# AN ECOLOGICAL SITE CLASSIFICATION FOR FORESTRY IN GREAT BRITAIN

by Graham Pyatt
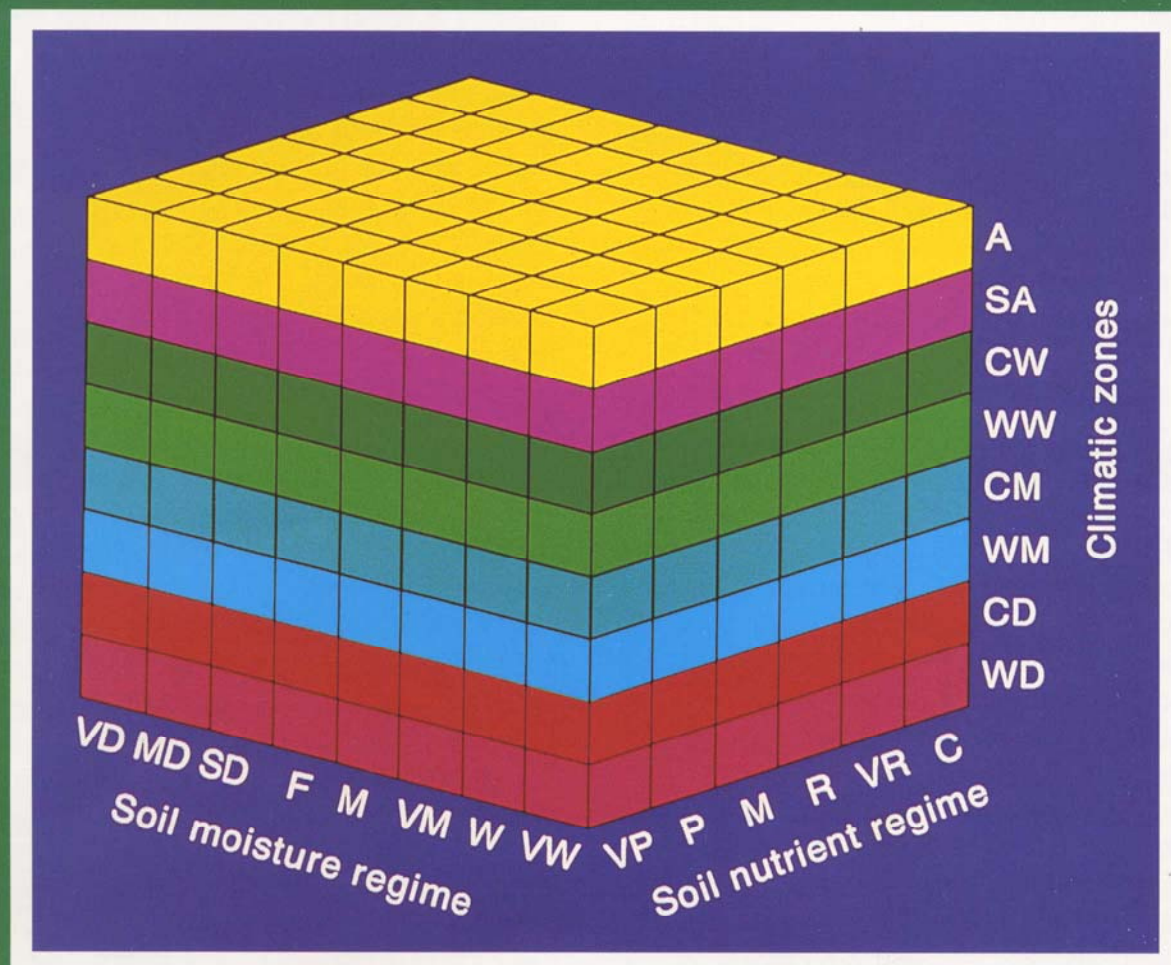
## Summary

A new ecological site classification (ESC) is being developed based on climate and soil quality. It will incorporate the present classification of soil types and use indicator plants and humus forms to help the identification of site types. It is hoped that it will lead to a better matching of site quality to the ecological requirements of indigenous and introduced tree species, leading to better growth and successful natural regeneration. It should also assist management of ground vegetation and the ecosystem as a whole.

