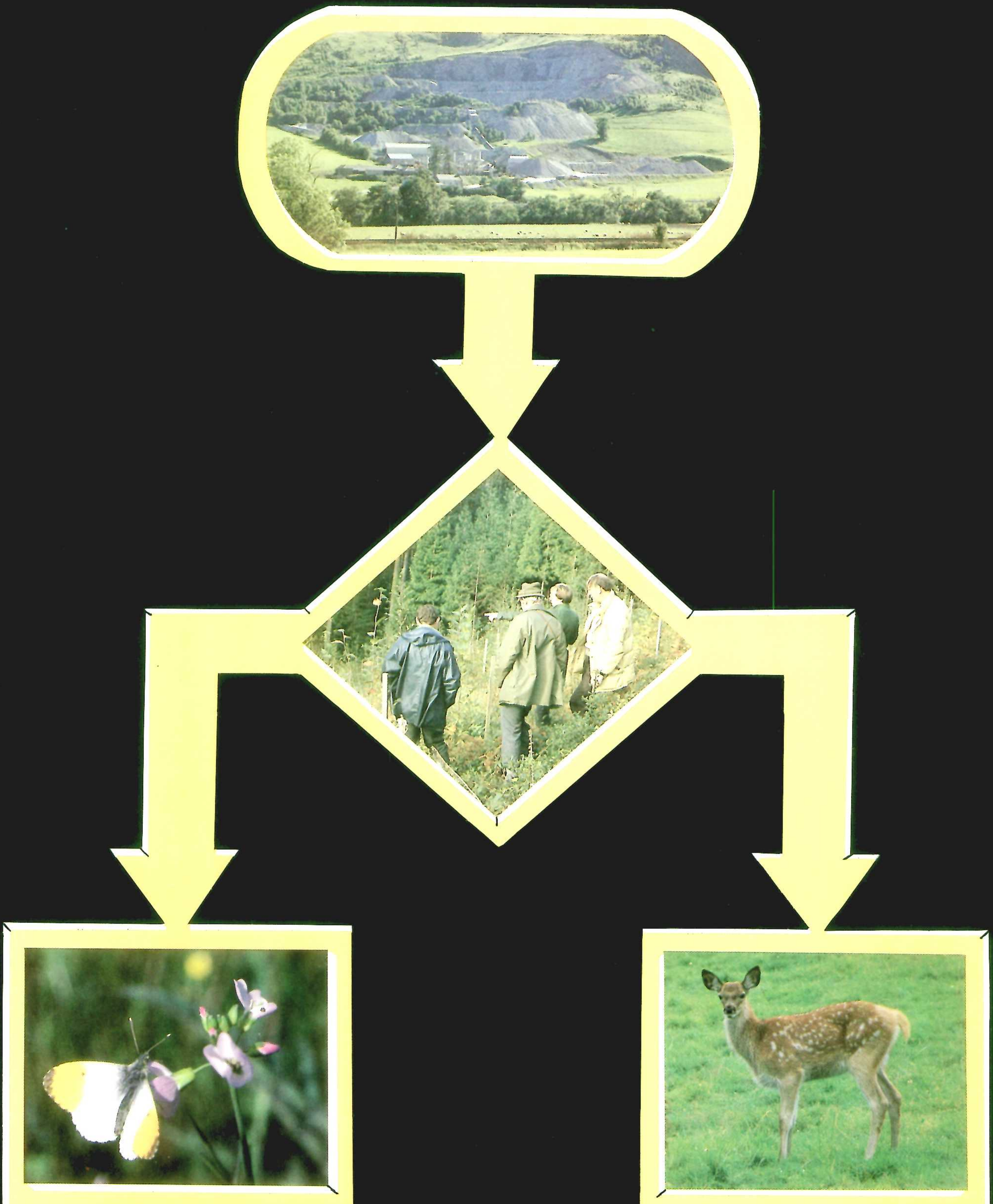
Natural Environment Research Council

Institute of Terrestrial Ecology



1984

Natural Environment Research Council

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Cover photographs

Rural Britain is subjected to the demands of a variety of land uses. ITE is currently assessing the associated landscape changes
(Photograph C J Barr)

ITE staff and other consultants in the Tavistock Woodlands, Devon, examining trials of *Nothofagus*, a genus with a high potential for dedicated wood energy plantations
(Photograph C J Barr)

A male orange-tip butterfly on a cuckooflower at the side of the Brentor rail track in Devon
(Photograph M S Warren)

A young male red deer
(Photograph D G Benham)

Cover design and artwork C B Benefield

The Institute of Terrestrial Ecology (ITE) was established in 1973, from the former Nature Conservancy's research stations and staff, joined later by the Institute of Tree Biology and the Culture Centre of Algae and Protozoa. ITE contributes to, and draws upon, the collective knowledge of the 13 sister institutes which make up the *Natural Environment Research Council*, spanning all the environmental sciences.

The Institute studies the factors determining the structure, composition and processes of land and freshwater systems, and of individual plant and animal species. It is developing a sounder scientific basis for predicting and modelling environmental trends arising from natural or man-made change. The results of this research are available to those responsible for the protection, management and wise use of our natural resources.

One quarter of ITE's work is research commissioned by customers, such as the Department of Environment, the European Economic Community, the Nature Conservancy Council and the Overseas Development Administration. The remainder is fundamental research supported by NERC.

ITE's expertise is widely used by international organizations in overseas projects and programmes of research.

Contents

Introduction

PARADIGMS LOST: A COMMENTARY ON TERRESTRIAL AND FRESHWATER ECOLOGY

"Vain wisdom all, and false philosophy"
Milton (Paradise Lost)

Introduction
The term 'ecology' is nowadays formally defined as 'the study of the relation of plants and animals to their environment and to each other' (Uvarov & Chapman 1979). However, it is clear that the word is currently being used in a very much wider sense, and now embraces a whole set of philosophical and semi-religious concepts. To many people, ecology is a policy and something to be advocated, rather than a science. Of course, the study of the relation of plants and animals to their environment and to each other need not be scientific. Natural history may be concerned with such relations in a purely descriptive way, without any experimental component and without the rigorous discipline of the formulation and testing of hypotheses necessary for a study to be regarded as scientific. Nevertheless, it is the loss of precision in the use of the word 'ecology' which is of the greatest concern to scientists.

The term 'ecosystem' was first used by Tansley (1935) to describe 'not only the organism complex but also the whole complex of physical factors forming what we call the environment'. This concept of the ecosystem as an ecological unit composed of living and non-living components interacting to produce a stable system has been restated in slightly different ways a number of times, for example as the biocoenosis. However, the main theoretical development of the concept, and the implementation of the research associated with that development, has occurred in the period from 1940 to the present, with the greatest impetus taking place in the 1950s. During that time, the ecosystem has become one of the principal paradigms of environmental science.

A second paradigm that controls all scientific research at the present time is that the publication of the results of scientific research should primarily be in the scientific journals in which the contributions are subjected to peer review through a system of referees. Indeed, so much importance is given to this form of publication that a scientist can expect little or no credit from making his or her research accessible to anyone incapable of reading and understanding the language and conventions imposed by the editor of the appropriate journal.

The ecosystem concept
Most historians of science date the beginning of modern ecology from the introduction of the ecosystem concept. This concept had its origins in the definition of the term by Tansley already referred to earlier in this paper, and was further developed by the food chain/pyramid concepts of Elton (1927, 1966) and the energetic trophic dynamics of Lindeman (1942). As a result, there is a more or less coherent body of knowledge that can be identified as being 'ecological' and concerned with the flow of energy and nutrients, and the interactions of populations of plants and animals in that flow. Many of these interactions are characterized by mathematically describable attributes, even if not well understood, such as diversity, stability and evolution. This new ecology, while springing from the field study of actual plants, animals and microbes, has reached sophisticated levels of abstraction which many biologists clearly find baffling, if not repulsive.

