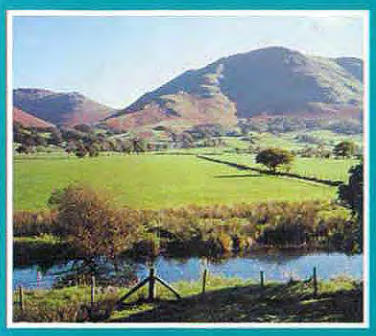
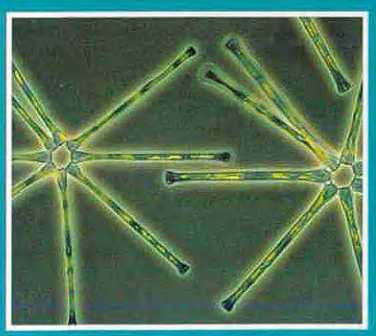




Centre for Ecology & Hydrology

Centre for Ecology & Hydrology

Annual Report 1996–97

Natural Environment Research Council

John Krebs FRS
Chief Executive
Natural Environment Research Council

Foreword

During the past three years the Government's Scrutiny of Public Sector Research Establishments and the Prior Options Reviews have generated a difficult and uncertain time for the Natural Environment Research Council. On the one hand, these reviews have been beneficial in focusing the thinking of Council on key functions and organisation. On the other, the reviews have generated considerable uncertainty amongst staff.

Council approach both during the past three years and in the future is based on three objectives:

- to be clear about the purpose of investment in Centres and Surveys, recognising their distinct roles in providing national capability and meeting national needs, as well as developing transparent mechanisms through which investment can be made;
- to achieve the right balance between central control and empowerment of individual Centres and Surveys;
- to realise the benefits of the integrated environmental science capability that resides within the NERC Centres and Surveys. This requires cohesion of action and a degree of corporate identity.

Achieving the right balance within and between these three objectives is by no means straightforward. It requires careful thought.

During the past three years there has been a significant move towards devolution of some functions from NERC Swindon Office to Centres/Surveys and there is now greater transparency in the relationship. This has been achieved while retaining a strategic partnership with the Centres/Surveys and ensuring that the integrated scientific capability across all NERC establishments was maintained.

Despite these changes, and the uncertainty associated with restructuring and rationalisation, this Annual Report shows that CEH scientists have continued to be at the forefront of terrestrial and freshwater research and have retained their high national and international reputation. The Centre has maintained a high output of scientific papers and reports in a very cost-effective manner and has also demonstrated the relevance and value of CEH research to a wide user community.

The substantial restructuring and rationalisation investment that Council has committed this year to CEH is a demonstration of confidence in the Centre's future.

This 1996–97 Annual Report highlights some of the exciting science conducted within CEH. I am confident that the Centre will continue to build on its excellent scientific base and credentials in the future. I commend this Annual Report to you.

Cover illustrations

The scale of CEH research in the terrestrial and freshwater environments ranges from global to microscopic.

Land use in the English Lake District. CEH plays a leading role in land use research and has a Core Strategic Programme dedicated to this area of science.

*Fritillary (*Fritillaria meleagris*) was once a common plant in the water meadows of southern England, but is now restricted to localised, protected habitats. Part of CEH's Biodiversity Programme covers conservation and restoration of habitats and species.*

Asterionella – *a very common freshwater, planktonic diatom, a nuisance in water treatment (photo © Dr Hilda Canter-Lund FRPS).*

Report of the Centre for Ecology and Hydrology 1996–1997

Natural Environment Research Council

ISBN: 1 85531 182 8

Contents

Centre for Ecology & Hydrology

The CEH mission

- To advance the sciences of ecology, environmental microbiology (including virology) and hydrology through high-quality and internationally recognised research, leading to a better understanding and quantification of the physical, chemical and biological processes relating to land and freshwater and the living organisms within these environments.

- To investigate, through monitoring and modelling, natural changes in the ecological, microbiological and hydrological environments, to assess both historical past and future changes, and to predict man's impact on these environments.

- To secure, expand and provide ecological and hydrological relevant data to further scientific research and provide the basis for advice on environmental conservation and sustainable development to governments and industry.

- To promote the use of the Centre's research facilities and data to provide research training of the highest quality and to enhance the United Kingdom's research base, industrial competitiveness and quality of life.

Professor Brian Wilkinson
Director, Centre for Ecology & Hydrology

Professor Mike Roberts
Deputy Director, CEH and Director, CEH's Institute of Terrestrial Ecology

Professor Pat Nuttall
Director, CEH's Institute of Virology and Environmental Microbiology

Professor Alan Pickering
Director, CEH's Institute of Freshwater Ecology

Professor Jim Wallace
Director, CEH's Institute of Hydrology

All components of CEH have had a successful year in terms of science quality, inter-Institute collaboration, links to the academic community, industrial/commercial involvement, outreach and influence, and public awareness of science.

Directors' Introduction

This year we have made a major change in the annual reporting arrangements for the four component Institutes of the Centre for Ecology and Hydrology. The CEH Annual Report for 1996–97 sets the broader scene and presents an overview of scientific activities, the interaction of CEH with NERC and other organisations, financial information and overall performance and output of the Centre. The annual Scientific Reports from the Institutes are focusing on their *scientific* achievements for the year and the role they have played in the overall research programme of CEH. The two sets of reports are complementary.

Nations are seeking to secure, through development, better standards of living for their people, while at the same time protecting and enhancing their own and the global environment, now and in the future (ie the concept of sustainable development). The 1992 UN Conference on the Environment and Development (the Earth Summit) in Rio de Janiero considered such issues. A comprehensive programme of action (Agenda 21), a Statement on the Conservation of Global Forests and Conventions on Climate Change and Biodiversity emerged. The UK Government has been in the vanguard of countries promoting a strategy and taking action to address the recommendations of the Earth Summit. Achieving sustainable development is a major challenge and requires a deep understanding of the physical, chemical and biological processes that support life systems. As a lead body in the UK for research, survey, monitoring and training in all the environmental sciences, NERC is well placed to meet this challenge. For example, CEH is helping with the programme for the implementation of the UK Government's Biodiversity Action Plan, carrying out research to improve climate change model prediction and impact studies of relevance to the Climate Change Convention. At a national level, the outcome from Phase One of the UK Technology Foresight Programme is having a demonstrable influence on science policy. From the NERC (CEH) perspective, it is encouraging that the 'natural resources and environment' will have its own 'Foresight Panel'. The Annual Report of CEH and the Scientific Reports of its Institutes demonstrate the relevance of all our programmes

CEH Core Strategic Programmes

1. Soil and soil–vegetation interactions
2. Land use science
3. The urban environment
4. Freshwater resources
5. Biodiversity
6. Pests and diseases
7. Pollution
8. Environmental risks
9. Global change
10. Integrating generic science

The Environmental Change Network has its own website – http://mwnta.nmw.ac.uk/ecn

to these and other major national, European and global science and policy issues.

FUNDING

In 1995, the NERC established a Funding Model for the distribution of its Science Budget. Four funding modes – Non-Thematic, Thematic, Core Strategic and Infrastructure – have been progressively introduced over the last two years. This distinction between funding modes is giving Council greater transparency, clarity of purpose and flexibility in its allocation of funds. The drawing together of CEH activities, both within and across Institute boundaries, has been helped greatly by the introduction of these new NERC funding arrangements.

Non-Thematic Programmes

This year, for the first time, the CEH Institutes have been able to bid for Non-Thematic (Responsive mode) research funds in competition with all sectors of the research community. Four awards have been made this year to CEH Institutes. Almost all bids have been made in collaboration with one or more universities. CEH has thus been presented with an opportunity both to increase the research funding being directed towards more basic science and to strengthen existing and develop new university links.

Thematic Programmes

Each year NERC selects a small number of key environmental issues and advances scientific knowledge and understanding of these through a three- to five-year programme of integrated research. These Programmes are funded through the Science Budget and are open to the UK academic community. CEH provides the management and secretarial support for six of these Thematic Programmes. We have also been successful in competing, often in collaboration with one or more universities, for research project funding within these Programmes. Our scientists have also developed several new concepts for Thematic Programmes during the year. A number of these have been reviewed and accepted by NERC's Terrestrial and Freshwater Science and Technology Board (TFSTB) and, following further development including seminars to involve the wider scientific and user community, have been taken by the TFSTB through to Council for final consideration. The role of CEH in relation to the NERC Thematic Programmes is described in some detail in a later section of this Report.

An important part of the mission of NERC, and of CEH, is to safeguard and expand the considerable data resource within their care. NERC has established seven Designated Data Centres for this purpose, two of which are in CEH – the Environmental Information Centre and the National Water Archive. A new initiative of NERC, the SEEDCORN project, was launched in 1996 to process, curate and make available for wider use some of the older data records which might otherwise be lost, and CEH is receiving funding under this scheme. CEH also manages the UK Environmental Change Network (ECN), an integrated network to detect and interpret environmental change.

Core Strategic

The increase in integration of science programmes between the Institutes is particularly noteworthy and has been brought about through the further development of the CEH Core Strategic Science Programme. Key features of the Programme are that it is long-term, interdisciplinary and based on large-scale facilities. The further refinement of the ten

Core Strategic Programmes CEH has developed on behalf of NERC, as part of the necessary re-alignment of research activities under the new NERC Funding Model, has been a major exercise during the year. Following an endorsement by four Programme Review Groups, with a membership drawn from academia, industry and UK Government departments (Appendix 4), the ten Programmes were approved by the TFSTB and work commenced on 1 April 1997. The breadth of science covered by these Programmes, and their relevance to regional, national and global environmental issues, is considerable.

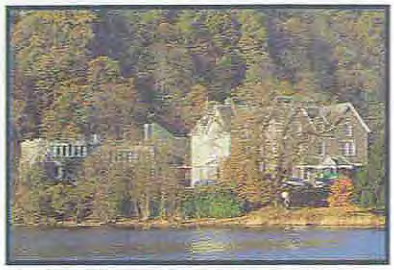
Through its Science and Technology Boards, NERC is developing a new science strategy. Together with the outputs from the Government's continuing Technology Foresight activity and any new initiatives from the international science programmes, this new strategy will be used to modify elements of the CEH future research programmes. The Programmes are therefore not static, but will be subject to review and modification to address new environmental issues as they emerge. A following section in this Report describes briefly some of the scientific research being undertaken within the Programmes. More comprehensive descriptions are given in the Institute Reports. It is noteworthy that each of the ten Programmes has a major input from at least three of the CEH Institutes.

Each Programme is composed of projects based on sets of scientific issues. The financial and other resources allocated to each of the projects, and the anticipated outputs with target dates, have been set. The Programmes are reviewed annually by the Programme Review Groups.

Within the Core Strategic Programmes, there are a number of projects which have been funded to encourage inter-Institute collaboration. These have become known as the Integrating Fund Projects. To qualify for support, projects must be of the highest scientific quality and involve collaboration between at least two CEH Institutes. The scheme has been running for three years. The Management Team subject the projects to annual review and we have been, in general, so pleased with the scientific output that three (bringing the total to 15) new projects were selected from the bids this year. This brings the Science Budget commitment to 14% for Integrating Fund Projects during 1997–98. A description of some of the Integrating Fund Projects is given in a subsequent section.

Infrastructure

Under the new NERC Funding Model the components of infrastructure, drawn from the Science Budget to contribute to the upkeep and support of the CEH Institute laboratories, are now clearly identified. The infrastructure costs are under constant review to see if savings through increased efficiency are possible. It should be noted, however, that only 57% of the infrastructure costs are met from Science Budget. The remaining 43% comes from overheads from our Commissioned Research (CR) projects and from the Thematic and Non-Thematic (Responsive mode) grants. The Departments, Agencies and other organisations who place CR with CEH are normally prepared to meet the full overhead costs associated with the research, but the Thematic and Non-Thematic Projects from NERC provide overheads that are below the economically viable level. This is placing a strain on the Science Budget element of infrastructure.



The Windermere Laboratory of CEH's Institute of Freshwater Ecology in Cumbria.

The integration of CEH's science, through the Core Strategic, Thematic and Non-Thematic Programmes, our strong CR activities and the sharing of datasets and other facilities have given CEH the capacity to tackle most terrestrial and freshwater science issues in a fully holistic manner. CEH probably has one of the strongest capabilities in this regard worldwide.

CEH's Institute of Hydrology at Wallingford, Oxfordshire.

CEH science is mutually dependent on funding from Science Budget and Commissioned Research sources. There is strong synergy between the SB- and CR-funded research. The CR component demonstrates the value of our science to the user community.

CEH involvement with universities has continued to grow this year and we now have 22 staff with professorial status.

CEH management hopes that it will not restrict CEH's full participation in these Thematic and Non-Thematic activities.

External Income

Approximately 50% of CEH's income comes from a wide range of customers who fund Commissioned Research. A breakdown of CEH's major customers is shown in the section on Finance and Staffing and an indication of our customer range is shown on Appendix 7. The CR undertaken by CEH is complementary to the science programme and a number of projects operate on a jointly funded basis. The CEH Core Strategic Programme is mutually dependent on funding from both SB and CR sources, the CR component demonstrating the value of the Programme to the user community.

CEH OUTREACH

Industrial Links

NERC, CEH and IVEM took a major step forward in their links with industry this year through the establishment of a new company, Oxford Vacs Ltd. This is an equal-part, joint venture between Vacs of Life plc and NERC. Oxford Vacs is to exploit some novel properties of arthropod saliva proteins identified by IVEM. This is the first occasion on which NERC has entered into such arrangements. Other opportunities for NERC to exploit CEH scientific capabilities, through links with industrial partners, are being explored. For example, CEH participates in the LINK programmes in Aquaculture and Earth Observation (LINK is the Government's principal mechanism for transferring knowledge and skills from the science base to UK industry). CONNECT is a NERC scheme to provide partnerships between the science base and industry, business and commerce. CEH's IFE has been involved in a project to recover phosphorus and metals from sewage. Further examples of CEH's range of links with industry are shown in Appendix 7.

University Collaboration

The CEH involvement with the university community has always been strong, but it has continued to grow during the course of the year. We now have 22 scientific staff with professorial status within UK or overseas universities. The level of CEH/university collaboration is shown in Appendix 5. Three examples are offered here.

- It is noteworthy that IFE, which is one of the smaller CEH Institutes, has some 40 PhDs working on IFE related research from 18 different universities
- IVEM has, together with the University of Oxford's Department of Engineering, helped to establish the Oxford Centre for Environmental Biotechnology (OCEB), with **Professor Chris Knowles** as the newly appointed Director.
- CEH's IH is an associate Institute of the University of Reading and an active member of the Centre for Earth and Atmospheric Sciences.

Europe

We have maintained and extended our many contacts with our scientific counterparts throughout Europe. CEH is particularly active in two European research organisation networks. The European Conservation Research Institute Network (CONNECT) held its Annual Management Board Meeting at ITE Banchory during the year. The meeting was hosted by **Mike Roberts** (Director ITE) and brought together all of the major ecological research institutes in northern and central Europe. The European Network of Freshwater Research Organisations (EurAqua), with a

membership of 15 European nations and representing more than 3000 research scientists throughout Europe, held its Annual Technical Review Meeting on 'The quality of aquatic ecosystems as an indicator for sustainable water management' in Koblenz during October this year. **Alan Pickering** (Director IFE) presented the UK paper.

International Issues

CEH has continued its active overseas research programme and, in particular, has contributed to the international thrust towards sustainable development embodied in the Conventions arising from the 1992 Earth Summit in Rio de Janiero. The UK response to the UN Commission on Biological Diversity was to develop and publish its Biodiversity Action Plan (BAP). CEH's ITE, through input to BAP Committees and by helping in identifying and selecting priority species and habitats, has contributed to the implementation of this Plan.

The World Meteorological Organisation (WMO) Commission for Hydrology, which meets every four years, held its Xth Session in Koblenz this year. **Brian Wilkinson**, as the UK Hydrological Advisor, led a small team, including **Frank Law** (IH), **Richard Streeter** (Environment Agency) and **Paul Hardaker** (Meteorological Office) and **Nigel Goody** (Scottish Environmental Protection Agency) The Commission's operational programmes are concerned with applying hydrology to meet the needs of sustainable development and use of water, mitigate water-related disasters and ensure efficient environmental management in the water sectors. The Commission's work has close links with other programmes in which CEH scientists are involved. These include the World Climate Research Programme (WCRP) and the Global Energy and Water Cycle Experiment (GEWEX). Details of such involvements will be found in the Institutes' Scientific Reports.

Professor Brian Wilkinson, Director CEH, and Dr Peter Lee, Office of Science and Technology, representing the UK at the UNESCO Natural and Social Sciences Commission in Paris.

There were two other particularly important events concerning overseas science which arose during the year. The UK rejoined UNESCO, and the Department for International Development (DfID) recently published a White Paper on International Development.

- During the years when the UK was not a UNESCO member, the value of the scientific programmes was, nevertheless, recognised. CEH maintained, through IH and ITE, a very active, although informal, involvement in the International Hydrology Programme (IHP) and Man and the Biosphere (MAB). Indeed, CEH has been providing the Chairmen and secretarial support for both of the UK IHP and MAB Committees. With our re-entry to UNESCO, UK terrestrial and freshwater scientists should now be able to play a full part in these important international programmes. In view of CEH's long involvement with UNESCO science, it was appropriate, and pleasing, for CEH to be involved

Professor Vladimir Zaletaev (Russian Academy of Natural Sciences) and Dr Nina Alexeeva (Moscow State University) presenting Professor Brian Wilkinson with his award of a Fellowship of the Russian Academy of Natural Sciences, during their visit to CEH in March 1997.

The maintenance of the quality of our science and the continued high output levels are a direct result of having highly skilled, well-motivated and innovative staff.

in the 1997 UNESCO General Conference. **Brian Wilkinson** was appointed as the UK Science Representative and led the small delegation at Conference's Natural and Social Sciences Commission.

- CEH has several major research projects in place with DfID and much of our Science Budget, Core Strategic and Thematic Programme (eg TIGER, LOIS, etc) research has a strong synergy with such projects. The Government's new White Paper on International Development, 'Eliminating world poverty – a challenge for the 21st century', launched recently by the Rt Hon **Clare Short**, Secretary of State for International Development, is focused on issues such as the elimination of poverty, sustainable development, partnerships, environmental audit, assessing and quantifying impacts of development funding. All these issues have important consequences in relation to CEH research. Many of our programmes and projects, which address developing world issues, are fully compatible with the thrust of the new White Paper.

STAFF

The maintenance of the quality of our science and the continued high output levels are a direct result of having highly skilled, well-motivated and innovative staff. There have been many honours and awards presented to members of staff during the year. For example, **Frank Law** (IH) was elected President of the British Hydrological Society, **Polly Roy** (IVEM) was awarded a professorship of the University of Oxford, **Jeremy Thomas** (ITE) was presented with the Marsh Award for Conservation Biology from the Zoological Society of London, **Ian Newton** FRS (ITE) was elected to the Council of the Royal Society for the Protection of Birds, **Colin Reynolds** (IFE) was appointed as the Acting Director of the Freshwater Biological Association, **Brian Wilkinson** (CEH) was awarded a Fellowship of the Russian Academy of Natural Sciences, and **Hans Kruuk** (ITE) gained the Annual British Mammal Society Medal. **Terry Wells** (formerly ITE) was awarded an OBE and **Richard Mann** (IFE) an MBE in the Queen's Birthday Honours for their services to science.

Whilst staff numbers reduced from 629 in 1995 to 616 in March 1997, a restructuring of the NERC Swindon Office responsibilities led to a transfer of 21 computing staff and seven remote sensing staff to CEH. The direct management of these two groups by CEH and its Institutes will lead to a much more effective and integrated computing activity across CEH and an enhancement of our science programmes in remote sensing. CEH now has to provide facilities for 644 staff and some 150 students and visiting workers.

SCIENCE AND SOCIETY

Many CEH staff are involved in a busy programme of exhibitions, presentations, interviews and lectures aimed at conveying an appreciation of the role of environmental sciences in society to the general public. For example, during the extended dry period that occurred in many parts of England and Wales from April 1995 to September 1997 (for some areas the driest consecutive 30 months on record), **Terry Marsh** and **Martin Lees**, IH staff with responsibility for the UK Surface Water Archive, gave many press briefings and interviews on radio and television so as to put these statistics into an historic perspective.

CEH also recognises how important it is to stimulate children's interest in the environmental sciences, and all CEH Institutes have a member of staff with special responsiblity for school liaison. For example, **Colin Barr**, **Robin Fuller** and **Sue Wallis** from CEH's ITE co-ordinated a national land use survey across English schools. The results have been published in a book. Highdown School in Caversham, Reading, is pioneering an information technology (IT) initiative as part of a Government-sponsored programme to exploit the educational potential of the Internet and linked multi-media technology. The 'Highdown Information Hub', which creates a 'connected learning community', has been developed by the school in conjunction with industry. It aims to enable students, teachers and parents to join together with the wider community in creating a new IT learning culture. Hydrology is now part of the National Curriculum and CEH's IH, working through the NERC Schools Programme, has made a start in developing an 'electronic textbook' on hydrological issues in relation to the management of water and our aquatic environment. This has become one of the first components on the Highdown Hub. Other examples of CEH's work with schools are described in a later section and in the Institutes' Scientific Reports.

Distinguished Visitors

Our Institutes were visited by many distinguished scientists during the year. We were also pleased to welcome to the IH Wallingford Laboratory **John Battle** MP, Minister for Science, Technology, Energy and Industry, and on separate occasions to ITE Edinburgh **Lord Sewel**, Scottish Office Parliamentary Under-Secretary of State (Agriculture, Environment and Fisheries), **Lord Lindsay**, formerly Scottish Office Minister for Agriculture, Forestry and the Environment, and **Adam Ingram** MP. Our ITE Merlewood and IFE Windermere Laboratories were pleased to receive **Tim Collins** MP. ITE Bangor was visited by **Betty Williams** MP and IVEM by the Rt Hon **Andrew Smith** MP. **James Smith** CBE, Chairman of NERC, and **Professor John Krebs**, Chief Executive, were available to host guests on several of these visits.

PERFORMANCE

CEH outputs may be judged using many indicators, ranging from staff representation on international committees, to development and promotion of software products, to publications. The publications record is, however, a particularly useful indicator as a basis for comparison of an organisation's performance, both within and outside NERC. Details of the number of papers published and Commissioned Research reports prepared during the year are given in a subsequent section. It will be seen that numbers have been maintained at a high level, although they are slightly down in relation to the previous year. This is probably a reflection of the disturbance

CEH Institutes have been visited by many distinguished guests during the year.

Minister for Science, Mr John Battle MP, receiving a computer-generated flood risk map from Professor Jim Wallace on his visit to the IH Wallingford Laboratory.

On average, every CEH scientist produced one published paper and a major report.

resulting from the reduction in scientific staff. Even so, last year, on average, every CEH scientist produced one published paper and a major report. The average cost of a CEH paper, based on the Science Budget supporting our Core Strategic Programme, was £12,000. It is believed that this level of output, and the associated costs, compare very favourably with those from other NERC Centres/Surveys and from the wider university community.

FUTURE OPPORTUNITIES

The past year's achievements have been accomplished against a background of continuing uncertainty over the outcome of the Prior Options Reviews, increased competition for Commissioned Research and financial constraints.

During the first half of 1996, the Government carried out the Prior Options Reviews of the Research Councils. This involved examination of 50 research establishments in the Public Sector. The NERC was required to review three of its Centres/Surveys (British Geological Survey, CEH and the Centre for Coastal and Marine Sciences). The principal outcomes of the Prior Options Reviews were presented in the CEH 1995–96 Annual Report: 'the Government has decided that the function of CEH is needed, that it should remain an entity in the Public Sector and that opportunities for rationalisation and restructuring will be pursued'. In taking the rationalisation and restructuring forward, NERC Council, in the spring of 1997, presented Director CEH with broad guidelines as to its needs. There was a requirement to report to the Chief Executive and in turn to the September 1997 Council meeting. Over the spring and summer of this year, CEH Directors carried out a major review of the viability of all sites and a large number of merger options were considered. Proposals were developed to achieve a sensible rationalisation of sites and long-term reduction of overheads, but also to gain long-term scientific benefits through new groupings of scientists with complementary skills and the provision of new or improved facilities. A proposal from CEH was approved by the NERC Chief Executive, **Professor John Krebs**, and then presented to Council as part of a total package of restructuring and rationalisation for NERC's Centres/Surveys. The overall Council objectives were to:

- invest in NERC establishments and reskill parts of the workforce,
- achieve better value for money for Science Budget expenditure,
- reduce the number of NERC sites,
- return a proportion of savings to headroom for other scientific initiatives.

It is essential that CEH has its laboratories distributed throughout Great Britain to give access to a wide range of climatic and biogeographical zones.

