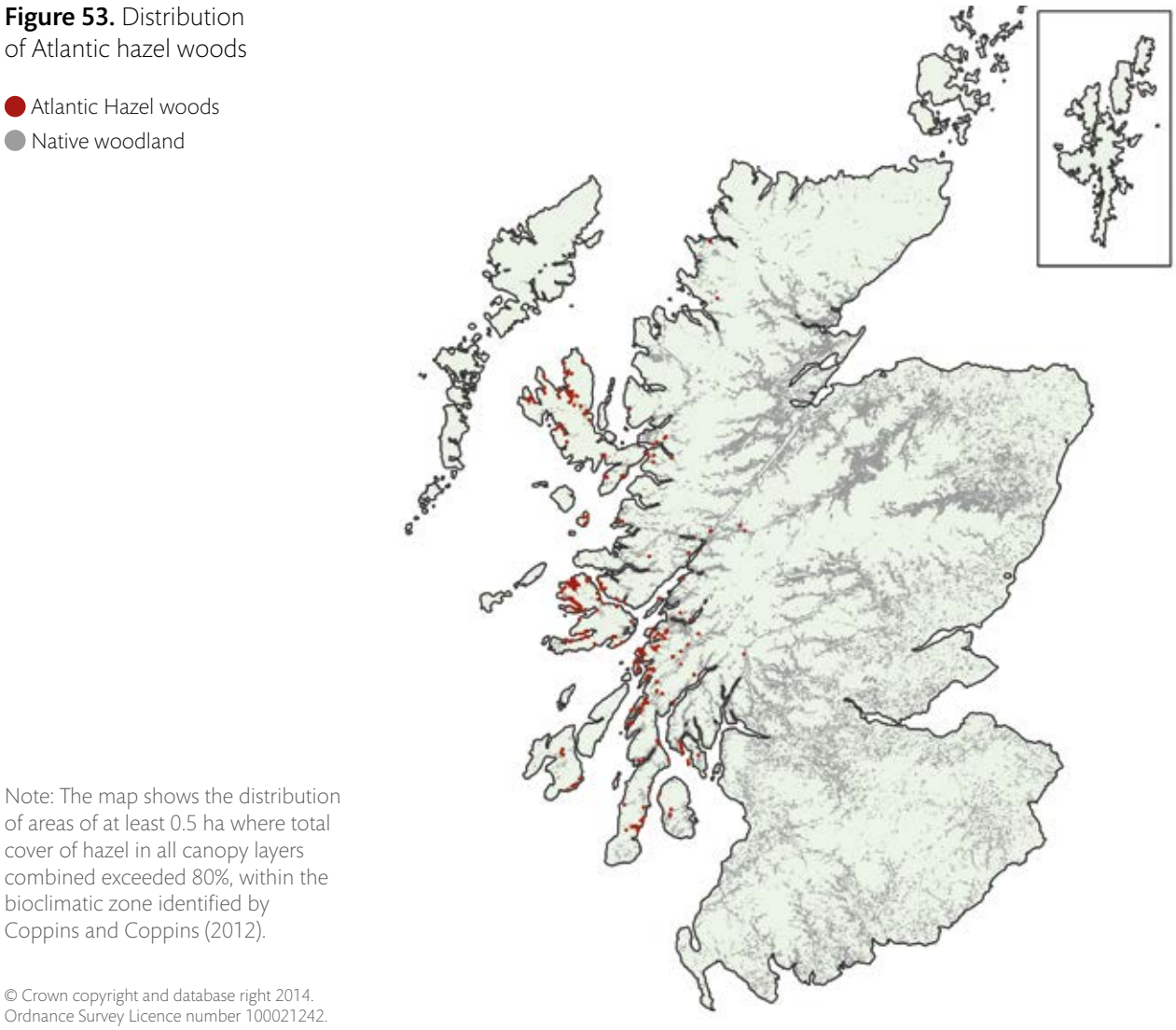
Box 8. Atlantic hazel woods

Recent research (Coppins and Coppins, 2012) has shown that hazel dominated woodlands on the Atlantic coastal fringes of the western seaboard are likely to be very ancient and may include surviving relicts of primary ancient woodlands that colonised after the ice age. These remnants have natural hazel dominance on base-rich but exposed coastal areas and hazel has maintained itself by layering and seeding, largely excluding other trees and shrubs.

In the NWSS, hazel woods were not surveyed separately as they were treated as part of the upland mixed ashwoods type in line with the habitat definition in the UK Biodiversity Action Plan. The NWSS data was however further analysed to indicate the presence of the Atlantic hazel woods, which is shown in Figure 53 below.

The total area of Atlantic hazel woods (over 0.5 ha) was estimated to be 934 ha, spread across 322 native woodland polygons in the NWSS.

Figure 53. Distribution of Atlantic hazel woods



Note: The map shows the distribution of areas of at least 0.5 ha where total cover of hazel in all canopy layers combined exceeded 80%, within the bioclimatic zone identified by Coppins and Coppins (2012).

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Native woodland scrub

Introduction

Native woodland scrub areas recorded through the NWSS are shown below, extracted from Table 3. The total area here is likely to be an underestimate for these types. This is because surveyors will not have found all of the smaller scattered areas which would not show readily as woodlands on aerial photographs, especially those that were distant from the candidate woodland areas that were surveyed.

Table 24 excludes the potential Atlantic hazel woods which is included as part of upland mixed ashwoods (above). If Atlantic hazel were classed as scrub it would take the total scrub area to 4,716 ha, which is around 1.5% of native woodland.

Some scrub species were not treated as scrub woodland types in the NWSS, e.g. whins (gorse) and broom.

