

# Global Change

## Predicting the effects of environmental change on trout growth

The growth of freshwater fish is sensitive to environmental perturbations, and measurements of growth rate often provide an index of performance. It is therefore important to develop growth models

temperature for optimum growth, the lower and upper temperatures at which growth rate is zero, the growth rate of a 1g trout at the optimum temperature, and the weight exponent.

### Effect of environment

The model can be used to compare growth in different year-classes from

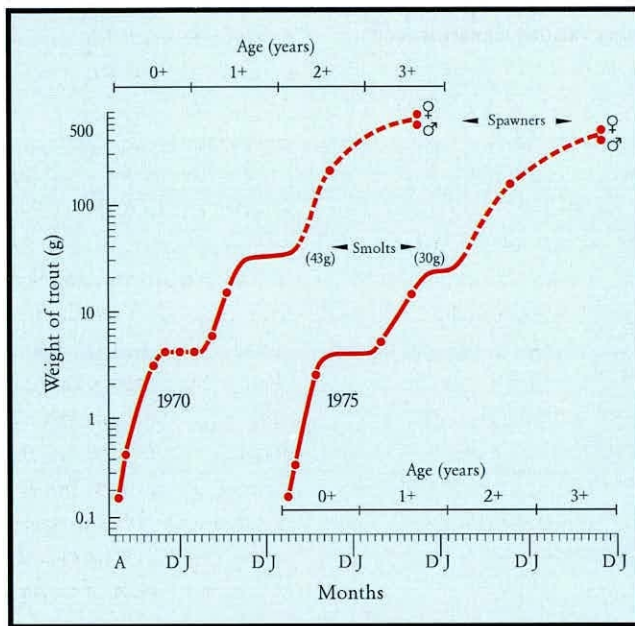


Figure 42. Growth pattern for the 1970 and 1975 year-classes in a Lake-District stream (note that trout weight is on a logarithmic scale and therefore the differences for the older fish are greater than they appear to be on the Figure).

so that actual growth rates can be compared against predicted values for optimal conditions. Ideally, the models should be realistic with parameters that can be interpreted in biological terms. One such model for brown trout, *Salmo trutta* L., was developed recently at IFE. The work was part-funded by the Atlantic Salmon Research Trust. The model is based on an analysis of individual growth data for 185 trout kept at fairly constant temperatures and fed on maximum rations. It is a continuous model over the range 3.8 - 21.7°C and has five parameters: the

same population and identify years when growth is exceptionally poor. For example, the 1970 year-class in a Lake-District stream is typical of the faster growing year-classes whereas the 1975 year-class exhibits the poor growth that is typical of year-classes affected by summer droughts (Figure 42). The model predicts correctly the marked difference in growth rates, with an estimated smolt weight of 43g in the good year-class and only 30g in the poor year-class. From similar analyses, the model has been used to predict the length and weight of older

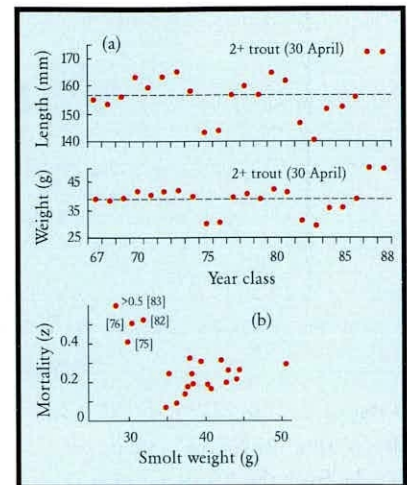


Figure 43. (a) Estimated values for mean lengths and mean weights of older trout (age just over 2 years) on 30 April in each year-class in a Lake-District stream (horizontal lines are arithmetic means); (b) Relationship between female mortality at sea ( $Z$ ) and smolt weight in each year-class.

trout on the 30 April, just before they leave the stream as smolts. Occasional field samples verified the accuracy of these predictions. Estimates for 22 year-classes show that the fish were exceptionally small in the 1975, 1976, 1982 and 1983 year-classes, and these were all affected by severe summer droughts in which stream temperatures were exceptionally high. As the model shows, high temperatures as well as low temperatures inhibit growth. Figure 43b compares female mortality rates at sea with the estimated smolt weight in each year-class, and shows that mortality was exceptionally high in the year-classes affected by the droughts. Life at sea is hazardous if you are a small smolt!

Such comparisons show how the effects of an adverse environment in one year may be responsible for poor survival at a much later stage in the life cycle. For example, the juveniles

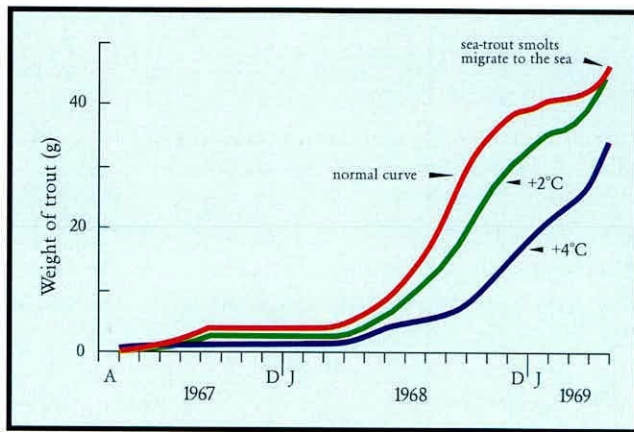


Figure 44. Predicted effects of increased temperature (+2°C, +4°C) on the growth of brown trout.

at the start of the 1979 and 1980 year-classes were chiefly the progeny of females from the 1975 and 1976 year-classes. Female survival was low in both these year-classes, presumably because of the small size of the smolts (see Figure 43), and therefore egg and juvenile production was poor. By the time these fish had become adults and returned from the sea, the drought of 1976 had been forgotten and any poor catches would be attributed to a variety of causes. Little is known about the delayed effects of poor years for growth and survival, but the development of predictive, realistic models will lead to a greater comprehension of these effects and reduce rather pointless speculation!