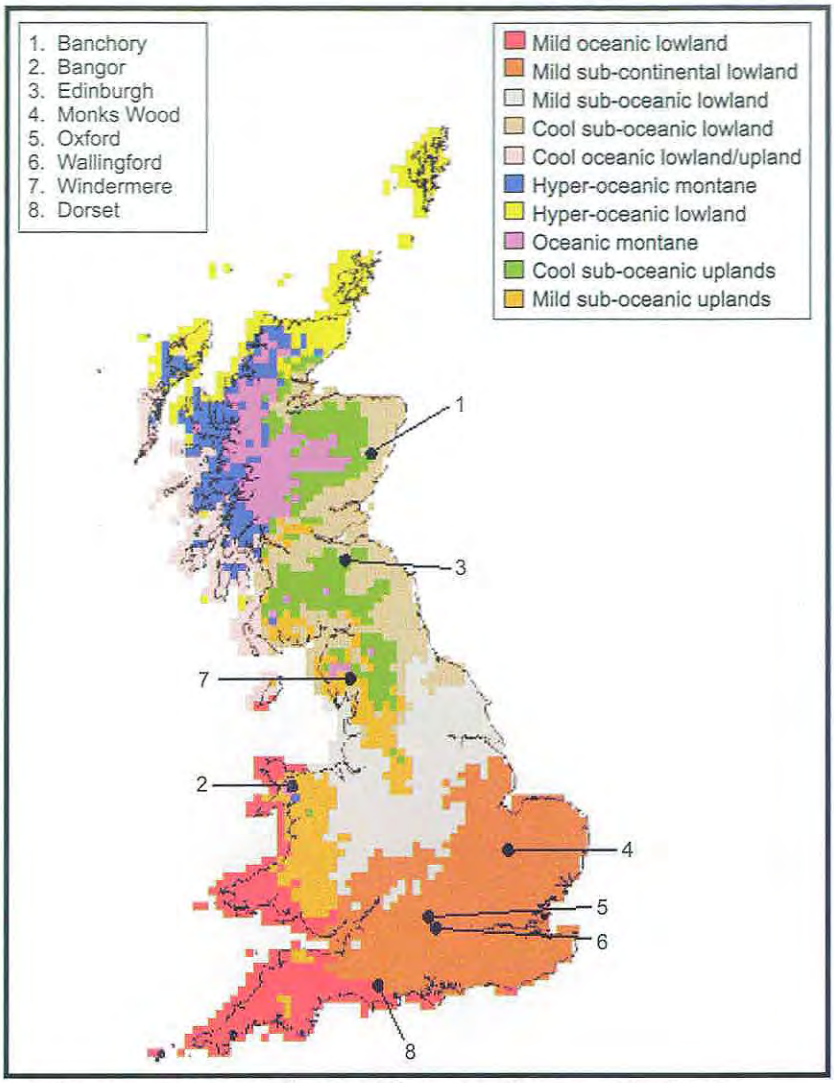
At Council, the elements of the package which related to CEH were considered and accepted in principle, subject to feasibility and detailed costings being made available. The proposals for CEH are to:

- close the CEH Dorset sites at ITE Furzebrook and IFE East Stoke and move to shared accommodation nearby,
- subject to satisfactory arrangements being made with the Freshwater Biological Association for the development of the Windermere site, close ITE Merlewood and move staff to Windermere,
- close the CEH sites at Plynlimon, York and Stirling, but maintain the operation of necessary facilities to ensure the continuation of long-term datasets,
- build an extension to the Wallingford Laboratory to house the 50 staff currently housed in temporary accommodation and upgrade facilities, and

- reduce CEH staff numbers by 40 over a three- to five-year period, releasing funds for up to 20 'new-blood' scientific appointments.

It is essential that CEH has its laboratories distributed throughout Great Britain to give access to a wide range of climatic and biogeographical zones. If the proposals are all put into place, the distribution of the eight remaining CEH laboratories should give ready access to these climate and biogeographic zones, as shown in the map.

The whole programme is expected to take three to five years to complete and will be dependent upon the fully developed proposals being both acceptable to Chief Executive and within the limits of the overall budget. The CEH Directors see this as recognition of the high value that Council place on our science and an opportunity for investment in the future of CEH. It will enhance the already strong science base and continue the process of scientific integration which has been so successful over the past three years. Directors see it as important to involve staff as fully as possible in the planning process and staff will be kept informed as to progress. The plans will be carefully developed to sensible timescales and in a way that should lead to minimum impact on CEH's research activities.



Main biogeographic zones in the UK and the proposed location of the CEH sites following rationalisation and restructuring.

Professor Brian Wilkinson
Director, Centre for Ecology & Hydrology

Professor Mike Roberts
Deputy Director, CEH and Director, CEH's Institute of Terrestrial Ecology

Professor Pat Nuttall
Director, CEH's Institute of Virology and Environmental Microbiology

Professor Alan Pickering
Director, CEH's Institute of Freshwater Ecology

Professor Jim Wallace
Director, CEH's Institute of Hydrology

CEH is undertaking ten NERC Core Strategic Programmes which provide a science base that underpins both national and international requirements in the terrestrial and freshwater sciences. The ten component programmes cover a wide range of topics of current importance. They are also dynamic and can be modified to incorporate new and emerging environmental issues.

CEH Core Strategic Programme

1: Soils and Soil–Vegetation Interactions

This programme is designed to improve our understanding and ability to model key soil processes controlling the transformations of materials within soils and the flux of water through the soil–vegetation–atmosphere continuum.

2: Land Use Science

This programme is aimed at promoting an integrated approach to land use science that is applicable to the wide range of user community requirements. The programme's themes will be developed to provide the basis for large-scale, long-term analytical studies of major land use change.

3: The Urban Environment

This relatively new programme aims to extend the interdisciplinary knowledge base and to understand the key environmental patterns and processes in urban situations and particularly change due to human activities. This knowledge is required to plan more sustainable urban environments.

4: Freshwater Resources

Increasing demands on freshwater resources have resulted in the need for a scientific basis for the effective strategic and sustainable management of freshwater resources. The programme will address these needs by integrating CEH research in the areas of water quantity, water quality, and the ecological aspects of freshwater systems.

5: Biodiversity

This programme aims to improve our understanding of microbiological and biological resources at a range of spatial scales. The research considers the underlying processes and resulting functions, and directs knowledge to the sustainable management of biodiversity.

6: Pest and Disease Control and Risk Assessment for GMOs

The primary aim of this programme is to undertake research in the provision of novel pest and disease control strategies whilst addressing any possible risk to the environment. The use of molecular biology is essential to maintain a novel and progressive approach to the themes of pest control and animal disease control.

7: Pollution

This programme is aimed at developing a better understanding of generic processes such as atmospheric transport, fluxes of pollutants and the fate of pollutants, in order to predict more accurately the likely impacts on environments and organisms.

8: Environmental Risks and Extreme Events

This research programme will develop understanding of how environmental extremes affect mankind and the natural environment, developing quantitative, predictive tools to describe these effects, and contributing to mitigating measures.

9: Global Change

This programme will help to reduce uncertainty in the magnitude of global change and its impacts. The research is focused on improving the accuracy of global change predictions through measurement programmes, the development of scaling-up methods and models, and the identification of ecosystem responses.

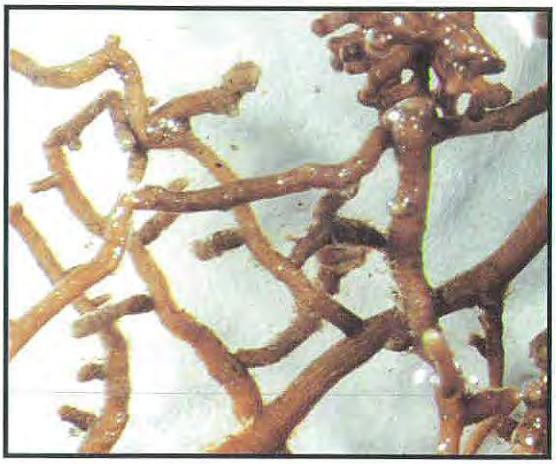
10: Integrating Generic Science

Programme 10 has been designed to provide a research framework for those areas of CEH science which underpin the nine other programmes (eg providing the data and technological support), as well as conducting its own fundamental research.

The following section of this Report provides an overview of each programme. Further details of the projects and issues that make up each of the ten Core Strategic Programmes are listed in Appendix 3 of this Report.

Programme 1: Soil and Soil–Vegetation Interactions

Soils have key roles in controlling global change, pollution impacts, maintenance of biodiversity and sustainable development. An understanding of soil physical, chemical and biological processes and functions is essential to the optimal and sustainable management of soils, land and water resources and the prediction and management of the impacts of pollution, environmental change and land use. The Programme will improve understanding and the ability to model key soil processes which control the transformations of materials in soils and the flux of water through the soil–vegetation–atmosphere continuum.



Main Project Areas

- **Physico-chemical processes affecting soil–water interactions**
- **Biologically mediated soil processes**
- **Physical and physiological processes controlling soil/water balances**

Participating CEH Institutes

IFE, IH, ITE, IVEM

Programme 1 Science within 1996–97 Institute Reports

IFE

Climatic effects on the output of dissolved organic matter from upland soils

IH

Uptake of water by roots in agroforestry

IVEM

The role of microbial diversity in regulating ecosystems

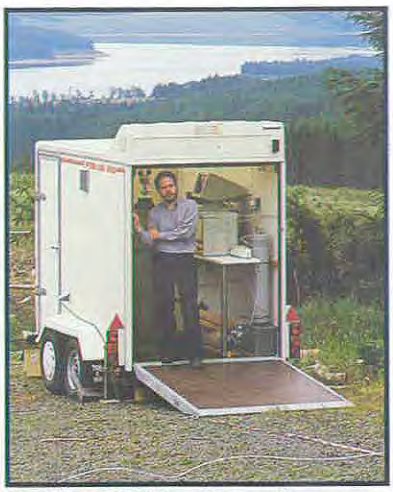
Programme Leader's Report

The research within Programme 1 comprises a combination of applied, strategic and more basic studies. Examples of current applied studies include assessments of the impacts of farming and forestry management on soil sustainability, with the aim of developing sustainable systems. The agriculturally related studies, for the Ministry of Agriculture, Fisheries and Food, are assessing the impacts of farm management on the status of the soil biota. The first stage of the study has involved a literature survey while the current phase is assessing the status of the soil fauna from a range of sites for which detailed management information is available. EU-supported studies in Spain and Portugal aim to provide guidelines for the management of *Eucalyptus* plantations to optimise and conserve organic matter content and nutrient status. These studies, carried out in collaboration with a timber company, have examined the impact of a range of management practices, including ploughing, removal of brash and brash incorporation into the soil.

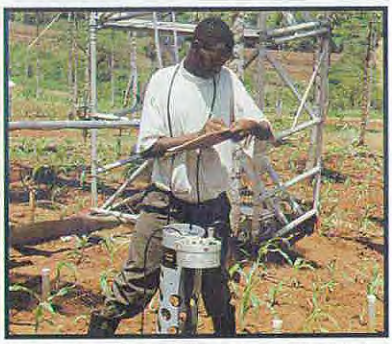
Current strategic research includes projects related to the impact of climate change on soils and to water use in agroforestry systems. Research initiated under the TIGER programme (details in IFE Scientific Report 1996–97) has examined the impact of global warming on carbon dynamics in a series of upland soils. The results suggest that there could be a significant increase in the rate of release of carbon from the organic rich soils both to the atmosphere as carbon dioxide and to drainage waters as dissolved organic carbon (DOC). DOC is a major concern in water quality terms and any significant increase could result in increased costs for water treatment.

Water transfer between soil and roots is a major control on evapotranspiration and therefore is vital to any fundamental understanding of the hydrological cycle. Study of this interface is being given high priority in Programme 1. Current work (details in IH Scientific Report 1996–97) is focused on the *Grevillea robusta*–maize agroforestry system in Kenya. The aim is to model the partitioning of water between the tree and cereal crop to support the development of improved management practices.

Some of the more fundamental research within the Programme is examining microbial diversity and processes in the rhizosphere. The rhizosphere is the most biologically active zone of the soil and an improved understanding of the processes operating in this zone is essential in the development of sustainable land management and in land reclamation/restoration. One of the rhizosphere-related studies (details in IVEM Scientific Report 1996–97) aims to define the diversity of pseudomonads within the rhizosphere of wheat in microcosms. This group of bacteria is often the most abundant and has a number of potentially exploitable traits. Other studies are examining the flows of carbon within the rhizosphere and the importance of rhizosphere processes in the degradation of pollutants.



The ITE mobile laboratory used for monitoring in situ *trace gas emissions from soils.*



Measuring changes in water content in an agroforestry experiment in Kenya.

Programme Leader
Prof M Hornung
ITE Merlewood

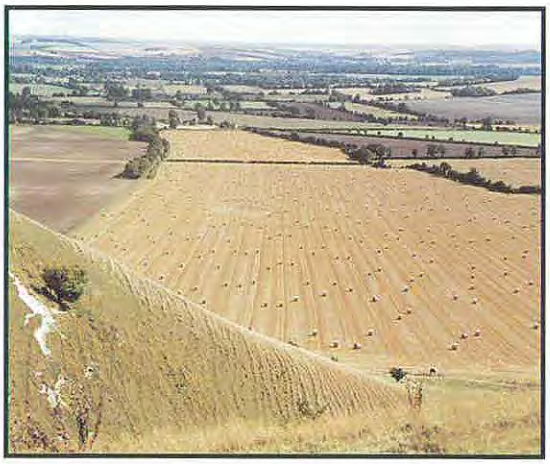
Programme 2: Land Use Science

Major changes in land use, locally, regionally and globally, have occurred over the last century. These will continue into the future and have a major impact on society. To ameliorate such impacts, the processes driving land use change need to be understood.

The Research Programme promotes an integrated approach to land use science that is applicable to the wide range of user community needs. The research focuses on:

- *monitoring and understanding the impacts of land use change on water and carbon balances and on habitats and wildlife*
- *modelling the processes and effects of land use change*
- *developing strategies for the optimisation of land use.*

These themes will be developed to provide the basis for large-scale, long-term analytical studies of land use change.



Main Project Areas

- **Long-term and large-scale monitoring of land use**
- **Land use systems**
- **Management of ecosystems in tropical regions**
- **Landscape function and modelling**

Programme 2 Science within 1996–97 Institute Reports

IH

Himalayan river sediments

Hydrological effects of short-rotation energy coppice

Groundwater recharge under dry farmed irrigation crops in central Spain

Combining hydro-ecological, agricultural and socio-economic modelling

ITE

Farmlands for biodiversity – the LANDECONET project

ECOFACT – ECOlogical FACTors controlling biodiversity in the British countryside

Coastal zone management

Participating CEH Institutes

IFE, IH, ITE, IVEM

Programme Leader's Report

The land use of Britain is changing rapidly, especially in relation to agriculture and forestry, driven by economic and political forces. The Land Use Science Programme addresses this by a wide range of studies dealing with the monitoring and modelling of the types and extent of land use change, the assessment of its consequences on the environment, and the development of management systems that are compatible with environmental objectives. As a consequence, this Programme encompasses both strategic and applied work.

Monitoring includes an understanding of the current landscape and land use as well as how they are changing. Examples are given in ITE Scientific Report 1996–97. This includes a description of an EU-supported study of habitat fragmentation and landscape change in farmland across northern Europe. At a more strategic level, the ECOFACT project (ECOlogical FACTors controlling biodiversity in the British countryside) is described, in which a vegetation classification for describing botanical character and change, and the underlying causes, has been developed.

The assessment of land use effects includes consideration of biological diversity, water quantity and water quality. There is currently encouragement from the UK Government and the EU for short-rotation coppice of species such as willow and poplar as a renewable source of energy. Work conducted for the Department of Trade and Industry (details in IH Scientific Report 1996–97) indicates that these coppice species have much higher water use requirements than agricultural crops or broadleaf trees, and so widespread plantations may not be appropriate in the drier parts of the country.

Once the functioning of a system has been understood, modelling provides a powerful tool to generate further insights into system behaviour and interrelations, as well as to predict effects of future changes. Survey data and species models may be used to identify critical population sizes and landscape characteristics where a species may be able to persist or may be at risk (details in ITE Scientific Report 1996–97). Models also allow the integration of social and economic factors with environmental processes for more appropriate natural resource management. In the CHASM (Combined Hydro-ecological, Agricultural and Socio-economic Modelling) project CEH scientists and economists are developing integrated methodologies in Britain and abroad. For example, research in Zimbabwe on a rural water supply project (see IH Scientific Report 1996–97) is attempting to identify and quantify the economic benefits for communities, and the relationship these benefits have with land management decisions and hydrological processes.

Detailed meteorological measurements over a poplar coppice.

The Rural White Paper for England advocates a significant expansion of lowland forestry.

Programme Leader
Dr M A Robinson
IH Wallingford

Programme 3: The Urban Environment

Urban areas provide employment, housing and social contact but they consume resources, generate waste and pollution, alter habitats and are prone to environmental hazard and decay. The Earth Summit in 1992 highlighted the need to develop more socially and ecologically sustainable cities. In the UK, urban issues permeate the priority areas of science and technology identified in the Technology Foresight Programme.

CEH has responded to the need for research dedicated to understanding urban environmental problems through the development of this new research programme. The Programme has two main aims:

- *developing and extending, through survey, monitoring and modelling, the interdisciplinary knowledge base required to plan and achieve more sustainable urban environments*
- *understanding the key environmental patterns and ecological and hydrological processes in urban situations and their responses to change, especially those resulting from man's activities.*

Main Project Areas

- **The patterns of urban land/water use and associated habitats**
- **Urban water dynamics, risk and hazard**

Participating CEH Institutes

IFE, IH, ITE

Programme 3 Science within 1996–97 Institute Reports

IFE

The characteristics of urban fresh waters

The Urban Waste Water Treatment Directive and the current status of Cumbrian lakes

Programme Leader's Report

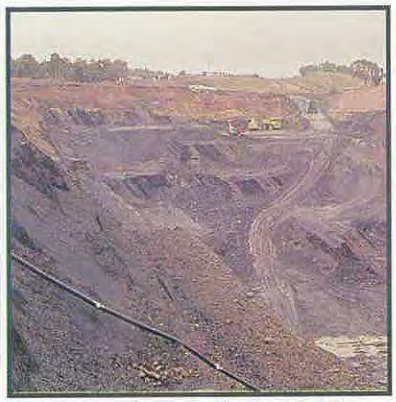
In Britain and other industrialised countries urban environmental issues have generally not been addressed by the natural sciences.

This Programme aims to fill the gap by putting the knowledge and experience gained in understanding how rural, relatively pristine systems function into investigating their degraded and polluted urban counterparts. Questions to be addressed include the following. How do urban systems differ in structure and function? What are the impacts upon them of particular urbanising processes? How can this improved understanding be put to good use in devising, creating and maintaining more ecologically sustainable cities? The CEH Programme will provide integrated underpinning science in terrestrial and freshwater ecology and hydrology which is essential to answer these questions. In doing so it will help to improve the lives of the 90% of our people who live and work in towns and cities.

The first stage in the Programme is the characterisation of urban environments. Work is well advanced to identify the key features which distinguish the plant and animal communities of urban land and water from their rural counterparts. In the case of the terrestrial studies, it has been shown that urban environments favour species tolerant of high temperatures, basic (calcareous) soils, and high levels of nitrogen, all factors known to be characteristic of urban environments. They also provide homes for a disproportionately high number of exotic species which are able to compete with native species in the highly artificial conditions. The freshwater studies indicate that the impacts of urbanisation on rivers and streams are generally greater downstream of the urban area than in its midst. Thus the influence of urbanisation extends well beyond the urban boundary, parallelling patterns of air pollutant dispersal from urban areas.

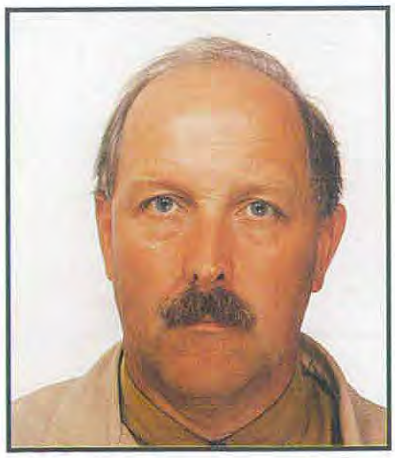
This work will be taken forward to investigate the effects of the geographical location of urban areas and their past and present patterns of development (sea ports, mediaeval market towns, old industrial towns, new towns, suburban infill) on their ecology and hydrology. This will enable modelling of these relationships to assist planners and developers in devising environmentally friendly systems of urban development, which will lead to the evolution of more sustainable towns and cities.

Heavily channelised section of the River Tame, West Midlands, running below the M6.



Opencast coal site. Understanding the environmental impacts of industrial activities can lead to improved restoration.

Programme Leader
Dr J E G Good
ITE Bangor



Programme 4: Freshwater Resources

The need for adequate and sustainable water resources forms the basis of much environmental policy world-wide, but the conflict between demands for freshwater and resource conservation are increasing, even in climatically wet countries like the UK. The driving objective behind this Programme is the need to improve the scientific basis for the effective strategic and sustainable management of freshwater resources required to overcome these conflicts.

The Programme brings together CEH's research in water quantity, water quality and the ecological components of freshwater systems into an integrated research programme, with major themes including:

- *water quantity – improving understanding in surface–groundwater interactions and water resource modelling*
- *water quality – measuring and modelling responses of aquatic biota to physical and chemical properties and improving water quality management*
- *fisheries and aquaculture.*

Main Project Areas

- **Surface–groundwater interactions**
- **Statistical modelling of resource availability**
- **Water resource modelling capabilities**
- **Integrated water quality modelling**
- **Integrated biotic response modelling**
- **Fish dynamics**
- **Physiological performance of freshwater fish**
- **Fish performance models**

Programme 4 Science within 1996–97 Institute Reports

IFE

Chaotic impacts of a dry winter on the phytoplankton of lakes

Phytoplankton distribution and inorganic carbon

Water quality of Esthwaite Water

Improving the water quality in Bassenthwaite Lake

Monitoring of Loch Leven zooplankton

Loch Leven phosphorus reduction

Mean trophic ranking

River Habitat Survey

Using angler opinion to set minimum flows

Modelling growth of salmon parr

The schooling dynamics of river fish

Selective breeding for stress tolerance in aquacultured fish

Migratory salmonids as vectors of C, N and P between freshwater and marine environments

IH

Modelling renewable water resources in Europe and Africa

Systematic estimation of annual river mass loads from national river flow and quality database

Participating CEH Institutes

IFE, IH, ITE

Programme Leader's Report

The CEH Programme on Freshwater Resources addresses broad issues of the hydrological cycle, integrating studies of water quantity, water quality and aquatic ecosystem function at the catchment scale. Increases in human demand for water, the effect of pollution on water quality, and constraints on riparian processes have all resulted in a deterioration in natural habitats and biodiversity. A scientific basis for resolving the conflicts and developing sound strategies for practicable and sustainable management of catchments becomes steadily more necessary and remains the central long-term objective of this Programme.

Recent work has focused on the formulation of better models of the key processes. This has included progress in modelling water resource availability at the catchment level, relating runoff and flow yields to the fluctuating balance between precipitation and evapotranspiration. CEH hydrologists have devised a method to represent hydrological balance on a grid basis which can be matched to aspects of terrain and land use to predict the level of water stress and the cumulative flow generated.

The mass of solutes leached from catchments is influenced by geology, geomorphology and geochemistry but, to a great extent, also by land use. CEH is assessing the accuracy and precision of flow concentration collation and is also deriving systematic estimation of hydro-chemical loads using models such as SMILER and CORAL. The general impacts of nitrates and phosphates in drainage water on the biological productivity are already well known; building on this work, this Programme is exploring the use of water plants as a means of ranking trophic status of rivers.

The first response to increased fertility in fresh waters is usually enhanced algal growth. Work by CEH has again demonstrated the overriding influence of water flow on this response, by studying the relative hydraulic retention times of different types of river channel. The conversion of nutrient load into plant biomass becomes increasingly effective with lake-like conditions. New work has demonstrated the importance of flushing rate on the development of planktonic communities, and that increased opportunities for nutrient recycling occur in shallow waters. The density-dependent controls on production and species selection, for instance through the depletion of carbon supplies, apply only after the constraints of physical entrainment have relaxed. Simulation of these effects is incorporated into the PROTECH model.

Fish population dynamics fluctuate around larger-scale properties of aquatic catchments, especially processes associated with the main channels. While the growth rates of young salmonids can be modelled using temperature and food availability, considerable effort is being made to relate the breeding success of fish to the physical habitats available in rivers. As efforts continue to gauge the impact of reproductive behaviour and environmental stressors on fish, the importance of managing the aquatic resource in a holistic, catchment-based context becomes increasingly evident. The close interdisciplinary liaison within this Programme and the strength of the science allow the delivery of practicable understanding and advice for managing freshwater resources.

Brown trout (Salmo trutta) *parr.*

The ciliated protozoon Lembadion magnum *trapping a planktonic microalga.*

Programme Leader
Prof Colin Reynolds
IFE Windermere

Programme 5: Biodiversity and Population Processes

Through the Convention of Biological Diversity and a diverse range of European and global protocols and legislation, the UK Government is committed to the conservation and sustainable use of biodiversity. Biodiversity is essential for the functioning of ecosystems, including wild places, rivers, lakes, forests, farmed land and urban environments. Understanding biodiversity is required to build sound national and international policies for the conservation of ecosystems and the sustainable use of natural resources from local to global scales.

The Programme will improve understanding of microbiological and biological resources at a range of scales. The research recognises biodiversity as the earth's biological capital, considers the underlying processes and resulting functions, and directs knowledge to the sustainable management of biodiversity.

Main Project Areas

- **Biodiversity characterisation, pattern and monitoring**
- **Ecosystem function and biodiversity**
- **Population processes underlying biodiversity**
- **Conservation and restoration of biodiversity**

Participating CEH Institutes

IFE, IH, ITE, IVEM

Programme 5 Science within 1996-97 Institute Reports

IFE

Microbial diversity and ecosystem function

Protozoan grazing triggers free-virus production

River management and the decline of the Great Ouse and Fenland fisheries

Food availability to cyprinid larvae in regulated rivers

Saving the Schelly

IH

Economic valuation of wetlands

IUCN freshwater policy for wetland conservation

Dambo processes integration experiment

ITE

Bioclimatic zones in Great Britain

Population structure and the dynamics of large herbivores

The impact of raptors on red grouse populations

IVEM

Locating biologically important epitopes on BTV VP7

Role of microbial diversity in regulating function in a freshwater ecosystem

Programme Leader's Report

In each of the four themes the research focuses on a number of key challenges

Biodiversity characterisation, pattern and monitoring aims to develop techniques for defining and measuring biodiversity (especially at the genetic level), monitoring changes and identifying patterns against environmental gradients, over both time and space. Frequently people think of higher plants and animals when describing diversity and not microbial organisms, despite the fact that they are crucial in food webs and important sources of disease. Traditional classification using morphological and ultrastructural characters is often inadequate for the identification of potentially pathogenic strains of amoebae. Scientists at IFE have made detailed genetic comparisons of the DNA of these organisms to provide a more useful picture of the phylogeny, the evolutionary relationships and differences between species that often appear identical.

Ecosystem function and biodiversity aims to determine the reciprocal interactions between biodiversity and the functioning of ecosystems by investigating processes involved in the maintenance of diversity. The microbial diversity in food webs may play a fundamental role in ecosystem function, and IFE and IVEM are collaborating to study this in a model freshwater system, Priest Pot, a one hectare pond in Cumbria. Here the role of particular microbial species in nutrient cycling can be studied in both space, through the water column and sediments, and time, across the seasons.