Nevertheless, this development of the ecosystem concept in ecology has spread rapidly from its largely Anglo-Saxon origins to all countries with the necessary educational and research facilities for modern scientific study. In part, this spread must be due to the speed of 20th century communication, through publication and attendance at international conferences. As a result, there is a consistent spectrum of activity in most countries which includes vegetation analysis, ecophysiology, and ecosystem dynamics, though with varying degrees of emphasis on the individual areas. The International Biological Programme (IBP) had a major impact in stimulating virtually all countries into a programme of studies of ecosystem productivity, rather fewer countries in studies of decomposition and mineral cycling, and fewer still on the mathematical modelling of ecosystem dynamics. Even where countries with less established traditions in science and ecology place current emphasis on vegetation analysis and mapping, such studies are either regarded as the precursors of studies of productivity, decomposition, etc, or are done in parallel with them.

It might seem, therefore, from this brief review, that all is well with the development of ecology, but the hard fact is that, while a great deal of research mascarades under the name of 'ecology', in fact very little of that research is actually related to the fundamental definition or to the paradigm of the ecosystem. Like most other scientists faced with complexity, biologists have, in the main, retreated to reductionist philosophies, and have contented themselves with the investigation of the behaviour of a single species in a limited or constrained environment. In this way, most of the complexity can be avoided. Some biologists have been more ambitious and have considered 2 species, as in predator/prey or host/parasite systems. Relatively few studies of plant or animal populations have investigated more than a few of the many possible physical and chemical attributes of the environment in which those populations live. There is, of course, no possible criticism of such reductionism in biological research, but we do need to question whether research which pays only lip service to the basic paradigm can really be regarded as 'ecology'.

Statistical methods and systems analysis
Part of the problem, however, clearly lies in the disparity between the abilities of research scientists to plan and execute experiments and surveys and the level of complexity required of such research if it is to encompass the variability that is contained within even the simplest ecosystem. The tragedy of the situation is that, at about the same time as the formulation of the concept of the ecosystem, a parallel revolution was begun in the development of statistical methods (Box 1978). 'Modern statistics began, it has been said, with the Fisher revolution. In the language of Kuhn (1974), statisticians in the twenties changed their paradigm' (Lindley 1984). Together with the gradual development of the ecological theory that depends on the ecosystem concept, modern statistical techniques have been developing in parallel, and certainly in ways which make it possible for the scientist to design effective programmes of research, even in the face of the variability which apparently makes ecological research difficult. Indeed, that variability can be turned into a positive advantage by many of the techniques that have been developed in statistical mathematics during the last 40 years.

Unhappily, with some notable exceptions, much biological and ecological research remains pathetically uncoupled from the significant developments of statistical methods and data analysis. Even major research programmes financed by the largest Government departments frequently show no indication that anyone concerned with the programmes has any idea of the fundamental requirements for the design of experiments or surveys that will provide results that are scientifically valid and that are efficient in obtaining the information at a reasonable cost. Faced with the need to study an ecosystem, most scientists seem to undergo some kind of mental paralysis that reduces their research to unthinking activity!

Even academic research has failed to embrace the opportunities that modern statistical techniques now provide. Rothery (1984), in a review of statistical practice in papers submitted for publication in the journals of the British Ecological Society, found more than 75% of papers with serious flaws in either the design or the analysis of the research. If this level of statistical incompetence is to be found in the research which actually gets to publication stage, the standards of much of the other research must be clearly cause for concern. My own experience as an external examiner indeed confirms that very few postgraduate studies have a logical basis that can even be regarded as adequate, let alone efficient.

This severe lack of an effective statistical basis, not because the techniques do not exist, but because the biologists and ecologists do not appear to know that they exist, has been recognized before. In 1972, the Natural Environment Research Council (NERC) set up a working party to consider the current state of biometrics and statistical methods in the environmental sciences, under the title *Quantitative methods in ecology*. In a carefully worded report (Gimingham 1975), the working party recommended a wide range of long-term educational measures to be met mainly by universities and related institutions, together with certain short-term organizational remedies to be applied in research institutes.

The results of ecological research
Two principal criticisms can be levelled at the outcome of past ecological research, whether within or without the paradigm of the ecosystem. First, as ecologists, we do not seem to have been able to formulate any fundamental principles which can be used by decision-makers, resource managers and administrators as a general guide to the management of our environment. Most other branches of science have at least some general principles which can be used as a background for practical decision-making, but ecology can hardly be claimed to have produced such principles. Perhaps the closest approach was that attempted by Norton and Walker (1982) and Walker and Norton (1982). These authors suggested 32 principles of applied ecology as a set of working hypotheses that may be of value in, for example, planning an environmental impact assessment. It was certainly a brave attempt, but it is doubtful if ecologists would agree that the hypotheses were sufficient, while most decision-makers would regard 32 principles as being rather more than they could hold in mind while making decisions, particularly in the 'cut and thrust' of political debate.

In part, it is the reductionist approach of much of the research which currently passes for ecology that precludes the development of a set of working principles. We are so busy pursuing research on the widest possible range of species and ecosystems that we have not paused to draw together the various strands to see if there are sufficient common relationships for us to formulate them as principles. We are repeating the successful local studies in different areas and on different species, because, in that way, we can be reasonably sure that something useful, or at least publishable, will be obtained. Thus, in part, the pressure to publish in the specialist journals, for our scientific colleagues, deters us from the much more difficult task of drawing out the more general principles from the many special cases that we have studied in our research. To be fair, however, it is only in the very recent past that adequate techniques for such formulations have become available, and the role of what have come to be called 'expert systems' in this development of a set of principles is discussed in more detail below.

The second criticism of ecology and ecologists is that very little of what has been done within the research community is available in an understandable form for the non-specialist. The principal reason for this lack of an adequate explanation of what it is that concerns us, as ecologists, is the paradigm of scientific publication that has already been mentioned in my opening paragraphs. If we are honest, we value the papers that will not be refereed by our peers less than those which will appear in the prestige journals with the accolade of peer approval. Indeed, we often hesitate to write the more general descriptions of the results of our research because we fear what our colleagues will say about such descriptions. Our hesitancy then opens the way to those writers who, with little or no scientific training, and certainly no actual research experience, are willing to act as the scientific 'middlemen'. It is their 'popular' view of ecology which, unchecked, has helped to debase the coinage of the word 'ecology', reducing 'ecologists', in the words of a recent Secretary of State for the Environment, to 'those chaps who demonstrate outside my office window'! Again, in the paragraphs which follow, I will suggest ways in which we might use some of the latest technological advances to widen the knowledge of the general public and of that part of the community, in particular, which has to make decisions that have major effects on our environment.

Anyone who has read this far might well object that there is at least one statement of ecological principles which, while short, does encapsulate most of the really important points. This is the World Conservation Strategy, as described by Allen (1980). This strategy is summarized by 3 main components:

1. maintaining essential ecological life processes and life-support systems;
2. preserving genetic diversity;
3. utilizing species and ecosystems sustainably.

However, it is important to make the distinction between a strategy and the fundamental principles by which such a strategy can be achieved. Anyone reading the World Conservation Strategy might well agree with it as a strategy for the future, but might equally well be entitled to say, 'Yes, but how?'

The future of ecology

NERC has a charter responsibility for the future of ecology, in the terrestrial, freshwater and marine environments. It exercises that responsibility by the support of research projects in universities and polytechnics, through the creating of fellowships and studentships, and by the definition of special topics. In its own institutes, NERC has the ability to create long-term programmes of multidisciplinary research, over a wide range of geographical locations, which could not be attempted in any academic institution, with tight direction in both economic and scientific terms. Because of its joint concern for both academic and institute research, collaboration between the various members of the scientific community in Britain can be fostered.

