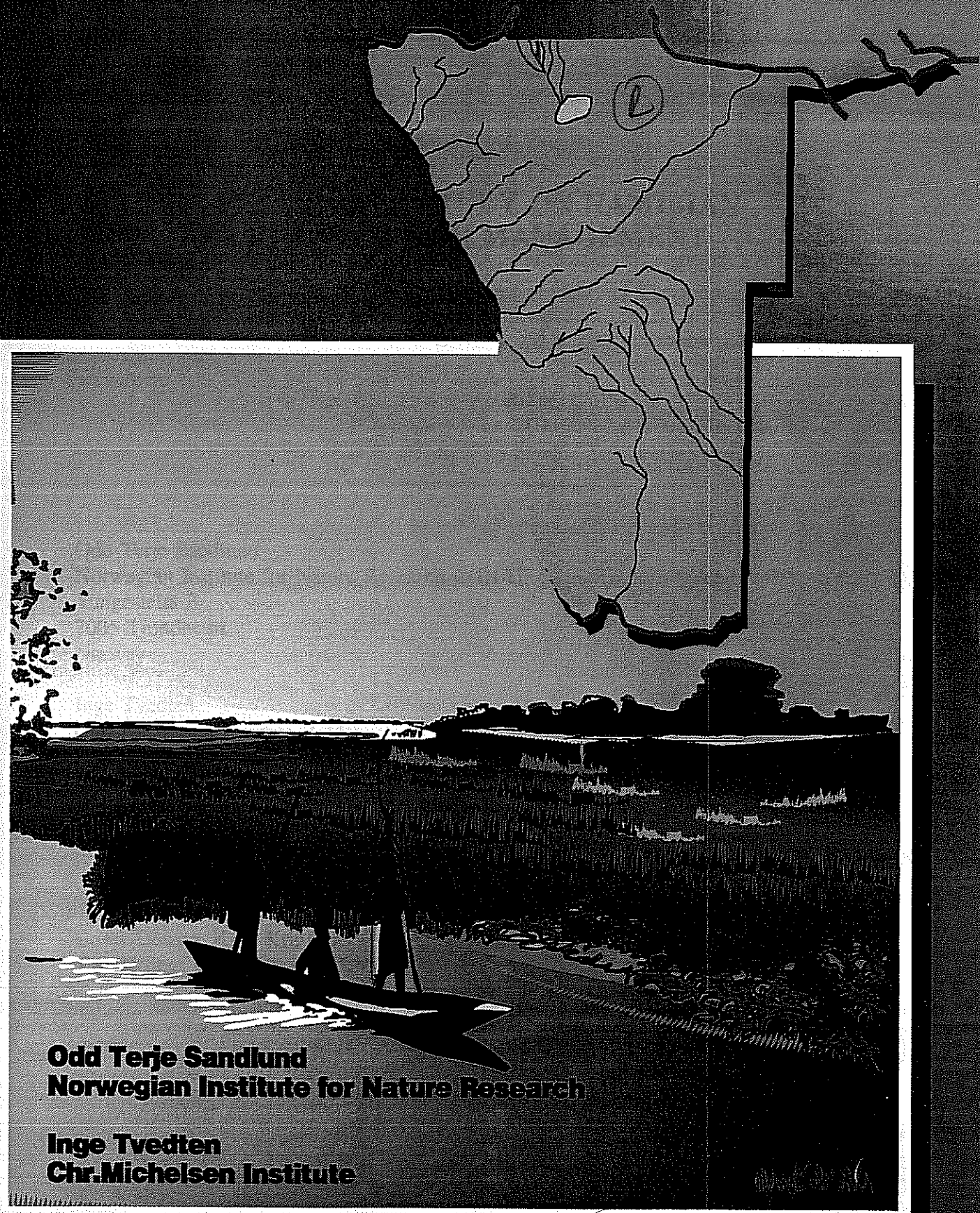


Pre-feasibility Study on Namibian Freshwater Fish Management



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Norwegian Institute for Nature Research

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October 1992

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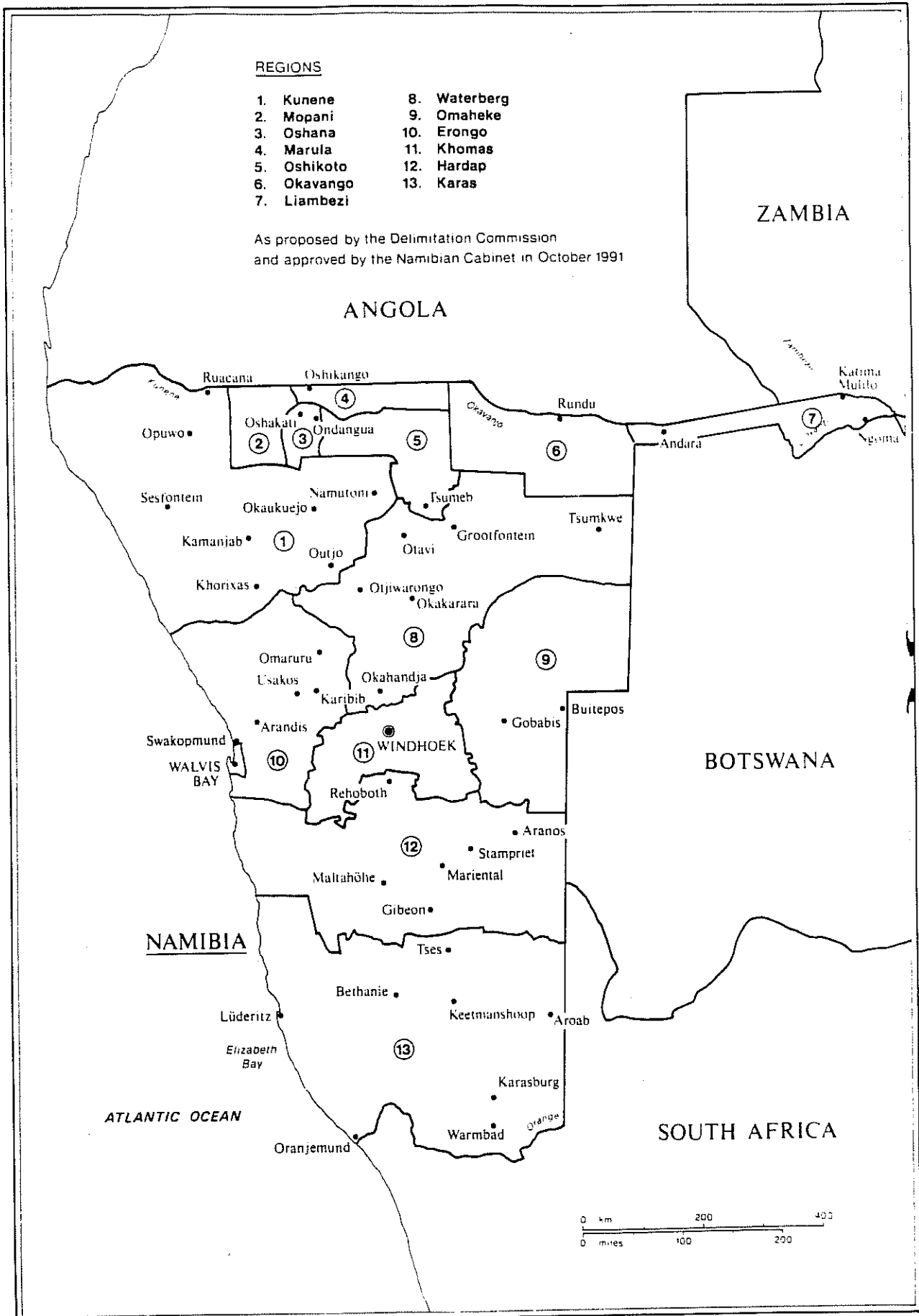
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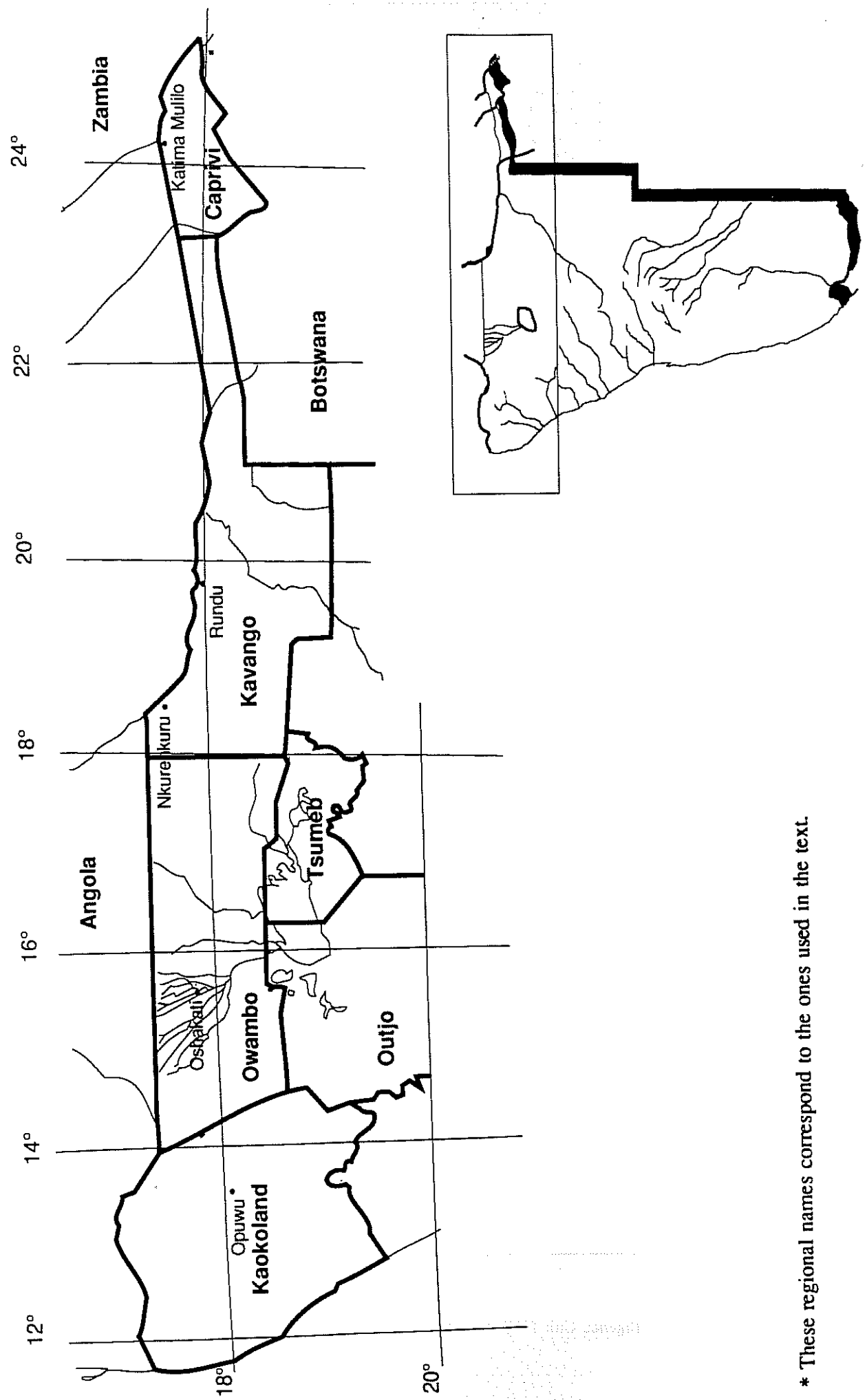
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NAMIBIA NEW REGIONAL AREAS 1991



Source: The Economic Intelligence Unit 1992. Namibia Through the 1990s. - Special Report No. M211. London.

Regions of northern Namibia*



* These regional names correspond to the ones used in the text.

Executive summary

Background

The Namibian Ministry of Fisheries and Marine Resources (MFMR) has requested the assistance of the Norwegian Agency for Development Cooperation (NORAD) to develop a national policy on freshwater fish resources, and further to develop legislation covering this sector. This report provides the findings of the pre-feasibility study in response to this request, and is based on discussions with Namibian authorities, with NORAD officials in Windhoek, and on a review of the relevant literature. The main aim of the report is to 1) provide a review of the socio-economic and biological status, and management and legislation, pertaining to this sector, 2) to identify information gaps, and 3) to provide a Terms of Reference for the further work necessary to complete a White Paper on freshwater fish management and fisheries development.

Freshwater fisheries

Inland fisheries in Africa is of great importance in creating jobs and providing protein-rich food particularly for the rural population. Fisheries in rivers and on the floodplains may produce as much as 50% of the total freshwater fish production on the continent. Inland fisheries are mainly labour intensive, and it has been calculated that around 4 million people in Africa are employed in some activity related to inland fisheries. Inland fisheries are often combined with other activities such as agriculture, pastoralism or other small-scale sources of subsistence and income. This risk reduction strategy is particularly important for poor households, and should be maintained in any development activity. The pattern of diverse activity of inland fishermen also tends to reduce the pressure on the fish stocks. Women are particularly involved in subsistence inland fisheries, both in production and in processing and trade. Men tend to become more involved with commercialization. Freshwater ecosystems are vulnerable to pollution and other anthropogenic encroachments, and inland fish stocks are easily overfished. Thus it is very important in all efforts to develop inland fisheries to integrate socio-economic and ecological aspects.

Freshwater fisheries in Namibia

The importance of freshwater fisheries varies among countries, and in Namibia this sector is of minor importance in terms of GNP. However, indications are that the local importance for subsistence and employment is considerable. The main

inland fisheries in Namibia are related to the floodplain systems of the rivers Zambezi/Kwando and Okavango in the northern and northeastern parts of the country. The seasonal wetlands systems of the Cuvelai River is also an important source of fish. The Kunene and Orange rivers, and the manmade State Dams on seasonal rivers are of less importance. The floodplain ecosystems are complex and variable. With increasing water levels during and after the rains, the water-covered areas increase tremendously, and the behaviour of the fish changes accordingly. The traditional fishing techniques applied varies with conditions. If water is available, extensive pond aquaculture may provide fish when catches are small. The feasibility of aquaculture for production of low-priced fish, however, depends on a supply of cheap fry and fingerlings. Economically viable aquaculture will therefore often depend on a market for high-priced fish. In some of the Namibian freshwater localities, angling is an important activity. In the rivers, angling may be an additional activity for tourists at the safari lodges, and in many of the state dams, angling is also popular.

