

**Supporting Documentation**  
**Environmental Change Network**  
**Freshwater Site Locations**

*Chapter 1 from:*

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# Chapter 1 INTRODUCTION

## Monitoring 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.

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 concentrated in databases and Geographic Information Systems (GIS) at designated Environmental Data Centres. Contributions are made from UK environmental monitoring programmes to international programmes such as the UN-ECE's International Co-operative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (IMP), and the United Nations Environment Programme's Global Environmental Monitoring System (GEMS) and Global Resources Information Database (GRID).

## 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 re-assuring the public.

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 quality 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.

## Monitoring freshwaters in the UK

Freshwater ecologists in the UK have long recognised the value of multi-disciplinary, long-term research and monitoring. The first comprehensive study of change in the lakes in the English Lake District was conducted by W.H. Pearsall between 1913 and 1928 (Pearsall 1930, 1932). A few years later, the Freshwater Biological Association (FBA)

was established on the shores of Windermere and it implemented a comprehensive lake survey programme using methods which have changed very little over the years (Lund & Talling 1957; Macan 1984). Elsewhere in the UK, several university research groups developed an interest in freshwater ecology and started a number of shorter-term surveys on rivers and reservoirs as well as on natural lakes. In the 1950s, one of the most productive groups was that led by W. D. Slack at Loch Lomond (Slack 1957). Several other university groups were set up in the 1960's, the most influential being those based at the University of Liverpool (see Hynes & Yadav 1985) and the London University colleges (see Duncan 1990). Much of the work done in London was centred on the Thames reservoirs where the Metropolitan Water Board was responsible for developing new methods and models (Ridley 1970; Steele 1972). Another significant influence in the 1970s was the research group established by the International Biological Programme on Loch Leven, Kinross (Morgan 1974). Most of the university research groups established during this period have now been dispersed but the work at Loch Leven continued and the site is now part of the ECN.

All effluent discharges into groundwater, inland and coastal waters in the UK require the consent of a regulatory authority. In England and Wales the Environment Agency (EA) is the responsible agency and it maintains public registers containing information about water quality, discharge consents, authorisations and monitoring. Similar arrangements apply in Scotland and in Northern Ireland, where control is exercised respectively by the Scottish Environment Protection Agency (SEPA) and the Environment and Heritage Service. All standing waters used for public water supply are monitored at regular intervals by the Water Companies and a large number of river sites are now monitored systematically by the statutory authorities. The most comprehensive freshwater monitoring programme in the UK is the Harmonised Monitoring Scheme (Simpson 1980). This operational scheme was established in 1974 to co-ordinate the collection of river water quality data throughout Britain and has recently evolved to include a separate sampling programme for Scotland.

## **The Environmental Change Network**

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 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 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' (HMSO 1984).

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 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.

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 the 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 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 data sets 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 data sets so as to identify environmental changes and to improve understanding of the causes of such changes.
- To make these long-term data sets 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 which are unable to commit funds for more than 3–5 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 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.

## Development of the network

Although ECN was conceived of as a programme covering a wide range of natural, semi-natural and managed terrestrial ecosystems as well as freshwaters, the need for urgent 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, which would 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 (page 40); it includes agencies responsible for both the freshwater and terrestrial sites. Additional information on the contributing agencies is provided in Chapter 5 (page 131).

## Site selection

Criteria for selection of ECN Freshwater sites are:

- a wide geographical spread, with a range of both upland and lowland catchments;
- known anthropogenic influences with site catchments having a known history of past change;
- preferably already monitored for a wide range of determinands;
- adequate size, in terms of flow or residence time, to have the capacity to respond to and integrate changes in their catchments.

It was recognised from the outset that it would be difficult to obtain absolute guarantees of long-term financial security and, as with the terrestrial sites, participating agencies could only be asked to state their firm intention of continuing support for a target number of years. Physical security, from the point of view of continuity of catchment land use practices, would also be difficult to achieve; it was inevitable that periodic disruptions such as afforestation and clear-felling would continue where forestry was the main land use. The main drivers of change in freshwaters were expected to be the same as those at terrestrial sites, (ie climate, pollutants and land use), and the question of whether the network should be concerned with only clean or only polluted waters was considered. It was concluded that there should be a spread of qualities which might allow the effects of the removal or addition of impacts to be studied. Pragmatism, and the need to meet the criteria outlined above, demanded that for the most part sites where monitoring was already in place should be used in the network and the selection was made accordingly from sites offered by sponsoring organisations.

There are currently 42 freshwater sites in ECN (Figure 1, page 17), two of which are joint terrestrial and freshwater sites. The distribution of the freshwater sites is currently being examined in relation to the main patterns of environmental variation across the UK and is expected to show that they are reasonably representative of the main landscape types. The sites have not been analysed in relation to climate, and at present there is no standardised method for meteorological recording at ECN freshwater sites, although it is anticipated that such routine recording will eventually be incorporated in the programme.

## Variable selection

Variables were selected because they may indicate the possible causes and consequences of environmental change in the aquatic environment. The causes of such change embrace changing climate, land use and industrial, urban and agricultural pollution.

Aquatic systems can be considered to consist of 'master variables' which are common to all freshwaters and include temperature, pH, major ions, oxygen concentration and transparency. Changes in these may significantly affect the system as a whole. Other variables mainly measure chemical concentrations, which are susceptible to changing inputs and biogeochemical processes, and biological components reflecting the overall water quality.

## Justification for selection of variables

### 1. Master Variables

Temperature	Fundamental physical property of water. Influences biogeochemical processes. Major variable in climate change studies.
PH	Measures hydrogen ion concentration of waters. Short-term shifts from air equilibrium values can be caused by depletion of carbon dioxide by plant growth and imbalances in the respiration rate of living organisations; long-term reductions in pH are related principally to increasing acidification.
Oxygen	Released into water by photosynthetic processes and consumed by respiration and chemical oxidation. Essential element in controlling biogeochemical processes.
Turbidity/Secchi disc	The only optical measurements. Measures of water transparency and underwater penetration of light. Important for determining plant growth.
Suspended solids	Gravimetric measurement of organic and inorganic particles in suspension.
Flow	Necessary for the calculation of loadings. Measure of catchment runoff and can be used to indicate changes in climate and both urban and rural land use. Contributions of significant discharges (floods) can be detected as can the effects of river management schemes. Efficacy of flow measurements can be affected by excessive macrophyte growth, exceptional low flows, and changes in channel cross-section due to deposition or flood events.

### 2. Major ions

Alkalinity, Chloride Sulphate, Sodium Potassium, Calcium Magnesium	Major ions give a measure of the basic chemical composition of the water. This may be altered by changes in terrestrial and/or atmospheric inputs.
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### 3. Major plant nutrients and associated variables

Ammonium	These variables give measures of the nutrient status of waters and information on their productivity. They are susceptible to change resulting from changes in terrestrial (rural, urban and industrial) and atmospheric inputs. Their total and particulate fractions can give valuable indicators of changing inputs and productivity. This is particularly useful when ratios of particulate C:N:P can be determined.
Nitrate	
Nitrite	
Total nitrogen	
Soluble reactive phosphorus	
Total phosphorus	
Particulate phosphorus	
Silicate	
Total organic carbon	
Particulate organic carbon	
Biological oxygen demand	
Suspended solids	
(105°C followed by ashing at high temperature to give measure of particulate carbon)	

### 4. Transition elements

Iron	These elements are important in biogeochemical processes in lakes, especially those which stratify. Seasonal increases during late summer and autumn are often associated with oxygen depletion in deep water.
Manganese	

### 5. Other elements

Aluminium	This element and its chemical state is pH dependent. It is of interest in lakes sensitive to, or undergoing, acidification. It may also give an indication of erosion in some circumstances. This element and its chemical state are pH dependent. It is of interest in lakes sensitive to, or undergoing, acidification. In some circumstances it may also give an indication of erosion.
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### 6. Heavy metals

Mercury	The presence of metals will be indicative of industrial discharges (aerial and effluent), sewage discharges, waste disposal, mining, and surface runoff from both urban and rural areas. In urban areas the contribution of metals from road surfaces is considerable and is associated mainly with the carried sediment. Metals are also associated with livestock slurries because copper, zinc and arsenic are incorporated in feed concentrates. The contribution from sewage sludge applied to land is likely to increase as a consequence of the 1998 ban on disposal at sea. Important factors controlling the sediment – water metal partitioning include changes in the ratio of flow to: suspended solids, dissolved organic content, ionic strength, pH, redox conditions as well as biochemically mediated reactions mobilising metals. Apart from sediments, metals will be accumulated by plankton, macrophytes and invertebrates.
Cadmium	
Copper	
Zinc	
Tin	
Vanadium	
Nickel	
Arsenic	
Lead	

## 7. Biological variables

Chlorophyll <i>a</i> Periphyton Macrophytes	Measures of plant biomass and indicators of nutrient status. Will affect levels of oxygen concentration and pH. Excessive growths will limit light penetration and contribute to organic loadings of sediment.
Invertebrates	Species and diversity of macro-invertebrates are useful indicators of general water chemistry, and for rivers a baseline against which data may be evaluated is provided by RIVPACs. Lake classification systems have also been based, successfully, on invertebrates, (eg Chironomidae). These are sensitive, for example, to trophic status and acidification. While littoral fauna are much more variable than profundal benthos, they are likely to be more responsive to change in water quality in the short-term and are easier and cheaper to sample. Routine sampling of invertebrates will therefore be confined to littoral communities but core samples from profundal regions may also be used to determine, retrospectively, longer-term changes in the profundal fauna.
Zooplankton	Measure of planktonic secondary production. Forms an important link in the food chain between the phytoplankton and fish. Some species are sensitive to relatively subtle changes in water chemistry.

