THE REPUBLIC OF NAMIBIA

DEVELOPMENT OF MARINE SCIENCES

Report prepared by: S. MORCOS
G. HEMPEL
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UNITED NATIONS EDUCATIONAL,
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(6-14 February 1993)

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1. MARINE SCIENCE MISSION TO NAMIBIA

Namibia has a special place in ocean sciences because of its highly fertile waters brought about by the cold Benguela current. With the independence of Namibia and the establishment of Namibia's 200 mile Exclusive Economic Zone, the marine living resources of the country assumed greater importance in the national economy.

The severe shortage of trained manpower required for the investigation and management of the marine resources and environment of Namibia is a long-term challenge that the country and the newly established University of Namibia face. UNAM received the support of the Intergovernmental Oceanographic Commission (IOC) of UNESCO in convening the International Workshop on Seaweed Resources in March 1992. UNAM enjoys also the support of UNESCO in other issues of higher education, and it was natural that UNAM with the support of the National Planning Commission request the advice of UNESCO and its Intergovernmental Oceanographic Commission (IOC) on the development of marine sciences in Namibia.

Because of the many facets of studying the sea and its resources, it was decided to send an inter-disciplinary mission of several specialists with experience in marine research as well as in developing countries. In an attempt to take into consideration the current activities undertaken by the Ministry of Fisheries and Marine Resources in collaboration with the donor countries, IOC/UNESCO contacted several organizations to nominate and support the participation of experienced scientists in the mission. Positive responses were received from GTZ (Germany), ICEIDA (Iceland) and NORAD (Norway), nominating respectively Professor Gotthilf HEMPEL, Dr. Stefan KRISTMANNSON and Dr. Tore STROMME. Together with Dr. Selim MORCOS from UNESCO, the mission visited Namibia between 6 and 14 February 1993. The mission was prepared and coordinated by Dr. Selim MORCOS, Senior Consultant with the Science Operations Unit and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. Mr. Edward M. MOYO, UNESCO Representative in Namibia arranged the Programme in Namibia and accompanied the mission in its discussions with the Namibian authorities.

The composition of the mission is a result of long consultation and reflects the desire of the bilateral and multilateral sources of assistance to coordinate their efforts and to work in close partnership with the national institutions for the benefit of the marine environment and resources of Namibia.

The mission visited the new Sea Fisheries Research Centre in Swakopmund and the research vessel 'Benguela' in Walvis Bay on Monday, 8 February 1993, and met with officials in Windhoek from 9 to 12 February 1993. Several useful discussions were conducted with the Vice-Chancellor of the University of Namibia; the Deputy-Minister of Education and Culture and the Permanent Secretaries of the National Planning Commission, the Ministry of Fisheries and Marine Resources, and the Ministry of Agriculture, Water and Rural Development. A complete list of the mission programme is attached as Annex II.

The members of the mission would like to express their sincere thanks to the Namibian authorities and officials for the time and effort they spent in the

discussions. We learned a lot about Namibia, its plans for the future and the aspirations of its people, thanks to the open exchange of views between officials and colleagues during our meetings in Swakopmund and Windhoek. We particularly wish to thank Dr. Peter H. KATJAVIVI, Vice-Chancellor of the University of Namibia, Mr. Buddy WENTWORTH, Deputy Minister of Education and Culture, Mr. Nama GOABAB, Permanent Secretary of the National Planning Commission, Dr. R. KANKONDI, Permanent Secretary of the Ministry of Fisheries and Marine Resources, Mr. Carl-Hermann SCHLETTWEIN, Permanent Secretary of the Ministry of Agriculture, Water and Rural Development and Ms. Tuli NGHIYOONANYE, Secretary General of the National Commission for UNESCO.

We are pleased to acknowledge the efforts of Mr. Edward M. MOYO, UNESCO Representative in Namibia for the careful preparation and execution of the mission.

2. THE SIGNIFICANCE OF MARINE SCIENCES FOR NAMIBIA

2.1 The Benguela Ecosystem

The ocean off the Namibian coast is a part of a large marine ecosystem dominated by the Benguela current which is one of the major boundary currents associated with oceanic gyre systems. The eastern boundary current systems are very significant oceanographic features in the Atlantic and Pacific Oceans, which include, as shown in (Figure 1) the following:

(i) Canary Current - Morocco, Mauritania and Senegal (North Atlantic)

(ii) Benguela Current - South Africa and Angola (South Atlantic).

(iii) Peru Current - Chile and Peru (South Pacific)

(iv) California Current - Oregon, California and Mexico (North Pacific).

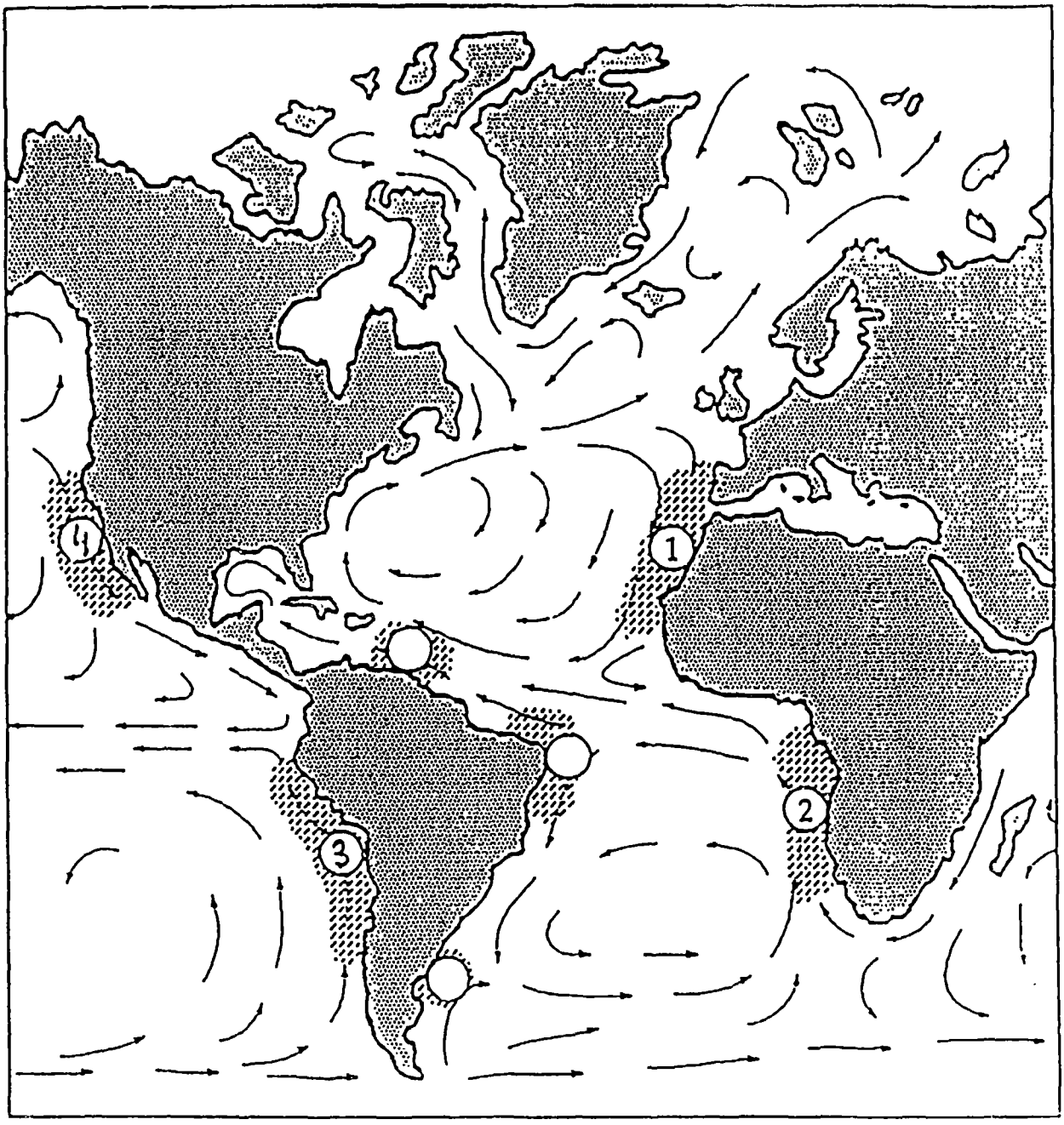
The upwelling, associated with these eastern boundary currents, is of great importance to the biological conditions, because the upwelled water brings nutrients into the upper layers and thus makes possible the development of large populations of plankton and of higher organisms.

The oceanography of the Namibian waters and the western coast of Africa south of about 15 degrees South is dominated by coastal upwelling associated with the Benguela current. Under the influence of the prevailing southerly winds, the surface layers are carried away from the coast and upwelling of water from moderate depths takes place with seasonal variations throughout the year. As a consequence of this upwelling, a band of water of low temperature and relatively low salinity is found along the coast extending to a distance of about 200 km.

In fact, the Namibian waters offer one of the typical "text-book" examples of upwelling zones (Fig. 2). The main current moving towards the equator, in this case the Benguela current, is superimposed by a transverse circulation transporting cold and, therefore, specifically heavy water, from a depth of 100 to 300 m. to near-surface layers. This cold water is also of relatively low salinity and oxygen but rich in nutrients.

The process of upwelling has lasting effects reflected, for example, in the great horizontal temperature differences maintained at the sea surface. According to Fig. 2, temperatures of 12 degrees C were observed on the coast, whereas those of 20 degrees C were measured only 250 km further seaward. Another effect is the abundance of nutrients in the upwelling water, as shown in Fig. 2.), by the example of the phosphate content contributing to the extraordinarily strong development of plankton. Like the abundance of nutrients, this is not restricted to some places but extends over the entire coastal region off Namibia and Angola.

As can be seen in Fig. 2, oxidation of sinking dead organisms results in strong oxygen consumption at shallow depths. Occasionally, even hydrogen sulfide has been observed, which is quite unusual in the world ocean, apart from enclosed



(1) Canary Current : Morocco, Mauritania and Senegal (North Atlantic)

(2) Benguela Current : South Africa, Namibia and Angola (South Atlantic)

(3) Peru Current : Chile and Peru (South Pacific)

(4) California Current: Oregon, California and Mexico (North Pacific)

Fig. 1. Main surface ocean currents

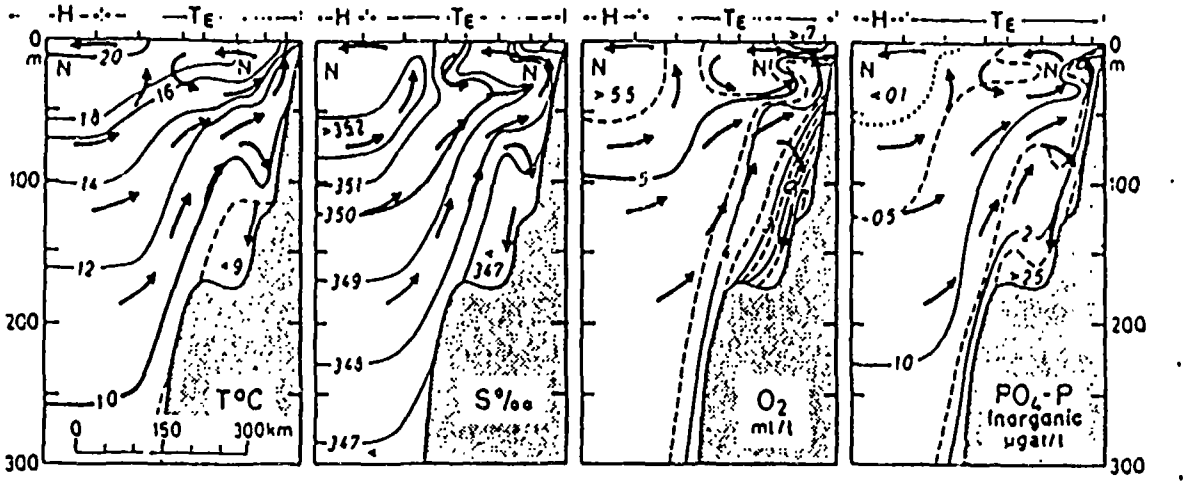


Fig. 2. Distribution of temperature, salinity, oxygen, and phosphate along a cross section through the Namibian upwelling region at 28 degrees, 40'S, based on observations of the research vessel William Scoresby on March 12-14, 1950. N: main current directed towards the north (perpendicular to cross section): Benguela current Arrows: transverse circulation of the main current. Marks at the upper edge: oceanographic stations. Vertical exaggeration of the cross section: 2500-fold (after Dietrich, 1956, from Dietrich et al., 1980).

adjacent seas. The consequence is a great mortality of fish. The abundance of plankton is reflected by a strongly diminished transparency of the water and by the green color of seawater in contrast to the deep-blue colour of the open ocean.

