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Management of the Deep-Sea Fishery of Namibia
Orange Roughy (*Hoplostethus atlanticus*)

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ABSTRACT

The management of the Namibian orange roughy fishery by quota management has a very short history. Despite the fact that the orange roughy fishery is not a large sector it has accumulated significant profits, in economic terms, for both Government and industry. Nevertheless, if long-term plans are put in place it could do more than that. This paper explores the success of the existing management policy. The main objectives of this paper is to design an improved orange roughy fishery management policy in order to ensure that the orange roughy resource is utilised in a manner consistent with the principle of long-term sustainability and promotion of social welfare. Due to the short history of the fishery, it was not feasible to estimate the sustainable yield although it was discussed. Assumptions were made to estimate profitability, cost of harvesting, and expected revenues and a set of recommendations provided to facilitate the process for refining the orange roughy management policy.

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1. INTRODUCTION

The commercial fishery for orange roughy in Namibian waters was initiated as an experimental fishery in 1994. In 1997 the fishery became commercial when it was integrated into the existing fisheries management regime. This paper intends *inter alia* to explore the success of the Fisheries Management Policy given the special attributes of the orange roughy fishery. Among these problems are:

1. Lack of sufficient scientific information on the current state of the orange roughy stock,
2. Lack of sufficient scientific information on the growth rate of orange roughy.
3. Lack of long time series on the orange roughy Fishery.

The orange roughy fishery has economic potential and its development has hitherto recorded a steady increase in harvesting and economic yield**.** (See Table 14.)

The catches from the orange roughy fishery have been monitored from the commencement of fishing in 1994. This data now forms the basis for describing the development of the catches and the CPUE trends (Table 6). The harvest is carried out by bottom trawl vessels 110 mm as wet fish.

Namibia's orange roughy is processed on shore and exported mainly to the USA market. Most of the processing is done by Gendor Fishing, which also processes orange roughy caught by Atlantic Sea Products. In the North American markets, orange roughy, despite little market development by suppliers, is a highly prized frozen fish fillet, ahead of species such as the Chilean Sea Bass and Alaskan Halibut. For Americans the pure white color and even flake, delicate flavor in fillets, and good size make orange roughy the ideal fish. Roughly 80% of the world's orange roughy production is consumed in North America. Other major markets are Australia, Canada and Japan. Because of the high prices it fetches, orange roughy is sometimes referred to as the diamond of the sea. (Namibia Foundation 1998).

In the domestic market orange roughy has found a place with the National Air Carrier (Air Namibia) which after tasting all deep-water species caught in Namibian waters, chose orange roughy on its menu for international business class flights.

2. THE NAMIBIAN FISHERIES

2.1 Environmental conditions off the coast of Namibia

The marine environment off Namibia and the dynamics of the Benguela Current are controlled by seasonal changes in the South Atlantic high-pressure system. Southerly winds blow off Namibia throughout the year and tend to be strongest in winter and spring. In the Luderitz area to the south, winds are stronger in spring and summer whereas in the central and northern regions they tend to be most intense in spring and autumn. Hot dry season begins from the east or north in autumn and winter also influence the coastal marine environment by locally suppressing upwelling and occasionally transporting large quantities of dust sand far out to sea.

In summer and autumn, the southerly winds relax off central and northern Namibia and upwelling becomes weak. These conditions are associated with increased solar radiation and the movement of the warm and more saline water of the Angolan Current mixing with the cooler water of the Benguela Current, therefore leading to stable conditions with relatively shallow well-defined thermoclines forming in the upper layers of the ocean. The surface water temperatures during these periods can rise to between 17 °C and 22 °C and the salinity is usually within the range of 35.5 to 35.9 ppt. The frontal areas where the two currents converge usually have high plankton production and are important spawning and nursery grounds for pelagic fish.

Unfavorable environmental conditions such as high temperatures, deep thermoclines and low nutrient and food levels (namely Benguela-El Nino conditions) can severely affect the movement, spawning behavior, and the development of the eggs and larvae. Too low temperatures due to pro-

longed and intense upwelling can result in the absence of thermoclines and transport of spawning products away from the coastal nursery grounds. Such conditions can slow egg and larval development. On the central Namibian shelf favorable conditions for spawning usually occur in late spring and early summer when upwelling begins to moderate. (Namibia Foundation 1998)[1].
The Namibian Fishing industry is based on the Benguela Current system. Because of the variability of atmospheric and oceanographic processes affecting the Benguela system, the Namibian Fishing industry is subject to large short-term and long-term changes in fishing conditions. The major processes of the environmental conditions off Namibia involve:

- Upwelling of cold nutrient-rich water, with the strongest cell of upwelling occurring off Luderitz
- A north-flowing coastal current, distributing nutrients and plankton along Namibia's coastal-shelf
- A poleward counter-current in central and northern Namibia
- Transitional zones with the warm Angola current in the north, and the Agulhas current, which is also warm, in the south;
- Substantial atmospheric and oceanographic variability, which affects temperatures, dissolved oxygen levels, nutrient concentrations, and plankton production. (Namibia Foundation 1998)

The continental shelf supports abundant fish life. The most common are pelagic species consisting mainly of pilchard, horse mackerel, and anchovy. The demersal fish are also a significant economic resource and the most important species being Hake, orange roughy, Oreo Dori, Alfonsino, and others stocks that straddle national maritime boundaries.
The nature of fishing opportunities and the relatively rough sea (with two fishing harbours in Luderitz and Walvis Bay (See Appendix 2)) deter small-scale fishing and have resulted in a highly industrialised fleet of about 260 vessels in 1998 (MFMR 1998).

2.2 Overview of the Namibian Fisheries Sector

The landed value is the value of fish as landed. This has increased dramatically in Namibia in the past few years. In 1995 it was N$ 937.3 million, growing steadily to 1,558.0 million in 1998. The final value is the value of fish products at export. It was N$ 1,453.0 million in 1996 and increased to N$ 2,226.6 million in 1998 (MFMR 1998).
An accurate number of employees in the fisheries sector could not be obtained at the time of writing.
In 1998, the total number of vessels licensed to fish in Namibian waters was 260 which shows a decrease of about 15% from the 307 vessels licensed in 1997. The percentage of Namibian vessels licensed has increased from about 75% in 1996 to almost 84% in 1998. The number of fishing crews has decreased and was 6,583 in 1998. However, the percentage of Namibians has grown from 57% in 1996 to 66% in 1998 (MFMR 1997a and 1998).
The total landings in Namibia is shown in figure 1. The decline in total fish landings from 1994 to 1997 was due to adverse environmental conditions, which have predominated since 1993.
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[1] Materials in this chapter are based on the information obtained from the Annual Journal of the Namibian Fisheries Sector (Namibia Foundation 1998).

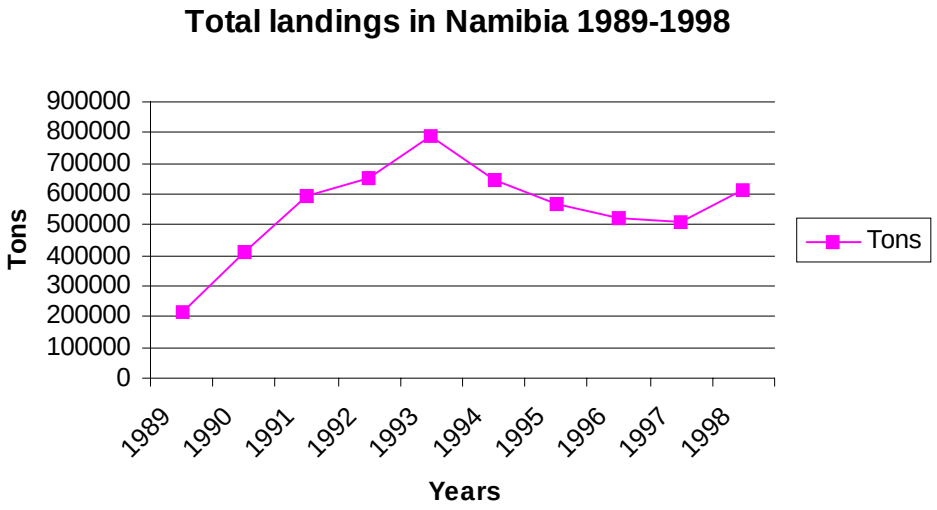

Figure 1: Total annual landings 1989/1998 (MFMR 1998).

The values of export by the fisheries sector from the year 1995 to 1998 are listed in Table 1.

Table 1: Summary of estimated export values (N$ m), 1995-1998 (MFMR 1998).

	1995	1996	1997	1998
Unprocessed	206	205	284	138
Fish Processed	1,159	1,217,7	1,332,8	2,194,9
Total	1,365.0	1,422.7	1,616.8	2,208.7

This shows an increase of approximately 61% in export value from 1995 to 1998. The increase in the value of export is due to the increase in the international market price, the devaluation of the Namibian Dollar and the increase in demand for Namibian fish and fish products as well as the establishment of new markets especially in Eastern Europe.
In the national economy, the fisheries sector occupies an increasingly important place despite the adverse environmental conditions in 1995 and 1996. Fisheries are the second largest export industry contributing 10% to the GDP in 1998.
The contribution of the fishing industry to the GDP decreased in 1996 and 1997 because of the drop in the value of unprocessed products but has improved in 1998 as indicated in Table 2, while export figures have risen steadily since 1995.

Table 2: Contribution to GDP (in N$ m and percentages)(MFMR 1998).