## Network sites

Figure 1 (page 17) shows the locations of the 42 freshwater sites as well as the 12 terrestrial sites. The freshwater sites are described below. In these descriptions latitude, longitude, National Grid Reference (NGR) and Irish Grid Reference (IGR) refer to the location at which chemical samples are taken (see Protocol FWC, page 56).

### L01 Upton Broad

Norfolk, England (Lat 52° 40'N; Long 1° 32'E; NGR 6387 3134)

Sponsor: *Environment Agency, Anglian Region*

Upton Broad is a shallow lowland lake, formed by the flooding of peat diggings, which were abandoned in the 14th century. It has an area of 6.9 ha and an approximate mean depth of 0.8 m. The broad lies in the valley of the River Bure at an elevation of less than 10 m above Ordnance Datum (AOD), but is isolated from the river system and is groundwater fed, with some drainage from surrounding land. Geologically, the area is underlain by Quaternary deposits of Norwich Crag, with glacial till and outwash deposits at the surface. The broad forms part of the Upton Broad and Marshes Site of Special Scientific Interest (SSSI). It is considered to have been relatively unaffected by the eutrophication that has damaged most of the lakes in the region, and supports a population of the nationally rare aquatic macrophyte *Najas marina*. The broad is surrounded by a band of alder (*Alnus glutinosa*) carr (wet woodland). To the north of the broad are drained grazing marshes which form part of the Broads Environmentally Sensitive Area, and to the south the catchment is given over to more intensive arable agriculture. The broad is used for angling by a private club; there is no other public access.



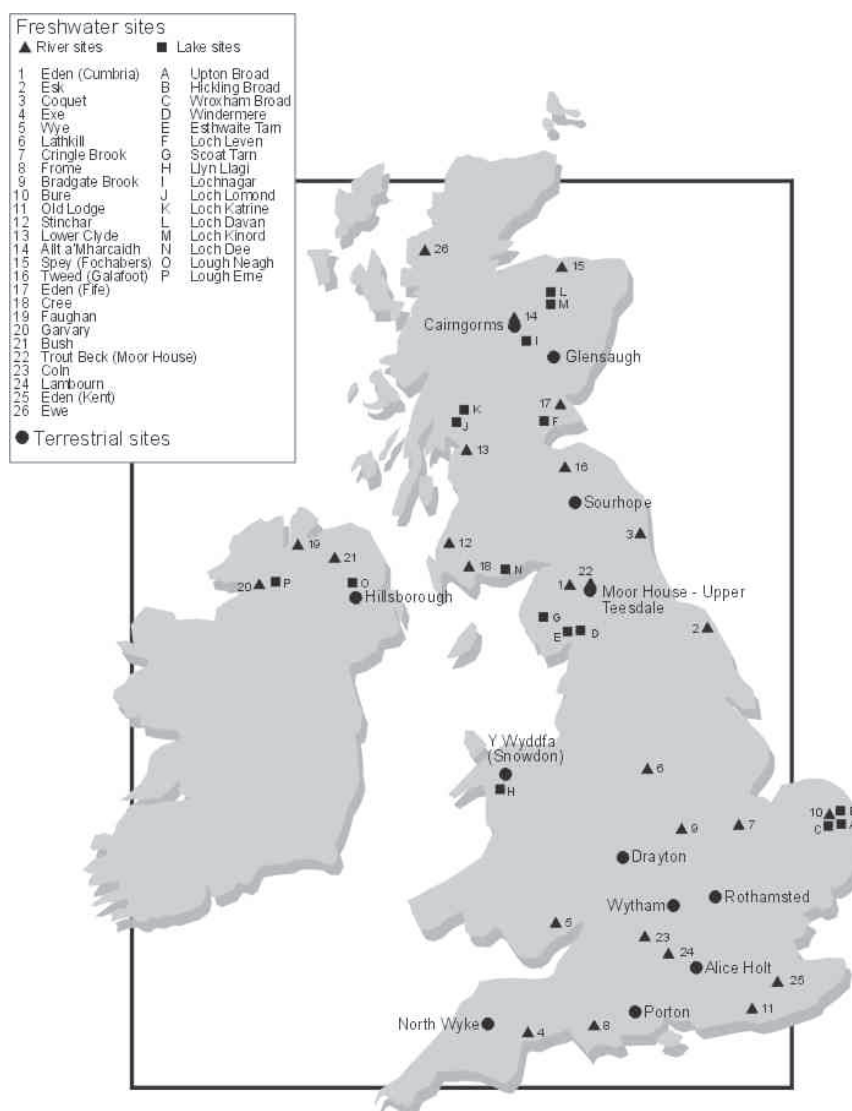


Figure 1. Location of ECN freshwater and terrestrial sites

## L02 Hickling Broad

Norfolk, England (Lat 52° 44'N; Long 1° 35'E; NGR 6415 3215)

Sponsor: Environment Agency, Anglian Region

Hickling Broad is the largest of the lakes that make up the Norfolk Broads, and is a result of extensive peat digging in the 12th and 14<sup>th</sup> centuries followed by flooding due to a rise in sea-level. The broad has an area of 141.1 ha, and an approximate mean depth of 1.3 m. It lies close to sea level in the valley of the River Thune and is connected to the river by an artificial channel approximately 0.7 km long. The broad is subject to a small tidal variation in water height and is brackish. It is part of a National Nature Reserve (NNR), owned and managed by the Norfolk Wildlife Trust. The broad is surrounded by extensive areas of reed bed and grazing marsh, although parts of the catchment have been deep-drained for arable cultivation. Geologically, the area is underlain by Quaternary deposits of Norwich Crag, with glacial till and outwash deposits at the surface. The broad is used extensively for recreational activities – sailing, windsurfing, tourist cruisers and angling. The broad is not subject to any point sources of nutrient input and has maintained a substantial aquatic macrophyte population in recent years, although there have been signs of eutrophication. At times it has suffered extensive fish kills due to the presence of the alga, *Prymnesium parvum*.

### **L03 Wroxham Broad**

Norfolk, England (Lat 52° 41'N; Long 1° 25'E; NGR 6312 3167)

*Sponsor: Environment Agency, Anglian Region*

Wroxham Broad is a shallow, lowland lake formed from the flooding of mediaeval peat diggings which were abandoned in the 14th century. The broad has an area of 34.4 ha and an average depth of 1.3 m. It is located in the middle reach of the River Bure, close to the upper tidal limit, at an elevation of less than 10 m AOD. The broad lies on the west side of the river, to which it has two navigable openings. It is separated from the river channel by a narrow, tree-covered bank. The broad has been subject to serious eutrophication, largely as a result of the discharge of treated sewage effluent to the River Bure. Since 1986 a programme of phosphorus removal has been in operation at the major sewage treatment works affecting the river, and this stretch of river is now designated a Sensitive Area under the Urban Waste Water Treatment Directive. The low gradients of the area and seasonally low flows of recent years have meant that the flushing rate of the broad is slow, although exact retention times are unknown. The surrounding catchment is underlain by Quaternary deposits of Norwich Crag, with chalk at depth, and superficial glacial till and outwash deposits. The area is subject to intensive agricultural activity, although surrounding the broad itself there are small areas of alder carr (wet woodland). The broad is used extensively for recreational purposes, particularly in the summer months.

### **L04 Windermere**

Cumbria, England (54° 24'N; Lat 2° 57'W; NGR 3382 5007)

*Sponsor: Natural Environment Research Council*

Windermere lies in the north-west corner of England in the English Lake District, an area of great natural beauty which has been a tourist destination since the romantic revival of the 18th century.

The dominant geological structure of the Lake District is that of a dome of Paleozoic rocks formed by uplift in the Tertiary. This uplift produced a radial drainage pattern which was enhanced during the Pleistocene glaciation, with the major lakes occupying bedrock basins in steep-sided, flat-floored valleys. Windermere is the largest natural lake in England having a surface area of 14.8 km<sup>2</sup> at an altitude of only 40 m AOD. The lake itself is divided by a shallow sill into two basins; the North Basin has a surface area of 8 km<sup>2</sup> and maximum depth of 64 m and the South Basin has a surface area of 6.7 km<sup>2</sup> and maximum depth of 42 m.

The North Basin of Windermere, which is the ECN sampling site, has a catchment of 180 km<sup>2</sup> which drains into the lake *via* two main rivers, several small tarns (lakes) and several streams. The catchment is mainly hill land, grazed by sheep throughout the year but also used intensively for recreational purposes. The villages in the valleys are also major tourist destinations with consequent increases in the sewage input to the lake. Over the past 50 years levels of dissolved reactive phosphorus in the lake have more than doubled, reaching their highest levels in the 1980s. The effluent discharged into the North Basin of Windermere from the main sewage works is now phosphate-stripped in an effort to reduce the nutrient loading to the lake.

The lake itself designated as SSSI; it is a source of potable water, a major recreational facility and a specialised fishery for charr (*Salvelinus alpinus*). The FBA, and latterly the Institute of Freshwater Ecology (IFE), have maintained a laboratory on the shore of Windermere for over 50 years and in consequence there is a large body of scientific literature based on Windermere and other Lake District lakes.

### **L05 Esthwaite Water**

Cumbria, England (Lat 54° 22'N; Long 2° 59'W; NGR 3360 4972)

*Sponsor: Natural Environment Research Council*

Esthwaite Water is a natural lake situated in a glacial valley and is generally agreed to be the most productive or eutrophic lake in the English Lake District. It lies approximately 65

m AOD and has an area of 1 km<sup>2</sup> and a maximum depth of 15.5 m. The average retention time is 90 days. The catchment area is 17.1 km<sup>2</sup> and the hills are composed geologically of Bannisdale slates and grits. The surrounding land is used chiefly for agricultural purposes and forestry. The lake is a Grade 1 SSSI and has been a designated 'Ramsar' site since November 1991.