It would, therefore, be particularly appropriate for NERC to initiate a new programme of ecological research which could properly be regarded as falling within the essential paradigm of the ecosystem, and which utilized the full capability of modern statistical mathematics and systems analysis. Such a programme should be initiated only after the fullest possible discussion between academic, institute, departmental, and industrial scientists who are concerned with ecological problems, and the first steps, therefore, will require the arranging of a series of seminars and workshops to explore the possibilities and to define the approaches which will provide the greatest opportunities for collaborative research.

Ideally, this new programme of genuinely ecological research should have international appeal, but several attempts have been made in the recent past to interest international organizations in such programmes, and, so far at least, it has proved to be too difficult to set up a worthwhile programme in the face of national interests and differences. The most pragmatic course of action is almost certainly to concentrate on a British initiative initially, and to hope that some other countries, especially in Europe, will subsequently wish to be included.

Because it is important that everyone concerned should have an opportunity to influence the discussion and the choice of the habitats, organisms and abiotic factors to be included in this proposed major programme of genuinely ecological research, no attempt is made here to define too closely what that programme should be. However, it should certainly concentrate on the essential processes in several habitats, and be reflected by the responses of a range of plant and animal assemblages. The approach to the necessarily complex investigation should be systems orientated, and should seek to engage the expertise of mathematicians, statisticians and computer scientists in the solution of the difficult, but not necessarily insoluble, logical and analytical problems. Such a programme would provide a valuable initiative for the drawing together of a wider range of different scientific disciplines, as occurred during IBP.

All the evidence points to a need for greater administrative and public awareness of the shortcomings of present-day statistical approaches to many of the key problems of modern society. Healy (1984) gives an example which must serve for the many which could be culled from almost every walk of life: 'a very recent leader in the British Medical Journal states that "Small increases in the amount of radioactivity in the environment are acceptable if they arise from uses of atomic energy which bring industrial, medical, social or scientific benefits". I count three terms with quantitative implications in this sentence, yet the statement as it stands is vacuous, with no indication in the whole article that the author is aware of the hideously difficult problems of measurement and comparison which these terms imply, nor that the ethical dilemma implicit in the statement relies for its resolution on these problems being faced'.

Utilization of existing information

The arguments listed above have necessarily concentrated on the future research which should be done in the broad field of ecology, or at least within the paradigm of the ecosystem, and have linked this research with the almost contemporary paradigm of modern statistical mathematics. Any consideration of the future of ecology, however, would be incomplete without a consideration of the wider use of the information which has been obtained by past research, but which is available only in the scientific literature, if at all. Almost by definition, this information is not freely available, or at least intelligible, to the decision-maker, the administrator or the resource manager.

The technical developments in the field of data and information processing have opened up new possibilities for the transfer of information which, so far, have only just begun to be used in practice. There are at least 2 ways in which these developments could be used, now, to transfer available information on ecological processes, habitats and organisms so that it could be used in the making of decisions which have an effect on our natural, semi-natural and cropped environments. First, much of the available ecological information is related to particular sites identified, in the UK at least, by a National Grid Reference. This information includes characteristics of the geology, climate, topography, habitats, communities of plants and animals, and the presence or absence of individual organisms. Such information could be readily displayed on television screens, graphics terminals, or microprocessors through a viewdata system. The information could be related to scales identified by the users, with a facility to concentrate on smaller and smaller areas, or, alternatively, to concentrate on regional or national distributions. The technology now exists to display such information interactively through a private viewdata system, and will shortly exist to display the information on video disks capable of holding some 30 000 images, including microprocessor routines to manipulate the images. The BBC, for example, is currently planning to produce just such a video disk for its 'Operation Domesday', due to be published in 1986, the 900th anniversary of the original Domesday Book.

Second, there are now reasonably well-validated simulation models of some of the more fundamental ecological processes. These models could also be made accessible through a viewdata network, and could be used to illustrate some of the consequences of proposed policies or management prescriptions for the rural environment. The models provide a more rigorous description of the behaviour of ecological systems than do the verbal descriptions of such processes in scientific papers and texts, and, even if the mathematics which underlies the models remains opaque to the user, many decision-makers may find it useful to check their preconceptions of how the system will behave against the best available hypothesis about such behaviour.

Both of these forms of information could be made available today, with existing technology. I envisage a viewdata system, probably run for NERC by a private viewdata company, and charging an annual subscription of, say, £2,000 to each registered user. The annual subscription would enable the user to consult all the information held on file. Much of this information might be provided free of further charge, but some of the more specialized information could attract an added charge of, say, 20p a page. Users would also have the option of registering a request, through the viewdata system itself, for further information which may not yet have been placed on the system. Such requests would be related automatically to the appropriate institute, thus building up a more direct rapport with those wishing to use ecological information in a practical way. The system of charging for access to the information would also yield a useful revenue for the further improvement of the system, and, hopefully, for more ecological research.

While such access to existing information is technically feasible today, there are new developments in computer hardware and software which are likely to have profound effects on almost all aspects of modern life, including ecology. During the last 10 years, there has been, on average, a halving of the price and a doubling of the power of computers every 2 years. Within the next 10 years, there is likely to be an increase in the power of computers by several orders of magnitude and a reduction in price by a least one order of magnitude (Feigenbaum & McCorduck 1983).

The development of the computer hardware, however, is only one part of the story, and an even more profound change is already taking place in the development of computer software, with computer programming moving from sequential and procedural data-based applications to declarative knowledge-based applications. In particular, the concept of an expert system is already beginning to have a major effect on the ways in which research in many different fields will be conducted, presented and used.

The formal definition of an expert system approved by the British Computer Society is as follows.

'An expert system is regarded as the embodiment within a computer of a knowledge-based component from an expert skill in such a form that the system can offer intelligent advice or take an intelligent decision about a processing function. A desirable additional characteristic, which many would consider fundamental, is the capability of the system, on demand, to justify its own line of reasoning in a manner directly intelligible to the enquirer. The style adopted to attain these characteristics is rule-based programming.'

While the development of expert systems is clearly still only at the very beginning of what promises to be one of the most exciting challenges for the human intellect, computer languages like PROLOG are already providing an insight into what is rapidly becoming possible. In ITE, for example, we are currently exploring the possibility that fundamental ecological principles might be derived from logically derived inter-relationships between separate studies on habitats, processes and organisms. General-purpose programs are available now for predicting the outcome from given sets of attributes or conditions, and such programs can be readily used, for example, to aid the management of animal populations in National Parks and Reserves. Similarly, diagnostic programs for plant or animal diseases, or for the identification of organisms, communities and habitats can be shown to be more reliable than human observers, and capable of transferring expertise that could only previously be obtained by long years of study and practice to relatively unskilled operators with access to the knowledge-based program.

In parallel, therefore, with the initiation of a new programme of genuinely ecological research, and the presentation of existing ecological information by means of viewdata and packet-switching systems, an intensive programme of review of that information should now be mounted so as to co-ordinate the information into expert systems of wide-ranging utility. While many important advantages are likely to be gained from such a programme immediately, the greatest gain will come from having prepared the way for the really major advances that will come with the introduction of the Fifth Generation computers and their associated software. Environmental scientists need to prepare now for the coming intellectual revolution!

"Be famous then
By wisdom; as thy empire must extend,
So let extend thy mind o'er all the world."
Milton (Paradise Regained)

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Projects

listed by Programmes as at 31 December 1984

The listing by Programmes also shows the numbers of other Programmes in which the project appears.