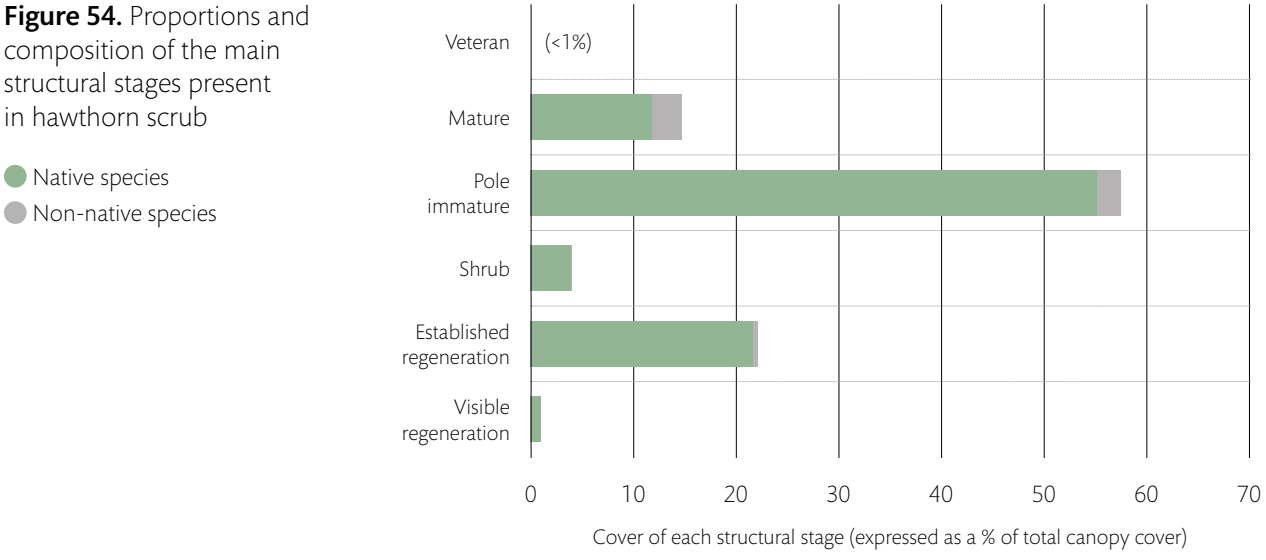
Table 24. Areas of native woodland scrub in the NWSS (ha)

Woodland scrub type	Total area
Blackthorn scrub	152
Hawthorn scrub	2,138
Juniper scrub	1,482
Montane willow scrub	10
Total	**3,782**

Note: Total area of all scrub components of native woodland polygons.

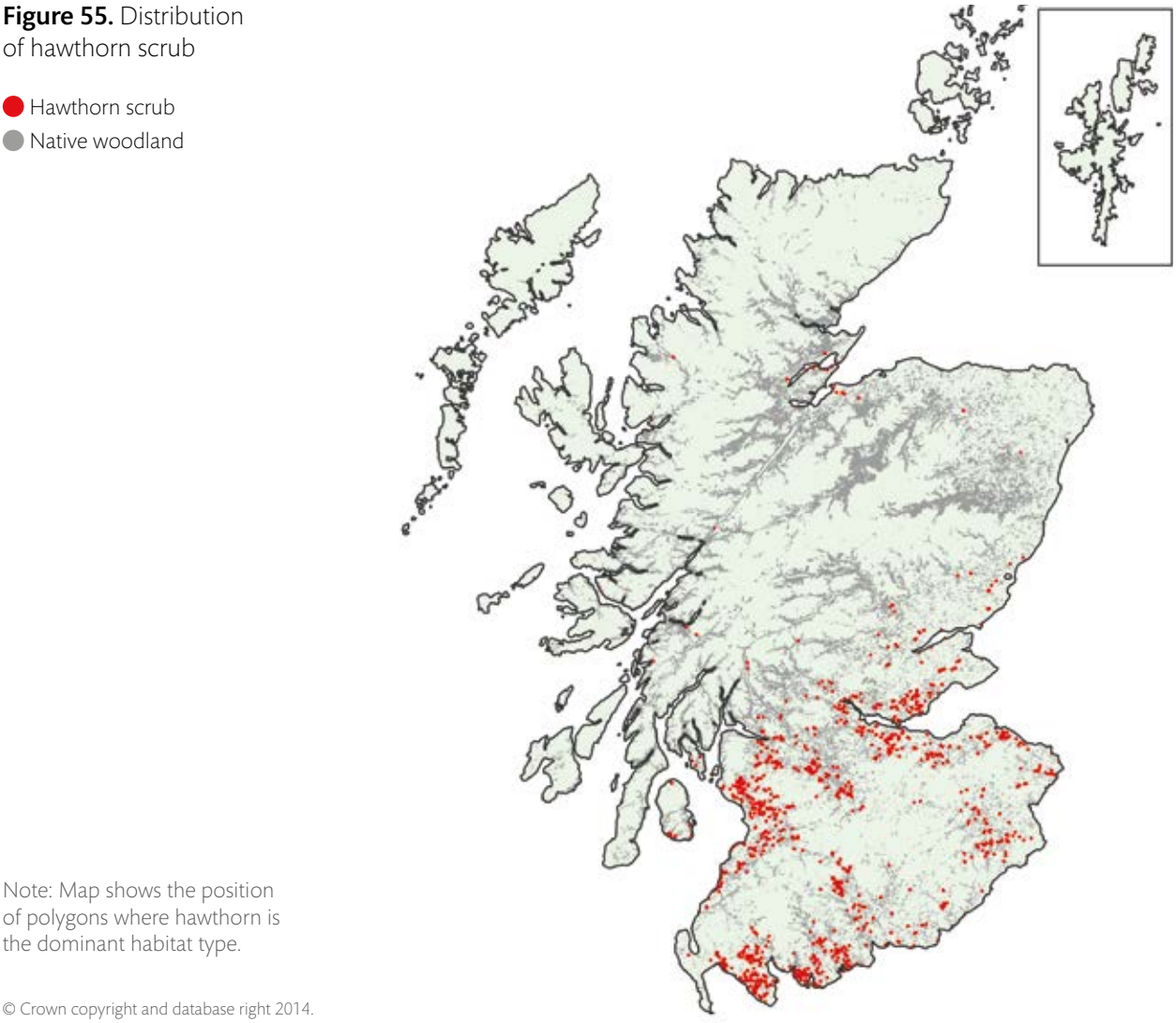
Note: Excludes an estimated area of 934 ha of Atlantic hazel woods which might be considered as woodland scrub but is included in the upland mixed ashwoods woodland type.

