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PROGRAMME, ABSTRACTS AND DIRECTORY
ABSTRACTS
The influence of substratum on the development of rocky intertidal communities

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The present study was undertaken to investigate the observation that dolorite and shale shores in the Transkei tended to have less algal cover and to support more grazers than sandstone shores. The structure of rocky intertidal communities is determined by the interaction of a number of biotic and abiotic factors. The chemical and physical nature of the substratum has been shown to have an influence on colonization, but few studies have attempted to quantify experimentally the differences in succession observed on different substrata. Rock tiles (10 x 10 cm) cut from shale, dolorite and sandstone were placed on three shores, each dominated by one of the rock types, and monitored photographically for 18 months. Within each type two treatments consisting of smooth and rugose surfaces were applied to assess the influence of rugosity on colonization. Experiments were initiated in summer and in winter to assess the influence of season on the colonization process. The rate of heating when exposed to insolation and degree of water retention of each rock type were determined in the laboratory. Heating rate in shale and dolorite was almost three times that in sandstone, while this rock type retained ten times more water after soaking than the other types. Within a month of placement all rock types supported a thin layer of filamentous algae. After six months only the sandstone supported significant growth of upright algae, while the shale and dolorite were largely devoid of macroalgae. The latter rock types attracted micro-algal grazers such as patellid limpets, which were comparatively rare on sandstone. This situation persisted to the end of the experiment by which time the sandstone was covered in coralline algae. There appeared to be no influence of season on this process. Rugose tiles attracted larger numbers of sessile invertebrates such as barnacles than the smooth tiles, but they were either engulfed by algae or obliterated by grazers depending on rock types. The above effects occurred at all sites indicating that site was less important than substratum in influencing colonization. These results suggest that the higher temperatures and degree of dessication on shale and dolorite retards colonization and prolongs early successional stages which are attractive to grazers. Grazing then takes over as the factor maintaining the relative bareness of these rocks.

The national water act : implications for estuaries

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The National Water Act (Act 36 of 1998) makes provision for a Reserve to be determined prior to authorization of water use (examples of the 11 water uses include agriculture, industrial uses, waste discharges). The Reserve is the quantity and quality of water required to satisfy basic human needs, considering both present and future needs and to protect aquatic ecosystems in order to secure biological sustainable development and use of the resource.

To facilitate the determination of the ecological reserve for aquatic ecosystems, water resources have been sub-divided into groundwater, rivers, wetlands and estuaries. Methodologies to determine the ecological reserve are still being developed and tested for each of these resources. There are currently three levels of Resource Directed Measure determination (RDM) for estuaries:

1. Rapid determination of RDM, which is a desktop assessment.
2. Intermediate determination (which takes approximately 2 months to complete)
3. Comprehensive determination (which takes approximately 12 months to complete).

The level of RDM determination required depends on the sensitivity of the water resource, the scale and degree of the impact of proposed water uses, and the urgency for a reserve determination. All three levels include six basic steps that are used to determine the reserve for estuaries:

Step 1. Delineate the geographical boundaries of the estuary;
Step 2. Determine the current ecological status of the estuary;
Step 3. Determine the reference conditions;
Step 4. Allocate the Future management class (FMC);
Step 5. Set the Resource Quality Objectives (RQO) for water quantity and quality;

This paper will discuss progress and development with regard to RDM determination for estuaries. The implementation process will be commented on as well as the links with other water resources. This is a collaborative effort that involves a number of estuarine scientists and managers.
USING PARASITES AS STOCK IDENTIFIERS FOR NAMIBIAN AND SOUTH AFRICAN HAKE (Merluccius capensis & M. paradoxus)

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The parasite loads of Namibian and West and South coast South African hake (Merluccius capensis & M. paradoxus) were compared to determine whether there were differences between regional parasite communities. This technique has been proposed as a supplement to genetic and morphological analysis of populations that are suspected of being separate stocks. During the course of the study eight previously undescribed parasite species were recorded, bringing to thirteen the number of species recorded in Southern African hake. Relationships between parasite loads and fish length and sex were analysed. Multivariate techniques were used to test the site-specificity of parasite prevalence, intensity and abundance. Results from 1997 and 1998 samples reveal a difference between West and South Coast (South Africa) populations, while preliminary analyses of 1999 samples suggest a difference between South Africa and Namibia populations. While these parasite community differences are insufficient to independently establish stock separation, they should be viewed as evidence suggesting some degree of stock separation.

PROPERTIES OF AGAR FROM SOUTH AFRICAN AGAROPHYES

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The term agarophyte is used to refer to red seaweeds that contain the phycocolloid agar, a jelly like substance that has a wide range of applications. Agars are complicated carbohydrates, made up of long chains of galactose molecules with sulphated side chains. This study investigated the properties of agar from four South African agarophytes.

Agarophytes used for agar extraction were Suhria vitata, Gelidium pristoides, Gracilaria gracilis and Gracilariopsis sp. Agar was extracted via a hot extraction method, with and without alkali treatment of the material before the extraction procedure. Dried algal samples were placed in beakers of distilled water, covered with foil and then heated slowly, while being stirred continuously. Agar was extracted by filtering the mixture with a pressure filter. The filtrates were then allowed to gel at room temperature. With the alkali treatment, the algal samples were first treated with NaOH, before the extraction procedure. The reason for alkali pre-treatment was to determine the degree to which an alkaline solution would influence the agar quality. Agar yield, gelling temperature, melting temperature and gel strength were analyzed for each species. The outcome of the experiment will determine which of the tested species yield the best quality agar for different applications.
PRELIMINARY MANAGEMENT STRATEGIES FOR Caelorinchus simorhynchus (GADIFORMES: MACROURIDAE) - REGARD OR DISCARD?

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The issue of bycatch is by no means a recent phenomenon though there has been an increasing focus on the management of these fisheries and the ecological impacts of bottom trawling. Investigations into the widely distributed macrourid fishes were initiated in the latter half of the eighteenth century. Their bathyal distribution and low commercial value has resulted in a lack of biological and catch data for most of these cod-like species. Currently only one commercially viable species, the roundnose grenadier Coryphaenoides rupestris, is regulated by a total allowable catch (TAC) in the NW Atlantic fishing zones. In the N Atlantic, macrourid species like Macrourus berglax and Coryphaenoides rupestris have been fished for some years. Fisheries for these macrourids are managed mainly through crude biomass estimates and the setting of a TAC. Prior to the regulation of this fishery, a TAC was proposed, based largely on guesswork rather than concrete management modelling. The fishery of macrourid species in the regions of NW Atlantic and Mid Atlantic ridge have shown similar trends with high initial catches and a rapid decline to fairly low catches. A successful, large-scale fishery requires a target species, which is abundant, widespread, susceptible to capture and has a high turnover rate of the population. Markets also dictate that fish for direct human consumption be (usually) sold in relatively large pieces. While C. simorhynchus appears to have some of these attributes, their relatively small size coupled with the distribution of the muscle-blocks, and its repulsive appearance disqualifies it (grenadiers have two main muscle blocks in the trunk region). However, C. simorhynchus is abundant and could be used in the production of trash-fish meal although the use of deep-sea fish in industrial operations like oil and fish meal has economic drawbacks. The input data for preliminary stock assessment will be taken from research surveys aboard FRS Africana (1997 and 1999) as well as from commercial catch data. As C. simorhynchus, is a largely unexploited resource, simple models (e.g. the swept area method or surplus production) will initially be used for determining stock size and maximum sustainable yield (MSY). The results of these and alternative (e.g. VPA) models will also be used to suggest future management strategies.

Oral

ASPECTS OF THE BIOLOGY OF A BYCATCH SPECIES, Caelorinchus simorhynchus (MACROURIDAE: GADIFORMES)

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Although C. simorhynchus is the most abundant grenadier species along the southern African coast, its commercial unimportance and deep distribution have resulted in a lack of biological and catch data. This species forms a considerable proportion of the bycatch associated with the hake-directed fisheries, and there is a need to study its biology. This study examines population structure, length-weight relationships, maturity stages, gonadosomatic indices (GSI), diet and feeding as well as age and growth. Growth curves are fitted to mean length at age data, of both sexes, by means of the von Bertalanffy growth equation. The data were collected during routine demersal cruises aboard the FRS Africana and from monthly observers aboard commercial vessels. Although ripe ovaries were found throughout the year, preliminary G.S.I. results indicate periods of more intense spawning activity during winter (June-August) and early summer (October-November). Stomach content analyses indicate a wide variety of food taxa are eaten, although crustacea, polychaetes and ophiuroids dominate the diet. There appears to be an increase in the proportion of teleost prey ingested with increasing fish size. A linear correlation was found to exist between predator size and prey size.
FISH REACTIONS TO PINGERS - CAN FISHERS AFFORD TO DEPLOY PINGERS?

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An increasing belief that acoustic deterrent devices (ADDs), popularly known as pingers, may be the answer to reducing incidental mortalities of cetaceans in fisheries is based on the assumption that these devices will not affect target fish catches and will therefore be welcomed by fishers. Little is known regarding the reaction of most fishes to the sounds produced by the pingers presently commercially available. This study recorded area use around active and inactive pingers by 17 species of fish, representing 13 families, housed in the main tank of the Durban Sea World. Both the Dukane Netmark(tm) 1000 and Loughborough PICE(c) 997074 pingers were tested. There was no significant response of any of the fish species tested to the Dukane pinger, while the clupeid Redeye roundherring Etrumeus whiteheadi and the mackerel Scomber japonicus showed a significant attraction to the PICE(c) pinger. Surprisingly, none of the fish species tested showed any significant avoidance reactions. Results suggest that particularly Clupeidae are affected by sounds within the frequency range transmitted by the pingers presently commercially available, and that some members of the Scombridae may respond. This implies that pingers may not be suitable as a bycatch mitigation measure if deployed in fisheries targeting these epipelagic species.

CORRECTIVE ACTION IN MARINE SCIENCE

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The South African Network for Coastal and Oceanic Research, SANCOR, commissioned a task team to investigate the progress of corrective action within the South African marine science community. The terms of reference for the task team were as follows:

1. What has been done in terms of corrective action in the past five years?
2. How have these initiatives been undertaken and what has been achieved?
3. What corrective action initiatives and tasks need to be undertaken from here?
4. How can these corrective action initiatives be implemented?

As a result of the apartheid imbalances, the South African economy relied on the skills of only 12.8% of its population, while excluding the other 87.2%. In addition, both external and internal political pressures have compelled not only government, but also all professional sectors to strive for equity. Corrective action is described as activities aimed at rectifying the disadvantages that certain groups of people suffered during the apartheid regime, thereby endeavoring to achieve equity. Corrective action is thus perceived as a moral effort employed to reform post-apartheid society.

This philosophy formed the backdrop of the task teams efforts. To determine the progress of corrective action within the South African marine sciences, questionnaires were formulated and sent to all SANCOR member institutions, which included Universities and Technikons. The information derived from questionnaires shows the recent history of corrective action, as well as the status and perceptions of corrective action and provides insight into future potential initiatives. Results revealed a slow but steady increase in the number of senior black marine science students. While, results in the workplace showed an extremely slow increase in the number of black's being employed in the marine science field. Various initiatives to facilitate the process are suggested.
HAKE OTOLITH MICROSTRUCTURE

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The two hake species, *Merluccius capensis* and *Merluccius paradoxus*, form the backbone of the South African bottom-trawl fishery. The age determination of a commercially exploited fish population is important information for effective stock assessment. Accurate age distribution data is used in stock assessment models to predict year-class strength and mortality. An important aspect in all age and growth studies is validation of the ageing method. This validation process should adequately demonstrate that the growth zones identified are annual. Moreover, identification of the first annulus in hake otoliths was identified by means of otolith microstructure analysis and daily ring deposition.

Juvenile hake were collected and frozen during pelagic fish research surveys conducted by Marine and Coastal Management. The otoliths were removed and placed in KOH to remove all excess soft tissue. Clean otoliths were mounted onto glass slides with Eukitt mounting medium. The otoliths were then ground and polished to reveal the nucleus. The microstructure was examined by means of image analysis using the Bony Parts software package.

The ground otoliths were then removed from the glass slides and prepared for scanning electron microscopy by means of critical point drying and sputter coating. The daily growth rings were examined with a backscatter detector.

HYDROGRAPHY AND WATER QUALITY IN SIMON'S BAY
(FALSE BAY)

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In March 1999, a collaborative, long-term project was initiated in Simon's Bay (adjacent to Simon's Town, Cape Peninsula). At this stage the partners involved are the Hydrographic Office of the South African Navy, the Institute for Maritime Technology (IMT) and the Oceanography Dept. of the University of Cape Town. Simon's Bay is subjected to a number of human-derived ecosystem pressures inter-alia urban settlement, various industries (including tourism), yacht club activities and a naval dockyard. The primary objective of this project, named Simon's Bay Sea Watch, was to assess existing water quality criteria, perform a suite of targeted studies within the ecosystem and, through continuing research, establish indicators and/or indices which can give a measure of degradation or improvement of ecosystem health and the local marine environment. The preliminary two-week assessment of Simon's Bay has used the Water Quality (WQ) Guidelines of the Department of Water Affairs and Forestry as a prime document. Simon's Bay was divided into three sub regions; Harbour, Inner Bay and Outer Bay. These were the focus of a spatial study using SA Navy Namakuras as sampling vessels. Coincident with the spatial coverage, a two-week time series of hydrographic variables was obtained by sampling from the anchored IMT vessel, Annie-K, and a number of moored sampling sites. A beach survey was also completed to assess the presence of floating and wind-borne litter. Acceptable target values for a number of variables are given in the WQ Guidelines and the results of this study have been placed in this context. It is hoped that the methods and protocols used during this project will have applicability to other marine systems subjected to human impacts and there for introduce some uniformity to the assessment of ecosystem health.
Research studies in the Southern Ocean have revealed the existence of four distinct fronts; the Agulhas Front (AF), Subtropical Convergence (STC), Subantarctic Front (SAF) and the Antarctic Polar Front (APF). It has been shown that the latitudinal position of these fronts can change substantially over short periods of time. As part of the 5 year Marion Island Oceanographic Survey (M.I.O.S) programme, the variability of these fronts, in the southwest Indian sector of the Southern Ocean, are studied each year. A research component of the MIOS 4 (1999) cruise was the completion of a "dog-leg" longitudinal transect from Marion Island (47° S 38° 09'E) to 31° S 44° E. The results presented provide a descriptive account of the standard hydrographic variables measured and therefore indicate the position and structure of the fronts which were crossed. An attempt has been made to establish interpretative links between the physical, biological and chemical variables.

Figure 1: Position of hydrographic stations occupied during the repeat transects along the Madagascar ridge.

Results showed that during the period of this transect (10 days) the fronts had moved considerably. During the northbound leg the AF was found to lie at approximately 40°S while the STC remained further south at 42°30'S and the SAF at 45°30'S. The AF and STC remain as separate fronts, pushed apart, it seems, by a warm eddy feature centred at 41°45'S. The SAF lies further to the north than observed two weeks previously where it lay at 46°45'S. This latitudinal variability is closely correlated with the prominent bottom topographic relief associated with the Madagascar ridge. In comparison, during the southbound leg, the AF, although in the same position as observed during the northbound leg (40°S), appears to have combined with the STC, which has moved further north to 42°30'S. The SAF also lay further north at 45°S. The northward shift in the frontal positions may have been due to the absence of the eddy feature observed previously at 41°45'S.
Oral

BENTHIC MACROFAUNA DIVERSITY IN THE KNYSNA ESTUARY: A 50 YEAR COMPARISON

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It is 50 years since John Day and his team described the benthic macrofauna of the Knysna estuary. Since then the littoral of the estuary has experienced considerable urban development and thus an increase in stormwater flow, treatment plant effluent volumes and increased human activity in the intertidal zone.

A joint study between the Knysna Basin Project and the Department of Zoology lead by Casper de Villiers was set up in 1997 to assess the diversity, distribution and density of the macrobenthos using the same collecting sites and methods reported by [Day, Millard and Harrison (1952) Trans. Roy. Soc. 33:367-413].

A two-way ANOVA has shown that there is no difference between the species richness reported for 1946/47 and 1997. The significance of this result and the striking diversity between quantitative samples of the intertidal soft sediments by the UCT team (Day et al. 1952) and the KBP team (1997) are discussed in the light of intermittent increased suspensoid levels in the estuary.

Oral

ALIWAL SHOAL: REFUGE OR ROADHOUSE FOR RAGGEDTOOTH SHARKS

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Historically there has been considerable concern regarding the impact of recreational SCUBA divers on the raggedtooth sharks (*Carcharias taurus*), which visit the Aliwal Shoal, Umkomaas, during the austral winter months. Following research into the use of natural spot patterns on the flanks of these sharks for individual identification, this project used underwater photographs taken on SCUBA to identify and catalogue sharks present on the reef during the past few seasons between 1995 and 1998. This study is the first of its kind attempted anywhere in the world and preliminary analysis has shown promising results. Two areas of the reef, Raggie Cave and Cathedral, have been identified as preferred habitats of these sharks, with over 90% of shark sightings occurring in and around these sites. The reason for this site specificity is unknown, however the unique cave-like topography of these two areas provides adequate shelter from strong currents, which are common at Aliwal Shoal.

A number of resightings of previously identified individuals have occurred, with time at liberty ranging from one day to four months. It therefore appears that while some individuals may only remain for a short period of time (days or weeks), others indulge in a longer stay on the reef (months). It is hoped that through further analysis of the short and long-term movements of these sharks, the exact importance of Aliwal Shoal to the breeding migration of *C. taurus* may be determined, so that adequate management recommendations can be implemented to maintain this booming tourist industry at a sustainable level for both man and shark.
THE EFFECTS OF KELP HARVESTING ON THE BIODIVERSITY OF KELP EPiphytes

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Increasing demands for kelp as abalone feed have led to intense local harvesting from kelp beds in certain areas. To measure the effects of harvesting near Jacobsbaai, north of Saldanha, a 400 m² area of kelp was harvested in 1995, and an adjacent area marked as a control. After 2.5 years the kelps had re-grown: there were no statistical differences between harvested and control areas with respect to mean kelp density and biomass, mean stipe length, number of fertile fronds per substrate area, or percentage fertility, but weight of epiphytes per kelp was higher in the control. Ordination analysis (Decorana) and diversity indices showed that understorey communities were similar in harvested and control areas, indicating that if there had been effects, they were no longer detectable after 2.5 years. After 3.5 years the biomass of epiphytic algae (either as a total of the 17 foliose species recorded, or as only the 4 obligate epiphytic species) and the weight of epiphytes per kelp were significantly different in the two areas, indicating that the epiphyte community had still not recovered to control levels. The implications of the slow recovery of the epiphytic algal community are discussed with respect to maintaining biodiversity in harvested kelp beds. It is recommended that when kelps are harvested, permanently non-harvested ‘reserve’ areas are left in all kelp beds.

OCEANIC FLOW DISTURBANCES IN THE ANTARCTIC CIRCUMPOLAR CURRENT AT THE PRINCE EDWARD ISLANDS

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The Prince Edward Island are located in the Indian sector of the Southern Ocean at 46º50'S and 37º50'E. Intensive past investigations have shown that they lie directly in the path of the Antarctic Circumpolar Current (ACC), sandwiched between the Subantarctic Front (SAF) to the north and the Antarctic Polar Front (APF) to the south. Two mesoscale surveys (MOES 2 and MIOS 2) were designed in order to study the impact these islands may have on the spatial and temporal variability of the oceanic environment in this sector of the Southern Ocean. Investigations carried out during MOES 2, showed that the SAF, influenced by the shallow topography, was deflected around the islands, while the APF remained distinctly south of the survey grid. Water masses in this region were shown to modify gradually from Subantarctic Surface Water (SASW) (7 °C, 33.75) to Antarctic Surface Water (AASW) (5 °C 33.70) as the Polar Frontal Zone (PFZ) was crossed. Downstream of the Islands a wake was formed resulting in the advected southwards across the PFZ, while cooler waters, which had been modified in the transitional band of the PFZ, were advected northwards. In comparison, during MIOS 2, the surface expressions of the SAF and the APF appeared to combine forming an intensive frontal feature upstream of the islands. Closer to the islands, these fronts separated, resulting in the SAF moving northwards around the islands, consisting of AASW was observed within the PFZ. Its exact genesis is unknown, but it is possible to have been generated by instabilities within the meandering PFZ. The cold-core eddy appeared to displace the SAF northwards. South of the eddy, a warm patch of SASW water was observed, its position possibly controlled by the meandering APF, which lay on either side of this feature. Evidence from the 2 surveys temporal and spatial variability. Under both conditions, enhanced cross frontal mixing were apparent, resulting in the advection of the neighbouring water masses into and across the PFZ.
SUPPLY-SIDE ECOLOGY OF THE BROWN MUSSEL, *Perna perna* ON THE SOUTHERN COAST OF SOUTH AFRICA

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On the southern coast of South Africa the brown mussel *Perna perna* is important: economically as a food source, and ecologically as a trophic link in the cycling of nutrients and in providing a complex settlement substratum for shellfish spat. The settlement of juvenile mussels varies in space and time and a knowledge of these settlement patterns is a fundamental requirement for effective resource management and understanding the ecology of adult mussel beds. This study investigates spatial and temporal variations in daily settlement rates of mussel spat, with particular emphasis on tidal rhythms and the effects of topography and hydrodynamics. Plastic pot scoucers, used as artificial substrate, were collected on a daily basis at low tide for six weeks during late austral summer. There were two main components of the study: the primary investigation examined spatial differences between three sites of similar tidal height, topography and aspect and separated by hundreds of metres, through a series of spring and neap tides; the secondary study examined topography and hydrodynamics at the smaller metre scale with samples taken from seaward facing, horizontal and landward aspects of an aeolian dunerock platform. The results indicated a high degree of both temporal and spatial variation in settlement rate. Furthermore, both primary and secondary settlement was recorded, with markedly high incidence of the latter. Temporal variation in settlement was clearly defined, with distinct peaks of settlement, but one site showed predictably higher rates than the other two. Likewise there was a great variation within sites (m scale), but with no clear ranking of localities. In the second study seaward facing surfaces had consistently lower settlement than horizontal or landward facing surfaces. This was unsuspected as adult densities were greatest on seaward rocks. These results suggest that the settlement of juvenile *Perna perna* may be affected by hydrodynamics and topography over a hierarchy of scales, ranging from a metre to hundreds of metres.

