

**BRYOPHYTE SURVEY OF  
SIDE WOOD,  
ENNERDALE, CUMBRIA,  
OCTOBER 2001**

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## 1 INTRODUCTION

### Brief general description of Side Wood

Side Wood is situated on the southern side of Ennerdale Water in the western part of the English Lake District (Map 1). It occupies about 40 hectares of the lower NNE-facing slopes, stretching for 2.4 km from WNW to ESE (along-slope), and up to 300 m from NNE to SSW (up-down slope). The altitudinal range is 112-270 metres above sea level. The bedrock is mapped as being in the category of *Granite, syenite, granophyre & allied types* (British Geological Survey 1979). A larger-scale map shows it to be mainly granophyre (which is coarse-grained and acidic), with some small areas with intrusions of finer-grained, more basic igneous rock.

The slopes are mainly moderate to steep, with numerous rock outcrops and boulders and a few small streams. The woodland vegetation has a canopy dominated by birch, with some oak, rowan, holly, hazel and ash, and a little bird cherry and hawthorn. The ground vegetation is made up of grasses, mosses and bilberry (National Vegetation Classification type W17 *Quercus-Betula-Dicranum* woodland). Up-slope the woodland opens out into bracken-dominated vegetation (NVC type U20 *Pteridium-Galium* community) and *Calluna*-dominated heath (mainly NVC type H12 *Calluna-Vaccinium* heath). There are also some bracken open areas among and downslope of some of the blocks of woodland on the lower slopes. In the middle-western part of the site there is a narrow open area just above the lake shore and below the woodland; this has an interesting mixture of grassland, bracken and wet flushes.

The site is used for sheep-grazing, though the SE end of the site - across a stock fence running down the slope - is currently ungrazed. AT NY 119 139 in the middle of the wood is a small (25 m x 25 m) stock-fenced ungrazed enclosure. This is one of a series of six 25 m x 25 m enclosures established at The Side in summer 1991. The other five enclosures are in heathland upslope of Side Wood.

A path, well used by walkers, runs along the lower, northern edge of the wood, just above the southern shore of Ennerdale Water.

### Climate

The climate is wet and oceanic. Data from the 20th century show an average annual rainfall of about 150-200 cm (Meteorological Office 1952), and an average of about 180 wet-days (1 mm or more of rain) a year (Ratcliffe 1968). Winters are cool, with a January mean daily temperature of about 3°C (Meteorological Office 1975). Summers are warm, with a July-August mean daily temperature of about 14.2°C (Meteorological Office 1975). The annual temperature range is quite small by general British standards. Cloud cover obscures bright sunshine for an average of about 70% of the day (Page 1982). Nitrate deposition has been estimated to be at a high concentration of about 0.6-0.7 g N m<sup>-2</sup> (Pitcairn & Fowler 1989). Sulphur dioxide pollution in 1987 was estimated to be at a fairly low concentration of about 4-8 µg S m<sup>-3</sup> (Hill *et al.* 1991).

## **Purpose of this survey**

The main, sheep-grazed part of Side Wood is owned by the National Trust, who commissioned this survey for the following purposes:

- to carry out a detailed bryophyte survey of Side Wood, noting the distribution and condition of the populations of the most notable species
- to collate existing information on the bryophytes of this site
- to assess the bryological importance of Side Wood in a wider geographical context
- to assess the effects of woodland management (particularly sheep grazing) on the bryophytes, and to make recommendations on appropriate future management

This survey also includes the south-eastern, ungrazed part of the wood, which is owned by the Forestry Commission.

## **Previous bryophyte surveys at Side Wood**

Bryophyte species lists have been made at Side Wood in the past by Francis Rose in July 1970 (species list plus a few notes, mainly about lichens), by Martin Wigginton on 6 January 1983 (species list plus a page of interpretative text) and by myself on a brief visit in October 1988 (species list only).

## **Nomenclature used in this report**

The botanical nomenclature in this report follows Stace (1997) for vascular plants, Blockeel & Long (1998) for bryophytes, and Purvis *et al.* (1992) for lichens.

## **2 METHODS**

I carried out the fieldwork on three days during the period 19-24 October 2001.

I made a list of all bryophyte species which I saw, recording the quantity of each species using four categories: abundant; frequent; occasional; rare.

I recorded the locations, abundance and habitats of species of particular interest: I marked locations onto a 1:10,000 map and made accompanying notes for each location. I took photographs of some of these sites; these should allow the exact places to be revisited for future monitoring. Photography was limited by wet weather, so I was not able to photograph all of the species of interest which I found.

I paid particular attention to sheltered, rocky habitats because these are generally the best habitats for the oceanic species for which the woods are particularly important. I did not explore the steepest areas because physical access was either impossible or too dangerous.

### 3 RESULTS

#### Bryophyte vegetation

Although this was primarily a survey of the bryophyte flora (rather than the bryophyte assemblages), the most common bryophyte assemblages merit brief description.

##### Woodland floor, banks, tree bases and the upper parts of rocks and logs

The large mosses *Rhytidiadelphus loreus*, *Hylocomium splendens*, *H. umbratum*, *Thuidium tamariscinum*, *Pleurozium schreberi*, *Plagiothecium undulatum*, *Hypnum jutlandicum*, *Dicranum scoparium*, *D. majus* and *Polytrichum formosum* are co-dominant with grasses and bilberry on most parts of the woodland floor. This mixture of species indicates that the soils are acidic. These mixtures of mosses also grow on steep banks, together with *Leucobryum glaucum*, *Sphagnum quinquefarium* and the liverworts *Bazzania trilobata*, *Mylia taylorii* and *Lepidozia reptans*. Similar assemblages are found around tree bases and on the level to gently sloping upper surfaces of rock outcrops, boulders and larger logs.

##### Steep rock surfaces

Soil can accumulate sufficiently on the gentle upper surfaces of outcrops and boulders for the woodland floor communities (see above) to occur. Steeper rock surfaces typically have more open assemblages of smaller bryophytes such as the mosses *Hypnum cupressiforme*, *Isothecium myosuroides* and *Dicranum scoparium*, and the liverworts *Diplophyllum albicans*, *Scapania gracilis*, *Bazzania trilobata* and *Lepidozia reptans*. Such assemblages indicate that the rocks are acidic. Some moist rocks appear more basic, with species such as the mosses *Ctenidium molluscum*, *Thuidium tamariscinum*, *T. delicatulum*, *Isothecium myosuroides*, *Brachythecium plumosum* and *Tortella tortuosa*, and the liverworts *Plagiochila porelloides*, *Metzgeria furcata*, *Lejeunea patens* and *Frullania tamarisci*.

##### Trees and shrubs

As in many other western woods a typical pattern of zonation can be seen on tree trunks: deep patches of large mosses such as *Rhytidiadelphus loreus*, *Hylocomium splendens*, *Thuidium tamariscinum*, *Dicranum scoparium* and *D. majus* around the tree base, grading up-trunk into a *Mnium hornum* moss zone on the lower part of the trunk, then higher still into an *Isothecium myosuroides* or mixed *Isothecium-Hypnum cupressiforme/H. andoi* moss zone on the steep trunks up to about 1-2 m above ground, and finally into a *Frullania tamarisci* liverwort zone on the steeper or higher parts of the trunk. The *F. tamarisci* zone can include scattered creeping shoots of the tiny liverworts *Microlejeunea ulicina* and *Lepidozia reptans*, and often thins out up-trunk, especially where more exposed. Where the bryophytes thin out, lichens can be abundant. Scattered cushions of the moss *Dicranum scoparium* are common in *Mnium*, *Isothecium/Hypnum* and *Frullania* zones. All of these assemblages indicate acidic bark conditions. On the normally richer-barked ash and hazel there can be some 'relief' from this, with species such as *Frullania dilatata* and *Metzgeria furcata*, but the general assemblages even on these trees are still more or less of the acid bark type. This suggests acidification as a result of rain-deposited pollutants from urban and industrial areas of Britain.



