

SANCOR

Summary report on marine research 1988

Summary report prepared for SANCOR by the
Chairmen of the Programme Committees

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COVER:

PREFACE

The South African National Committee for Oceanographic Research (SANCOR) Programme is one of a number of cooperative research programmes which have been managed by the Foundation for Research Development (FRD) of the Council for Scientific and Industrial Research (CSIR). These programmes depend upon cooperation between scientists and engineers from various organizations and disciplines for the solution of diverse questions including many with important management applications.

During 1988 the SANCOR programme was administered under seven sub-programmes. These were: Benguela Ecology, Coastal Processes, Estuaries, Marine Linefish, Marine Pollution, Ocean Engineering and the South African World Ocean Circulation Experiment (WOCE) and Open Ocean Programme.

This summary report is published every year. It comprises the annual chairmen's reports from each programme and is supplementary to a volume, of which a limited number is printed, containing the progress and final reports submitted to SANCOR during 1988.

The financial support of the CSIR, the Department of Environment Affairs and the Central Energy Fund are gratefully acknowledged. Without their contribution and encouragement the important marine research undertaken in the SANCOR programme would not be possible.

Special thanks are due to all SANCOR committee members and programme chairmen who have, during 1988 more than any other year, given of their wisdom and time to assist in guiding marine science research in South Africa. The year 1988 has been a one of uncertainty and reorganisation, the support and assistance the community provided in this process is sincerely appreciated.

ABSTRACT

The South African National Committee for Oceanographic Research has coordinated and administered a significant portion of the marine research conducted in South Africa under seven sub-programmes. These are: Benguela Ecology, Coastal Processes, Estuaries, Marine Linefish, Marine Pollution, Ocean Engineering and a South African contribution to the World Ocean Circulation Experiment (WOCE). This report includes brief statements on the activities of each of these programmes in 1988 and emphasizes important findings and conclusions.

The total budget for SANCOR for 1988 was approximately R 3 570 000.

OPSOMMING

'n Belangrike deel van mariene navorsing in Suid-Afrika is deur die Suid-Afrikaanse Nasionale Komitee vir Oseanografiese Navorsing in sewe sub-programme gekoördineer en geadministreer. Die programme is: Benguela-ekologie, Kusprosesse, Getyriwiere, Mariene Lynvis, Seebesoe-deling, Oseaan Ingenieurswese en 'n Suid-Afrikaanse bydrae tot die 'World Ocean Circulation Experiment (WOCE)'. Hierdie verslag bevat beknopte samevattinge van die aktiwiteite van elk van hierdie programme gedurende 1988 en beklemtoon belangrike bevindinge en gevolgtrekkings.

Die total begroting vir SANKON vir 1988 was ongeveer R 3 570 000.

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EXECUTIVE SUMMARY

The following is a summary of selected highlights and important findings extracted from the Chairmen's reports for 1988.

BENGUELA ECOLOGY PROGRAMME

SANCOR allocation for 1988 : R 862 507

Number of SANCOR-funded projects:	24
Researchers funded	17
Publications	59
Publications in press	14
Post graduate qualifications	3 MSc
	5 Hons

- Against the background of change and rationalization within both the CSIR and the SFRI, the Scientific Committee, after much deliberation, clarified the research framework of the programme into three primary research directions:

- . the detailed functioning of the overall Benguela system,
- . the spatial and temporal variability characterizing key elements and processes within the system and
- . the vital specialist support required by resource managers.

All BEP projects have been placed within this framework which will provide a timeous sharpening of the research focus within the Programme.

- The Inshore Systems Project which came to an end in 1987, was highly successful, producing many results of scientific importance, some with significant implications for resource management in the coastal zone. A major review of the work of the project, and of earlier work on the inshore region of the Benguela, has appeared in the 1988 issue of the prestigious Annual Reviews of Oceanography and Marine Biology.
- Three short-term projects on euphausiids, jellyfish and microzooplankton were completed. The evaluation of the research findings of these projects made possible the launching of a new Invertebrate Zooplankton Project.
- The BEP's association with senior overseas scientists who have become consultants to the programme has continued. Amongst those who have visited are: Professor Richard Newell of the Plymouth Marine Laboratory, Dr Tony Starfield (Minnesota and Cambridge), Dr Bill Peterson of SUNY, New York, Dr Anne Linley from Plymouth, and Dr Val Loeb from Moss Landing, California.

- The BEP welcomed the launch of the South African International Geosphere Biosphere Programme and made a strong contribution to its first meeting, the National Conference on Long-Term Data Series Relating to Southern Africa's Renewable Natural Resources.
- The BEP continues to see evaluation as essential to the maintenance of the high quality of research and output from the programme. This evaluation takes place when a project is proposed, each year of its duration, and on its completion. The Benguela and Comparable Ecosystems Symposium in 1986 resulted in a major international evaluation of the first five year phase of the BEP, and a similar but more focused international assessment is being planned at the end of its second phase.

COASTAL PROCESSES PROGRAMME

SANCOR allocation for 1988 : R753 900

Number of SANCOR-funded projects:	27
Researchers funded	28
Publications	80
Publications in press	8
Manuscripts	14
Post graduate qualifications	3 PhD
	4 MSc

- The probable consequences of harvesting the limpet *Patella granularis* have been established. Recruitment of this species is dependent upon the presence of a viable population of adults in close proximity to the sites cleared through harvesting. This goes counter to previously held opinions that recruitment of broadcast spawners such as limpets may originate from populations located at substantial distances from the settlement site. An optimal harvesting strategy could be formulated from the results.
- The invasive exotic rock mussel *Mytilus galloprovincialis* was shown to outcompete its indigenous counterparts, *Choromytilus meridionalis* and *Aulacomya ater*, and is expected to have a substantial impact on the Brown Mussel, *Perna perna*. Attention is drawn to the potential of *M galloprovincialis* as an exploitable resource.
- The Natal Dolphin Working Group was established at the request of the Coastal Processes Programme Committee. This involves all the researchers active in studying dolphins off the East coast. It is functioning effectively, co-ordinating research and facilitating the exchange of ideas and information.
- The impact of increasing population pressure on the coast has been a major consideration in the planning of the Programme since its inception. During 1988 close cooperation with social scientists was initiated and two projects aimed at establishing human attitudes towards, and perceptions of, the marine environment as a national amenity have commenced. These are funded jointly by SANCOR and the Human Sciences Research Council and are strongly supported by the Department of Environment Affairs.

ESTUARIES PROGRAMME

SANCOR allocation for 1988 : R479 453

Number of SANCOR-funded projects:	18
Researchers funded	13
Publications	51
Publications in press	12
Post graduate qualifications	5 MSc
	3 Hons

- Increasing cooperation across disciplinary and institutional boundaries within the SANCOR estuaries programme has over the years resulted in:
 - . the production of a series of reports, scientific publications and popular publications including definitive management recommendations on the Bot River system;
 - . a series of scientific reports and a popular publication on the role of estuaries in the life cycle of several marine fishes;
 - . the application of a one-dimensional hydrodynamic computer model for research in a series of estuarine river systems, e.g. the Wilderness Lake system, Swartvlei, Knysna, Swartkops, Boesman and Kariega;
 - . the accumulation of a wide base of knowledge and/or data resulting from coordinated research on several big systems e.g. Bot, Langebaan, Swartvlei, Swartkops, Sondags, St Lucia and Kromme;
 - . an improved understanding of geological and sedimentological processes in the eastern Cape (Rosie programme), in Natal (SEAL programme) and in the West and southern Cape;
 - . research undertaken in the Kariega and Great Fish River systems in the eastern Cape which addressed the freshwater requirements of these estuaries;
 - . the publication of the document 'An assessment of the state of the estuaries of the Cape and Natal in 1985/86' which is being used extensively by planning authorities;
 - . the establishment of a biotic index whereby estuaries can be classified according to their biotic components. This classification can then be explained on the basis of physical and chemical characteristics of these estuaries and their catchment areas. This work has now been extended in Natal to a degradation index which indicates to what extent an estuary has declined since its early pristine state.
 - . An improved understanding of the functioning of estuaries by the timely, co-operative studies launched immediately after natural disasters such as hurricane Damoina, the 1987 Natal floods and the 1988 Orange River flood.

MARINE LINEFISH PROGRAMME

SANCOR allocation for 1988 : R163 947

Number of SANCOR-funded projects:	13
Researchers funded	10
Publications	38
Publications in press	7
Post graduate qualifications	1 PhD
	3 MSc

- Important resource management recommendations were made for the bronze bream, red steenbras and geelbek. There are some similarities between these recommendations and considerable further improvement in the 1984 linefish regulations is now possible.
- A finding common to several reef fish has been their slow growth, late maturing and sex reversal. Bronze bream, musselcracker and red steenbras all attain ages of 30 years; while roman and dageraad may reach 20 years. This explained the apparent slow recovery of these and related fisheries (such as the seventy-four) and emphasises the need for larger term studies.
- Adult geelbek migrate seasonally from the Southern Cape to Natal in order to spawn and also to feed on a variety of pelagic fishes - especially the pilchard. Vulnerability of this species to fishing pressure during its spawning aggregation is partly the reason for its heavily over-exploited status.
- Good progress has been made with techniques of age determination; especially in the interpretation and validation of results. The development of specific linefish techniques and methods includes optimal sampling strategies in linefish data collection, fitting of growth curves, yield per recruitment analyses and hook size selectiveness.
- The National Marine Linefish Catch Statistics Programme increased substantially with 330 000 recreational anglers' and 550 000 commercial fishermen's outings documented. The ORI tagging project now has 1 750 tagging members with nearly 25 000 fishes tagged. Results from both these projects are incorporated in other studies.