Benefit Oral

FECUNDITY AND SOMATIC GROWTH OF COPEPODS AND ESTIMATED PRODUCTION OF MESOZOOPLANKTON IN THE NORTHERN AND SOUTHERN BENGUELA CURRENT REGIONS

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In situ rates of egg production and juvenile growth of copepods were measured during BENEFIT research and training cruises in 1997 and 1999 in the Benguela Current region off Angola, Namibia and South Africa. Data were obtained using the bottle incubation technique, whereby individual adult females and artificial cohorts of juvenile stages of dominant copepod species were incubated for 24 h at ambient conditions of sea surface temperature and food (as chlorophyll alpha concentration), and at subdued light in on-deck incubators. Rates of egg production were measured for the species *Calanoides carinatus, Centropages branchiatus, Metridia lucens, Nannocalanus minor, Undinula vulgaris, Rhincalanus nasutus*, and species of the genera *Pontella, Pontellina, Labidocera* and *Eucalanus*, as well as for a variety of unidentified copeods. Limited data were also obtained for *Rhincalanus cornutus, Euchaeta* sp., *Calanus* sp., *Acartia* sp., *Scolecithrix* sp. and *Pleuromamma* sp. In addition, moulting rate measurements were obtained for *Calanus agulhensis* and *Calanoides carinatus*.

Measurements of daily egg production and juvenile growth of copepods off Angola and Namibia during these cruises provide the first direct estimates of copepod production in the northern Benguela Current region. These data, combined with an extensive dataset obtained off South Africa since the late 1980s, allowed a significant, negative relationship between copepod growth rate and body size to be established over a broad size range of copepods. Given the wide spatial and temporal scales over which the data were collected, it is suggested that food is limiting growth rate of copepods in a size-dependent manner, with larger copepods being more food limited. In addition, such empirical relationship is useful in attempts to estimate secondary production of mesozooplankters for the entire Benguela Current region based on accurate measurements of their biomass and knowledge of their size distribution.
SUITABILITY OF THE SWARTKOPS SOLAR SALTWORKS FOR FISH CULTURE

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In South Africa, mariculture has the potential to be successful. Industries, like solar saltworks see mariculture as a means of diversification. The Swartkops solar saltworks utilises two pumps at a rate of 7 500lt/hour and has a very good natural food supply (mean density of zooplankton = 15 904.55m$^{-3}$). Fish enter the inlet pond via these pump outlets as larvae. It would be interesting to determine whether a mariculture venture would be feasible. A 13-month was undertaken to determine the density and diversity of the ichthyofauna (March 1998 to March 1999). Some physical parameters have also been recorded. Two very important abiotic factors for fish culture, salinity and temperature, have been found to be acceptable. The pH of the system is higher than the optimal range, due to pollution from a nearby informal settlement. The Cape silverside (Atherina breviceps) is the most dominant of the small fish component (~98%) of the total six months of catches. Mullet and the Cape stumpnose (Rhabdosargus holubi) are the predominant large fish component, though during the first three months of the study the Mozambique tilapia (Oreochromis mossambicus) had the most numbers. Further investigation into determining the water quality of the system is being undertaken.

DOES SEX OR SIZE INFLUENCE ROCK-LOBSTER APPETITE?

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Few studies of rock-lobster diet have included analyses of mature females or juveniles of either sex. Our study assessed the diet of male and female West Coast rock lobsters (Jasus lalandii) in three size classes (viz. 10-35 mm CL (carapace length) - small, 40-59 mm CL - medium and 70-85 mm CL - large), using visual analyses of stomach contents. The principle aims were to examine potential differences in rock-lobster diet between: (1) males and females; (2) size and (3) between areas of known fast- and slow-growth rates. The dominant prey items of all sizes of rock lobsters were the black mussel (Choromytilus meridionalis), ribbed mussel (Aulacomya ater), barnacle (Notomegabalanus algicola), sea urchin (Parechinus angulosus), sponge and crustacean remains. There was no difference in diet between male and female rock lobsters within any size class. Analysis of Similarity (ANOSIM, Primer v 4.0) showed significant differences (p<0.05) between diets of the three size classes. This was supported by Bray-Curtis similarity and Multi-Dimensional scaling plot analyses, both of which revealed differences between small, medium and large rock-lobster diets. Small rock lobsters consumed mainly ribbed and black mussels, whereas medium rock lobsters consumed higher percentages of barnacle and sponge. Sea urchins comprised a substantial percentage of large rock-lobster diet. The gut fullness index decreased with increasing rock-lobster size. Differences in diet were not apparent between areas of fast- and slow-growth despite dramatic differences in benthic community structure. In conclusion, there was no difference in diet between male and female rock lobster, regardless of their size. However, rock-lobster diet does vary with size. The inverse relationship between gut fullness index and size, shows that small rock lobsters, which have a higher moult frequency, feed more frequently than larger rock lobsters. Benthic community composition plays no role in determining the growth rate of rock lobsters from different areas.
Poster

CHANGES IN THE ABUNDANCE AND DISTRIBUTION OF SOUTHERN RIGHT WHALES, *Eubalaena australis*, IN FALSE BAY, WITH A COMMENT ON THEIR BEHAVIOURAL RESPONSES TO BOATS

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There have been few studies on the local movement of the southern right Whale, *Eubalaena australis*, around South Africa. This project examines the distribution of right whales around False Bay through the course of the 1999 season. Particular attention is paid to the relationship between distribution and abundance, and weather conditions and habitat, because these data may be of value to the ecotourism industry. Preliminary results from a study of the behavioural responses of whales to boat-based whale watching operations are also presented.

Oral

MARINE SCIENCE IN THE SERVICE OF GOVERNMENT: QUO VADIS?

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Transformation at many levels in the government, including fisheries management, has led to uncertainty about the future role of marine science. The question needs to be asked: how best can the available expertise best be retained and harnessed to serve the needs of the people of the country, in terms of both fisheries management and marine science and technology as strategic disciplines?

There are various options for a future scenario ranging from the status quo (central government retention) to full privatization. Pros and cons are discussed, and a case ultimately made for the creation of a new organization operating on the lines of Marine Science Council, with full autonomy, with the state as its main client, but able to offer services within its core competence to other clients. Some possible new functions, for example, research instrumentation and mariculture technology development, and possible future roles, as well as a possible modus operandi, including the maintenance of strong links to academic institutions and industry are described.

It is argued that the level and cost-effectiveness of advice to government would be enhanced by the creation of such an organization while contributing to the retention of expertise in the country. At the same time, it would align with strategic objectives of the national system of innovation.
CATCHMENT EFFECTS ON SMALL, TEMPORARILY OPEN
ESTUARIES: SOME CASE STUDIES

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The management of estuaries is a matter of concern and importance throughout the world. In South Africa, a generally arid country, the ecological viability of estuaries is coming increasingly under the spotlight as national freshwater requirements for domestic, agricultural and industrial use are beginning to reach levels similar to the total available. Increased water abstraction from rivers has meant that diminishing amounts of freshwater reach estuaries, both in terms of volume and time. This has had particularly severe effects on estuarine mouth dynamics. Thus the number of estuaries that remain permanently open to the sea is probably diminishing, with as yet unmeasured effects on organisms that rely on estuaries for a part of their life cycle. At the same time, estuaries themselves are being directly placed under increasing pressure from development, the nature of this development varying from subsistence level harvesting, through industrial development to various kinds of recreational developments.

The Eastern Cape Province, on the southeastern coast of South Africa, possesses roughly half the estuaries in that country. This is due in part to the presence of a narrow coastal plain backed by a series of rises, and has resulted in numerous small catchment areas that drain directly into the sea. Thus in the East London region, there are a number of estuaries with catchment basins of 40-60 square kilometres in area. At the same time, within a relatively small, climatically uniform area, the land is subjected to a number of different land uses. These include intensive western style commercial agriculture (such as dairy and pineapple farming), traditional African farming practices, nature conservation, and intermediate intensities of land use. In an attempt to examine the effects on land use on estuarine dynamics, the authors have initially selected four estuaries, each with catchments measuring approximately 40 square kilometres in area. Each catchment basin has a different predominant form of land use. In each case information has been collected on estuarine biodiversity, biomass, estuarine morphology and sediment distribution as well as a number of water quality parameters. At the same time, the varying forms of land use have been quantified using both current and historical aerial photography, the latter dating as far back as 1938. This paper presents the preliminary findings of this study.
TOWARDS SUSTAINABLE DEVELOPMENT: THE ARTISANAL FISHERIES IN THE
SOUTHERN PART OF THE NAMPULA PROVINCE
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The districts of Angoche and Moma are located on the northern Mozambican coast, in southern Nampula Province between latitudes 15o58'S and 17o01'S.

Since 1997 a monitoring programme developed for the artisanal beach seine fishery is in place. Based on the analysis of data collected in 1997 for the districts of Angoche and Moma a number of recommendations concerning the management of the beach seine fishery in these areas were implemented. These include:

- the establishment of an exclusive artisanal fishing zone extending 3 nautical miles from the coast of Angoche and Moma. This would reduce user conflict between artisanal and industrial fishers where the latter sector sometimes move close inshore to trawl.
- the establishment of co-management committees to educate fishermen on the detrimental effects of the use of mosquito nets has led to a decrease in the lining of beach seine cod-ends with mosquito nets.

A further incentive to fishermen to discontinue the use of mosquito nets was the reduction of the stretched mesh size from 38 to 12mm. These actions have reduced the juvenile fish catch from 10% in 1997 to 8% in 1998. While this is a positive step, the 8%, however, represents 1200 mt of juvenile fishes, which is still cause for concern. The total catch declined by 7% from 1997 to 1998. Despite the overall decrease in total catch, catch rates have increased over the 1997 to 1998 period. The mean CPUE in 1997 was 116 kg/seine-net day and increased to 152 kg/seine-net day in 1998.

The dominant fishes harvested are small pelagics. The dominant species belong to the family Engraulidae. The percentage increase, by weight, for the family Engraulidae was from 26% in 1997 to 42% in 1998.

As observed in 1997, effort was high in the first six months of the year. Low effort in the second half of year is related to lower catch rates in the latter half of the year as well as to the movement of fishers to southern parts of the fishing area. Species harvested in the seine net fishery were grouped into two categories. One was based on the species primary habitat while the other ranked species into 'vulnerability' groups based mainly on life history characteristics and other criteria. These classifications were attempted to promote better management strategies that depend solely on group characteristics rather than relying on the more traditional single-species plans.

SATELLITE OCEAN COLOUR AND PIGMENT CHARACTERIZATION OF PHYTOPLANKTON

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Large-scale patterns of phytoplankton distribution were investigated during an Atlantic Meridional Transect cruise from Cape Town to UK in May/June 1998. Ocean colour was determined on a daily basis using SeaWiFS data and continuous surface and depth profiling was undertaken for phytoplankton pigments using high pressure liquid chromatographic (HPLC) analysis. Ocean colour images of the Benguela and NW African upwelling ecosystems revealed high chlorophyll concentrations on the continental shelves and many detailed features such as fronts, eddies and meanderings were well illustrated. Surface distributions of HPLC derived pigment complemented the satellite chlorophyll data, while chemotaxonomic accessory pigments indicated the diverse nature of the phytoplankton community. A mixed community of diatoms, nanoflagellates and dinoflagellates occurred in the southern Benguela, with diatoms dominating in the north along the Namibian coast. Smaller nanoflagellates and prokaryotes were prevalent in the oligotrophic regions of the north and south Atlantic, while increased production of diatoms and nanoflagellates were observed in the NW African upwelling zone. Generation of SeaWiFS optical data as phytoplankton absorption and scattering images showed that diatom and dinoflagellate dominated communities could be characterized in terms of high absorption and low scattering, but nanoflagellate and prokaryote populations scattered more light and absorbed less.
SEAWIFS OCEAN COLOUR ON LEG 1

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Ocean colour data of phytoplankton biomass distribution are usually produced in the form of chlorophyll images, illustrating variations from high levels of pigment in inshore productive areas to low concentrations in offshore, warmer waters. However, analytical models of ocean colour derived from optical properties of phytoplankton offer improvements in pigment algorithms and provide information about the absorption and scattering properties of the phytoplankton community. Selected data from the 1999 BENEFIT training and research cruise will be used to show the distribution patterns chlorophyll, absorption and scattering along the cruise tract, and appropriate inferences of the phytoplankton community structure.

A FOREDUNE SENSITIVITY ASSESSMENT OF THE CAPE COAST

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An aerial survey of Coastal foredunes was undertaken from Cape Town to the Kei river. The objectives was to identify dune sensitivity as indicated by the extent of bare sand ‘blowouts’ along the coast. The hypothesis tested was that human use of the Coast is a major factor in the formation of blowouts. The data from the study do not fully support the hypothesis and the major finding was that geomorphological conditions are the prime causes of sensitivity with human use a contributory factor. A detailed study in Algoe Bay was undertaken in an attempt to understand some of the dynamic forces at work in the foredunes. The data arising from that study suggest that foredunes in half-heart bays along the South Coast are especially sensitive to natural climatic and weather events and that management aimed at keeping people off the dunes may not be an adequate strategy. Some ideas on the requirements of a more complete strategy are suggested.
LAST TANGO? ARTISANAL FISHING IN TANGA, TANZANIA

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The Tanga region along the north-eastern coast of Tanzania is characterized by fringing and patch coral reefs, seagrass beds, mangrove forests, estuaries and embayments. The 0.3 million inhabitants rely heavily on harvesting marine resources from these ecosystems for their livelihoods. The coastal fisheries are open access, artisanal in nature and catch a wide diversity of fishes and invertebrates. Fisheries statistics for the region show that the number of fishers has increased steadily whilst the total catch has declined. Most indicators point to a combination of growth, recruitment, ecological and Malthusian over-fishing in the region as a result of the use of destructive fishing practices such as dynamite, small mesh nets and poisons.

The Tanga Coastal Zone Conservation and Development Programme was initiated in 1994 in an effort to introduce participatory, community-based integrated coastal zone management in the region. Subsequently the Oceanographic Research Institute was requested to evaluate the activities of the programme with regard to artisanal fisheries and to assist in developing a management strategy for artisanal fisheries in Tanga.

Indicators to monitor the fishery were recommended whilst fisheries enhancement methods and best-use options for degraded areas were examined. In view of the nature of the artisanal fishery in Tanga and the capacity at government level in Tanzania, co-management was recommended for the Tanga region. Permanent fishery reserves or closed areas appear to be the only suitable management tool for the multi-species reef fishery. A drastic reduction in fishing effort is necessary in order that populations of reef fishes can recover and alternative sources of income such as mariculture, agriculture and tourism will have to be developed. Further, the Tanzanian government has to take responsibility for the eradication of dynamite fishing along the coast and international pressure should be brought to bear on the country in this regard.

PHYTOPLANKTON AND OCEAN COLOUR: MORE THAN CHLOROPHYLL

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An assessment is made of the processes underlying ocean colour with a focus on harmful algal blooms in the Benguela. Phytoplankton absorption spectra, measured with the filter pad technique, are used in combination with particle size distribution data and Mie modelling to obtain scattering data for a variety of phytoplankton assemblages.

Measured and modelled absorption and scattering data are used in conjunction with the Hydrolight radiative transfer model to analyse the sensitivity of water leaving radiance to variations in phytoplankton assemblage structure. These analyzes are used to discuss the merits of in-situ and remotely sensed ocean colour data, algorithms for the derivation of phytoplankton biomass indexes, and their appropriate operational use.
Benefit Oral

OPTICAL ABSORBANCE AND SCATTERING PROPERTIES OF PHYTOPLANKTON

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Analytical models of ocean colour are based directly upon the optical properties of phytoplankton and offer significant potential improvements over empirically derived pigment algorithms, such as those currently used with SeaWiFS. Data from the 1999 Benefit cruise, consisting of measured phytoplankton absorption and particle size distributions, are used to derive spectral and angular scattering using anomalous dispersion and Mie modelling. These data, in combination with HPLC pigment concentrations, are used to assess potential causes of ocean colour variability in the Benguela.

Poster

THE ECOLOGICAL EFFECTS OF EPITHALLLIAL SHEDDING IN SOUTH AFRICAN CRUSTOSE CORALLINE ALGAE

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Coralline algae (Rhodophyta, Corallinales) are calcified red algae. Many are epiphytic, epizoic or even parasitic on other corallines. Crustose corallines range from a few microns to several centimeters thick crusts. They are often slow growing and may cover almost 100% of rocky surfaces and occur on coral skeletons, shells, other algae or sea grasses. Some coralline’s slough off a surface layer of epithelial cells. This epithelial shedding is thought to be a means of getting rid of damaged cells and antifouling.

Epithelial shedding may occur as a few cells at a time or large sheets of cells peeling off. Previous work was done in Fiji to determine the antifouling effect of epithelial shedding in three crustose coralline algae on a coral reef. The aim of the present project is to analyze the recruitment of organisms on the surface of live and killed coralline algae. The study was conducted within tide pools at Kalk Bay on the Southwestern coast of South Africa using Heydrichia woelkerlingii. Half of the samples that were collected were killed by immersing them in a solution of 10% formalin for 30 minutes. The specimens were then attached to chicken wire on concrete slabs, using cable ties. The coralline fragments were then tagged, numbered, and placed back in the tidal pool. Specimens were photographed at the beginning (June) and monthly till the end of the experiment (September). Tanks were also used to create a controlled environment with both live and formalin treated coralline algae, which were kept at the Sea Fisheries Research Institute. Analyzed photographs of the specimens were used to determine the area of visible shedding and the area occupied by organisms recruiting onto the surface of both the live and killed coralline fragments. The results are discussed in terms of the role of coralline algae in the marine ecosystem.
CHARACTERIZATION AND COMPARISON OF THE DIETS OF ANCHOVY (*Engraulis capensis*) AND SARDINE (*Sardinops sagax*) PRE-RECRUITS IN MIXED SHOALS IN THE SOUTHERN BENGUELA

K. Booi¹, C.D. van der Lingen², and S. Painting¹

In the southern Benguela, adult sardine and anchovy are trophically distinct: adult sardine derive most of their dietary input from phytoplankton and small zooplankton, whereas adult anchovy obtain most of their nutritional requirements from large zooplankton. Preliminary studies on the diet of sardine and anchovy recruits have suggested that they too might be trophically distinct: sardine recruits consume significantly smaller zooplankton prey than do anchovy recruits. These differences have been hypothesised as being partly responsible for observed regime shifts between these two clupeoid species, both in the southern Benguela and in other upwelling ecosystems.

This study assesses the hypothesis that sardine and anchovy pre-recruits are also trophically distinct. The species composition and size-frequency distributions of ingested prey of sardine and anchovy pre-recruits from mixed shoals were analyzed to evaluate this hypothesis.

Sardine and anchovy pre-recruits both ingest phytoplankton (principally *Coscinodiscus gigas* and *Peridinium* spp.) and small zooplankton, such as *Oithona* spp. and copepod eggs and nauplii. Preliminary results suggest that there is no significant difference between the size frequency distributions or species composition of the diet of these two species. However, sardine seems to ingest more prey than anchovy of similar lengths. Further analyses will examine the relative contribution made by phytoplankton and zooplankton to the dietary carbon of these two species, and may elucidate trophic differences between them.

