

1989 — 1990  
R E P O R T



**Institute of  
Terrestrial  
Ecology**

**Natural Environment Research Council**

## **Foreword**

1990 marks the 25th Anniversary of the formation of the Natural Environment Research Council as the main UK organisation responsible for research and training in the environmental sciences. Environmental issues have a greater priority, both nationally and globally, than ever before. These issues must be addressed on the basis of sound scientific knowledge. The Terrestrial and Freshwater Sciences Directorate focuses on both fundamental and applied science in land use and development of natural resources, the maintenance of environmental management and conservation.

The Institute of Terrestrial Ecology is part of the Terrestrial and Freshwater Sciences Directorate of NERC. The Directorate's in-house capability also comprises the Institutes of Freshwater Ecology, Hydrology, Virology and Environmental Microbiology, the Unit of Comparative Plant Ecology (Sheffield University), the Water Resource Systems Research Unit (Newcastle University), the Interdisciplinary Research Centre for Population Biology (Imperial College London) and the Unit of Behavioural Ecology (Oxford University).

The Institute of Terrestrial Ecology is pre-eminent in ecological research, has all the necessary skills to make a major contribution to our priority research objectives in climate change impacts, forest science, land use and remote sensing, population biology, ecotoxicology, water quality, environmental biology and environmental pollution. This Report illustrates the broad range of research activities and the ability of Institute scientists to work individually or as multi-disciplinary teams.

### **P B Tinker**

Director of Terrestrial and Freshwater Sciences  
Natural Environment Research Council

*Cover illustration:*

*Lowland landscape near Leighton Bromswold, Cambridgeshire*

**Report of the  
Institute of Terrestrial Ecology  
1989/1990**

**Natural Environment Research Council**

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# Directors' introduction



**Dr O W Heal**

The year 1989-90 was notable for the resolution of several long-standing issues which had significant implications for the future of the Institute of Terrestrial Ecology (ITE). Important developments have taken place in environmental legislation, in the consideration of the structure of the Research Councils, and in the strengthening of ecological and land use research in the Terrestrial and Freshwater Sciences Directorate (TFSD) and in ITE.

The Environment Protection Bill now before Parliament introduces a system of integrated pollution control, aimed at minimising the impact of certain industrial discharges on the environment as a whole. It also makes new provisions for waste disposal, nature conservation, and the control of genetically manipulated organisms. Internationally, the concept of 'sustainable development' continues to be discussed, and the UK Government's White Paper on the environment will provide a major focus of attention in the coming year. The European Commission has drafted proposals for a European Environmental Agency. These legislative measures and policy developments reflect the widespread interest in – and concern for – the environment. The developments can be effective only if they have a strong scientific foundation. In collaboration with other Institutes within the Natural Environment Research Council (NERC), with Universities, and with other organisations, ITE scientists will continue to have a central role in providing this scientific foundation for Government and for those concerned with implementing the policy decisions.

1990 marks the 25th anniversary of the formation of NERC as the primary organisation in Britain responsible for planning and executing research and training in the environmental sciences. The importance of environmental research has never been greater and there is unprecedented opportunity for the Institutes and Universities associated with NERC.

Uncertainty over the restructuring of the Research Councils has been resolved, and the future of ITE within NERC is now

assured. However, environmental issues transcend organisational boundaries, and the successful translation of the Joint Agriculture/Environment Programme into practical research in 1989-90 has been one visible sign of the essential collaboration between NERC and its sister Councils, the Agriculture and Food Research Council and the Economic and Social Research Council (ESRC). NERC and ESRC have also collaborated in establishing a major programme on land use at the University of Newcastle.

Important developments within TFSD and ITE during 1989 have provided a more stable base for productive collaboration between the component Institutes of NERC and the Universities. The foundation for ecological research in TFS has been extended with the establishment of the Interdisciplinary Research Centre in Population Biology at Imperial College, the NERC/ESRC Land Use Programme (NELUP) at Newcastle, and the Unit of Behavioural Ecology at the University of Oxford. In each case, ITE has been involved in the initial planning and is collaborating in the research development. Collaboration with the long-established Unit of Comparative Plant Ecology (UCPE) at the University of Sheffield reached a new peak.

During 1989, the management structure of the Institute was strengthened to encourage the development of centres of scientific excellence, to improve internal communication, and to increase collaboration with other research groups. The two parts of ITE – ITE North and ITE South – have functioned as separate cost centres for the first time, whilst, at the same time, maintaining a high degree of collaboration between the six Research Stations.

## **Research objectives and priorities**

The remit of ITE has been reviewed, and the following objectives have been confirmed.

1. To improve understanding of the factors determining the structure, composition and processes of terrestrial ecosystems and of individual plant and animal species.



**Dr T M Roberts**

- To develop a sounder scientific basis for predicting and modelling environmental trends arising from natural and man-made change.
- To disseminate the results of the research to those responsible for the protection, management and wise use of natural resources.

Within these broad objectives, the priorities outlined in the document *NERC strategy for Terrestrial and Freshwater Sciences – the green light* (published in March 1989) provide the focus for ITE research. Seven priority areas are identified, all of which are relevant for the development of ITE's research in the current year and for the near future.

**Climate change impact** – the analysis of long-term data sets and the development of experimentation to provide a basis for predicting impacts, combined with quantification of trace gas sources and sinks. Analyses of the effects of the mild winters of 1988–89 and 1989–90 have identified key sensitive parameters, and have contributed to detailed planning and feasibility studies in this subject area.

**Forest science** – expansion of research on the biology of forest trees and forest ecosystems, both at home and overseas. The Special Topic on farm forestry has provided initial expansion of UK effort, and tropical forest research has been strengthened, particularly in Africa, through contract funding.

**Land use and remote sensing** – the development of multidisciplinary approaches to monitoring changes in land use and predicting effects on ecology. The establishment of the Environmental Information Centre last year provides the focus for remote sensing technology and data bases. Completion of an extensive study on the ecological consequences of land use change provides the basis for major research on land use and ecological change in the 1990s.

**Population biology** – increased support for this core subject for understanding, managing and conserving biological resources. Establishment of the Centre at Imperial College provides a major momentum, linked to ITE and strengthened by the Joint Agriculture/Environment Programme on the ecology of farmland.

**Water quality** – strategic studies have been developed on the transport of pesticides, chemical speciation of natural organic pollutants, sediment interactions, microbial transformations, and assessment of potential effects on wildlife. Although

primarily directed towards other Institutes, ITE has an important role in understanding the terrestrial controls on water quality and on ecotoxicology: two areas in which inter-Institute collaboration has been enhanced during the year.

**Environmental microbiology** – the detection and identification of micro-organisms, the measurement of gene transfer, dispersal and growth rates, and biochemical interactions between organisms in the natural environment are all high priorities. This subject is led by the NERC Institutes of Virology and Environmental Microbiology and of Freshwater Ecology (IFE), and is the area where ITE's capability is most in need of strengthening, despite existing strengths in mycorrhizal ecology.

**Atmospheric pollutants** – the adjustment of effort to expand research on pathways of nitrogen inputs, effects of ozone, 'greenhouse' gas fluxes, and radionuclide dynamics. ITE is well placed to develop new research on critical loads of atmospheric pollutants and on greenhouse gases, including enhanced CO<sub>2</sub> levels, building on the expertise and facilities established during a decade of work on acid deposition.

Whilst corresponding to the interests of major customers, these priorities have been identified as subjects where high-quality basic research is essential.