MARINE POLLUTION PROGRAMME

SANCOR allocation for 1988: R538 281

Number of SANCOR-funded projects:	12
Researchers funded	18
Publications	34
Publications in press	Nil
Post graduate qualifications	1 PhD
	1 MSc
	2 Hons

- The influence of intermittent and diffuse sources is being examined in two ways, firstly as so-called stormwater, and secondly the occurrence and distribution of ubiquitous chlorinated hydrocarbons. Rapid urbanization and industrial deregulation in South Africa means increased contamination of urban runoff. Studies in northern False Bay and in Algoa Bay and the Swartkops River have demonstrated the limited dispersion obtained with shoreline discharges. What is also emerging is that there is a consistent 'base flow' present in these discharges equivalent in some cases to that from runoff.
- Chlorinated hydrocarbons continue to provide significant research activity. These are materials which are virtually impossible to control other than by restricting their manufacture.
- Research on matters which relate to public health interest have featured strongly in the MPP in the last few years. Cooperative plans with the Medical Research Council are materializing to examine more exactly the relationships between water quality and diseases associated with swimming or eating contaminated shellfish.
- In early September a one-day technical symposium was held in Muizenberg to examine the nature, degree and control of marine pollution in South African coastal waters.

SA WOCE AND OPEN OCEAN PROGRAMME

SANCOR allocation for 1988: R95 000

Number of SANCOR-funded projects:	4
Researchers funded	2
Publications	31
Post graduate qualifications	1 PhD

- The importance of South Africa's role in the international WOCE is evidenced by South African participation in the planning meeting for the Southern Ocean component of WOCE in Bremerhaven, the global ocean planning meeting in Washington, and the implementation phase and hydrographic programme planning meeting in Woods Hole.
- South Africa's proposal for field experiments during the prestigious TOPEX/POSEIDON satellite mission has been accepted.
- A number of precision sea level gauges are being built and deployed around the South African coast in preparation for WOCE
- Studies on the fluxes of heat and moisture at the Agulhas retroflexion are being linked to weather and climate in Southern Africa.
- The planned South African contribution to the international WOCE will consist of elements most directly beneficial to South Africa. These include the flux of the Agulhas Current, exchange between the Indian and Atlantic Oceans, circulation in the Cape Basin and heat flux across the Subtropical Convergence.

OCEAN ENGINEERING PROGRAMME

SANCOR allocation for 1988: R450 000*

Number of projects:	8
Researchers funded	5
Publications	7
Post graduate qualifications	1

- A conceptual design report on "Foundation and structural monitoring" resulted from the project investigating the prediction of pile behaviour in offshore structures for South African calcarenis sand conditions.
- Research on the bearing capacity of offshore piles and numerical modelling and piles has confirmed the basis for decisions on the design of the foundations of the platform.
- Two publications are in preparation on the formation of giant waves through the interaction of the wave and current systems and their interaction with the structure.

* SANCOR: R150 000, CEF: R300 000.

TERMS OF REFERENCE OF SANCOR

The terms of reference of the South African National Committee for Oceanographic Research (SANCOR) are to provide policy and scientific guidance in matters pertaining to oceanographic research in South Africa by designating priorities. Specifically it:

- takes cognizance of actions and developments affecting marine science and technology in southern Africa and promotes communication within the oceanographic community;
- reviews the objectives, priorities and progress of its constituent programmes;
- guides effort by deciding on the funding of its constituent programmes, keeping in mind also the need for balance both geographical and disciplinary;
- ensures that its research findings reach decision makers;
- keeps informed on international developments in marine science, *inter alia* by acting as national committee for SCOR and related international bodies.

OBJECTIVE

The objective of the SANCOR Programme is to gain knowledge of the basic structures, processes and relationships in the marine environment around southern Africa in order to provide a fundamental scientific understanding and to facilitate:

- the efficient exploration, exploitation and conservation of living and non-living resources;
- the judicious management of the coastal zone;
- improved prediction of weather and climate;
- improved utilization of environmental information in maritime activities.

THE BENGUELA ECOLOGY PROGRAMME

INTRODUCTION

The year under review was the second year of the second five-year phase of the BEP, a research programme which seeks, in its principal goal, to improve knowledge of the dynamic processes controlling the distribution and abundance of standing stocks of key species in the Benguela system. It is the responsibility of the BEP Scientific Committee to establish a suitable research framework within which this principal goal can be achieved. This year, against the background of change and rationalization within both the CSIR and the SFRI, the Scientific Committee, after much deliberation, clarified the research framework of the programme into three primary research directions:

- the detailed functioning of the overall system
- the spatial and temporal variability characterizing key elements and processes within the system and
- the vital specialist support to management.

All BEP projects have been placed within this framework which will provide a timeous sharpening of the research focus within the Programme. It has been endorsed by the BEP community.

PROGRESS AND NEW DEVELOPMENTS

The impact of the long-running Inshore Systems Project which came to an end in 1987 continued to be felt. The project sought to investigate the factors controlling community structure in intertidal and shallow water ecosystems and to trace the flow of energy through such communities in the Benguela region. The customary evaluation of the completed project revealed that over its seven years it had been supported by SANCOR in respect of 22 man years of which seven were post-Ph.D. With the project leaders, the project personnel published no fewer than 44 international journal articles, 21 local journal articles and nine chapters in books. Three masters degrees and three Ph.D.'s were awarded to project personnel. The project was highly successful, producing many results of scientific importance, some with significant implications for resource management in the coastal zone, e.g. the importance of thinning-out rather than stripping of mussel beds during harvesting, the negative effect on the primary input of energy to sandy beaches of gathering kelp from these beaches, and the impact that rock lobsters have on the benthic community structure has been clearly identified. A major review of the work of the project, and of earlier work on the inshore region of the Benguela, has appeared in the 1988 issue of the prestigious Annual Reviews of Oceanography and Marine Biology. This project was a cornerstone of the BEP to date and its completion meant that less emphasis will be placed on the inshore systems in the future.

1987 also saw the completion of three short term projects on euphausiids, jellyfish and microzooplankton. These projects were intended to investigate the places of these organisms in the planktonic food chain of the southern Benguela. It was found that the patchiness of the distribution of red jellyfish made estimates of their abundance difficult without undertaking a major survey, possibly using acoustic techniques. However, the abundance of these jellyfish observed at certain sites was such that it seemed easily possible for them to completely clear the water of all zooplankton. This may be a significant factor in contributing to the relatively low zooplankton biomass observed in the southern Benguela, and thus accordingly contribute to limiting fish production. The evaluation of the research findings of these projects made possible the launching of a new Invertebrate Zooplankton Project which will now form one of the major thrusts of the Programme. It brings together several well established researchers, and the success of the small projects and the enthusiasm which they generated should mean that the new project will be highly productive.

The BEP has always gained considerably from its association with senior overseas scientists who have become consultants to the programme. In 1988 Prof. Richard Newell of the Plymouth Marine Laboratory spent a month with the BEP early in the year. He took part in two workshops on nutrient cycling and had detailed discussions with members of the Food Chain and Whole Systems projects. Later in the year a second programme of workshops on modelling organized by the Whole Systems Group was led by Dr Tony Starfield (Minnesota and Cambridge). The BEP continues to benefit from the presence of Dr Bill Peterson in the Invertebrate Zooplankton work. Whilst Dr George Jolly has not visited during 1988, his improved anchovy survey design continued to attract attention at international meetings and to provide tangible benefits in the considerably higher anchovy quota for the South African pelagic fishing industry. Other visitors included Dr Anne Linley from Plymouth, and Dr Val Loeb from Moss Landing, California, who spent three months working in the Historic Ichthyoplankton Project.

A number of BEP researchers undertook overseas visits during the year. Dr Robert Crawford participated at a workshop in Mexico where the importance of global-scale environmental influences in determining long term shifts in the distribution and abundance of sardine and anchovy stocks was highlighted. Dr Mike Armstrong presented a paper on the egg production methodology used in assessment at the annual CalCOFI meeting in California, and Dr Dave Pollock, Geoff Bailey and Andy James attended the Joint Oceanographic Assembly in Mexico.

During the year the BEP continued with its successful Monday Forum with an increasing emphasis being placed on discussion of data and ideas, rather than the presentation of final results. A number of workshops were also held and these continue to stimulate the interdisciplinary interaction which is one of the strengths of the Programme.

The South African International Geosphere Biosphere Programme was launched in 1987 with a National Conference on Long-term Data Series Relating to Southern Africa's Renewable Natural Resources. The conference saw the involvement of many participants from the BEP community and a strong marine contribution was made to the proceedings.

In 1988, four new projects were initiated and an ongoing project on sediment fluxes through the water column was transferred to the BEP from another SANCOR programme. One of the new projects is the Statistical Advisory Service for members of the BEP community. This project fulfilled a long felt need for expert statistical advice to be available to projects at all stages of their development. The service will be particularly valuable for those projects which are due to terminate in 1988. The quality of their results should be enhanced by exposure to the service and to the training workshops on particular statistical techniques held on two occasions in 1988.

As five projects finished in 1987 (one was terminated after a non-start) and six new projects started, there were 24 projects funded by SANCOR in the BEP during 1988. In terms of the three primary research directions accepted by the BEP, 10 projects are concerned with aspects of the detailed functioning of the overall system, 15 with the spatial and temporal variability of the processes and components, and 7 with more direct specialist support in assessment and management procedures. Naturally a number of projects address overlapping issues and so contribute to more than one direction.

