

CHAPTER 2

Description of study sites

2.1 Introduction

The shade house trial was set up in one of the Forest Research nurseries (Forestry Commission) at the Bush Estate, Roslin, 12 km south of Edinburgh. Field trials were carried out in the Glen Affric Caledonian Pinewood National Nature Reserve in the Highland Region of Inverness-shire (Figure 2.1).

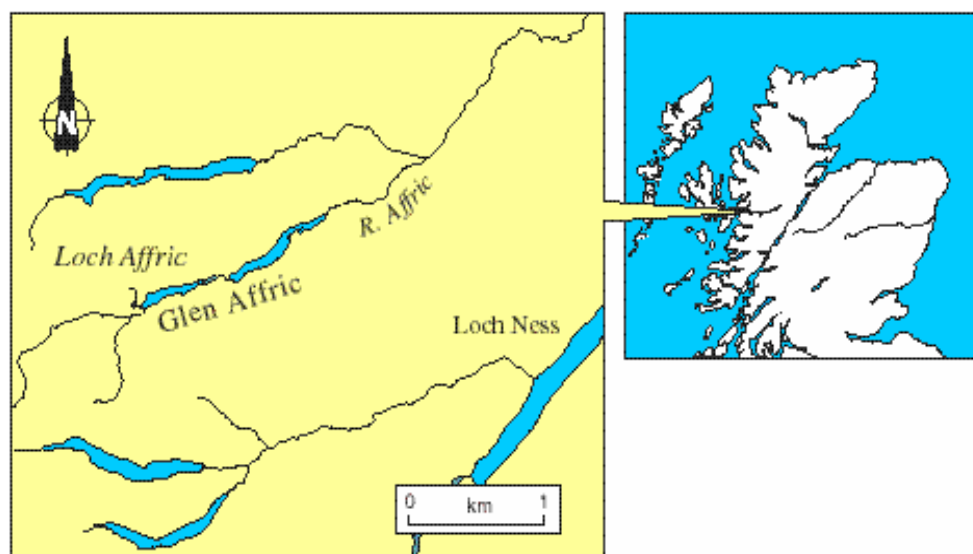


Figure 2.1 Glen Affric location map. Source: <http://www.es.stir.ac.uk/Affric/index.htm>.

2.2 Glen Affric field site

The Glen Affric Caledonian Pinewood Reserve is delineated approximately by Ordnance Survey map references NH0714, 3021, 3031 and 0721 (Forest Enterprise, 1997). High hills of 450-700 m surround the reserve entrance at the eastern end, whilst there are mountains of over 1000 m to the west. Two lochs dominate the length of the Glen, namely Loch Affric (5 km long) and Loch Beinn a Mheadhoin (8 km long). Fieldwork that involved planted seedlings was in seven different sites around Loch Beinn a Mheadhoin (Figure 2.2). Fieldwork involving natural regeneration was on Coille Ruigh na Cuileige, a ridge on the north side of the Loch (Figure 2.2).

2.2.1 *Climate, geology and soils*

The climate of Glen Affric is characterised by frequent severe frosts and the growing season is estimated at four to five months (Forest Enterprise, 1997). The annual

