

LOW ALPINE, SUBALPINE AND COASTAL
SCRUB COMMUNITIES IN SCOTLAND



Coille Beithe na Gaidhealtachd
**HIGHLAND
BIRCHWOODS**



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Cover background photo: *Salix lanata* (Lorne Gill, SNH).

Insert photos, from left to right: *Betula nana* (Lorne Gill, SNH), *Sorbus rupicola* (Neil MacKenzie), *Quercus petraea* and oak apples (Neil MacKenzie), Creag Fhiaclach (Neil MacKenzie).



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LOW ALPINE, SUBALPINE & COASTAL SCRUB COMMUNITIES IN SCOTLAND

A report to Highland Birchwoods

Neil A MacKenzie
July 2000

FIGURE 1 - LANDSCAPE

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Introduction

The nature of the true climax scrub communities of Scotland is poorly understood and the ecology of the existing remnants has never been studied in detail. The mountain willows, *Betula nana* and other tree and shrub species surviving at the limits of their natural range are frequently overlooked in many surveys. Their remote and often inaccessible locations, difficulties in the identification of species or of sex and their limited area and extent have meant even basic survey data are often lacking.

Much of the existing information has been collected over the years by botanical recorders, collectors, travellers and local residents and many of these early anecdotal references, such as the location of *Sorbus rupicola* in Wester Ross and in the hills above Loch Ness (New Statistical Account, 1845), are an important reminder of the former extent of such scrub vegetation. Current checklists contain records from the invaluable contributions of the county recorders, from the pioneering ecological studies of McVean and Ratcliffe (1962) and Ratcliffe (1977) as well as from more recent surveys. The Atlas of the British Flora (Perring & Walters, 1990) and the maps of the Scarce Plants in Britain (Stewart et al, 1994) thus contain many records which are up to twenty five years old, some of which are over sixty years old and a few which date from the nineteenth century.

Despite recent advances in the quantity of survey data for native woodlands (Roberts *et al*, 1993; MacKenzie, 1999a) scrub communities have generally been excluded, except where they form an understorey shrub layer in mature woodland and in some of the west coast islands where scrub woodland is often the only woodland (MacKintosh, 1990). Woodland census reports provide area statistics on scrub if the communities consist of tree species (Locke, 1987) and, although other national databases include a scrub category, the species are either not identified

or locational information is limited to a ten kilometre square (MacKey et al, 1998; MLURI, 1993). In all regional or national surveys there is also a lower size limit which usually lies between a quarter of a hectare and two hectares (MacKenzie, 1993). The majority of scrub in Scotland is often under this minimum area or the community exists at such a low density that it tends to be included in the dominant vegetation type, for example one of the National Vegetation Classification (NVC) heath or mire communities (Rodwell, 1991b). The Atlas of the British Flora and the maps of the Scarce Plants in Britain do give useful information on the national distribution of scrub species on a presence-absence basis for each ten kilometre square. There are also several regional guides which provide some additional records on distribution (Webster, 1978; Duncan, 1980; Hadley, 1985; Henderson, 1992; Rothero & Thompson, 1994; McBride, 1997).

The purpose of this review is to consolidate all the available survey information from reports, databases, file notes and verbal sources in order to update current knowledge on the location and extent of upland and mountain scrub communities in Scotland. The information has focused largely on climax scrub communities above the treeline and on other sites where edaphic conditions are a limiting factor on the growth of native trees and shrubs. However, for *Juniperus communis*, records on seral and woodland understorey communities are also included.

The report summarises the distribution and current state of the main low alpine, subalpine and coastal scrub species and provides a set of distribution maps based on the ten kilometre square national grid. The data are a collation of material previously compiled in Mackenzie, 1996 & 1999b and extracted from site-based information contained within a dataset which is available from Highland Birchwoods.

Definition and types of scrub

The term scrub encompasses a wide range of tree and shrub species in a range of different habitats many of which are common or widespread. A review by Hester (1995) and descriptions in Rodwell (1991a) illustrate the types of communities that could be described as scrub vegetation. Hester defined scrub as all tree and shrub growth (excluding ericoid and prostrate dwarf shrubs such as *Arctostaphylos* spp., *Salix repens* and *S. herbacea*) less than five metres in height. The definition is therefore a wide-ranging one and incorporates low alpine and subalpine scrub, as well as lowland scrub, woodland understorey species, seral scrub and regenerating trees which exhibit arrested

growth as a result of over-browsing.

This paper has excluded understorey and seral scrub (with the exception of *Juniperus communis*), scrub created by land-use activities, and ubiquitous or common species such as *Ulex europaeus*, *Sarothamnus scoparius* and *Myrica gale*. It has also excluded lowland scrub communities such as stands of *Salix cinerea* on wetland sites (eg the NVC W3 *Salix pentandra-Carex rostrata*) although these are sometimes referred to as woodland or as a natural succession to woodland (Rodwell, 1991a). The main upland scrub species which have been recorded in the dataset are:-

Mountain Willow

All known records of: *Salix lapponum*, *S. lanata*, *S. myrsinites*, *S. myrsinifolia*, *S. phylicifolia*, *S. arbuscula* and *S. reticulata*. *Salix aurita* and other upland willows are included if these occur above the treeline.

Juniper

Representative examples of *Juniperus communis* (ssp. *communis* and ssp. *nana*) as a seral scrub, as a woodland understorey component, above the treeline, and on coastal or otherwise exposed situations.

Birch, dwarf

All known records of *Betula nana*.

Whitebeam, Rock

All known records of *Sorbus rupicola*.

Tree Species

Representative examples of *Betula pubescens*, *Sorbus aucuparia*, *Corylus avellana*, *Populus tremula*, *Quercus* spp., *Pinus sylvestris* and other native species where these occur in a wind-pruned or stunted shrub-like form on exposed coastal, cliff and treeline sites.

Altitude zones

A number of terms which describe the different vegetation zones at particular altitudes are in common usage (Figure 1). The main ones are reviewed in a paper by Horsfield and Thompson (1996). Several terms are used interchangeably and this may lead to some confusion. There are additional terms for Annex 1 Habitats in the Corine manual (eg sub-arctic which is equivalent to alpine and subalpine) (Commission of the European Communities, 1991). Zones which contain scrub communities in Scotland are:-

Low Alpine zone (referred to as montane zone by Ratcliffe & Thompson, 1988). The upper limit of all scrub communities and the zone of mountain willow, *Juniperus communis* and occasional individual scrub *Pinus sylvestris* or *Sorbus aucuparia*.

Subalpine zone (referred to as montane zone by Ratcliffe & Thompson, 1988). Below the alpine zone and the zone where trees and scrub exist in a form of scrub woodland (in Britain well described only from the one location, Creag Fhiaclach, in the western Cairngorms). Scrub can include tree species as well as *Juniperus communis* and mountain willows.

Forest zone (referred to as sub-montane by Ratcliffe & Thompson, 1988). Includes all tree and shrub species up to the potential altitudinal limit of woodland (where the mature canopy normally exceeds five metres in height). Excludes most of the mountain willows.

Uplands There is no exact definition which is uniformly applied throughout the European Community. In Britain, upland areas are generally not just situated at a high altitude but also where climatic conditions are particularly unfavourable. Ratcliffe and Thompson (1988) define the uplands as lying typically above the limits of enclosed farmland and, in Britain, the usual altitudinal qualification for upland areas is above 240 metres (compared to 700 metres in France and 1000 metres in Italy) (Economic & Social Consultative Assembly, 1990). Thus, fifty percent of the land area of Scotland could be considered as uplands.

Historical background

During the Holocene period when the climate was at its most favourable, about 7000-5000 years BP (Before Present), the natural forest cover of Scotland had reached its maximum extent and probably covered over eighty percent of the total land surface (Birks, 1988; Bennet, 1989; Tipping, 1994). The treeline vegetation at that time would have developed into a natural ecotonal zonation of scrub communities between the upper edge of the forest zone and the upper edge of the subalpine zone. However, little is actually known of the former composition or the actual extent of the scrub communities above the forest zone. *Juniperus communis* was probably widespread over much of the central mainland in association with the *Pinus sylvestris* and *Pinus-Betula* communities. Mountain willows may have occurred on moderately base-rich sites within the subalpine zone and, in the northwest and islands, *Betula* spp.-*Corylus avellana*-*Sorbus aucuparia* communities probably predominated. The Western Isles and parts of Caithness may never have contained much woodland although pockets of *Betula pubescens*, *Corylus avellana*, *Sorbus aucuparia* and *Salix* scrub probably existed on sheltered sites (Birks, 1988).

The maximum elevation of the treeline during this period of the Holocene has been estimated by Birks (1988), Walker & Lowe (1997) and Huntley *et al* (1997). The upper limit of trees tended to decrease in actual maximum height above sea level between the central Highlands and the northwest and islands. The highest treeline estimate was 880 metres for the Cairngorms, 716 metres for the Western Grampians, 550 metres for Wester Ross and 457 metres for the Isle of Skye. Above these elevations some form of subalpine scrub communities would probably have existed although, clearly at this time, there were quite extensive areas without any tree or scrub community. In the Western Isles and other locations near sea level in the north and west where the exposure is high, woodland trees develop a shrub-like appearance similar to scrub in the subalpine zone (McVean, 1964). In the southern uplands treelines have been

estimated at over 615 metres in the Moffat Hills (Tipping, 1997) although, quite possibly, there were no unwooded areas south of the Central Belt.

The downward displacement of the treeline began 5000-4000 years BP along with early deforestation as a result of increasing human activity and a change to a more oceanic climate, particularly in the west Highlands. Scrub in some low-lying areas in Lewis and Caithness was destroyed by the pastoral activities and early agricultural clearance of the Neolithic peoples (Birks, 1988) and the change in climate with a consequent expansion of blanket bog may have reduced the extent of subalpine scrub in the other areas.

The lack of a current known treeline of climax vegetation and the added complication of anthropogenic disturbance, overgrazing and degraded vegetation, mean that estimates of potential contemporary treelines are difficult to establish. There is likely to be considerable localised variation due to topography and the degree of shelter in addition to the overall descent of the upper limit between the east and west. Estimates of the potential treeline in Scotland range from 91-135 metres in the west Highlands (Poore & McVean, 1957), 300 metres in Sutherland (Ratcliffe & Thompson, 1988), 550 metres in Glen Barrisdale (Steven & Carlisle, 1959) and 685 metres in sheltered parts of the Cairngorms (Pears, 1968). The remnant scrub communities found around and above these altitudes indicate the current locations of the subalpine and low alpine zones. The higher limits have been estimated by Spence (1960) at 220 metres in Shetland, 400 metres in west Sutherland, 500 metres in Rum and 840 metres in the central Highlands.