### Fortune telling

The model can also be used to answer "What if .....?" questions. Figure 44 shows what would happen to trout growth if there was an increase in water temperature due, for example, to climate change. The "normal curve" for the 1967 year-class in a Lake-District stream is compared with growth curves for rises of 2°C and 4°C. Smolt weight would be slightly below normal for + 2°C but markedly less for + 4°C. As shown earlier, the smaller size of the trout at the end of the summer would affect their survival. The increases in temperature could therefore lead to a reduction in numbers as well as growth rates.

The model can be used in similar fashion to test various scenarios such as warmer winters with cooler summers or vice-versa, and earlier emergence of juveniles because of milder winters. Although debates about climate change continue, temperature changes could be due to many causes such as the construction of a reservoir, water transfers between rivers, afforestation or deforestation. The development of the new growth model and similar models facilitates the prediction of the possible effects of such changes on the fish populations **before** the change occurs with irreversible damage.



Figure 45. A cyanobacterial bloom in Windermere

## The response of cyanobacterial blooms to increased concentrations of atmospheric CO<sub>2</sub>

### Introduction

An increase in the concentration of atmospheric CO<sub>2</sub> is the most certain feature of global change which can be attributed to the activities of Man. The concentration of CO<sub>2</sub> has already increased from about 270 ppm in pre-industrial times to 360 ppm today and is predicted to reach 700 ppm before the end of the twenty-first century. However, many fresh waters are partially decoupled from the concentration of atmospheric CO<sub>2</sub> because the rate of physico-chemical transfer across the air-water interface can be slow in relation to biological transformation within the water.

Many cyanobacteria (blue-green algae) are buoyant and can form blooms or scums just beneath the water-surface (Figure 45). In this position they may obtain CO<sub>2</sub> diffusing in from the air above as well as from the water below. Furthermore, because a bloom of cyanobacteria contains a high density of cells, rates of carbon-uptake may outstrip rates of resupply. This will lead to carbon-depletion within the bloom which may be alleviated by increased atmospheric concentrations of CO<sub>2</sub>.

### From the macro- to the micro-scale: measurements with microelectrodes

The contribution of air and water to the supply of inorganic carbon for photosynthesis was quantified using microelectrodes to measure profiles of conditions and rates of gross photosynthesis within an artificial bloom of cyanobacteria exposed to different atmospheric concentrations of CO<sub>2</sub>. The work was undertaken with Dr Bas Ibelings, School of Biological Sciences, University of Bristol.

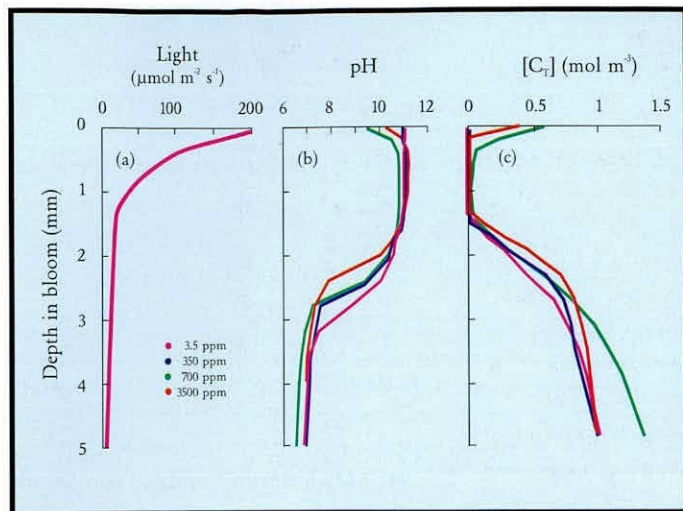


Figure 46. Depth profiles of: a) light (400-700nm), b) pH and c) the concentration of total inorganic carbon (C<sub>T</sub>) in an artificial bloom of cyanobacteria with four different atmospheric concentrations of CO<sub>2</sub>

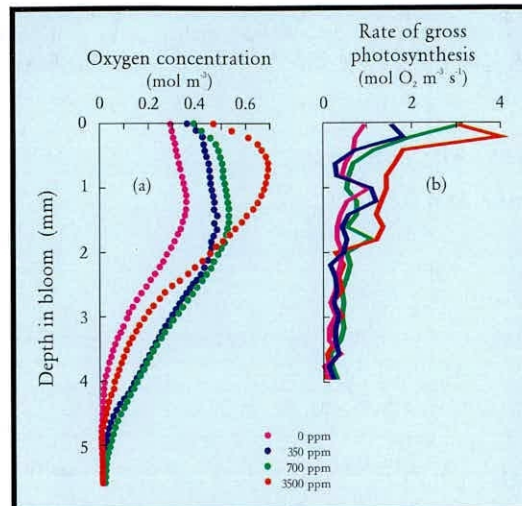


Figure 47. Depth profiles of: a) oxygen concentration and b) rates of gross photosynthesis in an artificial bloom of cyanobacteria with four different atmospheric concentrations of CO<sub>2</sub>