The Benguela current was defined by Hart and Currie (1960) as a region of cool upwelled coastal water which forms the eastern periphery of the anticyclonic gyre in the South Atlantic. Most of the earlier observations of the Benguela current were but a small part of other programmes, as the ships concerned passed down the coast on their way to different ocean areas and they were carried out in widely separated intervals of times. Ross (1847) was the first to show that the Benguela current was an entity by itself and not a continuation of the West Wind Drift. At the turn of the century a cruise on the "Valdivia" contributed to the knowledge of the biology of the region off South West Africa. The voyage of the "Move" in 1911 contributed some physical and chemical data from the coastal area. The important data collected onboard the "Meteor" in the mid-twenties enabled Defant (1936) to study the Benguela current and biological studies were furthered.

The data collected onboard the "William Scoresby" in 1950 was the material that Dietrich (1956) and Hart and Currie (1960) based their work on. Prior to 1970 the literature was mostly descriptive in nature. Since then several important papers on the oceanography of the Benguela current have appeared, e.g. the review papers of Shannon (1985) and Shannon, Field and Siegfried (1986).

The northward flow of the Benguela Current (Fig. 3) is 15-20 cm/sec at the surface on the average (Shannon, 1989). The seaward boundary of the Benguela system exists as an oceanic thermal front. In the southern part it coincides approximately with the run of the shelf break but it is more diffused by eddies in the northern part. The width of the upwelling zone also varies seasonally. The northern boundary of the upwelling system shifts within the northernmost zone of upwelling. The most intense upwelling along the Namibian coast is the Luderitz upwelling cell. In late winter and spring, cold low-salinity water, characteristic of upwelling, is usually widespread along the Namibian coast especially in the south. During summer and early autumn, intrusions of warm, saline, oceanic water move towards the coast from the north and mix with the cooler, less saline, coastal water.

There is evidence of interannual variability of the oceanography of the Benguela current. Intrusions of warm saline Angolan water are responsible for warm periods in the Benguela system. The result is a slackening of the usual northerly flow of the Benguela. Warm periods are known to have occurred in 1934, 1949, 1963, 1974 and 1984.

Throughout the warm events of 1963 and 1984, winds were favorable to upwelling but the biological effectiveness of the upwelling was greatly reduced by the cap of saline water spreading south from Angola (Boyd et al., 1985 and Mann, 1992). As a result, the abundance of phytoplankton and zooplankton was reduced off Namibia. In the Benguela system the combination of frequent but erratic upwelling of nutrient rich deep water into the productive surface zone and the high incidence of sunlight produces one of the richest but most variable areas of phytoplankton production in the world. The zooplankton develops more slowly than the phytoplankton, and therefore it is often not efficiently matched at the same time or place to the phytoplankton blooms. During upwelling physical process

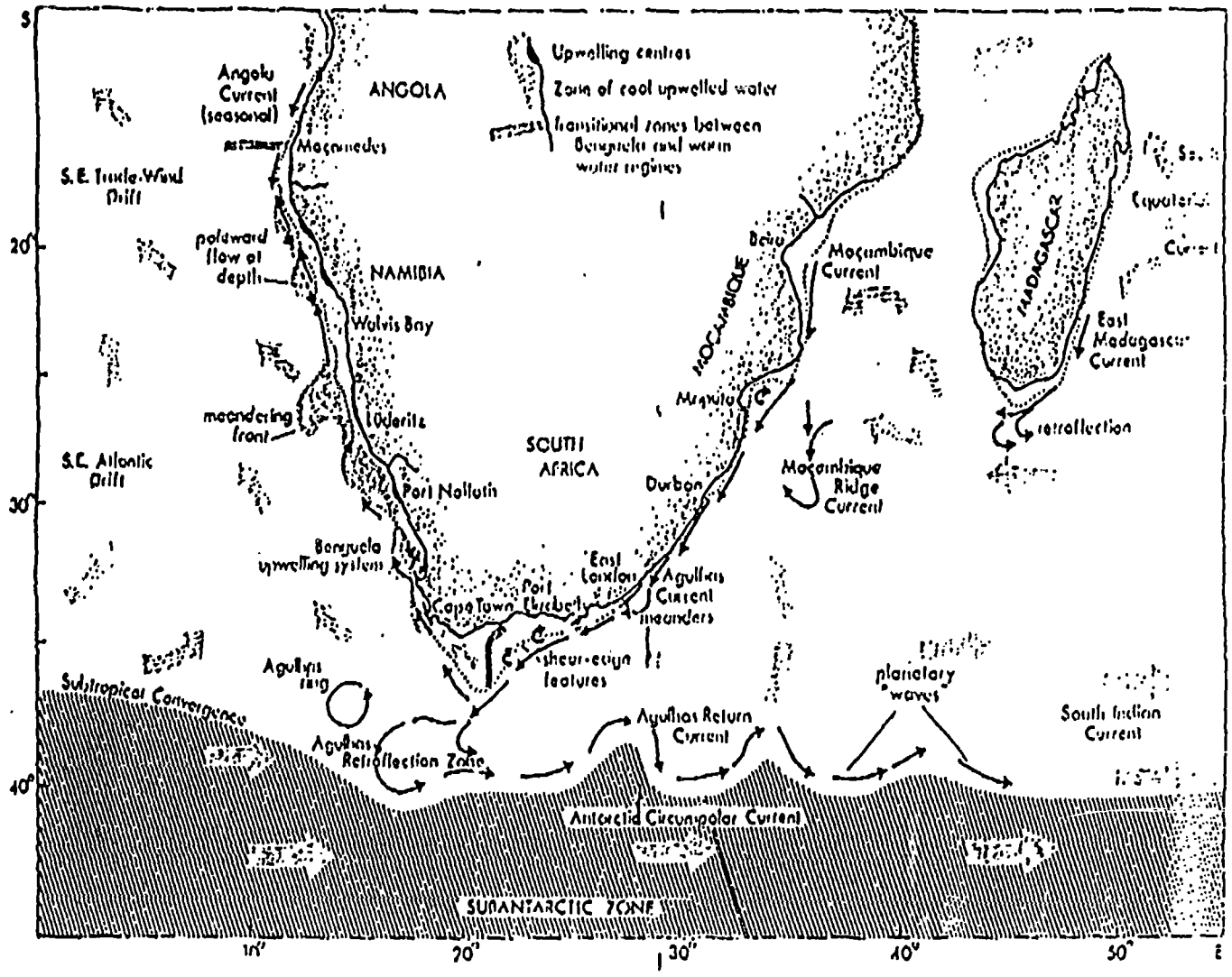


Fig. 3. The Benguela Current (from Shannon, 1989)

determine the phytoplankton production, but downstream, with increased stratification, biological and chemical processes determine the phytoplankton variability (Pitcher et al. 1992). In general, there is an increase in zooplankton abundance during upwelling when phytoplankton blooms. Areas of high concentrations of plankton are utilized to advantage by epipelagic fish in some areas.

Shannon et al (1992) studied the changes in the Benguela ecosystem in the 1980s. They state: "Much of the observed variability could have been reasonably expected in an upwelling system such as the Benguela current which has warm water regimes at both poleward (the Aqulhas current) and equatorward (the Angola current) boundaries, and which is subject to pulsing on a wide spectrum of spatial and temporal scales".

For the past few years the focus has been to increasingly study the Benguela current with respect to its living resources. Variations in the environment were, in the 1980s, documented together with fluctuations of the living resources of the ecosystem, although no causative mechanisms were established. However, short lived epipelagic species seem to be highly susceptible to environmental influences and year classes of longer lived species varied widely. Therefore, a broad spectrum of species in the Benguela ecosystem, from plankton to top predators, appears to be influenced by change in the physical environment, directly or indirectly.

2.2 Marine Living Resources

2.2.1 The fish resources' position in the ecological system-species interactions.

The pelagic fish species such as pilchard and anchovy feed mainly on plankton and thus utilize directly the rich biological production in the upper water layers. In contrast the demersal species such as the hakes have a position higher in the food chain. In their habitat they live from bottom dwelling animals and smaller fish species, but they also frequently seek the pelagic zone to prey on smaller fish and invertebrates. Non commercial fish such as lantern fish and gobies are an important prey for the hake when it inhabits the pelagic zone, and young hake frequently function as cannibalistic prey for the adult specimens. A lot of research on species interactions and on predator-prey relationships in Namibian waters has been carried out from South Africa in the past, but due to lack of capacity by the newly established research staff in Namibia, such analysis is not prioritized at the moment. It will, however, as soon as the immediate needs for management are covered (such as setting short- term Total Allowable Catch (TAC) for the major fish stocks), again become an important research task.

2.2.2 The main Fish Stocks

The fisheries in Namibian waters are based on a few dominant fish stocks. These are the pilchard and anchovy in the inshore coastal waters and hake and horse mackerel more offshore. In addition there is a fishery of lesser abundant but highly priced species such as monk (angler fish), kingklip, snoek and rock lobster.

The pilchard

The pilchard lives on plankton in the coastal waters from Lüderitz and northwards into southern Angola. In the later years the main part of the stock has been concentrated in the waters northwards from Walvis Bay. The fishery on the species started in the early fifties and during a period of rapid expansion of the fisheries it culminated in 1968 with an annual catch of close to 1.4 mill. tons. This represented a heavy overfishing for several years, followed by a rapid decline in the annual catch. Since 1978 the catches have stabilized around 50 000 tons. Since independence the stock is in a slow recovery state, but several years of strong regulations are needed before the stock's potential can be established. The long term potential of the stock is assessed to between 300 000 and 500 000 tons, perhaps within a scope of 10 years. The main part of the catch today goes to the canning industry and the products are an important source of protein to low income groups in the Southern Africa region.

The anchovy

The anchovy distribution overlaps with the pilchard and does to a large extent also compete for the same food resource. The species is relatively short-lived and the stock size is thus directly dependent on success or failure in the reproduction of a new year class. Therefore, large size stock fluctuations are a natural feature of the stock. In contrast, longer living species have a higher buffer capacity, as the stock size is determined by several year classes. The fisheries started in 1968 and annual catches have varied between 83 000 and 355 000 tons until 1983. Since then the annual catch fell below this, except in 1987 and 1988 when a sudden and temporary increase occurred. The long term yield is assessed to between 100 000 and 200 000 tons, and where the lower range is perhaps the best. As the anchovy competes for the same food as the pilchard, the effect of a prospected increase in the pilchard stock on the anchovy is expected but not well understood.

Horse mackerel

Horse mackerel is distributed over the continental shelf from the coastal zone to the shelf edge with its highest concentrations in the northern half of the shelf. An offshore trawling fishery on the species was established in the early sixties and after a period of rapid expansion, the annual yield was

around 200 000 tons in the early seventies, increasing to around 500, 000 from 1975 to 1980. The annual catch peaked in 1982-83 with more than 600 000 tons, and in the later years until independence, the catch was around 500 000 tons. The long term yield from the species is uncertain. There are reasons to believe that the species interact to a large extent with the hake, as they compete partly for the same food, and as the horse mackerel also can act as prey for the adult hake. With a management policy of rebuilding the hake stocks, it is expected that the standing stock of horse mackerel might be reduced, but no scientific evidence has been established. A conservative estimate of the long term yield would be around 300 000 tons.

The hakes

The hakes consist of two species, the cape hake and the deep water hake. The cape hake is found over the entire shelf from about 80m bottom depth into the slope down to about 300m. The young fish is located in the shallower part and as it grows it migrates both into deeper waters and partially northwards. The significant resources of hake in the offshore waters of the Benguela Current was reported by several foreign surveys in the late 1950s. The exploitation of these resources started in the early 1960s by long-distance trawlers, and by 1965, this industry had developed into a multinational fishery with an annual catch of half a million tons. The expansion of this fishery can be seen in the context of an overcapacity in the trawl fisheries in the North-Atlantic, causing overfishing and reduced catch rates in these waters. The development of offshore fisheries off the South West African coast was therefore a much needed transfer of excessive catching capacity from the overloaded fishing grounds in the north. The need for foreign fishing grounds was further reinforced, with the widespread establishment of 200 nautical miles fishing zones in the mid-1970s. Until independence in March 1990, the waters beyond 12 nautical miles off the Namibian coast were treated as international waters and the fishery was regulated through the International Commission for the Southeast Atlantic Fisheries (ICSEAF), which, in practice, was a self - administered management regime of the active fishing nations in the region. The catches of hake in Namibian waters peaked in 1972 with a catch of 820 000 tons. The high level of exploitation continued until 1980, with a gradual decline in the annual yield to below 200 000 tons. Due to lower fishing efforts, the reported catches then increased gradually to 410 000 tons in 1985. In the last five years before independence the catch gradually fell down to 320 000 tons. In the same period, the total allowable catch (TAC) set by ICSEAF was gradually reduced, but consistently set about 100 000 tons higher than the actual catch. This clearly demonstrates that the TACs set by the Commission in this period were too high and caused over fishing and reduced catch rates. Recruitment in the same period was low.