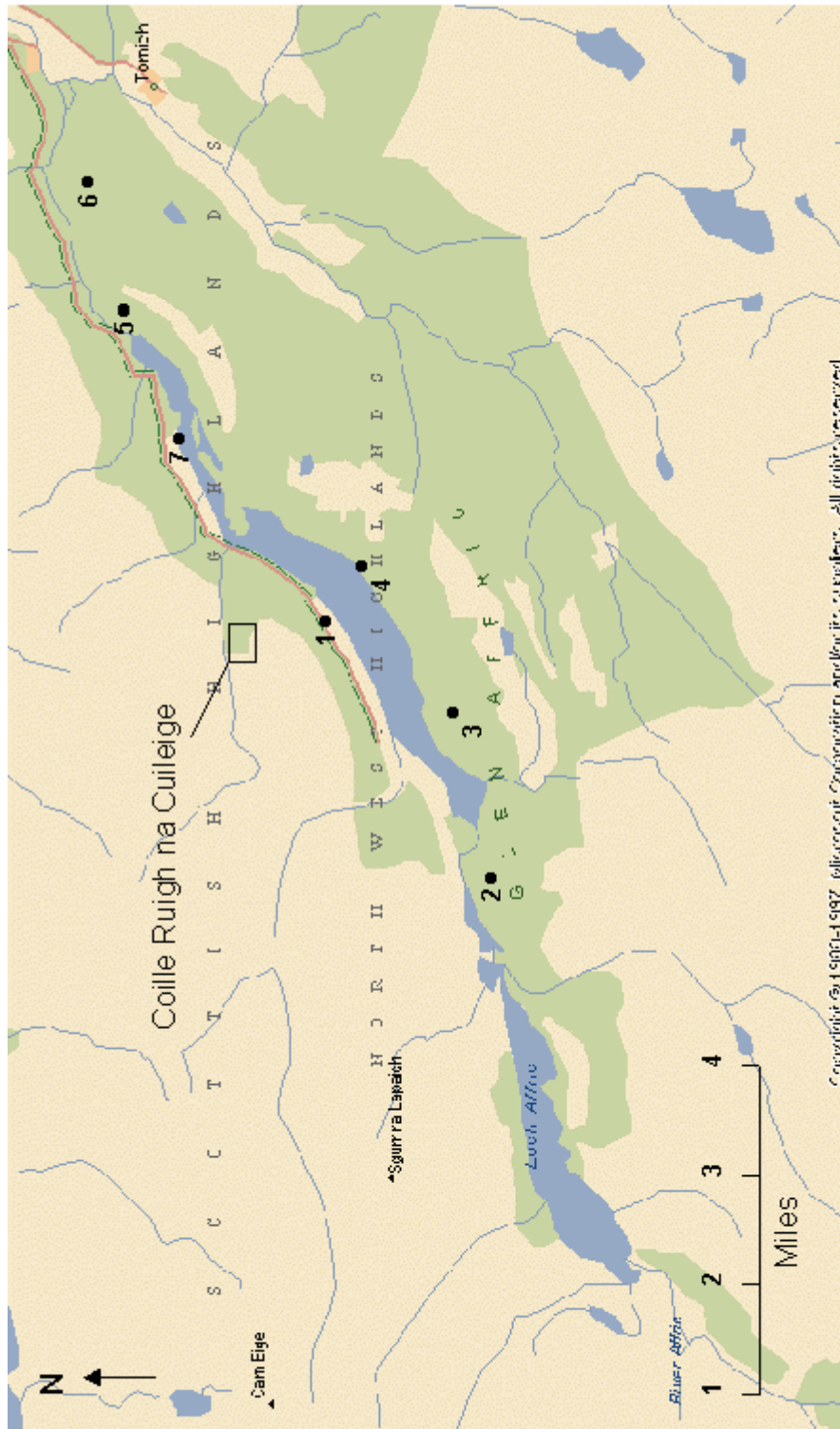


Figure 2.2 Map of Glen Affric showing the location of field study sites. The field trial involving planted seedlings was carried out in seven sites (as numbered) around Loch Beinn a Mheadhoin. The natural regeneration trial was carried out on Coille Ruigh na Cuileige as shown in the boxed location. Map source: Microsoft Autoroute Express™ GB 98

rainfall varies from 1600 mm east of Loch Beinn a Mheadhoin to 2800 mm, west of Loch Affric.

Glen Affric is underlain by metamorphic minerals of the Moine series, including mica schist and gneisses (Steven & Carlisle, 1959; Forest Enterprise, 1997). Geomorphological evidence of glaciation is extensive, with glacial till deposits giving rise to a characteristic hummocky terrain. The nature of the soils varies locally with topography and aspect. The eastern end of the Glen is dominated by brown earth soil, with surface water gleys and deep peats occurring where drainage is poor. Peat is extensive on upper slopes and to the west of Loch Beinn a Mheadhoin, including peaty podzols, peaty ironpan soils, peaty gleys and deep peat (Forest Enterprise, 1997).

2.2.2 Woodland types and vegetation

Pinus sylvestris is the dominant species in the reserve giving rise to the two main woodland types; W18d on peaty podzols and W18b¹ on more freely draining podzols (Rodwell, 1991; Averis, 1994). The pinewoods towards the east tend to be well-stocked with the presence of pine-birch (*Betula pubescens*) mixtures and patches of pine associated with a variety of other deciduous trees such as *Sorbus aucuparia*, *Salix caprea*, *Alnus glutinosa* and *Populus tremula* (Forest Enterprise, 1997). Birch-oak woodlands types (W11¹ and W17¹) as well as one small ash wood (W9¹) are found in the far eastern pocket where brown earths predominate (Averis, 1994). Another birchwood type (W4¹) is also found on wetter ground adjacent to the pine.

Towards the west, the pine becomes more scattered, occurring sparsely as small groups or solitary trees on well-drained slopes and along river banks. The age distribution of Scots pine in Glen Affric is similar to other Scottish Highland pinewood remnants (Section 1.2.3). Work has shown that trees are concentrated in the 143-202 year age-class with a lack of regeneration 60-120 years ago (Arkle & Edwards, 1996) due to intensive grazing pressure. The lack of regeneration still characterises the native pinewoods except where disturbance along roadsides has encouraged seedling germination or where deer exclusion in fenced exclosures has allowed seeding growth.