Figure 54. Proportions and composition of the main structural stages present in hawthorn scrub



All these scrub areas are highly semi-natural and have native species at over 90% of canopy cover. Each has a component of mature and pole stage tree cover amongst it (see Figure 54 which shows hawthorn scrub). This could also partly explain the significant amounts of deadwood reported in these woodland scrub types, which ranges from 5-9m^3/ha (Figure 18).

Figure 55. Distribution of hawthorn scrub



Note: Map shows the position of polygons where hawthorn is the dominant habitat type.

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Even allowing for the NWSS field work not capturing all scrub areas, the results indicate the rarity of these transitional and ecotone communities, which are very valuable for biodiversity (Mortimer et al., 2000).

Juniper has declined significantly in range and abundance over the last few decades (Plantlife Scotland, 2011). Montane and treeline scrub has almost vanished from our uplands, although efforts are now being made to promote and restore these habitats (Scottish Natural Heritage, 2000).

Discussion and conclusions

Area

The Native Woodland Survey of Scotland is the first consistent and authoritative national survey of native woods. Previous estimates were flawed in various ways, which is why the survey was necessary.

The total area of native woods found through the NWSS is less than previous estimates made for the UK Biodiversity Action Plan, but greater than estimates of native woodland in the High Nature Value Farmland and Forestry indicator (see Box 5)

There is perhaps limited value in comparing the NWSS with historical estimates in depth, rather than considering how to use NWSS data to help secure native woods for the future. However, the work reported here comparing the estimates from the Scottish Ancient Woodland Inventory with those from the NWSS is important in telling us something about changes over recent decades in ancient woodlands.

The ancient woodland area is now less than was estimated by SAWI, with the difference due to a combination of mapping method and errors as well as a real loss of woodland area of up to 14% in the last 40 years, nearly all to open unenclosed areas.

More investigation of case histories will be needed to understand what change has actually happened and why, which can help us to avoid losses in the future. The widespread high herbivore impact in upland native woods which were shown in NWSS results is likely to be a major reason for the losses which have occurred. It seems very possible that similar types of loss may have occurred to other upland native woods beyond the ancient woodland sites and this will also be important to investigate.

The NWSS has given us an authoritative update of information from both SAWI and the Caledonian Pinewoods Inventory (CPI), and consistently describes the current area and condition of our ancient woods for the first time. This should have great value for developing land-use policies and planning, including development planning.

NWSS data allows a refreshed identification of the most important sites for conservation and restoration. The category 'Ancient, semi-natural and native woods (ASNNW)' may be a useful way to do this; the NWSS has classed 64,000 ha of woodlands in this category, which is almost a fifth of the total area of native woodlands.

Despite considerable pinewood restoration work over the last two decades on CPI sites, NWSS results show how vulnerable and fragmented these ancient remnants still are. There are 31,000 ha of CPI native woodlands with just 11,300 ha in the 84 core areas.

Above: Planting native trees. Abernethy Forest, Cairngorms National Park.

© Peter Cairns/2020VISION

Left: Autumn in Glen Affric, Highland.

© Mark Hamblin/2020VISION

Condition

Native woodland condition is moderate overall with 46% of areas in satisfactory health for biodiversity; slightly less for ancient native woods and slightly for more CPI pinewoods. It is encouraging that most of the rest need only a single key condition factor to be addressed to achieve satisfactory health.

Although the assessment methods are different, the NWSS condition index is broadly comparable to the approach used in designated site condition monitoring by SNH, who recently reported that 59% of woodland habitat features were in favourable condition, with another 9% unfavourable but recovering (Scottish Natural Heritage, 2010). The main reported reasons for poor condition were browsing and grazing preventing tree regeneration, followed by threats from rhododendron and non-native tree species.

NWSS results are closely comparable with these in terms of the scale and nature of the threats. It is not surprising that designated sites should have a somewhat higher proportion in satisfactory condition than the average across all native woods.

Some native woodland types are particularly vulnerable due to their low area and poor condition: upland mixed ashwoods, upland oakwoods and native pine-CPI sites (main factors: herbivores and invasives) and lowland mixed deciduous woodland (main factors: invasives and non-native trees). Threats from any new plant diseases and pests may add to the risks to their future health.

Reducing herbivore impact is the biggest single issue to be addressed to improve native woodland health and survival. A third of areas suffer from high or very high impact levels that would prevent future regeneration. Some areas in the medium impact category will also be sub-optimal in terms of the diversity of regeneration that can result.

Deer are by far the most widespread type of herbivore recorded and are likely to be the major source of impacts.

Setting aside areas of regeneration established by planting, the current amount and distribution of established natural regeneration is likely to be too low to sustain the overall resource of native woodlands, especially for upland oakwoods, semi-natural pinewoods, and lowland mixed deciduous woodland. Natural regeneration also has a vital role in allowing genetic adaptation by means of natural selection in response to climate change and other environmental pressures.

Amongst the encouraging aspects of native woodland condition emerging from the results are the strongly semi-natural characteristics and the high average proportion of native tree species cover in all canopy layers. These should both help native woodland ecosystems to be resilient provided regeneration can be secured.

The high proportion of PAWS woodlands that are both semi-natural and native is also welcome and this may partly show the early results of the ancient woodland restoration work which has been started on many sites in recent years.

NWSS data for veteran trees and native scrub communities show how relatively rare these important habitats are and can highlight opportunities to conserve and enhance them.

Above: A vigorously regenerating birchwood which has survived a recent wildfire. Arisaig, Highland.

© Gary Servant

Further opportunities for analysis

There are so many potential uses of the data that this report can only give a summary overview and then suggest how much more can be explored using the data at various scales. Forestry Commission Scotland is very keen to work in partnership with others to do this.

Examples of possible uses which Forestry Commission Scotland is already considering include:

- revising native woodland habitat network maps and models to help guide native woodland expansion and management;
- using NWSS data to support native woodland management planning;
- using NWSS structure and composition information to help target survey or management for rare species;
- developing strategies for control of invasive non-native species;
- examining recent historical changes in upland native woodlands and their causes;
- modelling projected climate change impacts upon native woods and possible adaptive responses;
- estimating potential wood production from native woods and interactions with other ecosystem services.

How can future changes in native woodlands be monitored?