Although there have been some baseline investigations performed on the fish stocks of the Namibian rivers, there is a lack of reliable figures for inland fish production. An MSY estimate for the Eastern Caprivi (the Zambezi/Kwando system) is 1,500 mt per year, when the 200 km² Lake Liambezi was filled. This lake has now been dry since 1985, and the present MSY from this area may be 800-900 mt. For the Okavango River, the MSY has been estimated at somewhere between 840 and 3000 mt. All these figures are, however, highly unreliable. The management of these complex systems should rather be based on time series data from monitoring programmes, which includes both biological and socio-economic parameters. A monitoring programme has been started on the Okavango River fish stock and fisheries, and a similar programme should be commenced on the Zambezi/Kwando system.

Socio-economic data on inland fisheries in Namibia are scanty; the importance of the inland fisheries sector for employment and subsistence is largely unknown. However, some inferences may be made from the general knowledge about inland fisheries, information from neighbouring countries, and population figures for the northern regions of Namibia. In Kavango, some 80% of the 165,000 inhabitants live within 5-10 km from the Okavango River. A large number of these seem to get some of their food as fish from the river, but data on the number involved in fishing or related activities are unreliable. In the bordering Okavango Delta area (Ngamiland) in Botswana, it has been estimated that some 10 % of the population is involved in fishing. Some data from northern Namibia indicate that freshwater fish is considered an attractive product. In some of the areas in Namibia, most of the fishing population appears to be living in traditional communities, where the traditional authorities still are important. Government institutions are well developed in all areas.

Characteristics of the river systems

The lower part of the Kunene River forms the border between Namibia and Angola. The annual discharge at the mouth is 5,500 million m³. This part of the river is steep, and runs through a thinly populated area, and fishing is negligible. The nomadic Himbas in the area do not use fish. There are plans for hydropower development in Kunene River. This will have both ecological and local socio-economic consequences which must be closely assessed.

The Cuvelai system is a seasonal wetland system (called oshanas) created by the floods in the Cuvelai River system in Angola. Fish is transported into the system by the floods, and is harvested with a variety of methods. All fish transported into the oshanas will die during the dry season, so management plans should aim at maximising the output in socio-economic terms without any consideration to the effects on fish stocks.

The Okavango River forms part of the border between Namibia and Angola before the river crosses the eastern part of the Kavango region of Namibia and enters Botswana, forming the famous Okavango Delta. The annual discharge is 5,000 million m³ where the river enters Namibia, and through supply from tributaries from the Angolan side, increases to more than 10,000 million m³ before entering Botswana. The fish stock, containing 82 species, is quite heavily exploited. Although overfishing probably do not occur, the increasing use of mosquito nets for fishing do cause some concern. Fishing is performed with a variety of traditional and modern methods. The available data indicate that fish is an important source of protein for both the urban and rural population in the area. A monitoring programme was started in 1989.

The Caprivi system consists of the Zambezi River, forming a major part of the border to Zambia, and the floodplain complex of eastern Caprivi, formed by the Kwando/Linyanti/Chobe tributary. The total area of these wetlands was 4680 km² in 1985. Since then, the 200 km² shallow Lake Liambezi has dried up, perhaps for ever. There are plans to erect a weir at the Linyanti River to create a lake of some 100 km². A total of 81 species of fish occur in the Zambezi system. Fishing is performed with a variety of methods, and a large number of fishermen still use traditional methods. Very little socio-economic data is available on the eastern Caprivi, in particular on the number of subsistence fishermen and their conditions. A monitoring programme to cover selected biological and socio-economic parameters should be started in the Caprivi system.

The Orange River forms the border towards South Africa in the south. The population density in this area is low, and very little fishing occurs in the river from the Namibian side. The Orange is heavily regulated in South Africa, and there is some concern that the wetlands at the Orange River mouth, which is a RAMSAR-site for the protection of waterfowl, may be destroyed due to reduced

river flow. For zoogeographic reasons, the fish fauna in Orange River is relatively species-poor; only 14 species have been recorded.

In the central part of Namibia, the only larger permanent bodies of surface water are the State Dams, mainly erected to trap water on seasonal rivers. Most of the dams are quite small, the largest (Hardap Dam) has a surface area of nearly 30 km² when filled. The main function of the dams is to provide water for consumption and irrigation. However, all dams have been stocked with fish, and some of them are quite productive. Fishing is mainly recreational, although some attempts have been made to start commercial fishing in some dams. Experiments with net cage production of tilapia (*Cichlidae*) has been performed, and a small enterprise is presently running in Hardap Dam.

There is a high number of small private dams on farms. These are of minor importance in this context, except for the fact that stocking and transport of live fish among dams pose a threat to the natural biodiversity in the different water systems. It is an important goal to prevent spreading of aquatic organisms among the various natural river systems of the country.

Aquaculture is of relatively little importance in Namibia, and with the restricted water resources available, it will most probably never be of any great importance. There are a few production units for fry and fingerlings, at Hardap, at Oshakati and at Mahenene. The Hardap unit is run by the Freshwater Fish Institute, but is presently in the process of being privatized. The Oshakati and Mahenene units are run by the Rural Development Centre, and provide farmers in the area with subsidized fish for extensive aquaculture in ponds. This system would probably not be viable without major subsidies.

In the floodplain systems of the north, human activities on land may heavily influence the aquatic ecosystems. Irrigation schemes may be of particular importance. A comprehensive overview of existing plans for increased irrigation is needed.

Hydropower development is planned in the Kunene River. This development will clearly lead to ecological and socio-economic consequences, which must be assessed. However, as virtually no fishing occurs in this river at present, the creation of a dam will most probably increase fishing output in the area.

Angling, in particular for tigerfish, is an important attraction for the tourist industry in the Okavango and Caprivi systems. There might be some conflict between subsistence and commercial fisheries, and angling. These problems should be looked into, and angling regulated. It may be feasible to leave control over the resources to local institutions, so that at least part of the revenues from tourist angling benefits the local communities.

Aspects of management

Management of inland fisheries may have several partly conflicting aims. The optimal sustainable output from an ecological point of view may not be compatible with social, economic or recreational management aims. However, a major objective for the management of floodplain fisheries of the type encountered in Namibia should be to ensure a sustainable utilization of the fish resources for the benefit of the local population. This may make it necessary to involve local communities in the management; i.e. to place responsibilities and benefits with local institutions, whether traditional or governmental. To prevent overfishing, limited access and local control and participation may be crucial. A major task will be to include local traditional management practices in a wider management policy based on ecological and socio-economic data.

Administrative setup

Freshwater fisheries in Namibia is under the Ministry of Fisheries and Marine Resources (MFMR). The Ministry has a research institution, the Freshwater Fish Institute, located at Hardap. The Institute has in recent years put priority on research in the river ecosystems in the north. Given the necessary funds, the Institute may recruit qualified people locally to increase their activities. No institutions are currently involved in the socio-economic development of the sector. Other ministries of relevance to inland fisheries and freshwater ecosystems are the Ministry of Agriculture, Water Affairs and Rural Development, and the Ministry of Wildlife, Conservation and Tourism. In the further development of policies and legislation on freshwater fisheries, it is important to consider the effects of the policies and legislation of these Ministries on the fisheries.

Terms of Reference

The ToR for the draft of a White Paper on freshwater fisheries and management include the following tasks:

- 1) An overview and assessment of socio-economic and biological aspects of the freshwater fisheries sector.
- 2) An assessment of strategies for the protection and management of freshwater fish resources and their environment.
- 3) An assessment of the perspectives for the development of freshwater fisheries.
- 4) An assessment of the type of legal framework needed for the management of the sector.

Given the nature and magnitude of the work to be carried out, a minimum period of 8 months will be needed. The studies suggested will involve a total number of 5-7 researchers, with 3 researchers forming a core group. This should include one socio-economist, one biologist and one legal expert. The final decision both as regards the ToR itself and the persons to be involved rests with the Ministry of Fisheries and Marine Resources.

Key figures on economy and society

Location	17.5°-29° S; 12°-24.5° E
Area	824,000 km ²
Population	1.4 million
Population density	1.69 persons per km ²
Gross National Product per capita (USD)	1,030
Annual population growth rate	3.1 %
Life expectancy at birth	57.5 years
Urban population	28%
Adult literacy rate	73 %
Infant mortality rate	102 per 1000 born

Key figures on the environment

Temperatures	
North Annual mean	22°C
Min-Max	2-42°C
Southern coast, max	21°C
Annual rainfall	
Maximum (Northeast)	600-700 mm
Minimum (South, West)	2 mm
Rainfall variability	
Northeast	25 %
South	80 %
Annual rate of evaporation in mm and in % of rainfall	
Northeast	2600 mm, 420 %
South	3700 mm, 1750 %
Vegetation biomes	
Desert	16%
Savanna	64 %
Dry woodland	20 %
National park area	13 %
Main rivers, annual discharge (mill. m ³)	
Kunene	5,500
Okavango	10,000
Kwando	1,200
Zambezi	40,000
Orange	11,900

1.0 Introduction

The following pre-feasibility study on freshwater fisheries and fish resources has been done at the request of the Namibian Ministry of Fisheries and Marine Resources (MFMR; Annex 1) and the Norwegian Agency for Development Cooperation (NORAD). During our work in Namibia a certain discrepancy appeared between the tasks described for the study in the Terms of Reference drafted by NORAD (Annex 2) and the expectations of the MFMR.

1.1 Interpretation of Terms of Reference

The aims of the Namibian authorities have been to develop as quickly as possible a draft White Paper which will define the future policies concerning the management and development of the freshwater fisheries and fish resources in the country. The outline of the White Paper on marine fisheries (entitled *Towards Responsible Development of the Fisheries Sector* and published in December 1991) is to be used as the basis also for the inland fisheries White Paper. The latter will subsequently form the basis for the development of a legal framework concerning freshwater fish resources. It has been anticipated by the MFMR that the present study would present a preliminary draft for a white paper.

Given the time available for the first stay in Namibia, and based on the discussions with the MFMR and NORAD/Windhoek, the following tasks were specified for this study.

- To provide a review of the socio-economic and biological status, as well as management and legislation, pertaining to freshwater fish resources and utilization.
- To identify information gaps which have to be filled before a proper draft White Paper on freshwater fish management can be completed.
- To draft TOR for the further work necessary to complete a draft White Paper on freshwater fishery development and fish management.
- To supply an extensive bibliography of existing socio-economic and biological information pertaining to the sector.

The final White Paper is to include the following topics:

- 1) An overview and assessment of socio-economic and biological aspects of the freshwater fisheries sector.
- 2) An assessment of strategies for the protection and management of freshwater fish resources and their environment.
- 3) An assessment of the perspectives for the development of freshwater fisheries.

- 4) An assessment of the type of legal framework needed for the management of the sector.

This means that a discussion of two main areas that are to be covered by the White Paper have been left out of this pre-feasibility study, namely the perspectives for the development of the sector and an assessment of the type of legal framework needed for the management of the sector. Both topics require more information and more in depth discussions with Namibian authorities. Relevant issues for both will be indicated in the proposed Terms of Reference for the Government White Paper (Chapter 5).

The work that has been carried out has been based on discussions with representatives of relevant Ministries and reading of relevant literature. Due to the lack of Namibia-specific information on a number of relevant issues, space has also been given to relevant comparative information from other similar freshwater environments. Finally the design of the report has been influenced by our shared conviction of the necessity to combine socio-economic and biological approaches. Freshwater fishery development cannot be adequately planned and implemented without taking the ecological context into consideration. And a proper management of freshwater resources cannot be carried out without due attention being paid to the people utilizing and depending on the resources. We will maintain that conservation should be synonymous with sustainable utilization.

1.2 Itinerary

The study was carried out in the period 21 September to 26 September 1992. One of the consultants (Mr. Terje Sandlund) stayed behind to attend a workshop on freshwater fisheries organized by the MFMR. An official summary of the workshop is given in Appendix 3. Discussions were held with the following persons:

Ministry of Fisheries and Marine Resources:

C.H.G. Schlettwein; B.W. Oelofson; B.J. van Zyl; C.J. Hay

Ministry of Agriculture, Water Resources and Rural Development:

J.S. de Wet; D. Lucks; R. Matzopoulos; H.P. Nghipandulwa; A. Ngulu.

Ministry of Wildlife, Conservation and Tourism:

H.J.W. Grobler.

Namibian Institute for Social and Economic Research (NISER):

B. Frayne

Namibian Economic Policy Research Unit (NEPRU):

R. Moorsom

Norwegian Agency for Development Cooperation (NORAD):

A. R. Øyen; O. Ekeli

2.0 Overview of the freshwater fisheries sector

2.1 Socio-economic characteristics of freshwater fisheries

In Africa in general, inland fisheries represent a considerable resource. More than 450,000 km² of the African surface area is covered by water. The total potential yield is estimated to be 3,2 million metric tons (mt), and actual production 1,6 million mt. Reservoirs and natural lakes provide the most productive fisheries, whereas rivers and floodplains are believed to account for about 350,000 mt though in reality their contribution is probably much higher. In comparison, the total potential yield for marine fisheries are estimated to be 6,8 million mt and actual catches 5,8 million mt. Practically all the inland production is caught by national fishermen in the artisanal sector, whereas domestic production make up 48 per cent of the marine catches with foreign fleets catching the remainder. 42 per cent of the domestic marine production comes from the artisanal sector. The fisheries sector is thought to contribute around 35% of the total animal protein intake in Africa.

With the exception of the semi-industrial fisheries in Lake Tanganyika and Kariba, most inland fisheries are small-scale and labour intensive. A total number of nearly 1,9 million full-time and part-time fishermen are believed to be active in the artisanal fisheries sector in general. Inland fisheries employ about 420,000 full-time fishermen and nearly the same number on a part-time basis. Moreover, for each inland fisherman 5 persons are believed to be active in support functions tied to processing and preservation, transport, marketing and production and maintenance of boats and gear. The equivalent figure for marine fisheries is 3 persons for each fisherman. This gives a total number of 8 million people employed in the secondary sector, and a total employment in African fisheries of nearly 10 million people or 9% of the total labour force in agriculture (see Tvedten and Hersoug 1992, FAO 1991, Bonzon & Horemans 1988).