## Bryophyte flora

I have recorded a total of 119 bryophyte species at Side Wood. Among the total of 69 species in the combined species list of Francis Rose in 1970 and Martin Wigginton in 1983, there are six which I did not find in this survey: the mosses *Philonotis fontana*, *Polytrichum piliferum*, *Racomitrium ericoides* and *Ulota bruchii*, and the liverworts *Tritomaria exsecta* and *T. exsectiformis*. The last two are uncommon (but not oceanic) species found mainly on rotting logs; the other four species are common in upland Britain. One additional species - the nationally widespread and common moss *Hypnum resupinatum* - was not recorded at Side Wood by myself, Rose or Wigginton but is listed by Adams (1993) as being recorded here. This brings the total number of bryophyte species recorded at Side Wood to 126.

The quantity of each species recorded by me at Side Wood is given in Appendix 2; this appendix indicates the habitats in which each species was found, and also the European distribution of each species according to the phytogeographical classification by Hill & Preston (1998).

The 'Target Notes' for the locations of species of particular interest are given in Appendix 3. The 1:10,000 map showing the locations where the Target Notes were recorded is in Appendix 4.

## 4 EVALUATION

### Bryological importance of these woods in a wider geographical context

#### Assessment based on total species list

The total number of bryophyte species recorded at Side Wood (119 in this survey; 126 in all surveys combined) is moderately high compared with those recorded in other woods in the British Isles. The abundant rocks and the wet flushes along the lake shore add considerably to the species list, but the number of species is limited by the scarcity of calcareous habitats and rocky streamside and ravine habitats.

The bryophyte flora encompasses several of the European phytogeographical groups of Hill & Preston (1998), varying from Boreo-arctic-montane (northern) to Southern-temperate (southern), and from Hyperoceanic (western) to Eurasian, Eurosiberian and Circumpolar (extending well to the east) (Table 1). Most species here are widespread in Europe.

Those with the most northern distribution patterns in Europe are the mosses *Andreaea rupestris*, *Calliergon sarmentosum*, *Dichodontium pellucidum*, *Dicranum fuscescens*, *Drepanocladus revolvens*, *Polytrichum strictum* and *Racomitrium lanuginosum*, and the liverworts *Leiocolea alpestris* and *Tritomaria quinquedentata*.

The most southern species are the mosses *Dicranum scottianum*, *Fissidens taxifolius* and *Homalothecium sericeum*, and the liverworts *Frullania dilatata*, *Harpalejeunea molleri*, *Lejeunea lamacerina*, *L. patens*, *Plagiochila exigua*, *P. killarniensis*, *P. punctata*, *P. spinulosa*, *Saccogyna viticulosa* and *Scapania gracilis*.

Several species have markedly western, oceanic distributions in Europe (some of these are also included in the above list of southern species): the mosses *Breutelia chrysocoma*, *Campylopus atrovirens*, *Dicranum scottianum* and *Hyocomium armoricum*, and the liverworts *Gymnomitrium crenulatum*, *Harpalejeunea molleri*, *Herbertus aduncus*, *Lejeunea lamacerina*, *L. patens*, *Lepidozia pearsonii*, *Plagiochila exigua*, *P. killarniensis*, *P. punctata*, *P. spinulosa*, *Saccogyna viticulosa* and *Scapania gracilis*. The filmy fern *Hymenophyllum wilsonii* has a similarly oceanic distribution, and grows with oceanic bryophytes on rocks and banks in Side Wood.

No non-native bryophyte species were recorded during this survey or any previous surveys at Side Wood.

#### Assessment based on rarity of species in the British Isles

Several species which have been recorded in these woods are uncommon in the British Isles (see Table 2). These are the mosses *Dicranum scottianum* and *Ptilium crista-castrensis*, and the liverworts *Anastrepta orcadensis*, *Bazzania tricrenata*, *Gymnomitrium crenulatum*, *Harpalejeunea molleri*, *Herbertus aduncus*, *Harpanthus scutatus*, *Lepidozia pearsonii*, *Plagiochila exigua* and (not found in this survey) *Tritomaria exsecta*. Each of these species has been recorded here only in small quantity. *T. exsecta* is classed by the Joint Nature Conservation Committee as Nationally Scarce because in Great Britain it has been recorded since 1950 in fewer than one hundred 10 x 10 km squares of the Ordnance Survey National Grid. *Dicranum scottianum*, *G. crenulatum*, *H. molleri*, *H. aduncus*, *H. scutatus*, *L. pearsonii* and *P. exigua* each have fewer than 200 post-1950 10 x 10 km square records in Great Britain.

#### Assessment based on species for which the British Isles is one of the most important areas in the world

Of particular interest here are the oceanic species (see Table 2): the mosses *Breutelia chrysocoma*, *Campylopus atrovirens*, *Dicranum scottianum* and *Hyocomium armoricum*, and the liverworts *Gymnomitrium crenulatum*, *Harpalejeunea molleri*, *Herbertus aduncus*, *Lejeunea lamacerina*, *L. patens*, *Lepidozia pearsonii*, *Plagiochila exigua*, *P. killarniensis*, *P. punctata*, *P. spinulosa*, *Saccogyna viticulosa* and *Scapania gracilis*. These species have strongly western distributions in Europe, and are better represented in British Isles than anywhere else in Europe (Ratcliffe 1968). Oceanic bryophytes evidently need a wet climate with cool summers and mild winters; even in the most wet, equable parts of the British Isles they are found mainly in sheltered, rocky woods and steep, rocky, NW-E-facing hillsides. The western Highlands and western Ireland are especially rich areas. Some oceanic species such as the liverwort *Plagiochila exigua* also occur in other parts of the world with a wet and equable climate, but some such as *P. spinulosa*, *P. punctata* and *Scapania gracilis* are known only from Europe and Macaronesia. In general, oceanic bryophytes favour shaded conditions, but most of them - including the species recorded at Side Wood - are not tolerant of excessive shade. This might not just be because of their own requirements for light, but could also be because in deeper shade they might be out-competed by common, shade-tolerant and robust bryophytes such as the moss *Isoetecium myosuroides* and the liverwort *Diplophyllum albicans*.

By total British standards Side Wood is moderately rich in oceanic bryophytes, with a total of 16 species recorded. Even though this is overshadowed by higher figures from

other woods in the Lake District (e.g. 30 oceanic species recorded at Seatoller Wood in Borrowdale (Averis 2000)), N Wales, Ireland and, especially, the western Highlands, Side Wood is among the many British woods rich enough bryologically to be of importance in a total European context. Given the relative scarcity of oceanic bryophytes in mainland Europe, all British and Irish woods with at least 15 or so oceanic species, or with good populations of scarce oceanic species, should be seen collectively as an internationally important resource.

