

Supporting Documentation

Environmental Change Network

Terrestrial Site Locations

Chapter 1 from:

Sykes, JM. and Lane, A.M.J. (1996). The United Kingdom Environmental Change Network: Protocols for standard measurements at terrestrial sites, The Stationery Office.

Chapter 1 INTRODUCTION

Monitoring global environmental changes

The occurrence of far-reaching changes in the earth's environment is now well recognised by scientists, politicians and public, and this recognition has generated a growing national and international interest in detecting and monitoring environmental changes. At the global scale these changes are caused by largely man-induced changes in climate, atmospheric composition and land use (International Geosphere-Biosphere Programme 1992), factors which also operate at regional and national scales where they are often exacerbated, or occasionally mitigated, by local factors.

International efforts to obtain reliable information on the responses of natural and managed ecosystems to global environmental changes have burgeoned during the last decade and have resulted in the involvement of several organisations and their associated actual or planned networks. An overview of existing organisations and networks is provided in Heal, Menaut and Steffen (1993) and a comprehensive listing is provided by Fritz (1991).

Environmental monitoring in the United Kingdom

The UK has a long history of environmental monitoring, sampling being carried out by a multiplicity of organisations for a wide variety of purposes. The majority of this monitoring is designed to ensure that there is compliance with policies of environmental regulation set out in international, national and local agreements. In addition, monitoring provides information on the effectiveness of policies already being implemented and may lead to proposals for new or modified policies or actions, especially where early warnings of environmental changes have been recognised. Finally monitoring is concerned with the measurement of background levels and the provision of benchmark data for research and policy purposes, as well as with reassuring the public. McCormack (1990) has provided an overview of UK environmental monitoring systems, especially in relation to the concepts, methods and strategies used.

Most UK environmental monitoring is de-centralised, the majority of sampling being carried out by local government, other public sector bodies including inspectorates, individual factories and at both central Government and other research laboratories. Most monitoring is also sectoral, in the sense that particular monitoring systems have been devised and developed to relate to a particular sector of the environment. Various central UK Government departments have responsibilities in the areas of, for example, air quality, water, land, soil, natural resources, flora and fauna. There is co-ordination of monitoring programmes within sectors, eg air monitoring networks, and also across sectors where this approach is necessary, eg monitoring radioactivity in air, drinking water, the sea, and in agricultural products.

Non-governmental organisations play an important role in environmental monitoring; they often optimise the involvement of the large pool of available amateur expertise and inform the public of environmental changes which are taking place.

There is a growing movement towards harmonised monitoring which, whilst it may be carried out by different organisations, produces reliable data, capable of comparison and integration at both national and international levels. The national environmental data resource is largely concentrated in databases and geographical information systems at designated Environmental Data Centres. Contributions are made from UK environmental monitoring programmes to international programmes such as the United Nations Economic Commission for Europe (UN-ECE) International Co-operative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (IMP), and the United Nations Environment Programme (UNEP), Global Environmental Monitoring System (GEMS) and Global Resources Information Database (GRID).

Further co-ordination of environmental monitoring is being achieved by the use of an area-based approach, using a system of land classification developed by the Institute of Terrestrial Ecology. The classification, which allows 1 km squares in Great Britain to be allocated to 32 land classes, provides an agreed objective sampling and stratification framework for national ecological surveys and monitoring (Bunce *et al.* 1996).

The Environmental Change Network (ECN)

The need for a general-purpose network designed for long-term, integrated environmental monitoring in the UK, especially in relation to current or future major anthropogenically induced factors, has been emphasised on numerous occasions and has eventually led to the formation of ECN (Tinker 1994). As early as 1976 a Natural Environment Research Council (NERC) Working Party on Biological Surveillance (NERC 1976) had noted the need for detailed surveillance at a limited number of sites with the objective of observing natural changes on a year-to-year and long-term basis. It was suggested that protected areas and sites with intensive research programmes or where substantial information was already available should be used for this purpose. Almost a decade later a House of Lords Select Committee on Science and Technology (1984) recommended that the effects of agricultural practices should be monitored by 'a small and highly selective network of projects . . . to give early warning of environmental consequences'.

As a consequence of these recommendations and a wide recognition in the scientific community of the need for a network which would meet the requirements of environmental change research and monitoring, NERC undertook, in 1986, to consult UK Government departments and research organisations primarily concerned with agriculture and the environment to explore the setting up of such a network. A working group on long-term reference sites was set up which produced a series of recommendations for the establishment of a national network of sites which would meet the requirements of different interested organisations (NERC 1986). These recommendations were taken up and put into effect by a consortium of agencies which agreed to contribute to the operation of the network, which became the UK Environmental Change Network (ECN).

The rationale for proposing a network of sites is summarised by Heal (1991), as follows.

1. Study sites are an essential component of ecological research. To answer questions on changes in the environment, we need sites which represent the main environmental, ecological and management variations in the UK. While studies of some individual topics will require other sites with particular characteristics, a 'core' network will provide opportunity to use existing information on the related topics.
2. Long-term studies are required to monitor changes external to the system which take place gradually or at infrequent intervals. Responses to those changes may occur through species or processes which have a slow turnover time or through a series of linked short-term events, the results of which are only apparent in a long-term study.
3. In addition to delayed and serial responses, it is also necessary to distinguish between the different factors which cause, or interact to cause, change. For these reasons it is important to have sites with integrated or multi-media monitoring and to carry out both observational and experimental research.
4. The scientific case for a network of long-term study sites in the UK is strong. Information on environmental changes and on their consequences is a serious need in UK Government. By concentrating on established sites, the cost of creating such a network can be kept to a minimum.

ECN objectives

The objectives of ECN are as follows.

- To obtain uniform and comparable long-term datasets at selected sites by means of measurement at regular intervals of variables identified as being of major environmental importance.
- To provide for the integration and analysis of these datasets so as to identify environmental changes and to improve understanding of the causes of such changes.
- To make these long-term datasets available as a basis for research and for the prediction of possible future changes.
- To provide, for research purposes, a range of representative sites where there is good instrumentation and reliable environmental information.

ECN Design

The ECN aims to monitor changes in selected biota in addition to the physical and chemical environment. The programme thus falls within the definition of 'ecological monitoring' (Hinds 1984). It is not surprising, therefore, that the design of the ECN has encountered the problems which the author identifies as needing to be overcome in successful ecological monitoring designs and which can be summarised as:

- selecting and quantifying specific entities within the continuous spatial and temporal flux;
- specifying appropriate replication standards in a world that is full of unique places;
- expense.

The need for long-term observations in ecology has been set out by Likens (1983) and Strayer *et al.* (1986) and summarised by Woiwod (1991), who also discusses the scientific, political and personal problems associated with long-term experiments and observations. The problems of sustaining a long-term programme such as ECN are exacerbated to some extent by the participation of many organisations, all of which have different objectives, are publicly funded, and are unable to commit funds for more than three to five years in advance. Nevertheless, it was believed that the programme could be sustained if it was not too ambitious, had a well-defined concept and organisation, was able to operate successfully within agreed target budgets, and if the network as a whole provided added value to the individual contributions of sponsoring agencies. The initial steps to be taken were as follows.

1. Select a series of variables related to climate, pollution and land use, changes in which would drive the states of a second set of 'response' variables. Both driving and response variables should be interpretable, informative, comparable and repeatable between sites and times, and response variables should be sensitive to changes in the driving variables. Within these constraints they should also, where possible, be simple and cheap and avoid labour-intensive operations. The variables should be selected so as to be measurable at each of a series of sites which may have a wide range of climatic, topographic, soil and vegetation (crop) conditions.
2. Establish agreed, strict and clear protocols for the sampling and recording system to be used for measuring each variable, for chemical analysis where necessary, and for quality control and assurance of the data.
3. Establish methods for managing and storing the data.

