

1990 — 1991  
R E P O R T



**Institute of  
Terrestrial  
Ecology**

**Natural Environment Research Council**

# Foreword

Environmental issues continue to grow in importance both nationally and internationally. These issues, whether local, regional or global, must be addressed on the basis of sound and up to date scientific knowledge. NERC's Terrestrial and Freshwater Sciences Directorate provides a focus for fundamental and applied research in land use and the development of natural resources, the maintenance of environmental quality and the principles which underline management and conservation.

Much of this research is interdisciplinary and demands the wide range of expertise in NERC establishments and higher education institutions. The Directorate's in-house capability comprises the Institute of Freshwater Ecology, the Institute of Hydrology, the Institute of Terrestrial Ecology, the Institute of Virology and Environmental Microbiology, the Unit of Comparative Plant Ecology (Sheffield University), the Interdisciplinary Research Centre for Population Biology (Imperial College, London), the Unit of Behavioural Ecology (Oxford University) and the Water Resource Systems Research Unit (Newcastle-upon-Tyne University).

The Institute of Terrestrial Ecology continues to provide the major national resource of expertise in ecology and related subjects. Its research in areas as diverse as air pollution effects and vertebrate population biology has an international reputation. This Report shows the wide range of skills of ITE staff and how essential the research is to the environmental quality and management of the land surface both in the UK and overseas.

**Dr P B Tinker**

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

**Report of the  
Institute of Terrestrial Ecology  
1990/91**

**Natural Environment Research Council**

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# Directors' introduction

In last year's Annual Report we looked forward to the publication of the Government's White Paper on the environment – *This common inheritance*. The Paper outlines the Government's policies and priorities for immediate action and for longer-term development. It also explores environmental issues in the context of Europe, the tropics, polar regions, and globally. The report of the Inter-Governmental Panel on Climate Change (IPCC), which was also published during the year, provided a state-of-the-art analysis by the world's scientists of the causes and mechanisms of climate change and of the probable environmental impacts. The results of the IPCC study were presented at the 1st World Conference on climate change, and studies in progress are focused on the UN Conference on Environment and Development in Brazil, 1992, which will consider global conventions on climate change and biodiversity.

These major national and international statements on the present and future state of the environment provide a policy framework for our research, as distinct from the scientific or financial context. What then is the relevance of the research of ITE to these issues? What are the key challenges to our research posed by the Governmental and inter-Governmental policies?

Two important general concepts are central to environmental policy both nationally and internationally – *sustainability* and *biodiversity*. These concepts have been generated from ecology, nature conservation, and land use. They are not new ideas and there is considerable experience in their application. What are new are the scales of complexity and of space and time which must be addressed, particularly in relation to sustainability. The Institute has a role in improving the definition and application of both of these concepts.

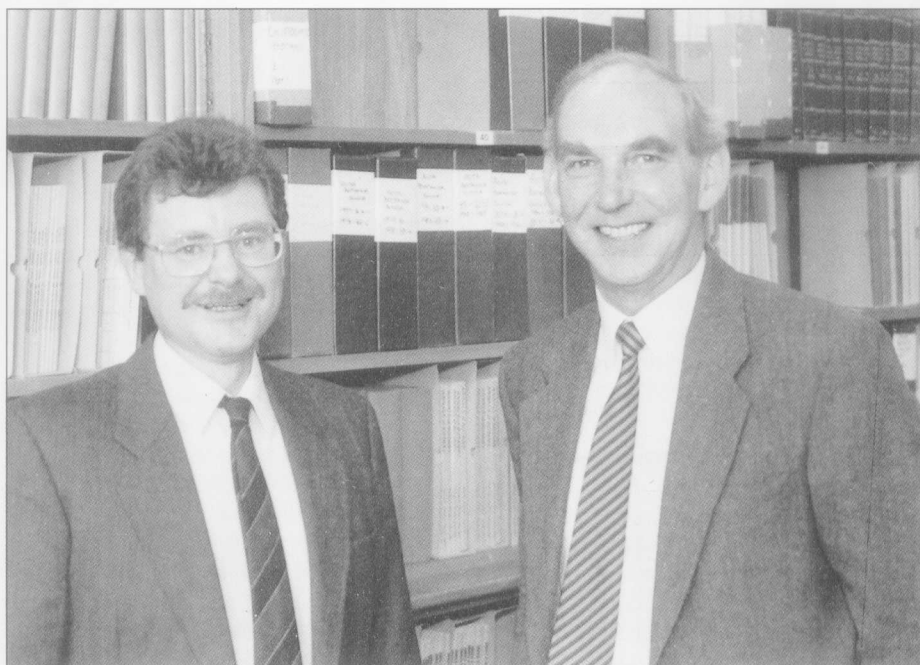
## Sustainability

The objective is to make efficient and effective use of natural resources without constraining the options for future generations. This complex subject has a sound basis in the ecological sciences. For example, animal population research has provided the models and practices for sustained cropping of wild species, such as deer and grouse. Knowledge of the carrying capacity of the habitat, combined with measures of immigration, emigration, birth and death rates, has been reasonably effective in calculating sustainable yields of individual species.

However, the analysis of sustained cropping of animal populations is becoming increasingly difficult because of independent changes in the environment, which alter food supply and habitat conditions for herbivores and predators. Analysis of single species has to be replaced by more complex models representing the interactions between a number of species. For example, what are the population levels of deer and

grouse which can be sustained with changing sheep stocks? To what extent do competing predators adjust their numbers in response to changes in prey species (eg small mammals or fish), which are themselves being cropped? These questions focus on the multiple interactions of the food web as the basis for assessing the sustainability of populations. Fisheries researchers and managers have been struggling with this problem for decades; the challenge is now apparent on land, and is just as applicable to ITE's research on the rangelands of Africa as in the hills of Scotland.

The sustainable production of agricultural and forestry crops has been concerned primarily with ensuring that (i) nutrients and water removed in the crop or lost through fire, leaching or gaseous flux are replenished, and (ii) management practices do not reduce the fertility of the site through acidification, loss of organic matter, erosion, salinisation, etc. Most of the immediate management problems are well understood by those concerned with



Professors T M Roberts (left) and O W Heal (right), Directors ITE South and North, respectively

the particular production systems and site conditions. However, it is now imperative that account is taken of interactions with the associated climatic, hydrological and wildlife systems in order to define what level of crop production is compatible with the sustained use of the other resources.

The wider spatial dimension to the sustainability of crop production systems is matched by the long timescales over which the balance of inputs and outputs has to be considered. In agricultural systems, the annual production cycle allows early identification of non-sustainable practices, but there is often a considerable time lag in the transport of fertilisers or pesticides into groundwater or in the salinisation of soils. In forestry, sustainability has to be considered over a number of cycles, and not from a forest balance sheet of nutrients, water or carbon measured as a snapshot in time.

The questions arising from the concept of sustainable development are driving the Institute's research towards a much more predictive approach than previously. Existing data and experience from particular sites or processes have to be combined across disciplines and extrapolated over larger spatial and temporal scales. The shift is from the techniques of analysis to those of synthesis and modelling.

## Biodiversity

Whether focused on Britain, the tropics or the world, the problem of the loss of species is causing concern. The materialistic view is that we are losing species of potential benefit to man, the aesthetic view is that wildlife diversity enhances the quality of man's life, the moral view is that man has an obligation to protect other species. For whatever reason, policy has to be based on scientific understanding of the causes, rates and consequences of change in biodiversity. Ecologically we can identify three aspects within the concept of biodiversity, which, although inter-related, require distinct types of research.

### Biodiversity within species

Within a species, genetic variation determines survival or adaptation to different environmental conditions across the range of the species and over time. Some species are highly variable, while others are not. Research must address the questions of how much variation is lost

as the size of the population declines, and what size of population is required to maintain the genetic diversity and long-term viability of the species. These questions require an analysis of the interactions between populations of a species (eg migration rates, isolation of habitats, and existence of corridors), as well as a knowledge of genetic heterogeneity and gene flow within the population in relation to population size. Such analysis applies to both plants and animals, but cannot be done for all species. The requirement is to identify the priority species for study on ecological and genetic criteria, from among the species of interest to conservation or production. We must also identify groups of species with similar characteristics, which provide working generalisations or hypotheses on which policy can be based.

### Diversity of species

The number of species in a community or area is the simplest measure of biological diversity, but we have to understand which species are being gained or lost, and why. Species lists do not help the policy-maker, although they are the basis for comparing different habitats or regions. An important approach is the aggregation of species into 'functional groups' which, because of their biological similarities, respond similarly to environmental change. This approach provides a means of summarising complex species lists and analysing the response to eutrophication (fertiliser or atmospheric nutrient input) or to changes in the frequency and intensity of disturbance.

To target policy, it is important to identify in the landscape the main reservoirs of species diversity. For example, in lowland Britain, policies to conserve species diversity should focus on field boundaries and other linear features, because these contain 60–80% of the plant species and comprise only 5% of the land area. In tropical forests, most vertebrate species will survive if 10–20% of the area is left as temporary islands during forest logging. The challenge for ecological research is to quantify the costs and benefits of policies to conserve species diversity, and to provide tangible criteria against which management options can be evaluated.

### Diversity of communities

Many ecologists believe that groups of

species occur as distinctive and predictable communities. This belief is the basis of much of our conservation policy. However, climate change will cause differential rates of migration of species, which will probably result in the formation of new communities whose composition we have not seen previously. Do we attempt to continue to maintain existing communities against the forces of change, or do we accept that they are transitory? What is our conservation strategy regarding new assemblages which emerge? ITE looks forward to an increased collaboration on biodiversity and conservation ecology to support the new Conservation Agencies.

## Research in ITE

The twin concepts of sustainable development and conservation of biodiversity are fundamental to the policies and codes of practice identified in the Government White Paper. In particular, publication of *This common inheritance* has already increased the demand for ecological research in support of policies for pollution control and land use. ITE has given increased priority to strategic research on techniques for environmental impact assessment and integrated pollution control. Research on spatial relationships between landscape features and biodiversity is being strengthened in response to more positive approaches to land management in the agriculture and forestry sector. Studies on gene flow in wild relatives of crops have been expanded, using molecular techniques, to support methods for environmental assessments of the release of genetically manipulated organisms.

Close parallels exist between specific issues in the White Paper and ongoing research in ITE on the following topics.

### Global warming

Measurement of emissions of greenhouse gases, modelling of carbon budgets for different communities, assessment of the effects of elevated CO<sub>2</sub> on vegetation, prediction of potential impacts of climate change on species distribution.

### Land use and planning

Assessment of causes and rates of change, factors controlling biodiversity at the landscape scale, techniques for environmental impact assessment and rehabilitation.



### Countryside and wildlife

Design of farm woodlands for wildlife; improved methods of vegetation classification; analysis of metapopulation dynamics; habitat recreation.

### Air pollution

Definition of critical loads for soils and critical levels for vegetation; quantification of deposition processes; international standardisation of methods.

### Hazardous substances

Long-term effects of pesticide residues; interactive effects of pesticides; trends in PCB residues in raptors; transport and effects of heavy metals.

### Nuclear power and radioactive waste

Assessment of radionuclide transfers in food chains to man; persistence in upland soils.

Many of the environmental questions concerning Britain are part of wider geographical issues, such as the long-distance transport of atmospheric pollutants, migration of plants and animals, environmental implications of European legislation (such as the Common Agricultural Policy), and international controls on toxic chemicals. The international dimension of environmental issues will increasingly influence ITE's research. Several distinct actions have already been activated:

- development of unified *international data bases* to allow direct geographical comparisons. ITE plays a lead role in the CORINE – Co-ordinated Environmental Information in the European Community – data base for Europe on land cover and biodiversity; and the UNECE – United Nations Economic Commission of Europe – mapping of acid deposition and critical loads.
- *monitoring of processes*, not as a statutory requirement but as a research approach to the measurement of rates of change (eg effects of land use change, such as afforestation, on water quality and biodiversity; effects of acid deposition on soil and surface water chemistry).
- *collaborative research* across countries to establish similarities and differences in processes (eg effects of acid deposition; nitrate leaching from soils; retention of Chernobyl fallout;

species migration in response to climate change; instrument calibration and standardised measurements).

