Activities of the National Programmes for Ecosystem and Aquaculture Research, 1983-1985

SOUTH AFRICAN NATIONAL SCIENTIFIC PROGRAMMES REPORT NO 127

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Cover: Coastal dunes are the most dynamic yet sensitive ecosystems in South Africa. They provide an effective buffer along a highly erodable shoreline, support a rich biota and offer spectacular scenery and recreational values if managed within ecological constraints. If urban, industrial or agricultural developments ignore the dynamic properties of dune systems, expensive and often irreparable damage to both property and biota will occur. The rapid pace of development along South Africa's coastline calls for the provision of ecologically sound guidelines for the management of these systems. The National Programme for Ecosystem Research has recently completed and published a detailed synthesis of the structure, dynamics and conservation needs of coastal dunes, providing a scientific basis for the formulation of management policies (see page 29).
Photo: Nahoon Estuary, East London, by P D Morant, National Research Institute for Oceanology.

Compiled by

Mrs E W Auret and the staff of
Ecosystem Programmes
Foundation for Research Development
Council for Scientific and Industrial Research
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PRETORIA
0001

The national programmes of the CSIR's **FOUNDATION FOR RESEARCH DEVELOPMENT** are mechanisms open to participation by all scientists and scientific institutions in South Africa.

The cooperative approach enables scientists from different backgrounds, institutions and parts of the country to work together to identify problems of national importance, to develop concepts, to plan joint action and to synthesize findings. This approach has made it possible to tackle problems which would otherwise have been too large and complex for any one organization or scientific discipline to tackle on its own. It has also provided a stimulus for new approaches in the investigation of environmental problems, for exchange between scientists, for training in previously neglected fields and for basic research in the fields involved, and has improved communication between researchers and the potential users of scientific information.

ABSTRACT

Activities of the National Programmes for Ecosystem and Aquaculture Research of the CSIR Foundation for Research Development are reviewed, within the programmes on Inland Water Ecosystems, Terrestrial Ecosystems, Nature Conservation Research, Human Needs, Resources and the Environment and Aquaculture Research. An outline of the cooperative research activities of each section for the period July 1983 to December 1985 is presented. Several important environmental problems in South Africa amenable to solution through cooperative research by scientists from different disciplines and different scientific institutions have received attention during this period. Topics which have received significant attention and which are described in the report are: the development of limnological guidelines for the management of Southern Hemisphere inland waters; the development of a monitoring baseline for the Kuiseb environment; coastal dune ecosystems of South Africa; the ecology of biological invasions; an evaluation of rural betterment schemes; and needs for aquaculture research in South Africa.

OPSOMMING

Die verslag bevat 'n oorsig van aktiwiteite van die Nasionale Programme vir Ekosisteem- en Akwakultuurnavorsing van die WNNR Stigting vir Navorsingsontwikkeling, onder die afdelings Binnelandse Waterekosisteme, Landekosisteme, Natuurbewaringsnavorsing, Menslike Behoeftes, Hulpbronne en die Omgewing en Akwakultuurnavorsing. 'n Oorsig van die koöperatiewe navorsingsaktiwiteite van elke afdeling vir die tydperk Julie 1983 tot Desember 1985 word aangebied. Etlike belangrike omgewingsprobleme in Suid-Afrika wat hulle leen tot oplossing deur middel van koöperatiewe navorsing deur wetenskaplikes van verskillende dissiplines en verskillende navorsingsinstansies het gedurende hierdie tydperk aandag geniet. In die verslag is spesifieke aandag aan die volgende onderwerpe gegee: die ontwikkeling van limnologiese riglyne vir die bestuur van binnelandse waters in die Suidelike Halfrond; die ontwikkeling van 'n moniteringsbasis vir die Kuisebomgewing; kusduinekosisteme van Suid-Afrika; die ekologie van biologiese indringers; 'n evaluasie van landelike beplanningskemas; en navorsingsbehoeftes vir akwakultuurnavorsing in Suid-Afrika.

ORGANIZATIONS REPRESENTED ON OR FUNDED BY COMMITTEES OF THE NATIONAL PROGRAMMES FOR ECOSYSTEM AND AQUACULTURE RESEARCH

UNIVERSITIES

University of Bophuthatswana
University of Cape Town
University of Durban-Westville
University of Natal
University of Port Elizabeth
Potchefstroom University for CHE
University of Pretoria
Rand Afrikaans University
Rhodes University
University of Stellenbosch
University of the North
University of the Orange Free State
University of the Western Cape
University of the Witwatersrand

MUSEUMS

Albany Museum
Kaffrarian Museum
McGregor Museum
Transvaal Museum
South African Museum

STATUTORY ORGANIZATIONS

Water Research Commission
Human Sciences Research Council
Fisheries Development Corporation of South Africa Limited
Development Bank of Southern Africa
Oceanographic Research Institute
Desert Ecological Research Unit
National Institute for Personnel Research
National Institute for Transport and Road Research
National Institute for Water Research
National Research Institute for Oceanology
National Parks Board
National Botanic Gardens of South Africa
Technical Advisory Committee for Nature Conservation

GOVERNMENT DEPARTMENTS

Department of Agriculture and Nature Conservation (SWA/Namibia)
Department of Agriculture and Water Supply
Department of Constitutional Development and Planning
Department of Development Aid
Department of Environment Affairs
Department of Health and Welfare

PROVINCIAL AGENCIES

Cape Provincial Administration
Provincial Administration of the Orange Free State
Transvaal Provincial Administration
Natal Parks, Game and Fish Preservation Board

NON-GOVERNMENTAL ORGANIZATIONS

Southern African Nature Foundation
South African Ornithological Society
Wildlife Society of Southern Africa
Endangered Wildlife Trust
Various industrial firms

OVERVIEW

1. Rapid development and change in the socio-economic fabric of South Africa will introduce new and challenging demands on the environment. To improve our ability to understand current and predict future interactions between man and his environment, a wide range of cooperative interdisciplinary research programmes have been developed during the last decade by the Ecosystem Programmes division of CSIR's Foundation for Research Development.

2. This report describes activities within the Inland Water Ecosystems, Terrestrial Ecosystems, Nature Conservation Research, Human Needs, Resources and the Environment, and Aquaculture Research programmes. Brief outlines of the goals and approach of each section are followed with highlights on major projects completed during the period July 1983 to December 1985.

3. A key aspect of the approach adopted in these activities is the endeavour to develop close and mutually beneficial interaction between the research and user-agency communities. Both parties are directly involved in the identification of problems and research needs, the review of progress within individual studies, the preparation of syntheses and the formulation of recommendations.

4. In executing the programmes approved by the National Committees for Ecosystem and Aquaculture Research, the cooperating organizations pool manpower and financial resources within new research programmes, while great value is also obtained through the use of workshops, symposia, study visits and desk syntheses to integrate existing knowledge.

5. Within the Inland Water Ecosystems Programme emphasis has been placed on examining factors influencing water quality in large impoundments. The need for a broad-based approach, embracing the judicious management of whole catchments, has become obvious. Studies in the limnology and hydrology of impoundments on the Mgeni River provided background to a major symposium and workshop on the water quality management needs of this system (p 5).

6. Due to the preponderance of limnological research and management experience having been developed in the Northern Hemisphere, much of what is practised in South Africa is based on studies undertaken in geologically, climatically and ecologically different systems. The mass of information available on Northern Hemisphere inland waters was reviewed and compared with Southern Hemisphere systems at a conference convened by the Committee for Inland Water Ecosystems in 1984. The two volumes which resulted from the meeting (p 9) provide new insights into the understanding and management of inland waters, and conclude that differences between the two hemispheres are of much less significance than anticipated.

7. The Committee for Terrestrial Ecosystems has developed a network of biome-based projects which currently involve over two hundred researchers in the savanna, grassland, karoo, fynbos and forest biomes. All attempt to develop a predictive understanding of how these systems function, as a basis for wise land-use.

8. During the early 1970's the development of a major uranium mine in the central Namib placed greatly increased water demands on the Kuiseb River basin. A multidisciplinary study was initiated to develop a baseline against which to monitor changes that water extraction could have on the sensitive desert ecosystem. The project has been completed (p 15) and has led to the agreement by the relevant authorities in South West Africa/Namibia to a series of recommendations aimed at ensuring the future of the Kuiseb basin ecosystem.

9. The successful culmination of a vegetation mapping and classification activity within the Fynbos Biome Project has enabled various inventory and conservation status assessments to be undertaken within an acceptable framework of vegetation divisions. As a result, almost all the questions asked at the outset of the Project, such as those relating to the extent of and major boundaries within the biome, and the extent of vegetation affected by alien plants, urbanization, grazing etc, have been answered (p 19).

10. Since the establishment of the Council for the Environment in 1982, increased demands have been made on researchers to provide guidelines on the optimal management of South Africa's environment. The Nature Conservation Research Section has already made major contributions in this regard, publishing standard reference works on threatened plants and animals, threatened habitats, the management of large mammals and the assessment and control of alien plant invasives.

11. At the initiative of South African scientists, an international research programme on the Ecology of Biological Invasions was launched in 1982 by SCOPE (Scientific Committee on Problems of the Environment). Experience in the biological control of alien plants already available in South Africa has been considerably expanded through an ambitious series of workshops, symposia and new research aimed at developing a substantial review of the alien biota problems in South Africa (p 27).

12. Coastal dunes cover over eighty per cent of South Africa's 3 000 km coastline. They are highly vulnerable to misuse and where they have been subject to careless development the resultant dune mobility has often led to major expense to local authorities. Besides their obvious recreational and real-estate value, coastal dunes are occupied by a wide diversity of plant and animal species, and include some regionally unique biological communities. A detailed synthesis of the geography and ecology, and conservation and management needs of South African coastal dune systems has been published (p 29) and will serve as the scientific basis for the development of guidelines for decision takers with responsibilities in the very sensitive coastal zone.

13. The Human Needs, Resources and the Environment Programme, previously administered by FRD, was transferred to the Human Sciences Research Council in 1985. The overall goal of the programme - to develop the capacity to assist in the understanding, measurement and prediction of the factors involved in the achievement of balanced socio-economic development and the satisfaction of human needs - remain unchanged.

14. Rural development has been frequently unsuccessful in South Africa due to a wide range of socio-economic and other factors. An evaluation of two rural "betterment" schemes illustrates the nature of the problems encountered and outlines the basic causes of the failure of attempts to improve the quality of life of the rural poor (p 36).

15. During 1982 a National Programme for Aquaculture Research was established to provide the research and development base for the industry in South Africa. An extensive series of workshops and symposia has led to the preparation and initiation of a detailed research programme (p 41).

16. This report can only cover a few of the major achievements of the National Programmes for Ecosystem and Aquaculture Research. An indication of the breadth of issues covered in the programmes is, however, provided in the series of abstracts of reports published in the South African National Scientific Programmes Reports Series (p 46) which reflect some of the results of successful cooperation between the personnel of universities, museums and user agencies.

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INTRODUCTION

The National Programme for Ecosystem Research has as its central aim "the development of a predictive understanding of the structure and functioning of South African ecosystems". This aim is furthermore directed towards developing the capacity to provide decision takers with reliable information and predictions on the environmental consequences of actions that may be taken within regional and national development plans. The National Programme for Aquaculture Research aims at enhancing the research and development base necessary for the development of the aquaculture industry in South Africa.

In order to attain the above goals, the national programmes not only fund over 135 individual research projects within universities, museums and other research institutes, but more importantly play a leading role in initiating, stimulating and coordinating interaction between scientists and user agencies. Through the medium of symposia, workshops, joint field projects, the preparation of national or international syntheses of scientific knowledge, visits to and from overseas laboratories, etc, the programme has succeeded in involving the vast majority of environmental researchers and decision takers in these programmes. The "invisible college" created by the national programmes provides an extremely strong body of expertise without a costly infrastructure. The voluntary contributions of numerous individuals to the endeavours of the national programmes far outweigh the direct costs of the activities - while the dynamic interaction between researchers and decision takers provides an immediate relevance to scientific projects.

The interactive national programme approach is a powerful tool in communicating environmental understanding at a time when the transfer and implementation of technology is regarded as essential for socio-economic development.

The National Programme for Ecosystem Research was initiated in 1972 and currently includes sections on Inland Waters, Terrestrial Ecosystems and Nature Conservation Research. This report also includes a review of the Programme for Human Needs, Resources and the Environment, which was administered by the National Programme until the end of March 1985, whereafter it was transferred to the Human Sciences Research Council.

The National Programme for Ecosystem Research is administered by the National Committee for Ecosystem Research (Chairman: Mr J P de Wit, Deputy President, CSIR). Funding for research is provided by the CSIR, the Department of Environment Affairs, the Water Research Commission, and Provincial Administrations.

The National Programme for Aquaculture Research is administered by the National Committee for Aquaculture Research (Chairman: Mr J P de Wit, Deputy President of the CSIR) and is funded by the CSIR.

A wide spectrum of international activities have been developed through the National Programme for Ecosystem Research, particularly in association with SCOPE (ICSU Scientific Committee on Problems of the Environment), SIL (International Association of Limnology), IUCN (International Union for the Conservation of Nature and Natural Resources and IUBS (International Union of Biological Sciences). These activities are described in this report.

A great diversity of research, review and synthesis activities have been undertaken during the period under review, and it is only possible to highlight a few of these. A number of these highlights have been extracted from reports in the South African National Scientific Programmes Report Series, and the reader is referred to these reports (of which abstracts appear on pages 46 - 55) for a more complete coverage of these topics.

INLAND WATER ECOSYSTEMS

INTRODUCTION

The rapid economic and population growth of South Africa and the extended drought which has been experienced during the past number of years emphasize the need for an adequate supply of high quality water in the long term. The demand for water in many well-developed industrial areas currently exceeds the supply. Furthermore, the discharge of sewage and industrial effluents into aquatic ecosystems has been the cause of innumerable ecological and water quality problems.

Increased mineral, nutrient and sediment loads, and radical changes in flood regime have been identified as the most important issues to be addressed. It has also been recognized that these problems can only be studied and resolved successfully if rivers and other water resources are reviewed within a wider ecological and socio-economic context. The major beneficial consequences of water resource development are a direct improvement in the health and welfare of the people of South Africa, increased recreation potential created by open water bodies, potential protein production through fish and biomass harvesting, and the creation of additional aquatic habitats for wildlife species.

The aims of the Inland Water Ecosystems Section are:

- the development of the understanding necessary to predict the effects of natural events, planned development and management actions on inland water ecosystems;
- improving the scientific basis for utilizing these systems, for instance for biological production and recreation; and
- the search for solutions to particular environmental and management problems relating to inland water ecosystems.

CURRENT ACTIVITIES

Environmental impact studies

These involve the assessment of the ecological implications of future development within particular catchment areas and planning regions, ways of keeping impacts to a minimum and identifying subsequent research needs.

Eutrophication in Hartbeespoort Dam

This programme is being funded jointly by the National Institute for Water Research, the Water Research Commission and the Committee for Inland Water Ecosystems. The first phase, a five year multidisciplinary research programme aimed at establishing the influence of excessive eutrophication on the physical, chemical and biological processes in the dam, has been completed (SANSPR* 110). A synthesis has been published of the most important findings of the subprogrammes on fish, zooplankton, physical-chemical characteristics of water and sediments, bacteria and phytoplankton. Management options have been reviewed and recommendations have been made on future research needs. Phase 2 of the research project will investigate the response of the system to the reduction of nutrient load with the introduction of the 1 mg phosphate standard in the Hartbeespoort Dam catchment area.

Mgeni River catchment

Research on the Mgeni River in the past concentrated on the limnological characteristics of Midmar Dam and a synthesis report on the topic was published in 1984 (SANSPR 78). The Natal Town and Regional Planning Commission realized that human activities within the catchment area dictated the water quality of the dam, and organized a symposium and workshop in cooperation with the Inland Water Ecosystems Programme in February 1985 to investigate all aspects of water quality management. Recommendations for the optimal management of the Mgeni system were made, and are described in the highlight on "Water quality management in the Mgeni catchment".

Wilderness lakes

The Wilderness region of the southern Cape coast is renowned for its beauty, recreational attractions and wildlife resources. The lake system is particularly vulnerable to the negative impacts of alterations to its hydrology by infrastructural developments. For this reason a detailed study of the limnology of these lakes was undertaken and a synthesis of the two-volume report on this work was published in 1984 (SANSPR 79). Further studies on the Wilderness lakes and their catchments, within a regional context, will be planned in 1986.

Wetlands

This subprogramme includes studies into the ecology, management, utilization and conservation of wetland areas. It includes floodplains, vleis, pans and endorheic water bodies. A bibliography and guide to African wetlands has been completed and a synthesis of completed wetland studies is being drawn up. These will be published in 1986. The need to compile an inventory of South African wetlands is a most pressing research requirement and a major effort will be launched during 1986 to fulfil this need.

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*SANSPR: South African National Scientific Programmes Report.
Abstracts of these reports appear on pages 46 - 55.

Pongolo River floodplain

The main objective of this subprogramme is to investigate the influence of flood control on the general ecology of the floodplain, with special reference to human resource needs. A workshop was held in 1985 to obtain an overview of research and biological monitoring which has already been undertaken on the floodplain, and to formulate a coordinated research and monitoring programme which would lead to the effective management of the floodplain. It has become increasingly evident that unless the interdependence of sociological and ecological factors is recognized, effective management of the floodplain ecosystem will not be possible.

