

1991 — 1992
R E P O R T



**Institute of
Terrestrial
Ecology**

Natural Environment Research Council

The ITE mission

The mission of the Institute of Terrestrial Ecology is to understand the science of the natural environment with particular emphasis on terrestrial ecosystems. Priority is placed on developing and applying knowledge in the following areas

- the factors which determine the composition, structure, and processes of terrestrial ecosystems, and the characteristics of individual plant and animal species
- the dynamics of interactions between atmospheric processes, terrestrial ecosystems, soil properties and surface water quality
- the development of a sound scientific basis for modelling and predicting environmental trends arising from natural and man-made change
- the dissemination of this research to decision-makers, particularly those responsible for environmental protection, conservation and the sustainable use of natural resources at national, regional and global levels

The Institute will continue to develop long-term, multidisciplinary research to maintain an international reputation, provide training of the highest quality, and attract commissioned projects. By these means, ITE will seek to increase scientific knowledge and skills in terrestrial ecology, and contribute to national prosperity and prestige

Front cover illustration

Hedgerows in the landscape – photographer C J Barr

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**Report of the
Institute of Terrestrial Ecology
1991–92**

Natural Environment Research Council

CONTENTS

Foreword by Director of the Terrestrial and Freshwater Sciences	1
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Director's Introduction	3
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Science Reports 1 (<i>see separate file</i>)	
Forest Science	9
Land use, agriculture and the environment	15
Science Reports 2 (<i>see separate file</i>)	
Global environmental change	30
Environmental pollution	36
Science Reports 3 (<i>see separate file</i>)	
Population ecology	54
Community ecology	66
Scientific Services	72

Appendices	81
1 Staff at 31 March 1992	81
2 Finance and administration	84
3 Research projects at ITE stations at 31 March 1992	87
4 Publications by ITE staff 1991-92	95
5 ITE publications	111

Foreword by Director of TFS

I came to my present post as Director of NERC Terrestrial and Freshwater Sciences at the end of 1985, from being Deputy Director at Rothamsted Experimental Station. I therefore stepped over the difficult divide between agriculture and the natural environment; I became a person with a foot in both camps, which has not always been a comfortable position in the succeeding seven years. Nevertheless, I have gained enormously from constant contact with a rather different view of the world, and I hope that the rather different perspective has allowed me to encourage change more than would have been possible for someone based solely in traditional ecology. However, with Institute experience, I came with a strong belief in the strengths of the Institute system, in its continuity, ability to mount interdisciplinary science, and focused and organised approach to its work.

ITE has certainly needed all its strength to cope with change in these five years, and it has done so with resilience and success. Firstly, it was split up into two parts, ITE North and South, to allow better and more direct management by the Directors. There was some resistance to this division, but I believe strongly that it has achieved its aims. It has occasionally led to friendly rivalry, but not to seriously competitive attitudes, and there are common services and arrangements that cover the whole of the ITE structure. Other changes have been in the setting up of the Environmental Information Centre, which has become a major success. The move of the Bangor Research Station to become a Unit within the University of Bangor has also proved successful, and emphasises how well we collaborate with the universities. Amongst the less happy changes, we have to remember that the Institute suffered from its first redundancy round in 1989. This was a traumatic event, but thankfully it affected small numbers, and has not been repeated. The fire at Banchory was a more recent trauma to which the staff responded with admirable vigour to minimise disruption to their research.

The main change has been the enormous increase in the amount of its financial support which ITE earns from commissioned work. This has risen from about 20% in 1985 to 65% in 1991–92. I see nothing wrong with the need for an Institute to earn a substantial proportion of its daily bread – this can be seen as proof of its relevance and its value to the nation and the community. An

Institute that justified itself solely by an appeal to its excellent science has got to be very excellent indeed in the current climate, and is always open to the question of why its work is not being done by a university department. ITE is now soundly based on a dependable community of customers. The increase in the commissioned earnings has not been achieved without stress, very hard work, and occasional resentment. I want to take this opportunity of thanking everyone in the Institute who has contributed to these great changes, and I hope there will now be less pressure for yet more commissioned earnings to be obtained.



Dr Bernard Tinker, Director of TFS, seen here with Prof Bill Heal (left), Director of ITE North, and Prof Mike Roberts (right), Director of ITE South

However, ITE also has a great deal of excellent science, as has been proven by the steady rise in the number of Individual Merit Promotion (IMP) staff, from two in 1985 to six in 1992. This has received added emphasis very recently by Ian Newton's promotion to IMP Grade 5, a rare distinction. I was particularly pleased by the fact that Ian was also awarded the Gold Medal of the British Ecological Society. All this, together with the steady increase in refereed publications, emphasises the quality and standing of the Institute. There has also been a big development in the global aspects of ITE work. ITE(N) in particular has won a considerable fraction of the funds in the TIGER project (Terrestrial Initiative in Global Environmental Research), much of it being overseas, and has a lead role in the NERC Special Topic programme on arctic ecology.

The combination of my background and the function of ITE gave me a special interest in the very widely used phrase 'sustainable development'. Sustainability implies care for the ecosystem, conservation and ecology, development implies land use, agriculture and production. The main question facing the world at present is how to balance and combine these two aims. It means taking a balanced view about changes and their impact on the landscape. ITE has among its staff a wide spectrum of views. However, I am certain that, in their work, they always have the overriding aim of maintaining scientific objectivity and accuracy.

It is hardly surprising that one of the characteristics of ecologists is diversity. I had not before appreciated how strong the tendency was for ecologists to work on their own patch of ground, or how many differences of approach and interpretation remain. This diversity has been a strength for the discipline, but in modern organised and centrally funded research it has become a weakness. Now we need an active mass, to work towards common aims, and to develop the cases and the ideas that will win funding on a large scale, for the advances that are beyond the scope of a single group. In the past, ecologists were too often a critical mass, more engaged in criticising each other than in looking for the common goal that all could gather around. It has been one of my main aims to change this attitude, and I believe that in programmes such as JAEP (Joint Agriculture and Environment Programme), TIGER and now LOIS (Land-Ocean Interaction Study), we are seeing this happening.

It is also very pleasing to note that the important and active collaboration between ITE members and ecologists in universities and elsewhere has gone from strength to strength. I think it is now fully recognised that ecologists will not get the support they need and deserve, unless they actively band together to fight for it. The growing collaboration between ITE staff and those in other research councils, particularly in the Agricultural and Food Research Council, is particularly heartening for me. The rapidly extending work at the international level, particularly in global change, is another major advance that benefits from an open and collaborative approach.

In all, it has been a most stimulating time. I have learnt a great deal about the natural, the administrative and the political worlds. The development of complex, global programmes has been a fascinating challenge. My other main impression is of the enormous heterogeneity of the terrestrial natural environment. This makes it particularly difficult to apply models and exact concepts, and I have seen with admiration how far my colleagues are able to go despite this handicap.

On my retirement, I want to thank the staff of ITE for the excellent work they have done whilst I have been Director of Science, in a situation often of extreme difficulty, and to wish them every success in the future.

P B Tinker

*Director of Terrestrial and Freshwater Sciences
Natural Environment Research Council*

Directors' introduction

The year 1991–92 was marked by an increased focus on the development of strategic research in response to national priorities. As a result, links with government departments continued to strengthen, particularly in addressing issues at a global scale. For example, ITE's research programmes on environmental protection, biodiversity and the sustainable use of natural resources contributed to

- the scientific basis for the UK input to the United Nations Conference on Environment and Development (UNCED) in Brazil
- the co-ordination of international data bases by the European Commission (EC) in order to extend the CORINE (Co-ordinated Environmental Information in the European Community) programme to include eastern Europe
- the evaluation of the effects of pollutants on terrestrial ecosystems by several government departments in developing procedures for the Integrated Pollution Control (IPC) provisions of the 1990 Environment Protection Act
- wildlife management and conservation prescriptions for 'environmental deliverables' for positive land management provisions in UK legislation and the revisions of the Common Agricultural Policy

These demands are expected to increase in the light of recommendations from the UNCED Conference, the resolution of uncertainties over the European Environment Agency, and the UK Environment Protection Agency, as well as the continuation of agricultural reforms

In view of the rapid expansion of applied commissioned research, it became imperative that the Institute maintained a clear view of the basic/strategic research priorities. In 1991–92, the remit of ITE, which had been in place for more than a decade, was reviewed and formulated as a more up-to-date mission statement (see inside front cover). The earlier emphasis on conservation ecology has been replaced by a broader remit giving greater priority to studies of biogeochemical pathways (in response to applied issues such as acid deposition and greenhouse gas fluxes) and the development of mathematical modelling (to predict the consequences of land use and climate change). The new mission statement gives due recognition to the increasing emphasis on the dissemination of information about environmental protection, biodiversity and sustainable development to industry and government. The new remit recognises the role of ITE in supporting international multidisciplinary programmes on regional and global issues. ITE's research is increasingly being integrated with the other institutes and university units in NERC's Terrestrial and Freshwater Sciences Directorate to form large collaborative projects. Community programmes are also being formulated for integrated research projects across the three Directorates of NERC.

Research strategy

In the face of many competing demands for resources, it is critical that the Institute has a clear view of its role in the national research infrastructure. The continuing strategy in ITE is to build on the characteristics which are unique to the directed-mode Institute research ethos. Research in ITE, therefore, has the following characteristics

- a focus on strategic research
- the maintenance of large facilities and national data bases

- co-ordination of interdisciplinary and inter-organisation projects
- the ability to respond to national and international priorities
- strong links to government departments and international agencies

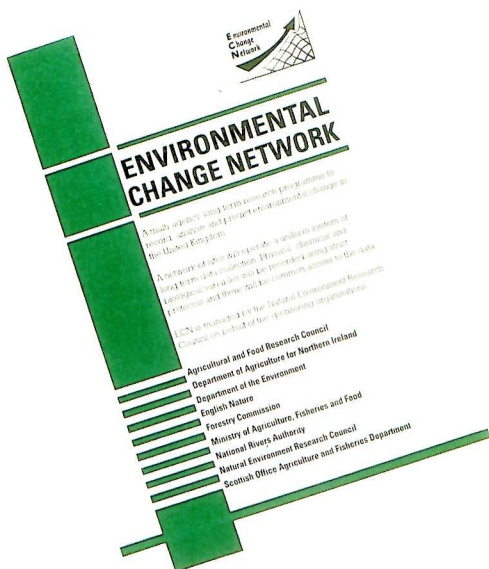
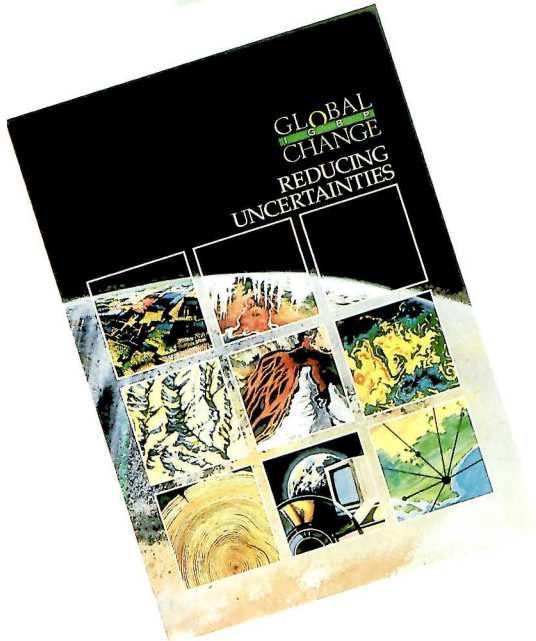
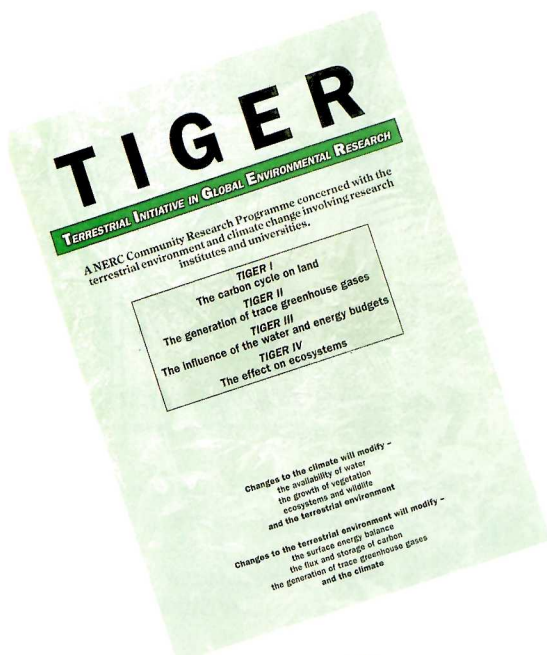
The ITE policy continues to support selectively three types of research

- a small core of basic ecology
- strategic research, directed to future international and national priorities
- a broad spectrum of commissioned applied research

The rapid increase in contract funding in recent years (reaching 55% of annual turnover in 1991–92) has resulted in a heavy emphasis on applied research and consultancy. Clearly, a single institute cannot and should not encompass all aspects of terrestrial ecology. Some of our current international and national priorities are described below.