EVALUATION WITHIN THE BEP

During the seven years of its existence the BEP has seen evaluation as essential to the maintenance of the high quality of research and output from the programme. This evaluation takes place when a project is proposed, each year of its duration, and on its completion. Initial proposals are evaluated by independent outside scientists, the Scientific Committee of the BEP and finally by the Programme Committee. Over the past seven years this has resulted in 78% of the proposals received being accepted. During the acceptance process liaison between the evaluators and the proposers often results in the improvement of initial proposals. During the annual review of progress reports emphasis is given to feedback from the Scientific and Programme Committees to project leaders. On the completion of the project the final products (publications, reports, trained manpower, management advice, etc) are keenly assessed in the light of the funds spent on the project and the total man-years it has taken. Thus far over 800 publications in peer-reviewed international journals have emanated from research undertaken in the BEP and more than 32 M.Sc's and Ph.D.'s have been awarded. Of the senior research leaders in the programme who are eligible for FRD evaluation six have an FRD rating of B and 10 have a C rating. These researchers account for 61% of the senior manpower, with 36% being people employed by the Sea Fisheries Research Institute and the CSIR and thus ineligible for evaluation to date. The Benguela and Comparable Ecosystems Symposium in 1986 resulted in a major international evaluation of the first five year phase of the BEP, and a similar but more focused international assessment is being planned at the end of its second phase.

THE FUTURE

The Programme is now entering the hard grind of the middle years of its second five year phase. We have a research structure built around the three research thrusts. We have key long term projects such as Population Modelling, Whole Systems, Food Chains, The Frontal Group and the Predation Group now joined by Invertebrate Zooplankton and the resuscitated Aggregating Behaviour Project. We have enthusiastic scientific researchers in all areas of our Programme. I look forward to the products of the second five year phase of the BEP.

G B Brundrit

CHAIRMAN: BENGUELA ECOLOGY PROGRAMME COMMITTEE

BENGUELA ECOLOGY PROGRAMME: PROJECTS 1988

<u>Projects and project leaders</u>	<u>Duration</u>
Benguela Pilchard and Anchovy Growth (J G Field, UCT)	1984 - 1988
Prey Identification Service (G J B Ross, MPE)	1986 - 1989
Benguela Resources Population Modelling (D S Butterworth, UCT)	1987 - 1991
Benguela Systems Analysis (A): Whole System Approach to the Pelagic Fishery (J G Field, UCT)	1987 - 1991
Benguela Systems Analysis (B): Historic Ichthyoplankton Analysis (J G Field, UCT)	1987 - 1988
Sound Scattering from Fish Targets (I Hampton, SFRI)	1987 - 1989
Benguela Aggregating Behaviour of Pelagic Fish (G B Brundrit, UCT)	1987 - 1989
Benguela Survey Strategy Evaluation (D S Butterworth, UCT)	1987 - 1992
Clupeoid Piscivory and Year Class Strength (J G Field, UCT)	1987 - 1988
Spawning Patterns of Pelagic fish off South Africa (M Armstrong, SFRI)	1987 - 1988
Carbon and Nitrogen Isotope Ratios: Indicators of Food Sources and Habitats of Pelagic Fish in the Benguela Ecosystem (N J Van der Merwe, UCT)	1987 - 1988
Plankton Food Chains (M I Lucas, UCT)	1987 - 1991
Physical Oceanography and Plankton Dynamics in the Anchovy Spawning Area (R A Carter, EMA)	1987 - 1989

BENGUELA ECOLOGY PROGRAMME: PROJECTS 1988 (Continued)

<u>Projects and project leaders</u>	<u>Duration</u>
Physical Structure of an Upwelling Filament (F A Shillington, UCT)	1987 - 1990
Kinematics of the Benguela Upwelling Dynamics (W S Barnard, USTL)	1987 - 1989
Benguela Squid Ecology (M R Lipinsky, UCT)	1987 - 1991
Dolphins as Indicators of the Distribution and Shoaling Behaviour of Pelagic Fish (J D Skinner, UPTA)	1987 - 1989
Benguela Piscivorous Fish (J G Field, UCT)	1987 - 1989
Foraging Ecology and Reproductive Success of Cape Gannets (W R Siegfried, UCT)	1987 - 1991
Monitoring of Anchovy Recruitment and Penguin Populations in the Benguela Ecosystem (W R Siegfried, UCT)	1987 - 1991
Towed Undulating Ocean Data Logger (TUODL) (G B Brundrit, UCT)	1988 - 1991
Invertebrate Zooplankton Feeding Reproduction and Interactions with Pelagic Fish (L Hutchings, SFRI)	1988 - 1991
Indian/Atlantic Interbasin Exchange (WOCE) and Benguela Upwelling Frontal Mixing (BEP) Study (M R Jury, UCT)	1988 - 1989
Statistical Support for Benguela Ecology Programme (L G Underhill, UCT)	1988 - 1991

COASTAL PROCESSES PROGRAMME

The Programme for Coastal Processes was due for review during 1988, with the appointment of a new programme committee and chairman. The imminent dissolution of the National Scientific Programmes and their replacement by FRD Special Programmes has, however, necessitated a holding operation, with the reappointment of the Committee as constituted in 1987, but under the chairmanship of Prof J Heeg, who replaced Prof T Erasmus following the latter's resignation from the Committee. Commitments to the existing programme needed to be met up to the end of 1989 through the established process of evaluation and allocation of funding.

The budget of R753 900 for 1988 was distributed among 27 projects, ten of which are due to terminate at the end of the current year. Regional analysis of these allocations is as follows:

<u>Region</u>	<u>Number of projects</u>	<u>Percentage of budget</u>
Western Cape	8	25%
Eastern Cape	14	58%
Natal	5	17%

Nine projects concerned with various aspects of sandy shores and their associated dune systems accounted for 47% of the total budget. This work, which involves several disciplines (sedimentology, biology, chemistry, etc.) and enjoys strong support from the Department of Environment Affairs, is largely centred on the University of Port Elizabeth (6 projects), with the Division of Earth, Marine and Atmospheric Science and Technology of CSIR and Rhodes University Accounting for the remainder. Other projects funded cover a variety of coastal problems, chiefly involving potential or realised human impact on coastal resources.

PROJECTS COMPLETED

Final reports on two projects, one completed and one terminated at the end of 1987 have been received.

Recruitment of Limpets and its relevance to harvesting

Project leader: W R Siegfried (Percy Fitzpatrick Institute for African Ornithology)

This project has yielded valuable results relevant to both the exploitation of limpets and broader issues in rocky shore ecology. In addressing the probable consequences of commercial harvesting of the limpet *Patella granularis*, the team have established that recruitment of this species is dependent upon the presence of a viable population of adults in close proximity to the sites cleared through harvesting. This goes counter to previously held opinions that recruitment of broadcast spawners such as limpets may originate from populations located at substantial distances from the settlement site.

An optimal harvesting strategy could be formulated from the results. It was further established that the invasive exotic rock mussel, *Mytilus galloprovincialis*, unlike its indigenous counterparts *Choromytilus meridionalis* and *Aulacomya ater*, provides a favoured settling site for young *P. granularis*, but that this advantage is unlikely to be sustained in the long term since *M. galloprovincialis* competes with the adult limpets for primary space. The team shows further that *M. galloprovincialis* outcompetes *C. meridionalis* and *A. ater*, and suggests that under the warmer water conditions of the South and South-East coasts it is also likely to have a substantial impact on the Brown Mussel, *Perna perna*. Attention is further drawn to the potential of *M. galloprovincialis* as an exploitable resource. Two publications have resulted from the research, with a further four either in press or in preparation.

Intertidal and Nearshore Benthic Ecology of Walker Bay

Project leader: C L Griffiths (University of Cape Town)

This project was undertaken as part of an interdisciplinary investigation in Walker Bay, where an intensive study on sediment dynamics (EMA) was being conducted. The aim was to establish the influence of sediment movements on the distribution of the intertidal and subtidal fauna in the study area. Studies on the intertidal macrofauna were completed during 1987, but it was felt, with the concurrence of the research team, that the results yielded did not justify the cost of continuing the work, particularly in the present climate of financial stringency. The results obtained during the one year tenure of the project are, at present, being prepared for publication.

THE DOLPHIN/SHARK NET CONTROVERSY

At its 1987 meeting, the Committee discussed the circumstances surrounding the much publicised and highly emotive issue of dolphin mortality in shark nets, which, through sensational and not always accurate media reporting of interviews with scientists involved, was rapidly becoming an area of friction between scientists, funding organisations, conservation bodies and government agencies. The Committee requested Prof G M Branch to investigate and, if possible, defuse the issue, and to establish a working group which would ensure cooperation between all those involved. Thanks to Prof Branch's efforts, this has been achieved, with the Natal Dolphin Working Group now coordinating all dolphin studies and facilitating the exchange of ideas and information.

INVOLVEMENT OF SOCIAL SCIENTISTS IN MARINE RESEARCH

The impact of increasing population pressure on the coast has been a major consideration in the planning of the Programme for Coastal Processes since its inception. During 1988 closer cooperation with social scientists in addressing this overriding problem was initiated. Two projects aimed at establishing human attitudes towards, and

perceptions of, the marine environment as a national amenity have commenced; these are funded jointly by SANCOR and the Human Sciences Research Council and are strongly supported by the Department of Environment Affairs. The investigations are, initially, concerned with devising suitable methods of assessment.