Vaal River catchment

The Vaal River is South Africa's most intensely utilized water resource - water demand already exceeds supply. At present irrigation expansion is restricted and water for potable and industrial purposes is imported from neighbouring catchments. A variety of land-use practices (industry, mining, agriculture and urban development) have an impact on water quality in the Vaal and many of these practices conflict with the needs of water supply agencies and conservation and recreation organizations. Although these conflicts are often site-specific, their origins are generally multi-faceted and geographically widespread. The problems associated with water quality in the Vaal River are essentially a reflection of catchment activities and therefore reconciliation of most conflicts will be best addressed by rational planning within the catchment itself. Sound knowledge of how catchment activities affect water resource usage is clearly of vital importance at this stage. This knowledge can only be gained through the development and execution of a sound research programme, and therefore a much greater emphasis on research in the Vaal River system is envisaged.

HIGHLIGHT: WATER QUALITY MANAGEMENT IN THE MGENI CATCHMENT

The Mgeni River (Figure 1) is a vital water resource for both the Durban-Pietermaritzburg development axis and for the province of Natal. It provides water for some 45 per cent of the province's population which produces approximately 20 per cent of the gross national product. Continued development will be dependent on augmenting the supply of water by transfer from other catchments (eg Mooi and Mkomaas Rivers) and on the effective management of water quality, as reclamation of effluents could play an important role in augmenting supplies.

A deterioration in the quality of the water supplies of a region is currently an inevitable consequence of urban, industrial and agricultural development within the river basins which supply the region. The adverse consequences of deterioration in water quality include: health risks, particularly to those who use water directly from local streams and rivers, and who use the rivers and dams for recreation purposes; higher water treatment costs and a reduction in the value of these rivers and dams for recreation purposes (more than 450 000 visitors per year make use of the Natal Parks Board's recreation resorts in the Mgeni catchment).

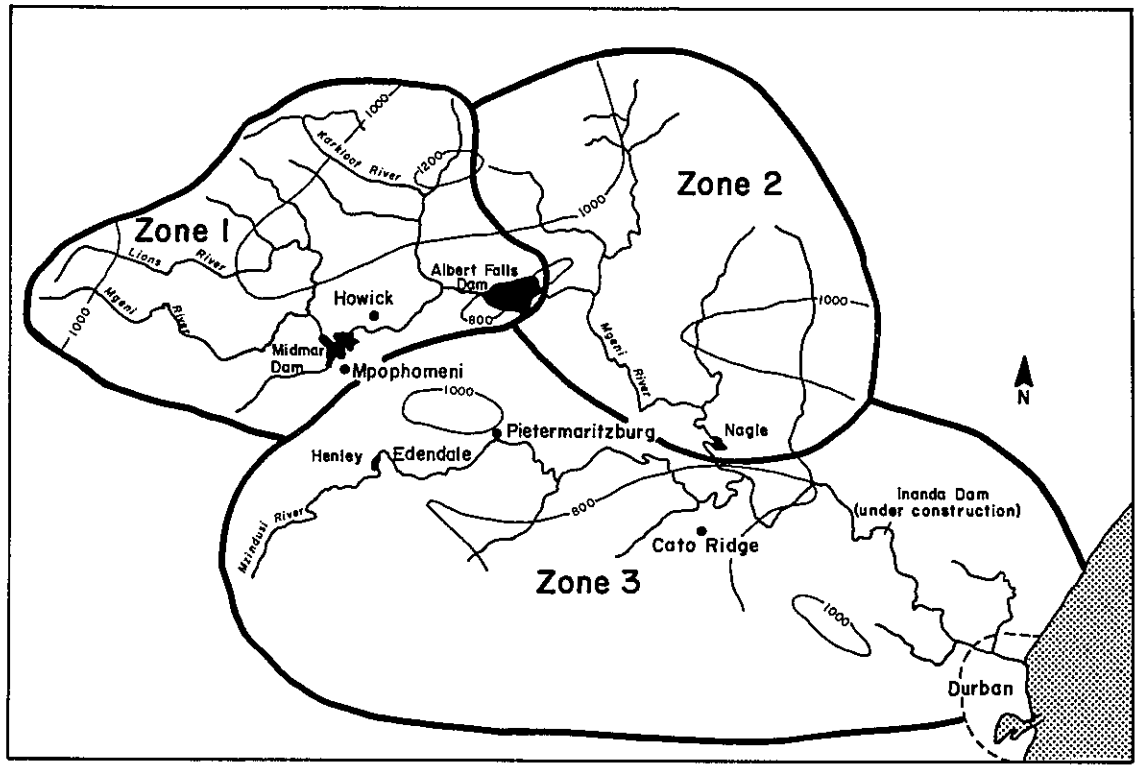


Figure 1. The Mgeni River catchment showing existing impoundments and the site of the Inanda Dam presently under construction. Also shown are the "development zones" which are recommended for the management of water quality. These zones are delineated on the basis of runoff, present water quality and patterns of land-use. Further details are given in the text.
Acknowledgement: Natal Town and Regional Planning Supplementary Report Vol 12, 1985.

Research on the Mgeni River system has been undertaken by several research organizations for the past two decades. Although further research is required and data collection and monitoring activities will have to be continued, several important conclusions can be made, based on this information:

- there is a significant health risk to those who use water directly from rivers without treatment, and this risk will increase with time. This applies particularly to the rivers in the lower reaches of the catchment;

- the continued development of spontaneous settlements in the Mgeni River catchment, without adequate water supplies, sewage disposal or storm water drainage systems, will not only create unhygienic conditions within these areas, but will also increase the health hazards in downstream rivers and dams;

- it is unlikely that the high standards of effluent treatment that can be attained in the urban areas will be achievable in these rural areas within the foreseeable future; and

- eutrophication from both point sources and diffuse sources is likely to be an increasing problem which can possibly be brought under control in Zones 1 and 2, but which is perhaps already beyond control in Zone 3.

After funding research on the Mgeni River system for a number of years, the Natal Town and Regional Planning Commission and the Committee for Inland Water Ecosystems recognized the need for the development of a policy for the management of water quality in the Mgeni catchment. They therefore sponsored a symposium at which a wide range of interested parties, including users, managers and researchers were able to express their opinions on the management of water quality in the catchment.

The following recommendations were made:

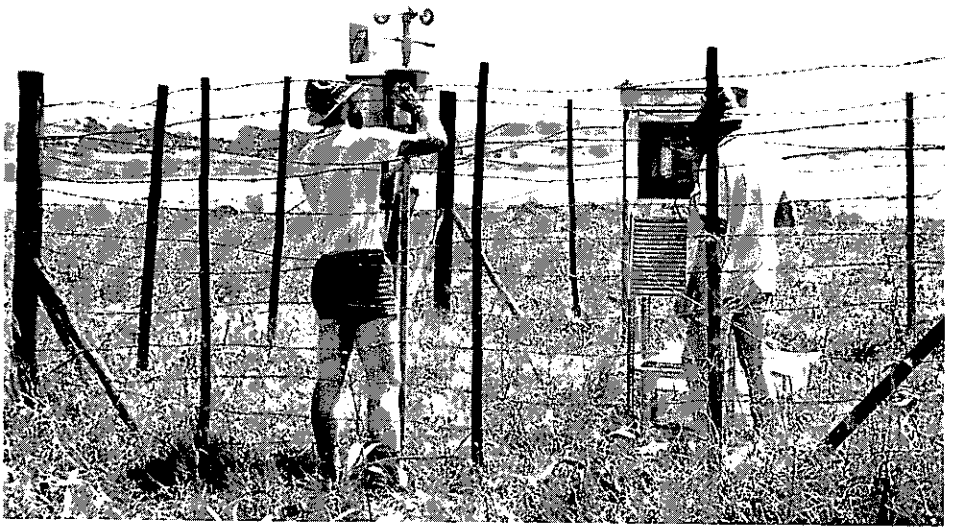
1. The principle of protecting critical catchment areas by controlling the development within those areas has already been established. Certain mountain catchment areas where no development is permitted have been proclaimed. However, none of these is within the Mgeni River catchment. In addition new afforestation for timber production is limited by legislation. This limitation has been applied to the Mgeni River catchment with a view to maintaining runoff from the catchment at its present level.

   It is not possible to curtail all development that will lead to the deterioration of downstream water supplies. Nevertheless, it is desirable to recognize "development zones" in the catchment so that future urban and industrial development can be located in areas where it will have the least adverse effect on the system as a whole.

   Zone 1: The Mgeni River catchment upstream of Albert Falls Dam, which includes Midmar Dam, produces more than half of the runoff that is generated within the system. This water is of an exceptional quality as there is relatively little urban and industrial development in the catchment. It is essential that every effort be made to preserve both the quantity and quality of water generated in the catchment. Urban development and the establishment of industries, particularly those which produce polluting effluents, should be limited to an absolute minimum. This single action will have a major effect in ensuring the highest possible water quality in the Mgeni River system.

   Zone 2 produces a minor proportion of the river flow in the system. Due to the spontaneous development (unplanned development, occurring in areas where structured planning is not enforced) taking place in this zone, it is anticipated that there will be some deterioration in the water quality, and that it will not be possible to achieve high standards of effluent treatment in the area in the foreseeable future. However, while no specific recommendations can be made relating to the control of future development in this zone, it is recognized that without improved catchment planning and management, development here will adversely affect water quality reaching the Nagle and Inanda Dams.

   Zone 3, which includes the Mzinduzi and Mgeni River catchments downstream of Nagle Dam, lies along the Durban-Pietermaritzburg axis. This area is already heavily populated and contains most of the indus-



The research programme on the Mgeni catchment area includes intensive studies of the physico-chemical conditions, nutrient dynamics, algal and zooplankton succession and primary production of Lake Midmar. An automatic weather station situated on a peninsula projecting into the lake plays an important role in these studies, as light, temperature and wind-induced mixing are principal determinants of lake processes.
Photos: Prof C M Breen, University of Natal.

tries that are located within the Mgeni River basin. It is recommended that new industrial development be concentrated in this area which already has the necessary infrastructure to support such development.

If the above recommendations regarding Zones 1 to 3 are accepted, the major degradation in water quality will occur in Inanda Dam and the adverse changes in Midmar and Albert Falls Dams will be minimized. In-dam ameliorative measures such as possible aeration and destratification of the stored water will then be limited to this one dam only, as will the implementation of sophisticated water treatment technology. The total water treatment costs for the system as a whole will be minimized, and the quality of water from the system will be maximized.

2. It is strongly recommended that a Regional Water Authority be established as soon as possible. This authority should liaise with all organizations concerned with statutory control in the Mgeni River basin area with the purpose of gaining consensus and commitment to a coordinated approach to water quality management. The authority should be vested with powers of regional planning veto in order to effectively implement policies directed at optimization of water use and water quality.

HIGHLIGHT: THE DEVELOPMENT OF LIMNOLOGICAL GUIDELINES FOR THE MANAGEMENT OF SOUTHERN HEMISPHERE INLAND WATERS

Limnological theory and inland water management practice have been developed almost exclusively in Northern Hemisphere temperate latitudes. Most of the land masses of the Southern Hemisphere fall within lower latitudes, from 20 to 40°S, where the climate tends to be dry, with low cloud cover and with high levels of incident radiation and high water temperatures. Wide extremes are experienced in both rainfall and runoff, which occur mainly in summer. Sedimentary geological structures give rise to dispersive soils and highly turbid waters. Physiological, behavioural or developmental adaptations in the floral and faunal components are necessary to cope with desiccation and low visibility.

All these characteristics differ significantly from those of Northern Hemisphere inland waters. The rapid development and enormous human population pressures and needs in large areas of the Southern Hemisphere and the consequent demands on limited water resources require wise planning and management policies. As a consequence, concepts and perspectives developed in the Northern Hemisphere must be carefully evaluated before being implemented in the management of water resources in the Southern Hemisphere.

To review and synthesize knowledge and understanding of significant features of Southern Hemisphere/low latitude inland waters, the Committee for Inland Water Ecosystems convened an international symposium and workshop during 1984 to:

- examine the degree to which limnological principles developed in the Northern Hemisphere/high latitudes are applicable in the Southern Hemisphere/low latitudes; and to

- interpret current knowledge in the light of environmental concerns, management strategies and future research and management needs.

The workshop report (SANSPR 93) combines and summarizes into one integrated document the knowledge, research findings, views and concepts of 65 contributors, coming from different Southern Hemisphere countries and from a wide range of disciplines (limnologists, hydrologists, engineers, managers). It also addresses various aspects of water quality in regions of the Southern Hemisphere with restricted freshwater supplies and it identifies the important limnological principles which form the basis of informed management of water supplies and their environments.

The report includes chapters on catchment management, stream regulation, pollution, salinization, turbidity and suspensoids, eutrophication, fisheries, as well as a glossary. Each chapter assesses the specific or general role that limnological knowledge plays in water quality management. Points regarded important for consideration by planners and managers are outlined and the urgent research needs are highlighted.

The symposium proceedings have been published under the title: Perspectives in Southern Hemisphere limnology, edited by B R Davies and R D Walmsley and published as Developments in Hydrobiology, Vol 28 by W Junk, B V Publishers, The Hague, October 1985.

The volume comprises a series of review papers on thermal characteristics, aridity and hydrological characteristics, seasonality-aseasonality, and suspensoids and turbidity. The unanimous conclusion of the symposium was that the distinctiveness of Southern Hemisphere aquatic ecosystems is one of degree and not of kind. The degree connotation relates particularly to the disproportionate distribution of land masses between the hemispheres and the resultant emphasis on arid and semi-arid environments within the Southern Hemisphere. Thus general limnological principles developed in the Northern Hemisphere should be applicable to situations in the Southern Hemisphere, but caution should be exercised in the interpretation of specific or local phenomena.

PROJECTS FUNDED DURING JULY 1983 - DECEMBER 1985

Environmental impact studies

1. Atmospheric fallout in the Umhlatuze Water Board area (Richards Bay). Mr C G M Archibald (National Institute for Water Research), 1982-1984.

2. Research on restoration of a river system. Part 1. The effect of integrated land management of the Siyaya River catchment on water quality and quantity. Mr C G M Archibald (National Institute for Water Research), 1983-1986.

3. Eutrophication and mineralization of the Buffalo River reservoirs. Prof R C Hart (Institute for Freshwater Studies, Rhodes University), 1983-1987.

Eutrophication in Hartbeespoort Dam

1. The dynamics and structure of fish populations in relation to phosphorus cycling in Hartbeespoort Dam. Dr K L Cochrane and Dr F M Chutter (National Institute for Water Research), 1981-1984.

2. The hydrodynamic processes within Hartbeespoort Dam and their importance to phosphorus cycling. Mr J R Hely-Hutchinson (National Institute for Water Research), 1981-1984.

3. The role of bottom sediment and the sediment/water interface in phosphate cycling in Hartbeespoort Dam. Dr A J Twinch (National Institute for Water Research), 1981-1984.

4. The hydrodynamic processes within Hartbeespoort Dam and their importance to phosphorus cycling. Mr J R Hely-Hutchinson (National Institute for Water Research), 1985-1988.

5. Maintenance and improvement of Hartbeespoort Dam ecosystem model. Dr K L Cochrane (National Institute for Water Research), 1985-1987.

6. General physical-chemical limnology of Hartbeespoort Dam. Dr J A Thornton (National Institute for Water Research), 1985-1990.

7. Phytoplankton species composition and population dynamics in Hartbeespoort Dam. Mrs T Segev (National Institute for Water Research), 1985-1988.

8. Management implications of factors regulating size and species composition of fish populations in Hartbeespoort Dam. Dr K L Cochrane (National Institute for Water Research), 1985-1988.

9. Sediment/water phosphate exchange in eutrophication management. Dr A J Twinch (National Institute for Water Research), 1985-1988.

Eutrophication in the Mgeni system catchment area

1. Patterns of nutrient loading in the Mgeni catchment area. Mr C E M Archibald (National Institute for Water Research), 1981-1984.

Wilderness lakes

1. The ecological impact of the hydraulic management of the Touw River floodplain following the building and operation of a sluicegate in the "Serpentine" Wilderness. Prof B R Allanson (Institute for Freshwater Studies, Rhodes University), 1982-1984.

Wetlands

1. Effluent treatment using a man-made wetland. Prof C M Breen (Department of Botany, University of Natal), 1985-1986.

Pongolo River floodplain

1. Effects of the drought and controlled floods on the Cynodon dactylon meadows. Dr H D Furness (Department of Plant Sciences, University of Fort Hare), 1985-1987.

2. Changes in the pattern and extent of agricultural utilization of the floodplain. Dr H D Furness (Department of Plant Sciences, University of Fort Hare), 1985-1986.

3. Submerged and floating-leaved macrophytes - recovery after drought response to controlled flooding and importance in ecosystem functioning. Prof C M Breen (Department of Botany, University of Natal), 1985-1987.

4. Recovery of fish stocks of the Pongolo floodplain after a sustained drought. Prof M N Bruton (JLB Smith Institute for Ichthyology, Rhodes University), 1985-1987.