An informal Workshop was held in September 1990 at which researchers, academics and environmental practitioners discussed organisation, possible sites, and the rationale and technicalities of a range of possible variables to be included in the programme. Subsequently the ECN Steering Committee set up two Working Groups to develop further the ideas and views from the Workshop.

A **Technical Working Group**, comprised of experts in areas of environmental science relating to the programme and chaired by Prof M Hornung, refined the list of suggested variables and formalised the methods of measurement to be used. Variables were selected to meet, as far as possible, the criteria set out in (1) above and resulted in a set of 'core measurements' which were to be undertaken at all of the ECN sites. A second set of variables, 'priority additional measurements', were considered as being desirable but not essential and therefore only to be undertaken if funds allowed. In practice, funds have been, and are likely to remain insufficient to allow such additional variables to be measured and these are not discussed further in this account. Where national sectoral monitoring schemes were already operating, their sampling design and methods were adopted by ECN. This provided added value for ECN in that data from its sites could be analysed in a broader regional and national context, whilst ECN could provide a comprehensive set of relevant environmental data for the sectoral networks. Examples of such sectoral networks are the Butterfly Monitoring Scheme, Rothamsted Insect Survey, Common Birds Census, Breeding Bird Survey and UK Precipitation Composition Network.

A **Statistics and Data Handling Working Group**, comprised of statisticians and computer scientists and chaired by Prof R M Cormack, advised on all matters relating to the statistical design of the programme, and in particular on the spatial location of sites and observation points within sites, the selection of variables and the methods and temporal frequency of measurement. The Group also advised on methods for storing and managing data, methods for analysing new and old data, and on the resources needed to meet their recommendations. Cormack (1994) discusses some of the statistical aspects of planning the network and the main questions put to the Group, together with the answers given. Some of the considerations are described below.

- For most environmental variables, sampling variation is likely to be much greater than analytical variability; however, the necessary degree of replication is difficult to define because information on distributional form or variance components of the selected variables is often unavailable.
- The intensity of destructive sampling in certain areas and the consequent need to avoid the possibility of one sample interfering with another affect the spatial layout of sample points.
- Objectivity in taking a sample may be more fundamental to the aims of the programme than the choice between random and systematic samples.

Protocols for data analysis have not been set down but the Group formulated some general principles.

- Analytical procedures to be applied routinely to data as they are collected should be simple but not make simplistic assumptions; more detailed parametric methods should be adopted to test specific hypotheses as they arise.
- Cusum charts and graphical procedures of exploratory data analysis should be widely used.
- A modelling paradigm should not be embraced too early: data dredging by techniques such as multiple regression should not be used without comprehensive cross-validation, and time-series modelling should be carried out only after the formulation of specific hypotheses.
- Space/time analyses may be informative as records accumulate but assumptions of spatial stationarity may need careful study.

Reciprocal feedback between the two Working Groups was an important part of the development process.

Development of the network

Although ECN was conceived of as a programme covering a wide range of natural, semi-natural and managed ecosystems, the need for early implementation of the programme led to the adoption of a step-by-step approach to network establishment. It was decided that attention would first be focused on setting up a network of terrestrial sites, to be followed as soon as possible by a parallel and linked network of freshwater sites, to include rivers and lakes. Each contributing agency agreed to provide one or more sites and the resources to carry out an agreed suite of ECN measurements, or to provide equivalent resources to support the general operation of the network. A list of current contributors is provided in Table 1, which includes agencies responsible for both the terrestrial and freshwater sites, though information on the latter is not provided in this publication but will appear in a later volume.

Site selection

A preliminary list of 140 possible sites was compiled, based on their being currently or recently active research sites which could provide historic data on some aspects of environmental research. The following criteria were then used to refine the list and to select a series of 24 target sites which, it was believed, could constitute a terrestrial network for the United Kingdom:

- good geographical distribution covering a wide range of environmental conditions and the principal natural and managed ecosystems;
- some guarantee of long-term physical and financial security;
- known history of consistent management;
- reliable and accessible records of past data, preferably for ten or more years;
- sufficient size and opportunity to allow further experiments and observations.

The target sites met most of these criteria but it was inevitable that, in a network for which there was very limited central funding, the second became the primary criterion. Whilst physical security was, for the most part, assured by the sites being located at or being associated with existing research stations, assurances of financial security for what was envisaged as a long-term project with an initial life expectation of at least 30 years were difficult to obtain.

The terrestrial network was thus founded, in January 1992, with eight of the target sites (Drayton, Glensaugh, Hillsborough, Moor House-Upper Teesdale, North Wyke, Rothamsted, Sourhope, and Wytham) being committed and with the expectation that other sites would join later. By 1996 the network had expanded to a total of 11 sites by the addition of Alice Holt, Porton Down and Snowdon/Y Wyddfa. None of the additional sites was in the original list of target sites but each increased considerably the geographical distribution and representativeness of the network.

It is intended that this 'spine' of representative sites should be extended in the future and supplemented by the recruitment of sites which will provide replication within the major axes of UK environmental variation.

Table 1. Supporting agencies and sites in ECN

Agency	Sites/support	Site type
Biotechnology & Biological Sciences Research Council	<ul style="list-style-type: none"> • North Wyke Research Station • Rothamsted Experimental Station 	Lowland grassland Arable
Countryside Council for Wales (jointly with Welsh Office)	<ul style="list-style-type: none"> • Y Wyddfa/ Snowdon NNR 	Upland grassland
Department of Agriculture for Northern Ireland	<ul style="list-style-type: none"> • Agricultural Research Institute, Hillsborough • 3 Freshwater sites 	Lowland grassland River & lake sites
Department of the Environment	<ul style="list-style-type: none"> • Support for Central Co-ordination Unit • 4 freshwater sites 	River & lake sites
Department of the Environment for Northern Ireland	<ul style="list-style-type: none"> • 2 freshwater sites 	River sites
English Nature	<ul style="list-style-type: none"> • Site & facilities at Moor House-Upper Teesdale NNRs 	
Environment Agency	<ul style="list-style-type: none"> • 13 freshwater sites 	River & lake sites
Forestry Commission	<ul style="list-style-type: none"> • Alice Holt Forest 	Woodland
Ministry of Defence	<ul style="list-style-type: none"> • Porton Down 	Chalk grassland
Ministry of Agriculture, Fisheries & Food	<ul style="list-style-type: none"> • ADAS Drayton • Soil Survey & monitoring at English & Welsh sites 	Mixed farming
Natural Environment Research Council	<ul style="list-style-type: none"> • ECN Central Co-ordination Unit • Moor House-Upper Teesdale NNRs • Wytham (site provided by Oxford University) • 4 freshwater sites 	Upland grassland & blanket bog Woodland & arable River & lake sites
Scottish Environment Protection Agency	<ul style="list-style-type: none"> • 12 freshwater sites 	River & lake sites
Scottish Office, Agriculture, Environment & Fisheries Dept	<ul style="list-style-type: none"> • Glensaugh Research Station • Sourhope Research Station 	Upland grassland Upland grassland
Welsh Office (jointly with Countryside Council for Wales)	<ul style="list-style-type: none"> • Y Wyddfa/ Snowdon NNR 	Upland grassland

Network sites

Figure 1 shows the locations of the 11 terrestrial sites as well as the 38 lake and river sites of the freshwater network which started operating in 1995. The terrestrial network sites are as follows.