The abundance of different individual oceanic species is also an important consideration. At Side Wood most oceanic species - especially the nationally uncommon ones - occur only in small quantity. By contrast Johnny Wood in Borrowdale has 18 oceanic species recorded (Averis 2000) - only 2 more than at Ennerdale - but is more obviously notable because of the good populations of the nationally uncommon *Sematophyllum micans* and *Adelanthus decipiens* there. From its geographical position Side Wood cannot be expected to be as rich in oceanic bryophytes as the Borrowdale Woods: being near the edge of the Lake District it experiences a considerably less wet climate than the Borrowdale area in the middle of the Lake District. However, given that it is so close to the western lowland fringe of Cumbria it is impressive that it has so much of an upland character, both in its general vegetation and in the abundance of some of the commoner western or upland bryophytes: *Bazzania trilobata*, *Mylia taylorii* and *Scapania gracilis*.

The more exacting oceanic species are generally commoner in the western Highlands and western Ireland than anywhere else in the British Isles. Their relative scarcity south of the Highlands - as typified by Side Wood - might be because the climate is less consistently wet, there is more atmospheric pollution and many woods have been managed more intensively; one cannot always separate out the effects of these factors. The most notable oceanic species at Side Wood are the moss *Dicranum scottianum* (on acidic rocks in the E), and the liverworts *Gymnomitrium crenulatum*, *Harpalejeunea mollerii*, *Herbertus aduncus* and *Plagiochila exigua* (on more basic rocks in the W).

#### Assessment based on species indicative of long-term historical continuity of woodland cover

Bryophyte species which have been found to be associated with a long history of woodland cover are not well represented in Side Wood. Work by Averis (1991) in the Highlands has shown four species to be particularly strongly associated with 'Ancient' woodland: the moss *Sematophyllum micans* and the liverworts *Adelanthus decipiens*, *Plagiochila atlantica* and *Jamesoniella autumnalis*. None of these species are recorded at Side Wood. In contrast, they are all recorded at Seatoller Wood in Borrowdale, and all but *P. atlantica* are recorded at Johnny Wood also in Borrowdale. Compared with Borrowdale the drier climate at Side Wood appears less favourable for at least *S. micans*, *A. decipiens* and *P. atlantica*, but is still as wet as some of the Scottish sites of these species. *J. autumnalis*, though found mainly in wet western parts of Britain, is less confined to such extremely wet areas than are the other three species.

The scarce oceanic liverworts *Harpalejeunea mollerii* and *Plagiochila exigua* are also associated with 'Ancient' woodland in Scotland, though less strongly so than *S. micans*, *A. decipiens*, *P. atlantica* and *J. autumnalis*. They grow on shaded rocks in the western part of Side Wood. The associated flora suggests moderately base-rich

conditions. These species grow in Britain mainly on rock and bark which appears to be neutral to mildly basic, so through most of Side Wood they might not be expected because the rocks and bark are (as judged by their flora) so acidic, regardless of the history of woodland management. However, their presence at the western end of the site might be an indication of relatively little past disturbance to the canopy here, especially as their habitat - lacking a stream or ravine - could experience a large decrease in humidity if the tree canopy is opened up.

The oceanic liverwort *Plagiochila spinulosa* is surprisingly scarce here, given the abundance of suitable-looking shaded, sheltered rock, bank and tree-bark habitats. This scarcity is also surprising given the abundance in these habitats of other typical associates of *P. spinulosa* in western British woods: the liverworts *Scapania gracilis*, *Bazzania trilobata* and *Mylia taylorii*. It seems possible that *P. spinulosa* has suffered a decline here as a result of opening up of the tree canopy at some time in the past, but it seems equally possible that it has declined as a result of acidification/pollution from the nearby industrial areas of western Cumbria. Some oceanic bryophytes, including *P. spinulosa*, are known to become restricted to more basic habitats in more polluted or otherwise marginal parts of its British range (Ratcliffe 1968, Hill 1988; Averis 1991).

### Summary

To summarize, Side Wood is of moderate bryological richness at both local and national levels. Like many other British woods its bryological richness is more notable at an international level on account of the relative scarcity of oceanic bryophytes in most of mainland Europe compared with western Britain and Ireland. The most notable species recorded here are the moss *Dicranum scottianum* and the liverworts *Gymnomitrium crenulatum*, *Harpanthus scutatus*, *Harpalejeunea molleri*, *Herbertus aduncus*, *Plagiochila exigua* and *Tritomaria exsecta*. All of these species are uncommon in the British Isles, and all except *H. scutatus* and *T. exsecta* are oceanic in Europe. The bryophyte flora shows signs of anthropogenic modification, probably causing losses of some oceanic species: this could have happened as a result of past silvicultural management, pollution, or both.

**Table 1** Number of bryophyte species in each phytogeographical group, and their percentage representation of the total flora recorded at Side Wood, Ennerdale, Cumbria

<i>Phytogeographical group</i>	No.	%
11 Oceanic Arctic-montane	0	0
12 Suboceanic Arctic-montane	0	0
13 European Arctic-montane	0	0
14 Eurosiberian Arctic-montane	0	0
15 Eurasian Arctic-montane	0	0
16 Circumpolar Arctic-montane	0	0
21 Oceanic Boreo-arctic Montane	0	0
22 Suboceanic Boreo-arctic Montane	0	0
23 European Boreo-arctic Montane	0	0
24 Eurosiberian Boreo-arctic Montane	0	0
26 Circumpolar Boreo-arctic Montane	9	7
32 Suboceanic Wide-boreal	1	1
34 Eurosiberian Wide-boreal	0	0
35 Eurasian Wide-boreal	0	0
36 Circumpolar Wide-boreal	8	6
41 Oceanic Boreal-montane	2	2
42 Suboceanic Boreal-montane	3	2
43 European Boreal-montane	5	4
44 Eurosiberian Boreal-montane	0	0
45 Eurasian Boreal-montane	0	0
46 Circumpolar Boreal-montane	5	4
51 Oceanic Boreo-temperate	0	0
52 Suboceanic Boreo-temperate	9	7
53 European Boreo-temperate	15	12
54 Eurosiberian Boreo-temperate	1	1
55 Eurasian Boreo-temperate	0	0
56 Circumpolar Boreo-temperate	27	22
63 European Wide-temperate	0	0
64 Eurosiberian Wide-temperate	0	0
65 Eurasian Wide-temperate	0	0
66 Circumpolar Wide-temperate	2	2
70 Hyperoceanic Temperate	3	2
71 Oceanic Temperate	1	1
72 Suboceanic Temperate	9	7
73 European Temperate	10	8
74 Eurosiberian Temperate	0	0
75 Eurasian Temperate	0	0
76 Circumpolar Temperate	2	2
80 Hyperoceanic Southern-temperate	9	7
81 Oceanic Southern-temperate	1	1
82 Suboceanic Southern-temperate	0	0
83 European Southern-temperate	1	1
84 Eurosiberian Southern-temperate	1	1
85 Eurasian Southern-temperate	1	1
86 Circumpolar Southern-temperate	0	0
91 Mediterranean-Atlantic	0	0
92 Submediterranean-Subatlantic	0	0
93 Mediterranean-montane	0	0
Unclassified	0	0
Introduced	0	0
<b>Total no. of species</b>	<b>125</b>	<b>100</b>
<b>Number of oceanic species*</b>	<b>16</b>	<b>13</b>

\* Oceanic spp. total = sum of spp. in phytogeographical groups 11+21+41+51+70+71+80+81+91

**Table 2 Bryophyte species of particular interest recorded at Side Wood, Ennerdale, Cumbria**

(o) = oceanic species; (u) = species which are uncommon in the British Isles ('uncommon' = based on a subjective assessment rather than the number of 10x10 km square records, because the latter does not always give the best indication of rarity).

