Dynamic properties of forest ecosystems

THE INTERNATIONAL BIOLOGICAL PROGRAMME

The International Biological Programme was established by the International Council of Scientific Unions in 1964 as a counterpart of the International Geophysical Year. The subject of the IBP was defined as 'The Biological Basis of Productivity and Human Welfare', and the reason for its establishment was recognition that the rapidly increasing human population called for a better understanding of the environment as a basis for the rational management of natural resources. This could be achieved only on the basis of scientific knowledge, which in many fields of biology and in many parts of the world was felt to be inadequate. At the same time it was recognized that human activities were creating rapid and comprehensive changes in the environment. Thus, in terms of human welfare, the reason for the IBP lay in its promotion of basic knowledge relevant to the needs of man.

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After a decade of work, the Programme terminated in June 1974 and this series of volumes brings together, in the form of syntheses, the results of national and international activities.

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Dynamic properties of forest ecosystems

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This volume is dedicated to the scientists of the IBP

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Preface

The evolution of IBP has been described in the first volume of this series of 'synthesis' volumes. Whilst the record is complete insofar as it concerns IBP as an entity, it makes few references to discussions and draft plans already in being for international collaboration prior to the emergence of IBP. It is, therefore, worth recalling that proposals for an international study of forest production had been discussed in the late 1950s by Dr H. Ellenberg and Professor J. D. Ovington. It was their hope that a limited number of parameters related to primary production in woodlands could be investigated at various sites in Europe. If this attempt at a standardized approach to woodland production were to prove successful, then it was their intention to extend the program to other parts of the world. Their proposal was welcomed by members of the Commission on Ecology of the International Union for the Conservation of Nature and Natural Resources (IUCN) who realized that the emerging science of production ecology could assist the Commission in its task of advising on methods for the conservation of natural ecosystems. But for the birth of IBP, there can be little doubt that the Ellenberg–Ovington plan would have been implemented by IUCN.

When, in 1960, plans for an IBP surfaced at a meeting of the International Union of Biological Sciences at Neuchâtel the investigation of forest productivity was seen as an essential component of such a program. Furthermore, it was decided that the study of primary production should not be confined to woodlands and forests but should be extended to cover other ecosystems. During the period 1960–3, the proposal was worked out in greater detail by a Committee chaired by Dr H. Ellenberg. It was proposed that the productivity of terrestrial ecosystems should be studied from three major points of view – those of ecology, physiology and conservation – and Dr H. Ellenberg was appointed Chairman of the subcommittee responsible for the ecological approach. It was this committee which later emerged as IBP–Terrestrial Productivity – abbreviated IBP(PT). Up to that point, attention had been concentrated on the measurement of primary production. It was decided to include the role of consumers and a meeting devoted to secondary production was held in Paris in 1963. The outcome of this preparatory phase was a paper prepared by the two 'originals', Dr Ellenberg and Dr Ovington, with me to give an animal biologist's point of view. This working paper was considered during the First General Assembly of IBP (Paris, 1964).

Prior to the Second General Assembly (Paris, 1966) the PT committee reviewed all woodland and forest projects submitted by national com-

mittees. Dr Ellenberg's influence was such that the first fully operational IBP project was at Virelles, Belgium. There a site selected by Dr P. Duvigneaud in consultation with Dr Ellenberg had become operational in 1964. Perhaps I should add that the Virelles project has another claim to fame. It never received any money from IBP sources throughout the whole period of IBP yet its contribution to the development of the Woodland Theme was of considerable importance.

It was in developing the Woodlands Biome program that Dr Ellenberg and Dr Duvigneaud stressed time and time again the need to have *minimum* and *maximum* programs. National committees favoured the 'big science approach (very often with inadequate resources) and the minimum program, which would have extended the range of sites beyond that which actually materialized, failed to gain support. As the list of projects in this synthesis volume shows, there were relatively few projects in the developing world. Gaps, however, were not confined to such areas. In spite of a very extensive proposal submitted to the PT committee in 1964, no major IBP investigation materialized in the coniferous forest zone of Canada.

It is worth recalling the aims of the Woodlands Theme as they were described in IBP News No. 13 (1969): 'The IBP program is concerned with the total production of trees, shrubs and ground vegetation in woodlands, and the flow of primary production to the major consumers, both of the grazing and detritus food chains. Productivity data obtained within IBP will enable comparisons to be made between mixed and single species stands, and between even and uneven aged communities. Studies on the production and energy flow of widely distributed genera such as *Pinus* and *Eucalyptus* will provide information on the variation of performance, structure and functioning of living communities under different environmental and management conditions, thus allowing us to better manage, on a long term, sustained yield basis, our important woodland resources.'

It will be seen that these aims make no mention of the use of systems dynamics techniques although, by the time that they were formulated, a systems approach, under the influence of the USA program, was becoming a way of life in IBP(PT). The Woodlands Biome vied with the Grasslands Biome to establish systems ecology on a sound theoretical basis. The Woodlands Workshop held at Oak Ridge in 1972 demonstrated the great strides which had been made in the functional analysis of ecosystems during IBP. There, non-linear seasonal simulation models were produced for deciduous, boreal coniferous, tropical deciduous, and broad-leaved evergreen forest from some thirty sets of IBP data. The same Workshop also showed that scientists from many parts of the world were prepared to make their results freely accessible to others in the program. This willingness to share unpublished results, to have them criticized and to have them incorporated in the anonymity of global models, has been one of the great achievements of IBP.