After its independence, Namibia established a 200 nautical miles EEZ in 1990 and most of the foreign fleet fishing on the hake were instructed to leave the zone. The government introduced strict regulations in order to rebuild

the hake stocks and for 1991 a TAC of 60 000 tons was given. For 1992 and 1993 this has been increased to 90 000 and 120 000 tons respectively. Since independence the stock has shown a rapid increase and the size composition has moved towards more large sized and more valuable fish. ICSEAF ceased functioning in 1990 with the establishment of the new EEZ.

With the present management regime, the TAC is predicted to be at the level of 150 000 tons by 1994-95 and perhaps 300 000 tons around year 2000. The long term yield is assessed to the level of 300 000- 350 000 tons annually.

2.2.3 Other species

The Kingklip is widely distributed along the shelf edge off the southern half of Namibia and off the South Africa West Coast. It is caught both as a by-catch in the trawl fisheries, aimed at the hake and in a direct long line fishery. The annual catch in Namibian waters is somewhat less than 5000 tons. With the recent strict enforced regulations on the trawl fishery, in order to rebuild the hake stocks, it is expected that the stock of kingklip also should increase.

The ***anglerfish*** (monk) has its main distribution in the southern half of Namibia and extends into South Africa. The catches in the late 1980s were about 15 000 tons, of which about two-thirds comes from Namibian waters. The species is mainly caught as by-catch in the hake fisheries and the abundance is expected to increase during the rebuilding of the hake stocks.

Snoek is a pelagic fish of the snake mackerel family with its distribution in Namibia and South Africa. The catches peaked with 80 000 tons in the late 1970s, of which the main part came from Namibian waters. An overall TAC of 34 000 tons was adopted by ICSEAF in 1985 for the rest of the decade but the catches for 1987 and 1988 reached only 25 000 tons.

Chub mackerel is a wide migratory species and its abundance is not well known. The catch level varies, but was in the late 80s about 30 000 tons.

Namibian rock lobster is found in shallow waters with rocky grounds north and south of Lüderitz. In the early 1960s the catch level was around 7000-8000 tons annually but was reduced towards the end of the decade due to over-exploitation. A further reduction in the mid 1970s was influenced by adverse environmental conditions. From 1980 to 1989 the catches varied between 1100 and 2900 tons which means about 1700 tons. This represents only 20-25 percent of the catches in the early 1960s. The present management objective has been to maintain the stock at its recent level, and a recovery of the stock would probably demand a period of significantly reduced fishing effort, which has been done in the last two years, TAC's between 100 and 200 tons.

Deep water red crab has been exploited on the continental slope in Namibia since 1973. The fishery culminated in 1983 with 10 000 tons which later fell to 7000-8000 tons during 1984-86. Quota of 1993 is 4900 tons. In later years the catch was about 6000-7000 tons. The effort might have to be reduced in order to utilize the stock's potential. The stock will also probably be strengthened by increasing the age at first capture by applying larger mesh size and escape gaps in the traps.

The ***Cape fur seal*** population has been monitored through aerial censuses of breeding colonies since 1972. The species is distributed from Port Elizabeth in South Africa and north to Baja dos Tigres in Angola. Breeding colonies are found north to Cape Cross and the northernmost non-breeding colony is at Cape Frio. Large colonies used to be established in the islands off Lüderitz, colonies that to a large extent became extinct due to unregulated harvesting in the last century. Since the early 1920s the population of seals off South West Africa has been in a steady growth due to introduction of legislative measures. Several colonies on the mainland were established in the 1940s in the restricted diamond areas and were protected in these areas from harvesting. The stock increase was further accelerated in the early 1980s by the collapse in the sealing industry, as a result of political developments in North America and Europe. The estimated annual pup production shows an increase from about 90 000 in the early 1970s to nearly 170 000 in 1984, and some reduction in the following years. The harvest from culling exceeded 50 000 pups up to 1982 and declined to a few thousands in the late 1980s. The total population was recently estimated to around 750 000 seals, and this is thought to represent a high abundance. As top predators the seals compete to a large extent with the fisheries on their target species, but the role of the seal stock in the marine ecosystem is not fully understood.

2.2.4 Seaweed

Seaweed (Gracilaria) washed up on the beaches in the Luderitz region is collected with an annual harvest of 10 000 - 15 000 tons. Up to now seaweed production is of little economic importance to Namibia. There is, however, remarkable potential both in harvesting the national crop and in seaweed aquaculture. A review of seaweed production in Africa south of the Sahara was the basis of one of the early initiatives of the young University which convened the First International Workshop on Sustainable Seaweed Resources Development in Sub-Saharan Africa in March 1992.

2.3 THE MARINE NON-LIVING RESOURCES

2.3.1 Natural Gas and Oil Exploration

The off-shore area, out to the 1000 m depth contour, is 240,000 km sq. The coastline is 1,400 km long. The Namibian Government has formulated a national energy policy and encourages foreign investment in hydrocarbon exploration and production. There is at present no production of petroleum but

foreign companies/consortiums have recently been awarded exploration licenses. A field of natural gas, the Kuderfield, has been found on the south coast and prospects of finding oil and gas look good. The history of oil exploration in Namibia suggests that the possibility of finding oil is greater in the offshore areas than onshore. There is also confidence in finding oil offshore by comparison with offshore oil occurrences from Angola and northwards.

2.3.2 **Diamond Mining**

Diamond mining (dominated by the De Beers operation CDM), accounted for 65 per cent of the total mining revenues in 1991. The company mines diamonds from open cast mines of the Orange River, one of the world's most concentrated sources of gem diamonds located in marine terraces. The longer-term future of the diamond industry depends on the successful expansion of sea mining operations. At present, most of CDM's mining is conducted on the shores of Namibia's coast, but these reserves are expected to run out at the turn of the century. After that, the company is likely to shift its activities to offshore mining.

Mining diamonds from the sea is a relatively new activity, and successful economic exploitation depends on developing feasible methods. One of the most economically successful methods is applied in the shallow waters off the rocky coast where the main rock lobster fisheries occur. This method consists of using suction pumps installed on boats or shore to remove the sediments from the rocky bottom and collect them on boats or shores for further treatment and examination. The effect of this method on the ecosystem and lobster fisheries is not yet clear. It was noted that the annual landing of rock lobster has declined from 2,000 tons to 350 tons during the same period when the diamond mining in the sea has intensified. However, no causal relationship between the two activities has been established so far. A similar decline in the rock lobster catch has been noted along the west coast of Africa including regions with no mining activities. The general decline may be attributed to major variability in the Benguela current system and/or over fishing. The effect of pumping associated with the diamond mining on the ecology and environment of the region is a very interesting question both economically and scientifically. Plans are under way to investigate this problem through a joint research project to be carried out by scientists from the Ministry of Fisheries and Marine Resources and German scientists.

2.3.3 The Potential of the Continental Margin

The high organic productivity resulting from the upwelling of nutrient rich subsurface water affects the composition and characteristics of the sea floor sediments. Examples are found in areas associated with upwelling in the major eastern boundary current systems in the world ocean as shown, by the shaded area, in Fig. 1.

The continental margin, which extends from the coastline across the continental shelf and slope, is a geologically complex portion of the ocean that has great scientific interest and economic importance. It is also the focus of rapidly increasing human interaction and interdependency.

The sedimentary deposits of the continental margins originate from the land and sea. They consist of land-derived sediments that mix with biological and authigenic sediment components which result from oceanic processes. The oceanic continental margin deposits preserve the geologic history of changing global conditions and often contain high concentrations of potentially economic mineral resources (including phosphorus, silica, manganese, and various trace elements such as uranium, platinum, rare-earths, cobalt-nickel, etc.). In addition, these deposits may contain increasing concentrations of various anthropogenic pollutants (such as heavy metal and organic toxicants, solid waste, etc.), along some margins.

On modern continental margins, authigenic sediments (such as phosphorite, dolomite, diatomite, etc.) often result from processes associated with high organic productivity and elevated levels of organic matter in seafloor sediments intimately associated with climate and boundary current dynamics. The upwelling region of the Benguela current offers a good example for the potential of studying the sediments of the continental margin off the coast of Namibia. These studies will contribute not only to the field of mineral resources, but also to the understanding of changing marine environment.

Because of the importance attached to the continental margins in upwelling areas, an international co-operative research project entitled "Continental Margin Environments and Mineral Resources (COMEMIR)" was developed as a Subprogramme within the framework of the "Ocean Sciences in relation to Non-Living Resources (OSNLR)" of the Intergovernmental Oceanographic Commission (IOC) and the United Nations Ocean Affairs and Law of the Sea Branch.

A regional component of the COMEMIR project covering the north-west African region bordering on the Canary Current System in the North Atlantic Ocean (Morocco, Mauritania and Senegal) was endorsed during the Third Session of the IOC Regional Committee for the Central Eastern Atlantic (IOCEA), Dakar, Senegal, 18-22 January 1993.

Namibia has been encouraged to join the IOC and its Regional Committee (IOCEA) which brings together the West African countries and co-ordinates their efforts in studying the sea. The Namibian scientists should benefit from the experience of participating in the COMEMIR research project on the continental margin associated with the Canary current System, so that a similar project can be initiated in the future on the Namibian continental margin.

2.4 **Tourism**

Namibia has a growing potential in the tourist industry in Southern Africa. Today the tourist industry is the fourth most important sector of the economy after mining, agriculture and fisheries. Namibia's state agencies manage some 12 per cent of the country's total area such as national parks and nature reserves. The regulation and promotion of tourism is the function of the Ministry of Wildlife, Conservation and Tourism. The tourism infrastructure in Namibia is of a comparatively high standard. All major centres in the country can be reached by tarred roads and the gravel roads are also well maintained. The communications system is excellent. From the modern international airport in Windhoek, all major tourist centers in the country can be reached by national airports or landing strips.

The desert coast of Namibia consists of several tourist attractions. However, the southernmost part is off limits because of diamond mining. Large nature reserves cover much of the remaining coast. They are the Namib Naukluft Park, the National West Coast Recreation Area (including the Seal Reserve at Cape Cross) and the Skeleton Coast Park. Wildlife is protected in some areas along the coast, for example, the wetland birds in Walvis Bay Lagoon.

Tourists are permitted to visit the Skeleton Coast, the Namib-Naukluft National Parks and the West Coast National Recreation Area, a 200 km long strip of coastline including Henties Bay, available for swimming, angling, etc. The dunes of the Restricted Diamond Area are forbidden territory. There is a high and very seasonal concentration of largely local tourists in the recreation and angling resorts at, for example, Swakopmund and Henties and Torra Bays. Luderitz is a popular resort in winter. With the further development of facilities, the coast could offer an additional attraction to foreign visitors and a main attraction to tourists from land-locked Southern African countries.

The fact that some parts of the coast are not accessible to tourists protects these areas from the negative effects normally encountered on overcrowded ones. Ecologically spreading the concentration of tourists is desirable. More coastal areas should gradually be opened to tourism to cope with the increasing flux of tourists. This should be accompanied by measures to monitor and protect the marine and coastal environment. Studies on coastal zone management in areas of concentration as well as in areas of potential expansion are recommended. The objective is to establish a long-term plan for a balanced use of the coastal areas of Namibia. Care therefore must be taken to avoid damaging this national resource through overuse. We have learned that the Ministry of Wildlife, Conservation and Tourism has commissioned a survey by experts on the optimal use of the country's tourism and their findings will be an important input in a master plan for the industry. We expect that this master plan will take into consideration the measures necessary to protect the fragile ecosystem of the coastal area.

2.5 **Marine and Coastal Environment**

The coastal area of Namibia consists of conservation areas, the diamond mining area and the smaller areas surrounding the towns of Swakopmund, Walvis Bay and Luderitz. Diamond mining along the southern part of the coast is essentially an earth-moving operation where large quantities of sand and gravel are moved from the beaches in several locations along 100 km of the seashore. A large part of the coastal plain is a government restricted diamond area. Monitoring as well as environmental impact studies should be continuously undertaken to assess the short and long-term effects resulting from this earth-moving operation, such as coastal erosion and changes in the coastline and landscape.

Diamond mining in the sea from the rocky fishing grounds of rock lobsters involve moving bottom sediments by suction pumps. The impact of these operations on the marine ecosystem has not yet been investigated. As proposed in the preceding section on marine non-living resources, a study should be undertaken to assess the impact of the mining operations on the marine ecosystem and the rock lobster fishery.

