APPENDIX 4: Ecological Site Classification

A4.1 Introduction

The Ecological Site Classification (ESC) for forestry in Great Britain classifies a site in terms of its climate and soil quality (Pyatt & Suarez, 1997, Pyatt *et al*., 2001). A program called the ESC Decision Support System (DSS) has been written to aid classification (Ray, 2001). If the elevation and grid reference of a site is know, the program can automatically calculate four climate factors which define the climate of the site: accumulated temperature, moisture deficit, windiness and continentality. Except for windiness, the climatic factors have been calculated from data from the Climatic Research Unit (CPU) database (University of East Anglia) for the recording period 1961-90. CPU variables for each 10 km x 10 km square were interpolated to a finer resolution to provide values for any 100 m x 100 m grid reference in Britain.

Soil quality is defined by two factors: soil nutrient regime (SNR) and soil moisture regime (SMR). In ESC DSS, SMR is defined by soil type whilst SNR is defined by plant type (plant indicator species). If more information is known on rooting depth, soil texture, stoniness, a more precise estimate of SMR can be made. If the lithology is known, combined with soil type and knowledge of plant indicator species, then a more precise estimate of SNR can be gained. Once soil quality and the climate zone have been identified, the ESC DSS classifies the site quality and generates suggestions of appropriate tree species and woodland types.

A4.1.2 Climatic factors

Accumulated temperature is the accumulated day degrees above a growth threshold temperature (above 5°C) and it provides a measure of summer warmth (Pyatt *et al*., 2001). Moisture deficit (mm) reflects the balance between potential evaporation and rainfall and emphasises the dryness of the growing season. It is calculated by subtracting monthly rainfall from monthly evaporation and keeping a running balance throughout the summer. The peak value reached is the moisture deficit for that year. Windiness is used to represent the amount of physiologically or physically damaging wind that a forest stand on a particular site experiences in the year. Windiness is expressed in DAMS (detailed aspect method of scoring) with scores ranging from 3 to 36 divided into nine classes. Continentality expresses the seasonal variability of the climate and it is based on the Conrad Index. The index increases with elevation, with easting and with distance from sea but decreases with northing. The range of values in Britain is from 1 to 13 grouped into four classes.

A4.1.3 Plant indicator species

The use of indicator plants in forestry to indicate soil suitability for planting certain trees has been widely recognised (Ellenberg, 1988; Rodwell & Patterson, 1994; Pyatt *et al*., 2001; Anderson, 2002). Indicator values directly related to ESC soil nutrient regime were objectively derived for about 85 vascular plants growing in British woodlands (Pyatt *et al*., 2001). Wilson's indicator values are based on combining vegetation and soil chemical data from 70 sites in the UK (Wilson, 1998). Another set of indicator values called the Hill-Ellenberg values are also used. They represent a calibration of F, R and N values for over 1000 plants and are based on vegetation composition rather than soil analysis.

In the ESC DSS, both indicator values are weighted depending on the abundance of each plant and two mean indicator site values calculated for each site. The ESC DSS recommends which site value to use to classify SNR, governed by the greater proportion of Hill or Wilson indicator plant species found at the site.

The Wilson values which are used in ESC are based on data from sites which are not well representative of very poor to poor upland sites. However, recent additional sampling has included 19 of these sites, generating new Wilson species values and enabling adjustments to the originals (Wilson, 2002). As yet, new Wilson values have not been integrated into the ESC DSS, so the classification results are based on the original values. The new Wilson values however, were used as indirect quantitative measures of soil nutrients, enabling an analysis of variance between stand treatments.

A4.2 Methods

Data on plant indicator species and soils were collected following fieldwork methodology outlined in the ESC DSS user's guide (Ray, 2001). Within each treatment plot, a 2 m x 2 m quadrat was laid down. All vascular plants present within the quadrat were recorded with an estimate of ground cover for each species (%). These data were recorded in another four quadrats which were placed around the plot on representative ground.

Soil pits adjacent to each plot were dug (approx. 0.5m deep). A description of the soil profile was made, noting the following factors at each soil horizon: thickness (including depth of moss & litter layer), soil colour and mottling, stoniness, texture and rooting depth. Soil type was then classified in accordance with the Forestry Commission soil classification (Pyatt, 1982). Details on soil and vascular plants

enabled a detailed assessment of site quality (ESC Pro) to be carried out in ESC DSS.

A4.3 Results

Climatic factors generated from ESC DSS for the grid reference and elevation of each individual site have been listed in Table A4.1. Old-growth stands were most variable in terms of soil type with a mixture of peaty podzols, peaty gleys, ironpans and *Sphagnum* bog (Table A4.2). Open sites were dominated by *Sphagnum* bogs whilst pole stands were dominated by *Sphagnum* bogs and peaty podzols.

Open sites were dominated by wet to very moist SMRs (Table A4.3). Pole and old-growth sites were more variable but similar, encompassing drier regimes from moderately dry to wet classes. Soil nutrient regimes across sites were more uniform dominated by the very poor class. The presence of a less poor site (poor) in two pole plots suggests a slightly improved SNR for this stand treatment. Wilson values were recommended to clarify SNR rather than Hill values for all sites. Both original and new Wilson mean site values (pooled across blocks) indicate very poor sites despite slightly higher estimates for the new values (Table A4.4).