Years	1995	1996	1997	1998
Fishing	365	391	491.1	624.6
Fish Processed	536	354	525.5	874.2
Total	901	745	1,016.6	1,498.8
Contribution to GDP	8.7%	6.3%	7.8%	10.3%

Fisheries research has been carried out in Namibia since the 1950s, but a major consolidation took place in 1993 with the opening of the National Marine Information and Research Centres at Swakopmund, and in 1995 similar facilities were established in Luderitz, but with a limited research capacity.

Fish consumption in Namibia has increased from 4 kg per capita in 1994 to 8 kg per capita in 1998. The attributive factor to this change is the Fish Consumption Promotion Campaign, launched in 1994 by the Ministry of Fisheries and Marine Resources in conjunction with the Overseas Fisheries Cooperation Foundation (OFCF) of Japan.

2.3 Fisheries Management in Namibia

In the pre-independence period, overfishing, illegal fishing and weak or non-existent management marked the Namibian fisheries sector. This position is based on the fact that foreign trawlers plundered the marine resources of Namibia in violation of UN Council Decree No. 1 of September 1974. Decree No. 1 of 1974 conferred the power to administer Namibia as a mandate territory to the United Nations Council. In terms of the said decree the South African occupation of Namibia was declared illegal and in relation to fisheries no foreign vessel was allowed to fish in Namibian waters without authorisation of the Council.
The United Nations recognised the South West Africa Peoples Organization (SWAPO) (the Liberation Movement from 1960 to 1989) as the sole authentic representative of the Namibian nation during the struggle for Namibia's independence.
Therefore, in 1982, SWAPO and the United Nations Council for Namibia signed the United Nations Convention on the law of the Sea of 10 December 1982. The said convention extended the Exclusive Economic Zone from 12 to 200 nautical miles.
Nevertheless the declaration of the EEZ by Namibia as an independent State was complemented in 1990 when the Namibian Government passed the Territorial and Exclusive Economic Zone Act (Act No. 3 of 1990) with subsequent amendment in 1991, which declared a 200 nautical miles Economic Exclusive Zone along the coast. This immediate action by the Government was done with aim to ensure the conservation and protection of Namibia's marine resources.
Consequently, a large number of unlicensed foreign vessels fishing within the 200 nautical mile boundary were forced to leave Namibian fishing grounds.
To protect the marine resources within the EEZ, the Government has put in place a relatively rigorous system of monitoring, control, and surveillance. The monitoring system is based on the dockside monitoring of all landings, the placement of observers on most major vessels and deployment of three fisheries patrol vessels, an aircraft, and a helicopter.
This effective surveillance system of operations has resulted in a number of arrests of illegal foreign fishing vessels in Namibian waters and severe penalties being imposed by the Namibian courts. Since the illegal fishing by foreign vessels is now rare, the surveillance operations are now directed towards ensuring compliance by licensed vessels with applicable regulations.
In recognition of the importance of the fisheries sector, a full Ministry of Fisheries and Marine Resources was created in 1991 when the Government upgraded the Department of Sea Fisheries. The initial major task of the Ministry was to draft a fisheries sectoral policy that was published in 1991 as a white paper under the title "Towards Responsible Development of the Fisheries Sector". The translation of this policy into a legal framework followed in 1992, when the Sea Fisheries Act was promulgated. In terms of the 1992 Sea Fisheries Act, the Sea Fisheries Regulations were issued in 1993.
The current Fisheries Management System consists of the Fisheries Management Regime, Monitoring, Control and Surveillance System and the Judicial System (there are no Special Fisheries Courts). Offences are treated as criminal cases and are recovered as civil judgements.

2.3.1 Access Rights

Rights to harvest are granted for access to each fishery for four, seven or ten years, depending on the degree of Namibian ownership and status of investment by the operator and the criteria for granting

rights and quotas are set out in the Sea Fisheries Legislation. Rights are not transferable except with the approval of and subject to the conditions determined by the Minister, but such approval can only be granted if the quota (if any) or portion thereof, connected with the right to harvest is also transferred to the same person (Parliament 1992). Access rights exist to limit capacity and to provide stability in the fishery.

2.3.2 The Quotas System and Quota Fees

The quota system in Namibia is known as Enterprise Quota System, which fall under the category of Individual Quotas (IQs). Quotas are allocated for the fishing only to right-holders (companies) using the same criteria as for access rights. Quotas are not transferable, except with the prior written approval by the Minister.
In terms of the Sea Fisheries Legislation in force an application for the transfer of quota or any part of it shall be made in writing to the Permanent Secretary. The application for the transfer of quota should be accompanied by an application form for the allocation of quota, duly completed by the person to whom the quota is to be transferred. Quotas are registered with the Ministry of Fisheries and Marine Resources where the records are kept and made available for inspection by member of the public. This quota system is devised to provide stability and limit capacity (Parliament 1992).
The present allocation of quota is addressed in a way that disadvantaged indigenous people are given preferential status in order to encourage and empower them. However, there are instances in which some of the indigenous quota-owners sold their quotas to foreign owned companies ignoring the objective purpose for which they were granted specials status. While foreign investment should be encouraged it is very important to develop a fisheries policy that makes it impossible to undermine the national goals in promoting the participation of disadvantaged people in Namibian fisheries.
Quota fees on fish species are determined by the Minister responsible for Fisheries and Marine Resources with concurrence of the Minister of Finance and are published in the Government Gazette. Fees on quota species exist to reduce demand for quotas and they may differ according to species of fish, areas within which fish may be caught, the purpose for which fish may be caught (under the quota it is intended), the place where the fish will be processed, or any other criteria as may be determined by the Minister.
According to Les Clark (Special Adviser to the Minister of Fisheries) in an interview for the 1997 B. R. Sen Award, “extracting fisheries rents for Government programs is one of the achievements, resulting in the Namibian industry paying the highest fishery fees in the world, averaging 15 per cent of landed value”. (http://www.fao.org/news 1997/ clark.e html visited 20 October 1999).
In 1997 it was decided that if less than 80% of the TAC in a specific fishery were not landed, the quota fees on the uncaught portion of the quotas would be waived. This was implemented retrospectively as from 1995.
In September 1999, Cabinet decided that quota fees payable for new rights will be phased in over a four-year period. In the first year, 25% of the amount normally payable must be paid, 50% in the second year, 75% in the third year and full amount in the fourth year. This adjustment has relieved pressure on the industry that in previous system was compelled to pay the full amount within the corresponding quota year. Cabinet also investigated establishing a Fisheries Development Fund to provide finance at reasonable rates, especially to smaller and medium-sized businesses in the sector. This move is directed at promoting Namibianization (The Namibian Newspaper 1999).
Bycatch is managed largely with bycatch fees, which are designed to stop targeting bycatch species and avoid the complexities of multiple quotas being necessary for any vessels.

2.3.3 Fund levy in addition to quota fees

Fund levy is collected for the promotion of the fishing industry. Fund levy accrue to the Sea Fisheries Research Fund into which all money collected in respect of levies imposed for the benefit of the fund on all fish, fish products and certain other marine resources is paid. The money appropriated by the National Assembly for the realisation of the objectives of the fund; interests on investments; money which may accrue to the fund from other sources with the approval of the Ministry of Finance and interest recovered from fish, fish products and other certain marine resources is also paid to the Sea Fisheries Fund.
The money collected into the fund is used to undertake research and development concerning the sea including the development of fishing harbours and other unspecified facilities and research programs. The fund can also be used to improve the methods for the harvesting of fish, the breeding of fish or the utilisation of aquatic plants, and the manufacturing of fish products or products wholly or partially obtained from aquatic plants and packing, processing and marketing of such products (Parliament 1992).

2.3.4 Licenses and Permits

Licenses are required for each fishing vessel and for fish factories, while permits are required for foreign fishing vessels wanting to fish in the Namibian EEZ under a fishing agreement. Fees for licenses and permits exist in addition to quota fees.
The 1992 Sea Fisheries Act did not establish a firm link between rights, quotas, and licenses. The revised Fisheries Legislation of 1999 (although still to be passed by Parliament) has now strengthened the links between these three elements making the right to harvest a prerequisite for receiving quotas and licenses.

2.3.5 Monitoring, Control and Surveillance (MCS)

There is a relatively rigorous system of monitoring, control, and surveillance based on the monitoring of all landings, the placement of observers on board most major vessels and deployment of fisheries patrol vessels, a patrol aircraft, and helicopter. The MCS include control of entry, TACs, effort, seasons, closed areas, and control on fishing mortality and gear restrictions.
In the revised Sea Fisheries Legislation of 1999 the Observer Programme has been formalised. An Independent Observer Board has been established with an Observer Fund that covers the cost of the observers. The cost of the Observer Program is charged to the industry. This move has once more strengthened the enforcement capacity and makes the industry responsible for management cost. Whereas the observers are entrusted with the main responsibility to observe the fisheries regulations, at the same time they are responsible for carrying out catch sampling that plays a crucial role in research and development of the fishery. In terms of personnel running the MCS, a total number of 96 fisheries inspectors and 250 fisheries observers was recorded in 1997 (MFMR 1997b).
The overall outcomes of fisheries enforcement operations are indicated in tables 3 and 4. The money collected from fines collected because of violations of the fisheries regulations accrue to the Sea Fisheries Funds and is used for fisheries management and development.

Table 3: Patrol Vessel Inspections at sea, 1994 - 1997 (MFMR 1997b).

Year	Number of Inspections	Summons issued	Summons withdrawn	Warning issued	Fines Imposed (N$)	Amount Paid (N$)
1994	370	335	3	19	100,000	88,000
1995	272	207	1	28	62,700	55,000
1996	484	160	0	118	151,000	141,284
1997	245	64	1	32	62,300	60,064
Total Amount	1371	766	5	197	376,000	344,348

The above table shows the total revenue collected in fines because of violations of Fisheries Regulations at Sea from 1994 – 1997. Most of the summons issued by fisheries inspectors during their patrol activities at sea were successful. Out of 766 only five were withdrawn over the period from 1994 to 1997 and some 197 warnings were issued.