Although there is no apparent sign of serious marine pollution in the 200 mile Exclusive Economic Zone (EEZ) of Namibia, one should expect that the region, which was, and still is, a theater for active shipping and fishing operations, is subject to several sources of pollution. Examples of potential damage are discharging or dumping of discards of fish, synthetic nets and fishing gears, lubricating oil from small and fishing crafts, as well as operational or accidental discharge of crude or refined oil, petroleum products and petrochemicals.

The lessons of well publicized previous oil spills make it necessary for Namibia to develop its own contingency plan to avert any accident. The magnitude and importance of fishing off Namibia make the development of a national contingency plan an absolute priority.

The coast of Namibia is sparsely populated but the growing economic activities, the development of the coastal towns and tourist facilities, will increase the pressure on the coastal zone of certain focal points of attraction. There is no coastal area development plan on the national or regional levels. The development of such a plan is recommended to insure the harmonious and compatible development of overlapping and often conflicting activities in the coastal zone. There is clearly a need for increased environmental concern in the coastal area. To name a few pressing topics:

1) Increasing size of the coastal towns could lead to increased output of discharge.

2) Increased pressure due to tourism may result in overload of the coastal area. This is especially relevant to the fact that angling along the coast has become for many a commercial activity instead of a recreational one.

3) Future diamond mining with respect to the ecology of the marine environment.

The "Sea Fisheries Act, 1992" states that the Ministry of Fisheries and Marine Resources is responsible for the conservation of Namibian marine resources. Considering the variable environment of the Benguela system and, therefore, the fluctuations of its living resources, it is of great importance to establish a programme of environmental research which, on a regular basis, monitors the sea waters of the Namibian shelf. The relationship between fisheries and environmental conditions is not well understood., Therefore, the programme should initially be geared towards the environmental impact on fisheries and form the foundation of further marine research of special processes, etc.

Under the Act it is clearly stated that discards of fish and dumping and discharging of anything that may disturb or change the ecological balance in any area of the sea is an offense. In addition, with the increased activities in oil exploration off the Namibian coast, it is of great importance to monitor the physical and chemical parameters of the coastal waters. In that way, a basic knowledge of the sea environment can be used as reference in case of a mishap.

3. NATIONAL MARINE SCIENCES PROFILE

3.1 Scientific Research in Namibia

During the colonial era in Namibia, two approaches towards scientific research can be identified. In the early years of the German administration an intensive investigation program was initiated by the Germans, partly due to the quest to optimize quickly the return on investment. During this time substantial studies to improve the ground water supply designed to set the conditions for large scale agronomy production were carried out. At the same time mineral exploitation research was prominent. The ensuing South African era, until independence, was characterized by integrating the research capacity of Namibia and including its research needs into the overall research planning of South Africa. The absence of any institution of higher learning in Namibia facilitated this situation. All young Namibians wishing to gain a University degree or a technical diploma, went to study in South Africa.

As a result, very strong ties exist between the scientific communities in Namibia and South Africa. Scientific research in Namibia is to a very large extent oriented towards South African institutions. However, an increasing number of those involved in scientific research and science policy acknowledge the need for broader international co-operation and for the development of Namibian sciences in a more balanced context.

If science research productivity is measured against publication records, as shown in Figure 4, it becomes evident that research of immediate economic return such as some aspects of geology superseded all other activities because geology in Namibia has a unique character and findings made in South Africa can hardly be transferred to Namibia. However, in the two other fields of economic importance for Namibia which would warrant indigenous research -agriculture and fisheries - very little was done because research activity relevant to Namibia was carried out by South African institutions.

At independence the following units, with a rather limited research capacity, existed. A research section in agriculture located in that Ministry dealt almost exclusively with animal breeding. In the same Ministry a tiny forestry section was housed. Also, the herbarium and veterinary research was housed in the Ministry of Agriculture. Scientific research was further undertaken in the Department of Nature Conservation which preceded the Ministry of Wildlife, Nature Conservation and Tourism. There, ornithology and animal physiology featured prominently. Fisheries research on near shore resources such as on rock lobster, seals and angling was undertaken in two small stations in Luderitz and Walvis Bay. Another institution where research was conducted is the Department of Water Affairs. Very limited research was undertaken at the Academy.

Though this is not a comprehensive list of research activities, one can state that at independence very few research facilities existed and improvement in this situation requires considerable effort and resources from the Ministries concerned and the new University of Namibia.

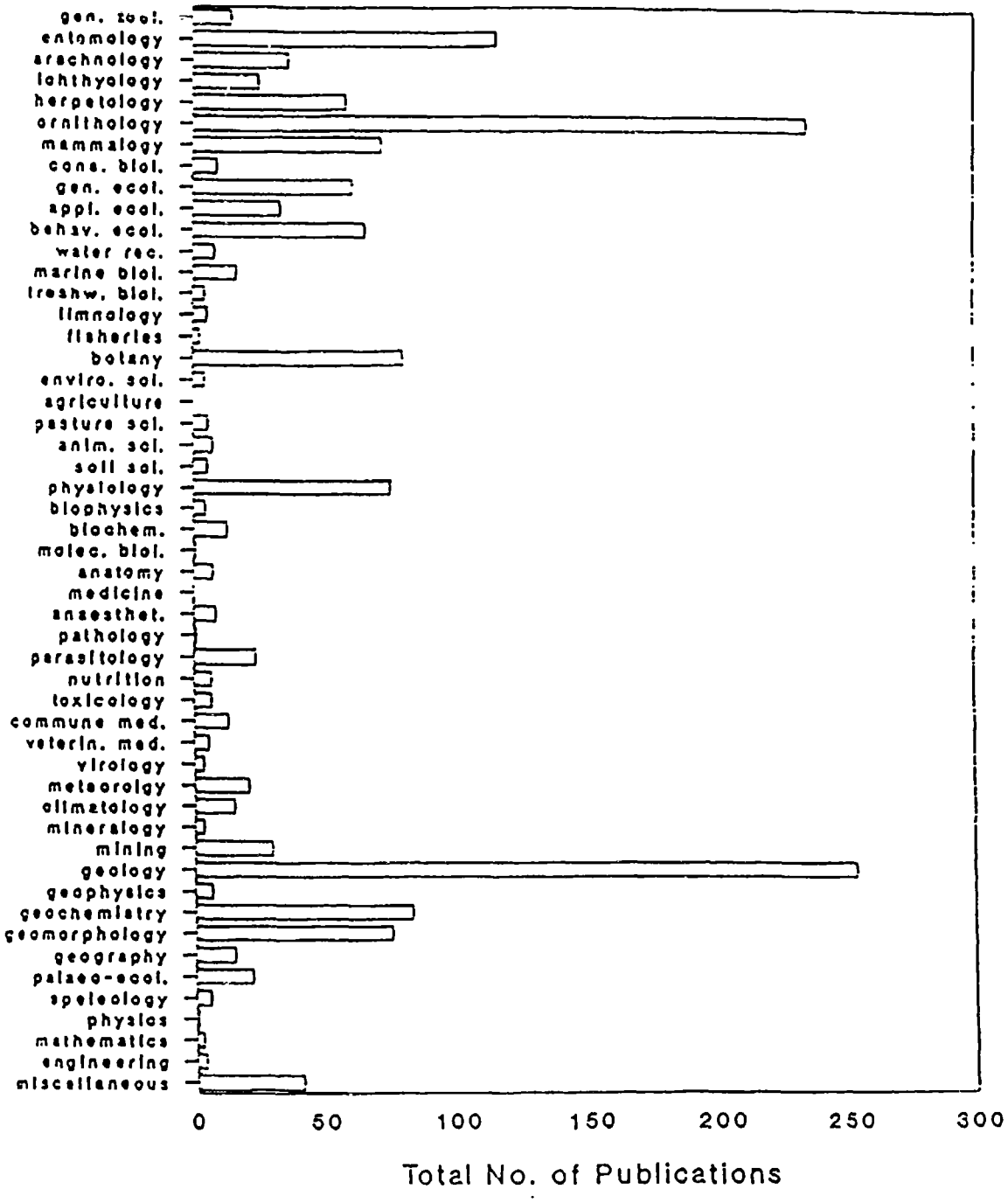


Figure 4. Scientific disciplines as represented by total number of publications over a period of 10 years, (popular and scientific papers. mostly popular papers), unpublished after D.J.M. Hubschle.

The most difficult problem which needs long-term planning is the scarcity of specialized manpower, especially in the fields of science and engineering. Several attempts to stimulate interest and education in sciences are being made by Government and private organizations such as the project of "Young Scientists" of the Rossing Foundation. The shortage of science teachers is a problem faced by the Ministry of Education and is reflected in the limited number of qualified candidates who can enter the University and enroll in science disciplines.

The University of Namibia is therefore confronted with the massive task of building the required manpower, particularly in science and engineering. Furthermore, the University of Namibia is the national institution entrusted with the mission of creating the necessary intellectual environment which could stimulate original research in Namibia. In order to achieve this goal, the co-operation of the scientific community in Namibia and the support of the international scientific community are of utmost importance.

3.2 Fisheries Research and the Ministry of Fisheries and Marine Resources.

3.2.1 Historical Background and Organizational Structure.

Before independence most of the fisheries in Namibian waters were administered and conducted from South Africa with Cape Town as the centre. Small research stations were operating in Lüderitz and in Walvis Bay. These were mainly occupied with research on the near shore resources such as rock lobster, seals and on the shore based angling fishery, mostly a leisure activity. With independence, fishery management and research were allocated to the Department of Fisheries and Water within the Ministry of Agriculture, Fisheries, Water and Rural Development. In February 1991 a Ministry of Fisheries and Marines Resources was created, and this also took over responsibility for the fresh water resources from the Ministry of Wildlife, Conservation and Tourism. The formal structure of the Ministry was established in April 1991 and is shown in Fig.5. The Ministry is organized into two directorates. The Directorate of Resource Management deals with research and management while the Directorate of Operations covers fishery surveillance, sector planning, fishery economics and the administration of the department..

During 1991 a total of 203 vacant posts were announced in order to establish the new Ministry, of which about 50 post were still vacant by the end of 1992. The 20 persons at the Fresh Water Research Centre at Hardap were integrated into the staff of the Ministry. In the marine research sector there are still many vacant posts . Of 6 posts as chief marine biologist, 4 are still vacant, and of 32 posts as marine biologist, 13 are vacant. There seems to be a considerable hesitation in employing expatriates.

All research expenditures except salaries for the staff are financed through the Sea Fisheries Research Fund which income is based on a research levy on all fish landed. During 9 months in 1992 the income on research levies was around 10 mill Rand, bringing the research fund balance close to 23 mill. Rand by the end of 1992. The new research building in Swakopmund is financed through the research fund, as well as the operation of the research vessels.

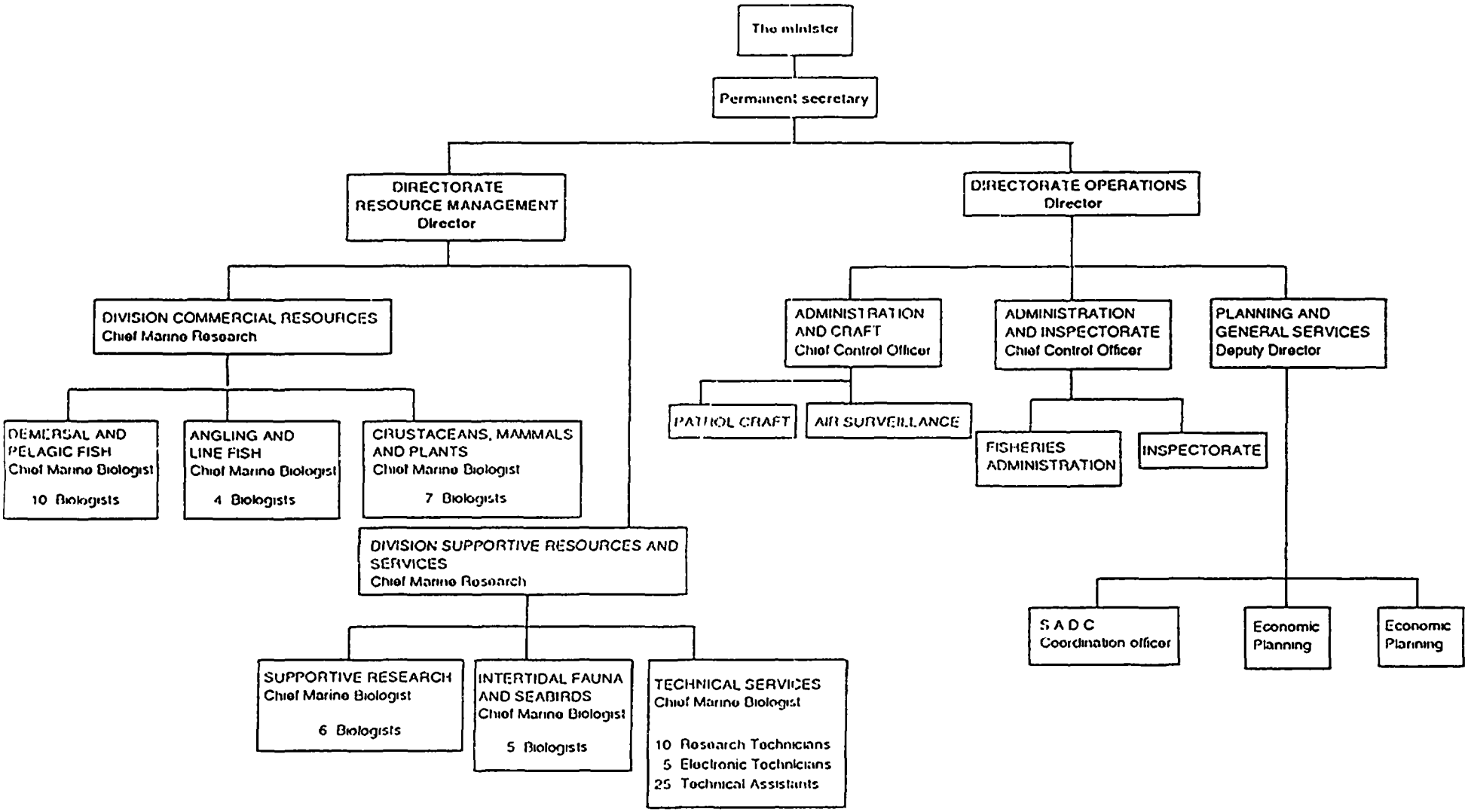


Fig.5 Organogram for the Ministry of Fisheries and Marine Resources.