## Resources

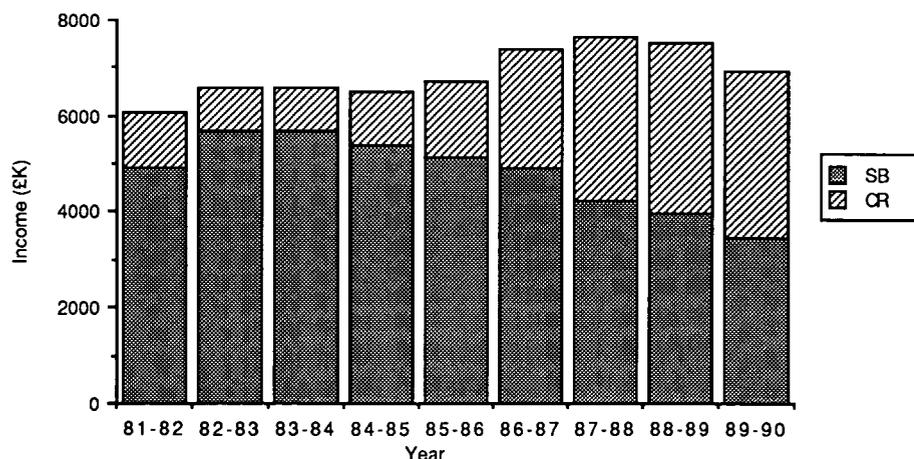
What changes have taken place in the resources of ITE, and how do we foresee the future in relation to the research priorities? The year 1989–90 saw the emergence of the Institute from a period of retrenchment and reorganisation. Although the Science Budget income continued to decline, the shortfall was

more than compensated for by a continued rise in commissioned income. The year 1989–90 was particularly notable in that commissioned receipts amounted to 50% of ITE's total income for the first time (see Figure). Recent years have seen a sharp increase in funding from the Department of Environment and private industry, and this trend is expected to continue, together with an increase in support from the European Commission.

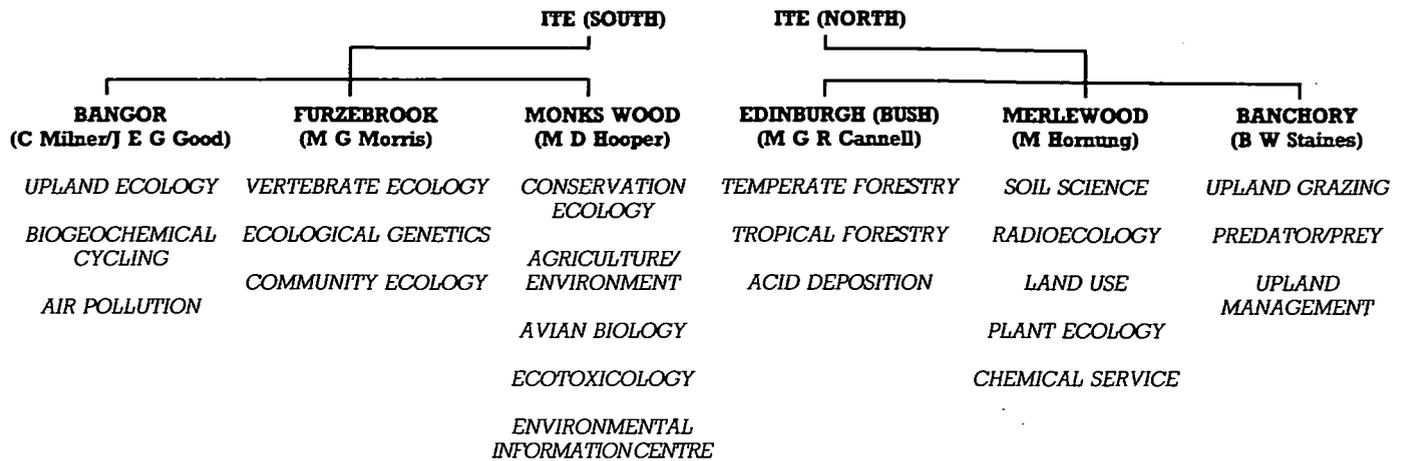
Whilst the growth in receipts is welcome, it will be necessary to ensure that commissioned research does not dominate the science priorities of the Institute. Every effort will be made to increase the scientific content of all contracts, and to match the research with ITE's science priorities.

The decline in numbers of permanent staff continued, but was more than offset by an increase in temporary appointments resulting from successful competition in NERC Community Programmes and Special Topics, and in posts supported by commissioned income. However, the reduction in permanent staff numbers (about 20% over five years) has left the Institute with too few young prime movers and support staff. Addressing the problems caused by the unbalanced staff structure will be a priority for management in the next few years.

The scientific staff of 168 is backed by 68 technical, support and administrative personnel, 14% of the total number being on period appointment. ITE's research capability is strengthened at any time by about 50 visiting research workers, post-doctoral and graduate students attracted through external awards or as part of collaborative programmes of research



The overall trend in income from Science Budget and from commissioned receipts for the period 1981 to 1990 (constant prices – 1981–82 figures revalued to 1989–90 using GDP indices)



Group structures and research themes in ITE Research Stations

with Universities both in the UK and overseas. It is now a central policy of ITE to take part in and build on open competition initiatives in NERC Community Programmes and Special Topics, recognising their multidisciplinary nature and the opportunities they provide for strengthening the broad scientific base of the Institute. ITE currently has over 25 period appointments from these Programmes, and was particularly successful in 1989 in the Joint Agriculture/Environment Programme and the Special Topic on farm forestry. The Institute looks forward to participating in future NERC initiatives in global environmental research and Arctic ecology.

The science is distributed between the six locations of ITE which provide a reasonably balanced geographical coverage over the UK. The dispersed nature of the Institute gains strength from the ability of each Research Station to develop expertise and facilities relevant to the characteristics and environmental problems of the region, whilst maintaining flexibility to meet national issues. Staff within the Stations are organised into sections/groups, each with a clear identity and a specified research remit (see structure diagram). This organisational structure will retain flexibility to meet emerging needs and research priorities. The key requirement is the ability rapidly to establish research projects from within Stations (and more widely), which can focus on a topic for a number of years, and then to reorganise. Project groups will be encouraged to incorporate and utilise relevant expertise from other Stations. There is thus a deliberate policy to move towards fewer, larger projects with improved integration.

All the Stations in ITE are adjacent to Universities and, during the current year,

staff at the Bangor site have been reorganised into a Research Unit which is now located within the University College of North Wales. Additional strengthening of the research community has resulted from the recent pattern of basing staff from different NERC Institutes within ITE Stations. Currently, ITE groups are based at both Monks Wood and Edinburgh, and NERC Scientific Services have established a Remote Sensing Applications and Development Unit at Monks Wood.

Thus, whilst there has been no dramatic expansion in resources during the year, ITE's general financial position, its basic core of staff with their proven ability to do excellent research and to win contracts, and the geographical locations of its Stations, combined with community development, provide a sound foundation on which to build.

### Strategy

In order to achieve the broad objectives and to meet the more immediate research priorities, the main elements of the Institute strategy are summarised as follows.

1. The funding will be selectively directed towards three types of research:
  - i. a small core of basic ecology of the highest quality, supported by Science Budget and supplemented by externally won funds on Special Topic and similar programmes,
  - ii. strategic research directed to future international and national priorities,
  - iii. a broad spectrum of commissioned research in response to Governmental, non-governmental, private sector and international priorities.
2. To respond to these three types of research and to retain flexibility, it is essential that ITE maintains a research capability in five core disciplines – population ecology, community ecology, genecology, ecophysiology, and biogeochemistry. The core disciplines must be supported by expertise in physics, chemistry, statistics, and mathematical modelling. Some staff development will be required to introduce new prime movers and essential support staff.
3. The Institute will maintain 'well-found laboratories', in which new technologies will be introduced more rapidly than in the past, together with improved experimental and laboratory facilities. In the last three years, over £1 million has been provided, with high priority being given to top-class, state-of-the-art equipment. Continued capital investment is essential to maintain the quality of this base.
4. Geographical dispersal remains an important strategy to exploit environmental variation, to provide a regional identity, and to respond to regional contract demand. The latter ability will be particularly important following the reorganisation of the Nature Conservancy Council. Both in the UK and overseas, viable research communities will be sustained through inter-Institute and University collaboration.
5. Research at each Station will maintain a degree of specialisation which, combined, provides the essential range of expertise of the Institute. Research groups of 5–20 people, led by high-quality scientists, will be the basic functional unit.
6. The expansion and exploitation of long-

comprehensive data bases will constitute an important research approach, associated with information technology, geographical information systems, and mathematical modelling. An increasing requirement will be for experimental and mechanistic research to provide an improved predictive capability.

