What is an ecosystem?
An ecosystem is a combination of natural (and sometimes human) features which interact, rely on each other, and operate as a system. Vegetation is usually the most important component and most ecosystems are named after their vegetation characteristics. However, soil, animals, insects, climate and people are also important parts of any ecosystem.

Energy and nutrients flow through all ecosystems and nutrients are stored within soil, litter and living flora and fauna (plants and animals). Each element of the ecosystem is affected by others, for instance soil type influences vegetation characteristics and vegetation can affect the soil, too. Ecosystems vary greatly in scale. Something as small-scale as a single hedgerow or a pond can be described as an ecosystem. Biomes are the largest global-scale ecosystems. Tropical rainforest and taiga, the band of coniferous forests across northern Europe, Russia and Canada, are ecosystems on this scale.

This unit focuses on one type of large-scale ecosystem – the coniferous forest.

What is a conifer?
Coniferous trees disperse their seeds by means of cones. The trees have needles rather than leaves. Almost all conifers are evergreens, but not quite all, and this is a mistake many people make. The European larch is one conifer which loses its needles seasonally and has bare branches in winter. The key characteristics of coniferous trees are illustrated in Figure 2.

Most conifers in the UK today are not native species. The three original types are Scots pine, juniper and yew. For thousands of years they covered a large part of the northern British Isles, the Caledonian Forest covering 20% of Scotland. Clearance for agriculture and settlement destroyed the majority of this and other UK coniferous forests. Today the Caledonian Forest covers only 1% of the Scottish landscape. Scots pine remains the most common native species; yew and juniper are now much rarer.

Global distribution of coniferous forest
The British Isles contain a tiny proportion of the world’s coniferous forests, but Figure 3 shows a large, clear band of boreal ecosystems stretching across the
northern hemisphere around latitudes 55°–70°N. This zone coincides with the taiga climatic region. Coniferous forests are also found in mountainous areas closer to the Equator, because increasing height reduces temperature and alters the expected vegetation type. This happens in the Western Cordillera (of which the Rocky Mountains are a part) in the USA.

Coniferous forests are much less common in the southern hemisphere. Southern Chile is the main forested area here. As you travel closer to the poles and temperatures drop, the species change to the toughest varieties and the trees themselves become smaller and more spread out.

**Boreal climate**

Conifers have several adaptations to help them cope with the harsh climate zones in which they grow (Figure 3). Figure 4 shows climate figures for Dawson, Yukon, Canada. This is a colder taiga area, with a temperature range of 42°C (+14 to –28°C). Ground is frozen for six months, so precipitation from November to April is wasted; the tree roots cannot use snow. The growing season for most plants is only five months but conifers with needles can photosynthesise all year. Within the Arctic Circle trees can take advantage of 24 hours of daylight for four summer months, but equally there is the same length of total darkness in winter. No photosynthesis can happen then.

**Nutrient cycling in coniferous ecosystems**

The three nutrient store sizes vary considerably in the coniferous forest ecosystem (Figure 5), although the differences are not as great as in some other systems. Tropical rainforest has almost all its nutrients in the biomass store. In boreal forest the litter store is by far the largest with biomass second; the soil store is the smallest.

Coniferous litter holds so many nutrients because it is composed of needles. Needles are very slow to decompose due to their waxy coating. Highly acidic vegetation plus a damp and cool/cold environment discourage bacteria and fungi, which break litter down into humus, as well as the insects, such as earthworms, which mix that humus into the upper soil. The profile of soils found under conifers, known as *podsols* (Figure 6), also shows this. Podsols have a particularly thick organic horizon, divided into three distinct layers. Conifers drop their needles steadily throughout the year, often at a faster rate than those already on the ground can decompose. This is why, when you walk through coniferous woodland, the ground feels springy or cushioned. The needles have to wait in a ‘queue’ to be decomposed. Eventually, they become part of the fermentation layer, where the actual decomposition takes place. Humus results, but again it has to wait before being incorporated into the soil because there are simply too few earthworms and other soil fauna to manage this task quickly.

The very fine arrows representing the nutrient flows on Figure 5 show how slowly the whole system operates. Arrow width is directly proportional to volume of nutrients moving between stores. The finest arrow is between litter and soil.

**Links within the ecosystem**

True podsols are found only under coniferous forest or heathland. Both climate and vegetation...
Some of the dissolved iron compounds may be deposited lower down in the B horizon (Figure 6), which can lead to the formation of an iron pan or hard pan, an impermeable layer. This prevents water passing easily through the soil, resulting in waterlogging so that the whole ecosystem works even more slowly.

**Human exploitation of coniferous ecosystems**

Unlike tropical forests, coniferous forests are less threatened by human activity and remain as some of the world’s last wilderesses. However, changes due to economic use are taking place.

**Afforestation**

Coniferous forests were originally cleared by early man for agricultural purposes. Afforestation, or the deliberate planting of trees, has been going on in the UK over the last 60 years. It will continue and perhaps increase. Planting new trees is done for a variety of reasons, for example:

- on land near to urban areas to provide recreation
- on otherwise unused land for economic purposes such as producing paper, chipboard and furniture timber
- in open countryside where soil erosion may become a serious problem.