Light was rapidly attenuated within the bloom (Figure 46a). pH was high within the upper layers of the bloom, although it was lower immediately below the water surface (Figure 46b). The concentration of total inorganic carbon (C<sub>T</sub>), calculated from pH, was close to zero in the illuminated section of the bloom but increased towards the surface and at depth in the water where light was nearly absent and so net uptake of inorganic carbon impossible (Figure 46c).

The concentration of oxygen followed the opposite pattern to that of C<sub>T</sub> (Figure 47a). Rates of gross photosynthesis were estimated from measurements of the rapid change in oxygen concentration at light-dark transitions. Gross photosynthesis in the upper layers of the bloom increased with the atmospheric concentration of CO<sub>2</sub> (Figure 47b) which resulted in greater rates of production per unit area at high atmospheric CO<sub>2</sub> (Figure 48).

### Modelling the response, predicting the future

The rate of supply of inorganic carbon to the bloom was modelled simply from calculations of rates of flux of

CO<sub>2</sub> from the air and the water using appropriate coefficients for gas-transfer and diffusion. The measured rates of gross photosynthesis were reasonably predicted from this simple supply-model (Figure 48). The model suggests that the atmosphere is the major source of inorganic carbon to a bloom even when atmospheric concentrations of CO<sub>2</sub> are low.

The measurements and the model show that cyanobacterial blooms can be strongly limited by the supply of

inorganic carbon. In a natural bloom the supply from the water will be restricted further as concentrations will typically be less than in our experiments. Under these conditions the atmospheric supply is likely to become even more important and increased atmospheric concentrations will increase productivity. Whether or not this will increase the incidence of cyanobacterial blooms, however, will depend on the availability of other potentially limiting factors such as light and nutrients.

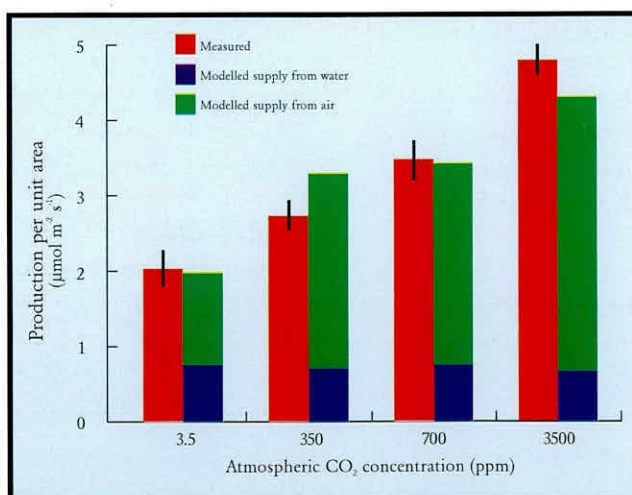


Figure 48. Rates of production per unit area measured and modelled from fluxes from air and from water for an artificial bloom of cyanobacteria with four different atmospheric concentrations of CO<sub>2</sub>

# Laboratory Services

## The library and information service

### The library

The number of items catalogued for the library rose by 20% during the reporting period to 12,800. The computerised catalogue (from January 1987 to present - 93,000 records at the end of March 1995) was loaded on the local area network (LAN) at Windermere and is now available to all staff on this site. In 1995/96 we hope to make this available to staff at the regional laboratories.

Sheila Scobie left the River Laboratory library in May 1994. Stephanie Smith joined the staff at East Stoke in September and undertakes library work for one day per week.

### The information services

NCS assisted us with the purchase of a CD-ROM jukebox which enabled us to make two further information retrieval databases - Aquatic Sciences and Fisheries Abstracts (ASFA) and Water Resources Abstracts - available to the Windermere staff over the LAN. We hope to make the ASFA database available over the River Laboratory LAN in 1995/96.

We continued to run current awareness profiles against Current Contents each week for staff on all IFE sites.

Two major proposals relating to electronic document delivery were put forward to the Higher Education Funding Council. Unfortunately neither bid was successful.

### National and International Networks

The provision of input to ASFA was again improved and 650 articles were

added. This still leaves a considerable backlog which will be tackled next year.

Anne Grosse, a student with the University of Human Sciences of Strasbourg, joined the library team for a two month practical training period. This is the fifth consecutive year that the library has cooperated with a French university in providing such placements.

## Electronics and instrumentation

### The development of an automated network of water quality monitoring stations in a series of European lakes.

Significant progress has been made in the first full year of this major three-year project (part-funded by the European Union under its 'LIFE' programme). All the core sensors and sub-systems have been evaluated and selected. An embryonic system is installed at Esthwaite Water enabling meteorological data to be retrieved by telephone modem and, in a related project for the NRA, the thermal structure of Bassenthwaite Lake was continuously recorded at a buoy station and data retrieved to the laboratory by telephone and low power radio telemetry link.