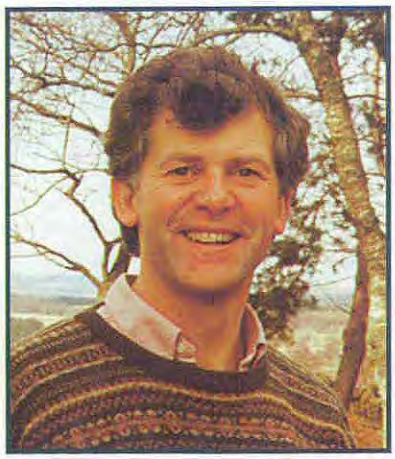
Population processes underlying biodiversity aims to identify the population processes, including population genetics, at the level of single species and groups of interacting species that influence abundance and underpin the maintenance of biodiversity. At ITE red grouse have been used as a model species to distinguish between a number of competing hypotheses relating to the pronounced population cycles shown by some species of voles and game birds. Recent work in collaboration with the Game Conservancy Trust has provided compelling evidence of the role of predation. Increasing numbers of hen harriers and peregrines may prevent the recovery of grouse populations after other factors have caused a decline to low numbers.

Conservation and restoration of biodiversity applies the principles established through the type of research described above, in order to manage ecological systems for conservation, restoration and sustainable use of biodiversity. An example is the work done by IH at Pevensey Levels, Sussex, where (in collaboration with the Environment Agency and University College, London) we are looking at hydrological functioning of the Levels to determine the sustainability of water management strategies and ensure its long-term security as a wetland of international ecological importance.

*Brazil nut tree (*Bertholletia excelsa*) in Rondoniâ, Brazil.*

Mutualism between ants and aphids.

Programme Leader
Dr S D Albon
ITE Banchory



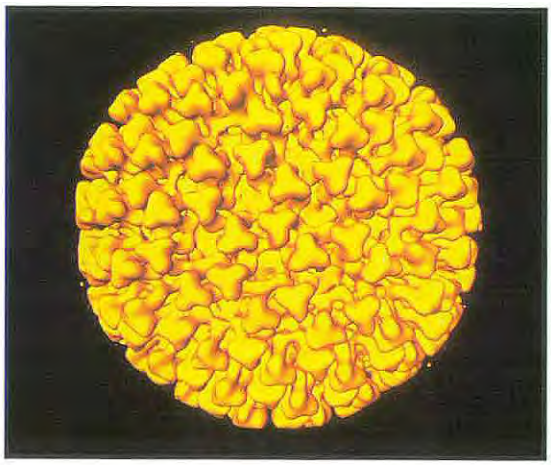
Programme 6: Pest and Disease Control and Risk Assessment for GMOs

There is a serious need world-wide for more effective control agents for pests and diseases that are both sustainable and environmentally friendly.

The primary aims of the Programme are to assist in the provision of novel pest and disease control strategies whilst assessing any possible risk to the environment. The Programme falls into two main themes:

- *pest control*
- *animal disease control*

Molecular biology is essential to much of the work which helps give the Programme a novel and progressive approach.



Main Project Areas

- **Development of sustainable insect pest management strategies**
- **Pathogen-derived genes for plant virus/vector management**
- **Environmental impact of GMOs and potentially invasive species**
- **Understanding and controlling arthropod-transmitted diseases**
- **Distribution of pathogens in fresh water**

Participating CEH Institutes

IFE, ITE, IVEM

Programme 6 Science within 1996–97 Institute Reports

IVEM

Ecology and biocontrol of baculoviruses

Host range of genetically modified viruses

Predicting the ecological impacts of pest- and disease-resistant genetically modified crops

Insect and virus resistance in wild cabbage

Orbiviral structures

Persistence of louping ill virus in the environment

Understanding and controlling tick-transmitted diseases

Programme Leader's Report

This Programme is concerned with the development of novel pest and disease control strategies. It takes a multidisciplinary approach, drawing on expertise from different areas, ranging from microbiology and molecular biology to ecology and mathematical modelling. One of the benefits of this approach is the major advances currently being made in the study of the composition and dynamics of pathogen populations. In the field, molecular techniques have demonstrated the role of the blue mountain hare in the persistence of louping ill, an encephalitic disease vectored by ticks. Studies on Lyme disease, another tick-borne disease which is a threat to humans, have shown that different pathogen genotypes (which manifest different clinical symptoms) are maintained within different vertebrate reservoirs. This result highlights the importance of vertebrate management techniques in the persistence of different pathogen genotypes.

Molecular studies are also important in unravelling the evolution and structure/function relationships within pathogens, which can lead to novel methods of disease control. Research on the gnat-transmitted orbiviruses, pathogens of veterinary importance, has demonstrated a high level of conservation within the proteins which comprise the virus particle across viruses which vary in both their biology and host range. The construction of an infectious clone of a virus related to louping ill provides the opportunity of elucidating the factors which determine virulence.

These more fundamental studies can also be used to underpin the risk assessment of GMOs, a programme currently covering organisms ranging from viruses and bacteria to plants. Research carried out by ITE and IVEM is focusing on the role of insects and diseases in the dynamics of wild crop plants. The nuisance value of wild plants may be enhanced by hybridisation with genetically modified counterparts engineered for resistance to either pathogens or pest insects. Initial stages of this project studying wild cabbage have found four commonly occurring viruses which have a differential effect on the survival of the plants in the wild.

Research on the release of genetically modified baculovirus insecticides has focused on the risk to less susceptible (non-target) lepidopteran hosts. Detailed laboratory studies have demonstrated fundamental differences in the response of insects which vary in susceptibility. These results could be used as criteria for distinguishing between hosts that are perceived to be at risk. Field studies have shown that the life history strategy of the caterpillar has a major influence on its likelihood of infection with wildtype and recombinant insecticides. This work has been combined with more detailed studies on the baculovirus genome. Results are starting to elucidate the genetic basis of host range, a key issue both from the perspective of risk assessment and for the design of custom-made insecticides.

Experimental plot of sugar beet used for the GMM field trial, 1993–94.

Dr John Burden explains IVEM's research at an Open Meeting held in Oxford (May 1997) to update the public on the field trials of genetically modified virus insecticides.

Programme Leader
Dr J S Cory
IVEM Oxford

Programme 7: Pollution

Recent years have seen the rapid development of legislation, at both national and international level, to regulate chemicals in the environment, particularly those pollutants known to produce adverse effects on the environment or on human health. Effective control of chemicals through legislation requires methodology to estimate the fate, hazard and risk associated with each chemical.

The Programme will develop a better understanding of generic processes such as transport processes, fluxes of pollutants and the fate of pollutants in order to predict more accurately the likely impacts on environments and organisms. The main themes of the Programme are:

- *long-range transport of persistent organics and metals*
- *further development of the critical loads approach, particularly for acidifying pollutants*
- *environmental pollution and human health.*

Main Project Areas

- **Radionuclides**
- **Acidifying pollutants**
- **Photochemical oxidants**
- **Toxic metals**
- **Organic pollutants**

Programme 7 Science within 1996–97 Institute Reports

IFE

Chernobyl radiocaesium in lakes – developing an emergency response model

Modelling the ecosystem effects of nitrogen deposition in Welsh Sitka spruce stands

Rapid 'bioassays' that screen for chemical impacts on soil organisms

Disposal of oiled beach material

IH

Behaviour of oestrogenic substances in rivers

Pesticides in the chalk aquifer

The effects of tree harvesting on stream water quality at an acidic and acid-sensitive spruce forested area.

IVEM

Microbial degradation of xenobiotics in rhizosphere soils

Modelling the transport and fate of viruses in the aquatic environment

Participating CEH Institutes

IFE, IH, ITE, IVEM

Programme Leader's Report

This Research Programme covers emission to the environment, transport and fate, interaction with abiotic components, degradation and effects on organisms of a range of hazardous chemicals. A large component is Commissioned Research assisting regulatory UK Government departments in setting and implementing policy for pollution control and environmental remediation. Example studies are presented.

Work on radionuclides is being conducted both in the UK and in the vicinity of the Chernobyl reactor. Recent studies validated models of dietary exposure of adults and children living in the vicinity of Sellafield, and eating home- or locally grown produce. Doses are significantly lower than recommended annual limits. Concerns over exposure of people in Ukraine have led to the development of an emergency response model to predict long-term levels of radionuclides in lakes in the area. Initial rapid removal of radioactivity to sediments can be followed by slow remobilisation.

Studies on the effects of both planting and felling conifers on acidifying pollutants are in progress. Good agreement between modelled and field-observed data has been shown for new spruce plantations on moorland; the system is nitrogen-saturated and further nitrogen deposition will lead to acidification of draining waters. Release of nutrients into waters draining forest stands has been shown to increase between six months and three years following tree felling. The range of nutrient species and degree of increase in surface water concentration are dependent on soil type and rainfall. There is little evidence of groundwater contamination.

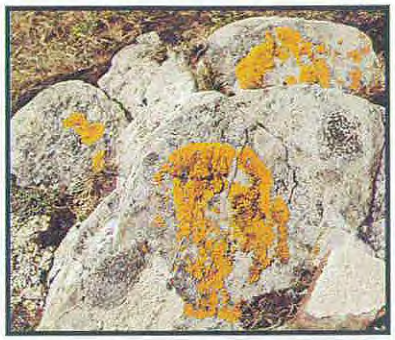
Monitoring of air in western Ireland has allowed validation of models to predict gas-phase concentrations of free radicals. Clear evidence emerged of tropospheric ozone production in polluted continental air and destruction in marine air arriving from the Tropics. Evidence of transport of trace gases across the Atlantic was also gained.

Biomarkers of toxic effect of metals have been shown to reflect field contamination gradients close to an industrial source. Results also correlated well with field-observed effects on population and reproduction survival of earthworms. Bacterial biomarkers using *lux* gene-mediated bioluminescence have been used to study toxicity and bioavailability of organics in soil. Different exposure conditions have been shown to affect both the capacity of soil microflora to degrade chlorobenzenes and the component organisms of the microflora populations.

Degradation of octylphenol, an oestrogenic component of industrial detergents, and its interaction with abiotic components of rivers have been studied. Breakdown of the compound is slow with adsorption on to sediment particles. In typical river flow, it will remain undegraded during transport.

Studies of pesticide movement to groundwater in chalk aquifers have shown the major route to be through the chalk matrix, with a minor component transported more rapidly through fissures. Calculations show that pesticide contamination of groundwater may occur between ten and 30 years after application.

Earthworms have proved to be sensitive indicators of pollution from industrial accidents.



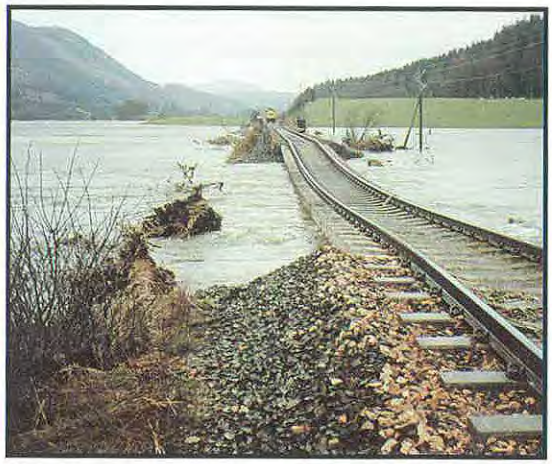
Lichens are sensitive indicators of atmospheric pollutants.

Programme Leader
Dr S Dobson
ITE Monks Wood

Programme 8: Environmental Risks and Extreme events

The 1990s have been designated as the International Decade for Natural Disaster Reduction (IDNDR). CEH is contributing significantly to this through its programme of research into the prediction of extreme natural events such as floods and droughts. These are disasters affecting millions of people and causing billions of pounds worth of damage annually around the world. In addition, other unusual unpredictable events such as fire, strong winds and temperature extremes can often have dramatic effects on ecological communities.

This Research Programme is contributing to an understanding of how environmental extremes affect mankind and the natural environment and is developing quantitative predictive tools to describe these effects.



Main Project Areas

- **Risk assessment and estimation of floods and other extreme events**
- **Real-time flow and water quality forecasting and decision support systems**
- **Understanding and modelling the role of rare events on ecological systems**

Participating CEH Institutes

IFE, IH, ITE, IVEM

Programme 8 Science within 1996–97 Institute Reports

IFE

Hysteresis of nutrient concentrations during storm events

IH

Rainfall mapping in upland areas

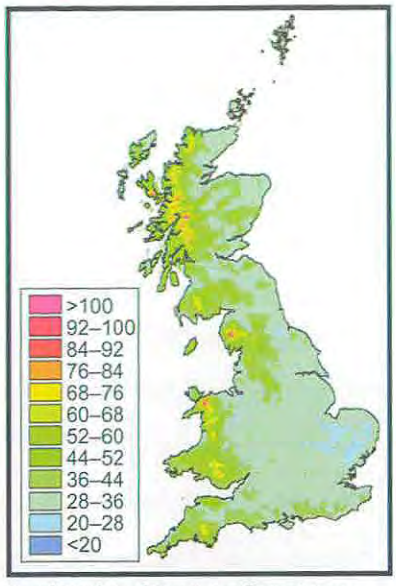
Programme Leader's Report

Risk assessment is important in many aspects of environmental science and engineering. Research on risk within this Programme aims to develop methods for improving the estimation of extreme events in the environment, focusing on flood, drought and rainfall extremes. Inferring the frequency of occurrence of rare events from historical records, often of short duration or outside the area of immediate concern, is problematic and requires improved methods of regionalisation and generalisation. Forecasting extreme events and the associated environmental risks provides an opportunity to mitigate damage through improved management and decision-making. This applies to a range of natural hazards – storm, flood, drought, freeze and wildfire – and their impact on man's environment and on ecological systems.

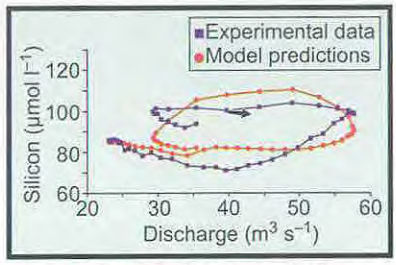
An important scientific challenge is to characterise the forcing variables (mainly weather-related) and to formulate process models which link these to impacts whilst reflecting the ecosystem response to extreme events. Environmental risk can then be assessed and used to support management decisions in planning, design and operational contexts.

The Flood Estimation Handbook research team at CEH's Institute of Hydrology has made progress on mapping an index of extreme rainfall across the UK. Analysis of the annual maximum rainfall totals of various durations (from 1 hour to 8 days) at raingauge sites has enabled mapping of the median annual maximum site value across the UK. The index value is used together with the FORGEX rainfall frequency method to provide design rainfall estimates at any location in the UK. The uneven distribution of raingauges, with especially sparse coverage in the uplands, led to the use of topographic information from a digital terrain model to underpin the spatial interpolation. A regression model links the median values of a number of variables and the residuals are further corrected by kriging. The resulting estimates of the median annual maxima values are obtained for a 1 km grid over the UK.

Research at the Institute of Freshwater Ecology has investigated the changing concentrations of sediment and chemicals during storm events, deriving from diffuse and point sources, as part of the LOIS Thematic Programme. For point sources, such as sewage effluents, the dilution of chemicals with storm water often results in a near linear relationship between concentration and the inverse of river discharge. However, the rising and falling stages of the flood hydrograph are often associated with a hysteresis effect, with higher concentrations for a given discharge on the rising limb. The effect has been described by a semi-empirical model which partitions the concentration between diffuse and point source components. The hysteresis of dissolved calcium, silicon, nitrate, nitrite, ammonium and phosphorus fractions in the River Swale during a major storm has been analysed within the framework of this model. The optimised model parameters are generally consistent with land use patterns in the Swale catchment and give some estimate of the relative importance of diffuse inflows. The method has potential use in comparing the chemical and nutrient dynamics in catchments and the relative importance of diffuse and point sources during flood flows when the greatest loads are exported from catchments.



Combined median annual maximum one-day rainfall (mm).



An example of the hysteresis of silicon concentrations in the River Swale catchment in Yorkshire. The arrow indicates the time sequence during the storm.

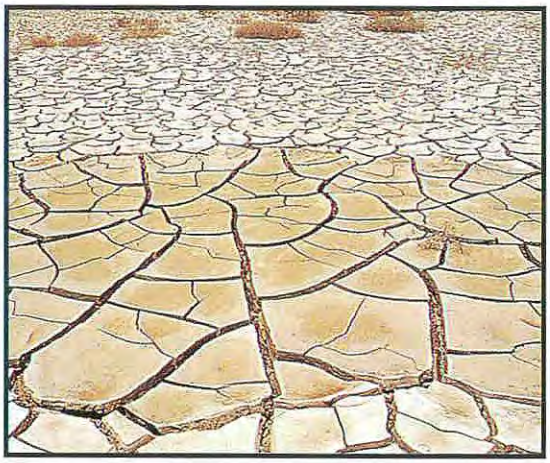
Programme Leader
Mr R J Moore
IH Wallingford

Programme 9: Global Change

Many changes are occurring globally as a result of man's activities. Some, such as losses of biodiversity, freshwater eutrophication and the emission of short-lived air pollutants, are occurring simultaneously in many places and their local or regional impacts are seen repeated around the world. Others, such as industrial activity, deforestation and desertification, occur locally but cause long-term significant changes directly or indirectly to the atmosphere or oceans, so that their effects persist and are seen globally – these global changes are the main focus of this Programme.

The Programme is reducing the uncertainty in the magnitude of global change and its impacts. The research is focused on improving the accuracy of global change predictions through:

- *improving our knowledge of greenhouse gas budgets and land–atmosphere interactions*
- *forecasting global change impacts on species, ecosystems and water resources.*



Main Project Areas

- **Greenhouse gas budgets and cycles**
- **Land–atmosphere–ocean interactions**
- **Forecasting and detecting the impacts of global change**

Programme 9 Science within 1996–97 Institute Reports

IFE

The impact of north–south movements of the Gulf Stream on the summer biomass of phytoplankton in Esthwaite Water (Cumbria)

ITE

Global effects of climate changes on terrestrial ecosystems

Aerosol chemistry, clouds and radiation

Economic impacts of the 1995 summer in the UK

IH

Water and carbon in tropical biomes

Persistence of rainfall in the Sahel

IVEM

Microbial basis of methane oxidation in soils

Participating CEH Institutes

IFE, IH, ITE, IVEM

Programme Leader's Report

During the year, the Inter-governmental Panel on Climate Change published its second assessment and the UK Review Group on Climate Change Impacts published a second report. CEH staff contributed to both documents, including new findings and insights from the Terrestrial Initiative on Environmental Research (TIGER) programme. TIGER was wound down during the year and one of the final meetings in London was addressed by the Minister for the Environment.

There is now a greater understanding of the role of the terrestrial biosphere in the global carbon cycle. CEH models, supported by direct gas flux measurements, have confirmed that major carbon sinks probably exist in both northern forests and in the Tropics. Using the transient climate output from the Hadley Centre model, it has been possible to show that this terrestrial carbon sink will probably increase until the 2050s, but will then weaken, taking up a decreasing fraction of the CO_2 emitted by man's activities. This weakening will result in large predicted changes in global ecosystems. At the UK scale, CEH has produced an inventory of sources and sinks of CO_2 caused by changes in the store of organic carbon in vegetation and soils, and it is now possible to estimate some gas fluxes for the whole UK directly by measuring changes in gas concentrations in the boundary layer using aircraft.

One of the major contributions of CEH has been the development of modelling tools to provide quantitative estimates of energy, water and carbon fluxes in major world biomes and for the terrestrial biosphere as a whole. These models have been parameterised using measurements in areas such as the Sahel, Arkansas river basin and the Amazon. The indication is that feedbacks between the land and atmosphere have significant effects on local climate predictions, and possibly modify global climate when the effects of CO_2 on surface conductance are included.

Recent studies by CEH have resulted in some important revisions to the estimated level and timing of impact from climate change. The rate of spread of organisms may be much slower than predicted by models which include no constraints on the dispersal of species. The acceleration in photosynthesis in elevated CO_2 may be less than previously thought, owing to down-regulation, and UV-B radiation may affect ecosystems subtly, by altering micro-organisms rather than by having large direct effects on plants.

Growth chambers at ITE Bangor are used to investigate the growth of plants in closely controlled environments.

Measurements of energy and water fluxes are being compared over a tundra mire.

Programme Leader
Prof M G R Cannell
ITE Edinburgh

Programme 10: Integrating Generic Science

This Programme has been designed to provide a research framework for those areas of CEH science that underpin the nine other Programmes. These activities are cross-cutting, often dealing with new and innovative technology. The fundamental work undertaken on environmental monitoring and data management falls into this Programme, as well as development of new methods for interpreting and manipulating complex data. Development of new instruments and sensors, essential for progress in environmental sciences, is a well-established part of CEH science and forms part of this Programme.

As well as providing data and technological support to the CEH Research Programmes, the research capability of the component areas will be developed in their own right.

Main Project Areas

- **Environmental assessment, economics and history**
- **Remote sensing**
- **Instrumentation**
- **Biotechnology development**
- **Analytical chemistry**
- **Databases and reference collections**
- **Biometrical applications, research and development**

Participating CEH Institutes

IFE, IH, ITE, IVEM

Programme 10 Science within 1996–97 Institute Reports

IFE

The Culture Collection of Algae and Protozoa (CCAP)

Instrument development

A long-term study of the macroinvertebrate fauna of a chalk stream

IH

Scaling effects on the use of satellite radar to monitor surface soil moisture

Stand-alone H_2O/CO_2 flux system

ITE

ITE data network and SEEDCORN

Stable isotopes in ecology

Quality assurance of chemical analysis

IVEM

BIOMATE

Prion diseases

Programme Leader's Report

Remote Sensing
Synthetic aperture radar (SAR) can be used to detect the moisture content of the soil. The European Space Agency has commissioned CEH scientists to assess the accuracy of the SAR system on the current ERS-2 satellite and to determine the usefulness of a proposed low-resolution SAR. Validation of soil moisture measurements is taking place in the upper Thames basin (temperate climate) and in Zimbabwe (marked wet/dry seasons). Results show that soil moisture in the Thames region can be measured sufficiently accurately at the field scale to identify current land use and seasonal changes can be observed in Zimbabwean soils.

Instrumentation
Algorithms are being developed for a prototype phytoplankton biomass sensor to identify the proportions of different functional groups of algae and other types of suspended material such as peats or clays, making up the suspended solids in water.

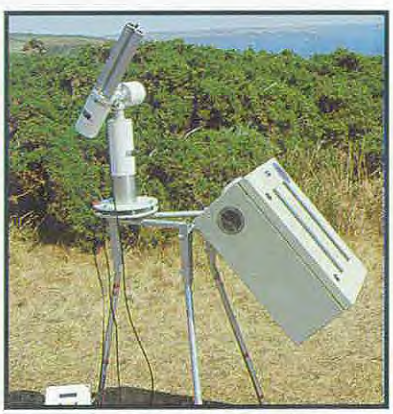
To improve the measurement of CO_2 budgets in the atmosphere, a stand-alone H_2O/CO_2 flux system is being developed. A miniature hygrometer and a 3-D, sonic anemometer will be linked with an infra-red gas analyser, which requires developments to improve sensitivity significantly. Software will then be produced to analyse the data and isolate CO_2 flux from the multiple measurements.

Biotechnology Developments
Transmissible spongiform encephalopathy diseases, like BSE, are thought to be transmitted by prions, a protein molecule present in normal neuronal cells. To understand the mechanism of this process, a reliable source of prion proteins is required. CEH scientists are making good progress in the use of recombinant viral technologies to produce these molecules, which will allow ligands for the molecule to be isolated, leading to improved diagnostic tests.

Analytical Chemistry
Recent developments in instrumentation have allowed the measurement of both ^{15}N and ^{13}C in individual compounds from environmental mixtures. Using these techniques, CEH scientists have shown that nitrogen uptake from soils to plants is linked to the availability of other nutrients, particularly phosphorus. In other studies it has been shown that *Littorella uniflora*, a small plant which grows rooted in sediments at the edges of lakes, develops a new set of leaves and flowers as the normal submerged form is exposed by falling water levels in spring, which also causes it to switch between the two main photosynthetic routes found in plants.

Databases and Reference Collections
CEH Institutes have received funding from NERC's SEEDCORN programme to identify and conserve their dispersed data holdings. This will allow easier dissemination to outside users. Datasets identified as candidates for rescue will be prioritised to form a work programme for the following two years. Recently 'rescued' macroinvertebrate data are being used to assess the impact of low flows in rivers on the macro-invertebrate assemblages, particularly their ability to recover after drought sequences of several years.

On the Web: real-time weather data, weekly site shots (as above) and direct access to summary data – all part of a developing ECN programme aimed at making monitoring data accessible to a wider audience (see http://mwnta.nmw.ac.uk/ecn).



A CIMEL sunphotometer retrieving aerosol optical depths during a remote sensing campaign using the NERC aircraft.

Programme Leader
Prof J Hilton
IFE Wareham

A key strength of CEH lies in the range of science covered by the Centre and the opportunity to combine the expertise held within its four Institutes. CEH scientists are increasingly involved in collaborative research, both internally with colleagues in cross-Institute integrating projects and externally with fellow scientists in research organisations around the world.

CEH Integrating and Thematic Science

CEH INTEGRATING FUND

CEH established the Integrating Fund projects in 1995, specifically to enable new and exciting cross-disciplinary research to be conducted. There are now 15 such projects underway in the Centre. Projects funded by the CEH Integrating Fund are shown in the Table below. Three new projects were approved in spring 1997

CEH Integrating Fund projects

Title	*IFE*	*III*	*ITE*	*IVEM*
Projects commencing in 1995–96				
The microbial basis of methane (CH_4) oxidation in soils	•		•	•
Microbial diversity and ecosystem function – Phase I	•		•	•
Interactions of viruses, aphids and wild *Brassica*			•	•
Combined growth and water use modelling of mixed vegetation			•	
Molecular genetics and process-level events in the biodegradaton of xenobiotics in rhizosphere soils			•	
Modelling the chemical availability of radionuclides in upland organic soils	•		•	
Upland forest canopy closure – its significance for chemistry, ecology and hydrology	•		•	
Projects commencing in 1996–97				
The role of seabirds in the epizootiology of Lyme disease				
Combined hydro-ecological and socio-economic models of land use, land management and environmental degradation (CHASM)	•	•	•	
The environmental characteristics of urban environments	•	•	•	
Microbial diversity and ecosystem function – Phase II	•		•	
Enhanced access to spatio-temporal information on environmental resources (EASIER)	•	•	•	
Modelling the fate of viruses in the aquatic environment		•		
Projects commencing in 1997–98				
Directly monitoring gene activity during periods of environmental change				
Modelling, risk estimation and management of ecological systems subject to natural hazards	•	•	•	
Development of a catchment-scale model of phosphorus sources, movement and fluxes	•	•	•	

Projects that commenced in 1995–96 will come to an end during 1998 and a final report summarising findings and future opportunities will be prepared. For those projects commencing in 1996–97, first-year reports were presented for review to the CEH Directors in October 1997. Summaries of those reports follow.

