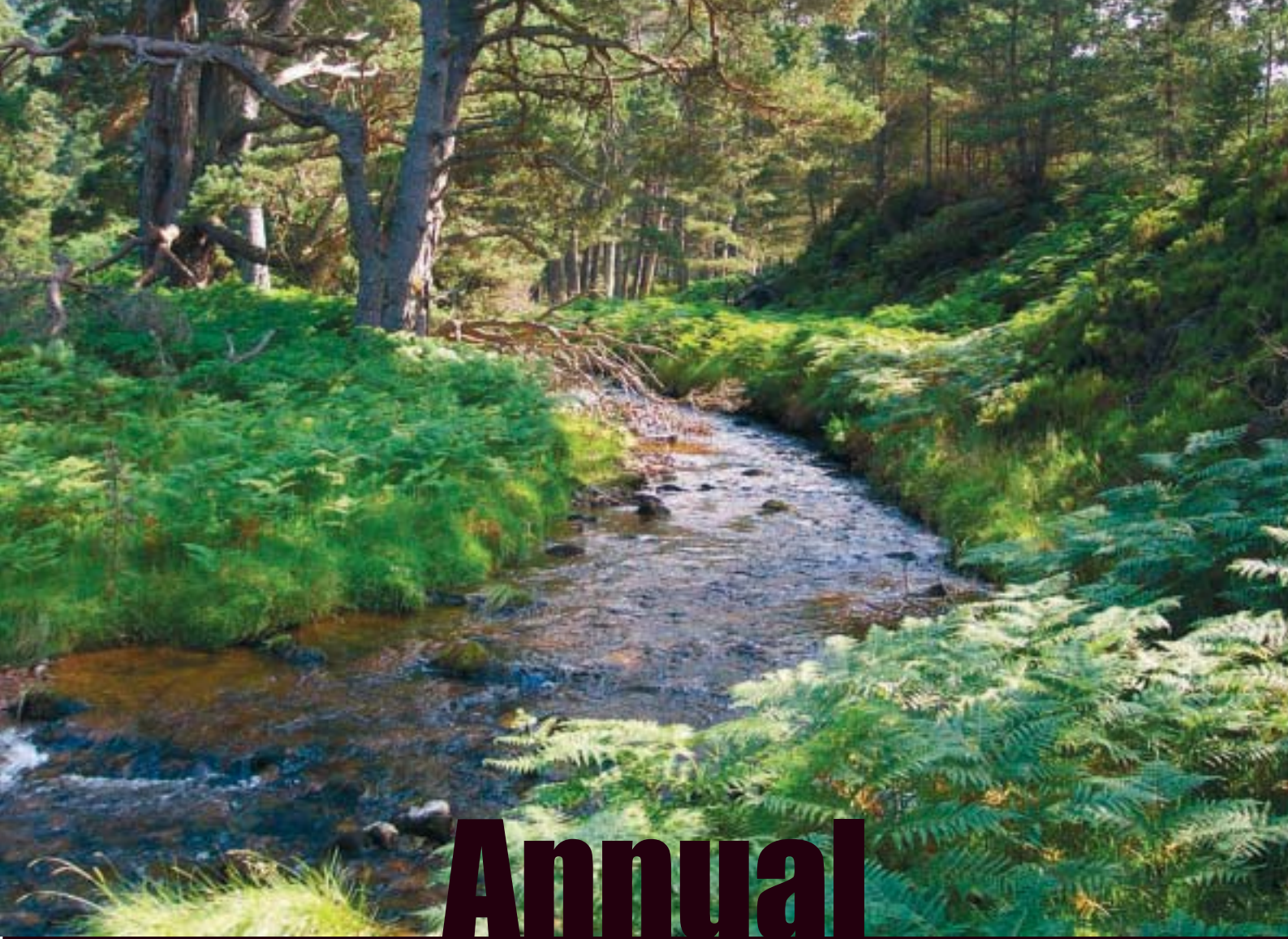




Annual Report

2001 - 2002



Centre for
Ecology & Hydrology

NATURAL ENVIRONMENT RESEARCH COUNCIL

CEH Advisory Committee Members

Lord Cranbrook, MA, PhD	Chairman of ENTRUST, the Regulator of Environmental Bodies under the Landfill Tax Regulations
Dr Alan Apling	Head of Science and Technical Policy Division, Department of Transport, Local Government and the Regions
Professor David Cope	Director, Parliamentary Office of Science & Technology
Mr David Jones	Department for Environment, Food & Rural Affairs
Dr Norman Lowe	Centre for Research in Environment and Health, University of Wales, Aberystwyth
Dr Mike Tricker	Director, Partnership and Innovation Directorate, NERC
Dr John Holmes	Head of Research and Development, Environment Agency
Dr Camilla Toulmin	Director, Drylands, International Institute for Environment and Development
Prof Chris Arme	Department of Biological Sciences, University of Keele (part year)
Mr Andrew Bennet	Chief Natural Resources Advisor, Department for International Development
Dr Eileen Buttle	European Environment Agency (part year)
Prof Chris Payne, OBE	Department of Horticulture and Landscape, University of Reading (part year)
Dr Andrew Rushworth	Head, Agricultural and Biological Research Group, Scottish Executive Environment and Rural Affairs Department (part year)
Professor Pat Nuttall, OBE	Director, CEH
Professor Jim Wallace	Deputy Director, CEH
Dr Jackie Hinton	Science Policy Co-ordinator, CEH (Secretary)

CEH'S Mission:

- *To advance knowledge in ecology, environmental microbiology, hydrology and virology through high quality, interdisciplinary research in support of the NERC Mission and international programmes.*
- *To describe and understand the dynamics of terrestrial and freshwater ecosystems through integrated monitoring, experimentation and modelling.*
- *To direct research towards predicting human impacts on the environment and generating potential solutions to improve quality of life.*
- *To enhance the UK's industrial competitiveness through technology transfer.*
- *To exploit the Centre's expertise and facilities to enhance research training in the UK and capacity building overseas.*
- *To secure and manage environmental data and provide access to academia, governments, industry and the public.*
- *To promote public awareness and understanding through communication of the Centre's research.*

Annual Report of the CEH Advisory Committee

I am pleased to present the fourth annual report of the CEH Advisory Committee. The Committee was formed in 1998, with a membership drawn from the academic and user community served by CEH. The principal responsibility of the Committee is to provide strategic guidance to the Director on the science direction and management of CEH. Specifically, the Committee was asked to: advise on the implementation of science and management strategy; help prioritise activities for CEH; monitor progress, and review and evaluate the science programmes. Members are listed opposite. In 2001, the Committee met three times, in May, October and November — twice in London and once at CEH Windermere.



The Advisory Committee was pleased to meet Professor Pat Nuttall, the incoming Director, at an early stage in her appointment. An immediate challenge was to come to terms with a shrinking income from NERC. At the same time significant changes were afoot in the government departments and agencies that are major stakeholders in CEH. Restructuring and rationalisation is essential to place CEH on a firm financial footing and enable them to address the scientific challenges ahead. The Committee discussed the Director's plans for the future of CEH, and provided advice on the development of a new science strategy, which must underpin forthcoming changes.

CEH has the capacity, unique in the UK, to carry out integrated and multi-disciplinary studies across terrestrial and freshwater ecosystems, to address international, national and regional issues. The major drivers of the environmental science agenda in the next 5-10 years, for example the EU Water Framework Directive, the Kyoto Protocol and the Johannesburg World Summit on Sustainable Development, require just such an interdisciplinary approach. Sustainability is key to the emerging CEH science strategy. The Advisory Committee will continue to provide guidance in the light of these priorities, particularly as they affect the science programmes of government departments, agencies and other research organisations. In addition, the Committee recognises that CEH will need to develop strong collaborative partnerships with the socio-economic research community, to deliver holistic solutions.

Throughout a difficult period of change, the staff of CEH have continued to perform excellent scientific research. To ensure the relevance of this research, the Committee has advised on a draft marketing strategy to ensure efficient and focussed communication between CEH and its major stakeholders. We applaud the creation of such a strategy and look forward to seeing the effects of its implementation.

As indicated in the membership list, several colleagues came to the end of their terms during the year. I take this opportunity to thank them, on behalf of CEH, for the time, effort and support they have given during their membership of the Advisory Committee.

On behalf of the Committee, I wish CEH well for the coming year. The Committee will continue to support the Director and all staff, as they build a strong future together.

Cranbrook
Chairman
July 2002



LETTER FROM CEH DIRECTOR

The year covered by this report, 2001-2002, is my first full year as Director of the Centre for Ecology and Hydrology (CEH). I knew that this was going to be a demanding job, but it has turned out to be more challenging than I thought possible. However, the bigger the challenge the greater the feeling of satisfaction when real progress is made! I am delighted to report that there have been several milestones through the period, culminating very recently in the decision by NERC Council to invest in CEH's future. In this brief introduction I should like to review our progress during the year.



Improved corporate relations

Our parent body, the Natural Environment Research Council (NERC), has recognised the need for more joined-up working and thinking between the central office at Swindon, and the research centres and collaborative centres of the NERC. This was a recommendation of the Randall Report, which proposed improvements to the way that NERC and its associated bodies operate. As a result, the NERC Executive Board (NEB) has been established, of which I am a member. Establishing NEB has far reaching implications, particularly in corporate working, and already there is more collective responsibility for delivering NERC's mission.

A new science strategy

An essential step in developing the vision for CEH is the production of a new science strategy. This has been a major focus during the reporting year, and is now almost complete. The strategy, entitled *Health and Wealth of the Environment*, is built around sustainability. It recognizes the often conflicting demands of creating a healthy and wealth-creating environment. Key issues are: a) understanding the processes governing Earth's life support systems (water, biogeochemical cycles and biodiversity), and b) scientific underpinning for tackling global change and delivering sustainable economies. Our science strategy seeks to make a strong contribution to the NERC's new strategy, *Science for a Sustainable Future*, and meet the needs of all our stakeholders.

Building CEH Lancaster

Building and refurbishment on the campus of Lancaster University is progressing rapidly. The original plan was to relocate CEH Merlewood to this new, purpose built site, and strengthen CEH's contribution to the Lancaster Environment Centre (LEC). More recently, NERC Council has given the go-ahead to expand this initiative to incorporate CEH Windermere. This will require some further refurbishment and new build. For CEH, there is a compelling case for bringing together the freshwater and terrestrial ecology of CEH Windermere and Merlewood to create CEH Lancaster. The University is making a similar investment. As a result, the LEC will be the largest grouping of its kind in Europe.



An artist's impression of the new building for CEH at Lancaster

Bringing CEH together

Whilst CEH's new science strategy was being developed, it became clear that we needed more opportunities for bringing together scientists and technologists across CEH. One response to this need was to hold our first CEH Conference. The theme of the Conference was *Environmental Conflict: Science for Solutions*. Nick Hanley, Professor of Economics at Glasgow University, kicked off with a talk on why environmental scientists need economists. This was followed by some 20 talks from across CEH illustrating how (often in partnership with universities) we are addressing and providing solutions to environmental conflicts. The conference was such a success that we plan to make this an annual event. A booklet reporting highlights of the meeting will be published shortly.

Links across Europe

The European Union's new Framework Six Programme offers many exciting opportunities for collaborative research. In order to make the most of these opportunities, six of the largest environmental research centres in Europe, including CEH, have founded the Partnership for European Environmental Research (PEER). The aim of the PEER partnership is to combine the strengths of the six organisations' scientific expertise, to tackle cutting-edge research in the areas of environmental science and ecological sustainability right across Europe.