STEPS TOWARDS THE DEVELOPMENT OF ALTERNATIVE STOCK ASSESSMENT MODELS FOR SOUTH AFRICAN LINEFISH

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South Africa is presenting developing management procedures for all harvested stocks, including its linefish resources. Integral to the management procedure is an assessment framework that comprises of one or more mathematical representations of the population dynamics of stock. The assessment framework therefore provides quantitative information on the current status of the stock and future stock status projections given management/harvesting alternatives. A set of decision rules, decided on by all stakeholders through a buy-in process, is used to take management action based on the assessment framework outputs. In the past, linefish stock assessments have been almost exclusively based on per-recruit models due to a combination of a lack of high quality data such as catch, age and effort. For a management procedure to be successful, alternative forms of output such as catch and/or effort levels are required. Presently per-recruit models only provide reference points based on fishing mortality and in some cases fishing effort. As a consequence, the stock assessment models and their associated data collection procedures applied to linefish stocks in South Africa need to be readdressed and a more rigorous assessment framework developed. This paper presents a comparison of stock assessment models that are either currently used or are in the process of development and their advantages and disadvantages discussed.
THE POTENTIAL RISK OF HARMFUL ALGAE TO ABALONE FARMING ON THE SOUTH COAST OF SOUTH AFRICA

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Toxic algal blooms are common world-wide and pose a serious problem to the aquaculture and fishing industry. Of the dinoflagellates, species such as Gymnodinium breve, Gymnodinium mikimotoi and Gyrodinium aureolum are recognised fish-killers implicated in various faunal mortalities. Toxic blooms of G. cf. mikimotoi were observed on the south coast of South Africa for the first time in 1988 and were responsible for wild and farmed abalone (Haliotis midae) mortalities. Attempts to isolate and culture G. cf. mikimotoi revealed the presence of several Gymnodinioid species on the south coast, some of which have been successfully isolated. Another fish-killing species, namely Heterosigma akashiwo, has also been isolated from this region. The toxicity of the above species has been investigated by means of an Artemia bioassay (ARTOXKIT), a routinely used method in marine and aquatic toxicology. A similar experimental procedure was used to assess the toxicity of each culture and its filtrate on both abalone larvae and spat (3mm animals). Similar experiments were conducted on Gyrodinium aureolum (Isolation site: Norway; Obtained from: Department of Phycology, University of Copenhagen, Denmark) for comparative purposes.

Oral

THE EQUALANT PROGRAM AND GULF OF GUINEA PROJECT

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The EQUALANT program (PI: C. Andrie -IRD, ex ORSTOM-) is a component of the ECLAT (Etudes Climatiques dans l'Atlantique Tropical) program, French component of the international CLIVAR (CLImate VARiability and predictability) program in the tropical Atlantic. One of the main objectives of this programme is the study of the ocean circulation variability and the ocean-atmosphere interactions in the equatorial Atlantic. The EQUALANT 99 cruise (PIs: C. Andrie and Y. Gouriou - IRD-) will take place in boreal summer 1999 during 42 days (July, 12 to August, 22) on board the R/V THALASSA, from Salvador de Bahia (Brazil) to Abidjan (Ivory Coast). It consists on carrying out hydrology (CTDO2), currents (VMADCP, LADCP), tracers (nutrients, CO2 system parameters, CFCs), and primary production parameters measurements along three meridional sections from 6ºS to 6ºN at 35ºW, 23ºW, 10ºW and along one zonal section at 8ºS in the western most part of the basin. XBT and XCTD (0-1000 m) probes will be launched every ¼º during transits and sometimes between casts. Along with these oceanographic measurements, meteorological parameters (temperature, wind, solar fluxes....) will be also measured thanks to an instrumented mast located on the foredeck of the vessel. Sounding balloons will be released during the stations carried out around Oh and 12h TU. 36 hours stations will be done at some PIRATA buoys locations (35ºW-Equator, 10ºW-Equator and 10ºW-2ºN), in order to assess turbulent fluxes at the sea-air interface and to improve their parameterizations. Along 10ºW, 16 SVP drifting buoys (given by NOAA/AOML) will be launched, along with one 'CARIOCA' buoy (pCO2 measurements). At the time of the cruise, four moorings will be deployed (PI: C. Provost -LODYC-) between 0º50'S and 0º50'N along 10ºW in July 1999 from the R/V ANTEA. These moorings will record hydrological (temperature, salinity) and current measurements continuously (ADCP and Yoyo system) in the first 1000 m depth at the equator (location of a PIRATA buoy), and current measurements between 1000 and 2000 m at the equator, 0º50' and 0º50'N, in order to assess the characteristics of the deep equatorial jets. Some very first results of this cruise will be presented.

A second cruise (EQUALANT 2000; PIs: C. Andrie and B. Bourles - IRD-) is planed in August-September 2000, in order to complete the survey of the Atlantic basin, east of 10ºW. From 2001-2002, it is planed to proceed to a systematic survey of the upper layers in the Gulf of Guinea, during the three annual cruises needed for the PIRATA maintenance.
In June and July 1999 a cruise was conducted off the west coast of Southern Africa between 34 and 15 degree south on FRS Africana as part of the 'BENEFIT' program. Work included the measurement of currents by means of a shipboard ADCP with differential GPS input and the deployment of 10 drifters. Of these, six were released on the inner shelf and 4 on the outer shelf. The flow patterns measured (Some of which will be presented separately as regional studies) are moderated in the light of previous research to arrive a classification of the Benguela System into areas with different dominant characteristics. In winter 1999, currents were strongest at the ends of the system, both showing southward and onshore flow on the inner shelf and northward-to-westward flow offshore. However off southern Angola warm, advected water comprised the offshore system. Off southern and central Namibia, the waters were cool and the currents were weak and many small frontal systems were observed. Off northern Namibia the measured on the outer shelf with variable flow in between. The likely linkages in terms of near-surface longshore flow between adjacent areas within the Benguela and southern Angolan Systems are examined.

Oral

TOWARDS EQUITY, SUSTAINABILITY AND STABILITY: A SECTOR PLANNING APPROACH TO FISHING AND MARICULTURE DEVELOPMENT IN THE NORTHERN CAPE PROVINCE

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The decline of diamond mining in the Northern Cape Province will lead to a loss of some 5000 jobs in the coastal region over the next few years. A baseline study of the Northern Cape Province economy indicated that fishing and mariculture offer a significant opportunity for sustainable economic development on the Namaqualand coast. The major opportunities include hake and lobster fishing, seaweed harvesting and aquaculture of abalone, seaweeds, oysters and finfish. However, in order to realize these opportunities, and the goals of the Marine Living Resources Act of 1988, a package of development support for local communities is required. Northern Cape Provincial Government is facilitating the development of these sectors (delivery) by means of a holistic sector planning approach. This has required the setting of clear developmental goals and targets, based on a stocktaking and diagnostic survey of community needs and the potential of the fishery and mariculture sectors. Based on the targets set and the resources available, constraints to development have included the establishment of a representative community and industry based Fishing and Mariculture Development Association (FAMDA), support for emerging fishing and mariculture entrepreneurs, a socio-economic baseline and impact assessment of the potential of mariculture and fishery development, research support to promote fishery and aquaculture development, the establishment of suitable institutional arrangements and the initiation, marketing and support of new projects and investments.
REALIZING SOUTH AFRICA’S INVESTMENT IN THE
GLOBAL OCEAN OBSERVING SYSTEM

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The vision of the Global Ocean Observing System (GOOS) is a world where the information needed to
deal with marine issues is supported by a unified global network. The information is needed by
government, industry, science and the general public. The global network will systematically acquire,
integrate and distribute ocean observations and will generate analyses, forecasts and other value-added
products. Such products are useful because a significant proportion of world economic activity and a
wide range of services, amenities and social benefits depend on the wise use of the sea. The expected
growth in population, particularly in the coastal zone, with the attendant pressure on natural resources
suggests that the economic significance of the oceans is likely to increase as will the need for its
sustainable use. Investment in GOOS is needed by national and international operational agencies, by
research organizations, commercial companies and by development agencies. Such investment can
produce economic and social benefits, which are valuable on a global scale at a cost and risk, which are
acceptable.

South Africa is a state with a long coastline and an extensive exclusive economic zone. The attainment
of the GOOS vision is of direct interest to South Africa. Internationally GOOS has recognized the
importance of an already operational Initial Observing System (IOS) in demonstrating the potential
benefits of GOOS. South Africa makes a contribution to this IOS, for example, through its sea level
network and its involvement in the Voluntary Observing Ship network and the Drifting Buoy
Programme, generating data used in maritime weather forecasts. This example has focused attention
on the marine services sector. However, South Africa also contributes to elements of the four GOOS
design modules for monitoring, assessment and prediction. These are for climate, for the coast, for
living marine resources and for the health of the ocean, extending from the physical into the biological
ocean environment. It is clear that the Southern African Data Centre for Oceanography will play a
pivotal role in providing an efficient data archive for the ongoing development of GOOS in South Africa.
GOOS presents South Africa with the opportunity to profit from previous investment in marine science
and to develop new initiatives. It becomes possible to contemplate forecasts of the sea state of the
coastal margin for days to decades into the future, giving improved seasonal and interannual climate
forecasts and extending into the biological ocean environment. The final benefit will accrue to
economically important industries and activities such as offshore gas and oil, fisheries, mineral
extraction, defence, coastal development, pollution management, climate prediction, port operations,
coastal protection, ship-routing, mariculture, tourism and public health.

Poster

FEEDING RATES OF COMMON PELAGIC CNIDARIANS AND CTENOPHORES
FROM ALONG THE WEST COAST OF SOUTH AFRICA

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Laboratory experiments were conducted in the research aquarium at Marine and Coastal Management
in Seapoint to determine the filtration rates of common medusae and ctenophores from along the west
coast of South Africa. The results are presented and extrapolated to the field. It is clear from this, that
the common species can filter appreciable volumes of water each day and this could have an impact on
the overall zooplankton assemblages.
Changes in the biological composition of the cnidarian and ctenophore assemblage in St. Helena Bay were studied from samples collected at a fixed station positioned in St. Helena Bay during a 28-day period in autumn 1987. Forty zooplankton samples were collected with a 200 mm meshed paired Bongo net system, which was towed from the bottom (47m) to the sea surface. Depth and temperature profiles were recorded simultaneously. All the samples were fractionated with a 1600 mm and a 500 mm mesh which separated the large diatoms from the zooplankton and which allowed the populations to be studied as a function of their size. Two upwelling events were observed during the course of the study, and changes in the composition of the assemblage are examined with respect to the physical and biological environment, which developed subsequently. The samples collected were vertically stratified, which enabled us to examine the behavioural response of the gelatinous carnivores (all medusae and Ctenophores) to the stratification of the abiotic (temperature, salinity) and biotic environment (phytoplankton concentration and other zooplankton abundances).

MORPHODYNAMICS OF TRANSGRESSIVE DUNEFIELDS IN THE EASTERN CAPE

Coastal dunes and dunefields can be categorized into two broad morphodynamic types: (1) transgressive (i.e. freely moving in a downwind direction) and (2) retentive or fixed dunes (those dunes that are more or less fixed by vegetation). The interactions between the rate of sand supply, wind energy and the sand-binding effectiveness of vegetation determine whether transgressive dunefields will develop in a particular setting or not. The Eastern Cape coast experiences high wind energy and is characterized by sandy beaches along much of its coastline. Extensive transgressive dunefields develop contiguous to or downwind of the sandy beaches where the dominant wind blows alongshore/onshore: large-scale accretionary sheet dunefields develop adjacent to the long shores of log-spiral bays, headland bypass dunefields cross prominent headlands as corridors of transverse dunes and buttress dunefields develop along the rectilinear coast north of Cape Padrone.

The dunefields are characterized by mobile reversing transverse dunes whose downwind migration is temporarily reversed during seasons when winds are opposing bimodal. The landward or lateral margins of the dunefields are fixed by vegetation and form significant geomorphic features. The morphology and transgressive potential of transgressive dunefields depends on:
- rate of sand supply;
- coastal wind energy (taking directional variation into account);
- shoreline configuration in conjunction with the prevailing wind direction;
- the change in downwind transporting capacity of the wind;
- and vegetation vigour.

The morphodynamics of headland bypass dunefields is used as a reference point to discuss the dynamics of accretionary sheet dunefields and buttress dunefields. Open-ended systems play an important role in maintaining the littoral drift system, and management in the coastal zone needs to take this into account.
BIOMEDICAL ACTIVITY OF SOUTH AFRICAN RED ALGAE
SECONDARY METABOLITES
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Previous studies on red seaweeds have shown that crude extracts may contain compounds possessing antiviral, antibacterial, cytokinin-like, cytotoxic, anthelminthic, anticoagulant and antioxidant activity. Some of these active compounds have been isolated, identified and put to medical use. In this study we determined the medical significance of the extracts of some red seaweeds from the South African West Coast. The biologically active compounds were isolated and identified. Anti-microbial, cytotoxic, immunomodulatory, anti-blood clotting and antioxidant activity of the extract were investigated. The methods used for these determinations included the disc-diffusion method for antimicrobial screening, bioautography method and various other assays. Active fractions were isolated and the compounds(s) identified using NMR and mass spectroscopy.

CROWN-OF-THORNS STARFISH: A PRICKLY PROBLEM?

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The incidence of crown-of-thorns starfish (COTS) has increased in recent years throughout the Indo-Pacific region. A spot outbreak appeared on Two-mile Reef at Sodwana Bay in 1994 and was monitored while funds were sought for further research on the local phenomenon. The study commenced in 1998, with attention being given to the biology of the COTS, the damage they are causing on the coral reefs, and the progress of reef recovery after infestation. A digital video technique was developed for rapid reef surveys and modeling techniques are being refined for the analysis of the data. Interesting findings to date are the degree to which the local COTS consume non-scleractinian corals, reef degradation continues after infestation and slow recolonization thereafter is dominated by soft corals.

LOBSTER WALKOUTS OR STRANDINGS IN THE 90s:
CAUSES, RESULTS AND IMPLICATIONS

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Faunal mass mortalities are a sporadic, but not uncommon, feature of the west and south coasts of South Africa. Of the 21 mass mortalities that have occurred in this region since the early 1960s some 17 have been along the West Coast with the bulk of these in the greater Elands Bay area. Examination of the frequency of lobster strandings or mass mortalities reveals that the 1960s, 1970s and 1980s were characterized by one or two such events per decade. The 1990s, however, has experienced five recorded mass strandings to date. But, more importantly, is that these have included by far the three most serious strandings (ca 60 tons in 1994, 2000 tons in 1997 and 200 tons in 1999) ever recorded.

This paper reviews the lobster strandings in the 1990s and discusses causes, results and implications. A continuation of the trend of increasing frequency and severity of lobster strandings would not only be devastating to the rock lobster industry, and especially the small fishing communities on the South African west coast, but could also have a serious impact on the ecology of the region.
The poster aims to provide information on marine environmental monitoring programmes conducted in order to assess potential increases in ambient marine turbidity, with specific reference to the mariculture industry, associated with dredging operations during port expansion developments - in Saldanha Bay, South Africa and Luderitz, Namibia. The potential environmental impacts of increased turbidity due to dredging on marine systems, specifically with regard to the mariculture industry will also be addressed. The methodology of monitoring, instrumentation used and associated problems will be presented as will a general overview of turbidity generating mechanisms in marine environments.

Turbidity data were collected using YSI and OBS instrumentation as well as water samples at discrete elevations throughout the water column. Sampling was conducted on a constant grid of stations around the dredging operations on a regular basis as well as at distant, unaffected reference stations and near sensitive mariculture sites in the bay. A number of in-situ water samples of known turbidity (as a function of total suspended particulate matter - TSPM) were taken, analyzed and used to calibrate the electronic instrumentation used in the routine monitoring programmes. Prior to the dredging operations, a number of samples were obtained throughout the bay areas to provide background turbidity values against which to measure the dredging related values. Maximum allowable suspended sediment loading of no greater than 150mg/l at a distance no greater than 150m from the dredger had been recommended in the EIA for the dredging phase. The results of the monitoring programmes show a distinct elevation in turbidity values with increasing distance (the farfield - i.e. greater than 150m from the dredger) from the source. An increase in the ratio of inorganic to organic matter in the total suspended particulate matter was also observed which appears to be as a result of the resuspension of surficial seafloor sediments during dredging. Surprisingly, a very distinct visual signature i.e. highly turbid water, is not always associated with a high total suspended sediment loading -this is attributed to the nature of the material in suspension, its grain size and reflectivity and the low ambient turbidity typical of the bays. In particular, dredging of calcrete seafloor sediments and bedrock appear to generate highly turbid waters which are often associated with low to medium sediment loadings. Aerial photography, undertaken on two occasions during the dredging phase, confirmed the high turbidity values as measured in the nearfield, and large areas of relatively low total suspended sediment loading in the farfield. The aerial photography also showed clear examples of natural turbidity generating mechanisms in the form of turbid plumes associated With headland erosion in the bay area. The maximum allowable suspended sediment loading, as determined in the EIA, was not exceeded during the dredging phase in either of the dredging projects. After cessation of the dredging, turbidity values measured in the water column decayed rapidly to typical natural turbidity levels.
**Poster**

**ECONOMIC IMPLICATIONS OF SHARK DIVING AT UMKOMAAS, KWAZULU-NATAL**

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KwaZulu-Natal has a population of 8,577 million representing 21% of South Africa's people and the largest population of all the provinces, yet its contribution to Gross Domestic Product (GDP) is only 14.5%. Economic activities are unevenly distributed over the province, with a high concentration in the metropolitan areas as well as the coastal areas where tourist activities have a considerable economic impact. Umkomanzi district (which incorporates the town of Umkomaas) has a lot to offer with its Nature Reserve and Historical sites, but is probably best known for the diving industry active on the Aliwal Shoal 5 km offshore. Undoubtedly, the most famous aspect of this dive site is the annual occurrence of aggregations of raggedtooth sharks *Carcharias taurus* during the austral winter months. This study aims to identify the economic impacts of the shark diving industry in the Umkomaas area with special reference to whether the industry has assisted in the development of the area. Visiting divers, towns folk, businesses and dive operators will be asked to complete questionnaires both before the 'shark season' starts and during the period that sharks are at the Aliwal Shoal. Thereby, the study will be able to determine why divers have come to Umkomaas, and the economic implications of recreational diving.

**Oral**

**INDIAN OCEAN INVERTEBRATES AND ALGAE: AN UNTAPPED SOURCE OF NEW ANTI-CANCER DRUGS?**

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For the last two and a half decades there has been a concerted international effort on the part of the National Cancer Institute in Maryland, USA to identify natural products, isolated from terrestrial plants and marine organisms, with exploitable anti-cancer activity. Collections of plant and invertebrate material have accordingly been made from all corners of the globe and the NCI's repository probably houses the most diverse store of biological material in the world. The discovery of Taxol a natural product isolated from the bark of the North American yew tree and now a front line drug for the treatment of breast and ovarian cancer is one of the NCI's success stories.

Very little is known about the anti-cancer potential of Indian Ocean Marine invertebrates and algae. In September 1998, a collection of 250 marine invertebrates and algae was made from Algoa Bay, South Africa as part of an ongoing collaboration involving scientists at Rhodes University, the University of Port Elizabeth, the Coral Reef Research Foundation and the National Cancer Institute. In this presentation, the politics and the advantages and disadvantages of bioprospecting will be briefly discussed. In addition, preliminary anti-cancer screening results of the extracts of these Algoa Bay marine organisms as well as contributions to basic invertebrate taxonomic data in this region will be described. The approaches adopted for the collection and taxonomic identification of South African marine organisms, plus the methods used for the screening and chemical work up of the active extracts of these organisms will be outlined.
THE IMPORTANCE OF ST. HELENA BAY TO PELAGIC FISHERIES

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Strong hydrographic links are sought to exist between the Cape Columbine upwelling cell and St. Helena Bay, a semi-enclosed system which lies on a broad shelf area to the north of Cape Columbine. Two transects were undertaken on the RS Africaner, a scientific research vessel, on the 16th and 17th of February 1999 in St. Helena Bay, in an attempt to study the hydrographic regime of the area and confirm the existence of the hypothesized retentive circulation patterns.

The phytoplankton blooms and productivity rates were also studied, in an attempt to determine the relative importance of the areas as a larval and juvenile recruitment ground for pelagic fish as have been suggested by a number of authors. Results of the data showed that, although no active upwelling was incurred during the cruise, the water in the bay did appear to be mature upwelled water, with salinities below 35ppt. Although there was no direct evidence to confirm the existence of Retentive circulation Patterns, indirect evidence from the interaction between biological and physical variables suggested that they did exist. Stratification of the water column, together with the presence of a relatively homogenous, stable inshore bottom mixed layer suggests the presence of retentive circulation within the bay. Similarly, conditions of oxygen-depletion, high NO3 concentrations, a salinity of 34, 8ppt and a temperature of approximately 9,8 º C beneath the thermocline provide further evidence of retentive circulation patterns in St. Helena Bay. Furthermore, a phytoplankton bloom with high chlorophyll concentrations (up to 31,24 mg/cubic meter) and productivity rates (averages 4.24 grams Carbon per m² per day) was located on the thermocline.

It therefore appears that St. Helena Bay is an extremely productive system due to the stability in the bay and the intermittent input of nutrients into the bay from upwelling in the Cape Columbine cell. It is therefore an ideal nursery area for pelagic fish and is extremely important for the successful growth and recruitment of pelagic fish into commercially important fisheries. Due to the low rates of new production (average 10.43%), it appears however that St. Helena Bay probably does not act as a sink for CO₂.