Microbial Diversity and Ecosystem Function

CEH Institutes: IFE, IVEM
Project Leader: Dr B J Finlay, IFE
Collaborator: Dr J I Cooper, IVEM

Much effort is currently directed at understanding the role of biodiversity in the natural environment. Staff from IFE, IVEM and ITE have discovered that in a small, freshwater lake the variation in microbial activity and diversity observed during a single summer exceeds that of the most dramatic successions of terrestrial plant communities spanning many years.

The nature and scale of ecosystem functions such as carbon fixation and nutrient cycling appear to be governed by reciprocal interactions involving physical, chemical and microbiological factors. Moreover, these interactions continuously create new microbial niches that are quickly filled from the resident pool of rare and 'cryptic' (and probably ubiquitous) microbial species. This could imply that microbial diversity in an ecosystem is never so impoverished that the microbial community cannot play its full part in biogeochemical cycling.

We still have only a crude idea of what constitutes a natural microbial community. It is particularly important to develop rapid and reliable methods of characterising the complete microbial community, and the relative abundances of component 'species'. Fatty acid methyl ester (FAME) analysis is now being used to identify bacteria collected from the lake and to compare the 'species' compositions of the different microbial communities in the lake. In the past year investigations have begun on the occurrence of cryptic (lysogenic) viruses in the collection of around 800 bacterial isolates from the lake.

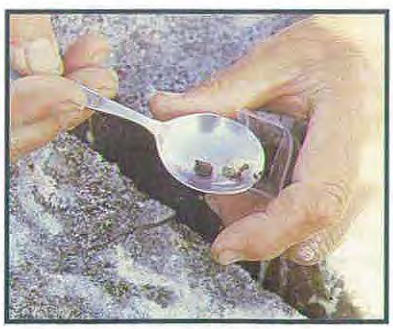
A range of bacteria found in Priest Pot – a small freshwater lake in the Lake District which is the study site for the microbial diversity and ecosystem function project.

Role of Seabirds in the Epizootiology of Lyme Disease

CEH Institutes: ITE, IVEM
Project Leader: Prof P A Nuttall, IVEM
Collaborator: Prof M P Harris, ITE

In October 1996 a project linking scientists at IVEM and ITE Banchory was initiated to investigate the role of seabirds in maintaining *Borrelia burgdorferi*, the agent that causes Lyme disease. This disease is the most widespread tick-transmitted infection of humans in the northern hemisphere. In the UK it is commonly transmitted by *Ixodes ricinus*, the sheep tick, and is maintained in enzootic cycles involving rodents, birds (such as pheasants), and sheep. Preliminary work by scientists at IVEM had previously identified the Lyme disease agent in seabird ticks, *Ixodes uriae*, collected by ITE scientists working on the Isle of May in Scotland.

The project aims to determine whether seabirds and ticks maintain a transmission cycle of the Lyme disease agent that is independent of the typical sheep tick transmission cycle. So far, approximately 2000 seabird ticks have been collected from the Isle of May. In addition, seabird ticks and sheep ticks were collected from North Sutor, a seabird reserve on the coast of north-east Scotland. Seabird ticks were found to be more common on guillemot (*Uria aalge*) than on kittiwake (*Rissa tridactyla*), and more adult birds were infested compared with chicks. Many of the ticks from the Isle of May and North



Seabird ticks on the Isle of May spend most of their time hiding in rock crevices.

A seabird tick feeding on an adult kittiwake.

Sutor were infected with the Lyme disease agent, which was detected using the polymerase chain reaction (PCR). Most infections were acquired when uninfected larvae fed on seabirds, thus providing the first indication that seabirds on the island are infected with *B. burgdorferi*. Curiously, the infection prevalence in off-host ticks decreased during the seabird breeding season. Like all good detective stories, there are more clues than answers – plenty of avenues to explore during next year's breeding season!

The CHASM project has brought together CEH scientists from a wide range of disciplines.

Combined Hydro-Ecological, Agricultural and Socio-Economic Modelling (CHASM)

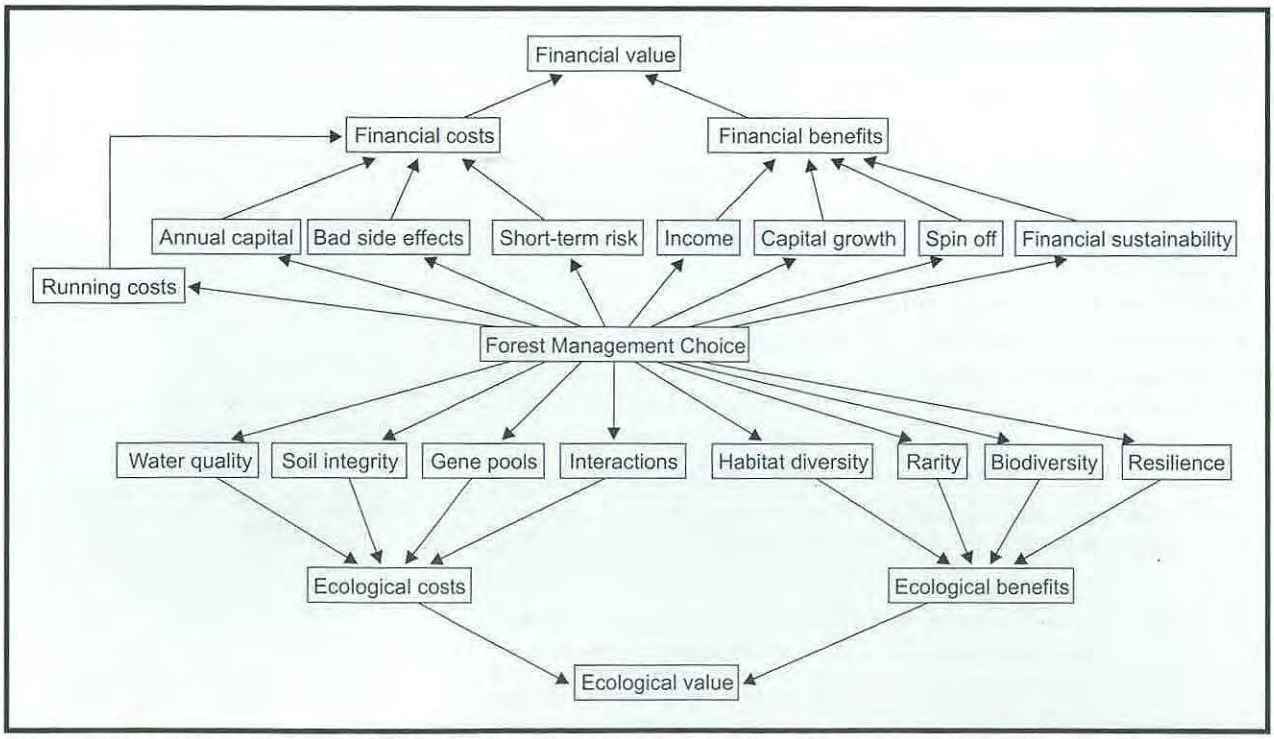
CEH Institutes: IH, ITE, IFE
Project Leader: Dr C H Batchelor, IH
Collaborators: D K N Waughray and J D Cain, IH; Prof J Sheail and Dr S McNally, ITE; Prof J Hilton, IFE

The CHASM project has brought together CEH scientists from a wide range of disciplines working on a wide range of research topics. CHASM has two main aims:

- to bring together strengths in natural and social sciences from CEH component Institutes;
- to develop improved methodologies for understanding and evaluating the relationships between the economy and the natural environment.

The project has five main objectives:

1. to achieve a greater awareness of environmental valuation techniques within CEH;
2. to improve methods of economic valuation within CEH's hydro-ecological research;
3. to enhance economic techniques as tools within CEH research into integrated environmental impact assessment, decision-making studies and evaluation exercises;
4. to examine the role of institutions in the formulation and implementation of environmental policy;
5. to develop a framework to encourage an integrated approach to environmental analysis and research within CEH.



Belief networks are being used as a tool in the CHASM project. This example represents a forestry management system at Glen Tanar.

These objectives are being achieved by focusing on three research themes that are of importance to all three participating Institutes. The themes are land use change, environmental degradation and water quality.

The main achievements and outputs from the project for this reporting period have been:

- the production of a pamphlet on environmental valuation techniques;
- two CEH workshops and workshop reports;
- a literature survey of integrated modelling techniques;
- a series of papers meeting CHASM objectives 2, 3 and 5;
- the development of a range of innovative methodologies related to integrated analysis.

Environmental Characterisation of Urban Environments

CEH Institutes: IFE, IH, ITE
Project Leader: Dr J E G Good, ITE
Collaborators: J C Packman, IH; Dr P D Armitage, IFE; Dr M O Hill, ITE

This Integrating Fund project forms a central part of CEH's new Core Strategic Programme in the Urban Environment. The aim of the project is to develop a stratification of urban areas based on geographical, socio-economic and environmental characteristics which takes account of pattern and scale. In turn, this stratification will provide a framework and stimulus for urban ecosystem process studies and for the management of urban areas in an ecologically sustainable manner.

The project has two main themes.

1. Patterns of urban land/water use and associated habitats

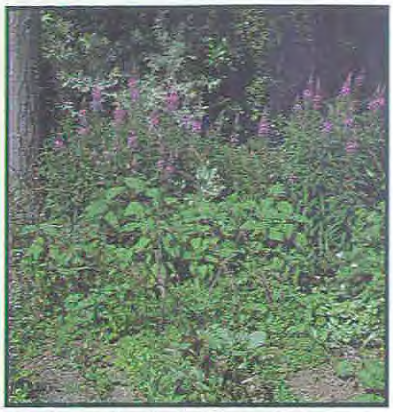
Objectives: to determine the links between patterns of urban land and water use and the development and maintenance of associated habitats and their component floras and faunas.

2. Ecological and hydrological consequences of the process of urbanisation

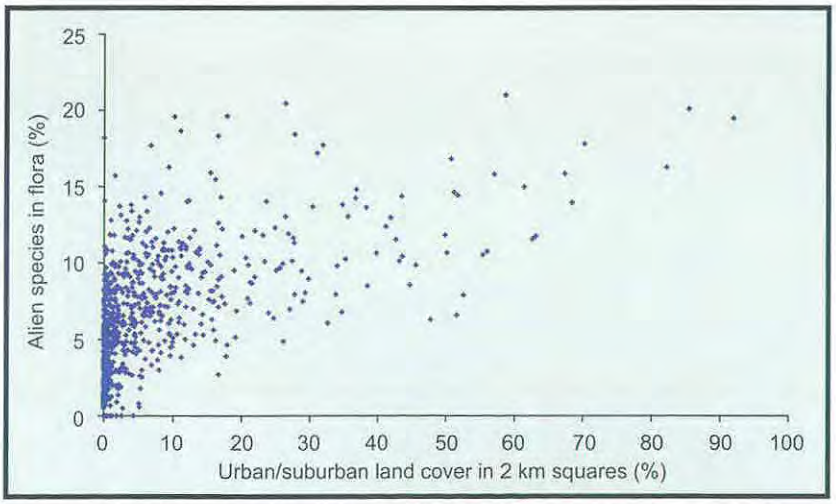
Objectives:

- to quantify the effects of past and present patterns of development on the ecology and hydrology of contrasting urban areas;
- to develop predictive models describing future changes in the ecology and hydrology of particular types of urban areas in response to patterns of land and water use resulting from particular policies and planning structures.

Work so far has identified the broad characteristics of the urban terrestrial flora, highlighting that the dominant species in urban environments are tolerant of high temperatures, basic soils and high levels of nitrogen; many of these are exotics. Studies on the relative importance of urbanisation as compared with river type in determining aquatic biota have also been undertaken. The hydrology component involves the development of a water balance model incorporating natural water flows and municipal water distribution which will enable water availability and fluxes to be predicted on short and long timescales.



*Rosebay willowherb (*Chamerion angustifolium*) is a common species on waste land and in urban areas.*



In comparison with the flora of rural areas, the flora of towns and cities includes a relatively high proportion of alien plant species. This can be seen in the relation between urban land cover in a 1988 satellite image and the percentage of alien species in 2 km squares ('tetrads') recorded in the same year by the BSBI Monitoring Scheme.

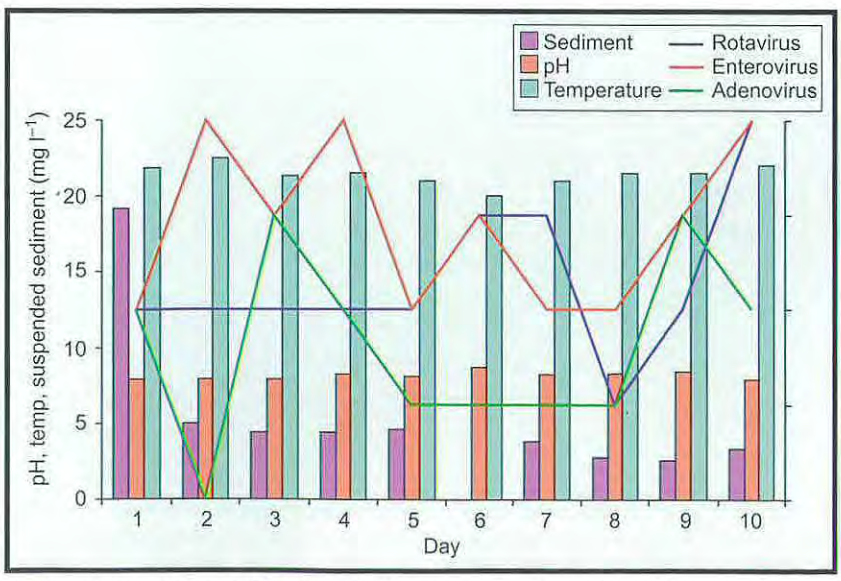
The Littlemore Brook site, 0.5 miles downstream from the outfall.

Modelling the Transport and Fate Of Viruses in the Aquatic Environment

CEH Institutes: IVEM, IH
Project Leader: Dr E A Gould, IVEM
Collaborators: Dr S Butcher, IVEM; Dr A Jenkins, IH; J Wilkinson, IH

Human enteric viruses occur as contaminants in many aquatic environments, but little is currently known about the movement of viruses or their potential hazard within the aquatic environment. This project aims to develop molecular biological methods to detect human enteric viruses in environmental samples. The factors influencing the distribution of viruses in the aquatic environment will also be investigated.

The presence of human enteric viruses was monitored in a sewage outfall and water sampled from the River Thames at five strategic points both upstream and downstream. One site is the Littlemore Brook site shown opposite. Viruses were initially concentrated by positively charged membrane filtration followed by further concentration and purification. Rotaviruses and enteroviruses were detected by reverse-transcription polymerase chain reaction (RT-PCR), and nested PCR was used for adenoviruses. These preliminary data are being used to elucidate the key processes governing virus survival and transport.



Daily variation in detectable viruses with water temperature, pH, and suspended sediment at Littlemore Brook over a ten-day period in July 1997.

Daily and diurnal variations in viral load at sites are also being assessed. In the limited dataset collected so far, no significant diurnal variation has been detected. Highly significant differences were found between viral loads at sampling sites at different distances from the outfall. Some correlations were found between pH and viral titer and these are being further investigated. Future data will be used together with existing models of bacterial transport to highlight differences in temporal and spatial dynamics between bacteria currently used to indicate water quality and viruses.

CEH NETWORKS AND CROSS-DISCIPLINARY GROUPS

As well as supporting the Integrating Fund projects, CEH has also established a number of research networks and cross-disciplinary groups. The aim is to foster collaboration and discussion in areas where complimentary expertise exists in different Institutes and to raise the profile of CEH in a number of targeted scientific areas.

The scientific networks and groups established so far include:

- remote sensing network
- instrumentation network
- oil network
- piscivorous birds/fisheries group
- wetlands research group
- arctic science group.

THEMATIC PROGRAMMES – CEH'S INVOLVEMENT AND CONTRIBUTION

CEH is an active participant in the Thematic Programmes of NERC. These are targeted programmes funded by NERC to encourage scientific excellence and to contribute to wealth creation and the quality of life in the UK. CEH is involved in both research and management of these programmes. A summary of activity in selected Thematic Programmes is given below and a full list of involvement shown in the section on Finance and Staffing.

Urban Regeneration and the Environment (URGENT)

Steering Committee member: Dr J E G Good, ITE

Reversing urban decay and its associated legacy of land contamination and dereliction, air, soil and water pollution, and developing new sustainable urban environments in which people will wish to live and work, is a major challenge in Britain, as elsewhere in the industrialised world. Urban Regeneration and the Environment (URGENT) is a new NERC Thematic Programme which aims to develop a coherent and comprehensible methodology for sustainable management of the urban environment. This will be done by focusing research on key issues:

- improvement of air, soil and water quality;
- remediation of contaminated land and its maintenance in a healthy state;
- identification and avoidance of physical hazards;
- sensitive use and exploitation of natural resources;
- management of urban ecosystems.

The outcomes from these research activities will be integrated into the work of other agencies, notably the Environment Agency. An important aim of the Programme is the development of products which users can readily apply.

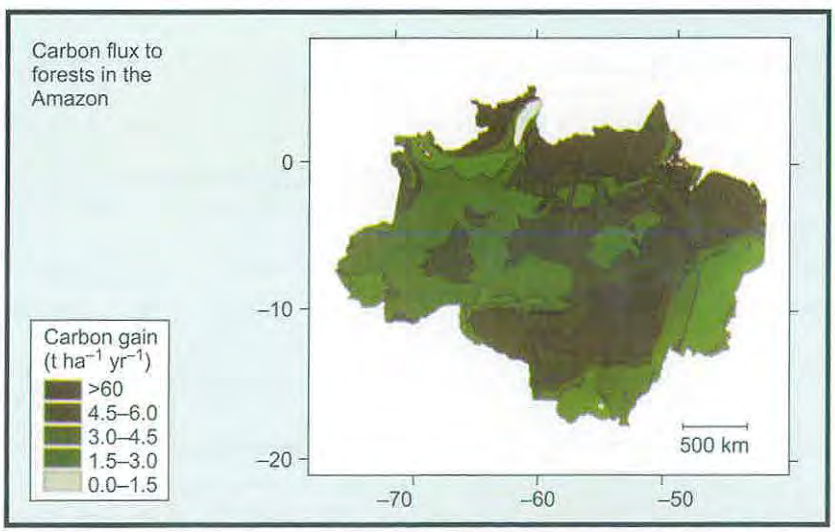
CEH hopes to play a major role in this Programme. There are eight research proposals currently under consideration in which CEH scientists are leaders or partners: this represents a third of the total number of full submissions called for by the Steering Committee. Many of these proposals address key issues of relevance to CEH Programme 3, the Urban Environment (described in an earlier section of this Report). The ability of CEH to provide an integrated scientific input across the whole range of ecosystem and hydrological sciences is a special strength, as it is only through the development of holistic solutions to a wide range of complex environmental problems that workable solutions can be found.

Terrestrial Initiative In Global Environmental Research (TIGER)

Programme Manager: G J L Leeks, IH (M A Beran, IH, until April 1997)

The TIGER Programme investigated how climate change affects the land surface and how, in turn, changes at

One of the projects in the TIGER Programme has been measuring emissions of methane from peat wetlands. Open water areas emit the bulk of the methane from wetlands. The stems of plants such as bogbean conduct methane from within the bog, by-passing the surface layer where the bacteria that break down methane are most abundant.



The map of annual average carbon gain over Amazonia was developed through the TIGER Programme. The work required teams of UK and Brazilian scientists to measure the movement of carbon into and out of the soil, leaves and tree canopy, above and below-ground vegetation, proportions of forest at different stages of regrowth and maturity, and a range of climatic factors.

The Environmental Diagnostics Programme is tracing the pathways of pollutants in the environment.

The Environmental Diagnostics Programme has a WWW page: http://mwnta.nmw.ac.uk/ceh/ed It can also be reached through the CEH homepage.

the land surface affect climate. From the TIGER Programme we know more about the causes and consequences of environmental change at local, regional and global scales and we are better placed to predict future changes.

Key issues that TIGER has investigated are the carbon balances in the UK and of tropical forest, emissions of greenhouse gases (carbon dioxide, methane, nitrous oxide) and what effects changes in climate, the chemistry of the atmosphere and ultraviolet radiation will have on the British landscape. The Programme has also considered global issues which affect how we predict climate and assess carbon stores.

The NERC-funded £20M Programme is managed and co-ordinated by CEH staff, with research teams from the CEH Institutes receiving funding in all study areas. This very successful Programme is now nearing the end of its allotted time and has been marked by a high-profile presentation in London opened by the Secretary of State for the Environment, as well as detailed scientific conferences. In addition to the vast number of scientific papers being produced, special issues of scientific journals are in the process of preparation covering all aspects of the studies.

Environmental Diagnostics

Programme Manager: Dr D Osborn, ITE

The aims of the Environmental Diagnostics Programme are to help the NERC user community plan and act more sustainably in future by providing:

- improved understanding of the movement, transformation and effects of waste materials in the environment, and
- tools for more cost-effective and long-term management of waste substances.

This Programme now has a substantial programme of work under way. There are 17 large consortia, 14 scoping and feasibility studies, and 7 CASE studentships in place; many of these projects feature CEH scientists in leading roles. In all, over 90 of the UK's leading research workers are now in receipt of support from the Programme.

The work covers many different areas of NERC science including: atmospheric sciences, catchment hydrology and geochemistry, hydrogeology, microbiology, environmental chemistry, and ecotoxicology.

The Programme is committed to making NERC data more available to the user community. Much of this environmental information will play a key part in wealth creation and enhancing the quality of life. A database of many of NERC's data holdings is being created as part of Environmental Diagnostics work with users, and this will shortly appear on the World Wide Web (WWW) as the UK Environmental Data Index (UKEDI).

As well as the input of £6.5M of NERC funds over the lifetime of the Programme, the user community has also made a substantial contribution. Most of this has come from public sector organisations including the Environment Agency, Ministry of Agriculture, Fisheries and Food, and the Department of Environment, Transport and the Regions. Added to the contributions from such private sector companies as Unilever, National Power, and Zeneca, the total cash contributions from users total £1.3M so far. The Programme has also received valuable contributions 'in kind' from the private sector (eg from ICI).

Environmental Diagnostics has a WWW page that can be reached through the CEH homepage.

The Land – Ocean Interaction Programme (LOIS)

Chairman of LOIS rivers scientific component: G J L Leeks, IH

The interface between the atmosphere, land, rivers and oceans in the coastal zone is subject to large anthropogenic and environmental perturbations at a range of scales. Knowledge of the interactions, in processes and fluxes, in the coastal zone is vital to our understanding of how man is affecting the environment.

The LOIS Programme is a six-year Community Research Programme, the largest and most ambitious ever to be mounted by NERC. It began in 1992 and involves over 250 scientists. CEH co-ordinates the rivers scientific component and is also making significant contributions to estuarine, atmospheric and long-term geological components.

The objectives of LOIS rivers research are:

- to measure the flux of materials from river basins to the marine environment;
- to characterise the key processes governing the fluxes;
- to develop models capable of predicting changes in fluxes due to environmental change.

The large-scale study area includes freshwater catchments of eastern England and Scotland. A vast range of research has been carried out upon the highly heterogeneous study area yielding large volumes of new data. Public agencies and private companies have also made available large data resources. Over 23 million data points have been placed within a highly structured LOIS database. Another major activity for the Rivers Data Centre is the planning and production of a suite of CD-ROMs and Internet access. The Data Centre has been working on the database design, the Access database and the integrated viewing software.

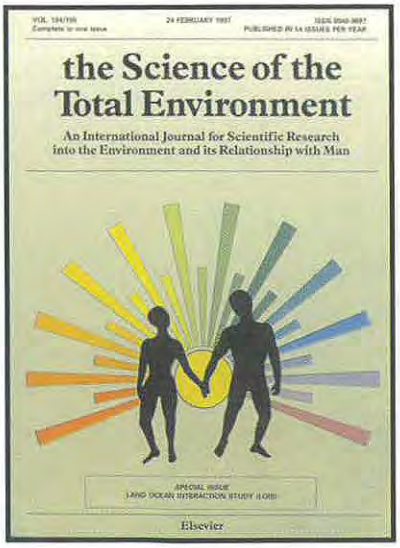
Advanced data visualisations from the LOIS Rivers Data Centre.

Valuable studies have also been carried out on the physical, chemical and biological dynamics of large-scale river basins. Large ranges in fluxes have been experienced over the study period, due to a sequence of extreme droughts and significant high flows. Traditional flux estimation methods give widely differing values; therefore, attention is being given to assessing and improving upon the methodologies which are available.

The prediction of future fluxes over the next 50 years is also an important objective of LOIS. The LOIS delivery model now includes a range of major ions, nutrients, metals and contaminants. The model is being run for representative catchments, giving simulations of daily mean concentrations.

The in-stream model is being run in two ways, firstly downstream from sites with observed data, and secondly using modelled data derived by the catchment delivery

The LOIS Programme is the largest and most ambitious ever to be mounted by NERC.



model. The linkages between the two applications are currently being investigated on the River Wharfe. The further integration of river models with estuarine models and the longer-term maintenance of the Data Centres form major activities in the LOIS Programme over the next two years.

A special volume of *Science of the Total Environment* on LOIS rivers was published in 1997, with many contributions from CEH Institutes.

Ecological Dynamics and Genes (EDGE)

Programme Manager: Dr R S Hails, IVEM

Molecular, genetic and modelling techniques are central to ecology, providing valuable new tools for addressing complex environmental questions. The challenge of this £3.5M initiative is to bring together molecular biologists and ecologists to exploit new molecular and genetic techniques to solve previously intractable ecological problems, in particular those concerning the spatial and temporal dynamics of ecological processes.

For example, conservation strategies require a strong underpinning knowledge of population structures and genetics.

The advent of novel molecular techniques also provides the opportunity to develop more environmentally acceptable technologies in, for example, biopesticides, bioremediation and plant genetic engineering. One aim of the Programme is to create an interdisciplinary community of scientists from the two normally disparate fields of molecular genetics and ecology.

In July this year, eight proposals were selected for immediate funding (see Table). A number of applicants have also been invited to submit associated studentships.