¹ National Vegetation Classifications (Rodwell, 1991). W18d: *Pinus sylvestris*-*Hylocomium splendens* woodland, *Sphagnum capillifolium*-*Erica tetralix* subcommunity; W18b: *Pinus sylvestris*-*Hylocomium splendens* woodland, *Vaccinium myrtillus*-*Vaccinium vitis-idaea* subcommunity; W11: *Quercus petraea*-*Betula pubescens*-*Oxalis acetosella* woodland; W17: *Quercus petraea*-*Betula pubescens*-*Dicranum majus* woodland; W9: *Fraxinus excelsior*-*Sorbus aucuparia* *Mercurialis perennis* woodland; W4: *Betula pubescens*-*Molinia caerulea* woodland.

Open heath and mire communities are integrated within or adjacent to the pine woodlands. Within woodland areas, ground vegetation includes *Calluna vulgaris*, *Erica* spp., *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Empetrum nigrum*, *Trichophorum cespitosum*, *Molinia caerulea*, *Deschampsia flexuosa*, *Sphagnum* spp. and *Hylocomium splendens* (Averis, 1994; Forest Enterprise, 1997).

2.2.3 Native tree species

Exploratory research ascertained which native² tree and tall-shrub species have occurred in the Glen Affric Caledonian Reserve in the past and which are still present to this present day. Information was collected from local pollen analysis (Wolff & Tipping, 1999), from a National Vegetation Classification survey (Averis, 1994), from historical extracts (Steven & Carlisle, 1959) and from the BSBI 10 km Atlas of Britain, (Perring & Walters, 1962). Personal communication with staff from *Trees for Life*, a NGO which has carried out recent tree surveys in the Glen, helped confirm the presence of species. Research results produced 16 species: two conifers, *Pinus sylvestris* and *Juniperus communis*, one evergreen broadleaf, *Ilex aquifolium* and 13 deciduous broadleaves, *Alnus glutinosa*, *Fraxinus excelsior*, *Populus tremula*, *Betula pubescens*, *Betula pendula*, *Prunus padus*, *Ulmus glabra*, *Corylus avellana*, *Quercus petraea*, *Sorbus aucuparia*, *Salix caprea*, *Salix cinerea* and *Salix aurita*. No additions could be made to this list from history extracts.

2.2.4 Woodland history

The pinewoods of East Glen Affric, from Cannich in the East to the head of Loch Affric to the West are regarded as among the finest examples of native Scots pine (*Pinus sylvestris* L.) in Scotland (Steven & Carlisle, 1959). The implicit assumption has been that these woods are a remnant of the primary or natural pine woodland of early-mid Holocene age (Wolff & Tipping, 2003). Holocene pollen data from West Affric (Davies, 1999) suggest that the woodlands were far from stable in prehistory, that much of the native woodland was lost 4000-3500 years ago, and that the native woodland was predominately deciduous woodland and only rarely featured *Pinus*.

In East Glen Affric, preliminary analysis of pollen from a small peat hollow at the woodland stand-scale suggests that broadleaved woodland, including *Betula*, *Alnus* and *Corylus* species, was more abundant than *Pinus* between 780-1130 AD (Shaw &

² "Native" has been defined as species that established themselves in Britain after the most recent glacial period approximately 11,000 years ago and before significant human civilisation (Peterken, 1996; Brown, 1997).

Tipping, 2003). However, after 1250 AD, pollen analysis from the same peat hollow, as well as from a large peat basin in the same area, show that *Pinus* became more abundant occurring with deciduous tree taxa (Wolff & Tipping, 1999; Shaw & Tipping, 2003). *Pinus* has remained in the pollen record up to the present day but between 1775-1980 AD, a decline in the broadleaf component is evident. Wolff & Tipping (1999) show how *Betula* became increasingly rare during this time period and *Alnus* and *Corylus* failed to regenerate after the 18th Century. In the last 200 years, a mono-dominance of *Pinus* was found around their peat basin coinciding with evidence of anthropogenic activity.

Pinewood, clearly did not disappear in East Glen Affric during the Holocene as in West Affric but pollen analysis has revealed much oscillation in woodland cover. Two to three phases of *Pinus* woodland regeneration and two phases of woodland collapse over the past 800 years have been identified (Wolff & Tipping, 1999). These changes have been explained as naturally sustaining cycles³ of *Calluna* and *Pinus* rather than external stresses such as human impact or climate change except in the last 200 years. Very recent analysis of another small peat hollow taken under a current stand of dense pine in East Glen Affric supports this theory. Prior to 250 years ago, pollen analysis indicates that the area was actually dominated by heathland with only a few scattered pine (H. Shaw, personal communication).