SHARKS CAUGHT IN THE PROTECTIVE GILL NETS OFF KWAZULU-NATAL, SOUTH AFRICA. THE SCALLOPED HAMMERHEAD SHARK, SPHYRNA LEWINI

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Between 1978 and 1997, 3325 scalloped hammerhead sharks Sphyrma lewini were caught in the shark nets that protect bathers at the swimming beaches of KwaZulu-Natal. This species is the third most abundant shark species taken in the nets, with an annual mean catch rate of 166.25 sharks per year. Catch rates showed a decline during the study period from 7.39 to 2.16 sharks. Km-net-1.year-1. The majority of sharks were caught to the far north and south of the netted regions. Catches showed strong seasonality with most sharks being caught in the summer months. Males ranged in size from 53.7 cm PCL (2.2kg) to 230.1 cm (124kg). Females ranged from 66cm PCL (4.1kg) to 243 cm (268kg). Both males and females matured at approximately 160cm PCL. Very few mature specimens were caught. Ongoing studies into feeding habits and characteristics, and ageing studies are currently being undergone.
Management procedures are an important management tool for the South African small pelagic, hake and rock lobster fisheries. These management procedures are based on the revised management procedure developed by the international whaling commission in the mid-1980's. In the case of the small-pelagic fishery, they are a simple set of formulae that convert the biomass estimates obtained from annual hydroacoustic surveys into TAC recommendations. Thus far, pelagic management procedures have used commercial and survey data only, ignoring data such as environmental indices. This paper investigates the use of such indices in the management procedure framework.

The shallow-water shrimp represent the most economical resource in Mozambique. Therefore, annual surveys have been carried out up to this year, to investigate the state of the stock during the last two decades.

Resource assessment was conducted on principal species captured to estimate levels of abundance and distribution in Sofala Bank between 5 and 50m depth during closed season in February-March 1999. The cruise was conducted in an industrial vessel belong to a fishing company. The area covered was 28500 km². Sixty random stations were previously selected.

By the swept area method 2398.5 tons of biomass of shrimp was estimated. From this, *Metapenaeus monoceros*, summed 639.6; *Penaeus indicus*, 813.3; *Penaeus latisulcatus*, 276.4; *Penaeus monodon*, 108.0; *Penaeus semisulcatus*, 38.1; *Penaeus japonicus*, 141.0 and other species 422.7 tons.

It was observed that the average carapace length of females *M. monoceros* were 25.7 mm and males 22.6 mm; females *P. indicus* were 31.2 and males 26.1 mm; females *P. latisulcatus* were 40.4 and males 22.6mm; females *P. indicus* were 31.2 and males 26.1 mm; females *P. latisulcatus* were 40.4 and males 36.7 mm; females *P. monodon* were 48.7 and males 48.0; females *P. semisulcatus* were 36.4 and males 27.0 mm; females *P. japonicus* were 39.6 and males 32.3 mm. Apparently there is evidence that the females have bigger size than males in within the species. For most of species the average length, increase with depth with stand out for females of *M. monoceros*, *P. indicus*, *P. semisulcatus* and *P. japonicus*.
THE INFLUENCE OF WATER TURBIDITY AND SURFACE WAVES ON SQUID CATCHES

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The inshore and offshore regions of the Eastern Cape are well documented as spawning grounds for chokka squid (Loligo vulgaris reynaudii). The environments of these regions are highly contrasting and one of the more important parameters responsible for this difference is turbidity. The inshore regions at times experience the presence of a benthic nepheloid layer - which it is believed - inhibits spawning inshore. Squid catches depend on successful inshore spawning. A study to determine the characteristics and dynamics of these turbidity events has been initiated and hopes to strengthen postulations on squid spawning strategies along the South African South Coast. The study comprises of 1) ship surveys over the Eastern Agulhas Bank, 2) time series CTD transects in St Francis Bay and 3) continuous monitoring of turbidity and wave height in St Francis Bay. Two South Coast surveys extending from Cape Agulhas to Port Alfred were performed on board the FRS Africana in April of 1999. Turbidity events were located specifically inshore in both surveys; with maximum turbidity occurring in the Cape Recife and Cape St Francis bays as well as in the Cape St Blaize region. These areas are prominent spawning grounds. Offshore shelf regions displayed clear waters. A more extensive and specific study is presently underway in the Kromme Bay (Cape St Francis). Time series data along two set transects, one situated within the Bay and the second West of Seal point, was obtained using a portable CTD with a turbidity sensor attached. Data to date shows that turbidity is generally higher within Kromme Bay. Previously obtained continuous monitoring data shows that turbidity occurs not only during an upwelling event, but also in isothermal conditions, and that wave activity is a definite cause. This continuous study has been resumed within Kromme Bay.

THE COMPOSITION OF WATERBIRD COMMUNITIES IN RELATION TO ESTUARINE CHARACTERISTICS IN THE EASTERN CAPE OF SOUTH AFRICA

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In an effort to understand processes that influence the distribution of aquatic birds in the Eastern Cape Province of South Africa, 22 estuaries were surveyed for waterbirds by boat around the city of East London. Each survey was undertaken once, to preclude confounding effects, such as territoriality, that might lead to overcounting individuals. Concurrent with the survey, an estimate of percent cover of vegetation types was made, as well as measurements of topographical features, average water depth, salinity, temperature and pH. Hydrographic parameters were measured electronically.

Wetlands were grouped into categories using cluster analysis, and birds organized into functional groups based on food habits, behaviour and microhabitat use. Correlated habitat variables were reduced to single factors using principle components analysis and associations with descriptive factors were tested with multiple regression. Groups of birds responded differently to environmental features, although salinity was an important feature in the distribution of many species. Further work is needed on temporal variability and waterbird abundance in relation to food distribution.
Oral

FAO'S INTERNATIONAL PLAN OF ACTION FOR THE CONSERVATION AND MANAGEMENT OF SHARKS -- A SOUTH AFRICAN PERSPECTIVE

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The FAO Committee on Fisheries (COFI) adopted in February 1999 an International Plan of Action for the Conservation and Management of sharks. The plan was developed in response to increasing concern about expanding catches of sharks and their potential negative impacts on shark populations. Generally the state of knowledge of shark biology and shark fisheries is poor and few countries have specific management plans for their shark fisheries. Further, there are few international management mechanisms addressing the capture of wide-ranging and highly migratory species.

Although compliance is voluntary, all concerned states are encouraged to adopt a national 'Shark - plan' by 2001 (the term 'shark' here including all sharks, rays and chimaeras). The Shark - plan should contain a description of the prevailing state of (1) shark stocks, (2) associated fisheries and (3) a management framework and its enforcement. The Shark - plan should also contain strategies for achieving its defined objective. These might include access control, effort reduction, improved utilization of the catch, improved data collection and monitoring and the facilitation and encouragement of research on little known species. Despite the small scale of its shark fisheries, South Africa is one of the few countries, which, prior to the FAO call, had already achieved some progress towards management. The chief Directorate: Marine and Coastal Management has initiated research projects on, and/or management procedures for, a number of shark fisheries. Shark-directed longline and gillnet fisheries are permit-restricted. Finning has been prohibited. Observer programs to identify and quantify the shark catch of the handline and demersal trawl fisheries have been set up. Dedicated research cruises focussing on commercially important shark species have been conducted. Attempts at modeling the *Galeorhinus galeus* (soupfin shark) fishery are underway. Non-consumptive exploitation of sharks, such as cage diving to view *Carcharodon carcharias* (great white shark), a protected species, or diving with *Carcharias taurus* (spotted ragged-tooth shark), a recently decmmericalised species, is either regulated or the subject of investigation. Several postgraduate projects focussing on shark or ray biology or fisheries have either been completed recently or are underway. South Africa is therefore some way towards fulfilling FAO's requirements for a national Shark-plan, although such a plan has still to be formally adopted. There is concern, however, that MCM does not have the funds to dedicate sufficient research and management effort to the country's shark resources.

Benefit Poster

LOW OXYGEN EXPRESSION AND THE POLEWARD UNDERCURRENT ON THE ANGOLA-NAMIBIA SHELF, JULY 1999


Deep-Sea Physical Oceanography, Marine & Coastal Management Roggebaai 8012, South Africa

Hypoxia on the continental shelf of the Benguela system has implications for fisheries resources as evident by hake recruitment failure off Walvis Bay in 1994 and several rock lobster mortalities in the Elands Bay region. Attempts to investigate the origin if such oxygen deficient water leading to these events has been hampered by a lack of knowledge on the relative contribution of locally generated hypoxia versus that which is advected from remote sources. This presentation attempts to address this question by examining the potential input of low oxygen into the shelf system from the Angola Current system.

The extent and intensity of the low oxygen expression of tropical central water is determined from the BENEFIT Training cruise hydrographic data. The lowered acoustic doppler current profiler data are examined to determine the extent and distribution of the poleward undercurrent on the south Angolan and northern Namibian shelf region, as a potential vehicle for the dispersion of the low oxygen water.
WATER MASS DISTRIBUTIONS OF THE ANGOLA BENGUELA FRONT

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Deep-Sea Physical Oceanography, Marine and Coastal Management Roggebaai 8012 South Africa

Properties of the Central and intermediate water masses encountered in the Angola-Benguela Front (ABF) region during BENEFIT Training cruise are described and discussed. During the cruise conductivity, temperature, pressure and oxygen (CTDO) measurements were made through the Antarctic Intermediate Water level at certain stations. Properties on the Intermediate Water salinity minimum were extracted from the data and their distribution is discussed. Southward movement of water at the intermediate and central water levels across the front over the shelf and slope is indicated by the data. The existence of the ABF as a front through the water column to the Intermediate Water level, not only at the surface, is demonstrated. A comparison is made with the first BENEFIT cruise data collected in 1997.

CAPACITY BUILDING IN SA - IS MARINE SCIENCE WORTH ITS SALT?

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With a coastline of over 3000km and a wealth of living marine resources in South Africa, appropriate research and capacity development is essential to determine, use, manage and adequately conserve these resources. The National Research Foundation (NRF, formerly the FRD) is one of the stakeholders funding research and capacity-building in this area, with funding allocated from the national budget's 'Science Vote'. With limited funding, the NRF's Marine and Coastal Resources Programme was largely designed by the Marine Science Engineering and Technology (MSET) community to ensure that the research funded is topical and relevant. Capacity-building is a cornerstone of the NRF mandate, and strategies have been developed to encourage student training especially in terms of blacks and females to address the needs of the country.

This poster reflects on funding patterns and statistics in terms of capacity building and corrective action for the past four years (1996 to 1999) in the various fields within marine science. While corrective action in terms of student, training is considered adequate; recommendations are made to increase the number of black and female researchers involved in MSET.

IS VARIABILITY IN INTRITIDAL POPULATIONS DEPENDENT ON SPATIAL AND TEMPORAL SCALES OF OBSERVATION?

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Data from a rocky shore surveillance project initiated in 1982 on the South East Coast of South Africa are used to investigate the relationship between temporal variability in invertebrate populations and spatial and temporal scales of observation. Data consist of abundance estimates made by regular monitoring of fixed 0.5 X 0.5m quadrats placed in the mid-littoral at six sites along the Transkei coast. The design allowed for investigation of variability at scales of 1m, 10m, 1km, 10km and 100km. Analyses were done at two levels of integration, namely the population level and the community level, using clustering techniques to identify discrete states occupied by the community at different times. The influence of temporal scale was investigated by comparing the above with random 3-year subsets of the data. There was an inverse relationship between population variability and scale of observation with greatest variability at small spatial scales. The variability of short-lived sessile species was considerably higher than that of long-lived species, and higher than that of most motile species. At the community level the trend was the same with greater variability (number of discrete states) at small spatial scales. In this case, however, the difference between the extremes of the spatial scales was less than for individual species. Trends were similar for both long and short time intervals. The analysis shows that spatial scale of observation has an important influence on observed variability, both at the population level, where longevity plays a role, and at the community level. These factors need to be considered when designing studies aimed at assessing variability in intertidal populations.
DETERMINING THE DYNAMICS OF THE *Merluccius capensis* STOCK OFF THE WEST COAST OF SOUTH AFRICA

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The hake fishery in South Africa, targeting both *Merluccius capensis* and *Merluccius paradoxus* began in the early 1990’s. Bottom trawling has always accounted for the bulk of the catch and management of the fishery has not considered it necessary to consider the two species separately. The last decade has seen a diversification of this fishery with long lines and handlines catching an ever-increasing total allowable catch. Most of which is the shallow-water hake, *Merluccius capensis*. The implementation of the new Living Marine Resources Act has already resulted in substantial quantities of traditionally trawled hake being made available for capture by long lines and there is reason to believe these allocations may increase in the future. These developments require a re-evaluation of the operational management procedure for this fishery. This study aims to assess the status of *Merluccius capensis* on the West Coast of South Africa, and to investigate ways in which to optimally manage those fishing sectors targeting this species. To achieve this a Geographical Information System is being developed to spatially quantify the degree of mixing between the two species in relation to depth and substrate type. The use of both historical information and the collection of accurate catch and effort data from the current fishery will be used to assess the current status of *Merluccius capensis* on the West Coast.

THE TRANSKEI - LAST (CRUMBLING) BASTION FOR ENDEMIC LINEFISH?

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A survey of the recreational and commercial skiboat fishery was conducted on the northern and southern regions of the Transkei coast from 1997 to 1999. Catches of both sectors were dominated by endemic reef fishes, particularly the family Sparidae, although pelagic species were of some importance to recreational anglers, particularly in the northern region.

More than half of the 61 species retained by fishers are endemic to South Africa/southern Mozambique. Species diversity in catches was higher in the northern region, although catches in both regions were dominated by relatively few species. Catch per unit effort in both commercial and recreational sectors, by both number and weight, were higher in the northern sector. Although knowledge and agreement with fishing regulations was fairly good, particularly amongst commercial anglers, compliance was poor. A combination of effective marine protected areas and a fisheries awareness programme are two management options that should be considered.
Lobster fishing for the shallow water spiny lobster *Panulirus homarus* along the east coast of Somali takes place under conditions of extreme hardship. Fishing is very high and there are no controls on the fishing process. The resource is thus heavily exploited, and total catches and CPUE have declined considerably over the last few years. Two divers searched an estimated 12,185 m² of reef between Foar and Eyl on the east coast of Somalia. Lobster densities were 4 lobsters per 100m² of reef area. Diving conditions were extremely difficult throughout the survey and densities may have been underestimated. The total lobster stock was estimated at 1,200,600 lobsters. However, the estimate is very dependent on the assumptions made about the total inshore reef area along the east coast of Somalia. The average size of lobsters caught by the commercial fishery was 59 mm carapace length (CL) for females and 62 mm CL for males. Female lobsters became mature at 58 mm CL and the main breeding season appears to be in October /November. Although the tangle net fishery appears to catch fairly large lobsters, 52% of females caught were below the size at which they reach maturity. Sex ratios were 1.3 males for every 1 female. Length/weight and carapace length/total length relationships calculated for *P. homarus* in Somalia were very similar to those in Southern Africa.

Average CPUE was 34 kg lobsters per boat per day, and 1.5 kg lobsters per man per day. There were estimated 1220 fishermen between Foar and Eyl and the estimated annual catch was in the region of 280 tons. Total stock size was probably somewhat under-estimated. Catch curve estimates of total mortality were between 1.84 and 2.70, with 1.84 probably being the more realistic figure. In the short to medium term, the yield-per-recruit for both males and female lobsters would be between 30% and 55% higher if the fishermen observed a minimum size limit of at least 60 mm CL. Current egg production may be only about 10% of the original egg production before the fishery started. A 60 mm CL size limit on the capture of female lobsters would greatly reduce the chances of recruitment failure.

Fishing pressure on the inshore Somali lobster stock is unlikely to decline in the short term. Almost the entire stock seems to be accessible to fishermen and there appear to be no unexploited areas. The heaviest fishing occurs during the main reproductive period and small or egg-bearing lobsters are not returned alive to the water. Traders who buy from fishermen are critical to the process of implementing fishery management measures.
INTRUSIONS OF SUB-ANTARCTIC SURFACE WATER ACROSS THE
SUBLTROPICAL CONVERGENCE SOUTH OF AFRICA.

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The terminal region of the Agulhas Current south of Africa is characterized by the complete retroflection of the Current. The area has been shown to be populated by a range of eddies and rings (Figure 1). It has been observed that the spawning of an Agulhas Current ring at the retroflection is proceeded by the northward wedging of the Subtropical Convergence (STC) through the retroflection loop to effectively "pinch" off these rings. The resultant entrainment of cold Sub-antarctic Surface Water (SMSW) behind the displaced STC is of climatic and oceanographic interest in light of the concurrent interruption and eastward retreat of the warm Agulhas Current. The leakage of Agulhas Current water into the Southeastern Atlantic Ocean in the form of filaments may also be temporarily terminated.

Figure 1. Conceptual diagram showing (1) the initiation (2) development and (3 and 4) growth of a SMSW intrusion at the Agulhas Retroflection.

A serial satellite image study, using both METEOSAT and NOM images, suggests that approximately four intrusions of SMSW are observed per year. These intrusions occur normally between 17 ° and 19 °E. In extreme episodes of SMSW intrusions secondary intrusions at approximately 11 °E may also be observed. The mean temperature and salinity distribution at the retroflection shows that the longitudinal location of SMSW intrusions seems to be geographically invariant suggesting a possible topographic influence by the Agulhas Ridge (- 18 °E) and the Panzarini seamount (- 11 °E).

Hydrographic analysis of these SAASW disturbances leads one to believe that they are not just shallow, short term phenomena but may reach to depths of approximately 800m to 900m; at times persisting for more than two months. These intrusions introduce voluminous amounts of low temperature (- 14 °C), low salinity « 35) water into the retroflection region. The extensive geographical coverage (300 to 600 km1 of SAASW intrusions suggests that these cold water perturbations have important oceanographic and biologic implications to the dynamics of the Agulhas Retroflection and the oceanic region to the west of it.
GENETIC AND MORPHOLOGICAL VARIATION WITHIN THE SOUTHERN AFRICAN POPULATION OF Lampanyctodes hectoris (MYCTOPHIFORMES: MYCTOPHIDAE)

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The amount of genetic and morphological variation within the southern African population of Lampanyctodes hectoris was examined. 15 Enzymes encoding 22 isozyme loci were examined, of which seven were polymorphic. The percentage of polymorphic loci ranged from 13.6 to 27.3%. The mean heterozygosity was generally low and ranged from 0.003 to 0.005. Genetic divergence was also negligible with genetic distance values (D) ranging from 0.00000 to 0.00011. The results showed the population of Lampanyctodes hectoris to be genetically invariant. Principal component analysis (PCA) was performed separately on 14 morphometric and 6 meristic variables and revealed extensive overlap between fish from all areas. However, discriminant analysis suggested that a small amount of morphological variability does exist within this population. While genetically the population of Lampanyctodes hectoris seems to be homogenous, morphologically it appears to be variable. A combination of these results suggests that there is no clear genetic basis for the slight morphological differentiation within the population.

SOME BRYOZOA FROM THE MID-SHELF REGION OFF THE WEST COAST OF SOUTH AFRICA

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In excess of 20 collections of Bryozoa were made along the west coast of southern Africa by the research submersible Jago during 1999. The samples were analysed and provisionally identified. These data are coupled with the results of over 2 000 video transects to give an overview of the bryozoan assemblages occurring in the region. The data are compared with information on the structure of bryozoan assemblages from elsewhere along the western seaboard of Africa.
EELGRASS, PREDATION AND ESTUARINE SHRIMP (Palaemon pacificus)

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Worldwide, estuarine eelgrass meadows provide important nursery grounds for a large number of commercially exploited fish and decapod crustaceans. Decapods are an important intermediate link in estuarine food webs, serving both as prey for many of the top predators and themselves acting as predators of many of the smaller invertebrate species in the system. In certain South African estuaries the shrimp Palaemon pacificus has been found to have a strong association with beds of the eelgrass, Zostera capensis. Initially, food availability was thought to be the main factor determining this association, as Palaemon feed on the epiphytic diatoms found on the Zostera fronds. However, current research suggests that predation may also be a primary factor regulating the structure and dynamics of soft bottom communities and that eelgrass beds may serve more as a refuge from predators than as a source of food.

A series of laboratory experiments were carried out to explore:
- the effects of predator presence on the behaviour and distribution of Palaemon with and without Zostera;
- the effects of Zostera presence on mortality of Palaemon with and without predators.

Throughout the experiments a common predator of Palaemon was used, the Cape or Round Moony (Monodactylus argenteus) and all stocks of Zostera, predators and Palaemon were collected from the same area of the Bushman's River estuary on the southern coast. To differentiate between the role of Zostera beds as a refuge from predation rather than as a food source, experiments were carried out with both natural and artificial eelgrass. In the experiments Palaemon, did not seem to show a strong behavioural response to predators or Zostera in terms of their distribution. However, Palaemon mortality was reduced in the presence of both natural and artificial Zostera. These results suggest that the primary role of Zostera beds with respect to Palaemon, is as a refuge from predation.

