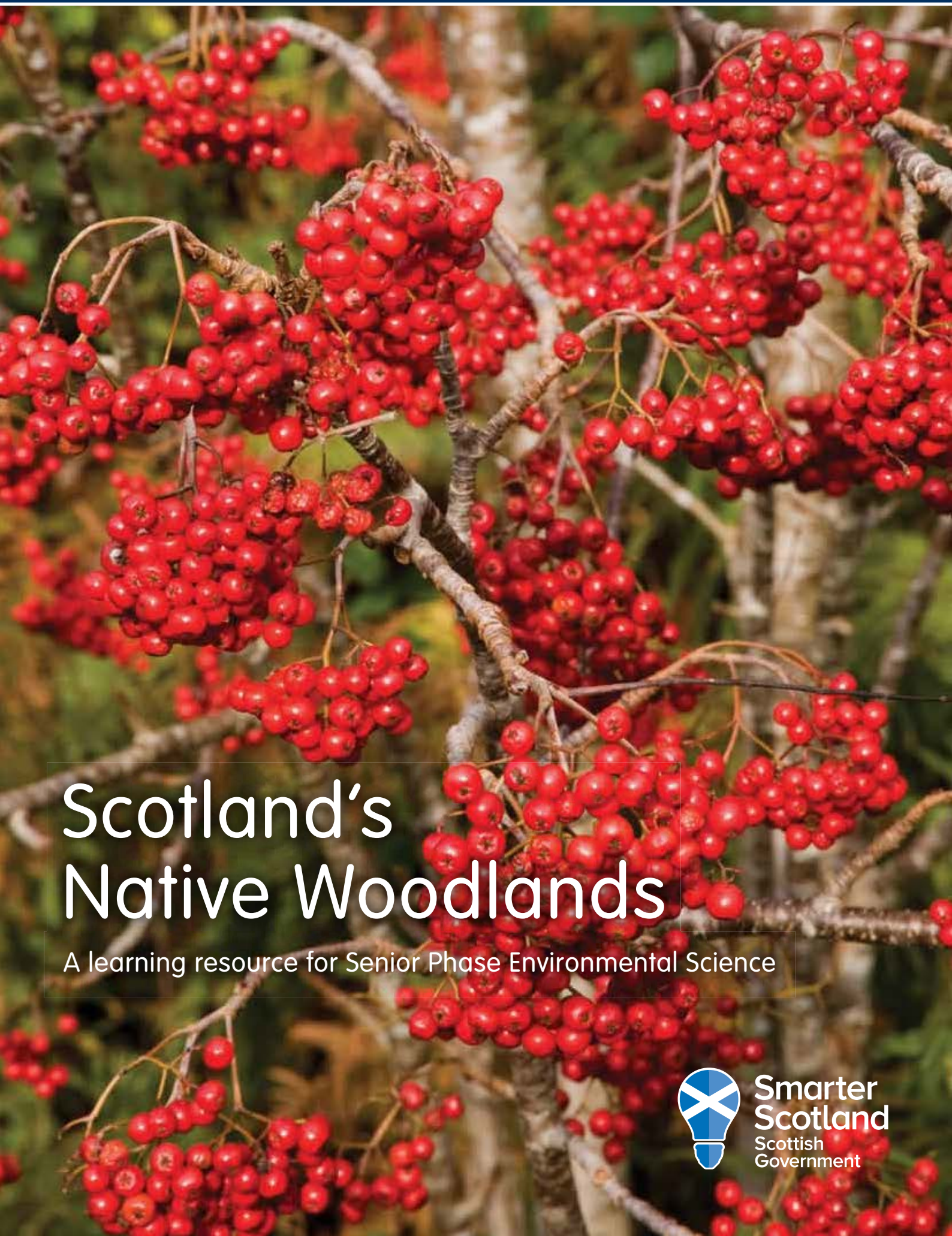
Forestry Commission Scotland
Coimisean na Coilltearachd Alba



Scotland's Native Woodlands

A learning resource for Senior Phase Environmental Science

Smarter Scotland
Scottish Government

Forestry Commission Scotland
Coimisean na Coilltearachd Alba

Scotland's Native Woodlands

Written by Dr Ruth Atkinson
for Forestry Commission Scotland.

About This Resource

This resource has been developed to enable environmental science teachers and pupils to access and interpret the results of the *Native Woodland Survey of Scotland*. The NWSS was a comprehensive survey of Scotland's native woodlands carried out by Forestry Commission Scotland and the results are available online at www.forestry.gov.uk/nwss in a printed report and summary material is available as leaflets and a DVD.

The resource looks at native woodland as a dynamic habitat. Native woods have been central to Scotland's biodiversity since the end of the last Ice Age 10,000 years ago. Human induced change in the past has marked the history of native woodland and will continue to do so in the future; always against a background of wider environmental changes including habitat fragmentation, disease, invasive plants and climate change.

Data from the NWSS allows us to look at the impact of these changes in detail. This resource explains the mapping and survey methods used and introduces the skills required for data interpretation, tree identification and fieldwork.

This resource is presented as text with images, figures and tables under the main topics of the Environmental Science Curriculum: Living Environment, Earth's Resources and Sustainability. There are activities and questions to develop and test understanding throughout.

Contents

1. Living Environment

1.1 What is Native Woodland?

The definition of native woodland used by NWSS is woodland where more than 50% of the canopy is made up by native species of trees.

This requires some more definitions to understand fully:

Woodland is ground covered with trees, so that if you looked at it from above most of the ground would not be visible because it is covered by the canopy of trees. Forests and woodlands are the same by this definition but in Scotland the word **forest** tends to be used to refer to a larger area of land predominantly covered by trees.

Canopy is the upper part of the tree, sometimes also known as the crown, and covers a much larger area than the tree trunk at ground level.

Native species is a species that arrived in Scotland without human help. To know what those species are and how to find them you need to be able to identify them; this is covered under **Identification**.

Ecology is a word to describe how living things interact with each other and with their non-living environment.

Tree ecology is important because trees are big, indeed they are the biggest living things. This means that they have a big impact on other species. They provide shade, homes and food for many other plants, fungi, insects, birds, mammals and other trees. They also live by photosynthesis; using energy from sunlight to convert water and carbon dioxide into masses of tree tissue (producer), which can then be eaten by many other things (consumer), which don't have the ability to make food from sun, rain and air themselves.

Carbon dioxide + water → oxygen + sugar

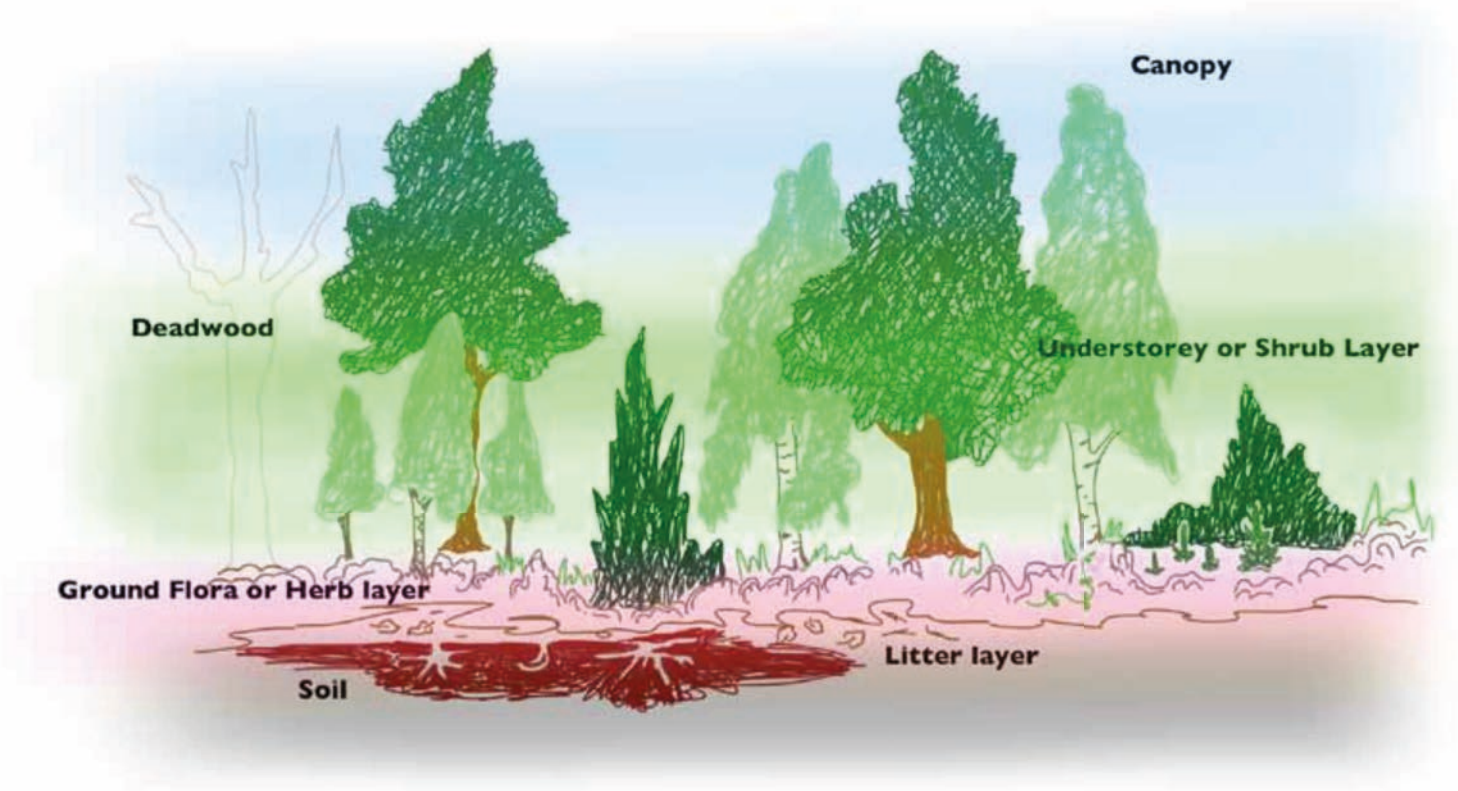
Trees are also constantly changing. They grow from tiny seedlings to massive trees over decades and can live for hundreds of years whilst still growing. Some changes are regular and predictable like producing fruit and seed and losing and re-growing leaves each year. Some changes, like losing branches or even being split apart by wind or lightning, are unpredictable. But trees are resilient and can adapt and survive so well that they live longer than any other living thing. All of this makes them complex, fascinating and important.