### Smolt counter

A prototype automatic smolt counter was constructed for use at the River Laboratory. Following promising initial tests, it is intended to enhance the unit during the coming year.

### Major installations

A large amount of electrical installation work resulting from building alterations at the River Laboratory has been carried out.

## Property, buildings and equipment

Due to the changeover in personnel within the support services, any changes throughout the laboratory have had to be kept to a minimum. Improvements in our security, fire and safety standards continued with minor changes to weekend provision.

One of the major concerns this year was the closure of the Lartington site. With a lot of work and assistance from Dr D T Crisp, this was finally completed by November and the site handed back to Northumbrian Water.

Open Days occurred this year, producing the usual logistic problems of keeping the laboratory running whilst preparing the site for our visitors, and extra work for the workshop in fabricating last minute items for the exhibitions.

In the grounds, a number of trees were found in need of urgent attention, particularly over the hatchery tanks. Because of bad weather this was delayed until February but fortunately no damage was done to the tanks or the fish.

Preparations for the re-roofing of the Pearsall Building were started, but this project was put on hold for the rest of the year. This should now take place during 1995/96.

To allow the ICP-MS machine in Chemistry to run overnight a bulk storage tank for liquid argon has now been installed.

# Staff and External Activities

## Staff changes

1994/95 saw the retirement of three long-serving members of staff. Mr S C Shinn retired as gardener, water keeper at the River Laboratory after 28 years loyal service, Mrs J P Lishman retired from the Windermere Laboratory at the end of 27 years as a highly-accomplished analytical chemist and Mrs J V Roscoe, who was appointed to the staff in 1970, retired from the Windermere Laboratory following valuable contributions in the fields of microbiology, algology and data-base management. We are most grateful for their long-term commitment to the Institute and for their skilled work over many years.

Dr P A Carling left to take up a Chair in the Geography Department of the

University of Lancaster. We intend to build on our existing strong links with the University and continue to work with Professor Carling on future collaborative research projects. Other staff to leave the Institute in 1994/95 were Miss R J Bainbridge (Caterer), Mr N J Grieve (Scientific Officer), Mrs G Machin (Receptionist) and Mrs V A Muzalewski (Personal Secretary). Our best wishes are extended to all of them in their future careers.

New appointments during the year (see photographs on pages 30 and 31) were Mr F H Denison (Assistant Scientific Officer), Mrs S M Dent (part-time Receptionist), Mr N H Dorsett (Administrative Officer), Dr G P Irons (Higher Scientific Officer), Mr A J Lawlor (Scientific Officer),

Mrs J C Rhodes (part-time Receptionist), Mrs S Smith (part-time Administrative Assistant), Mrs A E Taylor (Administrative Officer), Miss M S Warwick (Higher Scientific Officer) and Mr M R Wright (Scientific Officer). To all these new staff we extend a warm welcome to the Institute.

## Honours and promotions

Dr C S Reynolds was awarded the Ecology Institute Prize 1994 for his outstanding contribution over many years to our understanding of limnological processes and for the application of this knowledge in the development of science-based models and for the management of lakes and reservoirs. This prestigious award endorses the extremely high quality of Dr Reynolds' research and is a fitting tribute to his dedication and ability. Congratulations are also due to Dr R H K Mann for the award of the degree Doctor of Science from the University of Leicester, in recognition of his important research in the field of fisheries science and to Dr P D Armitage who was awarded the Percy Sladen Memorial Fund Travel Grant to support his visit to Tenerife. Miss K M Atkinson's exemplary work for the IPMS was recognised by the well-deserved Long Service Award from the union. During the year promotion was achieved by Mrs M A Hurley and Dr T G Pottinger (Grade 7), Mr D V Leach (HSO) and Mrs H E H Mallinson and Mr A C Pinder (SO). These awards, honours and promotions during 1994/95 underline the high quality of the IFE staff and their work.

## NERC activities

As appropriate for an Institute at the forefront of its field of research, IFE staff continued to play key roles in



Mr S C Shinn



Dr P A Carling



Mrs J P Lishman



Mrs J V Roscoe

the administration of NERC research programmes. Dr P A Cranwell was a member of the Organic Geochemistry Mass Spectrometry Advisory Committee, Dr W A House participated in the RACS(R) coordination meeting of LOIS and Dr A F H Marker was a member of the Chemical and Biological Coordination Group and Dr E W Tipping a member of the Management Committee for the same programme. Dr S C Maberly acted as secretary and Dr Reynolds as member of the Special Topic on Testable Models of Aquatic Ecosystems and Drs R W Pickup and House served on the Freshwater Sciences Research Grants and Training Awards Committee. Dr D G George was a member of the TIGER IV Working Group, the Large Scale Processes Review Panel and also contributed extensively to the Environmental Change Network Freshwater Committee. Dr L C V Pinder and Prof A D Pickering were also members of this group. Dr Reynolds was a member of the PRIME Committee, Prof Pickering served on the Steering Committees of the Wildlife Diseases Special Topic and the Catchment Ecosystem Research Initiative and Dr Tipping participated in a joint NERC/MRC meeting on Environment and Health.