Fish production potential of the P K le Roux Dam

1. Studies on the hydrodynamics of Lake le Roux. Prof B R Allanson (Department of Zoology, Rhodes University), 1984-1985.

TERRESTRIAL ECOSYSTEMS

INTRODUCTION

The Terrestrial Ecosystems Section extended its activities to establishing cooperative projects in all five major biomes in South Africa during the period 1983 to 1985. Research activities in the agro-economically important grassland and karoo biomes were expanded. Activities in the longer established Savanna and Fynbos Projects were centred more on the interactions between user agencies and research groups. In particular, ecological principles for various land-use systems are being formulated, reviewed and prepared for publication in handbook form. Finally, research activities were initiated in the forest biome, with the formal launching of a cooperative project during 1985.

The biome programmes of the Terrestrial Ecosystems Section all share the same overall objective: to develop a predictive understanding of the structure and functioning of the ecosystems in question and of their responses to various natural and man-induced stresses. Despite this common objective, each of the biome programmes has developed along rather different lines in response to local circumstances, unique problems and individual interests, and has followed the dictates and depended on the assumptions of very different ecological concepts. This has in turn led to a valuable diversity of perspective and opinion on ecological processes. A workshop with the theme "Concepts in southern African terrestrial ecology" was convened in 1985 with the objective of comparing the prevailing ecological concepts which underpin much of the work being carried out within the different biome programmes. The meeting provided an opportunity to clarify concepts and points of difference, define clear hypotheses and provide the stimulus to test predictions emanating from these.

In addition to the objective of developing a predictive understanding of the component ecosystems, the programmes developed within the Terrestrial Ecosystems Section also aim to search for solutions to specific problems such as invasive plants, fire, soil erosion, pesticide residues and for information which will throw light on such problems.

CURRENT ACTIVITIES

Savanna Ecosystem Project

This interdisciplinary project is now in its third phase, that of developing principles for bushveld management, by examining the effects of various management activities on the stability and resilience of bushveld systems.

This phase has extended research activities beyond the intensive studies on the Nylsvley Nature Reserve, to a wide range of studies throughout South Africa. Two workshops on management practices in savannas were held in 1983 and 1984, in conjunction with the Bushveld Study Group of the Department of Agriculture and Water Supply.

Several interdisciplinary research projects on plant-herbivore relationships in savanna have been completed or are nearing completion, and an overview of the results is in preparation. A review was also undertaken on nutrient dynamics in savannas. Specific attention was given to ways to expand and test stability/resilience theory in savannas.

Future activities within the Savanna Ecosystem Project will form a significant component of the recently launched international "Decade of the Tropics" programme. South African scientists have played a leading role in the development of this IUBS (International Union of Biological Sciences) initiative. The research programme at Nylsvley and elsewhere in South African savannas will participate specifically in the project on tropical soil biology and fertility, and in the the project on the response of savannas to both man-made and natural disturbances and stress. The former project addresses the two facets of soil organic matter (SOM) and synchrony of nutrient release from litter and uptake by vegetation (SYNCH).

Fynbos Biome Project

A principal objective of the first phase of this project was to define the geographical distribution and extent of the major vegetation types of the biome. The successful culmination of the vegetation mapping and classification activity is described as a research highlight later in this report.

The new map of the vegetation of the fynbos biome shows the total extent of the biome, including agricultural and urban areas, to be approximately seven million ha of which approximately 4,7 million ha comprise natural vegetation. Eighty-one per cent of the natural vegetation is confined to mountains. Lowland fynbos vegetation has been fragmented from an estimated original area of 2,8 million ha to only 31 per cent of that - a mere 850 500 ha. Along with the reduction of fynbos vegetation by agriculture and other developments, further reduction in conservation value is caused by invasive alien woody plant species. Estimates show that about 24 per cent of the existing area carrying natural vegetation has been invaded. Descriptions of the invasive alien organisms in the fynbos biome as well as their management were provided by workshop reports on the topics (SANSPR 85 and 111).

In natural systems, particularly if fire-prone, a predictive knowledge of community dynamics provides the soundest base for long-term management. Information on phenology is essential in the understanding of community dynamics, since it describes the timing of events such as growth, flowering, fruiting and predation, all functions which are dramatically affected by fire, drought, mowing etc. A synthesis of plant phenology in the fynbos biome has therefore been undertaken (SANSPR 88).

Sites of particular conservation merit throughout the lowland region of the fynbos biome have been identified and categorized (SANSPR 87). A general recommendation emerging from the survey is that conservation agencies

should accept as a long-term goal the need to protect as much as possible of the area covered by the 153 sites listed, ensuring that representative portions of the component ecosystems of the fynbos biome be preserved.

The Swartboschkloof catchment area in the Jonkershoek State Forest is one of the primary sites identified for the study of mountain fynbos ecosystems. A report on the plant communities of the area (SANSPR 104) will form part of a master programme for studies of mountain fynbos ecology. Within the next two years research activities will concentrate mainly on an experimental burn of the Swartboschkloof catchment area, which is planned for March 1987. It will present an ideal opportunity for testing a number of hypotheses developed over the past ten years and synthesized in a series of models which are described in SANSPR 105.

Karoo Biome Project

The karoo biome occupies 427 015 km^2 or 35 per cent of South Africa. It is almost exclusively used for extensive pastoralism and supports a profitable small stock industry. Of the total gross income derived from small stock, 36 per cent of the wool, 48 per cent of the mutton, 60 per cent of the mohair and 60 per cent of goat meat incomes are produced in the Karoo. The area's considerable contribution to the gross domestic product of South Africa is dependent on veld as a primary source of fodder for small stock. There are thus strong economic motives for gaining a predictive understanding of the structure and functioning of karoo ecosystems. Although the major problems in the karoo biome are agro-ecological they will not be fully comprehended without giving attention to theoretical issues such as resource limitation, predation, adaptation, competition and the like. Much applied research has been undertaken by agro-ecologists, but basic research data are few and have made little impact in the open literature. The launching of the Karoo Biome Project, to optimize research efforts through formal coordination within the structure of a collaborative research programme, is therefore a timely development. Studies are urgently required on the adaptive physiology, behaviour and reproductive biology of selected species and growth forms in relation to various climatic and defoliation regimes. Without these data it will also not be possible to develop community and ecosystem models of meaningfully adequate predictive power.

A descriptive document of the Karoo Biome Project and a synthesis of karoo research will be published in 1986.

Grassland Biome Project

A review of grassland research in South Africa has recently been published as SANSPR 96. This provides an exhaustive analysis of over 700 papers on grassland studies in South Africa and will serve as a key reference for the planning of future research in this field.

A major grassland monitoring programme is currently being established by the Department of Agriculture and Water Supply. The results of two workshops held on grassland monitoring will contribute substantially to this monitoring programme, as well as to the National Grazing Strategy published recently by the Department.

Vegetation mapping and classification in the grassland biome is also receiving attention after being neglected since Acocks's classic study of 1953. A revised classification, typology and map of highveld grasslands will be developed, concentrating on the western and eastern Transvaal.

Forest Biome Project

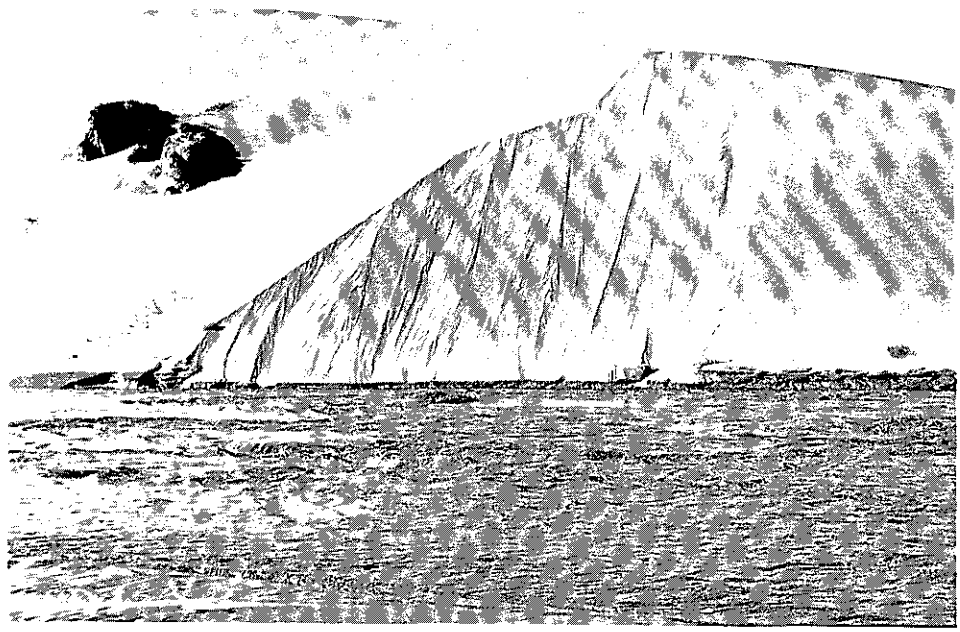
Activities within the Forest Biome Project have centred around the production of an annotated bibliography of South African indigenous evergreen forest ecology; the production of a map of the localities of all South African indigenous evergreen forests; a workshop aimed at developing a structural classification of South African forests; a workshop on forest edge dynamics; the identification of research priorities and the development of a description of the Forest Biome Project. The bibliography is complete (SANSPR 107) and the eastern sheet of the forest map has been produced.

HIGHLIGHT: THE KUISEB ENVIRONMENT - THE DEVELOPMENT OF A MONITORING BASELINE

The development of the world's largest open-cast uranium mine at Rössing in the Central Namib Desert introduced rapidly increasing demands for water to the area in the early 1970's. At the time it appeared that these demands would have to be met by water drawn from the Kuiseb River, either by abstraction from underground reservoirs in its lower reaches in the Namib-Naukluft Park, or through the construction of dams in its upper catchment in the Khomas Hochland and Escarpment.

The consequences of the increased use of the water resources of the Kuiseb basin were believed to cause a lowering of the water table which would result in the death of the dense acacia woodland which forms a linear oasis across the desert; the unhindered northward advance of dunes from the main Namib Sand Sea; the termination of subsurface flow of freshwater from the Kuiseb to Sandvis Lagoon; the depletion of drought reserves for plains game and Topnaar Hottentot domestic stock through the loss of the acacia woodland and associated vegetation; and ultimately the siltation of Walvis Bay Lagoon.

In the absence of adequate factual information, an inconclusive debate between parties in favour or against the concept of increased water use from the Kuiseb River ensued. In 1973 however, the responsible authorities established a multidisciplinary cooperative research programme, the Kuiseb Environmental Project to, inter alia, identify and quantify key environmental features. These, through regular monitoring, would provide baseline information of the types and rates of change within the system under an anticipated declining water table, in order to provide decision takers with scientifically sound information on which to base management and conservation plans. The limited availability of funds and manpower led to the use of a systems analytical approach in which the Kuiseb basin was divided into hydrological/ecological compartments within and between each of which the rates and directions of water transfers, and the factors influencing or influenced by these flows, could be studied.



The Kuiseb River has been an effective barrier to the northerly advance of the Namib Sand Sea, as is shown clearly on the top photograph. This advance was checked mainly by the eroding effect of the River on the adjoining dunes during periodic floods, thereby preventing the sand from moving over the riverbed. Photos: J D Ward, Geological Survey, Windhoek.

The geological/geomorphological history of the Namib was studied and the results indicate that a desert environment has predominated uninterrupted for at least the last 65 million years. The present Kuiseb River valley developed approximately 16 million years ago, although the present incised course is probably two to three million years old. The Kuiseb River has been an effective barrier to the northerly advance of the main Namib Sand Sea for at least the last 1,8 million years, mainly by means of the periodic floods which wash away the dune fronts and consequently prevent the sand from moving over the riverbed.

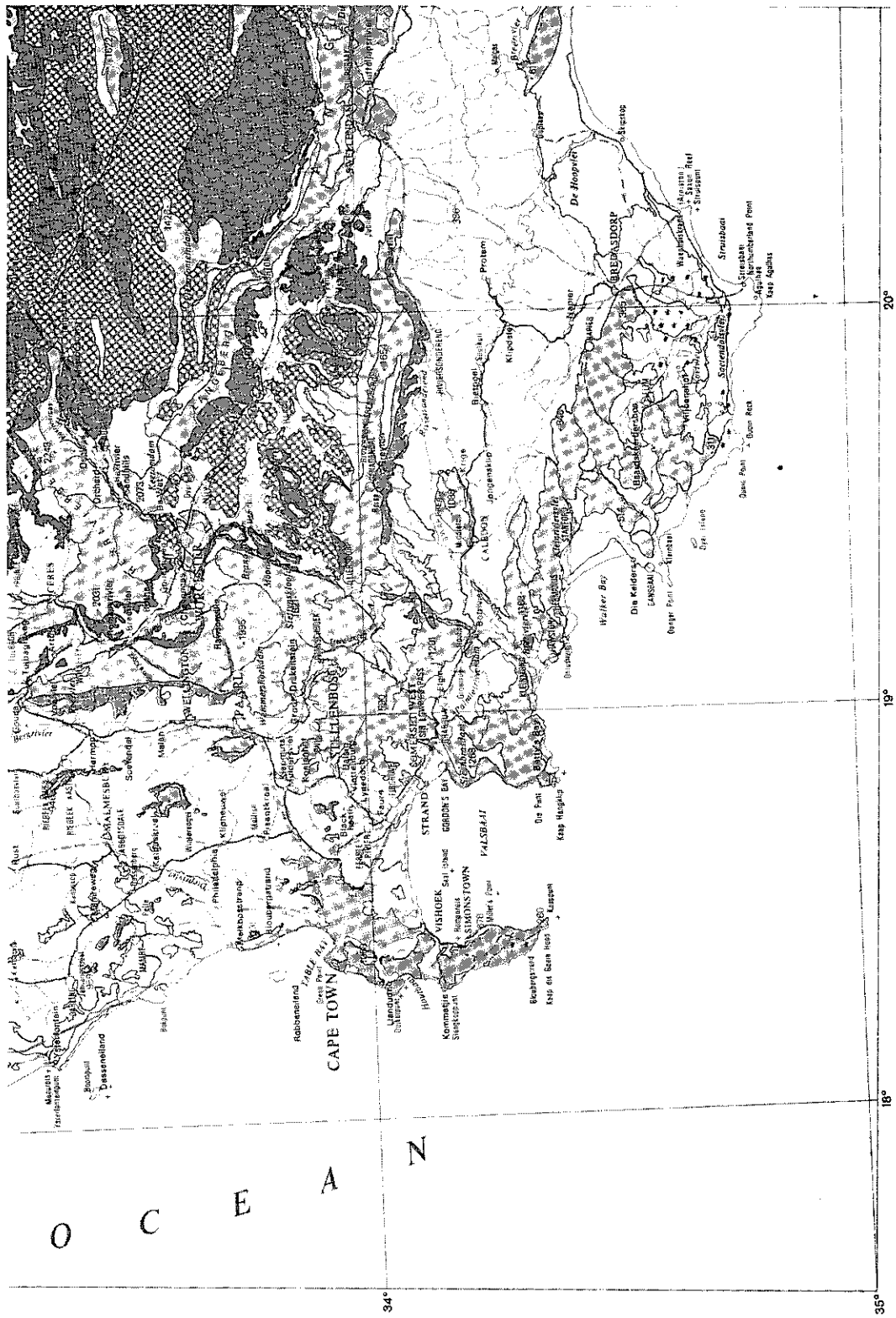
Detailed monitoring of the sand dynamics in the Lower Kuiseb indicated that the movement of dunes is relatively slow, and in the absence of the flushing action of floods, the estimated time for dunes to cross the southern delta channel ranges from 25 to 100 years, approximately 1 500 to 2 000 years to cross the Rooibank to Swartbank area and from 100 to 800 years in the Swartbank to Natab sector.

Hydrological and geohydrological studies indicate that the Kuiseb catchment receives on average only 159 mm rainfall per annum and provides an extremely widely fluctuating water yield, ranging from ca 220 M m^3 to zero, with a mean of ca 40 M m^3 per annum at the base of the escarpment, with an as yet undetermined flow to the main abstraction area at Rooibank. During the last 146 years the river surface flow has reached the Atlantic on only 15 occasions.

The vegetation of the Lower Kuiseb was surveyed, classified and mapped and a detailed analysis of the structure and vitality of the woody species was made. The study sites fell within three hydrological compartments, one of these being the main water abstraction area. Although fairly marked negative changes in the vitality of the woody species were recorded, the changes occurred in all sectors and appeared to be related to the below average rainfall experienced during the study period and not due to changes induced by water abstraction. The use of aerial photographic techniques, especially that involving colour infra-red photographic emulsions, proved to be extremely efficient and accurate in monitoring changes in woody plant structure and vitality.

The availability and utilization of forage and water sources within the riverine woodland linear oasis was measured and indicated that they played a significant role in the ecology of oryx and Hartmann's zebra, particularly for the populations occupying the inland dune areas to the south of the Kuiseb. The domestic stock of the Topnaar Hottentot communities of the Lower Kuiseb were almost wholly dependent on these food and water resources, and caused changes to the vegetation through overgrazing.