1989-90 has been a year of restructuring and consolidation, especially in the southern Stations, which it is hoped will be followed by a period of relative stability and targeted development. Staff changes have included the retirements of Dr S B Chapman, Dr P Merrett, Professor C Milner, Dr F Moriarty, Mr M D Mountford, Dr D F Perkins, Mr I R Smith, Dr R E Stebbings, and Dr A Watson, all of whom have played important and distinctive roles in ecology, both in ITE and its predecessor, the Nature Conservancy. We acknowledge particularly the contribution that Professor Milner made to the Institute during his long service as Head of the Bangor Research Station. Dr J E G Good has been appointed as his successor. The quality of science in the Institute has been reflected in the individual merit promotion of Dr J Sheail for his work in historical ecology. Dr I Newton was awarded the President's Medal by the British Ecological Society for his research on the population ecology of raptors, whilst, on the international front, Dr P Ineson received the Paolo-Buchner Prize for young scientists in terrestrial ecology. The personal and Institute highlights are built on ITE's wide range of research, reflected in the reports which follow. These reports are grouped within five of the 12 TFS Research Programmes but, as in any classification of ecology, the boundaries are not sharp, and the cross-fertilisation between subject areas is apparent.

**Dr O W Heal**

Director ITE (North)

**Dr T M Roberts**

Director ITE (South)

# Appendix 1 Staff at 31 March 1990

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*Grade 6* Prof C Milner

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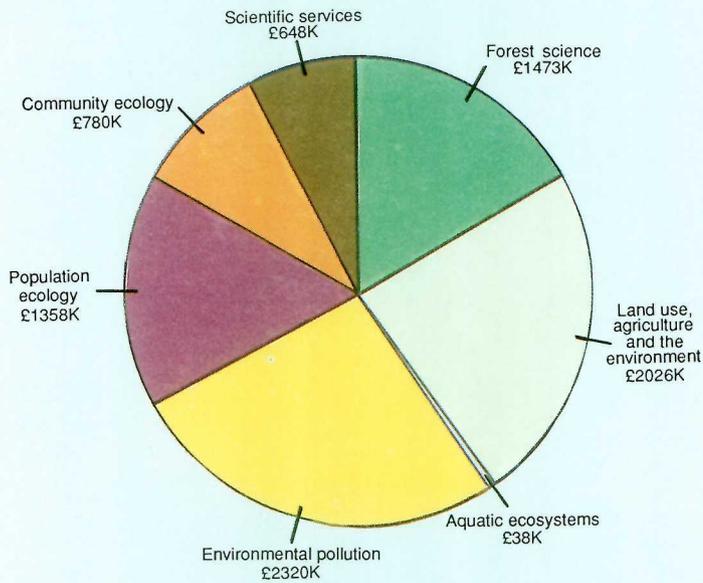
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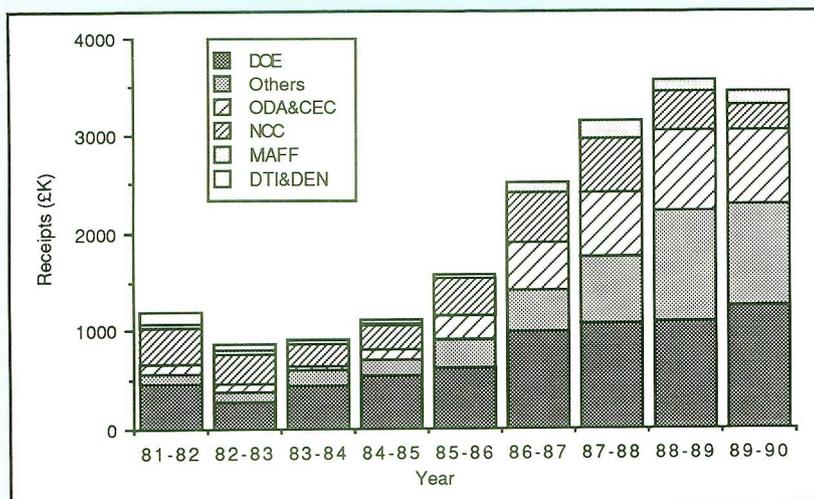
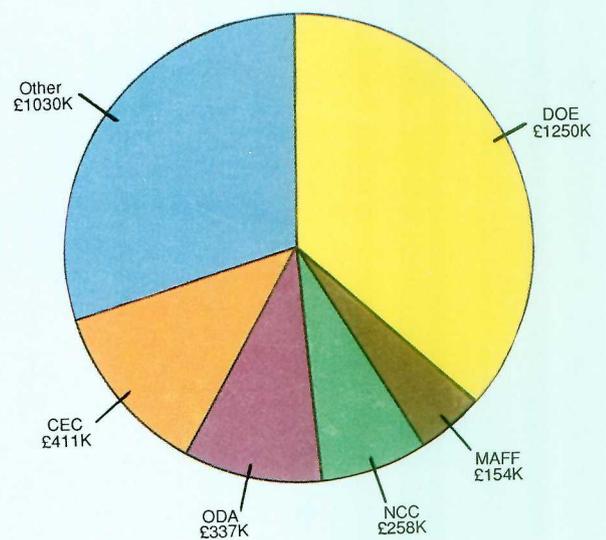
# Appendix 2 Finance and administration

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 1989-90 by scientific programme of work

