COASTAL FISHERY MANAGEMENT IN NIGERIA: A BIOECONOMIC ANALYSIS OF THE BONNY ARTISANAL CANOE FISHERY

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ABSTRACT

COASTAL FISHERY MANAGEMENT IN NIGERIA:
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Lack of adequate high quality biological, ecological, social and economic information needed to improve the qualities of policy formulation, planning and management is possibly the single most important problem facing coastal fisheries administrators and managers in Nigeria. The present study shows and quantifies the relative effects of some major socio-economic variables influencing the performance of Nigeria's coastal artisanal canoe fisheries. Some constraints to the productivity of the coastal artisanal fishery and ways to alleviate them are documented.

The data reported in the thesis were obtained from two principal sources, a socio-economic information (including fishing operational costs and revenue figures) obtained through a personal interview questionnaire survey of 287 randomly selected coastal artisanal fishermen and, catch and "effort" data on the artisanal fishery supplied by the Federal Department of Fisheries, Lagos.

A variance analysis of the socio-economic data to compare the Bonny fishery to four other artisanal fisheries in Rivers State shows significant differences between these fisheries based on nine economic performance variables. The fisheries are most disparate in fishermen's

income, fuel cost and labourer's wage. They show also significant differences in fishermen's total operational costs, solvency and quantities of catch sold to cover debt. Only one of the other four fisheries exibits similarities with Bonny. Overall, the differences can be attributed to variabilities in the proximity of the fisheries to urban fish markets, accessibility, local economy, fishing technology, values and culture, all of which may have serious implications for fisheries development program planning, project implementation and results. There are indications that each fishery has its unique characteristics and possibly problems that require locally appropriate solutions.

Standard and stepwise multiple regression analysis of the socio-economic data show ownership of canoe with outboard engine, gear cost, size of fishing operator's household and market channel as the strongest predictors of fishermen's income in the fisheries. Employing fishing labour has a negative effect on income. These results indicate that capital intensity affects economic change in small-scale fishery enterprises; that the household is the basic operational unit (labour force) in artisanal fisheries and that the reliability of market channel affects fishermen's income. Such facts should provide improvements in future coastal fishery management planning and project implementation in Nigeria.

A report of the annual averages of total catch of major fish species per fisherman for the Bonny fishery from 1976 to 1981 shows little variations in the catch figures. Fish price varied constantly during this period but the 1981 average of ₦2.08 per kilogram for the most valued species is reasonably low, compared to the higher prices of other animal proteins such as beef, pork, and poultry. The Nigerian

coastal fishery thus holds promise as an inexpensive human dietary protein source. Lack of knowledge about the present and potential yields from the fishery makes any advice on the probable level of education premature.

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CHAPTER I

INTRODUCTION

A. Background

In recent years, the Nigerian coastal fisheries have become increasingly important and have received greater attention in Nigeria's overall economic development (Nigeria 1975 and 1981). This attention is justified because of increasing shortages of human dietary protein - a common characteristic of many developing countries of the world - which is very pronounced among young children of the rural poor, and high unemployment and underemployment of labour in rural communities. Fish constitute as much as 80% or more of the animal protein consumption for Nigerian native coastal communities, and fishing is their predominant occupation.

Nigeria's fast growing population (approximately 80 million people) and higher income (currently ₦ 560 per capita)[1] have also increased the domestic demand for fish and fish products. The income elasticity of demand for fish in Nigeria is 1 (Sutinen et al. 1981); implying a linear relationship between increase in income and the quantity of fish demanded. Another factor contributing to the increase in demand for fish and fish products in Nigeria is the reduction in numbers of imported cattle from the Republics of Chad and Niger, the production having fallen due to the persistence of the devastating Sahelian drought. According to Josserand (1979), the per capita consumption of fish in Nigeria is greater than that of meat: the ratio of fish/meat consumption is about 1.7.

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[1] ₦ = Naira, Nigerian official currency name.
₦ 1 ≃ 1.57 1982 United States of America dollars.

In addition to rising beef prices, the prices of wildlife meat, poultry, and other protein sources have nearly doubled because of declining domestic production and government restrictions on importation, in order to conserve foreign exchange.

Fish also is a major raw material for the animal feed industry which is growing very fast in Nigeria. Nigeria imports more than N 3 million worth of fish meal annually (Nigeria, 1975). Finally, the agricultural sector (including the fishery) still remains the "mainstay of the Nigerian economy" and its development is based on rural integration (Nigeria, 1981).

Nigeria has the largest domestic market for fish and fish products in West Africa (FAO, 1966; Ladipo, 1973; Sutinen et al. 1981). Current effective demand for fish food in Nigeria stands well over 1.5 million metric tons per annum, but the yearly domestic production was put at 640,000 metric tons in 1972 out of a total supply of 710,000 metric tons (Nelson et al. 1972; Nigeria, 1975 and 1981). More conservative estimates of domestic production are quoted by other sources. The ban on importation of dried cod, locally called "stockfish", during the Nigerian civil war accounts for the low level of fish imports in 1972. Imported stockfish has increased in quantity since lifting the ban in 1974. Table 1 shows Nigeria's projected fish supply from 1973 to 1980.

Despite the high demand for fish food in Nigeria, it has one of the lowest per capita consumption of fish, 6.3 kg per person, in the entire Eastern Central Atlantic Region (Crutchfield and Lawson, 1974). This compares to the 10 kg. per person for the whole region. Congo, Senegal, Gabon and Gambia have the highest figures of 33.3, 29.8, 28.1 and 24.2 kgs. per person, respectively (FAO, 1971).