Table 4: Coastal Patrol and Inland Inspections, 1994 – 1997 (MFMR 1997b)

Year	Number of Inspections	Summons issued	Summons withdrawn	Warning Issued	Fines Imposed (N$)	Amount Paid (N$)
1994	296	265	76	34	51,040	19,505
1995	267	410	36	21	64,905	36,135
1996	423	419	18	42	83,620	65,530
1997	469	423	36	24	70,470	62,300
Total amount	1455	1517	166	121	270,035	183,470

The total revenues collected by coastal and inland inspectors for the years 1994- 1997 was N$ 270,035 as illustrated in Table 5. The Government covers the cost of this inspection. Out of 1517 summons issued for coastal patrol and inland inspections for the period starting 1994 to 1997 only 166 were withdrawn while 121 warnings were issued.

2.3.6 The Fisheries Judicial System (FJS)

The Namibian Judicial System does not provide for special fisheries courts. The normal legal process takes too long to process fisheries cases that most times are urgent. In Namibia fisheries violations are treated as criminal cases. Prior to the revision of the fisheries legislation, fisheries offences were considered minor offences and the courts were thus reluctant to give heavy penalties for fisheries violations.
This situation might have sent the wrong message to lawbreakers that fisheries resources were of insignificant economic value compared to other natural resources, (e.g. diamonds, which is highly valued). With the revised Sea Fisheries Legislation, the issue of penalties has been addressed by increasing the maximum fine to N$ 2 million for serious violations. The new legislation does not state minimum fines. At the same time, it remains questionable whether the judicial personnel is trained well enough to understand the dynamics of the fisheries sector and

its role in the national economy, since the courts are entrusted with the responsibility to determine the monetary value of fisheries fines.

2.3.7 Administrative and Advisory Capacity

The advisory and administrative capacity is limited, making it difficult for both the Government and the industry to meet their objectives in developing the fisheries sector. The Ministry is heavily dependent on advice by expatriate advisers in policy and planning while no formal department of legal affairs exists within the Ministry of Fisheries and Marine Resources.

2.3.8 Future Issues in the Namibian Marine Fisheries Sector

1. Continuous stock assessment and development of the orange roughy fishery,
2. Improving the consultative process between the Government, the industry and other stakeholders,
3. Putting a proper management regime in place for orange roughy deep-sea fishery.
4. Refining management strategies to cope better with effects of environmental conditions.
5. Improving collaboration with Angola and South Africa.
6. The establishment of a Regional Fisheries Management Organization for the South-East Atlantic Ocean.

3. THE ORANGE ROUGHY (*HOPLOSTETHUS ATLANTICUS)* FISHERY

3.1 Background

Orange roughy is widespread in the South Atlantic, off the coasts of Namibia and South Africa, and in the Pacific off the coast of Australia and New Zealand. Its flesh has a firm white texture; almost shellfish like flavour, which can withstand temperature changes. Fillets are deep skinned to remove the sub-dermal wax ester layer. The skin and subcutaneous layer is rich in oil, which can be used in a variety of cosmetic and related industrial applications. Orange roughy has been listed the most valuable fish among all demersal species in Namibia, with price unit value of approximately US$ 2.5 per kg (approximately N$15 per kg).

The Namibian orange roughy TACs Policy is based on the experiences of the orange roughy fishery in Australia and New Zealand. In those countries initially, fishermen and managers assumed that the species would sustain the same kind of fishing pressure as other demersal species such as hake until they realised that a more conservative approach was needed.

Exploratory fishing for orange roughy in Namibian waters commenced in 1994. In 1997 and 1998 three companies were allocated commercial quotas from a TAC of 12 000 t and two other companies were given exploratory fishing rights in the Exploratory Fishing Areas (EFAs). The EFAs are areas that before being declared Fisheries Management Areas are first operated experimentally.

The fishery has to date been considered to be based on a unit stock but managed assuming four separate aggregations. Recent research has indicated that one aggregation (Hotspot) is most likely biologically distinct from the other three known aggregations (Rix, Frankies, and Johnies) (Appendix 2).

Surveys started in April 1994, but major acoustic and commercial swept-area stock assessment surveys were undertaken with the assistance of a Norwegian research vessel (R.V. Dr. Fridtjof Nansen) accompanied by a fishing vessel from the industry in July 1997 and repeated in July 1998. Results from these surveys were used to estimate the biomass indices and to determine biological parameters.
Further data used in the 1998/1999 quota-year stock assessment include commercial catch and effort data. A Bayesian risk-analysis, based on an age-structured production model was performed for each ground separately. The following three indices were used in the model: (i)-targeted acoustics, (ii) commercial swept-area, and (iii) research swept-area biomass indices. Table 5 describe the research pattern for orange roughy stock assessment since 1997 (NatMIRC 1999).

Table 5: Stock assessments from 1997 – 1999 (Nat-MIRC 1999).

Previous assessments of orange roughy	
1997 -	Swept area analysis on commercial CPUE data (Branch)
1997 -	Acoustic/trawl survey(Dr. Fridtjof Nansen)
1998 -	Swept area analysis on commercial CPUE data (Branch)
1998 -	Acoustic/trawl survey (Dr Fridtjof Nansen)
1999 -	Swept area analysis on commercial CPUE data (Brandao)
1999 -	Bayesian assessment and risk analysis(McAllistar and Kirchner)

During the surveys swept-area analysis of commercial catch rate data was used to provide a relative abundance estimate. The surveys covered three of the major aggregations and their immediate surroundings and the data collected facilitated the compilation of biomass estimation based on hydro-acoustic and Commercial Swept–area Methods. Commercial Swept-area Method is the method used by commercial fishing vessels for the purpose of research on commercial basis (See Table 6).

Table 6: Actual catches and relative abundance indices used within the population dynamics model (by QMAs) (Nat-MIRC 1999).

1. Johnies				
Year	Actual Catches	Acoustic	C-Swept-area	R-Swept-area
1994				
1995	4531		109650	
1996	1610		61286	
1997	4730	26081	72915	57650
1998	4677	3837	16772	6980

2. Frankies				
Year	Actual Catches	Acoustic	C-Swept-area	R-Swept-area
1994	-	-		-
1995	-	-		-
1996	9611	-	46801	-
1997	5307	16055	20815	30995
1998	2820	5311	5130	2400

3. Rix				
Year	Actual Catches	Acoustic	C-Swept-area	R-Swept-area
1994	-	-		-
1995	151	-		-
1996	1475	-	15286	-
1997	1975	14187	23728	-
1998	4277	8140	19717	-

4. Hotspot				
Year	Actual Catches	Acoustic	C-Swept-area	R-Swept-area
1994	-	-		-
1995	824	-	21469	-
1996	622	-	8381	-
1997	283	-	4439	-
1998	227	-	4539	-

As per Table 6, the sequence of research activities indicates that not all fisheries management areas have been explored.
Since 1997, age determination work has been carried out to study the age at maturity and growth of orange roughy from the four known Namibian grounds. The age study indicated that age at maturity differs between Hotspot and the three southern areas of Johnies, Frankies, and Rix. The latter are similar, that's why their data has been combined for estimating age and growth values. The study has also outlined that although adequate data to estimate growth parameters for the three southern grounds were obtained, there is insufficient data for Hotspot where age at maturity and size structure of orange roughy are similar to orange roughy in New Zealand.For the 1998/99 quota year the centres of aggregation at Frankies and Johnnies moved slightly southwards compared to 1997/98. The proportions of exploratory fishing in 1998/99 is given in Table 7.

Table 7: Exploratory fishing effort for the 1998/99 fishing season up to end October 1998 (Nat-MIRC 1999).

Orange roughy 98/99			
		98 QMA boundaries	
Season	Ground	No. of tows	Catch (t)
98/99	Hotspot	98	167.8
	Rix	1444	3759
	Frankies	591	531
	Johnies	1005	4382
	Total	3138	8839.8
	Exploratory	133	46.8
	Total	3271	8886.6

The virgin biomass (B_o), biomass at the end of 1999(B_{99}) and the depletion of orange roughy on each ground ($\%B_{99}/B_o$) as well as for the combined stock was estimated and the results are shown in Table 8 while the uncertainty in these estimates are indicated by the high coefficient of variation. The probability density functions for the virgin and current stock size of each ground are shown in Figure 2.

Table 8: Posterior Medians and CVs in parenthesis for virgin stock size (B_0) (average unfished biomass), and stock biomass (B_{99}) and stock depletion ($\%B_{99}/B_0$) at the beginning of the year 1999 (NatMIRC 1999).

	B_0	B_{99} (CV in % terms)	$\%B99/B_0$
Johnies	42000 (46)	26000 (63)	0.61 (3.4)
Frankies	34000 (41)	17000 (64)	0.49 (3.9)
Rix	43000 (52)	35000 (56)	0.79 (2.4)
Hotspot	18000 (80)	16000 (84)	0.86 (2.6)
Total	13 700 (219)	94 000 (267)	2.75 (12.3)

The industry established from the catch results that the orange roughy at Frankies is not available to the fishing gear and they agreed among themselves that in order to determine the cause of this, only one vessel would be deployed at Frankies at any one time.

Figure 2 shows the probability spread of biomass, the peak indicates the biomass with the highest probability of being the most precise one (Nat-MIRC 1999).