The NWSS was designed to establish a baseline to allow future monitoring of change. The survey could be repeated either in full or in part to monitor change. Native woodlands do not usually change rapidly and an interval of 10 -15 years may be suitable before a repeat survey.

A partial repeat survey could be an effective means of detecting changes, including spatial change, if sample areas are suitably representative of the country as a whole.

Alternatively, a partial survey could be considered as a way of monitoring responses to a major disturbance such as a catastrophic storm or severe losses due to a virulent and widespread tree disease or major pest.

There may also be opportunities to use new methods to reduce costs, for example techniques for remote monitoring by satellite and other technologies may become more effective and full ground-truthing may not be essential in repeat surveys.

Another option is to rely entirely on the statistical estimates for native woodland that will be obtained from the National Forest Inventory (NFI). However, this cannot provide information on spatial changes of native woodland, so that a combination of NWSS and NFI may be the best option.

Conclusion

The Native Woodland Survey of Scotland (NWSS) has provided a unique dataset that can be used at any spatial scale and for a wide range of purposes.

This report provides a summary overview of what the NWSS tells us about the state of our native woods today, but it can only show only a fraction of the ways in which the data can be used to help people understand our native woods and their needs.

Until as recently as the 1980s native woods had suffered centuries or even millennia of exploitation and decline, and they were rarely recognised or managed as important habitats outside nature reserves and designated sites. Since then awareness of the value of native woodland has greatly increased. So too has action to restore and expand native woods on public and private land and through the actions of trusts, charities and many individuals, with much Government support and funding.

The NWSS has revealed some encouraging signs of progress from these recent efforts which are reflected in the health and regeneration of many woods. However, the survey has also shown the nature and extent of the pressures and challenges which still need to be tackled if we are to secure a flourishing resource of native woodlands for the future generations to enjoy.

The most widespread single factor inhibiting native woodland recovery is high levels of browsing and grazing impacts which inhibit woodland regeneration. Invasive shrubs, field layer species and non-native tree species are locally important threats, whilst climate change and new pests and diseases are presenting new challenges. Evidence from the NWSS can help to shape responses to all these challenges at national, regional and local scales.

References and further reading

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Annexes

Annex 1

Tree and shrub species native to Scotland

1. The following trees and shrubs were recorded with cover estimates in all structural stages in which they were found.

Ash	*Fraxinus excelsior*
Aspen	*Populus tremula*
Birch	
• Intermediate birch	*Betula spp.* (intermediate forms between silver and downy birch where species could not be distinguished)
• Downy birch	*Betula pubescens*
• Dwarf birch	*Betula nana*
• Silver birch	*Betula pendula*
Bird cherry	*Prunus padus*
Blackthorn	*Prunus spinosa*
Common alder	*Alnus glutinosa*
Crab apple	*Malus sylvestris*
Dog rose*	*Rosa canina*
Elder	*Sambucus nigra*
Gean/wild cherry	*Prunus avium*
Guelder rose	*Viburnum opulus*
Hawthorn	*Crataegus mongoyna*
Hazel	*Corylus avellana*
Holly	*Ilex aquifolium*
Juniper-upright	*Juniperus communis* (upright growth habit)
Juniper-dwarf	*Juniperus communis (dwarf/prostrate growth habit)*
Oak	
• Intermediate oak	*Quercus spp* (intermediate forms between pedunculate and sessile oak where species could not be distinguished)
• Pedunculate oak	*Quercus robur*
• Sessile oak	*Quercus petraea*
Rowan	*Sorbus aucuparia*
Scots pine	*Pinus sylvestris*
Whitebeams:	
• Arran whitebeam	*Sorbus arrenensis*
• Rock whitebeam	*Sorbus rupicola*
Willows	
• Grey willow	Salix cinerea
• Goat willow	Salix caprea
• Eared willow	Salix aurita
• Other native willows**	*Salix myrsinifolia, S. pentandra, S. purpurea, S. phylicifolia.*
• Montane willows**	*Salix reticulata, S. herbacea, S. arbuscula, S. myrsinites, S. lanata, S. lapponum & S. repens*
Wych elm	*Ulmus glabra*
Yew	*Taxus baccata*

2. Species recorded with a single cover estimate for the whole polygon

Bramble	*Rubus fruticosus*
Broom	*Cytisus scoparius*
Gorse/Whin	*Ulex europaeus*

Note: Non-native trees and shrub species were also recorded wherever they were found. For details see the full protocol on the Forestry Commission Scotland website.

* Other wild rose species were also recorded as dog rose.

** Not distinguished by species when recording survey data.

Annex 2

Codes used for National Vegetation Classification (NVC) communities and Priority Woodland Type (PWT)

A. Both NVC community and PWT are identified

W1/WW:	*Salix cinerea – Galium palustre* woodland/Wet woodland.
W2/WW:	*Salix cinerea – Betula pubescens – Phragmites australis* woodland/Wet woodland.
W3/WW:	*Salix pentandra – Carex rostrata* woodland/Wet woodland.
W4/UB:	*Betula pubescens – Molinia caerulea* woodland/Upland birchwoods.
W4/UO:	*Betula pubescens – Molinia caerulea* woodland/Upland oakwoods.
W4/WW:	*Betula pubescens – Molinia caerulea* woodland/Wet woodland.
W5/WW:	*Alnus glutinosa – Carex paniculata* woodland/Wet woodland.
W6/WW:	*Alnus glutinosa – Urtica dioica* woodland/Wet woodland.
W7/UMA:	*Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland (Ashwoods are distinguishable as drier woods dominated by Deschampsia caespitosa)/Upland mixed ashwoods.
W7/WW:	*Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland/Wet woodland.
W8/LMDW:	*Fraxinus excelsior – Acer campestre – Mercurialis perennis* woodland/Lowland mixed deciduous woodland.
W9/UMA:	*Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland/Upland mixed ashwoods.
W10/LMDW:	*Quercus robur – Pteridium aquilininum – Rubus fruticosus* woodland/Lowland mixed deciduous woodland.
W11/UB:	*Quercus petrea – Betula pubescens – Oxalis acetosella* woodland *Oxalis acetosella* woodland/ Upland birchwoods.
W11/UO:	*Quercus petrea – Betula pubescens – Oxalis acetosella* woodland/Upland oakwoods.
W16/LMDW:	*Quercus spp. – Betula spp. – Deschampsia flexuosa* woodland/Lowland mixed deciduous woodland.
W17/UB:	*Quercus petrea – Betula pubescens – Dicranum majus* woodland/Upland birchwoods.
W17/UO:	*Quercus petrea – Betula pubescens – Dicranum majus* woodland/Upland oakwoods.
W18/NPW:	*Pinus sylvestris – Hylocomium splendens* woodland/Native pinewoods.
WLz/LMDW:	Oak-birch woodland with field layer dominated by *Luzula sylvatica* in the lowland zone /Lowland mixed deciduous woodland.
WLz/UB:	Oak-birch woodland with field layer dominated by *Luzula sylvatica* & <30% oak /Upland birchwoods.
WLz/UO:	Oak-birch woodland with field layer dominated by *Luzula sylvatica* & 30% oak /Upland oakwoods.
WPc/NPW:	Lichen rich *Pinus sylvestris* woodland/Native pinewoods.