New Director for CEH Oxford

Following open competition, Professor Mark Bailey has been appointed the new Director of CEH Oxford. Mark has already built an international reputation for his work in molecular microbial ecology at CEH Oxford. He is now applying his considerable skills in research and leadership to building a strong future for Oxford's scientists. We are grateful to Dr Ernie Gould for standing in as acting Director in the preceding period.

Staff successes

There have been many notable staff achievements during the year. These include the election of Professor David Fowler (CEH Edinburgh) as a Fellow of The Royal Society, the award of Individual Merit Promotions to Brenda Howard (CEH Merlewood for her work in radio- ecology, and to Mark Bailey (CEH Oxford). Paul Harding (CEH Monks Wood) received an MBE for his significant contribution to biological recording. Robin Fuller, Geoff Smith and their team (CEH Monks Wood) completed Land Cover Map 2000, which was launched in London by DEFRA's Minister, Lord Whitty, in November 2001. A more general reflection of staff successes in delivering the highest quality science was in the allocation to CEH of fourteen NERC studentships. The algorithm on which this allocation was based showed that CEH is second only to Cambridge University in the number of NERC grants currently held.



*Land Cover Map 2000 was launched by
DEFRA Minister, Lord Whitty*

CEH Annual Report 2001/2002

In the following pages we have chosen examples of CEH's science that illustrate how we contribute to key areas identified in the Randall Report. These cover the delivery of excellent scientific research, monitoring and survey; the provision of integrated, well managed national capabilities; international co-operation; technology expensive projects; and participation in major programmes solving complex scientific problems. We also provide examples of how our science has been put to work in real world applications, and how we interact with the public. I hope you enjoy reading this year's report and welcome your comments.

Professor Pat Nuttall, OBE
Director CEH



CEH is the UK's Centre of Excellence in the terrestrial and freshwater environmental sciences.



CEH manages and groups its science within a framework of Science Programmes. We present examples of our research illustrating all nine of these programmes:

Soils and Soil-Vegetation Interactions

Helping microbes to decontaminate soils

Ian Thompson, CEH Oxford, email ipt@ceh.ac.uk

The distribution of organic contaminants in the soil tends to be patchy, and currently there are no reliable methods for modifying the distribution of these contaminants through soils. Consequently, some sites have such high concentrations of contaminants that the microbes that could break them down are inhibited. Other sites have concentrations so low that microbial activity cannot take place. The distribution and movement of the microbial soil communities is critical to the breakdown of the contaminants. We have found that by applying electrokinesis (electrical stimulation producing movement), a more even distribution of pollutants in soil can be achieved, and at present electrokinesis is the only means of achieving this effect. The treatment is also effective at stimulating rates of contaminant degradation. Our experiments, using soils contaminated with pentachlorophenol and given electrokinetic treatment, showed a 15% increase in the rate of degradation, as compared against a control sample. These studies are still at an early stage, but we are confident that we can increase the magnitude of the effect.



The bioavailability of radionuclides

Arthur Sanchez, CEH Merlewood

As part of the EU funded BORIS project (Bioavailability of radionuclides in soils), we are developing experimental approaches to investigate the role of micro-organisms in determining the bioavailability of important radionuclides. Traditional methods are inappropriate for investigating the effects of soil micro-organisms, so we are developing new experimental approaches, using radioanalytical and microbiological techniques. Currently, our results show that soil bacteria and fungi can substantially increase the sorption of ^{137}Cs and ^{89}Sr (caesium and strontium isotopes) onto soil solids. This may be due to a number of factors, including: a) radionuclide uptake via either adsorption (sticking to) or absorption (eaten by) soil microorganisms, and b) microbes causing changes in soil water which in turn affect radionuclide interaction with soil solids. The information we gain will contribute to the development of improved assessment models.



Soil organisms and the 'Climate-Carbon' phenomenon

Nick Ostle, CEH Merlewood, email no@ceh.ac.uk

Soil functional ecology has been something of a 'black box' until now, but use of $^{13}\text{CO}_2$ (carbon dioxide isotope) pulse-chase tracer techniques has enabled us to investigate carbon flow phenomena in the rhizosphere, the area of soil immediately surrounding and influenced by plant roots. Our experiments are aimed at defining the importance of soil animals and micro-organisms in the binding of atmospheric carbon dioxide, and its rate of release by soils. Our findings show that 70% of recent plant carbon is returned to the atmosphere as carbon dioxide within 72 hours of its assimilation. Breakthroughs in isotope science have enabled us to determine the incorporation rate of photosynthate ^{13}C (carbon isotope) into microbial molecular markers such as phospho-lipid fatty acids (PLFAs), and ribonucleic acid (RNA) obtained from field experiments. Results from these unique *in vivo* tracer projects identify gram negative bacteria as being intimately linked with carbon flow in the rhizosphere, and that there is a complete turnover of microbial RNA every 10 days. The results are preliminary but groundbreaking, and will permit a clear assessment of the role played by microbial communities in carbon cycling within soil ecosystems.





Fungal partners, forest fires and tree seedlings

Philip Mason, CEH Edinburgh, email pam@ceh.ac.uk

Mycorrhizal fungi (soil fungi living in an close advantageous relationships with plant roots) are known to be essential for the regeneration of many tree seedlings. The fungi are normally very common in forest soils, but when forest fires occur, these fungi are killed outright or suppressed. After the fire, their distribution is very patchy, and they may only occur well below the normal surface soil layers. Our study, in Greece, investigated the impact of this loss of fungal 'partners' on the regeneration rate of tree seedlings. We found that other fungi appear to benefit from the action of fire and reduced competition, becoming more widespread and abundant especially in the top few centimetres of soil. Tree seedlings formed mutually beneficial partnerships with these post-fire fungal colonisers, and were able to obtain the nutrients they needed, despite the diminished presence of their normal fungal partners. These findings will be helpful to forest managers trying to re-establish tree growth on fire-scarred areas.



Evaluating the environmental effects of GM crops

Les Firbank, CEH Merlewood, email lgf@ceh.ac.uk

CEH is undertaking the evaluations on herbicide-tolerant GM crops at farm scale, over a three-year period, and will be due to report to the UK Government in 2003. The second full season of the project in 2001, saw monitoring of 21 winter oil seed rape sites, 26 beet sites, 30 spring oilseed rape sites and 22 maize sites, a substantial increase over the first year. The outbreak of the Foot and Mouth epidemic required us to put in place stringent hygiene precautions and to work closely with farmers, police and Government vets., but all planned fieldwork was completed. This second year of the trials has seen advances in the data management of the project, and automated analyses. The project has been commended by the Organisation for Economic Co-operation and Development (OECD) for the quality of the science underlying the project, for the very high ecological and ethical standards being used and for addressing such issues as credibility, regional cultivation practices and farmer behaviour issues.



What factors affect Scots Pine regeneration?

Dave Scott, CEH Banchory, email dscot@ceh.ac.uk

Previously, the major factor affecting the regeneration of Scots Pine has been thought to be the density of red deer populations. We have been monitoring pine regeneration at a site in NE Scotland where red deer have been maintained at a low density of 3-4 per sq. km for several years. Our study shows that, although a reduction in red deer numbers was weakly related to an increase in the numbers of tree saplings surviving, other factors were involved too. These are a) proximity to a seed source, b) the height and type of the ground vegetation, and c) the amount of bare ground. Even with a low deer density of 3-4 per sq. km, saplings grow very slowly. It may take 20-25 years for the saplings to reach a height of 1.5-2 metres, when they are safe from deer grazing damage. Our findings reveal that land managers need to take into account these additional factors affecting tree survival, as well as deer population density.

Urban Environments

Green Corridors - an urban myth?

Mark Hill, CEH Monks Wood, email moh@ceh.ac.uk

Green corridors are an accepted part of urban planning and conservation, supposedly to enhance biodiversity values, and to allow the movement of plant and animal species. Our study, in collaboration with two universities, investigated the significance of the connectivity of habitats. While the corridors often provide useful habitat, especially on river corridors and railway land, we found no evidence that plant and wetland specialist beetle diversity is greater on or near the green corridors, and no evidence that corridors are necessary for dispersal of either plants or butterflies. These organisms do not respect connectivity, and for the invertebrates, habitat *quality* appears to be the significant factor. We conclude that green corridors make little difference to the diversity of plants and beetles found in our towns and cities. If corridors are used in city plans, we recommend that they should be treated either as habitat in their own right or as routes for people.



Fine sediment dynamics in urban systems

Graham Leeks CEH Wallingford, email gill@ceh.ac.uk

Better knowledge of the dynamics and transport of sediments in urban river networks is very important for improving river system management. CEH researchers, working with three other partners, led a study to investigate events in the Bradford catchment area.

Most previous studies of urban rivers have been for only short periods, but our three-year study permitted an investigation of suspended sediment transport on both an annual timescale and for short-lived, high flow events. Using electronic monitoring systems specifically designed and refined for use in urban rivers, we monitored changes in pH levels, electrical conductivity and water temperature. This data can be used to identify the occurrence and influence of sewer outfalls, which are significant contributors to the sediment load of many rivers. We also monitored the dynamics of sediment flux during short term events, where within only 15 minutes, water discharges can rise from less than 1 cubic metre/second up to over 30 cu. metres /second. The study was designed specifically to contribute to the design and assessment of Urban Pollution Management surveys, a major area of expenditure by Government and the Water industry to assist in meeting water environment standards.



Urban aliens: menace or miracle?

Phil Hulme, CEH Banchory, email pehu@ceh.ac.uk

There is increasing concern over the spread of non-native plant species in the British Isles, and the possible consequences for our native biodiversity. Household density is a key driver of non-native species richness in the British Isles, and increasing urbanisation introduces and accelerates the spread of non-native or alien species, which now make up a significant proportion of the urban flora. We explored the interaction between urbanisation and non-native species at both the national scale and within the West Midlands Conurbation. We found that in the Conurbation there were specific associations between native and alien species richness, in a wide range of habitats. Whilst alien species certainly contribute to species-poor urban wastelands, they also threaten the few hotspots of native biodiversity within cities. Our investigations have emphasised the need for planned strategic management of problem species rather than piecemeal local targeting.





Accessing underwater sources of carbon

Stephen Maberly, CEH Windermere, email scm@ceh.ac.uk

Freshwater plants evolved from terrestrial plants about 65 million years ago. While they were freed from water supply problems, their photosynthesis was potentially limited by carbon supply because carbon dioxide diffuses about 10,000 times more slowly in water than in air. Rapid photosynthesis can also remove carbon dioxide from the water faster than it can be replaced. This has

led freshwater plants to evolve a number of strategies, including carbon-fixation pathways more normally associated with terrestrial desert plants. Another strategy is the ability actively to take up bicarbonate ions as an alternative source of inorganic carbon.

We have shown this ability to be present in about half the species tested, and to show evolutionary and ecological patterns. For example, we showed that while the starwort *Callitriche hermaphroditica* can use bicarbonate, other members of the genus cannot. This appears to be linked to evolutionary history and environment since *C. hermaphroditica* belongs to a section of the genus that is closely adapted to living in water whereas previously tested species from another section tended to be amphibious. Physiological features, such as bicarbonate use, can control species distributions and so this type of information is important for understanding and predicting ecological patterns. *Photo by late Prof. D. H. N. Spence.*



Water quality functioning and the River Kennet

Colin Neal, CEH Wallingford, email cn@ceh.ac.uk

Lowland river catchments in the UK have two major functions, as water resources for human populations and agricultural use, and for amenity use for extensive urban areas. The nutrient functioning of a watercourse is of major environmental importance for all users. Over the past four years, CEH's work on the River Kennet has yielded significant advances in understanding,

especially with regard to the effects of phosphorus removal from sewage effluent and its effect on stream water quality and biology. Removing the phosphorous before effluent enters lowland streams is a practical management option for controlling the nutrient impacts that cause excessive algal growth (eutrophication).