The importance of inland fisheries varies considerable between different regions in Africa, with Southern Africa being the region where it is most important. SADCC-countries currently account for about 60 per cent of the total inland catches in Africa, though the rate of exploitation is estimated at only 57 per cent. As seen from Table 1, Tanzania, Malawi and Zambia stand out as the countries with the most significant inland fisheries both in terms of production and employment. Botswana finds itself on the other end of the scale, but also here the

Table 1
Key data on Inland Fisheries in Southern Africa¹⁾

	Marine potential (tons)	Inland potential (tons)	Domestic marine production (tons)	Domestic inland production (tons)	Marine employment	Inland employment	Part time employment	Per capita fish supply (kg/year)	Inland waters (km ²)
Angola	655,000	115,000	70,258	8,000	17,000	7,000	50,000	18.0	2,000
Botswana	-	15,000	-	1,900	-	200	500	3.0	20,000
Lesotho	-	290	-	16	-	200	n.a.	3.0	-
Malawi	-	120,000	-	72,852	-	21,000	10,000	10.2	24,405
Mozambique	175,000	34,500	34,595	767	10,000	10,000	25,000	3.0	18,000
South Africa	600,000	33,000	1,251,266	n.a.	n.a.	n.a.	n.a.	8.8	n.a.
Swaziland	-	700	-	44	-	100	100	0.1	-
Tanzania	70,000	370,000	47,775	342,700	18,000	48,000	66,000	13.0	52,000
Zambia	-	200,000	-	68,199	-	24,000	50,000	11.0	53,680
Zimbabwe	-	35,000	-	17,500	-	7,200	3,440	2.1	4,000
Namibia	1,500,000	12,500 ²⁾	350,668	6,250 ²⁾	4,000	n.a.	n.a.	9.0 ²⁾	7,000 ³⁾

Source: Bonzon and Horemans 1988/Ministry of Fish and Marine Resources 1991, United Nations Institute for Namibia 1986.

- 1) All data should be regarded as indications, and not absolute quantities. The reference years applied are 1984-1988.
- 2) The estimates are taken from United Nations Institute for Namibia 1986, (Chapter 5) and are non-qualified estimates.
- 3) The figure refers to the situation at the end of the rainy season. Preliminary estimates indicate that the area may be reduced to approximately 2,000 km² in the dry season.

inland fisheries are very important for the regions concerned. As we shall see, Botswana is the country with which Namibia can most fruitfully be compared (see Bonzon & Horemans 1988 and FAO 1988).

Despite the importance of freshwater fisheries, however, the attention given to the sector from governments and international aid institutions have been limited. The major reason seems to be the limited economic importance in comparison with marine fisheries. In Southern Africa, the discrepancy between inland and marine production is particularly large in South Africa, Angola and Namibia (see Table 1). In addition, fresh water fisheries development is considered difficult because of the close integration with other economic sectors and, more recently, its close integration with environmental protection which requires a multi-disciplinary approach. In fact, a large part of the development efforts have been carried out within the general framework of rural development. Of fisheries projects per se, the total support to inland fishery projects within SADCC in 1987 was \$ 2,3 million with an additional \$ 1,8 million being used for aquaculture, whereas marine fishery projects were supported with \$ 13,9 million (FAO 1988: Annex 2).

Inland fisheries are thus considered important mainly as a source of subsistence consumption and employment. It is, as noted, typically labour intensive with small catches per unit effort, and employ both men, women and children. The former tend to be employed in the more productive fisheries in rivers, lakes and dams, whereas the latter tend to be employed in less productive flood plains and other non-perennial waters. However, women are generally more involved in inland fisheries than in marine fisheries. Women also normally dominate in the processing and trade of fish, although again the picture is ambiguous. Men tend to get more involved in all aspects of the sector (i.e. production, processing and distribution) with increased commercialization (see Scudder & Conelly 1985 and Jul Larsen 1981).

Freshwater fisheries is also typically pursued part-time and as one of several sources of subsistence and income. The number of full-time fishermen is particularly low in non-perennial rivers and floodplains, at least partly because of the seasonal nature of fish accessibility. Fishery is normally combined with arable agriculture and pastoral production, but may also be combined with the production of artifacts, petty trade or other forms of small-scale production. The risk reduction implied by such a multiple strategy is important not least for poorer households, and will also have positive implications for the management and conservation of fish resources.

The importance of inland fisheries as a source of animal protein is evident from a number of countries in Southern Africa (see Table 2). Besides the fact that such a large part of the fish caught is used for direct consumption, the involvement of women (who often bear the main responsibility for child upbringing), and the

relatively low price of fish compared to meat, contribute to its importance particularly among poorer household groups.

Table 2
Contribution of fish in total animal protein supply
in Southern Africa (1982-84, in per cent)

Angola	24.6
Botswana	3.6
Lesotho	7.7
Malawi	45.0
Mozambique	32.5
South Africa	n.a.
Swaziland	0.0
Tanzania	30.5
Zambia	29.1
Zimbabwe	6.7
Namibia	n.a.

Source: FAO 1988.

Many traditional freshwater fisheries have experienced a transition towards an increasingly commercial fishery, often in response to population pressures and growing demands for cheap animal protein from the rural areas as well as urban centers. This has often led to immigration and encroachment by outsiders. The development has tended to go through four distinct stages, from a primarily subsistence fishery, via an incipient commercialization and to a primarily commercial fishery. Without appropriate management, the last stage may lead to a situation of overexploitation and "subsequent decline in productivity, very low returns to all factors of production and - too frequently - physical depletion and even extinction of the resource itself" (Crutchfield 1982:9). Important social consequences have been a widening socio-economic gap between a majority of relatively small-scale fishermen and a minority of successful entrepreneurial fishermen, and the partial or full exclusion of women from the sector (see Scudder & Conelly 1985).

Namibia currently seems to find itself in between the first and second stage. However, even though the Namibian freshwater systems currently may seem underutilized in terms of total catches, there are also indications of specific fisheries approaching a level of maximum yields. All this makes it extremely important to see the socio-economic aspects of freshwater fisheries in close integration with the biological and ecological aspects of freshwater ecosystems.

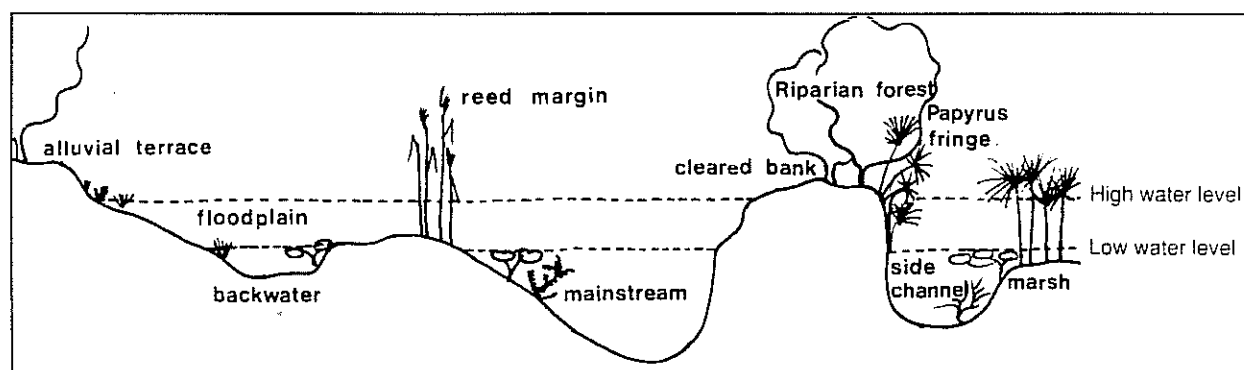
2.2 Biological characteristics of freshwater ecosystems

Tropical freshwater systems of relevance for fish production includes rivers and standing waters of various types, e.g. lakes, ponds and swamps. Although important fisheries of both subsistence and commercial types occur in most lakes in Africa (Lowe-McConnell 1987), it has been estimated that more than 50% of the annual catch of freshwater fish on the continent comes from rivers (Welcomme 1979).

Most tropical large rivers to some extent form a floodplain, where the water-covered area varies tremendously between the dry and rainy seasons. The floodplains form very complicated ecosystems, where terrestrial and aquatic elements are closely interlinked. The fish communities are usually diverse, and their dynamics in terms of annual activity patterns, habitat use and production rates are not well known (Welcomme 1979). Floodplains are also highly fertile areas with easy access to water for irrigation. Due to this, man's activities in the catchment area may easily come into conflict with the aquatic ecosystem and fish production.

The aquatic habitats of floodplain ecosystems vary through the annual rainfall pattern (Fig. 2). During high water levels, the habitats included are e.g. river channels, ponds, oxbow lakes, swamps and inundated forest, bush or grassland. During low water levels, only the river channels and some oxbow lakes and swamps may still be available for fish. As a result of this variability, traditional floodplain fisheries are highly variable, both in the number of methods used, in the seasonal efforts by the fishermen, and in the size of the catches. It should also be realized that no development of floodplain fisheries can erase the seasonality and variability of the ecosystem. The variability of the floodplain ecosystem causes estimates of possible fish yield to be even more uncertain than in lakes. Consequently, monitoring programmes for the complex floodplain fisheries should be carefully planned.

Figure 2
Schematic profile of the habitats of a floodplain river



To some extent, aquaculture may be used to provide fish in periods of low catches from the natural stocks. Aquaculture, however, depends on available water, available areas for pond construction, and available fry or fingerlings for stocking. Small-scale extensive aquaculture is locally of some importance in parts of Africa. The aquaculture production depends on a supply of fry and fingerlings, which usually must be purchased at some centralized hatchery. Thus, for the individual farmer, the feasibility of an aquaculture enterprise to a large extent depends on the price of fry and fingerlings. Any development of aquaculture should therefore be based on a realistic cost-benefit analysis.

2.3 Freshwater fisheries in Namibia

The surface freshwater resources of Namibia are restricted to four perennial river systems, some seasonal surface water bodies and a number of state dams. In addition there are a few very small natural water bodies (sinkholes and natural springs) inhabited by fish. Although of no importance for a fishery, some of these contain endemic species of high conservation value (Irish 1988). The protection of these ecosystems should be secured through legislation for freshwater fisheries.

Production and yield of natural systems

There are no reliable figures for fish production for any of the Namibian rivers. Attempts have been made to estimate maximum sustainable yield (MSY) for eastern Caprivi (the Zambezi-Kwando system) and the Okavango River in Namibia (Van der Waal 1990, 1991b). The figure of 1500 mt for Caprivi includes some 6-700 mt from Lake Liambezi. As this lake has been dry since 1985, the MSY of this wetland system should now be approximately 8-900 mt. For the Okavango River, MSY estimates performed by different methods varies between 840 and 3000 mt (B. Van Zyl, personal communication). It is not possible at present to judge which figure is most reliable, but it may be prudent to base management and development plans on the lower figure.

There are serious doubts concerning the use of the MSY concept (Roedel 1975). It has been said that the actual MSY can only be established when the stock has been seriously over-exploited (Hillborn & Walters 1992). When it comes to applying MSY to complex floodplain systems, the available data on these complex fish communities are not at all sufficient to allow a proper application of MSY models. MSY estimates should be based on reliable production data for the individual species. To estimate total MSY of a fish community including more than 80 species, specific data on at least the dominant species should be available. Second, the MSY concept does not pay the necessary attention to interactions between species in the form of predation or competition. Due to such interactions, selective exploitation of some species will influence the production of other species (Hillborn & Walters 1992). The high MSY figure for Okavango was based

on so-called morphoedaphic index calculations (MEI). Somewhat simplified, MEI calculations apply environmental factors such as mean depth and water quality to calculate possible total fish production in inland lakes. However, MEI has been developed mainly for lakes, and may at best give a very vague indication on the level of production in a floodplain area (Lowe-McConnell 1987). For floodplain rivers, a general relation has been calculated between catchment area and yield (Welcomme 1979), but the figures obtained are still only very rough estimates.

A wise management of the fish stocks in the rivers and swamps should therefore mainly be based on monitoring data, where parameters such as community and stock structure, catch per unit effort, and yield, are recorded. A proper monitoring program may allow corrections in harmful exploitation patterns before serious harm has been inflicted on the stocks. Admittedly, this may be difficult to apply along the Namibian rivers, due to lack of economic and personnel resources. The point is, however, that MSY estimates should be treated with utmost care, while monitoring programs should be given highest priority.

The MSY estimates for the dams are probably more reliable, as these water bodies contain much simpler fish communities which can be reliably sampled. According to these estimates, the four dams where figures are available may yield a total of approximately 314 mt of fish annually. Fish production in these localities will also, however, depend heavily on annual rainfall to keep them filled.

Natural freshwater fish stocks may be exploited through a subsistence or commercial fishery or through a recreational fishery (usually angling). In this report, subsistence and commercial fisheries are given the main attention. A few words may, however, be necessary to indicate the difference between types of exploitation. In subsistence or commercial fisheries, the value of the catch as food or as a product to be sold is of overriding importance. The economic value of recreational fisheries rests not on the value of the catch itself, but on various aspects of the experience of fishing. A combination of a commercial and recreational fishery may usually work out fine, as the angling species may be different from those which constitutes the bulk of commercial catches. However, in freshwater fisheries, preferred angling species may also fetch the highest price on the commercial market. Examples in the Okavango and Caprivi area may be tigerfish and large tilapias. Thus, some form of compromise between commercial and recreational fishery must be reached. An important point is to involve local traditional institutions in the management of all types of fisheries, so that the local communities take an active part in decisions and benefits.

Information on angling competitions in Caprivi seems to indicate that catches may be unreasonably large, and that some regulations are needed on the fishing performed by tourists, e.g. in the form of bag limits (Grobler 1992).

Socio-economic conditions

The available information on socio-economic aspects of freshwater fisheries in Namibia is scanty. No study has been carried out specifically about inland fisheries. What is available is either information included in articles on biological/ecological conditions, or references in socio-economic studies of a more general nature. The former do contain relevant information, but of a too quantitative and sketchy nature to yield a sufficiently in-depth picture. The latter tend to leave out information on fisheries to the extent that the sector's importance seems to be clearly under-reported. In addition, no relevant and recent socio-economic studies have been carried out in the Caprivi region where fisheries seems to be most important for subsistence and income. Having said this, there is enough information to at least indicate that most of the general conditions related to inland fisheries discussed in the previous chapter are relevant also in the case of Namibia.

All the main water bodies in Namibia are located in the northern parts of the country, i.e. in the districts of Kaokoland, Ovambo, Kavango and Caprivi (see Fig. 1b). The region is inhabited by approximately 850,000 people, of whom 25,000 live in Kaokoland, 520,000 in Ovambo, 165,000 in Kavango and around 92,000 in the Caprivi. The majority of the people live next to or near perennial water bodies or seasonally flooded plains. Data are available only for Kavango, where 80 per cent of the population is settled in a narrow 5-10 km strip along the south bank of the Kavango river, but the percentage is likely to be at least as high in the Caprivi. Also in Ovambo the major population centres are within the confines of the Cuvelai system. There is one major population centre in each of the regions (i.e. Opuwo in Kaokoland with approximately 5000 inhabitants, Oshakati and Ondangwa in Ovambo with a combined population of 120,000, Rundu in Kavango with around 16,000 inhabitants and Katima Mulilo in Caprivi with around 20,000 inhabitants). With the exception of Opuwo, each of these are located close to perennial or seasonal water bodies. However, they still represent important potential markets for fish (see Fosse 1992, Töttemeyer 1992, Tapscott 1990a).