The international dimension

As highlighted in our Introduction to last year's Annual Report, global issues will increasingly influence the research agenda. It became clear in the lead up to the UNCED Conference that political action to slow the rate of global change would be dependent upon the outcome of research to reduce the uncertainties in the timing and magnitude of the environmental impacts. Two major UK collaborative initiatives, developed during 1991–92, now provide foci for international collaboration in global change research. First, ITE played a major role in planning and implementing the major NERC community research



programme – Terrestrial Initiative in Global Environmental Research (TIGER). This programme, co-ordinated by the Institute of Hydrology, is focused on the causes and consequences of climate change at sites in Britain and in selected tropical biomes. TIGER brings together scientists from Higher Education Institutes (HEIs) and several NERC institutes into collaborative projects in four main areas:

TIGER I	The carbon cycle on land
TIGER II	The generation of trace greenhouse gases
TIGER III	The influence of the water and energy budgets
TIGER IV	The effects on ecosystems

After peer review of a wide range of proposals, the main projects of TIGER I and II were established during 1991–92, with major ITE involvement both in UK and the tropics; ITE is not involved in TIGER III. Proposals for analysis of the impacts of global change on ecosystems (TIGER IV) were developed, reviewed and selected during the year. The successful projects will be established in 1992–93, with a major input from ITE. TIGER IV will then provide a credible UK input to the core project of the International Geosphere–Biosphere Programme on global change and terrestrial ecosystems (GCTE). This extensive research portfolio on global change will provide an important strategic research base of relevance to industry and government departments.

The second initiative was in the context of monitoring global change. NERC has played the lead role in establishing a multi-agency long-term system to record, analyse and predict environmental change in the UK. The Environmental Change Network (ECN) was launched in 1992; a network of eight founding sites will operate a uniform system of long-term environmental data collection. NERC is supporting two of the sites (Moor House–Upper Teesdale and Wytham Estate), with support for the other six from the Agricultural and Food Research Council, the Department of Agriculture for Northern Ireland, the Ministry of Agriculture, Fisheries and Food, and the Scottish Office Agriculture and Fisheries Department. The ECN co-ordination centre at ITE Merlewood will provide for the integration and analysis of the data sets to identify the environmental changes, and will actively seek links with existing and developing long-term

environmental networks in Europe, the USA and elsewhere.

The global dimension of ITE's existing research was also strengthened, for example through:

- the successful development by the Edinburgh Centre for Tropical Forests (ECTF) of a major project on tropical forest management and conservation in Indonesia, funded by the Overseas Development Administration
- involvement in the planning and scientific content of the first European conference on forest ecosystems in Florence in 1991
- support for the planning phase of the European Environment Agency through the involvement of the Environmental Information Centre (EIC) at Monks Wood in the EC CORINE programme
- extension of critical loads mapping to include participation in the United Nations Economic Commission for Europe programme on acid deposition
- playing a lead role in the European Conservation Research Institute Network (CONNECT), through which several proposals were submitted to the EC 3rd Framework and Human Capital and Mobility Programmes.

ITE is well placed to contribute fully to the development of the European and global agendas for ecological research.

The UK dimension

The government's environmental strategy, as laid out in the 1990 White Paper *This common inheritance*, continues to have important implications for ITE's research priorities. Major projects which match the government's priorities funded by NERC and various government departments are as follows.

Climate change

- Research on carbon budgets, trace gas fluxes and responses of terrestrial ecosystems

Land use and planning

- Assessment of causes and rates of change through analysis of the Countryside Survey 1990 data; development of new procedures for environmental assessment

Countryside and wildlife

- Research on the factors controlling biodiversity at the landscape scale; design of farm woodland for wildlife; development of techniques for coastal and moorland habitat restoration

Air pollution

- Definition of critical loads for soils and critical levels for vegetation; quantification of deposition processes and development of dose/response relationships; mapping of the national distribution of critical load exceedances

Hazardous substances and genetically modified organisms

- Monitoring of long-term trends in pollutant residues in wildlife; evaluation of ecological effects at the population level; assessment of the significance of pollutant interactions
- Investigation of the genetic structure of plant populations; assessment of the rates of gene flow in plant and animal populations; evaluation of the potential for gene flow from crops and wild relatives

Nuclear power and radioactive waste

- Assessment of radionuclide transfers in foodchains to man, and persistence in upland soils

The significance of research results is fed into the policy development process through ITE representatives on government committees. These include the Critical Loads Advisory Group, the Advisory Committee on Pesticides, the Advisory Committee on Hazardous Substances, the Advisory Committee on Releases (of genetically modified organisms), and the Red Deer Commission.

The White Paper announced a wide range of initiatives for improving the rural environment and 'greening' agricultural policies. The rate of change will be accelerated by the environmental proposals in the reformed Common Agricultural Policy (CAP). In response, ITE has played a significant role in formulating the NERC mission for land use research. The mission statement recognises three vital stages:

- ensuring that environmental information on land use is available, accurate and comprehensive

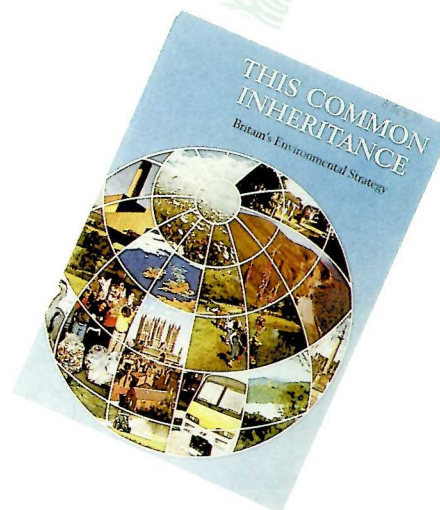
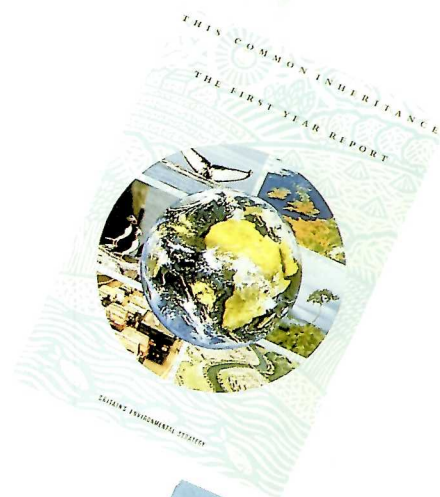
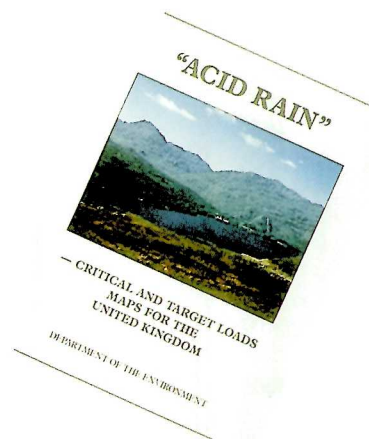
- developing the ability to predict the environmental consequences of major changes in land use
- providing a basis on which policies may be formulated.

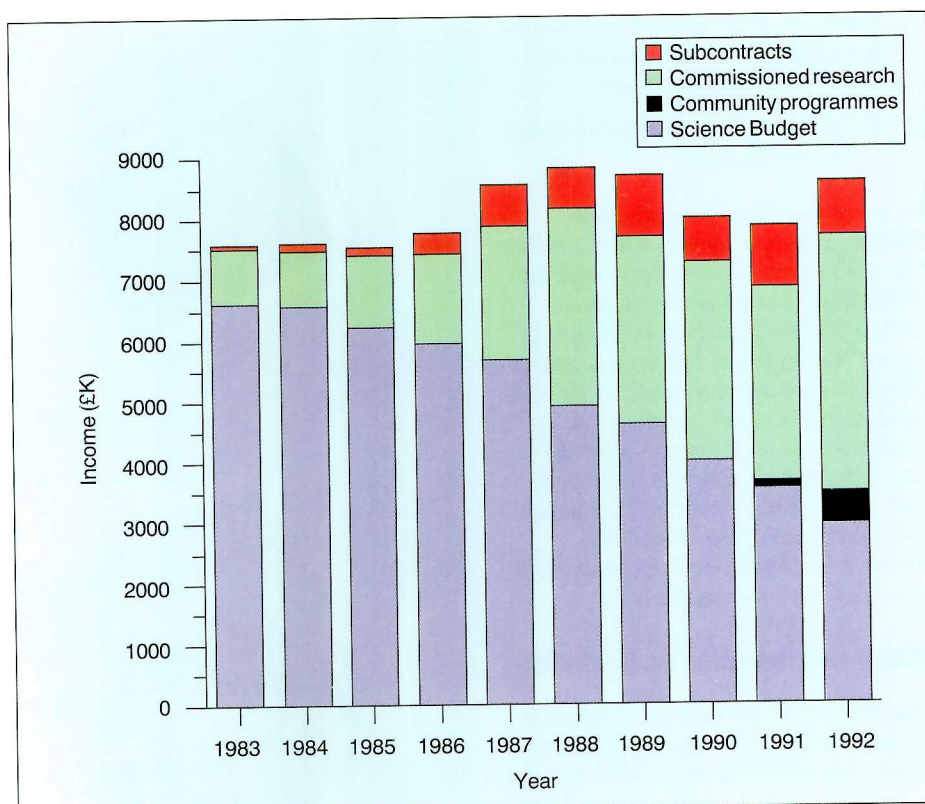
An integrated approach has been adopted based on collaboration between ITE, the Institute of Hydrology, and the NERC/ESRC Land Use Programme (NELUP) at the University of Newcastle upon Tyne. A major seminar on land use policy was held in the spring of 1992 in London, and an NERC publication entitled *The land of Britain – land use research for the future* was produced. This strategic planning by ITE staff has promoted joint research council discussions on the research required to underpin rural sustainability.

ITE performance in 1991–92

The finances of the Institute continue to be finely balanced. The trend of recent years continued with a gradual reduction in the Science Budget (SB) support and a tendency for the commissioned research income (CR) to increase slowly. Several internal SB initiatives were delayed or part-funded as a result, but success in open competition for new NERC community programmes such as TIGER is now having a positive effect on ITE finances, as well as its science (see top graph, p6). The CR income provided nearly 60% of the annual turnover in 1991–92 and most projects had a significant element of applied research as a result. The most important sources of CR income were once again the Department of the Environment and the public/private industry (see bottom graph, p6). The main problems with commissioned research are still the relatively small size of many contracts (less than £30K) and their short duration (less than two years on average). Nevertheless, it was a real achievement to reach a balanced budget at the end of a difficult year. The Institute administered a significant number of interdisciplinary contracts for government departments which involved subcontracting research with other institutes and HEIs. This co-ordination role is an important aspect of the ITE's function and has increased further with the initiation of the TIGER programme.