How can we define the ecological status of lakes?

Laurence Carvalho, CEH Edinburgh, email laca@ceh.ac.uk

The new EC Water Framework Directive requires member states to achieve 'good ecological status' in all surface waters by the year 2015. However, the methods for deciding how to assess this status have not yet been agreed. CEH Edinburgh is investigating possible approaches, which will represent the environmental, societal and economic dimensions of sustainable

development. CEH's long-term datasets have been invaluable for this work, providing realistic reference conditions and defining the boundaries between high, good and moderate ecological status.

Status levels have been highlighted in a long-term study on Loch Leven. Data on nutrient chemistry and alkalinity, and communities of phytoplankton, macrophytes (large aquatic plants), invertebrates and fishes were used to compare different time periods with relatively undisturbed reference conditions, using an ecological quality ratio. We found that ecological status, relatively high prior to 1830, had already begun to decline by 1910. This was due to the combined effects of eutrophication - high nutrient levels causing excessive algal growth - and an altered hydrological regime. We found a further clear decline since the early 1970s due to continuing eutrophication. On a brighter note, more recent data (1996-2000) show an improvement in ecological status. This is probably a response to the significant reduction in nutrient load from catchment sources that occurred during the late 1980s.

Biodiversity and Population Processes

How many sand-eels do seabirds take?

Francis Daunt, CEH Banchory, email frada@ceh.ac.uk

The industrial sand-eel fishery is the largest single species fishery in the North Sea, but sand-eels are also a major prey of seabirds. We need to understand the interactions between hydrography, predators and prey, so that we know more about the ecosystem dynamics in which the fishery is operating.

We equipped diving seabirds with miniature devices that, for the first time, can accurately record the temperature and depth profiles where they are feeding. The birds were also equipped with loggers that measured the rate of their prey capture. These techniques have removed the need for expensive ship-board sampling. The data we obtained have enabled us to build a three-dimensional description of the marine environment where the seabirds are operating, and to estimate for the first time the profitability of different hydrographic conditions to predators. Parallel research shows that sand-eels are strongly associated with particular temperature gradients. The knowledge we have obtained will allow us to give fishery managers high quality advice on the impact of the fishery on top predators.



Genetic diversity can be eroded by logging

Andrew Lowe, CEH Edinburgh, email alowe@ceh.ac.uk

Mahogany, *Swietenia macrophylla* King, is the most economically important global timber species of the American tropics and has been extensively logged across its natural range. Working in Costa Rica, we examined the diversity in three tree populations, using DNA tests. Our results indicated a significantly clumped distribution - trees growing close together were genetically more similar than those further apart. The average size of the clumps was less than 100 m, which corresponds to the upper limit of recorded seed dispersal distance for the species. Our survey of the seedlings from individual trees also indicated that long distance pollination was rare, most pollination involving neighbouring trees. Therefore, if diversity is removed from a mahogany population by logging, it will be very difficult for the trees to recover it by their normal gene flow mechanisms. Additional planting will be required to restore genetic variation and protect the species.



Mimicking the chemicals of ants

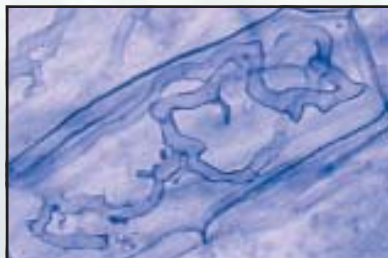
Jeremy Thomas, CEH Dorset, email jat@ceh.ac.uk

Insects that in some way depend on ants are known as myrmecophiles, and represent a species-rich group (globally over 20,000 species) which can have strong effects on ant population biology. We have studied the chemical ecology of *Microdon* hoverflies and their impact on their host ant populations, and also the biology and evolution of the extreme host-specificity shown in this relationship. The hoverflies are dependent on the ant grubs as a source of food and spend two years in the ant nest, but only four days on the wing. This year we have identified a cryptic species of *Microdon*, new to science, and we have identified and synthesized two compounds found on the surface of the eggs. The presence of the compounds induces the ants to accept the hoverfly eggs as familiar, and not attack them. The compounds are thought to be responsible for the extreme host specificity shown by this species, and are manufactured in the female *Microdon*'s oviduct glands. We have also developed ten genetic markers in order to study the population structure of the host ants.

Our findings will be valuable in the conservation of such locally-evolved species, and for predicting where cryptic species may be prevalent.



Biocontrol and Biotechnology Research



A new way to fight fungal disease

Ian Cooper, CEH Oxford, email jic@ceh.ac.uk

Baculoviruses (viruses that kill insects) have many genes, and one such gene can make an enzyme that dissolves chitin, called chitinase. Chitin is a structural component in some fungi, and also occurs in insects. We transferred DNA from the insect virus into tobacco plants (a model system which provides speedy results), and found it lessened disease caused by two fungi. Cultivars of the tobacco plant were then constructed, that would express the baculovirus-derived chitinase, and patent protection was sought by NERC to cover the baculovirus-derived gene. We are now looking at the implications of chitinase produced in this way towards pathogenic fungi, and towards 'friendly' fungi – those that live in the soil in association with plant root systems (mycorrhiza). Our next step is to investigate whether or not transformations of plants have any effect on development of structures within the mycorrhiza, their functioning or plant growth.



Do viruses control plant population dynamics?

Joanna Bond, CEH Dorset, email jomb@ceh.ac.uk

Little is known about the control of plant population dynamics by disease, except for economically important crop plants. Many viral infections generate no symptoms, but may influence natural plant community structure and the maintenance of biodiversity. We need to know more about the role of diseases in regulating plant growth and reproduction. In addition, we cannot begin to predict the effects of gene flow from genetically modified (GM) crops to wild relatives unless we have baseline data on the incidence of disease, and its effects on plant population dynamics. We surveyed eight widespread grass species in habitats such as chalk grassland, heathland and salt marshes, looking for wild and 'agricultural' strains of virus. All the grasses had exceptionally low levels of viral infection, and so were not acting as reservoirs of infection, contrary to our expectations. Our initial survey shows that viruses appear to have a limited impact on adult grasses within a natural community.



How do viruses survive between outbreaks?

Rosie Hails, CEH Oxford, email rha@ceh.ac.uk

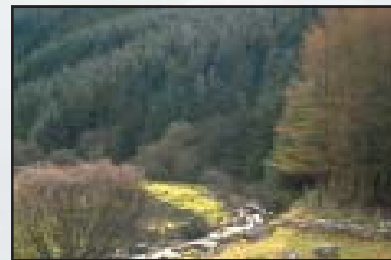
Viruses that kill insects (Baculoviruses) are widely studied, but rarely found in the field. They are most often observed when their hosts are at high densities, but it is not known how they survive between outbreaks, when their hosts are at low densities. We are investigating the hypothesis that the viruses persist in the host as a latent infection, and are triggered into full infections by biological factors. We used *Mamestra brassicae* caterpillars and their baculoviruses, in which a latent infection had been detected in laboratory culture. Field populations were sampled, and for the first time virus DNA has been detected in apparently healthy field insects. The viral DNA may exist in an independently self-replicating form (an episome), rather than being integrated into the host genome. Our early results suggest that latency may indeed be an important mechanism by which baculoviruses persist. If their survival mechanisms can be understood they may have potential as a biopesticide in the future.

Pollution

Can soil carbon/nitrogen ratios indicate nitrogen saturation?

Brian Reynolds, CEH Bangor, email br@ceh.ac.uk

Measuring the ratio of carbon to nitrogen in soils (C/N ratio) has been proposed as an indicator of nitrate leaching, from forests that are receiving enhanced nitrogen deposition. In the UK, it has been established that nitrate leaching from soils contributes to the acidification of upland waters. However, attempts to model the accumulation of nitrogen and leaching of nitrate in moorland systems have not been satisfactory. Our collaborative study, based on measurements at four moorland sites, showed that as nitrogen is deposited and nitrate leaches there is a decline in the C/N ratio in the uppermost 5 cm of the soil. But in sites that have severe soil acidification, the nitrogen cycle is probably disrupted, soil biological activity is impaired, and the relationship between C/N ratio and nitrate leaching is broken. We concluded that soil C/N ratios do have a value for predicting nitrate leaching from moorland soils, but only in less heavily impacted sites. Further study of the ratios will help us develop nitrate leaching models to predict future impacts of N deposition, in both terrestrial and freshwater environments.



Contaminant mixtures affect soil invertebrates

Claus Svendsen, CEH Monks Wood, email csv@ceh.ac.uk

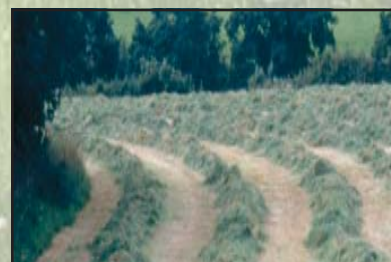
Soil-living invertebrates are frequently exposed to mixtures of soil contaminants, and the effects can be much greater than might be expected. In a collaborative study, we modelled the behaviour of mixtures of these contaminants, to reveal the subtle interactions found in earthworms exposed to copper, zinc and cadmium across a range of doses. The interactions between copper and zinc (both essential elements, but toxic at high concentrations) and cadmium (toxic only) are particularly interesting. Usually regulatory levels are set for individual contaminants, but effects of mixtures can be conflicting, can be cumulative, or can provide enhanced effects. For example, we have shown that at certain levels of zinc exposure, if cadmium is present as well then toxicity is greatly increased.



Reducing ammonia emissions in grasslands

Mark Sutton, CEH Edinburgh, email ms@ceh.ac.uk

As part of a major EU initiative, our collaborative team studied the effects of agricultural management on ammonia exchange. We used a combination of flux measurements and process modelling to reveal that cutting grassland induces ammonia emissions across Europe. This effect lasts from a few days up to two weeks. Fertiliser, usually applied a few days after the cut, causes an emission peak and a rise in the nitrogen status and ammonia emissions of the vegetation. Our measurements agree with the predictions of an ecosystem model, which explicitly models the dynamics of plant nitrogen pools during these events. The emissions are partly caused by the imbalance between the large amount of nitrogen available, and a deficiency in carbon supply, due to low photosynthetic activity after the removal of active foliage. By delaying the application of nitrogen fertilizer for a few weeks after grass cutting, ammonia emissions can be greatly reduced.



Hydrological Extremes and Ecological Response



Can we link extreme rainfall and climate change?

Chris Huntingford, CEH Wallingford, email chg@ceh.ac.uk

Following the severe floods of Autumn 2000, there is a perception that the occurrence and magnitude of UK extreme rainfall is increasing. We investigated whether there is a link between more frequent extreme rainfall and climate change, by a novel interpretation of rainfall predictions. These predictions had previously been made by the Hadley Centre's Regional

Climate Model, which is 'nested' within the full climate model for different greenhouse gas concentrations. Previously, only mean rainfall figures have been analysed, but when compared with actual rainfall data, we demonstrated that the climate model can predict the weather as well as the climate. These future predictions indicate that extreme rainfall events will become more frequent.