A key function played by ITE in Europe has been the lead role of staff in the establishment of collaborative *research networks*. These include co-ordinated research on the measurement of trace gas flux; on nitrogen loadings in forest soils (the Forest Ecosystem Research Network – FERN); on comparative catchment studies (European Network for Co-Ordination of Research on Ecosystems – ENCORE); on catchment manipulations (nitrogen saturation experiments – NITREX); and on conservation (European conservation research institute network – CONNECT).

At the global scale, Government policy is to improve forest productivity in developing countries, and to ensure proper protection of the world's polar regions. The contribution of ITE to strategic research in both regions is based on the application of ecophysiology and genecology, and is related also to the theory of 'plant growth strategies' developed by the NERC Unit of Comparative Plant Ecology in Sheffield. In the tropics, ITE's research is focused on selection for improving beneficial characteristics of tree species for particular conditions, on the management of nutrients to reduce gaseous or leaching losses, and on increasing nutrient uptake through mycorrhizas in impoverished tropical soils. Much of this research is commissioned by the Overseas Development Administration or through

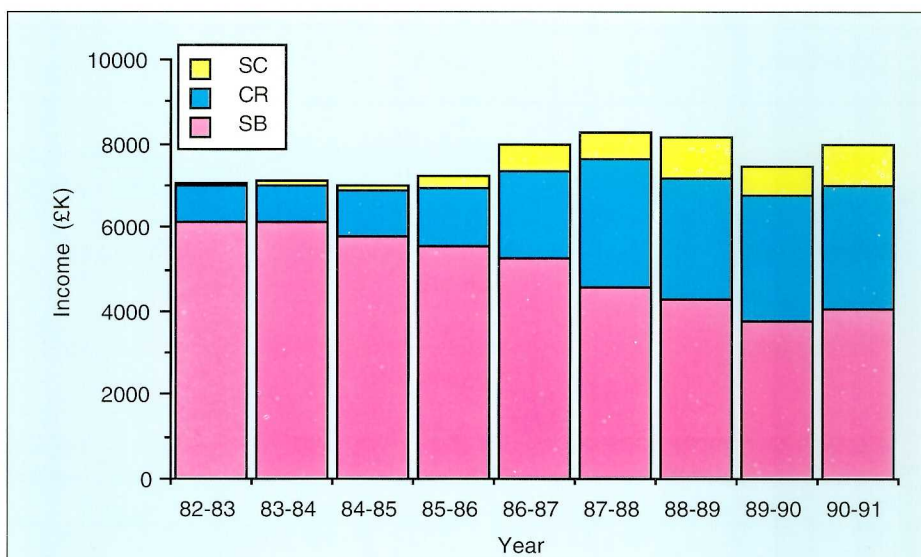
bilateral arrangements. Funding for research in the Arctic has come from NERC with the initiation of a new Special Topic, building on previous ITE work with Scandinavian countries. Collaborative projects with university scientists have been established in Svalbard on plant/soil/herbivore interactions in stressed environments.

### ITE in 1990–91

The finances of the Institute continue to be delicately balanced. The trends indicated in last year's Report have continued, with the gradual reduction in Science Budget support combined with a tendency for commissioned income to plateau (Figure below). Staff changes have been minimal, although some important appointments have been made during the restructuring of the southern Stations. Despite the reduction in Science Budget support and the reduction of prime-movers by 13%, staff have maintained a creditable rate of scientific output (Figure overleaf). Contract output has increased, whilst the high rate of publications in refereed journals and books has been maintained.

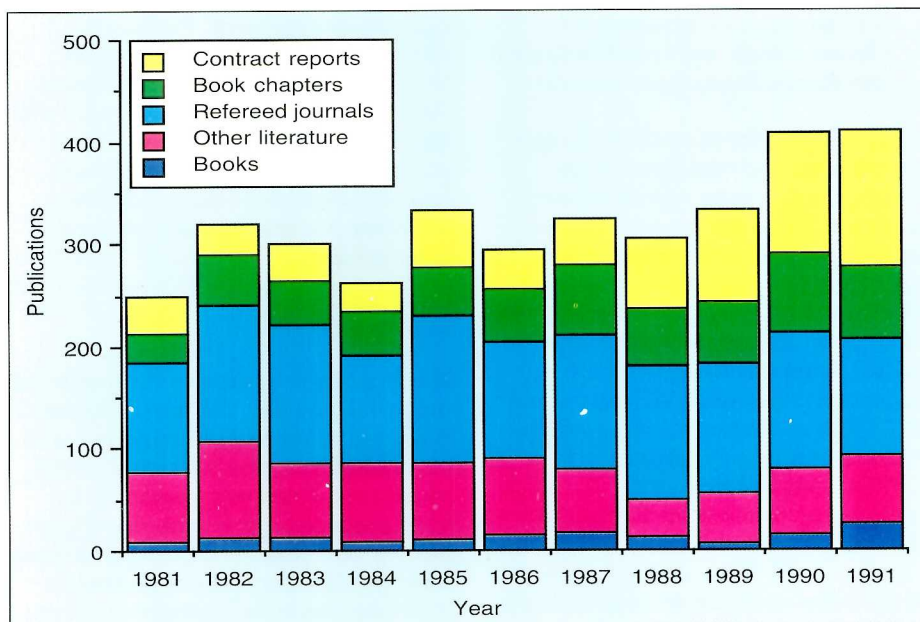
The main scientific developments during 1990–91 are described in the following reports, grouped under NERC's Terrestrial and Freshwater Sciences programme structure. However, a number of important activities should be highlighted.

- The strengthening of links with universities (especially the Centre for



Trends in income, showing that the decline in baseline Science Budget (SB) funds has largely been compensated for by the increase in commissioned research (CR). Subcontracts (SC) relate to income passed directly to universities, consultants and other research institutes





*Trends in publications by ITE staff (1981-91) showing the continuing high rate of scientific publications and the increase in contract reports*

- Population Biology at Imperial College, the NERC/ESRC Land Use Programme at Newcastle upon Tyne, and the Unit of Comparative Plant Ecology at Sheffield). Particularly notable was the opening of the Bangor Research Unit within the University College of North Wales by Professor J Knill (Chairman of NERC).
- Establishment of a network of conservation research institutes across Europe (CONNECT).
  - Integration of research on tropical forestry through the formation of the Edinburgh Centre for Tropical Forestry (ECTF).

- New research on global change through the TIGER (Terrestrial Initiative in Global Environmental Research) programme.
- Development of strategic research programmes on the effects of CO<sub>2</sub> on forestry and upland vegetation at Edinburgh and Bangor.
- Participation in the major international conference on air pollution in Glasgow (particularly by staff from Edinburgh, Bangor and Merlewood).
- Combination of the 1990 national field survey of land use and ecological change with the first satellite-derived

land cover map of UK, and with a survey of freshwaters (linking Merlewood, Monks Wood and the Institute of Freshwater Ecology – Figure below).

- Application of the new technology of geographical information systems (GIS). A major project has led to the publication of critical loads maps for the UK and Europe, in support of UNECE policy deliberations on acid pollutants (linking Merlewood, Monks Wood and Edinburgh).
- New research programmes in 'molecular ecology', involving the establishment of DNA fingerprinting laboratories at Furzebrook and Monks Wood.

Personnel highlights during the year have been the awards of Individual Merit Promotion to Grade 6 to John Goss-Custard (Furzebrook) and Terry Callaghan (Merlewood). Honours conferred on staff by the wider scientific community have included an Honorary Doctorate of Philosophy from the University of Lund to Terry Callaghan, Honorary Professorships for O W Heal at Edinburgh, T M Roberts at Kings College and York, and J Sheail (Monks Wood) at Loughborough, and the election of Melvin Cannell (Edinburgh) as a Fellow of the Royal Society of Edinburgh.

O W Heal  
T M Roberts

Objective	Funding	Technique	Output
Land use change	Dept of Environment	Allocation of sample squares; ground survey	Land use survey and classification
Water quality	National Rivers Authority	Field survey	Physical/biological parameters
Conservation	Nature Conservancy Council	Field survey	Biodiversity
Census by remote sensing	Dept of Trade and Industry	Air photo interpretation Landsat image classification	Land use mapping
Development of techniques	NERC	Research underpinning	New and improved techniques

*Summary of the integrated project, co-ordinated by ITE staff in 1990, to monitor the ecological effects of land use change in GB*

# Appendix 1. Staff at 31 March 1991

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HSO Dr B A Emmett

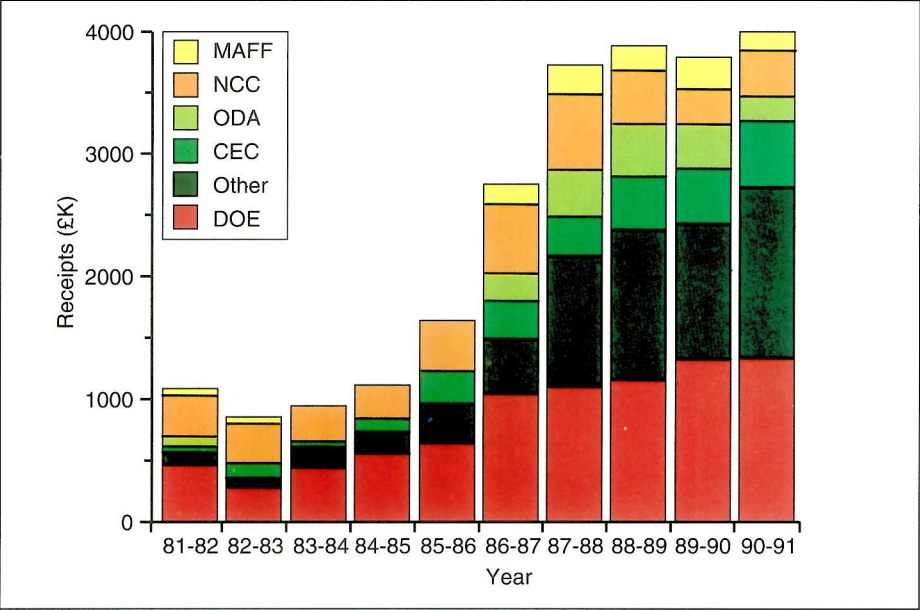
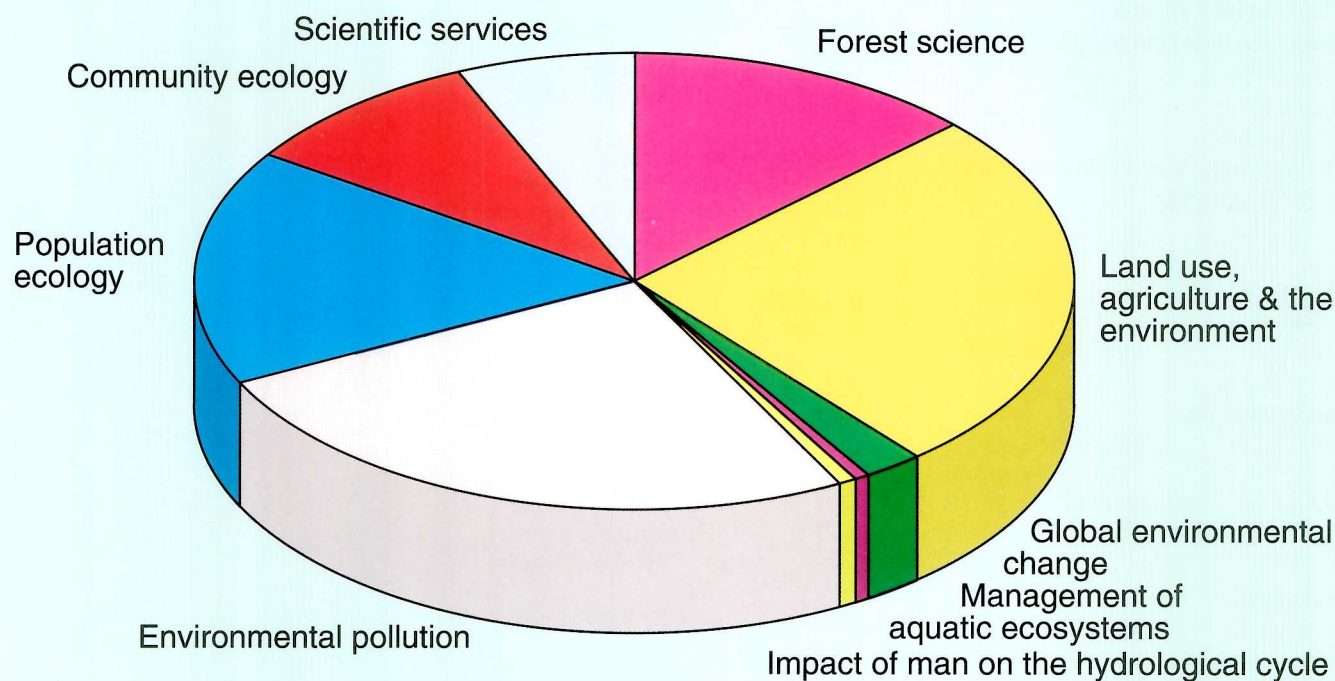
SO Mrs S A Bell  
 SO Mr S Hughes  
 SO Mr D A Norris  
 SO Mr T G Williams