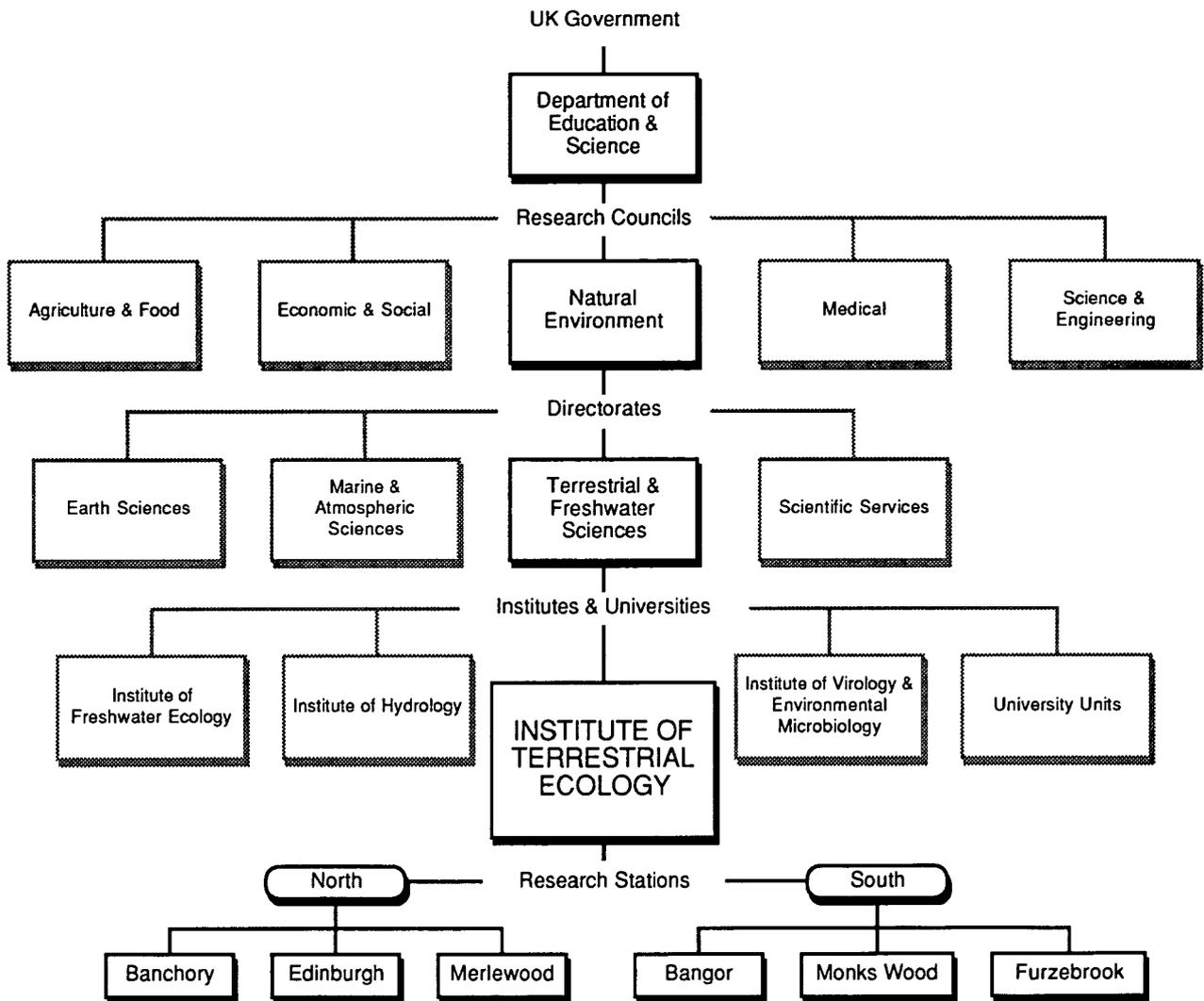
The pie chart shows a complete breakdown of 1989-90 commissioned receipts by major customers



The graph illustrates the changing pattern of receipts from major customers during the period 1981 to 1990 (at constant prices - 1981-82 to 1988-89 revalued to 1989-90 using GDP indices)

## Location of ITE within the UK Research Council system

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



Geographical location of the six ITE Research Stations

# ITE NORTH

Director Dr O W Heal

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Dr B W Staines

**Edinburgh Research Station**  
  
Dr M G R Cannell

**Merlewood Research Station**  
  
Dr M Hornung

**Bangor Research Unit**  
  
Dr J E G Good

**Monks Wood Experimental Station.**  
  
Dr M D Hooper

**Furzebrook Research Station**  
  
Dr M G Morris

Director Dr T M Roberts

# ITE SOUTH

# Appendix 3 Research projects at 31 March 1990

## ITE NORTH – EDINBURGH RESEARCH STATION

### Programme 1 Forest science

T01057-5	Temperate tree biology	M G R Cannell/ A D Watt
T01057c1	Genetic improvement of tea	M G R Cannell
T01057e1	Agroforestry: experimental assessment of novel biomass systems	G J Lawson
T01057f2	Assimilate partitioning in branches	M G R Cannell
T01057g2	Light use efficiency of trees	M G R Cannell
T01057h2	Cones and tree carbon balance	J McP Dick
T01057i2	Silviculture of re-spacing Sitka spruce	J D Deans
T01057j2	Mechanics of windthrow	R Milne
T01057k5	Tree stability: interactions among trees	R Milne
T01057l5	BES special symposium: ecology of mixed species stands of trees	M G R Cannell
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
T01057o2	Population dynamics of forest insects conference	A D Watt
T01057p1	Containerised forest nursery stock (proposal)	J D Deans
T01057q2	Frost hardiness of tree roots	J D Deans
T01057r1	Organisation and management review of the Tea Research Foundation	M G R Cannell
T01057s2	Genetic improvement of forest trees (proposal)	H Billington
T01057t2	Tree and forest modelling (proposal)	R Dewar
T01057ul	Review for Wiggins Teape	M G R Cannell
<b>T01059-5</b>	<b>Mycorrhizas and tree production</b>	<b>J Wilson</b>
T01059a2	Mycorrhizas and tree growth	P A Mason
T01059b2	Characterisation of sheathing mycorrhizas	P A Mason
T01059c2	Occurrence of fruitbodies of mycorrhizal fungi in field plantings of different provenances of <i>Picea sitchensis</i> and <i>Pinus contorta</i>	J Wilson
T01059d1	Mycorrhizal research links with India	J Wilson
T01059e1	Large-scale production of mycorrhizal inocula (proposal)	J Wilson
T01059f2	Influence of mycorrhizas on root growth potential	P A Mason
T01059g2	Evaluation of the need for mycorrhizal inoculation (proposal)	J Wilson
T01059h1	<i>Eucalyptus</i> mycorrhizas in Chile (proposal)	P A Mason
T01059i1	Mycorrhizas and nutrient cycling in Amazonian forests (proposal)	J Wilson
<b>T01060-5</b>	<b>Tropical forestry and tree improvement</b>	<b>R R B Leakey</b>
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 (proposal)	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
T01060ml	CGIAR review	R R B Leakey
T01061a3	The effects of farm woodland size, shape, structure and species composition on insect diversity	A D Watt

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

T02051f1	Environmental constraints on the UK wind energy resource	B G Bell
T02051h2	Long-term environmental reference sites	O W Heal

### Programme 7 Environmental pollution

<b>T07055-3</b>	<b>The effects of atmospheric pollutants on forests and crops (Special Topic programme)</b>	<b>B G Bell</b>
T0705513	Exchange of NO <sub>x</sub> and other gases before and after exposure to wind, ozone and polluted cloud water	D Fowler/ J Grace
<b>T07056-5</b>	<b>Ecological effects of climatic change</b>	<b>M G R Cannell</b>
T07056b2	The occurrence of extreme winds	R Milne
T07056d2	Response of trees to elevated CO <sub>2</sub> concentrations and temperature	D Eamus
T07056e2	Relationship between tree growth and temperature: analyses of tree-ring data	R Milne
T07056m2	Carbon budget of the UK (proposal)	M G R Cannell
T07056n2	Carbon storage and harvest models (proposal)	R Dewar
T07056o1	Review for DoE of impact of the 1989 summer and the 1989–90 winter (proposal)	M G R Cannell
<b>T07057-5</b>	<b>Atmospheric pollutants and trace gases</b>	<b>D Fowler</b>
T07057a1	Land-atmosphere exchange of NO <sub>x</sub> , O <sub>3</sub> and NH <sub>3</sub> (dry deposition)	D Fowler
T07057b1	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 (proposal)	D Fowler
T07057e5	Land-atmosphere exchange of ammonia (proposal)	M Sutton
T07057f1	Cloud deposition (proposal)	D Fowler
T07057g5	Pollution climate at Dunsclair (proposal)	A Crossley
T07057h5	Deposition of lead-210	R Mournie
T07057i1	N deposition effects on plant communities (proposal)	C Pitcairn
T07057j2	Factors affecting nitrous oxide and nitric oxide emissions from soils (proposal)	D Fowler
<b>T07058-5</b>	<b>Atmospheric pollution modelling and chemistry</b>	<b>J N Cape</b>
T07058a2	The chemical composition of rainfall	J N Cape
T07058b5	Scavenging of pollutants by snow (proposal)	T Dore
T07058c1	Nitrogen chemistry on Great Dun Fell (proposal)	D Fowler
T07058d1	Physical properties in open-top chambers (proposal)	D Fowler
T07058e2	Modelling UK deposition (RGAR and GDF) (proposal)	J N Cape
<b>T07059-5</b>	<b>Effects of atmospheric pollutants on trees</b>	<b>D Fowler/ J N Cape</b>
T07059a5	Frost hardiness of red spruce in relation to forest decline and effects on red spruce of winter exposure to SO <sub>2</sub> and NO <sub>2</sub>	M G R Cannell
T07059b1	Open-top chamber studies on spruce and beech	D Fowler
T07059c2	Responses of conifer trees to artificial acid mist	C G M Henderson