Fish prefer high-energetic habitats

Anton Ibbotson, CEH Dorset, email ati@ceh.ac.uk

Currently, most models that link fish abundance to a river's physical habitat variables are simplistic, empirical and reflect a steady state. In 2001, we applied a three-dimensional (3-D) computational fluid dynamics model, so that we could simulate hydraulic patterns in natural river channels.

Simulations were tested using both 2-D (electromagnetic current meter) and 3-D ("Acoustic Doppler Velocimeter") measurements. This hydraulic modelling has enabled us to develop and apply a process-based model to predict energy input, and therefore habitat quality, for drift-feeding juvenile salmonids.

Our experiments have demonstrated that the 3-D formulation of the model improves significantly over previous (at-a-point) bioenergetic models. When we compared the model's results with measured fish location data, it was shown that fish preferentially choose the areas of high energetic gain. Use of energy information, rather than empirical 'habitat', provides a clearer link to fish growth and abundance. This link will provide improved information to river managers.



The ecological impacts of varying river flows

Ralph Clarke, CEH Dorset, rtc@ceh.ac.uk

Adequate water flow is one of the many demands on river water sources, and is essential for healthy freshwater plant and animal communities. Previously, the freshwater larger invertebrate families (macroinvertebrates) have been 'scored' according to their abundance, and also their tolerance of low and slow river flows. The average score of the families present at a site gives an

index called LIFE (Lotic invertebrate Index for Flow Evaluation). In the absence of stress related to flow levels, the expected value of LIFE will however vary with the physical characteristics of river sites.

We have now expanded the RIVPACS* system, so that it will provide site-specific estimates of the LIFE score, and will allow us to compare the estimated ecological degree of flow-related stress at any river site in the UK. We are assessing its effectiveness as a biological indicator and monitoring tool, using historical series of matched flow and macroinvertebrate sample data. This collaborative research and the methods we have developed will be used with national Catchment Abstraction Management plans.

* For more information on RIVPACS see <http://www.nwl.ac.uk/ih/www/products/bswrivpacsiii.html>

Global Change

Are moorlands vulnerable to climate change?

Alwyn Sowerby, CEH Bangor, email asowe@ceh.ac.uk

Moorlands contain large stores of carbon because cold, wet conditions limit many of the biological processes that normally recycle carbon within an ecosystem. If climate change induces warmer, drier conditions, we may expect more carbon to be released from moorland systems, and consequently for CO₂ levels to rise in the atmosphere. In order to test this, we used a series of retractable roofs, that covered some moorland experimental plots. Some roofs reflected long wave radiation back into the ground at night causing warming; others are used in summer to cover the moor when it is raining, producing a drought. We found that, generally, plant biomass increased indicating that more carbon is being taken from the atmosphere into the vegetation. Under drought conditions, the ecosystem quickly returns extra carbon to the atmosphere via increased rates of soil respiration. But unexpectedly, with warming we have not yet recorded any significant increase in dissolved or gaseous losses from the large amounts of carbon in the soil, however there are some indications that dissolved losses may be increased in these peaty soils. Data from this site feed into a Europe-wide project which aims to predict and mitigate against the consequences of climate change for heathland ecosystems.



Detecting real change

Andrew Scott, CEH Merlewood, email was@ceh.ac.uk

The UK Environmental Change Network (ECN) has 54 sites across the country, which record long-term variables of environmental importance. During analysis of these variables, it is important to be able to distinguish between short-term fluctuations, local or seasonal influences, and real long-term trends. A technique known as generalised additive modelling has been used to separate out these components from 'noisy' time series data. Analysis of trends in surface-water sulphate at ECN freshwater sites, using historic data from nine sites, showed a consistent downward trend across all sites over the last decade, associated with the policy of reducing emissions of sulphur to the atmosphere. Exceptionally, there were some "events" in 1995 (and to a lesser extent in 1990) in which sulphate concentrations increased as a result of dry conditions. There was also evidence that local factors can over-ride national trends at some sites. The same modelling method will be applied to other physio-chemical variables, and used for seeking evidence of climate impacts in ECN's biological data. The eventual aim is to provide an on-line system that shows the main trends and changes in ecosystems across the UK, and gives early warning of environmental change. See more info on ECN at <http://www.ecn.ac.uk/>



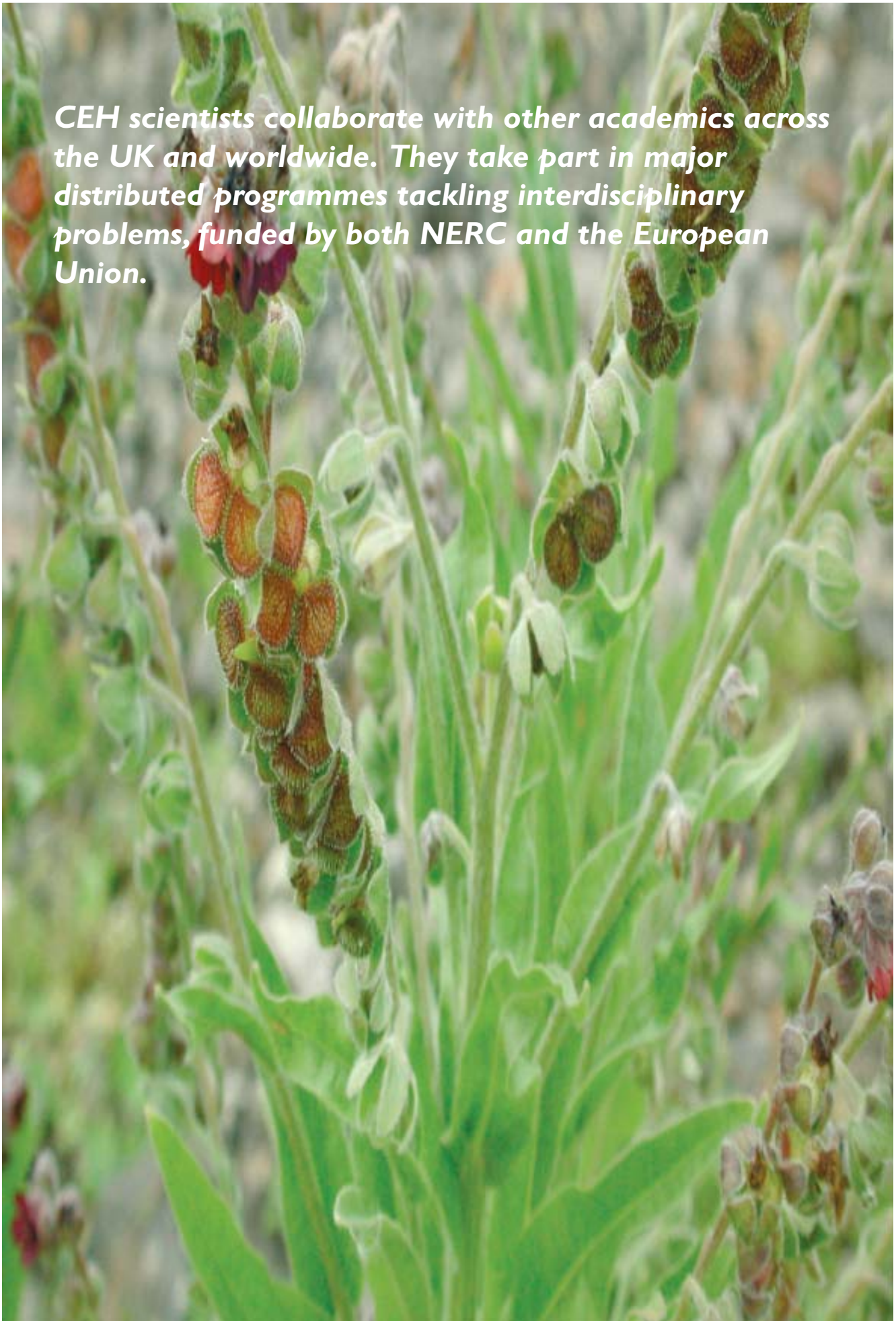
Mitigating CO₂ emissions is not enough

Tim Lenton, CEH Edinburgh, email tlent@ceh.ac.uk

A model that couples the carbon cycle and global surface temperature has been used to explore the effects (up to year 3000) of climate-carbon cycle feedback mechanisms, and of burning different amounts of fossil fuel at different rates. We found that, to limit the maximum rate of global warming this century to less than 0.2 °C/decade, the rate of increase in fossil fuel emissions must be at least halved. If emissions continue to increase at the present rate, global warming will accelerate from the present approximate 0.15 °C/decade, towards 0.3 °C/decade. The faster we burn fossil fuels the greater will be the peak global warming (from 6 °C up to 9 °C). Global warming is amplified by about 20%, by positive feedbacks that suppress land and ocean carbon storage. If Earth's entire fossil fuel resource was burned, the Earth's surface would be expected to warm by more than 5 °C by the end of the (third) millennium, regardless of the rate of burning. We must consider leaving a fraction of fossil carbon unused, and/or develop technical solutions for large-scale carbon capture and storage.



CEH scientists collaborate with other academics across the UK and worldwide. They take part in major distributed programmes tackling interdisciplinary problems, funded by both NERC and the European Union.



Urban Regeneration and the Environment, (URGENT): Understanding and managing the interaction of natural and man-made processes in the urban environment is closely linked with urban regeneration programmes

Emissions of aerosols in urban areas

Eiko Nemitz, CEH Edinburgh, email: en@ceh.ac.uk

Until now, aerosol emission levels from industrial processes, vehicles and domestic combustion have been estimated separately, using emission factors and activity statistics. For any one area of land, which may have several different sources, it has not been possible to establish an average emissions figure. To solve this problem, we used micro-meteorological methods, which enable us to measure the emission and deposition rates of very small particles (10nm to 5 μ m diameter). Measurements were taken over 'footprints' of central Edinburgh, typically three sq. km. in area. This technique has allowed us to quantify the different sources of emissions under a range of conditions. We can now measure the re-suspension of particles from surfaces by the wind, and have developed an algorithm that relates the emission flux for different sizes of micro-particles to the wind speed.



Global Nitrogen Enrichment, (GaNE): This thematic programme is studying the problems arising from nitrogen enrichment of our environment

Nitrogen deposition in atlantic oakwoods

Ruth Mitchell CEH Banchory, email: rujm@ceh.ac.uk

Atlantic oakwoods are scarce in Britain, and host an interesting array of plants. This study monitored seven oakwoods, ranging from Loch Maree in Northern Scotland, to Borrowdale in the Lake District. At each site, precise monitoring enabled us to measure the amounts of nitrogen being deposited from the atmosphere as rain or from the atmosphere, and as water running down tree trunks. We wished to investigate the effects of this nitrogen pollution on bryophytes (mosses and liverworts) growing on the surface of the oaks, and establish how it affected their tissue nitrogen content and their growth rates. In addition, in order to assess how well the plants could recover from high levels of nitrogen exposure, some bryophytes were transplanted from low to high nitrogen deposition areas, and some from high to low nitrogen deposition areas. The transplanted bryophyte samples were collected after a year, and analysed for tissue nitrogen and growth rates. Final analysis and reporting is now nearly complete.



European Framework Programmes: EU funded research demands international collaboration and sharing of knowledge and skills, across established Member countries and New Accession states.