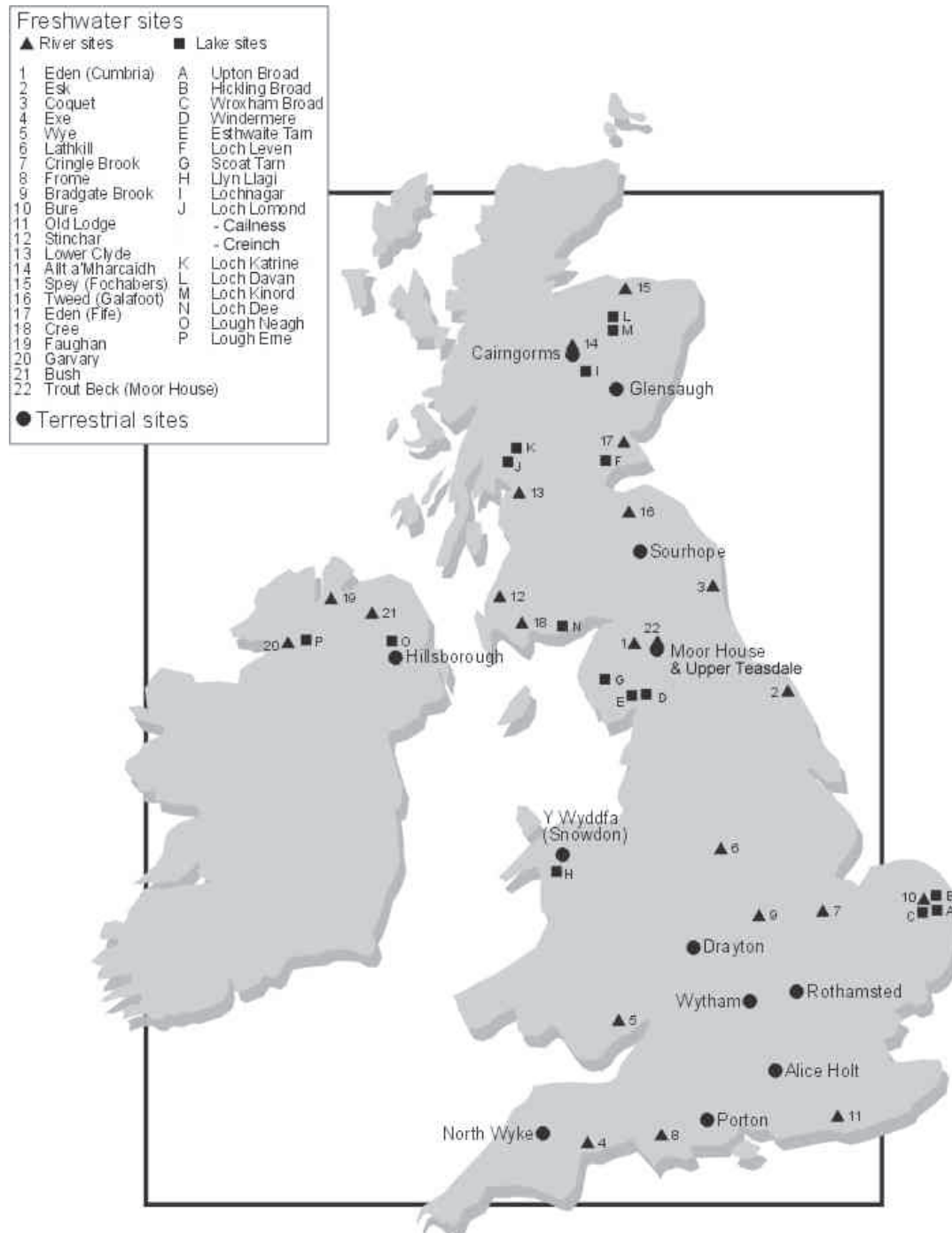


Figure 1. Location of ECN freshwater and terrestrial sites

Alice Holt Forest, Surrey, England (Lat 0° 50'W; Long 51° 10'N)

Sponsor: Forestry Commission

Alice Holt Forest lies in the Weald, between the North and South Downs in southern England. The Forest is situated on a very gently sloping plateau at an altitude of 110-125 m and has a mean annual rainfall of 768 mm (1956-94). The soils range from brown soils

and podzols to surface-water and ground-water gleys. The Forest, which has belonged to the Crown since the time of William I who was responsible for the creation of the Royal Forest as a hunting preserve, was subjected to severe felling for warship building programmes during the 17th and 18th centuries. Replanting of oak (*Quercus robur*) took place subsequently and some of the plantings between 1815 and 1820 still survive. By 1881 it had become clear that oak on the leached and less fertile soils was not growing satisfactorily and some of this was cleared and the ground replanted with conifers. The forested area of 850 ha is mainly of Corsican pine (*Pinus nigra* var. *maritima*) but 140 ha of the oak planted in 1820 remain, and there are 21 ha of 'unproductive' forest. Vegetation is diverse, ranging from base-rich communities of the ash (*Fraxinus excelsior*), field maple (*Acer campestre*), dog's mercury (*Mercurialis perennis*) type of woodland, base-poor communities of oak, bracken (*Pteridium aquilinum*), and bramble (*Rubus fruticosus*) on the sand/gravel soils, and oak and birch (*Betula pendula*) on the heathy, acidic soils. These acidic areas are generally planted with either Scots pine (*Pinus sylvestris*) or Corsican pine and there is often abundant natural regeneration of birch.

The Forestry Commission has had a research establishment at Alice Holt Lodge, formerly used as a private residence, for almost 50 years, and climatic data have been recorded at the site since the late 1940s. There is other monitoring on the site which is particularly relevant to ECN, such as the Rothamsted light trap which has been used continuously to collect macro-lepidoptera since May 1966; a more recent long-term project, the Forest Condition Survey, began in 1984 and the Forest is now a European Union site for monitoring the effects of atmospheric pollution on trees. A variety of other experimental work in Alice Holt Forest has been carried out on forest insects, pathogens, silviculture, mensuration and ecology. There is an active current research programme undertaken by the Forest Authority's Research Division from Alice Holt Lodge, which includes research on forest soils, hydrology, atmospheric deposition, insect ecology and conservation, pest management, management of habitats and landscapes, including deer, squirrels, bats, raptors, seed testing, nursery techniques, pathology, yield and carbon storage modelling. The site also has permanent sample plots, an arboretum, registered seed orchards, and clone banks, and a farm woodland demonstration plot.

Drayton, Warwickshire, England (Lat 1° 45'W; Long 52° 12'N)

Sponsor: Ministry of Agriculture, Fisheries and Food

Situated 5 km west of Stratford-upon-Avon in the English Midlands, Drayton is part of a Research Centre, one of a network of five such Centres operated by the Agricultural Development and Advisory Service, a central UK Government agency which provides consultancy and advice services to the land-based industries in England and Wales. The farm at Drayton occupies 190 ha and is underlain by Lower Lias rocks comprising calcareous clays inter-bedded with thin, brashy, fossiliferous limestone. The depth of the overlying clay drift varies from a few centimetres to more than 1 m. The soils are very heavy, with clay contents of 50-75%. They have poor natural drainage, are extremely difficult to work and compaction and smearing can occur easily if they are cultivated when wet; however, they weather readily, are generally alkaline and have a high potash level, though available soil phosphate tends to be low. The altitude of the farm is 40-80 m, with gentle gradients falling towards the south and east. The climate is typical of the central lowlands of England - fairly dry, with cold winters and warm summers. Average rainfall (1941-93) is 620 mm. February (39 mm) is the driest month and August (68 mm) is wettest. Average minimum air temperature in January-March is <2°C whilst average maximum temperature in the period June-September is >19°C.