The socio-political context within which most fishermen find themselves is characterized by the continued importance of traditional kinship relations and the extended family, and continued importance of tribal authorities such as chiefs and village headmen. There are also village councils, which is the highest legislative, administrative and judicial body in the traditional system. Traditional authorities seem to have maintained the strongest position in the Caprivi, and the weakest position in Ovambo (see Tapscott 1990 and Fosse 1992). In all areas, government institutions have well-established parallel institutions. A closer assessment of the possible role of the respective institutions for fishery management and development will be important.

The main source of subsistence and income in the regions in question is arable agriculture and pastoral production, but fishing is practised on a small scale basis by a large number of people. Petty trade and formal employment are other sources of subsistence and income. The formal employment opportunities have decreased considerably with the deployment of the South African Defence Forces in Ovambo, Kavango and Caprivi.

The majority of the people fishing seem to be women and children, although men seem to be increasingly active particularly in the larger rivers using gill nets and other modern equipment. With the current disintegration of the extended family obligations and the likely increase in the number of female headed households, the role of women in fisheries should be taken into particular consideration (see Tapscott 1990a and Fosse 1992).

There is no reliable information neither on the total number of fishermen nor on the relative numbers of full-time, part-time and occasional fishermen. Van der Waal (1991a) indicates that as many as 32 per cent (or 35,000) of the population fish during 7 months a year or more in the Kavango alone, but it is uncertain both how he has arrived at this number and how he defines a fisherman. Studies from Okavango in Botswana, which in many ways are comparable to the Caprivi freshwater fishery areas, indicate that the total number of active fishermen in the Okavango is 1000, with another 2000 occasional subsistence fishermen. In addition comes a similar number of women who fish during receding floods, and children fishing for fun and food. This gives an estimated total fishing population of 6000. The population of the Ngamiland District is around 80,000, with 80 per cent living in or around the Okavango River and Delta (see Tvedten 1985 and Skjøsberg & Merafe 1987). A qualified estimate of the number of people fishing in Namibia is important both from a socio-economic and ecological point of view, and should be given priority.

There is no evident distinction between the different ethno-linguistic groups as regards involvement in the fishery sector, with the exception of the Hereros/Himbas in Kaokoland who do not fish and the Basubya and the Bayei of Caprivi who have long traditions as fishermen.

The gear used is a mixture of traditional (fish funnels, fish traps, fish fences, scoop baskets, bow and arrow, spears etc.) and modern (hook and line, gill nets, seine nets etc.) equipment (see Von Brandt 1984 for information on various types of gear). Reports on the status of the fish stocks indicate that overfishing is still not eminent, but no information exists on the fishermen's *own perception* of the resource situation which has an important bearing on their strategies.

Thus the majority of the people practising fishing in inland water bodies in Namibia do so on a small scale and mainly for own consumption, and hence with limited surpluses for processing and exchange. With the current population

increase and the drought situation with decreased agricultural and pastoral production, however, fish is increasingly important as an alternative source of protein. The current high price level on fish and fish products also indicate an increasing demand. In a recent survey as many as 63 per cent per cent of the sample indicated that they have bought fish, and 93 per cent per cent indicated that they would buy fish if the prices were acceptable (van Zyl in press). In conclusion, the importance of inland fisheries, and in consequence the pressure on inland fish resources, is certain to increase.

2.4 Socio-economic and biological aspects of main water bodies

This chapter provides a brief description of the water bodies within Namibia of relevance to freshwater fisheries and freshwater resources. The four large perennial rivers are the Kunene, Okavango, and Zambezi in the north, and the Orange River in the south. In addition, we will briefly discuss state dams, private dams and aquaculture.

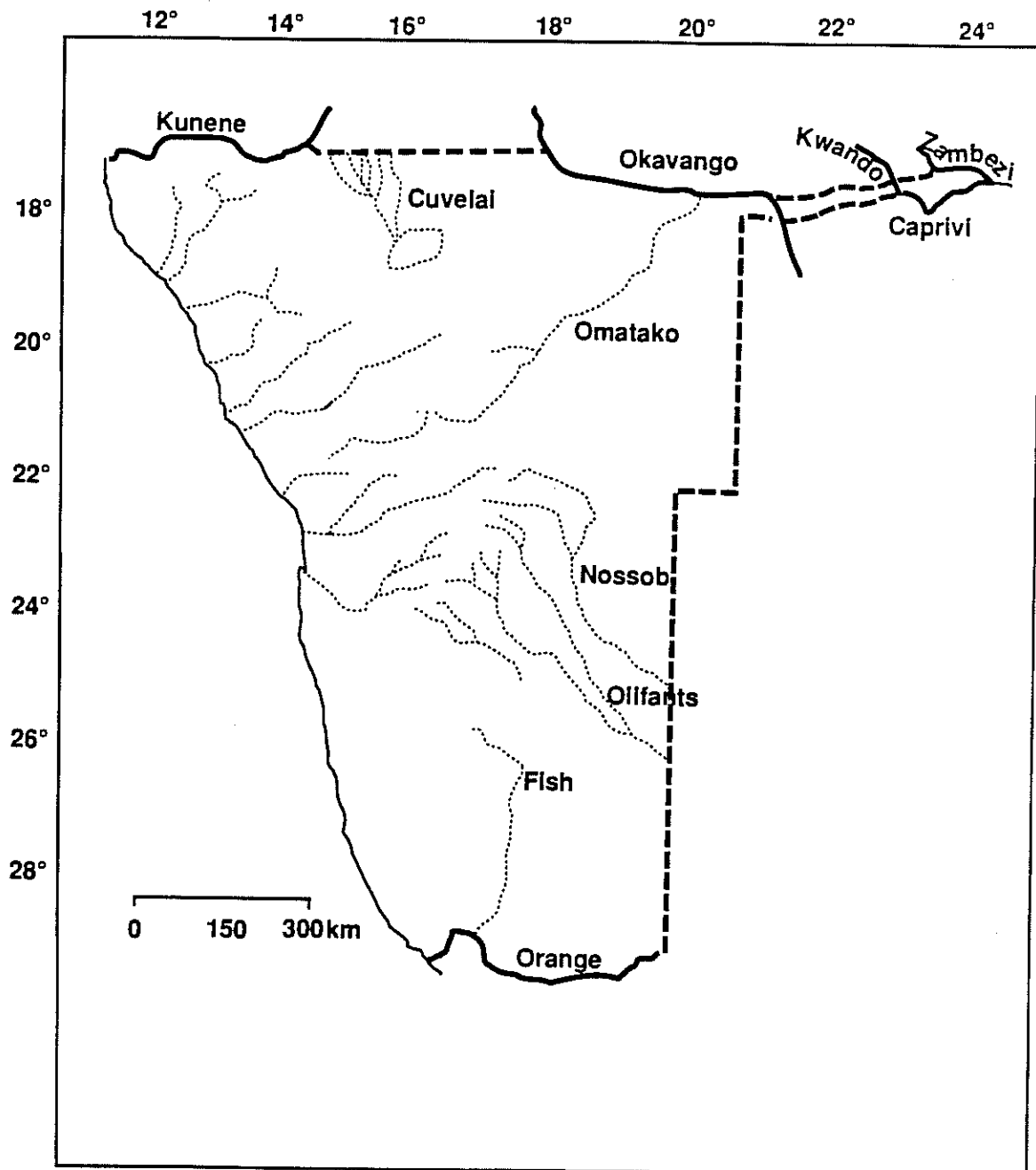
Kunene River

The Kunene River originates in the Bié plateau close to Huambo at about 1750 m a.s.l. in Angola (Fig. 3). The upper 400 km is relatively steep, whereas the middle section has a lower gradient forming a marshy floodplain (Fig. 4). When meeting the Namibian border at Ruacana, the river forms a 120 m waterfall, and the remaining distance to the sea is steep, with a gradient of 1:447. The fast-flowing river below Ruacana, some 400 km long, forms the border between Namibia and Angola. At Ruacana there is a hydropower facility, and there are plans to further develop the river for hydropower production, with a major dam at Epupa falls (see Tapscott et al. 1992). In the Angolan part of Kunene there are also hydropower dams. The annual discharge at Ruacana is 5500 million m³, and as the river receives no major tributary on its way to the Atlantic Ocean, the discharge at the mouth is the same. The floods occur from December to June, with a maximum in February/March.

The Freshwater Fish Institute has recently performed preliminary investigations on the fish fauna of the Namibian part of Kunene (Hay et al. in press). They identified some 69 freshwater fish species in the river. However, more research on the fish resources of this river is clearly needed. The plans for hydropower development makes this even more urgent, as proper baseline data greatly improves the value of the environmental impact assessment that is to be carried out.

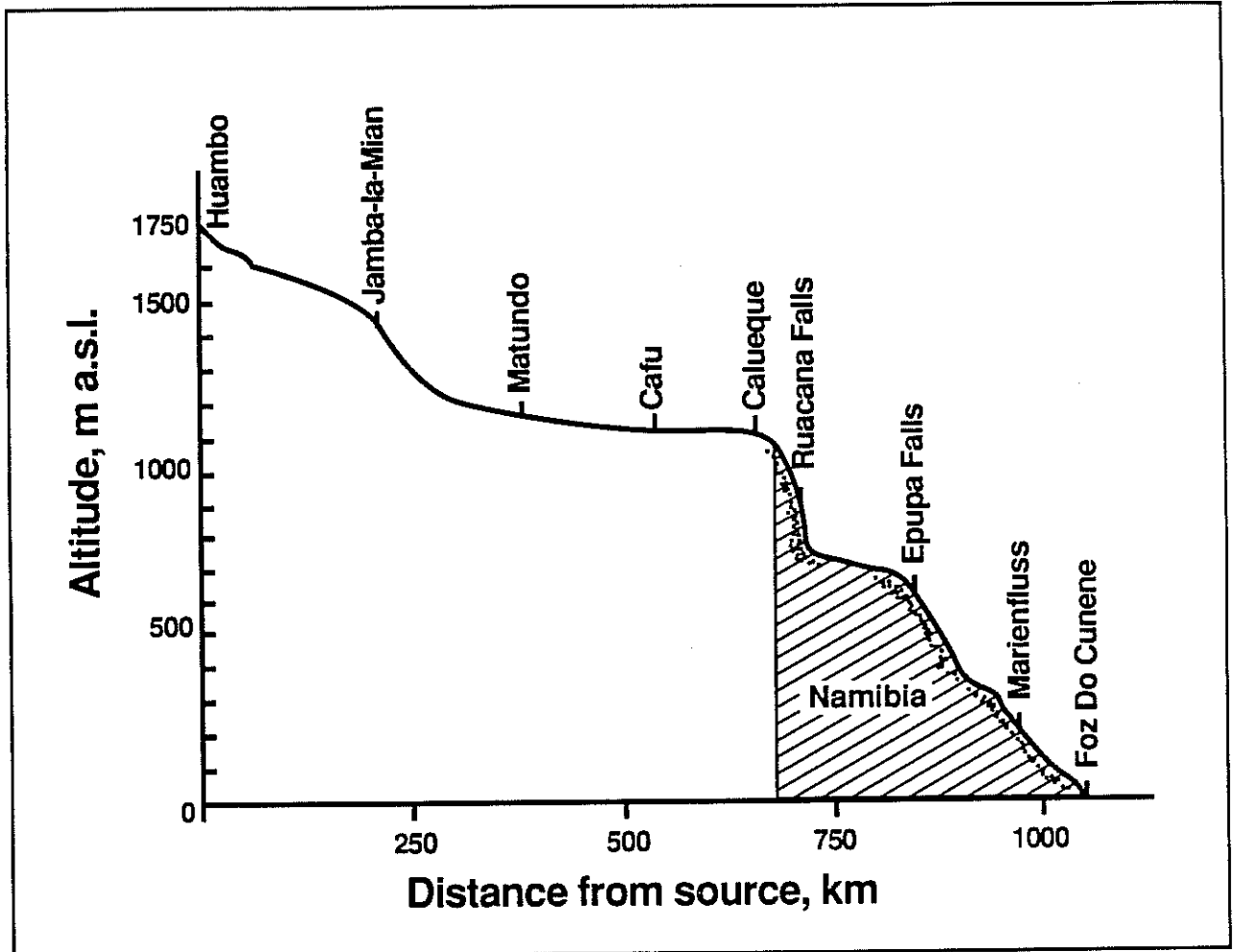
Due to the low population density and the fact that the Herero/Himbos inhabiting the area along the lower part of Kunene do not utilize fish for food, the fish stock is presently not exploited to any significant degree. Hydropower development in

Figure 3
Main river systems of Namibia*



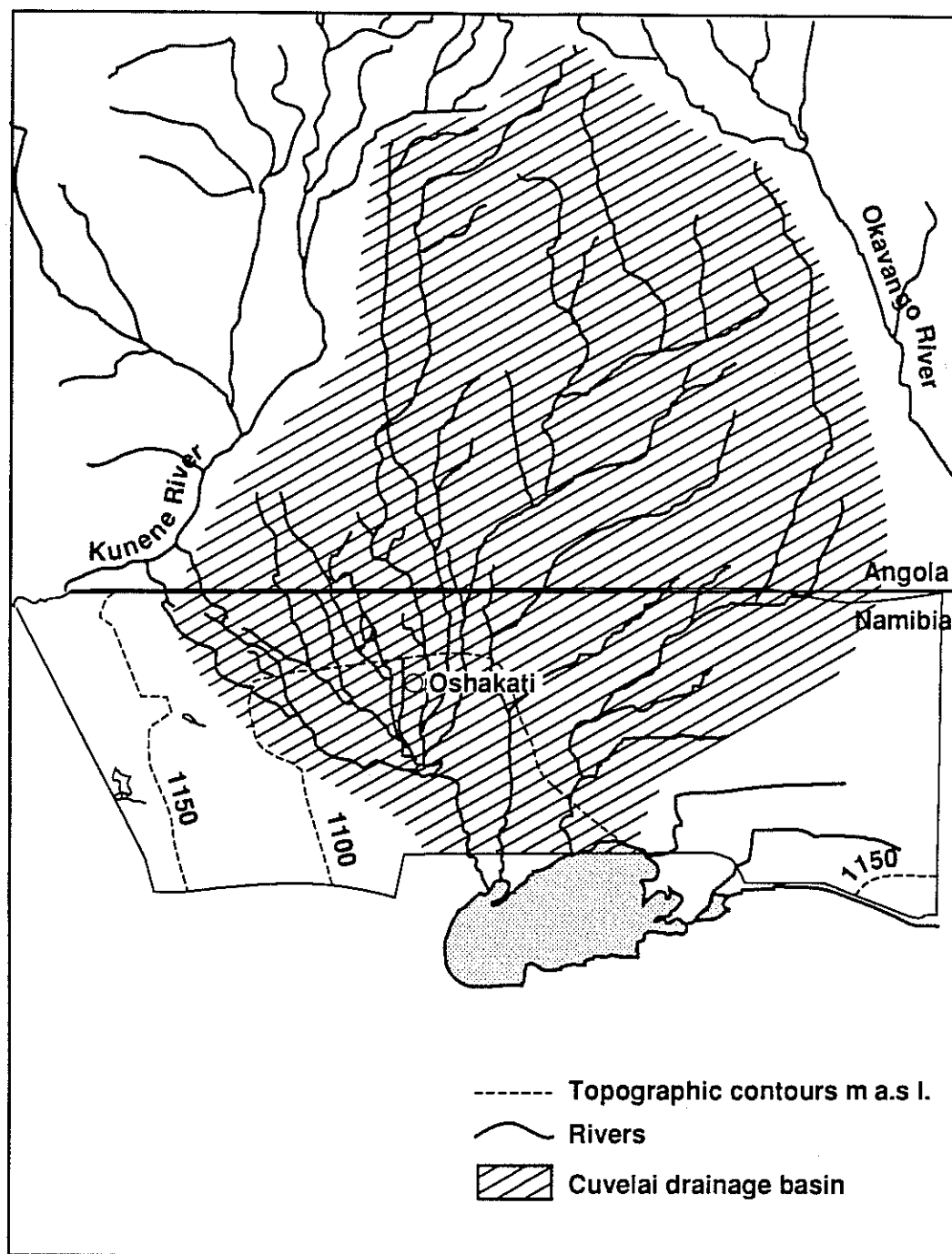
* The rivers indicated by dotted lines are seasonal.