What do you think are the most ecologically important features of trees?
This includes: size and complexity, providing home and shelter for many other species; ability to fix energy via photosynthesis on a large scale; long-lived so they provide stability and continuity.

Native woodland is a type of habitat
Habitat is a name to describe the sort of home an animal or plant lives in. The habitat of a red squirrel is woodland. The habitat of primrose is woodland. The habitat of red grouse is moorland. The habitat of brown trout is fresh water.

Native woodland is rich in biodiversity
Biodiversity is the variety of species present in the community of an ecosystem.
The community is all the organisms present in an ecosystem. A place that is rich in biodiversity has many different species of plant, animal, fungi and even microscopic things like bacteria living in it. Native woodland is rich in biodiversity.

Woodland Structure



Components of the woodland structure

Canopy: the top woodland layer Made from the crown of trees and often with a dominant tree species. The canopy casts shade and creates a microclimate that shelters a wide range of other organisms.

Shrub Layer or **Understorey:** shrubs and young trees below the canopy. May be dominated by shrubby species like hazel or juniper or immature trees in a successfully regenerating woodland.

Herb Layer or **Ground flora:** usually from ground level to about 1 metre high. Consists of herbaceous, non-woody plants like grasses, rushes, mosses and other woodland plants. It may also include small shrubs and climbers like heather, bramble or honeysuckle. The herb layer is more variable than the canopy or shrub layer and often determines the woodland type.

Litter layer: detritus from woodland plants and animals, especially leaf mould, forms an important layer on the soil surface, protecting seedlings and the soil from drying out. It is home to many organisms that recycle woodland nutrients.

Soil: derived from rock and organic matter and home to multitudes of living things. Depth, pH and drainage of soil are important factors for trees.

Deadwood: an important component of the woodland ecosystem. Home to many organisms and essential to the cycle of death, decay and woodland regeneration.

1.2 A Changing World: The Past

Native woodland is a dynamic habitat. This means that it is changing now and has changed, sometimes dramatically, in the past.

A Brief History of Native Woodland

Scotland was almost entirely covered with ice during the last Ice Age and there were no trees when the ice melted around 10,000 years ago. Trees can be good travellers; their seeds hitching lifts on animals or by air. The trees arrived fairly quickly, colonising bare ground and covering most of Scotland in woodland.

For several thousand years native woodland covered much of Scotland except for high mountains, very wet areas, some islands and parts of the far north; this is sometimes known as the **wildwood**. The wildwood may have been quite variable in **structure** with areas of dense thickets of trees or scrub, places of scattered trees and large open glades.

There was a rich variety of wild animals living in the woodland, including species like **aurochs**, (now extinct), a type of wild cattle, and others including **brown bear**, **lynx** and **wolf** (now extinct in Scotland but surviving in other countries). These species had a big impact on the **ecology** of native woodland. All of these species went extinct before accurate records were made, which means we can't be sure exactly when they disappeared but we know why. Two human factors led to these prehistoric extinctions; they were hunted to extinction or lost their habitat so they could no longer survive. Wolves survived much longer than most and the last wolf in Scotland was said to be shot sometime in the late 1600s.

In **Mesolithic** times people only used stone tools and were hunter gatherers. Aurochs were big, dangerous, full of proteins and fat so must have been a big prize for hunters. But there were very few people in Scotland in Mesolithic times and their impact would have been limited by their low population and stone tools like arrowheads and hand axes.

Things changed dramatically in the **Neolithic**. Stone tools were still in use but people started to domesticate animals and to grow crops for food. The start of **agriculture** allowed human populations to expand and to become more settled in small communities, so they were no longer moving in nomadic groups as they had in the Mesolithic. This had a dramatic impact on native woodland. Much of the wildwood was destroyed, mostly by the damage caused by the browsing and grazing of domestic animals like cattle, sheep and goats, but also by felling for timber and burning to clear ground for crops. The native woodland that remained was very much reduced and, by 2,000 years ago may have occupied only about 20% of Scotland's land area.

Climate change has had a continual impact on native woodland. The climate warmed rapidly after the ice melted 10,000 years ago and it remained generally warmer than today, though with some fluctuations, until about 2,500 years ago, when it deteriorated to the cool, damp climate we know now.

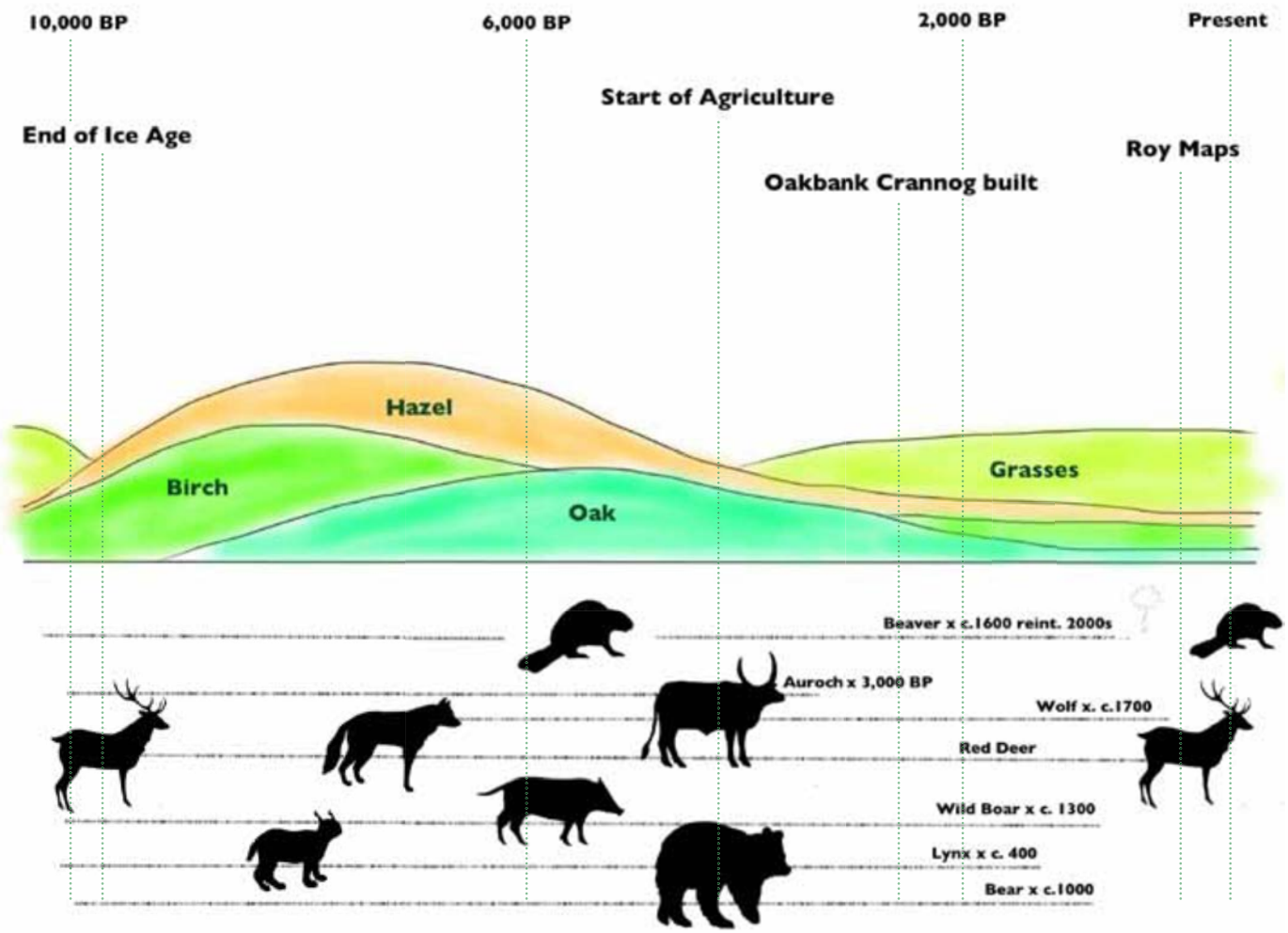
Woodland destruction that started with the coming of agriculture about 6,000 years ago and continued into recent times, coupled with the cool, damp climate of more recent times encouraged the formation of **peat bogs**, which replaced woodland in many parts of upland, western

and northern Scotland. Wet peat is a difficult medium for tree seedlings and the spread of peat bogs continues to restrict the ability of native woodland to re-establish in many areas.

Habitat destruction had a huge impact on wild animals, on top of continued hunting through prehistoric times and perhaps climate change. Auroch and elk were extinct by 2,500 years BP (Before Present) and woodland animals like lynx and bear were losing habitat and were to become extinct by 1000 years BP. Wild boar hung on for another few hundred years but went extinct under the pressure of continual hunting and woodland loss.

Many other smaller species of insects and plants may also have become extinct because of this loss of habitat but there is very little evidence about them.