Forage production on the gravel plains to the north of the Kuiseb varied considerably according to rainfall patterns and accounted for the massive fluctuations in the large herbivore population from an estimated maximum of 7 212 animals in October 1979 to a minimum of 1 039 in June 1981. The surviving animals became increasingly dependent on the food and water resources of the Kuiseb riverine woodland as the drought advanced.



A reduced portion of the 1:1 000 000 map of vegetation of the fynbos biome.

The overriding conclusion which could be drawn from the studies conducted within the Kuiseb Environmental Project is that the entire ecosystem is extremely dynamic, undergoing unusually large fluctuations in all climatic, geomorphological, hydrological and ecological processes. Water is unquestionably the principal driving force in the Kuiseb environment and changes to the volume, rate and directions of flows within the system would have major consequences. As yet, man-induced changes to the hydrology of the Kuiseb basin have not been demonstrated to have influenced geomorphological or ecological processes within the area. No appreciable lowering of the water level or water quality has been reported.

Water supplied from the nearby Omaruru River caused a considerable reduction in the rate of water abstraction from the Lower Kuiseb, following an initial three-fold increase from 1974 to 1977. This undoubtedly averted major changes being recorded during this study. The detailed baselines established during the project will provide an invaluable bench-mark against which changes can be measured in the long term, whether or not increased water use from the Kuiseb becomes necessary in the future.

At the final meeting of the Steering Committee for the Kuiseb Environmental Project, the relevant authorities in South West Africa/Namibia agreed to a series of recommendations aimed at ensuring the future of the Kuiseb system.

All aspects of the rainfall, runoff, water extraction, quality and water level, the vegetation and game and dune movement will be monitored systematically. All facets of the Kuiseb water situation and ecology will be reviewed regularly to detect any early signs of possible change. Any development which would cause overutilization of the vegetation in the Kuiseb valley will be undertaken judiciously or if possible, be strictly limited.

HIGHLIGHT: MAPPING THE VEGETATION OF THE FYNBOS BIOME

Prior to the inception of the Fynbos Biome Project in 1977, little attention had been devoted to mapping, classifying and characterizing the vegetation of the biome. The handful of botanists (chiefly taxonomists) employed on vegetation studies were facing a daunting task of getting to know the 8 500 plant species encountered in the biome. As a result Acocks's map of the Veld Types of South Africa, produced in 1953, had to suffice as an overall classification of the biome. Over the years it had become clear that Acocks's classification, which included five veld types for the fynbos biome, was inadequate. Acocks himself had stated that the subdivision of mountain fynbos, for instance, into Macchia and False Macchia was like "dividing the tropical vegetation of South Africa into grassveld and bushveld".

A principal objective of the first phase of the Fynbos Biome Project was thus to define the geographical distribution and extent of the major vegetation types of the biome. During the last seven years, concomitant with the emergence of the Fynbos Biome Project, there has been an upsurge of research activity in the biome. Many workers undertook descriptive studies aimed at mapping, classification and characterization of biome vegetation both on an intensive and extensive scale. As a result, a great

deal of new regional phytosociological and structural data became available. In addition the major vegetation types were mapped from Landsat imagery.

As a result of these research activities two separate schemes of vegetation classification of the fynbos biome were produced. One scheme was based primarily on a 1:1 000 000 vegetation map drawn from Landsat images. The other scheme resulted from a workshop specifically designed to produce an up-to-date categorization of the major plant communities based on the knowledge of individual fieldworkers. It seemed appropriate that an attempt should be made to combine these two undertakings, and a scheme of vegetation categories linked to the mapped communities was the ultimate result. This is considered to be a second approximation to Acocks's pioneering work.

The scheme consists of 23 mapped and described vegetation types, of which 15 are in the lowland category and eight in the mountain category. The classification consists of a four-tier hierarchy. The two higher tiers are major vegetation units, based on world floristic kingdoms and the UNESCO map of the vegetation of Africa. These have been included in order to relate the scheme to recognized African and world schemes. The third tier consists of structural/environmental descriptions of mapped vegetation units, while the fourth tier consists of the 23 units themselves. Acocks's terminology has been maintained throughout as his concepts are valid and have become familiar to local workers.

The successful culmination of this vegetation mapping and classification activity within the Fynbos Biome Project has enabled various inventory and conservation status assessments to be undertaken within an acceptable framework of vegetation divisions. As a result, almost all the questions asked in the first phase of the Fynbos Biome Project have been answered. They include questions such as: what is the extent of the biome, where are the major boundaries within the biome; how much of the vegetation is affected by weeds, grazing etc; and what additional areas should be conserved in order to ensure a fully representative cover of protected areas in the biome. It would not have been possible to do this before the initiation of this successful cooperative venture.

A feature of all these activities has been the ability of the Fynbos Biome Project to develop multidisciplinary interaction to examine and report on issues affecting the severely depleted natural habitats of the biome.

PROJECTS FUNDED DURING JULY 1983 - DECEMBER 1985

Savanna Ecosystem Project

1. Quantitative ecological surveys of the woody vegetation of the Nylsvley study area. Prof R A Lubke (Department of Plant Sciences, Rhodes University), 1974-1989.

2. Long-term monitoring studies of the herbaceous layer on the Nylsvley Nature Reserve (Burkea africana savanna). Prof G K Theron (Department of Botany, University of Pretoria), 1974-1986.

3. The effects of soil and vegetation disturbance on the movement of selected nutrients in two savanna soils. Prof B H Walker (Centre for Resource Ecology, University of the Witwatersrand), 1983-1985.

4. The short-term responses of the grass layer of savannas to grazing, drought and nutrient stress. Dr M T Mentis (Department of Botany, University of the Witwatersrand), 1984-1987.

5. Analysis of the structure and dynamics of savanna grassland communities. Dr M T Mentis and Dr R I Yeaton (Department of Botany, University of the Witwatersrand), 1984-1987.

6. A comparative study of the effect of environmental variation on the rate of photosynthesis and aboveground respiration of the vegetation at Nylsvley. Prof C F Cresswell (Department of Botany and Microbiology, University of the Witwatersrand), 1975-1984.

7. Food-energy economy in the digestion process and determination of carrying capacity of game at Nylsvley: (1) Kudu. Dr W van Hoven (Department of Zoology, University of Pretoria), 1981-1989.

8. Food-energy economy in the digestion process and determination of carrying capacity of game at Nylsvley: (2) Impala. Dr W van Hoven (Department of Zoology, University of Pretoria), 1983-1988.

9. Trophic ecology of large herbivores: factors influencing the consumption of woody plants and forbs. Dr R N Owen-Smith (Centre for Resource Ecology, University of the Witwatersrand), 1980-1984.

10. Trophic ecology of large herbivores: diet selection strategies of grazing and browsing ungulates. Prof B H Walker and Dr R N Owen-Smith (Centre for Resource Ecology, University of the Witwatersrand), 1980-1985.

11. Trophic ecology of large herbivores: grass responses to consumption by grazing ungulates. Prof B H Walker (Centre for Resource Ecology, University of the Witwatersrand), 1980-1983.

12. The role of arboreal ants in a savanna ecosystem. Prof V C Moran (Department of Zoology, Rhodes University), 1981-1984.

13. Factors influencing the regrowth capacity of coppicing Acacia. Prof E J Moll (Department of Botany, University of Cape Town), 1982-1983.

14. Trophic ecology of large herbivores: patterns of grass selection by indigenous large herbivores versus cattle (Roan). Dr R N Owen-Smith (Centre for Resource Ecology, University of the Witwatersrand), 1983-1986.

15. Trophic ecology of large herbivores: woody plant response to ungulate herbivory. Dr R N Owen-Smith (Centre for Resource Ecology, University of the Witwatersrand), 1983-1986.

16. The effects of different patterns of defoliation imposed by cattle and impala on savanna grasses. Prof B H Walker (Centre for Resource Ecology, University of the Witwatersrand), 1983-1985.

17. Trophic ecology of large herbivores: the role of plant secondary metabolites. Dr R N Owen-Smith (Centre for Resource Ecology, University of the Witwatersrand), 1984-1987.

18. The role of disturbance in landscape dynamics: a hierarchical perspective I. Dr M T Mentis and Dr A J Hansen (Department of Botany, University of the Witwatersrand), 1985-1987.

19. The role of disturbance in landscape dynamics: a hierarchical perspective II. Dr M T Mentis and Dr A J Hansen (Department of Botany, University of the Witwatersrand), 1985-1988.

20. The ecological implications of land transformation. Prof B H Walker (Centre for Resource Ecology, University of the Witwatersrand), 1983-1986.

21. Patterns and processes in savanna ecosystems. Dr M T Mentis and Mr P G H Frost (Department of Botany, University of the Witwatersrand), 1983-1985.

22. Synthesis of the results of long-term experiments in southern Africa. Prof B H Walker (Centre for Resource Ecology, University of the Witwatersrand), 1983.

Fynbos Biome Project

1. Post-fire regeneration studies at Pella. Prof E J Moll (Department of Botany, University of Cape Town) and Mr C Boucher (Department of Agriculture), 1980-1990.

2. Pleistocene and Holocene environments in the fynbos area. Prof H J Deacon (Department of Archaeology, University of Stellenbosch), 1979-1983.

3. Studies on the phosphorus cycle in the fynbos biome. Prof D T Mitchell and Prof O A M Lewis (Department of Botany, University of Cape Town), 1979-1983.

4. A preliminary study on mineral cycling and the distribution and activity of micro-organisms in the soil. Prof D T Mitchell (Department of Botany, University of Cape Town) and Miss D L Olivier (Department of Microbiology, University of Cape Town), 1979-1983.

5. Microbial populations of fynbos soils in relation to soil conditions, particularly pH. Prof M A Loos (Department of Microbiology and Virology, University of Stellenbosch), 1982-1986.

6. Sunbird-Erica pollination systems in mountain fynbos. Prof W R Siegfried (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1982-1984.

7. The germination physiology and morphology of representatives of the Ericaceae and the Restionaceae. Prof J G C Small (Magaretha Mes Institute for Seed Research, University of Pretoria), 1983-1985.

8. Factors determining the geographical distribution of lizards in the fynbos ecosystem. Dr B W Oelofsen and Mr P le F Mouton (Department of Zoology, University of Stellenbosch), 1983-1986.

9. Plant-bird dispersal systems in fynbos. Prof W R Siegfried (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1983-1986.

10. Modelling review and development for the fynbos biome. Prof D T Mitchell (Department of Botany, University of Cape Town), 1982-1983.

11. Palynology of the Tertiary and Quaternary of the south-western Cape. Miss J A Coetzee (Institute of Environmental Sciences, University of the Orange Free State), 1976-ongoing.

12. The palaeoecology of the fynbos biome: a synthesis. Prof H J Deacon (Department of Archaeology, University of Stellenbosch), 1982-1983.

13. An investigation of photosynthetic C-fixation in fynbos growth forms and its variation with season and environment conditions. Prof O A M Lewis (Department of Botany, University of Cape Town), 1985-1987.

14. The origins and evolution of the fynbos. Prof H J Deacon (Department of Archaeology, University of Stellenbosch), 1984-1986.

15. The Eerste River catchment study: Lang River and Swartboschkloof. Dr B R Davies and Dr J A Day (Department of Zoology, University of Cape Town), 1984-1986.

16. The response of the fynbos vegetation to nutrient additions. Prof D T Mitchell and Prof E J Moll (Department of Botany, University of Cape Town) and Mr G R Thompson (Department of Agriculture and Water Supply), 1984-1988.

17. The detection of mycorrhizal associations in coastal and mountain fynbos ecosystems. Prof D T Mitchell (Department of Botany, University of Cape Town), 1984.

18. Insect pollination in selected Erica species. Prof J H Giliomee (Department of Entomology, University of Stellenbosch), 1985-1987.

19. Alien plant regeneration and control effects on populations at Pella. Prof E J Moll (Department of Botany, University of Cape Town) and Mr I A W Macdonald (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1983-1988.

20. The role of Erepsiinae (Mesembryanthemaceae) in the Capensis domain. Prof J J A van der Walt (Department of Botany, University of Stellenbosch) and Dr H E K Hartmann (Institut für Allgemeine Botanik, Hamburg), 1983-1986.

21. Prehistoric pastoralism in west coast Strandveld; a model of vegetation use and its effects. Prof A B Smith (Department of Archaeology, University of Stellenbosch) and Prof E J Moll (Department of Botany, University of Cape Town), 1985-1986.

22. Germination and seed dynamics of ericoid species. Prof E J Moll (Department of Botany, University of Cape Town), 1985-1988.

Karoo Biome Project

1. Defoliation and moisture studies on perennial forage plants in the field and glasshouse. Prof W L J van Rensburg and Mr H A Snyman (Department of Pasture Science, University of the Orange Free State), 1983-1986.

2. Late quaternary environmental history of the Karoo. Dr M E Meadows (Department of Geographical Science, Rhodes University), 1986-1987.

3. Ecological studies in the south-eastern Karoo. Dr R M Cowling (Department of Botany, University of Port Elizabeth), 1985-1986.

4. Floristics, structure and dynamics of subtropical and karroid shrublands along a climatic gradient in the Sundays River valley, south-eastern Cape. Dr R M Cowling (Department of Botany, University of Port Elizabeth), 1985-1987.

Grassland Biome Project

1. The effect of spring burning on the radiation balance and water use of a grassland community. Dr M J Savage and Prof R E Schulze (Department of Soil Science and Agrometeorology, University of Natal) and Prof N M Tainton (Faculty of Agriculture, University of Natal), 1983-1991.

2. The determination of phytomass production of Themeda veld under grazing. Mr L F Vorster (Department of Pasture Science, University of the Orange Free State), 1983-1984.

3. Effects of water supply on availability of ammonium and nitrate nitrogen in soil under grassland. Dr G H Wiltshire (Institute of Environmental Sciences, University of the Orange Free State), 1982-1985.

4. A simulation of the grazing of sour grassveld. Dr M T Mentis, (Department of Botany, University of the Witwatersrand), 1982-1985.

5. Gradient analysis in Natal grasslands. Dr M T Mentis (Department of Botany, University of the Witwatersrand) and Prof J M de Villiers and Mr M V Fey (Department of Grassland Science, University of Natal), 1983-1986.

6. Nature and rate of vegetation and soil changes on the important soil series in the western area of the grassland biome. Prof O J H Bosch (Department of Botany, Potchefstroom University for CHE), 1984-1987.

7. Relationship between veld condition score and long-term stocking rates applied to some grassvelds in Natal. Prof N M Tainton (Faculty of Agriculture, University of Natal), 1984-1987.

8. Growth and production studies on natural veld and under controlled conditions in relation to moisture and defoliation. Prof W L J van Rensburg and Mr W D Venter (Department of Pasture Science, University of the Orange Fee State), 1984-1986.

9. Relationship between soils, climate and the degree of sweetness or sourness of veld. Prof N M Tainton (Faculty of Agriculture, University of Natal), 1984-1989.

10. The identification, demarcation and ecological interpretation of the vegetation of the western part of the grassland biome. Dr G J Bredenkamp (Department of Botany, Potchefstroom University for CHE), 1984-1989.

11. A plant sociological study of the new Steenkampsberg Nature Reserve. Prof G K Theron (Department of Botany, University of Pretoria), 1985-1987.

12. Effect of species composition changes and soils on the productivity of plant communities in the western part of the grassland biome. Prof O J H Bosch (Department of Botany, Potchefstroom University for CHE), 1985-1987.

13. Veld fertilization. Dr M T Mentis (Department of Botany, University of the Witwatersrand), Prof N M Tainton (Faculty of Agriculture, University of Natal) and Prof J M de Villiers (Department of Pasture Science, University of Natal), 1985-1987.

NATURE CONSERVATION RESEARCH

INTRODUCTION

A most significant event for the cooperative activities of Ecosystem Programmes, but most particularly for the Nature Conservation Research Section, was the creation in 1982 of the Council for the Environment. The Council's purpose, namely to advise the Minister for Environment Affairs on the management or resolution of environmental problems, gave rise to a clearly stated need for a national policy and strategy for environmental conservation. The drafting of a comprehensive national strategy is a detailed, long-term task. A role for several sections within Ecosystem Programmes was seen to exist in providing the information needed to compile resource management strategies for discrete components of the natural landscape and its biota.

Very basic texts such as directories, bibliographies, syntheses, surveys and Red Data Books form important building blocks which will continue to be produced. More explicit treatments have been undertaken of resource areas at risk or of high management priority (coastal dunes, wetlands, rivers, invasive alien species). The mechanisms for achieving these tasks have depended increasingly on collaborative efforts at workshops and seminars and through multi-authored publications aimed at practical management needs.

The principal objective of this section is to stimulate and coordinate the research needed to develop the ecological principles and practices necessary for the conservation of indigenous species and communities, together with their habitats and life support processes, for the long-term benefit of mankind.

CURRENT ACTIVITIES

Species conservation

In South Africa a major contribution to the assessment of the conservation status of our indigenous plant and animal species has been made through the projects on threatened species, leading to the publication of Red Data Books for all the vertebrate groups and for vascular plants. These Red Data Books are currently being revised. The revised and greatly expanded Red Data Book for birds has now been published, and revised Red Data Books for fishes and for terrestrial mammals will be published soon. It is intended to revise the Red Data Book for vascular plants in sections,

determined by the biogeographical regions of southern Africa. The first revision in this series, relevant to the fynbos and karoo biomes, has been published as SANSPR 117.