Drayton is representative of the mixed farming systems used on the Midland clays. The landscape comprises a patchwork of grass and arable fields with an average size of only 4.9 ha, enclosed by hedgerows which are dominated by hawthorn (*Crataegus monogyna*) and which have a total length of 17 km on the farm. There are few mature trees, partly due to the effects of Dutch elm disease, and no areas of established woodland. Watercourses include two small permanent streams, drainage ditches and two ponds.

The farm has the following cropping regimes:

- intensive, continuous, arable cropping of autumn-sown, combinable crops based on wheat, with field beans and oilseed rape as break crops;
- rye-grass leys of four to six years' duration, alternating with two or three years of arable (wheat) crops;
- permanent or long-term rye-grass leys.

In addition, 13 ha of formerly arable land are currently occupied by farm woodland. Livestock on the farm includes a flock of 300 ewes which are kept for lamb production, a flock of 140 wethers, and dairy-bred calves.

Experimental work has been carried out at Drayton since 1940. Recent research has included studies of various aspects of weed, pest and disease control on arable crops, including determination of pesticide efficacy, development of forecasting systems for pest and disease control, and comparisons between chemical and cultural control of weeds. Two long-term studies are measuring the economic, agronomic and environmental effects of reducing inputs of pesticides and nitrogen compounds into farming systems. Other projects aim to quantify the effects of pesticides on non-target organisms. Recent developments in setting aside formerly arable land have led to monitoring of vegetation development, pests, diseases and soil nitrogen during rotational and non-rotational set-aside regimes and to the evaluation of farm woodland establishment and management techniques. Livestock research includes forage production and evaluation and animal health studies, whilst a related study is examining potential pollutants in runoff from animal wastes applied to grassland.

Glensaugh, Grampian Region, Scotland (Lat 2° 30'W; Long 56° 51'N)

Sponsor: Scottish Office, Agriculture, Environment & Fisheries Department

The Macaulay Land Use Research Institute's Glensaugh Research Station is situated on the south-eastern edge of the Grampian Mountains, 55 km south-west of Aberdeen. It extends to 1125 ha, of which 970 ha are semi-natural vegetation, 150 ha short-term and permanent grassland and 5 ha deciduous and coniferous woodland. There is also a small loch. The land rises from an altitude of 100-450 m. Mean annual rainfall at 195 m is 1040 mm and annual mean daily sunshine hours are 3.83. At higher altitudes there can be considerable snow cover for periods in the winter.

The site is bisected on its east/west axis by the Highland Boundary Fault. North of the Fault soils have been developed on drifts derived from a variety of Upper Dalradian schists, whilst south of the Fault soils have been developed on till derived from an admixture of Lower Red Sandstone sandstone and Dalradian schists. The whole area has been extensively glaciated so that the hill tops are well rounded, and deep glacial till deposit covers the lower slopes with thinner drift on the upper slopes on both sides of the Fault. North of the Fault brown forest soils and podzols are most common on the lower slopes, whilst peaty podzols cover the higher slopes and there are extensive areas of peat with an average depth of 2 m on the summit areas. South of the Fault humus-iron podzols predominate on the lower slopes, changing to shallower, stony peaty podzols at higher elevations. A number of streams drain the small catchments related to the four hills on the site, running south into the River North Esk, some of them via Loch Saugh.

Dry heather (*Calluna vulgaris*) moor is extensive on the more freely drained slopes, the associated species being mainly blaeberry (*Vaccinium myrtillus*) and wavy hair-grass (*Deschampsia flexuosa*). The dry heather communities gradually merge into heather/cottongrass (*Eriophorum vaginatum*, *E. angustifolium*) blanket bog on the deep peat of the hill tops north of the Research Station. A regular burning rotation of the moor is aimed for, but unsuitable weather over the last five years and the proximity of large forest plantations to leeward of the prevailing wind have prevented burning at the desired frequency.

Rye-grass/clover (*Lolium perenne*/*Trifolium* spp.) swards are found at most lower altitudes, half the area being permanent pasture and the other half in five-year leys. About half of this grassland is cut for silage each year. On the lower hill slopes are both

species-rich and species-poor bent/fescue (*Agrostis/Festuca*) communities. Bracken is associated with these communities, particularly on south-facing slopes and at the interfaces of bent/fescue and heather communities.

The principal agricultural enterprise is the production of weaned and finished lambs from a flock of 100 ewes, but in addition there are 60 beef cows and 120 farmed red deer (*Cervus elaphus*) hinds which, like the ewes, are grazed on both the sown grassland and semi-natural vegetation.

Glensaugh has been used as a research facility for over 50 years and in consequence there is a good record of past resource management, as well as meteorological data over the same period and many data from long-term experiments and monitoring, some of it relevant to ECN. The Station provides land resources for a wide range of research including agroforestry, vegetation dynamics of heather moorland, ruminant foraging behaviour, biology of red deer, acidification of catchments and the dynamics of nutrients and pollutants in the soil. Much of the research is collaborative with other research institutes and universities.

Hillsborough, Co Down, Northern Ireland (Lat 6° 05'W; Long 54° 27'N)

Sponsor: Department of Agriculture for Northern Ireland

The Agricultural Research Institute, Hillsborough, lies 12 miles south-west of Belfast and was set up in 1927 in Large Park, then part of the Hillsborough Castle Estate. The Institute controls 200 ha of Large Park and the land is mostly in grass, interspersed with 200 ha of State Forest. Hillsborough Lake occupies 15 ha on the interface between Large Park and the town of Hillsborough and is surrounded by amenity woodland which is open to the public. The land rises from an altitude of about 110 m around the town to 170 m at its southern boundary. The underlying rock is Silurian slate overlain by varying depths of glacial clay till and with alluvial deposits between the drumlins in the northern part of the site, where shallow peats also occur locally. The climate is oceanic, ie mild and wet, and data for the period 1987-91 show a mean maximum daily temperature of 12.2°C and a mean minimum daily temperature of 5.9°C. Total annual precipitation for this period ranged between 737 mm and 973 mm and mean daily hours of sunshine were 3.87. In winter, while prolonged periods of lying snow are unusual, the site is exposed to cold winds from the north and west, and summers are also often cool and cloudy; these conditions are typical of the north-west of the British Isles. Lack of insolation combines with relatively heavy, water-logged soils to produce humid, cool, ground conditions which suit relatively cold-adapted, hygrophilous organisms and there is a year-round problem with slug populations on horticultural and other crops, as well as considerable local damage to earthworm populations due to predation by the introduced New Zealand flatworm (*Artioposthia triangulata*).

The Institute provides resources for research, primarily into beef and dairy cattle nutrition and the management of grassland, but a wide range of other, often collaborative, research activities are undertaken to help improve the competitive position of the Northern Ireland agriculture and food industries. Some current research areas are:

- factors affecting carcase composition in beef cattle;
- bull beef production on forage diets;
- continental beef production;
- development of near infra-red reflectance spectroscopy for the prediction of forage metabolisable energy content and the intake of forages by dairy and beef cattle;
- effects of silage fermentation type and the nature of concentrates fed on milk production in dairy cattle;
- sheep production from grass and sheep response to silage/concentrate feeding;
- quantitative studies of the nitrogen cycle in grazed grassland;
- reduced input systems for winter barley, oilseed rape and potato crops;
- flax preservation and retting;
- the fertilizer value of sewage sludge;
- investigation of methods to improve the resistance of concrete to attack by silage effluent.