The overall aim of IBP – The Biological Basis of Productivity and Human Welfare – demanded that the program should contribute towards the development of rational procedures for managing the biosphere. The Woodlands Biome studies have helped to refine and make more predictive management plans not only for woodland areas but for total landscapes. It is evident from documentation already produced for the Program on Man and the Biosphere, especially the reports dealing with different types of land use, management practices and the impact of human activities on ecosystems, that it must build upon the solid achievements of the Woodlands Biome studies.

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Foreword

The International Biological Programme was a unique experience for environmental biologists – its inception, participation, execution and accomplishments. The IBP was originally conceived to be a scientific program to learn about the Earth's productive capacity for the welfare of mankind. From these early agronomic orientations of yield, participating scientists emphasized the need for understanding the ecological processes governing the productivity of the diversity of world ecosystems. Scientists participated in the IBP sometimes because the IBP had received their national support through the International Union of Biological Sciences, more often because they had funded research projects, and always because they had a deep commitment to the scientific issues and environmental objectives of the IBP.

I first became involved with the IBP in the summer of 1966 while attending an international symposium on the *Productivity of Terrestrial Ecosystems* (Petrusewicz, 1967) at Jabłonna, Poland, that was organized by Professor Kazimer Petrusewicz. His leadership and friendship have been an inspiration to many of us through the years. At this meeting, Professor Paul Duvigneaud and I were elected to co-chair the Woodlands Working Group of the Terrestrial Productivity Section. Professor Francois Boulière served as convenor of the PT Section and Dr Malcolm Hadley as his staff assistant. Without the leadership and dogged persistence of these two, much would not have been accomplished.

Implementation of an international woodlands program began with a workshop in 1968 in Tennessee, USA, published as *Analysis of Temperate Forest Ecosystems* (Reichle, 1970). This was followed by *Productivity of Forest Ecosystems of the World* (Duvigneaud, 1971), a UNESCO symposium held in 1969 in Brussels, Belgium. In 1971 a workshop in Sweden (Rosswall, 1971) refined conceptual approaches and analytical measurements for forest studies. Three workshops were held to facilitate exchange and analysis of data being produced at the nearly 120 international forest research sites. The data files of the first workshop in 1972 in Tennessee, USA, were published as *Modeling Forest Ecosystems* (Reichle, O'Neill & Olson, 1972). From the next workshop in 1974 organized by Professors Ellenberg and Ulrich in Göttingen, Germany, an updated data file was prepared and published as *Data Analysis and Data Synthesis of Forest Ecosystems* (Ulrich, Mayer & Heller, 1974). A common computer format was established, and computer storage and analysis of data was assumed by the Oak Ridge National Laboratory, USA. In 1975 one last workshop was held in Jädraas, Sweden, to update the data files. The results of this sequence

of efforts is the data base upon which this synthesis volume of the woodlands IBP group is based.

Years of research effort, countless miles of travel and numerous meetings by innumerable scientists are the foundation for this volume. A dedicated IBP staff in London provided continuing impetus, as well as coordination with CUP. In 1974 in Göttingen, participants in the Woodlands Group developed the outline for the synthesis effort. Chapter editors were selected to coordinate the contributions of colleagues and to begin the analysis and interpretation of data provided by the 117 research sites in 22 different countries that collaborated in this effort.

This volume, thus, represents the integrated product of all collaborating scientists. This was a unique venture and a courageous effort. The success of the endeavor depended upon the willingness to share and exchange unpublished data. It required different 'schools' of ecology to meld and complement. It necessitated breaking both scientific and language barriers. It helped to usher in a new generation of ecologists and a new kind of ecology. It provided the conceptual and empirical data base for a new wave of international environmental programs. Most importantly, it led to the development of an international community of ecologists whose mutual respect and scientific collaboration continue long after the official end of the IBP.

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References

Duvigneaud, P. (ed.) (1971). *Productivity of forest ecosystems*. UNESCO, Paris.
Petrusewicz, K. (ed.) (1967). *Secondary productivity of terrestrial ecosystems (principles and methods)*. (2 vols.) Panstwowe Wydawnictwo Naukowe, Warsaw.
Reichle, D. E. (ed.) (1970). *Analysis of temperate forest ecosystems*. Springer Verlag, Berlin–Heidelberg–New York.
Reichle, D. E., O'Neill, R. V. & Olson, J. S. (1972). *Modeling forest ecosystems*. EDFB–IBP–73–7. Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA.
Rosswall, T. (ed.) (1971). *Systems analysis in northern coniferous forests – IBP workshop*. Bull. 14 Ecol. Res. Com., Swedish Natural Research Council.
Ulrich, B., Mayer, R. & Heller, H. (1974). *Data analyses and data synthesis of forest ecosystems*. Göttingen Bodenkundliche Berichte 30, Göttingen.