1. Forest and woodland ecology
2. Freshwater ecology
3. Rehabilitation of disturbed ecosystems
4. Management of natural and man-made habitats
5. Survey and monitoring
6. Airborne pollutants, including radionuclides
7. Plant physiology and genetics
8. Ecophysiology and pollution in animals
9. Plant population ecology
10. Autecology of animals
11. Animal species interactions and communities
12. Cycling of nutrients
13. Land resources and land uses
14. Chemical and technical sciences
15. Systems analysis and biometrics

Key for symbols against project numbers

@ NCC contract
\+ DOE contract
£ Other contract
! PhD or other student project
$ Visiting worker project
* Project not yet approved by Management Group

1. Forest and woodland ecology, the integrated effects (botanical and zoological) of woodland and forest management practices

Programme Leader: F T Last
Core Group: D Jenkins, E D Ford, A H F Brown (Sec)

1	Semi-natural woodland classification	R G H Bunce	1	
9	Monitoring at Stonechest	J M Sykes	1	
90	Birch on moorland soil and vegetation	J Miles		(1)12
137	Population ecology of sparrowhawks	I Newton		(1,8)10
246	Physical environment, forest structure	E D Ford	1	(7)
359	Fibre yield of poplar coppice	M G R Cannell		(1) 7
367	The Gisburn experiment	A H F Brown		(1)12
389	Management effects in lowland coppices	A H F Brown	1	
417	Silvicultural systems-N Ireland experiment	A H F Brown	1	
454	Monitoring of woodlands	J M Sykes	1	
463	Age class of amenity trees	J E Good	1	
479	Red deer in production forests	B W Staines	1	(10)
483	Scottish deciduous woodlands	R G H Bunce		(1) 5
517	Primary productivity in woodlands	J N R Jeffers	1	
528	Red deer populations in woodland habitats	B Mitchell	1	(10)
549	Monitoring in native pinewoods	J M Sykes	1	
568	Subcortical fauna in oak	M G Yates		(1,11)10
574	Potential for fuel cropping in upland Wales	D I Thomas	1	
606	Grey squirrel damage and management	R E Kenward	1	(10)
625£+	Effects of clear-felling in upland forests	M O Hill		(1)12
633	Water level & vegetation change-Kirkconnell Flow	J M Sykes	1	
636	Song bird density and woodland diversity	D Jenkins		(1)11
711	Tree growth and climate	A Millar		(1) 7
721	Dry matter in forests: world review	M G R Cannell	1	
746	Grazing in woodlands	T W Ashenden	1	
773	Silviculture of respacing Sitka spruce	E D Ford	1	
793	Ecotypic variation in oak	M W Shaw	1	
794	Rhododendrons in Snowdonia	M W Shaw		(1) 4
820	Regional aspects of forest dynamics in Europe	P Ineson	1	(12)
832	Operation of the Rivox field site	R Milne		(1,7)14
839	Assessing pressures on pheasants at Pipar, Nepal	N Picozzi	1	
852£	Impact of herbivores on vegetation in pinewoods	J M Sykes	1	
862	Population ecology of pine beauty moth	A D Watt		(1)10
898	Light use efficiency of coppice	M G R Cannell		(1) 7
910	Physiology of reproduction in trees	K A Longman		(1) 7
933*!	Succession under birchwoods	A J Hester	1	(9)
935*	Evaluation of red alder	L J Sheppard	1	(12)
936*	Trees and wildlife in the Scottish highlands	D Jenkins	1	

2. Freshwater ecology, with special reference to synoptic limnology and the interactions between flora and fauna

Programme Leader: J P Dempster
Core Group: I Newton, P S Maitland (Sec), I R Smith

117	Freshwater survey of Great Britain	P S Maitland	2	(5)
124	Distribution and biology of fish in GB	P S Maitland		(2) 5

289	Residues and effects of pollutants	F Moriarty		(2) 8
481	Monitoring and chemistry of aquatic pollutants	K R Bull	2	(8)
527	Long-term changes in zooplankton	L May	2	(11)
577	Predation of freshwater zooplankton	D H Jones	2	(11)
584	Nutrient loading, phytoplankton and eutrophication	A E Bailey-Watts	2	(5,11)
585	Diatom ecology	A E Bailey-Watts	2	
586	Freshwater phytoplankton periodicity	A E Bailey-Watts	2	
609+	Biological classification of UK rivers	D Moss	2	(5)
642	Physics of freshwater systems	I R Smith	2	
644	Breeding success & survival in the common toad	C J Reading		(2)10
676	Ecology of lampreys in Loch Lomond	P S Maitland		(2)10
694	Zooplankton communities in freshwater lakes	D H Jones	2	(11)
698	Zooplankton population dynamics	L May	2	(11)
739	Life history of the common frog	C P Cummins		(2,10) 8
765	Ecology of the heron	M Marquiss		(2,8)10
797	Effects of acid rain on fresh water	K R Bull		(2) 6
833	Fish farms: mass balance and pollutants	I R Smith	2	
837£	Fish populations and acid precipitation	P S Maitland		(2) 6
847	Hydroclimate services	I R Smith	2	
863	4th international rotifer symposium	L May	2	
866	Aerial remote sensing of Lochs Leven, Lomond, Tay	A A Lyle	2	(5)
870	Mixing and spatial variation in lakes	I R Smith	2	
871	River condition scale	I R Smith	2	
886	Organizing 2 symposia at Brathens	D Jenkins	2	
903	Morphometric studies of British lampreys	K H Morris	2	(15)
926@£*	Loch Leven phosphorus load	A E Bailey-Watts	2	

3. Rehabilitation of disturbed ecosystems, and creation of biologically rich habitats from scratch

Programme Leader: J P Dempster
Core Group: B N K Davis (Sec), T C E Wells

360£	Tree planting on opencast sites	J E Good	3	
408+	Arboriculture: selection	F T Last	3	
500	Recolonization by spiders on Hartland Moor	P Merrett		(3,4)11
511	Landscaping at Swindon	F T Last	3	
567	Coastal dune management guide	D S Ranwell	3	
690	Plant succession in a limestone quarry	B N K Davis	3	
693	Plant species establishment in grassland	L A Boorman	3	(4)
707	Plant establishment in woodland	L A Boorman	3	(4)
726	Restoration of heathland vegetation	R H Marrs		(3) 4
819	Creation of butterfly habitats on landfill site	B N K Davis	3	
834£	Revegetation after disturbance	J Miles	3	
848	Mosses and indigenous plant litter in bare ground	N G Bayfield	3	
859£	Restoration of heathland	N R Webb	3	
887@	Creating attractive grasslands	T C E Wells	3	(9)
889	Monitoring floristic changes	T C E Wells	3	(9)
905£	Ecological aspects of alternative routes for the A3	S B Chapman		(3) 5
907	Bracken and heathland studies	J E Lowday		(3) 4
917£*	EIA of skiing on Aonach Moor	N G Bayfield	3	
921£	The use of grass on reinforced dam spillways	L A Boorman	3	

4. Management of natural and man-made habitats, but excluding forests and disturbed sites, effects of management, including grazing, cutting . . . on plants, animals and soils