During recent centuries scrub communities have been severely reduced in extent and distribution and altered in their structure and composition. Many areas have been damaged or destroyed by burning and grazing and secondary scrub development, particularly of *Juniperus communis*, has replaced the climax woodland type at some sites. The mountain willow communities possess a very limited

distribution, occur in very small fragments or scattered individuals and are now largely restricted to inaccessible crags and ledges. Natural treelines in Scotland have now virtually disappeared and one can only speculate on the composition of the scrub vegetation at or above this altitude. *Betula pubescens*, *Sorbus aucuparia* and *Salix* spp., possibly with *Juniperus communis*, of a declining stature is one possibility (McVean, 1961; Birks, 1988) while another, as in Norway, is a zone of *Salix* spp. and low

Juniperus communis scrub (Ratcliffe & Thompson, 1988). The current known distribution of relict mountain willow scrub in Scotland and their presence on cliff sites but not on similar soils on open ground nearby might suggest that these species had a much wider distribution in former times. Poore and McVean (1957) conclude that a scrub zone of *Salix* spp. and *Juniperus communis* probably did once succeed the forest zone at higher altitudes over much of the Highlands.

Methods

The data on species and sites were collated from available survey reports, the scientific site files located in the area offices of Scottish Natural Heritage (SNH) and verbal information from staff in SNH, Forest Enterprise, The National Trust for Scotland and from several botanical recorders. The most recent records were used wherever possible and, although a few rare records from the 19th and early 20th centuries are listed,

most pre-1950 site records were excluded. Further details of some species or sites can be found in various reports and publications and several of these are listed at the end of this report.

There is virtually no information on the condition or on the number of plants for the majority of the records.

Species distribution and summary of records

Mountain willows (Figure 2)

The dataset contains 864 records where one or more species of *Salix* occur. The seven species of mountain and upland willows have a wide distribution throughout Scotland but there are particular concentrations in mountain areas within the central Highlands. The Caenlochan/Glen Doll area contains all of the seven species and the Ben Lawers massif contains six species although it is possible that *Salix phylicifolia* and *S. myrsinifolia* are under-recorded or mis-identified at some sites (see below). Current records of *Salix lanata*,

S. reticulata and *S. arbuscula* are restricted to the Scottish Highlands although it is likely that *S. arbuscula* has only recently become extinct in the Scottish Lowlands. This latter species was recorded in the Southern Uplands over sixty years ago but there have been no recent sightings (Stewart *et al*, 1994).

In all but a few notable locations numbers of mountain willow plants are low, sometimes solitary and, occasionally, consist of single sex individuals.

Salix arbuscula

This mountain willow is mainly concentrated in the central Highlands, particularly Breadalbane, and the dataset records 120 sites in 7 districts (see Figure 7.). There is also a 1934 record from White Coomb in the Scottish Lowlands but there have been no recent observations and the plant may well be extinct in this area. The largest colonies are to be found on limestone crags and outcrops on Ben Lawers and Meall Ghaordie in Perth & Kinross district, Meall na Samhna and Kirkton Glen in Stirling district and Meall nan Gabhar in Argyll. The plant is rare in Glen Doll, the Cairngorms, Creag Meagaidh and indeed further north. The most northerly record is from the Mamores in Lochaber.

Other mountain willows often associated with it include *Salix lapponum*, *S. myrsinites*, *S. reticulata* and unknown hybrids. On Meall na Samhna and Carn Gorm in Perth & Kinross *Salix arbuscula* grows on damp ledge communities with *Dryas octopetala*, *Carex rupestris*, *Sagina saginoides* and the above three *Salix* species (plus *Salix lanata* at Meall na Samhna). At other locations (Meall Ghaordie) it grows with *Silene acaulis* banks and *Salix reticulata* or with *Dryas octopetala*

and *Potentilla crantzii* in a *Festuca vivipara* sward (Cam Chreag in Stirling). *Salix arbuscula* is also abundant on Meall nan Gabhar within the W20 *Salix lapponum-Luzula sylvatica* scrub community, with U17 ledge communities plus some *Betula pubescens* and *Sorbus aucuparia*, with CG14 ledge communities and in species-rich U4 grassland with *Dryas octopetala* (Leishman, 1998). On Ben Lui it has been recorded on M10 flush (Leishman, 1998) and in Kirkton Glen on acid crags with *Salix lapponum*.

At Ben Lawers there is a healthy population of both male and female plants at several crag sites and there is good seed production where the willows are abundant (Mardon, 1995). Most plants appear to have a procumbent form probably as a result of grazing pressure. Elsewhere on Ben Lawers and at the edge of its range the species is probably declining.

Salix arbuscula grows mainly on north or east-facing crags and ledges with an altitude range from 420 metres on Meall nan Gabhar in Argyll to 890 metres on Carn Gorm in Perth & Kinross.

Salix lanata

This is the rarest of the mountain willows and the only one recorded in the Red Data Book as endangered. There are 32 sites in 6 districts listed in the dataset but viable populations only survive at a few of these locations. Coire Cheap in Strathspey contains, at about one thousand plants, the largest colony in Scotland (Marriott, 1994) and there are also significant numbers of well developed bushes in Corrie Sharroch in Glen Doll. Other locations with smaller populations include Meall na Samhna in Stirling district, Glen Callater in Deeside, the Sgurr nan Conbhairean area of west Affric and Coire Gharblach in the Cairngorms. There are three sites in Perthshire but each contains just one female bush. Marriott's 1994 survey included a number of other sites (eg Meall Ghaordie in Perth & Kinross) where *Salix lanata* had previously been recorded but appeared not to be present now. Some of these locations were in the Drumochter Hills where possible hybrids with *Salix lapponum* had been recorded. These are now thought to be an extreme form of *Salix lapponum* or a hybrid *S. lapponum-S. aurita* (see *S. lapponum* below). *Salix lanata* is almost exclusively found on limestone areas in more or less north-facing corries at altitudes which range from 550 metres to 1000 metres. On Coire Cheap it grows with CG14 *Dryas octopetala-Silene acaulis* ledge communities and with *Dryas octopetala-Salix reticulata* herb-shrub communities or, occasionally, among the CG12 *Festuca ovina-Alchemilla alpina-Silene*

acaulis dwarf herb community (Smedley, 1996). This unusual 'alpine calcareous grassland site with subalpine willow is rated as the best in the central Highlands for this habitat' (Horsfield, in Smedley, 1996). One or more of the other *Salix* species (*Salix lapponum*, *S. myrsinites*, *S. arbuscula*, *S. myrsinifolia*, *S. herbacea* etc.) are usually present at most of the crag or ledge sites. On the Corrie Sharroch crags the willows are associated with *Luzula sylvatica* and *Sphagnum* spp., or *Vaccinium myrtillus* and *Sphagnum* spp. in damper areas, and with dwarf shrubs including *Vaccinium* spp., *Calluna vulgaris* and *Empetrum nigrum* in drier areas (Leishman, 1989). Few tall herbs and ferns are present but *Sorbus aucuparia*, *Betula pubescens* and *Juniperus communis* are found throughout.

The larger colonies (Coire Cheap, Corrie Sharroch, Meall na Samhna) contain a good balance of male and female plants with viable seed (Marriot, 1994). At Coire Cheap young plants are present and there is little in the way of browsing damage despite the accessibility of the *Dryas octopetala* heath. Smedley (1996) suggests that the instability of the soils around the outcrops may inhibit grazing, particularly as grazing levels have probably diminished with the removal of domestic stock. Late snow lie may also offer some protection against grazing.

Salix lapponum

This species occurs as far north as Shetland, where a solitary plant has survived since at least 1959, and as far south as the Merrick Hills in Stewartry district. The most northerly mainland location is Ben Hope. No records are known from Orkney or the Hebrides however, and it is now extinct from a previously known site in the Ochil Hills. *Salix lapponum* is the most common of the mountain willows and there are 302 sites in 15 districts recorded in the dataset. Some sites such as Mullach a' Ghlas-thuill (Skye & Lochalsh), Creag Meagaidh (Badenoch & Strathspey), Cama' Choire (Perth & Kinross) and Corrie Sharroch (Angus) contain many hundreds of plants and there have been a few studies and some survey work at these and

other sites (eg. Leishman, 1998; Mardon, 1995; Rae, 1996; Royal Botanic Gardens, 1987; Sullivan, 1997). The main concentrations are to be found in the Beinn Dearg-Seana Bhraigh area (Ross & Cromarty), the Affric-Cannich hills (Inverness), Ben Nevis (Lochaber), Strathspey, the Perthshire hills, several hills in Stirling district and a few hills, such as Meall nan Gabhar, in east Argyll. The two sites at White Coomb and the Merrick Hills in the Scottish Lowlands contain only a few plants. Most plants grow at altitudes above 450 metres and the highest recorded specimen is found in the Cairngorms at 1100 metres. The one exception is the Shetland site at under 140 metres.

Salix lapponum grows with various communities - on crags, wet ledges, boulder scree, on damp stream banks or on flushed sites with *Sphagnum* spp., *Luzula sylvatica*, *Oxyria digyna*, *Sedum rosea*, *Alchemilla alpina* and *Saussurea alpina*, and on drier sites tending to *Vaccinium-Calluna* heath. It prefers moderately calcicolous or flushed sites but not all mountain areas with calcareous vegetation possess these mountain willows as they are absent from Ben More Assynt (Ratcliffe, 1960). However, it is probably the least lime demanding of the mountain willow species. The NVC communities associated with this *Salix* include the tall herb vegetation U17 *Luzula sylvatica-Geum rivale*, W20 *Salix lapponum-Luzula sylvatica* scrub (mainly when there are numerous plants present), U16 *Luzula sylvatica-Vaccinium myrtillus* tall herb community and U15 *Saxifraga aizoides-Alchemilla glabra* banks. Some of the tall herb and ledge communities where there is only a scattering of *Salix* bushes may be transitional to W20 scrub. Plants have also been found growing with vestigial woodland flora and occasional tree species (*Sorbus aucuparia*, *Betula pubescens* and *Salix cinerea*) such as at Cama' Choir in Perthshire.

At many sites other *Salix* species (*Salix myrsinites*, *S. lanata* etc) are often present and hybrid plants (with *Salix phylicifolia*, *S. reticulata* or *S. herbacea*) have been recorded in the Cairngorms, Meall Ghaordie (Perth & Kinross) and in Corrie Sharroch. Some surveyors have identified a hybrid *Salix lanata* x *lapponum* in the Drumochter Hills (Perth & Kinross) and in Corrie Sharroch but there has been conflicting evidence on the verification of these records. However, Meikle (in Leishman, 1989) and McAllister (Liverpool University, 1979 letter in SNH file, Battleby) have discounted the possibility of hybridisation between the two species while Marriott's survey (1994) of *Salix lanata* found no evidence of hybridisation with *S. lapponum*. The likely conclusion of these authorities is that *Salix lapponum* appears to exhibit considerable variation in leaf shape and size and may sometimes resemble *S. lanata*.

On ungrazed ledges plants can grow up to one or one and a half metres in height (Halcrow, 1995; Rae, 1996) but elsewhere there is considerable variation between upright and prostrate forms, probably depending on the degree of exposure and grazing. Bushes grow on a variety of substrates and there appears to be no preference for a particular aspect. Soil pH has been measured at Creag Meagaidh and varied between 5.8 and 7.2 (Evans, 1997). Insect damage to leaves does occur principally from caterpillars and molluscs (Sullivan, 1997) and leaf galls caused by the sawfly, *Pontania dolichura* have also been identified (Hogarth, 1995). The root tips frequently possess the mycorrhizal associate, *Cenococcum geophilum* (Watling, in Evans, 1997).