B. Native woodland scrub communities: NVC code only

W19:	*Juniperus communis ssp. Communis – Oxalis acetosella* woodland (Juniper scrub).
W20:	*Salix lapponum – Luzula sylvatica* scrub (Montane willow scrub).
W21:	*Cratageous monogyna-Hedera* helix scrub (Hawthorn scrub).
W22:	*Prunus spinosa – Rubus fruticosus* scrub (Blackthorn scrub).

C. PWT with no identifiable NVC type

WN/LMDW:	Lowland mixed deciduous woodland but not identifiable as a distinct NVC type.
WN/NPW:	Native pinewoods not identifiable as a distinct NVC type.
WN/UB:	Upland birchwoods not identifiable as a distinct NVC type.
WN/UMA:	Upland mixed ashwoods not identifiable as a distinct NVC type.
WN/UO:	Upland oakwoods not identifiable as a distinct NVC type.
WN/WHN:	Native woodland or scrub not identifiable as a distinct priority woodland habitat type or NVC type.
WN/WW:	Wet woodland not identifiable as a distinct NVC type.

D. NVC type with no identifiable PWT

W1/WHN:	*Salix cinerea – Galium palustre* woodland/not identifiable as a priority woodland habitat type.
W2/WHN:	*Salix cinerea – Betula pubescens – Phragmites australis* woodland/not identifiable as a priority woodland habitat type.
W3/WHN:	*Salix pentandra – Carex rostrata* woodland/not identifiable as a priority woodland habitat type.
W4/WHN:	*Betula pubescens – Molinia caerulea* woodland/not identifiable as a priority woodland habitat type.
W5/WHN:	*Alnus glutinosa – Carex paniculata* woodland/not identifiable as a priority woodland habitat type.
W6/WHN:	*Alnus glutinosa – Urtica dioica* woodland/not identifiable as a priority woodland habitat type.
W7/WHN:	*Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland/not identifiable as a priority woodland habitat type.
W8/WHN:	*Fraxinus excelsior – Acer campestre – Mercurialis perennis* woodland/not identifiable as a priority woodland habitat type.
W9/WHN:	*Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland/not identifiable as a priority woodland habitat type.
W10/WHN:	*Quercus robur – Pteridium aquilininum – Rubus fruticosus* woodland/not identifiable as a priority woodland habitat type.
W11/WHN:	*Quercus petrea – Betula pubescens – Oxalis acetosella* woodland/not identifiable as a priority woodland habitat type.
W16/WHN:	*Quercus spp. – Betula spp. – Deschampsia flexuosa* woodland/not identifiable as a priority woodland habitat type.
W17/WHN:	*Quercus petrea – Betula pubescens – Dicranum majus* woodland/not identifiable as a priority woodland habitat type.
W18/WHN:	*Pinus sylvestris – Hylocomium splendens* woodland/not identifiable as a priority woodland habitat type.
Wh/WHN:	*Hypericum pulchrum-Melampyrum pratense* ride community.

Annex 3

Relationships between Priority Woodland Type (PWT) and National Vegetation Classification (NVC) communities

	NVC															
PWT	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W16	W17	W18	WLz*	WPc**
Native pinewoods														●		●
Wet woodland	●	●	●	●	●	●	1									
Upland birchwoods				2							3		4		5	
Lowland mixed deciduous woodland								●		●		●			6	
Upland mixed ashwoods							7		●							
Upland oakwoods				8							9		10		11	

From: Averis and Rodwell, 2006 (on NWSS webpages)

● = main relationship

* WLz = field layer dominated by Luzula sylvatica.

** WPc = Lichen rich Pinus sylvestris woodland.

Note 1: W7a/b; and W7c which lacks ash, elm or hazel and is generally of alder, willow or birch and in 'wetland' situations such as valley floors.

Note 2: W4a birch-dominated, with oak <30% of canopy cover.

Note 3: Where birch-dominated, with oak <30% of canopy cover.

Note 4: Where birch-dominated, with oak <30% of canopy cover.

Note 5: Where birch-dominated, with oak . <30% of canopy cover, and WLz is associated with W11 or W17.

Note 6: Where associated with W8, W10 or W16.

Note 7: W7c with ash, elm, hazel etc, mainly on slopes.

Note 8: W4a in which oak forms >30% of canopy cover.

Note 9: Where oak forms >30% of canopy cover.

Note 10: Where oak forms >30% of canopy cover.

Note 11: Where oak forms >30% of canopy cover, and WLz is associated with W11 or W17.

[Letters a,b,c denote NVC sum-communities]

Annex 4

Ancient woodland area change estimates: examples for local authority areas

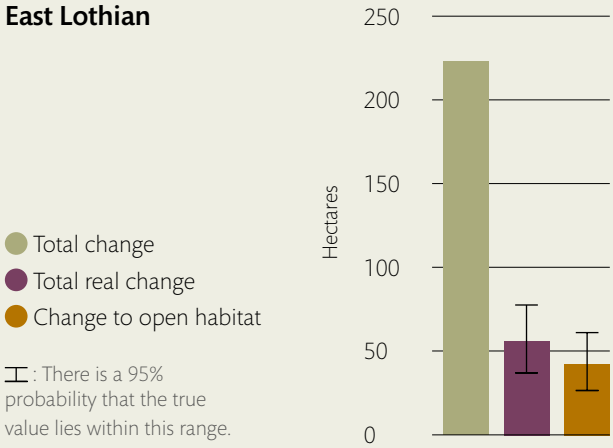
Data showing differences between NWSS and the Scottish Ancient Woodland Inventory for Scotland and five local authorities are presented below. These figures cover a spread of both predominantly lowland authorities and those with significant upland areas. They highlight the variation both in the extent of changes and the proportions of change to open habitats (see also Annex 5). More detail for all local authority areas can be found on the NWSS webpages, including confidence intervals and ranges.