A one-day workshop on 'People on Beaches and Dunes', organised and chaired by Mr Tim Hart of the HSRC, brought together natural and social scientists, all of whom were involved in research on the human impact on, and attitudes towards, coastal dune and beach systems. The discussions were aimed at an exchange of information on the kinds of problems being investigated and an evaluation of the different methods used to determine human attitudes and perceptions. The desirability for merging the very different approaches to the common problem was clearly apparent from the discussions and future consultation, clearly to the benefit of both disciplines, was facilitated.

THE PROGRAMME FOR COASTAL PROCESSES AND FRD SPECIAL PROGRAMMES

In view of the imminent mandatory review of the Programme for Coastal Processes, discussions on the future of the programme were ongoing early in 1988. Such planning needed of necessity to take cognisance of the broader SANCOR structure, within which it was to operate. Unlike other SANCOR programmes, PCP has always functioned as something of a 'catchall' into which essentially shore based projects were accommodated which did not fit into the other, more clearly defined and demarcated, programmes. Activities since the programme's inception have ranged from nearshore physical/chemical oceanography through sedimentology to dune dynamics, and from algal taxonomy through the ecology of inshore biota to dolphin behaviour. The programme lacked the cohesion and circumscribed goal definition of other SANCOR programmes, and planning its future was seen as initially involving a rationalisation, with consideration being given to a possible splitting into two or more new programmes with more narrowly defined objectives.

The introduction of the new system of FRD Special Programmes, scheduled for 1990, pre-empted further planning for the restructuring of PCP; it would cease to function as a programme at the end of 1989, with the role of the Committee being reduced to phasing it out. The Committee nonetheless felt that some advisory input, based on its collective knowledge and experience in the field of coastal research, might prove of value in the initiation of the new system.

The questions addressed were whether past PCP achievements, activities and expertise provide a likely foundation from which one or more Special Programmes could be launched, and whether a body such as the PCP Programme Committee, which has directed coastal research funded by SANCOR over the past years, is perhaps desirable or even necessary under the new dispensation.

In spite of its apparently diffuse nature, the Programme for Coastal Processes has been an undoubted success, whether considered from the point of view of productivity, its selectivity in accepting projects for inclusion and funding, cost effectiveness, the impact of its achievements, or the standing of its main project leaders in the scientific community, both nationally and internationally. During the immediate past five years (1984-1988), 38 projects, of which 14 have been

completed, were funded through the programme. Dates set for the completion of the remainder are as follows:

1988	8
1989	11
1990	5
1991	3

The cost of these projects will, up to the end of 1988, have amounted to R2 609 600, some 20% of the total SANCOR budget. The NP10s for both ongoing and new projects considered during this period numbered 110, of which 77 (70%) were funded following evaluation. The mean annual cost was R35 337 per project. A synthesis summarising the achievements of PCP since its inception will be prepared in the near future, so only a few will be highlighted here.

Within the ambit of the programme since its inception:

- a centre of expertise of world standing has developed at the University of Port Elizabeth (all aspects of sandy shores), while the Department of Zoology at the University of Cape Town has further consolidated its position as a world leader in all aspects of intertidal and inshore marine biology,
- a definitive work on sandy beaches as ecosystems has been produced,
- Smith's Sea Fishes, with its world-wide application, has been fully revised,
- a monographic study of the red seaweeds of Natal, a work relevant to the whole Indo-Pacific, is nearing completion, and,
- several problems related to the conservation and rational exploitation of marine resources have been addressed at the request of management agencies.

A large number of scientific papers arising out of the research funded through the programme have been published in the primary scientific literature; indeed, continued funding through the Programme has been dependent upon the publication of results. Of the 21 current project leaders, 12 are, or have recently been, employed by universities or museums, and were therefore eligible for evaluation under the FRD system; of these, 11 have been evaluated and are thus eligible for participation in the Special Programmes scheme as project leaders.

The stated aims of the Special Programmes are understood to be to foster scientific research of a high calibre through undertaking goal-directed investigations of specified limited duration, and, in so doing, to train scientific manpower to meet the future needs of the country. This has, in a large measure, been achieved over the past years under the present SANCOR system, particularly in the Programmes for Coastal Processes. In the absence of any stated priorities by FRD, the Committee has identified areas of research which would optimally utilise the proven expertise available in achieving the aims set out above through addressing problems whose magnitude and demand for skilled manpower are likely to increase in the future. These areas are: The conservation and exploitation of the biota of rocky shores; Beach/dune/estuarine

interactions; Algoa Bay; False Bay; Quarternary coastal evolution; Taxonomy of marine organisms; and Socio-economic studies.

If the new system is to achieve the same measure of success as the old, it seemed necessary to the Committee to identify those attributes which, over and above the competence of the participating scientists, have contributed substantially to that success, which is ascribed to:

- the proven system of peer evaluation applied to all projects both prior to their initiation and throughout their execution, which has ensured feasibility, scientific rigour and excellence and that stated aims were achieved,
- the outstanding support provided by the FRD management team, whose intimate knowledge of the programme, excellent relations with the participating scientists and total dedication to its success has ensured close cooperation both within the programme and between SANCOR programmes, and,
- the presence of user agencies (Department of Environment Affairs, Sea Fisheries Research Institute, etc) on the Committee, which has not only kept researchers aware of national priorities, but, through their active participation in the evaluation of projects, has ensured relevance to those priorities.

The Committee recommends, in the strongest terms, that cognisance be taken of the above when procedures for the introduction of marine related Special Programmes are considered. This implies programme committees, necessarily smaller than the present PCP committee, but serving essentially the same function. The present cooperation and interaction between disciplines can also only be effectively maintained through marine related Special Programmes operating within a body such as SANCOR with a permanent FRD support team which, like the present, has a thorough, in depth knowledge of its activities. It is further considered essential that user agencies, particularly the Department of Environment Affairs and relevant second tier government agencies, maintain their contact with researchers through such a body, and channel funds for specific contract research through FRD.

Implementation of the above recommendations comes close to achieving the changes deemed necessary in the early discussions on the rationalisation of the Programmes for Coastal Processes and will ensure continued excellence and relevance in future coastal resource.

ACKNOWLEDGEMENTS

On behalf of the Committee and all participants in PCP, I wish to express our sincere appreciation to the FRD management team for their support, help and guidance during the year. For me, in my first year as Chairman, this has been indispensable. The input of the Committee into formulating recommendations for the future of coastal science, as well as the evaluation of current projects, is also gratefully acknowledged.

J Heeg

CHAIRMAN: COASTAL PROCESSES PROGRAMME COMMITTEE

COASTAL PROCESSES PROGRAMME: PROJECTS 1987

<u>Projects and project leaders</u>	<u>Duration</u>
Coastal Natal Benthic Algae (R E Norris, Kirstenbosch)	1982 - 1990
The Ecophysiology of the Primary Producers and Microbes in Sandy Beach Surf Zones (A McLachlan, UPE)	1987 - 1989
Comparative Studies of South African Beaches (A McLachlan, UPE)	1987 - 1989
Walker Bay Coastal Processes - Base Line Physical Study (L Lenhoff, EMA)	1986 - 1989
The Biology of Carrageenan-producing Red Seaweeds in the Benguela Region (J J Bolton, UCT)	1987 - 1987
Dune/Beach Interactions (A McLachlan, UPE)	1987 - 1989
Walker Bay Coastal Processes: Synoptic Coastal Measurements (D H Swart, EMA)	1986 - 1989
Community Structure of Eastern Cape Mixed Shores (C D McQuaid, URHO)	1987 - 1989
Littoral Invertebrate Resources of Natal (Phase I - Mussel, Oyster and Pyura) (A J De Freitas, ORI)	1987 - 1990
Social Responses to and Uses of Natural Resources on the Natal Coast: a Study of Resource Use and Management (J F L Butler-Adam, UDWV)	1987 - 1988
Ecology of Rocky Shores and Reefs along the Eastern Cape Coast (B L Robertson, UPE)	1986 - 1988
Algoa Bay Programme: Physical and Chemical Processes (E H Schumann, UPE)	1986 - 1988
Sediment Dynamics of the Coastal Zone near the Sundays River Mouth (I C Rust, UPE)	1986 - 1989
Dolphin Capture in Natal Shark Nets (V G Cockcroft, MPE)	1988 - 1989
Densities and Distribution of Dolphins and Gannets on the South East Coast (G J B Ross, MPE)	1988 - 1988
Antimicrobial Properties of Seaweed Extracts (M E Aken, URHO)	1988 - 1988

COASTAL PROCESSES PROGRAMME: PROJECTS 1987 (Continued)

<u>Projects and project leaders</u>	<u>Duration</u>
Subtidal - Macrobenthic and Ichthyofaunal Community Survey Tsitsikamma Coastal National Park (C D Buxton, URHO)	1988 - 1989
Coastal Zone Management, Dune Dynamics and Dune Stabilization in the Eastern Cape (R A Lubke, URHO)	1988 - 1989
Flora of the Seaweeds of the South African West Coast (J J Bolton, UCT)	1988 - 1991
Comparative Feeding Ecology of Kelp Gulls <i>Larus dominicanus</i> and Hartlaub's Gulls <i>L. hartlaubii</i> (P A R Hockey, UCT)	1988 - 1988
Squid Ecology (M R Lipinsky, UCT)	1988 - 1990
The Ecology and Conservation of the Indian Ocean Bottlenosed Dolphin <i>Tursiops aduncus</i> off the Natal Coast (D A Melton, UNAT)	1988 - 1989
Human Perception of Coastal and Marine Systems on the Wilderness/Knysna Coastal Zone (A Odendaal, UPTA)	1988 - 1988
Coastal Dunefield Dating (I C Rust, UPE)	1988 - 1988
Sedimentology of the Port Elizabeth Beachfront (I C Rust, UPE)	1988 - 1990
Review of Tidal Prediction in South Africa (G Toms, EMA)	1988 - 1989
Impact of Human Activities on the Shore (G M Branch, UCT)	1987 - 1989

ESTUARIES PROGRAMME

INTRODUCTION

The SANCOR Estuaries Programme was initiated in 1981 and was managed during its first five years on the basis of the research outline as given in the programme document (**South African National Scientific Programmes (SANSP) Report No 67**). The programme was revised in 1986 and after thorough consideration it was decided that the basic research framework, as stated in the abovementioned document, was still valid, namely:

'The objectives of the SANCOR Estuaries Programme are to provide a scientific understanding of estuaries - in particular of the interactive physical, chemical and biological processes within them, of their interactions with their fringe areas and with their adjacent marine and terrestrial environs and finally of human impact upon them - thereby contributing information required for their wise management.'