On the more technical/administrative side, Miss Atkinson was a member of the Schools Liaison Officers Group, Mr M A Rouen represented the IFE at the CEH Computing Group and the NERC Computer Users Committee and Prof Pickering was a member of Promotion Panel 1, the NERC Fact-Finding Mission to ISPRA and the CEH Management Board.

### Collaboration with other NERC Institutes

Extensive collaboration was developed with most Institutes including the other component Institutes of the Centre for Ecology and Hydrology (IH, ITE and IVEM). Dr G H Hall

continued his research on the disposal of oiled beach materials with ITE (Merlewood) and BGS, Dr A E Bailey-Watts and colleagues worked with ITE (Banchory) on lacustrine food webs in the Dinnet Lochs and Dr D T Crisp collaborated with IH (Plynlimon) as he pursued his studies of the effects of afforestation on fish populations. Dr Tipping studied the potential impacts of climate change on the processing of organic carbon in upland soils in collaboration with ITE (Merlewood) and also worked with IH (Wallingford) on the LOIS programme. The new Integrating Fund will do much to extend this type of collaboration within CEH during the coming year.

Collaboration with our colleagues in the marine community were also extremely successful during 1994/95. Dr J G Day maintained his close association with his counterpart at the Culture Collection of Algae and Protozoa (CCAP) in Dunstaffnage Marine Laboratory (DML), Mr K J Clarke worked on the ultrastructure of free-living bacteria with the Plymouth Marine Laboratory and, working with the same organisation, Dr George extended his fruitful collaboration on the impacts of the Gulf Stream on lake processes. This work also involved terrestrial ecologists at the Unit of Comparative Plant Ecology in Sheffield. Extending our collaboration even further, Mr Clarke undertook a study of the fine structure of bacteria with colleagues at the British Antarctic Survey.

### Scientific societies

As expected of innovative scientists at the forefront of their fields, IFE staff continued to play a full role in the work of a wide range of scientific societies. Dr Pickup acted as convener for the Environmental Microbiology Group of the Society for General Microbiology, Dr Tipping as board member of the International Humic

Substances Society and Dr I J Winfield as council member of the Fisheries Society of the British Isles and council member for the North West Branch of the Institute of Fisheries Management. Mrs Hurley continued her appointment on the committee of the Lancashire and Cumbria Group of the Royal Statistical Society and Dr Maberly was a member of the committee of the British Psychological Society. Dr F H Dawson played a full role on several of the committees of the Institute of Biology, Prof J G Jones was a member of the Environment Committee and Prof Pickering acted as Workshop Leader at a symposium on Environmental Impact from Increased Access to the Countryside for the same organisation. Mr I Pettman chaired the Britain and Ireland Association of Aquatic Sciences Libraries and Information Centres and was the UK representative for the equivalent European organisation. Maintaining the flow of information, Mr I McCulloch continued to serve as secretary to the Association for Information Management (Northern Branch) and Dr Day edited the newsletter for the UK Federation of Culture Collections.

### Other organisations

Drs J M Elliott and Marker both worked on the DoE Standing Committee of Analysts (Biological Methods) and Dr Elliott also represented the FBA on the steering group for the Catchment Ecosystem Research Initiative (Prof Pickering represented the IFE on this group and also contributed to one of the Technology Foresight Regional Delphi Working Groups). Prof Jones played a full part in a range of organisations including the DTI LINK Programme Management Committee (Biological Treatment of Soils and Water), NERC committees for TIGER and LOIS, the Baikal International Centre for Ecological

## STAFF AND EXTERNAL ACTIVITIES

Research Management Committee and the Lakes Consultative Committee. IFE staff were also represented on the NRA's Regional Fisheries Advisory Committees - Dr M Ladle for Wessex, Dr Crisp for Northumbria and Yorkshire. Dr Ladle was also very active in other local organisations, being chairman of the Fleet Study Group, chairman of the Frome Conservation Trust and a member of the Somerset Wildlife Trust committee. From his base in Scotland, Dr Bailey-Watts played a role on the British Consultants Bureau Africa Committee and, closer to home, Mr A A Lyle served as a member of the Loch Lomond Research Group. Dr Dawson continued his valuable collaboration with the NRA by serving on their Technical and Advisory Group on River Habitat Classification and Dr House served on DoE's Technical Committee on Detergents and the Environment and on the ADAS Phosphorus Working Group. Dr Armitage was a national member of the Biological Methods Committee of the British Standards Institute and Mr M T Furse acted as advisor to the NRA River Habitat Working Party and took his place as a member for the DoE's project on Countryside Information Data Management. Endorsing the taxonomic expertise in the IFE, Dr J F Wright continued as a member of the Natural History Museum Identification Qualification Advisory Board and also served on the Moors River Standing Committee. Dr Reynolds played a full role as a member of the Office of Water Services for the North West and, once again, served as an elected member of the South Lakeland District Council. An important contribution to local government was also made by Miss Atkinson who continued her appointment by the Secretary of State as a Member of the Lake District National Park Authority and chaired its Planning Policy Committee.

### Editorial commitments

Dr B J Finlay continued to edit *Archiv für Protistenkunde*, Prof Jones was editor for two publications, *Advances in Microbial Ecology* and *Freshwater Forum* and Dr Winfield was invited to edit the *FSBI Annual Symposium* and the *IFM Annual Study Course*. Dr Elliott co-edited the *Proceedings of the International Charr Symposium, Trondheim 1994* and Dr Reynolds co-edited *Archiv für Hydrobiologie*. The *Journal of Fish Biology* had three assistant editors from the IFE, Drs Mann, Pottinger and Winfield, thereby underlining the strength of this area of science within the Institute. The following members of staff also served as associate editors or members of the editorial board for a range of other scientific journals.