## Appendix 2. Finance and administration

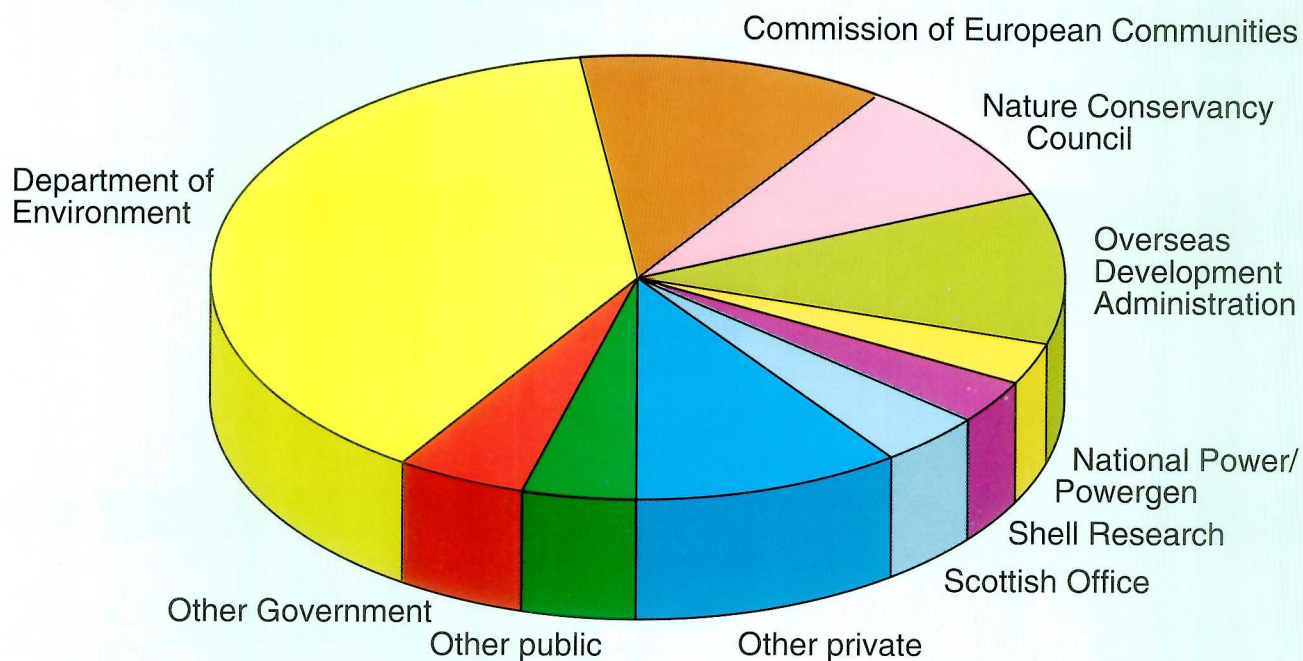
The following diagrams indicate levels of funding for the Institute, and provide details of expenditure.

The pie chart shows Institute expenditure (as full economic cost) for the year 1990–91 by scientific programme of work



The graph illustrates the long-term pattern of receipts from major customers (at constant prices – 1981–82 to 1989–90 revalued to 1990–91 using Gross Domestic Product indices)

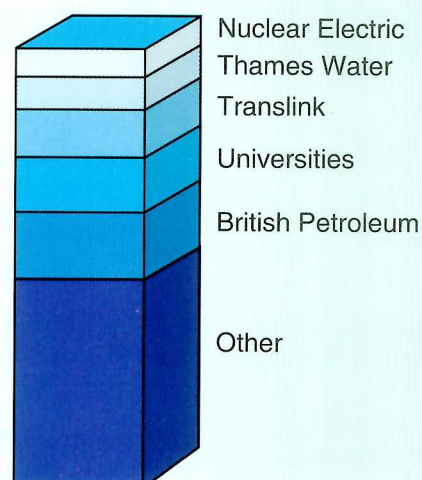
The pie chart shows the division of 1990–91 commissioned receipts by major customers, while the bars provide a breakdown of the 'Other' categories.



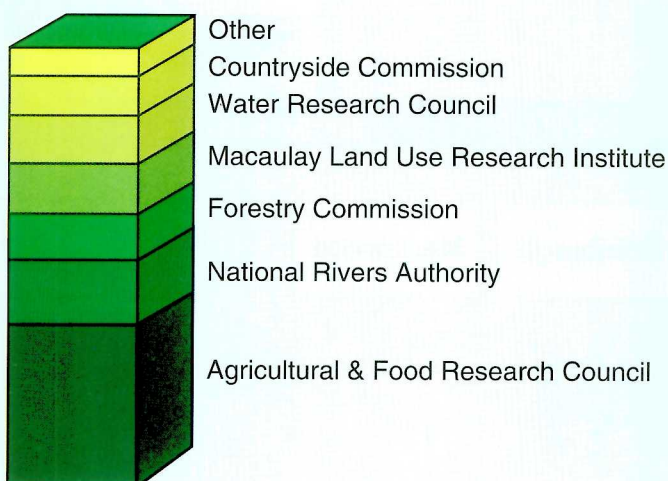
#### Other Government departments



#### Other private agencies

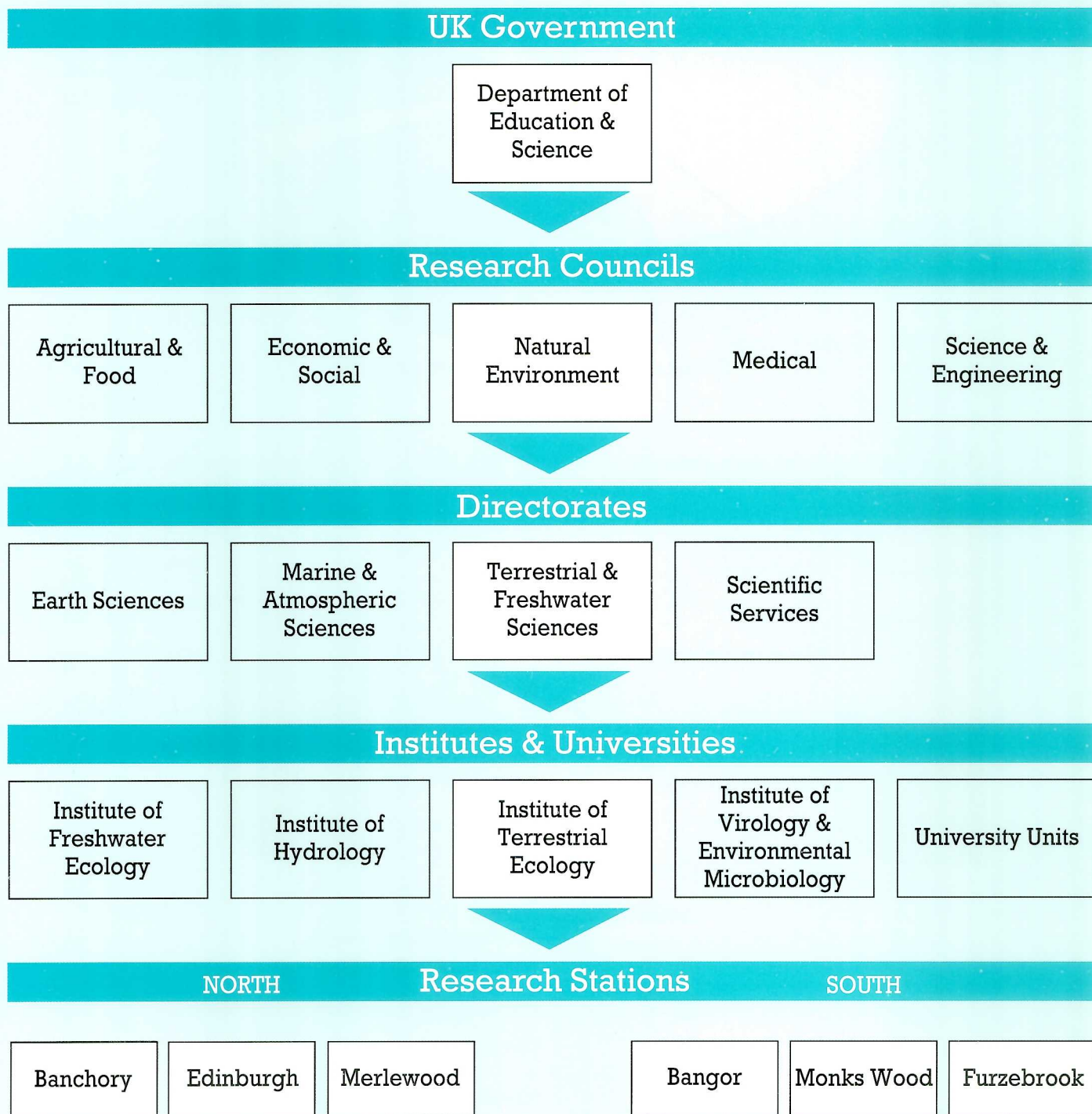


#### Other public bodies





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 1991

## ITE NORTH — EDINBURGH RESEARCH STATION

### Programme 1 Forest science

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

T01057f2	Assimilate partitioning in branches	M G R Cannell
T01057g2	Light use efficiency of trees	M G R Cannell
T01057j2	Mechanics of windthrow	R Milne
T01057m2	The population ecology of the pine beauty moth	A D Watt
T01057n2	The population ecology of the winter moth in Sitka spruce plantations	A D Watt
T01057q2	Frost hardiness of tree roots	J D Deans
T01057s2	Temperate tree improvement	J D Deans/ H L Billington
T01057t2	Tree and forest modelling	R C Dewar/ J H M Thornley
T01057v5	Frost hardiness of oak provenances	J D Deans

#### 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

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

T01060a2	Domestication of tropical hardwoods	R R B Leakey
T01060d1	Vegetation propagation of <i>Eucalyptus grandis</i>	R R B Leakey
T01060g1	Agroforestry and mycorrhizas in E Africa	R R B Leakey
T01060i1	UNESCO MAB contracts	O W Heal
T01060j1	ITE/CATIE link	R R B Leakey
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
T01060p1	Domestication of Cameroon fruit trees	R R B Leakey
T01060q1	Advisory Board to Novalal PLC	R R B Leakey
T01061a3	The effects of farm woodland size, shape, structure and species composition on insect diversity	A D Watt
T01061e3	The opportunity cost of farm woodland establishment and management	J A Johnson

### Programme 2 Land use, agriculture and the environment

T02051h2	Long-term environmental reference sites	O W Heal
T02051u5	Land use in Scotland	B G Bell

## Programme 3 Global environmental change

T03051a6	Major uncertainties in global carbon balance	P Jarvis
T03060a6	Temperate wetlands as a source of atmospheric methane	R S Clymo
T03060b6	Systems for quantifying emissions of N <sub>2</sub> O from agricultural soils	S D Young/ K A Smith
T03061b6	Reaction of organic molecules in cloud	J N Cape
T03063a6	Instrument evaluation for methane and nitrous oxide fluxes	D Fowler
T03072a6	Soil/vegetation/atmosphere schemes	R J Harding