Timeline of Extinctions and Reintroductions



Source: adapted from *Kilmartin: an introduction and guide*. Rachel Butter. Kilmartin House Trust. 1999.

Stone tools from the Mesolithic

Imagine Scotland 8,000 years ago

The climate was a little warmer than today but agriculture was unknown and most people lived by hunting and gathering. There were very few people. Most of the ground was covered in woodland.

Wolves were relatively common and were strong enough predators to feed on big herbivores, including **red deer**. **Lynx** were also around but, as smaller, solitary hunters, they fed on smaller species like **Roe Deer**. Big herbivores included deer and the **auroch**. Like deer, they fed on **grass** but they also liked to browse on **trees**, eating leaves and young twigs and stripping bark. **Beavers** lived in wet areas and modified their habitat by felling trees and building dams. They created beaver meadows; areas of wet grassland where they could feed and which were attractive to big herbivores like **elk**. It also helped protect them from carnivores, especially wolves. Omnivores like **people** and **bears** could eat plants and animals, including **insects**.

Use this passage to draw a food web showing the flow of energy. What are the animals eating. Which are herbivores? Which are carnivores? Where do the detritivores fit in? Where do people fit in your web?

What do you think would happen if one species went extinct?
Take out one species at a time and see what happens. Start with auroch, then bear, then elk, then lynx, then beaver, then wolf.

What do you think would happen to native woodland once these species have gone?
You can use this to play the **Web of Life Game**, which makes physical interconnections between organisms with string, effectively demonstrating the tangled nature of livings systems!

All of the species in your food web once lived in Scotland. Now only red deer, roe deer and people still live here. Beaver were extinct but they have been reintroduced recently and are doing well. Some people would like to reintroduce lynx, wolf, even bear. Why do you think this is?

1.3 Identification

How do you know what that tree is? If you are in a woodland you will see lots of trees and they might look all the same to you, but they are likely to be several different species.

Identification is important because:

- To know if a tree is **native**, you need to know what it is.
- Different trees species have different ecologies, which means that they have different ways of responding to things like soil type and climate. So to understand its **ecology** you need to know what the tree is.
- To work out what **type of native woodland** you need to know what the trees are.
- To understand **woodland habitat** you need to be able to identify trees and shrubs. For example mammals like red squirrel, invertebrates like the wood ant, birds like the Scottish crossbill and plants like the ostrich plume feather moss and twinflower are

specialised to live in native pinewood and tree species are important to their individual ecologies.

- Identifying a tree gives a **key to knowledge** about it, such as where else in the world it lives, who its relatives are and how people use it or what stories they tell about it.

There are **39 native tree and shrub species in Scotland** (see Annex 1 in NWSS report for a full list). If you think this is a lot, there may be about 20,000 tree species in Brazil.

Of the 39 Scottish species seven are scrubby willows which only occur on a few mountains and four are a group of willow species which are too difficult to tell apart with certainty, even by professional surveyors. If you exclude them there are only 28 species, which really isn't many at all.

What is it?

Broadleaves and Conifers

Most native tree and shrub species are **broadleaves**. They have flat, usually quite broad, leaves, which they lose in winter (except for holly). Trees which lose their leaves seasonally like this are **deciduous**.

Some common broadleaf species are not native. They include **beech** and **sycamore**. Both these species have been in Scotland for several hundred years, at least, and can appear to be native. However, woodland ecologists think they were both introduced to Scotland by people because there is documentary evidence that they were planted and there is no evidence of their pollen in ancient peat or lake deposits (see pollen in Chapter 1.5).

There are three native species of **conifer**: Scots pine, juniper and yew. Confusingly only one of these species has cones, the Scots pine. Seeds of juniper and yew are covered in coloured flesh, similar to rowan and bird cherry fruits but they are not closely related to broadleaves. Scots pine is the characteristic species of native pinewood. Juniper is also important in this type of woodland and in some forms of native woodland scrub. Yew is not common in Scotland but our oldest tree, indeed Scotland's oldest living thing, is a yew tree, growing in Fortingall churchyard in Glen Lyon, Perthshire. It could be 5000 years old.

Tree Detective

You can be a tree detective by learning to be careful and systematic and working through a series of steps until you succeed.

It takes a bit of practice though and some species are quite tricky. Once you start looking you can become remarkably good at identifying living things.

In the field

First find your trees, preferably several different ones to get more practice and compare them. Be careful about trees in parks and gardens. They may be exotic species, from virtually anywhere in the world with a similar climate to ours, so they could be very difficult to identify.

Check on Map Viewer to find your local native woodland, try and go there to find your trees.

Start by taking notes. Useful things to note are:

- Where you are. Try and give a map reference as well as the name of the wood.
- The date.
- Your name(s).

- What does it looks like? Is it tall and thin or broad and spreading? Does it have needles or broadleaves? If it's winter does it still have leaves, or needles?
- How tall is it? (a quick, and very rough but ok for this, way is to get a friend whose height you know to stand by the base and then estimate how many of your friends could stand on each other's heads to reach the top of the tree. Multiply this number by your friend's height to get the tree's height. Don't worry about centimetres, metres will do).
- What does the bark look like? Is it smooth or rough? What colour is it? Try doing a bark rubbing.
- What is the trunk like? Is it short and fat or tall and slender? Does it have big branches near the base, or split into several trunks?

What else?

- Take photographs.
- Collect leaves, twigs, fruit, cones, acorns, seeds, any bits you can find so that you can take a proper **specimen**. Trees are big so they won't miss small bits being taken from them, but don't take too much. You will probably find leaves on the ground, but it is also useful to collect a twig with leaves on it, or in the winter with leaf buds. Take your specimen back to the classroom to help you identify your tree.

Important: if you are going to identify more than one tree then make sure you keep your specimens separate. Botanists use a special system to number their specimens. Your numbering system should start with your initials and the number 1. A botanist would use the same system for their whole life. You can start your own number sequence for life, or it is probably easier to start one specially for this project, either individually or in groups.

In the classroom

Take out your specimens and identify the trees they came from. Use a **key** to do this.

A key is a special aid to identification. It asks questions in a sequence that should lead you to the right answer. **The Tree Name Trail** is a key available through the Forestry Commission website or published as a hard copy by Field Studies Council that will help you identify trees with leaves, which means it is not very useful in winter. Books like *Collins Tree Guide* help identify trees just by using twigs with buds.

Look at pictures of native tree species so that you are familiar with what to look out for next time you are around trees and woods.

Refer to your notes and photographs. They could be very useful.

Draw your specimens. Try and be as accurate as possible. Look at an identification book like the Collins Tree Guide to see the way they represent trees.

Specimens can be mounted on paper and stored in a special collection, botanists call this a **herbarium**. They need to be pressed and dried and it is important to label each specimen with the date, where it was collected and your collecting number. Other things from your notes could also be added such as tree height and other tree species it was growing with.

Leaf rubbings are another way of recording your tree. Collect leaves and place them under thin paper. Rub over the leaf with a soft pencil or crayon so that the leaf outline, even its veins, show on the paper. Label your leaf rubbings in the same way as you would for a proper specimen. **Bark rubbings** are similar but need to be done in the field. Place paper, preferably fairly thin but tough, against the tree bark and rub with soft pencil or crayon.

1.4 Ecology of Trees and Shrubs

Some of the commonest native trees in Scotland are listed in Table 1. Ecological information about them includes what soils they prefer, diseases that might affect them, how they react to climate, their seed types and the native woodland type where they occur.

This information can help predict how different tree and shrub species spread and why they live where they do.

Table 1. Ecology of common Scottish native trees

Species	Ecology	Seed type	Native Woodland Types
Birch	Tolerates cold climates and acid soils, including very wet or very dry soils.	Small, very light with small papery wings. Abundant	Upland birchwoods Native pinewoods Lowland mixed deciduous woods Wet woodland Upland oakwoods Upland ashwoods
Oak	Can cope with different soil types but less tolerant than birch of soils and climate	Acorns. Heavy and good food for animals that can cope with the tannins, such as squirrels. Sometimes abundant in 'mast' years.	Lowland mixed deciduous woods
Scots Pine	Can cope with cold climate and acid soils, though not wet soils. Needle blight is a disease that affects Scots pine.	Seeds produced in woody cones. The seeds are quite light and have a long, papery wing.	Native pinewoods
Ash	Not tolerant of acid soils. Vulnerable to frost. Ash Dieback is a serious threat.	Seeds often abundant, but there are separate male and female trees (which can change sex!) so not all trees produce seed. Seeds have a long wing, or 'key'.	Upland ashwoods
Hazel	A shrub, that can grow big but usually under the canopy of other trees. Prefers deeper soils.	Hazel nuts. Heavy. Very tasty and nutritious to all animals (including us) that can get into them, especially mice and squirrels.	Lowland mixed deciduous woodland

Why do you think birch occurs in so many native woodland types?

Consider the following:

How do you think these species spread their seeds? Which trees use which method? Which method do you think will help a seed travel furthest?

Aspen

The Native Woodland Survey of Scotland was able to supply detailed data on all the main tree species. For example aspen, which is an uncommon species but widely distributed across the country and in different woodland types. (Map in NWSS P34, fig. 11 and bar chart, fig. 12).

1.5 Travelling Trees

Trees have an enormous impact on their own environment, often changing the conditions to suit them. But if something happens to threaten their survival they can't move themselves away from the threat. This doesn't mean they are always stuck in the same place.

Seeds

Trees can't move themselves but their seeds can. Seeds have different strategies for making sure they move away from the shade of their parent tree. The shape, weight and size of seeds gives some clues as to their strategy.

Some seeds are blown by the **wind**. They are lightweight and often have papery wings or fluff to catch the wind and help them fly further. Birch, ash, willow, aspen and elm have seeds like this.