In 1983, 78% of the supported projects in the Estuaries programme were of a biological nature. In an attempt to have a better balance between physical, chemical, biological and socio-economic studies in the programme, six categories were identified in 1986, to which most of the research in the programme belongs:

* Human influences on estuaries	(7%)
* Biological processes and population dynamics	(19%)
* Energy production and productivity studies	(13%)
* Physical-chemical and geological processes	(31%)
* Multi-disciplinary studies	(28%)
* Low level monitoring	(2%)

THE ESTUARIES PROGRAMME DURING THE PERIOD 1982-1988

Background

Statistics for the Estuaries Programme for the past five years show a number of interesting facts and tendencies.

In 1982, R171 440 was allocated to estuarine research, against R501 013 in 1988, an increase of 19.6% per year. During the past five years, from 1984, when R 264 830 was spend on estuarine research, the increase was 17.3%, somewhat less than the average growth in the SANCOR budget, which increased by 20% per year from R 1,86 m to R 3,81 m in 1988.

The Estuaries Programme Committee supported 53 projects from 1984 to 1988, each running for an average of two years, at a total cost of R 2.05 m. This represents about R 38 700 per project. Individual project costs for each project per year increased during this period from R 16 748 to R 26 359, or 12% per year, which is lower than the

inflation rate. This means that the average project decreased slightly over the five years.

Only 30 project leaders in total were responsible for the 53 projects, which means that every project leader handled 1.77 projects on average. The projects were carried out by the different institutions as follows:

University of Port Elizabeth	14
University of Cape Town	9
Rhodes University	9
University of Natal	8
University of Durban-Westville	1
Natal Parks Board	1
Oceanographic Research Institute	2
CSIR	12

Initially (in 1984) the percentage of funds allocated in the A+ category was more than 80% out of the total of requested funds. This has, however, now decreased to about 50%, which suggests that more and bigger projects are submitted for consideration and is indicative of the increasing stress on research funds.

Highlights

Not all of the highlights selected below fall under the SANCOR umbrella, but they are discussed here to complete the picture. The items are not listed according to priority or chronologically.

- The financial support of the Department of Environment Affairs has enabled the Estuaries Programme to expand and emphasizes the importance which the Department attaches to the execution of fundamental research as part of the solution to management problems in estuaries. The Department was also active in establishing the linkage between fundamental research and implementation. As a result of the Department's support, the Estuaries Programme Committee published, in 1985, the document 'An assessment of the state of the estuaries of the Cape and Natal in 1985/86', which has since been used extensively by planning authorities.
- The establishment of a Unit for Estuarine and Coastal Research (ECRU) at the then National Research Institute for Oceanology (NRIO), contributed greatly to the development of a healthy linkage between the more fundamental research within SANCOR and the more directed research within ECRU.
- The book **Estuarine ecology with particular reference to Southern Africa** by Prof J H Day served as a milestone in estuarine research in South Africa, and combined decades of research into one volume. However, the book also clearly pointed out that knowledge of biological components of estuaries at that stage (1981) was more comprehensive than the knowledge of chemical/physical components.
- Research by Dr G W Begg in 62 estuaries in Natal finally resulted in the establishment of a biotic index according to which it is possible to classify estuaries according to their biotic components

and then to explain this classification on the basis of physical and chemical characteristics of these estuaries and their catchment areas. This research indicated the start of a new trend in estuarine research. Instead of the previous more descriptive studies, explanatory, quantitative studies are now more accentuated. Begg's work has in the mean time been extended by Dr Ramm of the CSIR to a degradation index which indicates to what extent an estuary has declined since its early pristine state. Although the results of these studies are very promising, in particular because the biota is an 'integrator' of pollution and physical decline (sedimentation) of estuaries, the method should be extended to accentuate physical/chemical characteristics.

- Researchers in the Estuaries Programme increasingly cooperated over disciplinary and institutional boundaries. This made it possible for the SANCOR Estuaries Programme to address aspects more specifically concerning estuarine research, namely:
 - . The production of a series of reports and scientific publications on the Bot River system based on the joint research programme by the University of Cape Town, the then NRIO, the Cape Department of Nature and Environmental Conservation and the Geological Survey, which included definitive management recommendations;
 - . A series of scientific reports as well as a popular publication on the role of estuaries in the life cycle of several marine fishes, based on joint work by the Port Elizabeth Museum, the University of Port Elizabeth and the University of Cape Town;
 - . The application of a one-dimensional hydrodynamic computer model, developed by the then NRIO, for research by several universities in a series of estuarine river systems, e.g. the Wilderness Lake System, Swartvlei, Knysna, Swartkops, Boesmans and Kariega;
 - . A wide base of knowledge and/or data, based on coordinated research on several big systems over and above the Bot, for example Langebaan, Swartvlei, Swartkops, Sondags, St Lucia and the Kromme
 - . A greatly improved understanding of geological and sedimentological processes in estuaries in the Eastern Cape as a result of work by the University of Port Elizabeth (ROSIE Programme), in Natal as a result of work by the University of Natal (SEAL Programme) and the then NRIO (now Division of Earth, Marine and Atmospheric Science and Technology, EMA), and in the West- and South-Cape as a result of routine bottom surveys by EMA;
 - . Research by the Rhodes University in the Kariega and Great Fish River systems of the Eastern Cape which *inter alia* also addresses the freshwater requirements of these estuaries;

- . A great number of scientific publications about South African estuaries, reflected for instance in: "A bibliography of South African estuarine research (1950-1984)" by A K Whitfield and B R Allanson of Rhodes University.
- It may seem strange to highlight natural disasters but I feel that the Dominae floods, the 1987 Natal floods and the 1988 Orange River flood essentially contributed to our knowledge of the concerned systems and through the unselfish cooperation of all improved inter-institutional ties.

Shortcomings

An analysis of the activities of the SANCOR Estuaries programme since 1982 shows a number of shortcomings in the present programme:

- A tendency exists to choose research projects because of present problem areas. This leads to two kinds of problems: Firstly, the research has to be hurried to ensure that results are available in time and, secondly, not enough attention is given to the changing needs of the future. An example of this is the project on socio-economic impacts which has only recently got under way.
- A similar trend exists whereby research fields are chosen simply because they are logistically easily accessible. More attention should be given to the relevance of the proposed research. Research in estuaries is, for example, greatly concentrated in Natal, around Port Elizabeth and in the south- and southwest Cape, while almost no work is being done in the Ciskei and Transkei and along the Cape west coast.
- Although it is not SANCOR's task to implement monitoring, it is desirable that one of the objectives of the Estuaries Programme should be to draw up recipes for the monitoring of the normal behaviour of estuaries and also of processes during floods. The work done by EMA through the CLEO project, where monitoring processes are evaluated and through ROMEO, where floods are observed, is a start, but much water will literally still have to flow under the bridges before a network is established according to which such monitoring can routinely be implemented and results processed.

DISCUSSION

The abovementioned highlights and shortcomings evidence the extent to which experts have been trained over the past six years and the level of knowledge that has been attained. This does not signify, however, that all questions have been answered. This is illustrated by the answers to a questionnaire I sent out earlier this year to 20 'wise' men in an effort to evaluate future requirements in the field of estuarine research. It is notable that the resultant list corresponds well with the underlying needs in the priority list of problem areas provided by the Department of Environment Affairs to FRD.

The following list of management requirements in estuaries was compiled from:

- answers to the questionnaire as mentioned above
 - DEA's priority list to FRD
 - experience of more than 300 research projects referred to the CSIR over a 10-year period.
- (i) Policy of release for dams in lower reaches of rivers
 - (ii) Optimal management policy for estuary mouths
 - (iii) Fresh water requirements of estuaries
 - for water quality
 - for estuary mouth
 - (iv) Utilization of flood-plains
 - disturbance of dynamic balance
 - (v) Natural resources in estuaries and coastal lakes
 - exploitation potential
 - reaction to variations in physical/chemical environment
 - (vi) Hydrology of estuaries
 - peak draining patterns
 - water levels
 - effect of long-term sea-level rising
 - (vii) Carrying capacity of estuary and surrounding area
 - recreation
 - pollution
 - township development
 - (viii) Sediment dynamics of estuaries
 - sediment balance, inputs from coastal area and coastal dunes
 - long-term tendencies consequent on management of catchment area
 - effect of better management in catchment area on sedimentation in estuary
 - (ix) Utilization patterns in catchment area
 - forestry
 - agriculture
 - urbanization
 - (x) Carrying capacity of catchment area
 - soil erosion
 - pollution

From this list it is immediately evident that there is a need to train experts and to build up expertise to address these management requirements. Here I must stress the importance of the linkage between basic research (the establishment of expertise), training (training of experts) and directed research which was one of the strengths of the old SANCOR.