<u>Mosses</u>	<u>Abundance at Side Wood</u>
<i>Breutelia chrysocoma</i> (o)	occasional
<i>Campylopus atrovirens</i> (o)	occasional
<i>Dicranum scottianum</i> (ou)	rare
<i>Hyocomium armoricum</i> (o)	occasional
<i>Ptilium crista-castrensis</i> (u)	rare
<u>Liverworts</u>	
<i>Anastrepta orcadensis</i> (u)	occasional
<i>Bazzania tricrenata</i> (u)	rare
<i>Gymnomitrium crenulatum</i> (ou)	rare
<i>Harpalejeunea molleri</i> (ou)	rare
<i>Herbertus aduncus</i> (ou)	rare
<i>Harpanthus scutatus</i> (u)	rare
<i>Lejeunea lamacerina</i> (o)	rare
<i>Lejeunea patens</i> (o)	occasional
<i>Lepidozia pearsonii</i> (ou)	rare
<i>Plagiochila exigua</i> (ou)	rare
<i>Plagiochila killarniensis</i> (o)	rare
<i>Plagiochila punctata</i> (o)	rare
<i>Plagiochila spinulosa</i> (o)	occasional
<i>Saccogyna viticulosa</i> (o)	occasional
<i>Scapania gracilis</i> (o)	abundant
<i>Tritomaria exsecta</i> (u)	probably rare
<u>Filmy fern</u>	
<i>Hymenophyllum wilsonii</i> (o)	occasional
<hr/>	
Total number of oceanic bryophyte spp.	16 (all seen in Averis 2001 survey)
Total no. of uncommon bryophyte spp.	11 (all except <i>T. exsecta</i> seen in Averis 2001 survey)
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## Relationships with management

Side Wood has been subjected to some silvicultural management in the past. Oak coppicing has been carried out in association with charcoal-burning and iron-smelting activities for which there is evidence here. The growth form of some oaks shows evidence of past coppicing. There may have been other silvicultural management in the form of felling or thinning. Some features of the bryophyte flora might be the result of past coppicing, felling or thinning, all of which produce increases in light and decreases in humidity, and can lead to losses of humidity-demanding oceanic species. For example, Ratcliffe (1965) said:

*.....clear-felling is obviously highly detrimental to the moisture-sensitive oceanic bryophytes and has done great damage to these plants in nearly all Lakeland woods.*

This may be why the liverwort *Plagiochila spinulosa* is so scarce through most parts of the wood. It may also be why *P. atlantica*, *Adelanthus decipiens*, *Jamesoniella autumnalis* and the moss *Sematophyllum micans* - all 'Ancient woodland indicators' and all species for which Side Wood appears to have a sufficiently wet and equable climate - are apparently absent. However, these last four species might never have grown here anyway, perhaps because of some 'chance' factor affecting their local distribution.

The effects of past woodland management on bryophytes are confused by those of pollution/acidification, which can evidently cause losses of some of the species which also appear susceptible to increased light from coppicing, felling and thinning. So, for example, the scarcity of *Plagiochila spinulosa* could equally well be the result of pollution from industrial western Cumbria, or past woodland management.

Grazing by sheep over many years will have modified the ground vegetation and largely prevented natural regeneration of trees and shrubs. Some of Ratcliffe's (1965) comments on maintaining or improving Seatoller and Johnny Woods in Borrowdale as examples of native hill woodland also apply to Side Wood:

*.....the avoidance of management methods which will cause any increase in artificiality, such as clear-felling and allowing or promoting the spread of non-indigenous species, e.g. sycamore and conifers [absent at Side Wood]. Though not of immediate urgency, the problem of regeneration will eventually occur, and it is likely to involve fencing under the present regime of heavy grazing. Speculation about a theoretical "natural" state of these woods, towards which restoration is a desirable end, is unprofitable, except to say that there should be encouragement of understorey development (mainly of holly and rowan) in the stands of pure oak.*

Most of Ratcliffe's (1965) suggestions about preservation of the bryophyte flora in Seatoller and Johnny Woods also apply to Side Wood:

*.....above all else, the maintenance of a more or less continuous canopy of trees or tall shrubs, preferably the former.*

*....clear-felling.....is to be avoided at all costs, and the power of spread of these bryophytes is so slow that even the felling of separate blocks at different times is most undesirable.*

.....As the woods mature, some system of selective felling should be adopted, taking out the biggest trees and allowing regeneration to fill the gaps before continuing the cropping. It is also desirable for some fallen trunks and branches to be allowed to rot away in situ, as decaying wood is an important or exclusive habitat for several hepatics.

Grazing alone is a less serious factor, though it prevents regeneration, and maintains the field communities in a modified state. These woods are probably regarded as valuable wintering grounds for sheep, and the exclusion of these animals at any one time from fenced plots of limited size may be the most that can be hoped for in this respect.

Grazing by sheep does not directly affect the bryophytes because these plants are not eaten. Also, most of the more interesting bryophytes species are not on the woodland floor but on steep rock faces and tree trunks.

I looked at the 25 m x 25 m ungrazed exclosure at NY 119 139 established in summer 1991 in the middle of Side Wood, and recorded brief notes on the vegetation which has developed there during 10 years without grazing:

*Deschampsia flexuosa* more abundant, taller (20-50 cm) and more abundantly flowering inside exclosure than outside; some *D. flexuosa* forming grass mats growing right over small, low rock outcrops; *Vaccinium myrtillus* taller (15-20 cm) and more abundant inside exclosure (scarce and shorter outside); young rowans abundant inside exclosure, growing up to 2-3 m tall; mosses less prominent on ground inside exclosure than outside.

This exclosure does indeed demonstrate that habitats close to the ground can change dramatically in response to the elimination of grazing. Particularly relevant to bryophytes is that low rocks, tree bases and the lower parts of larger rocks can get smothered by grasses. Bryophyte cover can decrease on the ground, though the scarcer and more notable bryophyte species rarely occur in this habitat anyway.

Some populations of oceanic bryophytes at Side Wood are above the height which grasses, forbs and bramble are likely to attain if grazing is reduced or eliminated. An example is *Dicranum scottianum* on steep rock faces in the currently ungrazed SE part of the wood.

Other notable species such as *Herbertus aduncus*, *Gymnomitrium crenulatum*, *Harpalejeunea molleri* and *Plagiochila exigua* occur closer to the ground. *H. molleri* and *P. exigua* are in very rocky places where the terrain might limit the development of ground vegetation regardless of the numbers of sheep. However, *H. aduncus* grows on a low bank in a place which has the potential to become thickly vegetated, and *Gymnomitrium crenulatum* and *Harpanthus scutatus* grow on rocks quite close to well-vegetated ground.

Therefore, 'safety' from being swamped out by taller ungrazed vegetation is uncertain. It is quite possible that removal of grazing, or a large reduction in grazing, could lead to populations of uncommon bryophyte species becoming overshadowed by tall vascular plants. It is also possible that such changes in grazing could lead to botanical losses in the interesting flushes just above the lake shore in the middle-western part of the site. Small vascular plants and bryophytes might become overwhelmed by denser growths of tall grasses, sedges and rushes.