Other seeds are spread by **animals**. Some seeds are big and nutritious to attract animals like mice and squirrel. Many get eaten but all these animals store seeds, when they are abundant in autumn, to help them survive when there are no seeds on the trees. Stored seeds are sometimes forgotten and can then germinate and grow into new trees. Oak and hazel are like this. Some trees have seeds inside a tasty fruit or fleshy coating, which makes them even more attractive to animals. These seeds might be quite small and tough so they are eaten with the fruit but are small enough to pass through the gut of the animal that eats them. They can spread a long way from their parent, especially if they are eaten by birds. Species like rowan, crab apple, hawthorn, yew, juniper, gean and bird cherry are spread like this.

Collect seeds when you visit native woodland.

How are the seeds carried on the tree? Are they in catkins, cups, cones, berries, sloes, etc? Are they fruity and fleshy or dry? Do they have wings?

Ash seeds

Elder berries

Draw seeds.

And try some experiments:

- drop seeds and watch how they move through the air. Try blowing them.
- weigh seeds (you will need a very sensitive balance). How many birch, ash, rowan... seed weigh the same as an acorn?
- try and figure out how they are spread now. And how they might have been spread in times or places with different animals than occur now.
- plant them. In pots under cover or, better if you can, outside in a small tree nursery. Some seeds need special treatment before they will germinate. Some may need to be removed from their fruit and they may need to be cold for a while before they germinate (why do you think this is?). Guidance on growing trees from seeds is given in *A Handbook of Scotland's Trees* by Fi Martynoga.

Pollen

Trees don't just travel via seed, they can also travel via pollen and have various **pollination** strategies. Pollen is the plant equivalent of sperm, carrying male gametes to fertilise female gametes in flowers or cones borne on the tree. Mobile pollen enhances the chances of cross fertilization. This allows trees to produce seed that is more genetically variable and so able to cope with a wider range of environmental conditions.

Insect pollination is common for many plants but poor weather, especially in spring when trees are in flower, reduces the activity of pollinating insects like bees or flies, especially in exposed places, like the woodland canopy, so insect pollination can be risky. **Wind pollination** is a common strategy for Scottish trees. Trees are also big and their exposed canopy makes wind a more reliable strategy in this climate. The downside of wind pollination for the tree is the need to produce lots of pollen, much of which ends up on the ground and eventually trapped in peat or lake sediment, where tough pollen coats can survive for thousands of years. The upside of this for people studying past environments is that pollen can give a very good idea of what plants grew where and, because trees produce so much pollen, this helps them understand how woodlands have changed since the Ice Age.

Palynology is the most important source of knowledge for ancient native woodlands.

Palynologists identify pollen from different species and have produced **pollen diagrams** for many parts of Scotland. This gives a good idea of past vegetation but it is not always entirely accurate; wind pollinated species produce vastly more pollen than insect pollinated species,

Hazel catkins

Willow

which can make it difficult to assess relative abundance of different species. For example **small-leaved lime**, an insect pollinated tree, was thought to be uncommon in the past but recent work suggests it was one of the commonest species in the wildwood, at least in the south of Britain.

Some pollen is difficult to identify, but some is very distinctive. Pine pollen has two big air sacs, which help carry it through the air, which make it very easy to recognise under the microscope.

The timeline (Chapter 1.2) shows relative amounts of hazel, birch, oak and grasses since the end of the Ice Age, estimated from pollen analysis from sites in Argyll. It shows how birch established quickly, followed by hazel and oak, and then how grasses became dominant with the start of agriculture in the Neolithic when the wildwood gave way to fields for crops and open ground for domestic grazing animals, cattle, sheep and goats.

Hazel seems very common from this timeline. This could be partly because it was favoured by hunter gatherer people in Argyll in the Mesolithic. Hazel was very important to them for nuts and for the rods, which are immensely useful for building lightweight structures and making baskets. It is also easily coppiced and they may have managed it and encouraged it on a relatively large scale because it was so important to them. Evidence for direct management of hazel using **archaeological methods** to look for artefacts is probably impossible to find, but the pollen evidence suggests that hazel could have been managed in the Mesolithic.

Ancient Trees and Deadwood

Granny pines are ancient Scots pine trees. They can be very conspicuous and are often splendid markers of native pinewood. **Ancient trees** are very important parts of native woodland because they are often big, can be very old and have large amounts of dead and decaying wood. This means they are home to many species, which are often rare, particularly lichens, fungi and insects. Many native woodlands do not have many ancient trees because big old trees have been felled for timber and they will be completely absent from newly planted or naturally regenerated native woodland.

Deadwood is an important habitat in its own right. Many species of lichen, fungi, other plants and animals live in or feed in deadwood. The great spotted woodpecker relies on deadwood when it is feeding by pecking into rotted wood looking for grubs and mature insects. Forestry Commission guidelines recommend an average of 20 cubic metres of deadwood per hectare.

Look at the bar chart, figure 18, on page 41 of the NWSS.

- Which native woodland type had the highest average volume of deadwood?
- Which type had the lowest average volume of deadwood?
- What was the average volume of deadwood for all native woodland types?
- How does this compare to the Forestry Commission's recommendations?

Deadwood: home to many species

1.6 Focus on Habitat and Biodiversity: Native Pinewoods

Habitat means home, and the more complex a habitat is the more homes it can provide for more different sorts of plants and animals and the richer its biodiversity.

One of the richest habitats in Scotland is Native Pinewood, sometimes known as **Caledonian pinewood**. It is one of our most widespread native woodland types and accounts for 28% of all native woodland. Described as a 'priority habitat' by the *European Union Habitats and Species Directive* it is legally protected because of its biodiversity.

Native pinewood

Native pinewoods occur in the **native pinewood zone**. This is an area of Scotland where native pinewoods are thought to have occurred in the past, and could occur now (see figure 30, map on page 55, NWSS Report). This area has a climate and soils that are suitable for Scots pine and species associated with it. The map on page 56 figure 31 in NWSS Report shows the current **distribution** of native pinewood.

Why do you think the two maps are different?

Scots pine may also be planted by foresters but it is not counted as native pinewood if it occurs outside of the native pinewood zone.

Why do you think this is?

Native pinewoods are an important habitat for some species that don't occur in any other sort of habitat in Scotland, including the crested tit and the twinflower.

Some species are not solely confined to native pinewood but it is still one of their most important habitats. This includes the Scottish crossbill (our only endemic bird species, i.e. it is not found anywhere else in the world) and capercaillie, which was once extinct in Scotland until it was reintroduced to native pinewoods.

Insects such as wood ant, sawfly and pine looper moth are important parts of the native pinewood **ecosystem** as are many plants such as ostrich plume feather moss. Even tiny species like this are part of the ecosystem and may be sources of food for other species. They may provide a place to hide or help to clean things up by eating rubbish like dead plants, dead animals or even faeces. Everything that lives in a particular habitat has a place in the **food web**.