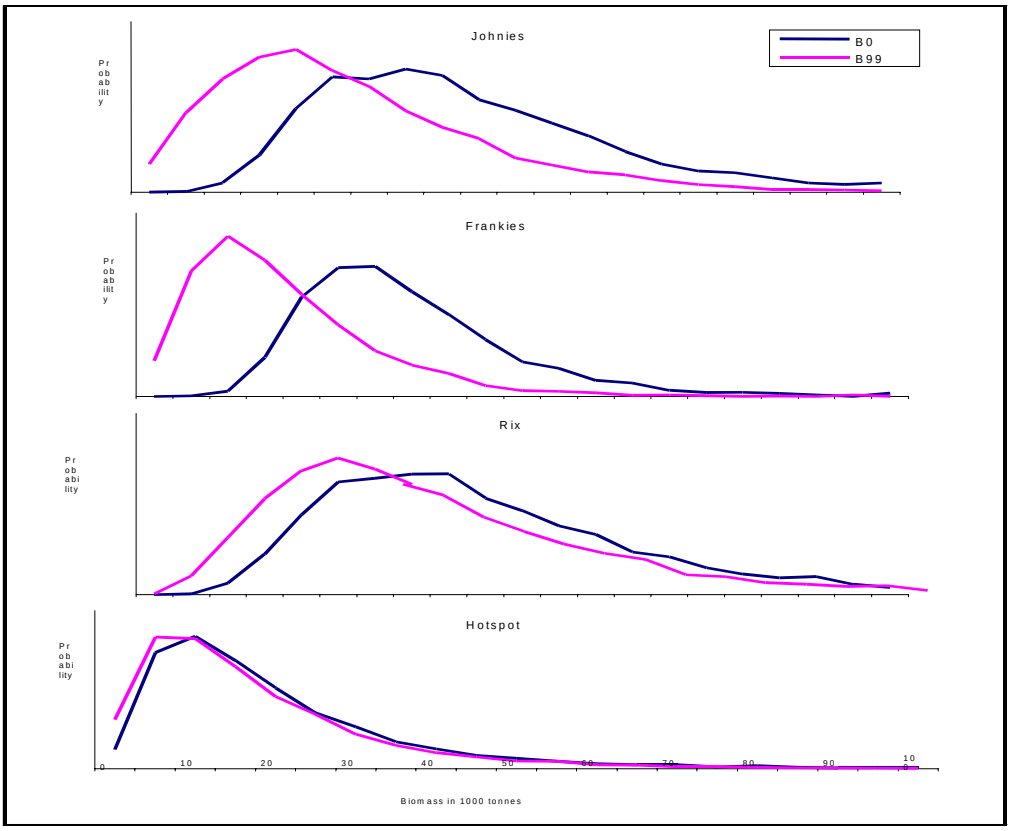

Figure 2: Probability density functions for the virgin stock size (B_0) and stock biomass (B_{99}) for the four quota management areas (NatMIRC 1999).

Risk analyses were performed using these biomass estimates for Hotspot, Rix and Johnies respectively (Table 9).

Table 9: Depletion and risk of depletion beyond the 0.5 B_0-levels which is MSY level) in the year 2000 (NatMIRC 1999).

QMAs	TAC	B_{2000}/B_0	$B_{2000} < 0.5B_0$
Hotspot	500	0.86%	3%
Rix	5000	0.71%	15%
Johnies	3000	0.56%	39%

Research on age and growth of Namibian orange roughy is continuing this year, and studies to estimate natural mortality from Johnies and simulation work to estimate sustainable yield levels relative to virgin biomass, should be completed in the near future. Estimates of natural mortality are of utmost importance as most stock assessment models, including the age-structured production model used in this analysis, are very sensitive to change in M. In this case the higher the M estimate the lower the predicted risk (Table 10).
The biological parameters for orange roughy have been revised from last year and are summarised in Table 10. Biological parameters estimated from age-readings were used in the 1998 assessment of orange roughy ("Baseline '98").

Table 10: Revised biological parameters for Namibian orange roughy (NatMIRC 1999).

PARAMETER	JOHNIES/ FRANKIES/ RIX	HOTSPOT
$L\infty$	29.5	37.0
K	0.069	0.065
T_0	-2.0	-0.5
A_m (A_r) *(age at mortality & Age rate)*	22.4	28.0
M *(Fishing Mortality)*	0.055	0.045

There are currently nine vessels fishing for orange roughy in Namibian water. This figure has increased by four vessels from five vessels in 1997/98-quota year.
Orange roughy must be processed on shore and there is only one processing plant run by Gendor, which also process the roughy caught by other companies.

3.2 Biological and Ecological Conditions

The Pacific orange roughy is believed to have a life span of more than 100 years and in general they reach sexual maturity only after reaching the age of 30 years. This makes the species vulnerable to overfishing and indicates that this resource cannot sustain significant exploitation.
The Namibian orange roughy however is believed to reach sexual maturity at an earlier age of 24 years, which may indicate a higher reproduction rate. They are smaller at maximum size than those found off New Zealand and Australia (Namibia Foundation 1998).

Although the Namibian orange roughy appears to be faster growing than in New Zealand and Australia, it is still a relatively slow-growing and long-lived species. Thus biological productivity is low, which translates to low sustainable yields.
Namibian orange roughy is distributed along the continental shelf edge from orange River in the South to Kunene River in the North. At this stage there are no indications that this resource is transboundary. These fish are located in gullies fauna hard rocky seamounts at the depth of 800 m to more than 1200 m. Being confined to such great depths, relatively little is known and stock assessment and management is difficult. The fish aggregate in a well-defined spawning season from June to September, but during the rest of the year are more widespread (Namibia Foundation 1998).
The 1994/1996 stock assessment survey recorded the biomass of orange roughy at 300 000 - 350 000 t. In 1997, stock assessment pointed to a lower biomass between 50 000 t and 110 000 t. During the 1997 survey an abundance of juveniles fish were caught, a new phenomenon in any orange roughy Fishery.
The discovery of shoals of small young orange roughy was very exiting news, because it is a sight that perhaps has never been observed elsewhere and it creates hope for future recruitment in the orange roughy fishery. The stock assessment survey of 1998/99 quota year pointed to the biomass estimates is less than 150 000 t of orange roughy aggregation, a higher figure than the estimates of 1997 (NatMIRC 1999 and Namibia Foundation 1998)(Table 11).

Table 11: State of the orange roughy stock 1998/99 (MRMF NatMIRC 1999).

State of the stock 1998/99	
Total biomass of the known four grounds of orange roughy:	< 150 000 t
Recruitment:	Unknown
Distribution:	Presently 4 known grounds
Recent exploitation level:	High, due to overfishing
Overall stock indicator :	Exploited (developing fishery)

The description of the allocated TAC and corresponding balance is shown in Table 12 which combines the catches, allocated TACs from 1994 to 1999 and the balance of what has been utilised and what was not utilised in percentages.

Table 12: Orange roughy TACs and balances with percentages from 1994- 1999 (MFMR 1997a and 1998).

Species	Year	Allocated TAC	Catches (tons)	TAC Remain-	% remaining
Orange roughy	1994	0	158	0	0
	1995	0	6,825	0	0
	1996	0	12,463	0	0
	1997	12 000	13,314	- 1314	-11%
	1998	12 000	10,945	1055	8,8%
	1999	9 000	-	-	-

The initial TAC was 3 % of the 300 000 ton estimated fishable biomass. This demonstrates how the Namibian Government decided on a conservative approach. This conservative management strategy was developed to ensure the long term sustainable utilization of this new valuable resource. The industry fully agreed with the Government's approach and the industry believed that with the quota for

orange roughy of 12 000 they could make a healthy profit without extending the resources (Dr. A. James pers.com.).
The TAC for 1999 was 9 000 tons, a significant reduction from 12 000 tons the previous year.

3.3 Socio-economic conditions

One of the attributive factors that accelerated the economic performance of the fisheries sector, doubling itgs contribution to the gross domestic product and export, is the development of the deep-sea fishery targeting orange roughy. Other attributive factors are the increases in the unit value of production, the decline in the value of the Namibian Dollar, the increase in real prices for most products and increase in value adding. The economic indicators of the fishery are summarised in Table 13.

Table 13: Economic indicators (N$ million) (MFMR 1998)

Fishery	Years	Production Value	Export value	Fund levy payable	Revenues
Deepwater-	1994	0,3	N/A	N/A	N/A
Orange roughy	1995	35,1	32.3	N/A	N/A
Fishery	1996	171,1	153.3	N/A	N/A
	1997	N/A	205.3	1.02	2.02
	1998	N/A	205.3	1.67	2.03

The Sea Fisheries Fund levy rate for orange roughy in 1997 and 1998 was N$ 150 per ton.

3.4 Regulatory conditions

The quota management regime for orange roughy was established in April 1997 with TAC set at lower level in the order of 3 % of the available biomass. Currently the fishery is based on four main grounds and the fifth one is under development.
Five vessels participated in the fishery during the 1997/98-quota year competing for a TAC of 12 000 tons. The performance of the fleet indicated the targeted nature of the deep-water fishery with a small by-catch component. Targeting and the limited size of the fleet enabled close co-operation between the industry and the Ministry and thus control of the development of this new fishery.
Nevertheless the number of vessels increased to nine in the quota year 1998/99, competing for a reduced TAC of 9000 tons.
Out of the 39 applications for deep-sea rights received by the Ministry in 1997, only five were allocated. The Five successful applicants were Atlantic Sea Products, Gendor Fishing, Glomar Fisheries, Continental Deep-sea Fishing, and Consortium Fisheries. Of these, the first three have been granted quotas for orange roughy in 1997. The other are expected to begin fishing when the fishery is more developed. All were granted four year rights except Gendor who received a 7 year exploitation right and a quota of not less than 33,3% of the overall TAC for any new stocks discovered during Gendor's exploratory fishing activity.
There are measures aimed at economic gains, this includes (a) recruitment and incentives for on-shore processing and (b) incentives to register vessels as Namibian and employ Namibian crew. Orange roughy is required to be processed onshore and rebates on quota fees are provided for onshore

processing, whilst quota fees are reduced for Namibian vessels of which more than 80% of the crew are Namibian nationals. (Namibia Foundation 1998)
It appears that there is little bycatch in the orange roughy fishery. The bycatch fee rates for orange roughy in 1997 and 1998 was $ 6 500 per tonDevelopment of A Management Policy for THE Orange Roughy Fishery

It should be aknowledged, that although the process to put in place a management regime for orange roughy is well on course, there is still room for improvement especially in strengthening the research capacity and stock assessment areas.
In developing a refined management policy for orange roughy, the national objectives and fisheries policies of Namibia were taken into account.