Conditions are good for grass growth; perennial rye-grass or mixed rye-grass/clover swards in Northern Ireland produce in excess of $30 \text{ t ha}^{-1} \text{ yr}^{-1}$ of silage. All but a few hectares of the site are sown with perennial rye-grass and re-seeded on a seven-year cycle. The bulk of this is harvested in a three-cut silage system or grazed by sheep or dairy cattle. Within this regime are small areas of permanent pasture, including the ECN Target Sampling Site (TSS). The TSS is managed on a two-cut silage system with the sward grazed early and late in the season by sheep. This is regarded as more typical of best local practice in the north Co Down area than the more intensive management adopted elsewhere on the farm.

The State Forest in Large Park is mostly coniferous plantations, with Norway spruce (*Picea abies*) and hybrid larch (*Larix x eurolepis*) as the main species. There is a sizeable area of mixed amenity woodland around Hillsborough Lake but elsewhere only scattered blocks of pure broadleaved trees with beech (*Fagus sylvatica*), sycamore (*Acer pseudoplatanus*) and oak predominating.

There is a long history of research at the site which has had a manual meteorological station for over 40 years and, more recently, automatic stations at some of the experimental sites. There are also precipitation collectors at several locations.

Moor House – Upper Teesdale, Cumbria and Durham, England (Lat $2^{\circ} 20' \text{W}$; Long $54^{\circ} 40' \text{N}$)
Sponsors: Natural Environmental Research Council and English Nature

This site, which is also a UNESCO Biosphere Reserve, comprises two National Nature Reserves (NNRs), is situated in the northern Pennines, and is the largest and highest site presently in the network.

Moor House was designated as the first English NNR in 1952, and was intended both to protect rare or endangered communities of animals or plants and as a good example of an upland ecosystem to be used as an 'open-air' laboratory. The Reserve covers approximately 3500 ha and its altitude ranges from 290 m to 848 m. The geology is Carboniferous and consists of alternating strata of limestone, sandstone and shale into which dolerite of the Great Whin Sill has intruded. The eastern side of the Reserve slopes gently and rocks are commonly masked in clayey glacial till, making the drainage poor and resulting in the development of blanket bog with peat 2-3 m deep. The vegetation here is dominated by cottongrass and sphagnum moss (*Sphagnum* spp.), with heather at lower altitudes but not at higher altitudes. The western side of the Reserve slopes steeply and rocks are commonly exposed, giving rise to a wider variety of soils and more diverse vegetation. The climate has been described as sub-arctic oceanic with rainfall averaging 1900 mm per year and ground frost being recorded in all months of the year.

Upper Teesdale NNR was established in 1963, and extended in 1969, to protect its unique arctic/alpine plant communities and other flora and fauna. It covers 3000 ha and ranges in altitude from 300 m to 780 m. At the lowest altitudes there are deciduous woodlands and herb-rich meadows but the majority of the Reserve is used for sheep grazing and grouse shooting. The geology, soils and vegetation of much of the site are similar to those of Moor House NNR but an unusual feature is the 'sugar limestone' soil, derived from limestone which has been metamorphosed by the dolerite intrusion - this soil and the damp river-side soils support many of the rarer plant species.

Meteorological recording began at Moor House in the 1930s and at 560 m this was by far the highest point in Britain at which records had been made, excepting Ben Nevis where the station had closed at the turn of the century. Research began in earnest in 1952 with the opening of the Moor House Field Station. Studies on the impact and potential of moorland management led to the establishment of experimental plots on a variety of vegetation types to examine the impact of sheep grazing intensity on vegetation and soils. Plots were also established where heather burning for grouse management and tree planting took place. Moorland drainage ditches were studied on a small catchment basis. Annual variations in invertebrate populations, accumulation and erosion of peat, and inter-actions between terrestrial and aquatic ecosystems were also examined.

In the late 1960s and early 1970s the blanket bog ecosystem at Moor House was studied intensively as part of the International Biological Programme. This work obtained estimates of primary and secondary biological production and quantified the main pathways and rates of circulation of dry matter and nutrients. A major series of faunal studies, some of them long-term and carried out principally through the University of Durham, have contributed significantly to the selection of some variables to be measured in ECN. At this time intensive work was undertaken at Upper Teesdale, stemming from concerns over building the Cow Green Reservoir, particularly its impact on fish populations and terrestrial plant communities. A weather station was set up to determine whether the presence of the reservoir would have an impact on local meteorological variables. In the 1980s research emphasis moved to the deposition of atmospherically transported pollutants, including the effects of altitude and the role of clouds in deposition.

The site has been a focus in NERC's Terrestrial Initiative in Global Environmental Research (TIGER). Sampling for the programme has been distributed across the site and there are three major research locations. An altitudinal sequence of sites has been established in which global warming has been simulated by moving soil cores from high to low altitudes, with some being retained at the higher site to act as controls; vegetation and nutrient dynamics of the cores are being investigated. At a second location small, open-top, plastic greenhouses have been installed at the interface between bracken and heather to study the impact of increased temperature on competition between these species. Similar greenhouses are being used at a third site to study the impact of elevated temperature on invertebrate populations.

A meta-database is available, giving details of past and present research and an archive of research data and documents is also maintained.

North Wyke, Devon, England (Lat 3° 54'W; Long 50° 46'N)

Sponsor: Biotechnology & Biological Sciences Research Council

North Wyke Research Station, part of the Institute of Grassland and Environmental Research (IGER), lies in undulating countryside to the north of the Dartmoor National Park boundary, 6 km north-east of Okehampton. The River Taw flows northwards through the site. Altitude ranges from 120 m to 180 m. Annual mean rainfall (1961-90) is 1034 mm, with a pronounced winter maximum from October to January. The wettest and driest months are January (129 mm) and July (53 mm) respectively. February (4.3°C) is the coldest month and July (15.3°C) the warmest. The annual total of hours of bright sunshine is 1448, with a mean daily range from 1.6 hours in December and January to 6.4 hours in June.

The site comprises 250 ha, of which 200 ha are lowland grassland typical of conditions in wetter, western Britain and 50 ha are deciduous woodland, mainly oak, ash and birch. The soils are predominantly impermeable clays and silty clays of the Hallsworth, Halstow and Denbigh/Cherubeer soil series, collectively known as the Culm Measures, and typically support permanent grass and dairying. The only well-drained soils on the Station comprise a narrow band of the Teign soil series alongside the River Taw.

IGER has a broad-based interest in climatic change with expertise spanning molecular biology, acclimatory physiology, environmental impact, and grassland agronomy and ecology. Specific topics include plant responses to drought, temperature extremes and elevated CO₂ levels. At North Wyke, which has new laboratory and extensive field-based facilities, there are research programmes on low-input grassland farming and relationships between grassland and the environment. Studies of nutrient cycling, especially of nitrogen but also of phosphorus, through the soil/plant/animal/farm wastes chain and effects on environmental quality, constitute major research programmes. There is particular emphasis on understanding the fluxes of nitrogen to waters as nitrate, and to the atmosphere as ammonia, nitrous oxide and nitrogen gas. Other research seeks to quantify and understand the emission of important greenhouse gases such as methane and nitrous oxide from grassland; pests and diseases, vegetation management to encourage species diversity, plant/animal interactions and the functioning of managed and natural grassland, and agroforestry are other research topics. About one-third of the

managed land area at the site is sown to grass/clover swards reflecting the interest in lower-input managed grasslands.