This is a relatively widely distributed mountain willow and, in areas where the plants are plentiful, the population is probably stable but most sites show few signs of regeneration. Plants on accessible herb-rich meadows adjacent to crags are generally heavily browsed. In the Drumochter Hills *Salix lapponum* may be declining as the plants are often accessible to grazing, although there is a substantial population of about one thousand two hundred plants in the Cama' Choir area; in the East Cairngorms shrubs were usually small and grazed single plants; at Creag Meagaidh there is a sizeable population of about five hundred plants but few signs of seedling establishment despite an abundance of fertile seed in some years, although vegetative spread does occur (Evans, 1997). At Ben Lawers (Perth & Kinross) the mountain willows have been in decline for at least two decades although several colonies possess a good sex ratio and fertile seed is present. In recent years a series of exclosures have been erected in the Ben Lawers NNR to allow regeneration and provide a protected area for the planting of several species of *Salix* (Mardon, 1995). In Corrie Sharroch there is a good population of healthy plants of both sexes but little evidence of regeneration (Leishman, 1989).

Salix myrsinifolia

A mountain willow with a widespread distribution which ranges from a single record in Orkney, one in Lewis and two in Caithness to a record in Wigtown district in the south-west. There are 135 sites listed in the dataset and the species is found in 23 districts.

There is a concentration of sites in the central Highlands but there are also a number of records scattered throughout the Scottish Lowlands. In the Drumochter Hills it occurs in gorges, burns and flushed areas, sometimes with *Salix lapponum*, and on Meall Ghaordie and Ben Lui it grows above the treeline on well-vegetated rock ledges (eg. U15 and U17 tall herb vegetation). It is common among rock outcrops on Ben Lawers and in the Glen

Doll/Glen Clova area where it is associated with other mountain willows as well as scattered *Betula pubescens* and *Sorbus aucuparia*. Hybrid forms such as *Salix myrsinifolia x phylicifolia* (see *S phylicifolia* below) are also recorded in these latter two areas. On Deeside it grows on species-rich meadows which have been invaded by scrub woodland. In the Lowlands the species is most often found in gorges and on the banks of rivers or streams but occasionally on crags such as those at White Coomb in the Moffat Hills.

The altitude range is from near sea level at 15 metres on mainland Orkney to 940 metres on Stob Binnein (Stirling) (Stewart *et al.*, 1994).

Salix myrsinites

This mountain willow is largely a Highland species with concentrations in the west and central Highlands but with one record of a lone female plant in Orkney and a small population on the crags at White Coomb, the only known Scottish Lowlands record. There are 152 sites in 16 districts listed in the dataset.

There are two locations, Inchnadamph and Glencoe, where the community is particularly extensive with the former holding the largest population in Britain. Both sites are heavily grazed where the plants are growing on accessible areas of *Dryas octopetala* heath. Exclosures to protect some of the *Salix* scrub at Inchnadamph have been in place since 1959 and the population in Glencoe has recently been surveyed and proposals to fence out grazing animals have been made to the National Trust for Scotland (Halcrow, 1996).

Good populations of *Salix myrsinites* are also found on calcareous or enriched crags and ledges in the Cairngorms, Ben Alder and the Drumochter Hills where it grows with tall herb

communities, CG12, CG14 or with *Dryas octopetala* heath. Associated shrubs include *Salix lapponum*, *S. lanata*, *S. arbuscula*, *S. reticulata* and *Juniperus communis nana*. In Perthshire it is rare and declining on Ben Lawers but is abundant on Carn Gorm and Meall Ghaordie and is found on the drier outcrops of Beinn Heasgarnich with *Salix lapponum*, *S. reticulata*, *Dryas octopetala*, *Carex vaginata* and *Luzula spicata*. On the grassy slopes below the dry calcareous cliffs above Loch Loch it is found with *Salix lapponum* and *S. caprea* and in Glen Doll and Caenlochan it is common on the crags with the other willows. In Stirling district it occurs on a number of basic crags with other willows and in Argyll Meall nan Gabhar contains a small population. Here it grows on ledges among U17, CG14 and in W20 with *Salix lapponum* and *S. arbuscula* (Leishman, 1998).

The altitude range for the species is from about 274 metres at Inchnadamph and 300 metres at Glen of Greor, Orkney to 980 metres on Slochd Mor in Glen Avon.

Salix phylicifolia

This species is much more widespread in its distribution than the other mountain willows and is found throughout the Highlands and Lowlands, from the Orkney Isles to Dumfriesshire. The dataset contains 115 sites in 21 districts although this is probably an underestimate of its abundance.

It can be found on mountain crags with other *Salix* species and tall herb communities, and on shingle islands and among rich bankside flora with *Alnus glutinosa*-*Salix* spp. scrub in the lowlands. In Glen Muick on Deeside it occurs with treeline *Betula pubescens*, *Sorbus aucuparia* and *Salix aurita* scrub. Lawrie (1992) counted one hundred and sixty *Salix phylicifolia* plants among the gorges and gullies of upper Glen Muick. There is a single record from Lewis where it occurs with *Salix aurita*, *Juniperus communis* and *Sorbus aucuparia* on an islet in a freshwater loch.

Hybrids of this species are very common and identification can be difficult, particularly between *Salix phylicifolia* and *S. myrsinifolia*.

Hybridisation with *S. myrsinifolia*, *S. repens*, *S. aurita* and *S. lapponum* have been noted at a number of locations, although not all of these are confirmed. On Ben Lawers *Salix phylicifolia* has not been recorded but there are several colonies of *Salix myrsinifolia* and hybrid forms of *S. myrsinifolia* x *phylicifolia* (Mardon, 1995). Hybrid *Salix myrsinifolia* x *phylicifolia* (*S.* x *tetrapla*) have also been recorded on Ben Lui, Ben Oss, Meall nan Gabhar and Glen Clova (Leishman, 1998; Payne, 1982). At some of these locations it is possible that the same plants have been identified by different surveyors as *Salix phylicifolia* or *S. myrsinifolia* rather than the hybrid form. McKean (in a letter from the Royal Botanic Gardens to SNH, 1998) believes pure *Salix phylicifolia* does not occur in central Scotland and that all specimens are the hybrid form, *S.* x *tetrapla*.

The altitude range of this species extends from virtually sea level in Orkney and on the Moine Mhor (Argyll) to over 690 metres on Ben Alder in Strathspey.

Salix reticulata

This species is concentrated mainly in the Highlands where there are 77 sites in 8 districts. Most of these are in Perthshire where it occurs on limestone and calcareous schist crags and outcrops with the other mountain willows, *Salix arbuscula*, *S. myrsinifolia*, *S. lapponum* and *S. myrsinifolia*. On Carn Gorm, Ben Heasgarnich and Meall Ghaordie it grows on ledge communities with *Dryas octopetala*, *Carex rupestris*, *C. vaginata*, *Luzula spicata*, *Cerastium arcticum*, *Silene acaulis* etc. It is also present at sites on Ben Lawers and in Glen Doll/Caenlochan. The plant is frequent on several calcareous schist crags in Stirling district, most notably Meall na Samhna where it grows with a rich *Salix* flora including *Dryas octopetala*. Further west in Argyll the species is rare, for

example on Meall nan Gabhar where a few plants survive on a rich CG14 ledge community (Leishman, 1998). In the north-east, *Salix reticulata* is uncommon but there is a sizeable population at Coire Cheap where it grows on limestone outcrops among a CG14 herb-shrub community with *Dryas octopetala* and *Salix lanata*. It also grows in a *Silene acaulis*-*Geranium sylvaticum* community in the upper slopes and extends onto the open *Dryas octopetala* heath of the lower slopes (Smedley, 1996). Ben Hope (Sutherland), where it occurs on calcareous outcrops with *Salix lapponum*, is the most northerly site.

The altitude range of the species is from 450 metres on Ben Hope to 1125 metres on Ben Lawers.

Dwarf birch (*Betula nana*) (Figure 3)

The dataset for *Betula nana* contains 303 sites in 12 districts. *Betula nana* has a widespread distribution throughout the north, east and central parts of the Highlands but appears to be absent from the Hebrides and Northern Isles and, with the exception of Rannoch Moor, from the western parts of the mainland. There are two records in the Torridon area from 1929 and 1954 plus more recent records from Beinn Eighe and Slioch from 1972 but none of these have been relocated in recent years. There are several notable concentrations of *Betula nana*, in particular, Rannoch Moor, Balmacaan-Guisachan, Ben Wyvis, Strathvaich-Braemore, Loch Shin area and parts of the Flow Country; and there is a hybrid population with *Betula pubescens* on the north-east slopes of Ben Loyal. In the central Highlands - Strathspey, Deeside and Highland Perthshire there are certain locations where the species is locally abundant, for example on the Allt Cam near Ben Alder and around Blargie in the upper Spey where it is widely scattered in peatland, bog and along the banks of the burns. In Deeside there are extensive colonies in Glens Derry and Luibeg including some in an enclosure with *Pinus sylvestris* regeneration.

Betula nana is also thriving in a number of other native woodland regeneration enclosures, for example in Strathfarrar (Inverness) and near Loch Glascarnoch (Ross & Cromarty). In enclosures on Rannoch Moor, plants can reach a height of almost a metre but on open ground are usually not much higher than the field layer.

Betula nana is typically found in blanket bog communities such as the M19 *Calluna vulgaris-Eriophorum vaginatum* but has also been recorded on Rannoch Moor in M17

Scirpus cespitosus-Eriophorum vaginatum blanket mire and, occasionally, in M15 wet heath and H12 dry heath (Everingham & Reid, 1997). Many of the populations are suppressed by grazing and burning.

One of the largest colonies of *Betula nana* is at the head of Loch Muick on Deeside where it grows among *Calluna* heath and granite block scree, including areas of shallow mineral soil rather than its more usual habitat of M19 blanket bog. Small pockets of birch woodland also grow in the area and there are seedlings of *Betula pubescens* among the *Betula nana*. However, no evidence of hybridisation has been found. The proximity of birch woodland to the *Betula nana* at this upland site offers an opportunity for the development of a natural treeline from lochshore woodland and scrub through to true subalpine scrub in the upper corries.

With the exception of the *Betula nana* on Rannoch Moor colonies further west are much rarer and information on their distribution is imprecise. The species may also be under-recorded in some areas as it is quite easily overlooked when kept short by heavy browsing. The most westerly record is at Loch Nell in Argyll but this has not been relocated in recent years. There are no records of *Betula nana* in the Scottish Lowlands. Further survey work and changes in grazing intensity will probably reveal new populations.

The altitude range for the species is from 130 metres on the peatlands of east Sutherland to 310 metres on Rannoch Moor and to 855 metres in the Angus Glens, although the lower limit could be under 100 metres if plants were to be rediscovered at Loch Nell in Argyll.

Rock Whitebeam (*Sorbus rupicola*) (Figure 4)

Sorbus rupicola is found at a number of coastal and upland locations throughout Scotland. There are 62 records of the species scattered over 14 districts. Although, the distribution is widespread *Sorbus rupicola* is quite rare and, at each location, the number of plants is invariably low, rarely more than two to three bushes and often solitary. There are significant populations at only three locations. The cliffs of Creag Dhubh in Strathspey contain twenty to thirty bushes; the islands of Bernera and Lismore in Argyll have significant numbers on seacliffs and raised beach cliffs; and there is a small population on Holy Island, Arran. It has also been found on the coastal escarpment at Elgol in Skye, on Raasay, at Loch Maree, Loch Ness, Ardnamurchan, the Black Isle coast and near Tongue in Sutherland. However, it is rare in the lowlands of Scotland.