3.5 National Objectives

The overall objectives of the Fisheries Sector are clearly outlined in the National Development Plan 1995/96 - 1999/ 2000 (NDP 1) as:

> "To utilise Namibia's fisheries resources on a sustainable basis and to develop industries based on them in a way that ensures their lasting contribution to the country's economy and overall development objectives" (NDP 1, p. 191).

In interpreting the above national objectives, three goals have been identified:

1. Sustainability
2. Creation of wealth
3. Other development goals

In terms of NDP 1 these goals are pursued through: (a) Stock rebuilding, and (b) Namibianization. The sectoral strategies promoting these objectives are envisaged in the Government Legislation on the Fisheries Sector. These can be summarised as follows:

- "Promotion of stock recovery to long-run sustainable yield levels through the conservation of marine resources and protection of the Namibian EEZ.
- Eradication of illegal fishing by unlicensed vessels and the control of fishing practices.
- Promotion of on-shore processing by means including the introduction of on-shore processing incentives.
- Namibianization of the fishing industry by encouraging access to the sector by Namibian nationals with emphasis on those who have been socially, economically and educationally disadvantaged by discriminatory laws and practices which were enacted or practised before the independence of Namibia.
- Promotion of human resources development in both the public and private sector.
- Provision of protein to the local population by making fish available at affordable prices.
- Maintenance of a fair contribution by the fisheries sector to Government revenue.

For the implementation of these objectives, the following have been identified:

- Setting of TACs at levels capable of promoting the recovery of depleted fish stocks.
- Application of efficient and competent methods with regard to the granting of fishing rights, the allocation of fishing quotas, and the licensing of fishing vessels.
- Strengthening of research capacities to facilitate the decision-making process on matters related to the setting of TACs.
- Building up of conductive environment for investment in on-shore processing facilities.
- Promotion of joint venture-undertakings between Namibian and foreign-owned companies.
- Application of a quota fee and research levy system for generating Government revenue." (NDP 1, V.1, p. 191-192).

3.6 Objectives of the Project

The objective of the project is to design an improved Fisheries Management Policy for the orange roughy Fishery in Namibia. In order to better ensure that the orange roughy resource is utilised in a manner that is consistent with the principle of long-term sustainability and promotion of social welfare. The desired management policy would provide strategies to finalize the orange roughy Fishery Management Regime.
The mean towards the realisation of the objective is the identification of better fisheries management strategies.
Two quota management tools can be identified:

1. The Current Individual Quota System (Enterprise Quota System)
2. The Individual Transferable Quota (ITQs)

These quota management tools each have their merits and should be considered within the context of national policies and the sectoral objectives.

3.7 Individual Quota System (IQs)

Since the orange roughy Fishery quota management system is already based on Individual Quotas, their in-depth discussion is less feasible at this stage. Therefore, attention is drawn to explore the Individual Transferable Quota System. It is, however, proposed that where the IQs are retained, the following recommendations are essential:

a) Sufficient scientific data should be obtained for determining the TAC
b) The TAC should be set at lower levels not exceeding 8000 tons
c) The number of vessels should be reduced to five in order to avoid crowding

3.8 Individual Transferable Quota System (ITQs)

The concept of Individual Fishing Quotas emerged in the context of long histories of conflict over limiting access to marine resources and until recently, an apparent social and legal commitment to the principle of open access. They have been depicted as a part of one of the great institutional changes of our times: the enclosure and privatization of the common resources of the ocean, as they followed the expansion of national jurisdiction over the seas in the late 1970's.
However their appearance in fisheries management in the 1980's and 1990's is more a product of the historical process of widening and deepening the role of markets and increased recognition of economic factors in protecting environments and managing natural resources. Therefore the ITQs are part of the current global expansion and integration of markets extended to fisheries. Even though their history is short, they are firmly rooted in the long tradition of Western thought and policy, where markets are the source of efficiency and ultimately, of economic growth and social welfare; exclusive, transferable, and well-defined property rights are the essential to markets (Sharing the Fish 1999).
ITQs are individual transferable quotas. They create property rights in the harvesting quantity. This property right is not a perfect one, it is not a property right in the fish stocks and even less so in individual fish (as would for example be the norm in animal farming).
This particular property right goes a long way (albeit not the whole way) toward eliminating the common property arrangement of the fish stocks and therefore the common property problem is greatly alleviated and the market system is in a position to generate a reasonably efficient utilization of the fish stocks.
It should be born in mind that when considering management of fish stocks based on the ITQs system, the fishery is being moved from the common (State) management regime to a property rights

management regime as the quota management will be determined by market forces. In Namibia there are several problems associated with introducing the ITQs, thus this project offers an opportunity to discuss these associated problems. These associated problems are discussed in a later section. Here follows the main ingredients of an appropriate specified ITQs system:

1. Share quotas: there should be various fractions of quotas in percentage and not in quantity.
2. Permanent: these fractions of quotas should be permanent.
3. Perfectly divisible and transferable: again these fractions of quotas should be able to be divided and transferred in a perfect manner. Transferability is very important because the share will go to the most efficient company and in the event where you have equally efficient companies it will benefit both companies. A careful approach should be taken, because the less economic efficient companies will leave the business, in which case the indigenous fishers are vulnerable and thus there is a risk of a monopoly. The concern is the possibility of creating a foreign monopoly in the national fishery, as it could undermine the constitutional policy toward economic development.

Under an ITQ system, each company should be in a position to maximise the profits from using its quotas. This depends heavily on the fact that the market works reasonably efficiently; thus the most efficient fishing companies will do the fishing. It then follows that the Total Allowable Catch will be caught in the most efficient way. For Namibia the questions of which are the most economic efficient companies and how efficiently the Namibian market works, are still unanswered.
Once rules have been established for the allocation of quotas the remaining problem is the setting of TAC, which depends on the condition of the stocks.
The value of permanent quota shares in the quota market, if accurately done, will reflect the expected fisheries rents given the existing and expected TACs. These expectations are those of the fishing companies and other quota market players and therefore it follows that in setting the TAC the Government will only have to:
(a) Monitor permanent quota share prices on the quota market
(b) Adjust the TAC until quota prices are maximized.
This procedure largely reduces the need for governments to run the fisheries research.
In terms of the Icelandic rules governing the ITQs Program, at the beginning of each fishing year the TAC for individual species is divided up between all the fishing vessels which hold a quota share for the species concerned. The combined share for all vessels amounts to 100% of each species. The quota share is multiplied by the TAC to give the quantity which each vessels is authorised to catch of the species concerned during the fishing year. This is referred to as the vessel's catch quota for a species.
A vessel's catch quota can change for a number of reasons:

- If the TAC is increased or reduced
- By transfer of catch quota for a single fishing year (rental quota)
- By transfer of quota share (permanent quota)
- By taking advantages of the option of moving catch from one fishing year to another
- By using a limited option to exchange one species for another

The above indicators inform us that both quota and catch quotas may be transferred between vessels. Although the transfer of harvest rights between fishing vessels is not valid until it has received the confirmation of the Directorate of Fisheries, there are in fact few limitations on transfers of either quota shares or catch quotas between fishing vessels and there is an active market for harvest rights and their price is determined by the current supply and demand.
The concept behind the Icelandic quota system is said to be simple. The aim of dividing the TACs among individuals fishing vessels was to prevent the wasted effort involved in competing for limited catch. In order for the system to have been introduced with minimum disruption, harvest rights were allocated in the beginning to fishing vessels on the basis of past catch performance. The decision to

have quotas that were transferable between vessels was intended to increase the cost-effectiveness of fishing and allow vessel operators flexibility.

3.8.1 Main advantages of the ITQ System

1. ITQs are theoretically efficient.
2. ITQs utilise the advantages of the market system to the utmost (to the greatest or highest degree).
3. Offers the opportunity for minimum centralisation, there will be less Government intervention as some management functions will pass to the private sector, e.g. quota trading and research.
4. Trading in catch quotas takes place through a public market, the Quota Exchange and anyone wishing to buy or sell quotas must register a bid or offer with the Exchange, and the trading in each individual species takes place at the same trading price for a single day.
5. Relatively inexpensive to run. This is because once some management functions are passed to the private sector, the Government will no longer have to fund the operations of such functions, thus reducing the cost of management.
6. ITQs work best in single species fisheries or in fisheries where all catch can be effectively controlled.
7. Flexibility: ITQs creates flexibility for vessel operators, while at the same time reduce the need for centralised decisions by the authorities. This is because vessel operators can increase or reduce their harvest rights and change their composition in accordance with what they feel is cost-effective. This is possible without infringing the rights of others, since full payment for harvest rights is made either in monetary form or by exchanging rights.