Benefit Poster

CURRENT MEASUREMENT AT CAPE COLUMBINE: BENEFIT CRUISE, 1999

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A single AANDERA RCM4 current meter was moored at 32° 44.54 S 17° 41.84E in 60m of water, from 22 June to 31 July 1999. This corresponded to the period during which work was undertaken on the BENEFIT cruises in the southern Benguela. The current meter was positioned at 42m above the sea floor, so that it was in the realm of the poleward undercurrent, as established by 13 years of measurement by M&CM at the same site. The deployment gave 923 measurements of hourly-integrated speed, with spot measurements of direction and temperature on the hour.

The progressive vector of displacements shows a net movement of water in a direction SSW, parallel to the bathymetry. The maximum poleward speed was 24cm.s⁻¹. Four episodes of poleward flow can be identified from the time-series, deployment occurring during the first, the second and the third lasting six days each, and the fourth three and a half days. Two prominent NNE episodes of flow occur towards the end of the series.

The temperature is normally distributed with a mean of 9.7 °C, a maximum of 12.1 °C, a minimum of 9.1 °C and standard deviation 0.3 °C. The positive-going spikes in the time series evidence the mixing of warmer water at this depth (118m), which is to be expected in the absence of a thermocline in the winter months. The intrusion of warmer water is especially noticeable during the two prominent equatorward events.

Wind and air pressure measurements were taken at Cape Columbine during the deployment period. The tendency was for the water to move in the same direction as the wind, rather than opposite to it, indicating the absence of coastal-trapped waves as a dominant mechanism at this depth, as in the summer months and a deep mixed layer.
Oral

SCHOOL BIOMASS AND SPECIFIC COMPOSITION AS INDICATORS OF STOCK ABUNDANCE OF PELAGIC FISH

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Pelagic fish aggregate in schools of several million individuals. This gregarious behaviour has multiple benefits and has evolved through selective pressure. A school of pelagic fish is constrained by a set of factors balancing the urge to increase its size (e.g. antipredatory behaviour) and the need to decrease it (e.g.: competition for food within the school). Because of these constraints and the use due to their diurnal dynamics schools tend to be highly unstable and dynamic entities. The size of the stock plays an important role in determining the encounter rate between individuals, which is a pre-requisite for the formation of schools. Moreover, pelagic fish stocks experience extreme fluctuations in abundance, which are often out of phase amongst species. As a result, pelagic species may find it difficult to form monospecific schools during periods of low biomass. Individuals of the secondary species would then have to join schools of other species of similar size and shape.

These processes are illustrated by several examples from pelagic fish that have experienced substantial fluctuations in abundance. Based on these examples, two stock biomass indices have been computed from catch per set of purse seiners operating in South Africa, Senegal and Cote d'Ivore. The first is the catch per set of a given species as an index of abundance of this species; the second is the average composition of mixed schools as an index of the relative abundance of species in the ecosystem. The influence of density-dependent as well as density-independent factors on the size and composition of the schools is discussed. Finally, we suggest that these two indices of stock abundance, both based on the catch per set, can be obtained and updated quite inexpensively from fishing data to provide alternative indices of abundance and to track the dynamics of pelagic ecosystems.

Oral

PREDATION IMPACT OF CARNIVOROUS ZOOPLANKTON ON MESOZOOPLANKTON IN THE WATERS SURROUNDING THE PRINCE EDWARD ISLANDS (SOUTHERN OCEAN)

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The feeding dynamics and predation impact of the carnivorous zooplankton in the waters surrounding the Prince Edward Archipelago was investigated at 30 stations in late austral summer (April/May) 1998. Throughout the investigation mesozooplankton comprising mainly copepods numerically and by biomass dominated Bongo samples. Zooplankton abundances and biomass ranged from 8 to 271 ind. m⁻³ and between 1.01 and 7.47 mg Dwt m⁻³, respectively. The carnivore component of the zooplankton community consisted mainly of four groups: amphipods, chaetognaths, euphausiids and jellyfish. Among these, chaetognaths (Eukrohnia hamata and Sagitta gazellae), euphausiids (Nematoscelis megalopes and Euphausia longirostris) and amphipods (Themisto gaudichaudi) were the most prominent. Collectively, the carnivores comprised up to 25% of the total zooplankton biomass. Results of gut content analysis showed a close relationship between the structure of the local mesozooplankton community and the diets of the carnivores. Diel feeding patterns were identified in the amphipods and euphausiids. Total daily predation impact varied considerably between the various stations but generally accounted for < 50% of the mesozooplankton standing stock. Results of the study suggest that carnivores zooplankton may transfer via faeces, substantial proportion of the secondary production to depth.
THE IMPACTS OF OFFSHORE DIAMOND MINING ON THE BENTHIC ENVIRONMENT OFF THE ORANGE RIVER: EVIDENCE FROM THE RESEARCH SUBMERSIBLE JAGO

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The benthic environment of the continental shelf off the Orange River mouth was examined from underwater videotapes collected by the research submersible Jago during 1996 and 1997. The videotapes represent archived records of surveys of the offshore concession areas that are being explored and mined by De Beers Marine (Pty) Ltd on behalf of Namdeb Diamond Corporation. Despite their different methodologies, the results of the 1996 and 1997 surveys both indicated that mining has quite a marked affect on the physical and biological structure of the environment. The undisturbed sites were often characterised by extensive areas of bio-active sediment, and scattered boulders and debris richly encrusted with a diverse epifauna. The recently mined sites were densely covered with clean rock debris, cobbles and gravel, and the sediments showed signs of a reduced infauna. Alterations to the physical environment caused quite drastic changes to the abundance and diversity of the nekton. Although most of those species which were associated with soft sediments, were absent, the provision of new hard substrata appears to result in an increase in the abundance of other species. Given the limited scale of mining, the implications for the ecosystem are discussed.

FACTORS CONTRIBUTING TO THE WEST COAST HAKE CPUE STANDARDIZATION PROCESS

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Catch per unit effort (CPUE) data are central to the assessments of the Cape hake resource since it is assumed that CPUE is proportional to abundance. A number of factors, however, could bias this proportional relationship, e.g. upgrading of vessels and changing fishing patterns. Effects such as these can be factored out by means of 'standardization' which is usually achieved by applying the technique of general linear modeling (GLM).

The West coast hake standardized CPUE indicated a widely divergent reflection of resource status to that of the nominal (unstandardized) CPUE and abundance indices obtained from independent research surveys. The standardized CPUE series initially indicated a decline in resource abundance of 0.4% per annum (over the period 1978-1994), whereas the latter two indicated 3.8% and 7% increases in abundance respectively for the same period. Further investigations revealed that the GLM was not properly adjusting for being directed away from hake in favour of bycatch (as a result of a positive correlation between hake and bycatch CPUE at low levels of bycatch CPUE). A method to correct for this in the GLM was developed and the resulting CPUE trend indicated resource abundance to be increasing at a rate of 0.6% per annum.

In addition to the bycatch issue, it was alleged that the CPUE of larger hake would provide a fairer reflection of the true status of resource abundance since the CPUE of smaller fish would have been biased, given that extensive use of liners was made since the late 1970s, only to have been phased out fairly recently. This certainly proved to provide a more positive reflection on the status of the resource, but there is concern that the separation of hake into size classes has not remained consistent over time and between companies. The lesser increase in hake abundance resulting from the standardization process is attributed to mainly three factors:

- that the effective average power of the vessels in the fleet has increased,
- that fishing operations have moved to deeper waters where catch rates tend to be higher, and
- that the increase in fish density in deeper waters has been more than offset by a simultaneous decrease in fish density in shallower waters.

The divergent trends obtained from the standardized CPUE and independent surveys may be explained by the fact that the standardized CPUE indexes exploitable biomass whereas the surveys index total biomass.
Poster

ACUTE TOXICITY OF CD, HG, CU, ZN, NI AND CO TO THREE ESTUARINE INVERTEBRATE SPECIES

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The acute toxicity of Gu, Hg, Gd, Zn, Go and Ni to the three estuarine invertebrate species Sesarma catenata, Paratylodiplax edwardsii and Nassarius kraussianus was determined by means of 96 h LG50. In S. catenata, size-related differences in susceptibility was established. The toxic effect of the heavy metals for both the crab species S. catenata and P. edwardsii was Hg > Gd > Gu, Zn » Go > Ni, while for the gastropod, N. kraussianus, the order was Gu > Hg > Zn > Gd » Ni > Go. Adult S. catenata proved to be more tolerant to heavy metal exposure than juvenile S. catenata. The species investigated were less susceptible to heavy metals when compared to other estuarine organisms from available literature.

Poster

AGE DETERMINATION IN THE HOTTENTOT, Pachymetopon blochii (Val.): SECTIONED Versus WHOLE OTOLITHS

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The sparid Pachymetopon blochii is an important linefish off the South African west coast; average commercial catch is approximately 600 tons per year (1991-1995). Although there have been two previous studies on the growth of hottentot, both were based on age estimates derived from whole otoliths. Because growth zones stack on the medial surface of sparid otoliths, whole (versus sectioned) otoliths may result in under-ageing of older fish, and consequently inaccurate estimates of mortality, growth rate and stock status. The objective of the present study was to evaluate whole and sectioned otoliths for age determination in P. blochii. Otoliths were collected from a total of 250 hottentot (14- 40 cm FL) sampled in Lamberts Bay between the 5th and 11th August 1999. A 0.5 mm transverse section was removed from the core of one otolith (randomly selected) of each pair. Age estimates based on whole and sectioned otoliths were then compared graphically. Growth curves fitted to age-Length data derived from sectioned and whole otoliths were compared statistically using a likelihood ratio test.

Oral

UNDERWATER OBSERVATIONS FROM THE RESEARCH SUBMERSIBLE JAGO ON THE NEKTON AND NEKTON COMMUNITIES OFF THE ORANGE RIVER MOUTH

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An assessment was made of the biological content of videotapes taken from the research submersible Jago, during surveys of offshore diamond mining areas off the Orange River Mouth in 1996 and 1997. The videotapes represent archived records of surveys of the offshore concession areas that are being explored and mined by De Beers Marine (Pty) Ltd on behalf of Namdeb Diamond Corporation. The sea floor environment was described and nekton associations with substratum features were identified, in both mined and unmined areas. The nekton exhibited generally low diversity, and different species were associated with different features of the physical environment. Nekton communities on soft sediments were dominated by pelagic goby (Sufflogobius bibarbatus), juvenile hake (Merluccius capensis) and cuttlefish (Sepia sp.), and by false jacopever (Sebastes capensis) and (Genypterus capensis) kingklip on rocky substrata.
VISUAL OBSERVATIONS ON THE BEHAVIOUR OF SOME COMMON DEMERSAL NEKTON OFF THE WEST COAST OF SOUTH AFRICA

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Observations on the behaviour of some common demersal teleosts were made from archived videotapes taken from the research submersible Jago. The videotapes were recorded during the surveys of offshore concession areas that are being explored and mined by De Beers Marine (Pty) Ltd. on behalf of Namdeb Diamond Corporation. Although each of the fish species seen had its one unique set of behaviours, these could nevertheless be grouped into a number of categories. These include hovering off the substrata, positioned on substrate, swimming, positioned in a crevice/under rock, occupying a shelter hole, and ‘buried’ in substrate. While most species rested on the seabed (e.g. hake, goby, jacopever, gurnard, sole and dragonet), some species (e.g. kingklip and hake) buried themselves in the superficial sediments. Others (e.g. false jacopever and kingklip) preferred rocky areas and typically occupied holes in the rock, while others still (e.g. kingklip) buried themselves in the sediments at the bottom of rocks. All observations were of behaviours exhibited by fish on ‘first sight’, before they took fright at the approach of the submersible. A short repeating videotape that more fully illustrates the behaviours observed accompanies this poster.

Poster

TWO ASPECTS OF CLOWNFISH PRODUCTION IN A PILOT SCALE HATCHERY; BROODSTOCK SPAWNING, AND PACKAGING FOR LONG DISTANCE TRANSPORT

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In 1996, the Oceanographic Research Institute initiated a marine breeding program with the aim of supplementing the wild capture of marine ornamentals for the marine aquarium trade. A pilot scale commercial clownfish farm was set up and has been in operation for three years. During this time, information has been generated, in the form of data and observations, regarding the improvement of clownfish production. The first topic discussed in this paper is the spawning frequency and periodicity of Amphiprion akallopisos kept under aquarium conditions. The second topic focuses on experiments conducted to determine the maximum stocking density for A. akallopisos during long distance transport.
ESTIMATING THE ABUNDANCE OF NESTING LOGGERHEAD TURTLES FROM TAGGING DATA

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For over three decades the KwaZulu-Natal Nature Conservation Service (KZNNCS) has tagged nesting marine turtles, mainly Caretta caretta and Dermochelys coriacea along the northern KwaZulu-Natal coast. Although, in earlier years the turtles were exploited by the local population, since the early 1960s these nesting turtles, their eggs and nestlings have been protected from exploitation. Following this protection, a tagging study was undertaken to ascertain whether the population of nesting turtles was increasing following this protection. However, this is not an easy evaluation to make. Firstly, little is known, worldwide, on the population dynamics of these animals and secondly, the tagging data and information collected were stored on a card filing system making analysis difficult.

In the present study, a population dynamics model based on tagging data was developed to estimate the population size of nesting Caretta caretta. The model is based on the number of nesting loggerheads that return in subsequent years of nest (re-migrants). The model accounts for differential tag loss (during the study three different types of tags were used), emigration from the study area and that re-migrants could have been tagged in any of the previous years of tagging. There is very good fit between the observed number of re-migrants and those predicted by the model.

The model was then extended to predict the size of the population of female loggerheads based on a ratio of the number of nesting turtles tagged and those handled but not tagged (Petersen estimate). The population of female loggerheads although annually variable has steadily increased from 10 000 in 1964 to about 40 000 animals in 1997. It appears that protection of nesting animals, their eggs and nestlings from human exploitation is paying off. The above model for loggerheads indicates that very few loggerheads return to re-nest in subsequent years i.e. the majority nest once, and then emigrate and are not seen again. It is actually a rare occurrence for a female to return to her original beach of nesting.

Poster

LONG-TERM MONITORING OF SOUTH AFRICA’S ‘CORAL’ COAST AS PART OF C-GOOS

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To improve management of the north coast of South Africa where coral reefs are present, a long-term monitoring project is proposed to quantify and understand the:
- diversify of marine species in the coral reefs
- dynamic behaviour of sandy beaches
- diversify of vegetation in the coastal dune forests
- human uses and impacts, and
- potential for limited development.

The bi-annual observational program at Mabibi will include measurement of:
- sand height along three transects
- near-surface wind profiles
- near-shore currents using drifting drogues
- sea and air temperature and soil moisture
- swell height and period
- bio-diversify assessment of coral species
- bio-diversify assessment of dune vegetation
- vehicular, pedestrian and snorkeling traffic.

In addition soil and water samples will be collected for analysis of fertility and pollution. Demographic surveys of local communities, visiting tourists, conservation officers and private developers will be conducted. The following Key Questions will be addressed:
- is the near-shore ocean circulation wave, wind or current driven?
- and does the net longshore drift display seasonal, synoptic, and tidal cycles
- how is dune vegetation destabilised and overtopped by blown sand from the incessant NE winds
- how will human pressure arising from local consumption, visitors from Sodwana and coastal developments alter the ecosystem.
SEDIMENTATION AND MANAGEMENT STRATEGIES IN THE KOWIE ESTUARY, SOUTH AFRICA


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The Kowie River has undergone many physical changes within the past 150 years with the last major change being the construction of the Royal Alfred Marina. Since the establishment of the marina three has been sediment build up between the two marina entrances. Tide gauge data suggests that the marine influx of marine sediments is not caused by flood tidal asymmetry, as is the case in most of the surrounding estuaries. Using section and current profile measurements near the southern entrance of the marina it has been established that 50% of the water entering the estuary flows through the marina on the ebb and flood tide. The increase in cross sectional profile and the resulting lowering of flow velocity has caused the deposition of marine derived sediment in the southern part of the marina and Kowie River. This influx of sediments is a major issue as it has threatened the use of the Estuary by boats.

This paper describes the flow structures and sediment dynamics of the estuary and proposes a unique management strategy to eliminate the sedimentation problem by using ebb flows to scour out specific channels.

ECOLOGICAL RELEVANT BIOASSAYS FOR CHEMICAL DEFENCE OF A SUBTIDAL WHELK (Burnupena papyracea BRUG.) BY A SYMBIOTIC, SHELL-ENCRUSTING BRYOZOA (Alcyonidium nodosum O'DON.)

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The subtidal whelk Burnupena papyracea co-occurs with a voracious predator, the rock lobster Jasus lalandii, in situations where other potential prey are largely eliminated. This has been ascribed to a symbiotic bryozoan, Alcyonidium nodosum, which characteristically encrusts the shells of B. papyracea and deters feeding of Jasus. In this study we show that this is not due to physical effects of either induced physical defences in the bryozoan or increased shell strength due to the presence of the bryozoan. Neither did spectroscopic screening of chemical extracts of the bryozoan or analysis for volatile constituents reveal any unusual metabolites at detectable analytical concentrations which possible might deter feeding. Nor did chemical extracts show larvicidal effects in a standard bioassay using the brine shrimp Artemia salina. Despite this, bioassays using individual Jasus indicated a chemical basis for feeding deterrence.

We conclude that the protection which Alcyonidium confers on Burnupena papyracea does have a chemical basis, but that the chemical responsible is either present in only trace quantities, or that it is a structurally unremarkable compound which is distasteful to Jasus. This work highlights both the advantages of using ecologically relevant bioassays (positive results when standard in house bioassay techniques give a negative result) and the disadvantages (logistic constraints on sample sizes when using large test animals and individual variability in a relatively sophisticated test animal).
THE USE OF ENERGY DISPERSIVE X-RAY MICROANALYSIS (EDX) TO DEMARCATE AREAS AROUND MARINE OUTFALLS THAT MAY BE INFLUENCED BY EFFLUENT DISCHARGE - A CASE STUDY

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The South African Department of Water Affairs permits the discharge of selected effluents to sea via deep-sea outfalls, provided that a number of stringent conditions are met. Amongst these is a requirement that environmental impact be closely monitored and that ecological integrity be maintained. In a recent attempt to refine monitoring techniques, we evaluated the use of a non-destructive method of environmental analysis-EDX, as means of demarcating areas of the seabed that might have been influenced by effluent discharge. The results of this pilot study, while limited to a small number of samples in the vicinity of 3 disparate pipeline outfalls, showed that 'signature' elements in effluent could be traced to sea-bed sediments and that EDX appeared able to demarcate areas influenced by pipeline discharge. This paper describes a case study in which EDX was used to analyze samples of seabed sediments around the Tioxide Southern Africa/AECI marine outfalls off Amanzimtoti on the KwaZulu-Natal South Coast. The work was performed in 1998, in parallel with the regular comprehensive annual impact assessment survey. Appropriate marker elements for the two disparate effluents were first determined using EDX (Tioxide - Fe and Ti; AECI - C and Mg). Sediment samples, which had been taken on a grid of 99 stations encompassing the outfalls, were then screened for the marker elements, again using EDX. Spatial analysis of the results allowed us to identify areas of the seabed that had apparently been in contact with the effluent or with effluent 'fallout'. A variance in the location of marker elements in sediments suggested a difference in the dispersal of 'fallout' from effluent emanating from the two pipelines. The placement of these areas, in relation to the predicted/modelled effluent dispersal patterns, and observed variations in benthic community structure are examined. In addition, the relative merits and demerits of using EDX, as opposed to more conventional methods, such as atomic absorption spectroscopy, are discussed.

EFFECTS OF WAVE ACTION ON FEEDING RATES OF THE PREDATORY WHELK, Nucella cingulata, IN THE INTERTIDAL ZONE ON ROCKY SHORES

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Mussels are an important coastal resource in South Africa. They are utilised extensively by subsistence harvesters around the country, form part of a profitable mariculture industry, and are an important food source for predators such as rocklobsters and seagulls. Nucella cingulata lives in densely packed beds of the black mussel Choromytilus meridionalis and the Mediterranean mussel Mytilus galloprovincialis. Its diet consists primarily of mussels, and previous studies suggest a consumption rate of about 0.08 mussels. Whelk -1 day-1. Consequently, whelk predation on smaller size classes of mussels is thought to have a large effect on mussel recruitment and succession.

The study tested the hypothesis that whelk predation is reduced at high wave action, thus enabling filter feeding mussels to proliferate in highly exposed areas. In part, this is a test of a much broader hypothesis that physical stresses should impact predators to a much greater extent than 'basal' organisms that occupy primary space. We conducted caging experiments at different intensities of wave action, at Groen river on the West Coast of South Africa, where Nucella cingulata is the most abundant invertebrate predator of mussels Mytilus galloprovincialis.