2.2.5 Land use and management history

The estate of Glen Affric was owned by the small Chisholm clan from the 17th Century AD. In the 17th century, they are known to have rented land as shieling grounds to different people from Kintail (in Wolff & Tipping, 1999). It is probable that the pinewoods were browsed by cattle, (although in low density) which in winter were kept in byres in the lowlands to the west. By 1851, Glen Affric was converted to sheep farming but due to being unprofitable was soon transformed into a deer forest. Glen Affric remained as a deer forest up to the 1950s, when parts of it were purchased by the Forestry Commission, initially managing it for timber marketing and plantation (MacRae, 1980; Forest Enterprise, 1997).

In 1960, the Forestry Commission declared part of the glen a 'Pine Reserve' (Wield, 2001). This prompted a variety of attempts to improve natural regeneration

³ A single population of pine trees dies because shading will not allow seedling regeneration. As it dies, young *Calluna* bushes spring up as they grow faster than pine seedlings. As *Calluna* matures, it grows leggy and becomes increasingly susceptible to lightning strikes and fire, which clear the ground. Pine seedlings are then able to establish in the gaps and the cycle continues (Wolff & Tipping, 2003).

in native pinewood remnants alongside productive forestry. Eight hundred and fifty hectares of woodland on the southern shore of Loch Beinn a Mheadhoin were deer fenced as an initial conservation measure (MacRae, 1980). Initial planting, within the fenced area was unsuccessful due to water-logging and browsing by red and roe deer. Secondary attempts with smaller fenced exclosures, much higher levels of deer culling, ploughing to improve drainage and application of ground mineral phosphate were more successful (MacRae, 1980). However, landscape considerations (mainly the effect of row ploughing on seedling patterns) as well as the presence of sufficient natural regeneration of Scots pine and birch as well as other broadleaves brought about a decision in 1975 to cease planting.

In 1975, the 'Pine Reserve' was designated a Site of Scientific Interest (Forest Enterprise, 1997; Wiold, 2001). In 1994, Glen Affric was declared the first Caledonian Forest Reserve covering an area of over 10 000 ha, committing Forest Enterprise to manage the area specifically for its heritage, environmental and recreational values. Since then, it has been proposed as a Special Area of Conservation (SAC) under the EU Habitats Directive and as a Special Protected Area under the EU Birds Directive. Funds from the EU LIFE programme and the Millennium Forest for Scotland project have also been acquired for restoration activities. Recently in April 2002, Glen Affric became a National Nature Reserve (NNR).

2.2.6 Forest management

Many environmental organisations have an involvement or interest in the restoration attempts at Glen Affric and come together under an umbrella organisation called *The Caledonian Partnership*. Recent NNR status has also led to the development of the Community Development Group (CDG) which involves people from the local community, with the aim of looking after their economic and environmental interests. The main players that have an active role in restoration practice in Glen Affric include the Forestry Commission and an NGO organisation called Trees for Life (TFL). Forest Enterprise and TFL have similar restoration principles and work co-operatively to manage and aid restoration.

The principal management objective of the Forest Enterprise (FE) in Glen Affric is to fully restore native woodland cover to the entire 10 645 hectare area where naturally feasible (Forest Enterprise, 1997). This is to occur on the most naturally suitable ground within the reserve boundary below the natural treeline, which is at about 600 m. The management plan for Glen Affric embraces all required output of the Pinewood Habitat Action Plan, SSSI, SAC and NNR requirements (Wiold, 2001).

All regulatory agencies have approved the plan, which also demonstrates best practice under the UK Woodland Assurance Scheme.

FE has split the reserve into three restoration zones for management:

- i) core woodland (12% of area), which requires minimal activity for restoration;
- ii) woodland with significant open space and non-native species (18% of area) which requires active restoration to deal with overgrazing and other factors;
- iii) open hill (70% of area) which requires a high level of activity for woodland restoration.

The restoration techniques that are currently employed include removal of the non-native species, use of natural regeneration and planting, naturalisation and deer management involving culling regimes and rotational fencing (Forest Enterprise, 1997). Forest Enterprise are committed to reducing deer numbers, hopefully to allow natural regeneration without deer fencing in the future.

It is clear from knowledge on the past and present composition and structure of the Glen Affric Caledonian woodlands, that broadleaved species were an important integral component. An understanding of their tolerance of shade combined with other limiting interacting environmental factors will thus aid restoration practice. This thesis will focus on both planted stock and natural regeneration excluding the browsing effects of deer to tie in with current management practice.