Figure 4
Vertical profile of the Kunene River



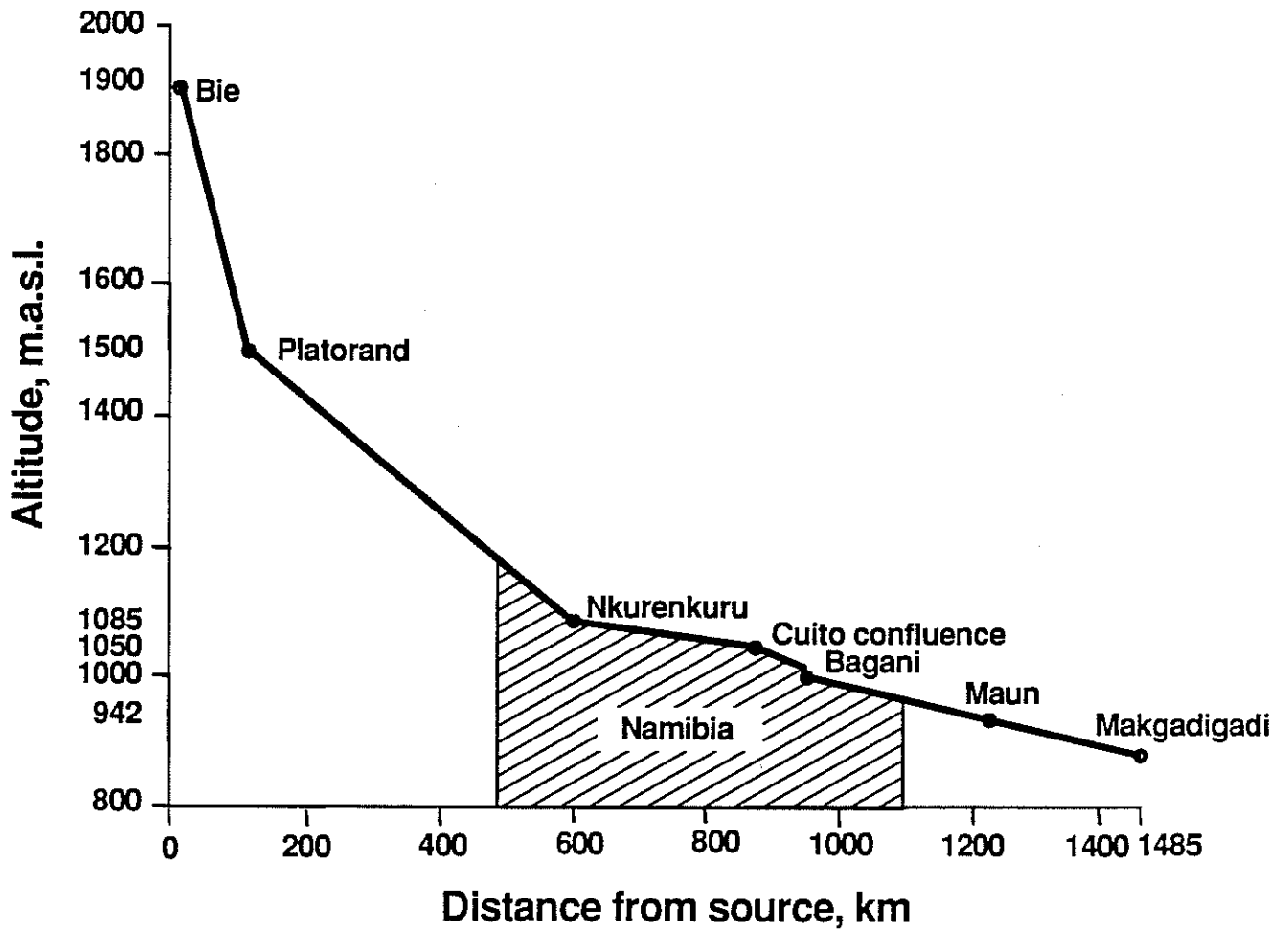
Source: Redrawn from Van Zyl 1991.

Figure 5
The Cuvelai System*



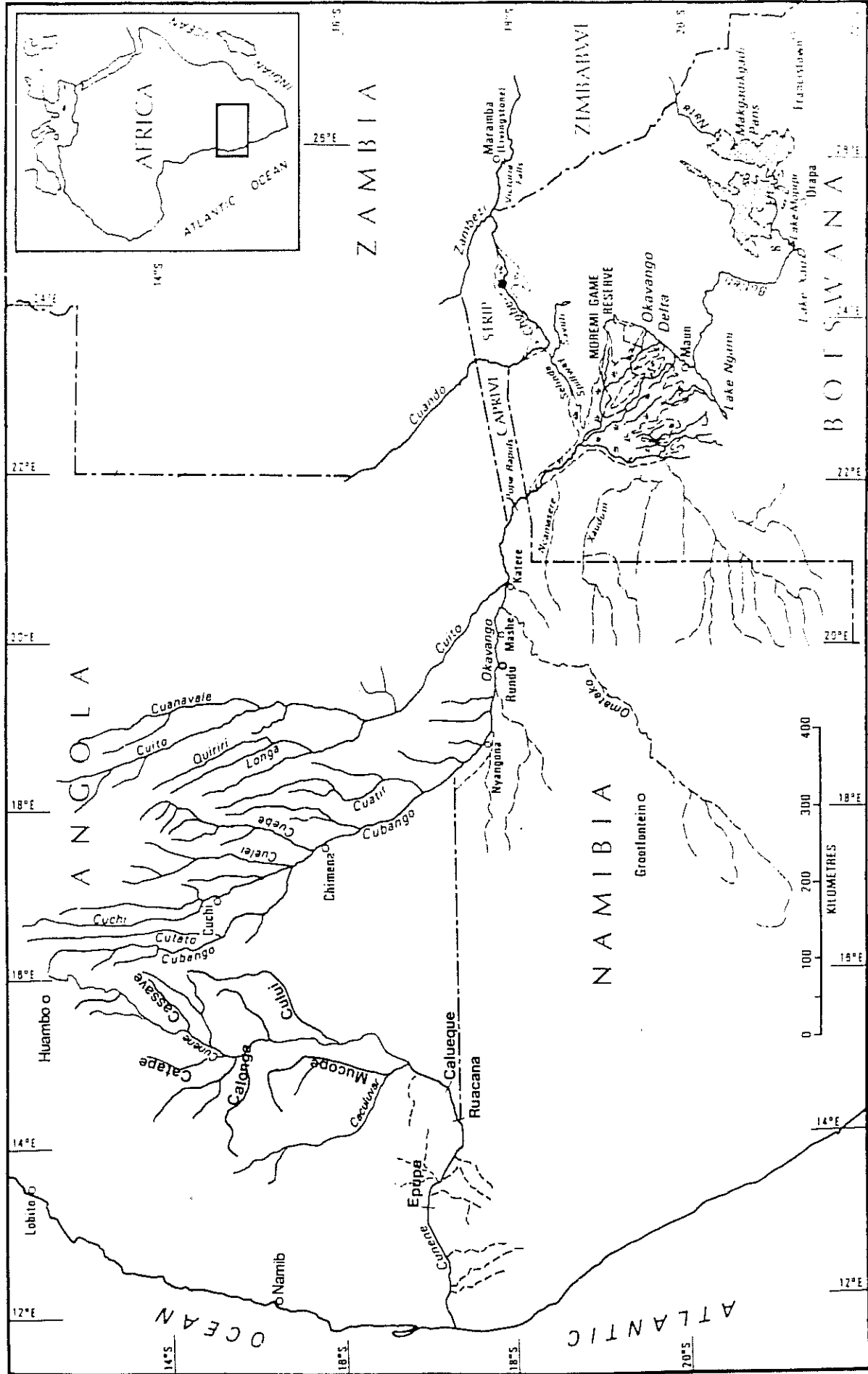
* The shaded area is the Etosha Pan.

Figure 6
Vertical profile of the Okavango River



Source: Redrawn from Smit 1991.

Figure 7
 The Kunene, Okavango and Zambezi/Kwando river systems
 in Angola, Namibia and Botswana



the lower part of the river will, however, most probably change this situation. On the one hand immigration by outsiders both during the construction phase and after may be expected. And on the other, some of the Herero/Himbos may in a longer term perspective turn to fishing if the current developments towards changes in their traditional way of life continues (Tapscott 1990b and Tapscott et al. 1992).

The Cuvelai system

The Cuvelai system (Fig. 5) on Namibian territory in Ovambo is a seasonal wetland system (oshana swamps) created by the floods (*efundjas*) in the Cuvelai River system in Angola, which occur in December to June, with a maximum in February/March (Marsh & Seely 1992). In years of high floods, water may even overflow to the Etosha pan. Originally Cuvelai was separated from the Kunene River, but at present Ovambo also receives water through an artificial canal from the Kunene River. While only 17 species of fish were originally recorded in the Cuvelai River, translocation of species from Kunene via the canal has resulted in a total of 46 fish species having been recorded in the oshana swamps. Thus, with regards to biodiversity conservation, Kunene and Cuvelai today form one system.

The amount of fish which can be caught annually depends on the flood size. Generally, all fish which enters the oshana swamps with the floods will die during the dry season and should therefore be harvested without any danger of over-exploitation. The annual output of fish from the oshana swamps in the Cuvelai system is not known, but will certainly depend on the size of the flood. Over a 35 year recorded period, major *efundjas* occurred only every eleven years, whereas medium to large *efundjas* occurred every four years.

Fish is caught by a variety of methods like seine nets, thrust baskets and hook and line. Catches may be high during large *efundjas*, and single fishermen may catch up to 150 kg per day. For part of the oshana area, output over a 60 day *efundja* period has been estimated at 250 tons. The major fish species are catfishes (*Clarias* spp.), barbs (*Barbus* spp.) and the cichlid (tilapia) *Oreochromis andersonii*.

Despite the irregular nature of floods, fish is a popular and important source of food in Ovambo. Dried fish is commonly sold at markets in Oshakati and Ondongwa. Some of this fish comes from Angola and Caprivi. Both men and women are involved in fishing, and some methods (like the thrust baskets) involve communal drives which implies some form of organizational structures tied to the adaptation. There is no reliable data on the number of people involved. On the one hand one would expect the type of seasonal fishing in question to be carried out on a small scale basis by a large number of people. On the other hand, however, the relatively large potential catches in easily accessible ponds and other water

bodies would imply competition and possibly also systems of control over the resources (Van der Waal 1991a, Marsh & Seely 1992).

Okavango River

The Okavango River originates at around 1700 m a.s.l. in the Bié plateau in Angola, its catchment area bordering on the upper catchment area of the Kunene River (Fig. 3). The upper part of the river within Angola is fairly steep (Fig. 6). When meeting the Namibian border at Nkurenkuru, however, the gradient decreases and the 415 km long Namibian part of Okavango forms a fairly wide floodplain (2-6 km) before entering Botswana and the Okavango delta. The wetlands along this part of the river covers an area between 119 km² in the dry season and 434 km² in the rainy season. The main perennial tributary to the Okavango is the Cuito River on the Angolan side, whereas all tributaries on the Namibian side are seasonal rivers. The annual discharge of the Okavango at Rundu is 5000 million m³, increasing to 10000 million m³ at Bagani. The floods occur from December to June, with a maximum in February/March.

There are 82 species of fish in the Okavango River, and the maximum sustainable yield in the Namibian part of the river has been estimated at alternatively 840 and 3000 tons. Some surveys of methods and catches in the fisheries have been performed in 1977 and 1987 (Van der Waal 1991b), demonstrating the use of a wide variety of methods, both traditional and modern.

The river has been monitored since 1989 by the Freshwater Fish Institute (Van Zyl in press), and the plans are to continue this monitoring programme. The data collected indicates that there is at present no overutilization in the river, but the introduction of mosquito nets in fishing causes some concern.

Of the approximately 165,000 inhabitants in the Kavango, around 100,000 live within 5 km of the river. Fishing seems to be an increasingly important alternative source of subsistence and income. A recent survey indicate that everybody in the area eats fish, and that at least 32% of the population along the river fish at least 7 months during a year. 85% indicated that they were willing to buy fish if fish was accessible and prices were reasonable (Van der Waal 1991b). The importance of fisheries is verified by another recent survey, where 99,2 per cent of those questioned said that they eat fish and 92,9 per cent said that they buy fish. As regards accessibility, 95,2 per cent answered yes to the question whether there is enough fish in the river to eat and 63,9 per cent answered no to the question whether there is enough fish available to buy (van Zyl, in press).

There is little information on the organization of production. Nine traditional and four modern types of fishing techniques have been recorded. The most widely used equipment is fish funnels, which are exclusively used by women. Other types

of gear, such as fish traps and gill nets, are exclusively used by men. There are also gear used on a communal basis, such as fish corral traps.