## Programme 7 Environmental pollution

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

T07055l3	Exchange of NO <sub>x</sub> and other gases before and after exposure to wind, ozone and cloud water	D Fowler/ J Grace
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#### T07056-5 Ecological effects of climatic change M G R Cannell

T07056b2	The occurrence of extreme winds	R Milne
T07056d5	Response of trees to elevated CO <sub>2</sub> concentrations and temperature	D Fowler
T07056e2	Relationship between tree growth and temperature, analyses of tree-ring data	R Milne
T07056n2	Carbon storage and harvest models	R C Dewar

#### T07057-5 Atmospheric pollutants and trace gases D Fowler

T07057a1	Land/atmosphere exchange of NO <sub>x</sub> , O <sub>3</sub> and NH <sub>3</sub> (dry deposition)	D Fowler
T07057b2	Variation of acidic deposition with altitude	D Fowler
T07057c1	Rural O <sub>3</sub> , NO and NO <sub>x</sub> concentrations	D Fowler
T07057d2	Land/atmosphere exchange of methane	D Fowler
T07057f2	Cloud deposition	D Fowler
T07057h2	Deposition of lead 210	R Mourne
T07057i1	N deposition effects on plant communities	C Pitcairn
T07057j5	Fluxes of nitrous oxide and methane from agricultural and natural ecosystems	D Fowler
T07057l1	Changes in species composition in vegetation close to the St Fergus Gas Terminal	D Fowler

#### T07058-5 Atmospheric pollution modelling and chemistry J N Cape

T07058a2	The chemical composition of rainfall	J N Cape
T07058b2	Scavenging of pollutants by snow	T Dore
T07058c1	Nitrogen chemistry on Great Dun Fell	D Fowler
T07058d5	Physical properties in open-top chambers	D Fowler

T07058e2	Modelling UK deposition	J N Cape	<b>T01062-5 Organic matter and nutrient dynamics in forest and upland soils</b>	<b>A F Harrison</b>
<b>T07059-5 Effects of atmospheric pollutants on trees</b>	<b>D Fowler/J N Cape</b>		T01062a2	Modelling chemical and biological processes in acid upland soils
T07059b5	Open-top chamber studies on spruce and beech	D Fowler	T01062b5	Effects of climate management practices and vegetation development on plant nutrition/soil relationships
T07059d3	Effects of episodes of wind, ozone and polluted cloudwater on beech and Norway spruce	D Fowler	T01062c2	Effects of environmental and soil conditions on organic matter and N & P cycling in forest and upland soils, assessed by <sup>13</sup> C, <sup>15</sup> N and bomb- <sup>14</sup> C techniques
T07059e5	Effects of acid mist on mature trees	A Crossley	T01062d1	Application of nutrient bioassays to eucalyptus forest management
T07059f5	Accumulation and effects of atmospheric particulates on forests	A Crossley	T01062f1	Fast-growing tree project, Karnataka, India
T07059g5	Early diagnosis of forest decline	J N Cape	T01062g5	Rehabilitation of <i>Acacia</i> fallow systems and nutrient dynamics in the Blue Nile region, eastern Sudan
T07059h5	Throughfall and stemflow studies	J N Cape	T01062h5	The scientific management of renewable natural resources in China

### 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
T13059e5	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
T01051e2	Nutrient cycling in forest litter an immunological approach	P Hitchcock

#### T01054-2 Ecological effects of forest management J M Sykes/A H F Brown

T01054a2	Effects of pure and mixed stands on soils, vegetation and waters	A H F Brown
T01054b2	The effects of management in lowland coppices	A H F Brown
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

#### 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
T01062c2	Effects of environmental and soil conditions on organic matter and N & P cycling in forest and upland soils, assessed by <sup>13</sup> C, <sup>15</sup> N and bomb- <sup>14</sup> C techniques	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	D K Lindley

### Programme 2 Land use, agriculture and the environment

#### T02051-5 Land use change and ecological impacts R G H Bunce

T02051e1	Ecological consequences of land use change	R G H Bunce
T02051k1	Classification of one km squares in Great Britain	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
T02051s1	Provision of land use data and related information to the Nature Conservancy Council	R G H Bunce
T02051v3	Collaboration with NERC/ESRC land use programme (NELUP)	R G H Bunce

#### T02064-5 Environmental impact assessment - ITEN Merlewood J M Sykes

T02064b1	Shetland saltmarsh survey	R Scott
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
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### Programme 3 Global environmental change

T03050a6	1 Crop yield and <sup>13</sup> C/ <sup>12</sup> C ratios over the last 150 years as indicators of atmospheric change	D S Powlson/A F Harrison
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	2 Carbon isotope techniques to measure carbon turnover in soils		T07053c2	Effects of atmospheric pollution on mycorrhizas	J Dighton
T03050b6	Improvements to the service routines used to measure $^{15}\text{N}$ at natural abundance levels to increase throughput of samples	C Quarmby	T07053d2	Effects of sulphur dioxide on litter-decomposing fungi in deciduous woodland	J C Frankland /P Ineson
T03063b6	Trace gas release from soils in the UK	P Ineson	T07053e5	Liming and faunal inoculation of forest soils	J K Adamson
T03084b6	Development of data base for research sites (Moor House/Upper Teesdale)	J M Sykes	<b>T07054-5</b>	<b>Acid deposition and its effects</b>	<b>M Hornung</b>
T03084c6	Research site co-ordinator	J M Sykes	T07054a5	Critical loads of acidity, N and S for soils	M Hornung
<b>Programme 7 Environmental pollution</b>					
<b>T07050-5</b>	<b>Radionuclides in vegetation and soil</b>	<b>A D Horrill</b>	T07054c1	Subcontract to Aberdeen University	M Hornung/ M Cresser
T07050c5	Post-Chernobyl radiation levels in soils and vegetation	R Moss/ A D Horrill	T07054d1	Subcontract to Lancaster University	M Hornung/ T A Mansfield
T07050g2	Selenium inputs, distribution and cycling in upland caesium isotopes in upland Britain	A F Harrison	T07054e1	Subcontract to Nottingham University	M Hornung/ J Colls
T07050i2	The absorption and recycling of plutonium in plants	A D Horrill	T07054f5	Solutes beneath larch and Sitka spruce at three sites	J K Adamson
T07050j2	Advisory committees on radionuclide research	A D Horrill	T07054g5	ENCORE	M Hornung
T07050k5	Radioactivity in natural ecosystems – EEC II	A D Horrill	T07054h5	Modelling critical loads of N	M Hornung
T07050l2	Radioecology computer-based bibliography	V H Kennedy	T07054j2	Modelling the effects on water quality of liming in upland catchments	M Hornung
T07050m2	Development and calibration of mechanistic models for radionuclide uptake from soils	B J Howard	T07055k3	Interaction of enhanced N loading on soil nutrient dynamics and forest growth	M Hornung
T07050n2	Uptake of radionuclides by and distribution within basidiomycete fungi	J Dighton	T07056p1	Effects of climate change on soil organic matter	P J A Howard
<b>T07051-5</b>	<b>Radionuclide-animal transfers</b>	<b>B J Howard</b>	T07056q5	Carbon cycling and climate change	P J A Howard
T07051c2	Comparative radioecology of Ag-110m and Cs-137	N A Beresford	<b>T07066-3</b>	<b>Environmental radioactivity (special topic programme)</b>	<b>V H Kennedy</b>
T07051d1	The dynamics of radionuclide uptake by sheep	B J Howard	T07066b3	Uptake of radiocaesium by plants and the role of mycorrhizal fungi in mediating uptake	J Dighton
T07051e1	Validation of and studies into Cs-134/Cs-137 ratios in Cumbrian soil and vegetation	B J Howard	T07066d3	Dynamic modelling of pathways for radionuclides from the atmosphere to grazing animals	M H Unsworth/ B J Howard
T07051f1	Development of a method to rapidly predict the availability of radiocaesium to animal products after an accidental discharge	B J Howard	<b>Programme 8 Population ecology</b>		
T07051g5	Factors affecting radionuclide transfer to ruminants	B J Howard	<b>T08052-5</b>	<b>Plant strategies: response to environmental stress</b>	<b>T V Callaghan</b>
T07051i1	Behaviour of S-35 in ruminants	B J Howard	T08052a2	Plant responses to environmental stress at high latitudes	T V Callaghan
<b>T07052-5</b>	<b>Geochemistry of radionuclides</b>	<b>F R Livens</b>	T08052b5	Strategies of growth and population dynamics of tundra plants related to climatic change	T V Callaghan
T07052c1	Radionuclides in freshwater systems	F R Livens	<b>Programme 9 Community ecology</b>		
T07052d2	Radiochemical development	F R Livens	T09056g5	National survey of natural ecosystems in Korea	D K Lindley
T07052e2	Immobilisation of radioactive caesium in upland soils	F R Livens	<b>Programme 13 Scientific services</b>		
T07052f2	Opportunities in radioecology research	F R Livens	<b>T13054-2</b>	<b>ITE library services</b>	<b>J Beckett</b>
T07052g2	Association of the actinide elements with soil organic matter	F R Livens	T13054e2	Data base of ITE staff publications	J Beckett
<b>T07053-5</b>	<b>Soil microbial response to pollutants</b>	<b>P Ineson</b>	<b>T13055-5</b>	<b>ITE chemical research and development</b>	<b>J A Parkinson</b>
T07053a1	Effects of forest fumigation with $\text{SO}_2$ and $\text{O}_3$ on roots and mycorrhizas of trees	J Dighton	T13055a2	Chemical support studies	J A Parkinson
T07053b1	Effects of air pollution	P Ineson	T13055c1	Chemical analyses for Nature Conservancy Council	J D Roberts

T13055g1	Chemical analyses for British Antarctic Survey	J A Parkinson
T13055h5	Certification analysis of white clover	A P Rowland
T13055i2	Merlewood Analytical Section accreditation scheme	A P Rowland
T13055l2	Analytical group methods book update and revision	J D Roberts

<b>T13056-4</b>	<b>NERC mass spectrometer service</b>	<b>C Quarmby</b>
T13056a2	NERC mass spectrometer service	C Quarmby
<b>T13057-5</b>	<b>Merlewood scientific support services</b>	<b>D K Lindley</b>
T13057a2	Graphics and publications	C B Benefield
T13057b2	Biometrics and modelling support services at Merlewood	D K Lindley
T13057c1	ITE advice and services to Nature Conservancy Council	J M Sykes

## 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

<b>T02050-5</b>	<b>Human impact, erosion rehabilitation</b>	<b>N G Bayfield</b>
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### 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

<b>T08050-5</b>	<b>Vertebrate population dynamics and upland habitat geometry</b>	<b>R Moss</b>
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
<b>T08051-5</b>	<b>Population ecology of predators</b>	<b>H Kruuk</b>
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 Harris

T08051i2	Feeding ecology and energetics of high and low latitude shags	M P Harris
T08051j5	Top predators in East African wetlands	H Kruuk

## Programme 9 Community ecology

<b>T09050-5</b>	<b>Dynamics of upland and montane plant communities</b>	<b>B W Staines</b>
T09050d1	Response of <i>Gentiana nivalis</i> population to withdrawal of sheep grazing	B W Staines
T09050e1	Modelling the agricultural and environmental consequences of sheep and red deer grazing heather moorland	B W Staines/ D Welch
T09050f2	Vegetation dynamics and soils	J Miles
T09050i2	Dynamics of <i>Macchia</i>	S Mazzoleni
T09050j5	Effects of sheep withdrawal on upland vegetation and wildlife (flora and fauna) and landscape	R Moss
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	B W Staines

## Programme 13 Scientific services

<b>T13053-5</b>	<b>Services at ITE Banchory</b>	<b>B W Staines</b>
T13053a1	Ecological advisory appointment with Scottish Development Department	J Miles
T13053c1	Brathens consultancies	B W Staines
T13053d2	Computing and statistical advice	D D French
T13053e1	Scottish Office consultancy	J Miles