North Wyke has records of temperature, rainfall and sunshine for the 30-year standard period 1961-90 with open-pan evaporation measurements available since 1983.

The TSS is a 0.66 ha paddock of old, biodiverse permanent grassland, comprised mostly of rough meadow-grass (*Poa trivialis*), perennial rye-grass, Yorkshire-fog (*Holcus lanatus*) and creeping bent (*Agrostis stolonifera*) with a considerable ingress of rush (*Juncus*) species in one area, which receives no nitrogen fertilizer inputs. There has been no history of N fertilizers being applied to the TSS for many years, possibly since the 1940s. Controlled cattle grazing, with zero N input, is by beef cattle from April to October, their numbers being varied to maintain a compressed sward height of 5-6 cm. Sward productivity is measured under exclusion cages four times each year and liveweight gain of the grazing cattle is monitored annually.

Porton Down, Wiltshire, England (Lat 1° 43'W; Long 51° 07'N)

Sponsor: Ministry of Defence

Porton Down lies to the north-east of Salisbury, on the southern edge of Salisbury Plain and has been part of a Government establishment since the First World War when chemical weapons were first used on the battlefield. The requirement for a testing and experimental ground resulted in the setting up of the first restricted area at Porton. By 1918 the 'Range' had been acquired, encompassing approximately the same area now owned by the Chemical and Biological Defence Establishment (CBDE).

The continual use of the site for experimental purposes has effectively excluded the modern agricultural development seen over the vast majority of southern England. This has resulted in the core of the area remaining as a unique snapshot of Wessex downland as it might have been centuries ago.

The ECN site, set up in 1994, has been a Site of Special Scientific Interest (SSSI) since 1977. The SSSI covers 1227.4 ha, of which approximately 190 ha are beech and conifer plantation, 30 ha mixed broadleaved woodland, and the remainder semi-natural chalk grassland with successional scrub. Apart from Salisbury Plain, which lies only a few kilometres away, this is the largest remaining tract of chalk grassland in the British Isles. Typically, both of these military areas are surrounded by intensive, largely arable, agriculture.

Porton Down is underlain by Upper (Cretaceous) Chalk with a few small patches of clay-with-flints on the high ground mainly to the west. The soils are generally referable to the Icknield series which comprises shallow, mostly humose, well-drained calcareous soils. Deeper flinty calcareous silts can be found in small coombes and valleys. The only acid soils are the caps on high ground and a few small areas on valley-sides. These soils are almost all free-draining.

The climate lies between the strong maritime influence of the Atlantic and the 'continental' influence of south-east England (the sub-Atlantic). The site is within the region which experiences the highest maximum temperatures in the UK, but also some of the lowest minima. The coldest months are January and February (February mean temperature 3.2°C), and the hottest months are July and August (July mean temperature 15.7°C). The number of days with frost averages 109 whilst mean daily sunshine averages 1.7 hours in December and 7.0 hours in June. Rainfall is highest in autumn and winter due to the maritime influence. Mean rainfall is 750 mm (800-850 mm on the highest parts of the SSSI). Much of the site lies around the 125 m contour line although the highest points are at 170 m.

The vegetation has only relatively recently been well documented, with systematic surveys in the early 1970s and in 1991. The greatest interest lies in the tracts of high-quality semi-natural chalk grassland together with large populations of localised plants and exceptional lichen communities. The rarest forms are those of sheep's

fescue/mouse-ear hawkweed/thyme (*Festuca ovina*/*Hieracium pilosella*/*Thymus* spp.), which have superb communities of terricolous lichens and abundant bryophytes. This grassland type is known only from Porton Down and from the Breckland of East Anglia. The main reason for the uniqueness of the downland vegetation is the continued existence of high populations of rabbits (*Oryctolagus cuniculus*). Rabbits appear to have made a sustained recovery from myxomatosis at Porton Down and essentially 'drive' the dynamics of the grassland communities.

Apart from the woodland which is mostly recent and therefore largely lacking in botanical interest, the other feature of great importance is the juniper (*Juniperus communis*) scrub. The population of junipers, many of which are very old, is considered to be the finest in lowland Britain.

The animal populations are diverse and unique and reflect the rarity of the habitat. Of the higher vertebrates, the stone curlew (*Burhinus oedinemus*) population is of national importance (about 10% of the UK total). Among the invertebrates, the butterfly populations are of immense national importance and include such rarities as the silver-spotted skipper (*Hesperia comma*). There are very large numbers of other species, particularly dark-green fritillary (*Mesoacidalia aglaja*) and marbled white (*Melanargia galathea*). Other important invertebrate communities include those associated with juniper, as well as spiders and moths.

Rothamsted, Hertfordshire, England (Lat 0° 22'W; Long 51° 49'N)

Sponsor: Biotechnology & Biological Sciences Research Council

Rothamsted was founded in 1843 and is the oldest continuously functioning agricultural research station in the world. The estate lies to the west of Harpenden, 40 km NNW of London, on a gently undulating plateau 95-134 m in altitude. The soils are well-drained to moderately well-drained flinty silty loams over clay-with-flints and/or chalk. Rothamsted farm and most of the surrounding area have been taken up with arable agriculture for 2000 years.

A number of long-term experiments, the 'Classical Experiments', were established at Rothamsted in the second half of the 19th century. These cover cereal growth, grassland management and woodland regeneration, and are a unique record of environmental change; they are backed up by long runs of meteorological, soil chemical and biological, and plant composition data.

Broadbalk, the most famous of the Classical Experiments, was first sown to winter wheat in 1843 and harvested in 1844. Wheat has been grown on all or part of the field every year since then to compare different organic manures with inorganic fertilizers. The treatments were varied in the first few years but since 1852 a more permanent scheme has been established. Some changes have since been made to ensure that the experiment remains relevant to modern agricultural and environmental problems, including the use of modern varieties of wheat. Yields of grain and straw have been recorded yearly and samples taken for chemical analysis. These samples, together with those from the other Classical Experiments, are archived and are still available for analysis.

The Broadbalk soil, which is a heavy clay loam overlaying chalk (Batcombe series), has been sampled and archived irregularly since the start of the experiment, but in recent years a scheme to sample and store it on a five-year cycle has begun. The samples have been used to look at changes in soil organic matter pre- and post-atomic levels of radionuclides, the build-up of various heavy metals and increases in organic compounds such as dioxins and PCBs.

The Park Grass Classical Experiment was started in 1856, but it is thought that the field had previously been in pasture for up to 200 years. It was established to examine the effect of different fertilizers on the production of hay but soon developed into an experiment that shows the effect of different types and amounts of fertilizer and lime on botanical populations. The plots are cut for hay in June and again in October for silage.

Small amounts of lime were applied to Park Grass twice in the 1870s and 1890s; a regular liming scheme was introduced in 1903, with lime added to half of most plots every four years. This continued to 1964 when the plots were further divided into four subplots of which three are now limed to a pH of approximately 7, 6 and 5 respectively; the fourth is left unlimed. The overall pH of the experiment was 5.7-5.8 in 1856. Where fertilizer is added as ammonium sulphate the plots have become very acid, with the pH of the surface soil on some plots being as low as 3.9 (in water) where lime has not been added. The steady acidification has resulted in aluminium, suddenly released from the soil when the pH reaches a critical value of about 4.2, being taken up in large amounts by the hay. The fertilizer and lime treatments have also affected the species composition of the plots. The most acidic plots are dominated by one or two species, eg Yorkshire-fog and sweet vernal-grass (*Anthoxanthum odoratum*), and are similar to an upland grassland. The unfertilized plots are still the most diverse and similar to a lowland pasture, containing 40-60 species.