Projects selected for immediate funding under the EDGE Programme

Title
Genetic variation and the dynamics of pathogens in host–pathogen interactions
Dynamics of gene flow between the Dutch elm disease pathogens, *Ophiostoma ulmi* and *O. novo-ulmi*
Pathogen variability and dynamics in insect populations
Impact of the genotype of symbiotic bacteria on the fitness of a phytophagous insect
A molecular genetic analysis of the ammonia-oxidising bacterial community in a defined hypereutrophic freshwater site
Microbiological basis of land use impact on the soil methane sink: molecular and functional analysis
Assessment of the influence of natural and applied selection pressures on the interactions between diversity of ammonia-oxidising bacteria, functional gene diversity and ammonia-oxidising activity
Host range evolution and genetic constraints in rhizobia

gene transfer via plasmids is a common occurrence in the wild. These findings are obviously useful in risk assessment, but also raise the possibility of using a small inoculation of genetically engineered bacteria to transfer beneficial properties (eg biopesticides) to the natural communities associated with particular plants.

Experiments are continuing to develop a better understanding of the consequences and factors controlling genetic transfer. This will allow us to estimate the risk assessment associated with the release of GMMs.

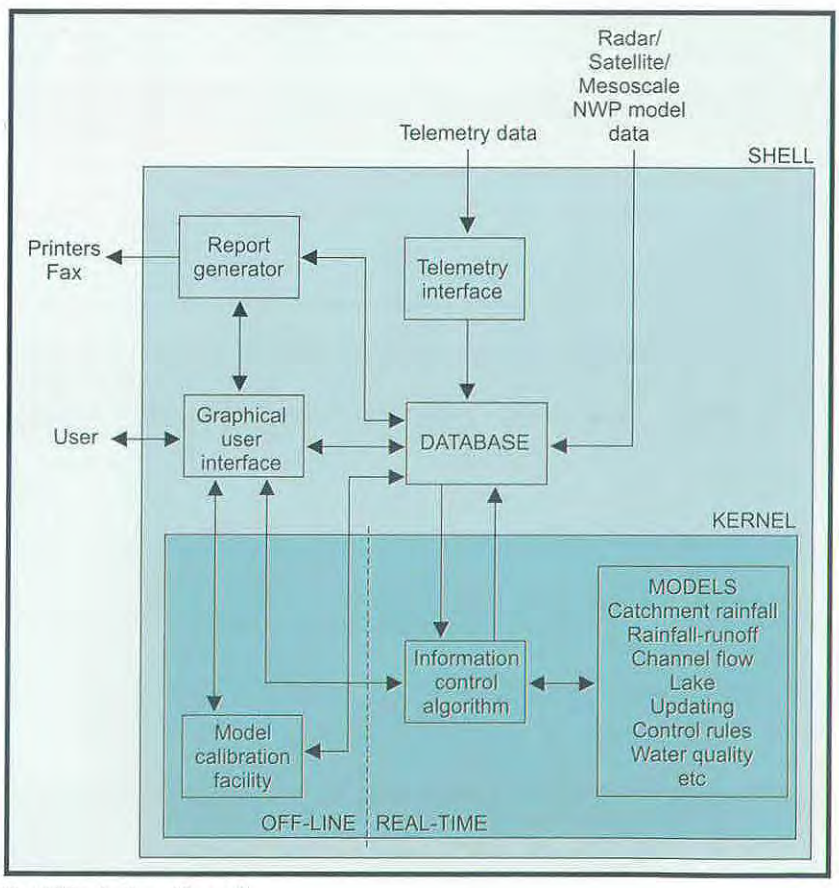
Contact: Dr M J Bailey, IVEM Oxford

FLOODING

Of all natural disasters, flooding affects the greatest number of people worldwide. In 1984 the Swiss Red Cross estimated that during the 1970s flooding accounted for over 50 000 deaths and in total affected over 15 million people. Although control of flooding by structural measures, such as flood alleviation dams and embankments, can reduce frequency of flooding, damage is dramatically increased when failure eventually occurs. More cost-effective alleviation of flood risk can often be provided through flood warning or flood protection combined with warning.

Over the last ten years CEH's Institute of Hydrology (IH) has devised and put into operation the River Flow Forecasting System (RFFS) – an operational system which can co-ordinate the construction of flood forecasts for both simple and complex river networks. The information control algorithm (ICA) invokes and manages the data and model components within the RFFS. Typically the model components initially calculate the catchment average precipitation from raingauge and weather radar information (via an interface to HYRAD – the Institute of Hydrology's HYdrological RADar system for the monitoring, forecasting and display of spatial rainfall) and also take into account snowmelt if applicable. Rainfall-runoff models are then used to represent flows from catchments in response to inputs from precipitation. A Probability Distributed Moisture model is used to represent the runoff from soil/vegetation assemblages of variable absorption potential as well as the transmission of water along channel and subsurface pathways. Channel flow routing models integrate input from tributaries to the flow as it moves downstream, and finally a more complex hydrodynamic model is used to describe the tidal portion of the catchment, incorporating tidal barrier controls if present.

For a complex river network many catchments and river reaches will



The RFFS shell and kernel.

Flooding in Carmarthen, south Wales, in October 1987.

require modelling using a variety of hydrometric data sources. The ICA manages this complex chain of information and generates river level forecasts for whole or selected parts of the river network in real time.

The first trial implementation of the RFFS began in early 1992 and provided forecasts at 150 locations within a 13 500 km² area of Yorkshire. By April 1993 there was sufficient experience in the use of RFFS for it to be used to provide routine flood warning for the river system upstream of York where flooding can be a major problem.

The RFFS has also been used as the basis of the White Cart Water Flood Forecasting System – which provides routine flood warning for a much smaller area in southern Glasgow. More recently (1994) the RFFS has been installed in the Hong Kong New Territories to provide forecasts for sites in a 70 km² basin.

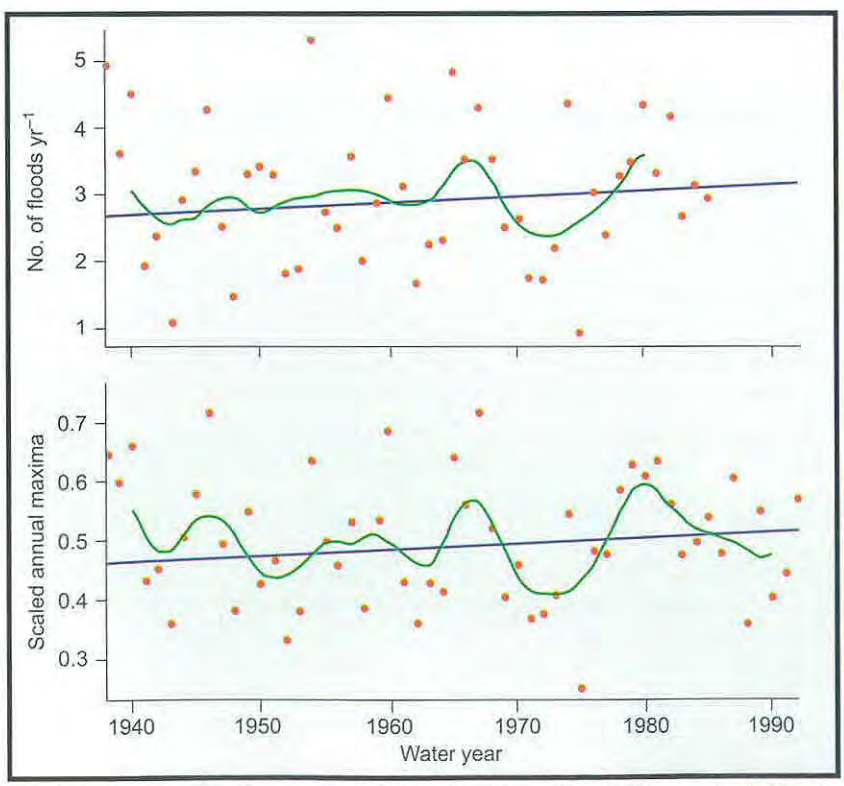
RFFS has given flood duty officers and water resource managers the ability to automatically interrogate the state of river levels across a region, retrospectively and currently, but more importantly for several hours or days into the future. This access to graphical information represents a significant step forward in supporting the management of flood risk.

Contact: Mr R J Moore, IH Wallingford

CEH's IH has also undertaken statistical analysis of long-term UK flood records. For both the general public and engineers, the presence of a trend in flood series is of concern since flood design studies and return period calculations assume unchanging flood characteristics. A failure of these assumptions could invalidate assessments and result in inappropriate actions being taken. It is also important that long-term records are kept under review so as to take into account any effects caused by climate change

IH holds two major datasets that were used in this study: the annual maximum flows database containing information on 1000 stations, and the peaks-over-threshold (POT) database which comprises 77 000 flood events on 857 catchments.

Due to the scarcity of flood data prior to the 1940s, initial analysis was conducted on datasets beginning in 1941. The long-term trends observed in flood frequency (number of POT floods per year) and flood magnitudes (annual maxima) were not significant. However, both datasets did show notable fluctuations over periods of 5–10 years (see Figure) – fluctuations which appear to have increased since 1960. This observation



Trends in number of floods per year and annual maxima. The solid line marks the fitted trend and the curve shows a smoothed local regression (loess) fit to the data.

suggests an increased tendency for flood-rich and flood-poor years to group together. Further analysis of flood series data from 1900 onwards (viewed with appropriate caution due to possible uncertainty over early data) shows similar fluctuations between 1910 and 1940 as have been observed since 1960, with 1940–60 being relatively quiet in terms of flood fluctuation. If these data are accurate, then the increased fluctuation since 1960 is neither a new nor uncommon phenomenon.

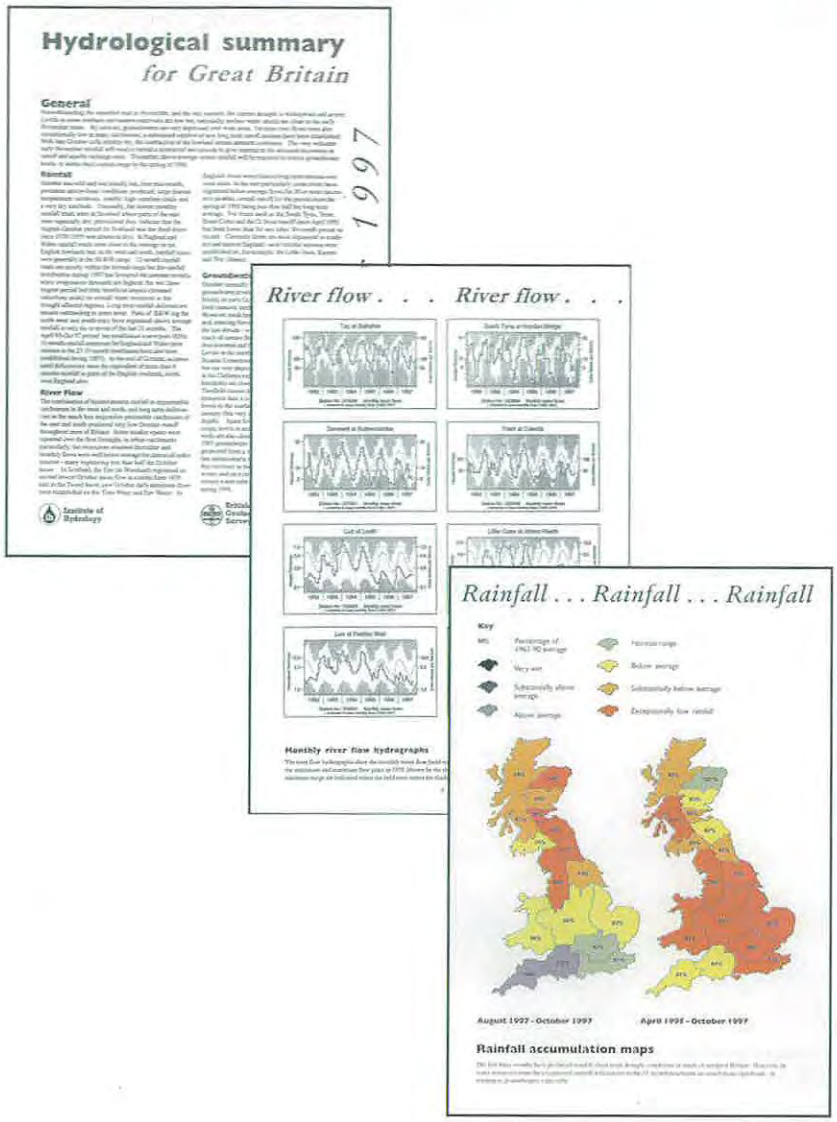
Climatic variation is the most obvious source of the fluctuation in the flood series, since other factors, such as urbanisation, tend to change in a slow and progressive way, rather than fluctuate. The variations in the predominance of different weather types seen in the UK affect rainfall patterns which in turn affect flooding, and similar fluctuating patterns are seen in long-term, annual rainfall series. However, this climatic effect means that any trends associated with land use change are difficult to identify.

This important work highlights the danger of conducting flood analyses on short (5–10 year) records which could result in different conclusions depending on the period analysed.

Contact: Dr A J Robson, IH Wallingford

Hydrological Summary of Great Britain

The Institute of Hydrology and the British Geological Survey jointly operate a national hydrological monitoring programme on behalf of the Department of the Environment, Transport and the Regions. As part of the programme, and in response to developing drought conditions, reports on rainfall, river flows, groundwater levels and reservoir contents



throughout Great Britain have been published monthly since 1989 as the *Hydrological Summary of Great Britain**. The reports form the basis of a range of briefing notes, articles and technical papers aimed at increasing scientific and public awareness of hydrological and water resource issues. The databases of the National Water Archive (based at the IH) provide the historical perspective within which the severity of droughts or flood episodes can be assessed.

Contact: Mr T J Marsh, IH Wallingford

** Copies of these reports are available on subscription (£48 per year) from the National Water Archive Office.*

CEH Output and Performance Indicators

CEH's science makes practical contributions to much of society, ranging from advancement in scientific knowledge and advice to government and industry to providing information to the public on matters of scientific importance. CEH collects an extensive database of output and performance indicators (OPIs) that are used as quantitative and qualitative measures of activity and performance. These include:

- measures of science output (publications)
- scientific achievements
- inputs to the user community
- services to the scientific community
- education and training
- technology development
- public understanding of science

CEH collects an extensive database of output and performance indicators that are used as quantitative and qualitative measures of activity and performance.

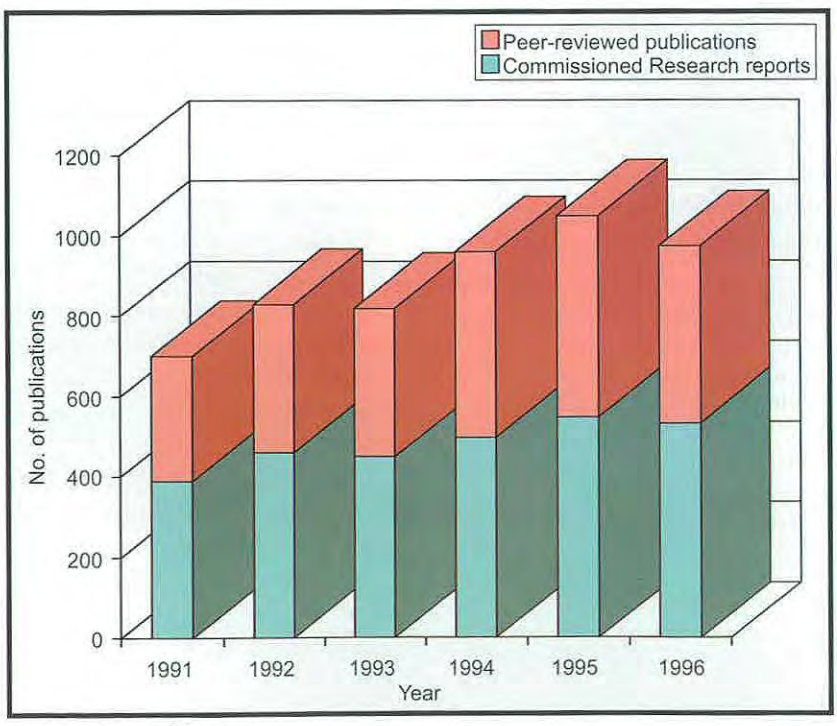


Figure 1. CEH publications.

CEH combines the need for long-term scientific research in areas of strategic importance, both nationally and internationally, with a proactive approach on topical issues in the environment. This is an interactive process which takes into account the environmental issues that are of immediate concern to government, industry and the general public.

CEH Science and Society

The following section presents details from the extensive portfolio of work that has taken place within CEH over the past few years in the following topical areas:

- conservation
- genetic engineering
- flooding

Further detailed descriptions of work undertaken in 1996–97 are presented in the relevant Institute Scientific Reports.

CONSERVATION

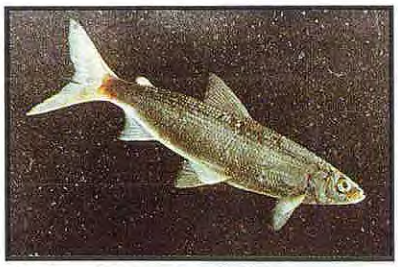
Fish Introductions and Conservation of Rare Species

Freshwater fish from the genus *Coregonus* are widespread in northern latitudes with representatives in Europe, Siberia and North America. All of the European populations are classified as either endangered or vulnerable due to threats such as eutrophication, acidification or overfishing.

Species list for the Coregonus*-containing lakes of England and Wales*

Species	Bassen-thwaite	Brothers-water	Derwent-water	Hawes-water	Red Tarn	Llyn Tegid	Ulls-water
Vendace	X		X				
Whitefish						X	
Pike	X		X			X	
Eel	X		X			X	X
Three-spined stickleback							X
Perch	X		X	X		X	X
Minnow	X		X	X		X	X
Trout	X		X	X	X		X
Arctic charr					X		
Roach	Xi		Xi				
Ruffe	Xi					Xi	

X = species present Xi = introduced species present



*Vendace (*Coregonus albula*).*

*Ruffe (*Gymnocephalus cernua*).*

In the UK this genus is represented by the whitefish (*Coregonus lavaretus*) (also known in different localities as schelly, powan or gwyniad) and the nationally rare vendace (*C. albula*), which is present in only two UK lakes and is protected under the Wildlife and Countryside Act. Work by CEH's Institute of Freshwater Ecology (IFE) has identified eutrophication and the introduction of new species of fish as the major threats to these fish.

Surveys by CEH's IFE have produced species lists for all the *Coregonus*-containing lakes of England and Wales (see Table on the previous page), indicating the presence of both native and newly introduced species of fish. Introductions of the ruffe (*Gymnocephalus cernua*) has raised the greatest concerns over possibly harmful effects on both coregonids and perch *(Perca fluviatilis)*. Introduction of ruffe is thought to have been initially due to its use as live bait by anglers, but after introduction this species has been shown to establish dense populations and become a major component of the fish communities in lakes – regardless of the trophic status of the water. In Bassenthwaite Lake (English Lake District) the first recording of ruffe was of two individuals in April 1991, indicating a probable introduction date in the late 1980s. By the end of 1991 ruffe represented 2% of survey catches, and by September 1995 ruffe comprised 42% of a survey undertaken by IFE. Over the same period the proportion of vendace in these surveys decreased from 16% to 1%, and roach decreased from 42% to 8%.

In Bassenthwaite Lake the poor status of vendace may actually be due to the effect of eutrophication from sewage input (causing reduced oxygen levels and siltation of spawning grounds) rather than to introduction of ruffe. This identification by IFE of the eutrophication threat in Bassenthwaite Lake has been instrumental in bringing about an upgrade to a major sewage discharge to the lake which will reduce phosphorus inputs by at least 50%.

However, the only other UK population of vendace occurs in Derwentwater and, although the status of this population is currently good, a river connects this lake with Bassenthwaite Lake, so it is probably only a matter of time before ruffe also become established in Derwentwater.

The major concerns of a harmful impact by ruffe have centred on possible competition with, and predation on, the rare coregonids, especially predation of the egg stage. Present results indicate no appreciable overlap in diet between ruffe (which tend to consume benthic macroinvertebrates during the summer) and vendace or whitefish (which are planktivorous), although this does raise the possibility that ruffe are competing directly with perch. However, work by other research groups has shown that, during winter in Loch Lomond, ruffe consume large numbers of whitefish eggs. There is, therefore, concern about the effect of this predation on recruitment to coregonid populations where they now co-exist with ruffe. In contrast, the dramatic increase in ruffe populations has caused a shift away from coregonids and towards ruffe as a prey species by predators of fish. The net effect of this increased coregonid egg mortality but decreased adult mortality will be difficult to assess.

The extension of the range of ruffe is of concern throughout the UK because it has included introductions to three out of only nine lakes

containing these unexploited, but rare, coregonids. Complete answers require both further experimental work and long-term population data for coregonids. The latter are limited in the UK due to the fact that there is no commercial coregonid fishery. However, this lack of a fishery influence means that UK results can make a valuable international contribution to the problem of ruffe introductions in the European lakes and the Great Lakes of North America (where ruffe was introduced via ballast water) which *do* have commercial fisheries.

Contact: Dr I J Winfield, IFE Windermere

Genetic Variation in Tropical Trees

Spanish cedar (*Cedrela odorata*) is an economically important timber species of the mahogany family which is native to the American tropics. However, there is increasing concern over its conservation due to high deforestation rates within its native range.

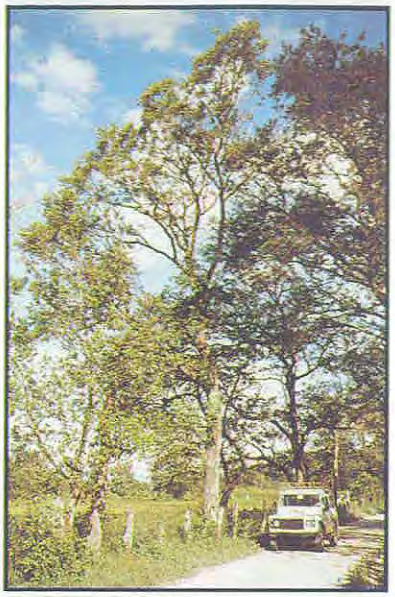
Tropical forests are well known for their species richness and, although in recent years there has been a greatly increased awareness of the effects of deforestation on biodiversity, very little is known about the effects on the genetic diversity within species.

Spanish cedar is patchily distributed within Costa Rica and occurs in geographically disjunct regions – primarily as remnant trees on farms and marginal land. The importance of conserving the genetic diversity of valuable timber species has been explicitly recognised in Costa Rica's National Conservation Strategy for Sustainable Development. CEH's Institute of Terrestrial Ecology (ITE) (funded by DG XII of the European Commission) is involved in a collaborative project to assess the genetic variation *between* isolated populations and *within* individual populations of this species using molecular techniques.

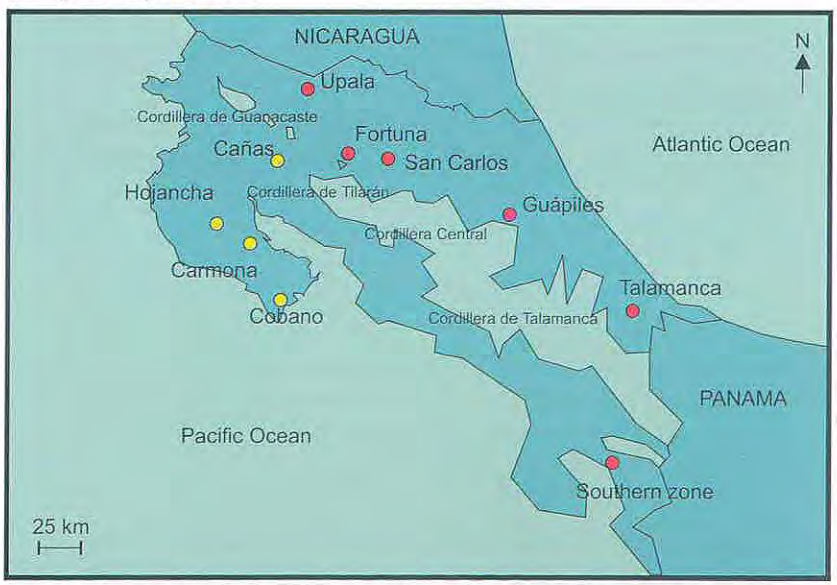
Populations originating from the northern Pacific region (lower rainfall and more dry months) were found to be highly genetically differentiated from those in both the Atlantic and southern Pacific regions (both higher rainfall and fewer dry months). However, little molecular variation was found between the populations *within* each of these regions, which may indicate effective gene flow within the regions.

These regional genotypic differences have phenotypic consequences with mature trees in the different regions expressing different morphological characteristics (eg in bark texture).

These results have important implications for the sustainable use and effective conservation of the remaining populations of Spanish cedar in Costa Rica. The northern Pacific populations and the Atlantic/southern Pacific populations both need to be adequately conserved to ensure preservation of the full genetic variation of this species. Also, in the event of re-introduction or large-scale plantation,



*Spanish cedar (*Cedrela odorata*) growing in the dry north Pacific region of Costa Rica.*



Map of Costa Rica, showing the locations of the ten populations of Spanish cedar included in the study. Red circles indicate populations from the wet Atlantic/south Pacific region, while yellow circles represent those from the drier north Pacific region.

*North African scorpion (*Androctonus australis*).*

consideration should be given to the use of seed sources from the same population/area to allow for regional adaptations. The high degree of genetic variation found by the current study must be maintained by suitable forest management strategies if they are to be genuinely sustainable.

Contact: Dr A C M Gillies, ITE Edinburgh

GENETIC ENGINEERING

Biological Pesticides

The key aim of genetic engineering of biological pesticides is to increase efficiency, particularly in agricultural situations, by increasing their speed of action. In 1993 CEH's Institute of Virology and Environmental Microbiology (IVEM) conducted the first field trial of a genetically improved baculovirus which expressed an insect-selective toxin from the North African scorpion (*Androctonus australis*), and targeted the cabbage looper caterpillar (*Tricoplusia ni*).

This trial demonstrated that in the field modified baculoviruses kill target species faster than wildtype (ie natural) virus strains, resulting in reduced crop damage, and in a way that also reduces the chance of secondary infection. This project was designed to test the genetically modified virus under challenging conditions of high insect density where the larvae were large and capable of causing serious crop damage.

Overall virus-treated plots had less leaf damage than untreated plots, but, in comparison to the wildtype virus treatment with the GMM (genetically modified micro-organism), resulted in 23–29% less damage (depending on dosage) due to the larvae dying 10–15% earlier.