The challenge for the present is to accomplish a similar linkage within the new framework of FRD.

FRAMEWORK FOR ONGOING ESTUARINE RESEARCH

After thorough consideration during the meeting of the Estuaries Programme Committee at St Lucia in September 1988, the Committee suggested that the following special programmes would lead to the establishment of experts and expertise which in the long run will satisfy the management requirements in estuaries.

Fundamental aspects

Estuarine Water Fluxes

A programme concentrating on the functioning of estuarine systems and the impact of human interference in estuaries (hydrodynamics of estuaries, rates of water exchange at the boundaries of systems and water quality with specific reference to the biota including primary and secondary production, food web dynamics, modelling and network analyses).

Estuarine Sediment Dynamics

A study of the different, underlying physical processes which contribute to the definition of the morphology of estuaries.

Directed system work

St Lucia

A whole system study including effects of changes in fresh water influx, consequent sedimentation, the functioning of the different components of the food chain and the probable results of socio-economic impacts.

Other relative proposals

Monitoring methodology

A programme to identify the practical key parameters for monitoring long-term change in estuaries, dunes and the coast. Of importance is the establishment of a system of continuous administration, dissemination and archiving of monitoring results and the appropriate channels for the funding thereof.

Socio economic methodology

Similar to monitoring methodology, but with emphasis on socio-economic parameters of importance in determining impacts on natural systems; development of the methodology to be followed in socio-economic evaluations.

Quaternary coastal evolution

Present studies and future predictions about the dynamics of the coastal zone can only be put into perspective by a good understanding of the coastal geology and the formation of coastal landforms (dunes, lagoons, estuaries, beaches, spits and the nearshore sand wedge).

Other programmes

The Estuaries Committee further felt that they could also make a contribution to programmes dealing with soft shore dynamics and long-term sea level rise.

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D H Swart

CHAIRMAN: ESTUARIES PROGRAMME COMMITTEE

ESTUARIES PROGRAMME: PROJECTS 1988

<u>Projects and project leaders</u>	<u>Duration</u>
A Study of the Mangrove Crab <i>Scylla serrata</i> Forskal - Phase 2 (A J De Freitas, ORI)	1987 - 1989
The Regulation of Erosion and Sediment Deposition by Littoral Vegetation (emergent and submerged) in Lake St Lucia (C M Breen, UNAT)	1987 - 1989
The Penaeid Prawn Fisheries of Natal with Particular Reference to St Lucia and Richards Bay (A T Forbes, UNAT)	1987 - 1989
Socio-economic Factors Affecting Estuarine Degradation (R F Fuggle, UCT)	1987 - 1989
Salt Marsh Energy Flow Studies (D Baird, UPE)	1987 - 1989
Modern Sedimentary Environments of the Natal Coast (T R Mason, UNAT)	1985 - 1989
Sedimentation Rates in Natal Coastal Rivers (P Badenhorst, EMA)	1986 - 1989
Applications of the One-dimensional Hydrodynamic and Water Quality Model to Selected Estuaries (P Huizinga, EMA)	1986 - 1988
Recruitment of Ichthyoplankton into the Swartvlei Estuary (A K Whitfield, JLB Smith Inst.)	1986 - 1988
St Lucia Changes (Ecosystem Change in Relation to the Hydrological Regime of Lake St Lucia) (R H Taylor, NPB)	1986 - 1989
Sundays River Processes (T Wooldridge, UPE)	1986 - 1989
Gebruik van Riviermonde deur Plesierbote (J A Zwamborn, EMA)	1988
Kromme River Investigations: Part 1: Model studies of the estuary (P Huizinga, EMA)	1988 - 1990
Modelling Hydrodynamics and Water Quality for the St Lucia Estuary (P Huizinga, EMA)	1988 - 1989
Impact of Sandsharks and Flamingoes on Estuaries (G M Branch, UCT)	1988 - 1989
Kromme River Investigations (D Baird, UPE)	1988 - 1990
Sundays River Mouth Dynamics (E H Schumann, UPE)	1988
Swartkops Sedimentary Processes (I C Rust, UPE)	1988

MARINE LINEFISH PROGRAMME

The origin of this programme can be attributed to the joint concern expressed by fishermen, resource managers and researchers who identified an urgent need to provide a scientific template on which to base management actions and hence, the future of the South African marine linefishery. Due to the pressing nature of many questions that were initially identified, this programme was launched in 1978, with a clear and rather tight set of objectives. Briefly, these included life history studies on the most important linefish species, the establishment of a catch statistics collection programme, identification of distinct stocks along the RSA coast and the investigation of the early life history of target species. With the exception of egg and larval studies, all the other objectives were vigorously addressed, so that within five years the life history of at least 15 target species was understood, data collecting was introduced country-wide and the total number of publications dealing with SA linefish doubled from 48 to 95. This satisfactory situation contributed materially to providing a first scientific basis to important linefish legislation - perhaps best illustrated by the successful elf management measures and the introduction of linefish management on a national basis.

The obvious success of these earlier developments led to a call for more quantitative information and a need to investigate regional fisheries. The linefish programme responded with greater focus being directed at parameters basic to stock assessment and the development of techniques necessary to provide these. Consequently, specialist workshops on topics such as age determination and quantitative analyses were held. This ongoing process of development and specialist education within the linefish research community was seen to be most productive - resulting in good inter-disciplinary and inter-institutional cooperation, improved publication record and most importantly, better advice to management.

This decade of cohesive linefish research has created a highly motivated group of researchers, optimally located around the South African coast. Their interaction with other researchers, resource managers and especially the fishermen, clearly places them in a strong position to identify and address research needs.

Far more attention will have to be directed at the linefishery in the future because management of this resource poses many unique and, as yet unsolved, problems. Any control measures introduced in this fishery have widespread social and economic ripple effects owing to the high 'visibility' of angling in South Africa. Consequently, the mere 4% of SANCOR funds directed at linefish research appears inadequate. Furthermore, linefish research by management agencies themselves, viz. SFRI, though valuable, is also limited by inadequate financial and staff support, if compared with that dedicated to other major fisheries. Marine linefish represents a national resource that sustains several thousand fishermen and multi-million rand infrastructure and support industries. Its future productivity is inextricably linked to good research and wise management.

PRESENT STATUS

During 1988 the marine linefish programme supported a total of thirteen projects, considerably more than in any previous year. There were five final reports submitted, while another four projects entered their final phase this year. Additionally, there were a number of non-SANCOR funded projects that also contributed to the overall objectives of the linefish programme.

Significant research findings on at least eight important species were presented this year, with results from the eastern Cape region particularly noteworthy. The focus on quantitative studies continued satisfactorily and for the first time fishery models have been applied to a range of species.

This year saw a trend towards development of specialist techniques and, in several cases, the need for a multispecies research approach to linefish.

Results at hand provide further confirmation of declines in endemic target species and their progressive replacement by previously under-utilised fishes. This fact has resulted in studies being increasingly focused on these 'new' or potentially exploitable species - especially the elasmobranchs such as Hexanchiform sharks, the vaalhai *Galeorhinus galeus*, St Joseph shark *Callorhynchus capensis* and blue stingray *Dasyatis pastinaca*. Their inherent vulnerability to over-fishing provides an important early warning to resource management.

The geographic distribution of projects remains optimal, with each providing a centre of expertise in one or more fields. No workshops were held this year - the planned marine resources workshop being re-scheduled for early 1989. Instead, a number of linefish researchers were invited to participate in important international activities and meetings. These included advice on marine reserves to the Comorean Government, joint research into sex reversal at the University of Tel Aviv, cooperative shark research in Taiwan, an international meeting and workshop on fish tagging in Seattle and an international symposium on billfish research and management in Hawaii. From all these events it became apparent that the South African linefish research group not only enjoys considerable international standing, but is generally well advanced in linefish matters.

HIGHLIGHTS

Several projects generated noteworthy results:

A most important feature evident throughout the programme was the positive approach towards resource management recommendations by individual project researchers. Most studies inevitably progressed well beyond simply answering the key questions and many provided constructive critical appraisal of present and potential management options. Thus, important recommendations were made for the musselcracker *Sparodon durbanensis*, bronze bream *Pachymetopon grande*, red steenbras *Petrus rupestris* and geelbek *Atractoscion aequidens*. There are a number of similarities between these recommendations and it is clear that considerable further improvement in the linefish regulations of 1984 is now possible.

A finding common to several studies involving reef fishes has been their slow growth, late maturing and sex reversal. Bronze bream, musselcracker and red steenbras all attain ages of 30 years, while Roman *Chrysoblephus laticeps* and dageraad *C. cristiceps* may reach 20 years. Whereas this points to K-selection and hence potentially more stable populations, it also implies greater vulnerability to overfishing - with longer response time needed to recover. This explains the apparent slow recovery of these and related fisheries (such as the 74, *Polysteganus undulosus* and further emphasises the need for longer-term surveillance and study of such fisheries.

Studies on migratory species throughout their range were highlighted by the geelbek *A. aequidens* project. Shown to comprise a single stock divided into age-related sub-populations, adult geelbek migrate seasonally from the S Cape to Natal in order to spawn and also to feed on a variety of pelagic fishes - especially the pilchard *Sardinops ocellata*. Vulnerability of this species to fishing pressure during its spawning aggregations was seen to be part of the reason for its heavily over-exploited status. The value of cooperation between researchers in different centres along the coast was well demonstrated here and more such projects will be necessary in the future.