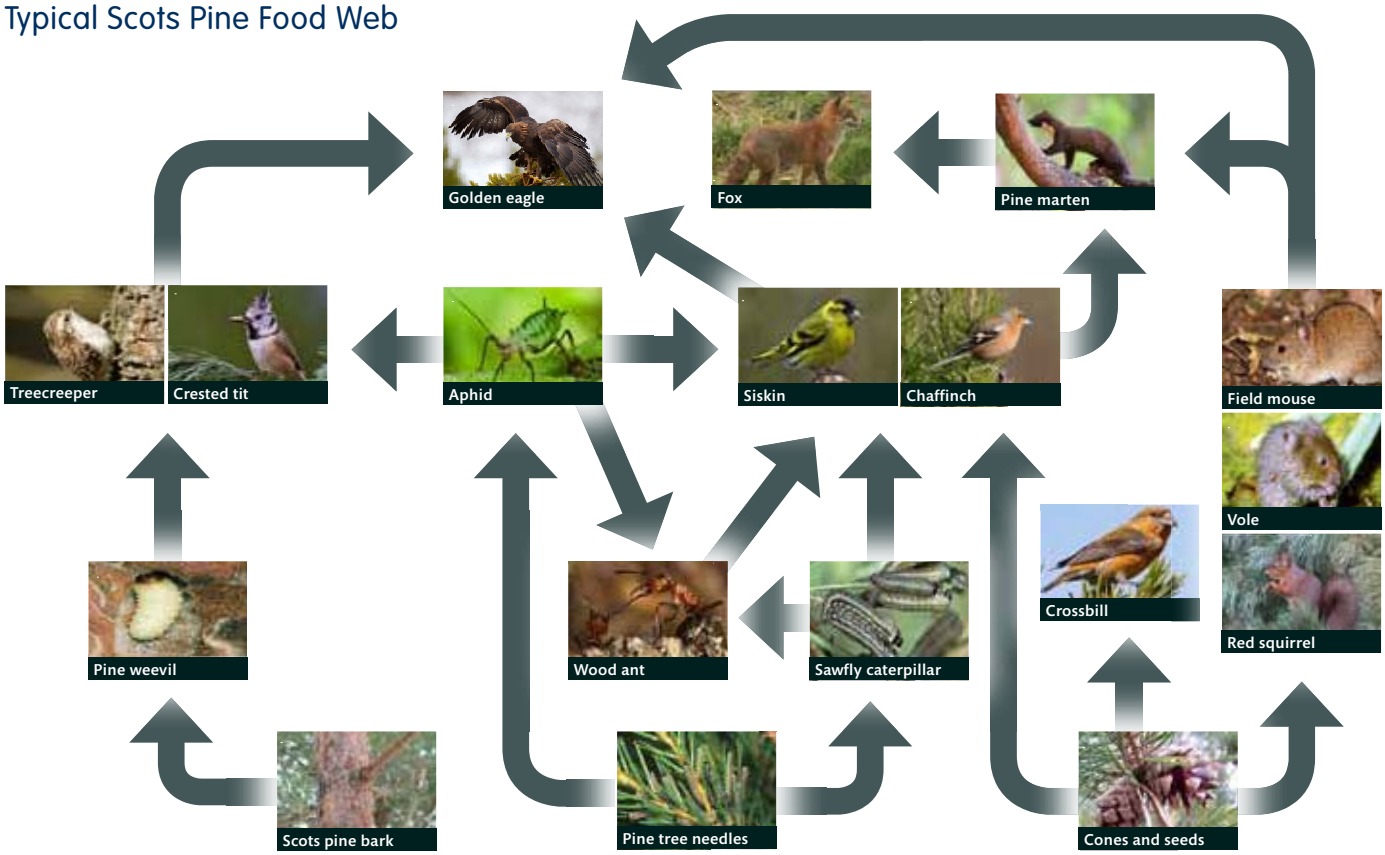
Native Pinewood Food Web

Like all trees, Scots pine attracts the attention of various insects. Some of these live in the fissures between the plates or flakes of the tree's bark, and these form a food source for birds such as the **crested tit** (*Parus cristatus*) and the **treecreeper** (*Certhia familiaris*), which specialise in winkling them out of the cracks and crevices. Larvae of the **pine weevil** (*Hylobius abietis*) burrow into the wood of the tree, and other insects live on the pine needles – **aphids** suck the sap, and **caterpillars** of species such as the **sawfly** (*Neodiprion sertifer*) and **pine looper moth** (*Bupalus piniaria*) eat the needles. **Wood ants** (*Formica aquilonia*) feed on these caterpillars, thereby helping to protect the trees from defoliation.

A variety of birds are associated with the Scots pine in Scotland, ranging from common insect and seed eating species like the **chaffinch** (*Fringilla coelebs*) and **siskin** (*Carduelis spinus*) to large raptors such as the **golden eagle** (*Aquila chrysaetos*).

The only bird which is endemic to the UK (ie found here and nowhere else in the world) is the **Scottish crossbill** (*Loxia scotica*), which is confined to the pinewoods. It is sometimes called the 'Scottish parrot' because of its crossed mandibles, which it uses to prise open the tightly-fitting scales of the Scots pine's cones. The seeds inside the cone form the mainstay of the diet for this rare bird. Mammals associated with the pinewoods include the **red squirrel** (*Sciurus vulgaris*), which also extracts and eats the seed from pine cones while they are still on the trees; **mice** and **voles**, which feed on pine seeds which have fallen to the ground, and the **pine marten** (*Martes martes*), which eats voles, red squirrels and small birds.

Typical Scots Pine Food Web



2. Earth's Resources

2.1 The Native Woodland Survey of Scotland

Forestry Commission Scotland manage trees, woodlands and forests for Scotland.

The **Native Woodland Survey of Scotland (NWSS)** was carried out by Forestry Commission Scotland to discover more about native woodland, especially **where** it was, what **type** of woodland it was and what **condition** it was in.

Soon after the NWSS was finished it proved very useful when Ash Dieback was reported in Scotland. Forestry Commission Scotland staff used the survey to find ash woodland so they could look for the disease throughout the whole country as soon as it was reported.

The survey was done between 2006 and 2012 by **surveyors** who used a specially developed **methodology**. The methodology involved the surveyors visiting woodland and recording what they found on a special checklist.

Some sorts of native woodland were identified as being particularly important before the NWSS started. These includes **ancient woodland** and **plantation ancient woodlands (PAWs)**.

Ancient woodland in Scotland is defined as an area that is marked as woodland on the first systematically produced Scottish maps and are still native woodland today. These maps, known as the Roy maps, were commissioned by the British government after the defeat of the Jacobite rebellions. They were made by General Roy between 1747 and 1755 and were the forerunner of the Ordnance Survey. Early Ordnance Survey maps were also used to locate ancient woodland.

PAWs are marked on the Roy maps as woodland and are now planted woodland or forest.

The NWSS report shows the results of the survey and is full of maps and statistics. The maps show where different types of native woodland occur.

2.2 Mapping

The Native Woodland Survey of Scotland started by trying to work out where native woodlands were.

They used other surveys including the Scottish Ancient Woodlands Inventory and Forestry Commission Scotland **databases**.

There are also **Ordnance Survey** maps. OS maps don't show whether a woodland is native or not but they do show if it is conifer or broadleaf. This is helpful where conifer woodland is not native, and where broadleaf woodland is quite likely to contain a high percentage of native species. The native pinewood zone maps give other clues as to whether a woodland is native. They show the shape of woodlands, if they are in valleys, on hills or plains, and whether the woodland is fenced or not. All of these are clues to whether a woodland is native or not throughout Scotland, not just in the native pinewood zone.

Things to look for on a map to identify native woodlands include:

- Is the woodland fenced (a solid black line)? Native woodland is less likely to be fenced than a conifer forest. Newly planted native woodland, and lowland native woodlands are likely to be fenced so this is not a certain indicator. But an unfenced woodland is unlikely to be planted.
- Are the woodland edges straight or wobbly? Wobbly edges suggest native woodland.
- Where is it? Native woodland is most common along valleys in upland areas and often follows natural land forms.
- How big is it? In many areas native woodlands are quite small, usually less than one hundred hectares. Outside of the native pinewood zone, woodlands bigger than this are likely to be conifer forests.

Use your local Landranger 1:50,000 OS map to find a native woodland or conifer forest. Then check on Map Viewer to see if it was surveyed by the NWSS.

Aerial photography is useful and accessible now through Google Earth, and can be used to identify native woodland. All the features shown on the map can be seen on aerial images, used by the NWSS or on Google Earth, and some additional things might also be visible:

- Scattered trees on the edge of woodland or open ground may not be mapped but are visible on aerial images.
- Many native woodlands have a few non-native conifers. These are often visible on aerial images.
- Maps do not show the location of different species, native or not. Although you probably won't be able to identify tree species from aerial images you may well be able to see differences in the texture or colour of the canopy where different species occur. This is useful if you are drawing a map of the woodland after you have surveyed it and already know what species are there.

Maps and aerial photographs help eliminate conifer forests from the surveys. Since native woodland only accounts for 22.5% of all woodland and forest in Scotland this saved a lot of time and work.

Map Viewer

Map Viewer is a **Geographical Information System** used by the Forestry Commission Scotland to present forest survey results on its website, www.forestry.gov.uk. The results of the NWSS are available through Map Viewer.

Use Map Viewer to find your nearest native woodland.

What type or types of native woodland occur there?

Use the "Measure Area" tool to find:

- The area of the whole woodland?
- Areas of different habitat types within it.

Instructions

To use the measure tool click on the tool then click around the boundary of measurable area to create a **polygon**. The area, in hectares, is shown at the top of the dialogue box on the right of the screen. The closer you get to the mapped boundary the more accurate you will be, so take your time and practise. To clear the measured polygon click on the measure tool.

Using Map Viewer go to Dunkeld (in Perth and Kinross, north of Perth) and use the screenshot

to locate Craig Wood and the woodland outlined in black on the west slope of Newtyle Hill. Then answer the following questions using Map Viewer. Keep the OS map as background and include the open areas within the fence lines in the Newtyle Hill woodland:

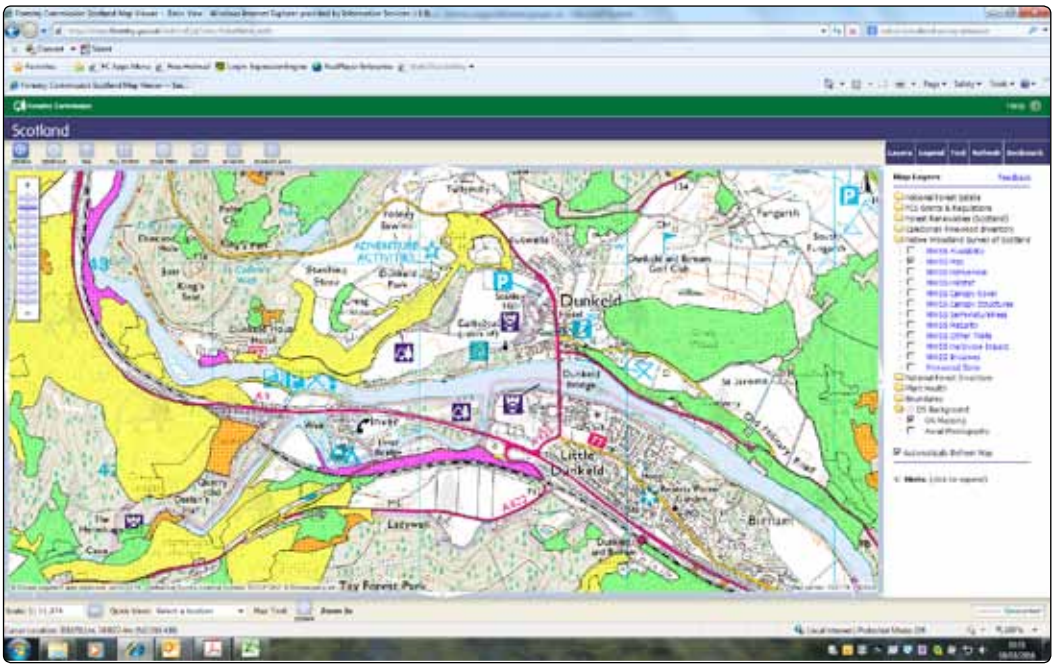
- What habitat type is Craig Wood?
- How big is Craig Wood?
- How big is Newtyle?
- What habitat types occur there?
- How big is each habitat type?

Present the Newtyle Hill results for habitat type as a bar chart.