Before sheep were introduced here there might have been a taller field layer, a denser and more varied canopy and shrub layer, and more humid and shaded conditions in general. If so, the vertical zonation of bryophyte assemblages and species might have been higher above ground than it is today. The subsequent grazing might have created less shaded and less humid conditions in which many oceanic species needed to descend closer to ground level in order to find the required high humidity. If grazing is significantly reduced, populations of the uncommon oceanic species *Gymnomitrium crenulatum*, *Harpalejeunea mollerii*, *Plagiochila exigua* and *Herbertus aduncus*, and the non-oceanic but scarce *Harpanthus scutatus*, are unlikely to colonize up rocks and up steep banks at a rate which keeps pace with fast-growing, taller and potentially overshading vascular plants.

Another threat to bryophytes from reduced grazing is the increased shade cast by an increasingly dense growth of young trees and shrubs. This could be particularly damaging to the bryophyte flora if holly became very common here.

Another factor to consider is the potential variation in grazing intensity in different parts of the wood. The small, more base-enriched areas with their relatively nutritious vegetation might be more heavily grazed than most other parts of the wood. If grazing is reduced, sheep may still continue to come to graze these areas out of preference. The effect of reduced grazing might therefore be expected to be less in the more base-rich areas than in the more extensive acidic areas. However, this might be offset by more rapid and vigorous growth of vascular plants in the more base-rich areas, as the more fertile soils would allow better plant growth there.

To summarize, the potential threats from reducing or eliminated grazing to the more notable bryophytes at Side Wood appear to be as follows:

*Dicranum scottianum*: little threat; species grows on very steep rock faces, well above ground level.

*Gymnomitrium crenulatum*: some threat; species is mostly <1.5 m above ground, on rocks.

*Harpalejeunea mollerii*: some threat; species grows <50 cm above ground, on rocks. Habitat evidently more base-enriched than in most parts of wood.

*Harpanthus scutatus*: some threat; species grows on rocks, <50 cm above ground.

*Herbertus aduncus*: some threat; species grows on low bank, <30 cm above more gently-sloping and potentially thickly vegetated ground, in open bracken glade.

*Plagiochila exigua*: some threat; species grows on rocks, mostly <50 cm above ground. Habitat evidently more base-enriched than in most parts of wood.

As in Seatoller and Johnny Woods the vascular flora and vegetation of these woods is not as notable as the bryophyte flora, so where there is a conflict between management for vascular flora and bryophytes it seems fair that management for bryophytes should take priority.

Taking all of the above into account, various future grazing regimes seem to me to be acceptable from the bryological point of view:

1. To keep grazing levels more or less as they are at present.
2. A widespread but only slight to moderate reduction in grazing throughout the main, sheep-grazed part of the wood. A relatively small reduction in grazing may allow vascular plant growth and perhaps tree and shrub regeneration to develop, but not so much as to overshadow the populations of important bryophytes.
3. A more dramatic reduction in grazing, or even a temporary removal of grazing, in the central to eastern, predominantly acidic, part of the wood. This might be considered as a means of encouraging natural regeneration of trees and shrubs. The bryophyte flora is of rather limited interest in this main part of the wood, so there is relatively little to lose from the effects of increased vascular plant growth and tree/shrub regeneration. Grazing would continue in the western part of the site, so there should not be a threat to the *Harpalejeunea molleri* and *Plagiochila exigua* there.

A temporary large decrease in grazing or removal of grazing throughout the whole wood might allow such development of vascular plants, even within a few years, to lead to losses of important bryophytes such as *H. molleri* and *P. exigua*.

A general increase in grazing would probably not affect the bryological interest adversely, at least for several years. However, it is not desirable because it would lower the chances of tree and shrub cover persisting here in the longer term, and increase the chance of some interesting species being rubbed off rocks by the sheep themselves.

There does not seem to me to be an urgent need for reducing grazing here to get increased tree and shrub regeneration. The woodland is not moribund or very open, and under the current grazing regime should persist for a long time yet. Perhaps at some time in the next 50 years or so a period of about 10-20 years with a moderate decrease in grazing throughout the whole site might be a good way to achieve an acceptable balance of natural regeneration and maintenance of bryological interest.

Ratcliffe (1965) mentioned the collecting of moss, either for commercial purposes or for bryological collection, as a potential threat to the bryological interest in Seatoller and Johnny Woods in Borrowdale. He noted that indiscriminate collecting of moss for commercial or garden purposes had taken place around the mid 20th century in the NE end of Seatoller Wood, but that there was less evidence of such activity elsewhere in that wood. The NE end of Seatoller Wood is easily accessible, being close to a road and houses. By comparison, Side Wood is so much more remote that this kind of moss-collecting seems unlikely (I saw no evidence of this), and probably does not threaten the bryophyte interest here. Deliberate collecting of the scarcer species at Side Wood would be more serious, though this does not seem to be such a threat as in the more bryologically richer and better-known woods in Borrowdale.

## 5 ACKNOWLEDGMENTS

John Hooson (National Trust) arranged for this survey to be carried out and provided me with maps, copies of information from previous surveys at Side Wood, and background information about the management of the site. My wife Alison kindly read and commented on a first draft of this report.

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## APPENDIX 1 - BRYOPHYTE SPECIES RECORDED AT SIDE WOOD, ENNERDALE, CUMBRIA

**Phy column:** European phytogeographical classes (Hill & Preston 1998):

- 11 Oceanic Arctic-montane
- 12 Suboceanic Arctic-montane
- 13 European Arctic-montane
- 14 Eurosiberian Arctic-montane
- 15 Eurasian Arctic-montane
- 16 Circumpolar Arctic-montane
- 21 Oceanic Boreo-arctic Montane
- 22 Suboceanic Boreo-arctic Montane
- 23 European Boreo-arctic Montane
- 24 Eurosiberian Boreo-arctic Montane
- 26 Circumpolar Boreo-arctic Montane
- 32 Suboceanic Wide-boreal
- 34 Eurosiberian Wide-boreal
- 35 Eurasian Wide-boreal
- 36 Circumpolar Wide-boreal
- 41 Oceanic Boreal-montane
- 42 Suboceanic Boreal-montane
- 43 European Boreal-montane
- 44 Eurosiberian Boreal-montane
- 45 Eurasian Boreal-montane
- 46 Circumpolar Boreal-montane
- 51 Oceanic Boreo-temperate
- 52 Suboceanic Boreo-temperate
- 53 European Boreo-temperate
- 54 Eurosiberian Boreo-temperate
- 55 Eurasian Boreo-temperate
- 56 Circumpolar Boreo-temperate
- 63 European Wide-temperate
- 64 Eurosiberian Wide-temperate
- 65 Eurasian Wide-temperate
- 66 Circumpolar Wide-temperate
- 70 Hyperoceanic Temperate
- 71 Oceanic Temperate
- 72 Suboceanic Temperate
- 73 European Temperate
- 74 Eurosiberian Temperate
- 75 Eurasian Temperate
- 76 Circumpolar Temperate
- 80 Hyperoceanic Southern-temperate
- 81 Oceanic Southern-temperate
- 82 Suboceanic Southern-temperate
- 83 European Southern-temperate
- 84 Eurosiberian Southern-temperate
- 85 Eurasian Southern-temperate
- 86 Circumpolar Southern-temperate
- 91 Mediterranean-Atlantic
- 92 Submediterranean-Subatlantic
- 93 Mediterranean-montane