The diverse aquatic invertebrate fauna includes a number of species with restricted distributions in Britain, one of which is the flatworm, (*Bdellocephala punctata*). The slender naiad (*Najas flexilis*), which is listed as Nationally Scarce, has been found in Esthwaite Water.

Esthwaite waterweed (*Hydrilla verticillata*) was discovered at Esthwaite Water in 1914 by W H Pearsall; this species is known only from this location in Britain and was last seen in 1941.

Artificial enrichment of the lake occurs by input from the Hawkshead Sewage Treatment Works (which has operated a continuous programme of phosphate-stripping since 1989) and by effluents from the fish farm which is situated towards the south of the lake. The lake undergoes summer stratification with oxygen depletion regularly below 7 m and sometimes as shallow as 5 m. The phytoplankton tends to be dominated by diatoms in spring and by cyanobacteria for much of the summer.

## **L06 Loch Leven**

Tayside, Scotland (Lat 56° 12'N; Long 3° 23'W; NGR 3135 7011)

*Sponsor: Natural Environment Research Council*

The loch covers 13.3 km<sup>2</sup> and lies at 106 m AOD. The catchment has a maximum altitude of 497 m AOD and its area of 145 km<sup>2</sup> comprises mainly arable crops (38.6%) and improved pasture (31.5%), but also upland moor (11.6%), coniferous woodland (3.8%), heathland (3.5%), rough grazing (3.5%), suburban/rural development (2.2%) with the rest (5.3%) being deciduous woodland, bog, bare ground and inland water. Poultry rearing units of relatively small area are also significant. High phytoplankton biomass is a major feature; this is due firstly to the following photosynthesis-promoting features (i) a moderate depth – mean 3.9 m, (ii) a clear water (little peat-staining) with >5m Secchi readings at low chlorophyll levels, and (iii) a rich supply of nutrients. Secondly, flushing rates are moderate, rarely >0.2 lake volumes per month. However, a major determinant of the amounts of phytoplankton per unit of total phosphorus loading depends very much on *Daphnia* population densities. Depending on the highly capricious, 'oceanic' weather regime in this part of the world, the loch stratifies intermittently and then mainly in the two deep kettle-holes which extend down to a depth of approximately 25 m.

The dense algal blooms threaten the world-famous trout fishery, although probably not the fish populations *per se*; they have almost certainly contributed to declines in macrophyte abundance and species richness and thus to the diversity of invertebrates associated with the wide spectra of physical and chemical conditions provided by such macrophytes. Special concern has been expressed over macrophyte losses in relation to the wildfowl populations, on the basis of which the loch is designated a 'Ramsar' site and NNR. Deterioration in water quality has also had a negative effect on local tourist and paper-making industries.

## **L07 Scoat Tarn**

Cumbria, England (Lat 54° 29'N; Long 3° 18'W; NGR 3158 5104)

*Sponsor: Department of the Environment, Transport and the Regions (through the Acid Waters Monitoring Network)*

Scoat Tarn, in the English Lake District, is a typical mountain corrie lake, being small and deep with an area of 5.2 ha and a maximum depth of 20 m. The lake lies in a west-facing valley at an altitude of 602 m AOD and drains into Wastwater via the Nether Beck. The catchment comprises a small corrie (95 ha) with steeply sloping walls and three summits in excess of 825 m. The bedrock is Ordovician tuff (undifferentiated) of the Borrowdale Volcanic series and the local soils are mainly shallow, peaty rankers. The eastern slopes

are mainly of rock and boulders while those to the north are less steep and are covered in rough grass and *Sphagnum* moss. Land use is confined to low-intensity sheep grazing.

Scoat Tarn is an Acid Waters Monitoring Network (AWMN) site, classified as having high acid deposition.

### **L08 Llyn Llagi**

Snowdonia, Wales (Lat 53° 01'N; Long 4° 01'W; NGR 2648 3483)

*Sponsor: Department of the Environment, Transport and the Regions (through the Acid Waters Monitoring Network)*

Llyn Llagi occupies a north-facing corrie in the central area of the Snowdonia region of North Wales. The lake lies at 380 m AOD beneath a steep backwall and comprises a deep, almost circular basin (maximum depth 16.5 m) bordered by an extensive, shallow (1 m deep) rim. The lake covers an area of 5.7 ha and the primary inflow constitutes the outflow stream from Llyn yr Adar. The lake drains towards the north-west to the Nanmor valley. The catchment (157 ha) consists primarily of Ordovician slates and shales of the Glanarfon series. The backwall is composed of a large doleritic intrusion with small intrusions of fine microgranites and volcanic tuff. The catchment soils are mainly stagnopodsols and gleys, interspersed with blanket peats. The vegetation is characterised by heather (*Calluna vulgaris*), purple moor-grass (*Molinia caerulea*) and cotton grass (*Eriophorum* spp), and the catchment is grazed at a low intensity by sheep. The lake and much of the catchment lie within a designated SSSI.

Llyn Llagi is an AWMN site, classified as having high acid deposition.

### **L09 Lochnagar**

Grampian, Scotland (Lat 56° 58'N; Long 3° 14'W; NGR 3253 7862)

*Sponsor: Department of the Environment, Transport and the Regions (through the Acid Waters Monitoring Network)*

Lochnagar lies at an altitude of 785 m AOD in the centre of the granite massif which comprises much of Balmoral Forest. Lochnagar is a corrie loch and lies below a north-east facing, steep backwall which rises to the summit of the same name. The loch is 9.8 ha in area with its deepest point at 24 m, and drains north-east into a tributary of the River Dee. Snow-melt comprises a major input to the loch which freezes regularly each winter. The precipitous catchment (91.9 ha) is composed of biotite granite, overlain in places by blanket peat, but dominated by bare rock with extensive fields of large boulders and coarse screes. The sparse moorland vegetation of the catchment is dominated by a community of stunted heather and bilberry (*Vaccinium myrtillus*). The catchment is above the limit for summer sheep grazing in the region, and there is no evidence for any landuse change or active land management.

Lochnagar is an AWMN site, classified as having moderate acid deposition.

### **L10 Loch Lomond**

Strathclyde Region, Scotland (Cailness: Lat 56° 13'N; Long 4° 41'W; NGR 2335 7062)

*Sponsor: Scottish Environment Protection Agency, West Region*

The Loch Lomond basin is of glacial origin, formed by an ice sheet moving southward from the Ben Lui area and depositing eroded material in the southern-most part around Balloch, thus ensuring that the loch was freshwater rather than marine. It is the largest (by surface area) body of freshwater in Britain, with a surface area of 71 km<sup>2</sup>. The natural catchment area is ten times greater, at 781 km<sup>2</sup>.

The two main feeder rivers are the River Falloch at the northern-most point, with a mean flow of 6.8 cumecs, and the River Endrick entering on the south-eastern side of the loch, with a mean flow of 7.8 cumecs. They have markedly different catchments – that of the Falloch is mountainous with a catchment area of 80 km<sup>2</sup>, whilst the Endrick has a typical lowland rural catchment of 220 km<sup>2</sup>. There are distinct differences in the chemistry of the two rivers, reflecting the differences in the geology of their catchments. The Highland

Boundary Fault cuts across the lower part of Loch Lomond, but there is also a narrow physical restriction halfway down the length of the loch. For these reasons, the water chemistry and topography of the so-called Northern and Southern Basins are quite different and, as a result, there are two ECN sampling sites, one in each basin.

### **L12 Loch Katrine**

Central Region, Scotland (Lat 56° 14'N; Long 4° 26'W; NGR 2486 7082)

*Sponsor: Scottish Environment Protection Agency, East Region*

Loch Katrine lies within the catchment of the River Teith, a major tributary of the River Forth. The loch forms part of the water supply system to the city of Glasgow and the loch and the whole of its catchment is owned by the West of Scotland Water Authority which controls all activities within the area. Water from two neighbouring lochs, Loch Arklet and Finglas Reservoir, is piped to Loch Katrine and water for Glasgow is moved 24 miles through underground aqueducts to Milngavie Reservoir on the outskirts of the city. Loch Katrine lies at an altitude of 116 m AOD (at top water level) and at its deepest point is over 140 m deep. It has a capacity to store 64.6 million litres of extremely high quality water. The loch is bounded at its southern end by a low dam and the surrounding hills rise to over 700 m on the northern and southern shores. The bed of the loch shelves away very steeply and only at its western end are there large areas of shallower water away from the shoreline. Vegetation in the catchment is grazed by sheep and red deer (*Cervus elaphus*) and consists mainly of rough heather and grassland with forested areas to the east. Being part of the Trossachs it is a very popular tourist area during the summer months.

### **L13 Loch Davan**

Grampian Region, Scotland (Lat 57° 06'N; Long 2° 55'W; NGR 3441 8008)

*Sponsor: Scottish Environment Protection Agency, North Region*

Lochs Davan and Kinord are situated adjacent to each other in an area of the River Dee catchment known as the Muir of Dinnet. The Muir of Dinnet (area 2 287 ha) is an SSSI and a NNR designated because of its value as a habitat for flora and fauna, and important geomorphological features. The Muir forms the south-western corner of the Howe of Cromar, a wide saucer-shaped plain at the foot of the Grampian Mountains. The landscape of the area was moulded by gravel and meltwater in the post-glacial era, and Lochs Kinord and Davan are kettleholes (ice depressions), surrounded by fluvio-glacial hummocks, ridges and hollows. Loch Kinord (area 79.0 ha) is oligotrophic whereas Loch Davan (31.1 ha) is mesotrophic with recent research suggesting a transition towards eutrophication. The difference in trophic status reflects the higher proportion of agricultural land use in the Davan catchment.