T07059d5	Wind and cloud effects on Norway spruce (proposal)	D Fowler	T01053c2	Biological manipulation of coniferous forest soils	C H Robinson
T07059e2	Effects of acid mist on mature trees	A Crossley	T01053d5	Rehabilitation of <i>Acacia</i> fallow systems and nutrient dynamics in the Blue Nile region, eastern Sudan	D K Lindley
T07059f5	Accumulation and effects of atmospheric particulates on forests	A Crossley	T01053e5	The scientific management of renewable natural resources in China	D K Lindley
T07059g5	Early diagnosis of forest decline	J N Cape	T01053f1	Effect of forest management on soil (proposal)	M Hornung
T07059h5	Throughfall and stemflow studies	J N Cape			

## Programme 12 Atmospheric science and hydrological extremes

<b>T12056-3</b>	<b>Atmospheric chemistry (Special Topic programme)</b>	<b>J N Cape</b>
T12056f3	Atmospheric chemistry Phase 11	J N Cape

## Programme 13 Scientific services

T13054a2	Utilisation of STATUS in ITE libraries: cataloguing	S M Adair
<b>T13059-5</b>	<b>Edinburgh scientific support services</b>	<b>M G R Cannell</b>
T13059a2	Glasshouses and nursery: support and development	R F Ottley
T13059c1	Glasshouse consultancy to IRI	R F Ottley
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
T13059h2	Graphics, photography and scientific illustrations (proposal)	R H F Wilson
T13059k1	Plant culture for IRI: rotation (proposal)	R F Ottley
T13059l2	Mathematical modelling at ITE Edinburgh (proposal)	R I Smith

## ITE NORTH – MERLEWOOD RESEARCH STATION

### Programme 1 Forest science

<b>T01051-5</b>	<b>Ecology of woodland soil fungi</b>	<b>J Dighton</b>
T01051a2	Role of fungi in nutrient cycling with special reference to <i>Mycena galopus</i> in forest soil	J C Frankland
T01051b2	An assessment of the status of mycorrhizas in the soil ecosystem	J Dighton
T01051c2	Nutrient cycling in forest litter: an immunological approach	J C Frankland
T01051d1	Mycorrhiza of <i>Eucalyptus</i> in relation to drought stress (proposal)	E Wani
T01051e2	Nutrient cycling in forest litter: an immunological approach (proposal)	P Hitchcock
T01051f2	Organisation of BMS and IUFRO conferences (proposal)	J Dighton
<b>T01052-5</b>	<b>Soil nutrient dynamics</b>	<b>A F Harrison</b>
T01052a5	A comparison of biological and chemical assessments of the fertility of soils	A F Harrison
T01052b2	Cycling of key nutrients in forest soils and their inter-relationships	A F Harrison
T01052c5	Field methods in terrestrial nutrient cycling studies (proposal)	A F Harrison
T01052d1	Effects of vitamin addition on nutrient mineralisation	J Dighton
T01052e5	Assessment of P & K fertiliser responses of Sitka spruce (proposal)	A F Harrison
T01052g1	Application of nutrient bioassays to <i>Eucalyptus</i> forest management	J Dighton
T01052j5	Control of growth and development in European forest ecosystems by phosphorus cycling (proposal)	A F Harrison
<b>T01053-5</b>	<b>Forest nutrient dynamics</b>	<b>P Ineson</b>
T01053a2	A comparison of denitrification in felled and unfelled plots of Sitka spruce	P Ineson
T01053b5	Nutrient cycling in European forests (proposal)	P Ineson

T01053c2	Biological manipulation of coniferous forest soils	C H Robinson
T01053d5	Rehabilitation of <i>Acacia</i> fallow systems and nutrient dynamics in the Blue Nile region, eastern Sudan	D K Lindley
T01053e5	The scientific management of renewable natural resources in China	D K Lindley
T01053f1	Effect of forest management on soil (proposal)	M Hornung
<b>T01054-2</b>	<b>Ecological effects of forest management</b>	<b>J M Sykes/ A H F Brown</b>
T01054a2	Effects of pure and mixed stands on soils and vegetation	A H F Brown
T01054b2	The effects of management in lowland coppices	A H F Brown
T01054d2	Soil and water acidity under different trees	A H F Brown
T01054e2	Effects of clearfelling in pure and mixed stands on soil water chemistry (proposal)	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 in coniferous forests (proposal)	J K Adamson
T01054j2	Root turnover in semi-natural woodlands (proposal)	G Howson
<b>T01062-5</b>	<b>Modelling chemical and biological processes in acid upland soils (proposal)</b>	<b>A F Harrison/ E Tipping</b>
T01062b2	Effects of climate, management practices and vegetation development on plant nutrition/soil relationships (proposal)	A F Harrison
T01062c2	Effects of environmental and soil conditions on organic matter and N & P cycling in forest and upland soils, assessed by natural abundance <sup>13</sup> C <sup>15</sup> N and bomb carbon techniques (proposal)	A F Harrison

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

<b>T02051-5</b>	<b>Land use change and ecological impacts</b>	<b>R G H Bunce</b>
T02051e1	Ecological consequences of land use change	R G H Bunce
T02051j2	Scientific principles of soil protection	P J A Howard
T02051k1	Classification of one km squares in Great Britain (proposal)	R G H Bunce
T02051l1	Assessment of vegetation survey methods (proposal)	R G H Bunce
T02051m5	Ecology and land use in Great Britain: 1990 survey (proposal)	C J Barr
T02051n2	Extending the use of the Merlewood land classification system: liaison and collaboration (proposal)	C J Barr
T02051o2	Land use data management and integration at ITE Merlewood (proposal)	C J Barr
T02051p2	The application of Geographical Information Systems (GIS) to the Merlewood land use data base (proposal)	D C Howard
T02051q2	Land use studies at ITE Merlewood: synthesis and publication of results (proposal)	R G H Bunce
T02051r1	Framework for modelling environmental changes in European agrarian landscapes (proposal)	R G H Bunce
T02051s1	Provision of land use data and related information to the NCC (proposal)	R G H Bunce
T02060e5	Review of catchment work in the COST countries (proposal)	M Hornung