As a consequence of the Red Data Book exercise, researchers in the winter rainfall karoo, the lowland fynbos and the eastern Cape are developing systems to use rare plant species data to provide practical guidelines for conservation action. Assistance is also being provided to enable species atlassing (birds and plants) to develop into a useful conservation tool. A by-product of these activities has been the development of two important data bases which now require long-term curation and maintenance if they are to remain useful. They are the Cape Rare Plants Inventory compiled by Prof A V Hall and currently housed at the Bolus Herbarium, and the Lowland Fynbos Conservation Priorities Inventory which is currently housed at the Fynbos Biome Project at the University of Cape Town. Negotiations concerning the future curation of these data are well advanced.

Habitat conservation

Habitat conservation requires the survey, inventory and classification of the full range of biotic communities and their habitats throughout southern Africa. It includes not only habitats as identified by Veld Types, but also ecological systems such as wetlands, river systems and water catchments, mountain ranges, coastal dunelands, estuaries and coastal marine systems.

Data sheets for all proclaimed conservation areas larger than 1 000 ha in South Africa have been completed and submitted to the IUCN's Protected Areas Data Unit (PADU) in England, for inclusion in their "IUCN Directory of Afro-Tropical Protected Areas". These data sheets were also published under the title "Directory of southern African conservation areas" (SANSPR 98). The publication contains a comprehensive inventory of the physical and biotic attributes of all the 155 protected areas, over 1 000 ha in size, that currently exist within southern Africa, including Lesotho and Swaziland. It provides a synthesis of the conservation cover of major biomes, ecosystems and veld types and indicates conservation priorities on a subcontinental scale.

A workshop which was held on the conservation status of the Transvaal Escarpment (with specific attention to the flora) recommended land-use and management strategies. A project on the conservation status of coastal dune ecosystems has been completed and a brief outline of the principal recommendations from the resulting publication (SANSPR 109) is included in this report. A publication on "Conservation priorities in lowland fynbos" has also been published as SANSPR 87.

The conservation and management of inland water ecosystems have been identified as having the highest priority for research on threatened habitats in South Africa. Activity in respect of rivers has gained considerable momentum as a result of Dr J H O'Keeffe's preliminary synthesis of ecological research on South African rivers, the results of which are to be published as a South African National Scientific Programmes Report in 1986. Similar synthesis and survey projects in respect of wetlands and highveld pans remain the highest priorities in the Nature

Conservation Research Programme. A specific emphasis has emerged not only to describe the environmental status and value of wetlands, rivers and pans but also to improve our knowledge of their ecological functioning.

Invasive biota

This subprogramme examines the nature and extent of invasions by alien species and their effects on natural ecosystems, as well as the characteristics of the more successful invading species with a view to facilitating their control. Intercontinental cooperative work is used to explore the global mechanisms of invasions, as well as the entire biology of the phenomenon, which is most evident in the winter rainfall areas of South Africa. Emphasis for much of this activity is placed on the topic of alien biota in protected areas. Workshops were held to assess the current knowledge about terrestrial aliens in the fynbos biome and the results of these, as well as management guidelines for alien invasions in the fynbos biome have been published (SANSPR 72, 85 and 111). The results of workshops on terrestrial aliens in Natal and South West Africa/Namibia will be published early in 1986 (SANSPR 118 and 119).

This subprogramme has been particularly active during the period under review, a situation which is likely to continue at least into 1987. The whole invasives programme is linked to the international SCOPE Project on the Ecology of Biological Invasions. Participation in the SCOPE project is described later in this report.

There is a great need for continued research activity, specifically on the extent of invasives in the karoo, savanna and grassland biomes and in coastal dune and coastal marine ecosystems. A general emphasis is needed on research into the ecological processes of invasions, and of post-treatment recovery. Procedures need to be developed to evaluate the invasive potential of species in order to devise appropriate preventative measures, including the control of importation. An assessment of both ecological and economic impacts of species, including studies of commercial utilization are justified. Additional priorities include studies of seed dynamics and dispersal strategies, inventory of invasive invertebrate species and the development of mathematical modelling in this field.

Management and utilization of wildlife

This subprogramme is concerned with the development of principles and practical guidelines for the management of protected areas and the sustainable use of natural resources on private land.

In defining directions for future research a general emphasis has been placed on game production and on the problems associated with conservation management on private land. Future research priorities include: determination of the economic basis of game production, evaluating the ecological consequences of increasing game fencing and the improvement of the practice of ecological management planning.

Concern about research needs in the area of pesticides and pollutants and their effects on natural ecosystems has long been acknowledged as a priority topic for the Nature Conservation Research Programme. A first

step has been taken by initiating a pilot project to determine the extent, nature and factual basis of the pesticide problem in South African natural and semi-natural ecosystems. A report on this pilot project will be presented in 1986.

Conservation behaviour

This topic concerns the examination of those aspects of human behaviour which affect or arise from man's interaction with the natural environment. This is undertaken to facilitate better individual motivation for the conservation of environmental resources and to develop values and attitudes leading to positive conservation behaviour by individuals. There are two ongoing research projects, on land-owner attitudes and on legislative disincentives for conservation.

Results from the land-owner attitudes project carried out in the western Cape wheat belt indicate that the most positive attitudes among farmers towards conserving areas of remnant renosterveld are associated with a high level of education, bilingualism and general affluence. A feature of these and other factors of lesser influence on conservation attitudes, is that they are not amenable to short-term influence. The reason for using virgin veld was most often economic necessity, even where conservation attitudes were very positive. Factors influencing conservation behaviour in respect of remnants of natural veld are extremely complex and interactive. Recommendations made by the project leaders include financial incentives, legislative changes and improved agricultural and conservation extension services.

Bird Populations Data

The South African Bird Ringing Unit (SAFRING) is a service and monitoring facility based at the Percy FitzPatrick Institute of African Ornithology at the University of Cape Town. It serves as a repository for all bird ringing records and other ornithological data from southern Africa. This activity is in the process of being expanded into a Bird Populations Data Unit, which will be responsible for collecting a much wider range of data relating to birds in southern Africa, and which will specifically pay attention to bird atlassing and nest records. The Nature Conservation Section is assisting with the administration of both the Bird Populations Data Unit and the initiation of the National Bird Atlassing Project sponsored by the Southern African Nature Foundation.

HIGHLIGHT: ECOLOGY OF BIOLOGICAL INVASIONS - AN INTERNATIONAL COOPERATIVE PROJECT

The invasive spread of plants, animals and microorganisms into regions remote from their centres of origin, is one of the more subtle but pervasive alterations that man has caused to the biosphere. The extent of invasions, which often lead to complete domination of natural and near-natural landscapes, is one of increasing global concern.

The ecological and economic impact of such species has frequently been serious. Whereas the economic costs may be readily evaluated, the ecologi-

cal consequences of invasions and their control measures are more difficult to assess. In all instances indigenous species are displaced, in some cases to extinction. In many instances the entire character of the biota and even soil and landscape characteristics have been changed. These phenomena are now evident on all continents.

Realization of these facts has led to the development of a SCOPE sponsored international project. The project has its origins in Mediterranean ecology, having first been proposed at the Third International Conference on Mediterranean Ecosystems held in South Africa in 1980. Subsequent discussions and meetings resulted in a proposal to the fifth General Assembly of SCOPE in Ottawa, June 1982, which was accepted as the basis for a SCOPE project. The project is aimed at developing a predictive understanding of biological invasions; seeking the answers to questions such as:

- Why does a species become invasive?
- What makes a site susceptible to invasion?
- How can this knowledge be used to manage invasions more effectively?

Professor H A Mooney of Stanford University was appointed as convener of the project advisory committee, which has worked through national correspondents or their equivalent, to integrate separate national research programmes as contributions towards a global synthesis. South Africa has been an active participant in this programme from the outset. While the general problem of invasive alien species in South Africa was appreciated, many problems have recently become evident because of a lack of understanding of the underlying processes, the inability to predict future invasions, and too little information on the impacts of control measures. Those involved in management of the natural landscape, especially nature conservation authorities, have found it difficult to devise long-term strategies to optimize the various control measures, particularly when faced with the need to reduce unit costs for management of extensive tracts of land. But control of invasives is imperative, given the actual and potential social and economic costs such as the loss of runoff from mountain catchments.

The specific emphasis that sets the South African national contribution apart from those of other countries or continents, is in the area of the effects of invasive plants on natural ecosystems; in particular the effects on protected areas and nature reserves. However, the South African programme probably has its most important strength in the field of management and control of invasions, specifically including bio-control. In these areas South Africa can justifiably claim to be among the world's leading practitioners.

A South African national synthesis symposium and workshop was held at Stellenbosch and Grabouw in 1985. The proceedings dealt with the history of the problem, the processes of invasion, the impacts of invasions and choice of management options. The objective of the national synthesis conference was to review and publish a synthesis of current knowledge on alien invasions in southern Africa with particular emphasis on describing the ecological processes involved, including those associated with human activities, and developing the principles necessary to control and manage alien species in semi-natural ecosystems.

Major points to emerge from the symposium were: the great number and diversity of invasive alien taxa in southern Africa; their ability to transform the environment; and the fact that the most successful invaders are controlled by predation and competition in their places of origin.

Conclusions of the meeting included the realization that complete eradication of biological invasions is seldom possible or economically feasible. Control measures should take into account the possible economic value of problem species and of the effects on the environment of rapid removal such as soil erosion or invasion by even more undesirable alien species. In municipal areas where land values are high it might be feasible to control unwanted plants by chemical and mechanical methods but in mountain catchments, forests, nature reserves, rivers, lagoons and agricultural areas biological control and extensive land management techniques should be used to provide long-term control.

The number of taxa introduced intentionally increases every year and many delegates felt that haphazard introductions should be prohibited. Potential imports should be evaluated using an information based screening process based on the behaviour of the organism elsewhere, its invasive features, its ecological equivalents in its native environment and the possibilities for its control using species-specific predators or pathogens. Public education is as important as the law in combatting further biological invasions in southern Africa.

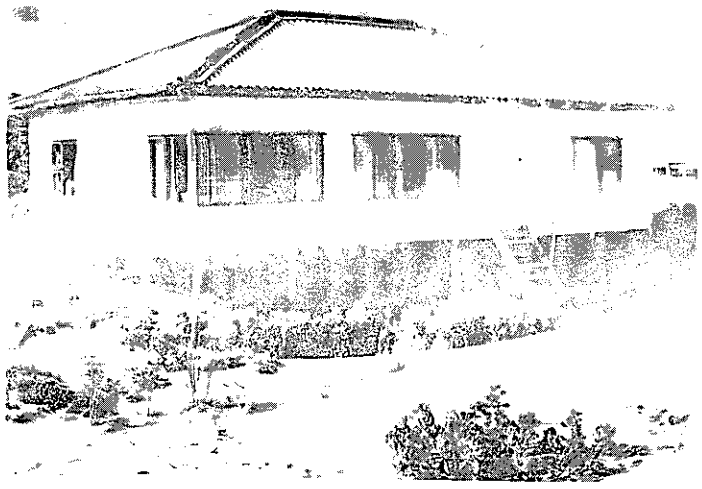
The proceedings of the symposium will be edited by I A W Macdonald and F J Kruger and published as a book in the latter half of 1986, and will be presented to the International SCOPE Symposium on Biological Invasions, which will be held in Hawaii in November 1986.

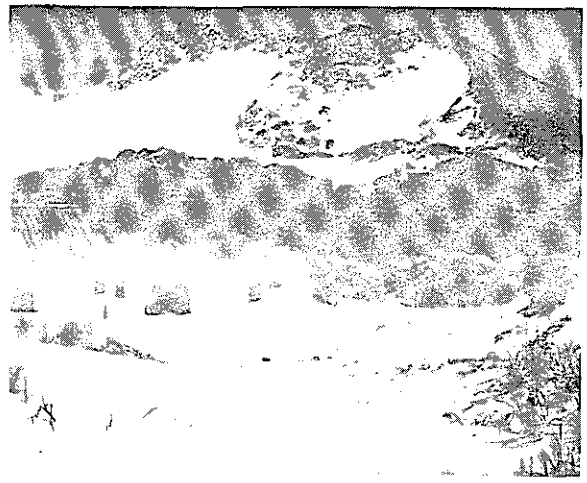
HIGHLIGHT: COASTAL DUNE ECOSYSTEMS OF SOUTH AFRICA

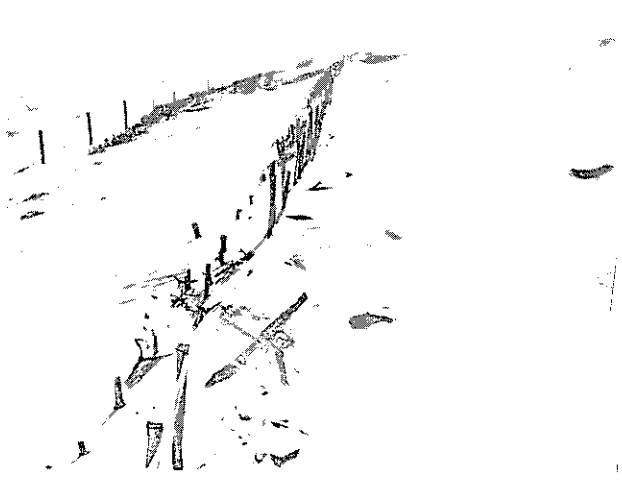
Over 80 per cent of South Africa's 3 000 km coastline is "soft", comprising sandy beaches, dunes, sediment-lined estuaries and lagoons. Much of this coastline is subjected to high energy seas and tides relative to other soft coastlines around the world. South African coastlines also share the erosional characteristics of 90 per cent of the world's soft coasts, namely a substantial net loss of sediments over the last several decades.

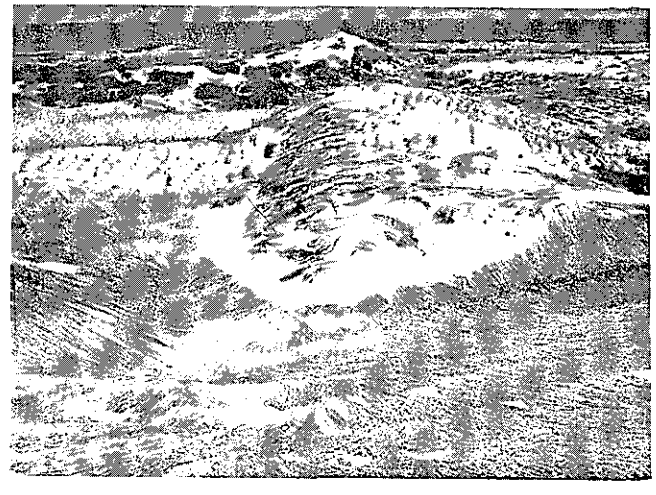
Against this broad background of a dynamic, sensitive and slowly eroding ecosystem is a pattern of development that is intense, economically and aesthetically exploitive and largely unplanned. The resulting conflict of interests in the development and use of this interface between land and sea has led to a pressing need for ecologically sound guidelines to minimize further environmental damage.

The finalization of a comprehensive synthesis report on this topic by Dr K L Tinley (SANSPR 109) together with the publication of the Coastal Sensitivity Atlas (Department of Transport, 1984) and the establishment of the Working Committee for the Coastal Zone by the Council for the Environment are events of great significance for the protection and development of the coastal zone.









The conflict of interests in the development and use of the interface between land and sea points to the need for ecologically sound principles to minimize further environmental damage and to repair damage already done. Examples of natural forested dunes, mined dune sands completely stabilized by planting of mainly indigenous grasses, shurbs and trees, the effects of wrong development in dune areas, the establishment of a new littoral zone, and efficient stabilization of bare reversing dunes by laying reed mats interplanted with dune pioneer plants are shown. Photos: K L Tinley.

Dr Tinley's report provides a wealth of detail on the factors influencing the coastal dune ecosystems of South Africa. The origins and geographical setting, the wind, wave and weather conditions, the physical and biotic components of dune systems and the way in which these factors interact to contribute to the movement and stabilization of beach and dune sands, are all dealt with. The irresistible dynamics of dune systems, arguably their most important and most frequently ignored attribute, is given special emphasis.

The development/conservation conflict, which is the key issue tackled by the report, is analysed. Huge sums of money are already being spent restoring eroded beaches, compensating for flood or wave damage, protecting structures from drift sands, etc, all of which could have been avoided if a few simple ecological rules had been built into the development planning process.