## ITE SOUTH — MONKS WOOD EXPERIMENTAL STATION

### Programme 1 Forest science

<b>T01061-3</b>	<b>Farm forestry (special topic programme)</b>	<b>T W Parr</b>
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
T02052f5	Characterisation of grassland type and condition using remote sensing	A R Jones
T02052g5	Remote sensing of Sahelian rangeland	B K Wyatt
T02052i2	Remote sensing in EIC	R M Fuller
T02052j2	Imagery and geographical data for national, regional and local land studies	R M Fuller
T02052k2	Geometric correction of images – PGRA supervision	R M Fuller
T02052l2	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 corne Biotopes Project	D Moss
T02053c1	Scientific co-ordination of the CORINE programme	B K Wyatt
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

### 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

### T02055-1 Environmental impact assessment M D Hooper

T02055b1	Channel Tunnel construction monitoring terrestrial (& freshwater) ecology	R C Welch
T02055d1	Ecological appraisal of a potential power station site	M D Hooper

T02055e1 Western Reservoir Planning Study review (WARPS2) R C Welch

T02055g1 Inner Thames Marshes SSSI, Rainham B C Eversham

T02055h1 Ecological appraisal of Hurley Golf Course at AFRC, IGAP site, Hurley R C Welch

### T02056-5 Grassland ecology T C E Wells

T02056a2	Monitoring floristic change	T C E Wells
T02056b2	Knocking Hoe cutting experiment	T C E Wells
T02056c2	Population studies on terrestrial orchids	T C E Wells

### T02057-5 Historical aspects of environmental management J Sheail

T02057a5 Historical aspects of environmental perception J Sheail

T02058g1 Ecological effects of hedgerow management M D Hooper

### T02059-5 Wetland dynamics and management J O Mountford

T02059b5	Land use and ecology of Swavesey Fens the fauna and flora in relation to both established and changing management	T Parish
T02059c5	Environmental impact of flood protection measures on the water regimes of wildlife habitats	J O Mountford
T02059d1	The effects of nitrogen on species diversity and agricultural production on the Somerset Moors	J O Mountford
T02059e5	British Rail-sponsored grassland experiments	J O Mountford

### T02061-3 Agriculture and the environment (special topic programme) J Sheail

T02061f3 Reducing residual soil fertility of abandoned agricultural land for the restoration of native vegetation R H Marrs

### 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

## Programme 3 Global environmental change

T03080a6 Preliminary study of indicator plants and plant communities N Webb/  
R Marrs/J Lawton/  
F Woodward/J Grime

## 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



T07061i1	Data base for HMIP	S Dobson
T07061j1	Habitat sensitivity	D Osborn

<b>T07062-5</b>	<b>Aquatic ecology and ecotoxicology</b>	<b>K R Bull</b>
T07062a1	National critical loads mapping programme	K R Bull
T07062f2	Modelling of atmospheric deposition into catchments	K R Bull

<b>T07069-5</b>	<b>Ecological consequences of climate change</b>	<b>K R Bull/ N R C Webb</b>
T07069a5	Application of GIS to climate change studies	K R Bull/ G L Radford
T07069b1	Department of the Environment climate change modelling programme	M O Hill/ J P Grime
T07069d1	Land cover mapping for predicting, assessing and managing the impacts of climate change	R M Fuller
T07069e2	Application of remote sensing technique to climate change studies	B K Wyatt/ A R Jones
T07069f5	Comparative studies of salt marsh processes	L A Boorman
T07069g2	Climate change, sea level rise and the English coast	L A Boorman
T07069h5	Modelling effects of climate change on species distribution	M O Hill
T07069i2	Effect of climate on population dynamics of heathlands	R H Marrs
T07069j5	Monitoring ecological change and plant species – a critical loads approach	T C E Wells/ R H Marrs
T07069k2	Influence of climatic factors on amphibian breeding success	C P Cummins
T07069o2	Butterfly monitoring scheme and climate change	J A Thomas

<b>T07070-5</b>	<b>Ecotoxicology of terrestrial vertebrates</b>	<b>D Osborn/ S Dobson</b>
T07070a2	Avian ecotoxicology	S Dobson
T07070b5	Mammalian ecotoxicology	R F Shore
T07070c1	Pesticide interactions effects of induction	A S Dawson
T07070d2	Detecting subtle impacts of pollutants on individuals	D Osborn
T07070e5	The effects of liming moorland on small mammal populations	R F Shore
T07070f5	Rodenticides and barn owls	I Newton
T07070h2	Ecotoxicology chemical analysis	M C French

## Programme 8 Population ecology

<b>T08054-2</b>	<b>Population dynamics</b>	<b>I Newton</b>
T08054a2	Population ecology of sparrowhawks ( <i>Accipiter nisus</i> )	I Newton
<b>T08055-5</b>	<b>Birds on farmland</b>	<b>I Newton</b>
T08055b5	Birds on arable farmland	I Newton
T08055c2	Tawny owls in fragmented habitats	S M Redpath
<b>T08056-5</b>	<b>Environmental control of annual cycles in birds</b>	<b>A S Dawson</b>
T08056a2	Environmental control of annual cycles in birds	A S Dawson

<b>T08068-5</b>	<b>Molecular ecology</b>	<b>A J Gray/I Newton</b>
T08068c2	Relatedness in sparrowhawks	I Newton
T08068d2	Relatedness in other birds of prey	I Newton

## Programme 9 Community ecology

<b>T09051-5</b>	<b>Ecology and management of coastal systems</b>	<b>L A Boorman</b>
T09051d1	Studies on salt marsh erosion in Essex	L A Boorman
<b>T09052-2</b>	<b>Heath and moorland systems</b>	<b>R H Marrs</b>
T09052a2	Heathland management research	R H Marrs
T09052b2	Long-term studies of vegetation change at Moor House NNR	R H Marrs
T09052c2	Effects of grazing in Snowdonia	M O Hill
T09052d1	Bracken distribution and management	R H Marrs
T09052e1	Moorland wilderness	R H Marrs
<b>T09053-5</b>	<b>Ecological processes in woodland</b>	<b>M O Hill</b>
T09053a2	Autecology of selected species on farm woodland	M O Hill
T09053c2	Modelling succession in farm woodland	M O Hill
T09053d2	Invertebrate fauna of native and introduced broadleaved trees in Britain	R C Welch
T09053e2	Management guidelines for the conservation of invertebrates, especially butterflies, in plantation woodlands	R H Marrs
T09053i2	Artificial intelligence applied to ecological and distributional information systems	M O Hill
T09053i5	Computerisation of National Vegetation Classification	M O Hill

## Programme 13 Scientific services

T13054c2	Development of current awareness services in ITE libraries	S P Edwards
<b>T13060-2</b>	<b>Statistical services in ITE South</b>	<b>K H Lakhani</b>
T13060a2	Estimation of population parameters	K H Lakhani
T13060b2	Statistical consultancy for Monks Wood/ITE/NERC	K H Lakhani
T13060c2	Biometrical research	T H Sparks
T13060d2	Statistical advice – Monks Wood and Bangor	T H Sparks
<b>T13061-1</b>	<b>ITE South consultancies</b>	<b>T M Roberts</b>
T13061a1	Small consultancies at ITE Monks Wood	M D Hooper

## ITE SOUTH — FURZEBROOK RESEARCH STATION

### Programme 2 Land use, agriculture and the environment

<b>T02058-5</b>	<b>Vegetation dynamics</b>	<b>R E Daniels</b>
T02058f5	Experimental studies on the management of reed beds for RBTS sewage treatment	R E Daniels
T02065o3	Ecological and genetic factors contributing to the decline in certain arable weed species (JAEP)	A J Gray

T02065p3 Fertiliser, liming and management effects on invertebrate community dynamics (JAEP) M G Morris

### Programme 3 Global environmental change

T03080a6 Preliminary study of indicator plants and plant communities N Webb/R Marrs/J Lawton/F Woodward/J Grime

T03082a6 Vertebrates as indicator species of ecological change J D Goss-Custard/J Krebs/J H Lawton  
identification of target organisms

### Programme 7 Environmental pollution

**T07069-5 Ecological consequences of climate change** K R Bull/N R Webb

T07069l2 Invertebrate geographical ranges and climate L K Ward

T07069n2 Invasion potential of ants G W Elmes

T07069o2 Butterfly monitoring scheme and climate change J A Thomas

### Programme 8 Population ecology

**T08057-5 Migratory wader ecology** J D Goss-Custard

T08057a2 Predator/prey interactions between the oystercatcher and mussel J D Goss-Custard

T08057b2 Winter feeding ecology of juvenile oystercatchers J D Goss-Custard

T08057c2 Habitat contraction, breeding density and reproductive output in waders J D Goss-Custard

T08057h5 Birds in estuaries J D Goss-Custard

**T08058-5 Resident vertebrate ecology** R E Kenward

T08058a2 Grey squirrel damage and management R E Kenward

T08058e2 Breeding success and survival in the common toad C J Reading

T08058f2 Ecology and population dynamics of the grass-snake (*Natrix natrix helvetica*) 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

T08058k1 Gull clearance from Farmoor Reservoir R E Kenward

**T08059-5 Plant genecology** A J Gray

T08059b2 *Spartina* population ecology A J Gray

T08059c5 Genetic variation in wetland plants R E Daniels

T08059g1 Poole Bridge replacement environmental impact assessment N R Webb

T08059i2 Population biology in peatland angiosperms R E Daniels

T08059k2 ISP seed protein study A J Gray

T08059m5 River Wyre barrage study A J Gray

T08059n1 Broad Oak Water ecological survey R E Daniels

**T08060-5 Butterfly and ant studies** J A Thomas

T08060a5 The conservation of the large blue butterfly J A Thomas

T08060b2 The ecology of woodland fritillary butterflies J A Thomas

T08060c2 Social biology and socioecology of genus *Myrmica* G W Elmes

T08060d2 Ant/butterfly interactions J A Thomas/G W Elmes

T08060e2 Population ecology of *Myrmica* G W Elmes

T08060f2 Purple hairstreak populations and ants J A Thomas

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 *Brassica* A J Gray

T08068b2 Ant socio-biology G W Elmes

T08068f1 Genetically modified crops and their wild relatives A F Raybould

T08068g1 Gene flow in natural populations of *Brassica* and *Beta* A J Gray

### 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

T09055q1 Ecological survey Isle of Gram N R Webb

**T09056-5 Grassland and scrub dynamics** M G Morris

T09056a2 Grassland management – invertebrates M G Morris

T09056b2 Study of scrub succession on chalk at Aston Rowant NNR L K Ward

T09056c1 Scrub management at Castor Hanglands NNR L K Ward

T09056d2 Demography and conservation of scrub L K Ward

T09056f2 Weevil studies M G Morris

### 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 Morris

### ITE SOUTH — BANGOR RESEARCH UNIT

#### Programme 2 Land use, agriculture and the environment

**T02060-5 Biogeochemistry and land use** J E G Good

T02060a2 Nature conservation in upland conifer forests J E G Good

T02060b2 Clonal selection in *Betula* and *Salix* J E G Good

T02060d2 Geochemical cycling in the uplands B Reynolds

T02060f2 Effects of clearfelling plantation forests extension P A Stevens

T02060h5 Role of mires as sinks for N, P and S B Emmett

T02060i5 Impacts of catchment liming on soil and soil water chemistry B Reynolds

T02060j2	Estimation of atmospheric inputs to ITE catchments	B Reynolds	T07064c2	Effects of acid mist on arctic-alpines	T W Ashenden
T02060k5	Nitrogen critical load experiment	B Emmett	T07064d2	Trace metals in terrestrial ecosystems	K C Walton
T02060l5	Phosphorus fertilisation experiment	P A Stevens	T07064g2	Engineering development (mechanical and electronic)	C R Rafarel
T02060m5	Forest nitrogen survey	P A Stevens	T07064i5	Critical loads of N and S deposition to carbon dioxide on grassland communities	T W Ashenden
T02060n1	Rainfall sample collection	B Emmett			
T02060o5	Dissolution rates of liming materials in acid upland mires	B Reynolds	T07069m2	Climate and high-altitude invertebrates	A Buse
T02060p5	Revegetation of land disturbed by hydroelectric pipeline replacement at Cwm Dyl, Snowdon	J E G Good	T07069p2	Effects of elevated concentrations of carbon dioxide on upland vegetation	T W Ashenden
T02060q2	Effects of chronic acid gas exposure on soil nutrient leaching	B A Emmett			
T02060r1	Grassland re-establishment, Glynneath	P A Stevens			
<b>Programme 3 Global environmental change</b>					
T03080b6	Evaluation of techniques for field studies in global environmental change	T W Ashenden/ T A Mansfield/ J P Grime			
<b>Programme 7 Environmental pollution</b>					
T07064-5	<b>Response of ecosystems to pollution</b>	<b>K C Walton</b>			
T07064a5	Pollution study of Wales	T W Ashenden			
<b>Programme 9 Community ecology</b>					
T09054-2	<b>Montane ecology</b>	<b>J E G Good</b>			
T09054e2	Sheep grazing intensity and radiance from vegetation	A G Thomson			
T09054f2	Exploitation of sheltered micro-habitats at high altitudes by small vertebrates	A G Thomson			
T09054g2	Status of the Snowdon beetle	A Buse			
T09054h2	Exploitation of montane habitats by free-ranging sheep	A G Thomson			
<b>Programme 13 Scientific services</b>					
T13061-1	<b>ITE South consultancies</b>	<b>T M Roberts</b>			
T13061c1	Small consultancies at ITE Bangor	J E G Good			