<b>T02064-5</b>	<b>Environmental impact assessment – ITE Merlewood</b>	<b>J M Sykes</b>	T07C63e5	Liming and faunal inoculation of forest soils: protection from acidification (proposal)	P Ineson
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	<b>T07054-5</b> T07054a1 T07054c1	<b>Acid deposition and its effects</b> Critical loads for soils Subcontract to Aberdeen University	<b>M Hornung</b> M Hornung/ M Hornung/ M Cresser M Hornung/ T A Mansfield M Hornung/ J Colls
<b>T02068-5</b>	<b>Long-term environmental monitoring (proposal)</b>	<b>J M Sykes</b>	T07054d1	Subcontract to Lancaster University	M Hornung/ T A Mansfield
T02068a5	Monitoring on Biosphere Reserves (proposal)	J M Sykes	T07054e1	Subcontract to Nottingham University	M Hornung/ J Colls
T02068b2	Ecological change network (proposal)	J M Sykes	T07054f5	Solutes beneath larch and Sitka spruce at three sites	J K Adamson
<b>Programme 7 Environmental pollution</b>					
<b>T07050-5</b>	<b>Radionuclides in vegetation and soil</b>	<b>A D Horrill</b>	T07055h3	Effects of elevated inputs of nitrogen on the uptake metabolism, retention and allocation of nitrogen in tree crops	G R Stewart/ A F Harrison
T07050a1	The distribution and dynamics of radionuclides in relation to land use in west Cumbria	A D Horrill	T07055k3	Interaction of enhanced N loading on soil nutrient dynamics and forest growth	M Hornung
T07050b2	The concentrations and movement of americium in a coastal ecosystem in Cumbria	A D Horrill	T07056f1	Phenology in the spring of 1989 (proposal)	J M Sykes
T07050c5	Post-Chernobyl radiation levels in soils and vegetation	G R Miller/ A D Horrill	T07056g2	Modelling the impact of climatic change on the productivity, species composition, and decomposition in a UK mixed deciduous forest (proposal)	P Ineson/ A F Harrison
T07050e1	Evaluation of data on the transfer of radionuclides in the foodchain (proposal)	A D Horrill	T07056h2	Evaluating the response of upland organic soils to CO <sub>2</sub> -induced climatic change (proposal)	P Ineson
T07050f1	The influence of mycorrhizas, potassium nutrition and microbial activity on radiocaesium cycling in heather-dominated ecosystems	A F Harrison	T07056i2	Evaluating the response of soils to increases in the CO <sub>2</sub> content of the atmosphere	P Ineson
T07050g2	Selenium inputs, distribution and cycling in upland grassland ecosystems (proposal)	A F Harrison	T07056j2	Determination of the impact of CO <sub>2</sub> -induced climatic change on forest decomposition processes (proposal)	P Ineson
T07050h5	The role of the litter layer in the recycling of caesium isotopes in upland Britain	A D Horrill	T07056k2	The sensitivity of vegetation and land use in Britain to possible long-term climate change	J Hossell
T07050i2	The absorption and recycling of plutonium in plants	A D Horrill	T07056l2	Intergovernmental panel on climate change (proposal)	T V Callaghan
T07050j2	Advisory committees on radionuclide research (proposal)	A D Horrill	<b>T07066-3</b>	<b>Environmental radioactivity (Special Topic programme)</b>	<b>V H Kennedy</b>
T07050k5	Radioactivity in natural ecosystems – EEC II (proposal)	A D Horrill	T07066b3	Uptake of radiocaesium by plants and the role of mycorrhizal fungi in mediating uptake	J Dighton
<b>T07051-5</b>	<b>Radionuclide–animal transfers</b>	<b>B J Howard</b>	T07066c3	Effects of sward conditions on radiocaesium cycling in hill and upland sheep systems	R Mayes/ B J Howard
T07051a1	Sheep feeding trials	B J Howard	T07066d3	Dynamic modelling of pathways for radionuclides from the atmosphere to grazing animals	M H Unsworth/ B J Howard
T07051c2	Comparative radioecology of Ag-110m and Cs-137	N A Beresford	T07066g3	Migration and retention of radionuclides in soils	A G O Donnell/ D Rimmer/P Ineson
T07051d1	The dynamics of radionuclide uptake by sheep	B J Howard	<b>Programme 8 Population ecology</b>		
T07051e1	Validation of and studies into Cs-134: Cs-137 ratios in Cumbrian soil and vegetation	B J Howard	T08050g2	Population genetics of mute swans	P J Bacon
T07051f1	Development of a method to rapidly predict the availability of radiocaesium to animal products after an accidental discharge	B J Howard	<b>T08052-5</b>	<b>Plant strategies: response to environmental stress</b>	<b>T V Callaghan</b>
T07051g5	Factors affecting radionuclide transfer to ruminants (proposal)	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
T07052a5	Relationships between soil organic matter and the actinide elements	F R Livens	<b>T08067-5</b>	<b>Populations and energetic consequences of trophic feeding interactions</b>	<b>P J Bacon</b>
T07052b2	Terrestrial geochemistry of transuranic elements	A S Hursthouse	<b>Programme 9 Community ecology</b>		
T07052c1	Radionuclides in freshwater systems	F R Livens	T09053b2	Farm woodland – primary and secondary effects of tree planting on soil (proposal)	J M Sykes
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 (proposal)	F R Livens			
<b>T07053-5</b>	<b>Soil microbial response to pollutants</b>	<b>P Ineson</b>			
T07053a1	Effects of forest fumigation with SO <sub>2</sub> and O <sub>3</sub> on roots and mycorrhizas of trees	J Dighton			
T07053b1	Effects of air pollution (proposal)	P Ineson			
T07053c2	Effects of atmospheric pollution on mycorrhizas (proposal)	J Dighton			
T07053d2	Effects of sulphur dioxide on litter-decomposing fungi in deciduous woodland	J C Frankland/ P Ineson			

## Programme 10 Environmental microbiology

T10055g3 Modelling intra- and interspecific competition of ectomycorrhizal fungi on tree root systems F Saunders/  
J Dighton

## Programme 13 Scientific services

**T13054-2 ITE library services J Beckett**

**T13055-5 ITE chemical research and development J A Parkinson**

T13055a2 Chemical support studies J A Parkinson  
T13055b5 Analyses for certification of EEC international tree leaf reference materials J A Parkinson

T13055c1 Chemical analyses for NCC J D Roberts  
T13055d1 Chemical analyses for universities J A Parkinson  
T13055e5 Standardisation scheme for chemical analysis of plant material for TSBF programme (proposal) A P Rowland

T13055f1 Chemical analyses for private organisations J A Parkinson

T13055g1 Chemical analyses for British Antarctic Survey J A Parkinson

T13055h5 Analysis of trace elements in white clover for EEC certification A P Rowland

**T13056-4 NERC mass spectrometer service C Quarmby**

**T13057-5 Merlewood scientific support services D K Lindley**

T13057a2 Graphics and publications C B Benefield  
T13057b2 Biometrics and modelling support services at Merlewood D K Lindley

T13057c1 ITE advice and services to NCC J M Sykes

T13057d2 Scientific community services (proposal) M Hornung

## 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

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

**T02050-5 Human impact, erosion rehabilitation (A Watson)**

T02050b1 Revegetation after disturbance J Miles  
T02050d1 Aonach Moor development plan N G Bayfield  
T02050e1 Footpath rehabilitation studies for the Yorkshire Dales National Park Committee N G Bayfield

T02050g1 Effects of past management on the potential of upland soils to support plant growth (proposal) G R Miller

T02050h1 Restoration of upland vegetation N G Bayfield  
T02050i1 Path revegetation trials on the Pennine Way N G Bayfield/  
G R Miller

T02050l1 Environmental impact assessment of Intake 8 (proposal) N G Bayfield

T02050m2 Manipulation of plant successions on disturbed ground (proposal) N G Bayfield

T02050n1 Erosion control on the North/South Highway, Malaysia (proposal) N G Bayfield

T02050p1 Orkney wetlands study B W Staines

T02050q1 NIREX deep repository study (proposal) N G Bayfield

T02050r1 Glas Maol monitoring (proposal) D Welch

T02050s1 Development opportunity in the natural environment (proposal) N G Bayfield/  
B W Staines

### Programme 7 Environmental pollution

T07050c5 Post-Chernobyl radiation levels in soils and vegetation G R Miller/  
A D Horrill

### Programme 8 Population ecology

**T08050-5 Vertebrate population dynamics and upland habitat geometry R Moss**

**T08050a2 Population dynamics of red grouse R Moss**  
T08050b5 Demographic effects of nest predation on golden plovers and other moorland waders R A Parr