## Appendix 1 (cont.)

### Mosses

Phyt	Species	Abundance	Habitats
46	<i>Amphidium mougeotii</i>	occasional	moist rocks
26	<i>Andreaea rupestris</i>	occasional	dry rock faces
56	<i>Atrichum undulatum</i>	rare	soil on woodland floor
56	<i>Bartramia pomiformis</i>	rare	dry rock crevices
56	<i>Brachythecium plumosum</i>	occasional	wet rocks in/by streams
56	<i>Brachythecium rivulare</i>	rare	wet ground/flushes
70	<i>Breutelia chrysocoma</i>	occasional	well-lit damp ground and flushes
56	<i>Bryum capillare</i>	rare	rocks
36	<i>Bryum pseudotriquetrum</i>	rare	wet flushes
26	<i>Calliergon sarmentosum</i>	rare	open flushes near lake
76	<i>Calliergonella cuspidata</i>	rare	open and shaded flushed ground near lake
56	<i>Campylium stellatum</i>	rare	open flushes near lake
70	<i>Campylopus atrovirens</i>	occasional	rock faces; open flushes near lake
72	<i>Campylopus flexuosus</i>	frequent	rocks; ground; logs
53	<i>Ctenidium molluscum</i>	occasional	rocks; flushes on lower slopes
26	<i>Dichodontium pellucidum</i>	rare	wet rocky/stony ground by streams
56	<i>Dicranella heteromalla</i>	rare	soil banks
43	<i>Dicranodontium denudatum</i>	occasional	rocks; logs
26	<i>Dicranum fuscescens</i>	rare	rocks; tree trunks
56	<i>Dicranum majus</i>	abundant	ground; banks
36	<i>Dicranum scoparium</i>	abundant	ground; banks; rocks; trees; logs
80	<i>Dicranum scottianum</i>	rare	steep, well-drained rock faces in E
26	<i>Drepanocladus revolvens</i>	rare	open flushes near lake
73	<i>Eurhynchium praelongum</i>	rare	shaded woodland floor/banks in W
56	<i>Fissidens adianthoides</i>	rare	open flushes by lake
73	<i>Fissidens dubius</i>	rare	well-drained rock crevices
83	<i>Fissidens taxifolius</i>	rare	soil banks
72	<i>Heterocladium heteropterum</i>	occasional	wet rocks by streams
84	<i>Homalothecium sericeum</i>	rare	rocks
72	<i>Hookeria lucens</i>	rare	shaded moist banks/rock crevices
73	<i>Hylocomium brevirostre</i>	rare	woodland floor
36	<i>Hylocomium splendens</i>	abundant	ground; banks
43	<i>Hylocomium umbratum</i>	occasional	woodland floor
71	<i>Hyocomium armoricum</i>	occasional	wet ground/rocks
72	<i>Hypnum andoi</i>	abundant	trees; rocks
66	<i>Hypnum cupressiforme</i>	abundant	trees; rocks
72	<i>Hypnum jutlandicum</i>	abundant	ground; banks
72	<i>Hypnum resupinatum</i>	rare	trees? (not seen in Averis surveys)
53	<i>Isothecium alopecuroides</i>	rare	rocks; tree bases
52	<i>Isothecium myosuroides</i>	abundant	rocks; trees
73	<i>Leucobryum glaucum</i>	occasional	woodland floor; banks; logs; trees
73	<i>Mnium hornum</i>	abundant	woodland floor; banks; logs; trees
66	<i>Philonotis fontana</i>	rare	open flushes? (not seen in Averis surveys)
73	<i>Plagiomnium undulatum</i>	rare	woodland floor

## Appendix 1 (cont.)

### Mosses (cont.)

Phyt	Species	Abundance	Habitats
56	<i>Plagiothecium denticulatum</i>	rare	rocks
54	<i>Plagiothecium succulentum</i>	rare	rocks
52	<i>Plagiothecium undulatum</i>	abundant	woodland floor/banks
56	<i>Pleurozium schreberi</i>	abundant	ground; banks
53	<i>Pogonatum aloides</i>	rare	soil banks
36	<i>Pohlia nutans</i>	rare	open ground
36	<i>Polytrichum commune</i>	occasional	wet ground in woodland and in open
56	<i>Polytrichum formosum</i>	abundant	woodland floor/banks
36	<i>Polytrichum juniperinum</i>	rare	open dry ground
36	<i>Polytrichum piliferum</i>	rare	? (not seen in Averis surveys)
26	<i>Polytrichum strictum</i>	rare	open ground near lakeshore
52	<i>Pseudotaxiphyllum elegans</i>	frequent	shaded rocks; banks
46	<i>Ptilium crista-castrensis</i>	rare	woodland floor/banks
52	<i>Racomitrium aciculare</i>	occasional	wet rocks by streams
72	<i>Racomitrium aquaticum</i>	rare	moist rock faces
32	<i>Racomitrium ericoides</i>	rare	open stony ground
53	<i>Racomitrium fasciculare</i>	rare	rocks
52	<i>Racomitrium heterostichum</i>	occasional	rocks
26	<i>Racomitrium lanuginosum</i>	occasional	rocks; open ground
56	<i>Rhizomnium punctatum</i>	rare	wet ground/flushes
52	<i>Rhytidiadelphus loreus</i>	abundant	ground; banks; logs; tree bases; upper rock surfaces
53	<i>Rhytidiadelphus squarrosus</i>	frequent	ground; banks
56	<i>Rhytidiadelphus triquetrus</i>	occasional	ground; banks
73	<i>Scleropodium purum</i>	occasional	ground; banks
56	<i>Sphagnum capillifolium</i>	occasional	ground; banks; flushes
53	<i>Sphagnum denticulatum</i>	frequent	ground; banks; flushes
53	<i>Sphagnum fallax</i>	rare	wet ground
56	<i>Sphagnum palustre</i>	occasional	wet ground
53	<i>Sphagnum papillosum</i>	rare	wet ground
42	<i>Sphagnum quinquefarium</i>	frequent	ground; banks
52	<i>Sphagnum subnitens</i>	rare	ground; banks
56	<i>Tetraphis pellucida</i>	rare	banks; logs
76	<i>Thuidium delicatulum</i>	occasional	ground; rocks
73	<i>Thuidium tamariscinum</i>	abundant	ground; banks; rocks; logs; tree bases
56	<i>Tortella tortuosa</i>	rare	rocks in W
56	<i>Trichostomum tenuirostre</i>	rare	moist rocks
73	<i>Ulota crispa</i>	occasional	trees