All figures are estimated reductions in area from the area of ancient woodland in SAWI to the areas in the NWSS data.

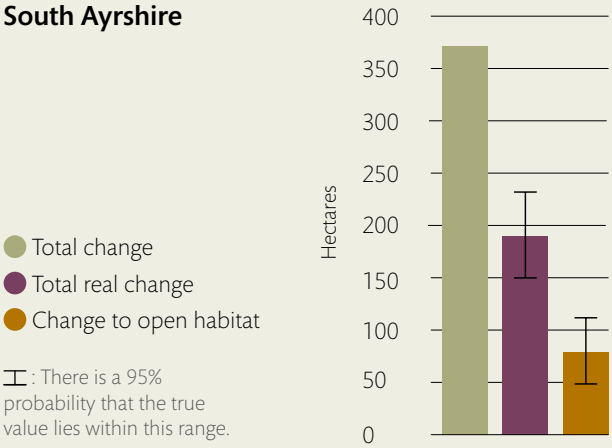
'Total change' includes map error.

'Total real change' and 'change to open habitat' are estimates of actual changes.

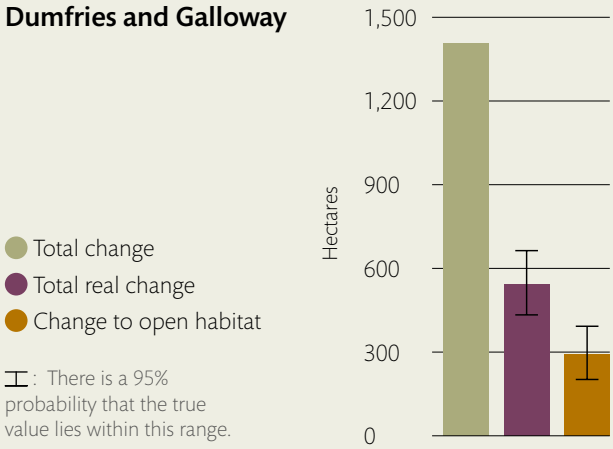
East Lothian



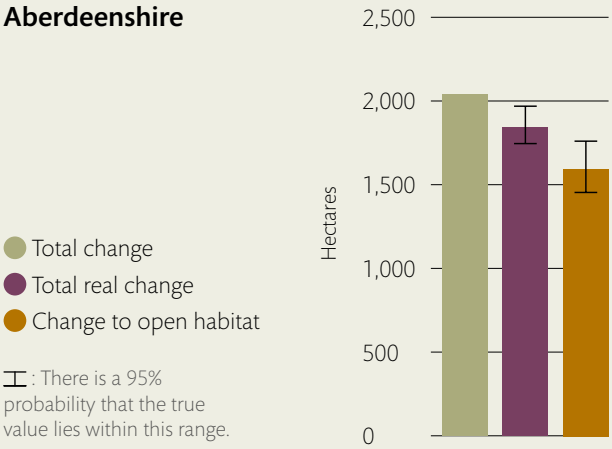
South Ayrshire



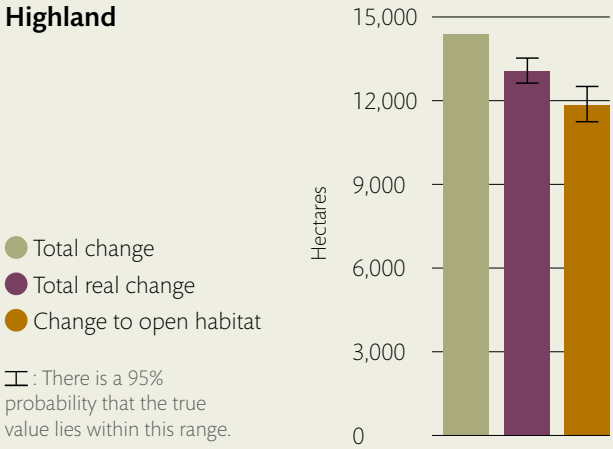
Dumfries and Galloway



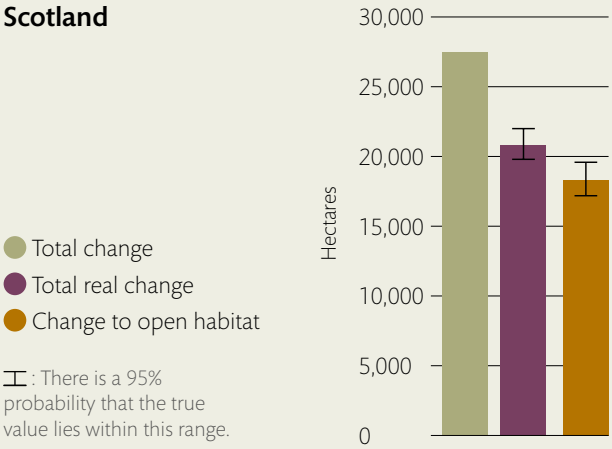
Aberdeenshire



Highland



Scotland



Annex 5

Ancient woodland areas: summary of the method for comparing results from NWSS with estimates made in the Scottish Ancient Woodland Inventory

The Scottish Ancient Woodland Inventory (SAWI) (Scottish Natural Heritage, 1997) identified and quantified the area of relevant woodland using a range of information sources available at the time, including the historical "Roy maps" and the 1st edition Ordnance Survey maps. The areas of ancient woodlands given in the NWSS local authority summary reports are consistently lower than the areas given in SAWI, so a sampling based review was carried out to determine and assign the reasons for this change in the SAWI woodland areas.