Caterpillars infected with the wildtype virus usually remained on the plant after death where they liquefied, thus aiding the release of large quantities of virus. However, the GMM caused both larval paralysis, which resulted in the caterpillars falling on to the soil, and also prevented large-scale release of viral particles. This has important implications for the evaluation of the safety of this bioinsecticide as it results in less chance of this GMM being passed on to other organisms.

Risk Assessment of GMMs

The previous study led on to an ongoing five-year programme of field studies relating to risk assessment of genetically modified baculovirus insecticides.

Naturally occurring baculoviruses *only* infect invertebrates and no similar viruses have been found in vertebrates or plants. However, it is important to look at the susceptibility of non-target insects and this is a major focus for risk assessment studies at IVEM. Currently trials are looking at the response of other Lepidopteran species which differ in susceptibility to this GMM and also in life style (ie foliar- versus soil-dwelling caterpillars).

A combination of recent laboratory and field results has suggested that the reduced yield, increased speed of kill and reduced transmission would result in a reduced reproductive rate of this GMM, and so, in comparison with the wildtype virus, the GMM is less likely to invade host populations in the wild.

Contact: Dr J S Cory, IVEM Oxford

Further studies of risk assessment of GMMs at CEH's IVEM are concentrating on assessing the level of exchange of genetic material between bacteria within the natural environment. Results, using bacteria which have been genetically modified in order to make them uniquely identifiable, suggest that

Wild cabbage leaf showing damage by a foliage feeder.

PUBLICATIONS

The high level of peer-reviewed publications has been maintained during 1996–97, although the overall number of Commissioned Research (CR) reports is slightly lower than last year. Figure 1 shows the numbers of peer-reviewed publications and Commissioned Research reports produced by CEH since 1991.

The science activity within CEH has been structured into the Core Strategic Programmes, which are described in more detail in an earlier section of this Report. Information on performance is collected at the Core Strategic Programme level and provides an important management tool for assessing the scientific output and relevance of the different Programmes. Figure 2 shows the publication output (peer-reviewed publications and Commissioned Research reports) for 1996.

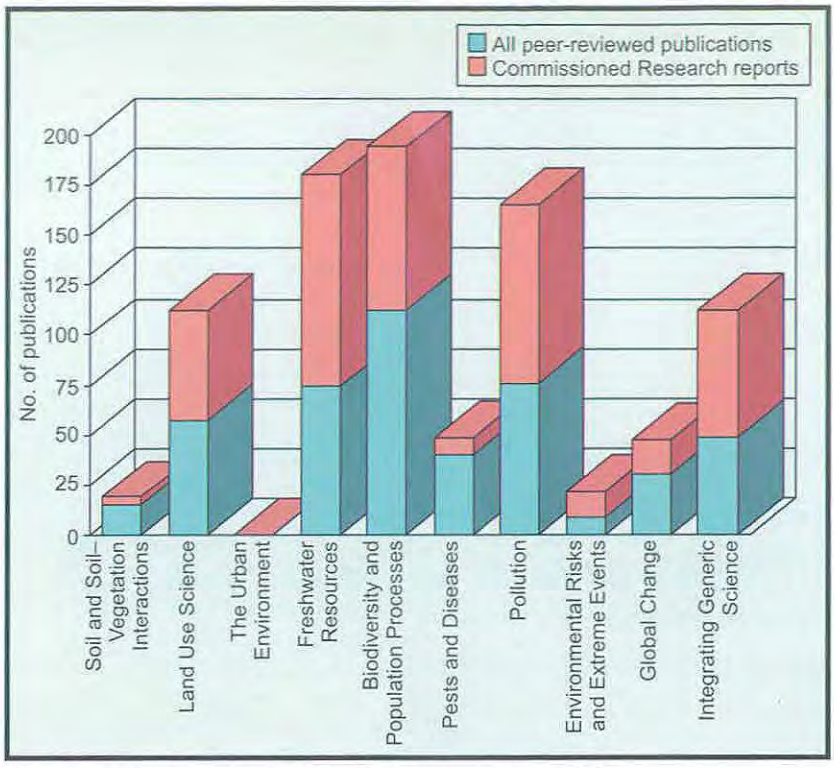


Figure 2. CEH publications by Core Strategic Programme, 1996.

Such information can also be used as a measure for assessing cost effectiveness across the whole scientific programme. Using publications as a key output indicator – both papers in the scientific literature and Commissioned Research reports – cost per paper *and* the added value of Commissioned Research can then be demonstrated. Science Budget provides support for fundamental science, from which knowledge and expertise can be used to win commissioned work. Figure 3 indicates the Science Budget cost per article for peer-reviewed publications alone and combined with Commissioned Research reports across the Core Strategic Programmes. The Figure shows that CEH is very efficient in producing its publications output with, on average, each refereed paper costing just over £12,000 to produce. This efficiency is especially evident when CR reports are included in the calculations.

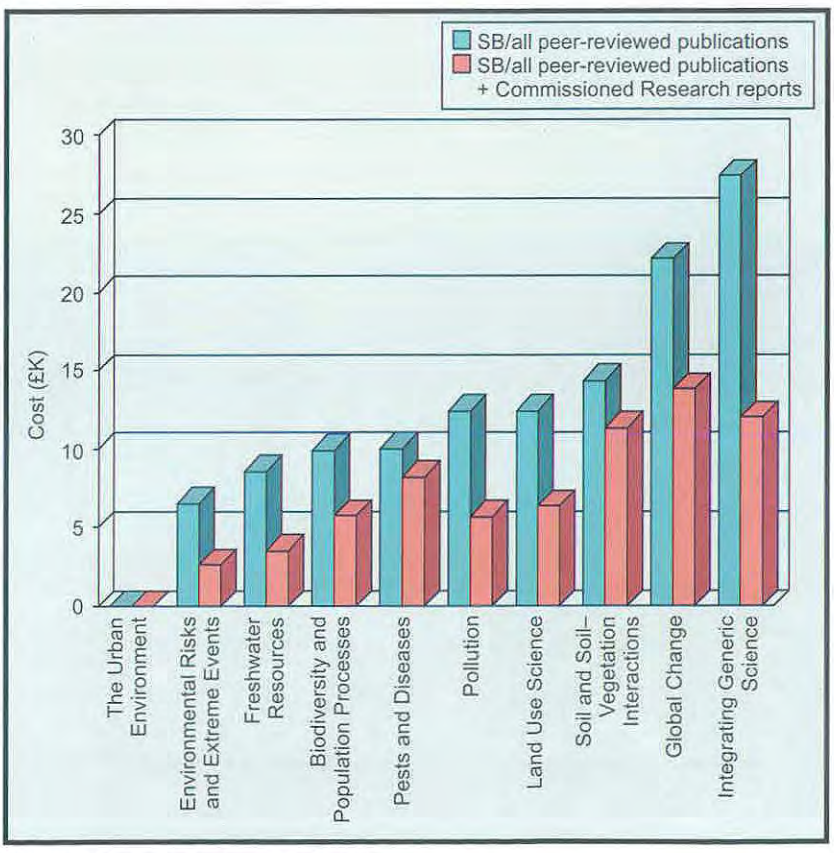


Figure 3. Science Budget costs per article.

PUBLIC UNDERSTANDING OF SCIENCE

As well as working at the leading edge of science, CEH is also committed to improving public access to and

The level and range of scientific expertise held within CEH is highly regarded throughout the world.

understanding of science. OPIs relating to this include:

- popular articles in magazines and newspapers;
- videos, TV and radio programmes;
- exhibitions attended, Science, Engineering and Technology (SET) activities, school activities, etc.

During the very dry months of spring 1997, scientists from CEH's Institute of Hydrology made numerous TV and radio appearances to comment and discuss the possible consequences of the drought for the UK.

Informing schoolchildren is also an important part of raising awareness at the local level. For example, the Merlewood Research Station of CEH's Institute of Terrestrial Ecology hosted a one-day exhibition in Grange-over-Sands, entitled *Understanding Change in the Environment*, to mark Science, Engineering and Technology week (SET97). The SET week is co-ordinated each year by the British Association for the Advancement of Science on behalf of the Department of Trade and Industry's Office of Science and Technology. Aspects of Merlewood's research were displayed, including opportunities for 'hands-on' experience. Parties from five of the local primary schools visited the displays in the morning, and members of the general public in the afternoon. In the evening there were a series of talks by selected members of staff. As a result of the success of the exhibition, the Merlewood Annual Lecture is now a feature of the Grange-over-Sands Lecture Society.

Clive Woods explaining weather patterns to local primary schoolchildren during the SET97 exhibition in Grange-over-Sands, Cumbria.

EXTERNAL LINKS AND INFLUENCE

CEH is continuing to develop strong links with a wide range of user communities. Interaction is particularly strong with the academic sector, as shown in Appendix 5. Industrial and commercial links with approximately 200 organisations, namely in the form of jointly funded projects and Commissioned Research projects, are shown in Appendix 7.

The level and range of scientific expertise held within CEH is highly regarded throughout the world and the Centre has considerable influence on many national and international decision-making committees. CEH has representatives on 18 major UK learned societies, 30 UK Government committees and 35 international committees. A full list is given in Appendix 6.

Finance and Staffing

FINANCE

Science Budget

In 1996–97 the value of the CEH baseline Science Budget, which supports the CEH Science Programmes and contributes towards the costs of infrastructure, fell below 1995–96 levels, although the overall effect is disguised by borrowing from central NERC funds. The year-on-year summary to date, including both the first three years of operation of CEH and the comparable figures for the two years prior to the formation of CEH, is included in Figure 1.

The separate totals for each CEH Institute (IFE, IH, ITE and IVEM) are shown in Figure 2. The overall Science Budget base allocation available to the Institutes has remained broadly static in cash terms (ie a decline in real terms), although this is not apparent from the Figures in view of the injection of additional funds for defined activities and projects, and cash flow support to manage end-of-year income/expenditure fluctuations.

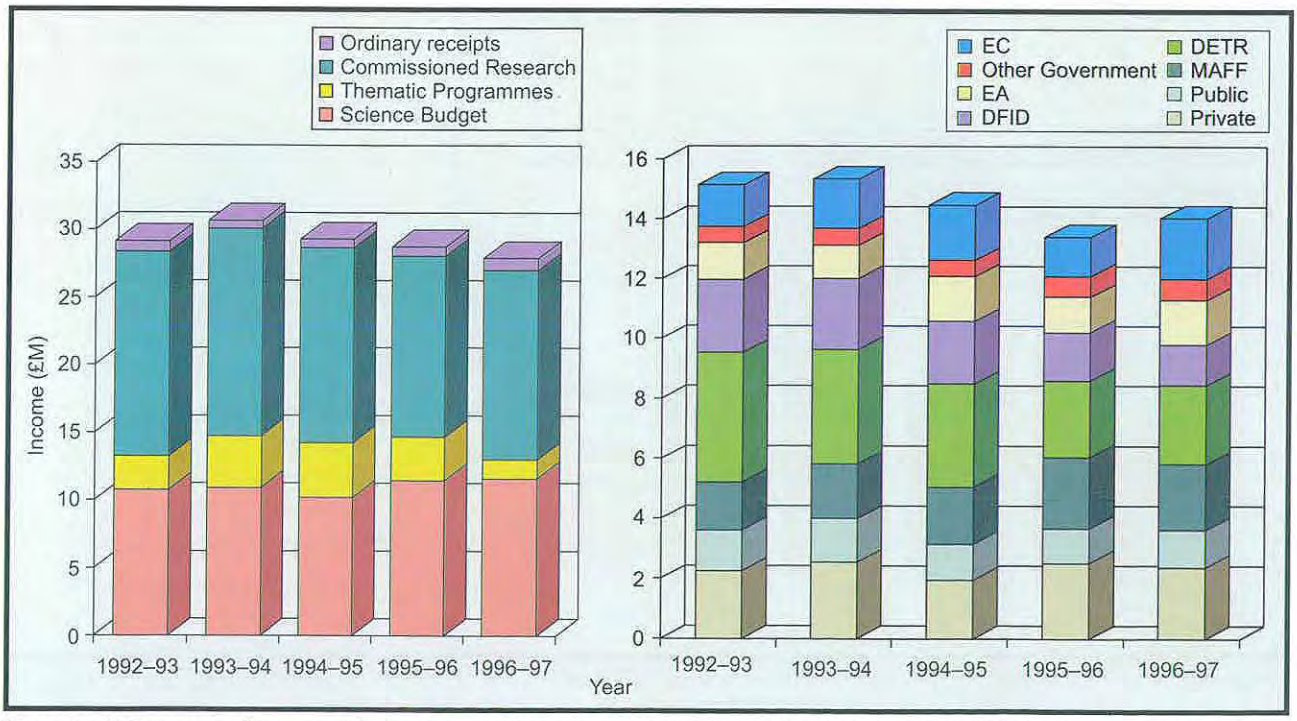


Figure 1. CEH sources of income. The breakdown of the Commissioned Research (CR) income for 1996–97 by major customer is shown separately.

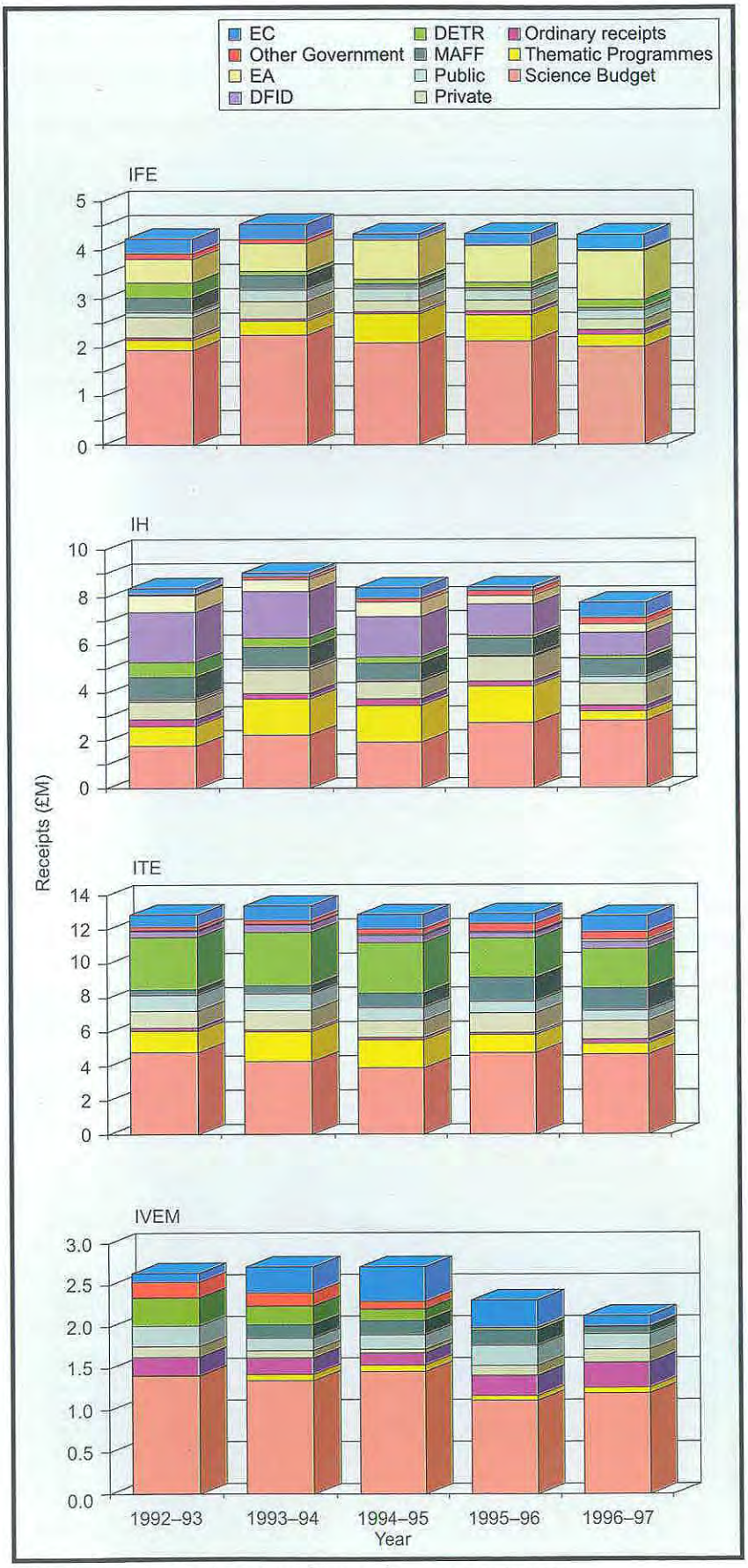


Figure 2. CEH Institutes' sources of income from major customers.

The distribution of CEH Science Budget allocation around CEH Institutes is, to a certain extent, historic. The balance is, however, being addressed through the continued development of the new Science Programmes and of such initiatives as the CEH Integrating Fund. The inertia in the system does, however, mean that change, although steady, is slow.

Core Strategic Programmes

During the course of the year the reshaping of the Science Programmes within CEH has been successfully completed. Until the NERC accounting system is replaced in 1997–98, however, actual expenditure on the new Programmes will not be shown under the new definitions. A broad analysis of Science Budget expenditure in the new Programme areas in 1996–97, prepared for planning purposes, is shown at Figure 3.

In 1995 the CEH Integrating Fund was established for specific funding of three-year projects within the Core Strategic Programmes regarded as suitable for full collaboration between two or more component Institutes. Seven projects were supported in 1995–96 and the initiative was rolled forward into 1996–97, with a further six projects being supported at a total cost of £1.2M over three years. Funding has been allocated for a third round of Integrating Fund projects starting in 1997–98.

Thematic Programmes

CEH Institutes continue to be actively involved in preparing proposals and bidding for support under Thematic Programmes. Strong bids have been made, for example, into the new Urban ReGeneration and the ENvironmenT (URGENT) and Ecological Dynamics and GEnes (EDGE) programmes. ITE and IVEM respectively have been awarded funds to undertake programme management for Environmental Diagnostics and EDGE. The deletion from the NERC

Business Plan of the highly rated Catchment Ecosystems Research Initiative (CERI) and its replacement at a lower level of funding for capacity building in freshwater sciences was a disappointment, although the newly approved Thematic Programme on Biological Diversity and Ecosystem Function in Soil offers other opportunities for CEH scientists.

There are problems to be faced as a result of total NERC funding for Thematic Programmes of interest to CEH being at a lower level than that for the major TIGER and LOIS Programmes. The significant reduction in income in 1996–97 as a result of the winding down of TIGER and LOIS could not be readily matched by a corresponding reduction in expenditure, particularly on staffing, and cash flow support was provided from central NERC funds to allow adjustments to be made on a more realistic timescale.

Thematic Programmes are open for competition, and CEH success can be measured by the number of such Programmes in which CEH Institutes competed and obtained support. In 1996–97 CEH Institutes received funding under the following:

- Terrestrial Initiative in Global Environmental Research (TIGER)
- Terrestrial Initiative in Global Geological Environmental Research (TIGGER)
- Land–Ocean Interaction Study (LOIS)
- Pollutant Transport in Soils and Rocks
- Wildlife Diseases
- Hydrological Radar Experiment (HYREX)
- Large-Scale Processes in Ecology and Hydrology
- Environmental Diagnostics
- Testable Models of Aquatic Ecosystems
- Along Track Scanning Radiometer
- Ecological Dynamics and Genes (EDGE) – programme management

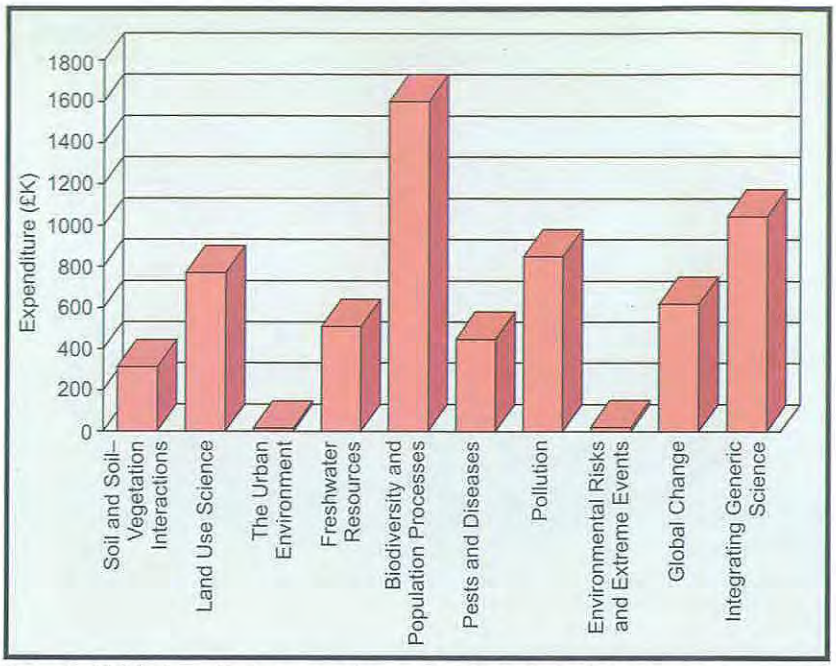


Figure 3. CEH Science Budget expenditure in the Core Strategic Programmes, 1996–97.

- Atmospheric Chemistry Studies in the Oceanic Environment (ACSOE)
- Instruments for Field Measurements in the Atmosphere

Non-Thematic Programmes

A limited opening of the Non-Thematic funding mode to Centres/Surveys has demonstrated that CEH Institutes can compete effectively for this funding stream, particularly in collaboration with university partners. In the first two award rounds in which Centres/Surveys have been able to participate, CEH has led 12 bids and received four awards. As with Thematic Programmes, however, no funds are available for the support of principal investigators, whose time on such Programmes must be costed to the Core Strategic element of the Science Budget.

Infrastructure

During 1996–97 the boundary between the Core Strategic Programme and infrastructure necessary to support the Science Programmes has been modified. Components of infrastructure have been more clearly identified and comparison on a year-by-year basis is now in place, with a view to

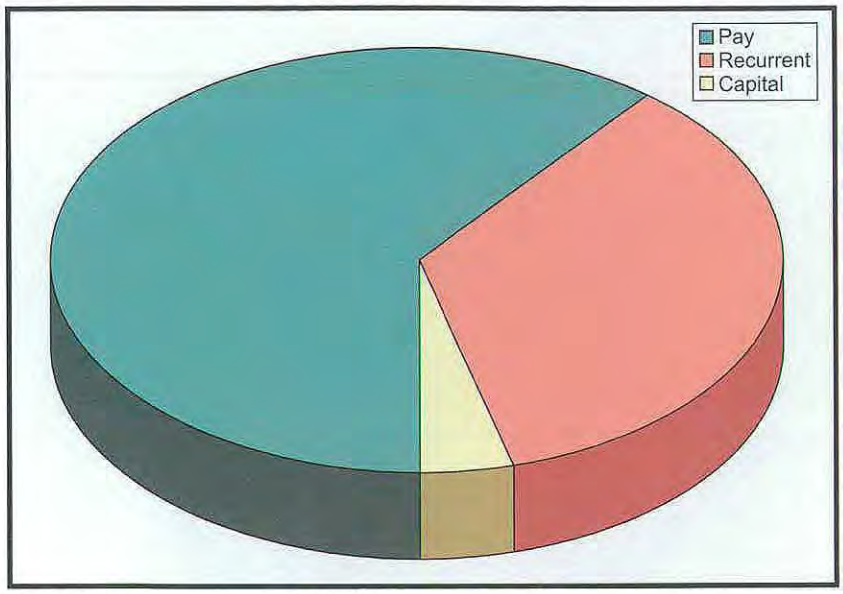


Figure 4. CEH expenditure, 1996–97.

identifying areas in which savings may be made. CEH recognises the need to keep infrastructure support under continuous review.

It is also significant that a high proportion of infrastructure costs (*c* 43%) has been met from Commissioned Research, other external income and by way of contributions from Thematic Programme awards. Generating other income thus reduces the level of grant required from the Science Budget to support infrastructure, and careful monitoring of the level of infrastructure makes CEH science more competitive.

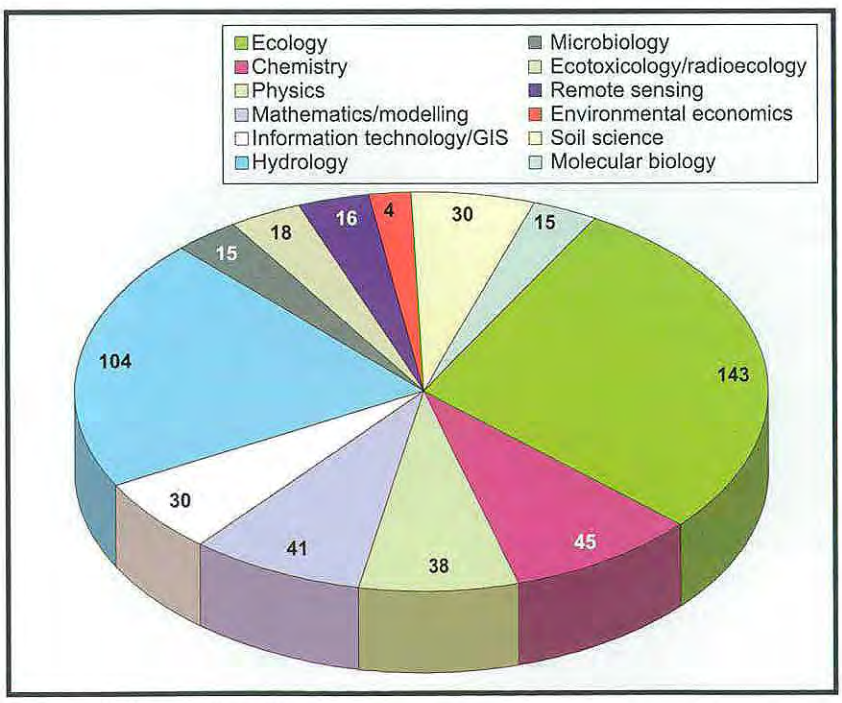


Figure 5. CEH scientific skills.

Commissioned Research and other income

CEH derives, and will continue to derive, a substantial proportion of its income from Commissioned Research and other sources. Figure 1 shows the overall contribution of external income to the CEH budget, and Figure 2 shows Institute receipts from major customers in 1996–97, with the receipts in earlier years, revalued to current prices, for the purposes of comparison. Research funding from major UK Government customers continues to be essential to maintain the level of income, but is affected by uncertainties in departmental research budgets. New sources of income are therefore being actively sought. Work on prestigious European Commission programmes continues to be supported at a significant level, although the requirement to identify funds to match EC contributions on EC-supported contracts is a limiting factor in increasing this funding stream.