My results

CRAIG WOOD Newtyle	
Total area	54.8 ha
Upland Birchwood	37.1 ha
Open (mapped and unmapped)	10.6 ha
Native Pinewood	2.7 ha
Upland Oakwood	2.1 ha
Wet Woodland	1.1 ha
Ashwood	1.2 ha

Dunkeld screen shot



2.3 Surveying Native Woodland

NWSS surveyors went to every potential native woodland in Scotland that had been identified.

They walked through the wood, taking a path that would enable them to **sample** all the different types of habitat present. They recorded what they found directly into a weatherproof computer in the field, answering a **questionnaire** designed to ensure that the information gathered would be **standardised** and **comparable**.

If you were going to survey a native woodland what questions would you ask?

Use the mapping exercises to find your local native woodland from OS maps and check on Map Viewer.

Visit it and survey it.

Before you go preparation is essential.

- Learn how to use keys to identify trees and shrubs and try and learn a few species before you go.
- Make sure you know how to take a grid reference. You can get apps for smartphones that will give your location in the form of a grid reference. This is very helpful and similar to what professional surveyors would do, though they would usually use a special GPS device to pinpoint their location. If you use an app, or GPS, learn how to take a grid reference anyway, so you understand what they mean. Instructions for taking a grid reference are given on all OS 1:50,000 Landranger maps.
- Learn about non-native invasive species and what they look like.
- Know the signs of herbivore impact (see Deer Detective)
- Make sure you have a recording sheet. Pack a clipboard and pens
- You are going outdoors so be prepared. Wear outdoor clothing and shoes and listen to safety advice. This is very important for professional surveyors, who often work alone in remote places.

Your Survey

Split into groups and try and make sure each group can work in a different part of the woodland. Be aware of where you are and where everyone else should be. Arrange a meeting place and time before you start.

The recording sheet should include:

- date
- your name, or names if you are working in groups
- grid reference

Look at the woodland. Record what you see on your recording sheet. This should have your questionnaire printed on it before you go so you don't have to remember what to look out for. Some of the things you should record include:

- **Habitat**. Describe the woodland in your own words. Try and describe the ground flora, name any species you know. Is there ivy, moss, ferns, bracken, bramble, grass, flowers, etc? What is the ground like? Are there rocks and boulders, bare ground, soil? Is it wet or dry?

- **Species**. Record each tree and shrub species you find and can identify in the field. If there is something you can't identify collect a twig with leaves on it (if possible) and take it back to the classroom to identify. Take photos too if you can.
- **Canopy cover**. Imagine you are looking at the woodland from above (or check it on Google Earth!). Record the % of ground that you think the canopy covers. Estimate the height of the canopy.
- **Invasive Species**. Record if present:
  - Rhododendron ponticum
  - Himalayan balsam
  - Japanese knotweed
  - Giant hogweed
  - Snowberry
- **Herbivore Impact**. Look for signs of herbivores (Deer Detective) and record. Estimate severity: low, medium, high, very high.

Caution: Giant hogweed has photosensitive sap that can cause severe burns if it gets on the skin and is then exposed to sunlight. So don't cut it or touch the stems or leaves.

Scots pine forest

2.4 Types of Native Woodland

There are eight types of different habitats identified in the NWSS within the broader habitat of native woodland.

This means they are all home to different plants and animals, though some **generalist** species may occur in several, or even all, eight types. The eight types are described in table 2.

Table 2. Native Woodland Types

Native woodland type	Distribution	Soils and climate	Main species	% Total native woodland*
Upland birchwoods	Throughout Scotland, especially on the edges of hilly areas above 250 metres.	Acid upland soils. Cool, damp climate	Birch (two species) plus rowan, hazel, oak, alder, bird cherry	29%
Native pinewoods	In the native pinewood zone, which includes much of the Highlands (but not most of Argyll, Caithness & Sutherland or the Islands).	Free draining acid soils Cool climate	Scots pine, birch, rowan, juniper. with alder and willow in wet areas.	28%
Wet woodland	Throughout Scotland	Wet soils	Alder, birch (especially downy birch), willows	14%
Lowland mixed deciduous woodland	Lowlands and straths in upland areas and coastal plains.	Free draining soils, acid and basic. Relatively mild climates	Ash, oak, birch, hazel, elm	8%
Upland oakwoods	Along glens and straths in upland areas	Free draining acid soils Cool, damp climates	Oak, birch. some rowan and alder. Richer sites with ash, hazel, hawthorn, blackthorn, bird cherry	6%
Upland mixed ashwoods (includes Atlantic hazel woods)	Valleys, ravines and gullies in upland areas. Atlantic hazel woods along west coast and Inner Hebrides	Moist base-rich soils Damp, cool climates. Mild and wet for Atlantic hazel woods.	Ash, hazel, downy birch, alder, oak	4%
Native woodland scrub	Mostly in southern lowlands (Hawthorn scrub)	Variable	Hawthorn, blackthorn, juniper, montane willows	c. 2%

* A category of 'other' woodland is not included here. It accounts for 9% of the total.

The ecological information in this table is similar to that given for the ecology of common Scottish native trees (Table 1). Why do you think this is?

Native birchwood

Ash woodland

Soils

Soils are important. Soils vary in pH so acid soils have a low pH and basic soils have a high pH. Mineral soils are derived from rocks and pH partly depends on the type of rock the soil developed from. Most rocks in north and west Scotland are very old and resistant to erosion and the soils derived from them tend to be thin, have low fertility and low pH. Soils in eastern and lowland Scotland tend to produce deeper, more fertile soils with higher pH. Peat is acid, wet and inhospitable to most trees.

Some trees, like birch, can grow on virtually any soils; others, like ash, prefer more fertile soils with a higher pH.

Judging from Table 2 and maps in the NWSS report what type of native woodland do you expect to occur near you?

Can you use this, with help from the passage above to predict the soil type too?

Use Map Viewer to find your local native woodland. What type is it?

2.5 The Value of Native Woodland

Although people destroyed large areas of native woodland in prehistoric times, we still have some left because it was valuable to people through time.

2.5.1 In the Past

Until two or three hundred years ago most people in Scotland had to grow most of their own food, make their own clothes and build their houses from locally available materials. If they didn't make it or grow it themselves they didn't go far to get it, and there was much less trade from other places than now.

Native woodland continued to be economically important throughout Scotland until recent times because it was the source of:

Timber. Round logs and sawn logs for roof timbers, building, furniture and larger constructions like bridges or crannogs.

Smallwood. From branches or young trees. Useful for furniture, some construction, household utensils and agricultural tools.

Coppice. Some species, especially hazel, can be cut to the ground every few years to produce long, straight, thin shoots that were essential for making house walls, fencing for animals, baskets and many other things.

Tree bark. Some bark, eg, from elm, has long fibres that can be twisted into strong ropes. Other bark, especially from oak, has high tannin content and was used for tanning animal skins to make leather.

Leaves and twiggy branches. This was gathered as fodder to feed to cattle, sheep and goats. Holly and elm were very good for this.

Fruit and nuts. Some species were very important food sources, especially in the late autumn and winter. Hazelnuts, acorns from oak and sloe berries from blackthorn were all valuable.

Meat. Meat from wild animals living in woodland, especially deer, could be an important food source, even for agricultural communities.

Firewood. Wood was an important source of fuel for cooking and heating. But even 2,000 years ago, native woodland was becoming scarce in many parts of Scotland, and peat became important as fuel.

Charcoal. Charcoal is made from wood that has been burnt very slowly so most of its water has been driven out. Charcoal burns hotter than firewood and was essential for making iron from prehistoric times until coal became widely available during the Industrial Revolution.

Magic, mystery and story. Trees have many ancient stories and beliefs about them. Oak groves were places of worship for Celtic peoples around 2,000 years ago. Hazel was the tree of wisdom in Celtic stories. The Gaelic alphabet uses trees for names of the letters.

Past Woodland Management

Native woodland was **managed** by people to increase its value to them. This included **coppicing**, **grazing and shelter**, **clearfelling** and some **tree planting**.

By the **1700s** native woodland was a rare and precious resource. The 18th and 19th centuries were times of great change in Scotland with the **Jacobite Rebellions**, beginnings of the **Industrial Revolution** and massive rural depopulation (known as **The Clearances**). Small scale subsistence farming was replaced by large scale sheep farming for profit. The value of

native woodland to the rural economy was lost and so increasingly neglected. By the early 1900s woodland covered less than 4% of Scotland's land area and was fragmented into small, isolated blocks.

2.5.2 Now

Forestry and woodland management has changed massively over the last three hundred years. In the past local people managed local woodlands for local needs. Now, most forests are managed to produce large volumes of timber for national and international markets. This situation developed largely because of decisions made in the past. World War I was nearly lost "for the want of timber than anything else" (Lloyd George) and the Forestry Commission was established in 1919 to create a strategic timber supply. This helped create the forest industry of today which is worth about £1 billion to the Scottish economy. Today multi-purpose forestry underpins the management of these forests and conserving and increasing native woodland is one component of this.

Native woodland is no longer used by people in the same way as in the past. Local sources of food, clothing and housing have lost the value they had as we source most of our raw materials from elsewhere, often from abroad. There has also been a huge change in the way that woodland is managed so that 77.5% of woodland in Scotland (see NWSS report) has been planted in the last two hundred years.

Timber production today

The value of native woodland has altered over time so they are now valued for other things like their conservation potential. Woodland management in native woodland will include felling trees for a variety of reasons, including timber. This timber can be sold on to provide an income for the owner. This income can then be used to provide other benefits from native woodlands which include:

Timber. Native species produce timber which is still valuable, including oak for specialist building and furniture and birch, which makes hardwearing and beautiful flooring.