ESC DSS generates a list of tree species and indicates which species are considered in forestry terms to be unsuitable, suitable or very suitable[1] to sites depending on climate and soil quality classifications. Across all sites, Alder was found to be unsuitable for growth with SNR being the limiting factor. Downy Birch however was very suitable for all sites. No information was available for Holly or Rowan. The majority of sites were found to be unsuitable[2] for the development of any type of woodland community. Exceptions were Block 2 and 3 in the old growth and B8 in Pole stage where W18 *Pinus sylvestris* woodland was marked as suitable.

[1] In very suitable conditions, a tree species is expected to achieve 75% or more of its maximum yield, remain unsusceptible to disease or pest attack and be capable of producing viable seed (Pyatt *et al*., 2001). In suitable conditions, a tree species is expected to achieve 50-75% of its maximum yield and growth to maturity but production of viable seed is not guaranteed. In unsuitable conditions, a tree species achieves less than 50% of its maximum yield severely limiting the production of sawlogs.

[2] In unsuitable conditions, natural regeneration of either the tree species or some of the characteristic species of the ground flora would not occur. In suitable conditions, the woodland can be expected to regenerate itself.

Table A4.1 Climate data output from the ESC DSS for each site (Ray, 2001). Climate data are based on the Meteorological Office 30-year recording period (1961-1990), specific to the grid reference and elevation of each site.

Grid reference	Block	Elevation (m)	Acc. Temp. (day-degrees above 5°C)	Moisture Deficit (mm)	Windiness (DAMS)	Continentality (Conrad index)
			Open			
NH231248	1	232	1038	65	13	5
NH197232	2	240	1030	62	12	5
NH228236	3	250	1017	60	13	5
NH243247	4	237	1032	64	12	5
NH278277	5	272	987	56	14	5
NH296282	6	185	1091	78	11	5
NH260269	7	230	1038	66	13	5
			Pole			
NH230247	1	232	1038	65	13	5
NH197232	2	240	1030	62	12	5
NH228237	3	245	1023	62	13	5
NH243246	4	240	1028	63	12	5
NH278277	5	270	989	56	14	5
NH296281	6	195	1079	76	12	5
NH260269	7	230	1038	66	13	5
			Old-growth			
NH230248	1	232	1038	65	13	5
NH167232	2	240	1030	62	19	4
NH228236	3	250	1017	60	13	5
NH243247	4	238	1030	64	12	5
NH278278	5	270	989	56	14	5
NH296282	6	190	1085	77	11	5
NH261269	7	230	1038	66	13	5

Table A4.2 Soil types for open, pole and old-growth treatment plots in Glen Affric with Forestry Commission classification codes. Numbers equal to block.

	Open	Pole	Old-growth
1	Upland Sphagnum Bog (10b)	Typical Podzol (Peaty) (3)	Typical Podzol (Peaty) (3)
2	Upland Sphagnum Bog (10b)	Upland Sphagnum Bog (10b)	Typical Podzol (Peaty) (3)
3	Upland Sphagnum Bog (10b)	Upland Sphagnum Bog (10b)	Podzolic Ironpan Soil (4z)
4	Typical Podzol (Peaty) (3)	Hardpan Podzol (3m)	Peaty Podzolic gley (6z)
5	Upland Sphagnum Bog (10b)	Upland Sphagnum Bog (10b)	Peaty Podzolic gley (6z)
6	Typical Brown Earth (1)	Upland Sphagnum Bog (10b)	Typical Podzol (Peaty) (3)
7	Upland Sphagnum Bog (10b)	Typical Podzol (Peaty) (3)	Upland Sphagnum Bog (10b)

Table A4.3 Soil quality best estimates from ESC DSS (Ray, 2001). Soil moisture regime (SMR) and soil nutrient regime (SNR) (from Wilson mean site values) for all blocks in the three stand treatments; open, pole and old-growth. SMR: wet (W); very moist (VM), fresh (F); slightly dry (SD); moderately dry (MD); very dry (VD). SNR: very poor (VP); poor (P); medium (M); rich (R); very rich (VR).

	Open		Pole		Old-growth	
Block	SMR	SNR	SMR	SNR	SMR	SNR
1	W	VP	W	VP	VM	VP
2	VM	VP	VM	VP	F	VP
3	W	VP	VM	VP	W	VP
4	W	VP	MD	P	W	VP
5	VM	VP	W	P	W	VP
6	VM	VP	VM	VP	VM	VP
7	VM	VP	W	VP	W	VP
Mean	VM	VP	VM	VP	VM	VP

Table A4.4 Original and new Wilson mean site values for open, pole and old-growth treatment plots.

	Open		Pole		Old-growth	
Blocks	Original	New	Original	New	Original	New
1	1.79	2.25	2.71	2.40	2.10	2.27
2	1.72	2.07	2.70	2.31	2.08	2.27
3	1.75	2.24	2.69	2.32	1.87	2.23
4	2.01	2.31	2.99	2.52	1.81	2.25
5	1.74	1.92	2.82	2.32	1.85	2.23
6	2.09	2.35	2.76	2.60	2.18	2.28
7	1.77	2.13	2.29	2.41	1.80	2.16
Mean	1.89	2.18	2.78	2.41	1.98	2.24