The Core Strategic Programme is mutually dependent on both Science Budget and CR funding. CR thus adds value to the science base and demonstrates the continuing importance of CEH science in meeting user needs. Although individual component Institutes may rely heavily on particular customers, the science of CEH as a whole enables the Centre to maintain a wide customer base.

Expenditure

The expenditure across CEH on staff, recurrent and capital in 1996–97 is shown in Figure 4. The balance between pay and non-pay costs reflects the nature of CEH science (including field-based work in the UK and overseas) and the requirements to maintain the Centre's infrastructure,

including sites and site facilities. Central resources available for computing support and computing capital have enabled CEH to keep pace with developments in this area of rapidly changing technology. A continuing difficult financial situation and tight expenditure controls have, however, limited the ability of Institutes to invest in major new or replacement items of non-computing equipment and facilities. A three-year major capital replacement plan, subject to the availability of resources, is being developed.

STAFFING

The spread of skills of current CEH scientific staff (Figure 5) reflects changes which have emerged, and will continue to emerge, in the balance of activities required to support Science Budget, Commissioned Research and Thematic and Non-Thematic Programmes. Following the loss of 21 staff in 1995–96, 12 more staff, mainly in the higher grades, were released on early severance or early retirement terms at the end of 1996–97. The current age distribution of staff in CEH is shown in Figure 6. Further restructuring is being considered in order to reskill parts of the workforce, and allow for appointments at a more junior level to enhance the age and skill profile.

Implementation of the NERC policy for the use of fixed-term appointments (FTAs) for scientific staff in CEH, and transfers on to the permanent staff complement, within the legal framework and bearing in mind customer requirements and good management practice, has proceeded at a steady pace. This is a continuous process and reviews have been taking place at regular intervals.

A total of 616 staff were in post in CEH on 31 March 1997, a net reduction of eight compared with 31 March 1996 and of 13 compared with the position on 31 March 1995. Of these, 193 are on fixed-term appointments. A further 21 staff joined CEH from the central NERC complement on 1 April 1997, following the restructuring of NERC Scientific Services and the transfer of responsibility for computer support to Centres/Surveys. Seven staff who were formerly part of the Remote Sensing Applications Development Unit (RSADU) based at Monks Wood also joined CEH (ITE) in summer 1997.

Total staff numbers in each of the CEH Institutes as at 31 March 1997 are contained in Appendix 2.

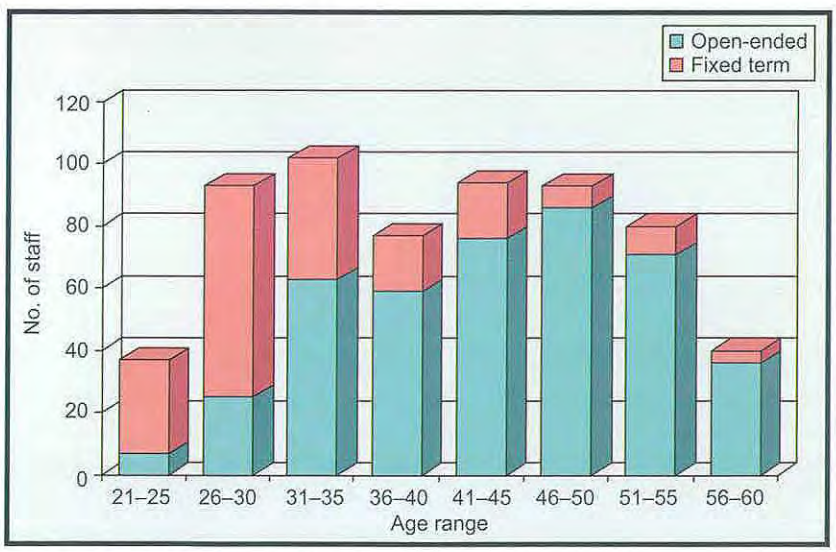
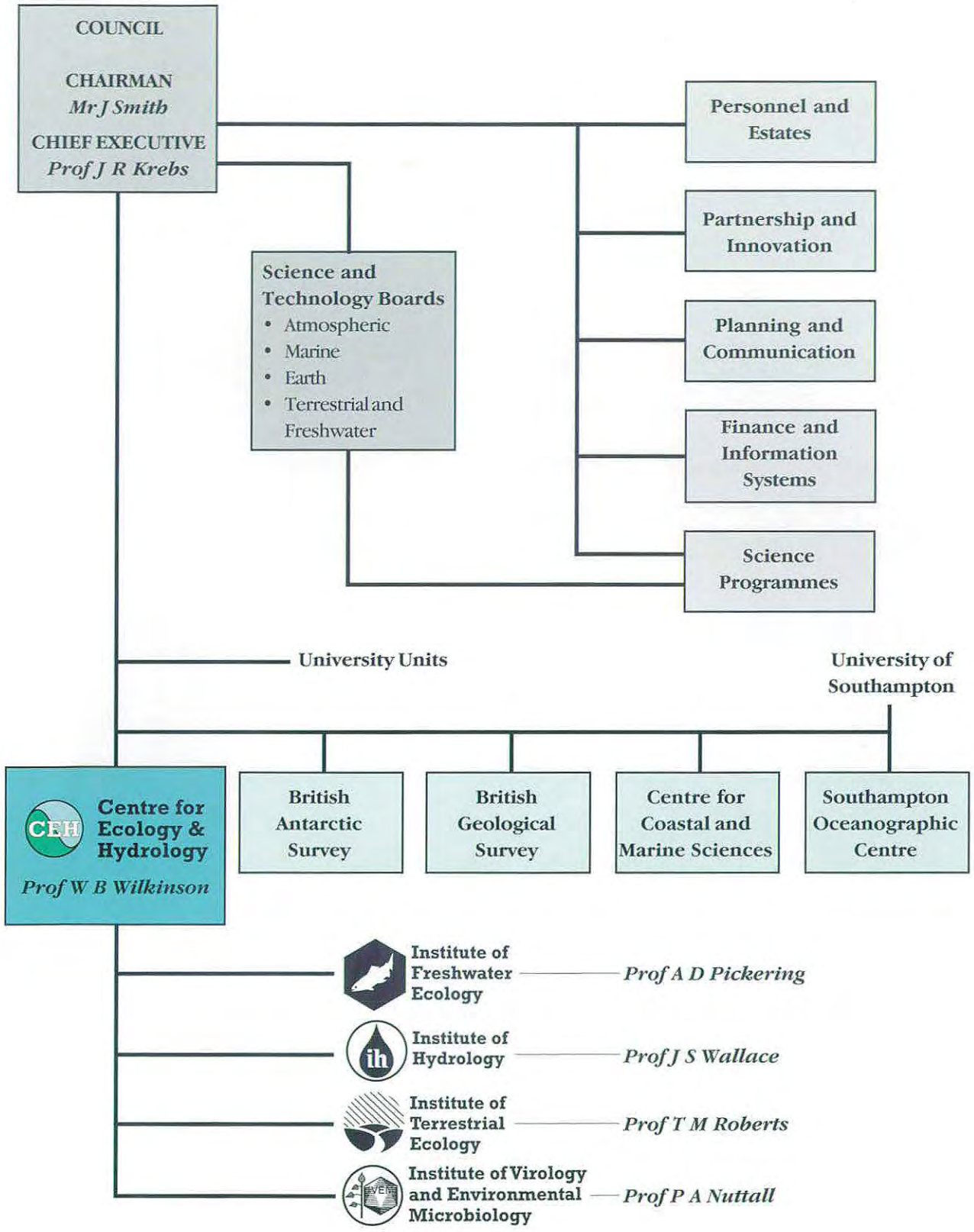


Figure 6. Age distribution of CEH staff.

Appendices

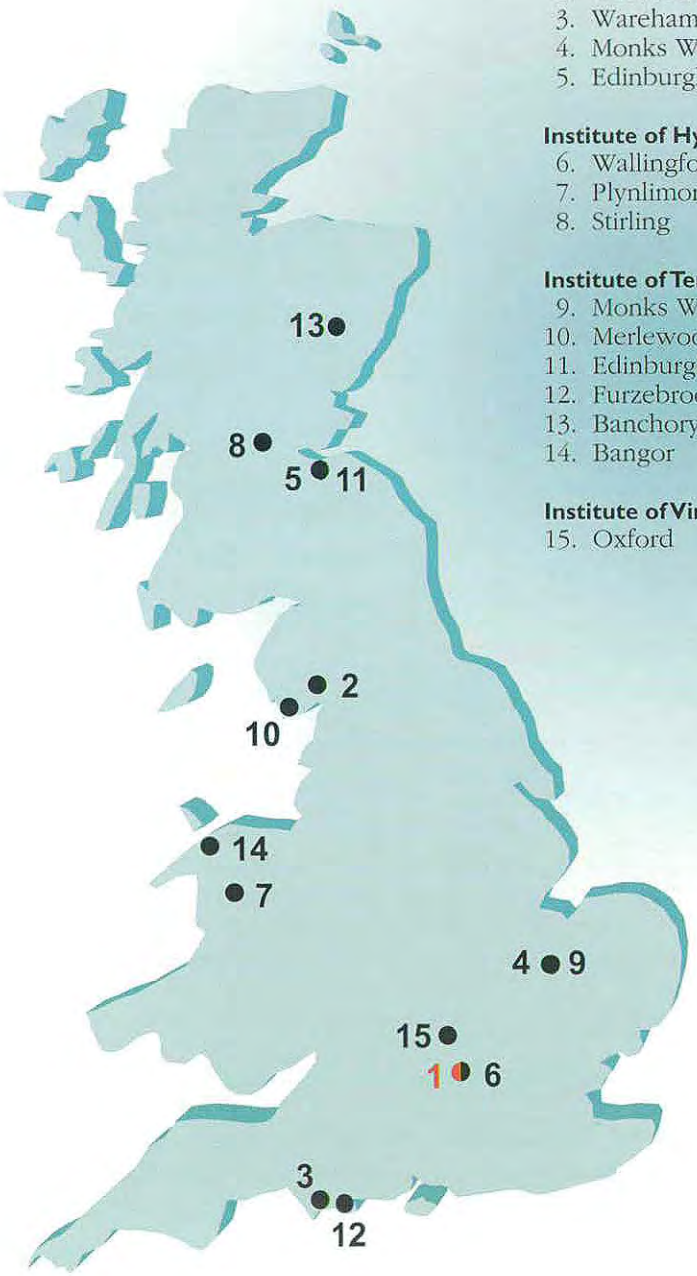
APPENDIX I

NERC structure



APPENDIX 2

Location of CEH sites



Centre for Ecology and Hydrology
1. Wallingford

Institute of Freshwater Ecology
2. Windermere
3. Wareham
4. Monks Wood
5. Edinburgh

Institute of Hydrology
6. Wallingford
7. Plynlimon
8. Stirling

Institute of Terrestrial Ecology
9. Monks Wood
10. Merlewood
11. Edinburgh
12. Furzebrook
13. Banchory
14. Bangor

Institute of Virology and Environmental Microbiology
15. Oxford

CEH organisation

Director	**Professor W B Wilkinson**
Management Board	Professor W B Wilkinson, Director CEH Professor T M Roberts, Director, Institute of Terrestrial Ecology and Deputy Director CEH Professor A D Pickering, Director, Institute of Freshwater Ecology Professor J S Wallace, Director, Institute of Hydrology Professor P A Nuttall, Director, Institute of Virology & Environmental Microbiology Mr P Williams, Head of Administration, CEH Dr J C Metcalfe, Head of Science Policy (Secretary)
Total staff	780 (including 21 staff providing computer support services who were transferred from the central NERC complement, and 154 students and visiting workers)

DIRECTORATE
Wallingford Laboratory
Crowmarsh Gifford
Wallingford, Oxon OX10 8BB
Tel: 01491 838800 Fax: 01491 692424

Director	**Prof W B Wilkinson**
Director's Secretary	Mrs K Vann

Administration

Head of Administration	**Mr P Williams** (based at NERC Swindon Office and Wallingford)
Finance Officer/Deputy Head of Admin	Mrs H M Wood
Contracts Officer	Ms L A Aspinall
Administration	Mrs A M Davies (from November 1997)

Science and Marketing

Science policy and co-ordination	Dr J C Metcalfe
GCTE Project Office	Mr J I Ingram, Miss K M Sutton
Marketing and science administration	Dr W D Graham

Information

Information services	Mrs P A Ward (based at ITE Merlewood)

Technical

Safety technician	Mr C Hankinson (based at ITE Merlewood)
Staff	13

INSTITUTE OF FRESHWATER ECOLOGY
Windermere Laboratory
Far Sawrey, Ambleside
Cumbria LA22 OLP
Tel: 015394 42468 Fax: 015394 46914

Director	**Prof A D Pickering**

Head of Fish Biology Division	**Prof J M Elliott**	Conservation of rare fish Fish stock assessment and management Modelling recruitment and growth The stress response of fish
Head of Microbial Ecology Division	**Prof A D Pickering**	Microbial diversity in fresh water Management of lakes and reservoirs Culture Collection of Algae and Protozoa Genetics of freshwater bacteria Algal productivity Palaeolimnology
Head of Aquatic Processes Division	**Dr E W Tipping**	Chemical speciation Modelling upland acid soils Pollutant transport Nutrient fluxes in the aquatic environment Automated water quality monitoring

Head of Ecosystem Management Division	**Prof J Hilton**	Fish ecology Pollutant transport Ecological assessment Biological classification of river quality Ecological impact of low flows
The River Laboratory East Stoke Wareham Dorset BH20 6BB *Tel: 01929 462314 Fax: 01929 462180*	**Prof J Hilton**	
Eastern Rivers Laboratory Monks Wood Abbots Ripton Huntingdon Cambridgeshire PE17 2LS *Tel: 01487 773381 Fax: 01487 773467*	**Dr L C V Pinder**	Restoration of fisheries Environmental impacts on lowland rivers Flow regimes and fish recruitment
Edinburgh Laboratory Bush Estate Penicuik Midlothian EH26 0QB *Tel: 0131 445 4343 Fax: 0131 445 3943*	**Dr A E Bailey-Watts**	Land use change and water quality Lake eutrophication Tropical limnology Biodiversity
Acting Director FBA	**Prof C S Reynolds**	Freshwater Biological Assocation
Staff	93	

INSTITUTE OF HYDROLOGY
Wallingford Laboratory
Crowmarsh Gifford
Wallingford, Oxon OX10 8BB
Tel: 01491 838800 Fax: 01491 692424

Director **Prof J S Wallace**

Head of Information and Scientific Services	**Mr F M Law**	Infrastructure National Water Archive Data and software systems Communications Library
Head of Water Quality Division	**Dr A Jenkins**	Catchment water quality modelling Hydro-chemical processes Sediment interactions Analytical chemistry Experimental catchments Thematic science management
Head of Bio-physical Processes Division	**Dr J H C Gash**	Global processes Regional environmental change Agricultural hydrology Vegetation and soil processes Instrumentation
Head of Risks and Resources Division	**Dr A Gustard**	Low flow, ecology and wetlands Regional flow regimes Flood-rainfall and climate analysis Hydrological systems modelling Surface–groundwater systems Water resource modelling
Plynlimon Office Staylittle Llanbrynmair Powys SY19 7DB Tel: 01686 430652 Fax: 01686 430441	**Mr J A Hudson**	
Stirling Office Unit 2, Alpha Centre. Innovation Park Stirling FK8 4NF Tel: 01786 447612 Fax: 01786 447614	**Mr R C Johnson**	
Staff	175	

INSTITUTE OF TERRESTRIAL ECOLOGY
Monks Wood
Abbots Ripton
Huntingdon, Cambs PE17 2LS
Tel: 01487 773381 Fax: 01487 773467

Director **Prof T M Roberts**

Monks Wood Abbots Ripton Huntingdon Cambs PE17 2LS *Tel: 01487 773381 Fax: 01487 773467*	**Dr B K Wyatt**	Animal ecology Earth observation Ecological processes and management Pollution and ecotoxicology Environmental Information Centre
Merlewood Research Station Windermere Road Grange over Sands Cumbria LA11 6JU *Tel: 015395 32264 Fax: 015395 34705*	**Prof M Hornung**	Environmental chemistry Land use Radioecology Soil ecology Environmental Change Network
Edinburgh Research Station Bush Estate Penicuik Midlothian EH26 0QB *Tel: 0131 445 4343 Fax: 0131 445 3943*	**Prof M G R Cannell**	Ecosystem modelling Trace gas fluxes and air pollution Tropical ecology
Furzebrook Research Station Wareham Dorset BH20 5AS *Tel: 01929 551518 Fax: 01929 551087*	**Prof A J Gray**	Invertebrate ecology Plant ecology and genetics Vertebrate and trophic ecology
Banchory Research Station Hill of Brathens, Glassel Banchory Kincardineshire AB3 4BY *Tel: 01330 826300 Fax: 01330 823303*	**Dr S D Albon**	Applied ecology Upland community ecology Vertebrate population ecology
Bangor Research Unit University of Wales, Bangor Bangor Gwynedd LL57 2UW *Tel: 01248 370045 Fax: 01248 355365*	**Dr J E G Good**	Air pollution and climate change impacts Biogeochemistry and land use Upland ecology
Staff	277	

INSTITUTE OF VIROLOGY AND ENVIRONMENTAL MICROBIOLOGY
Mansfield Road
Oxford OX1 3SR
Tel: 01865 281630 Fax: 01865 281696

Director **Prof P A Nuttall**
Deputy Director **Dr E A Gould**

Science sections		Molecular microbial ecology Microbial diversity Virus ultrastructures Plant virology Ecology and biocontrol Flaviviruses Water-borne viruses Biotechnology Tick-borne pathogens Molecular biology of baculoviruses Orbivirus research Virus protein functions
Staff	53	

APPENDIX 3

Core Strategic Programme

Soils and soil–vegetation interactions

Project 1.1 Physicochemical processes affecting soil–water interactions
Issue 1.1.1 Solid-solution partitioning of chemical species
Issue 1.1.2 Organic matter decomposition and the production of humic substances
Issue 1.1.3 Mineral weathering
Issue 1.1.4 Integration of soil processes

Project 1.2 Biologically mediated soil processes
Issue 1.2.1 Activity and diversity of key functional populations
Issue 1.2.2 Trophic interactions in soils and their influence on soil organic matter production and degradation
Issue 1.2.3 Manipulation of soil populations to improve soil quality

Project 1.3 Physical and physiological processes controlling soil water balances
Issue 1.3.1 Soil–root interactions at the individual plant root and stand scale
Issue 1.3.2 Soil–plant–atmosphere flux transfers in mixed vegetation
Issue 1.3.3 Root–soil–water interactions adjacent to fluctuating water tables

Land use science

Project 2.1 Long-term and large-scale monitoring of land use
Issue 2.1.1 National-scale survey of land use and cover
Issue 2.1.2 Remote sensing of land use and cover
Issue 2.1.3 Monitoring and evaluation of land use policies

Project 2.2 Land use systems
Issue 2.2.1 Environmental impacts and management of farming and forest systems - uplands
Issue 2.2.2 Environmental impacts of farming systems - lowlands
Issue 2.2.3 Land use manipulation to minimise adverse impacts
Issue 2.2.4 Hydrological impacts of land use change
Issue 2.2.5 Holistic catchment studies
Issue 2.2.6 Development of water resource management strategies
Issue 2.2.7 Coastal zone survey and management

Project 2.3 Management of ecosystems in tropical regions
Issue 2.3.1 Management and restoration of forests and drylands
Issue 2.3.2 Agroforestry

Project 2.4 Landscape function and modelling
Issue 2.4.1 Modelling spatial processes
Issue 2.4.2 Applied landscape ecology
Issue 2.4.3 Integrated modelling of land use processes including social and economic variables

The urban environment

Project 3.1 Patterns of urban land/water use and associated habitats
Issue 3.1.1 Pattern and distribution of urban habitats in relation to past and present land/water use
Issue 3.1.2 Development of an index for urban soil 'health'
Issue 3.1.3 Biogeochemical survey of urban soils, sediments and waters
Issue 3.1.4 Physical properties of urban soils

Project 3.2 Factors and processes determining the development of urban environments
Issue 3.2.1 Understanding soil processes
Issue 3.2.2 Urban impacts on hydrological processes
Issue 3.2.3 Aquatic ecosystem function
Issue 3.2.4 Terrestrial ecosystem function

Project 3.3 The distribution and dynamics of atmospheric pollution
Issue 3.3.1 Measurement of transport, chemistry and deposition of gases/particles in urban environments
Issue 3.3.2 Reaction chemistry of primary pollutants close to source
Issue 3.3.3 Development of novel sensors for small-scale spatial heterogeneity
Issue 3.3.4 Measurement of direct effects of hydrocarbons on vegetation
Issue 3.3.5 Urban sources/sinks of radioactive pollutants

Project 3.4 Urban water dynamics, risk and hazard
Issue 3.4.1 Low flows and pollution loads
Issue 3.4.2 Floods and pollution flushes
Issue 3.4.3 Surface–groundwater interactions
Issue 3.4.4 Risk and hazard

Project 3.5 Sustainability, restoration and remediation of urban ecosystems
Issue 3.5.1 Collation of information on restoration and remediation requirements
Issue 3.5.2 Ecotypic selection and genetic engineering
Issue 3.5.3 Exploitation of soil processes
Issue 3.5.4 Sustainable water management

Freshwater resources

Project 4.1 Surface–groundwater interactions
Issue 4.1.1 The recharge–runoff division
Issue 4.1.2 The river–aquifer boundary and floodplain issues
Issue 4.1.3 Wetland interactions
Issue 4.1.4 Integrated catchment scale analysis

Project 4.2 Statistical modelling of resource availability
Issue 4.2.1 Estimation of resource availability at ungauged sites
Issue 4.2.2 Drought frequency estimation
Issue 4.2.3 Estimation of drought frequency from non-stationary data

Project 4.3 Water resource modelling capabilities
Issue 4.3.1 Improvement of representation of hydrological systems in catchment models
Issue 4.3.2 Risk analysis techniques
Issue 4.3.3 Integrated decision support facility

Project 4.4 Integrated water quality modelling
Issue 4.4.1 Quantifying point sources
Issue 4.4.2 Catchment models: diffuse sources
Issue 4.4.3 In-stream water quality monitoring
Issue 4.4.4 Whole-catchment modelling
Issue 4.4.5 Modelling uncertainty
Issue 4.4.6 Water quality indicators

Project 4.5 Integrated biotic response modelling
Issue 4.5.1 Flow resistance in channels and river ecosystems health
Issue 4.5.2 Integration of models of water quantity, quality and biotic variability
Issue 4.5.3 Improvement and diversification of biotic models
Issue 4.5.4 Biotic responses to long-term environmental change
Issue 4.5.5 Maintenance of knowledge base

Project 4.6 Fish dynamics
Issue 4.6.1 Fish population dynamics
Issue 4.6.2 Acoustic deflection and counting of migratory smolts
Issue 4.6.3 Determination of habitat requirement

Project 4.7 Physiological performance of freshwater fish
Issue 4.7.1 Physiological performance of freshwater fish

Project 4.8 Fish performance models
Issue 4.8.1 Models of growth and survival
Issue 4.8.2 Models of thermal metabolic performance
Issue 4.8.3 Environmental influences on fish distribution
Issue 4.8.4 Development of new technologies for assessing the growth performance of freshwater fish

Biodiversity and population processes

Project 5.1 Biodiversity characterisation, pattern and monitoring
Issue 5.1.1 Species richness in relation to environmental factors
Issue 5.1.2 Methodologies for biodiversity assessment in Europe
Issue 5.1.3 Microbial diversity in fresh waters
Issue 5.1.4 Biosystematics initiative
Issue 5.1.5 Biodiversity in forests
Issue 5.1.6 Biodiversity in rivers

Project 5.2 Ecosystem function and biodiversity
Issue 5.2.1 Trophic interactions and ecosystem function: insect–plant interactions
Issue 5.2.2 Role of microbial diversity with respect to ecosystem function
Issue 5.2.3 Hydrological functions and wetland biodiversity

Project 5.3 Population processes underlying biodiversity
Issue 5.3.1 Environmental determinants of population processes
Issue 5.3.2 Interactions between demes, local populations and greater populations
Issue 5.3.3 Interactions between populations of different species
Issue 5.3.4 Bacterial population dynamics in terrestrial ecosystems
Issue 5.3.5 Within- and between-species comparative population and community processes

Project 5.4 Conservation and restoration of biodiversity
Issue 5.4.1 Single-species conservation programmes: monitoring and evaluation
Issue 5.4.2 Genetics of introduced species
Issue 5.4.3 Habitat creation and restoration
Issue 5.4.4 Community attributes of restored ecosystems
Issue 5.4.5 Wetland management and restoration

Pest and disease control and risk assessment for GMOs

Project 6.1 The development of sustainable insect pest management strategies
Issue 6.1.1 Population dynamics of pests of exotic plants in the UK
Issue 6.1.2 Use of plant resistance in pest management
Issue 6.1.3 Understanding the role of pathogens in insect population dynamics
Issue 6.1.4 Ecological impact of microbial control agents for disease vectors
Issue 6.1.5 Development of genetically modified bioinsecticides

Project 6.2 Pathogen-derived genes for plant virus/vector management
Issue 6.2.1 Understanding the impact of plant viruses
Issue 6.2.2 Bacterial control of plant pathogens

Project 6.3 Environmental impact of GMOs and potentially invasive species
Issue 6.3.1 Gene flow in natural plant populations
Issue 6.3.2 Environmental impact of genetically modified viruses and introduced pathogens
Issue 6.3.3 Development and risk assessment of genetically modified bacteria

Project 6.4 Understanding and controlling arthropod-transmitted diseases
Issue 6.4.1 Vector–host interactions
Issue 6.4.2 Pathogen–host interactions
Issue 6.4.3 Pathogen–vector interactions
Issue 6.4.4 Pathogen–host–vector interactions

Project 6.5 Distribution of pathogens in freshwater
Issue 6.5.1 Monitoring and risk assessment of pathogens in freshwater
Issue 6.5.2 Development of novel methods for detecting viruses in water
Issue 6.5.3 *Aeromonas salmonicida*: link between disease and life cycle strategy