## Introduction

There is a need for an ecologically based site classification if forest managers are to respond fully to the demands of multiple-use forestry. By focusing attention on ecological site quality and its relation to the ecosystem we shall have a sound basis for the sustainable production of wood and for the conservation of wildlife. This new approach should also benefit the educational and recreational uses of forests.

This Note summarises the results of a feasibility study of the development of such a system. The proposed system has many features in common with the Biogeoclimatic Ecosystem Classification (BEC) which has gained wide acceptance in forest management in British Columbia (Pojar et al., 1987). Ecological classifications of sites have been used for forest management in several European countries for many decades (Cajander, 1926; Ellenberg, 1988) and recent developments show there is a measure of international agreement on methodology. The advent of the National Vegetation Classification (NVC) for Britain (Rodwell, 1991) provides further scope for integrating the silvicultural and conservation aspects of forest management through the use of an ecological site classification.

The site classification is three dimensional, with climate, soil moisture regime and soil nutrient regime chosen as the principal factors (Front cover). Since these factors are composites of many individual variables, it is necessary to develop a separate classification of each factor, so that it can be represented as a simple series of classes.

## The principal factors and their estimation

### Climate

The classification of climate uses two main variables: accumulated temperature (a measure of the heat energy supply) and moisture deficit (the balance between rainfall and evaporation during the summer) (Birse and Dry, 1970; Birse, 1971; Bendelow and Hartnup, 1980). Figure 1 shows eight zones defined by the first two variables. At the regional scale subzones will be defined by finer sub-divisions of these variables. Figure 1 also shows four classes of oceanicity (measured by the annual range of temperature, but related also to the humidity, length of growing season and degree of winter cold) which may be used to define variants within zones or subzones.

The first step in using the site classification will be to locate the site of



**Figure 1.** ESC climatic zones in Britain (excluding Northern Isles).

*Front cover. Ecological site classification: the three principal factors. Climatic zones – A: alpine; SA: sub-alpine; CW: cool wet; CM: cool moist; WM: warm moist; CD: cool dry; WD: warm dry. Soil moisture regimes – VD: very dry; MD: moderately dry; SD: slightly dry; F: fresh; M: moist; VM: very moist; W: wet; VW: very wet. Soil nutrient regimes – VP: very poor; P: poor; M: medium; R: rich; VR: very rich; C: carbonate.*
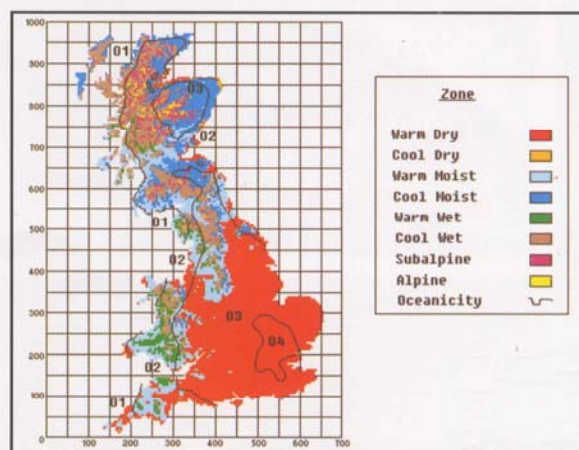
interest on a larger scale version of this map and read off the climatic zone and local sub-divisions. The second and third steps will be to examine the site and estimate its soil moisture and soil nutrient regimes.

## Soil moisture regime

Soil moisture regime (SMR) deals with the relationship between the availability of water and oxygen to plant roots and soil organisms. At one end of the range of SMR the soil is frequently wet or waterlogged at shallow depth and oxygen supply is likely to be impaired. At the other extreme, oxygen is unlikely to be deficient but summer drought will frequently be experienced. For soils that are not freely draining, SMR can be roughly described by the average depth of the water-table in winter. It is proposed to have eight classes of SMR (Figure 2).