Climate change effects on lakes

Glen George, CEH Windermere, email: dgg@ceh.ac.uk

The REFLECT project brought together researchers from nine European countries, to study the historical and future effects of weather changes on the dynamics of lakes in northern, western and central Europe. Historical analysis of the REFLECT lakes revealed that the North Atlantic Oscillation has a major effect especially in the winter months, affecting freeze-thaw dates and spring plankton growth. Elsewhere, critical climatic effects were caused by variations in average rainfall and the frequency and intensity of (wind-induced) mixing of the lake waters. A series of automatic water quality monitoring stations were installed in a selection of lakes and provided high-resolution data, used to validate physical and biological models. The models demonstrated that short-term changes in the weather had an important effect on the seasonal succession of phytoplankton and zooplankton. This work is now being extended to lakes in the former Soviet states, including Siberia.



CEH holds, maintains and develops databases of national importance, and develops new ways of using and interrogating them. Our environmental monitoring programmes are renowned for their time-span, quality and detail, both in the UK and internationally.

- Databases and data management:



The National Biodiversity Network Gateway

Jon Cooper, CEH Monks Wood, email jcoop@ceh.ac.uk

The National Biodiversity Network (NBN) is a union of likeminded organisations that are collaborating to create an information network of biodiversity, accessible to everyone via the Internet. The NBN Gateway is the central focus of the Network. The pilot Gateway website has been completely revised during 2001, and is now based on new Oracle databases.

Access mechanisms have been established which enable data providers to control which users can see different types of products using their data. New biological datasets such as the Atlas 2000 Vascular plants database, and boundaries such as Common Land in England have been added. The Gateway has newly enhanced geographical displays, which enable users to view biological information and site boundaries against an Ordnance Survey backdrop. Explore the NBN Gateway at <http://www.ukbiodiversity.net/>



A new Bioinformatics Data Centre

Dawn Field, CEH Oxford email dfield@ceh.ac.uk

Bioinformatics is a new science, involving the use of extensive electronic databases on genomes and protein sequences. The genome or DNA found in each living cell is, as we have all heard, the 'blueprint' of life. We now have the ability to 'scale up' from the study of just a few genes to complete genomes, using developing genomic technologies. This provides an

unprecedented opportunity to ask questions about the molecular mechanisms that organisms use to adapt and survive. The recently established Environmental Genomics Programme is funded by the NERC at £16.5M over five years. The Programme's mission is to use existing and emerging genomic knowledge and technology to gain a better understanding of ecosystem structure and function. Projects will address fundamental ecological and evolutionary questions in environmentally important organisms, ranging from microbes to vertebrates. As a major part of the mission, the Programme is investing in a proactive Data Management Initiative, which will include the creation of a specialised Data Centre at CEH Oxford. The Centre will use a combination of open-source and commercial bioinformatics solutions for analysing, storing, distributing, and mining genomic data.

More information at <http://envgen.nox.ac.uk>.



Assessing accidents in the Arctic

Brenda Howard, CEH Merlewood, email bjho@ceh.ac.uk

The Arctic is especially vulnerable to contamination by radio-caesium. We are investigating the long-term impact of possible accidents at the Kola Nuclear Power plant on human populations in N. Norway and N.W. (Arctic) Russia. We modelled probable and worst-case scenarios for Radiocaesium and Strontium⁹⁰ under specific meteorological conditions. We found that the

contribution of external gamma dose to the total dose was negligible. But human ingestion doses were dominated by radiocaesium via locally produced food products. Radiocaesium in reindeer meat is the dominant contributor for the first year after contamination, and persists for many years after an accident. Reindeer keepers, who eat large amounts of reindeer meat, would be receiving excessive doses for up to twenty years after an accident, much greater than the excessive dose for other inhabitants (four years). Fifty years after accident deposition, reindeer meat, dairy products, semi-natural mushrooms and berries become important contributors to the dose of all inhabitants. The assessments confirm previous work, that inhabitants of the Arctic are vulnerable to radionuclide (especially radiocaesium) contamination, and that their vulnerability is likely to persist for many years after accident deposition.

- Monitoring:

Monitoring and Assessing Soil Quality: MASQ

Helaina Black, CEH Merlewood, email hbl@ceh.ac.uk



MASQ was established to produce soil data from samples taken during the nation-wide Countryside Survey 2000. We have succeeded in producing a unique series of datasets that provide information on the chemical and biological properties of soils, in combination with detailed site characteristics (vegetation type, habitat, land use history, geographical location, soil type etc.). These datasets are now a baseline resource for soil and other environmental monitoring programmes; information is now available for over 1000 locations across the British countryside. Soil biological properties are a key element of the datasets, and we have established the feasibility of assessing these properties in a national survey. Our next challenge in the MASQ project will be to gain a better understanding of the relationships between the soil's biological and chemical properties and its environment. We shall take into account the soil's inherent characteristics (e.g. location, climate, geology) and a variety of human and economic influences.

- Application of a database:

Using Land Cover Map 2000

Geoff Smith, CEH Monks Wood, email gesm@ceh.ac.uk



Land Cover Map 2000, a major component of Countryside Survey 2000, has now been completed and was launched in November 2001. This major achievement used satellite data to produce a digital dataset that records the vegetation cover across the whole of the UK, in the form of an object orientated vector database. The data is recorded as land 'parcels' that are classified by vegetation type and correspond with Broad Habitats (and so provides a tool for work within the UK Biodiversity Action Plan). Datasets are provided to users under licence, and are used in geographic information systems (GIS), alone or in conjunction with many other types of data. Uptake so far has been enthusiastic. Users include: Government Departments and Agencies in England, Scotland and Wales; County Councils; Charities and Commissions; and environmental management bodies. Some examples of applications so far include:

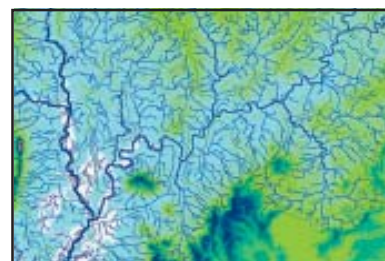
Environmental assessments	Animal disease distribution
Transport planning	Environmental protection
Mapping bird records, linking to habitats	Forestry research & management
Catchment management plans	Landscape Character planning

This three-year project was funded by NERC and a Consortium of partners including DEFRA, the regional Governments and Agencies. For further information, see <http://www.ceh.ac.uk/data/lcm/index.htm>

- Application of software:

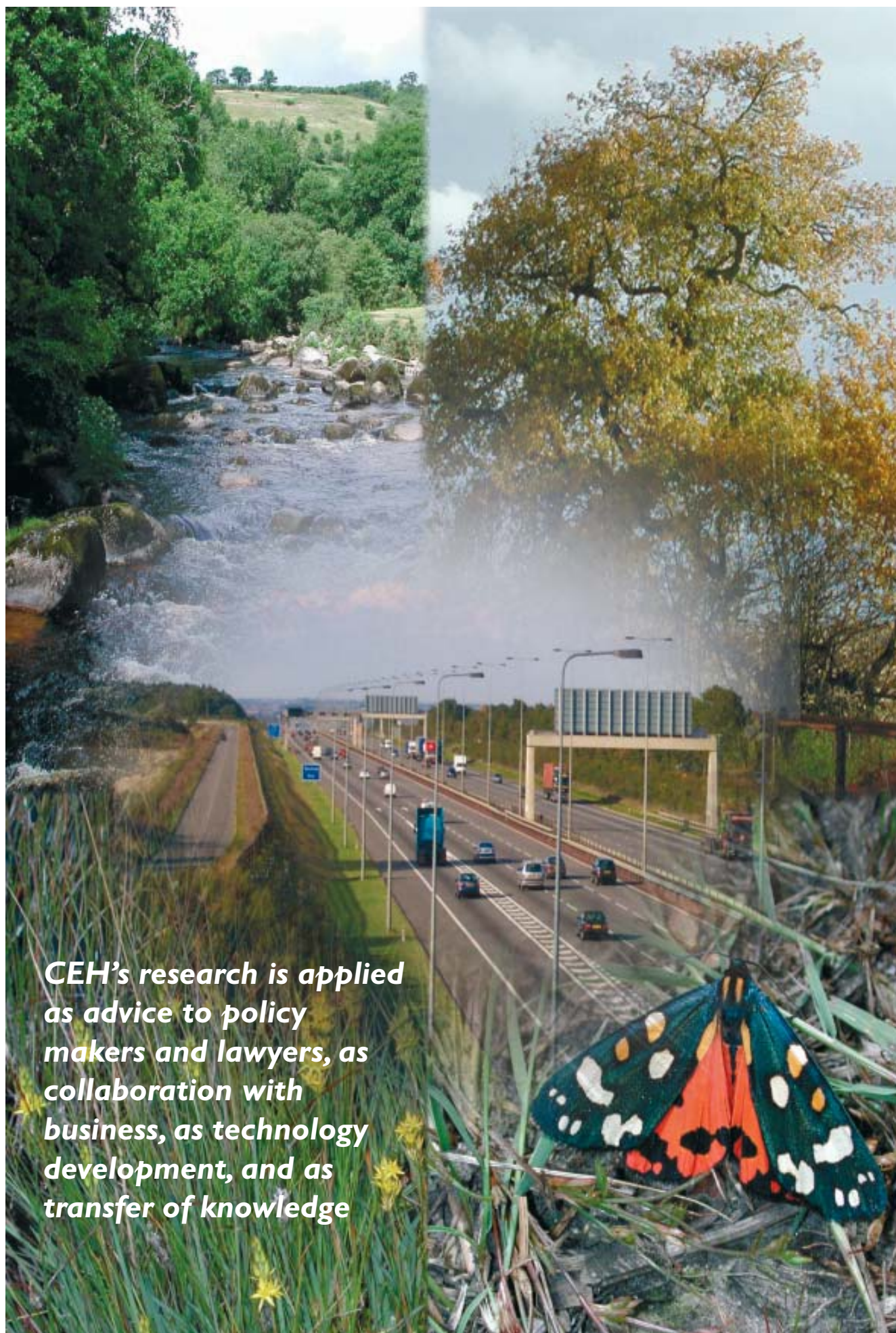
Disseminating research to the water industry

Matt Holmes, CEH Wallingford, email mgrh@ceh.ac.uk



CEH has developed the 'Low Flows 2000' system, which is an advanced decision support tool designed to both estimate river flows at ungauged sites, and to aid the development of catchment and regional water resources. The Environment Agency have invested £1.2M in the implementation of the system as an operational tool, throughout all eight of their Regions. CEH staff have prepared a total of 92 installations covering the whole of England and Wales, and trained over 80 users within the Agency. The Agency has made a significant investment of time, in order to populate the Low Flows 2000 database with data quantifying the impact of artificial influences on natural river regimes (abstractions, discharges and impounding reservoirs). Low Flows 2000 will be fully 'rolled out' by 2003/4. The product will directly underpin the development of Catchment Abstraction Management Strategies (CAMS), and the implementation of the European Water Framework Directive within England and Wales.