Staff changes were minimal, and the restructuring of the southern Stations was largely completed (see structure diagram, p7). The large number of





Trends in income

fixed-term appointments (nearly 25%) does present some difficulty in ensuring continuity and career development. Nevertheless, the recent trend of increasing output of publications was more marked in 1991–92. In spite of the declining SB support and the pressures for contract reports, the scientific publications increased by around 20% (see graph, p7). There was a notable increase in publications in refereed journals.

Scientific achievements have been numerous and some are illustrated by the reports which follow. In particular, there have been significant developments in the following areas.

Long-term monitoring

- Analysis of 30-year trends of pollutant residues in wildlife to show a decline in pesticide residues and increases in PCBs
- Establishment of the rate of recovery of predatory birds following a decrease in pesticide applications
- Analysis of 12-year data base on the land cover of Great Britain to show the continuing decline of hedgerow length and change in composition
- Simulation of climate change effects on long-term population dynamics of arctic plants

Ecological modelling

- Development of new models for plant succession, density dependence in shorebirds, population dynamics of ant/butterfly/parasitic wasp assemblages and nitrate leaching from forests;

development of a mechanistic model for bracken growth and spread; completion of a 'niche' model for *Spartina anglica*

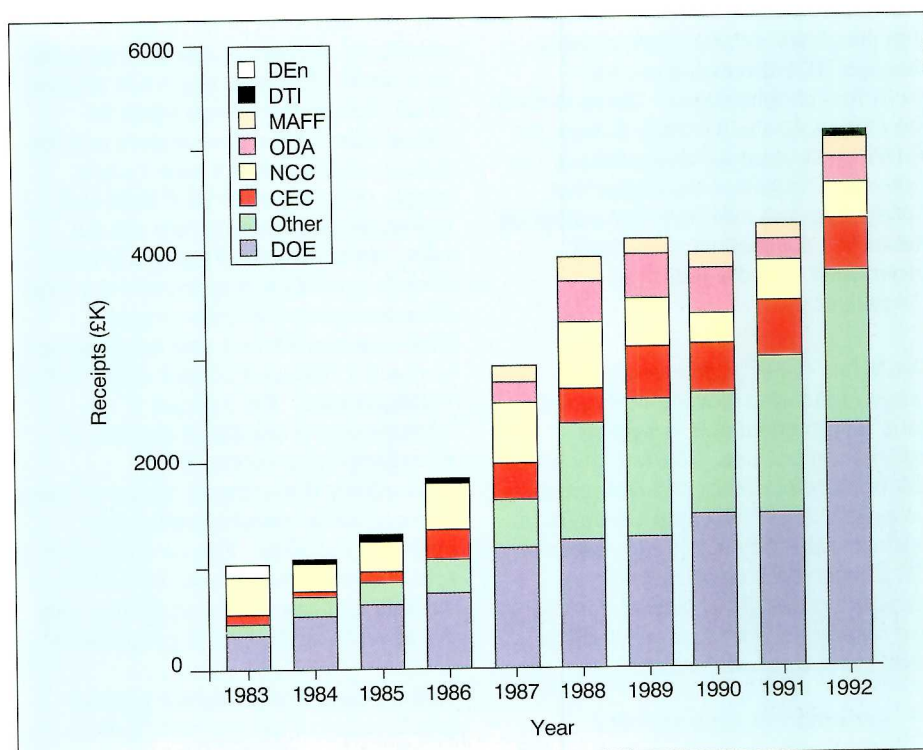
- Application of the Edinburgh Forest Model to assess the effects of management, carbon dioxide and nitrogen fertilization on the carbon balance

Landscape ecology

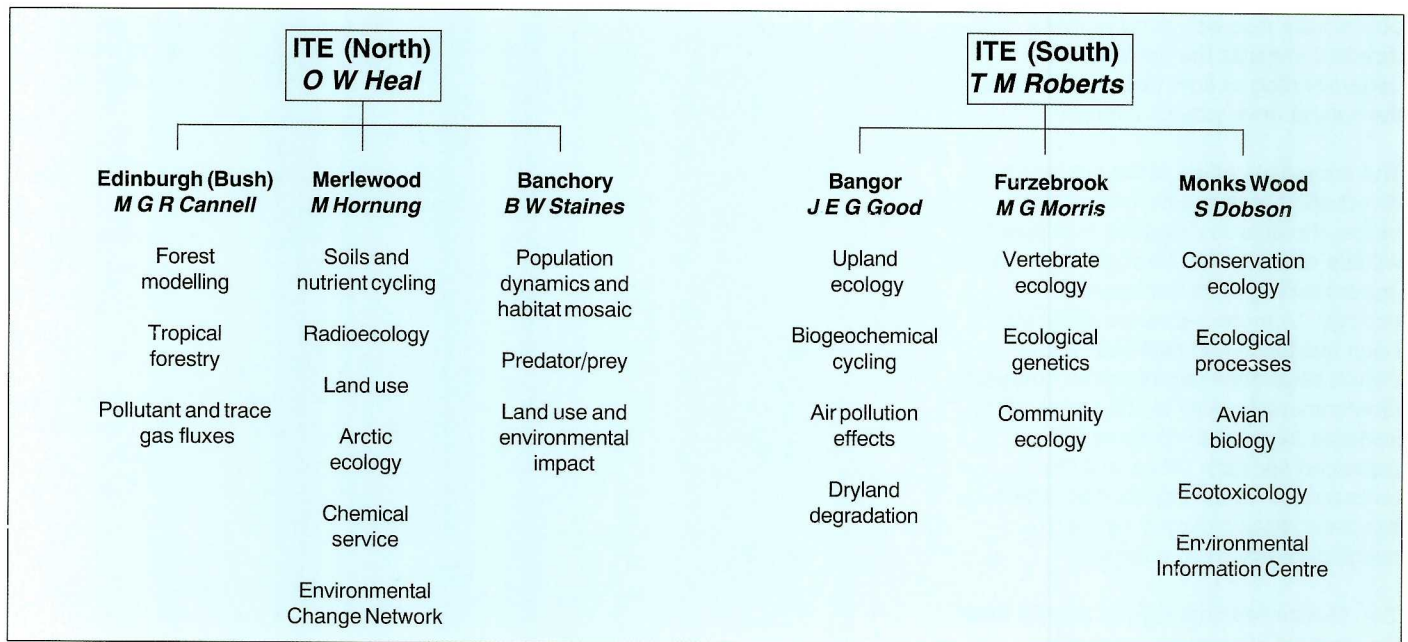
- Collection of detailed information on species turnover for birds and also insect diversity in woodland fragments, and on species richness of linear features
- Development of sink/source relationships for capercaillie populations in forested landscapes

Pollution research

- Major developments in the use of geographical information systems for producing critical loads maps for the UK; establishment of the significance of stand age in the acidification of surface waters and of mechanisms to reduce nitrate leaching from mature forests; demonstration that acid mist impairs the growth of mature spruce; production of a revised budget for reactive atmospheric nitrogen over the UK



Long-term pattern of contract income from major customers



Current organisation within ITE

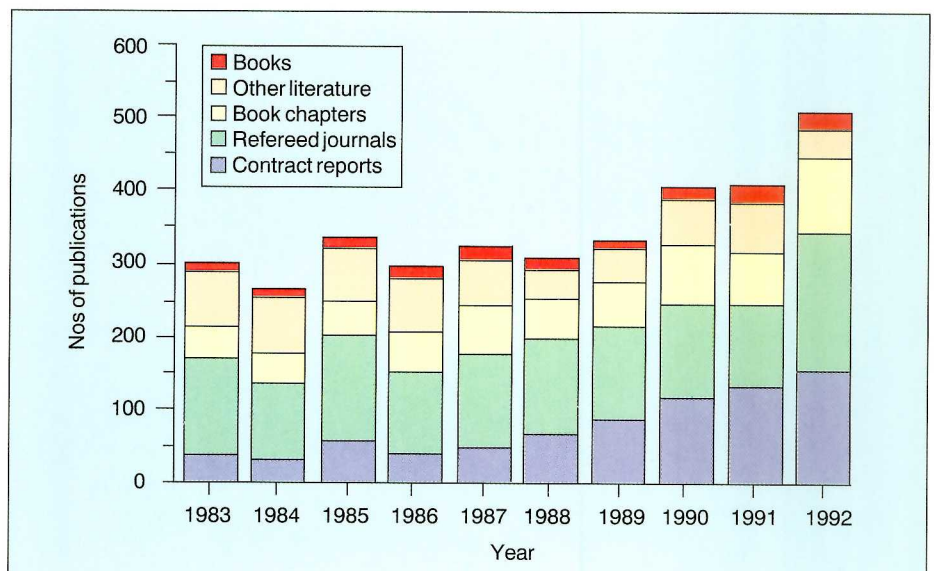
- Prescription of the buffer zones required to prevent effects of pesticide spray drift; development of *in vitro* method for determining radiocaesium availability to herbivores; demonstration of reduced photosynthesis of arctic dwarf shrubs to low levels of ultraviolet radiation (UV-B)

Institute staff have written 16 books on such diverse topics as the environmental history of electricity generation, orchid biology, biotopes in Europe, and scientific management for conservation. In addition, major reviews were published on wildlife diseases (which led to the establishment of a NERC Special Topic programme), the importance of territorial behaviour in limiting bird density, environmental auditing and assessment techniques for integrated pollution control, environmental health criteria for DEHP, cadmium and 1,1,1-trichloroethane, biological recording of changes in British wildlife, and evaluation of the potential terrestrial impacts of climate change.

Personal achievements during the year have been the awards of Individual Merit Promotion to Grade 6 for Dr David Fowler and to Grade 5 for Dr Ian Newton. Dr Fowler was awarded a Special Professorship in Environmental Sciences by the University of Nottingham, and Dr Newton also received the Royal Society for the Protection of Birds Medal for services to the scientific conservation of birds. Dr Max Hooper retired at the end

of the 1991–92 year after a long and distinguished career, first in the Nature Conservancy and then in ITE. Dr Hooper has been the Head of Station at Monks Wood for the last ten years; he has been replaced by Dr Stuart Dobson. Dr Ken Walton retired from the Bangor Research Unit in January 1992, having begun his career with the Nature Conservancy in 1958. Dr Rob Marrs also left ITE Monks Wood in 1991–92 for the Chair of Applied Ecology at the University of Liverpool. A welcome appointment has been that of Prof John Monteith, FRS, as NERC Senior Visiting Fellow, based at ITE Edinburgh, to continue his research on plant/atmosphere interactions.

There were many important developments and achievements during the year but one tragic incident cannot pass without comment. The fire which destroyed part of the ITE Banchory Research Station at Brathens in December 1991 was started by animal rights activists. It was aimed at our research on grouse population ecology because of its connection with the game industry. However, as stated by Prof John Knill, the Chairman of NERC, in *The Scotsman* on 17 December 1992, 'far from helping animals, this violent attack at Banchory has set back the cause of conservation. There can be no justification for the destruction of long-running research records or for



Trends in output of publications

obstructing research programmes directed towards the fundamental understanding of how man, wildlife and the natural environment interact'

The immediate effect of the fire was to divert effort at Banchory from a wide range of research designed to support wildlife conservation through improved understanding of its fundamental ecology. A more pervasive effect has been that funds and staff time which should have gone into research on major environmental issues in ITE and in other institutes have been diverted into enhanced security. Thus, it is the environment, including wildlife, which has been disadvantaged by the misguided actions of activists.