T08050c5 Population ecology of capercaillie R Moss

T08050d1 Effects of afforestation on moorland birds and their predators R A Parr

T08050e1 Park Hall grazing survey (proposal) R Moss

T08050f5 Adaptation of capercaillie to novel environments R Moss

T08050h2 Red grouse rearing and release R Moss

**T08051-5 Population ecology of predators H Kruuk**  
T08051b2 Occurrence of some heavy metals and PCBs in otters in Shetland H Kruuk

T08051c5 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

T08051f5 Effect of water temperature on the behaviour and ecology of the European otter (*Lutra lutra*) P S Taylor

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

T08051k2 Seabirds and sandeels S Wanless

### Programme 9 Community ecology

**T09050-5 Dynamics of upland and montane plant communities G R Miller**

T09050a2 Quantity and quality of seeds produced by montane plants G R Miller

T09050b5 Effects of grazing on *Nardus* and *Calluna* moorland D Welch

T09050c2 Development of subalpine scrub at northern Corries, Cairngorms SSSI G R Miller

T09050d1 Response of *Gentiana nivalis* population to withdrawal of sheep grazing G R Miller

T09050e1 Modelling the agricultural and environmental consequences of sheep and red deer grazing on heather moorland B W Staines/  
D Welch

T09050f2 Vegetation dynamics and soils J Miles

T09050g2 The effects of birch on moorland soils and vegetation J Miles

T09050i2 Dynamics of *Macchia* 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 research (proposal) D Welch

### Programme 13 Scientific services

T13053-5 Services at ITE Banchory B W Staines

T13053a1 Ecological advisory appointment with SDD J Miles

T13053b5 Caring for the high mountains – conservation of the Cairngorms J W H Conroy

T13053c1 Brathens consultancies B W Staines

T13053d2 Computing and statistical advice D D French

T13053e1 Scottish Office consultancy J Miles

T13053f2 Scientific community services B W Staines

## **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**

<b>T02052-5</b>	<b>EIC remote sensing</b>	<b>R M Fuller</b>
T02052a2	Information extraction from imagery	R M Fuller
T02052e1	Remote sensing in the Less Favoured Areas: models for rural land use planning	A R Jones
T02052f2	Characterisation of grassland type and condition using remotely sensed data	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

<b>T02053-5</b>	<b>EIC GIS and cartography</b>	<b>B K Wyatt</b>
T02053a2	Digital cartographic service	G L Radford
T02053b1	EEC Corine 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

<b>T02054-5</b>	<b>EIC Biological Records Centre</b>	<b>P T Harding</b>
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

<b>T02055-1</b>	<b>Environmental impact assessment</b>	<b>M D Hooper</b>
T02055a1	Avalon Lakes design studies	M D Hooper
T02055b1	Channel Tunnel construction – monitoring terrestrial (and freshwater) ecology	R C Welch
T02055c1	Folkestone terminal – specialist advice	M D Hooper
T02055d1	Ecological appraisal of a potential power station site	M D Hooper
T02055e1	Western Area reservoir planning study (WARPS 2)	R C Welch
T02055f1	EIA of Chep Lap Kok – Hong Kong airport	R C Welch

<b>T02056-5</b>	<b>Grassland ecology</b>	<b>T C E Wells</b>
T02056a2	Monitoring floristic change	T C E Wells
T02056b1	Knocking Hoe cutting experiment	T C E Wells
T02056c2	Population studies on terrestrial orchids	T C E Wells
T02056d1	Wild flower swards for trunk road and motorway landscaping	T C E Wells

<b>T02057-5</b>	<b>Historical ecology</b>	<b>J Sheail</b>
T02057a5	Historical aspects of environmental perception	J Sheail

<b>T02058-5</b>	<b>Vegetation dynamics</b>	<b>T W Parr</b>
T02058a2	Roadside vegetation dynamics	T W Parr
T02058b2	Modelling competition in grass swards	T W Parr
T02058c1	Effects of growth retardants on the ecology of roadside vegetation in west Sussex	T W Parr

T02058d1	<i>Phragmites</i> seedlings – their use in RBTS sewage treatment	T W Parr
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T02058e1	Factors affecting the establishment and performance of reeds ( <i>Phragmites australis</i> ) in RBTS systems: a survey in the UK of reed bed treatment	T W Parr
T02058f1	Experimental studies on the management of reed beds for RBTS sewage treatment	T W Parr
T02058g1	Ecological effects of hedgerow management	M D Hooper

<b>T02059-5</b>	<b>Wetland dynamics and management</b>	<b>T Parish/ J O Mountford</b>
T02059a2	Modern agriculture and wildlife	T Parish
T02059b2	Land use and ecology of Swasey 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
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T02059d1	The effects of nitrogen on species diversity and agricultural production on the Somerset Moors	J O Mountford
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T02059e5	British Rail-sponsored grassland experiments	J O Mountford
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<b>T02061-3</b>	<b>Agriculture and the environment (Special Topic programme)</b>	<b>J Sheail</b>
T02061f3	Reducing residual soil fertility of abandoned agricultural land for the restoration of native vegetation	R H Marrs

<b>T02065-3</b>	<b>Ecology of farmland (JAEP)</b>	<b>D Osborn</b>
T02065g3	Biodiversity in agricultural landscapes: species dispersal, patch dynamics and island biogeography (JAEP)	M B Usher
T02065k3	The role of dispersal in maintaining bird populations in small woods on farmland (JAEP)	I Newton

### **Programme 4 Management of aquatic ecosystems**

T04053k1	Physical habitat simulation in rivers – model calibration (PHABSIM)	J O Mountford
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### **Programme 7 Environmental pollution**

<b>T07061-5</b>	<b>Hazard assessment</b>	<b>S Dobson</b>
T07061a1	Hazard assessment of chemicals	S Dobson
T07061b1	Pesticides 'call-off' consultancy to DoE	S Dobson
T07061d1	Pesticide drift and impact	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

<b>T07062-5</b>	<b>Aquatic ecology and ecotoxicology</b>	<b>K R Bull</b>
T07062a1	National critical loads mapping programme	K R Bull



TC8059g1	Poole Bridge replacement: environmental impact assessment:	N R Webb
TC8059i2	Population biology in peatland angiosperms	R E Daniels
TC8059j1	Release of captive bred species	A J Gray

<b>T08060-5</b>	<b>Butterfly and ant studies</b>	<b>J A Thomas/ G W Elmes</b>
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 socio-ecology of the genus <i>Myrmica</i>	G W Elmes
T08060d2	Large blue butterfly/ <i>Myrmica</i> ant interactions	J A Thomas/ G W Elmes
T08060e2	Population ecology and adaptive speciation of <i>Myrmica</i>	G W Elmes
T08060f2	Purple hairstreak populations and ants	J A Thomas
T08060g1	Black hairstreak habitat creation – M40 (proposal)	J A Thomas
<b>T08068-5</b>	<b>Molecular ecology</b>	<b>A J Gray/ I Newton</b>
T08068a2	Gene flow in brassicas	A J Gray
T08068b2	Ant socio-biology	G W Elmes

### Programme 9 Community ecology

<b>T09055-5</b>	<b>Heathland impacts</b>	<b>N R Webb</b>
T09055a1	Wytch farm development: biological monitoring	R E Daniels
T09055b1	Purbeck-Southampton pipeline: biological monitoring	R E Daniels
T09055c1	Hinkley Point public enquiry	R E Daniels
T09055d1	Rehabilitation of oil well sites	R E Daniels
T09055e1	Heathland invertebrates	N R Webb
T09055f1	Heathland restoration	N R Webb
T09055g1	Effects of temporary roadways on heathland vegetation	N R Webb
T09055h2	Dorset heathland survey	N R Webb
T09055m1	Survey at Sandford	N R Webb
T09055n1	Dorset oilfield: biological monitoring (proposal)	R E Daniels