For hydrological software available see <http://www.nwl.ac.uk/ih/www/products/iproducts.html>



CEH's research is applied as advice to policy makers and lawyers, as collaboration with business, as technology development, and as transfer of knowledge

Applying our research and expertise

- As advice to policy makers:

Developing a strategy for Welsh acid waters

Brian Reynolds, CEH Bangor, email br@ceh.ac.uk

This study, for the National Assembly for Wales, assessed the benefits to Welsh acid waters of the emissions reductions negotiated under the Gothenburg Protocol. It also evaluated the options for local remediation measures such as liming and agri-environment schemes, and options for the re-introduction of aquatic invertebrates. A team of scientists from CEH and UK universities analysed data from regional surveys, long-term monitoring sites, and from use of a suite of models, and presented conclusions to the Assembly. Our researchers found that international emission control policies are delivering real improvements in the acid deposition climate for Wales, and that delivery of the Gothenburg protocol targets will directly benefit Welsh waters. Achieving reduction of future deposition of sulphur and oxidised nitrogen will be highly dependant on emissions outside Wales, but local benefits should be achieved in South Wales if future sulphur dioxide emission controls are targeted on local sources. The team found difficulty in predicting the future importance of nitrogen deposition to the recovery of acid waters in Wales, as these processes are not yet well understood. Biological recovery is predicted to be slow and probably incomplete, and may need intervention to aid recovery at selected sites.



NEGTA 2000 and UK Critical Loads

David Fowler, CEH Edinburgh, email dfo@ceh.ac.uk

An authoritative review by the National Expert Group on Transboundary Air Pollution (NEGTA) of the current pollution climate of the UK, and the changes in emissions, deposition and effects over the last 20 years has been completed and published for DEFRA. The report shows that acid deposition is declining and that the first stages in the recovery of acidified freshwaters have been detected. It also shows that deposition of nitrogen compounds are now the dominant source of deposited acidity, and that despite reductions in NO_x emissions the deposition of nitrogen in the UK has changed little. A critical load is the maximum amount of pollutant deposition a part of the environment can tolerate, without significant harmful effects. Large parts of the UK remain in exceedance of critical loads for acidity and also for eutrophication by nitrogen compounds (nutrient loading of freshwaters causing excessive algal growth). Ozone concentrations are also shown to have changed, with the peak concentrations having declined by about 30% over 20 years, and the mean values have increased by up to 0.7 parts per billion of ozone/year during the last decade. For information on Critical Loads see <http://critloads.ceh.ac.uk/>



- As advice to lawyers:

Dundee Water Law

Jeremy Meigh, CEH Wallingford, email jrm@ceh.ac.uk

CEH is contributing to a project that is developing a legal assessment methodology for international water rights. The methodology will enable countries in international river basins to determine their rights of water use in a systematic and rational manner.

It will also enable individual countries to assess their obligations towards other countries in the river basin. The methodology will enable these countries to gain an improved understanding, leading to a better statement of their position in international negotiations on shared water.



- As collaboration with business:



Managing irrigation with saline water

Ragab Ragab, CEH Wallingford, email rag@ceh.ac.uk

Growing salt-tolerant crops and irrigating them with salt water increases the amount of land available for agriculture. But the use of saline irrigation causes a big build-up of salt in the soil. We have developed a field water management scheme, SALTMED, that can be used with saline irrigation.

SALTMED is a physically based model that uses an integrated approach that can account for water, crop, soil and field management. Unlike existing models, which were designed for a specific irrigation system or a specific process, our model is generic. It can be used for a variety of irrigation systems, soil types, soil stratifications, crops and trees, water application strategies and water qualities. For hydrological products see <http://www.nwl.ac.uk/ih/www/products/iproducts.html>

- As technology development:



OPTIMO: measuring suspended sediment in liquids

David Cooper, CEH Wallingford, email jdc@ceh.ac.uk

Collaboration between the UK, France, Italy and Portugal has developed an instrument, known as OPTIMO (OPTical Technology for Intelligent Monitoring Online), for measuring suspended sediment and colour in liquids.

The instrument has a wide range of uses: in CEH we are developing it to make in-situ measurements of suspended sediment in rivers. Other partners used it to measure particles in water treatment works, particularly *Cryptosporidium* and *Giardia*; and the colour of port wine (to aid classification and identify fakes). A wide range of applications has already been demonstrated, we expect interest in many other industrial and scientific applications. CEH Wallingford designed and manufactured the mechanical components for the water treatment works and the river applications, and also conducted the river trials.



Structure function-relationships of tick proteins

Miles Nunn, CEH Oxford, email amn@ceh.ac.uk

Histamine has recently been shown to have a wider role than previously thought in regulating immune responses. In collaboration with a number of research organisations we are exploring the associated effects of HBPs found in ticks. (HBPs are proteins in tick saliva that prevent the action of histamine by binding it). Our understanding of HBPs has been refined by protein

engineering; and crystallographic studies continue in association with the Wellcome Trust Centre for Human Genetics. Evolute, (a CEH spin out company) has an advanced drug development programme that involves the use of an HBP as treatment for seasonal allergic conjunctivitis, associated with hay fever. In trials the molecule is more effective than the current market leader, and clinical trials in humans are planned for 2002, in collaboration with Harvard Medical School.



- **As transfer of knowledge and skills:**

A key to larval and juvenile fish

Adrian Pinder, CEH Dorset, acp@ceh.ac.uk

This year we have published a major identification key for the larval and juvenile stages of coarse fishes, from freshwaters in the British Isles. The key includes 26 species of coarse fish and each species is split into 5 developmental stages to help identification. In addition, the key gives clear methods for the collection and preservation of young fishes. This is crucial to their correct identification as many of the criteria involve the patterns of melanophores (colour containing cells), which can alter substantially during capture and preservation. A useful literature review on taxonomic papers is included, and a chapter on the general characters of fishes and the terminology used in the keys. The key is likely to become the reference text for the identification of the early stages of fish species. It will empower research on a much-neglected aspect of fish population biology - the factors that influence recruitment through the early part of their life histories.



Managing salt marshes

Sue Brown, CEH Dorset, email slb@ceh.ac.uk

A team of CEH staff have developed an interactive information and Decision Support System (DSS) as a practical tool for salt marsh management. The DSS was produced as part of the EUROSAM (EUROpean SALT marshes Modelling) project, funded by the European Fifth Framework Programme. The system is designed for use by both coastal scientists and non-specialists, and structured so that increasing levels of detail can be accessed for each topic.

By using selected examples from the EUROSAM programme, it can be used as an aid to help predict salt marsh response to environmental change and the impacts of changing management or human use of these habitats. As a guide for the non-specialist, the DSS highlights the important role of salt marshes, and the many interactions between components of the salt marsh system. It is available as a CD-Rom.

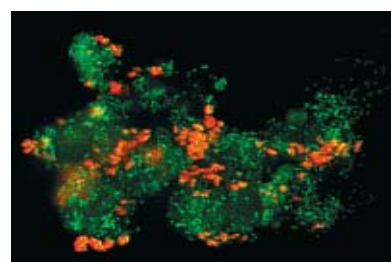


Degrading phenols by bioremediation

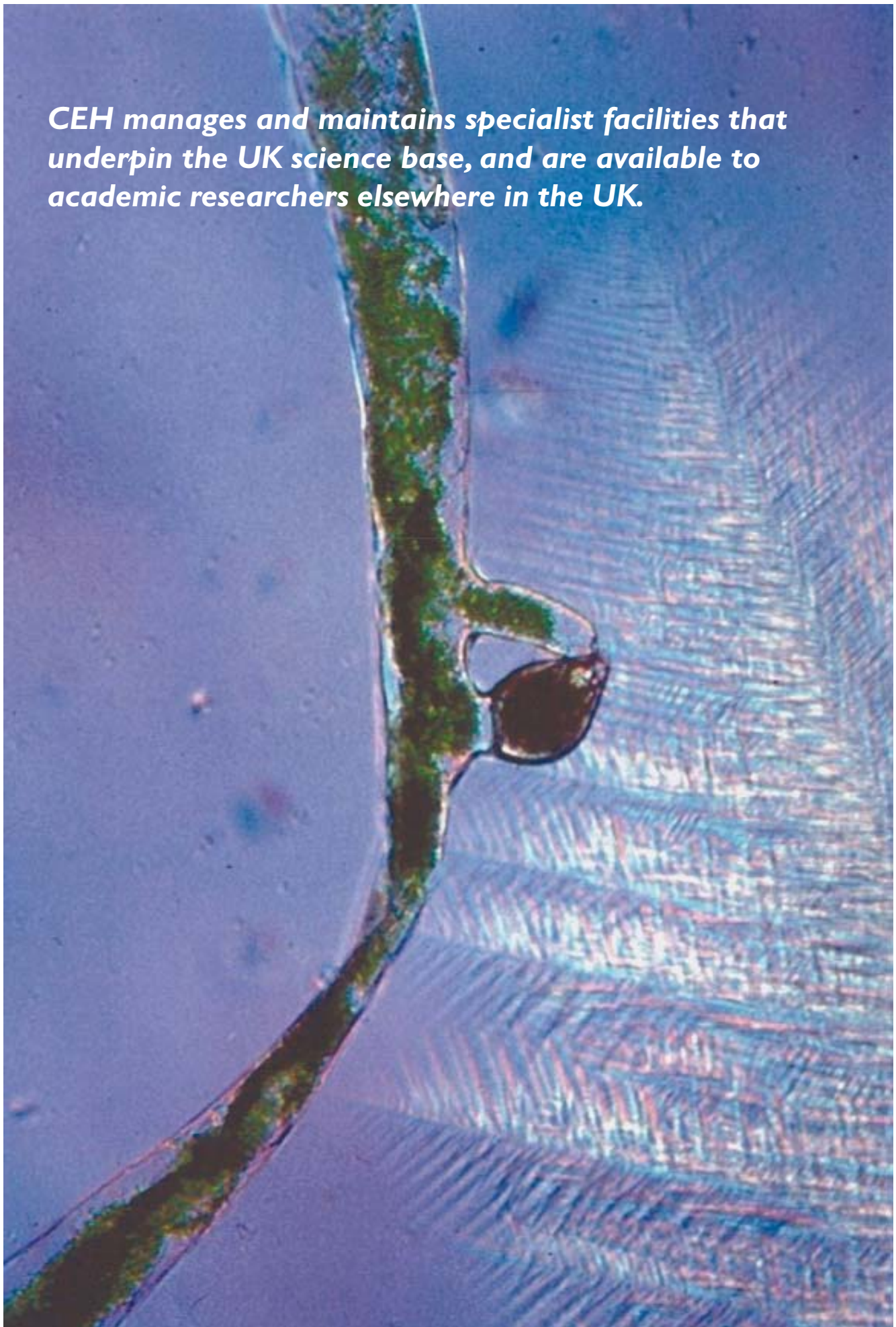
Andrew Whiteley, CEH Oxford, email aswhi@ceh.ac.uk

One of the major limitations to the advancement of microbial ecology and the understanding of microbial diversity, has been our inability to define the truly active component. We have developed novel approaches to study and define the active diversity of microbial ecosystems (i.e. not only what bugs are present, but also what they are doing).

We have achieved a significant advance in the use of stable carbon isotope labelled substrates (^{13}C labelled phenol in this case), so that we can follow the ^{13}C label into organisms which utilise the labelled substrate and incorporate it into their cells. When combined with standard DNA sequencing analysis, the technique enables us to identify those organisms responsible for degrading the substrate. We can now identify a novel organism that is the primary degrader of phenol in an industrial bioreactor and has not previously been cultured in any laboratory,



CEH manages and maintains specialist facilities that underpin the UK science base, and are available to academic researchers elsewhere in the UK.