Dr P D Armitage - *Regulated Rivers, Research and Management*  
*Netherlands Journal of Aquatic Ecology*

Dr P A Cranwell - *Organic Geochemistry*

Dr B J Finlay - *Microbiology, Microbial Ecology, European Journal of Protistology, FEMS Microbiology Ecology*

Dr W A House - *Internationale Revue der gesamten Hydrobiologie*

Dr S C Maberly - *Aquatic Botany, Internationale Revue der gesamten Hydrobiologie*

Dr L May - *Internationale Revue der*

*gesamten Hydrobiologie*  
Mr I Pettman - *Environmental Management and Health*  
Prof A D Pickering - *Diseases of Aquatic Organisms*  
Dr R W Pickup - *Microbiology*  
Dr C S Reynolds - *Journal of Plankton Research, Limnologia Aquatic Sciences*  
Dr E W Tipping - *Environmental Technology*

Additionally, all senior scientific staff within the Institute played their full role in refereeing numerous articles and papers for other international journals.

### Collaboration with Universities

#### Teaching

Prof J Hilton was a Visiting Professor at the University of Reading, Prof Jones a Visiting Professor at the University of Liverpool, Prof Pickering a Professor Associate at Brunel University and Dr Tipping a Visiting Reader at the University of Lancaster. Dr Pickup and Dr Winfield were Visiting Lecturers at Lancaster University, Dr Crisp acted as a part-time Lecturer at Durham University and Mr Furse was an external tutor at Lancaster University. Drs Bailey-Watts and Pickup were Honorary Visiting Research Fellows at the Universities of Edinburgh and Liverpool, respectively.



Mr N H Dorsett  
(Administrative Officer)



Mr F H Denison  
(Assistant Scientific Officer)



Dr G P Irons  
(Higher Scientific Officer)



Mrs S M Dent  
(part-time Receptionist)

Seminars were given by IFE staff at the following universities :- Bournemouth (Dr Wright), Edinburgh (Dr Bailey-Watts), Lancaster (Dr George, Prof Pickering), Napier (Dr Bailey-Watts), Plymouth (Dr George), Reading (Dr Wright). Staff also fulfilled duties as external examiners for PhD students and for MSc courses at the Universities of :- Konstanz (Dr Finlay), Lancaster (Dr Tipping, Dr George), Manchester (Dr Finlay) and Trondheim (Dr Elliott).

**Research**

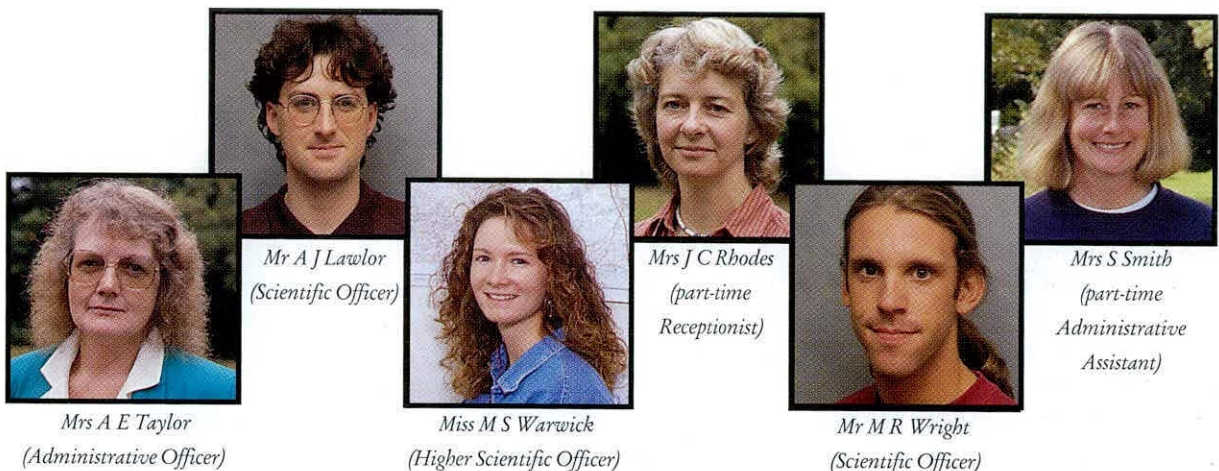
In addition to the above teaching commitments, 1994/95 saw a continuation of the extensive research collaboration between the IFE and Universities throughout the UK, Europe and further afield. Dr Armitage collaborated with colleagues at Umea, Sweden on studies of chironomids and Dr Bailey-Watts continued his links with Lancaster in the study of plankton communities in Loch Ness. He also worked with Robert Gordon's University on Loch Leven phytoplankton, with Dundee on cyanobacterial ecology and toxicity and with University College, London on nutrient analysis and eutrophication. With Dr Sinn-Chye Ho (University Sains, Malaysia), Dr Day has collaborated on the development of a diagnostic expert system for the culture of algae and Dr Elliott has worked with Dr R J Fryer (SOAFD, Aberdeen) on the