The key recommendations in the report include:

- definition of a coast buffer zone which includes all of the most dynamic and sensitive areas ("littoral active zone") in the coastal strip, and the limitation of all but the most unavoidable development to the landward side of that zone (eg a protected strip comprising the littoral active zone plus approximately 100 metres);

- where development has to encroach on the coastal buffer zone the project must be designed for minimal impact and minimal susceptibility to damage from natural forces. For this purpose the principal dynamic components at each site need to be identified and their effects fully evaluated relative to the planned structure or form of land-use;

- comprehensive land-use planning of the entire coastline, incorporating zoning for different categories of development or protection, including restrictions on the form and function of development structures. Such zoning should include areas of total protection for important remnants of natural vegetation and dune landscapes; and

- recommendations on areas deserving total protection. These vary from single dunes (the climbing-falling dune on Robberg Peninsula) to entire coastlines (Cape St Lucia to Ponta do Ouro). They total 42 sites, or sections of coastline, distributed as follows:

West Coast - 4	Transkei Coast - 5
South-west Coast - 6	Natal Coast - 14
South Coast - 10	KwaZulu Coast - 2
East Cape Coast - 1	

In addition, detailed recommendations are provided for other administrative, legislative and planning needs, including requirements for reclamation and damage control at appropriate sites (for example badly designed or sited structures and dune mining sites). An important list at the end of the report enumerates and defines the human values attached to coastal dune systems.

The administrative recommendations include:

- the establishment of an effective coastal management agency to control and coordinate development;

- the revision and streamlining of current legislation which is complex and often conflicting in effect;

- the provision of an ecologically sound conservation/development advisory service which would include environmental impact analysis in its terms of reference;

- a series of very stringent conditions to be imposed on any development that has to extend into the littoral active zone of any soft coast (especially: frontal dunes, beaches, river mouths, estuarine flats, lagoons etc); and

- a similar series of stringent conditions (imposed through on-site inspection) on any dune stabilization or reclamation activities or proposals.

PROJECTS FUNDED DURING JULY 1983 - DECEMBER 1985

Habitat conservation

1. A survey of the conservation status of the coastal dune ecosystems of South Africa. Dr K L Tinley (Consultant Ecologist), 1981-1983.

2. An ecological survey of South African rivers. Dr J H O'Keeffe (Institute for Freshwater Studies, Rhodes University), 1984-1986.

3. An inventory and assessment of the conservation value of the Mkuze swamp system. Prof C M Breen and Mr E G J Akhurst (Department of Botany, University of Natal) and Mr P S Goodman (Natal Parks Board), 1985-1987.

Species conservation

1. Survey of rare and endangered plants in the Cape Province. Prof A V Hall (Bolus Herbarium, University of Cape Town), 1974-1984.

2. A revision of the South African Red Data Book: Fishes. Dr P H Skelton (JLB Smith Institute of Ichthyology, Grahamstown), 1982-1983.

3. Conservation status of some unique plant communities and floral elements in the eastern Cape. Prof R A Lubke (Department of Botany, Rhodes University), 1983-1986.

4. Plant species distributions in the winter rainfall karoo. Prof J J A van der Walt (Department of Botany, University of Stellenbosch) and Mr M B Bayer (Karoo Botanic Gardens), 1983-1986.

5. Revision of Red Data Book: Terrestrial mammals. Dr R H N Smithers (Transvaal Museum), 1984-1985.

6. The ecological correlation of rare plant distribution. Prof E J Moll (Department of Botany, University of Cape Town) and Prof A V Hall (Bolus Herbarium, University of Cape Town), 1985.

7. Revision of the South African Red Data Book: Aves. Prof W R Siegfried and Mr R K Brooke (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1978-1983.

Invasive biota

1. The effects of indigenous and imported insect herbivores on the invasive weed Sesbania punicea in South Africa. Prof V C Moran (Department of Zoology, Rhodes University), 1982-1985.

2. Alien biota in southern African protected areas. Prof W R Siegfried (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1983-1986.

3. Fine-scale determinants of avian community structure in natural and man-modified fynbos of the south-west Cape. Dr R P Prys-Jones (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1984-1986.

4. A preliminary survey of the aquarium trade in South Africa and assessment of the potential impact of introduced aquatic organisms. Prof M N Bruton and Dr A J Ribbink (JLB Smith Institute of Ichthyology, Rhodes University), July - December 1984.

5. Dynamics of alien Acacia saligna and A cyclops seed stores following different clearing procedures in the south-western Cape. Prof E J Moll (Department of Botany, University of Cape Town) and Mr I A W Macdonald (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1985-1986.

6. Bibliography of alien birds at large in southern Africa. Mr R K Brooke (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), July - December 1984.

7. An analysis of Mr H C Taylor's two data collections on alien plant infestations in the Cape of Good Hope Nature Reserve. Prof A V Hall (Bolus Herbarium, University of Cape Town) and Mr I A W Macdonald (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1983.

8. Bibliography of invasive animals in South African natural and semi-natural inland waters. Prof M N Bruton (JLB Smith Institute of Ichthyology, Rhodes University), October 1983 - March 1984.

9. Atlas of alien fish and fish parasites. Prof M N Bruton (JLB Smith Institute of Ichthyology, Rhodes University), October 1984 - June 1986.

Conservation behaviour

1. Socio-economic factors in renosterveld conservation. Prof J R Grindley (Department of Environmental and Geographical Science, University of Cape Town), 1983-1985.

2. Promotion of nature conservation through financial incentives. Prof R F Fuggle (Department of Environmental and Geographical Science, University of Cape Town) and Prof M A Rabie (Department of Public Law, University of Stellenbosch), 1983-1985.

Management and utilization of wildlife

1. Long-term modelling of game management. Prof A M Starfield (Department of Applied Mathematics, University of the Witwatersrand), June - December 1984.

2. Investigation into pesticides in the South African environment. Dr M R Barlin-Brinck (Durban), 1985-1986.

South African Bird Ringing Unit

1. Awards to registered bird ringing projects. Mr T B Oatley (Percy FitzPatrick Institute of African Ornithology, University of Cape Town), 1983.

HUMAN NEEDS, RESOURCES AND THE ENVIRONMENT (HNRE)

INTRODUCTION

The achievement of balanced development and the satisfaction of human needs are great challenges facing decision takers in South Africa today. This can only be achieved by an understanding of the factors important in determining quality of life and by policies formulated on the basis of the interdependence of socio-political, economic and ecological factors.

The principal objective of the HNRE Programme is to develop the capacity to assist in the understanding, measurement and prediction of relative effects of the factors involved in the achievement of balanced socio-economic development and the satisfaction of human needs. The following are the main aims of the Programme:

- to determine the most relevant and important socio-political, economic and ecological relationships involved in the satisfaction of human needs;
- to develop the capacity to measure and predict both the interrelationships and the outcome of planning policies;
- to provide the inputs necessary for planning policies aimed at balanced development and satisfaction of human needs within a national and regional framework; and
- to monitor and evaluate developments in all these spheres.

In compliance with a decision made by the Executives of the CSIR and the Human Sciences Research Council (HSRC), the Programme for Human Needs, Resources and the Environment was transferred to the HSRC on 1 April 1985. Close contact will be maintained between the Programme and the CSIR, especially with regard to the Subprogramme on Human Ecology and Development and its interaction with the activities of the FRD's national cooperative programmes.

ACTIVITIES JULY 1983 - MARCH 1985

Quality of life research

The purpose of this sub-section is the determination of

- ways in which quality of life can be measured, as well as which are the most relevant subjective and objective indicators of quality of life and the relationship between the two;

- the relative importance of the various quality of life factors playing a role in different societies, at different levels of development, and how they change over time; and

- ways in which these assessments can be used in planning and policy formation.

A joint project was undertaken by the HNRE Programme, the Centre for Applied Social Sciences at the University of Natal and the Human Sciences Research Council to develop a model for the determination of the perception of quality of life. With this instrument it would be possible to determine the quality of life perceptions of the White, Black, Indian and Coloured population groups, and compare these regionally and over time.

Basic needs studies

There are two main research foci in the Basic Needs Subprogramme: firstly, the determination of people's basic needs, the resources available and the bottlenecks between resource allocation and the satisfaction of needs; and secondly the relationships between quality of life, the satisfaction of basic needs, and planning policies.

The specific basic needs covered in recent studies supported by this subprogramme were employment opportunities and health. Some of the other basic needs, like water, education and transport, were covered under the Research Programme in Support of Regional Economic Development. Attention was specifically paid to basic needs in rural areas. The determinants of the perception of basic needs in a rural area, and the relationship between the satisfaction of basic needs and economic growth in South Africa were also studied.

An aspect which still needs research attention, is the relationship between quality of life and the satisfaction of basic needs. The initial results of some of the research undertaken suggest that the satisfaction of people's basic needs does not necessarily increase people's perception of their quality of life. For example, the results of a study show that people in squatter camps who often have many of their more physical basic needs uncatered for, are often more satisfied with their quality of life than people for example in townships where most physical basic needs are provided for.

Human ecology and development

The approach of this subprogramme is to focus specifically on the interrelationship between ecological factors and the satisfaction of human needs. This relationship is especially important in developing areas where policies often reflect scant attention to and understanding of ecological factors. The imbalance between the carrying capacity of the physical resource base and the demands made thereon by increasing development activities and population growth is causing growing concern. These problems have to be addressed jointly by both social and environmental scientists.

Specific attention was given to the determination of the underlying causes and consequences of the present land-use practices in some rural areas; the extent to which people can exist on the resources at their disposal in these areas, and the short-term and long-term consequences of this resource use; as well as the implications of the above-mentioned factors for policies aimed at development and the satisfaction of basic needs. One project investigated the recreational needs and the effects of increased human pressure in the Cape coastal zone.

Regional economic development programming

This research programme was carried out for the Department of Constitutional Development and Planning. It focused on the following areas of concern:

- economic growth;
- employment - the size, composition, growth and migration of the labour force, as well as the creation of employment opportunities.
- the achievement of a more even spatial distribution of socio-economic development; and
- the satisfaction of basic needs, focusing specifically on education, transport and the supply of water and sanitation.

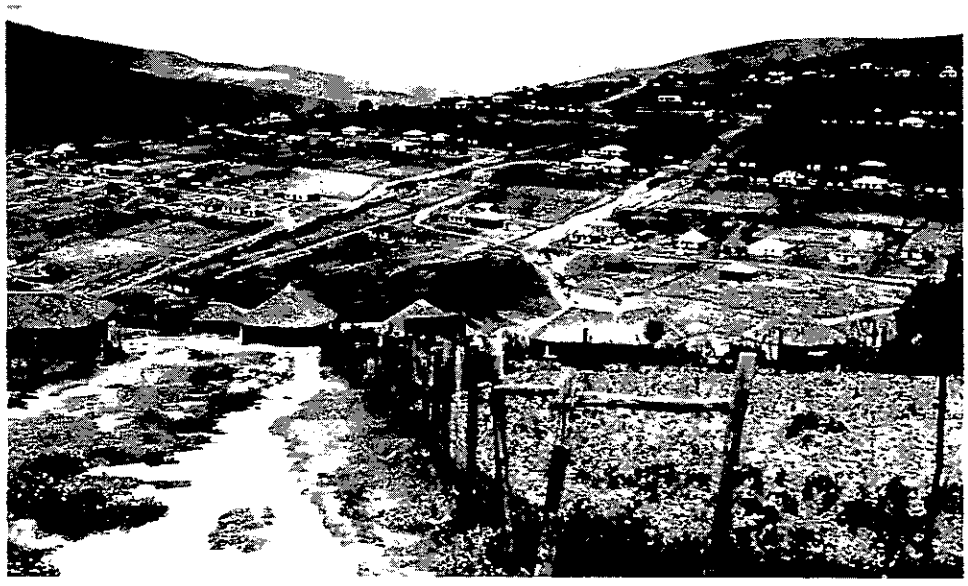
A social accounting matrix was drawn up for South Africa. This was a joint project by economists of the University of Pretoria and Colorado State University in the USA.

Most of the research projects in this programme have been concluded, and a workshop to provide the opportunity for researchers and decision takers to discuss the findings will be convened by the Human Sciences Research Council early in 1986.

HIGHLIGHT: AN EVALUATION OF RURAL BETTERMENT SCHEMES

Attempts by government agencies to improve the socio-economic situation in rural areas through so-called betterment schemes have recently been critically reviewed. The Department of Anthropology and the Institute of Social and Economic Research at Rhodes University examined the socio-economic and agricultural implications of so-called "betterment" schemes to improve agriculture and environmental conservation in Chatha in the Ciskei and

Near Shixini village, Transkei, with lines marked out indicating proposed residential sites after "betterment".
Photo: C de Wet, Rhodes University.



A post-"betterment" residential area in Chatha village, Ciskei.
Photo: C de Wet, Rhodes University.

Shixini in the Transkei. Chatha had already undergone betterment in the 1960's, while Shixini was in the initial stages of implementing betterment when the survey was undertaken. The betterment programmes involved a reorganization of the settlements involved, and the division of an area into formal residential areas, arable lands and grazing commonage with the intention of rehabilitating the environment and making the area economically viable so that people could subsist off the land. This necessitated people being moved from their old homesteads to the newly allocated central residential areas to make the rest of the area available for cultivation and grazing.

Many problems were encountered in the implementation of the betterment programmes in the two areas studied, and the inhabitants generally responded negatively to the action. They felt that the scheme was forced on them, and that it represented a threat to their culture and way of life. Unhappiness and resentment were caused especially by the forced move to the new residential areas. The people's experience of the betterment planning programme as forced and negative was partly caused by bad communication between them and the officials involved, which resulted in their lack of understanding of the situation and distrust of officialdom.

The study found that these betterment programmes resulted in an increase in demographic pressure, remoteness of resources, deterioration in agricultural productivity (except in the areas under irrigation), soil erosion, social disruption, and misunderstanding of and resistance towards the concept of planning as locally applied. In many cases the size of farmlands to which people had access was reduced, and the solidarity of the residential areas was destroyed, which led to people regarding themselves at a greater disadvantage socially and economically as a result of the betterment planning programme. In the Ciskei case-study only the 24 households on the irrigation scheme which profited directly from the undertaking had positive attitudes towards planning.

The betterment programme could not succeed in its aims (to improve agriculture and environmental conservation in the Black rural areas), as it could not alleviate the basic over-population of people and livestock, and because it could not overcome the basic shortage of equipment, markets, information services, money, motivation and space. The survey concluded that agricultural development should be seen as only one of the components of general rural development, whereby the quality of life of rural communities is being improved to the extent that its members have the moral and economic resources, as well as the skills and infrastructure to commit some of their energy and resources to agriculture. Only when these enabling conditions are present and can be sustained will significant agricultural production occur.

The survey recommended that a general rural development strategy should be implemented, and suggested that the following could be possible starting points of direct relevance to agriculture:

- improvement of access to water-points;
- improvement of transport facilities; and
- provision of credit facilities.

The research project related to the effect of betterment as implemented in Tribal Authority areas. It is however felt that whether it is Tribal Authority areas, or recently expropriated White farms which have been added to Black homelands through consolidation, the approach to agricultural development should be the same. Lasting self-sustainable improvement in agricultural production will only be achieved through the general improvement of the quality of life of rural communities.

HIGHLIGHT: SEMINAR ON BASIC NEEDS IN RURAL AREAS

The activities of the Basic Needs Subprogramme culminated in a Seminar on Basic Needs in Rural areas, which was held in Cape Town in 1985. The purpose of the meeting was to provide an opportunity for interaction between researchers and decision takers. A report on the seminar (SANSPR 116) includes papers on the following topics: the relevance of the basic needs approach to the South African situation; constraints and remedial policies regarding food production in the homelands; water, sewage disposal and fuel as basic needs; rural employment and solutions to unemployment; health as a basic need; rural Blacks' perceptions of basic need fulfilment; and difficulties and constraints in formulating policies and implementing programmes to answer basic needs questions.

PROJECTS FUNDED DURING JULY 1983 - MARCH 1985

Basic needs

1. Community health research project. Prof M T D Savage (Department of Sociology, University of Cape Town), 1982-1983.

2. Framework for a national settlement strategy and the satisfaction of basic needs. Prof D Dewar (Urban Problems Research Unit, University of Cape Town), 1982-1983.

3. Conditions of life in rural areas. Prof M E West, Dr J S Sharp and Mr A D Spiegel (Department of Social Anthropology, University of Cape Town), 1981-1983.

4. The relationship between the supply of basic needs and economic development in Brits and its surroundings and the planning implications involved. Prof B J Piek (Development Studies Institute, Rand Afrikaans University), 1983-1984.

5. The relationship between the satisfaction of basic needs and growth in South Africa: an empirical analysis. Mr S van der Berg (Department of Economics, University of Stellenbosch), 1983-1984.

6. Migrant workers' plans for domicile and occupation after retirement in relation to the conditions and resource base in rural areas of retirement. Dr V Möller (Centre for Applied Social Sciences, University of Natal), 1983-1985.

7. Determinants of the perception of basic needs in a rural area project. Prof J C Kotzé and Mr A Fischer (Department of Anthropology, Rand Afrikaans University), 1984-1985.

Human ecology and development

1. Rural communities in transition - a study of socio-economic and agricultural implications of agricultural betterment and development in Ciskei and Transkei. Prof S B Bekker (Institute of Social and Economic Research, Rhodes University), and Mr C de Wet and Mr P McAllister (Department of Anthropology, Rhodes University), 1982-1983.

2. Investigation of the emerging patterns of Zulu land tenure and their implications for the establishment of effective land information and administrative systems as a base for development. Prof D A Scogings and Prof D P Jenkins (Department of Surveying and Mapping, University of Natal), 1985-1986.

3. Sandveld-Swartland region: environmental inventory. Mr B Gasson (Urban Problems Research Unit, University of Cape Town), 1984-1985.