3.2.2 Swakopmund Research Centre

The Research Centre was founded in 1991 under the Ministry of Fisheries and Marine Resources following a decision in 1988 by the then Department of Sea Fisheries. It is based in Swakopmund, some 360 km from the capital Windhoek. The Ministry has also smaller research centres in Luderitz (on the southern part of the Namibian coast) and a fresh water fish research centre in Hardap (inland).

The Research Centres have a scientific personnel of 14 in Swakopmund, 5 in Luderitz and 2 in Hardap. A provisional list of marine scientists in the fisheries research centres in Namibia is given in Annex III. The scientists include 4 Ph.D's in marine biology, marine mammals, algal ecology and fresh water fish: 7 M.Sc's in biological oceanography, water ecology, desert ecology, zooplankton, physiology and zoology (2): and 10 B.Sc's in biology, limnology (2), zoology (5), microbiology and agriculture. Still, there are 40 per cent vacancies for scientists at the Research Centre. On-the-job training is provided by two advisers in fisheries and physical oceanography from Iceland and an electronic engineering technical officer from the United Kingdom.

On 25 February 1993, a new building for the Research Centre was inaugurated in Swakopmund. It is a modern marine research facility with 15 laboratories (about 350 square meters) and 54 offices (Fig. 6 and Fig. 7). The new building accommodates also a computer room, a photographic studio, an electronic workshop, a mechanical workshop, a board room, a boat house, 1.2 garages, cold rooms and storage facilities. A new library of about 150 square meters is attached to the new building. It has only 950 monographs in stock and currently subscribes to 78 periodicals. A future extension to the new building will include an auditorium, a public aquarium and several technical research facilities.

The new building offers the Centre a great opportunity to expand its research activities. The performance of the Centre can be substantially enhanced by acquiring the modern scientific equipment and oceanographic literature which are badly needed to carry out the planned research programmes.

3.2.3 Research Vessels

The Research Centre has 3 research vessels. The largest one is the 43 m 1968 built R/V "Benguela" which works the shelf waters off Namibia, particularly in fish stock assessment. The R/V "Benguela "will be replaced in 1994 by a new 47 m research vessel donated by Japan. The other 2 research vessels are smaller wooden boats to be replaced in the near future. The officers onboard the R/V "Benguela" are part of the ICEIDA team and their mission includes training Namibian crew to run the research ship in the near future. At present there are no available Namibian officers to man the research vessel. The future running of the research vessels may possibly be contracted out to a private company. In the light of positive experience in other countries, we welcome the plans of the Ministry regarding future private operations of Namibia research vessels. The Japanese research vessel should be operated by a private firm with experience in running research vessels. As much as possible the present crew of the R/V "Benguela" should be retained under private contract. The Ministry together with the private operator should see to

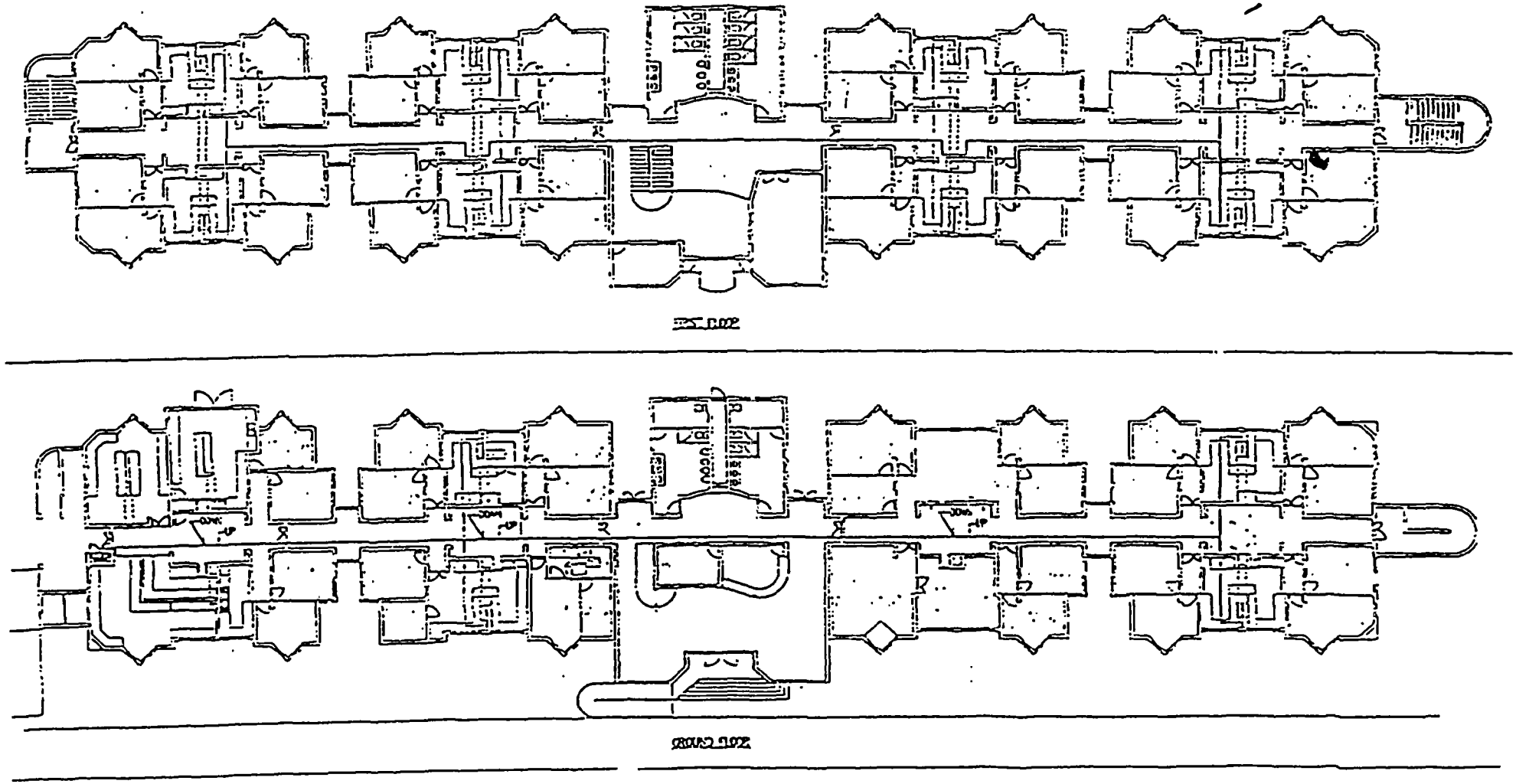


Fig.6: Part of the Swakopmund Research Centre

Fig.7: The new Marine Research Centre
in Swakopmund, Namibia

(Inaugurated on 25 February 1993)

it that in the long run Namibian naval officers and engineers take over from the Icelanders.

3.2.4 Present research activities.

The scientific staff is at present mainly occupied with monitoring the abundance of the fish stocks, as this is the most immediate task in connection with the newly established fishery management regime. The various research groups are:

The *pelagic research group* with responsibility for pilchard, anchovy, round herring and horse mackerel. Their assessments are mainly based on the acoustic and biological data collected by the R/V "Benguela" and R/V "Dr. Fridtjof Nansen". The group consists of three scientists.

The *demersal species group* works mainly on the hake. The hake stocks are monitored by two annual trawl surveys carried out by R/V "Dr. Fridtjof Nansen". In addition to this, the group has initiated some investigations on the minor demersal species, such as angler fish, kingklip and large-eye dentex. The group consists of two scientists.

The *line fish and angling fishing group* works on monitoring the near-shore game fisheries. They are also doing tagging experiments. Two scientists work in this group.

Crab research started in 1991 with the collection of catch statistics and with a tagging programme in an attempt to determine population size, growth and migratory patterns. One scientist is responsible for this.

The *seal group* consists of two scientists who are mainly occupied with monitoring the stocks by aerial surveys during the breeding season. They are also working on population modeling.

The *lobster group* assesses the stock of rock lobster through a sampling scheme carried out by divers. They also monitor the environmental parameters in the rock lobster habitat, particularly the oxygen conditions. This group consists of two scientists based in Lüderitz.

The *seaweed section* in Lüderitz works on biomass and growth assessments on Gracilaria, kelp and other intertidal seaweeds. The group has recently started cultivation experiments on the Gracilaria.

The *environment research group* has just recently been established and has not started any monitoring activities, due to lack of equipment. Instruments for environmental monitoring have been ordered and projects are about to be formulated.

As already mentioned, the capacity of the scientific staff at present is just sufficient to cover the most immediate research tasks necessary to produce the short term TAC's for management. To bring the institute up to international standards, the

scope of its research must be considerably widened. In comparison with more advanced institutions, there are a number of research activities/topics that are lacking in Namibia. Of these one could briefly mention:

- Fish growth (monitoring, determinants, time series)
- Stock size fluctuations (causes, time series)
- Recruitment studies
- Predator/prey relationships, cannibalism
- Species interactions
- Food chains, energy flows
- Living resources impact studies from environmental fluctuations and anomalies.
- System analysis, community structures
- Modeling, (multispecies models, energy flow models)

3.2.5. Bilateral and multilateral assistance.

A number of countries and international agencies give assistance to fisheries development in Namibia. In February 1993 a donors conference was held at the new research centre in Swakopmund where the various projects pertaining to the fisheries department were presented. Of these projects the following are the ones that are of direct concern for fisheries research:

Acquisition of a new fisheries research vessel (Japan).

The R/V "Benguela" which is the Ministry of Fisheries' main research vessel at present is an old vessel that was taken over from the South African government with independence. It is an old vessel and is not suited for several research tasks, as, for instance, trawl surveys. In 1990 the then Department of Fisheries requested financial assistance from Japan to replace the outdated "Benguela". A japanese design team visited Namibia in 1992 to discuss the specifications of the new vessel, and an agreement for provision of a new vessel was signed in March 1993. The new vessel is scheduled to be ready from the yard in Japan in March 1994, and after testing and transfer, it could be ready for survey operations in Namibia towards the second half of 1994. There are no follow up activities from Japan linked to the new research vessel.

Cooperation and technical support in research and training (Iceland).

The Icelandic International Development Agency (ICEIDA), has since 1990 provided assistance in running the R/V "Benguela", and in giving scientific assistance on board the vessel and at the Research Centre in Swakopmund. The vessel operations are supported through 5 ship officers , who have a key role in the successful operation of the vessel. The scientific assistance is provided through one fishery biologist and one oceanographer participating at cruises and in the research work at the Centre. The project also supports study tours to Iceland for Namibian scientists. The first phase of the project expires in 1994, and a prolongation is under negotiation. In this connection it is not yet clear if ICEIDA will provide the ship officers for the new vessel scheduled for delivery in mid-1994.