The differences between the two inventories were categorised as change from ancient woodland (SAWI) into the current uses (from NWSS) of:

Agricultural use (fields)

Development (eg. roads, houses, farm buildings, quarries)

Estate gardens and sports fields/golf courses

Open Habitat (often on heath/moorland, with either scattered trees or no trees identifiable at all).

Additionally, the extent of map error was recorded, either as error in the original SAWI map or in the new digital woodland map.

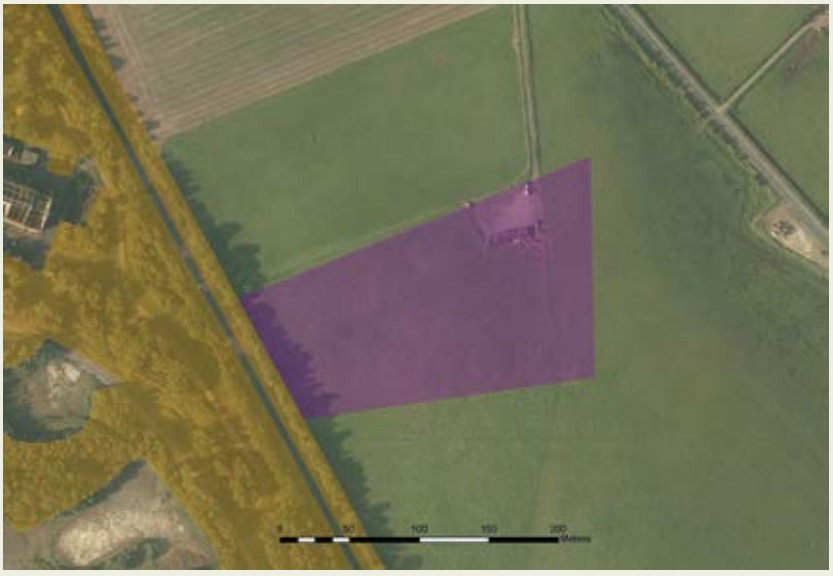
"Open Habitat" was defined as:

'Where land previously categorised as woodland no longer has a tree canopy density of at least 20% and where the land is not contained within a clearly recognisable agricultural enclosure and has not been converted to a clear agricultural use (grazing, cropping etc)'.

For each local authority, sample areas were selected using a proportional sampling scheme. By overlaying SAWI and NWSS data layers on aerial photography it was possible to quantify and categorise the types of change between the two datasets. Some examples of these changes are illustrated below, and the analysis methodology is explained in more detail on the NWSS webpages.

Example of change to agricultural use – No identifiable trees in the area and there were clear field boundaries

- Woodlands on SAWI; not found during NWSS survey.
- Woodlands recorded by NWSS surveyor.



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Example of change: to open habitat

1. No trees – There were no identifiable trees in the area

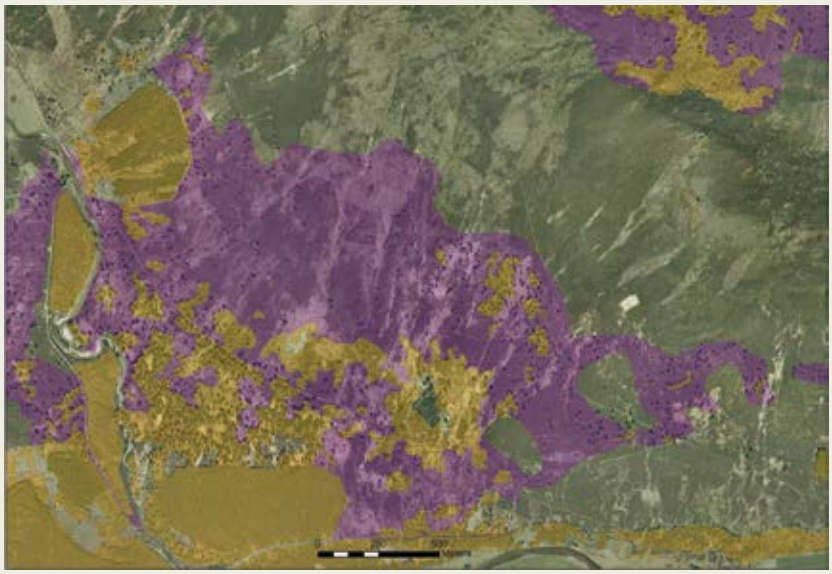
- Woodlands on SAWI; not found during NWSS survey.
- Woodlands recorded by NWSS surveyor.

© Getmapping plc.

Example of change: to open habitat

2. Scattered trees – Scattered trees often around areas of core woodland

- Woodlands on SAWI; not found during NWSS survey.
- Woodlands recorded by NWSS surveyor.



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The vast majority (by area) of change to open habitats fell into the two categories above.

On occasion it was difficult to distinguish change to open habitat from change to agriculture, such as in upland areas when seeking to compare land that is perhaps used for hill grazing from open moorland. Change to clearly identifiable agricultural land with boundaries was relatively straightforward to identify.

Map error

These categories of 'change' identified areas that could be regarded as woodland loss but in fact were errors in the mapping process. Map errors were very significant in the analysis and, generally, the more recent NWSS/NFI datasets have been digitised more accurately than the SAWI maps were.

There are two identifiable sub-categories of map error:

a) Digitising error (shown below)

b) Polygon offset

Example of digitising error

The digitising of the SAWI polygon was not accurate as it does not cover the woodland in some areas whilst covering too much in others.

- Woodland on SAWI not found during NWSS survey
- SAWI woodland

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Annex 6

NWSS Herbivore impact assessment categories and definitions

Herbivore impact	Description	Implication if this level is maintained in future
A Low	Any browsing or bark stripping is affecting fewer than 10% of stems in any significant species / size class record* and is restricted to two or fewer minority records** (which may only represent a single stem). Poaching absent, or not greater than 25% of woodland area***. Grazing not significant.	Very low or no herbivore impacts. Tree and shrub regeneration will not be restricted by browsing. Generally allows diverse wildlife as well as tree and shrub regeneration. However in some cases more grazing may be desirable for site objectives, eg wood pasture.
B Medium	Browsing recorded on over 10% of stems of at least one significant record or at least three minority records. No heavy browsing or bark stripping of significant woody species*. Poaching absent or not greater than 25% of the woodland area. Grazing not significant.	Could meet a wide range of objectives but some tree and shrub species may be under-represented in regeneration.
C High	Heavy browsing or bark stripping recorded on at least one major woody species record; and/or intermediate levels of poaching observed.	Limited prospects for successful tree regeneration, and in general future woodland biodiversity will be restricted.
D Very high	Heavy browsing observed on woody species that make up at least 50% of the woodland; and/or with a grazed sward; and/or with heavy poaching.	Very little chance of new regeneration and restricted field and shrub layer. Woodland not sustainable in the long-term

* A significant record is defined as a species which has been recorded with a value of at least 100 stems/ha or at least 5% canopy share.