4. Appraisal and monitoring of Mboza development programme. Prof J J Maasdorp (Economic Research Unit, University of Natal), 1984-1986.

5. The resource value of indigenous plants to rural people in a low agricultural potential area. Prof E J Moll (Department of Botany, University of Cape Town), 1984.

6. Recreational needs and the effects of increased human pressure in the Cape coastal zone. Prof J R Grindley and Prof R F Fuggle (Department of Environmental and Geographical Science, University of Cape Town), 1984-1985.

Regional economic development programming

1. Public utility pricing and regional development in southern Africa. Prof M L Truu and Mr J L Wallis (Department of Economics, Rhodes University), 1982-1984.

2. The regional differential influence of international trade on the spatial distribution of economic activity in South African financial establishments. Prof C L McCarthy (Department of Economics, University of Stellenbosch), 1983.

3. Analysis of factors influencing labour market participation decision of black workers as an element of the dynamics of migration in development regions. Prof G G Maasdorp and Mr J F Hofmeyr (Economic Research Unit, University of Natal) and Mr N Bromberger (Development Studies Research Group, University of Natal), 1982-1983.

4. The dynamics and problematics regarding migration in the development regions. Prof I N A van der Walt (Department of Economics, Rand Afrikaans University), 1983.

5. An investigation into the supply and demand of labour in the Bloemfontein-Bochabela (Onverwacht) district. Prof J J Lourens (Department of Economics, University of the Orange Free State) and Mr J S Uys (Department of Industrial Psychology, University of the Orange Free State), 1982-1984.

6. A social accounting matrix (SAM) for South Africa. Prof J J Stadler (Bureau for Economic Politics and Analysis, University of Pretoria), 1982-1984.

7. Income distribution, employment and regional development in South Africa. Prof J B Eckert (Department of Economics, Colorado State University, Fort Collins, USA), 1982-1985.

8. Black education in the development of region D. Dr A J Penny (Department of Education, Rhodes University) and Prof P A Black (Department of Economics, Rhodes University), 1983-1984.

9. The role of the provision of water and sanitation in economic development on the level of areas of development. Prof L A van Wyk (Department of Economics, Potchefstroom University for CHE), 1982-1985.

10. The determination of the basic needs for transport/accessibility in respectively rural and urban areas of development regions. Mr J W M Cameron and Mr A H Naudé (National Institute for Transport and Road Research), 1982-1983.

11. An investigation into the needs and strategy for regional research into manpower issues. Prof J Nattrass (Development Studies Unit, Centre for Applied Social Sciences, University of Natal), 1982-1985.

NATIONAL PROGRAMME FOR AQUACULTURE RESEARCH

INTRODUCTION

Although fish culture has been practised for over 2 000 years, it is only during the past few decades that aquaculture has developed into a commercial activity which is dependent on advanced technology and coordinated scientific research. Aquaculture offers a controlled and relatively stable means of increasing food production. The contribution of aquaculture to the world food supply, which increased by over 50 per cent between 1975 and 1980, is especially meaningful in view of recent events in South Africa and elsewhere which demonstrated the limited and unpredictable nature of the ocean as a sole source of aquatic products.

Aquaculture is not a total newcomer to South Africa. It had its beginnings over one hundred years ago with the introduction of trout for angling purposes. Currently the culture of rainbow trout and oysters are the only established intensive aquaculture industries in the country; the oyster venture is however still dependent on foreign support in respect of seed production.

It should be borne in mind that aquaculture in South Africa must be seen as a complementary development to the harvest of natural resources. Aquacultural products are likely to be valuable for import replacement and as commodities for local consumption and export. In rural areas, the integration of aquaculture into agriculture could contribute to a more rational use of water and land, thereby increasing yields and profitability per production unit. Aquaculture also offers a possible means of utilizing thermal effluents and organic wastes for food production.

The objectives of the National Programme for Aquaculture Research are:

- to create a sound scientific basis for the successful development of the South African aquaculture industry by coordinating existing and stimulating new research on the cultivation of suitable organisms in salt, fresh and waste water; and

- to promote the transfer of scientific findings to user groups in order to realize the full commercial potential of aquaculture.

Priorities for aquaculture research in South Africa

CANDIDATE SPECIES	SURVEY OF LITERATURE	AQUACULTURE SYSTEM				ECONOMICS PROCESSING AND MARKETING	SUPPORTIVE RESEARCH
		HATCHERY	PRODUCTION SYSTEMS	NUTRITION AND FEED	PATHOLOGY AND DISEASES		
Current commercial species	Survey of relevant literature with special reference to local conditions and ecological requirements	Genetic selection of strains and hybrids to improve their adaptability to local conditions Mass production of seed and juveniles according to demand	Development of optimal production systems relating to local conditions Selection of appropriate sites Development of optimal management techniques Technological aspects of production systems	Determination of specific nutritional requirements Formulation of diets Feed preparation (in particular least-cost feed)	Diagnosis/control/treatment/prophylaxis	Market research and feasibility Processing technology of aquaculture products	Biology Physiology Behaviour Immunology Endocrinology Pathology Genetics Ecology
High potential candidate species							
Other potential candidate species							

RESEARCH NEEDS

Research needs for the aquaculture programme may be presented in a two-dimensional matrix in which the horizontal component includes generalized information and research needs which apply to all culturable species in terms of aquaculture systems; economics and marketing; and supportive research. The vertical component of the matrix includes specific requirements for species which are either currently in culture or are potentially culturable. These species are listed in the following groups:

Current commercial species

Rainbow trout, waterblommetjies, Pacific oyster, ornamental fish.

High potential candidate species

Marine prawn, abalone, freshwater prawn, marron, tilapia, brine shrimp, sharptooth catfish, Nile crocodile, turbot.

Priority species for research

American channel catfish, marine crab, black mussel, Dover sole, brown mussel, Atlantic salmon.

Lower priority species for research

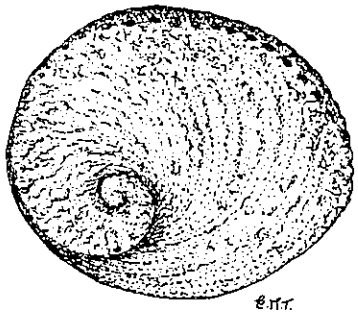
Cape stumpnose, flathead mullet, blacktail, butter catfish, sea catfish, moggel, kob, common carp, rabbitfish, grass carp, river bream, silver carp, milkfish, bighead carp, Agulhas sole, African freshwater eel, spotted grunter, Spirulina.

The identified research needs are summarized in the table opposite.

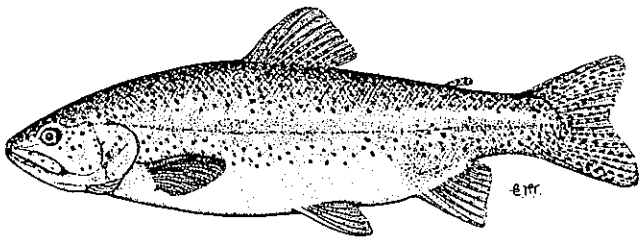
CURRENT ACTIVITIES

Aquaculture is a multi-disciplinary field of endeavour which requires coordination and close cooperation between the scientific community, producers, distributors, financiers and legislators. In order to strengthen this cooperation the CSIR and the South African Agricultural Union organized a joint symposium on aquaculture in South Africa in 1984. Specific issues addressed were: candidate species for aquaculture; recent developments in biotechnology; fish diseases; and socio-economic considerations relating to aquaculture. The proceedings have been published in the Ecosystem Programmes Occasional Report Series.

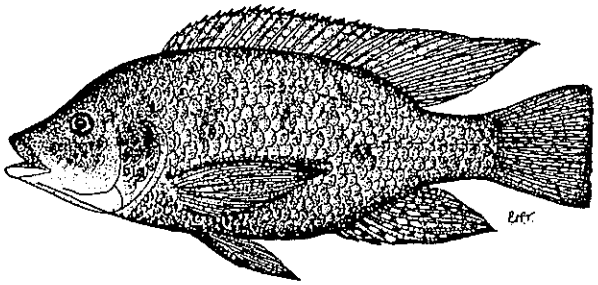
A number of research projects have been initiated in the programme during 1985, including studies on *Oreochromis mossambicus*, *Salmo gairdneri*, *Clarius gariepinus*, *Cherax tenuimanus* and on cichlids.



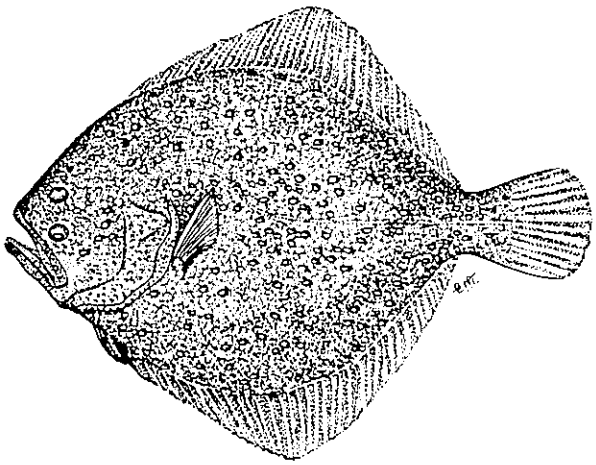
Abalone or perlemoen
(Haliotis midae)



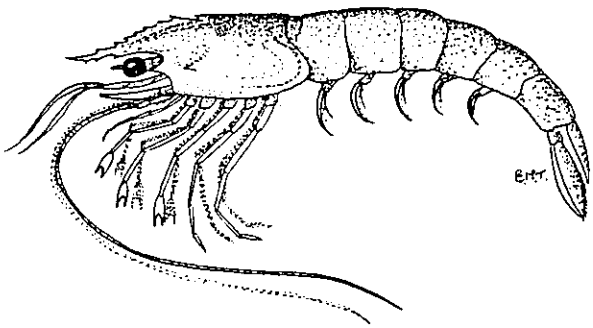
Rainbow trout *(Salmo gairdneri)*



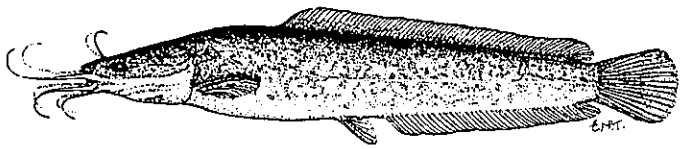
Tilapia *(Oreochromis mossambicus)*



Turbot *(Scophthalmus maximus)*



Marine prawn *(Penaeus monodon)*



Sharptooth catfish *(Clarias gariepinus)*

Examples of priority species for research and development in Aquaculture.
Drawings: Miss E M Tarr, JLB Smith Institute of Ichthyology.

PROJECTS FUNDED DURING 1985

1. The biology and culture potential of cold-tolerant Oreochromis mossambicus in brackish and freshwater of the eastern Cape. Prof M N Bruton (JLB Smith Institute for Ichthyology, Rhodes University), 1985-1986.

2. Aquaculture of aquarium fishes in South Africa with particular reference to cichlids. Dr A J Ribbink (JLB Smith Institute for Ichthyology, Rhodes University), 1985-1988.

3. Least-cost feed development for intensive trout Salmo gairdneri culture in South Africa. Dr T Hecht (Department of Ichthyology and Fisheries Science, Rhodes University), 1985-1987.

4. Environmental requirements of Clarius gariepinus larvae and fry under intensive hatchery culture conditions. Dr T Hecht (Department of Ichthyology and Fisheries Science, Rhodes University), 1985-1987.

5. Size-related nutritional requirements of juvenile and sub-adult Clarius gariepinus under intensive culture conditions. Dr T Hecht (Department of Ichthyology and Fisheries Science, Rhodes University), 1985-1987.

6. Genetic selection of the red mutant of Oreochromis mossambicus as a candidate species for aquaculture. Dr J J Ferreira (Department of Zoology, Rand Afrikaans University), 1985-1988.

7. The energetics of feeding, metabolism and growth in Cherax tenuimanus. Dr G H L Read (Department of Zoology, Rhodes University), 1985-1986.

MAJOR SYNTHESES AND PROGRAMME DESCRIPTIONS

(Abstracts of publications within the South African National Scientific Programmes Report (SANSPR) Series and the FRD Ecosystem Programmes Occasional Report Series, July 1983 - December 1985).

INLAND WATER ECOSYSTEMS

SANSPR 77. Limnology and fisheries potential of Lake le Roux. B R Allanson and P B N Jackson (editors). December 1983. 182 pp.

The fisheries potential of the reservoir in the Orange River has been determined by multidisciplinary studies involving ichthyologists and limnologists. It is argued that the low metabolism of the lake caused by the low summer temperature is the primary factor in control of the reservoir's production of fish. The considerable natural mortality of up to 80 per cent by the end of the third year, occurs due to starvation amongst the small mouth yellowfish. Annual breeding takes place regularly, confined almost exclusively to the flowing Orange River at the lake's upper end. In contrast the other important food fish, the Orange River labeo, spawns irregularly depending on more local rainfall. The total annual yield is provisionally assessed at 150-250 tons, and it is recommended that a commercial gill-net fishery be established, primarily for yellowfish, with a mesh size chosen to optimize the harvest of subadults up to 30 cm long before they die of starvation. Larger fish would remain and form the basis of a recreational angling fishery. Recommendations include the careful monitoring of the commercial catch in conjunction with continued assessment of the response of the stocks to this policy by fisheries biologists of the Cape Department of Nature and Environmental Conservation.

SANSPR 78. Limnology of Lake Midmar. C M Breen (editor). December 1983. 140 pp.

This is a report on a collaborative study undertaken by the University of Natal, the National Institute for Water Research and the Committee for Inland Water Ecosystems. Lake Midmar is a shallow well-mixed water body receiving most of its water from agricultural catchments. The study has shown that the lake is naturally suited to management directed at the supply of good quality water. This objective provides not only for the provision of potable water to a large part of the population of Natal, but also for recreation which has become an important component of the multipurpose use of the upper Mgeni system. The report gives a description of the Upper Mgeni catchment, the limnological characteristics of Midmar and a discussion of nutrient loading and eutrophication modelling.

SANSPR 79. The limnology of the Touw River floodplain. B R Allanson and A K Whitfield. December 1983. 35 pp.

This report is the summary of a larger two-volumed report on the limnology of the Touw River floodplain originally presented to the

Coastal Lakes Working Group in 1981. The floodplain contains a series of shallow lakes, running in an east-west direction between the village of Sedgefield in the east and Wilderness in the west. They have been formed by segmentation of an earlier barrier lagoon associated with the Touw River. The physical and chemical structure of the lakes is dominated by tidal influence when the estuary mouth is open and by erratic flooding of the Touw River and the Duiwe River, the latter flowing into Eilandvlei which during floods is responsible for marked but short-lived pulses of phosphate and nitrate derived from agricultural activity on the upland catchment. Normally the lakes are pristine and constitute, together with their associated reed covered margins, an important wetland for a variety of animal forms, particularly birds. The aesthetic quality of this coastal region and the floodplain is under threat by the demands of human activity associated with urban development.

SANSPR 93. Limnological criteria for management of water quality in the Southern Hemisphere. R C Hart and B R Allanson (editors). December 1984. 181 pp.

(See the highlight on this topic).

SANSPR 110. The limnology of Hartbeespoort Dam. National Institute for Water Research. September 1985. 269 pp.

This is a report of a joint project by the Limnology Division of the National Institute for Water Research in collaboration with the Water Research Commission and the Inland Waters Section of the Ecosystem Programmes. Hartbeespoort Dam has to date posed unsolved management problems, and enjoys intensive multiple use for irrigation, recreation and potable water supply. A simulation model of the functioning of the Dam has been built and used in a predictive mode to evaluate the impact of the 1 mg l^{-1} orthophosphate standard for effluents discharged in the catchment on the functioning of the ecosystem; assess the consequences of hypolimnotic aeration or destratification on the characteristics of the impoundment; assess the feasibility of biological management to ameliorate undesirable properties; assess the protein production potential of the impoundment; and evaluate other in-take management strategies which might become apparent during the study.

SANSPR 113. Alien and translocated aquatic animals in southern Africa: a general introduction, checklist and bibliography. M N Bruton and S V Merron. October 1985. 59 pp.

At least 93 species of alien and translocated indigenous aquatic animals have established populations in southern Africa. Fishes, which constitute the majority (68,8 per cent) of the invasive species, in some cases may have several deleterious effects on aquatic communities, including habitat alterations, removal of vegetation, reduction of water quality, introduction of parasites and diseases, trophic alterations (eg competition and predation), hybridization, extinction of endemic species and overcrowding. In some cases the introduction of alien fishes may

have beneficial effects, as in the culture of fishes for food or for the aquarium trade. All major southern African river systems are inhabited by alien animal species, especially fishes, and the intricate network of intercatchment irrigation canals, pipes and tunnels will further facilitate their transfer. There is therefore an urgent need to assess the impact of invasive animals and to control those populations which are causing damage. There are fewer known invasive animals in the seas surrounding southern Africa (four species), but this aspect has received little attention and more invasive species may be found in future.

A list of references to research and records of alien and translocated aquatic animals in southern Africa is given, as well as a general introduction to the problem of invasive aquatic animals. Reference is made to 587 publications. The genera of invasive species are listed as keywords, and a keyword index is provided.