A key will be developed to enable SMR to be assessed from soil properties, slope and aspect and thence to adjust for the influence of climate.
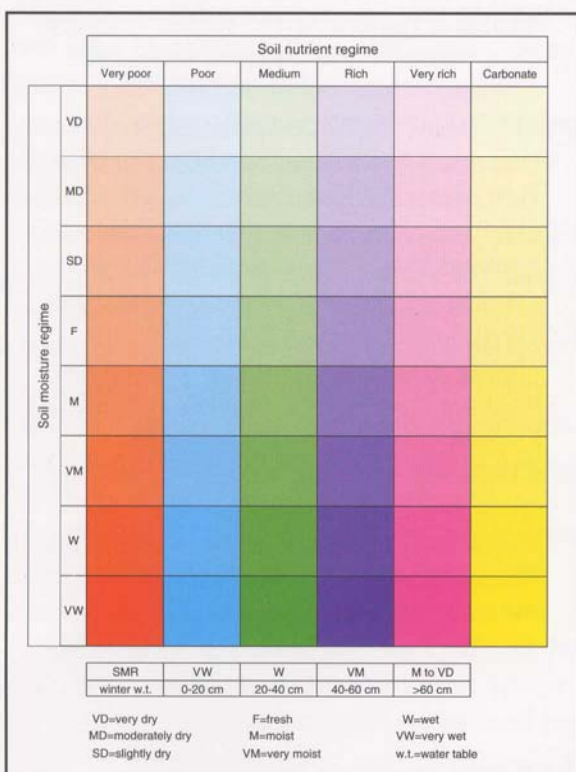
**Figure 2.** *The soil quality grid.*

## Soil nutrient regime

Soil nutrient regime (SNR) reflects the availability of major nutrients, particularly nitrogen, but also phosphorus, potassium, calcium and magnesium. It is proposed to have six classes of SNR (Figure 2). Nitrogen availability increases and soil acidity decreases across the five classes from 'very poor' to 'very rich'. The sixth 'carbonate' class is intended to represent strongly calcareous soils in which the availability of nitrogen and some other nutrients is rather low. Phosphorus is normally low in 'very poor' and marginal in 'poor'.

The estimation of SNR is the most difficult step in using the site classification. There are several ways of doing this, from the very simple and approximate to the more complicated and precise. A combination of two or more of the methods could be used, depending on the balance between reliability and effort appropriate to the purpose.

## Soil types

The existing Forestry Commission classification of soil types and phases (Pyatt, 1977 and 1982) is a flexible system for noting the main features of the profile, but provides no clear ranking by SMR or SNR. Figure 3 shows the theoretical distribution of some major soil types on the grid, but does not indicate how much overlap there is between types due to variations in lithology and topography. Therefore, soil type alone is not considered to be an adequate
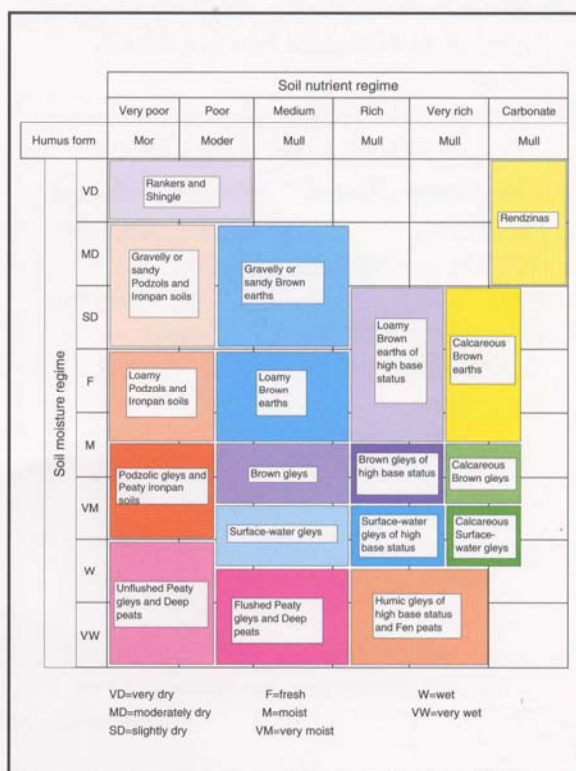
**Figure 3.** *Simplified distribution of soil types and humus forms on the soil quality grid.*

assessment of soil quality in respect of either SMR or SNR. It is clear that some of the detail that has gone into the classification of soil types and phases and their mapping for afforestation purposes has less relevance in the context of the second rotation or even in the later stages of the first. It is therefore likely that there will be fewer ESC site types in any given forest than there are soil types and phases under the existing system.