Almost all fishing is done for subsistence, but a growing awareness of the economic value of fish is evident. However, in the survey by Van der Waal (1991b), more than 60 per cent of those questioned were uncertain about fish prices, which indicates an absence of a commercial market.

The Caprivi system

The Caprivi system consists of the Zambezi River forming a large part of the border to Zambia, and the floodplain complex in the eastern Caprivi formed by the Kwando-Linyanti-Chobe tributary (Fig. 3). This complex consists of the Upper Kwando River, the Lower Kwando and Linyanti Swamps, Lake Liambezi, the Chobe River and Marsh, and the Zambezi and Chobe floodplains. The Zambezi River originates in North West Zambia and Eastern Angola (Fig. 7), at an altitude of approximately 1600 m a.s.l. The total area of the Caprivi wetlands was 4680 km² in 1985. The 200 km² shallow Lake Liambazi has been a very important source of fish in the area, yielding an estimated 600 mt annually. However, the low rainfall since 1985 has caused the lake to dry up. It is believed that the hippos are instrumental in maintaining the channels leading water from the rivers to Lake Liambezi. The hippo stock has been greatly reduced during the dry years, and there is some doubt as to whether the stock will ever again become large enough to have any influence on the channels to Lake Liambezi. In addition, there are plans to erect a weir on the Linyanti River at Ngoma, to create a shallow lake with an area of some 100 km² (pers. comm., B.W. Oelofson, MFMR).

The floods in Zambezi occur from December to June, with a peak in April. The discharge of the Kwando River peaks in April-June, but the floods in Zambezi dominate the system so that the waterflow in the Chobe River changes direction annually. During low discharge in Zambezi, the water in the Chobe River runs eastwards. During high floods in Zambezi, however, the water runs westwards in the Chobe River. In times of very high water level, the Kwando/Linyanti system is connected to the Okavango delta via the Selinda spillway (Fig. 3). At present (September 1992), however, the water level in Zambezi is said to be the lowest in 89 years, which means that fishing activity which normally creates no problems may be vastly more efficient and cause over-exploitation of the stocks.

The Caprivi system is the least documented system from a biological point of view. Some investigations have been done in this area some years ago (see Van der Waal 1990), but proper baseline data on the fish stock and the exploitation are still lacking. Thus, there is an urgent need to start a monitoring programme similar to the one for Okavango. What is presented below should therefore be taken as preliminary data.

A total of 81 fish species occur in the region of the Zambezi River system. The maximum sustainable yield is estimated at approximately 1500 tons during a normal flood year, provided that the water level in Lake Liambezi is adequate.

There is some information available on the species composition of catches in the Caprivi area (Van der Waal 1990). In a 1975-76 survey, commercial gillnet catches were dominated by the catfish *Clarias gariepinus* and the cichlids (tilapias) *Oreochromis andersonii* and *O. macrochir*. Tigerfish (*Hydrocynus vittatus*) and African pike (*Hepsetus odoë*), as well as several other cichlids, are also common.

The Caprivi is the area least documented also from a socio-economic point of view. With the large areas covered with perennial or seasonally flooded water (up to 35% of total surface) fish is an important alternative source of subsistence and income. Caprivi is also the area where inland fisheries traditionally has been most important, with the Basubya and the Bayei fishing for own consumption for generations. Today the largest number of fishermen live in the Zambezi, Zambezi Floodplain and Chobe regions. No estimate on the total number of fishing men and women exists, but the percentage is likely to be at least as high as for the Kavango region (see Chapter 2.3)

Van der Waal also reports of a lively trade in fish among the commercial fishermen, involving exports to Zambia and Botswana and sales to Katima Mulilo. Based on data on net profits, he argues that "the occupation of fishermen must be an attractive one" (Van der Waal 1990:13). However, the majority of people still fish with traditional methods and mainly for subsistence.

The traditional fishery in the Caprivi area is performed with a variety of traps, fences and funnels, as well as fishing spears and push baskets. Although modern nylon gill nets have been available for a number of years, 70% of 564 fishermen asked in a survey from 1980 still used traditional fishing gear in addition to gill nets (Van der Waal 1990). A number of species not recorded in gill net catches are caught in the traditional gear, among these mormyrids, mochokids and several cichlids and catfishes. No data are available on the catch per unit effort in traditional fishing gear in Caprivi.

The catch per unit effort in commercial gill nets (stretched mesh sizes 51-152 mm) by Caprivi fishermen was recorded at 2.8-4.2 fish per net and night. In an experimental fleet of gill nets (stretched mesh sizes 25-190 mm), catch per unit effort varied between 7.4 and 249.5 fish per 50 m net and night. Catches in the small mesh sizes (25 and 50 mm) dominated by numbers. The weight of catches per 50 m net and night varied between 2.4 kg in the Linyanti area and 13.8 kg in the Zambezi and floodplains.

Orange River

The Orange River forms the southern border of Namibia towards South Africa (Fig. 3). The river originates in the mountain areas in and around Lesotho, and drains a large part of South Africa. The Orange River system has been heavily regulated in South Africa, so that the annual water discharge pattern has changed from 75% during November-April and 25% during May-October, to 54% and 46%, respectively. The main tributary from Namibian territory is the Fish River. The species diversity in the Orange River is low, as only 14 species have been recorded. This is mainly due to zoogeographical reasons (Hay & Van Zyl 1992).

Possible fish yield and the ecology of the fish in the lower part of the Orange River have not been investigated. The utilization of the fish in the river is low, mainly due to the low population density along the river in this area. There is, however, some concern that increasing water use in the upper part of Orange River (in South Africa) may be detrimental to the Orange River Mouth, which is a RAMSAR wetland area for the protection of waterfowl.

The state dams

Some data on the state dams are given in Table 3. The main purpose of the state dams is to provide water for consumption and irrigation. The dams are all situated on seasonal rivers, and become filled during the rainy season. In normal years, there is still water in the dams at the end of the dry season, but during periods with low rainfall in the rainy season over many years some of the dams may become empty. The fish stocks of the dams are monitored regularly, and maximum sustainable yield has been calculated for some of them, varying between 39 and 86 kg per ha annually. The Department of Water Affairs may in many cases want to introduce new species to dams for weed control and to improve water quality through so-called biomanipulation.

The dams are not subject to any traditional fishery. At the site of most dams, no perennial water body existed prior to the construction of the dam. Consequently, the fish fauna in the dams have been introduced. In principle, the fishery in the dams may be managed through harvesting of self-recruiting stocks, or extensive or intensive aquaculture for a maximum output, under the restrictions given by the main purpose of providing water for consumption. Any combination of recreational fishery, commercial harvest fishery and aquaculture may be considered, depending on the specific conditions of the various dams.

Table 3
Characteristics of some Namibian state dams*

Name	River	Surface area (km ²)	Catchment area (km ²)	Volume (10 ⁶ m ³)	No of fish spp.	MSY (kg/ha)
✓ Hardap	Fish	29.6	13600	300.2	7	42
✓ Swakopport	Swakop	7.8	8400	69.1	5	-
✓ Naute	Löwen	11.6	8660	81.8	4	86
✓ Von Bach	Swakop	4.9	2920	49.9	5	39
✓ Omatako	Omatako	11.1	5320	42.6	2	62
Dreihuk	Hom	2.7	2120	11.8	-	-
Friedenau	Kuiseb	0.8	210	6.7	-	-
Goreangab	Gammams	1.0	131	4.2	-	-
Avis	Avis	0.5	102	2.4	-	-
Daan Viljoen	Black Nossob	0.2	5300	0.3	2	-
Tilda Viljoen	Black Nossob	0.2	5300	1.2	3	-
Bondels	Satco	0.8	-	1.1	-	-
Merensky	Aub	0.1	-	0.1	-	-
✓ Oanob	-	2.7	-	34.5	-	-
✓ Olushandja	Etaka Oshona	-	-	42.3	39	-
✓ Omatjenne	Ugab	-	-	45.1	-	-
Otjivero main	-	1.5	-	9.8	3	-
Otjivero silt	-	3.2	-	7.8	3	-

* Area and volume of the dams are at maximum water level. Maximum sustainable yield (MSY) is based on total yield divided by surface area at maximum water level. -: no information available.

Private dams

There is a large number of small dams on private ground, i.e. farms in the central area. Many of these are used to produce fish for private consumption. The main concern regarding this activity is that it may contribute to spreading of species among watersystems.

2.5 Aquaculture

Several missions to Namibia the last few years have reviewed the feasibility of aquaculture in the country (Remedio & Regadera 1991, Wilton undated). With the restricted water resources available, and the market restrictions caused by low priced marine fish, freshwater aquaculture appears not to have any large potential. Experience from other parts of Southern Africa also seem to indicate that there are a number of problems related to the implementation of aquaculture in traditional settings (UNDP/NORAD/FAO 1987, Weeks 1990, Woodford-Berger 1987). However, as there may be some potential in utilizing state dams or ponds along the rivers for this purpose, some points should be made here.

There are several stages and types of freshwater aquaculture which should be recognized.

- Hatcheries, for production of fish fry or fingerlings, to be introduced in natural waters to enhance natural fish stocks, or to be introduced in ponds or net cages for production of marketable fish meat.
- Extensive fish culture, where fingerlings are introduced in ponds and left to themselves to grow until harvested. The production will be based on the natural production of food organisms in the pond.
- Intensive fish culture, where fingerlings are introduced in ponds or net cages and intensively fed with artificial feed until harvested.

At present there are a few hatcheries for production of fingerlings in Namibia. At Hardap, the Freshwater Fish Institute produces fingerlings of tilapia and catfish, a function which is now in the process of being privatised. The Ministry of Agriculture, Water Resources and Rural Development is involved in fry and fingerling production through the Rural Development Centre (RDC) at Ongwediva (Oshakati) and fish ponds at Mahenene. These facilities also produce fry and fingerlings of tilapia (*Oreochromis, Tilapia*) and catfish (*Clarias*). A breeding programme to develop domesticated catfish strains has been initiated at the RDC.

The fry and fingerlings are sold to farmers at a subsidized price to be introduced in dams for various types of extensive culture. The economy of extensive or semi-extensive pond production for the individual farmer will depend on production costs relative to market prices. The cost of fry or fingerlings constitutes a large part of total production cost. Namibian authorities have expressed that their aim is to privatise the hatchery business. To evaluate the future of extensive aquaculture, the non-subsidised price of fry and fingerlings must be established, and included as a part of the production costs for marketable fish. However, it has also been stated that if the natural resources in the rivers and wetlands are over-exploited, extensive fish-farming in ponds should be encouraged.

In urban areas, a market may exist for high-priced fish products from intensive or extensive fish culture in ponds or state dams. There are some positive experiences regarding intensive cage-production of tilapia and catfish in Hardap dam. However, no detailed calculations on the economy of this activity based on non-subsidized fingerlings have been available.

2.6 On the relevance of irrigation, hydropower and tourism for freshwater fish management

Irrigation

There are plans to increase agricultural production based on irrigation both along Okavango and in Caprivi. Larger irrigation schemes should be subject to proper environmental impact assessments, as their effect on the aquatic environment in rivers and wetlands may be detrimental. It should also be emphasized that other agricultural practices may negatively affect the fish populations in the rivers. A detailed overview of plans for increased irrigation is needed to evaluate the possible effects on the aquatic ecosystems.

Hydropower

Hydropower development is planned in the Kunene River. The fish stocks in this river are presently not exploited, and the planned development will therefore not influence fish yield for human consumption. The plans will, however, have significant environmental and socio-economic impact, and proper environmental impact assessments should therefore be performed.

Tourism

Tourism related to the wetland ecosystems is being developed particularly in the Caprivi area. Part of the product offered is angling, but the local fishermen are presently not involved in the tourist industry. Some information indicate that tourist angling may mean a selective pressure on the fish stocks, which conflicts with subsistence and commercial fisheries. More detailed information on the effects and potential of tourist angling should be compiled. The discussion of the various ways to utilize the aquatic resources is closely related to the question of local participation and responsibility in the management of the resources.

3.0 Protection and management of freshwater fisheries

3.1 On the purpose of management

In general terms, management of natural resources will aim at securing a sustainable output for human consumptive or non-consumptive use on a long-term basis. Inland fisheries management should in rural Africa combine conservation of fish stocks with a sustainable utilization of the fish resources for the benefit of the people in the areas concerned. The biological aspect of a sustainable management of natural fish stocks means that the exploitation of the stock should not be detrimental to recruitment and production. However, the optimal yield in a biological sense may not be compatible with social, economic, or recreational management aims. A major objective for the management of floodplain fisheries, as found in Namibia, should be to ensure a sustainable utilization of fish resources for the benefit of the local population.

Modern management should be based on relevant information on the fish stocks and the aquatic ecosystem, as well as social and economic factors in the local community and on available fish markets. The chosen management strategy may often be a trade-off between subsistence fisheries, commercial fisheries, recreational fisheries and the conservation of stocks. In developing countries, the necessary basic information on the fish stock and the aquatic ecosystem is usually lacking, as is information on the production, distribution and consumption of fish and the general socio-economic environment in which fishery and fish management take place. Due to the lack of funds and qualified personnel, and the complexity of both the human societies and the ecosystems, adequate information is also difficult to obtain. Whenever possible, management plans for inland fisheries should be based on time series of monitoring data covering the appropriate biological, social, economic, and recreational indicators. When data are inadequate, management plans should preferably aim at conservative exploitation rates. As information becomes available from investigations and monitoring programmes, exploitation may be increased.

Evidence from other countries in the region suggest that management of freshwater fisheries is difficult both to organize and control (see f.ex. Scudder & Conelly 1985, Panayotou 1982, Degnbol 1992 and Lindqvist & Mölsä 1992). The best option seems to lie in the combination of traditional and external management practises, based on the two concepts *limited access* and *local participation*. For a proper management to be designed, current traditional management practises,

alternative external or government practises, as well as traditional and government institutions through which policies can be implemented, must be properly assessed.

3.2 Traditional and government management practises

Traditional forms of management of fresh-water fisheries can be divided into *inadvertent* and *intentional* practises (see Degnbol 1992, Scudder & Conelly 1985, Panayotou 1982 and Welcomme 1979). The former include a wide range of behavioral patterns, customs and beliefs which indirectly conserve fish populations by restricting access to certain communities, groups or individuals and by prohibiting the consumption of certain species. The latter include management practises which are implemented and enforced with the explicit goal of conserving fish resources.

The effectiveness of traditional management practises have generally been reduced during the past decades due to the commercialization of fisheries and the secularization/reduction of traditional beliefs. However, some forms of practises are generally found in most fishing communities and there are indications that both types mentioned above are represented also in Namibia. In addition, it is necessary to involve traditional institutions if local participation in the management of freshwater resources is to be accomplished. A growing amount of evidence indicate that sustainable use of natural resources in general depends on the participation from local communities (Agarwal 1992, Kiss 1990).