Programme Leader: F T Last
Core Group: M G Morris, M D Hooper (Sec), C Milner

78	Management of sand dunes in Wales	D G Hewett	4	
89	*Calluna-Molinia-Trichophorum* management	J Miles	4	
92	Effects of grazing on *Nardus* and *Calluna* moorland	D Welch	4	
228	Effect of cutting on chalk grassland	T C E Wells	4	
230	Grassland management – invertebrates	M G Morris	4	(11)
243	Scrub succession at Aston Rowant NNR	L K Ward	4	
296	Scrub management at Castor Hanglands	L K Ward	4	
374	Sand dune ecology in East Anglia	L A Boorman	4	
457	Grazing models	C Milner		(4) 15
467	Roadside studies	T W Parr	4	
500	Recolonization by spiders on Hartland Moor	P Merrett		(3,4) 11
599	Bracken and scrub control on lowland heaths	R H Marrs	4	
602	Modelling sports turf wear	T W Parr	4	(15)
634	Field plot survey – Monks Wood	R Cox	4	
650	Amenity grass irrigation	M D Hooper	4	
665	Coastal management	D S Ranwell	4	
666	Coastal publications	D S Ranwell	4	
674£	Plant species for energy in Great Britain	T V Callaghan	4	(7)
693	Plant species establishment in grassland	L A Boorman		(4) 3
703	Vegetation change at Dungeness and Orfordness	R M Fuller	4	
707	Plant establishment in woodland	L A Boorman		(4) 3
718@	Impact of land drainage on wildlife	J O Mountford	4	
726	Restoration of heathland vegetation	R H Marrs	4	(3)
743	Railway resource monitoring	C M Sargent	4	
744	Effects of grazing in Snowdonia	M O Hill	4	
769	Bracken biofuel potential for energy in Wigtown	T V Callaghan	4	
772	Japanese knotweed control	R Scott	4	
776@	Long-term studies of vegetation change at Moor House	R H Marrs	4	
794	Rhododendrons in Snowdonia	M W Shaw	4	(1)
796	Poole harbour salt marshes	A J Gray	4	
835£	ITE/UCL EIA Lake Ichkeul: plant vegetation dynamics	T W Parr		(4,15) 9
836£	ITE/UCL EIA Lake Ichkeul: remote sensing survey	R M Fuller		(4) 5
838£	Sizewell ecological survey	D S Ranwell	4	
853£	Falkland Islands airport ecology impact	J Miles	4	(5)
875	Structure and dynamics of motorway vegetation	C Sargent		(4,5) 9
878	Use of remote sensing for mapping rhododendron	R J Parsell		(4,5) 13
883£	Desertification in South Africa	C Milner	4	
896£	Assessment and mapping of wetland vegetation in Tunisia	J O Mountford		(4) 5
901£	Environmental advice to Halcrows	M D Hooper	4	
907	Bracken and heathland studies	J E Lowday	4	(3)
908	*Spartina* population ecology	A J Gray		(4) 9
912£*	Rangeland mapping from remote sensing	B K Wyatt		(4) 5
914$	Somerset water resources study	M D Hooper	4	

922£	Ecological aspects of different routes for the A34	M D Hooper	4	
934*	Upland soil and vegetation dynamics	J Miles		(4)12

5. **Survey and monitoring** of plant and animal distributions and abundance

Programme Leader: J P Dempster
Core Group: P S Maitland, M O Hill, B K Wyatt (Sec)

117	Freshwater survey of Great Britain	P S Maitland		(5) 2
124	Distribution and biology of fish in GB	P S Maitland	5	(2)
132	Monitoring in the Cairngorms	A Watson	5	
181@	Birds of prey and pollution	I Newton		(5) 8
204@	Assessing butterfly abundance	E Pollard		(5)10
208@	BRC: botanical recording schemes	C D Preston	5	
209@	BRC: vertebrate recording schemes	H R Arnold	5	
309	Phytophagous insect data bank	L K Ward		(5)11
340	Survey of Scottish coasts	D S Ranwell	5	
405	Fauna of pasture woodlands	P T Harding		(5)11
406	Distribution and ecology of non-marine Isopoda	P T Harding	5	
424	Ecological survey of Britain	R G H Bunce		(5)13
466	Ecology of railway land	C M Sargent	5	
469	Scottish invertebrate survey	R C Welch	5	
470	Upland invertebrates	A Buse		(5)11
483	Scottish deciduous woodlands	R G H Bunce	5	(1)
529@	BRC: data bank	D M Greene	5	
534	National land characteristics and classification	D F Ball		(5)13
557@	BRC: terrestrial and freshwater invertebrate recording	P T Harding	5	
584	Nutrient loading, phytoplankton and eutrophication	A E Bailey-Watts		(5,11) 2
591	Terrestrial Environment Information System	B K Wyatt		(15) 5
609+	Biological classification of UK rivers	D Moss		(5) 2
615	Heathland invertebrates	N R Webb		(5)11
656@	BRC: marine invertebrate recording schemes	H R Arnold	5	
657@	Biological Records Centre – general	P T Harding	5	
684	Mapping Broadland vegetation with aerial photographs	R M Fuller	5	
751	National survey of fluoride in predatory birds	D C Seel		(5) 6
760£	EEC ecological mapping	B K Wyatt		(5)13
761£	EEC remote sensing	B K Wyatt		(5)13
771	Chemical data bank (Monks Wood)	K R Bull		(5,8)14
774	Long-term trends in upland vegetation	J Dale	5	
795	Standard procedures for recording data	D M Greene	5	(15)
799	Dutch elm disease resurvey	J Wilson	5	
806	Assessment of Landsat value for land use	B K Wyatt		(5)13
807	Ecobase	B K Wyatt	5	
822	Landsat classification and vegetation survey of Bhutan	C M Sargent	5	(13)
836£	ITE/UCL EIA Lake Ichkeul: remote sensing survey	R M Fuller	5	(4)
850£	Pembrokeshire NP air photo interpretation	D F Ball	5	(13)
853£	Falkland Islands airport ecology impact	J Miles		(5) 4
866	Aerial remote sensing of Lochs Leven, Lomond, Tay	A A Lyle		(5) 2

875	Structure and dynamics of motorway vegetation	C M Sargent		(4,5)	9
878	Use of remote sensing for mapping rhododendron	R J Parsell		(4,5)	13
896£	Assessment and mapping of wetland vegetation in Tunisia	J O Mountford	5	(4)	
899	Rural land cover and landscape change	D F Ball		(5)	13
900	Air photo assessment of landscape change	D F Ball		(5)	13
904£	Ecological studies at Winfrith Heath	S B Chapman	5		
905£	Ecological aspects of alternative routes for the A3	S B Chapman	5	(3)	
906	Ecological data unit	G L Radford	5		
909	Changes in the rural environment	C J Barr		(5)	13
912£*	Rangeland mapping from remote sensing	B K Wyatt	5	(4)	
919£	Poole Harbour environmental sensitivity	A J Gray	5		
927£*	BBC Domesday project	D F Ball		(5)	13
932	Local applications of remote sensing	R E Daniels	5		

6. Airborne pollutants, including radionuclides, their pathways through and effects on terrestrial ecosystems

Programme Leader: F T Last
Core Group: S E Allen, M H Unsworth, I A Nicholson, D F Perkins (Sec)

160£	Fluorine pollution studies	D F Perkins	6		
380	Monitoring atmospheric SO_2 and No_x at Devilla	I A Nicholson	6		
426	Review of sulphur cycle	I A Nicholson	6		
453	SO_2 dry deposition in Scots pine forest	D Fowler	6		
491	Radiochemical development	A R Byrne		(6)	14
524	Fluoride in predatory mammals	K C Walton	6		
525	Fluoride in predatory birds	D C Seel	6		
526	Biological monitoring in the Forth Valley	B G Bell	6		
553£+	Radionuclide pathways	S E Allen	6		
556	Estimation in acid rain	K H Lakhani	6		
669	Interaction of grazing and air pollution	T W Ashenden	6		
710	Airborne pollutants and Scots pine	J N Cape	6		
751	National survey of fluoride in predatory birds	D C Seel	6	(5)	
753	Fluoride and magpies	D C Seel	6	(10)	
756	Fluoride pathways in invertebrates	A Buse	6		
790£+	Effects of polluted atmosphere on crops	I A Nicholson	6		
791	Effects of acid rain on Sitka spruce	D Fowler	6		
797	Effects of acid rain on fresh water	K R Bull	6	(2)	
809	Fluoride toxicology	D Osborn		(6)	8
830	Rainfall acidity and gas transport and exchange	J N Cape	6		
837£	Fish populations and acid precipitation	P S Maitland	6	(2)	
841£	Throughfall and stemflow under different trees	I A Nicholson	6		
849!	Distribution of radionuclides in soils	F R Livens	6		
873+	Effect of land use on radionuclides in W Cumbria	A D Horrill	6		
874+	Transfer of radionuclides to coastal sheep	B J Howard	6		
880	Radionuclides in the food of birds	V P W Lowe	6		
884	Dynamics of Americium in coastal Cumbria	A D Horrill	6		
888+	NO_x, O_3 and NH_3 dry deposition	M H Unsworth	6	(12)	
893£	Effects of acid rain on Scots pine	J Dighton	6	(12)	