# Appendix 4. Publications by ITE staff in 1990–91

## 1. Papers in refereed journals

- Adamson, J.K. & Hornung, M.** 1990 The effect of clearfelling a Sitka spruce (*Picea sitchensis*) plantation on solute concentrations in drainage water *J Hydrol*, **116**, 287–298
- (Akeroyd, J.R.) & Preston, C.D.** 1990 Notes on some Aizoaceae naturalized in Europe In *Flora Europaea Notulae systematicae ad Floram Europaeam spectantes* Series 2 No 3, edited by A O Chater *Bot J Linn Soc*, **103**, 197–200
- (Anderson, S.S.), Livens, F.R. & Singleton, D.L.** 1990 Radionuclides in grey seals *Mar Pollut Bull*, **21**, 343–345
- Ashenden, T.W., Bell, S.A. & Rafarel, C.R.** 1990 Effects of nitrogen dioxide pollution on the growth of three fern species *Environ Pollut*, **66**, 301–308
- (Ashford, R.W.), Wyllie, I. & Newton, I.** 1990 *Leucocytozoon toddi* in British sparrowhawks *Accipiter nisus* observations on the dynamics of infection *J nat Hist*, **24**, 1101–1107
- Bacon, P.J. & Mountford, M.D.** 1990 The effect of genotypic and yearly variations on the egg volumes of the mute swan *Cygnus olor* *Wildfowl*, **41**, 7–12
- Bacon, P.J., (Ball, F. & Blackwell, P.)** 1991 Analysis of a model of group territoriality based on the Resource Dispersion Hypothesis *J theor Biol*, **148**, 433–444
- Bacon, P.J., (Ball, F. & Blackwell, P.)** 1991 A model for territory and group formation in a heterogeneous habitat *J theor Biol*, **148**, 445–468
- (Barnes, J.D.), Eamus, D. & (Brown, K.A.)** 1990 The influence of ozone, acid mist and soil nutrient status on Norway spruce *Picea abies* (L) Karst *New Phytol*, **114**, 713–720
- (Barnes, J.D.), Eamus, D., (Davison, A.W.), Ro-Poulsen, H. & Mortensen, L.)** 1990 Persistent effects of ozone on needle water loss and wettability in Norway spruce *Environ Pollut*, **63**, 345–364
- Barr, C.J.** 1990 Mapping the changing face of Britain *Geogr Mag*, **62(9)**, 44–47
- (Barrie, J.), Greatedorex-Davies, J.N., (Parsell, R.J.) & Marrs, R.H.** 1990 A semi-automated method for analysing hemispherical photographs for the assessment of woodland shade *Biol Conserv*, **54**, 327–334
- Boorman, L.A.** 1989 The grazing of British sand dune vegetation *Proc R Soc Edinb*, **96B**, 75–88
- Buse, A.** 1990 Influence of earthworms on nitrogen fluxes and plant growth in cores taken from variously managed upland pastures *Soil Biol Biochem*, **22**, 775–780
- Callaghan, T.V., (Tyler, N.J.C. & Carlsson, B.)** 1990 Fluctuation in plant growth and in reindeer populations in Svalbard *Rangifer*, special issue no 3, 157–158
- Cannell, M.G.R.** 1990 Modelling the phenology of trees *Silva Carelica*, **15**, 11–27
- Cannell, M.G.R. & (Morgan, J.)** 1990 Theoretical study of variables affecting the export of assimilates from branches of *Picea* *Tree Physiol*, **6**, 257–266
- Cape, J.N., (Freer-Smith, P.H.), Paterson, I.S., Parkinson, J.A. & (Wolfenden, J.)** 1990 The nutritional status of *Picea abies* (L) Karst across Europe, and implications for "forest decline" *Trees*, **4**, 211–224
- (Carlsson, B.A.) & Callaghan, T.V** 1990 Effects of flowering on the shoot dynamics of *Carex bigelowii* along an altitudinal gradient in Swedish Lapland *J Ecol*, **78**, 152–165
- (Carlsson, B.A.) & Callaghan, T.V.** 1990 Programmed tiller differentiation, intracolonial density regulation and nutrient dynamics in *Carex bigelowii* *Oikos*, **58**, 219–230
- (Carlsson, B.A.) & Callaghan, T.V.** 1991 Simulation of fluctuating populations of *Carex bigelowii* tillers classified by type, age and size *Oikos*, **60**, 231–240
- Carss, D.N.** 1990 Concentrations of wild and escaped fishes immediately adjacent to fish farm cages *Aquaculture*, **90**, 29–40
- Carss, D.N., Kruuk, H. & Conroy, J.W.H.** 1990 Predation on adult Atlantic salmon, *Salmo salar* L, by otters, *Lutra lutra* (L), within the River Dee system, Aberdeenshire, Scotland *J Fish Biol*, **37**, 935–944
- (Cayford, J.T.) & Goss-Custard, J.D.** 1990 Seasonal changes in the size selection of mussels, *Mytilus edulis*, by oystercatchers, *Haematopus ostralegus* an optimality approach *Anim Behav*, **40**, 609–624
- (Chappell, N.A., Ternan, J.L., Williams, A.G.) & Reynolds, B.** 1990 Preliminary analysis of water and solute movement beneath a coniferous hillslope in mid-Wales, UK *J Hydrol*, **116**, 201–216.
- Clarke, R.T., (Welton, J.S. & Ladle, M.)** 1990 Estimation of larval feeding rates using normal linear models involving censored and truncated observations *J appl Stat*, **17**, 199–209
- (Cowden, D.G.), Harding, P.T. & Eversham, B.C.** 1990 Some records of invertebrates from Northern Ireland, including three spiders new to Ireland *Ir Nat J*, **23**, 321–325
- Daniels, R.E.** 1990 Variability in three marginal populations of *Lobelia aurea* L in Britain *Vegetatio*, **90**, 63–71
- Deans, J.D., Leith, I.D., Sheppard, L.J., Cape, J.N., Fowler, D., Murray, M.B. & Mason, P.A.** 1990 The influence of acid mists on growth, dry matter partitioning, nutrient concentrations and mycorrhizal fruiting bodies in red spruce seedlings *New Phytol*, **115**, 459–464
- Deans, J.D., (Lundberg, C., Tabbush, P.M.), Cannell, M.G.R., Sheppard, L.J. & Murray, M.B.** 1990

The influence of desiccation, rough handling and cold storage on the quality and establishment of Sitka spruce planting stock *Forestry*, **63**, 129–141

**Dennis, P., (Wratten, S.D. & Sotherton, N.W.)** 1990 Feeding behaviour of the staphylinid beetle *Tachyporus hypnorum* in relation to its potential for reducing aphid numbers in wheat *Ann appl Biol*, **117**, 267–276

**Dennis, P. & (Wratten, S.D.)** 1991 Field manipulation of populations of individual staphylinid species in cereals and their impact on aphid populations *Ecol Entomol*, **16**, 17–24

**(Devereux, B.J.), Fuller, R.M., (Carter, L. & Parsell, R.J.)** 1990 Geometric correction of airborne scanner imagery by matching Delaunay triangles *Int J remote Sensing*, **11**, 2237–2251

**Dewar, R.C** 1990 A model of carbon storage in forests and forest products *Tree Physiol*, **6**, 417–428

**Dewar, R.C** 1991 Analytical model of carbon storage in the trees, soils and wood products of managed forests *Tree Physiol*, **8**, 239–258

**Dick, J.McP., (Jarvis, P.G. & Barton, C.V.M.)** 1990 Influence of male and female cones on assimilate production of *Pinus contorta* trees within a forest stand *Tree Physiol*, **7**, 49–64

**Dick, J.McP., (Jarvis, P.G.) & Leakey, R.R.B.** 1990 Influence of male cones on early season vegetative growth of *Pinus contorta* trees *Tree Physiol*, **6**, 105–117

**Dick, J.McP., Leakey, R.R.B. & (Jarvis, P.G.)** 1990 Influence of female cones on the vegetative growth of *Pinus contorta* trees *Tree Physiol*, **6**, 151–164.

**Dick, J.McP., Smith, R. & (Jarvis, P.G.)** 1990 Respiration rate of male and female cones of *Pinus contorta* *Trees*, **4**, 142–149

**Dighton, J., Mason, P.A. & Poskitt, J.M** 1990 Field use of  $^{32}\text{P}$  to measure phosphate uptake by birch mycorrhizas *New Phytol*, **116**, 655–661.

**(Dore, A.J., Choularton, T.W.), Fowler, D. & Storeton-West, R.** 1990 Field measurements of wet deposition in an extended region of complex

topography *Q J R met Soc*, **116**, 1193–1212

**Durell, S.E.A. Le V.dit & (Kelly, C.P.)** 1990 Diets of dunlin *Calidris alpina* and grey plover *Pluvialis squatarola* on the Wash as determined by dropping analysis *Bird Study*, **37**, 44–47

**(Dutch, J.) & Ineson, P.** 1990 Denitrification of an upland forest site *Forestry*, **63**, 363–377

**Eamus, D., (Barnes, J.D., Mortensen, L., Ro-Poulsen, H. & Davison, A.W.)** 1989 A delayed effect of ozone fumigation on photosynthesis of Norway spruce *Ann Sci for*, **46** (Suppl.), 568s–572s

**Eamus, D., Leith, I. & Fowler, D.** 1989 The influence of acid mist upon transpiration, shoot water potential and pressure-volume curves of red spruce seedlings *Ann Sci for*, **46** (Suppl.), 577s–580s

**Eamus, D., (Barnes, J.D., Mortensen, L., Ro-Poulsen, H. & Davison, A.W.)** 1990 Persistent stimulation of  $\text{CO}_2$  assimilation and stomatal conductance by summer ozone fumigation in Norway spruce *Environ Pollut*, **63**, 365–380

**Elmes, G.W. & (Petal, J.)** 1990 Queen number as an adaptable trait: evidence from wild populations of two red ant species (genus *Myrmica*) *J Anim Ecol*, **59**, 675–690

**Elmes, G.W., Thomas, J.A. & Wardlaw, J.C.** 1991 Larvae of *Maculinea rebeli*, a large-blue butterfly, and their *Myrmica* host ants: wild adoption and behaviour in ant-nests *J Zool*, **223**, 447–460

**Fowler, D., (Morse, A.P., Gallacher, M.W., & Choularton, T.W.)** 1990 Measurements of cloud water deposition on vegetation using a lysimeter and a flux gradient technique *Tellus*, **42B**, 285–293

**(France, J.), Thornley, J.H.M., (Lopez, S., Siddons, R.C., Dhanoa, M.S., Van Soest, P.J. & Gill, M.)** 1990 On the two-compartment model for estimating the rate and extent of feed degradation in the rumen *J theor Biol*, **146**, 269–287