Assessment of fish stocks in the Namibian Exclusive Economic Zone. (Norway)

The R/V "Dr. Fridtjof Nansen" is a fishery research vessel run by the Institute of Marine Research (IMR), Norway, as executing agency, through funds from the Norwegian Agency for International Development (NORAD). The vessel is run as a global project in cooperation with FAO and UNDP, but has since 1990 mainly served Namibia and Angola, and to some extent Mozambique and North West Africa (Morocco-Guinea Bissau). Since 1990 six acoustic surveys and six trawl surveys have been carried out in Namibian waters, providing report and estimates on the state of the major stocks twice a year as input to fisheries management. The project also gives training on board to Namibian counterparts. Research work by two scientists at IMR is to a large extent aimed at supporting Namibian research. The programme is linked to a Master of Philosophy study in Fishery Biology at the University of Bergen, which provides study seats to students from developing countries. Namibia has at present two seats at this bi-annual study.

The 18 years old "Fridtjof Nansen" will be replaced by a new research vessel that will be in operation from the beginning of 1994, and that has been offered to serve Namibia and Angola for the first 3 years. Linked to the research programme of the new research vessel NORAD will provide extra funds for institutional support and development in the countries the vessel is operating. The time framework for institutional development is wider than what is envisaged for the operation of the vessel and may be up to 10 years. Negotiations on the content and extent of cooperation between IMR and the Ministry of Fisheries and Marine Resources for the period 1994-1997 is in its initial phase and is expected to be finalized during 1993.

Technical support to fisheries research (UK).

The UK agency, The International Cooperation for Development (ICD) provide one electronic engineer for two years (1993-94) as technical support for the research vessels and for the laboratories ashore.

Institutional support in fisheries management, policy and planning (FAO/UNDP).

The UNDP finance a FAO expert (fisheries economist) working at the ministry with the objective of strengthening fisheries management, the regulatory framework for fisheries, institutional development and economic analysis. In addition he supports project development and implementation and provides training for the economic staff. The assignment has a scope of 2 years and expires in May 1994.

Support to the SADC coordinating office for marine fisheries and resources within the Nordic/SADC initiative (Iceland).

The Southern African Development Community (SADC) has as an objective to stimulate development in the Southern African region. In late 1991 Namibia was given the coordinating role in the sector of marine fisheries. ICEIDA provides one advisor to the marine sector coordinating office situated at the Ministry of Fisheries and Marine Resources in Windhoek. The assignment is for 30 months and expires at

the end of 1994. The office organizes seminars and workshops and will starting in 1994 host the SADC training course in fisheries management, at present situated in Tromsø, Norway.

Advisory assistance to the Ministry of Fisheries and Marine Resources (Germany).

The German Agency for Technical Cooperation (GTZ), provides a fishery advisor for three years to work at the ministry. At present he assists in establishing a legal framework for implementation of fisheries policies, but could also assist in the preparation and implementation of management plans. The assignment expires in May 1995.

Effects of diamond dredging on the marine ecosystem (Germany).

The project is planned to start in the second quarter of 1993 and has as primary objective to assess the impact of present and future marine mining activities on the marine ecosystem and especially on the stocks of rock lobster and commercially important fish. The project has a duration of 24 months and the GTZ will provide 1 marine biologist and 4 research divers for the study.

Proposed projects by Ministry of Fisheries and Marine Resources.

During the donor conference in February 1993 the ministry presented several projects for which they were seeking donor funding. Of these a project of relevance to research is a project for an *integrated fisheries information management system*. This system will be used in resource management, licencing, quota control, levy management, fisheries monitoring, control and surveillance.

3.2.6 A Strategic Plan for fisheries research and management.

At present a strategic plan for the development of research and management has not been formed. Such a plan would fill both the purpose of bringing the Ministry up to international levels in research and management within a reasonable time frame and the purpose of allocating the limited national resources, both in terms of manpower and financial resources.

3.3 UNIVERSITY OF NAMIBIA

3.3.1 Historical Background and Organization

The University of Namibia is a new institution founded on 31 August 1992, when the University of Namibia Act (1992) became operative. It is a new institution established to respond to the developmental needs of the newly independent Namibia. However, in the process of its foundation, the University has inherited the "Academy" which was created in Windhoek in 1980 to provide for the tertiary education needs before independence.

The Academy was composed of the Technikon Namibia, a career-oriented training centre, the College for Out-of-School training as well as five Faculties including one for Natural Sciences. According to the University of Namibia Act, the Academy ceased to exist. However, it is intended that through a smooth transition, most activities of the former Academy will be continued. All students in the former Academy were given the opportunity to complete the programmes for which they were enrolled.

The plans of the new University comprise seven Faculties including the former Faculty of Science of the Academy in a developed form and a proposed one for Agriculture and Natural Resources as well as five Centres including the existing Computer Centre and a proposed Multi-Disciplinary Research Centre. While some of the new Centres will begin functioning and a number of new programmes will be phased in from 1993, the University will open its doors fully in 1994.

The Faculty of science has seven Departments: Botany, Chemistry, Computer Science, Mathematics, Physics, Statistics, and Zoology. The Faculty offers B.Sc. degrees after a minimum of three years of study.

The mission discussed the issues related to the introduction of Marine Sciences in UNAM with Dr. Peter H. Katjavivi, the Vice-Chancellor in an introductory meeting attended by Mr. Richard Jacobs, Chairman of the Strategic Planning Committee of the University and Professor Keto E. Mshigeni, Chairman of the Research and Postgraduate Studies Committee. This meeting was followed by a larger one with members of several Departments interested in relevant marine science issues. We visited the City Campus which housed the old Academy and its Faculties. We were shown some of the student laboratories and facilities. We had access to and have received several documents on the University and related subjects. The following assessment is based mainly on these sources as well as other views expressed during our visit to Namibia.

1. Each of the seven Departments of the Faculty of Science are staffed by 2-3 members on the average. At present, the Faculty has 9 Ph.D's occupying the posts of Senior Lecturers and a few other Lecturers with an M.Sc. or B.Sc. degree. At this early stage of development of the new University, it is advisable that the strategic planning attempt to find the right balance between the traditional organization of a University (e.g. Departments) and the new approaches including the emphasis on interdisciplinary teaching and research, particularly in sciences.

2. At present a 3-year programme is offered to 150 students. A 4-year programme will start in 1994. The number of students applying for admission exceeds the University's ability to enroll them. There is only one laboratory per Department for practical lessons, but this situation will improve by moving to the new campus in 1994. Needless to say, the number of staff is very limited and the members of the Faculty are under pressure to cope with teaching responsibilities and have very little time to do research.

3. Establishing a new University is an exciting undertaking and an exceptional opportunity to influence the course of development in a young country, especially when the University is the first and only institution of its kind. The members of the mission are satisfied that every effort is being made to build the University on wise planning that insures high quality education and research, relevant to the needs of a young country facing a shortage of qualified manpower. We understood that there is an active consultation between the University and the private and public sectors. Furthermore, according to the Vice-Chancellor, the presence on the University Council of Permanent Secretaries should be understood in terms of the symbiotic relationship between UNAM and the Government. Whereas the Government formulates the national policy on tertiary education, UNAM for now is the only institution which implements that policy. It is also correct to assume that UNAM will in some way influence Government policies, since many of the University's graduates are going to become civil servants.

3.3.2 **Marine Sciences in the University of Namibia**

The overriding need to introduce marine sciences in the University of Namibia is an obvious case. There are many arguments that speak in favour of a speedy decision to make the introduction of marine sciences in UNAM an absolute priority.

- Namibia borders on the Benguela current system which is one of the most exciting scientific problems in modern oceanography. Continuous inter-disciplinary research is required to understand the variability of this "Large Marine Ecosystem". Introducing teaching and research in marine sciences in UNAM will provide the University with opportunities to co-operate with international advanced institutions and to train their graduate students and young scientists in several aspects of biological, physical and chemical oceanography.

- Marine living resources of Namibia represent a growing economic sector, which will be in the near future, according to reliable forecasts, second only to the mineral resources. The mission of the Fisheries Research Centre in Swakopmund will be greatly enhanced by the complementarity of research between the Institute and the University.

- Non-living resources such as diamond mining along the shores of the Namibian coast and off-shore oil exploration, underline the importance of preparing UNAM for the challenges of economic expansion and ecological hazards.

- Tourism is a growing industry in Namibia and its potential impact on the coastal zone and near shore biota requires a sound management policy and

highlights the need for trained personnel in ecological and environmental sciences as well as in coastal area development.

- The risk of marine pollution is presently at a minimum. With the increase in population and the growth of commerce, industry, urban centres as well as oil exploration, there is a great need for personnel to monitor and manage various sources of pollution in the marine environment.

- The Namibian population is concentrated in the interior of the country. They are separated from the coastal zone by the Namib desert. The University has a role to play to change the orientation of the younger generation from this inward look to a greater interest in the sea and its resources. The marine wealth of Namibia has been explored and exploited for many generations by foreign fleet and manpower. UNAM has a great responsibility in building the manpower necessary for the exploration, exploitation and conservation of the marine resources of the country. Introducing marine sciences as a major subject is a first step towards this goal. In addition, the commitment of the University will stimulate the younger generation and raise the public awareness of the importance of the sea for Namibia.

- Namibia was recently selected as the co-ordinating centre for the Southern African Development Community (SADC) in marine resources development. We believe that this is a responsibility as well as an opportunity for UNAM to serve as the regional centre for University education and research in marine sciences. We understand that there is an active exchange between UNAM and the Universities of the region. Active consultation with neighboring Universities is necessary to insure a sound regional co-operation and compatibility between the courses offered by UNAM and participating Universities.

We are pleased to note that the new University, at its early stage of development, was able to take certain initiatives in the field of marine sciences such as:

a. Organizing the First International Workshop on Sustainable Seaweed Resource Development in Sub-Saharan Africa, Windhoek, 1992, with the support of several organizations including IOC of UNESCO and SAREC (Sweden).

b. The intended transfer of a Regional (Postgraduate) Course of Fisheries Planning and Management (FPM) which used to be offered by Tromso University (Norway) to the University of Namibia to serve SADC countries. It is worth noting that the transfer of the course came as a result of the close collaboration between the Ministry of Fisheries and Marine Resources and UNAM, both institutions having shown keen interest in offering facilities to make the transfer possible.

c. The University counts among its visiting staff two specialists: Professor Keto E. Mshigeni from the University of Dar-Es-Salaam,Tanzania, a marine algologist, the Chairperson of the Research and Postgraduate Studies Committee of UNAM and Professor Charles H. Hocutt from the University of Maryland Eastern Shore, U.S.A., an ichthyologist with experience in aquaculture and fisheries research in the rivers and lakes of Africa.

3.3.3 **Marine Sciences at the Undergraduate Level**

The 1993 yearbook of the Faculty of Science of UNAM shows an extremely structured and compartmentalized Faculty comprised of seven Departments: Botany, Zoology, Chemistry, Mathematics, Physics, Statistics and Computer Science. While the mission recognizes the importance of basic sciences, it is suggested that the new four-year courses planned for 1994 emphasize the inter linkage between the many disciplines required to understand the environment. Ecology should be a major topic of University training at the undergraduate level with specializations in the last two years in marine and terrestrial environments. In this respect the mission wishes to voice its support for strong interdepartmental links to avoid the traditional risk of academic isolation and to strengthen the interdisciplinary approach which is vital for the modern needs of environmental research and management. Co-operation between the Faculty of Science and relevant social and economic sciences in UNAM should be insured in order to provide the necessary integration of the socio-economic factors in managing Namibia's marine and terrestrial ecosystem and resources. This approach will insure that UNAM graduates are well prepared for the job market in Namibia and SADC countries. A pragmatic restructuring of the undergraduate courses is required to satisfy the needs of the country in several environmental related sectors, particularly in the conservation and fisheries sectors.

The desire to develop the new University on a more realistic basis to serve the needs of the country was voiced by the Vice-Chancellor on several occasions. For example, it was reported that in the Faculty of Science under the Academy "the student enrollment was dismally small, training in vital fields of agriculture, fisheries and marine biology was not offered, etc.".

We have been further informed that the proposed new Department of Biological Sciences (involving the amalgamation of the current Department of Botany and Zoology) will also be involved in introducing vital concepts pertaining to fisheries and marine sciences at the undergraduate level. Some views have been expressed that a separate Department of Marine Biology should be established in the Faculty of Science. Specialization in marine biology at the undergraduate level does not seem adequate in view of the limited demand for manpower at this level of specialization. Instead the Department of Biological Sciences should have a strong emphasis on ecology in general. Undergraduate students trained in ecology may later specialize in marine, terrestrial and fresh water fields, which are all of great importance to the welfare of Namibia and of relevance to the SADC region in general.

We have also noted that a Department of Marine Sciences is proposed in the new Faculty of Agriculture and Natural Resources. We should, however, advise the University to be cautious in developing several overlapping initiatives in the organizational structure of a young and relatively small University. Streamlining marine sciences in the University is easier to achieve at this stage of development than it will be several years from now.

It is strongly recommended that the University seek the advice of advanced institutions in marine ecology with experience in University teaching and research, when drawing up the courses and syllabi of the undergraduate studies leading to a B.Sc. degree.