The most common inadvertent practise is related to *water tenure*, i.e. practises where there is limited access to specific water resources. Limited access may be vested upon territorial units (ethno-linguistic groups, villages), kin groups or individuals. Where individuals control access to certain fishing sites, this may be related to political patronage. One example likely to be relevant for Namibia is individual titleship to seasonally flooded depressions (*molapos*) in floodplain areas. In Okavango in Botswana, such depressions are controlled by titleholders. There are also indications that headmen in the Kavango are in a position to determine where certain types of fishing gear (such as fish fences) are to be located and how they are to be managed (see Van der Waal 1991).

Other types of inadvertent management strategies include *technical inadequacies*, meaning that there are no techniques available for catching otherwise available fish stocks or that physical constraints (such as the combination of unsteady dugout canoes and hippos/crocodiles) inhibit production. The latter is reported as an important constraint on an effective fishery in the case of Okavango in Botswana (see Skjønberg & Merafe 1987). Furthermore, there are *ritual prohibitions* against fishing in certain areas. This is reported for example from the Middle Zambezi Valley across the border from Caprivi. And finally, two general types of *taboos* are reported which inadvertently protect fish stocks. The first is a general taboo

against eating fish in any form (reported from the Hereros/Himbos in Kaokoland), and the second includes more specific taboos against eating more specific species (reported from Caprivi)(see Tapscott et al. 1992 and Van der Waal 1990).

Intentional traditional strategies for resource management first of all involve *closed seasons*. Throughout Africa "owners" of pools and other water bodies frequently prohibit all fishing (except possibly single hook and line fishing) for parts of seasons or, as is also reported, over a period of several years if fish are considered to be scarce. A second intentional strategy is that of *gear restrictions*. Gear restrictions can be explained both on biological and sociological grounds, but the most common seems to be prohibitions of efficient techniques that will influence the catches of other groups. From the Cuvelai system we know that there is opposition to the complete closure of rivers and streams with net bags practised at certain points. And a third type of intentional strategy is *intensification*, normally in floodplain areas. In its simplest form floodplain intensification involves merely connecting the primary channel of the river with adjacent floodplains by cutting a channel through the levy. There are also cases recorded where fishermen fertilize bodies of water adjacent to their communities with various types of wastes, and cases of what has been called "fish parks" (Welcomme 1979). Vegetation is placed in shallow water to attract fish in search of food and refuge, with the "park" subsequently surrounded by netting or other types of gear. No cases of deliberate intensification is reported from Namibia, but they are fairly common in other comparable inland fishery contexts.

Having emphasized the importance of traditional management strategies, it is also important to realize that even managerial practises which are still strong and relevant must be fitted into a more comprehensive strategy which includes external management. Most fishing societies now find themselves in circumstances which differs greatly from the situation when the traditional strategies were developed, with increased population pressures, involvement in markets, integration into state structures and increased environmental pressures. To be effective, however, external management strategies must be congruent with local institutions and structures.

External management commonly means that some centralized political authority imposes regulations on the fisheries, to protect the resources from over-exploitation. External management may also aim at reserving the privilege of fishing for some specific population group. Government agencies have traditionally tended to avoid involvement by local institutions. They have emphasized gear restrictions (including minimum mesh size and the prohibition of certain techniques) and various forms of closed seasons or closed areas (sanctuaries). As such regulatory measures often have undercut the economic efficiency of the fishing units, they have been practically impossible to enforce. In addition, removing the ownership or stewardship of local natural resources from the

traditional local authorities has often caused serious over-exploitation and destruction of the resources (Scudder & Conelly 1985, Agarwal 1992).

External legislation and management strategies must therefore be developed in close collaboration with local, traditional authorities (Degnbol 1992). Active, local participation in the management and protection of local resources may be achieved if local rights are protected from encroachment by outsiders, and if revenue generated from resource use benefits the local communities and institutions. Numerous examples from game and wildlife management during the recent years indicate the importance of involving local institutions in the management of local resources (Kiss 1990).

On the basis of the discussion above, three points of convergence between traditional and external management strategies seem particularly relevant. The first is limited access. The second is local participation. And the third is closed seasons or closed areas. It is still too early to indicate to what extent these are relevant for the future management of freshwater resources in Namibia, but they should be considered carefully.

3.3 Freshwater management in Namibia

Administrative framework, management and legislation

Freshwater fisheries is under the Ministry of Fisheries and Marine Resources, at the Directorate of Resource Management. The section Fresh Water is one of two sections in subdivision Angling and Line Fishing, in the division Commercial Resources, which is one of two divisions in the Directorate of Resource Management. The freshwater fisheries were only recently transferred from the Ministry of Conservation, Wildlife and Tourism. People at the Freshwater Fish Institute expressed satisfaction with this transition.

The Freshwater Fish Institute, which presently employs two biologists, is situated at Hardap Dam on Fish River. It has been discussed to move the Institute to Oshakati, Grootfontein, or some other town in the north, but no decision has been taken so far. The main reason that this is under discussion is that research priorities has changed from the State dams and aquaculture to the natural river systems. As the distance by air from Hardap to Ovambo is more than 500 km, travel expenses and general logistics problems impose major restrictions on the activities of the Institute.

The Freshwater Institute is in the process of employing an additional biologist. The supply of qualified biologists (M.Sc. or similar) is fairly good in Namibia, and people from South-Africa may also be recruited. There is, however, a problem with finding qualified technicians, as there is no adequate education available for

research technicians in ecological research. Measures have, however, been taken to alleviate this problem through suitable courses at the University of Namibia.

Some of the activities of the Ministry of Agriculture, Water Affairs and Rural Development (MAWARD) are important for the inland fisheries. For example, the Department of Water Affairs handles the Water Act, and the Directorate for Rural Development is actively promoting extensive aquaculture in the northern areas. The Ministry of Wildlife, Conservation and Tourism (MWCT) is responsible for national parks and other nature conservation areas. Some of their work clearly affects freshwater fisheries, and it will be increasingly important to coordinate policies between MFMR and MWCT, as well as MAWARD.

No institutions are currently involved in socio-economic developments specifically related to the inland fishery sector. However, the Rural Industries Section of the MAWARD has expressed an interest in focusing more specifically on inland fisheries, and the Namibian Institute for Economic and Social Research (NISER) has carried out several socio-economic base-line analyses which represent a good point of departure for more fishery-specific studies. Finally the Namibian Economic Policy Research Unit (NEPRU) has been involved in policy studies related to other economic sectors.

As regards legislation, there is at present no legislation covering the fisheries on communal lands, i.e. the areas in the north where the major inland fisheries in Namibia takes place. The Nature Conservation Ordinance, No 4 of 1975, contains some detailed regulations concerning inland fish, but appears to be of relatively little relevance for the various aspects of management of the fish resources. Of some relevance to the protection of freshwater fish habitats is the Water Act, No 54 of 1956, which makes provisions for the protection of river catchments, controls effluent discharges into rivers, and includes legislation covering water pollution.

However, the aim of Namibia is to develop a modern legal framework for the sustainable management and utilization of the natural resources. This aim has been stated in the Constitution (Article 95), and has been followed up by the preparation of e.g. "Namibia's Green Plan" and the White Paper on the marine fish resources. The Green Plan indicates several needs related to freshwater fish management. This includes a need to develop an appropriate water conservation policy and strategy for the country, to develop legislation to protect wetlands, to develop an effective soil conservation act, and to ensure protection of ecosystems and biodiversity. At present, the first steps have been taken to develop a legal framework for environmental conservation. Norway is involved in this process. When legislation concerning freshwater fisheries is developed, it is of vital importance to carefully consider the relationships between this law and the laws concerning the various aspects of environmental protection. A basic premise should be that conservation should be synonymous with sustainable exploitation.

All major rivers in Namibia are completely or partly forming borders with neighbouring countries. The resources must therefore be shared, and managed in collaboration. This aspect must be considered in any management policy. Establishment of bi- or trilateral commissions to develop principles of collaboration and common management practices is of utmost importance.

4.0 Terms of Reference

4.1 Introduction

The objective of the study is to produce a draft for a government White Paper on freshwater fisheries and management in Namibia. The White Paper is subsequently to form the basis for the development of a legal framework concerning freshwater resources.

The study should be done under four main headings. The outline has been based on the outline for the White Paper on marine fisheries entitled *Towards Responsible Development of the Fisheries Sector*, published by the Ministry of Fisheries and Marine Resources in December 1991.

The first part of the study is to include an overview and assessment of the socio-economic and biological characteristics of inland fisheries in Namibia. *The second* part is to include an assessment of strategies for the protection and management of freshwater resources and their environment. *The third* part is to include an assessment of the perspectives for the development of the freshwater fisheries in Namibia. And *the fourth* part is to include an assessment of the type of legal framework needed for the management of the sector.

The ToR has been organized into blocks corresponding to the main headings of the White Paper. As has been reiterated throughout this pre-feasibility study, however, the very nature of inland fisheries and fish resources demand a close integration of the various sub-topics and a close cooperation between the people involved.

Through the current pre-feasibility study, gaps in the present knowledge about the sector have been identified. These will have to be filled before the White Paper can be written. The topics proposed below represent what we consider to be minimum requirements for the objective of writing the White Paper. We have also included suggestions of institutions and people we believe are well qualified to carry out the study, but emphasize that the final decision both as regards the ToR itself and the persons to be involved rests with the Namibian Ministry of Fisheries and Marine Resources.

4.2 The socio-economic and biological background studies

The socio-economic survey

Given the immediate purpose of background information for the White Paper and the time at disposal, the socio-economic survey should be carried out in the form of a Rapid Rural Appraisal (RRA).

The RRA should be based on structured interviews and a limited questionnaire survey.

1) The structured interviews should be held with relevant government and traditional institutions, as well as individuals directly involved in the sector. These include regional commissioners, regional representatives for relevant ministries, representatives for the tourist industry, chiefs, headmen, agricultural extension workers and representatives for fishermen, fish-traders and people involved in support-functions. Particular care should be taken to interview women involved in the sector.

2) The questionnaire survey should cover the main types of freshwater fishery adaptations in Namibia, i.e. perennial rivers (the Okavango), annually flooded floodplains (the Caprivi) and sporadically flooded floodplains (the Cuvelai system). The questionnaire should be carefully designed and tested, and a sample of at least 100 should be selected at each site. For regions where there already exist general socio-economic baseline studies (Owambo and Kavango) the questions should be fishery-specific, whereas they may have to include questions of a more general nature in the case of the Caprivi.

The following topics should be covered by the structured interviews and questionnaires:

- An assessment of the relative importance of fishing in relation to the main alternative adaptations, both as regards income and nutrition.
- An assessment of the regional and/or ethno-linguistic differences as regards the importance of fishing.
- An assessment of the characteristics of households where fishing is an important source of subsistence and income, with particular emphasis on economic status and composition.
- An assessment of the principle fishing technologies, with a particular emphasis on possible ongoing changes towards more intensive methods.
- An assessment of the current practises as regards processing and storage of fish.
- An assessment of the traditional management methods, with a particular emphasis on practises of limited access to the fish resources.

- An assessment of the relative importance of production for subsistence and production for commercialization, with a particular emphasis on possible changes towards more commercialized fisheries.
- An assessment of the main institutions/decision-making units relevant for fishing, with a particular emphasis on the possible links between traditional and government institutions.
- An assessment of the magnitude/importance of recreational fishing, with a particular emphasis on actual and possible implications for local fishermen and communities.
- An assessment of the local fishermen's perception of the resource situation and the options for increasing production.
- An assessment of the plans and attitudes of local and regional government institutions towards the inland fishery sector, with a particular emphasis on their possible involvement in management and development.
- To the extent possible, a qualified estimate of the total number of people involved in the sector on a full-time, part-time and seasonal basis should be made.

The RRA should preferably be carried out during the main fishing season in each setting, but given the time constraint the period from January to April 1994 is suggested. The survey should be carried out over a minimum period of three to five weeks.

The RRA should be carried out by one socio-economist familiar with the areas in question, preferably in collaboration with one socio-economist familiar with the freshwater fishery sector. In addition, at least three assistants should be recruited to take part in the questionnaire survey.

Alternative institutions and candidates include: 1) The Namibian Institute for Social and Economic Research (NISER), Windhoek, Namibia. Candidates should be identified by the Institute. NISER should also identify assistants 2) Chr. Michelsen Institute, Bergen, Norway: Inge Tvedten. 3) Women in Development Consulting, Oslo, Norway: Else Skjønberg. 4) Lasse Krantz Consultancy A/B: Lasse Krantz.

The biological surveys

The following tasks should be performed to provide the best possible biological basis for the White Paper:

- 1) A complete compilation of all available data on the fish biology and the fisheries in the river systems. Many relevant results are only available in Afrikaans, and unpublished data may also be available from the biologists who have been doing research in the relevant areas.

2) A complete field survey of small natural water bodies (sinkholes, natural springs, etc.) should be performed to facilitate the development of a comprehensive conservation plan for these valuable ecosystems.

3) A monitoring programme for the Caprivi system (Zambezi/Kwando) should be started as soon as possible. The setup should be comparable to the monitoring of Okavango. During the planning stage, the monitoring programme on Okavango should may be evaluated to ensure that all relevant indicators are included.

The following types of biological data should be given priority:

- Species composition and structure of fish communities and catches
- Fluctuations over time in stock sizes and catch volumes
- Long term trends in catches
- Catches in relation to water levels
- Present and past catch methods; concurrent changes in catch and catch composition
- Geographical distribution of fishing efforts, both total and with various types of gear

The biological surveys should be carried out during the period from November 1992 to April 1993. It is important that the compilation of available data starts immediately, in order to avoid overlaps.

All surveys should be the primary responsibility of the Freshwater Fish Institute (FFI), which should be given the necessary resources to carry them out. In addition to the two biologists currently employed, the recruitment of a third biologist should be given priority.

For the surveys on small natural water bodies and the monitoring of the Caprivi system, collaboration with biologists from the Ministry of Wildlife, Conservation and Tourism (MWCT) will be feasible.

For all surveys, the possible participation of B.C.W. van der Waal (Department of Zoology, University of Venda, South Africa) should be considered, due to his long-term involvement with the ecosystems in question.

Finally, it is suggested that Norwegian personnel are involved in the planning of the surveys, in the field work and in discussions during the final stages of the surveys to the extent deemed feasible. In addition, the possibility for longer-term institutional collaboration between the FFI and relevant institutions in Norway (such as the Norwegian Institute for Nature Research, NINA) should be evaluated.