## Appendix 1 (cont.)

### Liverworts

Phyt	Species	Abundance	Habitats
42	<i>Anastrepta orcadensis</i>	occasional	steep mossy banks
36	<i>Aneura pinguis</i>	rare	flushes
46	<i>Barbilophozia attenuata</i>	occasional	rocks; trees
46	<i>Barbilophozia floerkei</i>	occasional	rocks; banks
43	<i>Bazzania tricrenata</i>	rare	banks among rocks in E
72	<i>Bazzania trilobata</i>	abundant	rocks; banks; woodland floor; tree bases
56	<i>Calypogeia muelleriana</i>	rare	rocky banks
56	<i>Cephalozia bicuspidata</i>	rare	rocks; logs
56	<i>Cephaloziella divaricata</i>	rare	rocks
52	<i>Diplophyllum albicans</i>	abundant	rocks; banks; logs
85	<i>Frullania dilatata</i>	rare	trees
52	<i>Frullania tamarisci</i>	frequent	rocks; trees
41	<i>Gymnomitrium crenulatum</i>	rare	well-lit rocks on lower slopes
80	<i>Harpalejeunea mollerii</i>	rare	shaded rocks in W
43	<i>Harpanthus scutatus</i>	rare	shaded mossy banks in E
41	<i>Herbertus aduncus</i>	rare	small sheltered bank in bracken glade in W
26	<i>Leiocolea alpestris</i>	rare	moist rocks
80	<i>Lejeunea lamacerina</i>	rare	moist rocks in W
80	<i>Lejeunea patens</i>	occasional	moist rocks, esp. in W
70	<i>Lepidozia pearsonii</i>	rare	mossy banks
56	<i>Lepidozia reptans</i>	frequent	banks; rocks; logs
73	<i>Lophocolea bidentata</i>	occasional	banks; rocks; logs
53	<i>Lophozia ventricosa</i>	occasional	banks; rocks; logs
53	<i>Marsupella emarginata</i>	frequent	rocks
53	<i>Metzgeria conjugata</i>	rare	streamside rocks
53	<i>Metzgeria furcata</i>	occasional	rocks; trees
72	<i>Microlejeunea ulicina</i>	occasional	trees
42	<i>Mylia taylorii</i>	abundant	rocks; banks; woodland floor; logs
53	<i>Nowellia curvifolia</i>	occasional	logs
56	<i>Pellia epiphylla</i>	rare	moist banks/ground
80	<i>Plagiochila exigua</i>	rare	shaded rocks in W
80	<i>Plagiochila killarniensis</i>	rare	shaded rocks in W
56	<i>Plagiochila porelloides</i>	occasional	rocks
80	<i>Plagiochila punctata</i>	rare	rocks and trees in E
80	<i>Plagiochila spinulosa</i>	occasional	rocks; banks
56	<i>Riccardia multifida</i>	rare	flushes near lake
81	<i>Saccogyna viticulosa</i>	occasional	rocks; banks
80	<i>Scapania gracilis</i>	abundant	rocks; banks; trees; logs
53	<i>Scapania nemorea</i>	frequent	rocks; banks; trees; logs
43	<i>Scapania umbrosa</i>	occasional	rocks; logs
53	<i>Scapania undulata</i>	rare	wet rocks
46	<i>Tritomaria exsecta</i>	rare	logs
56	<i>Tritomaria exsectiformis</i>	rare	logs
26	<i>Tritomaria quinquedentata</i>	occasional	rocky banks

## APPENDIX 2 - TARGET NOTES

The locations of these Target Notes are shown in Map 2 in Appendix 3.

1. NY 1094 1431. Small, rocky stream at western end of wood, just west of fence and stone wall. Mixed woodland of ash, rowan, birch, hazel, bird cherry, holly and hawthorn. Bryophyte flora on rocks and banks by stream is of moderate richness, including mosses *Campylopus atrovirens* (rare), *Hyocomium armoricum* (abundant) and *Thuidium delicatulum* (frequent), and liverworts *Bazzania trilobata* (occasional), *Mylia taylorii* (rare), *Lejeunea patens* (rare), *Plagiochila spinulosa* (occasional) and *Scapania gracilis* (frequent). Also Wilson's filmy fern *Hymenophyllum wilsonii* (occasional).

2. NY 1103 1430. Area of rocks forming a narrow band running up-down slope, looking like a dry rocky stream-bed. Rather rich bryophyte flora here, with evidence of base-enrichment. Species include mosses *Ctenidium molluscum* (occasional), *Hookeria lucens* (rare) and *Hyocomium armoricum* (occasional), liverworts *Lejeunea patens* (frequent), *Harpalejeunea molleri* (rare), *Plagiochila exigua* (occasional), *P. killarniensis* (occasional; widely scattered), *P. spinulosa* (abundant), *Saccogyna viticulosa* (occasional), *Scapania gracilis* (abundant), *Bazzania trilobata* (rare) and *Mylia taylorii* (rare), and Wilson's filmy fern *Hymenophyllum wilsonii* (occasional). See Photographs 1-4 for locations of *H. molleri* and *P. exigua*.

3. NY 1107 1428. Area of moist rocks forming a narrow band running up-down slope, looking like a dry rocky stream-bed. Rather rich bryophyte flora, again with evidence of base-enrichment. Species include liverworts *Lejeunea lamacerina* (rare), *L. patens* (occasional), *Plagiochila exigua* (locally frequent), *P. spinulosa* (frequent), *Saccogyna viticulosa* (occasional) and *Scapania gracilis* (occasional). See Photograph 5 for location of *P. exigua*.

4. NY 1095 1423. Liverworts *Herbertus aduncus*, *Lepidozia pearsonii*, *Scapania gracilis*, *Anastrepta orcadensis* and *Bazzania trilobata* on mossy bank just below small boulder in open bracken area on steep NNE-facing slope at 180 m alt. (See Photographs 6-7).

5. NY 1122 1425 - NY 1167 1417. Open area just N (downslope) of lower margin of wood, and immediately upslope of southern shore of Ennerdale Water (see Photograph 8 for general view). This area includes many wet flushes with a flora indicating base-enrichment. Species in flushes include *Trichophorum cespitosum*, *Rhynchospora alba*, *Carex panicea*, *Erica tetralix*, *Drosera rotundifolia*, *Parnassia palustris*, *Linum catharticum*, *Huperzia selago*, mosses *Drepanocladus revolvens*, *Breutelia chrysocoma*, *Campylopus atrovirens*, *Sphagnum denticulatum*, *Polytrichum strictum*, *Calliergon sarmentosum*, *Calliergonella cuspidata*, *Campylium stellatum*, *Scorpidium scorpioides*, *Bryum pseudotriquetrum* and *Ctenidium molluscum*, and liverworts *Aneura pinguis*, *Scapania undulata* and *Riccardia multifida*. Also present in this area are several conspicuous moss hummocks, up to about 80 cm high and with steep sides (examples shown in Photograph 9). At least some of these appear to be developed over and around rock outcrops. The hummock vegetation consists mainly of the mosses *Sphagnum capillifolium* and *Polytrichum strictum*. Many other species are present in smaller quantity: these include *Vaccinium*

*myrtillus*, *Deschampsia flexuosa*, *Nardus stricta*, *Galium saxatile*, *Pteridium aquilinum*, *Sorbus aucuparia* (seedling), the mosses *Pleurozium schreberi*, *Hylocomium splendens* and *Rhytidiadelphus loreus*, the liverwort *Mylia taylori* and the lichens *Cladonia* spp..