By increasing our knowledge of predator feeding rates and prey size selection at sites of varying degrees of wave action, we may gain a better understanding of the implications of predation on prey distribution.
IDENTIFICATION OF PRIORITY COASTAL CONSERVATION AREAS IN THE WESTERN CAPE

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This talk reports on the marine component of the 'CAPE' (Cape Action Plan for the Environment) Project - a World Bank and WWF funded programme which aims to identify priority conservation areas within the Cape Floristic Region. Separate consultants are carrying out parallel studies on estuarine, freshwater and terrestrial systems, and these will all be integrated at a later stage. Three approaches are being taken in the marine analysis. In the first phase we examined biodiversity and endemicity patterns. This was done by dividing the coastline into 50 or 100km stretches and comparing numbers of species and proportions of endemics within each. Groups examined were the octocorals, molluscs, amphipod, isopod and decapod crustaceans, echinoderms, fish and coastal birds. Some groups (molluscs, echinoderms, decapods, fish) showed increasing species richness eastwards, but others (amphipods, isopods, octocorals) peaked in the South Western Cape. Birds were the only group showing maximal species richness on the West coast. Endemicity patterns are more consistent, all groups showing peak endemicity in the southern and southwestern Cape. These patterns must be interpreted with due regard to biases caused by unequal sampling effort and the way endemicity is defined.

The second approach has been to examine the nature and distribution of the threats to biodiversity. The major threats to biodiversity conservation in the region as a whole were identified as overexploitation and introduction of invasive alien species. The secondary or ecosystem effects of these impacts are especially poorly understood. Other threats tended to be localized or specific in their impact. In the third phase (still underway) we are examining the usefulness of current conservation measures, including the effectiveness of each of the existing marine protected areas in the region. Based on these findings recommendations on the priority sites for further conservation in the region will be made and discussed at a dedicated conference in 2000.

THE DEVELOPMENT OF THE CAPE COMMERCIAL LINEFISHERY DURING THE 20TH CENTURY: MANAGEMENT IMPLICATIONS FOR THE NEW MILLENNIUM

Marc H. Griffiths

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The Cape commercial linefishery, established in the 1800s and accounting for 90% of the total line-catch, is one of the oldest fisheries in the country. In spite of massive technological advances -- including vessel motorization, nylon lines, echo sounders, electronic navigational aids and on-board freezer facilities -- the catch rates of many species -- predominantly long-lived members of the Sciaenidae and Sparidae -- have declined dramatically (the majority > 95%) during the 20th century. Assessment of several of these stocks confirms that the catch declines have been indicative of severe stock depletion. Not only has stock depletion resulted in a reduction in potential yield, but ecosystem effects and loss of genetic diversity are also anticipated. Management implications of these results are reviewed in terms of the objectives embodied in the new (1998) Living Marine Resources Act.
ANTIMICROBIAL ACTIVITY OF SELECTED SOUTH AFRICAN RED ALGAE

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New and better antibiotics are sought continually because of the ability of microorganisms to develop resistance. Testing for antimicrobial activity in the red algae will allow us to isolate active compounds that may be used pharmaceutically as antibiotics. The microorganisms used were: a gram-positive bacterium, Staphylococcus aureus; a gram-negative, Pseudomonas aeruginosa and a yeast-like fungus, Candida albicans. The objective of this project was to determine the antimicrobial activities in extracts of selected red algae and use chromatography to isolate the active compounds. Seaweed were dried and ground. The dried material was extracted using 80% ethanol. The Brine Shrimp Assay was used to determine the toxicity of the algae. Agar plates were prepared using seeded plating, overlay plating and spread plating with the three test microorganisms. The antimicrobial screening was done using the disc-diffusion method. Dried extracts were dissolved and sterilized by filtration. Discs were impregnated with extracts and placed on the agar plates. Control discs were also prepared. Plates were incubated and the inhibition zones then measured. Bioautography was done using chromatography to isolate the active compounds. Fractionation will continue on the active fractions, which allow us to isolate and purify these active compounds.

GENETIC VARIABILITY AMONG GEOGRAPHICALLY SEPARATED GROUPINGS OF ANTARCTIC KRILL

(Euphausia superba dana): RESULTS FROM RAPD-PCR ANALYSIS A.R.

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Antarctic Krill (Euphausia superba) is one of the key species in Antarctic food web. Knowledge of the population structure of Antarctic krill is of vital importance for the sustainable management of this key resource in the Southern Ocean. Presently, two hypotheses exist on the population structure of krill. The first suggests that the Antarctic Circumpolar current around the Antarctic continent transports a single superpopulation of krill. The second hypothesis proposes that krill sub-populations, limited by gene flow, may persist within macro-scale oceanographic features such as gyres.

Extensive allozyme studies undertaken between geographically separated krill stocks indicate that genetic variations between populations are not significant, thus supporting the first hypothesis. In contrast more recent studies, using mtDNA sequence analysis, provide some evidence for significant genetic differences between krill stocks around South Georgia and those within the Weddell Sea. However, the existence of Krill subpopulations still remains uncertain. The most recent studies suggest that investigations at the DNA level are more appropriate for the elucidation of krill population structure. The present study uses a DNA-based technique, RAPD-PCR, which has repeatedly proven its value for differential analysis within and between species.
AN INVESTIGATION OF THE POSSIBLE IMPACT OF EFFORT SATURATION ON THE ABUNDANCE INDEX USED IN ANNUAL SOUTH COAST ROCK LOBSTER RESOURCE ASSESSMENTS

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Standardized CPUE for SCRL has declined by 50% since 1991. This index is the most important in the assessment used to set annual TAC for this fishery. Following this trend, TAC for the resource has been reduced, from 477 tons (1994) to 402 tons (1998), but this has not impacted on the rate of decline, and a further, larger cut in TAC seems likely in the near future. However, there is concern that the standardized CPUE index used for the annual assessment does not only reflect the trends in the abundance of the resource, but is also influenced by changes in the fishing strategy. Changes in the recent years include a change in regulations restricting the number of traps allowed per vessel, the purchase of larger fishing vessels, increase in numbers of traps used per vessel (and soaktimes of traps), and the installations of modern navigational equipment.

Conceptually, it is the increase in traps on the fishing grounds that affect CPUE, mainly because these traps compete with each other (CPUE = numbers caught per trap), and because productive areas are over-occupied, forcing other vessels to set traps on less productive areas. To investigate, an effort reduction experiment was devised, in which the fishing fleet reduced effort on an areal basis-two areas (Agulhas Bank and Eastern fishing grounds and two treatments, full effort and reduced effort, and two treatments. It was predicted that CPUE would increase rapidly, with the removal of inter-trap-competition and the access of all vessels to high productive areas. The response in CPUE to effort reduction treatment varied according to area, and was sensitive to the level of effort reduction. The response of the CPUE index.

STABLE NITROGEN ISOTOPE RATIOS OF THREE EUPHAUSIID SPECIES FROM THE PRINCE EDWARD ISLANDS (SOUTHERN OCEAN): IMPLICATIONS FOR THE PELAGIC FOOD WEB

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Nitrogen occurs naturally as two isotopes (\(^{14}\)N and \(^{15}\)N). The lighter isotope is metabolized more readily and, as a result, enrichment of the heavier isotope occurs with an increase in trophic level. Consequently, stable nitrogen isotope ratios (\(\delta^{15}\)N) can be used to identify trophic position. Nitrogen isotope analysis was carried out on three common sub-Antarctic euphausiid species, \textit{Euphausia vallentini} (juvenile and adults), \textit{E. longirostris} (adults) and \textit{Nematoscelis megalops} (adults). Specimens were collected in the downstream region of the Prince Edward Islands during austral autumn 1998 on board the \textit{mv SA Agulhas}. For comparative purposes, nitrogen isotope ratios of the copepod \textit{Calanus similisimus} (herbivorous), the hyperid amphipod, \textit{Themisto gaudichaudi} (omnivorous) and the fish, \textit{Ceratoscopelus warmingi} (carnivorous), were also analysed.

As expected the lowest average value was found in the herbivorous copepod, \textit{C. similisimus} (\(\delta^{15}\)N = 1.72 \%), and the highest in the fish (average \(\delta^{15}\)N = 9.55 \%). Among the euphausiids, \textit{E. vallentini} juveniles had an average value of 2.38 \% which was similar to \textit{C. similisimus} indicating a herbivorous diet, while \textit{E. vallentini} adults were closely grouped with \textit{T. gaudichaudi} (average \(\delta^{15}\)N values of 3.66 \% and 4.13 \% respectively indicating an omnivorous feeding strategy. A further stepwise increase was found in \textit{E. longirostris} \(\delta^{15}\)N = 6.88 \%), suggesting that the species display a largely carnivorous feeding habit. Trophic position of the species investigated is discussed in conjunction with gut content analysis.
WATER CHARACTERISTICS OF FOUR TEMPORARILY OPEN ESTUARIES FROM THE EAST LONDON REGION, EASTERN CAPE PROVINCE

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Hydrological data covering a selection of characteristics were collected from the Cefane, Cintsa Igoda and Kiwane estuaries. All four estuaries have small catchment areas and are situated near East London, Eastern Cape Province, and thus are subject to similar rainfall and climatic regimes. All are closed to the sea for a large part of the year. Data collected include measurements of salinity, temperature, pH and dissolved oxygen as related in the estuary and depth. The results obtained are reported and discussed in the light of existing knowledge and understanding of these estuaries.

CIRCULATION AND RESIDENCE OF WATER IN SMALL MEDITERRANEAN-CLIMATE ESTUARIES

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Estuaries in Mediterranean-climate regions exhibit classical estuarine circulation during the wet winter. In the dry summer months, however, longitudinal density gradients may go to zero or even reverse. Characterized by hypersalinity, water is retained in the estuary basin for long periods during summer. In cases where upwelling occurs at the mouth, a thermal exchange flow may develop. These dry summer and wet winter patterns, along with upwelling have been observed in Tomales Bay, California. The winter estuarine circulation is further influenced by the pulsed nature of the fresh water inflow. The timing of this inflow also influences the nature of the summer circulation and the development of hypersalinity. Comparison of these dynamics with South African systems may lead to greater understanding and improved utilization of our own estuarine environments. Comparisons are made with estuaries such as Saldanha-Langebaan, Knysna, Palmiet and Krom systems.
RECRUITMENT OF INTERTIDAL MUSSELS AROUND THE COAST OF SOUTHERN AFRICA - HOW VARIABLE IS IT?

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Intensity of intertidal mussel recruitment was compared across a range of spatial and temporal scales around the coast of southern Africa. Comparison of east and west coasts revealed significantly higher recruit densities on the west coast, corresponding to larger adult densities. The difference between the two coasts reflects biogeographical dissimilarities in the composition of mussel species, growth rates and spawning intensities, oceanographic conditions and productivity. Significant spatial variations in recruitment were recorded between region 100-1000km apart, and between localities 1-25km apart. Results suggest that the influence of dispersal processes on recruitment patterns acts at a relatively small scale, and may affect the abundance and distribution of adults only a few kilometers apart along the shore. The highly variable recruitment at scales of only a few metres suggests that larval supply to the intertidal region is locally patchy, and/or that settlement preferences are sensitive to small-scale differences in adult mussel density. Significant temporal variability in the recruit density was recorded, both between 3-monthly sampling intervals and between years. There were no seasonal differences for the northwest regions, whereas asynchronous seasonal patterns were displayed in other regions. Results suggest that temporal cycles of recruitment are irregular and episodic, which may have important consequences for the dynamics of adults. Significant positive correlations were obtained between maximal recruitment and adult abundance, measured by density, or total numbers of adults within a section of the shore. This could be explained by the density-dependent role of adult conspecifics in providing suitable settlement habitat, or supply-side recruitment limitation. These results have important implications for the management of exploited populations of mussels around the coast of southern Africa.

SUSTAINABLE SUBSISTENCE INTERTIDAL HARVESTING: A PARTICIPATORY EXPERIMENTAL APPROACH

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This paper reports the results of a field experiment to determine sustainable levels of mussel harvesting by subsistence harvesters on the northern KwaZulu-Natal coast. A section of coast zoned for exclusive subsistence use was subdivided to allow different levels of fishing intensity. Experimental harvesting was conducted by community subsistence gathers under the direction of community monitors appointed by a joint Management Committee. The stock status in each experimental sub-zone was determined at intervals over 5 years, and the impact of the different F values assessed from both a mussel population as well as a community structure and biodiversity perspective. Recommendations for and problems related to, management and implementation of subsistence fisheries are discussed.
**NEMATODES OF SALDANHA BAY**

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In the marine environment, nematodes form one of the major components of the benthic meiofauna. They are among the most abundant metazoan animals on earth, and evidence suggests that only insects in the tropics may parallel the diversity of deep-sea forms. Nematodes are very sensitive to the environment within sediments and the gradient of diversity reflect factors such as grain size, closeness of packing particles, organic, oxygen and sulphur content of interstitial waters. It is expected that shallow water nematodes would be susceptible to disturbances in the environment and would respond quickly to small-scale changes in the environment. If this assumption is true, it would make nematodes particularly useful organisms in the studies of environmental disturbances. Despite their perceived importance to the marine economy, our understanding of nematode biology, ecology and taxonomy is poorly known, especially around the South African shores. This presentation intends to place nematodes within the general framework of diversity studies in the South African marine environment, in particular, and global diversity framework in general. The presentation will give an outline of the rationale for conducting this study, as well as presenting future applications of the results in determining environmental disturbance along the coast of South Africa.

**SIGHTINGS FROM MINING VESSELS OFF SOUTHERN NAMIBIA**

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De Beers Marine is a diamond exploration and mining company that operates mainly on the West Coast of Southern Africa. As part of the company's environmental management system a sightings programme was initiated in May 1996. The reason for the program was to determine if marine mammals are deterred by the noise made by the vessels. The primary area that sightings are made is in the diamond concession are in Southern Namibia. De Beers Marine officers, with no scientific training, act as observers onboard each vessel and make sightings twice daily. They record marine life that is observed, mainly focusing on Heaviside's dolphins but also noting incidental sighting of whales, sunfish and turtles. Some trends of Heaviside's dolphin sightings will be presented as well as recommendations of how the sighting programme should be conducted in the future.
Oogenesis and vitellogenesis in six species of patellogastropods (Patella barbara, P. argenvillei, P. granularis, P. oculus, P. miniata, Helcion pectunculus) were examined by light, transmission and scanning electron microscopy. The structure of the ovary wall, oogenesis and vitellogenesis was similar in all six species. The ovarian wall consists of smooth muscle cells, connective tissue, interspersed amongst which are haemocoelic spaces. The ovary is partitioned by plate-like structures (trabeculae) emerging from the ovarian wall. Each trabecula consists of muscle cells, non-germinal cells (at least three types) and connective tissue, surrounding a haemocoel. The oocytes are surrounded by follicle cells (attached to each other and the oocytes by desmosomes), which form part of the outer wall of the trabeculae. This close association is maintained until the oocytes are fully developed. The cytoplasm of previtellogenic oocytes contains few organelles and the oolemma is not elaborated. During vitellogenesis lipid and yolk bodies (one type only) accumulate in the cytoplasm.

Evidence from the distribution of yolk bodies being formed, mitochondria, rough ER and endocytotic activity suggest that yolk precursors are derived predominantly by heterosynthesis, a feature of fast egg production. Rapid vitellogenesis would, in theory, enable females to spawn more than once per year. Lipid is probably produced by autosynthesis. A number of changes also occur at the cortex of the egg and to the oolemma during vitellogenesis. Golgi bodies (6-12 flat cisternae) become aligned around the egg cortex, producing cortical granules (the first observation for a prosobranch), which accumulate beneath the oolemma. At a few sites along the oolemma, the egg membrane invaginates, and the follicle cells become separated from the egg. Microvilli begin to form and an egg coat develops in the form of fibrous deposits between the microvilli and follicle cells. The fibrous deposits appear to be released from the terminal ends of the microvilli. As the microvilli increase in length and number, the egg coat increases in thickness, forming an almost continuous layer around the oocyte. The egg coat of mature oocytes consists of two layers, an inner vitelline layer and thicker outer jelly coat which has a fibrous appearance. Correlation between egg coat morphology and sperm structure are currently being investigated. Differences in the egg morphology and oogenesis between patellogastropods and other prosobranchs suggest that studies on gastropod eggs will provide useful phylogenetic information.
FEASTING AND FASTING IN THE OCEAN: HOW COPEPODS FARE IN A FLUCTUATING FOOD ENVIRONMENT

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Calanoides carinatus and Calanus agulhensis are large calanoid copepods, which dominate the copepod biomass of the southern Benguela upwelling region and the Agulhas Bank respectively. Both species occur throughout the year, and their distribution ranges overlap. One common region of the co-occurrence is off the West Coast between Cape Point and Cape Columbine. Here *C. carinatus* always out-numbers *C. agulhensis*, suggesting that it is better adapted to the fluctuating food environment characteristic of this region. Starvation experiments were conducted to test this hypothesis. Females were acclimatized to excess quantities of the diatom *Thalassiosira weissflogii*, then starved for 1, 3, 5, 7 and 9 days, and time taken for egg production to return to normal (to ‘recover’) was monitored. Following short (1-3 days) periods of starvation, *Calanus agulhensis* egg production returned to the unstarved rate (51.12 eggs.fem⁻¹.d⁻¹) more quickly than that of *Calanoides carinatus*. Following longer (5-9 days) periods of starvation, however, *C. carinatus* regained non-starvation levels of egg production (55.84 eggs.fem⁻¹.d⁻¹) more rapidly than *C. agulhensis*.

The time required for post-starvation egg production to recover was proportional to the period for both species. *Calanus agulhensis* was better adapted to short-term food variability, recovering faster than *Calanoides carinatus* from short periods of starvation (1-3 days), and continuing to lay eggs for at least three days after being placed in filtered seawater. Delayed cessation of egg production in response to food deprivation should be beneficial in a system characterized by a low frequency of food variability, such as the Agulhas Bank. If the absence of food is likely to be short-lived, it should be more energetically efficient to maintain egg production, albeit at a lower rate, rather than to completely halt and then restart egg production within a short period of time. If there is likely to be a long period without food, however, it would seem more efficient to immediately cease egg production and wait for better conditions. This appears to be the strategy used by the upwelling species *C. carinatus*, which, combined with plentiful lipid reserves and faster development than *C. agulhensis*, enables rapid recovery from long periods without food and provides a clear competitive advantage in the highly variable food environment of the southern Benguela upwelling region.
PRINCIPLES FOR THE MANAGEMENT OF ESTUARY MOUTHS

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A number of principles for the management of estuary mouths are presented:
♠ The water level in the estuary should be as high as possible before breaching. The reason is that as much sediments as possible should be flushed from the mouth and from the estuary.
♠ The mouth of an estuary should be breached as late in the winter and/or spring as possible. It is normally beneficial for ecological (juvenile fish migration and salt marsh vegetation) and water quality reasons that an estuary mouth in South Africa is open during spring and summer. The management policy should therefore be aimed at creating open mouth conditions during this period.
♠ The mouth of a small estuary should be breached about three days before spring tide. At smaller estuaries such as the Great Brak, breaching a few days before spring tide can be beneficial as the mouth sometimes closes within a few days at neap tide.
♠ The actual moment of breaching during the tidal cycle is at high tide or as close after high tide as possible, waves permitting. If it is unlikely that waves will interfere at high tide, then breaching can even be undertaken up to two hours earlier. High outflow after breaching causing scouring lasts over several hours and sometimes more than a tidal cycle. The maximum outflow normally occurs approximately 4 to 8 hours after a breaching and the flow velocities will increase at a higher difference in water levels between the estuary and the sea. High waves can sometimes interfere with the breaching process at high tide and shortly after high tide. It is therefore important to watch the effects of the waves in front of the mouth. The mouth can be breached as soon as it is considered that the waves will not interfere any more in a significant way.
♠ If possible, not a small trench, but a deeper and wider trench should be excavated before breaching. A considerable amount of water is sometimes used to flush a small and narrow trench open to a medium sized trench. A larger initial trench will result in higher flow velocities and in more sediment flushed out to the sea. This guideline is more relevant at a small estuary such as the Great Brak, where a limited volume of water is available for flushing, than at a large estuary. These principles are applicable for circumstances when the opportunity exists to apply them, but breachings should, in case of emergencies, be undertaken in the quickest way possible. It should also be considered that the greatest threat to an estuary often originates from the catchment. Runoff from the catchment is the lifeblood of the estuary and reduction in runoff can have a major impact. Similarly, erosion in the catchment can result in serious sedimentation downstream.

EFFECT OF OCEANOGRAPHIC ENVIRONMENT ON MESOZOOPLANKTON COMMUNITY STRUCTURE IN THE VICINITY OF THE PRINCE EDWARD ISLANDS (SOUTHERN OCEAN): INTER-ANNUAL VARIABILITY

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Mesozooplankton community structure and physical oceanography in the vicinity of the Prince Edward Islands were investigated in late austral summer 1996 to 1999. Zooplankton samples were collected with a bongo net (300Fm mesh) at stations upstream (west), between and downstream (east) of the islands as well as at the Sub-Antarctic Front (SAF) in each year. The physical oceanography was defined by a grid of CTD stations conducted in the top 400-1000m water layer. The island ecosystem is influenced by two major frontal systems, the SAF and the Antarctic Polar Front (APF). The positions of the fronts, which are recognized as important biogeographical boundaries, are highly variable. Furthermore, they interact with the shallow topography of the Prince Edward Islands plateau creating dynamic abiotic and biotic environments. In 1996 and 1998 the SAF was situated north of the islands while the APF, which is usually situated south of the islands, was not crossed. In 1997 and 1999 the SAF and APF were found in close proximity to each other in the upstream region of the islands. Cluster and ordination analyses were used to analyze the zooplankton community structure within and among years. Preliminary results indicate pronounced inter-annual variability in the community structure and the distribution patterns of zooplankton.