The trend towards more quantitative studies, initiated three years ago, has resulted in the advancement of knowledge in specific fields of research. Consequently, good progress was made with techniques in age determination and especially the interpretation and validation of results. Furthermore, good cooperation continued with staff of the Department of Applied Mathematics at UCT, resulting in several joint publications in press or print. The development of techniques and methods, with specific linefish application, progressed to include optimal sampling strategies in linefish data collection, fitting of growth curves, yield per recruit analyses and hook size selectivities. Much of this has already found widespread applicability - largely facilitated by the excellent PC computer program that was compiled and distributed to all linefish researchers.

The involvement of researchers with resource users remained an important activity, although several areas of improvement were identified by individual project leaders. The National Marine Linefish Catch Statistics Programme (NMLCS) increased substantially with 330 000 recreational angler's and 550 000 commercial fishermen's outings documented. The NMLCS forms an ever important component of many research projects and at least four data reports were produced this year. Similarly, the nationwide tagging project, based at ORI, experienced growth now involving 1 750 tagging members with nearly 25 000 fish tagged. Here, too, the results in the form of scientific data reports, are increasingly incorporated into other studies.

FUTURE PROJECTS

During the course of 1988 linefish researchers identified the most important areas of study needed to retain a cohesive approach to linefish research in South Africa, in order to ensure optimal resource utilization in the future. These key areas of regional and national interest now form part of a proposed linefish special programme submitted to FRD. The main points can be identified as being

- To conduct continuing biological and especially quantitative fisheries research on target species with the specific purpose of improving and refining linefish management strategies.
- The development of censusing techniques, sampling strategies, statistical models and improved tagging methods for specific application to linefish.
- Evaluation of marine reserves as a linefish management option.
- Develop expertise in studies on the early life history of fishes and specifically to undertake egg and larval surveys of target species.
- Investigate the role of boundary currents in spawning migrations of adult linefish and subsequent dispersal of their eggs and larvae.
- Investigate new technologies and develop innovative methods that can improve linefish resource utilization and assist in meeting the demands of the future.

Finally, two important considerations will need to be accommodated in the near future. First, the need to collate linefish research findings into a well-motivated management recommendation, and second, to recognise that studies and subsequent management options on endemic reef species will have to be long-term, if positive results are to be forthcoming.

ACKNOWLEDGEMENTS

The generous support of many organizations and individuals to the linefish programme may have been inadequately acknowledged in the past - but it has certainly not been taken for granted. In particular, the SANCOR Secretariat, Masters and crew of the RV *Africana*, *Meiring Naudé* and *Sardinops*, and staff of both CPA and NPB coastal fisheries departments have made valuable contributions. Furthermore, support of the Director and staff at SFRI continues to be a major factor in the success of this programme.

R P van der Elst

CHAIRMAN: SANCOR MARINE LINEFISH PROGRAMME COMMITTEE

MARINE LINEFISH PROGRAMME: PROJECTS 1988

<u>Projects and project leaders</u>	<u>Duration</u>
The Biology and Ecology of the Blue Stingray <i>Dasyatis pastinaca</i> (L J V Compagno, JLBSI)	1988 - 1989
South Coast Shark Project (M J Smale, MPE)	1988 - 1988
Fish Otolith Atlas for Southern Africa (M J Smale, MPE)	1988 - 1990
Biology and Ecology of the Sharks in the Hexanchiformes (L J V Compagno, JLBSII)	1988 - 1989
South Coast Reef Fish Project-Density Estimates (C D Buxton, URHO)	1988 - 1989
Catch-Statistics Sampling Strategy Evaluation (D S Butterworth, UCT)	1983 - 1988
Port-Alfred Ski-boat Fishery (Phase 2) (T Hecht, URHO)	1987 - 1989
A Study of Deep Reef Sport Fishes of Natal Serranidae and Sciaenidae (R P Van der Elst, ORI)	1984 - 1989
The Shark Fishery of the Southwestern Cape Coast (C L Griffiths, UCT)	1987 - 1989
Age Determination and Growth of Linefish Species in Natal (P A Garratt, ORI)	1988 - 1990
Zone Formation in South African Sparid Otoliths (C D Buxton, URHO)	1988 - 1989
Effects of the De Hoop Marine Reserve on Linefish Stocks (C L Griffiths, UCT)	1988 - 1988
Natal Deep Reef Sparids (P A Garratt, ORI)	1988 - 1989

MARINE POLLUTION PROGRAMME

INTRODUCTION

The debate continues over whether our coastal waters are contaminated. The likelihood is that this debate will escalate and not diminish. With an expanding population and only 3 000 km of relatively arid coastline available to us, the job of maintaining clean estuaries and coastal seas becomes more demanding. The role of the marine research community in providing fundamental information upon which advice is based equally becomes more crucial. Competing demands are being made on coastal waters, while the capital costs which are involved in ensuring the highest levels of effluent pre-treatment are enormous. Consequently, sound scientific understanding is playing an increasingly greater role in even the most pragmatic decisions concerning development.

Research into the various aspects of marine pollution has continued to be undertaken in three major geographical areas (Cape Town, Port Elizabeth and Durban), with the largest group in the Cape Town area. The new CSIR with its strong market-orientated approach is still in the process of re-directing its efforts, but it is clear that the more fundamental (i.e. process-oriented) studies are being conducted at the SFRI and UPE, with DEMAST providing an efficient vehicle for development and application of techniques and design criteria. This complimentary suite of activities is a successful recipe.

SCIENTIFIC PROGRESS

In simple terms, the objective of the MPP has always been to provide the sound scientific information from which sensible decisions can subsequently be made. It can be expected that future developments within the coastal zone will place a greater demand on the distillation of research findings, but at the same time recommendations are likely to be more circumspect and less specific. The reason for this is partly because most of the major discharges along the coast have already been 'cleaned up'.

During the last 10-20 years, in South Africa as in the rest of the world, awareness of environmental perturbations has succeeded in controlling the major highly concentrated and localised problems. A fairly significant move is now towards understanding the long-term effects of the more ubiquitous chemicals, as well as the diffuse and intermittent discharges to estuaries and the sea. The examination of these will provide for less precise data due to 'background noise', and will be far less exact in estimating effects on biota. Also the ultimate control of such discharges is certain to be more complex and expensive, and harder to defend.

The influences of intermittent and diffuse sources is currently being examined in two ways, firstly as so-called stormwater, and secondly the occurrence and distribution of ubiquitous chlorinated hydrocarbons. In contrast with other previously comparable countries (e.g. Australia, USA) rapid urbanisation and industrial deregulation in South Africa means increased contamination of urban runoff. Studies in northern False Bay and in Algoa Bay and the Swartkops River, have clearly

demonstrated the limited dispersion obtained with shoreline discharges. However, what is also emerging is that there is a consistent 'base flow' present in these discharges equivalent (in load) in some cases to that from runoff. (This is apart from the normal groundwater flow which also provides a significant nutrient source to nearshore waters.) Remedial measures for such discharges will have to be simple and innovative, and should preferably consider parts of, or even entire catchment areas for satisfactory control.

The persistent chlorinated hydrocarbons continue to provide significant research activity. These are materials which are difficult - if not virtually impossible - to control other than by restricting their manufacture. The completion of a three-year programme on the occurrence and distribution of these materials in marine biota, and a detailed examination of existing information on these substances has led to a number of specific conclusions. Examination of dolphin blubber, where previously depuration by pregnant females was confirmed, has now been quantified, with 80% of the female's body load being passed to her calf. Male dolphins continue to incorporate chlorinated hydrocarbons into their blubber and mature males are the most suitable monitoring organisms for these materials. The bottlenosed dolphin, which feeds in the nearshore region, contains substantially higher levels than the common dolphin which feeds over the entire continental shelf area, indicating the significant terrestrial contribution of these materials.

Research on matters which relate to public health interest have featured strongly in the MPP in the last few years. It has been unequivocally demonstrated that traditional bacterial indicators (i.e. faecal coliforms) provide at best, a general indication of contamination. More specific indicators, such as viruses are far preferable, but are highly unlikely to be useful for any routine examination. Consequently, research is emphasising pathogen viability. In addition, cooperative plans with the Medical Research Council (MRC) are materialising to examine more exactly the relationships between water quality and diseases associated with swimming or eating contaminated shellfish. Although the effects of poor water quality are unlikely to be considered of significant concern for human mortality (maximum of 10 possible deaths associated with contaminated shellfish consumption in the UK during the last 10 years, the economic affects, such as influence on tourism and associated industries, and on other users of the water such as aquaculture, are substantial and will always demand a high quality of nearshore waters.

The chemical analysis of samples has always provided a cornerstone for the study of marine geochemical cycles of which pollutants, or contaminants are examples. In South Africa, skills and facilities are both limited and spread across a number of institutions. The MPP has not attempted to recommend a rationalisation of these in light of the dramatic changes at the CSIR institutes and anticipated changes in university financing. This feature of our pool of resources should be considered carefully during the evaluation of Special Programmes. Nonetheless, the community of analytical chemists conducted a number of intercalibration exercises and interlaboratory exchanges during 1988 to maintain close association. A major re-emphasis is the requirement for properly designed clean rooms for sample handling.