A small part of the west end of the Broadbalk Experiment (0.2 ha) was fenced off in 1882, and a larger area of a bean field (1.3 ha) called Geescroft was fenced off in 1886. Both areas have been left untended and on both a mixed deciduous woodland has developed. These wilderness sites provide a resource for studying the long-term effects of acid rain on soil acidification, weathering and the mobilisation of toxic metals.

Aerial insect populations of moths and aphids have been monitored daily throughout Great Britain for the last 25 years by the Rothamsted Insect Survey. This has used a network of light and suction traps and has produced a unique database on invertebrate populations covering over 1000 species. These data have been used for a wide range of purposes, from applied pest forecasting and fundamental population dynamics to studies on the effects of climatic and environmental change on insect populations. Three light traps have been run continuously on the Rothamsted estate for over 25 years, and for one data go back almost 60 years. Results clearly show that large changes in insect populations have occurred as a result of intensification in agriculture, some of the largest changes in diversity and population size taking place during the 1950s.

Sourhope, Borders Region, Scotland (Lat 2° 15'W; Long 55° 30'N)

Sponsor: *Scottish Office, Agriculture, Environment & Fisheries Department*

The Sourhope Research Station of the Macaulay Land Use Research Institute is situated 24 km south of Kelso, on the western slopes of Cheviot close to the Scotland/England border. The Station covers 1119 ha and the range in altitude is 200-600 m. Of the land resources, 989 ha are rough grazing, 105 ha permanent pasture and 23 ha woodland. The long-term mean rainfall at 210 m is 1055 mm and the mean daily number of sunshine hours is approximately 3.8. There can be considerable snow cover in the winter.

The soils are developed on locally derived drift from andesitic lavas of Old Red Sandstone. Brown forest soils of the Sourhope series characterise the lower slopes whilst more acid peaty podzols (Cowie series) and peaty gleys (Edgerston series) occur at higher elevations, with small areas of deep peat on hill summits. Stony skeletal soils are found on steep slopes.

Approximately 30% of the rough grazings occur on mainly brown forest soils where bent and fescue species predominate, with bracken of varying density. The remaining rough grazings at higher elevations are grass heaths dominated by mat-grass (*Nardus stricta*) or purple moor-grass (*Molinia caerulea*). The permanent grassland has been derived mainly from reseeding with perennial rye-grass/white clover (*Trifolium repens*) of formerly bent/fescue areas 10-30 years ago. Approximately 20 ha can be used for the production of hay or silage. There are small areas of coniferous woodland, aged 20-40 years, which act in part as shelterbelts. There are a number of streams draining the six hills on the Station and these drain small catchments with steep-sided valleys.

The vegetation resources are grazed by 2200 hill ewes, predominantly of the Scottish Blackface and Cheviot breeds, the latter comprising pure-bred sheep of the North Country and the South Country breeds together with crosses between the two breeds.

There is also a cashmere goat herd of 450 breeding females and followers and a herd of 50 beef cows. Most of the ewe flock and cashmere goat herd are wintered outside. The permanent pastures are used in the summer by the most productive sheep and goats and for the production of silage for feeding the beef cows in the winter. In the autumn the pastures are grazed by ewes prior to their mating and are rested from grazing in the winter. The output from the ewe flocks and the beef cow herd is mainly sold as store lambs and weaned calves in the autumn.

Sourhope Research Station has been used as a research facility for almost 50 years. In consequence there is a comprehensive record of how the resources have been managed and a long run of meteorological data for this period. There have also been long-term sheep systems and soil fertility experiments which provide extensive information of the resources over past years. In addition, monitoring of precipitation and stream chemistry had been initiated prior to the start of the ECN.

Current research focuses on:

- vegetation change in permanent pastures subjected to low grazing pressures and no fertilizer inputs;
- vegetation change in mat-grass grassland grazed by combinations of sheep and cattle;
- cashmere production from goats;
- semi-fine wool production and breeding for higher reproductive potential in sheep;
- smaller-scale studies being conducted often in collaboration with other research institutes and universities.

Wytham, Oxfordshire, England (Lat 1° 20'W; Long 51° 47'N)

Sponsor: Natural Environmental Research Council

Wytham Estate has been owned by the University of Oxford since 1943 and is renowned for the pioneering studies of community and animal ecology which have been carried out in Wytham Woods. Wytham, like the Moor House-Upper Teesdale ECN site, is a focus for the NERC TIGER programme, and major experiments to understand and predict the effects of climate change on woodland and grassland ecosystems are taking place at the site. Wytham continues to be used by researchers in many other areas of the environmental and biological sciences, many but by no means all of whom are based at Oxford University. The ECN site consists of two main areas: Wytham Woods and the University Farm. The Woods cover approximately 400 ha and include unmanaged ancient and secondary woodlands, plantations, and small areas of semi-natural grassland. The Farm covers approximately 370 ha and produces a variety of livestock and crops; it is operated commercially but there is provision for research.

The whole site is encompassed by a loop of the River Thames, 5 km north-west of Oxford; it rises from an altitude of around 60 m on the river floodplain to 165 m at the top of Wytham Hill. A change in geology and soil type parallels the topography. Alluvium beside the Thames overlies Oxford Clay and away from the river the clay is exposed, with a large area of deep, heavy soils (eg Denchworth series) which are often waterlogged in winter. Towards the top of Wytham Hill is a thin band of sandstone, (giving rise to sandy Frilford series soil in places) and the summit is composed of coral rag limestone covered by extremely thin, well-drained soils (Sherborne or Morton series). A number of streams, many of which dry up in summer, rise on the estate and drain into the Thames.

The climate is typical of the Midland region; long-running data from the Radcliffe Meteorological Station in Oxford, where the first measurements were made in 1767, show a mean annual rainfall of 640 mm and mean air temperatures of 3.6°C for January and 16.4°C for July, the coldest and warmest months of the year respectively.

Vegetation on the estate was systematically surveyed in 1993 and 1994, building on earlier work. The ancient woodland, ie that believed never to have been cleared, is mostly abandoned coppice or coppice-with-standards. Hazel (*Corylus avellana*) and maple (*Acer campestre*) are the most common coppice species and oak the most frequent standard. Quite large areas of the woods are known to have grown up naturally

in the last 200 years or so, after the abandonment of wood pasture, pasture, or cultivation, and the most prominent trees here are ash and sycamore. Neither the ancient nor the secondary woodland is actively managed and where possible dead wood is left where it falls. Plantations of various broadleaved and coniferous species have been established, most of which are 40-50 years old, though there are also some much older stands of beech. The semi-natural grasslands are mainly on the limestone areas and include areas of both ancient and modern origins; the latter have been the subject of a number of studies in vegetation succession. The agricultural land includes improved permanent pasture, grass leys and arable land used for wheat, barley, oilseed rape and other conventional crops; there are also hedgerows and some small wetland areas around drainage systems.

The animal populations include large numbers of fallow (*Dama dama*) and muntjac (*Muntiacus reevesi*) deer which have a major influence on woodland structure by browsing the shrub layer. Badgers (*Meles meles*) are also very common and have been studied in great detail; wood mice (*Apodemus sylvaticus*) and bank voles (*Clethrionomys glareolus*) have been monitored since 1948. As many as 152 bird species have been recorded on the estate, approximately half of which are regular residents. In-depth studies on blue tits (*Parus caeruleus*) and great tits (*Parus major*) have allowed numbers to be followed from year to year and have led to an understanding of some of the mechanisms determining breeding success in relation to climatic fluctuations. Birds of agricultural land, such as starlings (*Sturnus vulgaris*), have also been the subject of much intensive research in recent years. Amongst the invertebrates the site is notable for the presence of five species of hairstreak butterflies (*Strymonidia* spp.) and important research on many other groups has been carried out here.