Figure 7 shows the main species planted in the UK. These are not generally native. Scots pine is native, and grows best on dry sandy soils. However, this means it is not suitable everywhere. Sitka spruce is the most commonly planted tree because it is so adaptable, able to cope with strong winds and high rainfall levels.

The style of planting has changed with experience. In early plantations the trees were in a series of straight rows. This was obvious from the ground, but even more so if you were flying and looking vertically down over areas such as south-west Scotland, where early plantations flourished.

**Sustainability**

People have modified the planting in several ways. Fragile environments are avoided in order to protect their ecosystems from change. More plantations are now mixed coniferous and deciduous because this helps to preserve a greater variety of wildlife. Some plantations which had damaged pre-existing ecosystems, such as those on lowland heaths, have been removed, and these areas returned to their previous habitat. Planting trees in straight lines no longer happens, so planted landscapes appear more natural.

The UK needs ten times as much softwood (from coniferous trees) as hardwood (from deciduous trees). Conifers have the advantage of growing much more quickly; and they can be cut after 50 years of growth. Deciduous trees, in contrast, take much longer, the exact time varying with the species.

Conifers can be grown on very poor-quality land which cannot be used for any other economic activity, so money is made where it previously could not be. In hill farming areas, where jobs are scarce and incomes low, conifer plantations can boost both jobs and income by using land that is not otherwise productive. Some wildlife species thrive – squirrels, for instance.

However, the impact of conifer plantations is not all positive. They increase the acidity of soil and water, resulting in the acidification of rivers and lakes. Fertilisers, herbicides and pesticides are sometimes used on the plantations. This can cause eutrophication of rivers and lakes. People then need to step in to restore a more balanced pH.

**Conclusion**

Coniferous woodland thrives in many parts of the UK. In the New Forest (Hampshire) and Ashdown Forest (Sussex) it forms semi-open land used for recreation. Elsewhere, such as in the Southern Uplands and Highlands of Scotland, exploitation contributes considerably to the local economy. These areas are all managed environments.

In more sparsely populated parts of the world, these forests cover huge expanses of land and only certain zones are exploited. There is much more potential for development here, as long as this is undertaken by sustainable methods.
Activities

1. Some species of coniferous trees are listed earlier in this unit.
   (a) Undertake some research to find the names of at least five other species.
   (b) Discover which types of conifer thrive in your home region.
   (c) Either: For pupils living in a relatively rural region:
       Which type of ecosystem dominates the landscape in your home area?
   Or: For pupils living in urban areas:
       Which type of ecosystem dominates the landscape in a more rural area which you have visited?

2. Study Figure 3, showing the distribution of coniferous forests across the northern hemisphere.
   (a) Describe the distribution shown on the map. Name continents, regions, countries and areas to make the locations really clear. Also refer to latitude to identify areas. Use your atlas to help you.
   (b) Why do you think there is no equivalent belt of taiga in the southern hemisphere?

3. (a) Figure 8 is a frame for a climate graph. Use a copy of this frame and the data in Figure 4 for Dawson in north-western Canada to construct a line graph for temperature and a bar graph for precipitation. Your temperature line should be coloured red and your precipitation bars shaded in blue.
   (b) Describe the climate patterns for Dawson, being careful to comment on both temperature and precipitation.
   (c) Why do geographers use a line graph to represent temperature, but a bar chart for precipitation? Think of the nature of the data being shown.

4. Answer either (a) or (b).
   Either:
   (a) Use Figure 2 and the photograph in Figure 9 to list the features of coniferous forests. Compare your list with those of others in your class.
   Or:
   (b) Cut out the photograph, stick it into a page in your file and add annotated labels to show the features of coniferous forests. For your answer to (a) or (b) you can also use the text and the data in Figure 4.
   (c) Find the links between these characteristics and the climate details you looked at in Activity 3. (In other words, how does the climate influence the trees?)

5. (a) Match the items in the two lists below to show the relative sizes of the three nutrient stores in a coniferous forest ecosystem.
   Biomass Largest
   Litter Smallest
   Soil Medium-sized
   (b) Explain why the smallest arrow in Figure 5 is from litter to soil stores.
   (c) For any other ecosystem which you have studied:
       (i) draw a nutrient cycle
       (ii) draw the soil profile.
   (d) Describe the differences between the two nutrient cycles and between the two soil profiles – that is, of the coniferous forest and your choice in (c) above.
   (e) Explain the differences which you have identified in question (d) above.

6. (a) Create two lists, one showing the positive aspects of exploiting coniferous woodland and one to show the negative aspects. Decide whether exploitation should:
   (i) be reduced
   (ii) stay at present levels
   (iii) expand.
   (b) ‘The exploitation of coniferous forests is one of the most sustainable and acceptable systems of using a difficult landscape.’ Discuss in small groups or have a classroom debate on this topic.