Perspectives in Southern Hemisphere limnology. B R Davies and R D Walmsley (editors). Published as Developments in Hydrobiology, Vol 28. W Junk, B V Publishers, The Hague, October 1985. 263 pp.

(See the highlight on "The development of limnological guidelines for the management of Southern Hemisphere inland waters".

TERRESTRIAL ECOSYSTEMS

SANSPR 75. Fynbos palaeoecology: a preliminary synthesis. H J Deacon, Q B Hendey and J J N Lambrechts (editors). December 1983. 216 pp.

Current knowledge of aspects of the geology, soils and palaeontology relevant to the study of the palaeoecology of the fynbos region is surveyed. Precambrian sediments, granites and rocks of the early Phanerozoic Cape Supergroup underlie the greater part of the region. The main physiographic features were established by folding during the Cape orogeny (278-215 Myr) and by subsequent erosion and faulting, in part associated with the outlining of the continental margin at the end of the Jurassic (140 Myr). The Cenozoic deposits (0-65 Myr) are discussed in a synopsis of the evolution of the modern landscape. Soils as indicators of palaeoenvironments are reviewed and a description and maps of soils of the Cape coastal platform are included. The palaeontological record as known from the study of the late Tertiary vertebrates, Quaternary large and small mammals, Cretaceous and Cenozoic plant microfossils and macrofossils is described and the palaeoenvironmental implications are reviewed. The history of human occupation of the region is put into perspective. It is clear that the fynbos region, an ancient landscape of high terrain diversity, showing varied substrate lithologies and a mosaic of eutrophic and dystrophic soils, has not been a constant environment over geological time. It is in this setting under conditions of dynamic environmental change that the composition of the modern biota has been determined and the specialized character of fynbos ecosystems has developed.

SANSPR 83. A description of major vegetation categories in and adjacent to the fynbos biome. E J Moll, B M Campbell, R M Cowling, L Bossi, M L Jarman and C Boucher. March 1984. 29 pp.

A scheme of major categories of the vegetation in and adjacent to the fynbos biome is given as a second approximation after Acocks' Veld Types (1953). A four tier hierarchy is presented with nineteen categories of vegetation. The major subdivisions recognized on the basis of their structural, environmental and floristic characteristics are: Cape Fynbos Shrublands, a mosaic of Cape Fynbos Shrublands and Subtropical elements, Cape Transitional Small-Leafed Shrublands; Cape Transitional Large-Leafed Shrublands; Subtropical Transitional Thicket; Afromontane Forest; and Karroid Shrublands.

In addition a vegetation map on which these categories were recognized was produced independently using Landsat imagery.

SANSPR 86. Terrestrial ecology in South Africa - project abstracts for 1982-1983. May 1984. 198 pp.

Abstracts are provided for research projects conducted during 1982-1983 in South African terrestrial ecosystems. The abstracts are arranged alphabetically according to the author's name and a keyword index is provided.

SANSPR 87. Conservation priorities in lowland fynbos. M L Jarman. December 1985. 55 pp.

Natural vegetation in the lowland regions of the fynbos biome has been transformed by modern land-use practices to a patchwork of small remnants. A system is described for identifying sites of conservation merit from these known remnants, and ordering them by means of a numerical rating. The principal factor contributing to the value of the rating is the current rarity of the vegetation types of each site. A second level of factors comprises habitat diversity, plant species richness and the existence of rare or threatened species. A third level of factors includes the size of the remnant, its shape, the degree of invasion by alien woody plants and the degree of other forms of "abuse" such as overgrazing, road building or quarrying. Finally a small bonus score is added to any site having a special attribute such as proximity to any other conserved remnant. Composite scores for 153 sites are presented with recommended conservation priorities in each of the five lowland regions of the study area. Comments on the methodology and the value of the data for further analysis are made.

SANSPR 88. A synthesis of plant phenology in the fynbos biome. S M Pierce. July 1984. 57 pp.

This synthesis provides an inventory of plant phenology in the fynbos biome up to February 1983, and an evaluation of the methods used. Phenology of species, genera and families, and also of communities in

terms of growth forms, individuals and species is compared and discussed in terms of current theory. This includes speculation about phenological implications of tropical origins and biogeography. The ecophysiological model of Specht et al (1983)* which explains the summer growth of certain species in Australian and Cape mediterranean-type ecosystems is refuted for the Cape. Instead, in order to understand plant-function, investigations into root architecture, water budgets, plant-animal interactions and the influence of radiation accumulation are suggested. Synthesis of the data shows that attempts to characterize seasonality in different growth form types are weak. Also, categorization of species into groups showing particular seasonal patterns is limited. The role of phenology in management of fynbos biome vegetation is discussed and its importance in understanding plant dynamics is stressed. Although the summer growth of proteoids is well-known, similar behaviour by certain ericoids and restioids is also observed. However, there is no evidence that fynbos grows in summer and statements concerning the phenology of fynbos biome vegetation types should be more explicit.

SANSPR 91. Monitoring in South African grasslands. M T Mentis. September 1984. 55 pp.

This report is based on a workshop held at Cathedral Peak in the beginning of 1984, which was organized by the Grassland Biome Project of the National Programme for Ecosystem Research. The various objectives of grassland users are spelt out and a system of techniques for monitoring that invite testing is proposed. It is concluded that monitoring in the grassland biome would be facilitated by a national network of bench-mark sites consistently managed in specified ways and assessed periodically. The data obtained would aid in interpreting constancy or change revealed by routine monitoring studies.

SANSPR 96. A guide to the literature on research in the grassland biome of South Africa. N M Tainton. December 1984. 77 pp.

Research into the management of grassland communities in South Africa spans a period of more than 50 years. The work has covered a wide range of topics relating to the form and function of grassland communities, and has had as its main objective the development of an understanding of how these communities can best be managed to ensure their sustained productivity, or indeed to increase their productivity. This publication serves to highlight the main work which has been undertaken in this biome, with the primary intention of providing a ready access to the South African literature on research in the grassland biome.

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*Specht R L, Moll E J, Pressinger F and Sommerville J E M 1983. Moisture regime and nutrient control of occasional growth in mediterranean ecosystems. In: Kruger F J, Mitchell D T and Jarvis J U M (editors). Mediterranean-type ecosystems. The role of nutrients. Springer, New York.

SANSPR 104. The plant communities of Swartboschkloof, Jonkershoek. D J McDonald. March 1985. 54 pp.

Swartboschkloof forms part of the Jonkershoek mountain catchment complex at the headwaters of the Eerste River, Cape Province. It has been selected as a primary study site for the Fynbos Biome Project multidisciplinary studies of mountain fynbos. Using the Braun-Blanquet phytosociological method, vegetation and environmental data were colleced at 201 relevés throughout the study area; 101 of these relevés are correlated with a survey of soils of part of the same area. Sixteen mesic mountain fynbos communities, classified into three groups, and five forest communities, classified into two groups, have been identified. A map of the plant communities is presented.

SANSPR 105. Simulation modelling of fynbos ecosystems: systems analysis and conceptual models. F J Kruger, P M Miller, J Miller and W C Oechel (editors). March 1985. 101 pp.

This report outlines progress with the development of computer based dynamic simulation models for ecosystems in the fynbos biome. The models are planned to run on a portable desktop computer with 500 kbytes of memory, extended BASIC language, and advanced graphic capabilities. The FYNBOS model, which simulates seasonal ecosystems dynamics, is the central model of the project. This model consists of 14 submodels of major ecosystem processes: climate; soil-water balance; energy balance; decomposition; nitrogen cycling; phosphorus cycling; uptake of water and nutrients by roots; carbon balance; growth and demography of shrubs, growth and demography of graminoids; growth and demography of geophytes; seedling growth; propagule dynamics; and plant-animal interactions. An additional two models, which expand aspects of the FYNBOS model, are described: a model for simulating canopy processes; and a Fire Recovery Simulator. The canopy process model will simulate ecophysiological processes in more detail than FYNBOS over a one day time period. The Fire Recovery Simulator models successional dynamics after disturbance with less ecophysiological detail than FYNBOS, over periods of decades and longer. The role of models in systems ecology, and the function of the three models described as aids in the research and management of the fynbos biome are also discussed.

SANSPR 106. The Kuiseb environment: the development of a monitoring baseline. B J Huntley (editor). March 1985. 138 pp.

(See the highlight on this topic).

SANSPR 107. Annotated bibliography of South African indigenous evergreen forest ecology. C J Geldenhuys. May 1985. 125 pp.

Annotated references to 519 publications are presented, together with keyword listings and keyword, regional, place name and taxonomic indices. This bibliography forms part of the first phase of the activities of the Forest Biome Task Group.

SANSPR 114. A synthesis of field experiments concerning the grass layer in the savanna regions of southern Africa. T G O'Connor. October 1985. 126 pp.

This report provides an empirical catalogue of the long-term experiments carried out in southern Africa concerning the grass layer of savannas. This information provides a basis for the investigation of the dynamical response of savanna systems to various management strategies, for a range of savanna types encountered in southern Africa. The study is therefore a keystone in Phase III of the Savanna Ecosystem Project - the study of management strategies for the optimal utilization of savanna ecosystems.

FRD Ecosystem Programmes Occasional Report No 3. Research techniques implemented in a quantitative survey of the woody vegetation of the Nylsvley savanna ecosystem study area. R A Lubke. 28 pp.

The techniques used in the quantitative surveys of the woody vegetation at Nylsvley are described. Certain methods developed for use in forested areas of North America or Europe require modification when applied to a savanna ecosystem for measuring abundance of trees and shrubs. Estimates of percentage frequency, density, importance, biomass and pattern of the species have been achieved in studies over eight years. These estimates have also been used to assess the standing crop and the dynamics of the woody plants over this time period.

NATURE CONSERVATION RESEARCH

SANSPR 72. South African programme for the SCOPE Project on the Ecology of Biological Invasions. A description and research framework produced by the Task Group for Invasive Biota of the National Programme for Environmental Sciences. July 1983. 25 pp.

A description of the aims of the international SCOPE Project on Biological Invasions is provided, together with a proposed four year time-table of international activities. This is followed by a brief account of the history, organization and current aims and approaches for research on invasives in South Africa. A motivation for increased research is included in the form of a set of key questions and a list of current and future research priorities for the South African component of the international SCOPE programme. A list of current research projects together with the list of institutions conducting research in this field is intended as a comprehensive future directory of South Africa's research activity in this field.

SANSPR 76. A South African perspective on conservation behaviour - a programme description. A A Ferrar (compiler). December 1983. 34 pp.

In South Africa there is a serious lack of understanding of the relationship between human behaviour and environmental conservation. A multidisciplinary field of study is described dealing with the causes and effects of people's attitudes and behaviour relative to their use of the natural environment. A conceptual framework is proposed for determining

research priorities in this new field of study. The framework describes four components, namely the setting of goals, the accumulation of baseline data (inventory and survey), analytical research (establishing cause and effect relationships) and a re-evaluation or monitoring component. Responses are invited from researchers in a wide variety of scientific and social disciplines in order to develop the programme and define research priorities.

SANSPR 85. Invasive alien organisms in the terrestrial ecosystems of the fynbos biome, South Africa. I A W Macdonald and M L Jarman (editors). April 1984. 72 pp.

This workshop report consists of a series of short accounts following brief "question and answer" sessions relating to the following major topics concerning fynbos terrestrial invasives: the extent of the invasives problem, the causes of the invasives problem, impacts of invasives, solutions to the invasives problem and identification of short-term research priorities. Accounts are brief and in many cases limited to a point-form summary. Tables were used extensively in the workshop situation. These are presented, with some synthesis of the findings. A comprehensive bibliography of fynbos invasive research is included.

SANSPR 92. Conservation of threatened natural habitats. A V Hall (editor). November 1984. 185 pp.

This book has grown from the proceedings of the International Symposium on the Conservation of Threatened Natural Habitats held at the University of Cape Town in September 1980, which brought together workers with extended experience from over 100 countries and all continents. It provides a global perspective on many issues fundamental to the conservation, utilization and management of the planet's varied habitats. The scope of the threatened habitat problem, the objectives of habitat conservation in the light of practical obstacles, genetic aspects, the ecosystem modelling approach to the management of endangered species and theoretical aspects of management and selections of areas for conservation are discussed.

SANSPR 97. South African Red Data Book - Birds. R K Brooke. December 1984. 213 pp.

Red data sheets are provided for 102 species of birds that breed on the South African mainland and a further six species for the oceanic Prince Edward islands. Species are listed according to the established IUCN criteria of extinct, endangered, vulnerable, rare, out of danger or indeterminate. Each data sheet is accompanied by a list of published sources and most by a distribution map. Of the 108 species, two are judged to be locally extinct and five have been allocated to the locally endangered category. Twenty-one species are vulnerable, 44 species rare, one species out of danger and 35 species are as yet indeterminate. Indications of past research effort and of future needs in both research and conservation management are provided, together with a comprehensive rare species bibliography.

SANSPR 98. Directory of southern African conservation areas. T Greyling and B J Huntley (editors). December 1984. 311 pp.

This directory provides detailed information on 155 conservation areas of greater than 1 000 ha administered by government and statutory bodies in the Republics of South Africa, Transkei, Bophuthatswana, Ciskei and Venda, and the Kingdoms of Lesotho and Swaziland. The data sheets for each of the 155 areas described include details on date of proclamation, geographical features, vegetation, flora and fauna, infrastructure and principal reference material. A synthesis of the data examines the historical development of the conservation area network in southern Africa, and provides analyses of the area conserved by state, province, management category, management authority and by biome and vegetation type. The synthesis concludes that greater emphasis should be placed on the acquisition of more land for conservation in the highveld grassland, succulent karoo and lowland fynbos ecosystems of southern Africa. The conserved areas cover a total of 5,76 million hectares, or 4,5 per cent of southern Africa.

SANSPR 109. Coastal dunes of South Africa. K L Tinley. September 1985. 293 pp.

(See the highlight on this topic).

SANSPR 111. Management of invasive alien plants in the fynbos biome. I A W Macdonald, M L Jarman and P Beeston (editors). October 1985. 140 pp.

This report summarizes available information on the control of alien plants invading areas of natural and semi-natural vegetation in the fynbos biome. Historical accounts of the control operations carried out by a representative range of land managers are presented. Distribution maps are provided for 24 of the most important alien species and the known extent of current infestations and past control operations are mapped for two groups of woody species. Area statistics extracted from these maps are tabulated. Proposals are made for the improvement of current control action.

SANSPR 117. South African Red Data Book: Plants - fynbos and karoo biomes. A V Hall and H A Veldhuis. 1985. 144 pp.

A list is given of 1 808 rare, threatened and recently extinct plants in the fynbos and karoo biomes in the Cape Province. The area covers the south-western and southern Cape, Namaqualand and the Karoo. Following the IUCN categories the area has 29 plants extinct, 118 endangered, 183 vulnerable, 495 critically rare, 281 indeterminate and 702 uncertain. Local lists are given for the main biogeographic zones in the area. The extent and causes of the threatened plant problem are discussed and lines along which research and conservation action might follow are proposed. Data are provided on the populations and conservation priorities of about 250 species.

FRD Ecosystem Programmes Occasional Report No 2. Guidelines for the bird atlas of southern Africa. Proceedings of a workshop held in Cape Town, 23-24 August 1984. P A R Hockey and A A Ferrar (compilers). 55 pp.

Bird atlassing harnesses the energy and expertise of a large number of naturalists, directing them purposefully towards scientific data gathering. The valuable end product, the Bird Atlas, would not be practical to attempt, were it not for widespread amateur involvement. The guidelines presented here provide a professional consensus on how local atlassing activities can best contribute towards a subcontinental "Bird atlas of southern Africa". They represent a framework for achieving this goal by the end of 1996. The scientific justification and the complicated administrative issues involved are discussed, together with a more detailed examination of the technical constraints within which bird atlassing must be conducted. Brief summaries of the current status of twelve existing bird atlassing schemes in southern Africa are presented. The principal implications of these guidelines are the need for a full-time atlas coordinator and the necessary development of atlassing, together with other forms of centralized bird data handling, towards an eventual Southern African Bird Populations Data Bank.

HUMAN NEEDS, RESOURCES AND THE ENVIRONMENT

SANSPR 116. Basic needs in rural areas. A report on a seminar held in Cape Town on 19 February 1985. December 1985. 103 pp.

(See the highlight on this topic).

AQUACULTURE

SANSPR 89. Aquaculture in South Africa: A cooperative research programme. O Safriel and M N Bruton. June 1984. 79 pp.

This document presents the basic framework of a national cooperative aquaculture research programme. Organisms which have a high potential for aquaculture are listed and the research priorities categorized into topics such as the types of aquaculture systems required, nutritional requirements, hatchery systems, diseases and economics.

FRD Ecosystem Programmes Occasional Report No 1. Aquaculture South Africa. Proceedings of a joint symposium by the Council for Scientific and Industrial Research and the South African Agricultural Union held at Cathedral Peak Hotel, Drakensberg, Natal, 3-4 May 1984. T Hecht, M N Bruton and O Safriel (editors). 1985. 156 pp.

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*Theses arising from the Human Needs, Resources and the Environment and Aquaculture programmes not included.

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