Y Wyddfa/Snowdon, Gwynedd, Wales (Lat 4° 05'W; Long 53° 04'N)

Sponsors: Countryside Council for Wales and Welsh Office

The Y Wyddfa/Snowdon site is situated 19 km south-east of Bangor in north Wales. The site is located in very rugged terrain and includes the summit of Y Wyddfa or Snowdon, the highest mountain in England and Wales. Its altitudinal range is 298-1085 m and in addition to Y Wyddfa it contains three other summits over 800 m. Snowdon is a popular destination for walkers and the visitor pressure, though high, is generally concentrated along the main footpaths. The site is part of the Y Wyddfa/ Snowdon National Nature Reserve and is managed by the Countryside Council for Wales under agreement with the owner.

The bedrock is a mixture of Ordovician acidic and basic volcanic rocks, with localised igneous intrusions. Evidence of glaciation is widespread and there is a prominent set of corrie moraines dating from the Loch Lomond Stadial. There are five lakes within the site, the three largest of which form a 'staircase'. The soils are varied and include brown earths, brown podzolic soils, gley podzols, gleys, stagnohumic gleys, organic peat soils and humic rankers. There are significant areas of frost-shattered scree beneath the steeper slopes.

Rainfall data have been collected at the site since the early part of the 20th century and other meteorological variables have been measured systematically since the 1960s. Rainfall is high and mean annual range across the site is generally in the range 3000-4000 mm. The mean annual number of days with rainfall >1 mm is 200 and, on average, snow lies for between 16 and 100 days per year, depending on altitude and aspect. Mean monthly air temperature at the TSS ranges from 2.8°C (February) to 15.3°C (August).

The predominant vegetation is acidic grassland with large areas dominated by sheep's fescue and bent in more freely drained areas and mat-grass where drainage is somewhat impeded. There are localised areas of calcicolous grassland with wild thyme (*Thymus praecox*), red fescue (*Festuca rubra*) and marsh thistle (*Cirsium palustris*). The largest of these areas includes the ECN TSS. There are small areas dominated by heather on steeper ground. Where the cliffs have a base-rich influence, tall-herb and crevice vegetation has developed; these locations are an important locus for a number of

arctic/alpine species including the Snowdon lily (*Lloydia serotina*) which in Britain is restricted to the mountains of Snowdonia. Scree vegetation occurs beneath the major cliffs, with frequent parsley fern (*Cryptogramma crispa*). The site also contains the largest stand of vegetation dominated by dwarf juniper (*Juniperus communis alpina*) south of the Scottish Highlands. Finally, in the lower part of the site there are areas of blanket mire with abundant cottongrasses.

The site is unenclosed and is grazed by Welsh mountain sheep, in addition to which there is a small herd of feral goats.

Research at the site dates back to the 1950s when work started on the distribution patterns of sheep grazing on different vegetation types. A number of small sheep exclosures which were set up in the 1950s remain on the site and form part of a sequence of such sites extending across the mountains of north Wales. Research into the energy flow and productivity of calcicolous grassland was undertaken as part of the International Biological Programme during the 1970s. Research has been undertaken more recently to assess the effects of different grazing levels on invertebrate populations.

Operation of ECN

ECN operates by consensus of its participating agencies, each of which is represented on the ECN Steering Committee, the body responsible for the main policy decisions affecting the network. The Steering Committee normally meets annually but a subgroup, the ECN Executive Committee (ECNEX), expedites urgent decisions as well as developing ideas and recommendations for the Steering Committee. The two Working Groups which were instrumental in developing the technical and statistical elements of the network have recently been amalgamated to form a joint Statistics and Technical Advisory Group (STAG) which reports to the Steering Committee. NERC provides the day-to-day management of the network by providing and supporting the ECN Central Co-ordination Unit (CCU) which is responsible for standardising procedures and for co-ordinating data collection and management. The CCU has four full-time staff: the ECN Co-ordinator, a statistician, a data manager and an assistant data manager, all of whom are staff members of the Institute of Terrestrial Ecology. At each site a sponsoring agency provides a Site Manager who is responsible for organising the timely collection and initial processing of data according to the agreed Protocols, and transmission of the data to the ECN Data Manager in an agreed format. The current organisation of ECN is shown in Figure 2.

J.M. Sykes

ECN Co-ordinator 1992-95

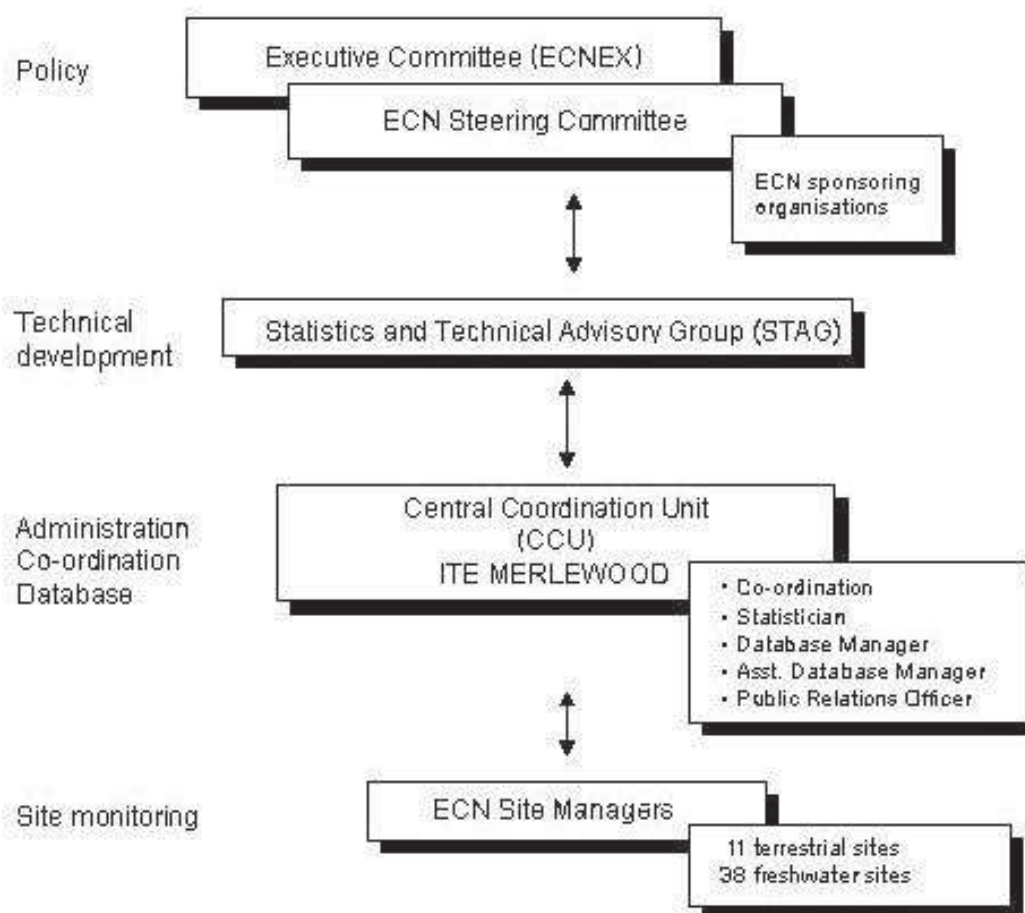


Figure 2. Organisation of ECN

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