6. NY 1156 1413. Oceanic liverwort *Gymnomitrium crenulatum* on well-lit rocks by small stream.

7. NY 1197 1388. Bryophyte flora on rocks by small stream shows evidence of base-enrichment, including mosses *Ctenidium molluscum*, *Tortella tortuosa* and *Homalothecium sericeum*, and liverwort *Lejeunea patens*. Bryophyte flora in this general area of woodland includes liverworts *Scapania gracilis* (abundant on rocks, banks, trees and logs), *Plagiochila spinulosa* (rare on rocky banks), *P. punctata* (scarce on tree trunks), *Saccogyna viticulosa* (occasional on steep banks), *Lepidozia pearsonii* (occasional on steep mossy banks), *Anastrepta orcadensis* (occasional on steep banks), *Mylia taylorii* (abundant on rocks, banks, tree trunks and logs), *Bazzania trilobata* (abundant on rocks, banks, tree trunks and logs) and *B. tricrenata* (rare on steep mossy banks), mosses *Hylocomium umbratum* (occasional on ground), *Sphagnum quinquefarium* (frequent on moist banks), *Dicranum fuscescens* (occasional on rock faces) and *Dicranodontium denudatum* (occasional on logs and low rock outcrops), and Wilson's filmy fern *Hymenophyllum wilsonii* (occasional on rocks, banks and lower tree trunks).

8. NY 1234 1365. Liverwort *Gymnomitrium crenulatum* on steep rock faces just above edge of small stream. Mosses *Hyocomium armoricum* on wet rocks in/by stream and *Breutelia chrysocoma* on wet, well-lit ground near stream.

9. NY 1249 1362. Steep oak-birch-rowan woodland with many rock outcrops and boulders, and very mossy vegetation (NVC W17a/b/c) on ground and on/among rocks. Luxuriant and prominent bryophyte assemblages on rocks, banks and tree trunks include mosses *Dicranum fuscescens* (frequent on rock faces), *D. scottianum* (rare on steep rock faces), *Dicranodontium denudatum* (rare on logs), *Ptilium cristacastrensis* (rare on banks) and *Sphagnum quinquefarium* (abundant on moist banks), liverworts *Scapania gracilis* (abundant on rocks, banks, trees and logs), *Plagiochila spinulosa* (scarce on rocky banks), *P. punctata* (frequent on tree trunks and some branches), *Saccogyna viticulosa* (occasional on steep banks), *Lepidozia pearsonii* (occasional on steep mossy banks), *Anastrepta orcadensis* (occasional on steep banks), *Mylia taylorii* (abundant on rocks, banks, tree trunks and logs), *Bazzania trilobata* (abundant on rocks, banks, tree trunks and logs), *B. tricrenata* (rare on steep mossy banks) and *Harpanthus scutatus* (rare on steep rock faces), and filmy fern *Hymenophyllum wilsonii* (frequent on rocks, banks and lower tree trunks).

10. NY 1244 1373. Liverwort *Gymnomitrium crenulatum* on steep side of boulder by streamlet in open bracken area of lower NNE-facing slope.

## **APPENDIX 3 - MAPS**

### **Map 1 Location of Side Wood, Ennerdale, Cumbria**

### **Map 2 Side Wood, Ennerdale, Cumbria - locations where bryophytes of particular interest were recorded by Ben Averis in October 2001**

Circled dots with code numbers (1-10) indicate places where species of interest were found. Details are given in the numbered paragraphs in Appendix 2.

The solid black line marks the boundary of the woodland.

The broken line marks the location of a fence running down the slope. To the west of this fence the land is owned by the National Trust and is grazed by sheep. To the east of this fence the land is owned by the Forestry Commission and is ungrazed.





## **APPENDIX 4 - PHOTOGRAPHS**

**Photographs of sites of some of the more notable bryophyte species found by Ben Averis at Side Wood, Ennerdale, Cumbria in October 2001**

**Photograph 1.** NY 1103 1430 (site of Target Note no. 2). View from just NE (downslope) of path by lake shore, looking SW (upslope) to rocks with species including *Plagiochila exigua*, *P. killarniensis*, *Harpalejeunea molleri* and *Lejeunea patens*.

**Photograph 2.** NY 1103 1430 (site of Target Note no. 2). View from path by lake shore, looking SW (upslope), showing closer view of rocks in middle of Photograph 1, indicating locations of *Plagiochila exigua*, *Harpalejeunea mollerii* and *Lejeunea patens*.

**Photograph 3.** NY 1103 1430 (site of Target Note no. 2). View looking ESE along path and along slope. Large rock with pale lichens, just left of middle of lower edge of picture, is the same rock as that shown in middle of Photographs 1 and 2 (rock with *Plagiochila exigua*, *Harpalejeunea molleri* and *Lejeunea patens*).

**Photograph 4.** NY 1103 1430 (site of Target Note no. 2). View looking SW (upslope) to rocks with *Plagiochila exigua* and *Lejeunea patens*, just SW (upslope) of fallen rowan shown in upper part of Photograph 1. *P. exigua* and *L. patens* scattered on shaded, vertical rock face (facing right) in middle of picture.

**Photograph 5.** NY 1107 1428 (site of Target Note no. 3). View from path just above lake shore, looking SW (upslope) to area of rocks with species including liverwort *Plagiochila exigua*. Rocks form long, narrow band running downslope, looking rather like a dry rocky stream. White notebook just right of centre is positioned on top of the most downslope (nearest) rock on which *P. exigua* was seen. *P. exigua* was found on several rocks 0-16 m SW (upslope) from rock with white notebook (i.e. in a narrow area running from white notebook towards the top-left corner of the photograph).

**Photograph 6.** NY 1095 1423 (site of Target Note no. 4). View from c. 20 m SE diagonally upslope from well-grown ash, looking SW upslope to site of oceanic liverworts *Herbertus aduncus* and *Lepidozia pearsonii*, growing with *Scapania gracilis*, *Anastrepta orcadensis* and *Bazzania trilobata* on mossy bank just below small boulder in open bracken area. Site is about 50 m SE (along-slope) from fence and stone wall.

**Photograph 7.** NY 1095 1423 (site of Target Note no. 4). View from place where Photograph 6 was taken (c. 50 m SE along-slope from fence/stone wall; c. 20 m SE diagonally upslope from well-grown ash), looking WSW diagonally upslope. Photograph taken to help relocate site of oceanic liverworts *Herbertus aduncus* and *Lepidozia pearsonii* shown in Photograph 6 (just off left edge of Photograph 7).

**Photograph 8.** NY 1122 1425 (site of Target Note no. 5). General view, looking E, showing open area between lake shore and lower edge of wood. Open area includes flushes of botanical interest, and hummocks of *Sphagnum capillifolium* and *Polytrichum strictum*.

**Photograph 9.** NY 115 142 (within site of Target Note no. 5). View showing examples of hummocks of *Sphagnum capillifolium* and *Polytrichum strictum* in open area between lake shore and lower edge of wood.

*Photographs 10-13. Close-up photos of a few bryophyte species of interest which occur in Side Wood.*

**Photograph 10.** *Plagiochila punctata* on birch branch, photographed in eastern part of Side Wood, NY 125136, October 2001.

**Photograph 11.** *Plagiochila exigua* photographed at Troutdale Woods, Borrowdale, Cumbria in October 2001 (looks similar to the *P. exigua* in Side Wood). *P. exigua* is small green liverwort with sharply bilobed leaves, in middle of picture. A difficult species to photograph because it is so small (requiring a very close view) and also because of the low level of light in its habitat.

**Photograph 12.** *Harpanthus scutatus*, photographed in the eastern part of Side Wood, NY 125136 in October 2001. *H. scutatus* is the small yellow-green liverwort on the low rock in the centre of the picture.

**Photograph 13.** *Bazzania trilobata*, photographed in the middle part of Side Wood in October 2001.