### **L14 Loch Kinord**

Grampian Region, Scotland (Lat 57° 05'N; Long 2° 55'W; NGR 3440 7995)

*Sponsor: Scottish Environment Protection Agency, North Region*

Lochs Kinord and Davan are situated adjacent to each other in an area of the River Dee catchment known as the Muir of Dinnet (see description of Loch Davan above). Loch Kinord (area 79.0 ha) is oligotrophic whereas Loch Davan (31.1 ha) is mesotrophic and the difference in trophic status reflects the higher proportion of agricultural land use in the Davan catchment.

Loch Kinord possesses a rich aquatic flora, and a full range of hydrosereal plant communities ranging from emergent fens dominated by sedges, to bog myrtle (*Myrica gale*) scrub, fen carr and birch woodland. It also has a rich invertebrate fauna and is an important site for aquatic beetles. About 80 species of birds breed within the SSSI and the lochs are important refuges for passage and wintering wildfowl, particularly greylag geese (*Anser anser*) and widgeon (*Anas penelope*). Since the early 1980s, introduced ospreys (*Pandion haliaëtus*) have colonised the area, and both lochs are important rearing and feeding grounds for young otters (*Lutra lutra*).



Pollen preserved in the sediments of Loch Kinord record an almost complete sequence of Devensian late-glacial and Flandrian vegetation history so that these two lochs are important reference sites for reconstructing changing environmental conditions in north-east Scotland since the last ice-sheet melted.

### **L15 Loch Dee**

Dumfries & Galloway Region, Scotland (Lat 55° 05'N; Long 4° 23'W; NGR 2478 5797)

*Sponsor: Scottish Environment Protection Agency, West Region*

Loch Dee forms the headwaters of the River Dee and has a surface area of 1 km<sup>2</sup>, with a total catchment area of 15.6 km<sup>2</sup>. It has three principal sub-catchments, the Dargall Lane, the White Laggan and the Black Laggan Burns (30% planted with Sitka spruce (*Picea sitchensis*)), and the Green Burn (67% planted with Sitka spruce). It has highly variable annual rainfall a predominant feature being dry periods in spring and summer. Average rainfall is moderately acidic (pH 4.6 – 4.9) and its chemistry is dominated by salts of marine origin, mainly sodium (Na<sup>+</sup>), chloride (Cl<sup>-</sup>) and sulphate (SO<sub>4</sub><sup>2-</sup>-S); for most samples the concentration ratios between the ions match those of sea water. The topography and land use affect the flows in the sub-catchments, giving a wide dynamic range of flows in the main tributaries. The Dargall Lane is steep and peaty, whereas the other two sub-catchments are afforested. As with many of the catchments in the Galloway area the geology comprises igneous rocks such as granite, with thin overlying soils giving poor neutralising and buffering capacities.

### **L16 Lough Neagh**

County Down, Northern Ireland (54° 37'N; Long 6° 24'W; IGR 3030 3750)

*Sponsor: Department of Agriculture for Northern Ireland*

Lough Neagh covers 386 km<sup>2</sup> and is by far the largest area of freshwater in the British Isles. Situated in north-east Ireland, it has a drainage basin of 4450 km<sup>2</sup>, which is shared between Northern Ireland (91%) and the Republic of Ireland (9%). The average water retention time is 15 months. Although large in area, the lake is relatively shallow with a mean depth of 8.9 m (max. 25 m). This, combined with its great size and a mild and windy oceanic climate, ensures that the water column is generally well mixed. The lake supports commercial fisheries for eels (*Anguilla anguilla*), pollan (*Coregonus autumnalis pollan*), perch (*Perca fluviatilis*) and trout (*Salmo trutta*) of which the eel fishery is the most significant, with an annual catch in the region of 600 t. Lough Neagh is hypertrophic with a mean annual total phosphorus concentration of 160 µg P l<sup>-1</sup>. Attempts to lower phosphorous (P) concentrations in the lough by curtailing point sources of P have been unsuccessful due to increasing inputs from diffuse sources. Levels of P in the lough support large phytoplankton populations with annual chlorophyll *a* concentrations typically in excess of 60 µg l<sup>-1</sup>. The dominant alga is the cyanophyte *Planktothrix agardhii* and the phytoplankton is now less diverse than in the late 1960s when regular monitoring began. Since then there has been regular monitoring of the plankton, lake and river nutrient concentrations, which have been used to produce nutrient budgets for the lake.

### **L17 Lough Erne**

County Fermanagh, Northern Ireland (Lat 54° 29'N; Long 7° 51'W; IGR 2101 3595)

*Sponsor: Department of Agriculture for Northern Ireland*

Lough Erne is the collective name given to Upper Lough Erne (34.5 km<sup>2</sup>) and Lower Lough Erne (109.5 km<sup>2</sup>), which are connected by the River Erne in County Fermanagh, Northern Ireland. The Upper Lough and the shallower regions of Lower Lough Erne present an example of a flooded drumlin landscape which has created an intricate mosaic of land and water. As a consequence of differences in depth and area, the water retention time of the Upper Lough is less than one month while that of the Lower Lough is four months. Passing from the shallow Upper Lough (mean depth 2.3 m) and through Lower Lough Erne (mean depth 11.9 m), phytoplankton abundance is reduced and algal composition alters, as do nutrient and temperature cycles. Phosphorus concentrations (100 µg P l<sup>-1</sup>) in the Upper Lough create eutrophic conditions, with high summer chlorophyll *a* concentrations, but phytoplankton abundance in the deep open water of the Lower Lough is more typical of a mesotrophic water body despite comparatively high



phosphorus concentrations ( $60 \mu\text{g P l}^{-1}$ ). The paucity of phytoplankton in this region is attributed to a high background light attenuation from the peat-stained water and the greater depth of the mixed water zone ( $>35 \text{ m}$ ). The lake supports a fish population dominated by a recent introduction, the roach (*Rutilus rutilus*), as well as pike (*Esox lucius*), perch, bream (*Abramis brama*), trout and the pollan. The Zebra mussel (*Dreissena polymorpha*) is a recent introduction (1996) which now has only a limited distribution in the Lower Lough. As this species expands its range and abundance throughout the Erne system, it may impact significantly on the lake ecology. Water monitoring is undertaken at the deepest portion of Lower Lough Erne with limited samples taken along a gradient towards the main river inflow of the lake.

## **R01 River Eden**

Cumbria, England (Lat  $54^{\circ} 39' \text{N}$ ; Long  $2^{\circ} 37' \text{W}$ ; NGR 3604 5282)

*Sponsor: Environment Agency, North West Region*

The river rises south of Kirkby Stephen on the Cumbria/Yorkshire border and flows northwards to Carlisle before discharging to the Solway Firth. The eastern part of the catchment is drained by short, relatively steep streams from the Pennines; the western part includes tributaries of the Eamont system which arise in the eastern hills of the English Lake District, and the major lakes, Ullswater and Haweswater. The catchment is largely rural, with farming the main industry. There are significant settlements on the upper part of the river at Kirkby Stephen and Appleby-in-Westmorland. Water quality in the upper reaches is classified as good and drinking water is abstracted to supply the city of Carlisle. The river is excellent for salmon (*Salmo salar*) fishing and also supports a sea trout (*Salmo trutta*) run. Many other species of fish are also found, (eg brown trout (*Salmo trutta fario*), grayling (*Thymallus thymallus*), chub (*Leuciscus cephalus*), dace (*Leuciscus leuciscus*), eel, minnow (*Phoxinus phoxinus*), loach (*Barbatula barbatula*), river lamprey (*Lampetra fluviatilis*), sea lamprey (*Petromygon marinus*), and brook lamprey (*Lampetra planeri*), stickleback (*Gasterosteus aculeatus*) and bullhead (*Cottus gobio*)). Otters and native crayfish (*Austropotamobius pallipes*) are also found in the Eden catchment. The Eden at Temple Sowerby is within the 'River Eden and Tributaries' SSSI, and the proposed Special Area of Conservation (SAC) under the EC Habitats and Species Directive.

The sampling site is in an upland farming area at an altitude of about 100 m AOD. The surrounding countryside is hilly, with some woodlands, rising to the bare slopes of the Pennine hills to the east. These have been mined for lead and silver in historic times, and gypsum is still extracted. The underlying bedrock is Permo-Triassic Penrith Sandstone, with smaller tributaries of the Eden draining from the surrounding Carboniferous Limestone. The market town of Appleby, with a population of about 3000, is roughly 14 km away by road. Its primary influence on the river is the discharge from the Sewage Treatment Works 16 km upstream, which currently has secondary treatment and, since January 1999, phosphorus stripping of the wastewaters it receives.

The ECN site is at the Eden Bridge in Temple Sowerby, where the A66 trunk road crosses the river.

## **R02 River Esk**

North Yorkshire, England (Lat  $54^{\circ} 28' \text{N}$ ; Long  $0^{\circ} 38' \text{W}$ ; NGR 4885 5089)

*Sponsor: Environment Agency, North East Region*

The River Esk rises on the uplands of the North York Moors National Park and is the only major river in the county of Yorkshire which drains directly into the North Sea. The catchment is sparsely populated and without the pressures of industrialisation and urbanisation which affect other rivers in the Region. Open moorland characterises much of the catchment and is an important habitat for a wide variety of wildlife. Within the Esk valley there are six SSSI, two of which extend south and cross the boundary of the Derwent catchment.

The source of the Esk is upstream of Westerdale, where a series of small streams known as the Esklets merge to form the River Esk. Many of these moorland streams are affected

by natural 'flushes' of acidity, as well as iron run-off from natural ironstone strata and old mineral workings, making some of these becks an ochreous-orange colour after periods of rainfall. The combination of the two factors restricts the invertebrate fauna in these head-streams. The majority of the River Esk downstream of the Esklets has very good water quality, with a diverse invertebrate fauna dominated by mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), caddis-flies (*Trichoptera*) and other pollution-sensitive groups. This good water quality is also very important in sustaining other species such as salmon, sea trout, dipper (*Cinclus cinclus*) and otter.