Significant woody species excludes bramble and the "shrubs preferentially browsed" category.

** A minority species record is where a species is present but is recorded with 0% canopy cover and less than 100 stems per hectare; so it may only represent an individual tree.

*** Poaching was rarely encountered or recorded above 25%.

Herbivore impact recorded	Definition
Browsing	Only recent browsing was recorded – where the effects observed at time of survey were estimated to have been from the previous 12 months. • Browsing rates were recorded differently for different size classes of tree. Estimates were recorded for browse rate on apical stems (significant for young or stunted trees), on basal & epicormic shoots (significant for established trees) and the presence of a browse line. • Browsing levels were estimated based on a sample of stems observed at the time of survey. Impacts estimated may have come from a number of different herbivores, with deer and livestock being the most common. The proportion of each woodland affected by each herbivore type was also recorded. • Where browsing was found to be present on less than 10% of stems then that tree species/size class was recorded as 'unbrowsed'. • 'Intermediate browsing' was recorded where between 10% and 75% (50% for browse rate of apical stems) of stems were found to be impacted. • 'Heavy browsing' was recorded where over 75% (or 50% for browse rate of apical stems) of stems were impacted.
Bark stripping	Recorded where 10% or more of stems within any species/size class showed signs of bark loss caused by herbivores in the 12 months prior to survey.
Poaching	Recorded as 'intermediate' where 25% to 50% of the ground layer was seen to be poached at time of survey and as 'heavy' when over 50% of the ground layer was seen to be poached at time of survey.
Grazed sward	Recorded where ground flora was seen to be composed of more than 20% palatable species and these species were, on average, grazed to less than 10cm in height over at least half of the area of the palatable species.

Annex 7

Native Woodland Condition Indicator: breakdown of areas outside the desired ranges for each condition factor and priority woodland type

Type	Area (ha) (and % of total area of the type) which is outside the desired range for 1 or more factors	% outside desired range for canopy cover*	% outside desired range for native species composition*	% outside desired range for herbivore impact*	% outside desired range for invasive species*
Upland birchwoods	59,604 (61%)	11	18	65	6
Native pinewoods	35,174 (38%)	17	31	50	2
CPI** native pinewoods	13,619 (43%)	18	8	73	1
Wet woodland	19,992 (54%)	13	33	46	8
Lowland mixed deciduous woodland	18,367 (73%)	6	61	22	11
Upland oakwoods	13,443 (64%)	5	25	58	12
Upland mixed ashwoods	7,656 (66%)	7	38	49	6
All Native Woods	**168,093 (=54% of native woods)**	**12**	**31**	**50**	**7**

Note: Areas for priority woodland types in this table are derived from the dominant habitat type allocated to each polygon. They therefore differ from areas of each type listed in Table 3 of this report which was based on all component types in each polygon.

* The % of the total area outside the desired ranges in the Native Woodland Condition Index which is due to each factor.

** Caledonian Pinewood Inventory.

Annex 8

Key National Forest Estate data

Summary of native woodland area by type

Native Woodland Type [1]	Area (ha)	%
Lowland mixed deciduous woodland [2]	875	2%
Native pinewoods	23,313	45%
Upland birchwoods	13,096	25%
Upland mixed ashwoods	901	2%
Upland oakwoods	2,673	5%
Wet woodland	5,058	10%
Blackthorn scrub	2	<0.1
Hawthorn scrub	20	<0.1
Juniper scrub	82	<1
Other type [3]	5,857	11%
Total	**51,877** [4, 5]	**100%**

Note 1: The top 6 rows are native woodland types which are priority habitats under the UK Biodiversity Action Plan.

Note 2: This type is sometimes referred to as lowland mixed broadleaved woodland.

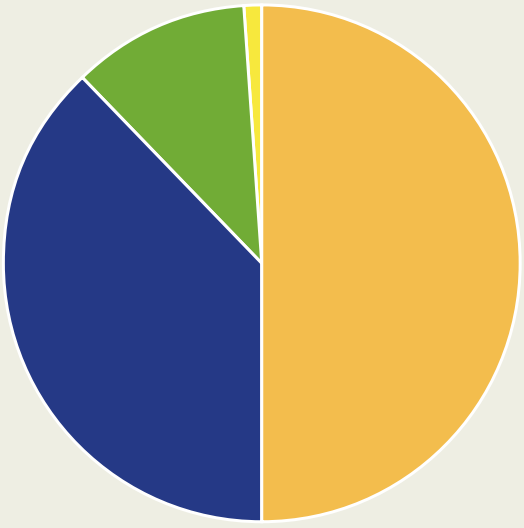
Note 3: "Other" native woodland includes areas that were not attributable in the field to a particular native woodland type.

Note 4: Native woodland occupied 12% of forest land and 8% of all land on the National Forest Estate as at April 2013.

Note 5: Native woodland areas include small amounts of overlap with other ownerships.

Native woodland condition indicator values - National Forest Estate (all native woods combined)

Note: The chart shows proportion of native woodland areas that scored 0, 1, 2, 3 or 4 for condition attributes i.e. the number of condition attributes which are in the desired range.



- 4: 25,830 ha (50%)
- 3: 19,673 ha (38%)
- 2: 5,783 ha (11%)
- 1: 552 ha (1%)
- 0: 38 ha (<1%)

Forestry Commission Scotland
Coimisean na Coilltearachd Alba

Forestry Commission Scotland serves as the forestry directorate of the Scottish Government and is responsible to Scottish Ministers

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