In early September, the marine research community (as well as the controlling authorities) put itself on show at a one-day symposium in Cape Town. The purpose of the symposium was to inform, and speakers were selected accordingly. There was surprisingly little general debate, and the many public interest groups present indicated their concern, but also their willingness to be conciliatory when provided with objective information. The polarisation of any aspect of our community life can never be beneficial; and the adjudged success of this meeting relates to the important fact that the scientific community was able to demonstrate the credibility and objectivity of its work. Scientists are paid directly from the public purse; they equally have a direct responsibility to the public.

CONCLUSIONS

It is worth observing that the MPP sponsors only a portion of the total research effort in this field in South Africa. For example, now that procedures have been established for the monitoring of effluents from the Richards Bay pipelines, the Mhlathuze Water Board is financing this work. However, it is of interest that changes in operating conditions in the pulp mill and phosphoric acid factory have both had significant influences on effluent quality and discharge conditions and thereby the details of the monitoring programme. In addition, further effluents are being considered for inclusion into the pipeline scheme. This extra loading will mean that concentrations of a number of the components of the effluent are close to their 'maxima', or levels considered 'assimilatable' by the marine environment. This means more research, as this situation was never projected in the original plans for discharge. Thus this interaction between research and the application of research findings continues.

With 1989 being the last year of the formal MPP, as long-term participant in this programme and more recently as chairman, I would like to pay special tribute to the atmosphere of cooperation and goodwill which the programme encouraged. So many have participated in this process and all can take pride in a successful research programme which in addition, attended to the needs of the community.

The new Special Programmes will offer an equivalent challenge, and it is pleasing that the programmes submitted for submission recognise the advantages of close inter-disciplinary cooperation.

D A Lord

CHAIRMAN: MARINE POLLUTION PROGRAMME COMMITTEE

MARINE POLLUTION PROGRAMME: PROJECTS 1988

<u>Projects and project leaders</u>	<u>Duration</u>
Marine Viral Pollution: Phase 2 (R Kfir, DWT)	1987 - 1989
The Ecological Effects of Offshore Dredge Spoil Dumping from Durban and Richards Bay Harbours (T P McClurg, EMA)	1987 - 1989
Pollution Monitoring - Granger Bay (HF-KO Hennig, EMA)	1986 - 1989
Toxicity Testing with Mussels <i>Perna perna</i> (A D Connell, EMA)	1986 - 1989
PCB's as Marine Geochemical Tracers (D A Lord, UPE)	1986 - 1989
Chlorinated Hydrocarbons in the Natal Marine Environment (R R Sibbald, EMA)	1986 - 1990
Port Elizabeth : Harbour and Papenkuils (D A Lord, UPE)	1987 - 1989
Pollution: Pollution Loading of False Bay (A C Brown, UCT)	1987 - 1988
Load of Health-related Micro-organisms in Effluents Discharged into False Bay (G Tredoux, DWT)	1987 - 1989
Occurrence and Mortality of Micro-organisms in the Marine Environment close to Sewage Outfalls (G Tredoux, DWT)	1988 - 1989
Pollution: Chlorinated Hydrocarbons, Marine Systems (A De Kock, UPE)	1988 - 1990
Motherwell Stormwater Discharge into Swartkops (D A Lord, UPE)	1988 - 1989

SA WOCE AND OPEN OCEAN PROGRAMME

INTRODUCTION

The SWOOP-programme was stimulated by the increasing interest worldwide in global research programmes, by international attention towards South African waters and particularly by the recognized lack of a strong research component within SANCOR specifically aimed at the open ocean. The programme has been running for one year and will continue for 1989/90 after which it is hoped that significant research problems of this field will be taken up by newly formulated Special Programmes. This report sketches the run-up to the programme, the successes of the programme during its brief existence and the key research thrusts identified for the near future.

RUN-UP TO PROGRAMME

Deep-sea oceanology research in South Africa may be considered to have had its origin in the sixties with the formation of SANCOR. This occurred in reaction to the International Indian Ocean Expedition, one of the major international scientific endeavours of that time. Since then deep-sea research has slowly decreased in magnitude as a component of the total South African research effort. In the mid-eighties a number of external factors once more focused attention on the key global role played by the ocean areas surrounding South Africa. One of these was recognition of the excellent work done by local oceanographers on these circulation systems, such as for instance that by L V Shannon on the Benguela system and M L Gründlingh on the Agulhas system.

As a result a number of co-operative research cruises with British and American colleagues were carried out in the area. With the advent of the international World Ocean Circulation Experiment (WOCE), the major component of the World Climate Research Programme, the results of these cruises played an important part in focusing of international attention on the critical role played by South African waters in global ocean circulation. It is the stated purpose of WOCE to generate oceanic data which will address the prediction of decadal climate change which is of crucial importance to South Africa.

The South African marine research community therefore decided after careful deliberation that a South African WOCE programme was to South Africa's decided benefit and, after wide consultation, drew up a framework for such a programme in 1986.

SUCCESSSES OF PROGRAMME

The South African community's expertise has been internationally recognised in all aspects of the planning of the international WOCE. Planning meetings for the Southern Ocean component of WOCE were attended by J R E Lutjeharms in Bremerhaven; for the global ocean in Washington by P Chapman; M L Gründlingh and J R E Lutjeharms and for the implementation phase and for the hydrographic programme by J R E Lutjeharms in Woods Hole.

A major supportive aspect of the WOCE programme is the global satellite coverage for the observational period. The key element of this is the TOPEX/POSEIDON altimetry venture. South Africa's proposal for field experiments in this prestige project was accepted as one of only three such projects outside North American and Western Europe. It is under the leadership of M L Gründlingh and combines efforts by the CSIR, Institute for Sea Fisheries, University of Cape Town and University of Stellenbosch.

As part of the first year's funding of the SWOOP, projects were supported on sea level, air-sea interaction and oceanographic background studies. In preparation for WOCE a number of sea level recorders are being built, deployed and initial data analysed by personnel of the CSIR and the University of Cape Town. This project under G B Brundrit and C C Stavropoulos has attracted international attention. M Jury of the University of Cape Town has ably demonstrated the flux of heat and moisture at the Agulhas retroflexion. In co-operation with N C van Heerden the importance of these fluxes to South African weather and ultimate climate have been demonstrated. The flux of water at the Agulhas retroflexion between the Indian and Atlantic Ocean has important climatological implications and, beginning in 1989, will receive increased attention as will the use of freon, an exotic anthropogenic gas, as a tracer of deep water movement.

FUTURE RESEARCH THRUSTS

It is expected that the South African contributions to the international WOCE will consist of those elements which are most directly beneficial to South Africa and which hold the greatest potential for outstanding science. These include i.a. the flux of the Agulhas Current, the exchange of water between Indian and Atlantic Oceans, the circulation of the Cape Basin and heat flux across the Subtropical Convergence. These proposals will tentatively be put forward at the International WOCE Implementation Meeting in Paris in November 1988.

It would be remiss not to identify some extremely serious threats to South Africa's participation in this important international programme or to South African's deep-sea research in general. Efforts of this scale and duration require a well-motivated, coherent, multi-disciplinary group of scientists and support staff. At present many of the main players in this undertaking within the CSIR and elsewhere are totally unsure whether such research will be permitted under the new dispensation. Furthermore, such research can only be undertaken within an organisation with the necessary technical infrastructure and support staff. South African oceanography runs the risk of faltering at the very threshold of exciting and important international scientific opportunities that have opened up, opportunities that have taken many years of hard work to come to fruition.

J R E Lutjeharms

CHAIRMAN: SA WOCE AND OPEN OCEAN PROGRAMME COMMITTEE

S.A. WOCE AND OPEN OCEAN PROGRAMME: PROJECTS 1988

<u>Projects and project leaders</u>	<u>Duration</u>
Oceanographic Bronnelyste (J R E Lutjeharms EMA)	1984 - 1989
New Sea Level Instrumentation and Data Processing (C C Stavropoulos EMA)	1987 - 1991
Sea Level Variability (G B Brundrit UCT)	1988 - 1991
Agulhas Retroflexion Aerial Survey (M R Jury)	1987 - 1989

LIST OF ACRONYMS

BEP	Benguela Ecology Programme
CEF	Central Energy Fund
CLEO	Continuous Low-Level Environmental Observations
CODAR	Radar sea state and surface-current monitoring system
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environment Affairs
DWA	Department of Water Affairs
EPA	Environmental Protection Agency
FRD	Foundation for Research Development (CSIR)
IGBP	International Geosphere/Biosphere Programme
JGOFS	Joint Global Ocean Flux Study
MPP	Marine Pollution Programme
DWT	Division of Water Technology (CSIR)
NMLCS	National Marine Linefish Catch Statistics
NPB	National Parks Board
EMA	Division of Earth, Marine and Atmospheric Science and Technology (CSIR)
ORI	Oceanographic Research Institute
PEM	Port Elizabeth Museum
RU	Rhodes University
SAM	South African Museum
SANCOR	South African National Committee for Oceanographic Research
SANECOR	South African National Engineering Committee for Oceanic Research
SANSP	South African National Scientific Programmes
SCOR	Scientific Commission on Oceanic Research
SEFREF	Sea Fisheries Research Fund
SFRI	Sea Fisheries Research Institute
SOEKOR	Southern Oil Exploration Corporation
UCT	University of Cape Town
UP	University of Pretoria
UPE	University of Port Elizabeth
UDW	University of Durban-Westville
UN	University of Natal
UND	University of Natal (Durban)
UNP	University of Natal (Pietermaritzburg)
US	University of Stellenbosch
WITS	University of the Witwatersrand
WOCE	World Ocean Circulation Experiment

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