The ECN site is at Briggswath, approximately 2 km upstream of the tidal limit. At this point the river is approximately 15 m wide, and in normal summer flows depths vary between 20–30 cm.

### **R03 River Coquet**

Northumberland, England (Lat 55° 21'N; Long 1° 38'W; NGR 4234 6061)

*Sponsor: Environment Agency, North East Region*

The River Coquet rises at Coquet Head on the Scottish border and flows generally eastward, draining the southern flanks of the Cheviot Hills, finally discharging to the North Sea at Amble. The Warkworth Dam marks the tidal limit.

The River Coquet is an excellent, clean river system of high conservation and ecological value. The River Coquet is designated as an SSSI as part of the National Programme of 27 river SSSI's. Bankside habitats range from woodland-fringed lower river and wooded lowlands through hay meadows, herb-rich valleys and the gravel haughs of lower Coquetdale to the upper moorlands of the Cheviots. This relatively undisturbed environment provides excellent habitats for wildlife including a number of protected species. Within the Coquet catchment there are 10 other SSSI's which directly influence, or are influenced by, the water environment. The principal protected habitats are hay meadows, woodland and the estuary.

The main river supports a healthy and diverse invertebrate fauna of mayflies, stoneflies, caddis-flies and other taxa which are sensitive to pollution. Their presence indicates the absence of chronic pollution. Although the habitat and water quality are suitable for native crayfish, they have never been found by the EA, even though they were reliably reported as being present at Thropton and Felton in 1981.

The ECN site on the Coquet is at Warkworth, approximately 2 km upstream of the tidal limit.

### **R04 River Exe**

Devon, England (Lat 50° 48'N; Long 3° 31'W; NGR 2936 1016)

*Sponsor: Environment Agency, South West Region*

The ECN site is at Thorverton weir on the River Exe which drains the Exmoor National Park and is situated above the City of Exeter and the more industrialised sub-catchment of the River Culm. Most of the catchment is populated by isolated farmsteads, hamlets, villages and small towns. The only major urban area upstream of this site is Tiverton. The River Exe rises at a level of 450 m AOD in the wet moorland of Exmoor, then passes through steep-sided valleys with extensive broad-leaved woodland. Further east, tributaries run off the Brendon Hills with the River Haddeo and the major water resource of Wimbleball Reservoir. Further south of these tributaries, towards Tiverton, the floodplain opens out and rolling farmland replaces woodland. The farmland in the catchment of Thorverton weir supports sheep, cattle and dairy farming. All stretches of river above Thorverton weir, except the Riverton canal, have water of good or very good quality suitable for all fish species. The average rainfall for the Exe catchment as a whole is 1097 mm, with a maximum of 2018 mm on Exmoor. Analysis of the flow record at Thorverton shows a mean daily flow of 15.887 cumecs and the river has a relatively 'flashy' flow regime compared with the rest of England.

## R05 River Wye

Monmouthshire, Wales (Lat 51° 47'N; Long 2° 40'W; NGR 3536 2098)

Sponsor: Environment Agency, Wales

The River Wye is one of the largest rivers in Britain. It rises on the Plynlimon mountains at 741 m AOD and flows through several towns, including Rhayader, Builth Wells, Hay-on-Wye, Hereford, Ross-on-Wye and Monmouth, before meeting the Severn Estuary at Chepstow. The total catchment area is 4136 km<sup>2</sup> and the population of 226 000 is centred on the main towns. The River Wye catchment is one of idyllic beauty and unspoilt scenery, ranging from mountainous uplands through intensively farmed agricultural land to the deep, wooded gorge of the lower river. The River Wye itself is designated as SSSI and a candidate Special Area of Conservation; it is one of the most important rivers in Britain in nature conservation terms. Much of the lower valley is designated an Area of Outstanding Natural Beauty (AONB).

The surface water in the Wye and its tributaries is mostly unpolluted and thus much of it is suitable as a source of drinking water and for supporting a salmon and trout fishery. Nevertheless, certain rivers and streams in the upper catchment suffer from acidification and localised pollution problems resulting from inadequate sewerage and agricultural sources also exist.

The Wye is one of the best-known salmon rivers in England and Wales. Shad (*Alosa* spp) and sea lamprey also migrate into the Wye. Other notable fish species include the bullhead, river lamprey and the brook lamprey. The river corridor supports a variety of plant communities, with plants of note being the rare river jelly lichen (*Collema dichotomum*) and extensive stands of river water-crowfoot (*Ranunculus fluitans*). These stands of *Ranunculus* form a habitat of European interest: 'Floating vegetation of *Ranunculus* of plain and submountainous rivers'. Otters, water voles (*Arvicola terrestris*), several bat species (*Microchiroptera*), dippers, sandmartins (*Riparia riparia*), kingfishers (*Alcedo atthis*) and little ringed plovers (*Charadrius dubius*) inhabit the river corridor. The biological quality of the river is generally good and supports some nationally rare or scarce invertebrate species including the mayfly (*Potamanthus luteus*), the freshwater pearl mussel (*Margaritifera margaritifera*), the depressed river mussel (*Pseudanodonta complanata*) and the native white-clawed crayfish. The river also supports several rare species of non-aquatic invertebrates associated with gravel shoals.

The ECN site is situated in the lower reaches of the Wye at Redbrook at an altitude of 15 m, approximately 37 km from its confluence with the Severn Estuary and 219 km from its source.

The river here is fast-flowing and averages 40 m in width and over 1 m in depth.

## R06 River Lathkill

Derbyshire, England (Lat 53° 11'N; Long 1° 40'W; NGR 4220 3647)

Sponsor: Environment Agency, Midlands Region

The River Lathkill is located in the Peak District National Park and is designated as SSSI. It is the only river in Britain which rises in, as well as flows through, limestone for its entire length. The upper parts are a winterbourne, and in summer the stream issues from bubble springs lower down the valley. Downstream there are alternately moderately flowing gravelly sections and silted pools, some formed by natural tufa dams, others artificially. In the pools there are abundant submerged plants including species of *Veronica*, *Ranunculus*, *Potamogeton* and *Callitriche*, while faster sections are carpeted with bryophytes, some of which are nationally rare (eg *Cratoneuron commutatum*). There are no direct discharges to the river but the Knotlow cave system has recently been contaminated with sewage effluent and there is concern that this may eventually wash into the river. There are two licensed abstractions of water for fish-rearing purposes and there are concerns over low flows which may affect water quality and the biota; in the summer of 1996 the lower 2 km of the river dried up completely. There was a suspected outbreak of crayfish plague in 1993 and crayfish have not been present in the invertebrate samples since that time.

### **R07 Cringle Brook**

Lincolnshire, England (Lat 52° 50'N; Long 0° 38'W; NGR 4921 3287)

*Sponsor: Environment Agency, Anglian Region*

Cringle Brook is a tributary of the River Witham, south of Grantham. It is a spring-fed limestone stream, 12 km in length. It has one small tributary, Wyville Brook, flowing into an impounded section comprising two small ornamental lakes whose total area is around 750 m<sup>2</sup>. The ECN sampling site is situated in the lower reaches of the Cringle, downstream of the impounded section, where the brook is 5–7 m wide and 10–50 cm deep, flowing over a sand/gravel substratum with a small content of cobbles and infrequent sections of limestone pavement. This stretch is surrounded by a private golf course, the river channel and adjacent river corridor being generally unmanaged, with extensive bankside tree-cover and no engineering works (eg weed-cutting, dredging or re-profiling) undertaken. The upstream impoundment maintains a year-round flow of little variation, and also buffers the downstream section against mild enrichment by a village sewage treatment works at Skillington and a sewage pumping station at Stoke Rochford. The brook consequently supports a stream fauna of very high diversity, including a resident population of native crayfish and also sustains a rich aquatic flora.

### **R08 River Frome**

Dorset, England (Lat 50° 41'N; Long 2° 09'W; NGR 3890 0867)

*Sponsor: Environment Agency, South West Region*

The River Frome is essentially a rural catchment of high amenity and ecological value. The upper part of the catchment lies within the Dorset AONB and is characterised by steep-sided valleys. The only large urban area within the catchment is Dorchester (population 15 104). In the upper reaches the river depends on springs and groundwater levels for flows. Many of the streams are winterbournes and the streams cease to flow in summer or are perched where the river goes underground for part of its length. All stretches of river above Holme Bridge have water of good or very good quality suitable for all fish species. Land use in the catchment is typically permanent grassland with dairying or stock rearing, with some cereals and natural wetland habitats. The majority of the upper reaches lies on chalk which produces the high groundwater component of flow. The lower reaches are dominated by sands, gravels and clays. Rainfall in the catchment varies between 850–1100 mm a year. Much of the flow depends on groundwater and the river responds slowly to rainfall events.

### **R09 Bradgate Brook**

Leicestershire, England (Lat 52° 41'N; Long 1° 14'W; NGR 4522 3098)

*Sponsor: Environment Agency, Midlands Region*

Bradgate Brook is located in the Charnwood Forest area of Leicestershire, important for its Precambrian granitic rocks. The brook flows through the ancient parkland of Bradgate Park and into Cropston Reservoir. The park is managed as a deer park, has never been agriculturally 'improved' and is designated SSSI. However it was bequeathed to the people of Leicester for their enjoyment and there are public access pressures on the site. There are no discharges to or abstractions from the brook, which supports an invertebrate community of regional importance, including a population of native crayfish.