Two factors which emerged rapidly from the incident were the remarkable resilience and dedication of the staff at Banchory and the support from within NERC and from many individual scientists, organisations and the general public. These responses have done much to compensate for the damage, and we gratefully acknowledge the constructive efforts of so many people.

Appendix 1. Staff at 31 March 1992

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SSO Dr R Milne
SSO Mr R I Smith
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<i>Grade7</i>	Dr G W Elmes
<i>Grade7</i>	Dr A J Gray
<i>Grade7</i>	Dr R E Kenward
<i>Grade7</i>	Dr J A Thomas
<i>Grade7</i>	Dr L K Ward
<i>Grade7</i>	Dr N R C Webb

<i>SO</i>	Mrs S A Bell
<i>SO</i>	Mr S Hughes
<i>SO</i>	Mr D A Norris
<i>SO</i>	Mr T G Williams
<i>ASO</i>	Mr C Edge

<i>SSO</i>	Dr S McGrorty
<i>SSO</i>	Dr C J Reading
<i>SSO</i>	Mr R G Snazell

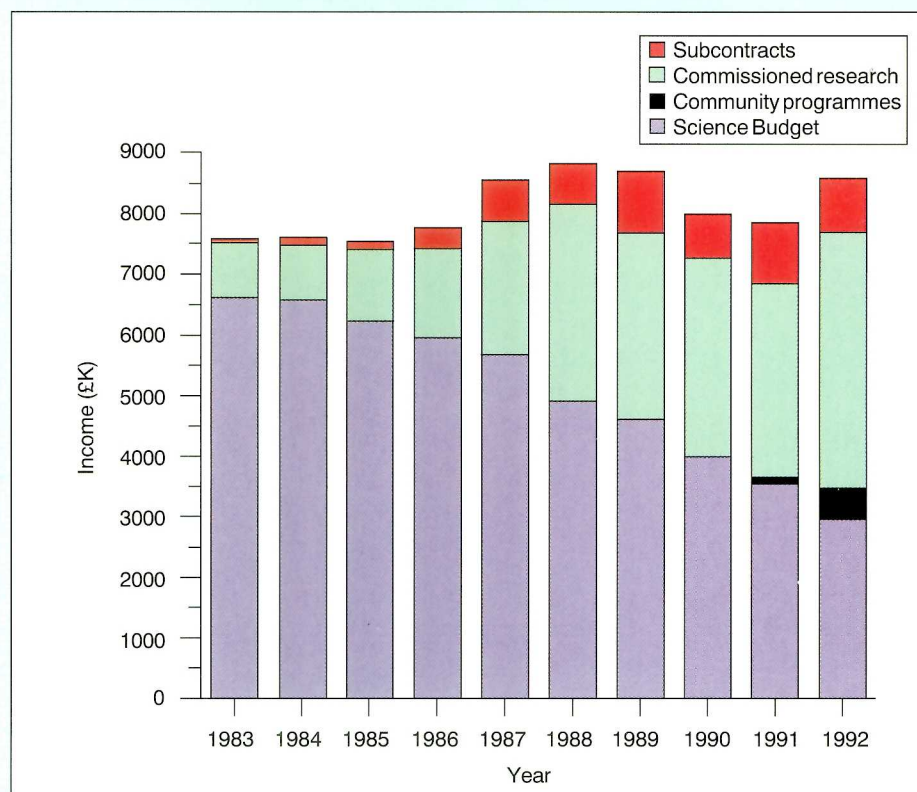
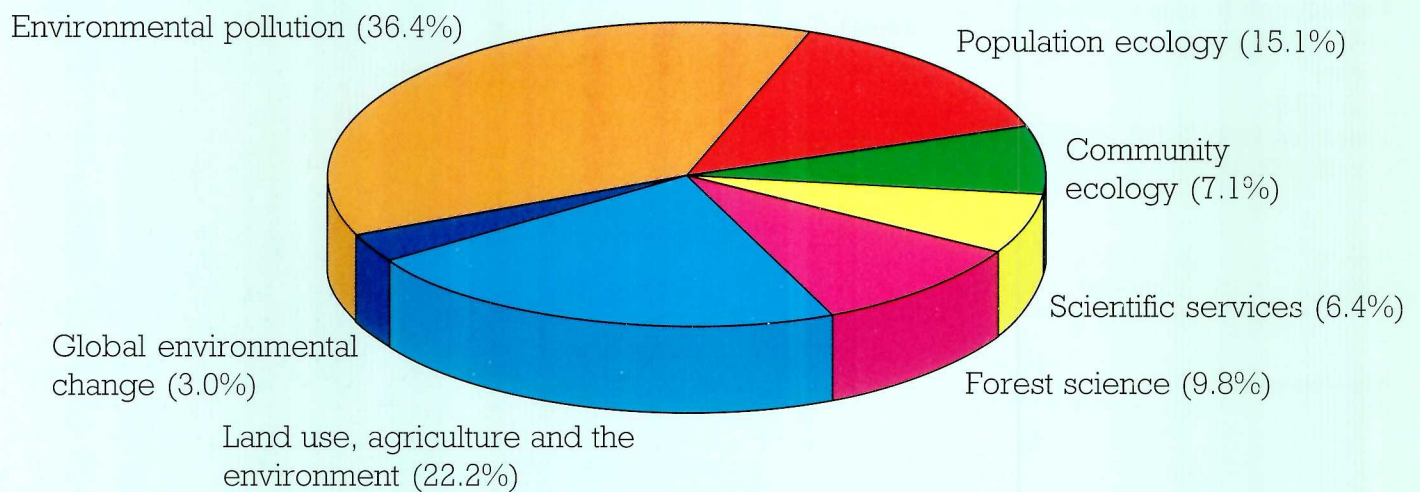
<i>HSO</i>	Dr R W G Caldow
<i>HSO</i>	Ms S Le V dit Durell (PT)
<i>HSO</i>	Dr R Moore
<i>HSO</i>	Mr B Pearson
<i>HSO</i>	Dr A F Raybould
<i>HSO</i>	Mr W E Rispin
<i>HSO</i>	Mrs J C Wardlaw (PT)

<i>SO</i>	Miss I L Moy
<i>SO</i>	Mr R J Rose
<i>SO</i>	Miss E A Warman

Appendix 2. Finance and administration

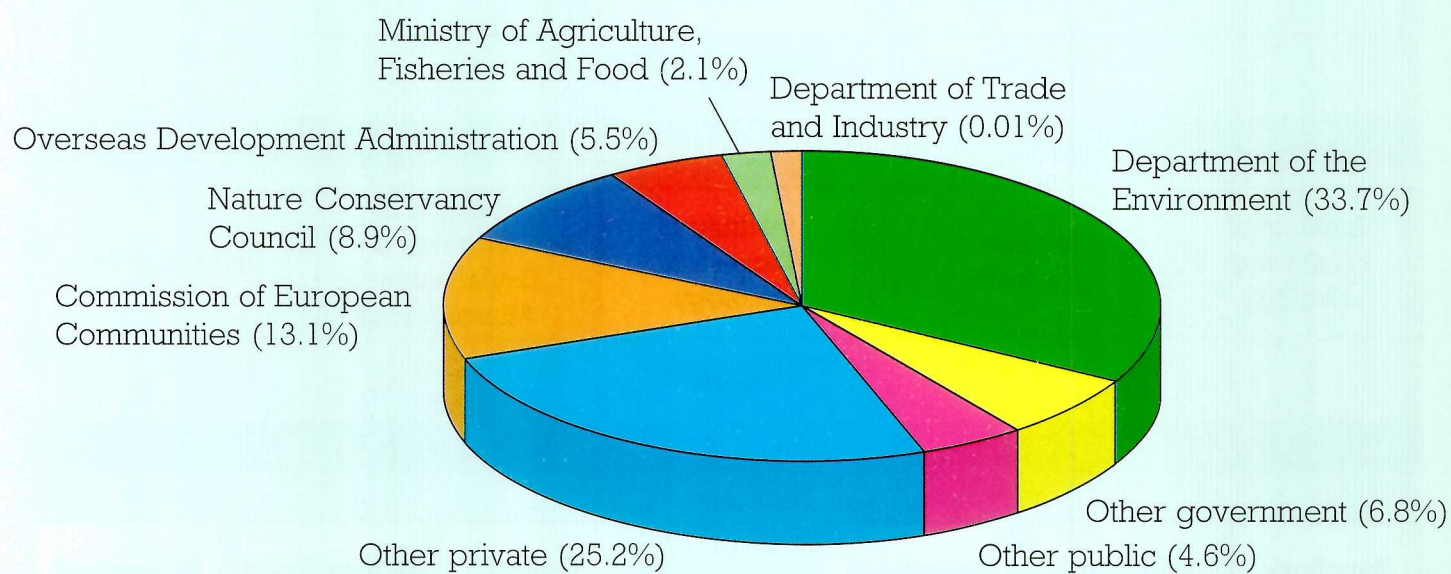
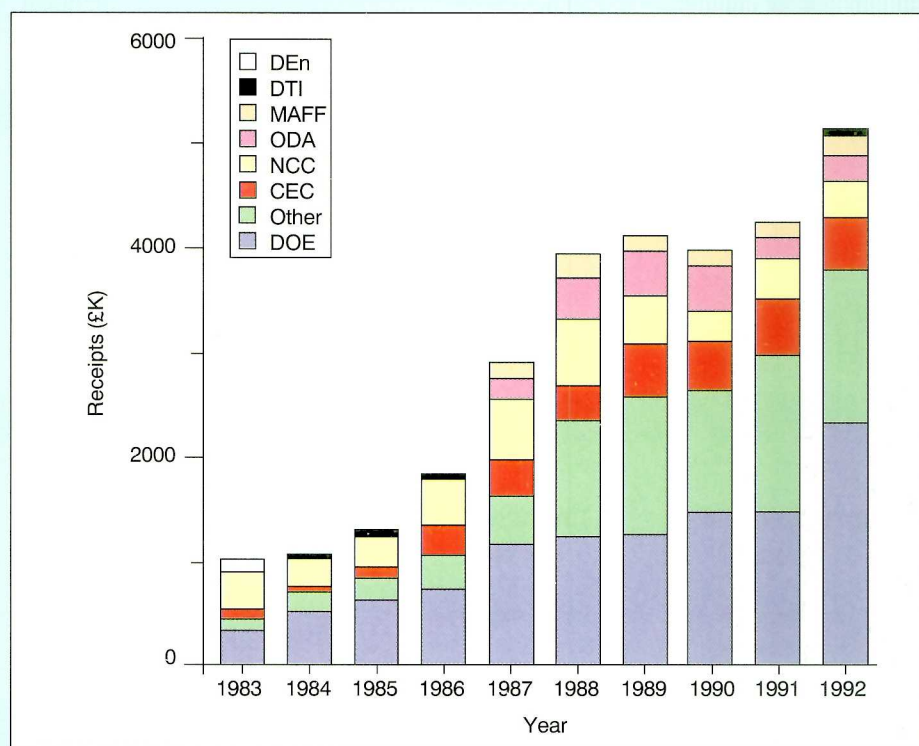
The following diagrams indicate levels of funding for the Institute, and provide details of expenditure.