Sorbus rupicola may be declining in some areas as several historical records have now disappeared leaving perhaps just one plant in isolation. Several of the records illustrate this type of isolation. For example, there is one old tree in a remote part of the upper Avon (Moray), one plant in a gully in the Drumochter Hills, one plant on crags above Aberfeldy and one plant on Arthur's Seat.

Sorbus rupicola is usually found on basic crags and cliffs and may be associated with a variety of other tree and shrub species including *Fraxinus excelsior*, *Betula* spp., *Corylus avellana*, *Quercus* spp., *Salix* spp. and *Prunus spinosa*. On Bernera it has been found with *Taxus baccata*. The altitude range is from sea level on the west coast to about 450 metres in the Cairngorms.

Juniper (*Juniperus communis* ssp. *communis* and ssp. *nana*) (Figure 5)

There are 1,186 records of *Juniperus communis* in the dataset. These are located in 31 local authority districts throughout the length and breadth of Scotland, from Shetland to Wigtown. It is particularly common as an erect or bushy shrub in Inverness, Easter Ross, Strathspey and the north-east where it forms part of the woodland understorey in birch and pine woods, occurs as seral scrub on moorland and former pastoral grassland and is also found on coastal cliffs and above the treeline as a semi-prostrate shrub. Aberdeenshire contains some of the finest stands in the country such as the extensive *Juniperus communis* heath on the slopes of Morven and the *Juniperus communis*-*Betula pubescens* scrub of Morrone Birkwood. In Strathspey *Juniperus communis* is a major component in all the native pinewoods and also occurs as a low shrub above the treeline throughout the Cairngorms.

Elsewhere in the central Highlands *Juniperus communis* is less common, for example in Perthshire there are a small number of notable seral and understorey sites but it is rare on hills. In Argyll and Lochaber it is rare in woodland and on hills but common on coastal sites and on many of the islands of the Inner

Hebrides. Further north, in Wester Ross and Sutherland, erect or shrub *Juniperus communis* as a woodland or seral scrub also becomes less common though there are several distinct populations. Wind-pruned *Juniperus communis* occurs on a number of islands in freshwater lochs in the north-west; there is the tall *Juniperus communis* population on the Loch Maree Islands where it exists in an unusual *Pinus sylvestris*, *Juniperus communis* and mire matrix; *Juniperus communis*, up to six metres in height, is found in a birchwood in Strathnaver; and there is the complex of *Juniperus communis* communities on the Torrisdale Bay-Invernaver coast where erect and semi-prostrate forms (of ssp. *communis*, ssp. *nana* and intermediate types) exist in a variety of NVC communities, including W19, an unusual H10-H16 intermediate heath, other wet/dry heaths, scrub, grassland, ledge and sand dune communities (Dargie, 1998; Averis, 1997).

However, the most distinctive prostrate *Juniperus communis* communities of the north-west Highlands are those associated with dwarf shrub heath, particularly the H15 found on the Cambrian quartzite plateaux of, for example, Cranstackie and Foinaven in

Sutherland and Beinn Eighe in Wester Ross, on the anorthosite of Roineabhal in Harris and on gabbro in the Cuillins on Skye (Averis, 1994; Averis & Averis, 1997a & b, 1998). The extensive Cranstackie - Conamheall *Juniperus communis* heath is one of the best in the country while the equally abundant Beinn Eighe population is particularly rich in hepatics and includes the only British Isles location of the very rare liverwort, *Herbertus borealis* (Rodwell, 1991b; Averis & Averis, 1998). Throughout the north-west prostrate *Juniperus communis* is still found in a variety of heath types with relict communities in mountain areas and in coastal heaths such as the waves of *Calluna-Juniperus-Arctostaphylos* heath at Cape Wrath (Ferreira, 1988). These communities were probably much more widespread and diverse in the past but *Juniperus*, which is very vulnerable to fire, has been eliminated from many moorland areas by frequent muirburning.

On the islands there are some flourishing seacliff populations, for example on Gruinard Isle in Wester Ross and in the Shetland Islands (MacLennan, 1981; Scott & Palmer, 1987). A recent survey on Fair Isle recorded over fifty thousand *Juniperus communis* ssp. *nana* on dry dwarf shrub heath and on seacliffs throughout the island (Riddiford, 1998). The extensive Fair Isle population appears to be in good condition, apparently benefiting from low intensity grazing.

In the Scottish Lowlands *Juniperus communis* colonies are scattered and, except for a few notable stands such as Tynron in Nithsdale, Hopes Water in East Lothian and Juniper Craigs in Tweeddale, most sites contain few individual plants. A survey of all eighty known sites in the Borders (McBride, 1997) found that fifty percent contained less than ten *Juniperus* bushes and the majority were over one hundred years old (the oldest record being circa two hundred years). Many colonies were being fragmented by grazing and regeneration was present at only nineteen of the sites. Despite the apparent impoverishment of the population a study to determine whether there was any deterioration due to genetic isolation found that there was no loss of genetic variation or any evidence of inbreeding (Borders Forest Trust, 1997). Similar results have also been established in *Juniperus communis* populations at Abernethy in

Strathspey. As *Juniperus communis* is much more widespread and populations are larger in the north-east fragmentation of the communities is perhaps less severe on a regional scale. However, problems with lack of regeneration also occur in numerous populations throughout Scotland, particularly in the upper parts of glens where there is often intense grazing pressure.

Most of the higher altitude and coastal *Juniperus communis* is of the semi-prostrate or prostrate form, often identified as *Juniperus communis* ssp. *nana* (or ssp. *alpina*), although the subspecies is not always confirmed during surveys because of difficulties in recognising specimens in the field when grazing or shelter have altered the growth habit of the plant. *Juniperus communis* associated with the H7, H10, H15 and H21 communities have usually been identified as the *nana* subspecies, for example in the north-west Highlands, but at other locations, for example on H10 heath in Knapdale and in the Cairngorms, the subspecies is *communis*. Further study is probably required on the taxonomy of *Juniperus*. Seral and woodland understorey *Juniperus communis* is invariably *Juniperus communis* ssp. *communis* which can exist as two forms - the erect shrub (Steven & Carlisle, 1959, recorded *Juniperus communis* of seven and a half metres height in the Barrisdale pinewood) and the low bushy, or even semi-prostrate, shrub. However, the effects of grazing and of exposure can limit the potential development of *Juniperus* at many locations. *Juniperus communis* ssp. *communis* is also common in the subalpine zone where it exists as a low shrub within heath communities and there is one location at Creag Fhiaclach in the Cairngorms where there is a natural altitudinal zonation from the W18 pinewood through W19 *Juniperus communis*-*Pinus sylvestris* scrub to low *Juniperus communis* scrub on heath above the treeline.

Juniperus communis can tolerate a wide range of soil types from acid heaths through base-poor conditions to fertile, calcicolous soils. It is thus found with several NVC communities in addition to the *Juniperus* - dominant W19 *Juniperus communis* ssp. *communis*-*Oxalis acetosella* scrub (Table 1). Some of these associations may be related to transitions from heath, woodland, grassland or mire or where a succession has been interrupted or altered by

Table 1 NVC communities recorded with a *Juniperus communis* ssp. *communis* and/or ssp. *nana* presence
(NVC communities from Rodwell, 1991a & b, 1992 and 2000)

<u>Woodland & scrub</u>	
W4	<i>Betula pubescens-Molinia caerulea</i> woodland.
W11	<i>Quercus petraea-Betula pubescens-Oxalis acetosella</i> woodland.
W17	<i>Quercus petraea-Betula pubescens-Dicranum majus</i> woodland.
W18	<i>Pinus sylvestris-Hylocomium splendens</i> woodland.
W19	<i>Juniperus communis</i> ssp. <i>communis</i> - <i>Oxalis acetosella</i> woodland.
W20	<i>Salix lapponum-Luzula sylvatica</i> scrub.
W23	<i>Ulex europaeus-Rubus fruticosus</i> scrub.
<u>Heath</u>	
H7	<i>Calluna vulgaris-Scilla verna</i> heath.
H10	<i>Calluna vulgaris-Erica cinerea</i> heath.
H12	<i>Calluna vulgaris-Vaccinium myrtillus</i> heath.
H14	<i>Calluna vulgaris-Racomitrium lanuginosum</i> heath.
H15	<i>Calluna vulgaris-Juniperus communis</i> ssp. <i>nana</i> heath.
H16	<i>Calluna vulgaris-Arctostaphylos uva-ursi</i> heath.
H17	<i>Calluna vulgaris-Arctostaphylos alpina</i> heath.
H20	<i>Vaccinium myrtillus-Racomitrium lanuginosum</i> heath.
H21	<i>Calluna vulgaris-Vaccinium myrtillus-Sphagnum capillifolium</i> heath.
<u>Mire</u>	
M10	<i>Carex dioica-Pinguicula vulgaris</i> flushed mire.
M15	<i>Scirpus cespitosus-Erica tetralix</i> wet heath.
M17	<i>Scirpus cespitosus-Eriophorum vaginatum</i> blanket mire.
M23	<i>Juncus effusus/acutiflorus-Galium palustre</i> rush pasture.
<u>Grassland</u>	
CG10	<i>Festuca ovina-Agrostis capillaris-Thymus praecox</i> grassland.
CG13	<i>Dryas octopetala-Carex flacca</i> heath.
MG6	<i>Lolium perenne-Cynosurus cristatus</i> grassland.
MG10	<i>Holcus lanatus-Juncus effusus</i> rush pasture.
U4	<i>Festuca ovina-Agrostis capillaris-Galium saxatile</i> grassland.
U5	<i>Nardus stricta-Galium saxatile</i> grassland.
U10	<i>Carex bigelowii-Racomitrium lanuginosum</i> moss-heath.
U20	<i>Pteridium aquilinum-Galium saxatile</i> community.
<u>Maritime</u>	
MC3	<i>Rhodiola rosea-Armeria maritima</i> maritime cliff ledge community.
MC9	<i>Festuca rubra-Holcus lanata</i> maritime grassland
SD12	<i>Carex arenaria-Festuca ovina-Agrostis capillaris</i> dune grassland.

grazing. A *Juniperus communis* presence as an understorey shrub in woodland has already been mentioned but it can also be found with W20 scrub in mountain areas and, occasionally, as in Glen Carvie (Strathdon), Culbin and Nairn beach, with W23 gorse scrub. In moorland and heath communities *Juniperus communis* has been recorded in H7 at coastal cliff sites on Iona, in H12 and H10 in Gleann Einich (Cairngorms) and Creag an Fhithich (Argyll) and in H12 on the slopes of Morven (Strathdon). It has also been recorded in H21 heath on the Little Hills of Ben Vorlich (Stirling). Where *Juniperus communis* ssp. *nana* forms a major component of *Calluna* heath it has been classified by the NVC as H15 *Calluna vulgaris*-*Juniperus communis* ssp. *nana* heath (Rodwell, 1991b). This community is found at over ten locations in the north-west of Scotland but also occurs in, for example, Mull (Averis & Averis, 1995) and, possibly, in Glen Ernan in Strathdon (Smedley, 1992).