### **R10 River Bure**

Norfolk, England (Lat 52° 43'N; Long 1° 21'E; NGR 6267 3198)

*Sponsor: Environment Agency, Anglian Region*

The River Bure is one of the major rivers flowing through the Norfolk Broads. The sampling site, at Horstead Mill, is in its middle reaches, approximately 40 km from the source of the river, at the limit of navigation, and at an elevation of less than 10 m. Here the river is 17–20 m wide and up to 4 m deep, with a predominantly silty substrate. The surrounding catchment is underlain by Quaternary deposits of Norwich Crag with chalk at depth and superficial glacial till and outwash deposits. Land use in the catchment is predominantly agricultural, especially arable. Due to problems with eutrophication of the



Broads, there has been a programme of phosphate stripping at the major sewage treatment works on the Bure since 1986.

Invertebrate monitoring takes place downstream of the Mill where the river is divided into two channels and there is a riffle area of gravel, pebbles and sand and areas of emergent plants (*Sparganium erectum*, *Glyceria* sp.) at the margins. Macrophyte and diatom monitoring takes place between 0.5–1 km upstream of the Mill at a semi-natural stretch of river away from man-made structures. The substrate is predominantly silty. There is a diverse submerged plant community, including a good cover of *Elodea nuttallii*. Several marginal and emergent species are also present.

### **R11 Old Lodge**

West Sussex, England (Lat 51° 03'N; Long 0° 05'E; NGR 5457 1294)

*Sponsor: Department of the Environment, Transport and the Regions (through the Acid Waters Monitoring Network)*

Old Lodge is a stream site within a catchment of 240 ha in Ashdown Forest, south-east England. The altitude of the catchment ranges between 94 m and 198 m. The underlying geology comprises Ashdown sands (Hastings beds) and the catchment soils are typically podsollic. Approximately 15% of the catchment is deciduous woodland, principally around the sampling site. Conifers occupy less than 5% of the catchment, with the remainder classified as heathland vegetation dominated by heather and bell heather (*Erica cinerea*), with abundant stands of bracken (*Pteridium aquilinum*).

There has been no land use disturbance in the catchment for the past 200 years, although severe wind-throw affected many trees after the storms of October 1987.

Old Lodge is also an AWMN site, classified as having moderate-to-high acid deposition. The catchment has been the focus of research into the relationship of acid stream chemistry and biological, particularly invertebrate, populations.

### **R12 River Stinchar**

Strathclyde Region, Scotland (Lat 55° 06'N; Long 5° 00'W; NGR 2085 5822)

*Sponsor: Scottish Environment Protection Agency, West Region*

The River Stinchar is situated in south Ayrshire. It rises close to Loch Doon and flows for 46 km before entering the Firth of Clyde at Ballantrae. It has a catchment area of 340 km<sup>2</sup> and its average flow is 11.2 cumecs. The catchment is largely rural, with only a few small and scattered communities. Farming is mostly dairy cattle and sheep rearing, and there have been some pollution problems associated with the latter, in particular through spillages of sheep dip chemicals.

The upper part of the catchment is extensively forested with conifers for commercial use. The granitic geology and the maturity of the trees have resulted in low pH values at the uppermost routine sampling point. Part of the flow of the upper reaches of the river is diverted by an aqueduct to feed water into the Loch Braden water supply reservoir. The ECN site is situated in the lowest reach of the river, where the acidity has been buffered by the base cations in the lower part of the catchment.

### **R13 Lower River Clyde**

Strathclyde Region, Scotland (Lat 55° 51'N; Long 4° 14'W; NGR 2595 6644)

*Sponsor: Scottish Environment Protection Agency, West Region*

The catchment area of the River Clyde is about 2000 km<sup>2</sup> and the river changes in character a great deal in its 121 km journey to the tidal weir in Glasgow. In its upper reaches, it is used to fill the Daer reservoir which supplies drinking water to much of south Lanarkshire; there is also sheep farming and commercial afforestation in this part of the catchment. The river is joined by tributaries of various sizes and quality reflecting the land uses of their catchments; there is much opencast coal mining in some, whilst others are urban or agricultural. The Clyde passes through a fertile valley in its middle reaches where there is extensive market gardening, fruit growing and garden centres. In its lower

reaches the river receives a considerable amount of treated sewage effluent from large regional sewage works. The river is quite sluggish in its flow because of the flat landscape. As a result of this and the biochemical oxygen demand (BOD) of the effluents, there is serious oxygen depletion in the lower reaches during the summer months.

The ECN sampling site is situated in the lowest reach, where average flow is 41 cumecs.

#### **R14 Allt a'Mharcaidh**

Highland Region, Scotland (Lat 57° 07'N; Long 3° 51'W; NGR 2869 8050)

*Sponsor: Scottish Environment Protection Agency, North Region*

Allt a'Mharcaidh is a stream site on the western flank of the Cairngorm Mountains. The catchment area is 998 ha and it drains to the River Feshie, a tributary of the River Spey. The catchment rises from 325 m at the sampling site to 1111 m and is covered by alpine and peaty podsols (60%) and blanket peat (40%). The underlying geology is intrusive biotite-granite of the Lower Old Red Sandstone age. Vegetation is characterised by a heather/fescue grass mixture (90%) with native pinewoods (*Pinus sylvestris*) (2%) interspersed along the lowest reaches. The catchment comprises part of the Cairngorm NNR and land use is confined to deer grazing. The stream gradient is steep and exposed bedrock, rapids and waterfalls and large boulders characterise the monitored channel section.

Allt a'Mharcaidh is also an AWMN site, classified as having moderate acid deposition.

#### **R15 River Spey**

Grampian Region, Scotland (Lat 57° 37'N; Long 3° 06'W; NGR 3341 8596)

*Sponsor: Scottish Environment Protection Agency, North Region*

The River Spey rises in the high ground of the Grampian Mountains and flows in a north-easterly direction towards the Moray Firth. It drains a relatively large catchment of 3008 km<sup>2</sup> with a stream network of 36 400 km, of which the main river comprises 157 km. The upper part of the catchment is characterised by its mountain wilderness regions, sheep farming and tourism, whilst in the lower catchment these are complemented by the distilling industry, cattle and arable farming, and related industries. There is restricted commercial forestry on the narrow valley bottoms and steep-sided hills of the upper catchment, but as the valley floor widens it becomes much more extensive (16% of total catchment land use). Most of the Spey catchment is underlain by metamorphic rocks of the Cambrian Period and these are intruded at a number of places by granite plutons and are overlain at the northern end of the catchment by Devonian sandstone. For most of its length the River Spey flows through a wide alluvial plain composed of silts, sand and waterborne pebbles.

The catchment is of great conservation value with 27 SSSI including various woodland, wetland and montane habitats, fossil sites, and various geomorphological features. The river itself is designated SSSI at the Insh Marshes, at the lower section downstream of Fochabers for its unique active braided channel and associated habitats, and at Spey Bay which is of prime importance for its geomorphology. The River Spey is renowned for its salmon fishing with an estimated input into the local economy of £6 million per annum. The salmon fishery is the subject of much research and fisheries management activity.

#### **R16 River Tweed**

Borders Region, Scotland (Lat 55° 36'N; Long 2° 46'W; NGR 3509 6347)

*Sponsor: Scottish Environment Protection Agency, East Region*

This is a stream site located 80 km from the source of the River Tweed, above Galafoot. The catchment area above this site is 150 000 ha. The catchment rises from 92 m at the sampling site to 400 m and is mainly covered by peaty and humus-iron podsols. The underlying geology of the upper Tweed catchment is of shales, mudstones, slates and greywackes. Land cover types for the entire Tweed catchment are improved grassland (26%), rough grassland (16%), woodland (16%), heather/peatland (10%) and arable (18%) although almost all of the latter is found downstream of this site. The River Tweed



has an international reputation both as a salmon river and as an excellent trout water. The Tweed has been designated as SSSI and is recognised as a nationally important example of a relatively nutrient-rich river system showing characteristic hydrological and biological sequences along its length. The upper Tweed has also been designated as a National Scenic Area (NSA) and there is an Environmentally Sensitive Area (ESA) designation covering that portion of the catchment in the central Southern Uplands.

### **R17 River Eden**

Fife Region, Scotland (Lat 56° 20'N; Long 2° 56'W; NGR 3415 7158)

*Sponsor: Scottish Environment Protection Agency, East Region*

The River Eden drains some 400 km<sup>2</sup> of north Fife, 307 km<sup>2</sup> of which lie upstream of the ECN site at Kemback. The river rises at around 220 m AOD and the catchment is predominantly low-lying. The major land use in the area is arable farming and approximately 76% of the catchment is prime agricultural land with very fertile soils or imperfectly drained brown forest and alluvial types. Underlying geology comprises Devonian and Carboniferous strata, the former including the most productive aquifer in Scotland, the Knox Pulpit formation. Water is abstracted from groundwater, the river and its tributaries for irrigating crops. The Balmalcolm area of the catchment is a designated Nitrate Vulnerable Zone under the EC Nitrate Directive. Although treated sewage is discharged to the river from several small communities and from the town of Cupar, the effect of diffuse inputs from agriculture is believed to be critical to river water quality. There is a modest salmon run to the river and otters are present. The river enters the sea 4 km to the north of St Andrews and its estuary forms the Eden Estuary Local Nature Reserve – an important overwintering site for wildfowl and waders.

### **R18 River Cree**

Dumfries & Galloway Region, Scotland (Lat 54° 57'N; Long 4° 28'W; NGR 2412 5653)

*Sponsor: Scottish Environment Protection Agency, West Region*

The River Cree has a catchment area of 515.7 km<sup>2</sup>, much of which is afforested, and a total river length of 57.5 km. It has become one of the most acidic catchments in south-west Scotland, with pH values as low as 5.0 being recorded occasionally. This raises concerns about its ability to meet the EC requirements for freshwater fisheries and about the survival of the salmon fishery. There are many sewage effluent discharges entering the river along its course, most of which have small flow rates; the largest discharge is from Newton Stewart. In the early 1980s, large stretches of the river were subject to excessive weed growth, believed to be due to the aerial application of fertilisers over large tracts of forest. The mean pH at Newton Stewart is 6.5, with lower mean pH levels upstream.