3.3.4 Graduate School of Marine Sciences

An early recommendation on marine science teaching at the University level was made by a UNESCO Workshop on University curricula in 1973 which stated that "Training of professional marine scientists should begin in graduate schools and be given to students holding at least a B.Sc. degree or equivalent in one of the natural sciences. The first graduate instruction in marine sciences should be a multidisciplinary course including physical, chemical, biological and geological oceanography. Although introductory it should be comprehensive and of sufficient substance to provide basic knowledge of these fields and emphasize interdisciplinary aspects. Specific curricula for the four basic marine science fields leading to an M.Sc. degree or equivalent are recommended".

Although there are many Universities with undergraduate courses in marine sciences, there is a clear preference in the marine science community for postgraduate schools that combine research with course studies. There are several reasons for this, including the high cost of training in marine sciences, the limited space available on research vessels and other facilities, the emphasis on quality graduates rather than on quantity, the importance of training on the job and linkage with the user institutions (e.g. the Fisheries Research Centre in Swakopmund) and the prudent policy of some Universities that keeps a steady but limited flow of highly qualified marine scientists who can satisfy the needs of their societies without flooding the job market with unwanted graduates.

UNAM is in the process of establishing the Multi-disciplinary Research Centre, since according to the Office of the Vice-Chancellor: "One of the characteristic features of a University institution is the involvement of its Faculty in creating new knowledge through research. In order to ensure effective co-ordination of research in Namibia, especially considering her relatively weak economic base, and the glaring paucity of highly trained and experienced researchers, and in order to avoid duplication of effort, UNAM will also establish a Multidisciplinary Research Centre (MRC). The MRC will be organically linked to the teaching Faculties and various research bodies in the Government Ministries, and the Private Sector."

This statement illustrates the compatibility between the planned Multidisciplinary Research Centre and our proposal to establish a Graduate School of Marine Sciences. Marine Sciences by nature is an inter-disciplinary science that requires the participation of a multitude of specialists from the University staff and other research institutions; it is greatly linked to the country's economy and should be carried out in consultation and co-ordination with the Government Ministries and the private sector. The most obvious counterpart is the Ministry of Fisheries and Marine Resources and its Research Centre in Swakopmund. Furthermore, establishing the Graduate School of Marine Sciences is also in keeping with UNAM's policy to maintain satellite campuses across Namibia. One of them will be in Swakopmund which is the ideal place for interaction between the Graduate School of Marine Sciences and the Swakopmund Research Centre.

Our experience in several developed or developing countries indicates that it is advantageous if the fisheries institutes interact and co-operate with the local Universities. Isolation creates stagnation but co-operation leads to complementarity of research programmes. Furthermore, senior scientists in the fisheries centres will

be invited to lecture and co-sponsor the thesis research work of graduate students. On the other hand, young researchers in the Research Centres of the Ministry can register as graduate students for higher degrees, i.e., M.Sc's or Ph.D's. Obtaining higher degrees while working on their research projects in the fisheries centres is a great stimulus for young scientists who will find their research more rewarding and supportive to their career development.

While we are emphasizing the necessity and the benefits of interaction between UNAM and the Fisheries Research Centre, we should indicate that there are many areas where co-operation between the two institutions is desirable and will result in complementary research, particularly in studying the marine environment. On the other hand, other areas such as the assessment of fish stocks is the main domain of the Fisheries Research Centre.

Our proposal to the University is to establish the Graduate School of Marine Sciences to be linked to and housed in the Multidisciplinary Research Centre with a satellite campus in Swakopmund for field training, collection of samples and research cruises. Contacts with the Ministry of Fisheries and Marine Resources should be started as early as possible to agree on the objectives and modalities of co-operation.

A brief proposal for funding a preparatory study on "Training and Manpower Development in Marine Sciences in Namibia" is attached as Annex I.

An Action Plan for the Preparatory Phase — Duration: One year

Once it is decided to establish the proposed Graduate School of Marine Sciences, a series of actions to be taken by UNAM are recommended:

1. To set up a University Committee including representatives from the Ministry of Fisheries and Marine Resources to study the following aspects:

1.1 Organizational aspects, particularly the position of the Graduate School and its relationship to the various Faculties and to the Multidisciplinary Research Centre, taking into consideration the University regulations and the "General Regulations and Guidelines on Postgraduate Studies at UNAM", as compiled by the "Research and Postgraduate Studies Committee", as well as its relationship to the Research Centre in Swakopmund within the framework of co-operation with the Ministry of Fisheries and Marine Resources.

1.2 Practical aspects of establishing the School, taking into consideration the facilities of the University campus in Windhoek and the facilities agreed upon with the Ministry of Fisheries and Marine Resources, such as available space and/or access to the Research Centre in Swakopmund, research vessels, field equipment, etc.

1.3 Financial aspects, taking into consideration the national resources and the potential contribution in cash and in kind from bilateral and multilateral sources of assistance.

2. To form a Curriculum Committee to take on the task of establishing an academic programme for postgraduate studies in marine sciences in UNAM, including prerequisites for admission, duration of study, courses of study, fields of specialization, degrees offered, syllabi and thesis requirements, etc. It is very essential that this Committee receive assistance from recognized experts in teaching and research in marine sciences at the postgraduate level in Universities known for their contribution in this field. It should be noted that this Committee is a Committee of specialists and should work closely with the University Committee mentioned above.

3. To request UNDP assistance in funding the preparatory steps of UNAM initiative in training and education of the necessary manpower in marine sciences with the technical assistance of UNESCO and its Intergovernmental Oceanographic Commission (IOC). Annex I is given as an example for such a request.

The main objective of this assistance will be:

- To set up the academic programmes, the required laboratory facilities and the capital equipment for the main disciplines of physical, chemical and biological oceanography, fish biology and coastal geology;

- To mobilize the assistance and co-operation of a few selected institutions to enter into a co-operative agreement by which UNAM could offer facilities and host visiting professors who could contribute in turn to teaching and to joint research programmes with graduate students from UNAM and other co-operating institutions.

3.4 International and Regional Co-operation in Marine Sciences

An important stimulus for scientific research is active communication and exchange of views within the scientific communities both at home and abroad. This applies to all branches of science, but particularly so in marine sciences, which are interdisciplinary in nature. The spirit of team-work is deeply rooted in the traditions of the important oceanographic expeditions that took place since the last decades of the nineteenth century, and in the more frequent oceanographic and fisheries cruises carried out by national institutions for specific purposes.

After World War II, oceanographic research became more demanding and co-operation among nations in exploring the oceans for the benefit of mankind became a necessity. The International Indian Ocean Expedition (IIOE) and the Co-operative Investigations of the Northern part of the Eastern Central Atlantic (CINECA), a region adjacent to West Africa, are just examples of international and regional co-operation in the sixties.

Namibia is a member of the South African Development Community and is designated as a focal point for the marine affairs for the SADC Region. As a young independent nation, Namibia is a member of the United Nations, its Programmes (e.g. UNDP and UNEP) and its Specialized Agencies such as FAO, IMO, UNESCO, WHO and WMO which have certain responsibilities in ocean affairs and can provide Namibia with advice and technical assistance in various aspects of marine related issues.

In addition, a number of intergovernmental and non-governmental organizations are directly concerned with marine research and their activities lend a great support to the Namibian marine science community and to its efforts in studying the ocean and its resources.

The Intergovernmental Oceanographic Commission (IOC) was established in 1960 within UNESCO and presently has 122 members. IOC is a body with functional autonomy within UNESCO.

The functions of the IOC are to develop, recommend and co-ordinate international programmes for scientific investigation of the oceans and to provide related ocean services to Member States. In doing so, the IOC must co-ordinate a far-flung network of associated scientific institutions in Member States. The IOC is the only body within the United Nations charged with basic oceanographic research. The IOC may also "act as a joint specialized mechanism of the UN system in the fields of marine sciences and ocean services."

One of the main functions of IOC is the co-ordination of international and regional programmes in marine research. The IOC Regional Committee for the Central East Atlantic Ocean (IOCEA) is of immediate interest to Namibia. By acquiring the membership of IOC and IOCEA, Namibia would join the neighboring nations of West Africa in the co-operative investigations and training opportunities while studying the marine environment and its living and non-living resources.

There are several non-governmental organizations in the main disciplines of marine sciences such as the International Association of Biological Oceanography (IABO), the International Association of Physical Sciences of the Ocean (IAPSO), the Commission of Marine Geology (CMG) and the International Association of Meteorological and Atmospheric Physics (IAMAP).

The above organizations are affiliated to the Scientific Committee on Oceanic Research (SCOR) which is a non-governmental organization reflecting the multidisciplinary nature of marine sciences. It is a committee of the International Council of Scientific Unions (ICSU) and has links with intergovernmental bodies such as IOC and other UN bodies.

Large-scale international programmes are jointly planned and organized by SCOR and IOC. Some of these programmes are of interest to Namibia and to the study of the Benguela Current. Examples are the World Ocean Circulation Experiment (WOCE), the Tropical Oceans and Global Atmosphere (TOGA), the Joint Global Ocean Flux Study (JGOFS) and the Global Oceans Ecosystems (GLOBEC).

4. RECOMMENDATIONS

In view of the great potentials of the marine Exclusive Economic Zone (EEZ) of Namibia, there is a need for establishing a coherent national marine research programme which should address a broad spectrum of marine topics. It should range from fish stock assessment into ecosystem management and integrated regional research projects as well as into the framework for environmental impact studies and environmental control programmes.

The following recommendations are designed as a balanced approach towards a national marine science policy, taking into account both national efforts and outside support.

1) National Marine Affairs Commission

Building up of an adequate marine research capacity in the country is a complex process of developing human resources, technical facilities and organizational structures. This process as well as the carrying out of a well-balanced and targeted National Marine Science Programme has to be supervised by a national coordination body. Therefore, it is recommended that, as in many maritime countries, a National Marine Affairs Commission be formed and attached to the National Planning Commission, with representatives of Government, academic, public and private sectors having a direct interest in the sea, its resources and environment.

2) Immediate Needs for Training

At all levels of personnel in the marine science institutions, there is an urgent need for well-trained local staff. Several ad hoc measures should be applied to satisfy the immediate needs of the institutions, e.g. by on-the-job training in Namibia and abroad, both at sea and in the laboratory, by group training such as workshops and training courses and by short-term fellowships to acquire certain skills and techniques in foreign laboratories. Apart from training of scientific personnel, emphasis has to be given to the formation of the technical staff in marine science institutions and of officers and crew of research vessels. Special training programmes have to be developed for those groups.

The various lines of ad hoc training have to be developed through close cooperation between UNAM and the Ministry of Fisheries and Marine Resources and their foreign partners. Financial support from bilateral and international sources will be needed to initiate and maintain the training programmes.

3) Graduate School of Marine Sciences

Priority should be given to the training of professional manpower in marine sciences and related fields necessary for the management of the marine resources and marine environment. Ad hoc measures designed to satisfy the immediate needs for trained personnel cannot solve the long-term problem of maintaining a regular supply of well-trained marine scientists to meet the future needs of Namibia and SADC countries. To satisfy the strategic needs of Namibia for specialized personnel,

it is recommended that the University of Namibia establish a Graduate School of Marine Sciences. Graduate students will receive instructions and do research under the supervision of University staff and the expertise available in the Ministry of Fisheries and Marine Resources and its Research Centre in Swakopmund. Advice and partnership of one or more advanced institutions in marine sciences should be actively sought by UNAM to enhance the national effort.

UNDP financial support for the Graduate School of Marine Sciences is very essential, particularly in the preparatory stage of the project.

4) A Strategic Plan for Fisheries Research

At present the research at the Ministry of Fisheries and Marine Resources is occupied with solving immediate tasks, such as providing abundance estimates on the major fish stocks. In order to bring the Research Centre up to an international level within a reasonable time, a strategic plan for the development of research should be formulated soon - as a dominant element of a National Marine Science Programme of a wider scope. The strategic plan should also include a multispecies approach in fisheries science and integration of environmental issues into fishery research problems and thus optimize the limited resources available.

5) Protection of the Marine and Coastal Environment

The prospect of population growth and economic development in the coastal zone and the increasing human and economic activities in the Economic Exclusive Zone (EEZ) of Namibia, necessitate the development of a coherent national policy based on specific measures to ensure a sustainable development, while protecting the marine and coastal environment from any negative effects. As early as possible and until an integrated national programme emerges, action should be taken along the following lines:

- Development of a national programme for the monitoring of the marine and coastal environment including long-term base line studies.

- Initiation of studies on coastal zone management with a view to elaborating a long-term plan for coastal zone development, particularly in regions where the coastal zone is subject to competitive and sometimes conflicting activities such as fisheries, mining, urban axpansion, industry, tourism, conservation and oil exploration and exploitation.