Firewood. Conifers don't make very good firewood but native hardwood species burn hotter and cleaner. They also make good **charcoal**. Firewood is a type of **biofuel** and, in theory, is **carbon neutral**, i.e. it captures as much CO_2 from the atmospheric as a growing tree as it releases when it's burnt. This makes it potentially important in planning to reduce the impact of climate change.

Shelter and grazing. Some native woodlands are still used by farmers for shelter and to graze their animals.

Shooting. Native woodland can be used for pheasant shooting.

Water quality. Native trees, especially broadleaves, can enhance the quality of freshwater for some fish.

Landscape. Native woodlands are an important part of our landscape and are often considered to be essential to Scotland's beauty. In this way they make an economically valuable contribution to tourism.

Recreation. Many people enjoy walking, cycling, fishing, foraging, camping or just being in native woodland and enjoying the magic, mystery and stories.

Ecology. Native woodland is probably Scotland's richest **habitat**, which means that it accounts for a relatively much higher **biodiversity** than any other terrestrial habitat. **Deadwood** is one component of this biodiversity that can be overlooked but it can contain a third of the plants and animals in the woodland. This makes native woodland invaluable, although it is almost impossible to put a financial price on this.

Some Economists have tried to put a price on natural resources like native woodland. If you were asked to put a price on native woodland how would you do it?

Do you think it's a good idea to put a price on nature?

3. Sustainability

3.1 Dynamic Woodlands: Native Woodlands Now

The total woodland cover of Scotland is 18% with 4% native woodland.

The United Kingdom as a whole has 13% cover. This is very low by European standards: Finland has 73%, Sweden, Latvia and Estonia more than 50% and France has 31%. (Source: FAO Global Forest Resources Assessment, 2015/ Forest Facts & Figures, 2016)
Present these figures in a bar chart.

Why does Scotland have so little woodland?

Be careful how you present native woodland. It is not clear how much native woodland is present in the other countries.

As we have seen, most of our woodland was lost hundreds of years ago, and even in the 1750s there was a similar percentage of native woodland as today, about 4%.

Native woodland is under threat but despite this there has been some positive change, particularly over the last twenty years or so.

3.2 Native Woodland Condition

The NWSS used four aspects of native woodland as indicators to assess its condition (in other words, the health of the woodland).

If all four indicators were in the desired range then the woodland was satisfactory. Scotland's native woodland is in **moderate condition** overall with 46% of native woodland being satisfactory according to this measure.

The **indicators** of healthy woodland are:

- Canopy cover. Less than 50% = too few trees for the woodland to be healthy. More than 90% = the woodland is too shaded and dense for tree seeds to germinate and grow or for other species of plant and animal to thrive. This is related to woodland **structural variation** and **fragmentation**.
- At least 90% of the canopy is native species. Less and the woodland may already be or may become dominated by non-native species of tree and shrub.
- Herbivore impact
- Non-native species

The percentage of native woodland outside of the desired range for each condition factor is shown in the pie chart on page 48, figure 23 of the NWSS Report. Each section of the pie represents the proportion of native woodland that is below the standard needed to maintain it in a healthy state for each condition indicator.

What percentage of native woodland has an unhealthy level of canopy cover?

What percentage has an unhealthy level of native species?

What percentage has a healthy level of herbivore Impact?

Which is the lowest threat to the health of native woodland?

Which is the greatest threat to their health?

Do you think this is a complete list of indicators for the health of native woodland?

If not, can you think of any other threats?

Why do you think these four indicators were chosen?

3.3 Invasive Non-Native Species

Invasive non-native species were introduced to this country as garden plants or as cover for gamebirds.

They are so successful here that they invade our natural vegetation and outcompete native plant species.

The main invasive non-natives threatening native woodlands are listed in Table 3 (also see Table 13 in the NWSS report).

Himalayan balsam

Rhododendron ponticum

Table 3. Invasive Non-native Species

Species	Origin	Seed Dispersal	Area covered within native woodland (hectares)
Rhododendron ponticum Large woody shrub	A rare species in its native habitat. It occurs on mountains in Portugal and Turkey. Scottish plants originally came from Turkey.	Tiny seeds. Wind dispersed from woody capsules that split and release the seeds in very large numbers.	3,691
Himalayan balsam Perennial herbaceous	Himalayas	Wind dispersed. The light seeds have small wings. It often grows by rivers and can also be dispersed by water.	113
Japanese knotweed Perennial herbaceous	Japan	Wind dispersed. The light seeds have small wings. It often grows by rivers and can also be dispersed by water.	113
Giant hogweed Perennial herbaceous	Turkey, Iran etc.	Wind dispersed. The light seeds have small wings. It often grows by rivers and can also be dispersed by water.	96
Snowberry Small shrub	Western North America	Small seeds spread in berries eaten by birds and small mammals.	46

Why do you think these species are so successful in Scotland?

Think about the climate of their places of origin and their seed dispersal.

Look at the areas covered by each species. Which is the most widespread?
Why do you think this species is even more successful than the others?

Non-native invasives can have a very harmful impact on native woodland but, apart from Rhododendron ponticum, they mostly occur in relatively small areas and their overall impact is quite small, although nationally they are a more significant problem within native woodland.

3.4 Fragmentation

Native woodland covers a fraction of the area it did 8,000 years ago when the wildwood covered most land suitable for trees.

Look at the map on page 20 of the NWSS report. This map shows the distribution of native woodland and other woodland/forests.

Where is most native woodland?

Native woodland is **fragmented**. This is because:

- Most native woodlands are small, especially in the Lowlands.
- There are large areas where there is no native woodland at all, especially in the Highlands, Islands and Southern Uplands.

Why do you think fragmentation is not used as an indicator of native woodland health by the NWSS?

Fragmentation is a problem for the ecological health of native woodland because:

- Some species cannot travel from woodland to woodland because the distances between them are great and the intervening habitat is unsuitable for their survival. Species like this are poor at dispersal (such as twinflower, hazel gloves fungus, black tinder fungus beetle).
- Some species are good at **dispersal** and can move between areas of native woodland but they cannot survive in other habitats because of their **specialised** feeding or breeding needs (such as crested tit, Scottish crossbill, pied flycatcher, and redstart).

Many native woodland species require **large areas** of suitable habitat (such as Scottish wildcat and pine marten). Fragmented patches are not big enough for their survival.

Dispersal

Different tree and shrub species have different dispersal abilities, depending on their seed types. This is important for understanding how they colonised the land after the Ice Age and is relevant to the fragmentary nature of native woodland today. Native woodland has increased in some areas in the last hundred years or so because of a decline in upland agriculture and by birch spreading out from existing areas. Species like oak, with heavy seeds, have spread much less. Much of the Highlands are bare of trees and, even if conditions were suitable, woodland would not re-establish for a very long time because seeds cannot travel between the fragmented woodland. An exception is rowan. If a tree is growing alone with no other trees for miles, it's worth a bet that it will be rowan. **Why do you think this is?**

Fragmentation also makes breeding between closely related individuals more likely. This means that some species may have less **genetic variation** which helps species cope with changes in their environment. **Aspen** is a native tree species that has limited genetic variation due to its method of reproduction. Aspen can spread **vegetatively** by sending suckers out from its roots that can develop into full grown trees. This means that all the trees in an aspen grove may be genetically identical, i.e. it is a single **clone**. Sometimes several aspen clones grow together but it is possible to map where one clone starts and another begins by differences in the time when they leaf flush, when their buds burst into leaf in spring. Aspen is not very common in Scotland probably because of fragmentation and the resulting lack of genetic variation (refer to aspen map in NWSS Report).

Structural Variation

Small patches of fragmented native woodland do not have much **structural variety** within them and the trees are often much the same age.

In older woods the canopy can be very dense so little light can get to the ground. This restricts the number of species that can live there.

Lack of structural variety, in the ground flora as well as the trees, is a problem for capercaille. They are the largest species of grouse and were shot for sport, which lead to their extinction by 1785, until they were reintroduced in the nineteenth century. They live in native pinewoods and near native conifer plantations but they need structural variety within this habitat including ground cover of heather and blaeberry. This range of habitat has declined in some of the places where capercailllie lives, and as a result the number of birds has reduced.

3.5 Regeneration

Regeneration is the renewal of woodland by seed germination, subsequent growth of tree seedlings into bigger saplings and eventually into mature trees; essential to the long-term survival of native woodland.

Mature trees produce vast numbers of seeds and many of them will germinate but it is the subsequent survival of seedlings that determines whether a native woodland can sustain itself beyond the life span of its existing mature trees. If seedlings do not survive, the woodland will disappear as its mature trees die. According to studies and calculations reported in the NWSS report (page 39) 'present natural regeneration is well below the level required overall to sustain our native woodland resource in the long term.'

3.6 Herbivore Impact

All the native woodland types in the Native Woodland Survey of Scotland have herbivore impact as the most frequent negative impact on their condition.

The pie chart below is important. It shows that 86% of all native woodland have herbivore impacts that range from medium to very high.

Deer are the biggest problem for the long-term survival of native woodland in Scotland and, to a lesser extent, other herbivores like mice, rabbits and sheep.

Red deer are responsible for most of the herbivore damage

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%)

'Slot'

Bark stripping

In many areas there are too many deer to allow native woodland to sustain itself through natural regeneration; even trees planted to create new woodlands must be protected from deer for them to survive to maturity. Your imaginary food web should help you to understand why there are so many deer. Since the large predators, like wolf, bear and lynx, went extinct the only control of their numbers is shooting and food shortage.

There are two native species of deer in Scotland, red and roe. They both damage native woodland, although they have different ecologies. There are also several introduced deer species, including fallow and sika, which can be very damaging to woodland.

Red deer in Scotland tend to live on open ground but would prefer woodland and they do seek shelter in woodland in winter, when they can cause a lot of damage. They also prevent regeneration on open ground, which otherwise could turn naturally into woodland.