The pie chart shows Institute expenditure (as full economic cost) for the year 1991–92 by scientific programme of work



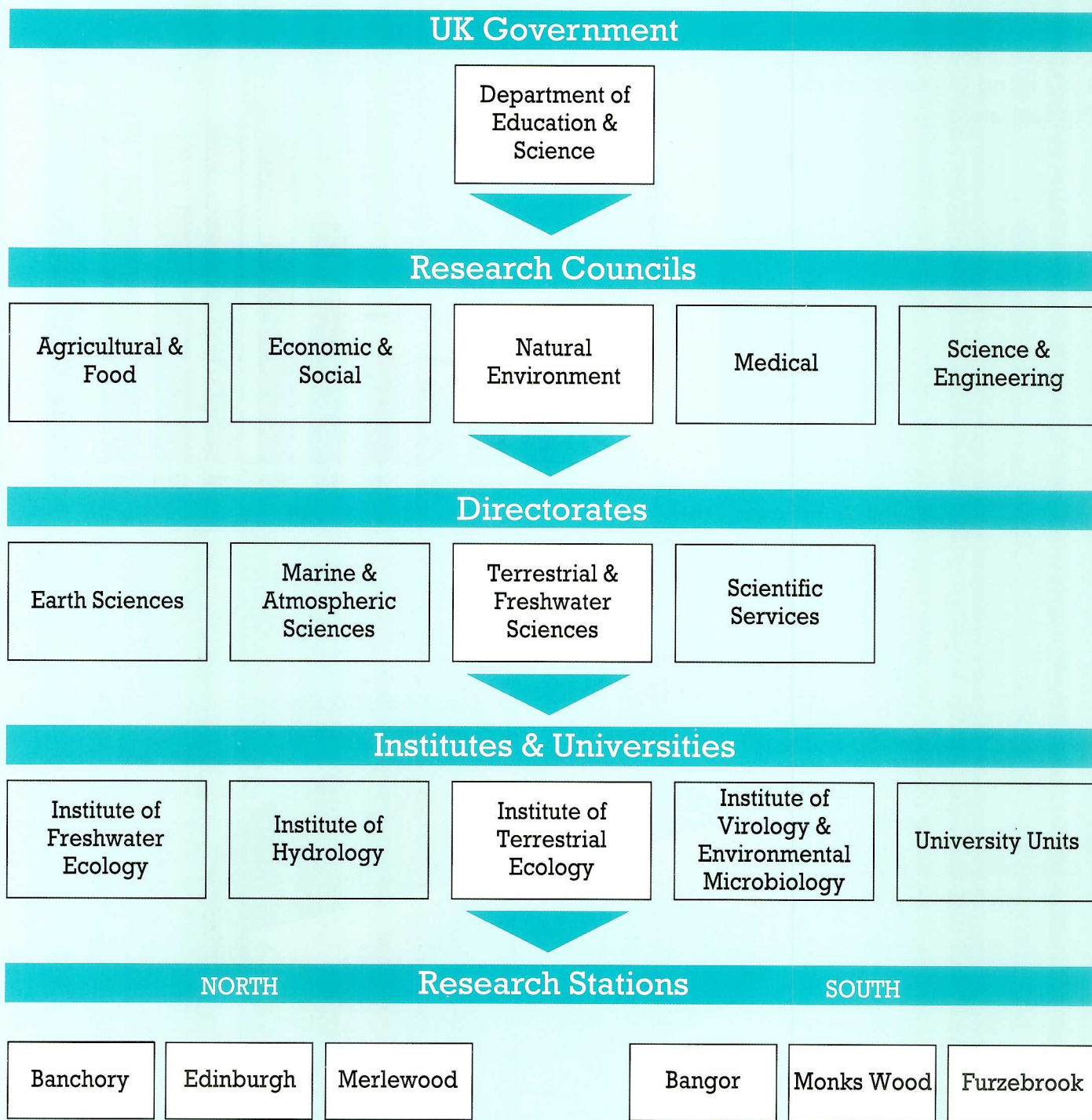
This graph illustrates trends in income (at constant prices – 1983–91 revalued to 1992 using Gross Domestic Product indices)

This graph illustrates the long-term pattern of receipts from major customers (at constant prices – 1983–91 revalued to 1992 using Gross Domestic Product indices)



The pie chart shows the division of 1991–92 commissioned receipts by major customers

The Institute's position within the UK Research Council system is shown below. ITE is an integral part of the Natural Environment Research Council, which supports a wide range of basic and applied research in universities and institutes. It is able to draw on the expertise of about 400 colleagues in terrestrial and freshwater research, and on 1300 scientists within NERC.



Appendix 3. Research projects at 31 March 1992

ITE NORTH — EDINBURGH RESEARCH STATION

Programme 1 Forest science

T01055-4 Forest Ecosystems Research Network O W Heal

T01057-5 Temperate tree biology M G R Cannell/A D Watt

T01057s2	Temperate tree improvement	J D Deans/ H L Billington
T01057v5	Frost hardiness of oak provenances	J D Deans
T01057w2	Mechanistic models of tree and forest growth	R C Dewar
T01057x2	Modelling the population dynamics of the pine moth	A D Watt

T01059-5 Mycorrhizas and tree production J Wilson

T01059a2	Mycorrhizas and tree growth	P A Mason
T01059k2	Root system architecture and symbiont infection processes	A Baker/ J Wilson
T01059n1	<i>Eucalyptus</i> mycorrhizas in Chile	P A Mason

T01060-5 Tropical forestry and tree improvement R R B Leakey

T01060a2	Domestication of tropical hardwoods	R R B Leakey
T01060i1	UNESCO MAB contracts	O W Heal
T01060j1	ITE/CATIE link	A Newton
T01060k1	Cameroon forestry - Phase 2	R R B Leakey
T01060l2	Relationship between growth, shade tolerance and the physiology of rooting in tropical trees	R R B Leakey
T01060p5	Domestication of Cameroon fruit trees	R R B Leakey
T01060s1	Tropical tree improvement training	J Dick
T01060v1	AMSAL Phase 2, Kenya	R R B Leakey
T01060x1	Cameroon forest management and regeneration	G J Lawson
T01060y1	Tropical trees potential for domestication, rebuilding forest resources	R R B Leakey

T01061a3	The effects of farm woodland size, shape, structure and species composition on insect diversity	A D Watt
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Programme 2 Land use, agriculture and the environment

T02051u5	Land use in Scotland	B G Bell
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Programme 3 Global environmental change

T03054a6	Modelling carbon dioxide exchange at regional scales	R C Dewar
T03055i6	Process-based modelling of grasslands and forests CO ₂ and climate effects	M G R Cannell/ J H M Thornley

T03057c6	Carbon flux in tropical forests below-ground biomass	J D Deans
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T03064b6	Methane emissions from UK wetlands	D Fowler
T03064h6	N ₂ O flux measurement using chamber and micrometeorological techniques	D Fowler

T03065a6	Measurement of methane emission fluxes at the field/landscape scale	D Fowler
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Programme 7 Environmental pollution

T07055-3 The effects of atmospheric pollutants on forests and crops (special topic programme) B G Bell

T07055i3	Exchange of NO _x and other gases before and after exposure to wind, ozone and polluted cloud water	D Fowler/ J Grace
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T07056-5 Ecological effects of climatic change M G R Cannell

T07056d5	Response of trees to elevated CO ₂ concentrations and temperature	A Friend
T07056t1	Carbon sequestration by vegetation in the UK	A D Watt
T07056v1	Impacts of the mild winters and hot summers in the UK in 1988-90	M G R Cannell

T07057-5 Atmospheric pollutants and trace gases D Fowler

T07057a1	Land/atmosphere exchange of NO _x , O ₃ and NH ₃ (dry deposition)	D Fowler
T07057d5	Land/atmosphere exchange of methane	D Fowler
T07057h2	Deposition of lead 210	R Mournie
T07057j1	Fluxes of nitrous oxide and methane from agricultural and natural ecosystems	D Fowler
T07057k5	Fate of nitrogen compounds around the North Sea	D Fowler

T07058-5 Atmospheric pollution modelling and chemistry J N Cape

T07058a2	The chemical composition of rainfall	J N Cape
T07058c1	Nitrogen chemistry on Great Dun Fell	D Fowler

T07059-5 Effects of atmospheric pollutants on trees D Fowler/J N Cape

T07059b5	Open-top chamber studies on spruce and beech	D Fowler
T07059e5	Effects of acid mist on mature trees	A Crossley
T07059h5	Throughfall and stemflow studies	J N Cape

Programme 13 Scientific services

T13054b2	Utilisation of LIBERTAS in ITE libraries cataloguing	L M Scoular
T13054d2	Utilisation of LIBERTAS in ITE libraries serials management	S M Adair

T13054f2	Use of Email over JANET for interlibrary loans	L Dickson
T13059-5	Edinburgh scientific support services	M G R Cannell
T13059a2	Glasshouses and nursery support and development	R F Otley
T13059e2	Controlled environmental facilities at ITE Edinburgh	R Milne
T13059f2	Operation of the Rivox field site	R Milne
T13059g2	Biometrics research and consultancy at ITE Edinburgh	R I Smith

ITE NORTH — MERLEWOOD RESEARCH STATION

Programme 1 Forest science

T01051-5	Mycological and faunal processes in carbon and nutrient flux in soil and soil/root interactions	J Dighton
T01051a2	Role of fungi in nutrient cycling with special reference to <i>Mycena galopus</i> in forest soil	J C Frankland
T01051g2	A mechanistic approach to the study of the role of extramatrical hyphae of mycorrhizal associations in nutrient uptake	J Dighton
T01054-2	Ecological effects of forest management	J M Sykes
T01054a2	Effects of pure and mixed stands on soils, vegetation and waters	S M C Robertson
T01054e2	Effects of clearfelling in pure and mixed stands on soil water chemistry	S M C Robertson
T01054f2	Effects of afforestation on fauna and flora	J M Sykes
T01054g2	Long-term dynamics of semi-natural forest ecosystems	J M Sykes
T01054i2	Rehabilitation of riparian zones following clearfelling of coniferous forest	J K Adamson
T01054l2	Kershope soil analysis, data analysis and paper writing	J K Adamson
T01062-5	Organic matter and nutrient dynamics in forest and upland soils	A F Harrison
T01062a2	Modelling chemical and biological processes in acid upland soils	E W Tipping/ A F Harrison
T01062b5	Effects of climate management practices and vegetation development on plant nutrition/soil relationships	A F Harrison
T01062d1	Application of nutrient bioassays to eucalyptus forest management	J Dighton
T01062f1	Fast-growing tree project, Karnataka, India	A F Harrison
T01062g5	Rehabilitation of <i>Acacia</i> fallow systems and nutrient dynamics in the Blue Nile region, eastern Sudan	D K Lindley
T01062h5	The scientific management of renewable natural resources in China	D K Lindley
T01062i5	Nutrient cycling in European forests	P Ineson
T01062k1	<i>Acacia</i> tree fallows in the Sudan/Senegal	D K Lindley

T01062l2	Interactions between mineral nutrition of plants and air pollution, particularly CO ₂	A F Harrison
T01062m5	Application of the nutrient deficiency root bioassays to forests	A F Harrison

Programme 2 Land use, agriculture and the environment

T02051-5	Land use change and ecological impacts	R G H Bunce
T02051m5	Countryside survey 1990	C J Barr
T02051n2	Extending the use of the Merlewood land classification system liaison and collaboration	C J Barr
T02051o2	Land use data management and integration at ITE Merlewood	C J Barr
T02051p2	The application of Geographical Information Systems (GIS) to the Merlewood land use data base	D C Howard
T02051v3	Collaboration with NERC/ESRC land use programme (NELUP)	R G H Bunce
T02051w1	Northern Ireland countryside survey	R G H Bunce
T02064-5	Environmental impact assessment - ITEN Merlewood	J M Sykes
T02064b1	Shetland saltmarsh survey	R Scott
T02064e5	National survey of natural ecosystems in Korea	D K Lindley
T02065d3	Population dynamics associated with cereal straw microbial and earthworm dynamics in relation to straw as a resource unit (JAEP)	J Dighton
T02068-5	Detection of environmental change	J M Sykes
T02068b2	Environmental change network	J M Sykes