**Frankland, J.C.** 1990 Ecological methods of observing and quantifying soil fungi *Trans mycol Soc Japan*, **31**, 89–101

**Fuller, R.M. & (Parsell, R.J.)** 1990 Classification of TM imagery in the study of land use in lowland Britain: practical considerations for operational use *Int J remote Sens*, **11**, 1901–1918

**Gough, M.W. & Marrs, R.H.** 1990 Trends in soil chemistry and floristics associated with the establishment of a low-input meadow system on an arable clay soil in Essex, England *Biol Conserv*, **52**, 135–146

**(Hamer, K.C., Furness, R.W.) & Caldow, R.W.G.** 1991 The effects of changes in food availability on the breeding ecology of great skuas *Catharacta skua* in Shetland *J Zool*, **223**, 175–188

**Harding, P.T.** 1990 The Biological Records Centre *Biologist*, **37**, 162–164

**(Harding, P.T.)** 1990 An indexed bibliography of the distribution and ecology of woodlice (*Crustacea Oniscoidea*) in Great Britain *Isopoda*, **4**, 1–32

**(Harkness, D.D.) & Harrison, A.F.** 1989 The influence of afforestation on upland soils: the use of "bomb  $^{14}\text{C}$ " enrichment as a quantitative tracer for changes in organic status *Radiocarbon*, **31**, 637–643

**Harris, M.P. & Wanless, S.** 1990 Breeding status and sex of common murrets (*Uria aalge*) at a colony in autumn *Auk*, **107**, 603–605

**Harris, M.P., (Towill, H., Russell, A.F.) & Wanless, S.** 1990 Maximum dive depths attained by auks feeding young on the Isle of May, Scotland *Scott Birds*, **16**, 25–28

**(Headley, A.D.) & Callaghan, T.V.** 1990 Modular growth of *Huperzia selago* (Lycopodiaceae: Pteridophyta) *Fern Gaz*, **13**, 361–372

**Horrell, A.D. & (Mudge, S.)** 1990 The influence of grassland management on the radionuclide inventory of soils in west Cumbria, UK *J environ Radioactivity*, **12**, 143–165.

**Howard, P.J.A.** 1990 Soil protection and soil quality *Milieu*, **5**, 248–256

**Howard, P.J.A. & Howard, D.M.** 1990 Titratable acids and bases in tree and shrub leaf litters *Forestry*, **63**, 177–196

- Howard, P.J.A. & Howard, D.M.** 1990 Use of organic carbon and loss-on-ignition to estimate soil organic matter in different soil types and horizons *Biol Fertil Soils*, **9**, 306–310
- Hughes, S. & Reynolds, B.** 1990 Evaluation of porous ceramic cups for monitoring soil-water aluminium in acid soils: comment on a paper by Raulund-Rasmussen (1989) *J Soil Sci*, **41**, 325–328
- Hughes, S., Reynolds, B. & Roberts, J.D.** 1990 The influence of land management on concentrations of dissolved organic carbon and its effects on the mobilization of aluminium and iron in podzol soils in mid-Wales *Soil Use Manage*, **6**, 137–145
- (Jefferies, D.J.), Hanson, H.M. & (Harris, E.A.)** 1990 The prevalence of *Pseudoterranova decipiens* (Nematoda) and *Corynosoma strumosum* (Acanthocephala) in otters *Lutra lutra* from coastal sites in Britain *J Zool*, **221**, 316–321
- (Johnson, I.R.) & Thornley, J.H.M.** 1990 Mathematical modelling in plant and crop physiology *Bull Inst Math Applic*, **26**, 1–9
- (Johnston, G., Walker, C.H.), Dawson, A. & Furnell, A.** 1990 Interactive effects of pesticides in the hybrid red-legged partridge *Functional Ecol*, **4**, 309–314
- (Johnston, P., Struyker, R.), French, M.C. & (Valleth, J.)** 1991 Contamination of soils and sediments in the vicinity of a mercury recovery plant *Bull environ Contam Toxicol*, **46**, 74–78
- (Jong, T.J. de, Klinkhamer, P.G.L.) & Boorman, L.A.** 1990 *Cynoglossum officinale* L. (Biological flora of the British Isles no 170) *J Ecol*, **78**, 1123–1144.
- Kruuk, H.** 1989 The ecology of social organization in carnivores *Monitore zool ital*, **22**, 511–512
- Kruuk, H. & (Balharry, D.)** 1990 Effects of sea water on thermal insulation of the otter, *Lutra lutra* *J Zool*, **220**, 405–415
- Kruuk, H. & (Goudswaard, P.C.)** 1990 Effects of changes in fish populations in Lake Victoria on the food of otters (*Lutra maculicollis* Schinz and *Aonyx capensis* Lichtenstein) *Afr J Ecol*, **28**, 322–329
- Kruuk, H. & (Moorhouse, A.)** 1990 Seasonal and spatial differences in food selection by otters (*Lutra lutra*) in Shetland *J Zool*, **221**, 621–637
- Kruuk, H., (Wansink, D. & Moorhouse, A.)** 1990 Feeding patches and diving success of otters, *Lutra lutra*, in Shetland *Oikos*, **57**, 68–72
- Leakey, R.R.B.** 1990 *Nauclea diderrichii* rooting of stem cuttings, clonal variation in shoot dominance, and branch plagiotropism *Trees*, **4**, 164–169
- Leakey, R.R.B., (Mesen, J.F., Tchoundjeu, Z.), Longman, K.A., Dick, J.McP., Newton, A.C., (Matin, A., Grace, J.), Munro, R.C. & (Muthoka, P.N.)** 1990 Low-technology techniques for the vegetative propagation of tropical trees *Commonw For Rev*, **69**, 247–257
- Livens, F.R.** 1990 Biogeochemical cycling of radionuclides in the environment *Analyt Proc*, **27**, 343–344.
- Livens, F.R. & Singleton, D.L.** 1991 Plutonium and americium in soil organic matter *J environ Radioactivity*, **13**, 323–339
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**Miller, G.R., Welch, D., Watson, A., Paterson, I.S., Scott, D. & McGowan, G.M.** 1990 *Monitoring the effects of snow fencing on vegetation, herbivores and soils at Glas Maol in 1990 Progress report* 14pp Scottish Development Department

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1991 *Restoration of natural vegetation on organic soils from buried viable seeds (Three Peaks Project report no 10)* 46pp Yorkshire Dales National Park Committee

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**Milne, R. & Brown, T.A.** 1990 *Tree stability and form Final report* 96pp Commission of the European Communities

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**Morris, M.G., Rispin, W.E. & Snazell, R.G.** 1990 *Invertebrate assessment of intensively-studied NNRs (Old Winchester Hill and Parsonage Down)* 52pp Nature Conservancy Council (South Region)

**Moss, D. & Wyatt, B.K.** 1990 *CORINE biotopes project Technical handbook, vol 1 Methodology and data specifications* Commission of the European Communities

**Moss, D. & Wyatt, B.K.** 1990 *CORINE biotopes project an inventory of sites of importance for nature conservation in the European Community Final report* Commission of the European Communities

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**Newton, I., Asher, A., Freestone, P., French, M.C., Leach, D.V., Morgan, A., Osborn, D. & Wyllie, I.** 1990 *Birds and pollution Annual report* 37pp Nature Conservancy Council

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**Pakeman, R.J. & Marrs, R.H.** 1991 *An environmental balance sheet for bracken and its control* 82pp Department of the Environment.

**Parish, T., Appleby, C.E. & Marrs, R.H.** 1990 *Environmental impact assessment of the release trials of two genetically modified organisms potato and oilseed rape* 14pp Nickerson International Seed Co Ltd

**Parr, R.** 1990 *Moorland birds and their predators in relation to afforestation* 48pp Nature Conservancy Council

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**Paterson, I.S. & Bayfield, N.G.** 1990 *Aonach Mor ski area 1990 environmental audit Report to Aonach Mor Working Group* 24pp Nature Conservancy Council

**Paterson, I.S. & Daniels, R.E.** 1990 *Wytch Farm development biological monitoring Tree damage close to new flare boxes at Wytch Farm Gathering Station* 4pp BP Exploration

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**(Pollard, E.) & Yates, T.J.** 1991 *The butterfly monitoring scheme review & suggestions for the future* 23pp Nature Conservancy Council

- (Rea, J.D., Nielsen, I.R.) & Howe, P.D.** 1990 *Environmental hazard assessment benzene Draft for comment* 73pp Department of the Environment
- Reading, C.J.** 1989 *Arne Wellsite G / Wellsite G to Gathering Station infield flow line 1 Survey and removal of reptiles and amphibians* 18pp British Petroleum
- Reading, C.J.** 1990 *Purbeck-Southampton oil pipeline Goathorn peninsula Arne G wellsite 1 Recolonisation of the PSP route and other sites by heathland plants and animals 2nd interim report* 46pp British Petroleum
- Reading, C.J.** 1990 *Purbeck-Southampton oil pipeline 1 Recolonisation of the PSP route by heathland plants and animals Interim report* 25pp British Petroleum
- Reynolds, B. & Emmett, B.A.** 1990 *Annual report on the soil and soil water chemistry of selected sites at Llyn Brannan* 40pp Department of the Environment
- Rispin, W.E. & Snazell, R.G.** 1991 *Rossmore Lodge ecological survey* Guy Pound Group Practice
- Rose, R.J. & Webb, N.R.** 1991 *The chemical and physical properties of reinstated pipeline soils* British Gas
- Rose, R.J. & Webb, N.R.** 1991 *The effects of temporary roadways on the recovery of heathland vegetation 1988 observations* British Gas
- Rose, R.J. & Webb, N.R.** 1991 *Wentworth water resources assessment survey of heathland and proposed reservoir sites* 65pp Institute of Hydrology
- Scott, R. & (Tibbetts, P.J.C.)** 1990 *Saltmarsh monitoring around Sullom Voe in 1989* 93pp Shetland Oil Terminal Environmental Advisory Group
- Scott, R.** 1991 *Assessment of the effects of 17th February 1991 oil spill on the Houb of Scatsta saltmarsh recommendations for a bioremediation experiment* 4pp Shetland Oil Terminal Environmental Advisory Group
- Scott, R. & Sykes, J.M.** 1991 *North Morecambe terminal environmental assessment habitat survey and wildlife impacts at the proposed site at Barrow-in-Furness* 19pp British Gas
- Shore, R.F.** 1990 *The effect of liming moorland catchments on small mammal populations Interim report* 27pp National Power
- Stevens, P.A., Emmett, B.A. & Rafarel, C.R.** 1990 *Annual report on the nitrogen deposition manipulation study August 1990* 46pp National Power
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- Ward, L.K.** 1990 *Ecological appraisal of the West Wellow by-pass - A36* 73pp MRM Adnan Lisney
- Watson, A.** 1989 *Early-summer inspection, Glenshee Ski Centre, 1989* Glenshee Chairlift Company
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- Watson, A. & (Smith, R.)** 1989 *Glenshee monitoring, autumn 1989* Glenshee Chairlift Company
- Watson, A. & (Smith, R.)** 1989 *Lecht monitoring, autumn 1989* Lecht Ski Company
- Watson, A.** 1990 *Environmental aspects of the 1990 environmental impact assessment at Glenshee Ski Centre* 85pp Glenshee Chairlift Company
- Webb, N.R.** 1990 *Poole Bridge replacement assessment of ecological effects* 22pp Dorset County Council
- Welch, R.C. & Eversham, B.C.** 1990 *Terrestrial ecological study on a proposed power station at Barking Reach (East site)* 11pp Thames Power Ltd
- Welch, R.C. & Parish, T.** 1990 *A34 Newbury by-pass ecological appraisal* 24pp Mott MacDonald Civil Ltd
- Welch, R.C. & Radford, G.L.** 1990 *Western Area Reservoirs Planning Study Review (WARPS2) Environmental studies - ecology & conservation* 22pp Together with a separate draft report on Bird strike hazards, by R.E. Kenward 14pp Sir William Halcrow & Partners Ltd
- Welch, R.C., Mountford, J.O., Cox, R. & Greator-Davies, J.N.** 1990 *Channel Tunnel terrestrial ecological monitoring of construction impact, 1989* 202pp Transmanche Link
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- Welch, R.C., Treweek, J.R. & Greator-Davies, J.N.** 1990 *Ecological appraisal of proposed golf course at AFRC, IGER, Hurley, Berkshire Preliminary report* 36pp Agricultural and Food Research Council
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- Wells, T.C.E., Bayfield, N.G., Cox, R. & McGowan, G.** 1990 *Wild flower swards for trunk road and motorway landscaping A handbook* 114pp Department of Transport
- Wilson, J., Munro, R.C., Ingleby, K., Dick, J.McP., Mason, P.A., (Jefwa, J., Muthoka, P.N.), Newton, A.C. & Leakey, R.R.B.** 1990 *Agroforestry and mycorrhizal research for semi-arid lands of East Africa Annual report (1989)* 110pp Overseas Development Administration
- Yates, T.J.** 1991 *Butterfly monitoring scheme Progress report* 17pp Nature Conservancy Council