Specialist Facilities

The Stable Isotope Facility (SIF)

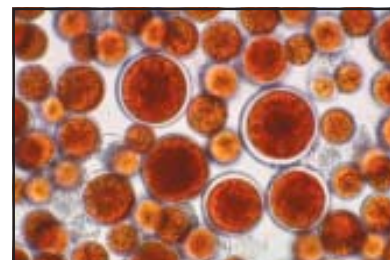
Andrew Stott, CEH Merlewood, email astott@ceh.ac.uk



The Stable Isotope Facility (^{15}N Nitrogen SIF) is one of the United Kingdom's leading light stable isotope laboratories, and is managed for NERC by CEH Merlewood. The Facility has experience of a wide variety of $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ (carbon and nitrogen) stable isotopic techniques and their ecological applications, at both enriched and natural abundance level. The SIF is equipped with three stable isotope ratio mass spectrometers that generate over 8,000 quality assured isotopic analyses per year, on a vast range of biological and environmental materials. These include carbon dioxide, methane and nitrous oxide gases; soils, vegetation, fungi, soil macro-fauna and others. Recently, we have advanced our isotope methodologies into the state-of-the-art arena of gas chromatography-combustion-isotope ratio mass spectrometry. This is an exciting technique capable of measuring the Carbon-13 values of individual organic compounds in complex biological matrices e.g. phospholipid fatty acids, hydrocarbons and amino acids. We have made major progress in the development of a new mobile field stable isotope gas capture laboratory. This will help our understanding of ecosystem carbon dynamics, in terms of pathways, rates of movement and mass balance. A second major development has been the design and building of a novel gas preparation interface, which has benefited NERC's GANE (Global Nitrogen Enrichment) and Soil Biodiversity Programmes. The SIF facility and its staff provide a pool of innovative stable isotopic expertise and provide analysis facilities for researchers within CEH sites, NERC institutes and other higher education establishments. It is currently supporting eighteen other University research projects that fall within NERC's remit.

The Algal Culture facility and the COBRA project

John Day, CEH Windermere, email jgd@ceh.ac.uk



Microalgae and blue green algae are highly diverse groups of organisms. They can occupy extreme habitats ranging from tropical coral reefs to the Polar Regions, and they contribute half the globe's photosynthetic activity. They also form the basis of the food chain for over 70% of the world's biomass.

The Culture Collection of Algae and Protozoa (CCAP) held at CEH Windermere, provides a key component of the underpinning scientific infrastructure of CEH and UK science as a whole. The CCAP provides cultures, data and services to a wide user community. It has the widest range of biodiversity (cyanobacteria, microalgae and protozoa) held in any Microbial Biological Resource Centre anywhere in the world. The users of the Collection are very varied (schools, academia and bioindustry), reflecting the variety of applications for which the strains are employed. Examples of such use over the past year include: teaching and academic research; supply of reference strains for ecotoxicity testing; biocide testing; biological control of 'nuisance' algae; aquaculture feed; and for the production of valuable metabolites such as astaxanthin (the pigment that makes salmon pink).

The COBRA project. Although commercial exploitation of microalgae is still in its infancy, a number of products are already extremely financially successful. In collaboration with seven partners across Europe, we are working on the COBRA project (**C**onservation of a vital European scientific and **B**io**te**chnological **R**esource: micro **A**lgae and cyanobacteria), funded by the EU Fifth Framework Programme. We are exploring the use of *in vitro* cryopreservation (extreme cold) technologies in the conservation and sustainable exploitation of microalgae and cyanobacteria. We are investigating the obstacles in preserving microalgae by these means, in order to develop novel methodologies to cryopreserve the valuable biotechnological, ecological and taxonomic resources held in key European Culture Collections

For details of the strains held by the Collection and services offered, see: <http://www.windermere.ceh.ac.uk/ccap>
Details of the COBRA project can be found at <http://www.cobra.ac.uk/>

Accessing CEH science – for students and the public



Professional Development for Teachers

Judith Wardlaw, CEH Dorset, email jcwa@ceh.ac.uk

The Dorset Education Business partnership invited staff at CEH Dorset to stage a professional development dialogue day, titled “Science in a Green Environment”. The event gave teachers of A-level students the opportunity to see scientific researchers at work, to consider the role of ideas and evidence in science and to assess the ethical repercussions. The teachers

visited the River Communities and Fish Ecology laboratories to gain some idea of the day-to-day activities of our scientists. As an example of current research, scientists presented work on shorebird behaviour models and described the consequences for conservation and shellfisheries. Later, the teachers participated in a mini-debate on the issue “This house believes that GM technology can help feed the world safely” using scientific papers and news clippings that were provided for both sides. A discussion session covered the wide range of partnership activities that can be undertaken between CEH researchers and schools. These include work experience, Nuffield Science Bursaries, Crest projects, PhD Researchers in Residence, Royal Society Partnership & COPUS grants, Science and Career Fairs, Science Week events and development of the Schoolnet and CEH Dorset websites.

Feedback from evaluation forms completed by the teachers was very positive - one even suggested that we install a webcam in the laboratory so that schools can witness scientists at work!



What is a Community Scientist?

Paul Howe, CEH Monks Wood, email pho@ceh.ac.uk

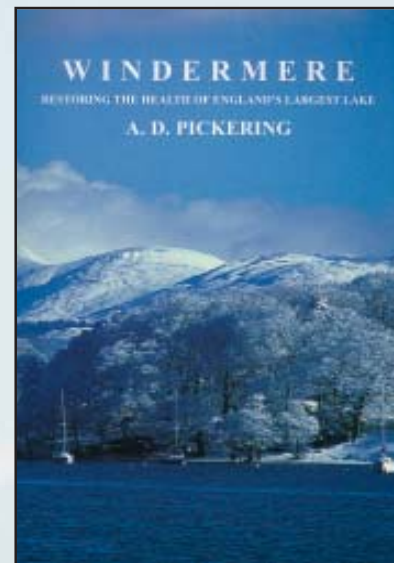
The aim of the Cambridge Community Scientists scheme is to increase enthusiasm for science in schools, by encouraging scientists to form partnerships with particular schools and teachers. A ‘real’ scientist coming into a school can bring new ideas, perspectives, experiments and demonstrations, which will help to inspire the children and increase both

their own and the teacher's interest in science. Each situation is different, but typically the scientist will be involved in planning experiments and investigations in conjunction with the teacher, and will become involved in the classroom, talking to and encouraging the children. There are currently around 35 active partnerships in the scheme, at school ages from infants to sixth form, five of which involve staff from CEH Monks Wood. The Cambridge Community Scientists network is funded by the Gatsby Charitable Foundation, and run by a local charity, South Cambs Forum for Industry Education Liaison (SCF). SCF manage a range of science and technology programmes for local education via the Mid-Anglia SATRO. These include Neighbourhood Engineers, Chemistry at Work, Young Discoverers and Nuffield science bursaries.

Restoring health to Windermere

Alan Pickering, CEH Windermere

Still waters are similar in some ways to sensitive scientific instruments, and respond to environmental change by generating biological responses. Like any good instrument, the changes are recorded, primarily in the sedimentary record on the bed of the lake. So, not only are the English Lakes important features in their own right, they are also indicators of the state of health of the broader environment. We used our long-term datasets to improve our understanding of how lake systems really work, and in particular to identify how they respond to waters flowing in from urban drainage, stormflow, and domestic waste. This has enabled us to make practicable management recommendations to improve the water quality of Windermere, our largest lake. If we can keep our lakes in a healthy condition, we will almost certainly be managing the surrounding landscape in a sensible and sustainable manner. The Lake District Still Waters Partnership commissioned a fully illustrated book on this topic for the general public, which was published this year by the Freshwater Biological Association. This explains the geography, geology, and history of Windermere, and details the decline in the health of the lake's ecosystems in the second half of the twentieth century. In this period, discharges from local sewage works increased and the ecological balance of Windermere was threatened. The book then goes on to describe the restoration to health of this beautiful lake. The publication was issued especially to mark the 50th anniversary of the establishment of the Lake District National Park.



'Windermere: Restoring the health of England's largest lake' by A.D. Pickering, costs £10 from the Freshwater Biological Association, Ferry House, Far Sawrey, Ambleside LA22 0LP, tel 01539 44246.

National Science Week Activities

Elaine Monaghan, CEH Windermere, email elmo@ceh.ac.uk

CEH Windermere & the Freshwater Biological Association joined forces in National Science Week (March 2002) by hosting an event for GCSE & 'A' level students. Our aim was to introduce the students to some current areas of research, to illustrate some practical applications of their classroom studies. We also wished to provide an insight into the life of scientists in a research institute. 150 students and teachers from six South Lakes schools spent half days on site. Competition for places was keen, with waiting lists for sessions, and some schools travelling for over an hour to reach us, with return journeys of up to 100 miles. Students were able to attend three science sessions. These ranged from fish biology, chemical analyses, and phytolimnology, to data collection on Lake Windermere from the research vessel, visiting the Culture Collection of Algae & Protozoa, an introduction to light and electron microscopy, and discussions on presenting, evaluating, and disseminating science. The students were given as much opportunity as possible for discussion and feedback during their visit. We enjoyed two lively days in the company of our local students, and were delighted with the enthusiastic and complimentary responses from their teachers. We hope to be able to build on this year's event in the future. *Photograph courtesy of the Freshwater Biological Association.*



See our website recording the event via the link at <http://www.ife.ac.uk/fritsch/National%20Science%20week/index.htm>

Publications

CEH's Publication Units manage the design and production of a range of publications, derived from research projects and long-term



Provisional Atlas of British spiders (Arachnida, Araneae), Volumes 1 and 2, by Peter R Harvey, David R Nellis & Mark G Telfer.

This is the latest and largest in the series of provisional atlases of the British fauna and flora published by the Biological Records Centre. The atlas is the culmination of a project started by the British Arachnological Society in 1987 and makes a major, original contribution to knowledge of the distribution, ecology and phenology of British spiders.

A4 paperback format in two volumes, totalling x + 406 pages. Sold as a pair £20 (includes p&p).

The Provisional Atlas of British Hoverflies (Diptera, Syrphidae), by Stuart G. Ball and Roger K. A. Morris. The bulk of the Atlas comprises 10-kilometre square distribution maps, flight-period histograms and accounts of the biology and distribution of each of the 266 British species. A bibliography and index to species (valid names and synonyms) are also provided.

A4 paperback format. Price £8.00 (includes p&p).



Aculeate Hymenoptera of Britain and Ireland:

Part 4. by Robin Edwards and Mark G Telfer.

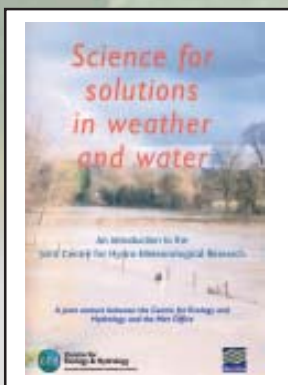
Parts 1 to 4 are available of this series of Atlases summarising information on species of bees, wasps and ants. The Atlases contain detailed profiles of species by specialist authors including sections on distribution, conservation status, habitats, flight period, nesting and feeding biology, and parasites. A 10-kilometre square distribution map accompanies each profile.

A5 paperback format, price £8.00 Part 4 (includes p&p).