Programme 3 Global environmental change

T03050a6	1 Crop yield and ¹³ C/ ¹² C ratios over the last 150 years as indicators of atmospheric change 2 Carbon isotope techniques to measure carbon turnover in soils	D S Powlson/ A F Harrison
T03055c6	CO ₂ fertilisation effects on decomposition processes	P Ineson
T03055e6	Field experiment study of the effects of global warming on carbon turnover in upland soils	P Ineson
T03064g6	Measurement of trace gas fluxes in forest and upland soils	P Ineson
T03090-3	Arctic terrestrial ecology (special topic programme)	T V Callaghan
T03090c3	Arctic ecosystems and environmental change	T V Callaghan

Programme 7 Environmental pollution

T07050-5	Radionuclides in vegetation and soil	A D Horrill
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T07050c5	Post-Chernobyl radiation levels in soils and vegetation	R Moss/ A D Hornill	T07054e1	Subcontract to Nottingham University	M Hornung/ J Colls
T07050h5	The role of the litter layer in the recycling of caesium isotopes in upland Britain	A D Hornill	T07054g5	ENCORE	M Hornung
T07050i2	The absorption and recycling of plutonium in plants	A D Hornill	T07054h5	Modelling critical loads of N	M Hornung
T07050j2	Advisory committees on radionuclide research	A D Hornill	T07054j2	Modelling the effects on water quality of liming in upland catchments	M Hornung
T07050k5	Radioactivity in natural ecosystems – EEC II	A D Hornill	T07054l5	Controls on nitrate leaching in Welsh forests	A F Harrison
T07050l2	Radioecology computer-based bibliography	V H Kennedy	T07054m5	Changes in acidity of Moor House soils	M Hornung
T07050m2	Development and calibration of mechanistic models for radionuclide uptake from soils	B J Howard	T07054n1	Costs of ecological impacts of the coal energy cycle	M Hornung
T07050n2	Uptake of radionuclides by and distribution within basidiomycete fungi	J Dighton	T07055k3	Interaction of enhanced N loading on soil nutrient dynamics and forest growth	M Hornung
T07050o1	Monitoring of radionuclides in tidally inundated pastures	A D Hornill	T07056q5	Carbon cycling and climate change	P J A Howard
Programme 8 Population ecology					
T07051-5	Radionuclide-animal transfers	B J Howard	T08052-5	Plant strategies: response to environmental stress	T V Callaghan
T07051c2	Comparative radioecology of Ag-110m and Cs-137	N A Beresford	T08052a2	Plant responses to environmental stress at high latitudes	T V Callaghan
T07051d1	The dynamics of radionuclide uptake by sheep	B J Howard	T08052b5	Strategies of growth and population dynamics of tundra plants related to climatic change	T V Callaghan
T07051f1	Development of a method to rapidly predict the availability of radiocaesium to animal products after an accidental discharge	B J Howard	T08052d2	Carbon isotope discrimination and water use efficiency in arctic clonal plants	J M Welker
T07051g5	Factors affecting radionuclide transfer to ruminants	B J Howard	T08052e2	Sources of water for polar semi-desert vegetation	J M Welker
T07051i1	Behaviour of S-35 in ruminants	B J Howard	T08052f2	Winter ecology in the high arctic of Svalbard: plant/animal interactions in snow-free and snow-lying areas	J M Welker
T07051j1	Identification of hot spots in restricted areas	N A Beresford	Programme 13 Scientific services		
T07052-5	Geochemistry of radionuclides	A D Hornill	T13054-2	ITE library services	J Beckett
T07052d2	Radiochemical development	A D Hornill	T13054e2	Data base of ITE staff publications	J Beckett
T07052e2	Immobilisation of radioactive caesium in upland soils	A D Hornill	T13055-5	ITE chemical research and development	J A Parkinson
T07052g2	Association of the actinide elements with soil organic matter	A D Hornill	T13055a2	Chemical support studies	J A Parkinson
T07053-5	Soil microbial response to pollutants	P Ineson	T13055i2	Merlewood Analytical Section accreditation scheme	A P Rowland
T07053a1	Effects of forest fumigation with SO ₂ and O ₃ on roots and mycorrhizas of trees	J Dighton	T13055j2	Data base for Merlewood Analytical Section records	A P Rowland
T07053b1	Effects of air pollution	P Ineson	T13055l2	Analytical group methods book update and revision	J D Roberts
T07053c2	Effects of atmospheric pollution on mycorrhizas	J Dighton	T13055m5	Analyses for certification of rainwater international standard reference material	J A Parkinson
T07053d2	Effects of sulphur dioxide on litter-decomposing fungi in deciduous woodland	J C Frankland/ P Ineson	T13056-4	NERC mass spectrometer service	C Quarmby
T07053e5	Liming and faunal inoculation of forest soils	J K Adamson	T13056a2	NERC mass spectrometer service	C Quarmby
T07053f2	Effects of sulphur dioxide on fungal decomposition of tree leaf litter	P Ineson/ J C Frankland	T13057-5	Merlewood scientific support services	D K Lindley
T07054-5	Acid deposition and its effects	M Hornung	T13057a2	Graphics and publications	C B Benefield
T07054a5	Critical loads of acidity, N and S for soils	M Hornung	T13057b2	Biometrics and modelling support services at Merlewood	D K Lindley
T07054c1	Subcontract to Aberdeen University	M Hornung/ M Cresser	T13057c1	ITE advice and services to Nature Conservancy Council	J M Sykes
T07054d1	Subcontract to Lancaster University	M Hornung/ T A Mansfield	T13057e1	Experimental design course for forestry staff, Nepal	D K Lindley

ITE NORTH — BANCHORY RESEARCH STATION

Programme 1 Forest science

T01061j3	Interactions between farm forestry and the population biology and dispersion of roe deer	M Gorman/ B W Staines
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Programme 2 Land use, agriculture and the environment

T02050-5	Human impact, erosion rehabilitation	N G Bayfield
T02050b1	Revegetation after disturbance	J Miles
T02050d1	Aonach Mor development plan	N G Bayfield
T02050e1	Footpath rehabilitation studies for the Yorkshire Dales National Park Committee	N G Bayfield
T02050h1	Restoration of upland vegetation	N G Bayfield
T02050i1	Path revegetation trials on the Pennine Way	N G Bayfield
T02050l1	Aonach Mor	N G Bayfield
T02050q1	NIREX deep repository study	N G Bayfield
T02050r1	Glas Maol monitoring	D Welch
T02050s1	Development opportunities in the natural environment	B W Staines
T02050t1	North-western ethylene pipeline project	N G Bayfield
T02051x1	Land cover data base for Scotland	R P Cummins

Programme 7 Environmental pollution

T07050c5	Post-Chernobyl radiation levels in soils and vegetation	R Moss/ A D Hornill
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Programme 8 Population ecology

T08050-5	Vertebrate population dynamics and upland habitat geometry	R Moss
T08050a2	Population dynamics of cycling and non-cycling tetraonids	R Moss
T08050c5	Population ecology of capercaillie	R Moss
T08050f5	Adaptation of capercaillie to novel environments	R Moss
T08050g2	Population genetics of mute swans	P J Bacon
T08050h2	Red grouse rearing and release	R Moss
T08050i2	Epidemiology of <i>Trichostrongylus tenuis</i>	R Moss
T08051-5	Population ecology of predators	H Kruuk
T08051c2	The effects of environmental factors on populations of otters and fish in the north of Scotland	H Kruuk
T08051d5	Piscivorous birds in Scottish salmon rivers	M Marquiss
T08051e5	Ecology of the pine marten	D Balharry
T08051h5	Monitoring of seabird populations and performance in the North Sea	M P Harns
T08051i2	Feeding ecology and energetics of high and low latitude shags	M P Harns
T08051i1	Oil spill contingency	J W H Conroy

Programme 9 Community ecology

T09050-5	Dynamics of upland and montane plant communities	J Miles
T09050d1	Response of <i>Gentiana nivalis</i> population to withdrawal of sheep grazing	B W Staines
T09050f2	Vegetation dynamics and soils	J Miles
T09050i2	Dynamics of <i>Macchia</i>	S Mazzoleni
T09050k2	Deer in production forests	B W Staines/D Welch
T09050l2	Response of Sitka spruce to browsing and bark-stripping damage	D Welch/ B W Staines
T09050m2	Competition and niche segregation in red and roe deer	B W Staines
T09050n5	Selection of individual plants within species by herbivores (JAEP)	B W Staines
T09050o5	The influence of vegetation pattern on the distribution and foraging strategies of hill sheep and red deer (JAEP)	D Welch
T09050p1	Blaeberry autecology	D Welch
T09050q2	Habitat use by wild boar in Tuscany	G Massei
T09050r2	Habitat use by red and roe deer in Abruzzo	E Bruno
T09050s2	The effects of culling in roe deer populations	B W Staines
T09050t1	Recreation and red deer	B W Staines

Programme 13 Scientific services

T13053-5	Services at ITE Banchory	B W Staines
T13053a1	Ecological advisory appointment with Scottish Development Department	J Miles
T13053c1	Brathens consultancies	B W Staines
T13053d2	Computing and statistical advice	P J Bacon
T13053e1	Scottish Office consultancy	J Miles
T13053f2	Scientific community services	B W Staines

ITE SOUTH — MONKS WOOD

Programme 1 Forest science

T01061-3	Farm forestry (special topic programme)	T W Parr
T01061b3	Vegetation development in relation to soil, site and tree species in new farm woodland predictive models of colonisation and succession	M O Hill
T01061g3	Crop pollination the role of farm woodlands as reservoirs for flower-visiting insects	S A Corbet/ R H Marrs
T01061h3	Island biogeography of farm woodlands	M B Usher/ M D Hooper
T01061k3	The introduction of ancient woodland field layer species into secondary woodland	A J Morton/ M O Hill

Programme 2 Land use, agriculture and the environment

T02052-5	EIC remote sensing	R M Fuller
T02052a2	Information extraction from imagery	R M Fuller