Juniperus communis is uncommon on mires but does occur on M15 damp heath at a

number of locations, for example, the Cuillins, Cranstackie, Iona and the Knapdale peninsula (Argyll). At Beinn Eighe the *Juniperus communis* in the M15c wet heath is as abundant as it is in the H15 heath (Averis & Averis, 1998). *Juniperus communis* is also moderately common on a variety of grassland communities, for example on U4, U5, U6 and CG10 in Glen Carvie and Glen Ernan, CG10 in Iona and MG6 and CG10 in Knapdale. At most of these grassland locations the land is either abandoned pasture or is still used for stock grazing. The farms of Ulva, Turbiskill and Danna in Knapdale consist of a range of communities from W11/17 woodland, H10 heath, M15 damp heath, U20 bracken to mesotrophic and calcicolous grassland (MG6 & CG10) - each of which contain a *Juniperus communis* ssp. *communis* presence (Dayton, 1997).

The altitude range for *Juniperus communis* is from about sea level on both east and west coasts to over 950 metres in *Nardus-Trichophorum* snowbeds in the Cairngorms.

Coastal, treeline and other wind-pruned scrub (Figure 6)

This category covers a wide range of different tree and shrub species with the common factor being a scrubby or wind-pruned form under five metres in height in areas where the effects of topography, soils and exposure produce severe limitations on normal growth. Scrub growing on exposed coastal locations has affinities with the true subalpine and treeline communities and both are a climax vegetation type which includes tree and shrub species such as *Betula pubescens*, *Salix* spp., *Sorbus aucuparia*, *Corylus avellana*, *Pinus sylvestris*, *Populus tremula*, *Quercus* spp., *Prunus spinosa* and *Juniperus communis*. The dataset contains 452 records in 23 districts from the Shetlands to Wigtown. The main concentrations are treeline and high altitude tree species in Strathspey and Deeside and coastal scrub in the exposed west and in the Northern and Western Isles.

There are very few areas in Scotland where there is a natural treeline between woodland and high altitude scrub. The most notable is at Creag Fhiaclach where the *Pinus sylvestris*

grades into “krummholz” *Pinus* and *Juniperus* and thence to dwarf *Juniperus communis* in the subalpine zone at over 650 metres. However, there are other treeline woodlands, but without the scrub zone above, in the Cairngorms, for example a stand of *Betula pubescens*, *Sorbus aucuparia* and *Salix* spp. in a sheltered gully at 670 metres in Gleann Einich. There are also extensive areas of wind-clipped *Pinus sylvestris* and *Juniperus communis* from the Northern Corries to Gleann Einich - all above the present treeline and extending up to 850 metres, albeit at reduced densities with increasing altitude and distance from the seed source (French, Miller & Cummins, 1997). In time, this scrub, some of which is up to forty years old, could develop into another natural treeline between the forest and the subalpine zone. In Deeside treeline *Juniperus communis*-*Betula pubescens* scrub between 600 metres and 850 metres can be found above Morrone Birkwood and on Geallaig Hill *Pinus sylvestris* regeneration extends up to 700 metres on south-facing slopes. Elsewhere in the Cairngorms and in

Glen Doll scattered or solitary *Betula pubescens*, *Sorbus aucuparia*, *Pinus sylvestris*, *Populus tremula* and *Salix* spp. are quite common on crags up to 900 metres.

Natural scrub type woodland can also develop where the effects of topography, soils and exposure combine to limit normal growth along the upper edge of the wood, for example the *Pinus sylvestris*, *Betula pubescens* and *Sorbus aucuparia* on the cliffs at Letterewe. The *Betula pubescens* on the slopes of Beinn Bhan, Ballachulish and at Kinloch on Skye provide examples of continuous woodland and scrub from near sea level to an altitude where there may be remnants of a natural treeline. At between 350 and 400 metres on Beinn Bhan the wind-blasted *Betula* are less than four metres in height. Further south, treeline scrub is much rarer although scattered *Betula pubescens*, *Sorbus aucuparia* and *Salix* spp. on the crags of Meall nan Gabhar (Argyll) at 530 metres and around the Gray Mare's Tail, Moffat Hills at 460 metres are indications of the potential. However, this report is far from comprehensive and new surveys should reveal additional locations for treeline development.

Coastal, wind-pruned scrub is common in the west of Scotland and Argyll in particular. Mull contains dwarf and semi-prostrate tree species, perhaps the largest concentration in Britain, along its exposed western and southern shores. *Quercus* spp., over 220 years old, range from the entirely prostrate with horizontal branches and a maximum height of half a metre to a variety of contoured shapes pressed against the cliff face. Other wind-pruned species include *Populus tremula*, *Corylus avellana*, *Prunus spinosa*, *Sorbus aucuparia* and *Betula pubescens*. Where there is shelter inland from the coast trees achieve a more normal stature. Similar wind-pruned scrub is found on many of the other islands of the Inner Hebrides. Colonsay, Lismore and Kerrera have stands of stunted W9 *Corylus avellana* communities, some of them barely one metre in height, and at Braigo on Islay there is a stand of wind-pruned *Quercus* spp. and *Betula* spp. which may be one of the most westerly woods in Britain (Ball, 1983).

Some of the most remote islands can be floristically very rich. The Garvellachs

contain a small stand of *Betula pubescens*, *Alnus glutinosa*, *Corylus avellana*, *Fraxinus excelsior* and *Salix* spp. on calcareous soils. The sheltered limestone cliffs of Bernera contain *Fraxinus excelsior*, *Ilex aquifolium*, *Crataegus monogyna*, *Prunus spinosa*, *Sorbus rupicola* and *Taxus baccata*. D. N. McVean described in 1973 the rich cliff ledge communities at nearby Minard Point where over forty *Taxus baccata* trees of apparent great age are growing over coastal crags. Some of the more inhospitable and treeless of islands contain a few individuals such as the scattered *Sorbus aucuparia* and *Salix* spp. on Coll and, further south on Ailsa Craig, there is a stunted *Populus tremula* of one metre height which was previously recorded at the same spot in 1895 (Zonfrillo, 1994). The island of Arran is the home of the endemic whitebeams, *Sorbus arranensis* and *S. pseudofennica* which survive in gullies and crags in the north-west corner. At the last count there were eight hundred and twenty two of these rather unique trees.

In the Northern and Western Isles all the native trees can be classed as scrub as the exposure confers severe limits to growth. Berriedale on Hoy (Orkney) is Britain's most northerly natural woodland and includes *Betula pubescens*, *Sorbus aucuparia*, *Populus tremula*, *Salix* spp. and two of only three naturally growing *Corylus avellana* on Orkney. Small groups, or solitary, *Sorbus aucuparia*, *Populus tremula* and *Betula pubescens* occur elsewhere but most are under three metres in height. There is no actual natural woodland on Shetland but scattered individual *Sorbus aucuparia*, *Betula pubescens*, *Populus tremula*, *Salix* spp. and *Corylus avellana* do occur. Two stunted crab apples, *Malus sylvestris*, have been recorded on exposed seacliffs. One of the most important sites on Shetland are the islands on Clubbi Shuns (North Roe) which contain *Betula pubescens*, *Sorbus aucuparia*, *Salix cinerea*, *S. aurita* and *Juniperus communis* ssp. *nana*. Most trees are under two metres in height and often less than one metre. The largest *Populus tremula* in the Shetlands, at two and a half metres in height and a diameter of eight centimetres, can be found on Ronas Voe and was first recorded in 1889 (Scott & Palmer, 1987).

Woodland scrub is found on a number of islands in freshwater lochs, particularly in the Western Isles. Grazing is absent or much reduced on small islands and there is thus an opportunity for a climax vegetation community to develop. Scrub also occurs on some mainland islands, for example in Loch Sionascaig at Inverpolly and in Loch a'Mhuirt, Sutherland, but on other, more sheltered, loch islands the natural climax vegetation is woodland rather than scrub.

On mainland coasts wind-pruned *Quercus* spp., *Corylus avellana*, *Populus tremula* and

Salix spp. scrub occurs in west Sutherland, Wester Ross, Ardnamurchan, along the west coast of Kintyre and to the south of Girvan; and there are occasional patches of *Crataegus monogyna* and *Prunus spinosa* scrub (W21 and W22) on the south coast, for example at Gilfoot Bay, Brighthouse Bay and at Loch Ryan. *Quercus* spp. trees under four metres in height on exposed seaward cliffs gradually increase in stature as one progresses inland where shelter creates more favourable conditions. Coastal scrub on the east coast is less common but *Prunus spinosa* can be found along the Fife Ness coast and around Buddo Ness.

Discussion

This is a preliminary examination of upland and mountain scrub communities in Scotland. The information is far from comprehensive and there are large gaps in our knowledge of the distribution and condition of many of these communities. The primary sources of information for this study were SNH files and reports, including old Nature Conservancy Council files containing the 1950s field notes of D. A. Ratcliffe, records from other organisations and data from botanical recorders. There is virtually no area information on these communities and data which are available may not give an accurate assessment when individual plants are scattered across crags and ledges. The recording of species on a presence-absence basis has, with few exceptions, been carried out since the initial surveys by Ratcliffe in the 1950s, and the same populations have probably been recorded over and over again without adding a great deal more to the fund of knowledge. There is a need to provide some kind of quantitative information on the number and condition of the rare and scarce species, particularly the mountain willows, in order to determine trends and aid the future monitoring of these populations.

The quality and detail of available survey information varies between regions and between species and depends on whether the collection of scrub data was a primary or secondary aim of a survey, the interests of the

surveyor and the method of recording key information. Specialist surveys of mountain willows, for example, usually provides maps and grid references and indicates numbers of plants while general plant lists for a particular mountain do not usually provide accurate locational information. Accurate detail is essential to avoid duplication when surveys of rare species are involved because gross area data are of little value and future monitoring requires total or sample counts of individual plants. Much survey information is available on the highest of the mountain areas and on those which are Sites of Special Scientific Interest (SSSI) and this can lead to a concentration of sites at certain geographical locations. Although this may very well reflect the true pattern, mountain willows can still be located outwith these areas as at Coignafearn in the Monadhliaths.

A concentration of survey effort also leads to a more detailed pattern in the distribution of some communities in certain areas, such as *Betula nana* in the Balmacaan-Guisachan area (surveyed by Payne for SNH in 1991; Matthews & Cosgrove, 1999) and coastal scrub communities in north-west Sutherland (surveyed by Ferreira throughout the 1980s). Again, this probably reflects the natural distribution but it does pose the question of why, for example, are there so few records of *Betula nana* in the west of Scotland? Some records do occur, as in the Torridon-Beinn

Eight area, but these have not been relocated in recent years. It is possible that *Betula nana* is indeed scarce, or at least exists at low population levels in the west but a more intense survey effort, or changes in land-use, particularly a reduction in muirburn and grazing levels, could eventually reveal a wider pattern of distribution.

The method of storing the information is equally important. Original files and maps are the main source and mean less error but are time consuming to collate; some data, for example the Arran whitebeams, are now being incorporated into a Geographical Information System database which includes both maps and grid references. Other databases are less useful as a source of information. SNH's "Recorder" system, for example, collates plant data held in SSSI files and stores it on a computer database. However, the recorded grid reference is invariably a centre point or mountain summit and not the actual plant location.