<b>T09056-5</b>	<b>Grassland and scrub dynamics</b>	<b>M G Morris</b>
T09056a2	Grassland management – invertebrates	M G Morris
T09056b2	Study of scrub succession on chalk at Aston Rowant NNR	L K Ward
T09056c2	Scrub management at Castor Hanglands NNR	L K Ward
T09056d2	Demography and conservation of scrub	L K Ward
T09056f2	Weevil studies	M G Morris
T09056h2	Invertebrate geographical ranges and climate	L K Ward
T09056i5	Invertebrate assessment of intensively studied NNRs	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	Statistical research	R T Clarke

<b>T13061-1</b>	<b>ITE South consultancies</b>	<b>T M Roberts</b>
T13061b1	Small consultancies at ITE Furzebrook	M G Morris

### ITE SOUTH – BANGOR RESEARCH UNIT Programme 2 Land use, agriculture and the environment

<b>T02060-5</b>	<b>Biogeochemistry and land use</b>	<b>J E G Good</b>
T02060a1	Nature conservation in upland conifer forests	J E G Good
T02060b2	Clonal selection in <i>Betula</i> and <i>Salix</i>	J E G Good
T02060c1	Ecological survey of Capel Cynon	G L Radford
T02060d2	Geochemical cycling in the uplands	B Reynolds
T02060f2	Effects of clearfelling plantation forests – extension	P A Stevens
T02060g1	Cwm Dyli pipeline consultancy	J E G Good
T02060h5	The 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
T02060j5	Estimation of atmospheric inputs to ITE catchments	B Reynolds
T02060k5	Nitrogen critical load experiment	B Emmett
T02060l5	Phosphorus fertilisation experiment	P A Stevens
T02060m5	Forest nitrogen survey	P A Stevens
T02060n1	Rainfall sample collection	B Emmett
T02060o5	Dissolution rates of liming materials in acid upland mires	B Reynolds
<b>T02067-5</b>	<b>Land use research overseas (proposal)</b>	<b>C Milner</b>
T02067a1	Kenya Agricultural Research Institute (proposal)	C Milner

### Programme 7 Environmental pollution

<b>T07064-5</b>	<b>Ecosystems' response to pollution</b>	<b>K C Walton</b>
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	K C Walton
T07064f2	Trace metals in rabbit bones from England and Wales	K C Walton
T07064g2	Engineering development (mechanical and electronic)	C R Rafarel
T07064i2	Fluorine pollution studies	(D F Perkins)
T07064j2	Radiocaesium in the Snowdonia sheepwalk ecosystem	(D F Perkins)
T07064k2	Radiocaesium cycling in <i>Nardus stricta</i>	(D F Perkins)
T07064l1	Critical loads of N and S deposition to semi-natural vegetation	T W Ashenden
T07064m2	Effects of elevated concentrations of carbon dioxide on upland vegetation	T W Ashenden

### Programme 9 Community ecology

<b>T09054-2</b>	<b>Montane ecology</b>	<b>C Milner</b>
T09054b2	Ecology of arctic-alpine species in Snowdonia	C Milner
T09054d2	Climate and high-altitude invertebrates	A Buse
T09054e2	Sheep grazing intensity and radiance from vegetation	A G Thomson
T09054f2	Exploitation of sheltered microhabitats 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
T09054i2	Grey heron research – writing up	A A Bell

### Programme 13 Scientific services

<b>T13061-1</b>	<b>ITE South consultancies</b>	<b>T M Roberts</b>
T13061c1	Small consultancies at ITE Bangor	C Milner

# Appendix 4 Publications by ITE staff in 1989–90

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- Boorman, L.A.** 1990. Salt marshes. In: *Use of vegetation in civil engineering*, edited by N.J.Coppin & I.G.Richards, 235–236. London: Butterworths.
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# Appendix 5 Contract reports for 1989-90

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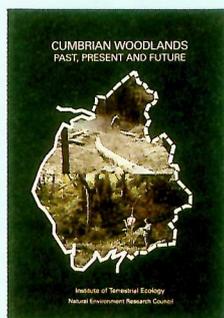
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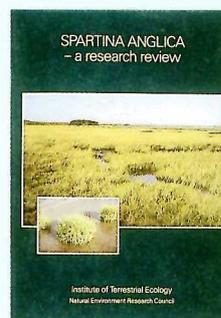
## Appendix 6 ITE publications

The ITE symposium series and the ITE research publication series are published by HMSO. New titles in these series which have been published during the year of this Report are listed below.



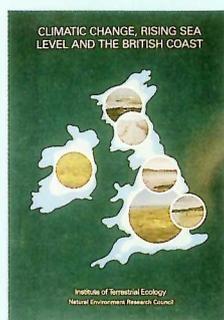
ITE symposium no. 25  
**Edited by J K Adamson**  
£7.10 88pp ISBN 0-11-701421-4

The diversity and richness of Cumbria's woodlands are well known, and, as one contributor points out, many of our broadleaved woodlands are much older even than our parish churches. These papers demonstrate the role of broadleaved and coniferous woodland in Cumbrian economic and social history, and examine some of the benefits and problems which modern forestry management may bring. Chapters discuss the composition, flora, fauna and management of woods, and the harvesting of woodland products, as well as looking at farm woodlands, nutrient cycling, agroforestry, water quality and amenity aspects.



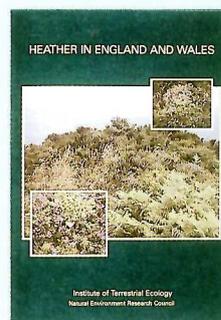
ITE research publication no. 2  
**Edited by A J Gray and P E M Benham**  
£8.75 80pp ISBN 0-11-701477-X

*Spartina anglica* is a vigorous and fertile plant which has spread spectacularly since its evolution from a sterile hybrid nearly a century ago. It now dominates the lower zones of salt marshes in temperate regions, presenting a number of ecological problems – and climatic and sea level changes are likely to favour further invasions in the future. Here, research scientists from several disciplines discuss its effects on the ecology of intertidal mudflats and marshes in Great Britain, Europe and China.



ITE research publication no. 1  
**L A Boorman, J D Goss-Custard  
and S McGroarty**  
£5.50 24pp ISBN 0-11-701429-X

If current predictions are borne out, a global warming associated with high concentrations of atmospheric pollutants will mean that Britain has some hard choices to make over the next century. A rise in sea level caused by climatic change would pose a serious threat to the flora and fauna of many coastal areas, and could also affect agricultural uses. This report considers the biological implications of rises of 0.8 m up to 1.65 m, and examines the different impacts on the coastal environment of various options in sea defence and coast protection.



ITE research publication no. 3  
**Edited by R G H Bunce**  
£5.90 40pp ISBN 0-11-701422-2

In response to widespread concern over heather decline, this project aimed to give a rapid assessment of the distribution and status of heather, the historical changes that had occurred and the potential for its restoration. The study was carried out over a six-week period in summer 1988, using satellite imagery. The main agents of change in both upland and lowland areas are identified and it is noted that lowland heaths (such as those in East Anglia) have suffered a proportionally greater loss of heather. The study concludes with a call for more research and long-term monitoring into the dynamics of heather moorland.

A complete list of ITE titles is available from HMSO. The publications can be obtained directly from HMSO Publications Centre, PO Box 276, London SW8 5DT (telephone orders 071 873 9090), or through any bookseller.

Provisional and preliminary atlases of species distribution produced by the Biological Records Centre are available from Publication Sales, ITE, Merlewood Research Station, Grange-over-Sands, Cumbria LA11 6JU (telephone 05395 32264). A list is available on request.



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