T02052e1	Remote sensing in the Less Favoured Areas models or rural land use planning	A R Jones	for decision-making in ecological assessment of afforestation schemes
T02052f5	Characterisation of grassland type and condition using remote sensing	A R Jones	
T02052i2	Remote sensing in EIC	R M Fuller	
T02052i2	EIC marketing – remote sensing	J C Metcalfe	
T02052m5	Remote sensing the land cover of Great Britain	R M Fuller	
T02052n5	Remote sensing in the countryside survey 1990	R M Fuller	
T02053-5	Ecological data management	G L Radford	
T02053a2	Digital cartographic service	N J Brown	
T02053b1	EEC Corine biotopes project	D Moss	
T02053e2	Data cataloguing and management	G L Radford	
T02053h2	National map data base	G L Radford	
T02053i2	GIS demonstrator	G L Radford	
T02053j2	EIC co-ordination	B K Wyatt	
T02053k3	GIS for monitoring and modelling land cover	G L Radford	
T02053l2	EIC marketing – spatial data (GIS)	J C Metcalfe	
T02053m5	A GIS for conservation in Wales	G L Radford	
T02053n1	Extension of Corine biotopes recording to central Europe	D Moss	
T02054-5	EIC Biological Records Centre	P T Harding	
T02054a5	EIC-BRC botanical recording schemes	C D Preston	
T02054b5	EIC-BRC vertebrate recording schemes	H R Arnold	
T02054c2	EIC-BRC non-marine Isopoda	P T Harding	
T02054d5	EIC-BRC terrestrial and freshwater invertebrate recording schemes	B C Eversham	
T02054e5	EIC-BRC Biological Records Centre co-ordination	P T Harding	
T02054f2	EIC-BRC population fluctuations in annual legumes	C D Preston	
T02054g5	EIC-BRC data management	C E Appleby	
T02054h5	EIC-BRC butterfly monitoring scheme	P T Harding	
T02054i5	EIC-BRC data base and atlas of aquatic plants	C D Preston	
T02054j2	EIC-BRC data analysis and interpretation	P T Harding	
T02054k2	EIC-BRC ecological and taxonomic studies of land slugs	B C Eversham	
T02054l2	EIC marketing – Biological Records Centre	J C Metcalfe	
T02054n5	Co-ordinating Commission for Biological Recording (CCBR) programme	P T Harding	
T02055-5	Environmental impact assessment	M D Hooper	
T02055b1	Channel Tunnel construction monitoring terrestrial (& freshwater) ecology	R C Welch	
T02055g1	Inner Thames Marshes SSSI, Ranham	B C Eversham	
T02055h1	Ecological appraisal of Hurley Golf Course at AFRC, IGAP site, Hurley	R C Welch	
T02055i2	Interpretation of ecological information in environmental impact assessment	J R Treweek	
T02055j2	Environmental assessment as a basis	J R Treweek	
T02056-5	Grassland ecology	T C E Wells	
T02056c2	Population studies on terrestrial orchids	T C E Wells	
T02056e1	Autecology of rare species	T C E Wells	
T02057-5	Historical aspects of environmental management	J Sheail	
T02057a5	Historical aspects of environmental perception	J Sheail	
T02057b2	Synthesis of the development of environmental sciences in NERC	J Sheail	
T02059-5	Wetland dynamics and management	T C E Wells	
T02059b5	Land use and ecology of Swavesey Fens the fauna and flora in relation to both established and changing management	K H Lakhani	
T02059c5	Environmental impact of flood protection measures on the water regimes of wildlife habitats	J Sheail	
T02059d1	The effects of nitrogen on species diversity and agricultural production on the Somerset Moors	T C E Wells	
T02059f1	Wetland restoration – techniques for an integrated approach	J Sheail	
T02065-3	Ecology of farmland (JAEP)	D Osborn	
T02065g3	Biodiversity in agricultural landscapes species dispersal, patch dynamics and island biogeography (JAEP)	M B Usher/ M D Hooper	
T02065k3	The role of dispersal in maintaining bird populations in small woods on farmland (JAEP)	I Newton	
T02070-2	Successional models for predicting ecological effects of changing agricultural practices	M O Hill	
T02070a2	Development of successional models	M O Hill	
T02070b2	Plant dispersal within and between habitats	M O Hill	
T02070c12	Neighbourhood relationships in establishing herb-rich grassland	P D Carey	
Programme 3 Global environmental change			
T03057e6	Radar remote sensing and tropical forestry inventory and carbon balance	G B Groom	
T03085d6	Landscape dynamics and climate change at regional and national scales	B K Wyatt	
Programme 7 Environmental pollution			
T07061-5	Hazard assessment	S Dobson	
T07061a1	Hazard assessment of chemicals	S Dobson	
T07061d1	Environmental impact of pesticide drift	B N K Davis	
T07061e2	Insecticide spray drift and bioassay	B N K Davis	
T07061f5	Birds and pollution	I Newton	

T07061g1	Analysis of biological and other environmental samples	M C French	T08068c2	Relatedness in sparrowhawks	I Newton
T07061k1	Task group for World Health Organisation	S Dobson	T08068d2	Relatedness in other birds of prey	I Newton
T07061l1	Environmental assessments – Taiwan	S Dobson	Programme 9 Community ecology		
T07061m1	Landfill operations and the contamination of wildlife	D Osborn	T09052-2	Heath and moorland systems	R H Marrs
T07062-5	Aquatic ecology and ecotoxicology	K R Bull	T09052d1	Bracken distribution and management	R H Marrs
T07062a1	National critical loads mapping programme	K R Bull	T09053-5	Ecological processes in woodland	M O Hill
T07062f2	Modelling of atmospheric deposition into catchments	K R Bull	T09053a2	Autecology of selected species on farm woodland	M O Hill
T07069-5	Ecological consequences of climate change	K R Bull/ N R C Webb	T09053c2	Modelling succession in farm woodland	M O Hill
T07069a5	Application of GIS to climate change studies	K R Bull/ G L Radford	T09053d2	Invertebrate fauna of native and introduced broadleaved trees in Britain	R C Welch
T07069b1	Department of the Environment climate change modelling programme	M O Hill/ J P Grime	T09053l5	Computersation of National Vegetation Classification	M O Hill
T07069e2	Application of remote sensing technique to climate change studies	B K Wyatt/ A R Jones	Programme 13 Scientific services		
T07069f5	Comparative studies of salt marsh processes	L A Boorman	T13054c2	Development of current awareness services in ITE libraries	M Palmer
T07069g2	Climate change, sea level rise and the English coast	L A Boorman	T13060-2	Statistical services in ITE South	K H Lakhani
T07069h5	Modelling effects of climate change on species distribution	M O Hill	T13060a2	Estimation of population parameters	K H Lakhani
T07069i2	Effect of climate on population dynamics of heathlands	R H Marrs	T13060b2	Statistical consultancy for Monks Wood/ITE/NERC	K H Lakhani
T07069j5	Monitoring ecological change and plant species – a critical loads approach	T C E Wells/ R H Marrs	T13060c2	Biometrical research	T H Sparks
T07069k2	Influence of climatic factors on amphibian breeding success	C P Cummins	T13060d2	Statistical advice – Monks Wood and Bangor	T H Sparks
T07070-5	Ecotoxicology of terrestrial vertebrates	D Osborn/ S Dobson	T13061-1	ITE South consultancies	T M Roberts
T07070a2	Avian ecotoxicology	S Dobson	T13061a1	Small consultancies at ITE Monks Wood	M D Hooper
T07070b5	Mammalian ecotoxicology	R F Shore	ITE SOUTH — FURZEBROOK RESEARCH STATION		
T07070d2	Detecting subtle impacts of pollutants on individuals	D Osborn	Programme 2 Land use, agriculture and the environment		
T07070e5	The effects of liming moorland on small mammal populations	R F Shore	T02065o3	Ecological and genetic factors contributing to the decline in certain arable weed species (JAEP)	A J Gray
T07070f5	Rodenticides and barn owls	I Newton	T02065p3	Fertiliser, liming and management effects on invertebrate community dynamics (JAEP)	M G Morris
T07070h2	Ecotoxicology chemical analysis	M C French	Programme 7 Environmental pollution		
T07070i1	Ecotoxicological testing on bats	R Shore	T07069-5	Ecological consequences of climate change	K R Bull/ N R Webb
T07073-5	Interactive effects of pesticides	A S Dawson	T07069l2	Invertebrate geographical ranges and climate	L K Ward
T07073a5	Pesticide interactions reproductive and field effects	A S Dawson	T07069n2	Invasion potential of ants	G W Elmes
T07073b4	Pesticide interactions biochemical effects	A S Dawson	T07069o2	Butterfly monitoring scheme and climate change	J A Thomas
Programme 8 Population ecology			T07069s1	Climate change impacts on conservation (Phases 1 and 2)	G W Elmes
T08054-2	Population dynamics	I Newton	Programme 8 Population ecology		
T08054a2	Population ecology of sparrowhawks (<i>Accipiter nisus</i>)	I Newton	T08057-5	Migratory wader ecology	J D Goss-Custard
T08055-5	Birds on farmland	I Newton	T08057a2	Predator/prey interactions	J D Goss-Custard
T08055c2	Tawny owls in fragmented habitats	S M Redpath			
T08068-5	Molecular ecology	A J Gray/I Newton			

	between the oystercatcher and mussel	
T08057b2	Winter feeding ecology of juvenile oystercatchers	S E A Durell
T08057c2	Habitat contraction, breeding density and reproductive output in waders	J D Goss-Custard
T08057h5	Birds in estuaries	J D Goss-Custard
T08057i1	Feasibility study on gas pipelines	S McGrorty
T08057j1	Cardiff Bay barrage bill	J D Goss-Custard

T08058-5	Resident vertebrate ecology	R E Kenward
T08058a5	Squirrel demography and conservation	R E Kenward
T08058e2	Breeding success and survival in the common toad	C J Reading
T08058f2	Ecology and population dynamics of the grass-snake (<i>Natrix natrix helvetica</i>)	C J Reading
T08058g5	Developing software for radiotag studies	R E Kenward
T08058h5	Population dynamics and requirements of raptors	R E Kenward
T08058j5	Population dynamics and biomonitoring of sea-eagles	R E Kenward

T08059-5	Plant genecology	A J Gray
T08059b2	<i>Spartina</i> population ecology	A J Gray
T08059c2	Genetic variation in wetland species	R E Daniels
T08059k2	ISP seed protein study	A J Gray
T08059n1	Broad Oak Water ecological survey	R E Daniels
T08059o1	Plant as detoxifiers	R E Daniels

T08060-5	Butterfly and ant studies	J A Thomas
T08060a5	The conservation of the large blue butterfly	J A Thomas
T08060c2	Social biology and socioecology of genus <i>Myrmica</i>	G W Elmes
T08060d2	Ant/butterfly interactions	J A Thomas/G W Elmes
T08060e2	Population ecology of <i>Myrmica</i>	G W Elmes
T08060g1	Black hairstreak habitat creation – M40	J A Thomas
T08060h2	Ant interactions in Brunei rainforest	G W Elmes

T08068-5	Molecular ecology	A J Gray/I Newton
T08068a2	Gene flow in <i>Brassica</i>	A J Gray
T08068b2	Ant sociobiology	G W Elmes
T08068f1	Genetically modified crops and their wild relatives	A F Raybould
T08068g1	Gene flow in natural populations of <i>Brassica</i> and <i>Beta</i>	A J Gray

T08071-4	Biodiversity of ants in Brunei rainforest	G W Elmes/R May
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Programme 9 Community ecology

T09055-5	Heathland impacts	N R Webb
T09055e2	Heathland invertebrates	N R Webb
T09055n1	Dorset oilfield biological monitoring	R E Daniels
T09055o1	West Wellow bypass ecological appraisal	L K Ward
T09055r1	Ecological survey of Dorset heathland fragment	N R Webb

T09056-5	Grassland and scrub dynamics	M G Morris
T09056a2	Grassland management – invertebrates	M G Morris
T09056d2	Demography and conservation of scrub	L K Ward

T09056f2	Weevil studies	M G Morns
T09056j1	M3 Bar End to Compton ecological studies	M G Morns/ N R Webb
T09056k1	New Forest cicada	L K Ward

Programme 13 Scientific services

T13060e2	Statistical and computing services at Furzebrook	R T Clarke
T13060f2	Statistical and computing services for the IFE River Laboratory	R T Clarke
T13060g2	Biometrical research at ITE Furzebrook	R T Clarke

T13061-1	ITE South consultancies	T M Roberts
T13061b1	Small consultancies at ITE Furzebrook	M G Morns

ITE SOUTH — BANGOR RESEARCH UNIT

Programme 2 Land use, agriculture and the environment

T02067-5	Land use research overseas	J E G Good
T02067a2	Land use ecology in Morocco	L S Anderson
T02067b1	Forest hydrology and soil erosion in Jamaica	P A Stevens
T02067d2	Clonal selection for tolerance of drought and salinity in semi-arid zone trees and shrubs	J E G Good
T02067e1	Development of a research programme in modelling agroforestry systems	L S Anderson

Programme 7 Environmental pollution

T07064-5	Response of ecosystems to pollution	T W Ashenden
T07064a5	Pollution study of Wales	T W Ashenden
T07064c2	Effects of acid mist on arctic-alpines	T W Ashenden
T07064d2	Trace metals in terrestrial ecosystems	
T07064g2	Engineering development (mechanical and electronic)	C R Rafarel
T07064i5	Critical loads of N and S deposition to semi-natural vegetation	T W Ashenden
T07064m5	Effects of increasing concentrations of carbon dioxide on grassland communities	T W Ashenden
T07064n5	Nitrogen dioxide survey of Wales	T W Ashenden
T07064o5	Critical loads of pollutants for semi-natural ecosystems in Wales	T W Ashenden