The maps and the original dataset details illustrate the distribution and the areas where there are a concentration of records of the individual species or communities. Viable populations of all the mountain willows can be found at several locations in the central Highlands. Outwith this area *Salix* populations are more scattered, often small in number and vulnerable to local extinction. At some sites, for example *Salix lapponum* in Shetland and *Salix lanata* in Perth & Kinross where there is one plant and three female plants respectively, the species is already ecologically extinct. The maps by themselves do not reveal the distribution of the individual *Salix* species but there are clear indications in the dataset that many of the central Highland populations are small and vulnerable. Regeneration is rare even in the larger populations and it is unclear at some sites why so few seedlings are detected. Sullivan (1997) showed that fertile *Salix lapponum* seed was abundant at Creag Meagaidh yet, despite reductions in the impact of grazing, no new seedlings have been detected away from the cliff ledges. At Geall Charn, however, Marriott (1994) described an apparently healthy colony of the much rarer *Salix lanata* with seed and young plants in areas which are accessible to browsing. One suggestion is that late snow lie may protect these high altitude

sites from grazing but there are still unanswered questions in relation to the absence of mountain willows on many basic crags and why there is so little evidence of seedlings at other upland locations.

A shortage of survey work and monitoring may be one reason why data are lacking. Mountain willow sites are not easy to survey and plants are very difficult to count. Crags are often inaccessible and seedlings may therefore be undetected. Fixed point photography seems to be the only feasible method for monitoring whole populations on cliffs and should be adequate for detecting long-term trends but will not assist in providing regeneration data over short periods. Successful *Salix* expansion by natural means may well be a long-term process depending not just on a reduction in grazing but also on a restoration of the balance between the different vegetation communities and the formation of a suitable substrate for successful establishment.

Juniperus communis is a much more ubiquitous plant with a wider distribution and a large population in certain areas of the central Highlands and the north-east; while the prostrate form is fairly common in the north-west Highlands, on the Argyll coast, especially in the islands of the Inner Hebrides, and also on Shetland, Orkney and Fair Isle. Yet, there are parts of the country where *Juniperus communis* is uncommon. It is absent or very rare from many of the mountain areas of Perth, Stirling and Argyll districts and, with a few notable exceptions, is also moderately uncommon as a woodland or seral scrub species across the same area. The Southern Uplands too have small and widely scattered populations with just a few significantly sized communities. A more intense form of upland agriculture and grazing regime may have caused the loss of communities in the historic past and new surveys should reveal additional *Juniperus communis* records but the species may never have been particularly common in these areas.

Coastal, wind-pruned scrub has been included in this study not because the species involved are particularly rare but because the habitat and form of the trees and shrubs have created a unique community that could not easily be restored if lost. On Mull, where there are

several extensive areas of wind-pruned *Quercus* spp. and *Corylus avellana*, Averis & Averis (1995) have reported on the rich assemblage of oceanic bryophytes, lichens and ferns beneath a canopy that is often less than two metres high. Such low canopies and multiple branching habit create conditions of high humidity allowing epiphytes to flourish. On the south coast of Wigtown district the cliff area of Ravenshall Wood is clothed with wind-pruned *Quercus* spp., *Ulmus glabra* and *Fraxinus excelsior* which, under the strong influence of wind and salt spray, has developed a rich association of specialised lichen and invertebrate species. All such sites will be maintained by a high degree of wind or salt spray exposure and by unfavourable edaphic conditions. The composition of the tree and shrub species will depend on the soil and underlying geology but in many instances the definition of what constitutes scrub or woodland will be an arbitrary one.

In the Northern and Western Isles the combination of higher latitudes, greater exposure and strong maritime influence mean that all naturally-occurring tree species are wind-shaped and of low stature. In the Inner Hebrides, particularly on the smaller islands like Eigg, the rich oceanic *Corylus avellana* scrub was probably always the climax vegetation type. Pollen analytical studies on a number of other basaltic areas in the Inner Hebrides, including Skye, have indicated that *Corylus avellana* was dominant throughout the post-glacial period and that *Ulmus glabra*, *Populus tremula*, *Betula pubescens* and *Sorbus aucuparia* were merely a minority component (Birks, 1988). Acid and peaty soils, common in the Western Isles, contain stunted and shrubby forms of *Betula pubescens*, *Sorbus aucuparia* and *Salix* spp. (*Salix cinerea* and *S. aurita*) in sheltered or inaccessible areas and these may have been the dominant climax vegetation over at least part of this landscape. Spence (1960) has suggested that the relict *Betula pubescens* scrub in Shetland is the equivalent of subalpine scrub at over 600 metres in the Cairngorms. Centuries of grazing, however, has meant that there is no well developed scrub community in Shetland, only isolated trees and a few tiny clumps on islands in freshwater lochs. On Orkney the situation is similar with the exception of Hoy which contains several gullies with small groups of trees and the one wood at

Berriedale. Berriedale Wood is unique not only because of its northern location but also because it is a rich scrub community which has been undisturbed from grazing, burning and felling for about fifty years (Taylor, 1995).

On the mainland (and in parts of Skye) climax scrub is located only on the most exposed situations and, with increasing stature correlated with increasing shelter and better soil conditions, tends to merge into woodland. Consequently, there are many transition type woodlands where the trees may have a variety of form or a wind-pruned canopy but are generally above five metres in height. Thus, coastal scrub communities are most common in north and west Sutherland and at other exposed locations like the Ardnamurchan peninsula. Inland, the main areas of climax scrub would be the upper woodland margins where these abut onto crags or cliffs. This is the nearest type of treeline scrub community remaining in the north and north-west of Scotland and is probably related more to the unfavourable ground conditions rather than the diminishing stature which would be associated with increasing altitude and exposure. For example, above 300 metres on the slopes of Ben Loyal and Ben Hope.

Certain tree species, particularly *Sorbus aucuparia*, are not uncommon within the subalpine zone and have been recorded at 850 metres on Beinn Dearg, almost as high as the 900 metre record for *Salix lapponum* on the same mountain (Royal Botanic Gardens, 1984). The ability of *Sorbus aucuparia* to arrive at such remote locations is clearly related to avian dispersion but its ability to thrive on high level rock ledges near the tops of some of Scotland's highest mountain areas as well as on sea stacks on the west coast of Lewis illustrates the wide tolerance level of this species. Other tree species like *Betula pubescens* and *Populus tremula* also survive as high as 700 metres and often along with the mountain willows on calcicolous ledges and with *Juniperus communis* on more base-poor sites. The subalpine zone is thus an area where not only do the true mountain willows and *Juniperus communis* exist but also elements of the forest zone, thus representing more of a transitional ecotone rather than a clearly defined zone of endemic mountain scrub.

One of the important values of the dataset upon which this report is based will be to show which mountain scrub locations offer the best potential for restoration of, either the communities themselves, or restoration of the natural altitudinal zonation between forest, subalpine and alpine habitats. The north-west flanks of the Cairngorms offer tremendous potential for regenerating a *Juniperus communis*-*Pinus sylvestris* subalpine scrub leading to dwarf *Juniperus communis* heath and with occasional patches of mountain willow on basic crags and flushes or high altitude *Betula pubescens*/*Sorbus aucuparia* scrub in sheltered gullies. In the east Cairngorms there is scope to develop a *Betula nana* scrub community above the native pinewoods in Glen Derry; and a similar community above *Betula pubescens* scrub in Glen Muick. In the west on Beinn Bhan, above Ballachulish, there is the potential to develop a treeline scrub community of *Betula pubescens* and *Sorbus aucuparia* leading to prostrate *Juniperus* heath at over 500 metres. High elevation birchwoods are already expanding at Creag Meagaidh although it may be some years before the mountain willows increase in area. At all these locations the species are already present as seedlings or suppressed growth.

Restoration of montane willows in isolation from surrounding habitats by the use of high altitude exclosures, even if it works, will only offer short-term benefits. A reduction in grazing levels is the ideal solution to permit the mountain willows to grow in a range of different communities. Alternatively, the creation of landscape scale perimeter fencing which would enclose the full altitudinal range from forest to alpine zone, can offer a suitable solution to poor regeneration. This is already beginning to happen at sites such as Glen Doll where the exclosure around the Corrie Sharroch *Salix* community extends down to 450 metres and there is some development of *Betula pubescens*-*Sorbus aucuparia* scrub at these lower levels.

The policies and practicalities involved in the restoration of upland scrub communities are beyond the scope of this report and have already been reviewed by Sydes and others in Gilbert, Horsfield & Thompson (1997).