895	Chemical composition of rainfall	I A Nicholson	6	
924£*	Acid mist and tree injury	A Crossley	6	
925+*	Rainfall at Great Dun Fell	D Fowler	6	

7. Plant physiology and genetics, responses of native and introduced species to environmental factors

Programme Leader: F T Last
Core Group: M H Unsworth (Sec), T V Callaghan

246	Physical environment, forest structure	E D Ford		(7) 1
266	Root dynamics of *Calluna vulgaris*	S B Chapman		(7)12
359	Fibre yield of poplar coppice	M G R Cannell	7	(1)
410	Tundra plants (bryophytes)	T V Callaghan		(7) 9
447	Freshwater and marine amoebae	F C Page	7	
449	Preservation of cultures	G J Morris	7	
512	National collection of birch	J Pelham	7	(9)
674£	Plant species for energy in Great Britian	T V Callaghan		(7) 4
702	Selection of frost-hardy trees	M G R Cannell	7	
711	Tree growth and climate	A Millar	7	(1)
717	Birch variation and environmental differences	J Pelham	7	(9)
748	Temperature limits of growth for *Chlamydomonas*	E A Leeson	7	
750£	Domestication of tropical hardwoods	R R B Leakey	7	
767	Formation of cones by lodgepole pine	K A Longman	7	
770	Evaluation of conifer clones and progenies	M G R Cannell	7	
785	Cultivation of freshwater algae	E A Leeson	7	
786	Cultivation of marine algae	N C Pennick	7	
787	Cultivation of free-living protozoa	J P Cann	7	
801	Radial growth of Sitka spruce roots	J D Deans	7	
805	Effects of mycorrhizas on assimilation	E J White	7	
815	Control of wood density in Sitka spruce	E D Ford	7	
816	IUFRO Conference 1984: trees as crop plants	M G R Cannell	7	
831	Modelling of transpiration in Sitka spruce	R Milne	7	
832	Operation of the Rivox field site	R Milne		(1,7)14
842!	The physiology of *Pinus contorta* buds	C J Couper	7	
851£	Viability and stability of micro-organisms	G J Morris	7	
861	Characterization of sheathing mycorrhizas	A Crossley	7	
865	Mycorrhizal toadstools in coniferous plantings	J Wilson		(7)12
872!	Effect of mycorrhizas on metal uptake in *Betula*	H J Denny	7	(12)
879£	Energy plantations – review	M G R Cannell	7	
881*	Ecology of rock-colonizing mosses in Britain	P J Lightowlers	7	
882	Cone initiation in lodgepole pine	J P McDick	7	
897	Cryobiology workshop at CCAP	J R Baker	7	
898	Light use efficiency of coppice	M G R Cannell	7	(1)
910	Physiology of reproduction in trees	K A Longman	7	(1)
916	Saline-tolerant *Petalomonas*	J P Cann	7	
931*£	Screening algal cells for industry	G J Morris	7	

8. Ecophysiology and pollution in animals, covering broadly the same fields as the former Subdivision of Animal Ecology

Programme Leader: J P Dempster
Core Group: I Newton (Sec), R Moss

129	Red grouse and ptarmigan populations	A Watson		(8)10

137	Population ecology of sparrowhawks	I Newton		(1,8)10
181@	Birds of prey and pollution	I Newton	8	(5)
255	Ecology of *Myrmica* species	G W Elmes		(8,10)11
256	Protein electrophoresis	B Pearson	8	
289	Residues and effects of pollutants	F Moriarty	8	(2)
393	Isolation effects on butterfly populations	J P Dempster		(8,10)11
444	Endocrine lesions in birds	S Dobson	8	
455	Heavy metals in avian species	D Osborn	8	
461@	Puffins and pollutants	M P Harris	8	(10)
481	Monitoring and chemistry of aquatic pollutants	K R Bull		(8) 2
559	Ecology of reproduction in the wild rabbit	I L Boyd	8	
624	Population genetics	P J Bacon		(8)10
630	Stress in birds	A Dawson	8	
697	Pesticides and wildlife: historical perspective	J Sheail	8	
728	Kestrels in farmland	A Village		(8)10
737	Population genetics of *Pardosa monticola* spiders	R G Snazell	8	
739	Life history of the common frog	C P Cummins	8	(2,10)
759+	Chemicals in the terrestrial environment	S Dobson	8	
763£	Data profiles on chemicals	S Dobson	8	
765	Ecology of the heron	M Marquiss		(2,8)10
771	Chemical data bank (Monks Wood)	K R Bull		(5,8)14
809	Fluoride toxicology	D Osborn	8	(6)
810	Lead poisoning in birds	M C French	8	
811	Foraging and reserve storage in red and grey squirrels	R E Kenward	8	(11)
812	Grouse aviary	R Moss	8	(10)
930*	Ecology of the great crested grebe	A Village		(8)10

9. Plant population ecology: the biology of individuals and populations, including a consideration of gene flow

Programme Leader: F T Last
Core Group: S B Chapman, A J Gray (Sec)

82	Seed population by montane plants	G R Miller	9	
225	Population studies on orchids	T C E Wells	9	
269	Autecology of *Gentiana pneumonanthe*	S B Chapman	9	
295	Survey of juniper in N England	L K Ward	9	
346	Genecology of grass species	A J Gray	9	
365	Competition between grass species	H E Jones	9	
410	Tundra plants (bryophytes)	T V Callaghan	9	(7)
508	Botanical variation in elm	J N R Jeffers	9	
512	National collection of birch	J Pelham		(9) 7
576	Isoenzyme studies in *Sphagnum*	R E Daniels	9	
649	Demographic genetics of *Agrostis curtisii*	A J Gray	9	
717	Birch variation and environmental differences	J Pelham		(9) 7
742	Population fluctuations in annual legumes	C D Preston	9	
775	Ecology of arctic alpines in Snowdonia	C Milner	9	
783	Interactions between mosses and vascular plants	N G Bayfield	9	
835£	ITE/UCL EIA Lake Ichkeul: plant vegetation dynamics	T W Parr	9	(4,15)
846	Influence of events on population growth	I R Smith		(9,10)15
875	Structure and dynamics of motorway vegetation	C M Sargent	9	(4,5)
887@	Creating attractive grassland	T C E Wells		(9) 3

889	Monitoring floristic changes	T C E Wells	(9) 3
908	*Spartina* population ecology	A J Gray	9 (4)
911	Taxonomy of bryophytes	B G Bell	9
913*	Characterization of *Dunaliella* species	N C Pennick	9
933*!	Succession under birchwoods	A J Hester	(9) 1