Alternative institutions and candidates include: 1) The Freshwater Fish Institute, Mariental, Namibia. B.J. van Zyl, C.J. Hay and the third biologist to be employed.

The FFI should also identify technicians, if necessary from outside of the institution. 2) Department of Zoology, University of Venda, South Africa. B.C.W. Van der Waal. 3) The Ministry of Wildlife, Conservation and Tourism. H.J.W. Grobler. 4) The Norwegian Institute for Nature Research. Terje Sandlund and Tor F. Næsje.

4.3 Protection and management of freshwater resources

This includes the elements needed to protect habitats and fish stocks, to ensure that the resources can be utilized for the benefit of the population on a long-term basis. It will be important to analyze how traditional management practices can be included in the national management plans. Long-term sustainability depends on the collaboration by the local population, who must take responsibility for and gain benefits from the utilization of the fish resources.

In addition to the local participation in management, additional measures may be necessary to avoid over-exploitation. The major question concerning measures to regulate fisheries is how rules and regulations can be enforced. Thus, the work towards the White Paper should particularly pay attention to the real effects of various restrictions.

Among measures that may be discussed are:

- Conservation areas to protect nursery grounds. This must be based on biological information on the fish stocks, as well as information on traditional fishing grounds and human population densities.
- Closed seasons to e.g. protect spawning sites or to protect the fish stock during particularly vulnerable period, e.g. during low waters.
- Restrictions on gear use. Gear restrictions may be necessary for biological reasons, to protect certain species or life stages of fish. Gear restrictions may also relate to the access to fishing by certain population groups.
- Limited access to fishing.

This work must be based on point 4.2 above, and should be carried out by the socio-economic responsible for the RRA-study, with some input from biologists. Input from legal experts regarding the relationship between traditional regulations and modern legislation may also be feasible.

Alternative institutions and candidates include: 1) The Namibian Institute for Social and Economic Research (NISER), Windhoek, Namibia. Candidates should be identified by the Institute. NISER should also identify assistants 2) Chr. Michelsen Institute, Bergen, Norway: Inge Tvedten. 3) Women in Development Consulting, Oslo, Norway: Else Skjønberg. 4) Lasse Krantz Consultancy A/B: Lasse Krantz.

4.4 Development of freshwater fisheries

The longer term development options for freshwater fisheries should first of all be addressed. The discussion should include such issues as the future importance of the sector as an alternative source of protein, the implications of a commercialization as opposed to a continued subsistence orientation of the sector and the policy implications of the considerable marine production in Namibia for inland fisheries.

Moreover, the need for specific development initiatives should be discussed. The following issues should particularly be emphasized:

- The need for fishery extension services in order to improve management practises and productivity within the sector.
- The need for externally initiated marketing outlets in order to secure income for the fishermen and a poverty-oriented distribution of fish
- The need for special initiatives in order to secure access to the sector for poorer sections of the population and women.
- The need for an organization of fishermen into more coherent production groups.
- The need for improved processing and storage facilities.
- The possibilities for establishing ties between the traditional fishermen and the tourist industry, both through management agreements and specific initiatives such as organized fishing trips, game and bird scouting, canoe hikes etc.

Given the close similarity between inland fisheries in Namibia and in Botswana, and the fact that most of the development efforts listed above have been implemented in the Botswana inland fisheries, a brief field work should be carried out in the Okavango (Ngamiland). Particular emphasis should be given to contact the Fisheries Unit of the Botswana Ministry of Agriculture, based in Maun, through which most of the development projects have been implemented.

The fieldwork in Botswana should be added to the 3-5 weeks proposed for the socio-economic survey. A period of 4-5 days should be sufficient.

Alternative institutions and candidates include: 1) The Namibian Institute for Social and Economic Research (NISER), Windhoek, Namibia. Candidates should be identified by the Institute. 2) Chr. Michelsen Institute, Bergen, Norway: Inge Tvedten. 3) Women in Development Consulting, Oslo, Norway: Else Skjønberg.

4.5 Legal framework

The White Paper is, finally, to include a chapter on areas that are to be covered by legislation related to freshwater fisheries and fish resources. The chapter is also to consider the relation between this legislation and the laws concerning the

various aspects of environmental protection. Among the themes that should be further discussed are:

- Protection of natural biodiversity. The freshwater fisheries act should cover all organisms permanently resident in freshwater. Other organisms should be covered by different legislation.
- Strict regulations on the import of exotic organisms and the movement of organisms between water systems.
- Conservation of fish stocks
- Conservation of endemic fish species and rare habitat types.
- Protection of traditional rights regarding subsistence fisheries.
- The involvement of local communities in the responsible management of fish resources.
- Ways and means to ensure that products and revenues deriving from local resources benefit the local communities.
- Access to fishing
- Regulation of aquaculture activities (hatcheries, ponds, net cages), and activities aiming at stock enhancement.
- Harmonization with legislation on all sectors which influence fisheries (nature conservation, pollution, irrigation, tourism etc.)
- Include, or facilitate the implementation of, necessary restrictions on e.g. fishing gear, bag limits, closed seasons and aquatic conservation areas.
- Regulate the utilization of fish resources for tourism to benefit local communities.
- Include the necessary means to enforce legislation.
- Harmonization of the various environmental-related acts to facilitate the use of law enforcement officers covering all the different areas
- Problems related to resources shared with other countries.

The study should be carried out by legal experts familiar with Namibia and with legislation related to the sustainable management and utilization of natural resources. The work should be done on the basis of the main findings in the other areas covered by the White Paper, and the general legal framework for environmental conservation.

Alternative institutions and candidates include: 1) The Ministry of Fisheries and Marine Resources, together with legal institutions in Namibia. Candidates should be identified by the institutions themselves. 3) Legal Office, FAO, Rome, Italy: The institution should identify candidates. 2) Directorate for Nature Management (DN), Trondheim, Norway: Terje Karterud.

4.6 Conclusion

The White Paper is to cover several distinct issues related to freshwater fisheries and fish resources, and the proposed study consequently involves several individual studies and researchers. As each topic to be treated are closely interlinked, they should all be finalized before the draft White Paper as such is written. While all participants will contribute to the final draft through their reports, we suggest that 2-3 people are responsible for production of the draft White Paper itself. The extent to which the Namibian Economic and Policy Research Unit (NEPRU) should be involved in the final phase of the work should be considered.

On the basis of the outline given above, the suggested itinerary and personnel to be involved is summarized below. We emphasize that we consider this to be minimal requirements. The total number of researchers proposed is 5-7, excluding assistants and technicians. A core group of 2-3 people should be established. These should preferably also produce the final draft of the White paper.

Suggested time schedule

<i>Study</i>	<i>Period</i>	<i>Time</i>
The socio-economic survey	January 93-April 93	3-5 weeks
The biological surveys	November 92-April 93	6 months
Protection and management of freshwater resources	April 93-May 93	3 weeks
Development of freshwater fisheries	January 93-April 93	1 week
Legal framework	April 93-May 93	3 weeks
Draft White Paper	June 93-June 93	3 weeks

Personnel requirements

<i>Study</i>	<i>Category</i>	<i>Number</i>
The socio-economic survey	Socio-economists	1 (2)
	Assistants	3
The biological surveys	Biologists	2 (4)
	Technicians	2 (4)
Protection and management of freshwater resources	Biologist	1
	Socio-economist	1
Development of freshwater fisheries	Socio-economist	1 (2)
Legal framework	Legal expert	1 (2)
Draft White Paper	Socioeconomist	1
	Biologist	1
	Legal expert	1

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REPUBLIC OF NAMIBIA

MINISTRY OF FISHERIES AND MARINE RESOURCES

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22 April 1992

Mr Oyen
Councillor
Norwegian Embassy
WINDHOEK

S. L. AL

7000 547

INN. AMB. WINDHOEK
23 APR. 1992
431 NAM 001.25

Dear Mr Oyen

*Kopi sendt NAT/2. t. don. 24/4-92
Auct*

1. Our Agreed Minutes of February, 1992, refers.
2. We are hereby requesting a consultancy team to start work as soon as possible on aquaculture and fresh water policy and legislation formulation.
3. Please enclosed see a frame work document on our fresh water fisheries activities and needs.
4. It is suggested, the fresh water fish policy should address areas as indicated on page two (2) of the document.
5. We are awaiting for the draft outline of terms of reference of the team of experts.

Yours sincerely

DEPUTY PERMANENT SECRETARY

FRAME WORK FOR FRESH WATER POLICY

CHAPTER 1

OVERVIEW OF THE FISHERIES SECTOR

CHAPTER 2

MANAGEMENT AND PROTECTION OF THE RESOURCES AND THEIR ENVIRONMENT

CHAPTER 3

PERSPECTIVES AND POLICY OPTIONS FOR THE DEVELOPMENT OF THE FISHERIES

CHAPTER 4

LEGAL FRAMEWORK, SYSTEMS FOR ENFORCEMENT.

CHAPTER 5

FISHERIES POLICY FOR NAMIBIA

TERMS OF REFERENCE

for

NAM 001 - Pre-feasibility study for freshwater management

1. BACKGROUND

Namibian authorities represented by the Ministry of Fisheries and Marine Resources requested NORAD in February 1992 to provide a team of consultants to assist in preparing a policy document for the freshwater sector followed by a legal framework with systems for enforcement.

The Ministry of Fisheries and Marine Resources (MFMR) is in charge of the freshwater sector formerly under the Ministry of Wildlife, Tourism and Conservation.

2. OBJECTIVES

The objective is to assist Namibia in preparing a policy document on the sustainable utilization of freshwater resources with the ensuing legal framework for the sector.

3. SCOPE OF WORK

The work shall comprise, but not necessarily be limited to, the following tasks:

- 3.1 Prepare a collection of available written information on the sector
- 3.2 Describe the present administrative framework for the management of the sector
- 3.3 Describe the status within the sector with respect to:
 - human consumption
 - irrigation
 - fisheries, including fish farming
 - hydropower
 - tourism
 - other
- 3.4 Discuss the authorities present thinking on the future developments within the subsectors described in 3.3

- 3.5 Discuss major problem areas with respect to lakes, rivers and ground water reservoirs
- 3.6 Prepare terms of reference and propose Norwegian and local candidates for a more in-depth study with the aim of producing a policy document and a legal framework for the sector based on a sustainable management of the resources to the benefit of the people.

4. MODE OF WORK

4.1 Method of work

The work shall be based on a study of all relevant documents and on discussions with relevant personnel within MFMR, MVCT, Fisheries Research and NGO's and others engaged in the sector in order to achieve a proper planning for the integration of resource management and sustainable development and an inter-ministerial and multi-disciplinary approach.

The work shall be based on a study of all relevant documents and on an active discussion with relevant personnel

4.2 Time schedule

The field work shall take place during the period September 21 - September 30.

A preliminary report with summary of findings and recommendations should be presented to MFMR and NORAD before leaving Namibia.

A final report should be presented to NORAD before October 10.

4.3 Team composition

The team consists of the following persons:

- Mr. Odd Terje Sandlund, biologist, Norwegian Institute for Nature Research.
- Mr. Inge Tvedten, social anthropologist Chr. Michelsens Institute, Department of Social Sciences and Development.

Oslo, 25 August 1992

Gustav S. Klem

**REPUBLIC OF NAMIBIA**

MINISTRY OF FISHERIES AND MARINE RESOURCES

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SUMMARY OF WORKSHOP ON FRESHWATER FISHERIES IN NAMIBIA**28 SEPTEMBER 1992****PREAMBLE**

The policy regarding the management and protection of freshwater fish resources in Namibia should be in accordance with the general policy for a sustainable management of natural resources, as stated in the Namibian Constitution (Article 95) : "The State shall actively promote and maintain the welfare of the people by adopting ... policies aimed at ... maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future ...".

Freshwater resources of Namibia are divided into five different systems :

1. Cunene-Cuvelai
2. Okavango
3. Caprivi (Zambezi/Kwando/Linejante)
4. Central
5. Fish/Orange

BWO/212/IS

1. INTEGRITY OF WATER SYSTEMS

Transfer of aquatic organisms between different systems should be prevented to protect the natural biodiversity.

- (a) Transport of boats and other fishing equipment must be regulated.
- (b) Conservation measures regarding permanent fresh aquatic fauna should be incorporated in the Fisheries Act. All other species should be incorporated into the Wildlife and Conservation Act. Control of problematic or potential problematic aquatic plants should be enacted by the Department of Water Affairs.
- (c) Vulnerable habitats and special ecological areas should be protected.

2. ANGLING

- (a) Angling should be regulated by specific bag limits in the different water systems.
- (b) Angling competitions must be regulated by the National Angling Control Board in collaboration with the Ministry of Fisheries and Marine Resources.
- (c) Use of boats for fishing are allowed.

3. EXOTIC SPECIES

Regulations on the trade of exotic species are needed to protect the local fauna.

- (a) Traders with live fish should be registered with the Ministry of Fisheries and Marine Resources.
- (b) Import of live fish must be accompanied by a health certificate.
- (c) Any trader in endangered species must apply for a permit from the Ministry of Fisheries and Marine Resources.
- (d) Dumping of exotic species into Namibian waters is prohibited.

4. AQUACULTURE

Aquaculture production will never be in a position to compete with marine fisheries in terms of price and quantity. However, it is very important from a subsistence point of view.

- (a) The Government should act as a catalyst to initiate aquaculture but not compete with private companies through subsidised production.
- (b) Eventually production should be privatised.
- (c) To prevent species contamination the import and distribution of aquaculture species should be regulated.

5. CENTRAL SYSTEM5.1 State Dams

- (a) Activities in State Dams should take note of water quality and should not be detrimental to the structure.
- (b) the sonation for the usage of Dams or parts of Dams should be performed by the Department of Water Affairs.

5.2 Private Dams

- (a) The introduction of fish species into private Dams should be regulated.

6. CUNENE-CUVELAI SYSTEM

Traditional gear is defined as all gear that is manufactured locally with local natural materials.

- (a) Non-traditional passive gear that blocks waterways is prohibited.
- (b) All other gear should be allowed, with certain mesh size restrictions.

7. OKAVANGO AND CAPRIVI SYSTEMS

- (a) No drag nets are allowed.
- (b) Gill nets of a stretch mesh of 70 mm and bigger are allowed.
- (c) Traditional gear is allowed.
- (d) Establishment of breeding sanctuaries is urgent to avoid over-exploitation. Sanctuaries must include riverine vegetation.
- (e) Co-operation between neighbouring countries must be obtained for protection of breeding sanctuaries.

8. RECOMMENDATION

- (a) Enactment of the Acts of the different Ministries should be co-ordinated. Law-enforcement officers should be trained to deal with the different Acts.
- (b) Communication with neighbouring countries regarding shared water resources should be encouraged to harmonise legislation.