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Key to figures 2 - 6

Number of records in each 10 km square

- > 21 records
- 11 - 20 records
- 6 - 10 records
- 2 - 5 records
- 1 record

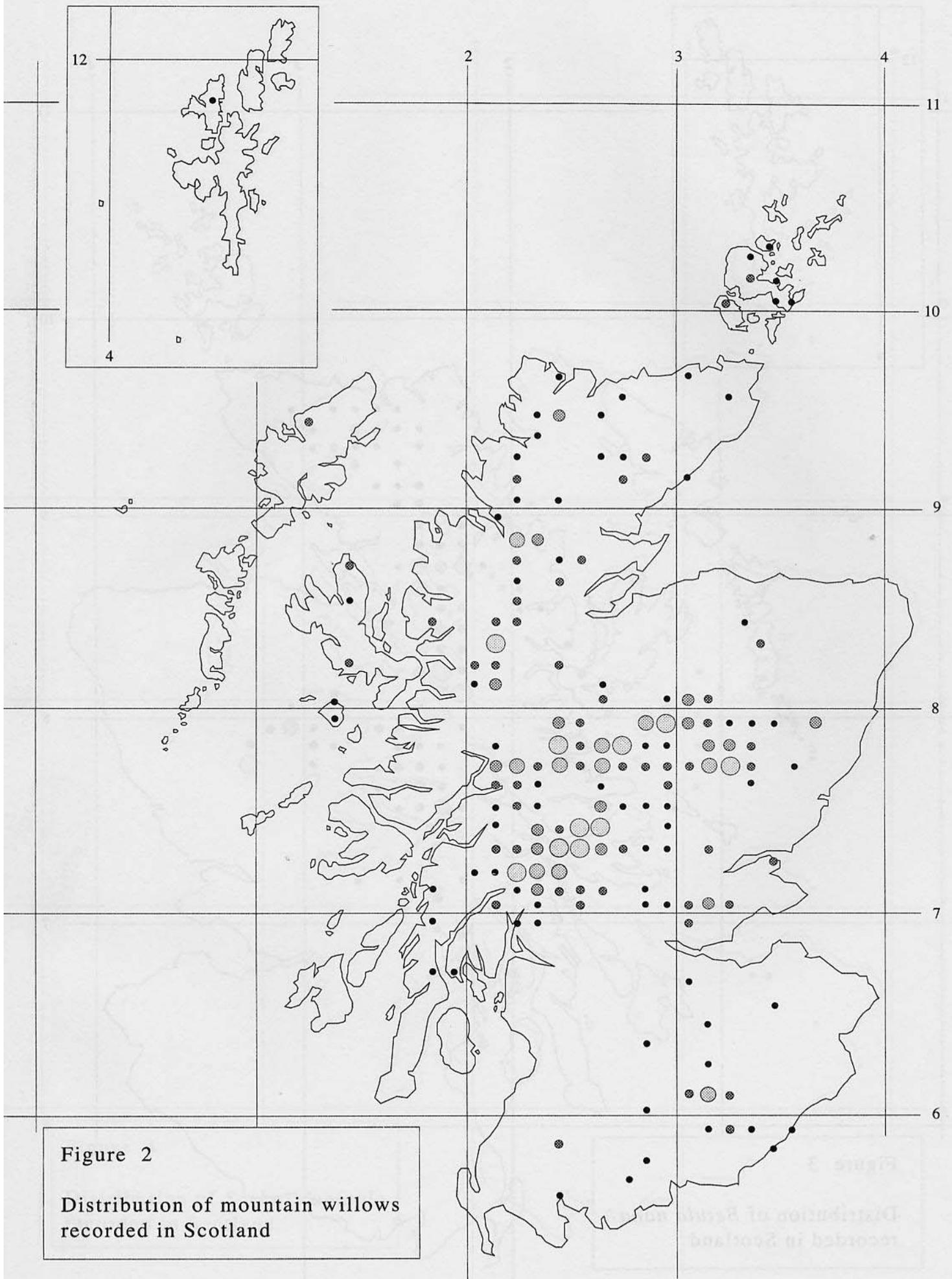


Figure 2
 Distribution of mountain willows
 recorded in Scotland

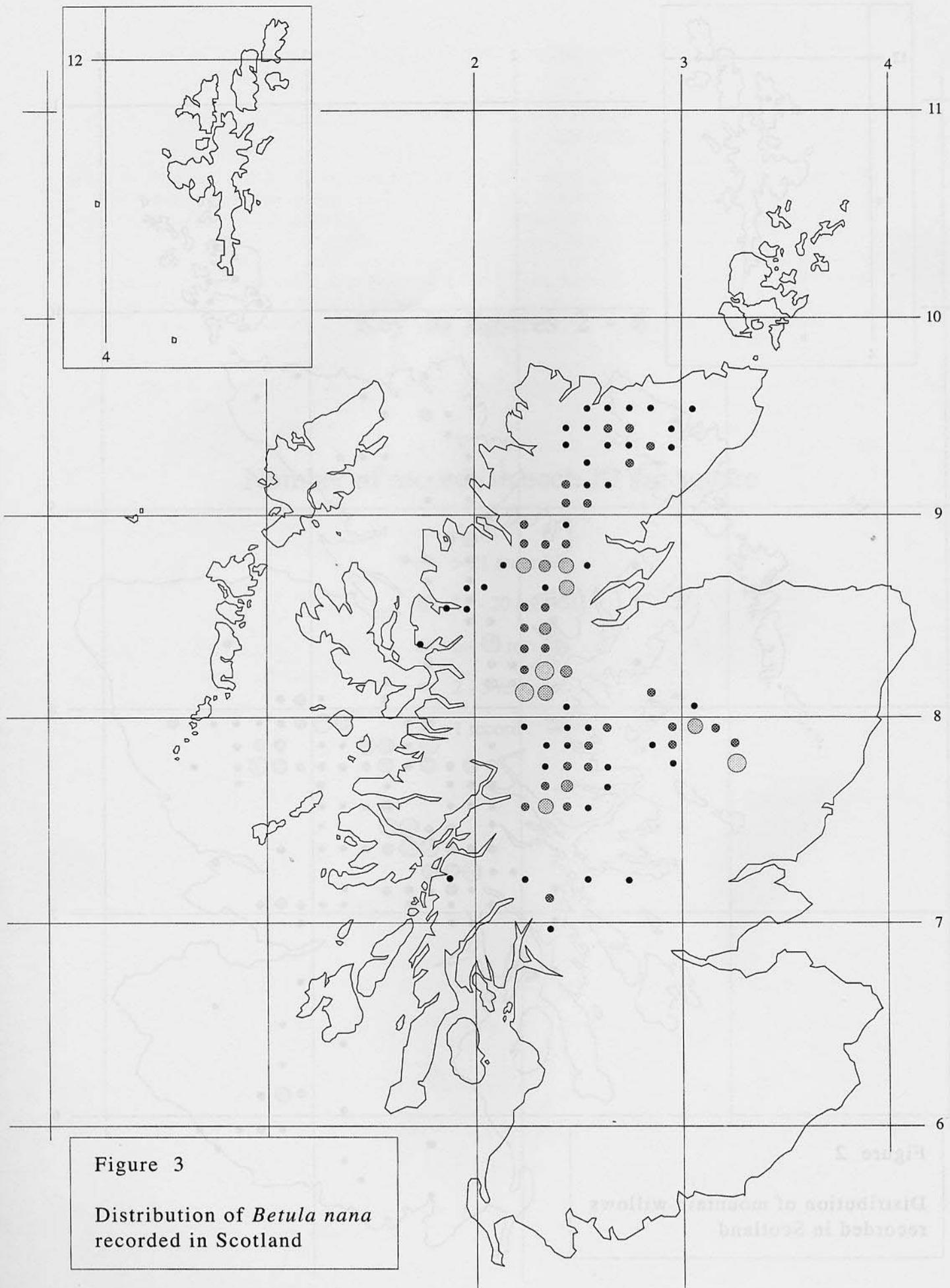


Figure 3
 Distribution of *Betula nana*
 recorded in Scotland

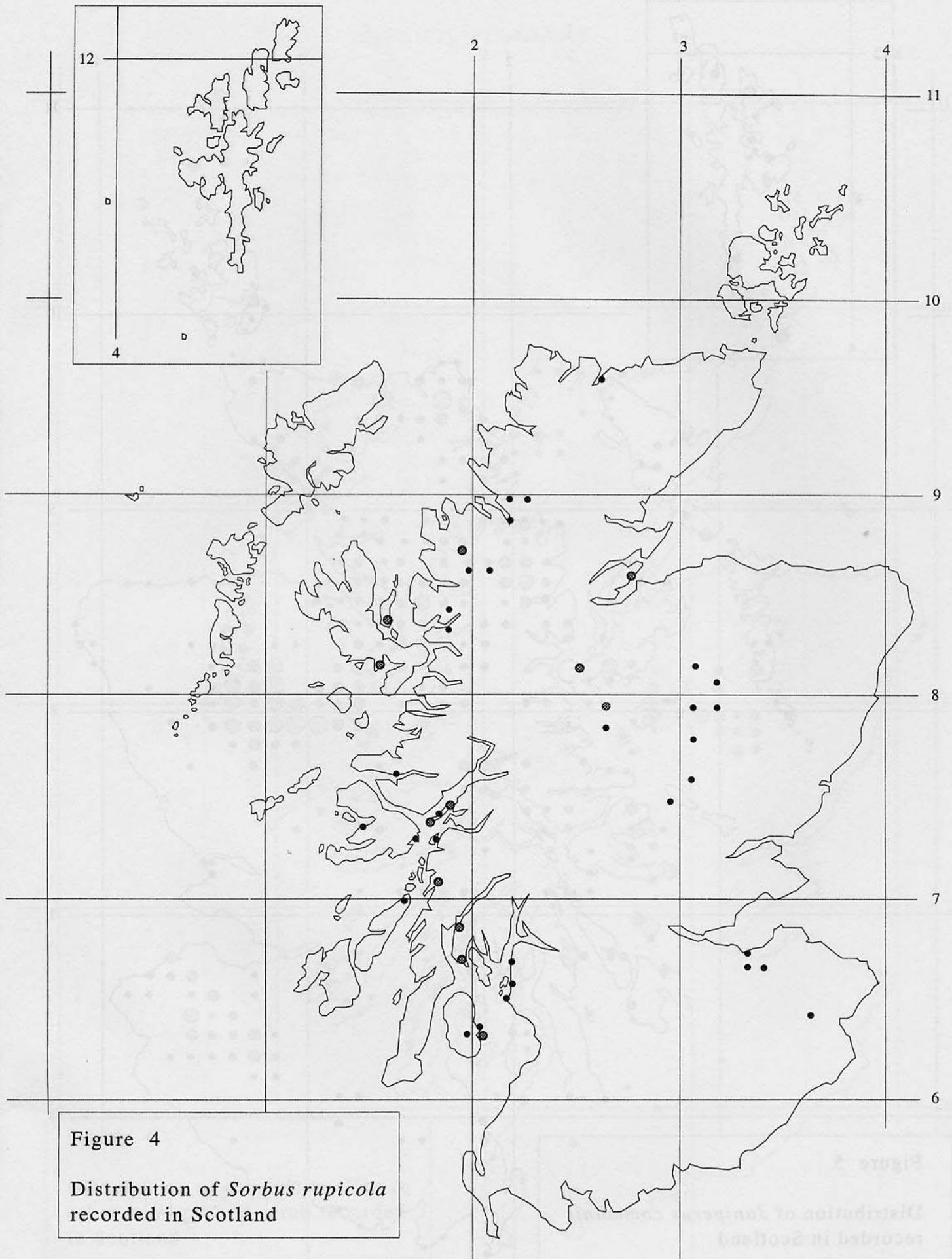


Figure 4

Distribution of *Sorbus rupicola* recorded in Scotland

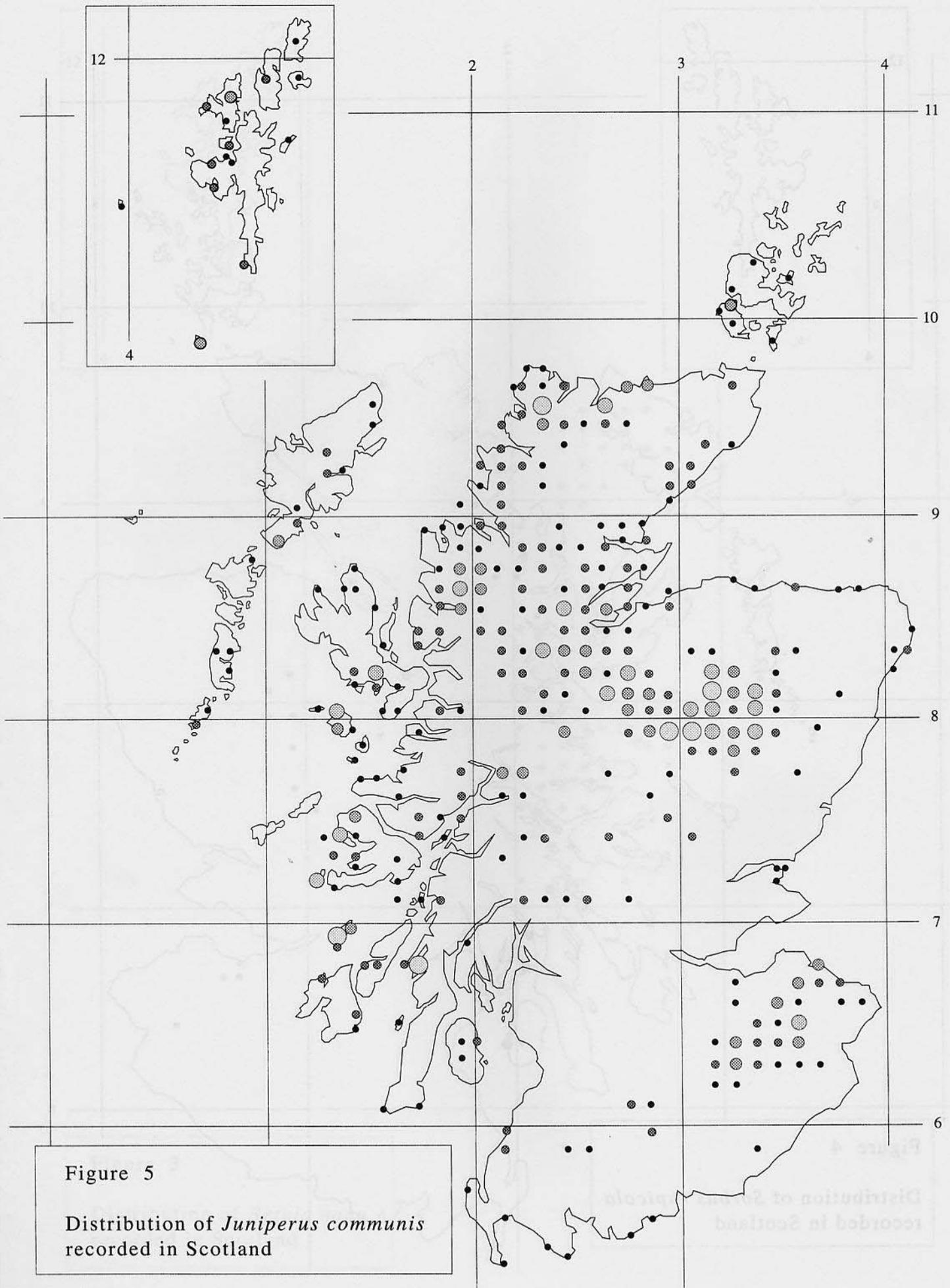


Figure 5
 Distribution of *Juniperus communis*
 recorded in Scotland

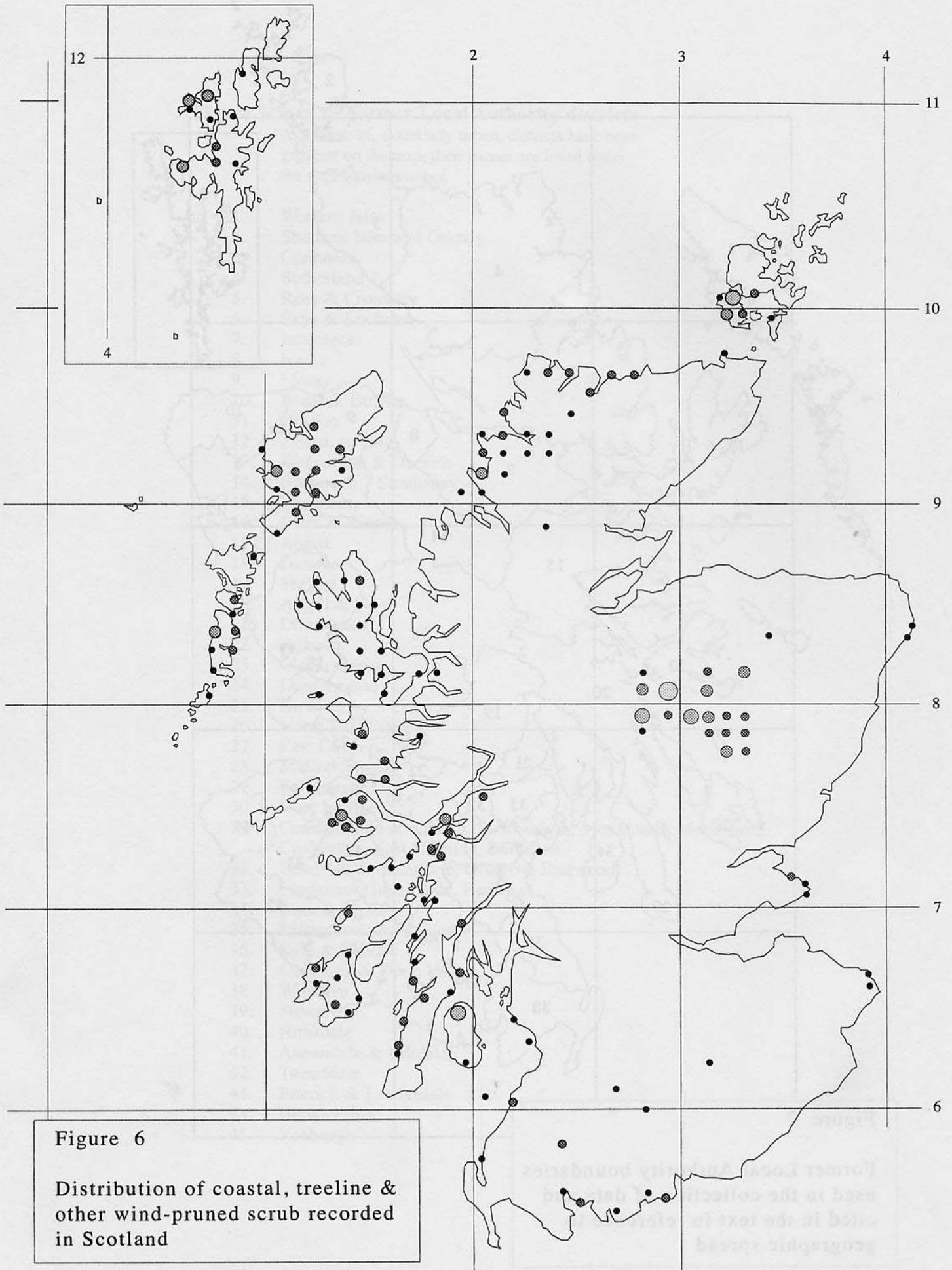


Figure 6
 Distribution of coastal, treeline &
 other wind-pruned scrub recorded
 in Scotland

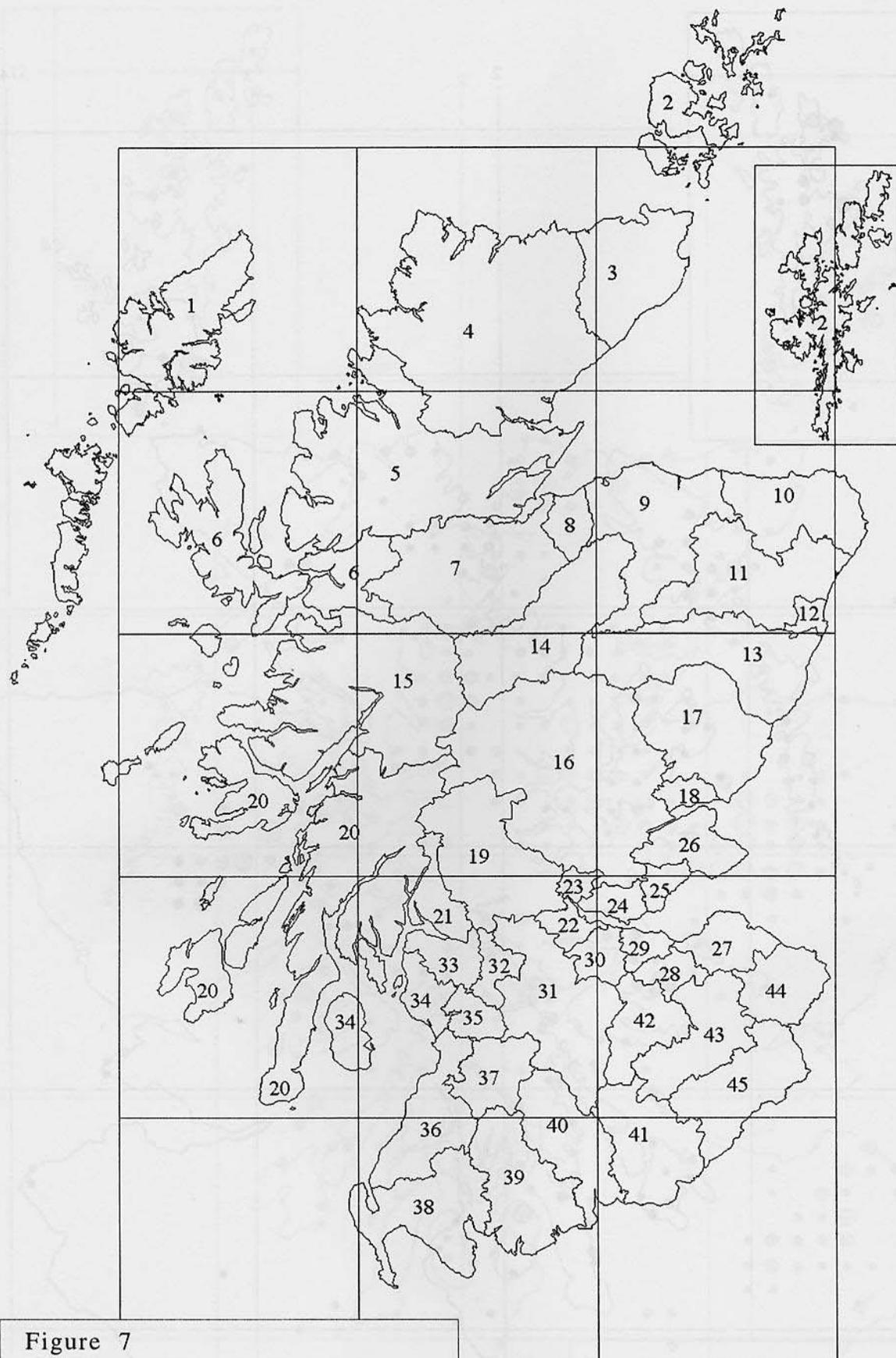


Figure 7
 Former Local Authority boundaries used in the collection of data and cited in the text in reference to geographic spread

Figure 7 Key to Former Local Authority districts