Roe deer are more likely to live in woodland and can be very damaging. Since they are smaller than red deer and don't live in big herds they can be very difficult to spot and even more difficult to shoot.

Both sheep and deer can kill trees but they also graze the ground flora under the trees. With high numbers of sheep or deer the ground flora becomes dominated by grasses, which can develop a dense sward, where it is difficult for tree seedlings to establish.

Deer Control

In order for native woodland to regenerate it is recognised that deer numbers need to be controlled.

Deer can be kept out of woodland by fencing but this is expensive.

Shooting deer for sport is important to many traditional Scottish estates. Landowners may charge for shooting deer for sport but their priority is to shoot stags. To bring numbers down low enough for trees to regenerate the hinds (females) need to be targeted. But this is less profitable and is done less often.

Stalkers are specialist deer hunters often employed by the landowner to control deer, which is expensive. Deer meat, venison, can be valuable but the quality and amount from wild animals is unpredictable. Deer skins make superb leather but there is currently no market for this. All this means that protecting native woodland from deer damage can be expensive.

Deer Tracker

When you visit your local native woodland look for signs of deer*

- **Bark stripping**
- **Snipped twigs**
- **Chewed leaves and branches**

All these signs will only occur up to the level deer can reach. In badly affected woodland you might see a 'browse line', where there is heavy browsing below about 1.5 metres or so and normal growth above it.

- **Footprints** (deer prints are called **slot**). If there is a lot of activity you might see 'poaching', where the ground becomes muddy and heavily disturbed.
- **Droppings**. Size and shape might help work out what sort of deer are present.
- **Deer paths**. Narrow paths that cross footpaths used by people are likely to be deer paths. Look for deer slot in exposed soil.
- **Ground flora** and **understorey**. If the woodland looks quite open at ground level, so you can see most tree trunks clearly and there are not many shrubs and not much undergrowth, then the wood is likely to have been heavily browsed for a long time. It might feel like a pleasant place but it is unhealthy woodland and if nothing is done to control the herbivores the mature trees will eventually die and the woodland will become open ground. This has happened in many places, especially in upland Scotland.

*Sheep signs are similar, but you'll probably see the sheep. Deer will disappear out of sight.

Levels of impact: low, medium, high, very high (see NWSS report).

3.7 New Native Woodlands

There are many new native woodlands because of an increasing recognition of the value of native woodland and that new woodlands should be created, as well as protecting existing ones.

Planted Woodlands

Forestry Commission Scotland encourages planting of **new native woodlands** through grant schemes. This is often done in partnership with environmental charities, including community woodlands, which are dedicated to protecting and creating more native woodlands.

Naturally Regenerated Native Woodland

Native woodland can also look after itself, if it's allowed to, and even spread naturally onto open ground. In some parts of Scotland native woodland has started to re-establish on land that was previously bare because of a decline in sheep. With less sheep, trees have been able to grow from previously nibbled seedlings. Birch is almost always the first tree to establish in these places, just as it was after the Ice Age. Perhaps, if it is left to get on with it, it will be colonised by other species like Scots pine and oak and all the other species that contribute to the rich biodiversity of native woodland. Despite these natural increases the potential for more native woodland to establish itself on a large scale is limited by deer and land management practices, including burning moorland for grouse shooting and sheep grazing on large areas of open ground.

3.8 Dynamic Woodlands: Looking to the Future

We are living in a changing world. The climate is changing, human populations are expanding, biodiversity is threatened, energy and land are in short supply and economic pressures are felt everywhere.

We can't be sure how native woodlands will change but we can make some guesses about the impact of a **changing climate**, for example, based on recent trends and scientific research. This is essential for an organisation like Forestry Commission Scotland, which is used to planning for the long term to make sure that our forests and woodland meet our needs today and in the future. We can also assume that **tree diseases** will continue to threaten native woodland and that new diseases are likely to arrive in Scotland.

Climate Change

Climate change could have a huge impact on forestry and woodland. It is likely it will become **milder** and **windier** in Scotland.

Warmer temperatures may allow more different tree species to grow. One such species is small-leaved lime. Small-leaved lime was a common tree in the wildwood but, as the climate got colder it was less able to set viable seed and it has declined to become a common species only in a few woodlands in southern Britain.

Cold Scottish winters helped protect our native species from diseases that could have been

introduced in the past, naturally or by people. With warmer winters diseases have become an increasing threat. Many have been introduced by people, and milder temperatures have allowed them to survive all year. Wetter summers also encourage many tree diseases, particularly fungal diseases like Ash Dieback and Dothistroma Needle Blight.

Wind can also be a problem for trees, breaking branches and sometimes even blowing them over and uprooting them. Scotland is a windy country, especially the west, north and upland areas. Our native woodland has developed over thousands of windy years in this country and can withstand it remarkably well. Wind may actually be an important trigger for regeneration of woodlands when new openings in the canopy allow more light to reach the ground, allowing seed germination and rapid seedling growth to fill the gap.

Windblown Scots pine tree looking from the root plate up the tree. Note the young pine trees growing on the deadwood!

Diseased trees

Disease

Tree diseases have become a big issue in recent years and are likely to become even more so with continued imports of plants from other countries and with climate change. **Ash Dieback** (*Hymenoscyphus fraxineus*) was first detected in Britain in 2012. In the Far East where it originates it infects different ash species to ours and tends not to kill them. It came to Europe and spread rapidly through European ash trees, devastating them. It came to Scotland with saplings grown in Europe for planting in new native woodland and spread from there. The disease reached southern Britain naturally as the light fungal spores that cause it were carried by wind from mainland Europe. Ash Dieback has infected around 90% of ash trees in Denmark and it could have a devastating impact here. Ash trees make up 4.2% of trees in the canopy of all native woodland (Figure 7 NWSS) but they can be very important as individual trees in some landscapes.

Other important tree diseases include:

- **Dothistroma Needle Blight**. Pine species, especially species like Corsican pine or lodgepole pine, can be very badly affected and it can also infect Scots pine.
- **Sudden Oak Death** (*Phytophera ramorum*). Sounds terrible, and it is for some non-native species like rhododendron and larch, but so far oak has not been badly infected.
- **Alder Disease** (*Phytophera alni*). This disease is spread by water and alder trees, which often have their roots in water, are vulnerable. The disease doesn't appear to remain equally virulent year to year and many alder trees have recovered.

How Tree Diseases Spread

Tree diseases are caused by species of fungus but are spread in different ways. Wind, water and insects are natural **vectors** that spread fungal diseases but transporting infected plants has spread them from continent to continent much more quickly.

High biodiversity is important because it helps species and habitats cope with the changing world that we live in. If a habitat, like native woodland, has high biodiversity it can cope with change better.

Many larger forests are now restructured in order to create multi-species and multi-layered diversity. This increases biodiversity and makes improvements to the landscape.

Ash in Scotland has a lot of **genetic diversity**, a kind of biodiversity that occurs within a species, so some ash trees are likely to have natural immunity to Ash Dieback, which means the species is unlikely to be wiped out in Scotland. Even if many trees die there will be other native tree species that could replace them, until ash trees build up a degree of disease tolerance to Ash Dieback. This is less likely with planted species like larch, which have much less genetic diversity and are planted without other tree species to replace them.

Why do you think diseases from abroad, especially from other continents, are such a problem?

What can we do to lessen the risk of introducing new tree diseases?

The Future of Native Woodlands

The Native Woodland Survey of Scotland (NWSS) provides a unique dataset for a wide range of purposes. It tells us about the state of our native woods today and provides data 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 Government support and funding, trusts, charities and many individuals.

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.

Can you suggest how we can predict what people will need from woodlands and forestry in the future?

4. Further information

Native Woodland Survey of Scotland

www.forestry.gov.uk/nwss

Scotland's Native Woodlands: Results from the Native Woodland Survey of Scotland. The source of the statistics, maps and survey methods referred to in this resource. Forestry Commission Scotland. 2014.

Scotland's Native Woodlands. DVD on the NWSS and some of the main native woodland types. Forestry Commission Scotland. 2014

Scotland's Native Woodlands. Leaflet summarising the results of the NWSS. www.forestry.gov.uk. Forestry Commission website. Allows free access to **Map Viewer**.

Teaching Resources

Wolf Brother. Teaching resource that looks at life in the Mesolithic. Forestry Commission Scotland. 2012

Trees and the Scottish Enlightenment. Teaching resource on the development of plantation forestry during the 18th and 19th centuries. Forestry Commission Scotland. 2013.

Tree Stories. Teaching resource with stories for 12 trees with their uses and beliefs in traditional culture. Forestry Commission Scotland. 2014.

All publications are available from Forestry Commission Publications and can be ordered via the Resource summary leaflet http://owlscotland.org/news/new-summary-resource-flyer

Identification

Tree Name Trail: a key to common trees. Available online through www.forestry.gov.uk and as a foldout laminated sheet. An illustrated key to common native and non-native trees. Field Studies Council & Forestry Commission. 2010, 3rd edition.

Collins Tree Guide. Owen Johnson and David More. Guidebook to all native and many non-native trees in Britain. Illustrated throughout, with keys to twigs in winter. William Collins Books. 2006 (paperback).

A Handbook of Scotland's Trees. Fi Martynoga. Covers native tree and shrub species with notes on how to grow them. Saraband. 2014.

Citizen Science and Trees

Citizen Science and Curriculum for Excellence. Outlines how Citizen Science can be used, with links to other resources.
https://education.gov.scot/improvement/Documents/RES1-citizen-science-and-cfe.pdf

OPAL Tree Health Survey. One of the many surveys provided by OPAL. Useful as an introduction to identifying and surveying trees. www.opalexplorenature.org/treesurvey

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