### **R19 River Faughan**

County Londonderry, Northern Ireland (Lat 55° 01'N; Long 7° 15'W; IGR 2476 4193)

*Sponsor: Department of the Environment for Northern Ireland*

Rising on the north-western slopes of the Sperrin Mountains above Claudy, the Faughan flows in a general north-westerly direction, augmented by numerous tributaries and eventually discharging to Lough Foyle. There are no significant urban influences until the river flows through the Drumahoe industrial estate.

Approximately 40 km long, the river has a catchment area of just under 300 km<sup>2</sup>. The River Flow Gauging Station at Drumahoe records flow for more than 95% of the catchment upstream of the ECN site, which is located at Mobuoy Bridge.

The geology of the upper reach consists predominantly of thin deposits of peat overlying schists and quartzite from the upper Dalradian period. This results in a typically 'flashy' runoff characteristic. Further downstream, the lithology changes to boulder clay (till) with significant deposits of sands, gravels and alluvium in the river plain. The underlying solid geology varies to include grits and slates with a thin band of Dungiven Limestone.

The steep valley slopes and upper reaches have little capacity to store and transmit groundwater, while the lower reach and river plain may be classified as moderately permeable solid aquifers. In particular, the sand and gravel deposits, overlying fractured grits and slates, are vulnerable to surface impacts and form an important source of base river flows.

The river is a renowned salmon and sea trout fishery with approximately 20 km of prime angling water which includes the tidal stretch downstream of Campsie. It also supports a significant brown trout fishery in its upper reaches and tributaries. In 1996, 13 000 salmon were recorded entering the system. The River Faughan is designated salmonid under the EC Freshwater Fish Directive and its chemical quality is good to fairly good. Biological quality is highly variable due to intermittent localised pollution.

## **R20 Garvary River**

County Fermanagh, Northern Ireland (Lat 54° 31'N; Long 7° 59'W; IGR 2009 3630)

*Sponsor: Department of the Environment for Northern Ireland*

Located to the north of Lower Lough Erne, the Garvary River has its source in the outflows from Loughs Vearty and Tullysiddagh. It flows in a general south-easterly direction, augmented by the Crossowen River and the outflow from Lough Scolban, and eventually discharges to Lower Lough Erne. Approximately 7 km long, the river has a catchment area of 35.5 km<sup>2</sup> of which around 5% is lake surface. At the ECN site, the river is 2.5–3 m wide and 30 cm deep with a few holding pools around 60 cm deep.

The drift geology of the catchment consists mainly of peat and bedrock at or near the surface which some glacial till and small amounts of sand and gravel. The solid geology is mainly mica schist of the Moinian period.

In its upper reaches, the river flows through moorland and peat bog. Soils in the catchment are peats and gleys with poor drainage capacity, supporting a vegetation cover of rough pasture, bracken and heather. The upper part of the catchment supports low intensity sheep grazing, while downstream the land use is predominantly improved grassland.

Although the river has not been designated under the EC Freshwater Fish Directive it has excellent water quality both chemically and biologically, and it is a very important nursery area with high densities of juvenile trout and salmon. Its banks have many trees (mainly alder, willow (*Salix* spp) and hazel (*Corylus avellana*)) which provide adequate shading for the juvenile fish. The river is not suitable for angling and does not have stocks of takable fish. Wildlife found in the river corridor include mallard (*Anas platyrhynchos*) and dragonflies (Odonata).

## **R21 River Bush**

County Antrim, Northern Ireland (Lat 55° 12'N; Long 6° 31'W; IGR 2940 4405)

*Sponsor: Department of Agriculture for Northern Ireland*

The River Bush enters the Atlantic Ocean close to the Giants Causeway on the north Antrim coast of Northern Ireland. Rising in the Antrim hills at 480 m AOD, for most of its length the river flows through a fertile valley devoted to grassland-based agriculture with limited arable cropping. The underlying geology is basalt and the water is slightly alkaline with magnesium making an unusually large contribution to total hardness. The river supports indigenous stocks of Atlantic salmon and brown trout, but it is the salmon population which is of the greater interest. Bush salmon have been the focus of long-term studies on salmon ecology and on the techniques suitable for managing salmon populations. A fish-trap on the river at Bushmills, some 3.5 km from the sea, enables ascending adult fish and returning juvenile salmon smolts to be intercepted, counted and sampled. This work has continued since 1973 and is accompanied by annual assessments of fry survival in the main spawning areas of the river. In addition to the river being part of the ECN network, it is an index river of the International Council for the Exploration of the Sea (ICES) which integrates the results with those of other salmon research programmes in the north-east Atlantic.

## R22 Trout Beck

Cumbria, England (Lat 54° 42'N; Long 2° 22'W; NGR 3758 5335)

*Sponsors: Natural Environment Research Council and English Nature*

Trout Beck is a headwater stream of the Tees which drains Great Dun Fell, Hard Hill and Knock Fell in the North Pennines. The ECN sampling site is at 535 m AOD and the catchment above this covers 1146 ha, rising to 848 m AOD. The geology is alternating strata of Carboniferous limestones, slates and shales. Blanket peat covers 90% of the catchment with skeletal soils towards the fell tops and small areas of limestone soils and alluvial soils. Vegetation is dominated by heather, cotton grass and *Sphagnum* moss. The catchment lies in Moor House NNR, which is owned by English Nature. Discharge is measured at a Compound Crump Gauging Station operated by the EA. The pH of Trout Beck averages 6.2 although there are wide fluctuations associated with the discharge. The site has a long history of ecological research. Trout Beck is the first ECN Freshwater Site with its catchment entirely within an ECN Terrestrial Site.

## R23 River Coln

Gloucestershire, England (Lat 51° 41'N; Long 1° 42'W; NGR 4204 1988)

*Sponsor: Environment Agency, Thames Region*

The River Coln rises at an altitude of about 200 m AOD near Sevenhampton in Gloucestershire and flows from the limestone Cotswold Hills in a south-easterly direction to Lechlade, where it joins the River Thames at an altitude of about 75 m AOD. There are no major tributaries. The sampling site is located in Lechlade about 70 m above the confluence with the Thames. The source of the river is in the Inferior Oolite aquifer in which it flows for the first few kilometres, but most of the river runs on the Great Oolite aquifer. Both limestone aquifers are sources for water abstraction; a total of 55 million litres per day are consented from the catchment. The river crosses Oxford Clay before running into the Thames. The catchment is mostly rural, with farming as the main industry. The upper catchment is mainly grazing land, and there are large areas of deciduous woodland in the south-west. The upper two-thirds of the catchment is within the Cotswold AONB, and around Fairford the river has been designated as a Nitrate Sensitive Area.

There are no large conurbations on the upper catchment, although Cheltenham, from where surface water drains into limestone above the river's source, has a population of over 100 000. The Coln catchment supports a population of around 9000. The main sewage inputs to the river are from works at Andoversford, Bibury and Fairford. Bibury trout farm has the largest discharge into the river, although most of this is 'on-line' through fish-ponds. The river has been subject to various enhancement schemes to improve ecology and fisheries. Water quality was recorded as 'good to fair' in 1995. The classification varies throughout the river, due to the effects of both discharges and low flows.

The biological quality of the river is very good. The river supports a brown trout fishery with good spawning beds. Natural populations of grayling also exist. Native crayfish have been recorded but not since 1991; populations of the introduced American signal crayfish (*Pacifastacus leniusculus*) are also present. Several pollution-sensitive caddisfly and mayfly families have been found, along with true-bugs, beetles and snails.

## R24 River Lambourn

Berkshire, England (Lat 51° 25'N; Long 1° 21'W; NGR 4453 1691)

*Sponsor: Environment Agency, Thames Region*

The River Lambourn rises near the village of Lambourn in the chalk of the Berkshire Downs at an altitude of about 152 m AOD. It is 26 km long and flows through the Kennet Valley in a south-easterly direction to Newbury where it joins the River Kennet at an altitude of about 85 m AOD. There is one important tributary, the Winterbourne Stream, which flows into the Lambourn from the north-east, just upstream of Newbury. The sampling site is located at Bagnor, 5 km above the confluence with the Kennet, at an altitude of about 80 m. Flow ranges between 1.2 and 4.1 cumecs.

The catchment is mostly rural, with mixed farming as the main industry, and there are extensive deciduous woodlands on the catchment boundary. The river forms part of the proposed Kennet and Lambourn floodplain SAC under the EC Habitats Directive. Most of the river is designated SSSI.

There are no large conurbations on the upper catchment but the river flows through Newbury, a town with a population of about 35 000, which provides inputs of surface water run-off. Ten kilometres from the source, the river receives input from East Shefford sewage works; the only other significant input is from Lambourn Trout Farm. Water quality in the Lambourn is good; the river is classified as GQA biological class 'b' and chemical class 'A'.

The river corridor is notable for reed beds and willow stands and the floodplain provides important feeding grounds for snipe (*Gallinago gallinago*) and water rail (*Rallus aquaticus*). There are good, extensive gravel spawning areas for salmonids; the river supports one of the best and most productive fisheries for brown trout in the area, with natural populations of grayling also present. The Lambourn is in the top 10% for England and Wales for the number of macro-invertebrate families recorded during the GQA survey; five nationally rare species of invertebrates are found in the river. Native crayfish have not been recorded in recent years, although they are present downstream in the Kennet; however introduced American signal crayfish are present.