Zooplankton dynamics in the vicinity of the islands was closely coupled with the oceanographic environment and particularly with the position of the major frontal systems.
**GUERRILAS IN THE MIST: CATCH, EFFORT AND ATTITUDES OF WEST COAST GILL-NET FISHERS**

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The gill-net fishery in the Western Cape is largely confined to the West Coast where approximately 658 permits are issued annually for the capture of harders, *Liza richardsonii* and St. Joseph Shark, *Callorhinchus capensis*. In an attempt to ascertain current catch, and effort levels as well as the socioeconomic status of participants in the fishery, access point and questionnaire surveys are being conducted. To date a total of 117 gill-net landings yielding 84,738 fish from 28 species have been monitored. Catch rates were 130 fish/net-hour for harder and St Joseph nets respectively. Numerically the target species *L. richardsonii* (91%) and *C. capensis* (2.5%) dominated the catches. Bycatch of Maasbanker (3.5%), white stump (1.2%), elf (0.8%) and Galjoen (0.2%) was low, but significant, given that a mean total catch of 730 tons is reported annually on the west coast. Annual effort may be substantially greater than the 6700 gill-net days as questionnaire respondents claimed an average 73 trips each year. This translates into a total of 41,500 gill-net days and a total catch of 5,400 tons annually. On the other hand, observed activity rates during monitoring indicate that no more than 20% of permit holders in an area are active at any time which suggests 10,000 gill-net days and a total catch of 1,300 tons per annum. Net-fishers appear to under-report catch and effort on compulsory catch returns and over-report effort in questionnaire surveys. In many areas the fishery is over subscribed (over 40km of licenced gill nets in St. Helena Bay) and it is economically not viable for all permit holders to operate commercially or even on a subsistence level. As a result, many holders derive most of their income from other fisheries or occupations and net-fish seasonally or in a recreational manner. This latent or subsidized effort must be drastically reduced to allow for better monitoring and management of the fishery as well as better catches for bona fide netfishers.

**LUMINESCENCE DATING OF COASTAL DUNES OF THE SOUTHERN CAPE**

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A large luminescence-dating project has been undertaken in the southern Cape. We used IRSL (infra-red stimulated luminescence); ages are adjusted using a thermal fading with $r = 600$ ka (thousand years). We confirmed some of the dates with thermoluminescence. Some of the possible sources of error are due to uncertainty in the consistency of the radiation dose rate over time, which partly results from complex carbonate cementation and dissolution history. Calcium carbonate cement and calcium carbonate sand grains attenuate the ambient radiation, which the quartz and feldspar sand grains receive.

The results have confirmed the geomorphologic evolution of the Wilderness dune-cordons, as dated using Aeolian sediment dynamics and geomorphologic appearance. The seaward cordon has a core dating to the last interglacial, and is capped with Holocene dunes (luminescence dating ages 11ka and 6.5 ka respectively). A midden within the Holocene sequence yielded a radiocarbon age of 2780yr. The middle cordon has a luminescence age of 200ka, which is interpreted to represent the second-last interglacial, although the cordon is probably polycyclic, like the seaweed cordon. The landward cordon has yielded two luminescence ages: 260 and 1380 ka. Overall it seems justified to say that the wilderness dune cordons were formed at least since the middle Pleistocene. At Cape St Francis dating of headland-bypass dunefields confirmed dune activity associated with Late Pleistocene interglacials (105 ka and 225 ka). Iron-enriched sands that form part of the dune deposits have been dated to 225 and 490 ka. In the Cape Recife area, dating of headland-bypass dunefields has revealed Pleistocene dunes (184 ka) capped by a well-developed black organic soil, radiocarbon age 1550 yr, overlain by late Holocene dunes (luminescence age 320 yr). A long western Algoa Bay, a fossil dune ridge (interpreted geomorphologically to be a Pleistocene equivalent of the adjacent retention ridge) was dated as 154 ka. Landward of the Alexandria Coastal Dunefield, dating of fossil dune ridges (interpreted geomorphologically to be Pleistocene equivalents of the Alexandria Coastal Dunefield, formed during previous interglacial) has yielded unexpected results. Supposedly successfully older sites were dated as 62, 107, 25 and 175 ka. The samples were not taken by augering down 1.5m and then hammering in a sampling tube. It seems that the samples were not taken from deep enough in the sequence, and that mixing within the 'soil' layer takes place up to a depth of 1.5m.
Benefit Poster

NEAR-SURFACE CURRENTS AND HYDROLOGY IN JUNE/JULY 1999
IN THE SOUTHERN AND CENTRAL BENGUELA:
FROM CAPE COLUMBINE TO WALVIS BAY

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This region experiences perennial upwelling, but with a clear minimum in early winter (when the first survey was done) for the region south of 25 ° S. Thus mainly weak gradients were reflected in the SST patterns although the established upwelling cells were evident during the June survey. The surface flow in this region is strongly influenced by the regular wind forcing. Currents measured continuously by the ADCP shows a mean southward flow inshore and a north to northwest flow on the mid-shelf, south 28 ° S (at 34m depth).

The flow at the Orange River line measured by the ADCP and the two drifters showed often a weak southward flow inshore and mid-shelf, but were stronger northward on the outer-shelf regions off the Orange River Cone. Repeat sampling of Orange River line revealed time dependence of the currents in addition to spatial changes. Opposite Walvis Bay, the currents were weaker and variable, however suggest a band of alternating north and southward flow. The depth-structure of the currents up to a depth of 150m on the two major lines will be examined. The effect of the current on the pelagic eggs and larvae during the winter period will also be examined.

Oral

MOULT STAGE DETERMINATION IN THE SOUTH AFRICAN WEST COAST ROCK LOBSTER, Jasus lalandii (H. MILNE EDWARDS)(CRUSTACEA: DECAPODA)

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The different stages in the moult cycle of the West Coast rock lobster Jasus lalandii are described. Nine stages and substages of the post-, inter- and premoult conditions were distinguished by microscopic examination of the cuticle, epidermal retraction and setal development in the pleopods. The postmoult condition is characterized by progressive thickening of the setal walls and cuticle through to intermoult. Premoult commences with apolysis (stage D₀), followed by setal development (stage D₁', D₁''', D₁'''') and culminates with cuticle deposition (stage D₂). The diagnostic features of the stages are generally similar to other crustacean species.

Poster

BRYOZOA FIND A HOME ON FLOATING ISLANDS

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A preliminary investigation was undertaken to determine the bryozoan assemblages colonizing the plastic debris floating in the oceans around southern Africa. A number of beaches were visited along the west and south coasts of South Africa and all the flotsam deposited over set distance of shore was examined. Material with encrusting Bryozoa was collected and returned to the laboratory for analysis. Species were identified using scanning electron microscopy, and the number of clones was counted. A comparison was then made of the diversity of bryozoa along the two coasts, and relationships with their substrata were examined.
RESTORATION OF COASTAL ECOSYSTEM AND ITS BIODIVERSITY IN BANGLADESH

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Bangladesh coastal zone provided about 750kms of shoreline from the south of the world largest mangrove sundarban up to the southern tip of the Teknaf peninsula and the numerous offshore islands including the coral rich St. Martin's. Unfortunately the biodiversities degraded rapidly through the several last decades. The major threats to the coastal marine, inshore and nearest forest ecosystem are the erosion of landmark and total coverage of the vegetation. The wildlife community was greater in the past time and gradually declined, which is now a day at the edge of extinction. The winter migratory birds now gather in small number and the local community hunting pressure is enormous. The sea turtle population degraded drastically within 2 decades time. The ongoing sea turtle conservation program (STCP) at St. Martin's and at the coast Teknaf Peninsula wants in itiating restoration of the remaining marine and inshore habitat for the turtle nesting and foraging and also habitat utilized by other wildlife community as well as indigenous species. The local people are reducing the mangrove formations and the existing endemic species are really in danger. Yet, government does not apply any other law enforcement and build up any awareness campaign against the poaching and exploitation. Conservationist all over the world whenever works faces tremendous backforce and in Bangladesh it is extreme. Major tasks to rehabilitate the ecosystem recognized as. Plantation of local plant species along the entire shoreline and restoring the mangrove formations, .Conserving the resident and migratory bird's inshore habitat as well as sea turtle nesting ground by declaring and protecting as wildlife reserve, .Controlling the invasive and pest species which effect seriously to the native threatened species, .wildlife inventories through the coastal zone and documenting regularly, .Awareness building and involvement of governments defenders and local communities in the conservation work in cooperation with the supporting and implementing NGOs. The current STCP effort initiated in 1996 October with the help of token money of MTSG of SSC/IUCN. Initially CARINAM(center for Advanced research in Natural resource & management) and later due to funding shortage it stooped after April1998. Since October 1998 Another NGO CNRS(Center for Natural Resource Studies) restarted the conservation effort. Since the beginning about 20, 000 hatchlings of Olive Ridley (Lepidochelkys olivacea) and green Turtle (Chelonia mydas) have been released in the bay of Bengal. About 70 % clutches so far been conserved in St. Martin's island. CNRS expand its STCP effort towards Teknaf Peninsular; more than 100 kilometer coastline. Previously 13 spots have been identified for nesting of 3 species including Hawksbill (Eretmochelys imbricata). More 16 spots including offshore islands should be investigated immediately.

THE INFLUENCE OF LONGITUDE AND DEPTH ON THE SIZE DISTRIBUTION OF Merluccius capensis OFF THE SOUTH COAST OF SOUTH AFRICA

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Two species of hake, Merluccius capensis and M. paradoxus, known collectively as Cape hakes occur off Southern Africa. M. capensis is a shallow-water species confined to depths of less than 440m, whereas M. paradoxus occurs from 120m to at least 800m. Thus, there is a band of overlap in the distribution of the two species of Cape hakes.

This study investigates the influence of longitude and depth on the size distribution of M. capensis on the Agulhas Bank. Data from eight demersal cruises to the South Coast conducted by Marine and Coastal Management were used during the study. The data indicated that depth is the most important parameter influencing size distribution of both male and female M. capensis on the Agulhas Bank. Therefore, it is important to stratify by depth when investigating the influence of geographic regions on the size distribution. There were sufficient data to examine changes in sex specific size distribution in only the 100-200m-depth range. The mean size increased from 40 cm for males and 42 cm for females off Cape Agulhas (20 ° E) to a maximum of 56 and 59 cm respectively between 24 ° E and 25 ° E and then decreased further eastwards.
EFFECT OF FEEDING FREQUENCY AND RATION ON THE GROWTH OF JUVENILE CLOWNFISH (Amphiprion percula)

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Feeding frequently and ration size are important factors for optimizing fish growth during the juvenile grow-out phase. A factorial growth trial was conducted to determine the effect of feeding frequency and ration size on the growth of juvenile clownfish (Amphiprion percula). Three feeding frequencies (1, 2 and 3 times daily) and six rations (2, 4, 6, 8, 10 and 12% body weight.day$^{-1}$ (BW.day$^{-1}$)) were used to test the growth response over a twelve-week period. No statistical interactions were found between ration and feeding frequency. Independent regression analysis of feeding frequency found no significant differences of growth between the three frequencies. However, regression analysis showed that ration did significantly increase growth was recorded from 6 to 12% BW.day$^{-1}$. This indicates that optimal juvenile clownfish growth is achieved at a ration of approximately 6% BW.day$^{-1}$.

CORAL PROPAGATION: WHY GROW CORALS IN SOUTH AFRICA?

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The marine aquarium industry has expanded considerably during the past decade, with a serious disadvantage being that most of the animals are collected in the wild. Live corals, which are prized for reef aquaria, are commonly chiseled off reefs, many of which are already degraded by pollution, tourism and fishing. Poaching of specimens is not uncommon, even though the implementation of restrictions is becoming more stringent. In addition, many specimens die from transport stress or placement in unsuitable aquaria.

There has also been an increase in the trade of marine organisms in the last few years (Best, 1995). This is not only due to an increasing interest in marine life, but also the increasing efficiency in airfreight; fragile reef corals and reef fishes can be easily transported to their destination within a day. The international trade in marine organisms has subsequently increased and this, in turn, will increase the pressure on valuable marine resources.

The future of a sustainable supply of corals for the aquarium trade lies in their artificial propagation. The ORI Coral Propagation Project was thus initiated to supply the market with suitable aquarium specimens. The propagation of corals is also intended to provide material to re-stock damaged coral reefs. The study will involve the selection of coral species most suitable for marine aquaria and monitoring their growth rates under different conditions to establish the optimum culture environment. The growth of parent colonies and subcultures will be monitored to assess the mode and rate of colony recovery.

ON THE NEED FOR A S.A. NATIONAL TROPICAL OCEANOGRAPHY PROJECT (SANTOP)

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The potential for climate prediction in southern Africa has many implications for marine resource management. Most of the predictability derives from ocean-atmosphere coupling over the Atlantic and Indian Ocean, in areas adjacent to Africa where SST exceeds 27°C. The transmission of El Nino Southern Oscillation events from the Pacific is dependent on this coupling. In both oceans cyclonic gyres just south of the equator cause shallow thermoclines susceptible to changes in wind forcing and flux budgets. Very little is known about the underlying processes and routine ship-based research efforts are limited. It is proposed that South Africa in conjunction with its SADC and international partners implement a national tropical oceanography project for real-time and in situ data collection in aid of climate prediction. The paper will describe the potential benefits from such a project.
INCIDENCE AND EFFECTS OF CYANOBACTERIAL ENDOLITHS IN THE SHELLS OF THE BROWN MUSSEL *Perna perna*

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Invertebrates that bore into calcareous materials can cause considerable damage to molluscan shells. In contrast, phototrophic endoliths have, until recently, been thought to be relatively benign. This paper investigates the incidence, distribution and succession of cyanobacterial endoliths of the mussel *Perna perna* and then examines the lethal and sublethal effects of these endoliths on the mussels. On the south coast the incidence of endolith infested shells ranged from 23 to 95%. Endolith incidence was generally highest on exposed headlands and promontories as opposed to more sheltered bays and also increased with both height on the shore and the age of the mussels. Colonisation of shells occurred once the protective periostracum of the shell had been damaged (e.g. by abrasion by other shells or suspended sand) and was followed by a succession of filamentous and colonial cyanobacteria. The greatest structural damage to shells was caused by a late successional colonial cyanobacterium which forms comparatively large cavities in the shell in the region of adductor muscle attachment.

This weakening of the shell results in severe shell degradation and eventually shell fragmentation and mussel mortality. It was estimated that on the midshore on the south coast of South Africa, between 18 and 50% of total mussel mortality can be attributed to endolith activity.

Using the fluorochrome Calcein as a shell growth marker, it was shown that infested mussels attempt shell repair by increasing the rate of shell thickening. However, this accelerated increase in shell thickness is not sufficient to compensate for endolith induced shell degradation. Instead re-routing of energy to shell repair has important sub-lethal effects on the reproductive output of mussels. During periods of reproduction, the gonad mass of infested mussels was approximately half that of uninfested individuals. We conclude that, by attacking the shell, phototrophic endoliths reduce both the longevity and reproductive output of the mussel *Perna perna*.

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**NONGENICULATE CORALLINE ALGAE OF SA: WHAT WE HAVE LEARNED IN THE PAST 10 YEARS OF RESEARCH**

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When we began working on the non-geniculate coralline algae in 1989, very little was known about this group in South Africa. A few species had been described by Harvey in 1849, and Foslie between 1898 and 1909, but these had not been reassessed in the light of more recent elucidation of this group. Seagrief (1984) listed 15 species of non-geniculate corallines in his Catalogue, but did not include all the species described by Harvey and Foslie. Of the 15 species listed by Seagrief (1984), six have required taxonomic changes, and four remain in an uncertain taxonomic status due to problems with type specimens or uncertain records. To date, we have recognized 58 species of non-geniculate coralline algae in South Africa, including several that appear to be endemic. The relatively cool West Coast is the area that has received the best study, followed by the subtropical East Coast, with very few records from the South Coast. No endemic species have been found on the East Coast, and it is too early to tell anything about the level of endemism on the South Coast. Presently, studies are underway to investigate the coralline flora of the East and South coasts in more detail. The distribution pattern that can be elucidated thus far appears to be the same as that for the seaweed flora as a whole.
Poster

EFFECTS OF TAGGING ON AQUARIUM-HELD *Jasus lalandii*

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The sustainable scientific management of the rock lobster (*J. lalandii*) fishery on the West Coast of the South Africa is largely dependent upon estimates of in situ growth rates of juvenile and adult rock lobsters. These estimates are obtained from measurements of changes in carapace length of the lobsters during mark-and-recapture studies. External tags are used in these studies, as they are inexpensive and easily visible. An additional advantage is that individual animals can be captured, identified and measured several times, providing useful information on long-term variability in individual growth rates. Tagging studies do, however, have a number of limitations; one of which is that little is known about the efficiency of the current tagging strategy.

Adult *J. lalandii* grow by moulting, and usually moult once a year. It is important to know how tags influence and are influenced by moulting. The primary objectives of this study are to determine the effect of tagging on both the mortality and moulting rates of adult males under aquarium conditions. Additional objectives are to investigate the rates of tag loss due to grazing by other lobsters before moulting, due to moulting itself, and/or due to methods used to tag the animals. The efficiency of dorsal vs. ventral tags will also be examined.

Oral

THE STRUCTURE AND TROPHIC ROLE OF ZOOPLANKTON COMMUNITY OF THE MPENJATI ESTUARY, A SUBTROPICAL AND TEMPORARILY-CLOSED SYSTEM ON THE KZN COAST

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Most of South African estuaries are temporarily closed. These estuaries have a limited water exchange with the sea and have small catchment areas resulting in the periodical closure of their mouths. Their trophic role and productivity are still virtually unknown. A bimonthly sampling survey has been conducted at the Mpenjati Estuary on the south coast of KwaZulu-Natal, from August 1998 to August 1999. Temperature and salinity values ranged from 10 to 27°C and 0 to 32 ‰ respectively, indicating a generally well developed stratification.

The zooplankton community of the estuary was dominated by the mysid *Gastrossaccus brevifissura* and by the copepods *Acartia natalensis* and *Pseudodiaptomus hessei*. The zooplankton biomass in the estuary ranged from 0.02 to 2.6 g.m⁻³ (DW) at night (mean 0.56 ± SD 0.3) and from 0.003 to 2.3 g.m⁻³ (DW) during the day (mean 0.3 ± SD 0.1). Pelagic chlorophyll alpha (chl α) varied between 0.23 and 13.0 mg.m⁻³ (mean 8.7 mg.m⁻³ ± SD 10.8). These values are low compared to those recorded in the permanently open estuaries of South Africa (Adams, et al. 1999) and seem insufficient to support the zooplankton biomass of this estuary. It is therefore suggested that other food sources must contribute to the energy budget of the pelagic sub-system. One possible source is the microphytobenthos which exhibited a maximum level of 618 mg.m⁻³ during the survey with a mean value (204 mg chl alpha .m⁻² ± SD 61 3). These levels are 1-2 orders of magnitude higher than phytoplankton biomass. Preliminary analyses of δ¹³C and δ¹⁵N ratios showed that *Gastrossaccus brevifissura* uses a large proportion of microphytobenthos in its diet, while *Acartia natalensis* and *Pseudodiaptomus hessei* seem to consume mainly detritus and particulate organic matter (POM), respectively. These results seem to indicate a clear trophic separation between the three species in the estuary. More experiments are currently being carried out to estimate the contribution of these food sources to the zooplankton of this temporarily closed estuary.
Oral

THE S.A. MUSSEL WATCH PROGRAM
TRENDS OVER THE PAST 5 YEARS - CAUSES AND SOLUTIONS

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The Mussel Watch Program is long-term water quality monitoring project conducted by the Department of Environmental Affairs and Tourism. This poster will look at any trends, over the past 5 years, of the various heavy metals analyzed. Thereby areas by low water quality can be identified and possible causes and even solutions to these proposed.

Poster


Deon Kleinsmith¹, Pierre Freon² and Jan van der Westhuizen

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3. MCM

Interannual catch variability of the main pelagic species on the South Africa coast are presented using ArcView GIS. Commercial catch data from 1987-1998 of anchovy Engraulis capensis, sardine Sardinops sagax, horse mackerel Trachurus trachurus capensis, mackerel Scomber japonicus and red eye Etrumeus whiteheadi are displayed. The synoptic distribution of anchovy was close inshore than those of pilchard which was comparably more offshore. Catch distribution is compared to fish distribution derived from acoustic surveys (1995 and 1996). High catch rates of anchovy and pilchard from the commercial fishery were found in the St. Helena Bay area which matched the fish distribution derived from the acoustic surveys. Anchovy and pilchard’s relative abundance and geographical distribution is contrasted over the study period. GIS is a powerful tool capable of organizing, analyzing, and displaying spatially explicit data and can be useful for both decision makers and scientists.