Planning improvements in natural resources management by Jeremy Cain. Guidelines for using Bayesian networks to support the planning and management of development programmes in the water sector and beyond

A4 paperback format, Price £20

(including software and documentation on CD-ROM)



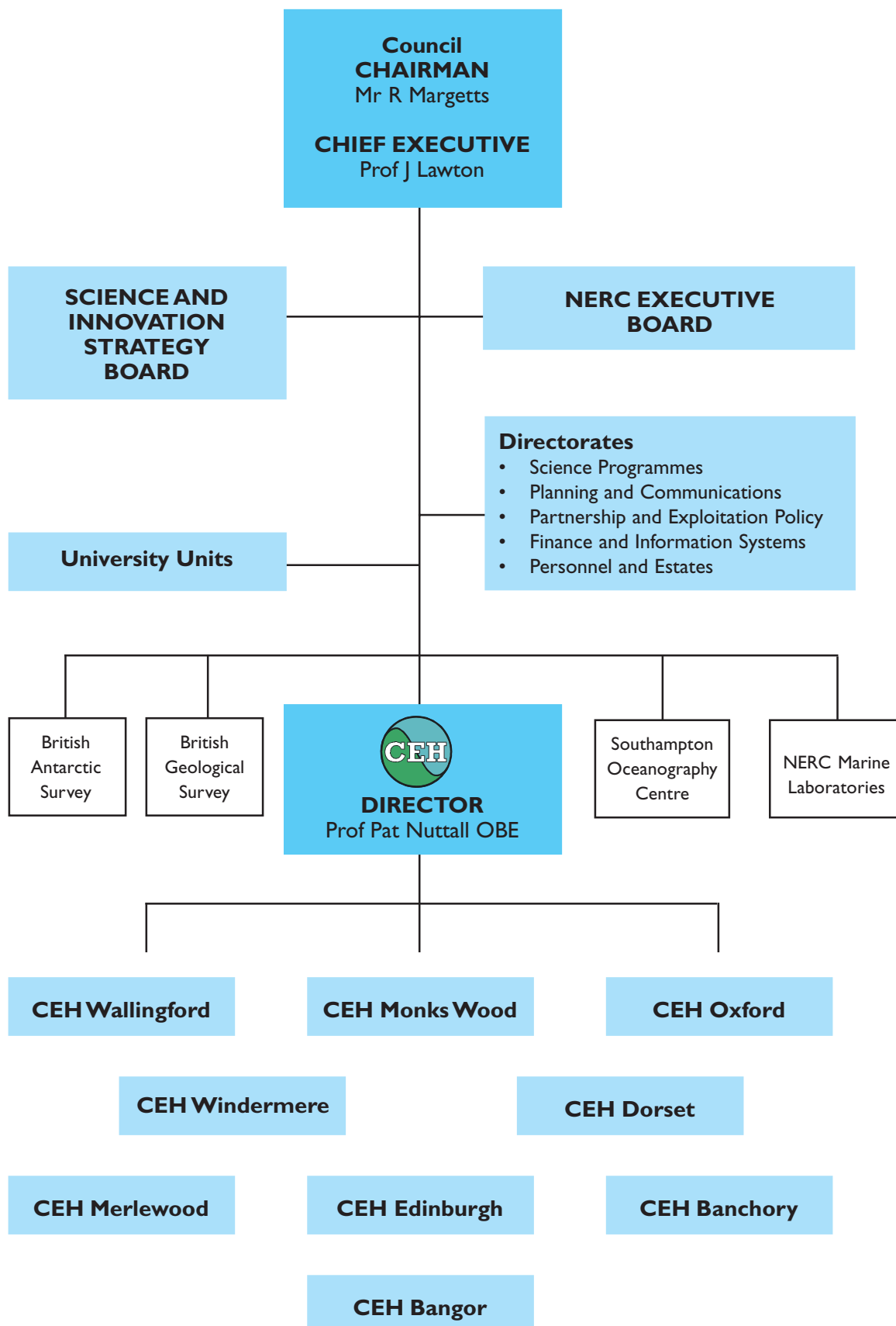
Science for solutions in weather and water

An introduction to the Joint Centre for Hydro-Meteorological Research. A description of a new venture between the Centre for Ecology and Hydrology and the Meteorological Office.

A4 paperback format, 15 pages, free of charge.

A listing of all CEH publications is at http://www.ceh.ac.uk/products_services/publications/index.htm

APPENDIX 1 - THE NERC STRUCTURE



APPENDIX 2 - CEH SITES

WALLINGFORD

J Wallace

A Jenkins
Water Quality

J H C Gash
Process Hydrology

A Gustard
*Water Resources &
Environment*

A Calver
Hydrological Risks

MONKS WOOD

D Osborn (Acting)

B K Wyatt
Earth Observation

M O Hill
*Ecological Processes &
Modelling*

R F Shore
Pollution & Ecotoxicology

D Moss
Environmental Information

WINDERMERE

P Matthiessen

T Pottinger
Fish Biology

B J Finlay
Microbial Ecology

E W Tipping
Aquatic Processes

S Maberly
Phytolimnology

EDINBURGH

M G R Cannell

D Fowler
Atmospheric Sciences

R Milne
Biosystem Dynamics

J Wilson
Biosystem Management

L May
Scottish Freshwater Ecosystems

N Cape
Air Chemistry & Effects

M Sutton
Ammonia

MERLEWOOD

M Hornung

L Firbank
Land Use

H E Jones
Soil Ecology

B J Howard
Radioecology

A P Rowland
Environmental Chemistry

T W Parr
*Environmental Change
Network*

DORSET

A J Gray

J Bullock
Conservation Management

J A Thomas
Population Ecology

J Hilton
River Ecology

R Clarke
Biometrics

OXFORD

M J Bailey

M J Bailey
Molecular Microbial Ecology

J S Cory
Molecular Viral Ecology

E Gould
Biotechnology

BANCHORY

S D Albon

A D Watt
Population Ecology

P Hulme
Community Ecology

BANGOR

B Emmett

T Ashenden
*Environmental Pollution &
Climate Change*

B Reynolds
Biogeochemistry & Land Use

APPENDIX 3 - DIRECTORATE FUNCTIONS

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Tenders	Recruitment
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Welfare	

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European liaison	Media contacts
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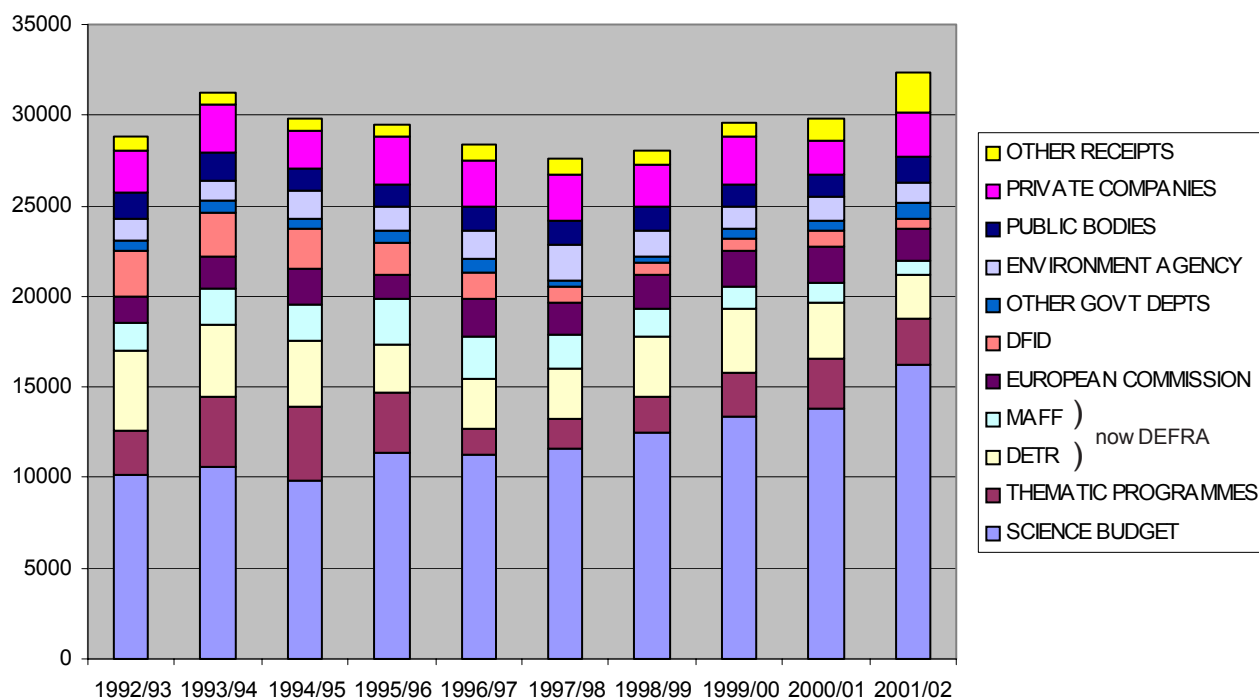
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Library Service *Sheila Scobie*

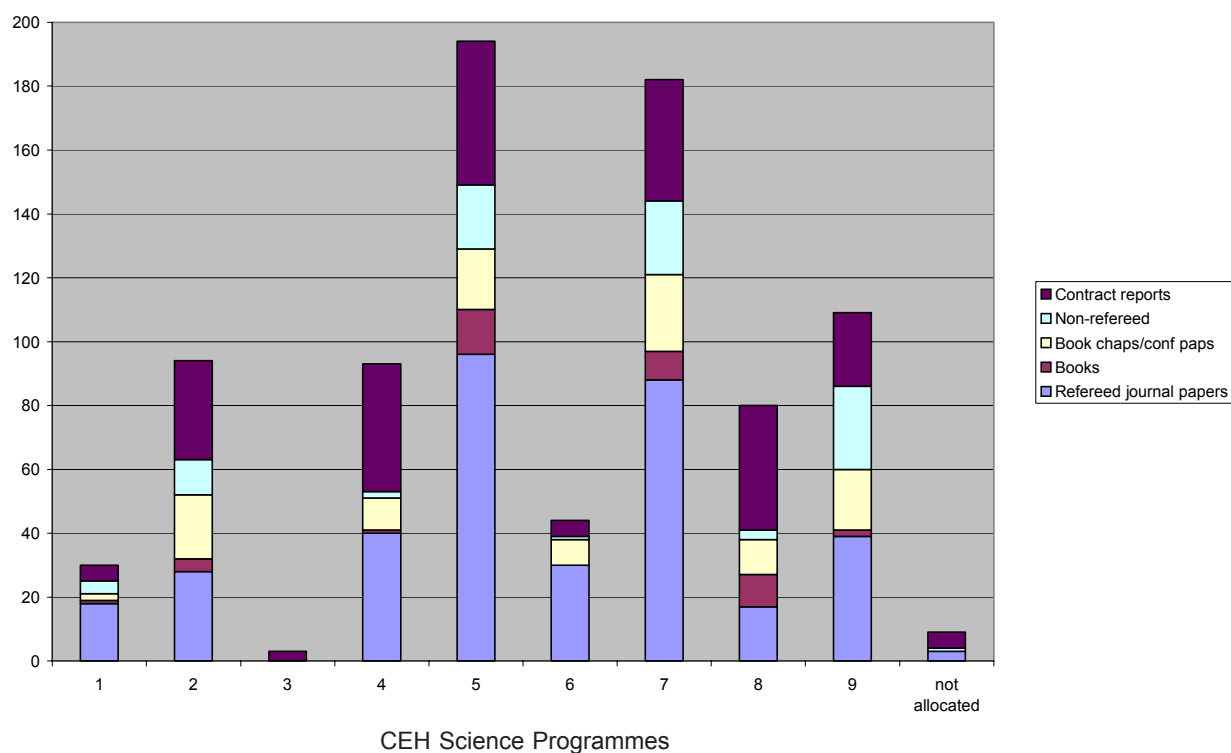
Library and information services	Staff publications records
Book and journal purchasing	Access to online databases and scientific journals

APPENDIX 4 - CEH STATISTICS

CEH Income



CEH Publications



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