## **R25 River Eden**

Kent, England (Lat 51° 10'N; Long 0° 10'E; NGR 5520 1438)

*Sponsor: Environment Agency, Southern Region*

The Eden is a tributary of the River Medway in Kent. It rises south of Caterham and flows eastward through Wealden clay to join the River Medway near Penshurst. Its main tributaries are the Gibbs Brook, Eden Vale Stream, Eden Brook, and the Felbridge Water. The Eden catchment is largely rural and agricultural although much of the dairy farming, which predominated previously, has now declined and has been replaced by mixed farming. The sampling site is east of Penshurst in a flat valley surrounded by agricultural land which is not wooded, and is upstream of a sluice where the river is slow flowing. There is no industry in the area.

Water quality in the Eden is mainly classified as GQA class C, although the headwaters near Oxted are class D. The river receives treated sewage effluent from two Southern Water Services Limited Sewage Treatment Works, serving Edenbridge and Oxted respectively; the stretches receiving these effluents are both subject to EC Urban Water Treatment 'Sensitive Waters' investigations. There are other, much smaller private sewage treatment works throughout the catchment. The river and its tributaries support coarse fisheries. Average flows at Penshurst range from 3.9 cumecs in January to 0.49 cumecs in July.

## **R26 River Ewe**

Highland Region, Scotland (Lat 57° 45'N; Long 5° 36'W; NGR 1858 8806)

*Sponsor: Scottish Environment Protection Agency, North Region*

The River Ewe, in Wester Ross, is a short stretch of river running north-westwards out of Loch Maree into the sea at Poolewe. The large upland catchment (441 km<sup>2</sup>), which includes Loch Maree and Loch Ewe, is mainly peaty moorland managed predominantly for deer grazing, with some hill sheep farming but negligible arable farming. It is well known for its populations of feral goats. Land rises to over 900 m AOD on a number of mountains including Slioch and Ben Eighe. Average annual catchment rainfall is 2272 mm and long-term average flow at the Poolewe gauging station is 29.6 cumecs.

The Ewe catchment is as close to pristine as is possible on the Scottish mainland and, unusually for this part of Scotland, it has no discharges from intensive fish farming. Parts of the catchment are of national scenic and conservation interest and have been designated as NNR and NSA. There are large areas of deer forest and protected woodlands of Scots pine (*Pinus sylvestris*) and native oak (*Quercus petraea*). There is

one small-scale hydroelectric scheme on a tributary flowing into Loch Maree; two further small schemes are proposed. The River Ewe and Loch Maree are important for their salmonid fisheries, but the decline of the trout fishery in Loch Maree is a well-recorded phenomenon which is under investigation by the SOAEFD; it is regarded as indicative of such declines generally on the west coast of Scotland.

Table 1. Supporting agencies and sites in ECN

Agency	Sites/support	Site type
Biotechnology & Biological Sciences Research Council	• 2 Terrestrial sites (North Wyke & Rothamsted)	Lowland grassland & arable
Countryside Council for Wales (jointly with Welsh Office)	• 1 Terrestrial site (Y Wyddfa/ Snowdon NNR)	Upland grassland
Department of Agriculture for Northern Ireland	• R21 Bush • L17 Lough Erne • L16 Lough Neagh • 1 Terrestrial site (Hillsborough)	River site Standing water site Standing water site Lowland grassland
Department of the Environment, Transport & the Regions (through its Acid Waters Monitoring Network)	• R11 Old Lodge • L08 Loch Llagi • L09 Lochnagar • L07 Scoat Tarn • Support for Central Co-ordination Unit	River site Standing water site Standing water site Standing water site
Department of the Environment for Northern Ireland	• R19 Faughan • R20 Garvary	River site River site
English Nature	• Site & facilities at 1 Terrestrial site (Moor House & Upper Teesdale)	Upland grassland & blanket bog
Environment Agency	• R09 Bradgate Brook • R10 Bure • R23 Coln • R03 Coquet • R07 Cringle Brook • R01 Eden (Cumbria) • R25 Eden (Kent) • R02 Esk • R04 Exe • R08 Frome • R24 Lambourn • R06 Lathkill • R05 Wye • L02 Hickling Broad • L01 Upton Broad • L03 Wroxham Broad	River site River site River site River site River site River site River site River site River site River site River site River site River site River site River site Standing water site Standing water site Standing water site
Forestry Commission	• 1 Terrestrial site (Alice Holt Forest)	Woodland
Ministry of Defence	• 1 Terrestrial site (Porton Down)	Chalk grassland
Ministry of Agriculture, Fisheries & Food	• 1 Terrestrial site (ADAS Drayton) • Soil Survey &	Mixed farming



	monitoring at English & Welsh sites	
Natural Environment Research Council	<ul style="list-style-type: none"> <li>• R22 Trout Beck (Moor House)</li> <li>• L05 Esthwaite Water</li> <li>• L06 Loch Leven</li> <li>• L04 Windermere</li> <li>• 2 Terrestrial sites:               <ul style="list-style-type: none"> <li>- Moor House &amp; Upper Teesdale;</li> <li>- Wytham (site provided by Oxford University)</li> </ul> </li> <li>• ECN Central Co-ordination Unit</li> </ul>	River site Standing water site Standing water site Standing water site Upland grassland & blanket bog Woodland & arable
Scottish Environment Protection Agency	<ul style="list-style-type: none"> <li>• R14 Allt a'Mharcaidh</li> <li>• R18 Cree</li> <li>• R17 Eden (Fife)</li> <li>• R26 Ewe</li> <li>• R13 Lower Clyde</li> <li>• R14 Spey (Fochabers)</li> <li>• R12 Stinchar</li> <li>• R16 Tweed</li> <li>• L13 Loch Davan</li> <li>• L15 Loch Dee</li> <li>• L12 Loch Katrine</li> <li>• L14 Loch Kinord</li> <li>• L10 Loch Lomond</li> </ul>	River site River site River site River site River site River site River site River site Standing water site Standing water site Standing water site Standing water site Standing water site
Scottish Office, Agriculture, Environment & Fisheries Dept	<ul style="list-style-type: none"> <li>• 2 Terrestrial sites (Glensaugh Research Station &amp; Sourhope Research Station)</li> </ul>	Upland grassland Upland grassland
Welsh Office (jointly with Countryside Council for Wales)	<ul style="list-style-type: none"> <li>• 1 Terrestrial site (Y Wyddfa/ Snowdon NNR)</li> </ul>	Upland grassland

## 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. The Working Groups which were instrumental in developing the technical and statistical elements of the network have 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 a staff of five and a half: the ECN Co-ordinator, a statistician, a data manager, an assistant data manager, a half-time assistant data manager and an Information Analyst, all of whom are staff members of the Institute of Terrestrial Ecology. At each operating 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 for transmission of the data to the ECN data manager in an agreed format.



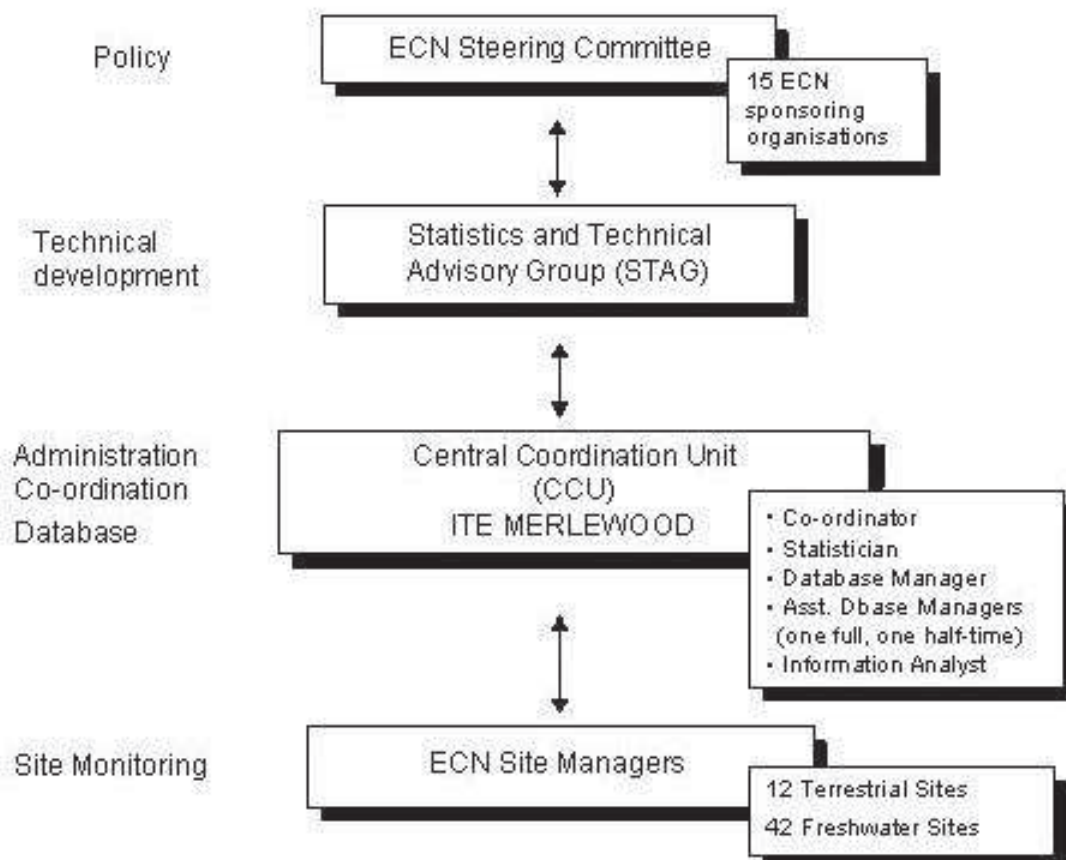


Figure 2. The current organisation of ECN

### J.M. Sykes & others

ECN Co-ordinator 1992-95

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