Oral

MARICULTURE SITE-SELECTION ALONG THE WEST COAST OF SOUTH AFRICA: A GIS APPROACH

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Although South Africa’s mariculture industry is underdeveloped; the coastline offers good opportunities for the emerging industry. This includes excellent water quality, good infrastructure (including roads network and electricity) and relatively cheap land in certain areas. Considering the lack of a national policy for mariculture, it is anticipated that decision makers will require environmental management (ecological as well as Socio-economic) database tools for its formulation. As part of the scientific co-operation /agreement between France and South Africa a GIS project first assessed suitability of the entire South African coastline for on and off shore mariculture operations. This was based on basic environmental criteria such as slope analysis, urban and MPA (Marine Protected Area) land users, road accessibility and coastal SST (Sea Surface Temperature). Final results of this phase clearly indicated that the West coast of South Africa is a highly suitable region for mariculture development, in the second phase of the work; the project is producing a high-resolution analysis of the Namaqualand area in the West Coast. This is done using high-resolution environmental data such as the diamonds mining activities and their infrastructure, SST, and kelp bed remote sensing data. The results are envisaged to indicate the potential for on-shore mariculture activities for seaweed, shellfish and finfish. In addition, results will show potential offshore regions for abalone ranching. The results show that the GIS database will be a useful tool both for holistic coastal planning and promoting aquaculture projects at a local level.
Ammophila arenaria L. Link (marram grass) was first successfully introduced as a stabiliser of South Africa drift sands in 1892 near Cape Town. Ever since it has been grown in nurseries and established all along the Cape Coast as far as East London. Climatic conditions probably limit the distribution of marram to the Cape Coast of South Africa, but within these limits it is fairly wide spread. Ammophila arenaria has become very invasive in Californian and organ dune ecosystems, and is still widely in use in South Africa for dune stabilization. It is therefore a matter of urgency to establish the potential invasiveness of marram, define methods for its wise use, and search for an indigenous alternative. South Africa has a long history of problematic alien plants, and it is important to control if not inhibit their use as far as possible.

Similarly, South Africa has spectacular mobile dune systems, which could become invaded by A. arenaria and thus lose their strong ecological and geographical value. The EC-INCO-DC program INVASS, is investigating the impact of invasive grass species on the structure, function and sustainable use of coastal and inland sand dune ecosystems in Southern Africa. In order to assess the invasiveness of A. arenaria in South African coastal dunes, we are investigating if and how the absence of both (specialized) soil-borne pathogens and successional species that naturally exclude the plants from their native vegetation, have an impact on the South African coastal vegetation. In order to define guidelines for dune stabilization, the application of indigenous plants for erosion control instead of the introduced species needs to be studied.

Besides their application along the entire coast of South Africa, other 'third countries' in Africa, that are also faced with dune stabilization problems, may adopt the techniques developed.
TIDAL AND RESIDUAL CIRCULATION NEAR THE MOUTH OF LANGLEBAAN LAGOON

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Exchange and mixing between coastal lagoons and the adjacent ocean or bay are important processes, which provide for the distribution and fate of nutrients, pollutants, sediments or other water-borne materials. In March 1997, measurements were undertaken in Langebaan lagoon and Saldanha Bay to gain a greater understanding of the hydrodynamics characterizing the exchange between the lagoon and the bay. The parameters measured included currents, water levels, temperature, salinity, density, and wind. Those observations, when combined to a theoretical understanding of tidal inlet hydrodynamics provide significant insight on the nature of the flow at Langebaan Lagoon inlets. It was seen that the tidal and residual velocity fields at Langebaan Lagoon inlets are controlled by the tide and exhibit a non-linear behaviour due to the complex geomorphology of the lagoon mouth. Circulation at the Langebaan Lagoon inlets is dominated by a strong ebb/flood asymmetry, which increases with the tidal range. In a similar way as in a single-inlet coastal lagoon, water particles released at the inlets during periods of high tidal range experience large Stokes drifts due to the asymmetry between the ebb and the flood flows. As a result, strong exchange and mixing occur between the Langebaan Lagoon effluent, Saldanha Bay waters and probably on some occasion, with the outer ocean.

The presence of two nearby inlets, although not directly influencing the tidal mixing process, accounts for the occurrence of a lateral temperature gradient near the mouth of Langebaan Lagoon and generates a residual circulation with the east inlet constituting the entrance route for Saldanha Bay water and the west inlet constituting the exit route for Langebaan Lagoon water.

MODELLING THE AGULHAS CURRENT AND ITS VARIABILITY

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Temporal variability within the greater Agulhas current may have significant consequences on the global thermohaline circulation, the fishery industry and may cause anomalous rainfall over the African continent. Ocean circulation models, when combined with measurements, are useful to investigate the sensitivity of the Agulhas current and its tendency to generate and shed rings. The Krauss and Biastoch regional ocean model (AGAPE) covers the South Atlantic and the South Indian Ocean with a resolution of 1/3 degree in the Agulhas region. This model simulates the Agulhas current, its retroflection and the shedding of Agulhas rings realistically. It is forced with ECMWF data and has been spun up for a period of 30 model years. A series of sensitivity studies are undertaken to investigate the response of the Agulhas current to windstress anomalies over the south Indian Ocean. The influence of the windstress anomalies on the current strength, position of the retroflection and SST variations are considered.
IDENTIFYING PRIORITY LINEFISH SPECIES FOR RESEARCH, MANAGEMENT AND CONSERVATION

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Approximately 200 species are recorded caught in the South African linefishery. Just half of these are important to at least one of the commercial or recreational sectors. Given the large number of species caught and the limited manpower and data available, these species need to be ranked in order of priority. Research and management efforts would then be concentrated on the higher priority species.

This paper outlines a prioritization exercise using a multi-criteria decision analysis (MCDA) approach that provided a consistent and theoretically justifiable means of scoring alternatives (fish in this instance) on the basis of a number of criteria. The criteria were then weighted in terms of importance and summed for each fish species giving it an overall scoring or ranking. This process included participation by user groups and management agencies, and considered a wide range of indicators of species 'importance', including catches, socio-economic value and existing indications of stock depletion.

SALINITY STRUCTURE AND STRATIFICATION IN KEURBOOMS AND KROM ESTUARIES: PROTOTYPICAL EXAMPLES OF “SALT-PLUG ESTUARIES”

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The highly stratified salinity structure of selected South African estuaries exhibits a 'salt-plug' character that is not well described by the existing 'salt wedge' paradigm. Exemplified by the keurbooms, this type of estuary has an extensive and semi-permanent flood tide delta and a deeply scoured upper estuary in which intense salinity stratification and oxygen depletion is observed. Data from recent field studies in the keurbooms and krom estuaries (as well as historical data on other systems, e.g., Swartvlei) are reported as an illustration of this general paradigm. Results are compared with relevant theory on sediment dynamics and hydrodynamics and the implications for estuarine water quality are considered briefly. 'Salt plug' estuaries are expected in regions where ocean and river conditions are similar to those along the south coast of South Africa (e.g., Australia, California, Chile).

STRATIFICATION AND BAROCLINIC CIRCULATION IN SALDANHA BAY

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During the early summer of 1998, two ADCP's and numerous thermistors were deployed in the 'Big Bay' part of Saldanha Bay. The aim was to observe thermal stratification, baroclinic circulation and upwelling-modulated exchange between the Bay and the ocean (as suggested by Monteiro and Largier, Est. Coast. Shelf Sci., 1999). In addition to time-series data on currents, water temperatures, sea level and wind, many CTD surveys were completed. Primary CTD surveys were 2-dimensional, along a line from outer Bay to the shore of the inner Bay. Secondary surveys were 3-dimensional, along a line from outer Bay to the shore of the inner Bay. Secondary surveys were 3-dimensional. A few drifter deployments were made-specifically to track the outflow from Langebaan and provide information that could help in connecting this study with that of Krug (M.Sc. thesis, UCT, 1999).

Thermal stratification and associated vertically sheared circulation exhibit both diurnal and tidal signatures, which are superimposed on a smaller amplitude wind-correlated, bay-ocean exchange flow. The wind-correlated and tidal signatures appear to be adequately described as local responses to tidal and multi-day variability in the longitudinal (bay-ocean) density gradient. The diurnal signature appears to be a direct response to diurnal winds (sea breeze and land breeze) that blow to and from Langebaan. This results in a daily collection of warm surface water in northern Big Bay, and subsequent relaxation flows, which appear to display some rotational behaviour in the sense of internal Kelvin waves.
LAGRANGIAN DRIFTERS IN THE BENGUELA CURRENT DURING WINTER 1999

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As an early component of BENEFIT, eleven satellite-tracked drifters were deployed in the Benguela current System during June-July 1999. Five drifters were deployed off the Orange River, in the region considered to mark a transition between southern and northern parts of the Benguela. In addition, three drifters were deployed off Cape Columbine in the southern Benguela and three drifters were deployed in the vicinity of the Angola-Benguela front at the northern end of the Benguela system. At each latitude, drifters were deployed at both shelf-edge and mid/inner locations.

At the time of writing, the drifters were recently deployed and little information is available. Initial results showed inshore drifters moving south in response to northerly winds, while offshore drifters were moving north. Concurrent information is obtained from AVHRR data on sea surface temperature and coastal wind stations. During the first few weeks of the drifter deployments, data are also available from a shipboard ADCP/CTD survey. Further, results from the Orange River region can be compared with drifters deployed previously by Namcor and described by Grundlingh (Deep Sea Res., 1999).

THE INFLUENCE OF TAXONOMIC RESOLUTION, MEASURES OF RELATIVE ECOLOGICAL IMPORTANCE AND DATA TRANSFORMATIONS ON MULTIVARIATE COMPARISONS OF ROCKY MACROFAUNAL ASSEMBLAGES

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Comparative studies of perturbed and unperturbed biotic assemblages require decisions about the level of taxonomic resolution to which organisms are identified, the ecological attribute to be measured and the transformation to be applied to the raw data. The effect of these decisions on the outcome of such comparisons is only now starting to be appreciated. Recent work on soft-bottom assemblages, for example, has shown that aggregation of species data to higher taxonomic levels results in no loss of discriminatory ability. When it comes to measuring the ecological importance of taxa the ease and speed with which the estimates can be obtained appears to carry more weight than the reliability of the indicator. Abundance, the most widely and often the only ecological attribute measured in such studies, is in fact considered to be one of the poorest indicators of the functional importance of a taxon within an assemblage. Few workers have considered the effect of data transformations on the outcome of multivariate comparisons of perturbed and unperturbed assemblages; the majorities have simply adopted the fourth-root transformation, as recommended by Field, Warwick and Clarke (1982). The choice of transformation, however, should depend on the aspect of the community one wishes to emphasize. If, for example, the assemblage is dominated by one or two taxa, and these are the organisms of particular interest, no transformation may be necessary. If, on the other hand, one wishes to afford all species equal importance, a severe data transformation must be applied. Although aggregation to higher taxonomic levels is likely to alter dominance patterns there have been surprisingly few studies on the combined effects of taxonomic resolution and data transformations on multivariate analyses. The present study makes use of data from rocky macrofaunal assemblages to examine the influence of taxonomic resolution, ecological attributes and data transformations on the outcome of multivariate comparisons of the biota from replicate exploited and non-exploited localities.
AN UNUSUAL EXAMPLE OF OPPORTUNISTIC FORAGING
BY HUMANS ALONG THE TRANSKEI COAST

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Many of the people living along the Transkei coast are known to supplement their diet with shellfish collected from the rocky intertidal. A recent study of the utilization of biotic resources by these coastal communities (Mqakama 1999) has revealed that they also make use of marine mammals stranded on the shore. A spectacular example of this opportunistic foraging was observed in 1998 when a young sperm whale was washed ashore at Port St. Johns. Members of the local community were observed selling chunks of the fluke, hacking pieces of flesh off the carcass with a panga and collecting the blubber deposited along the adjacent strandline. Marine mammal strandings of this type appear to be not only as a source of meat but also for medicinal purposes.

SPATIAL AND TEMPORAL COUPLING IN POPULATIONS OF THE BROWN
MUSSEL, Perna perna, AT LOCAL SCALES:
SPAWNING, LARVAL ABUNDANCE AND RECRUITEMENT

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The brown mussel Perna perna (Linnaeus) is an important resource species; in terms of both economic value as an informal fishery, and ecological value as a dominant and integral part of exposed rocky shore communities on southern and eastern South African coasts. Adequate sustainable management of mussel beds necessarily requires a fundamental understanding of supply and recruitment ecology, as well as utilization of the resource, encompassing both the main scales of variation and the forcing processes involved.

A yearlong monitoring program has been undertaken within a local scale on the southern coast of South Africa, exploring in detail the spatial and temporal patterns of variation in and coupling of Perna perna populations within and between shores. Adult standing stock, female spawning, larval distribution and abundance in the nearshore water column, and recruitment to the adult population have been examined and a suite of climatic and environmental variables have also been recorded. The results of this study in terms of spatial and temporal scales of coupling will be presented and their implications briefly discussed.

AN ASSESSMENT OF TRACE METAL CONTAMINATION IN SEDIMENTS OF
DURBAN HARBOUR AND BEACHWOOD MANGROVES

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In order to assess trace metal contamination in surface sediments the concentrations in the sediment need to be compared relative to reference levels. It is increasingly recognised that these guideline values need to be based on local natural background levels, rather than a set of general standards for an entire region. This is because the geology within a region can vary between localities, resulting in different background values. Background levels for the Mgeni estuary in Durban (Kwazulu-Natal) were determined by analyzing pre-industrial sediments using XRF (X-ray fluorescence spectrometry). Natural background populations were established for the various trace metals using geochemical normalization. It was assumed on historic, geological and mineralogical grounds that these background levels could be used to assess contamination levels in both the Mgeni estuary and Durban Harbour. Using this approach, contamination in Durban Harbour was characterized and point sources identified. The mangroves occurring in these two systems show remarkable similar enrichment trends, which appear to reflect the intrinsic characteristics of particular components of these mangrove communities.
CONSIDERATIONS ON THE CULTURE AND CONSERVATION OF THE KNYSNA SEASHORE, 
_Hippocampus capensis_

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At present there is a global trend towards the conservation of Syngnathids, in particular the Indo-Pacific seahorses, which are heavily exploited for the Traditional Chinese Market. An estimated 20 million seahorses are consumed annually in Asia alone. The slow reproductive rate, low fecundity and pair bonding nature of these animals, coupled with the ever increasing and seemingly unsustainable exploitation levels, has caused concern amongst conservationists. Conservation efforts focus primarily on establishing small-scale community-based aquaculture ventures for the fishers whose livelihoods depend on the collection of wild caught seahorses. Before this can be successfully implemented, much research is needed to develop the technology and basic biological requirements for seahorses maintained under captive culture conditions.

Our situation in South Africa is however quite different and rather unique. The Knysna seahorse (_Hippocampus capensis_) is not exploited for the Traditional Chinese Medicine market but is arguably one of the most threatened seahorse species in the world. A recent proposal submitted to the IUCN RedList Programme has resulted in the re-classification of this animal from Vulnerable to Endangered according to the IUCN red list criteria. The animal is considered endangered due to its exceptionally limited distribution, the threat of a decline in habitat quality and sudden mass mortalities possibly resulting in extreme fluctuations in the number of mature individuals within the existing population. These factors, coupled with our paucity of knowledge regarding its abundance within this limited distribution, make this animal a likely candidate for extinction within the next ten to twenty years.

A captive breeding programme for the Knysna seahorse has been underway for four years at Rhodes University. During this time, we have developed the technology to breed and rear the seahorses all year round under captive conditions and have closed the reproductive cycle on a sustainable basis.

There is clearly potential for aquaculture of the Knysna seahorse on a commercial scale for the Traditional Chinese Medicine Market. This gives rise to numerous ethical and conservation-oriented questions, which need to be addressed. Can an endangered animal, bred under captive conditions, be sold to the East in an attempt to conserve the exploited Indo-Pacific seahorse species? How can South African conservationists use this technology to conserve the endemic Knysna? What other conservation approaches could be used?

This presentation addresses the threats facing the Knysna seahorse and explores various conservation options.
This presentation is based on the captive breeding programme for the Knysna seahorse, *Hippocampus capensis*. The different experiments can be divided into three broad categories: Breeding, rearing and nutritional studies.

**Breeding studies:**
Experiments were designed to determine the effects of photoperiod and temperature manipulation on the reproductive activity of the Knysna seahorse. Seahorse pairs were kept at three constant photoperiod regimes 20L: 4D and 12L: 12D each at three temperatures 22°C, 25°C and 28°C for a period of four months. The number of broods and the total number of young produced from the different treatment groups was not dependent on the temperature or photoperiod regimes ($P \geq 0.05$).

A further breeding experiment was initiated to determine the effects of light intensity on reproductive success of the Knysna seahorse. Seahorse pairs were placed under low, medium and high (9.1 X $10^{14}$, 5.45 X $10^{15}$ and 9.83 X $10^{15}$ quanta.sec$^{-1}$.cm$^{-2}$) light intensities for a period of four months. The seahorse pairs exposed to the medium light intensity produced more broods ($x^2 = 6.14$, $k=2$, $P \geq 0.05$) than those pairs maintained under the low and high light intensities.

**Rearing studies:**
Two pilot scale experiments were conducted to determine the appropriate Artemia feeding densities for newly born seahorses in relation to seahorse stocking density. The appropriate feeding densities were then used for experiments, which tested the effects of tank background colour, light spectra and light intensities on growth and survival of the juveniles over a five-week period. Tank background colour and the different light spectra tested did not influence growth or survival of the young ($P \geq 0.05$), while those seahorses exposed to the medium light intensity displayed the highest mean lengths and weights ($P=0.0001$).

**Nutritional studies:**
Highly unsaturated fatty acids (HUFA), such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have been found to be important components in the diets of marine larvae. More recently, the ratio between EPA and DHA has been found to influence the survival, growth and fitness of marine larvae. The DHA/EPA ratio of 0.6 was found to have a profound effect on reproductive output, increasing the number of young produced from the broodstock during the study. The young were however smaller in size compared to the young produced from the broodstock fed the remaining diets.

These studies were extended to determine the effects of DHA/EPA ratios on the growth and survival of juvenile seahorses reared for four months. DHA and/or EPA were important for survival of the juvenile seahorses ($P<0.05$).

**Oral**

**COMMUNITY CHANGES IN SAND DUNE SYSTEMS ON THE SOUTH EAST COAST OF SOUTH AFRICA**

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Although the plant communities within the sand dune system may appear to be static to the casual observer, there are continuous changes in species composition, abundance and diversity in response to ever-changing environmental conditions. In this paper selected examples of foredune and dune slack communities, which have been the subject of on-going research of many years, are examined to highlight the magnitude and the direction of these changes. Certain key species are important in the process of community change and factors responsible for the change in these species is briefly presented.
PREDICTING CHANGES TO HYDRODYNAMICS, WATER QUALITY, SEDIMENT TRANSPORT AND WAVE RESONANCE CHARACTERISTICS IN SALDANHA BAY RESULTING FROM ALTERNATIVE PORT EXPANSION LAYOUTS

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The possible medium term expansion of the port of Saldanha into the north-eastern sector of small Bay will have a potential impact on the water circulation in Small Bay that could in turn have impacts on water quality, sediment transport and wave resonance. These aspects have been investigated using a suite of coupled numerical models. A hydrodynamic model was used to determine the modification to the current regime due to a number of proposed Harbour layouts. A three-dimensional numerical model was used to simulate the current regime due to tides, winds and water temperature gradients for a range of representative environmental conditions. These results were then used in a water quality model to investigate the potential deposition of organic matter and fine particles of both natural and industrial origin in the Harbour and the fate of other pollutants arising from shipping operations (ore dust and hydrocarbons). In addition, the potential interactions between internal and external sources of pollutants, the potential interactions with mariculture activities and the potential impact on Langebaan lagoon were assessed.

A sediment transport model was then used to determine the likelihood of any potential negative impacts by the proposed Harbour layouts as regards sediment transport dynamics, e.g. the likelihood of sedimentation in the proposed new navigation channels. A resonance model was used to determine the natural periods of oscillation of the various basin layouts in order to assess mooring conditions inside the proposed basins. These model results provided a quantitative assessment of the impacts of the various proposed Harbour layouts as departures from the existing status quo, which allowed the optimum layout to be determined. It was found that all the layouts assessed caused a discernable change to the hydrodynamics of Small Bay, but did not significantly impact the hydrodynamics in Big Bay and Langebaan Lagoon. It was found that the more open layouts outperformed the more enclosed layouts since these layouts minimize stagnant areas which can potentially cause water quality problems due to low bottom shear stresses, which should exceed 0,05 Pa in order to minimize the likelihood of deposition of organic particles.

Sedimentation of the entrance channel could be prevented by suitably designed spur breakwaters could prevent sedimentation of the entrance channel. Regarding wave resonance, rectangular-shaped basins having dimensions, which are multiples of one another, were found to cause potential resonance problems, which could be avoided by minor changes to the basin geometry.