- Elaboration of a national contingency plan in case of accidental oil spills based on co-ordinated efforts of all governmental Departments concerned and in consultation with the private and public sectors.

- Carrying out environmental impact studies on new and some ongoing activities to assess their effects on the coastal and marine environment. Continuous monitoring of environmentally sensitive areas in areas of concentrated activities is essential to detect; at an early stage, significant changes in the environment.

6) National Cooperation

Marine Science in Namibia has to be developed by cooperation between the scientists of the Ministry of Fisheries and Marine Resources and the University of Namibia. The cooperation should consist of interalia:

- participation of the scientists of the Ministry of Fisheries and Marine Resources in the teaching programme of the University, particularly in courses held in Swakopmund and in on-the-job training for graduate students.

- provision of research facilities including research vessels to scientists of the University.

- planning and carrying out of joint research projects.

The cooperation should be formalized and financially supported by agreement between the Ministry of Fisheries and Marine Resources and the University of Namibia. The scientific programme and related issues should be supervised by a Scientific Advisory Board including also foreign experts.

The National Marine Affairs Commission should participate in the planning of the cooperation which might also involve the Ministry of Wildlife, Conservation and Tourism.

7) International Links

Namibia's marine sciences is still largely influenced by South African science institutions. It is benefiting also from bilateral cooperation with countries such as Norway, Iceland and Germany. Such scientific links should be retained, strengthened and focused in the light of the proposed strategic plan for fisheries research and other elements of the recommended National Marine Science Programme. The National Marine Affairs Commission should see to it that the efforts of international donor organizations and national institutes are coordinated and streamlined in support of Namibia's marine research and monitoring activities.

8) Regional and Global Programmes

Namibia's marine research would benefit from being a partner in relevant regional and global programmes of marine research and monitoring. By participation in those programmes the country would fulfill international obligations and would attract international financial support attached to those programmes. Full participation would be facilitated by Namibia becoming a member of the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

9) A Regional Research Programme

The Benguela Current System is one of the most productive and dynamic ecological systems in the world's ocean. The physical conditions of the regime form a natural unit in which plankton production, fish production and top predators as marine mammals and fishing can be analyzed and managed as a whole.

All management should work towards the perspective of such a large marine ecosystem and will then involve a regional approach. It is therefore recommended that parts of the research activities be aimed towards the wider scope of a regional management system. Such a research programme should have its operational centre situated in Namibia as part of the country's responsibilities as the focal point for marine resources development in the SADC region. To the extent that Namibia will have to prioritize immediate tasks in the phase of building up its national research capacity, external bilateral or multilateral support should be sought both in terms of funding and scientific competence.

A regional programme on the Benguela Current System would be attractive both to the national and international science community and would serve the long-term economic needs of the country. It would give focus and momentum to the further development of marine science in Namibia and in the SADC region. Namibia and SADC with the assistance of UNESCO/IOC and other relevant international organizations should organize a scientific planning meeting of a small group of experts from the region and from some advanced laboratories interested in the problem. This meeting should preferably take place in early 1994.

10) Follow Up Mission

It is recommended that UNESCO/IOC organize a follow up mission in the first half of 1994 in order to study the progress achieved in the building up of a national marine science programme in Namibia and to advise on further action including outside support.

Annex I

PROPOSAL FOR TSS-1 FINANCING (1994/95)

COUNTRY: Namibia

TITLE: Training and Manpower Development in Marine Sciences in Namibia

AGENCY: UNESCO (Intergovernmental Oceanographic Commission, IOC)

I. BACKGROUND

The marine living resources of Namibia are presently in a growing state. They have a great potential and an important role to play in the national economy. Prior to independence the fishing industry had a less significant economic role, contributing only 2% of the GDP. But with the recent establishment of Namibia's 200 mile Exclusive Economic Zone (EEZ), it is estimated by the World Bank that the fishing industry could eventually earn an excess of US$ 1 billion per annum for the country.

Management and research of the fish stocks and the marine environment in the 200 mile EEZ require highly trained personel. Historically speaking the study of Namibian waters was made exclusively by foreign powers and very little was done to promote the indigenous research in the marine resources of the country and to create the required national manpower of young scientists and technicians.

The Southern African Development Community (SADC) has designated Namibia as the focal point for marine resources development.

The present proposal is developed as a result of the findings of a mission of four consultants from UNESCO and its Intergovernmental Oceanographic Commission (IOC) which visited Namibia upon the invitation of the Government from 6 to 14 February 1993.

II. ISSUES TO BE ADDRESSED

There is a great need for University education at the graduate level to provide a national base for the recruitment of skilled manpower capable of investigating and managing the marine environment and resources. The newly established University of

Namibia has a Multidisciplinary Research Centre which will have a beneficial relationship with the School of Marine Sciences. The University staff and students of the Graduate School of Marine Sciences will concentrate their research on the physical, chemical and biological aspects of the marine ecosystem, thus complementing the work of the Ministry of Fisheries and Marine Resources through its Sea Fisheries Centre at Swakopmund which is mainly occupied with fishery related research. The interaction and co-operation of the two institutions will (i) insure the long-term need for highly trained manpower; (ii) satisfy the optimal use of research facilities and human resources and (iii) stimulate the multidisciplinary approach in studying the environmental conditions that may induce sudden fluctuations in the fish stocks of such a Large Marine Ecosystem (LME) as the Benguela Current. Such fluctuations brought about by oceanographic and meteorological factors occurred in other countries (e.g. Peru) due to the phenomenon of El Nino and caught decision makers and planners off guard.

III. INTENDED USE OF THE RESULTS

The planning and execution of the proposed activity will: i) design UNAM curricula and ii) identify additional sources of funding and bilateral co-operation with a view to establishing operational projects (e.g. TSS-2 projects of UNDP).

IV. EVIDENCE OF GOVERNMENT PRIORITIES, COMMITMENT AND PARTICIPATION

The UNESCO inter-disciplinary mission of four marine scientists visited Namibia from 8-12 February 1993 upon the request of the Government of Namibia. UNAM has established the Multidisciplinary Research Centre which encompasses marine sciences. During the mission Government officials expressed their interest and support for this proposal to address the severe shortage of manpower in this vital field.

V. DESCRIPTION OF WORK AND SCHEDULING OF ACTIVITIES

1. Consultation with four marine scientists in biological, physical and chemical oceanography and fishery biology with a view to proposing a consolidated curriculum to the University with the required capital equipment.

2. Consultation with UNAM and the Ministry of Fisheries and Marine Resources to finalize the curriculum taking into consideration the Namibian environment and the University regulations.

3. Contacts with bilateral and multilateral sources for the provision of assistance in kind (e.g. visiting professors, equipment, fellowships) or in cash.

4. Inviting advanced marine science institutions to establish joint research programmes on the Benguela current ecosystem with a strong component of training Namibian counterpart.

VI. PROPOSED BUDGET

Consultation and co-ordination (2 m/m)	US$ 20,000
Travel	$ 10,000
Preparation of technical papers for submission to National Workshop (Contracts)	$ 20,000
National Workshop (with invited speakers) on manpower needs in Namibia and development of curriculum in marine sciences in UNAM	$ 30,000
	$ 80,000

VII. LOCAL COSTS AND SOURCES OF FINANCING

The University of Namibia will provide the counterpart academic staff and technical secretariat necessary to carry out the project.

VIII. INDICATION OF PRIORITY AS ASSIGNED BY AGENCY

Very high priority.

ANNEX II

Programme of Marine Sciences Mission in Namibia
8-12 February 1993

Sea Fisheries Research Institute of the Ministry of Fisheries and Marine Resources
SWAKOPMUND

Dr. Gert Cloete, Chief, Marine Research
Dr. Vidar Helgason, Senior Fisheries Biologist, ICEIDA

Research Vessel 'Benguela', Walvis Bay

Captain, chief officers and engineers from ICEIDA

Tuesday, 9 February

University of Namibia

Dr. Peter H. Katjavivi, Vice-Chancellor
Dr. Richard Jacobs, Chairman of the Strategic Planning Committee
Prof. Keto E. Mshigeni, Chairman of the Research and Post-graduate Committee

Office of the Prime Minister

Mr. L.S. Angula, Director of Training

National Planning Commission

Mr. Nama Goabab, Permanent Secretary
Mr. Willy Goseb, Development Co-operation
Ms. Kristi Angula, Development Planning
Ms. Elizabeth Amukuso

Wednesday, 10 February

National Commission for UNESCO

Ms. Tuli Nghiyoonanye, Secretary-General
(also Chief, Education Planning, Foreign Aid Project Planning)

Ministry of Education and Culture

Mr. Buddy Wentworth, Deputy Minister for Education and Culture
Mr. Klaus Linow, Chief Education Planner (Science)
Mr. I.F.J. Merwe, Director, Curriculum Research
Mr. J.A. Myburgh, Education Planner
Mr. Cliff Olivier, Adviser, Life Sciences Project
Mr. P. Tyloessly, Co-director, N.N.F. Olympia

Ministry of Fisheries and Marine Resources

Dr. R. Kankondi, Permanent Secretary
Dr. Jan Jurgens, Director, Resource Management
Dr. Gert Coete, Chief, Marine Research
Mr. S. Njaba, Deputy Director, Administration and Craft (Training Programme)
Mr. Wolfgang Scharm, Adviser

Mr. Olafar V. Einavsson, SADC Fishery Advisor

Ministry of Wildlife, Conservation and Tourism

Dr. O.S. Brown, Head, Environmental Affairs
Mr. P. Tarr, Environmental Planning Unit

Tuesday, 11 February

University of Namibia

Prof. Keto E. Mshigeni, Consultant, Office of the Vice-Chancellor
Prof. Charles H. Hocutt, Visiting Professor, Ichtyology
Mr. O.J.B. Hubschle, Director, Central Veterinary Laboratory
Dr. Fritz Becker, Acting Dean, Faculty of Arts, also Acting Head, Department of Geography
Dr. N.J.L. Heideman, Acting Dean, Faculty of Science, also Senior Lecturer, Department of Zoology
Dr. Elizabeth McClain, Acting Head, Department of Zoology
Mrs. Erika Maas, Acting Head, Department of Botany
Dr. W.J. Jankowitz, Acting Director, Agriculture and Nature Conservation
Mr. Charl Goosa, Lecturer, Agriculture and Nature Conservation
Mr. Geoff Kiangi, Lecturer, Computer Science/Engineering
Mr. Choshi Kasanda, Lecturer, Education
Mr. K.E. Avafia, Librarian

Ministry of Agriculture, Water and Rural Development

Mr. Carl-Hermann Schlettwein
Permanent Secretary

The Rossing Foundation

Mr. David Godfrey, Director
Mr. L. Le Roux, Assistant Director
Mrs. June Horwitz, Young Scientists Programme

United Nations Development Programme

Mr. Fidele Dionou, Acting Resident Representative

National Planning Commission

Final working session chaired by Mr. Nama Goabab, Permanent Secretary, with a combined team from the Ministry of Fisheries and Marine Resources, the Ministry of Education and Culture, the University of Namibia, the National Commission for UNESCO and the National Planning Commission.

ANNEX III

Marine Scientists in Research Centres

SWAKOPMUND

Name	Project
G.E. Venter, B.Sc. Hon.	Sandwich Harbour
D.C. Boyer, M.Sc.	Pelagic - Stock Assessment
E. Klingelhoeffer, M.Sc.	H. Mackerel - Stock Assessment
H. Hamukuaya, M.Sc.	Hake
R. Cloete, B. Sc. Hon.	Pelagic - Commercial Monitoring
J. Coetzee, B.Sc. Hon.	Pelagic Stock Assessment
L. Maartins, B.Sc. Hon.	Demersal - minor species
M. J. O'Toole, M.Sc., Ph.D	Ichythyoplankton - Demersal Stock Assessment
L. Le Roux,B.Sc. Hon.	Crab Stock Assessment
J. Botha,M.Sc.	Phytoplankton - Primary Production
K. Nikodemus, B.Sc. Hon.	Environmental Data
C. Bartholomae, B.Sc. Hon.	Environmental Data
J. Traut, B.Sc. Hon.	Hake - Commercial Monitoring
F. Botes, B.Sc., Agriculture	Angling fish - Impact of

LUDERITZ

J.P. Roux, Ph.D.	Mammal (Seals) - population ,model dynamics
F. Molloy; Ph.D.	Sea plants
K. Grobler, B.Sc. Hon.	Rock lobster - Stock Assessment
K. Noli, B.Sc. Hon.	Zooplankton production Luderitz region

HARDAP (Inland Waters)

B.V. Zyl, Ph.D.	Fresh Water Fish Stock Assessment
C. Hay, B.Sc. Hon.	Fresh Water Fish Stock Assessment

ANNEX IV

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ANNEX V

LIST OF FIGURES