3.8.2 Main disadvantages of the ITQ System

As Namibia has already an IQs in place, there may be little problems with ITQs. There could be problems associated with administrative aspects such as:

(1) Discarding
   (a) An increased tendency to discard inferior fish. They can encourage discarding and dumping at sea if this provides an advantage to the fishermen. Discarding can also occur when landings are restricted and there is a price differential depending on size. The fishermen may dump small lower-valued individuals and retain only the larger more valuable sizes. The total impact of discarding is not clarified yet in fisheries theory, but one may assume that it occurs due to the market demand for high quality fish.
   (b) An increased tendency for improved catch selection. Fishers will be compelled to catch fishes of good quality (mature fish) as they have the most economic value.

(2) Quality of fish catch
   (a) An increased tendency for improving the quality of the catch, because there will be fewer nets, shorter hauls, better preservation of catch.
   (b) The impact on the catch quality almost certainly positive in the short run while the long run is more uncertain.

(3) Enforcement

   If the individual quotas are transferable they can be effective in maintaining a balance between the resource and fleet capacity levels because fishermen have no incentive in unnecessary fishing power and the open access problem is overcome. However, this system requires accurate resource assessment, monitoring, and control of catches to work. Unless this is assured in Namibia, such a system will fail.

The experience with the ITQs where they have been adopted is generally very good, still there are few developing countries with a very good record of the ITQs.

In Argentina in 1998, a law was passed by Parliament introducing the ITQs as a fisheries management tool, but this particular legislation could not be implemented. The Argentinean Fisheries Legislation that provides for the introduction of the ITQs has institutionalised the creation of a Federal Fisheries Council, a National Fisheries Fund, a National Reserve for crews and a Resources Extraction Fee. It also introduced an ITQs quota management system, extended provincial jurisdiction from 3 to 12 miles, set aside quotas for artisanal fisheries and a strict penalty and infraction regime. As priorities, the law includes a range of issues to be considered when allocating quotas. These are:

- the size of the local workforce employed ion the sector
- effective investments in the country
- average harvest of the past 8 years
- average fish products processed at sea and on shore
- the absence of infractions

The new Argentinean Fisheries Law placed a wide range of management measures including area and time closures, vessel replacement rules, TACs, fleet quotas, and ITQs.

Although Argentina opted for the ITQs to address the overexploitation crisis and the Government has taken several steps, this could not materialise. Some of the problems emanate from the socio-political front. Preliminary analysis indicated that the implementation of ITQs might have a negative impact on the employment situation due to short-term reduction in the catch and effort. Though social mitigation assistance to fisheries workers will be required there is a political change this year and it is not clear whether with the change of Governments the new authorities will support managing fisheries resources on the ITQs base (Parliamente 1998).

ITQs have succeeded in countries with a good economic balance where the market forces really determine the quota market and countries with little socio-political problems. A clear example can be cited with reference to Iceland, which never experience any real war, Australia, and New Zealand, almost the same as Iceland.

The FAO predictions categorized two groups of major fishing nations that adopted ITQs in their fisheries management system. In the first group fall nations that have already adopted the ITQs in significant parts of their fisheries and these are Iceland, Australia, New Zealand, Canada, the Netherlands, Greenland, Namibia (because of her Individual Quota system with very restricted form of transferability) and South Africa. In the second group fall countries which are preparing to adopt ITQs including Argentina, Chile, Peru, USA, Morocco and United Kingdom (FAO 1997).

3.8.3 Problem areas associated with the ITQs for Namibia

1. One of the problems associated with ITQs is the transferability of quotas (which are property rights) within the parameters of Namibianization and Affirmative Action. This poses a burden to explicitly spell out the manner in which transferability can be done to avoid concessionaires to simple transfer their quotas in an unprescribed manner. Certain rules can be adopted, e.g. quota for orange roughy can be transferred subject to the following conditions:
   a) between Namibian companies or Namibian individuals whose vessels are registered as Namibian vessels and fly the Namibian flag and which more than 80% of its crew are Namibian nationals
   b) between Namibian companies or Namibian individuals whose companies are 100% Namibian-owned
   c) between Namibian companies or Namibian individuals who demonstrated the ability to process orange roughy on shore.

   The definition of a Namibian Company includes joint ventures between Namibians and foreigners who comply with the criteria for the classification of Namibian ownership.
2. ITQs can promote monopoly, because the quota share will always remain in the hands of economically efficient companies and those who can afford the market price. On one side this is

positive as it provide economic efficiency to the most economic strong company, its negative side is in relation to the indigenous quota owners most of whom are not economically strong as they have been previously disadvantaged by colonial discriminatory practices. The indigenous quota owners may be forced out of the fishery and this would be a defeat to the policy of Namibianization.

3. Quota trading is determined by market forces, therefore a fisheries quota trading market should be established with strict operating standards.

3.8.4 The likely outcome of the ITQs

The main effects of the implementation of the ITQ system are likely to be as follows:

a) The fishery is moved from the common (State) property to individual property, which is why the common property problem must be solved. In countries where this system has been applied the perception is that of moving the fishery from a none-profitable or less profitable point to a profitable or more profitable point. ITQs are more related with profitability as the main purpose, while in Namibia profitability is not the only main purpose for the exploitation of marine living resources, it comes along with other national priorities although financial resources from the fishery are indeed needed.
b) An ITQ system would be beneficial in enabling individuals to maximise profits in the industry.
c) This may allow those who practise unsustainable fishing to gain control and force smaller enterprises out of the industry.
d) Consolidation can be confronted by planning restrictions on transferability of the individual transferable quotas. One such limitation would to put an upper limit on how large a quota a single person or company can hold.
e) Regardless of the approach, it is important to establish an equitable ownership allocation process in achieving sustainability. The application of this approach should consider measures aimed at sustainability explicitly.
f) Within the ITQs, selling their individual quotas will pay those who want to leave the fishery. This justifies the importance of having the property rights transferable (quotas); this will contribute to effective management. The new entrants will get access by buying the quota share and rights at the quota market.
g) The costs of operating the ITQ Fisheries Management System would be charged to the industry, because they benefit from the resource. If they pay, the management system is going to be effective and transparent because they would like to know about it, so it is in itself a system of check and balance.

In conclusion, ITQs can be used in a preventive manner to remedy overfishing (if any), overcapitalisation and incentives to fish under dangerous conditions, but in general it is believed that ITQs will be more successful in the following conditions:

- The TAC can be specified with reasonable certainty,
- The goals of improving economic efficiency and reducing the number of companies, vessels and crew in the fishery have high priority,
- Broad stakeholder support and participation in the fishery is present,
- The fishery is amenable to cost- effective monitoring and enforcement,
- Adequate data exist, and
- The likelihood for spillover of fishing activities into other fisheries is recognised and provisions are made to minimise its negative effects.

The proposed Management Policy requires an efficient MCS to ensure the monitoring of:

(a) Licenses and Permits: It is necessary to monitor the fleets on land, at the landing points and at sea.

(b) Individual quotas or ITQs: It will require to monitor the catches at sea, monitor the landings at the landings points and monitor the processing at the orange roughy processing plants.

3.8.5 The Cost of MCS under ITQs

In an ITQ system the cost of management may be charged to the industry. The cost of MCS is a very important aspect to consider because it affects:

(a) The optimal policy
(b) The choices of management tools

Even under the ITQs the enforcement function usually remains the responsibility of the central government. This means the Government will undertake training and providing law enforcers. It does not necessarily cover the cost of MCS that could become the industry's responsibility. In an effective Monitoring, Control and Surveillance system it is good to have the industry operating the MCS themselves, because if the industry cheats, then they cheat themselves. This concept at present is not viable for the Namibian orange roughy, as there are a number of responsibilities within MCS that are too demanding to leave to the industry.

Normally, the cost of management increases with the extent to which the management is trying to control effective fishing effort (Arnason, R. *Costs of Fisheries Management: Theoretical and Practical Implications*. The Annual Meeting of the European Association of Fisheries Economists - EAFE, Dublin 7-10 April 1999). This is illustrated in Figure 3. The figure shows that considering fisheries management costs, the optimal fishing effort (E**) is increased compared to the fishing effort that seems to be optimal (E*)when fisheries management costs are ignored.

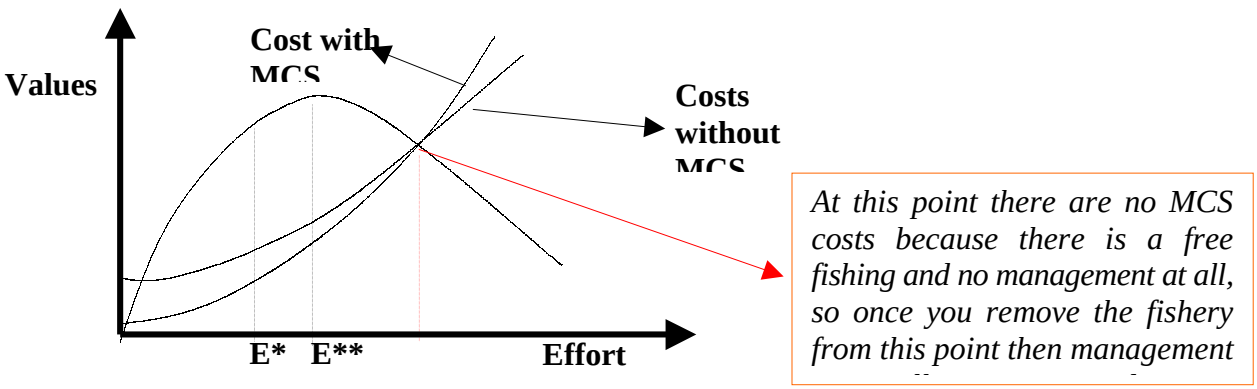

Figure 3: The impact of monitoring costs on the optimal policy.