## Humus forms

The identification of humus form provides a better indication of SNR than that given by soil type alone (see Figure 3). Three main categories – mor, moder and mull – with a number of subdivisions are recognised, and identification will only require a little practice with a simple key.

## Indicator species

All plants exhibit ecological preferences, that is, **in competition with other plants** they can only succeed under a certain range of availability of light, soil moisture and soil nutrients (not to mention other climatic requirements). Some plants exhibit narrow ecological amplitudes (ranges) and are better indicator species than those found over a wide range of conditions. But even a plant that grows on many site types will usually be absent from part of the range of possible site types, and by its absence may then be a useful indicator of those conditions. While every plant is thus a potential indicator, a reliable estimate of soil quality for a site will require the identification of a number of plants. Figure 4 gives short lists of common plants according to the cell which is thought to represent their central preference. In practice, however, most plants have an ecological amplitude that covers at least four cells of the grid. So any one site can be expected to have plants from several adjacent cells, and site quality has to be judged by the average position thus indicated, preferably taking account of the relative abundance of the species.

At this stage, only vascular plants are used as indicator species, although it is appreciated that mosses can be useful too. Longer lists of indicator plants are available.

## Soil analysis

Suitable sampling of the soil and analysis in the laboratory provide the most reliable way to identify the SNR, but the labour and cost involved will normally only be justified for research or other special purposes.

## Soil quality

The grid formed with axes of SMR and SNR is referred to as the soil quality grid (Figure 2). A site type will be defined firstly by its climatic zone and then by a part of the grid. Site types will typically occupy from one to four adjacent cells of the grid. In many forests the range of soil quality only represents about a quarter or a third of the grid. It is important to realise that although the overall appearance of the soil quality grid is the same for all climatic zones, the site types and their ecological or silvicultural properties will normally differ between zones.

| | | Soil nutrient regime | | | | | |
|---|---|---|---|---|---|---|---|
| | | Very poor | Poor | Medium | Rich | Very rich | Carbonate |
| | VD | Early hair-grass | | | | | Biting stonecrop (wall-pepper) |
| | MD | Hare's-foot clover | Bearberry, sheep's sorrel | | | | Hoary ragwort, hairy violet* |
| | SD | Bell-heather, cowberry* | Creeping lady's tresses*, wood sage* | Dove's-foot cranesbill*, common speedwell* | Fat hen, petty spurge* | Henbit*, smooth sow-thistle | Early purple orchid*, wayfaring tree |
| Soil moisture regime | F | Heather (ling), bell heather | Wavy hair-grass*, creeping soft-grass* | Greater woodrush*, wood melic* | Male fern*, wood avens*, wood-sorrel* | Dog's mercury*, elder, chickweed* | Sanicle*, black bryony* |
| | M | Heather (ling) | Hard fern*, bilberry* (blaeberry*) | Oak fern*, yorkshire fog | Bugle*, scaly male fern*, broad buckler-fern* | Ramsons*, enchanter's night-shade*, stinging nettle* | Coltsfoot |
| | VM | Heath rush | Tufted hair-grass*, Purple moor-grass | Wood horsetail*, Soft rush | Lady-fern*, Creeping buttercup* | Cuckoo-pint*, Yellow pimpernel*, Hedge woundwort* | Fragrant orchid, hard rush |
| | W | Cloudberry | Marsh thistle, cross leaved heath, lousewort | Wild angelica, meadow-sweet, water avens* | Crack willow* | Great willowherb, red-veined dock* | Marsh hawk's-beard*, common meadow rue |
| | VW | Cotton-grass (hare's-tail), deer-grass | Common cotton-grass, bog myrtle | Golden saxifrage*, marsh bedstraw* | Marsh marigold | Reed-grass, reed | Purple osier, yellow mountain saxifrage |

| | | |
|---|---|---|
| VD=very dry | F=fresh | W=wet |
| MD=moderately dry | M=moist | VW=very wet |
| SD=slightly dry | VM=very moist | * = shade-tolerant species |