modelling of fish growth. In order to develop automated techniques for pesticide analysis, Mr I S Farr visited the University of Amsterdam to consult appropriate experts. Dr Finlay maintained his Danish links and collaborated on the Mariager Fjord Expedition and Mr Furse continued his joint research with the University of Valencia, Spain. He was also adviser to the Laboratorio Regional de Engenharia Civil in Portugal. Closer to home, Dr Hall continued his close collaboration on the TIGER programme with Liverpool and Warwick and, working on another important thematic programme, LOIS, Mr D V Leach linked with the Universities of Exeter, Hull and Durham. Working within the same programme, Dr Tipping collaborated with Lancaster and Plymouth. Maintaining his overseas network of contacts, Dr Maberly worked with collaborators from Germany, Denmark, the USA as well as with Bristol University. Dr Pinder hosted a visit from the University of Lodz, Poland to work together on epiphytic chironomids. Dr Pickup was successful in his collaboration on a total of four NERC grants with Liverpool and Newcastle Universities as was Dr Pottinger with Brunel University. Additionally, Dr Pottinger also extended his collaboration to Nijmegen, Holland as part of his research programme on the factors influencing the responsiveness of fish

to environmental stress. Finally, Dr Wright worked with colleagues in Spain and Poland on the possible application of the RIVPACS methodology to European rivers and with partners in Germany, Holland and France on future EU proposals.

Members of staff also acted as supervisors for students registered for PhD degrees:-

- Mr G Biagini (Cardiff, CASE) Metabolic pathways in free-living anaerobic protozoa (Dr Finlay)
- Mr C Brereton (London, CASE) The role of silt and mucus secreted by invertebrates in retaining organic matter over the substratum of streams (Drs Armitage and House)
- Miss A M Brookes (Southampton, FBA) An investigation of the influence of landscape variables on stream macroinvertebrates using a geographical information system (Mr Furse)
- Mr S Ball (Lancaster, CASE) The role of picophytoplankton in lakes of different trophic state (Dr Maberly)
- Miss S Brown (Liverpool, part-time) The molecular systematics of naked amoebae (Dr Finlay)
- Miss C Cannan (Southampton) Extrapolation of reach level channel and riparian habitat information to catchment scale (Dr Armitage)





## STAFF AND EXTERNAL ACTIVITIES

- Mr F L Charlton (Edinburgh, CASE)  
Remote sensing of freshwater phytoplankton (Dr George)
- Mr D Clarke (Exeter, CASE)  
Microthermal habitats in British rivers (Drs Crisp and Ladle)
- Mr S Clough (Leeds, Esmée Fairbairn Trust (FBA)) Composition, distribution and dynamics of populations of river fish (Dr Ladle)
- Miss P S Davies (Leeds, TESCO (FBA)) Phosphorus dynamics in limnetic ecosystems (Dr Reynolds)
- Mr D Deere (Liverpool, CASE)  
Identification of bacteria by flow cytometry (Dr Pickup)
- Miss N J Fielding (Liverpool, NERC Targeted) Algal nutrient cycling in brackish lagoonal systems: mechanisms to control algal development in isolated dock complexes: top-down control (Dr Maberly)
- Mr R A Fleck (Dundee) Assessment of cell damage and recovery in cryopreserved freshwater protists (Dr Day)
- Miss A S Fulcher (Lancaster) The physiological ecology of the rotifer community in the plankton of Loch Ness and the Cumbrian Lakes (Dr May)
- Mr P Garner (Birmingham, FBA)  
Fluvial effects upon the recruitment of 0+ cyprinids (Dr Mann)
- Miss S Griffiths (St Andrews, CASE)  
Schooling dynamics of dace in the River Frome (Dr Ladle)
- Miss A Hartley (Birmingham, CASE)  
Microelectrode studies of calcification and gas exchange within hardwater algal biofilms (Dr House)
- Mr R Hastings (Liverpool, NERC)  
Distribution of nitrifying bacteria in lakewater and sediments (Dr Pickup)
- Miss E Hawtin (Birmingham)  
Chironomids in lowland rivers in relation to water quality and physical habitat (Dr Pinder)
- Mr R M Head (Lancaster, CASE) The role of sediments in blue-green algal blooms (Dr Bailey-Watts)
- Mr P Irving (Oxford, CASE) The origins and evolutionary significance of Schreckstoff (alarm substance) in minnows (Dr Ladle)
- Miss L A Jones (Brunel, NERC)  
Effects of alkylphenols and related chemicals on gonad development and sex determination and gamete quality of trout (Dr Pottinger)
- Miss W Lester (Reading, CASE) The distribution and fate of micro-organic pollutants in river sediments (Dr House)
- Miss J Long (Reading, LOIS Special Topic) Contribution of river sediments to the translocation of pesticides (Dr House)
- Miss S J Marshall (Cardiff, CASE)  
Roles of natural surfactants in pollutant biodegradation in biofilms in river sediments (Dr House)
- Miss S McGowan (Liverpool, CASE)  
Palaeolimnology of blue-green algal bloom formation (Dr E Y Haworth)
- Mr I Miskin (Liverpool, CASE)  
Identification and distribution of bacteria and their plasmids in sediments (Dr Pickup)
- Miss S A Owen (Cardiff, CASE)  
Sorption and biodegradation of pesticide/surfactant formulations in biofilms on river sediments (Dr House)
- Miss J Reeve (Canterbury, Development Programme)  
Polycultures of aquatic plants - nutrient removal from waste waters (Dr Dawson)
- Mr G Rhodes (Liverpool, CASE)  
Molecular evolution of plasmids in deep sediments (Dr Pickup)
- Mr M Scott (Manchester, CASE)  
Climatic effects on the export of dissolved organic matter from peat (Dr Tipping)
- Mr R Skidmore (Durham) The effect of environmental conditions on the plankton production dynamics in the feeder rivers of the Humber Estuary and the flux of autochthonous carbon to the estuary (Dr Marker)
- Mr S Walker (Aberystwyth, FBA)  
Otolith structure as a possible indicator of stress in fishes (Drs Winfield and Pottinger)
- Miss V Wanstall (Liverpool, NERC Targeted) Algal nutrient cycling in brackish lagoonal systems: mechanisms to control algal development in isolated dock complexes: bottom-up control (Dr Maberly)
- Miss C Whitby (Liverpool, CASE)  
Nitrification in freshwater systems (Dr Pickup)
- MSc Students from the Universities of Edinburgh, Lancaster, John Moores (Liverpool) and Reading were supervised by Drs George, May, Dawson, Bailey-Watts and Pickup. Mr Clarke continued supervision of a student from the University of Girona, Spain on the subject of new species of green, photosynthesising bacteria and their associated microorganisms.