T07069m2	Climate and high-altitude invertebrates	A Buse
T07069p2	Effects of elevated concentrations of carbon dioxide on upland vegetation	T W Ashenden

T07072-5	Upland nitrogen dynamics	B Reynolds
T07072a5	Nitrogen critical load experiment	B A Emmett
T07072b5	Forest nitrogen survey	P A Stevens
T07072c1	Phosphorus fertilisation experiment	P A Stevens
T07072d5	Estimation of atmospheric inputs to catchments	B Reynolds
T07072e2	Effects of increased nitrogen	B A Emmett

	deposition on soil nutrient leaching	
T07072f5	Fate of applied lime in an acid heath at Llyn Brianne	B Reynolds
T07072g5	Catchment manipulations at Llyn Brianne	B Reynolds
T07072h5	Biochemical consequences of climate change upon riparian wetlands	B A Emmett
T07072i2	Modelling upland nitrogen dynamics	B Reynolds
T07072j2	Solute pathways in upland catchments	B Reynolds

Programme 9 Community ecology

T09054-5	Montane ecology	J E G Good
T09054g2	Status of the Snowdon beetle	A Buse
T09054h2	Exploitation of montane habitats by free-ranging sheep	A G Thomson
T09054j1	Grassland re-establishment, Glynneath	J E G Good
T09054k5	Revegetation of land disturbed by hydroelectric pipeline replacement at Cwm Dylh, Snowdon	J E G Good
T09054l1	Effects of grazing on upland invertebrates in Snowdonia	A Buse
T09054m5	Modelling rhododendron invasion in Wales	A G Thomson

Programme 13 Scientific services

T13061-1	ITE South consultancies	T M Roberts
T13061c1	Small consultancies at ITE Bangor	J E G Good

Appendix 4. Publications by ITE staff, 1991–92

1. Papers in refereed journals

- (Aebischer, N.J.) & Wanless, S.** 1992 Relationships between colony size, adult non-breeding and environmental conditions for shags *Phalacrocorax aristotelis* on the Isle of May, Scotland *Bird Study*, **39**, 43–52
- Ashenden, T.W., Rafarel, C.R. & Bell, S.A.** 1991 Exposure of two upland plant species to acidic fogs *Environmental Pollution*, **74**, 217–225
- (Atkinson, C.J.), Wookey, P.A. & (Mansfield, T.A.)** 1991 Atmospheric pollution and the sensitivity of stomata on barley leaves to abscisic acid and carbon dioxide *New Phytologist*, **117**, 535–541
- Bacon, P.J. & (Beekman, J.)** 1991 Models of swan population dynamics and growth – a review (Proceedings of the 3rd IWRB International Swan Symposium, Oxford, 1989) *Wildfowl*, Suppl no 1, 327–335
- (Baker, J.R., Briggs, S.A., Gordon, V.), Jones, A.R., (Settle, J.J., Townshend, J.R.G.) & Wyatt, B.K.** 1991 Advances in classification for land cover mapping using SPOT HRV imagery *International Journal of Remote Sensing*, **12**, 1071–1085
- Bardgett, R.D.** 1991 The use of the membrane filter technique for comparative measurements of hyphal lengths in different grassland sites *Agriculture, Ecosystems and Environment*, **34**, 115–119
- (Bart, J., Earnst, S.) & Bacon, P.J.** 1991 Comparative demography of the swans a review (Proceedings of the 3rd IWRB International Swan Symposium, Oxford, 1989) *Wildfowl*, Suppl no 1, 15–21
- Baxter, R., (Emes, M.J. & Lee, J.A.)** 1991 Short term effects of bisulphite on pollution-tolerant and pollution sensitive populations of *Sphagnum cuspidatum* Ehrh (ex Hoffm) *New Phytologist*, **118**, 425–431
- Baxter, R., (Emes, M.J. & Lee, J.A.)** 1991 Transition metals and the ability of sphagnum to withstand the phytotoxic effects of the bisulphite ion *New Phytologist*, **118**, 433–439
- Baxter, R., (Emes, M.J. & Lee, J.A.)** 1992 Effects of an experimentally applied increase in ammonium on growth and amino-acid metabolism of *Sphagnum cuspidatum* Ehrh ex Hoffm from differently polluted areas *New Phytologist*, **120**, 265–274
- Bell, S.A., Ashenden, T.W. & Rafarel, C.R.** 1992 Effects of rural roadside levels of nitrogen dioxide on *Polytrichum formosum* Hedw *Environmental Pollution*, **76**, 11–14
- Beresford, N.A. & Howard, B.J.** 1991 The importance of soil adhered to vegetation as a source of radionuclides ingested by grazing animals *Science of the Total Environment*, **107**, 237–254
- Beresford, N.A., Howard, B.J., Barnett, C.L. & (Crout, N.M.J.)** 1992 The uptake by vegetation of Chernobyl and aged radiocaesium in upland west Cumbria *Journal of Environmental Radioactivity*, **16**, 181–195
- (Beswick, K.M.), Hargreaves, K.J., (Gallagher, M.W., Choularton, T.W.) & Fowler, D.** 1991 Size-resolved measurements of cloud droplet deposition velocity to a forest canopy using an eddy correlation technique *Quarterly Journal of the Royal Meteorological Society*, **117**, 623–645
- Billington, H.L. & Pelham, J.** 1991 Genetic variation in the date of budburst in Scottish birch populations implications for climatic change *Functional Ecology*, **5**, 403–409
- (Blenkinsopp, S.A., Gabbott, P.A.), Freeman, C. & (Lock, M.A.)** 1991 Seasonal trends in river biofilm storage products and electron transport system activity *Freshwater Biology*, **26**, 21–34
- Brown, A.H.F. & (Iles, M.A.)** 1991 Water chemistry profiles under four tree species at Gisburn, NW England *Forestry*, **64**, 169–187
- Bull, K.R.** 1991 The critical loads/levels approach to gaseous pollutant emission control *Environmental Pollution*, **69**, 105–123
- Bull, K.R. & Hall, J.R.** 1992 A classification of acidified catchments in Britain *Environmental Pollution*, **75**, 323–332
- Caldow, R.W.G. & (Furness, R.W.)** 1991 The relationship between kleptoparasitism and plumage polymorphism in the Arctic skua *Stercorarius parasiticus* (L.) *Functional Ecology*, **5**, 331–339
- Cape, J.N. & Vogt, T.C.** 1991 Application of Hartel's turbidity test across Europe *Canadian Journal of Forest Research*, **21**, 1423–1429
- Cape, J.N., Brown, A.H.F., Robertson, S.M.C., Howson, G. & Paterson, I.S.** 1991 Interspecies comparisons of throughfall and stemflow at three sites in northern Britain *Forest Ecology and Management*, **46**, 165–177
- Cape, J.N., Leith, I.D., Fowler, D., Murray, M.B., Sheppard, L.J., Eamus, D. & Wilson, R.H.F.** 1991 Sulphate and ammonium in mist impair the frost hardening of red spruce seedlings *New Phytologist*, **118**, 119–126
- Cape, J.N., Sheppard, L.J., Fowler, D., Harrison, A.F., Parkinson, J.A., (Dao, P.) & Paterson, I.S.** 1992 Contribution of canopy leaching to sulphate deposition in a Scots pine forest *Environmental Pollution*, **75**, 229–236
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- Clint, G.M., Dighton, J. & Rees, S.** 1991 Influx of ¹³⁷Cs into hyphae of basidiomycete fungi *Mycological Research*, **95**, 1047–1051

- Clint, G.M., Harrison, A.F. & Howard, D.M.** 1992 Rates of leaching of ^{137}Cs and potassium from different plant litters *Journal of Environmental Radioactivity*, **16**, 65–76
- Crossley, A., Wilson, D.B. & Milne, R.** 1992 Pollution in the upland environment *Environmental Pollution*, **75**, 81–88
- (Crout, N.M.J.), Beresford, N.A. & Howard, B.J.** 1991 The radioecological consequences for lowland pastures used to fatten upland sheep contaminated with radiocaesium *Science of the Total Environment*, **103**, 73–87
- Davis, B.N.K., Lakhani, K.H., Yates, T.J. & Frost, A.J.** 1991 Bioassays of insecticide spray drift the effects of wind speed on the mortality of *Pieris brassicae* larvae (Lepidoptera) caused by diflubenzuron *Agriculture, Ecosystems and Environment*, **36**, 141–149
- Davis, B.N.K., Lakhani, K.H. & Yates, T.J.** 1991 The hazards of insecticides to butterflies of field margins *Agriculture, Ecosystems and Environment*, **36**, 151–161
- Dawson, A.** 1991 Effect of daylength on the rate of recovery of photosensitivity in male starlings (*Sturnus vulgaris*) *Journal of Reproduction and Fertility*, **93**, 521–524
- Dawson, A.** 1991 The induction of photorefractorness and molt in starlings, *Sturnus vulgaris*, by continuous or intermittent long days *Physiological Zoology*, **64**, 1252–1261
- Dawson, A.** 1991 Photoperiodic control of testicular regression and moult in male house sparrows *Passer domesticus* *Ibis*, **133**, 312–328
- Dawson, A. & (Coleman, A.E.)** 1991 Plasma LH concentrations in mute swans *Cygnus olor* of different ages during spring (Proceedings of the 3rd IWRB International Swan Symposium, Oxford, 1989) *Wildfowl*, Suppl. no 1, 323–324
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- Dewar, R.C.** 1992 Inverse modelling and the global carbon cycle *Trends in Ecology and Evolution*, **7**, 105–107
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- Dighton, J.** 1991 Acquisition of nutrients from organic resources by mycorrhizal autotrophic plants *Experientia*, **47**, 362–369
- Dighton, J. & (Jansen, A.E.)** 1991 Atmospheric pollutants and ectomycorrhizae more questions than answers? *Environmental Pollution*, **73**, 179–204
- Dighton, J., Clint, G.M. & Poskitt, J.M.** 1991 Uptake and accumulation of ^{137}Cs by upland grassland soil fungi: a potential pool of Cs immobilization *Mycological Research*, **95**, 1052–1056
- (Dore, A.J., Choularton, T.W.), Fowler, D. & Crossley, A.** 1992 Orographic enhancement of snowfall *Environmental Pollution*, **75**, 175–180
- Eamus, D. & Murray, M.B.** 1991 Photosynthetic and stomatal conductance responses of Norway spruce and beech to ozone, acid mist and frost – a conceptual model *Environmental Pollution*, **72**, 23–44
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- (Evans, H.F., Stoakley, J.T., Leather, S.R.) & Watt, A.D.** 1991 Development of an integrated approach to control of pine beauty moth in Scotland *Forest Ecology and Management*, **39**, 19–28
- (Fahey, T.J.), Hill, M.O., Stevens, P.A., Hornung, M. & Rowland, A.P.** 1991 Nutrient accumulation in vegetation following conventional and whole-tree harvest of Sitka spruce plantations in north Wales *Forestry*, **64**, 271–288
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- Hargreaves, K.J., Fowler, D., Storeton-West, R.L. & (Duyzer, J.H.)** 1992 The exchange of nitric oxide, nitrogen dioxide and ozone between pasture and the atmosphere *Environmental Pollution*, **75**, 53–59
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(Wright, J.F., Furse, M.T.), Clarke, R.T. & Moss, D. 1991 *Testing and further development of RIVPACS* 141pp National Rivers Authority

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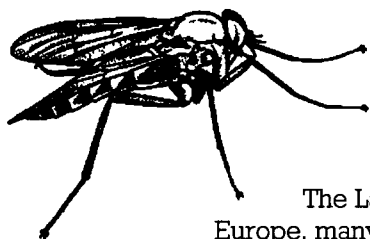
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