**Figure 4.** Indicator species for soil quality.

## General silviculture

As was suggested by Anderson (1950), ecological site classification provides a sound basis for the choice of species. The soil quality grid is also a useful starting point in any consideration of the sustainability of forestry practices, such as the use of fertilisers. The similarity of the present classification to BEC aids the transfer of ecological knowledge gained from natural forests in western North America to our plantations. This is particularly relevant in the context of natural regeneration where the type and vigour of weed growth in relation to the available light is often crucial to success. The factors used in the classification of climate were chosen partly because they were related to the yield of forest stands. The site classification is therefore expected to have value in extrapolating the results of site–yield research.

## Native woodlands

Many of the plant communities and particularly the sub-communities of the NVC clearly occur within a definite part of the range of climate and soil quality (Whitbread and Kirby, 1992; Rodwell and Patterson, 1994). If the species found in the ground flora are allocated the numerical ecological indicator values given by Ellenberg *et al.* (1992) it is possible to estimate the average soil quality for each sub-community. No direct estimate of the range of soil quality is possible, but it can be roughly judged from the range of species present and the other site information given. Figure 5 is an example of a soil quality grid showing woodland communities located by this method. Faced with the need to create a new native woodland, the manager could therefore first identify the climate class and soil quality of the site, then look at the appropriate chart similar to Figure 5. The method could equally well be used for the non-woodland communities which it may be desirable to foster within the forest boundary.

## Biodiversity

The wide variety of  plant species found in the different communities of the NVC are one illustration of the link between site quality and biodiversity. It is likely that there are similar links with the even greater variety of invertebrate animals, bacteria, fungi and other taxonomic groups that are also dependent on the soil (Moore *et al.*, 1995).

## Application at different scales

Nationally or regionally (e.g. Forestry Authority conservancies or Forest Enterprise regions) the climatic zones and subzones or variants may be useful for broad-scale planning, especially if allied to information on areas of forest types or species. For individual forests, with areas ranging from a hundred to several thousand hectares, long-term planning of forest design can be aided by recognising landscape site units. These are defined locally and based on a portion of the soil quality grid comprising a group of cells within one climatic class (i.e. several related site types). They will often be determined by variations in local climate/topography or geology/soil quality. For detailed operations within a regeneration coupe or subcompartment, consideration will be given to individual site types. Advice from research on silvicultural and conservation matters will normally be tailored to individual site types or their approximate equivalents, e.g. sub-communities of NVC.
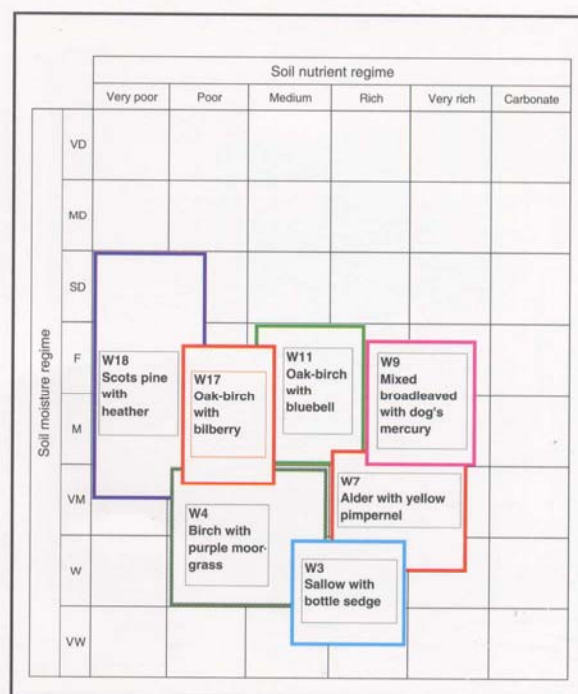


**Figure 5.** *New native woodlands for ESC climatic zones warm wet, cool moist and cool wet.*

## Further development

The classification is being tested to support a number of forest design plans during the current year. The intention is to begin introducing the system in 1996.

## Acknowledgments

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