10. Autecology of animals, with particular reference to population management for conservation and pest control

Programme Leader: J P Dempster
Core Group: I Newton, E Pollard (Sec), A Watson

54	Ecology of red deer on the Isle of Rhum	V P W Lowe	10
104	Distribution and segregation of red deer	B W Staines	10
111	Population dynamics of red deer at Glen Feshie	B Mitchell	10
129	Red grouse and ptarmigan populations	A Watson	10 (8)
131	Golden plover populations	A Watson	10
137	Population ecology of sparrowhawks	I Newton	10 (1,8)
202	The population ecology of the Roman snail	E Pollard	10
204@	Assessing butterfly abundance	E Pollard	10 (5)
255	Ecology of *Myrmica* species	G W Elmes	(8,10)11
291@	Population ecology of bats	R E Stebbings	10
292@	Specialist advice on bats	R E Stebbings	10
386	Behaviour and dispersion of badgers	H Kruuk	10
393	Isolation effects on butterfly populations	J P Dempster	(8,10)11
400	The large blue butterfly	J A Thomas	10 (11)
403	The black hairstreak butterfly	J A Thomas	10
404	The brown hairstreak butterfly	J A Thomas	10
441	Oystercatcher and shellfish interaction	J D Goss-Custard	(10)11
442	Ecology of capercaillie	R Moss	10
461@	Puffins and pollutants	M P Harris	(10) 8
479	Red deer in production forests	B W Staines	(10) 1
499	Taxonomic studies for mammalian autecology	V P W Lowe	10
509	Wood white butterfly population ecology	E Pollard	10
528	Red deer populations in woodland habitats	B Mitchell	(10) 1
543	Population ecology of the red squirrel	V P W Lowe	10
568	Subcortical fauna in oak	M G Yates	10 (1,11)
606	Grey squirrel damage and management	R E Kenward	(10)1
624	Population genetics	P J Bacon	10 (8)
644	Breeding success and survival in the common toad	C J Reading	10 (2)
660	Adonis blue populations	J A Thomas	10
676	Ecology of lampreys in Loch Lomond	P S Maitland	10 (2)
687	Radio-location & telemetry development	T Parish	10
692	Goshawk population dynamics	R E Kenward	10
715	Monitoring otters in Shetland	J W H Conroy	10
722	The habitat ecology of the spider *Eresus niger*	P Merrett	10
728	Kestrels in farmland	A Village	10 (8)
734	Estimation of seabird numbers	M P Harris	10
735	Oystercatcher population dynamics	M P Harris	10
739	Life history of the common frog	C P Cummins	(2,10) 8
753	Fluoride and magpies	D C Seel	(10) 6
764£	Habitat requirements of black grouse	N Picozzi	10
765	Ecology of the heron	M Marquiss	10 (2,8)
777	Estimation of population parameters	K H Lakhani	(10)15
789	Food resource limitation in the orange-tip butterfly	J P Dempster	10

808	Effect of food availability on otter behaviour	H Kruuk	10	
812	Grouse aviary	R Moss		(10) 8
818	Increasing guillemot populations	M P Harris	10	
828	Rabbit foraging, dispersal and mortality	R E Kenward	10	
846	Influence of events on population growth	I R Smith		(9,10)15
860!	Resource limitation of 2 tephritid flies	N A Straw	10	(11)
862	Population ecology of the pine beauty moth	A D Watt	10	(1)
891	Winter feeding of young oystercatchers on the Exe estuary	J D Goss-Custard	10	(11)
892	Habitat, etc, of waders: feasibility study	J D Goss-Custard	10	(11)
930*	Ecology of the great crested grebe	A Village	10	(8)

11. Animal species interactions and communities, including studies of the interactions between species (eg competition, predator/prey) and between fauna and their habitats (eg effects of area and isolation)

Programme Leader: J P Dempster
Core Group: M G Morris, J D Goss-Custard, D Jenkins, J R Baker (Sec)

230	Grassland management – invertebrates	M G Morris		(11) 4
252	Hartland Moor NNR survey	A Abbott	11	
255	Ecology of *Myrmica* species	G W Elmes	11	(8,10)
270	Distributional studies on spiders	P Merrett	11	
309	Phytophagous insect data bank	L K Ward	11	(5)
393	Isolation effects on butterfly populations	J P Dempster	11	(8,10)
400	The large blue butterfly	J A Thomas		(11)10
405	Fauna of pasture woodlands	P T Harding	11	(5)
407	British Staphylinidae (Coleoptera)	R C Welch	11	
441	Oystercatcher and shellfish interaction	J D Goss-Custard	11	(10)
470	Upland invertebrates	A Buse	11	(5)
500	Recolonization by spiders on Hartland Moor	P Merrett	11	(3,4)
527	Long-term changes in zooplankton	L May		(11) 2
568	Subcortical fauna in oak	M G Yates		(1,11)10
569	Insect fauna of *Helianthemum* and *Genista*	B N K Davis	11	
577	Predation of freshwater zooplankton	D H Jones		(11) 2
584	Nutrient loading, phytoplankton and eutrophication	A E Bailey-Watts		(5,11) 2
612	Analysis of Common Birds Census	M D Mountford	11	
615	Heathland invertebrates	N R Webb	11	(5)
621	Models of rabies epidemiology	P J Bacon		(11)15
636	Song bird density and woodland diversity	D Jenkins	11	(1)
641	Invertebrate fauna of *Nothofagus*	R C Welch	11	
694	Zooplankton communities in freshwater lakes	D H Jones		(11) 2
698	Zooplankton population dynamics	L May		(11) 2
724	Protozoan parasites of wild British animals	J R Baker	11	
811	Foraging and reserve storage in red and grey squirrels	R E Kenward		(11) 8
821	Modern agriculture and wildlife	T Parish	11	
826	Fauna of native and introduced trees	R C Welch	11	
827	Weevil studies	M G Morris	11	
854!	Competition between red and roe deer in forests	M Hinge	11	
860!	Resource limitation of 2 tephritid flies	N A Straw		(11)10
867!	Parasitic diseases of bats	R A Gardner	11	
890	Bat trypanosomes in diagnosis of Chagas' disease	J R Baker	11	
891	Winter feeding of young oystercatchers on the Exe estuary	J D Goss-Custard		(11)10
892	Habitat, etc, of waders: feasibility study	J D Goss-Custard		(11)10

920£*	Irian Jaya butterfly consultancy	M G Morris	11		
928£*	Ornithological survey of Parkstone Bay, Poole	J D Goss-Custard	11		

12. Cycling of nutrients: the movement and utilization of nutrients

Programme Leader: F T Last
Core Group: O W Heal, M Hornung, J Miles (Sec)

90	Birch on moorland soil and vegetation	J Miles	12	(1)	
153	Mineralogical methods	A Hatton	12		
266	Root dynamics of *Calluna vulgaris*	S B Chapman	12	(7)	
364	Early growth of trees	A F Harrison	12		
367	The Gisburn experiment	A H F Brown	12	(1)	
431	Soil change through afforestation	P J A Howard	12		
438	Ecology of *Mycena galopus*	J C Frankland	12		
589	Microbial characteristics in soils	P M Latter	12		
594+£	Geochemical cycling	M Hornung	12		
625£+	Effects of clear-felling in upland forests	M O Hill	12	(1)	
645	Effects of soil chemistry on decomposition	D D French	12		
654	Status of mycorrhizas in the soil ecosystem	J Dighton	12		
695	Effects of mycorrhizas on tree growth	F T Last	12		
714	Role of forest vegetation in pedogenesis	P J A Howard	12		
738!	Effect of altitude on grassland at Moor House	J C Hatton	12		
820	Regional aspects of forest dynamics in Europe	P Ineson		(12)	1
824	Nitrogen and phosphorus cycling in forest soils	A F Harrison	12		
865	Mycorrhizal toadstools in coniferous plantings	J Wilson	12	(7)	
872!	Effect of mycorrhizas on metal uptake in *Betula*	H J Denny		(12)	7
888+	NO_x, O_3 and NH_3 dry deposition	M H Unsworth		(12)	6
893£	Effects of acid rain on Scots pine	J Dighton		(12)	6
918*	Collembolan grazing and sheathing mycorrhiza	J Dighton	12		
923+*	Acid water in Wales	M Hornung	12		
929	Effects of altitude on nitrogen mineralization	R H Marrs	12		
934*	Upland soil and vegetation dynamics	J Miles	12	(4)	
935*	Evaluation of red alder	L J Sheppard		(12)	1
937*	Potassium bioassay	H E Jones	12		