A number of, essentially urban, districts have been grouped on the map, their names are listed under the appropriate number.

1. Western Isles
2. Shetland Isles and Orkney
3. Caithness
4. Sutherland
5. Ross & Cromarty
6. Skye & Lochalsh
7. Inverness
8. Nairn
9. Moray
10. Banff & Buchan
11. Gordon
12. Aberdeen City
13. Kincardine & Deeside
14. Badenoch & Strathspey
15. Lochaber
16. Perth & Kinross
17. Angus
18. Dundee
19. Stirling
20. Argyll & Bute
21. Dumbarton
22. Falkirk
23. Clackmannan
24. Dunfermline
25. Kirkcaldy
26. North East Fife
27. East Lothian
28. Midlothian
29. Edinburgh
30. West Lothian
31. Cumbernauld & Kilsyth, Strathkelvin, Monklands, Motherwell, Clydesdale, East Kilbride, Hamilton
32. Bearsden & Milngavie, Glasgow, Eastwood
33. Clydebank, Inverclyde, Renfrew
34. Cunninghame
35. Kilmarnock & Loudon
36. Kyle & Carrick
37. Cumnock & Doon Valley
38. Wigtown
39. Stewartry
40. Nithsdale
41. Annandale & Eskdale
42. Tweeddale
43. Etterick & Lauderdale
44. Berwickshire
45. Roxburgh



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