## Appendix 5. ITE publications

HMSO publishes for the Institute, and acts as an agent for a substantial backlist of ITE titles. Unless specified otherwise, all books are paperback and prices are shown net (as per the Net Book Agreement), and available from HMSO bookshops

### Forest science

#### Attributes of trees as crop plants

M G R Cannell & J E Jackson (eds)

592pp 0 904282 83 X £20 00 (Hardback) 1985

#### Cumbrian woodlands (ITE symposium no. 25)

J K Adamson (ed)

94pp 0 11 701421 4 £7 10 1989

#### The ecology of even-aged forest plantations

E D Ford, D C Malcolm & J Atterson (eds)

582pp 0 904282 33 3 £9 00 (Hardback) 1979

#### Effect of birch on moorlands

J Miles

18pp 0 904282 47 3 £1 50 1981

#### Environmental aspects of plantation forestry in Wales

(ITE symposium no. 22)

J E G Good (ed)

77pp 1 870393 02 3 £6 95 1987

#### A field key for classifying British woodland vegetation: Part I

R G H Bunce

103pp 0 904282 68 6 £3 00 1982

#### A field key for classifying British woodland vegetation: Part II

R G H Bunce

95pp 0 11 701417 6 £7 95 1989

#### Pasture woodlands in lowland Britain

P T Harding & F Rose

94pp 0 904282 91 0 £5 00 1986

#### The temperate forest ecosystem

(ITE symposium no. 20)

Yang Hanxi, Wang Zhan, J N R Jeffers & P A Ward (eds)

189pp 1 870393 01 5 £15 00 1987

#### Trees and wildlife in the Scottish uplands

(ITE symposium no. 17)

D Jenkins (ed)

196pp 0 904282 97 X £7 50 1986

#### Virus diseases of trees and shrubs

J I Cooper

74pp 0 904282 28 7 £3 00 1979

### Land use, agriculture and the environment

#### Agriculture and conservation in the hills and uplands

(ITE symposium no. 23)

M Bell & R G H Bunce (eds)

164pp 1 870393 03 1 £10 00 1987

#### Agriculture and the environment (ITE symposium no. 13)

D Jenkins (ed)

195pp 0 904282 73 3 £7 00 1984

#### Angling and wildlife in fresh waters (ITE symposium no. 19)

P S Maitland & A K Turner (eds)

84pp 0 904282 99 6 £8 00 1987

#### The biology and management of the River Dee

(ITE symposium no. 14)

D Jenkins (ed)

160pp 0 904282 88 0 £6 00 1985

#### Britain's railway vegetation

C Sargent

34pp 0 904282 76 7 £3 50 1984

#### Distribution of freshwaters in Great Britain

I R Smith & A A Lyle

44pp 0 904282 25 2 £2 00 1979

#### Historical ecology: the documentary evidence

J Sheail

22pp 0 904282 34 1 £2 00 1980

#### Moorland management: a study of Exmoor

G R Miller, J Miles & O W Heal

130pp 0 904282 79 1 £4 50 1984

#### Rural information for forward planning

(ITE symposium no. 21)

R G H Bunce & C J Barr (eds)

115pp 1 870393 05 8 £11 00 1988

#### The use of land classification in resource assessment and rural planning

R S Smith

43pp 0 904282 62 7 £3 00 1982

#### Vegetation change in upland landscapes

D F Ball, J Dale, J Sheail & O W Heal

45pp 0 904282 64 3 £2 00 1982



## Global environmental change

### Climatic change, rising sea level and the British coast (ITE research publication no. 1)

L A Boorman, J D Goss-Custard & S McGrorty  
24pp 0 11 701429 X £5 50 1989

### Climatological maps of Great Britain

E J White & R I Smith  
37pp 0 904282 69 4 £2 00 1982

## Environmental pollution

### Acidification and fish in Scottish lochs

P S Maitland, A A Lyle & R N B Campbell  
71pp 1 870393 04 X £6 95 1987

### Early diagnosis of forest decline

J N Cape, I S Paterson, A R Wellburn, J Wolfenden, M Mehlhorn,  
P Freer-Smith & S Fink  
68pp 1 870393 07 4 £5 00 1988

### Effects of air pollutants on agricultural crops

F T Last, D Fowler & P H Freer-Smith  
27pp 0 904282 90 2 £2 00 1985

### Metals in animals (ITE symposium no. 12)

D Osborn (ed)  
77pp 0 904282 77 5 £3 50 1984

### Methods for studying acid precipitation in forest ecosystems

I A Nicholson, I S Paterson & F T Last (eds)  
36pp 0 904282 36 8 £3 00 1980

### Pollution in Cumbria (ITE symposium no. 16)

P Ineson (ed)  
92pp 0 904282 96 1 £5 75 1986

### Predatory birds, pesticides and pollution

A S Cooke, A A Bell & M B Haas  
74pp 0 904282 55 4 £4 00 1982

### Radionuclides in terrestrial ecosystems

K L Bocock  
27pp 0 904282 42 2 £2 00 1981

## Population ecology

### Birds of St Kilda

M P Harris & S Murray  
42pp 0 904282 27 9 £6 50 1989

### Butterfly research in ITE

M L Hall  
28pp 0 904282 46 5 £1 50 1981

### Conserving otters

D Jenkins  
14pp 0 904282 44 9 £1 00 1980

### Distribution and status of bats in Europe

R E Stebbings & F Griffith  
142pp 0 904282 94 5 £5 00 1986

### Handbook of European Sphagna

R E Daniels & A Eddy  
262pp 0 11 701431 1 £17 50 1990

### The status of the Atlantic salmon in Scotland

(ITE symposium no. 15)  
D Jenkins & W M Shearer (eds)  
127pp 0 904282 92 9 £6 00 1986

### Woodlice in Britain and Ireland: distribution and habitat

P T Harding & S L Sutton  
152pp 0 904282 85 6 £5 00 1985

## Community ecology

### Bedford Purlieus (ITE symposium no. 7)

G F Peterken & R C Welch (eds)  
209pp 0 904282 05 8 £1 00 1975

### Coast dune management guide

D S Ranwell & R Boar  
105pp 0 904282 93 7 £6 00 1986

### Ecology of quarries (ITE symposium no. 11)

B N K Davis  
77pp 0 904282 59 7 £2 00 1982

### Heather in England and Wales

(ITE research publication no. 3)  
R G H Bunce (ed)  
40pp 0 11 701422 2 £5 90 1989

### Spartina anglica – a research review

(ITE research publication no. 2)  
A J Gray & P E M Benham (eds)  
80pp 0 11 701477 X £8 75 1990

## Scientific services

### **Chemical analysis in environmental research (ITE symposium no. 18)**

A P Rowland (ed)

104pp 0 904282 98 8 £7 00 1987

### **Cotton strip assay: an index of decomposition in soils (ITE symposium no. 24)**

A F Harrison, P M Latter & D W H Walton (eds)

176pp 1 870393 06 6 £12 50 1988

### **Ecological mapping from ground, air and space (ITE symposium no. 10)**

R M Fuller (ed)

142pp 0 904282 71 6 £6 00 1983

### **Register of permanent vegetation plots**

M O Hill & G L Radford

32pp 0 904282 86 4 £2 00 1986

## **New titles published in 1990-91**

### **The greenhouse effect and terrestrial ecosystems of the UK**

(ITE research publication no. 4)

M G R Cannell & M D Hooper (eds)

56pp 0 11 701488 5 £4.95 1990

The 'greenhouse effect' has provoked many wild predictions of the likely impact on the environment. In these research papers, scientists from the Institute of Terrestrial Ecology appraise current evidence and evaluate likely repercussions on soils, plants, animals and ecosystems of a UK rise in carbon dioxide emissions. Are trees especially vulnerable to change? How do the UK upland regions react to temperature fluctuations? Should we monitor insects to measure climatic change? Will many rare plant species disappear? Predictions are made and areas for future research suggested in this balanced review of the 'greenhouse effect' and its potential impact on our terrestrial ecosystems.

### **Identification of ectomycorrhizas**

(ITE research publication no. 5)

K Ingleby, P A Mason, F T Last & L V Fleming

112pp 0 11 701461 3 £30 00 1990

Up until recently the published descriptions of ectomycorrhizas have often been insufficient for precise identification. This booklet describes a rapid but accurate method for examination and characterisation using a series of 24 descriptions of ectomycorrhizas most commonly encountered on young trees in Britain by the ITE research group. Produced for use in the laboratory, the format is designed to relate to the way in which whole root mounts are examined. It is hoped that this guide will improve the accuracy and interpretation of experimental data, facilitate communication and stimulate research, thus encouraging the identification of unknown ectomycorrhizas.

The following titles have been published by the Biological Records Centre at ITE Monks Wood, and are available from Publication Sales, ITE Merlewood

**Provisional atlas of the insects of the British Isles: Part 4, Siphonaptera, fleas**  
R S George

72pp 0 900848 70 7 £1 00 1974

**Atlas of the non-marine Mollusca of the British Isles**  
M P Kerney

105pp 0 904282 02 3 £3 00 1976

**Provisional atlas of the nematodes of the British Isles: Parts 1-3. Longidoridae, Trichodoridae and Criconematidae**

D J F Brown, C E Taylor, B Boag, T J W Alphey & K J Orton-Williams  
74pp 0 904282 04 X £2 00 1977

**Provisional atlas of the insects of the British Isles: Part 8, Trichoptera Hydroptilidae, caddisflies (Part 1)**  
J E Marshall

35pp 0 904282 18 X £2 00 1978

**Provisional atlas of the insects of the British Isles: Part 9, Hymenoptera: Vespidae, social wasps**  
M E Archer

18pp 0 904282 38 4 £2 50 1987

**Provisional atlas of the insects of the British Isles: Part 5, Hymenoptera: Formicidae, ants**  
K E J Barrett

51pp 0 904282 39 2 £3 00 1979

**Provisional atlas of the marine dinoflagellates of the British Isles**  
J D Dodge

142pp 0 904282 53 8 £4 00 1981

**Provisional atlas of the mycomycetes of the British Isles**

B Ing  
104pp 0 904282 67 8 £1 00 1982

**Provisional atlas and catalogue of British Museum (Natural History) specimens of the Characeae**

J A Moore & D M Greene  
121pp 0 904282 73 2 £6 35 1983

**Provisional atlas of the marine algae of the British Isles**  
T A Norton

67pp 0 904282 89 9 £3 50 1985

**Provisional atlas of the Sepsidae (Diptera) of the British Isles**  
A Pont

33pp 1 870393 00 7 £3 00 1986

**Provisional atlas of the centipedes of the British Isles**

A D Barber & A N Keay  
127pp 1 870393 08 2 £7 00 1988

**Preliminary atlas of the millipedes of the British Isles**

British Myriapod Group  
65pp £3 00 1988

**Provisional atlas of the ticks (Ixodoidea) of the British Isles**  
K P Martyn

62pp 1 870393 09 9 £4 00 1988

**Provisional atlas of the click beetles (Coleoptera: Elateroidea) of the British Isles**  
H Mendel

89pp 1 870393 11 2 £5 50 1990

**Provisional atlas of the harvest-spiders (Arachnida: Opiliones) of the British Isles**

J H P Sankey  
42pp 1 870393 10 4 £3 00 1988



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