During the year the following research student was awarded the degree of Doctor of Philosophy: Mr N Hesketh, Manchester University.

### International meetings and visits

Dr Armitage presented a paper at the Sixth International Symposium on Regulated Streams in the Czech Republic, gave an illustrated talk in Tenerife on the collection of chironomids and visited the Basque Government to advise them on ecologically acceptable flows in rivers. Dr Bailey-Watts travelled extensively during 1994/95. He gave seminars in Japan to the staff of the Lake Biwa Research Institute and to the staff and students of Kyoto University on eutrophication studies at the IFE, to the Centre for Research and Production in Fisheries, Romania on

nutrient enrichment and the management of cyanobacterial populations and to the University of Galati, Romania on phytoplankton ecology. Travelling east again, Dr Bailey-Watts also gave talks and seminars at the Central Inland Capture Fisheries Research Institute in Barrackpore, West Bengal.

Miss Brown visited The Institute of Hygiene and Epidemiology, Brussels to further her collaborative research on the molecular systematics of amoebae and presented some of the results of her work at the Annual Meeting of the Groupement des Protoplastologues de Langue Francaise in Nice. Dr Dawson travelled to Dublin to present a paper at the Ninth International Symposium on Aquatic Weeds. Maintaining his very strong links with Norway, Dr Elliott was the keynote speaker at the International Symposium on Arctic Charr in Trondheim and was a member of the Visiting Group, convened by the Norwegian Research Council to assess the performance of the Norwegian Institute for Nature Research. Dr Finlay visited Madrid as part of his preparations for an EU Framework bid and took part in the Danish scientific expedition to Mariager Fjord.

Again on EU business, Dr George visited the collaborating partners in the LIFE programme on automated water quality monitoring in lakes at Granada and Dublin, participated in the Lake Acidification Meeting at the University of Innsbruck and contributed to the Northern Sweden Field Workshop. Prof Hilton visited Cork as part of the collaborative programme on biosensor development, and travelled to Antwerp and Malaga for contract meetings on radioecology. Dr House attended an EU meeting in Brussels on the subject of pesticide stability and Prof Jones was invited to the NGO Conference in Suzdal, Russia.

Mr A A Lyle visited Bordeaux to examine shad spawning grounds and to discuss problems of mutual interest with CEMAGREF scientists.

Dr Maberly accepted an invitation to spend some time at the University of Gainesville, Florida to undertake further studies on the utilisation of carbon by phytoplankton and Dr Mann collaborated in a joint study with colleagues in Spain on the ecology of the freshwater fish, *Cobitis paludicola*. Acting as a member of the Organising Committee, Dr May played a major role in the VII International Rotifer Symposium in Poland. Also in Poland, Mr Pettman presented two papers at the Fifth Meeting of the European Association of Aquatic Sciences Libraries and Information Centres at Gdynia. Dr Pickup visited colleagues at the University of Barcelona as part of the preparations for EU Framework IV bids.

Dr Reynolds was again in demand as a keynote/guest speaker at meetings throughout the world, including a NATO Symposium in Italy on microbial processes, an IAWQ Symposium in Holland on selection and the GRIL Symposium in Montreal. The subject of radioecology was the focus of meetings attended by Dr J T Smith in Kiev and Antwerp. Dr E W Tipping was a guest speaker at an OECD meeting on organic complexation of radionuclides in Switzerland and, whilst in the country, gave a seminar at the University of Geneva on organic matter/metal interactions. He also visited Sweden and Norway in preparation for Framework IV

and spent two weeks at the University of Wageningen, Netherlands working on problems of soil acidification. Dr J M Winder also spent time in the Netherlands at a conference of the Association for Environmental Archaeology in Amsterdam. Finally, Dr Wright travelled to Canada to present a paper at the Fraser River Workshop in British Columbia.