13. Land resources and land uses, habitat characteristics, their inter-relations and value in site assessments and resource management

Programme Leader: F T Last
Core Group: J N R Jeffers, O W Heal, D F Ball (Sec)

4	Soil classification methods	P J A Howard	13	
377	Historical aspects of environmental perception	J Sheail	13	
424	Ecological survey of Britain	R G H Bunce	13	(5)
471	Soils of Upper Teesdale	M Hornung	13	
534	National land characteristics and classification	D F Ball	13	(5)
541	Marginal land in Cumbria	C B Benefield	13	
561	Soil fertility	M Hornung	13	

700+	Ecological guidelines for locational strategies	G L Radford	13	
745	Land availability for wood energy plantations	R G H Bunce	13	
747£	Highland Region land classification	R G H Bunce	13	
760£	EEC ecological mapping	B K Wyatt	13	(5)
761£	EEC remote sensing	B K Wyatt	13	(5)
806	Assessment of Landsat value for land use	B K Wyatt	13	(5)
822	Landsat classification and vegetation survey of Bhutan	C M Sargent		(13) 5
844£	Potential wood production on the Culm Measures	R G H Bunce	13	
850£	Pembrokeshire NP air photo interpretation	D F Ball		(13) 5
878	Use of remote sensing for mapping rhododendron	R J Parsell	13	(4,5)
894	Publication - the land in Britain	D F Ball	13	
899	Rural land cover and landscape change	D F Ball	13	(5)
900	Air photo assessment of landscape change	D F Ball	13	(5)
909	Changes in the rural environment	C J Barr	13	(5)
927£*	BBC Domesday project	D F Ball	13	(5,9)

14. Chemical and technical sciences, as a service to ITE

Programme Leader: J N R Jeffers
Core Group: S E Allen (Sec), M Hornung, I H Rorison

484	Chemical technique development	D Roberts/ P Freestone	14	
485	Chemical support studies	S E Allen	14	
486	Engineering development	G H Owen	14	
487	Microprocessor development studies	C R Rafarel	14	
489	Glasshouse and nursery: support and development	R F Ottley	14	
490	Photographic development	P G Ainsworth	14	
491	Radiochemical development	A R Byrne	14	(6)
771	Chemical data bank (Monks Wood)	K R Bull	14	(5,8)
788	Electron microscopy of algae and protozoa	K J Clarke	14	
804	Effect of changing environment on plant growth	E J White	14	
832	Operation of the Rivox field site	R Milne	14	(1,7)
885	NERC mass spectrometer service	C Quarmby	14	
902	Utilization of STATUS in ITE libraries	S M Adair	14	
915	Landscaping the new extension at Bush	R F Ottley	14	

15. Systems analysis and biometrics

Programme Leader: J N R Jeffers
Core Group: C Milner, M D Mountford (Sec), E D Ford

376	Statistical training	C Milner	15	
402	Biometrics advice to NERC	M D Mountford	15	
434	ITE computing services	C Milner	15	
457	Grazing models	C Milner	15	(4)
503	Development of systems analysis	J N R Jeffers	15	
518£	UNESCO MAB Information System	J N R Jeffers	15	
591	Terrestrial Environment Information System	B K Wyatt		(15) 5
602	Modelling sports turf wear	T W Parr		(15) 4

610	Computerization of CCAP records	D F Spalding	15	
613	Computerization of ITE/NERC costing procedure	M D Mountford	15	
621	Models of rabies epidemiology	P J Bacon	15	(11)
663	Estimation of abundance of populations	M D Mountford	15	
699	Checklist of computer programs	D K Lindley	155	
754£	Development of bilateral link with IES Khartoum	J N R Jeffers	15	
777	Estimation of population parameters	K H Lakhani	15	(10)
795	Standard procedures for recording data	D M Greene		(15) 5
802£	MAFF environmental sampling in W Cumbria	D K Lindley	15	
825	Statistical consultancy in ITE	M D Mountford	15	
835£	ITE/UCL EIA Lake Ichkeul: plant vegetation dynamics	T W Parr		(4,15) 9
846	Influence of events on population growth	I R Smith	15	(9,10)
868$	Training in computing and statistics for Chinese	D K Lindley	15	
869*	Graphics for general publications	C B Benefield	15	
877	Image analysis support services	R J Parsell	15	
903	Morphometric studies of British lampreys	K H Morris		(15) 2
906	Ecological data unit	G L Radford		(15) 5

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Publications

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Thames Water Authority. ITE project 901.

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Customer	Project number	Project title
Nature Conservancy Council	181, 461	Birds and pollution
	204	Butterfly monitoring scheme
	208/9/11, 529, 557, 656	Recording of data on individual species
	291/2	Population ecology of bats
	718	Impact of drainage on wildlife
	776	Moor House data analysis
	852	Impact of herbivores on woodland
	887	Creating attractive grassland
	—	Advice and services
Department of the Environment	408	Arboriculture
	491, 553, 873/4	Radionuclides
	573	Amenity grass
	609	Biological classification of UK rivers
	594, 625 (pt)	Upland management and water quality (joint FBA/IH)
	759, 763	Biological effects of chemicals in the environment
	797	Effects of acid rain on fresh water in north-west England
	367, 790, 837, 888	Acid deposition on soils and plants
	923	Acid deposition – land use in Wales
	925	Acid deposition – Great Dun Fell
Department of Industry	851	Effects of long-term preservation on micro-organisms
Ministry of Agriculture, Fisheries and Food	802	Environmental sampling in west Cumbria
Ministry of Defence	834	Gruinard Island decontamination assessment
Anglian Water Authority	—	Holme Dunes study
British Alcan	917	Impact of skiing developments
British Petroleum	919	Poole Harbour ecological study
Building Design Partnership	853	Falkland airport survey
Central Electricity Generating Board	838	Ecological survey of Winfrith Heath
Central Electricity Research Laboratories	—	Mycorrhiza/acid rain
Dartington Trust	844	Wood production on Culm Measures
Dornier	760	EEC mapping project
Dyfed County Council	850	Pembrokeshire National Park
English China Clay Company	859	Furzeyground restoration scheme
Essex County Council	819	St Osyth conservation scheme
Halcrows Consultants	914	Water resources in Somerset
Inveresk Research	—	Planting and landscaping
Laurence Gould Consultants	858	Environmental study of Thames drainage

Mott, Hay and Anderson	905, 922	A3 alternative and A34 Newbury bypass
National Coal Board	360	Tree planting study
	—	Vegetation overburden mounds
Readers Digest	—	Biological Records Centre maps
Rofe, Kennard and Lapworth	921 (pt)	CIRIA reinforced grass
Salford Civil Engineering Ltd	921 (pt)	Reinforced grass waterways
Severn & Trent Water Authority	858	Soar Valley improvement scheme
Shetland Oil Terminal Environmental Advisory Group	715	Otters at Sullom Voe
Welsh Office	160 (pt)	Fluorine pollution
	594, 625 (pt)	Upland management and water quality
	845	Acid rain in Wales
European Commission	160 (pt)	Fluorine pollution
	553 (pt)	Radionuclides
	625 (pt)	Land management and water quality
	674	Native and naturalized species for energy production
	760 (pt)	European mapping
	888 (pt)	Acid rain NO_x fluxes
	—	Acid deposition on plant and soils
	924	Acid mist tree injury
	912	Remote sensing in West Africa
	—	Monitoring encroachment of the desert
EEC consultancy	—	Athens mapping project
UNESCO	518	MAB project inventory
World Pheasant Association	764	Black grouse studies
World Wildlife Fund	400	Large blue butterfly studies

Expected level of income from commissioned work for the financial year 1984/85

	(£1000)
Nature Conservancy Council	205
Department of the Environment	411
Other Government Departments	92
Public bodies and other UK organizations	154
Overseas customers and contracts	106
	968

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