3.8.6 Policy Analysis

3.8.6.1 Profitability as a function of sustainable harvest

The following formula was employed to assess the profitability of the orange roughy fishery.

$$\pi = P \cdot Y - \alpha P \cdot Y - \beta N$$

π = Profits in millions US$, P = Price of catch in US$, Y= catch in 1000 tons, N= number of vessels in the fishery. α and β are parameters of the cost function; α = Unit Variable costs; β = vessel fixed cost in millions of US$.

Examination of orange roughy profitability accounts indicate the following values of the parameters of the profit function:

P= 2.50, α=0.5, β=2.00.

Thus, the cost function is:

$$\pi = 2{,}5 \cdot (1\text{-}0.5) \cdot Y\text{-}2\ N\ = 1{,}25\ Y\text{-}2\ N$$

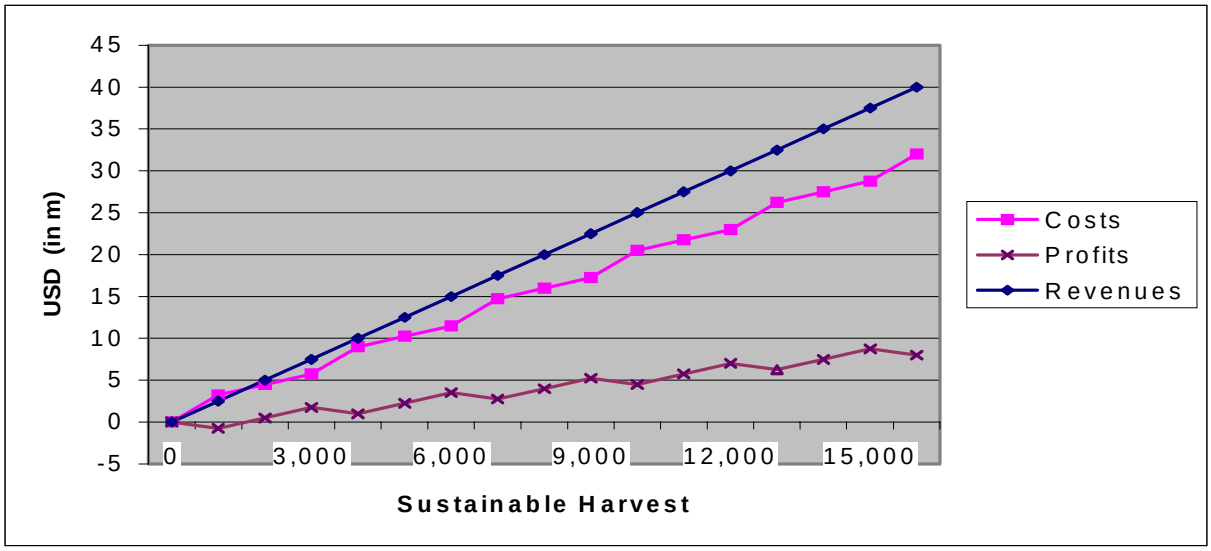

Figure 4: Profitability as function of sustainable harvest

Figure 4 shows that profits can be good even at low levels of TAC. The cost function is not linear since there is a fixed cost per vessel (2 million) regardless of harvest and there is a stepwise increase in the number of vessels needed.
This paper also put strong emphasis on analysis of data to determine the optimal sustainable levels of the stock abundance, the production function and the TACs, to assess the risks in the TACs, biological risks associated with overexploitation, economic risks, the effects on economic rent generation, environmental and other impacts, the real costs of fishing, impacts on operational costs and the affordability of cost reduction, and fishing efforts. All these aspects are of significant impact to the quota management and management performance in general.

3.8.6.2 Biomass Growth Function

The Biomass Growth Function is obtained by using the formula:

$\dot{X} = G(x) = \alpha X - \beta X^2$.

This the relationship between the (G) growth and the number of fish available (X) multiplied by co-efficients α and β.

3.8.6.3 The Harvest Function

The Harvest Function is the relationship between the catch, fishing effort and the available biomass. The following equation can guide us to estimate the harvest function.

$Y = F(e,x) = \alpha \cdot e \cdot x$

Y = harvest, e = fishing effort, x= biomass and α = coefficient (parameter).

3.8.6.4 The Sustainable yield function

The sustainable yield function is a relationship between sustainable harvest and fishing effort derived from the harvest function and the biomass growth function. Typically, this function looks like shown in Figure 5.

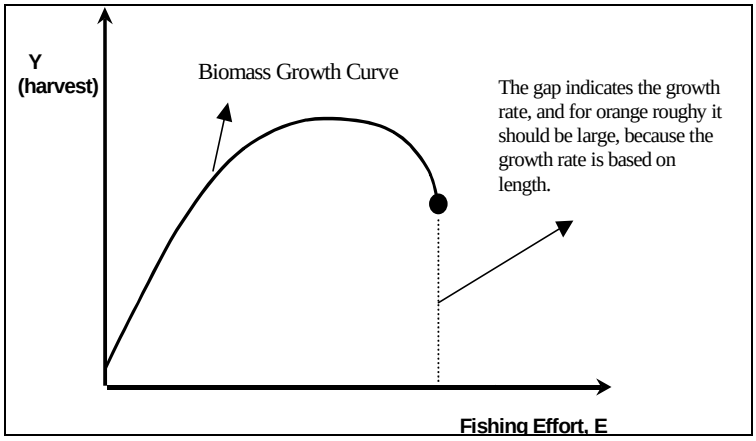

Figure 5: The biomass growth rate.

It is very important to obtain good estimates of the sustainable yield curve in order to determine the optimal TAC and fishing effort policy. Due to the short history of the orange roughy fishery in Namibia and the lack of sufficient scientific data, it was not possible to obtain good estimates of the sustainable yield function.

Therefore, in the case of the orange roughy fishery, it is not possible to determine the optimal TAC. The immediate management task is to set TACs that do not exceed the maximum sustainable yield level.

3.8.6.5 The cost function

The cost is revenue multiplied by fishing effort.

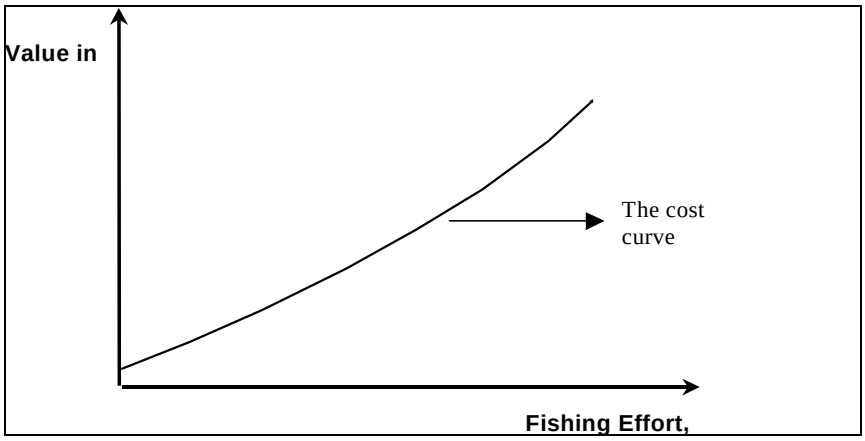

Figure 7: Shows the cost function.

3.8.6.6 The Setting of TAC

In any fisheries management, the most crucial and difficult process is deciding the Total Allowable Catch especially the initial TAC.
The importance of setting the TAC is that without it being determined no quota allocation could be done and consequently no legal fishing activities. Nevertheless, it is important to have the TAC that is set on the basis of scientific information rather than having it determined in the political context. The responsibility to determine the TAC should always lie with the central government in order to meet its constitutional responsibility of sustainable conservation of marine resources.
When TAC is determined many factors should be considered in order to ensure the success of the management process. The following may lead to inappropriate TAC's:

- Inadequate capability and/or data for the provision of scientific advice and analysis on TAC levels. This was the case and continues to be a significant problem in many fisheries, e.g. when ITQs were introduced in New Zealand, there was little information available about the status of many stocks, including orange roughy. In Australia, the introduction of ITQs was delayed in many fisheries because there was inadequate data to confidently establish TACs.
- Manipulation of the TAC in a negotiation context. TACs have been subjected to manipulation in a political context even when the scientific basis of TACs is well established, this was the problem in the European Community and has been identified as one of the major shortcomings of the Common Fisheries Policy.
- Lack of structure in recommended TACs where differentials between price age or size classes are large. This can result in targeting of specific parts of the stock with unexpected implications on overall fish mortality rates and spawning stock abundance.
- Constant catch quotas where stock levels vary considerably as a result of natural variation in recruitment may negatively affect the TACs, because it can result in the increased risk of stock collapse and varying exploitation rates. When recruitment is low, a constant quota will take a larger proportion of the standing stock than it would when recruitment is high (FAO 1997).

4. DESIGNING A FISHERIES JUDICIAL SYSTEM (FJS)

A Fisheries Judicial System can not be devised for each fishery, but for the fisheries sector as a whole. The advocacy in this paper is not that of a special judicial system for the orange roughy fish-

ery as such, but for a fisheries judicial system that constitutes an integral element of a fishery management system, under which orange roughy fishery will be accommodated.
The outlook of the FJS is based on the need to improve it taking into account the economic importance of fisheries to Namibia, the lack of a special Fisheries Judicial System and the role the courts play in the adjudication process.
A theoretical insight is thus important to guide us to look into what should be the purpose of the Fisheries Judicial System.