Pollution

Project 7.1 Radionuclides
Issue 7.1.1 Parameterisation of radionuclide contamination and transfer
Issue 7.1.2 Incorporation of spatial variability
Issue 7.1.3 Extending the range of radionuclides (and applications to heavy metal transfers)
Issue 7.1.4 Improving estimation of radiation doses
Issue 7.1.5 Development of countermeasures
Issue 7.1.6 Collaboration

Project 7.2 Acidifying pollutants
Issue 7.2.1 Emissions
Issue 7.2.2 Atmospheric chemistry and transformations
Issue 7.2.3 Deposition
Issue 7.2.4 Impacts on soil–plant systems
Issue 7.2.5 Surface water and catchment-scale impacts
Issue 7.2.6 Modelling
Issue 7.2.7 Critical loads

Project 7.3 Photochemical oxidants
Issue 7.3.1 Atmospheric transformations and transport
Issue 7.3.2 Emission, deposition and concentration fields
Issue 7.3.3 Impacts on vegetation, materials and human health

Project 7.4 Toxic metals
Issue 7.4.1 Transport and deposition
Issue 7.4.2 Soil processes and soil–plant transfers
Issue 7.4.3 Transfer to animals
Issue 7.4.4 Ecotoxicology and environmental standards

Project 7.5 Organic pollutants
Issue 7.5.1 Monitoring
Issue 7.5.2 Transport and food-chain transfer
Issue 7.5.3 Biological degradation and transformation
Issue 7.5.4 Physico-chemical processes controlling transport in soils and waters
Issue 7.5.5 Catchment-scale processes
Issue 7.5.6 Ecotoxicology and environmental standards

Environmental risks and extreme events

Project 8.1 Risk assessment and estimation of floods and other extreme events
Issue 8.1.1 Mainstream research
Issue 8.1.2 Generic solutions to 'joint probability' problem
Issue 8.1.3 Collective risk for environmental extremes
Issue 8.1.4 Continuous simulation modelling for flood estimation

Project 8.2 Real-time flow and water quality forecasting and decision support systems
Issue 8.2.1 The use of neural networks for flow forecasting
Issue 8.2.2 Development of real time flow forecasting models for arid regions
Issue 8.2.3 Development of improved water quality forecasting models
Issue 8.2.4 Real-time flood forecasting for gauged and ungauged catchments

Project 8.3 Understanding and modelling the role of rare events on ecological systems
Issue 8.3.1 Rare events and ecological processes
Issue 8.3.2 Establishment of long-term monitoring areas to study the impact of extreme events on ecosystems
Issue 8.3.3 The ecological repercussions of floods and droughts

Global change

Project 9.1 Greenhouse gas budgets and cycles
Issue 9.1.1 Global atmospheric CO_2 monitoring
Issue 9.1.2 Controls of net CO_2 and water/energy fluxes in Amazonia
Issue 9.1.3 Net CO_2 fluxes for UK vegetation and soil
Issue 9.1.4 Exchange mechanisms in high-latitude wetlands
Issue 9.1.5 Greenhouse gas emissions for the whole UK
Issue 9.1.6 Atmospheric oxidation processes
Issue 9.1.7 Soil sinks of methane
Issue 9.1.8 Mid-latitude sources of N_2O and NO

Project 9.2 Land–atmosphere–ocean interactions
Issue 9.2.1 Improved hydrological representations within GCMs
Issue 9.2.2 Land surface/climate interaction: tropical deforestation and desertification
Issue 9.2.3 Snow-melt and routing models for northern latitudes
Issue 9.2.4 The use of macroscale hydrological models to validate GCMs
Issue 9.2.5 Dynamic ecosystem modelling
Issue 9.2.6 Fully interactive global ecosystem models

Project 9.3 Forecasting and detecting the impacts of global change
Issue 9.3.1 Regional hydrology and freshwater quality
Issue 9.3.2 Climate impacts on species populations and distributions
Issue 9.3.3 Responses of salt marshes to sea level rise
Issue 9.3.4 Species responses to elevated CO_2 and temperature
Issue 9.3.5 Ecosystem responses to elevated CO_2 concentrations
Issue 9.3.6 Ecosystem responses to elevated UV-B radiation
Issue 9.3.7 Using CEH databases to detect climate change impacts

Integrating generic science

Project 10.1 Environmental assessment, economics and history
Issue 10.1.1 Improved methodology for quantitative prediction of environmental impacts
Issue 10.1.2 New methods for environmental remediation
Issue 10.1.3 Environmental valuation
Issue 10.1.4 The efficacy of habitat maintenance and restoration in the UK farmed countryside
Issue 10.1.5 The development of practical management systems for the sustainable utilisation of renewable environmental resources, particularly in dryland areas
Issue 10.1.6 Historical context of 20th century UK environmental policy-making
Issue 10.1.7 Impacts of historical land use change

Project 10.2 Remote sensing
Issue 10.2.1 Algorithm development
Issue 10.2.2 Ground reference and scaling up
Issue 10.2.3 Data integration
Issue 10.2.4 Sensor development
Issue 10.2.5 Regional scale evaporation

Project 10.3 Instrumentation
Issue 10.3.1 Intelligent sensor clusters

Project 10.4 Biotechnology development
Issue 10.4.1 Virus replication
Issue 10.4.2 Structure/function relationships of viral proteins
Issue 10.4.3 Molecular technology collaboration across CEH

Project 10.5 Analytical chemistry
Issue 10.5.1 Determination of organic pollutants and metabolites
Issue 10.5.2 Organic matter quality and characterisation
Issue 10.5.3 Trace metal distribution and speciation
Issue 10.5.4 Bioavailability of nutrients and pollutants
Issue 10.5.5 Sample matrices
Issue 10.5.6 Field analytical techniques
Issue 10.5.7 Chemical databases
Issue 10.5.8 Stable isotope facility

Project 10.6 Databases and reference collections
Issue 10.6.1 Integrity and accessibility of databases and collections within CEH
Issue 10.6.2 Monitoring environmental change
Issue 10.6.3 Environmental management
Issue 10.6.4 Microbial diversity

Project 10.7 Biometrical applications, research and development
Issue 10.7.1 Biometrical collaboration
Issue 10.7.2 Application and development of biometrical methods
Issue 10.7.3 Statistical training

APPENDIX 4

Membership of CEH Programme Review Groups

Land and water resources

CEH Programmes
1. Soil & soil–vegetation interactions
2. Land use science
3. The urban environment
4. Freshwater resources

Prof H S Wheater (Chair)	*Engineering hydrology*	Imperial College London
Dr A M C Edwards	*Water quality*	Environment Agency, Leeds
Prof K Killham	*Soil microbiology*	University of Aberdeen
Prof R H Marrs	*Land*	University of Liverpool
Dr J Mulder	*Soil-water science*	NISK, Norway
Prof G E Petts	*Land/river interactions, ecology*	University of Birmingham

Biodiversity

CEH Programmes
5. Biodiversity
6. Pests and diseases

Prof C C Payne (Chair)	*Virus biotechnology*	Horticulture Research Inst
Dr V K Brown	*Invertebrates*	Int Inst Entomology, London
Prof C Gliddon	*GMOs*	University of Wales, Bangor
Prof D A Ritchie	*Microbial genetics*	University of Liverpool
Prof M B Usher	*Ecology*	Scottish Natural Heritage
Prof K Vickerman FRS	*Zoology*	University of Glasgow

Pollution, risks and environmental change

CEH Programmes
7. Pollution
8. Environmental risks
9. Global change

Prof R W Battarbee (Chair)	*Limnology, palaelimnology*	University College London
Dr C W Anderson	*Statistics*	University of Sheffield
Prof C Cunnane	*Flood hydrology*	University of Galway
Prof J Grace	*Climate change*	University of Edinburgh
Prof J A Lee	*Pollution*	University of Sheffield
Prof C H Walker	*Ecotoxicology*	University of Reading

Monitoring, data, assessment, valuation

CEH Programme
10. Integrating generic science

Prof J C Rodda (Chair)	*Hydrology*	President of IAHS
Prof T A Burke	*Genetic fingerprinting*	University of Leicester
Prof P J Curran	*Remote sensing*	University of Southampton
Dr R H Haines-Young	*GIS*	University of Nottingham
Mr J Murliss	*Atmospheric pollution*	University College London
Prof C Perring	*Environmental economics*	University of York
Dr P A S Rae	*Environmental planning*	British Gas

APPENDIX 5

University links

In addition to numerous collaborative research projects with sister Institutes in the Natural Environment Research Council, CEH Institutes have a wide range of formal links, collaborative projects and affiliations with Higher Education Institutions.

Formal links with 19 universities, including those through co-location:

Aberdeen	Loughborough	Southampton	Neuchatel
Cambridge	Newcastle-upon-Tyne	Stirling	Sapporo
Edinburgh	Oxford	Wales	Singapore National
Lancaster	Oxford Brookes	Warwick	Western Australia
Liverpool	Reading	York	

Twenty-two members of CEH staff are **Visiting Professors**

T W Ashenden	Newcastle	I Newton	Oxford
M J Bailey	Cardiff	P A Nuttall	Oxford
K R Bull	Nottingham-Trent	A D Pickering	Brunel
M G R Cannell	Edinburgh	R D Possee	Oxford Brookes
J M Elliott	Tromso	P Roy	Oxford
D Fowler	Nottingham	C S Reynolds	Buenos Aires, Reading
J E G Good	Wales	T M Roberts	York
A J Gray	Southampton	J Sheail	Loughborough
M P Harris	Glasgow	J S Wallace	Reading
J Hilton	Reading	N R Webb	Liverpool
M Hornung	Lancaster	W B Wilkinson	Reading

A total of 402 **students** (including sandwich course and CASE students) from both UK and overseas universities benefit from CEH expertise and facilities

Some 398 university **lectures** given by staff during the past year

55 CEH staff acting as **external examiners** on undergraduate and postgraduate courses at UK and overseas universities

Collaborative research with 129 universities through EU, Non-Thematic and Thematic Programmes such as TIGER, LOIS, Environmental Diagnostics, etc, and extensive involvement with university counterparts in the development of new Research Council Thematic Programme proposals.

CEH has close collaboration with universities on **various Commissioned Research** projects. For example,

- IFE collaborates with eight universities
- IH collaborates with five universities
- ITE manages 36 projects in collaboration with 44 universities
- IVEM collaborates closely with nine universities

APPENDIX 6

CEH representation on key external scientific and decision-making committees

	Committee	*CEH Representatives*	
UK	**MAJOR LEARNED SOCIETIES**		
	Botanical Society of the British Isles	Dr C D Preston	
	British Arachnological Society	Mr R G Snazell	
	British Ecological Society	Dr B A Emmett	
	British Ecological Society	Prof A J Gray	Vice President
	British Ecological Society	Dr M O Hill	
	British Ecological Society	Prof I Newton	
	British Ecological Society, Meetings Committee	Dr J A Thomas	
	British Ecological Society		
	- F & GP Committee	Prof A J Gray	Chair
	- Publications Committee	Dr S D Albon	
	- Publications Committee	Prof A J Gray	Chair
	- Strategic Plan Working Group	Prof A J Gray	
	British Hydrological Society	Mr F M Law	President
	British Hydrological Society	Mrs C Kirby	
	British Mycology Society	Dr J C Frankland	President
	British Ornithological Union	Dr A S Dawson	
	British Phycological Society, Flora Committee	Dr E Y Haworth	
	British Phycological Society	Dr S C Maberley	
	Executive Committee of the Tropical Agriculture Assoc	Mr H M Gunston	
	Institute of Fisheries Management (NW)	Dr I J Winfield	
	Remote Sensing Society	Dr B K Wyatt	
	Royal Entomological Society	Dr J A Thomas	
	Royal Entomological Society	Dr A Watt	
	Royal Meteorological Society	Prof D Fowler	Vice President
	Royal Society	Prof I Newton	Fellow
	Royal Society for the Protection of Birds	Prof I Newton	
	Royal Society of Edinburgh	Prof M G R Cannell	
	Royal Society for Tropical Medicine & Hygiene	Prof P A Nuttall	
	Royal Statistical Society	Mrs M A Hurley	
	Society of General Microbiology	Dr E A Gould	
	- Environmental Microbiology Group	Dr M J Bailey	
	- Virology Committee	Dr I M Jones	
UK	**GOVERNMENT DEPARTMENT AND OTHER PUBLIC SECTOR**		
	Advisory Committee for Genetic Modification	Prof T M Roberts	
	Advisory Committee for Hazardous Substances	Prof T M Roberts	
	Advisory Committee on Pesticides	Prof T M Roberts	
	Advisory Committee on Releases to the Environment	Prof A J Gray	
	Advisory Committee on Toxic Substances	Dr S Dobson	
	Biotechnology & Biological Sciences Review Committee	Prof P Roy	
	CS2000, DoE Steering Group	Mr M T Furse	
	Climate Change Review Group	Prof M G R Cannell	
	Critical Loads Advisory Group	Prof T W Ashenden	
	Critical Loads Advisory Group	Prof K R Bull	
	Critical Loads Advisory Group	Prof D Fowler	
	Critical Loads Advisory Group	Ms J R Hall	
	Critical Loads Advisory Group	Dr A Jenkins	

Critical Loads Advisory Group	Prof M Hornung	
Critical Loads Advisory Group - Freshwaters Subgroup	Dr B Reynolds	
Critical Loads Advisory Group - Soils Subgroup	Dr B Reynolds	
Countryside Information System Advisory Committee to DoE	Mr M T Furse	
DETR		
- Biodiversity Action Plan Steering Groups	Dr M Marquiss	
- Biodiversity Information Group	Prof T M Roberts	
- Biodiversity Steering Group	Prof T M Roberts	
- Working Group on Birds of Prey	Prof I Newton	
- Working Group on Endocrine Disruptors	Dr A S Dawson	
DFI/MAFF Horticulture Link Programme Management Committee	Dr J I Cooper	
DfID Environment Research Programme Science Committee	Prof T M Roberts	
DoE Technical Committee on Detergent and the Environment	Dr W A House	
DTI Queens Award Panel 1	Prof J Sheail	
Detection and Assessment of Environmental Contamination SC	Dr A Jenkins	
Food and Agricultural Countermeasures Group	Dr B J Howard	
Foresight DTI/OST Agriculture, Horticulture Forestry Panel	Dr J I Cooper	
HSE ACDP Committee	Dr E A Gould	
HSE Working Group on the Containment of Infected Animals	Dr E A Gould	
Health & Safety Executive Working Group	Dr R F Shore	
Interdepartmental Committee for Hydrology	Mr F M Law	Chair
International Designations Group, JNCC	Mr P T Harding	
JNCC - Steering Group on Red Kite Reintroduction	Prof I Newton	
MAFF Phosphorus Working Group	Dr W A House	
MAFF/HSE Advisory Committee on Pesticides	Dr S Dobson	
Radioactivity Research and Environment Monitoring Committee	Dr B J Howard	
Water Quality and Water Resources Indicators Working Group	Mr T J Marsh	
UK Mirror Task Force - Environment Water	Prof A D Pickering	
UK Round Table on Sustainable Development (Water Subgroup)	Prof W B Wilkinson	

UK

Other

AGI Environmental Interest Special Group	Mr N J Brown	Chair
BSI Biological Methods Committee	Dr P D Armitage	
British Consultants Bureau - Water Engineering Committee	Mr F A K Farquharson	
British Trust for Ornithology		
- Estuaries Advisory Panel	Dr J D Goss-Custard	
- Population & Surveys Committee	Prof I Newton	
- Population Monitoring Advisory Panel	Dr J D Goss-Custard	
- Ringing Committee	Dr S Wanless	
- Science Advisory Committee	Dr L G Firbank	
- Unconventional Marking Panel	Prof M P Harris	
Butterfly Conservation Society	Dr J A Thomas	Vice President
CIWEM Expert Panel on Water Resources	Mr I G Littlewood	
Conservation Research Committee, Institute of Zoology	Dr J D Goss-Custard	
EA Toxic Algal Task Group	Dr C S Reynolds	
Executive Committee, Linking Environment & Farming	Dr L G Firbank	
Joint Committee for Conservation of British Invertebrates	Mr P T Harding	
Joint Committee for Conservation of Large Blue	Dr J A Thomas	
Land Use Research Co-ordination Committee	Dr L G Firbank	
Monitoring Committee, Shetland Oil Terminal Environmental Assessment Group	Prof M P Harris	
National Biodiversity Network	Prof T M Roberts	
OFWAT CSC (North West) Advisory Board to the Identification Qualification (IdQ) for Macroinvertebrates	Dr J F Wright	
Photochemical Oxidents Review Group	Prof D Fowler	Chair
Scientific Advisory Committee, Joint Raptor Project	Prof I Newton	Chair
Steering Committee, Centre for the Study of Environmental Change and Sustainability	Prof M G R Cannell	
Terrestrial and Freshwater Science and Technology Board	Prof W B Wilkinson	
UK Acid Waters Monitoring Network	Mr W R C Beaumont	
UK Forum for Culture Collection	Dr J G Day	
UK National Committee for Biodiversity	Mr P T Harding	
UK Plant Genetic Resources Group	Prof A J Gray	

APPENDICES

EUROPEAN

EurAqua	Prof W B Wilkinson	UK leader
BIOTEX Subcommittee of Eurotrac	Prof D Fowler	Chair
Board of the European Forest Institute	Prof M G R Cannell	
Convention on Long Range Transboundary Air Pollution (CLRTAP)		
- Executive Body Bureau	Prof K R Bull	
- Task Force on Mapping	Ms J R Hall	
- Working Group on Effects	Prof K R Bull	Chair
Council of Europe - Group of Experts on the Conservation of Invertebrates (Berne Convention)	Mr P T Harding	
EC DG XII (Environment Space) Thematic Co-operation Group on Space Techniques in the Context of Major Hazards	Mr D S Biggin	
EC Working Group on Ozone Strategy	Prof K R Bull	
EEC Biostructure Groups	Dr I M Jones	
EIFAC Working Party on the Influence of Management Practices on the Environment	Dr I J Winfield	
EurAqua	Prof W B Wilkinson	UK Leader
European Committee of Chimeric Virus-like Particles	Prof P Roy	
European Conservation Research Institute Network (CONNECT)	Prof T M Roberts	
European Geophysical Society - Natural Hazards Section	Mr R J Moore	
European Heathland Network	Prof N Webb	Convenor
European Invertebrate Survey	Mr P T Harding	
European Representative Basins Network	Mr I G Littlewood	
European Topic Centre on Land Cover	Mr R M Fuller	
European Topic Centre for Nature Conservation	Dr D Moss	
Seabird Group	Dr S Wanless	Chair
UNESCO International Hydrological Programme FRIEND - N Europe	Dr A Gustard	

INTERNATIONAL

Baikel International Centre for Ecological Research	Dr I J Winfield	
IAHS Comptroller	Mr I G Littlewood	
IAHS International Commission for Surface Water	Dr A Gustard	Vice President
IAHS Programme Committee for IUGG 1999 Conference	Prof W B Wilkinson	
IAWQ UK National Committee	Prof J S Wallace	
ICID Sustainable Use of Natural Resources for Crop Production Working Group	Dr R Ragab	Chair
IDNDR Co-ordinating Committee	Prof J S Wallace	
IDNDR Working Group on Drought Mitigation	Dr L S Anderson	
IGBP, BAHC Committee	Dr J H C Gash	
IGBP, GCTE Focus 3 Committee	Dr J I Ingram	
IGBP-DIS Global Land Cover Working Group	Dr B K Wyatt	
IUCN/SSC Freshwater Fish Specialist Group	Dr I J Winfield	
IUCN/SSC Invasive Species Specialist Group	Dr I J Winfield	
IUCN Introductions Committee	Dr J A Thomas	
IUCN Invertebrate Conservation Task Force	Dr G W Elmes	
IUCN Social Insect Conservation Specialist Group	Dr G W Elmes	
IUCN Wetlands Programme Advisory Committee	Dr M C Acreman	
Intergovernmental Panel on Climate Change	Prof M G R Cannell	
International Association on Water Quallity	Dr A Jenkins	
International Committee on Atmosphere-Soil-Vegetation Relations	Prof J S Wallace	Vice President
International Committee of 100 for the International Ornithological Congress	Prof I Newton	
International Committee for the Taxonomy of Virus	Prof P A Nuttall	
International Scientific Programme, Water Resources and Environment Reseach: Towards the 21st Century, Japan	Mr R J Moore	
International Society for Avian Endocrinology - Scientific Committee	Dr A S Dawson	
International Wildfowl Research Bureau - Waterfowl Ecology Working Group	Dr J D Goss-Custard	Co-ordinator
International Union of Forestry Research Organisations	Prof M G R Cannell	
OECD Working Group on Avian Toxicity Testing	Dr S Dobson	
Programme Committee, Peregrine Fund, North America	Prof I Newton	Chair
Raptor Research Foundation	Dr R E Kenward	
SCOPE Committee on soil and sediment biodiversity and ecosystem functioning	Dr B J Finlay	

Society for Invertebrate Pathology	Dr J S Cory	Trustee
Technical Advisory and Support Group. SCALE aquaculture development programme Cambodia	Mr G D Collett	Chair
UNESCO MAB UK Committee	Prof T M Roberts	Chair
UNESCO International Hydrological Programme - UK Committee	Mr F M Law	Chair
UNESCO International Hydrological Programme Project 1, FRIEND	Dr A Gustard	Chair
UNESCO Natural and Social Sciences Commission	Prof W B Wilkinson	UK Leader
WHO/FAO Joint Meeting on Pesticides - Core Assessment Group	Dr S Dobson	Chair
WHO Review Board for Concise International Chemical Assessment Documents	Dr S Dobson	
WMO Commission for Hydrology	Prof W B Wilkinson	UK Leader
WMO Commission for Hydrology	Mr F M Law	
WMO GEWEX Canadian Advisory Panel	Prof W B Wilkinson	

APPENDIX 7

Industrial and commercial links

CEH has a wide range of links and contacts with organisations in the industrial and commercial sectors.

Jointly funded projects with:

ADAS
Biotrack
British Steel
Butterfly Conservation
Chapman & Hall Ltd
Danish Fisheries Research Institute
East of Scotland Water
Edinburgh Instruments
Fisheries Research Scotland
Foundation for Water Research
Game Conservancy
HR Wallingford
Hoechst
Laserscan
Levington Horticulture Ltd
Macaulay Research & Consultancy Services
National Power plc
Natural Resources Institute
North West Water plc
Ordnance Survey
Oxford Biomedica
Oxley Developments Co
RSPB
Shell UK
SIMRAD Inc
Soil Survey
UK Water Industry Research
Zeneca Ltd

Work subcontracted by CEH Institutes to/from industry/commerce includes:

IFE contracts with:

AEA Technology
Applied Photosynthetics
BNFL
Ecosurveys Ltd
ENSIS
Fish Farm Developments
Fish Guidance Systems Ltd
Foundation for Water Research
Gibb
Hazleton
Laboratoria Regional de Engharia Civil, Madeira
National Power plc
North West Water plc
NRA/Chemical Indus Assoc/Unilever/Proctor G
Sutton & E Surrey Water plc
Terence O'Rouke plc
Thames Water Utilities
UNDP
Westlakes Research Institute
Wildfowl & Wetlands Trust
Yorkshire Water plc

IH have 27 private sector contracts including:

ARC
Binnie, Black & Veatch
Dulas Engineering
ENSIS
ERASM
JKWIR
Mott Macdonald
National Power plc
South West Water plc
Unilever
Water Training International
Yorkshire Water plc

ITE contracts with:

ADAS
Archaeological Operations & Conservation
BioSS
Building Research Establishment
Ecological Surveys (Bangor)
Entec UK Ltd
ERM, London
ICI
Laserscan
Logica
Mason Brothers
Mott McDonald
National Power plc
North West Water plc
Ordnance Survey
Pieda plc
RPS Clouston
Sir William Halcrow
Water Resources plc
Williams Shipping
Wilmott Pertwee Crop Protection

IVEM contracts with:

BP-ICI
Edinburgh Instruments
Glaxo
Oxford University
Pfizer Ltd
Vacs of Life plc
Zeneca Ltd

Licence agreements for manufacture or for use of patents – approaching 350 overall.

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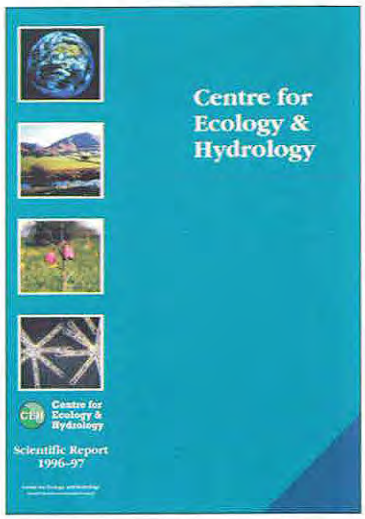
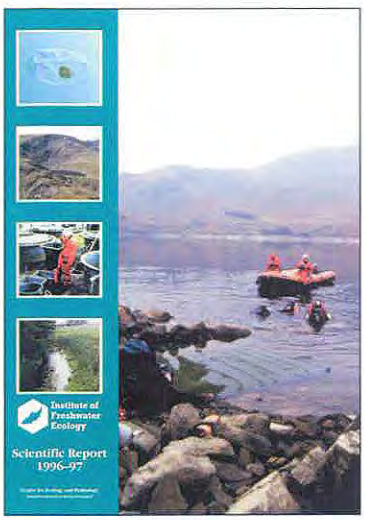


Centre for Ecology & Hydrology

http://www.nmw.ac.uk/ceh

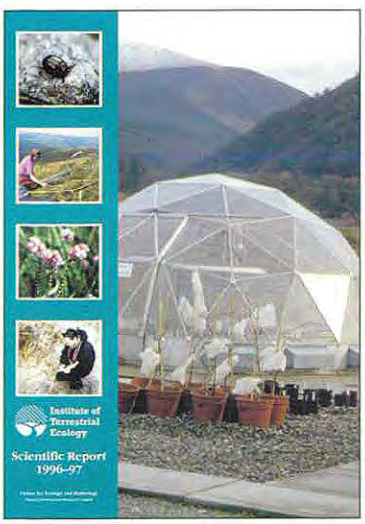


Institute of Freshwater Ecology

http://www.ife.ac.uk/

Institute of Hydrology

http://www.nwl.ac.uk/ih



Institute of Terrestrial Ecology

http://www.nmw.ac.uk/ite

Institute of Virology and Environmental Microbiology

http://www.nox.ac.uk/

Centre for Ecology & Hydrology

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