The purpose of the Fisheries Judicial System needs to:
1. process alleged violations
2. apply sanctions as appropriate

The people in the judicial system should determine what motivates violations in the fishery sector. They need to look into the theory of crime from the fisheries point of view, so that they can devise the appropriate Fisheries Judicial System.
The basic assumption that should guide is **"** *Violations will occur if their expected value is positive* **".** The expected cost is likely to increase with the number of violations. The more violations are committed the more the cost is expected and the greater the benefits from violations and lower the expected costs, the more violations.
If the MCS activities is reduced there will be more violations, if the penalties are reduce there will be more violations, but if the penalties are increased there will be less violations. It is not possible to have a successful MCS if the expected value of violation is positive, because there is benefit in violating the fisheries regulations. It should be given weight that only when the value of violation is negative it will be possible to successfully manage the fishery.
In order to properly address the above issues it is necessary to identify the following:
- What are the respective functions of each component of the management regime;
- All necessary links in the chain of management;

Each component has to be designated with respect to other: e.g. if MCS is poor there is little point in spending a great deal on having a good FJS and FMS.
An important concept is that of deterrence. If the maximum fine that a fisher is liable for is not commensurate with the fisher's perception of his/ her chances of being caught and the gains he makes from violating the regulations, then ignoring the morality of the issue, it is national behavior for many, or even most, to continue breaking the law. At minimum, fines should exceed the product of these two quantities probability of detection and benefit to the fishers from the infraction (Sharing the Fish 1999).

The Judicial System should provide for the establishment of the Special Fisheries Judicial System and in the event where its is impossible because of the legal system in Namibia, the Judicial System should integrate:
1. The legal foundation that is designed to make it sufficiently easy to convict the wrongdoers for breaking fisheries regulations. This requires:
   - a clear, operative definition of fisheries violations
   - a clear and fair stipulation of the burden of proof
2. The system must provide for an effective processing of alleged fisheries violations and this includes:
   - Administrative fines of special fisheries courts
   - Speedy processing
   - Training of officials, judges, lawyers to understand the fisheries importance to the country's economy and that is giving weight to the value of fisheries resources. This is very important since the courts are entrusted with the responsibility to determine the monetary penalties from fisheries violations

4.1 Approaches that can be taken to improve the FJS

I. Training sessions for judges, to explain the implication for conservation of fishermen breaking the law. This approach can be taken accord the judicial personnel and fisheries managers to discuss the implication of fisheries conservation measures within the context of national and international law.

II. Invoking automatic penalties whenever there has been violation. Sometimes the response has been tied as a condition to the license and this will mean that the Ministry of Fisheries and not the courts will have the power to force the pace of enforcement, e.g. no fisher's license can be renewed if all data required by the Ministry have not been satisfactorily provided by the license holder for the preceding season.

III. Place fisheries offences in the context of the civil law as opposed to the criminal law, for example such is case in the USA where the civil penalty is employed in federal fisheries legislation. The main advantages of this is that standard of proof may be lower, and it allows more case settlements just like other civil suits instead of plea bargaining, tough penalties are often lower. It often means that matters can be settled quickly and vessels are released quickly.

IV. In New Zealand for example, a major part of enforcement process works by requiring companies in the possession of fish or fish products to be licensed and that all fish transactions be recorded with the records maintained for seven years, misreporting transactions is treated in a similar manner as a bank cheating its customer it is considered commercial fraud (FA0 1997).

5. RECOMMENDATIONS

The following is a set of recommendations in relation to management of orange roughy in order to meet the sustainability criteria and promotion of social welfare.

1. The TAC for orange roughy should be set at lower levels not exceeding 8 000 tons until sufficient scientific data is available for all five MFAs.

2. Sufficient scientific data serves as the basis for determining TAC.

3. Judicial Personnel needs to be trained to understand the complexity and economic importance of fisheries, because they have the responsibility to determine the monetary value of penalties from fisheries violations.

4. Stock assessment in all FMAs should be completed as soon as possible, no later than by the year 2001.

5. Reduction in the number of vessels to five in order to avoid overcapacity

6. Maintain the number of orange roughy processing plants at no more than two; in order to avoid overinvestment.

7. Maintain a reduce number of right holders in the orange roughy fishery.

8. Increase the proportion of Namibian participation in the orange roughy fisheries in order to meet the requirement of Namibianization.

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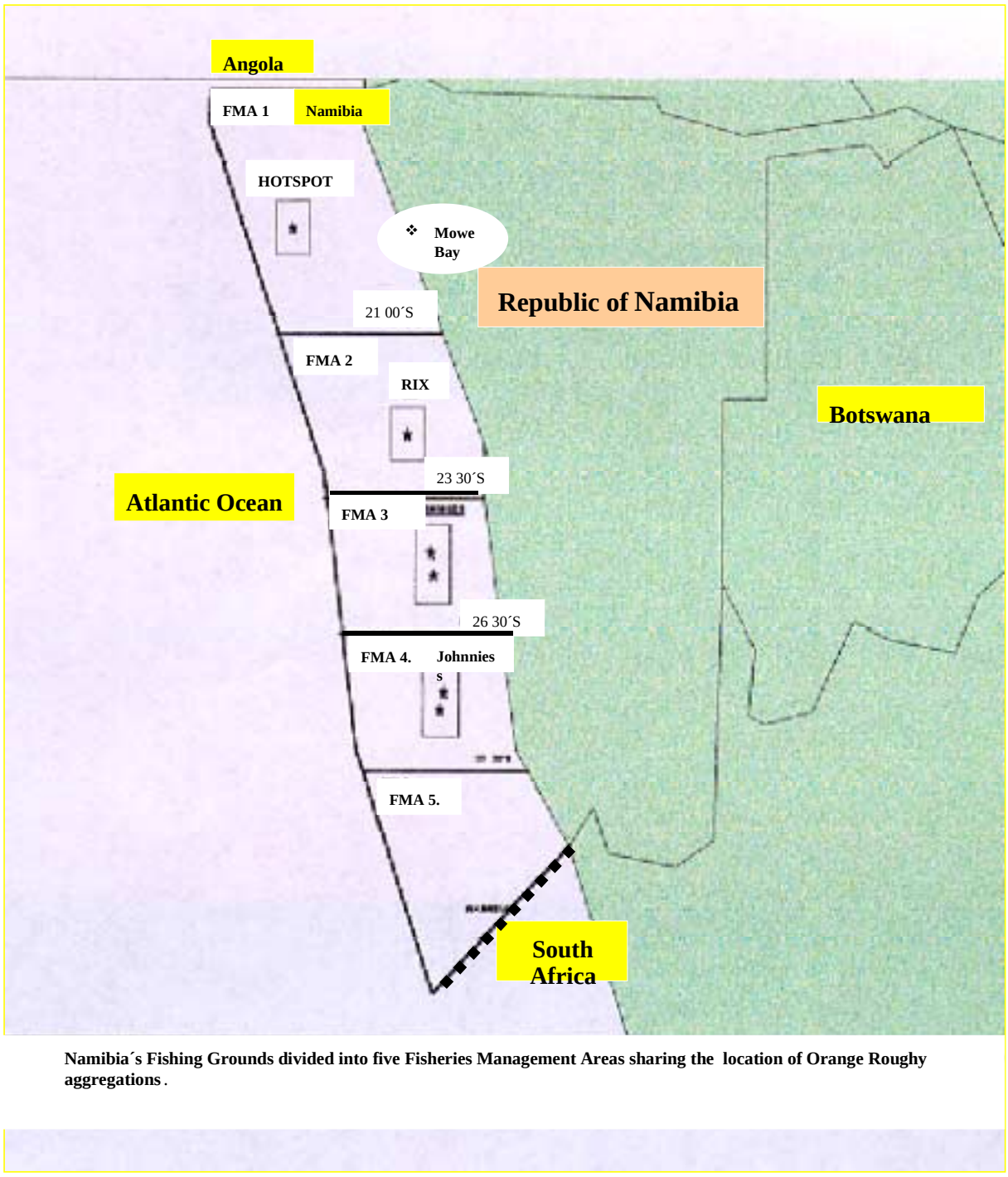
Appendix 1: Abbreviations

1. CPUE: Catch Per Unit Effort
2. C-Swept-area: Commercial Swept Area
3. CV: Coefficient of Variation
4. DWFWG: Deep Water Fishing Working Group
5. EEZ: Exclusive Economic Zone
6. EFAs: Exploratory Fisheries Areas
7. FJS: Fisheries Judicial System
8. FMA: Fisheries Management Area
9. FMR: Fisheries Management Regime
10. FMS: Fisheries Management System
11. GDP: Gross Domestic Product
12. IQs: Individual Quota System
13. ITQs: Individual Transferable Quotas
14. MFMR: Ministry of Fisheries and Marine Resources of Namibia
15. MCS: Monitoring Control and Surveillance
16. MSY: Maximum Sustainable Yield
17. N$: Namibia Dollar
18. N/A : Not available
19. NatMIRC: National Martime Information and Research Centre of Namibia
20. NDP 1: First National Development Plan
21. NJS: Judicial System
22. OFCF: Overseas Fishery Co-operation Foundation of Japan
23. OSY: Optimum Sustainable Yield
24. QMA: Quota Management Area
25. R-Swept –area: Research Swept Area
26. SWAPO: South West Africa People's Organization
27. TAC: Total Allowable Catch
28. UNU FTP: United Nations University Fisheries Training Programme
29. US$: United States of America Dollar
30. USA: United States of America
31. VQS: Vessels Quota System

APPENDIX 2: **MAP OF NAMIBIA FISHING GROUNDS**



Namibia´s Fishing Grounds divided into five Fisheries Management Areas sharing the location of Orange Roughy aggregations.