Table 1. Nigeria's Projected Fish Supply in Thousand Metric Tons.

Year	Domestic Production*	Stockfish Imports**	Other Fish Imports***	Total Supply
1973	663	13	85	761
1974	700	105	95	900
1975	740	250	100	1,090
1976	818	260	110	1,185
1977	895	270	120	1,285
1978	985	280	130	1,295
1979	1,085	290	140	1,515
1980	1,190	300	150	1,640

SOURCE: Nigeria (1975) pp. 125, Table 9.2.

*Figures based on assumed 10% annual increase in production.

**Based on removal of import restriction imposed during the civil war.

***Converted to line weight equivalents.

In Nigeria, like in many other countries of the world, the fisheries according to the third and fourth National Development Plans are managed for economic, social, and biological objectives. Specific objectives are: (1) to increase production from Nigerian waters to meet local demand and reduce imports; (2) to earn foreign exchange by exporting highly valued shrimp which is abundant in the Niger River delta; (3) to improve the quality of life of the small-scale indigenous fishermen through improved earnings from fishing; (4) to provide employment for the unemployed and underemployed rural poor by making the fishery more productive; (5) to encourage better food fish processing and local production of fish meal; and (6) to increase protein supply to many malnourished Nigerians, especially children in the rural areas (see Nigeria 1981).

The importance attached to the fisheries in Nigeria's agricultural development is evident in the governments allocations to the fisheries subsector during the past and current Development Plan periods. Table 2 shows a breakdown of governments allocations to the agricultural sector during the second (1970-'74), third (1975-'80) and fourth (1981-'85) development plan periods. The fishery, which together with forestry had a share of ₦ 20.877 million (8.7%) out of a total allocation of ₦ 240 million to the agricultural sector during the second plan period, alone accounts for ₦ 101.554 million (4.6%) out of ₦ 2.201 billion during the third plan period, and ₦ 171.029 million (1.9%) out of ₦ 9.032 billion during the fourth (current) plan period. The smaller share enjoyed by the fishery during the current plan period can be explained by the greater emphasis now placed on food crop production, the extensive irrigation projects, the reforestation programme, and probably the limited possibility of

Table 2. Governments of Nigeria Allocations to the Agricultural Sector from 1962 to 1985 in Thousand Naira.

Agricultural Subsector	Development Plan Periods		
	2nd 1970-74	3rd 1975-80	4th 1981-85
Crops	173,195	1,646,000	5,626,223
Irrigation			2,266,331
Livestock	45,363	344,046	674,724
Forestry	20,877	109,727	299,571
Fishery		101,554	171,029
Total All State and Local Governments	149,236	1,188,274	3,631,878
Total Federal Government	90,199	1,013,053	5,400,000
Grand Total Agriculture	239,435*	2,201,327	9,031,878
Grand Total All Sectors	3,000,000	30,000,000***	--
% Fishery	8.7**	4.6	1.9

SOURCES: Nigeria (1970, 1975 and 1981).

*Represents actual expenditure.

**Includes Forestry.

***Includes N 10 billion aggregate private sector investment.

expanding the capacities of Nigeria's ocean fisheries. However, the allocation to the fishery is still very substantial if one remembers that the total budgets of Nigeria for all sectors of the economy during the first (1962-68) and second plan periods were ₦ 2.2 billion and ₦ 3.0 billion, respectively.

Fisheries management and development pose many complex problems since the fishery is a common property or open access resource whose exploitation is free for everybody. The resource is thus susceptible to over-capitalization, over-exploitation, and possible depletion of valuable or target species that could lead to serious social, economic, politcal and ecologial problems (Munro and Loy 1978; Lecomber 1979; Troadec 1980). Over-exploitation occurs because every individual fisherman will want to catch as much fish as possible since other fishermen will catch whatever he did not catch. No fisherman is held responsible for his actions; any externalities or social costs generated are borne by all fishermen, and such costs are partly transferrable to consumers "via market mechanism (Lecomber, 1979)." Uncontrolled harvest coupled with overcapitalization could deplete the fish stocks and make fishing unprofitable, since costs of operation will be higher than revenue. Redundant capital will constitute an economic waste.

In the past, fisheries management efforts were based on purely biological information but in recent years it has been realized that no presumably biological problem can be adeguately resolved without due consideration for the social, economic and political elements which often are overlooked by many resource scientists and planners. Pollnac (1981) stressed also the importance of cultural and technical information.

In Nigeria, fisheries development problems emanate from the "allocation of scarce resources in an environment of complex interactions among physical, social, economic and political components --- involving multiple and often conflicting values (Ladipo 1973). Biological, social and economic fishery research on West Africa is limited in scope and quality (Gulland et. al. 1973; Linsenmeyer 1976; Alfred-Ockiya 1979). The few studies undertaken in Nigeria are mainly biological; socio-economic information only focuses on historical analysis of macro-economic implications of government policy on fisheries. This study contributes to the scanty and widely scattered information that is available on Nigerian fisheries. It focuses on the coastal artisanal canoe fishery which employs the majority of the coastal inhabitants of Nigeria, whose social and economic well-being is the concern of the local, state and federal governments.

Pressure from local and foreign fishermen on the Nigerian coastal fishery has mounted in recent years despite its limited resources. The Nigerian coast is known to be low in biological productivity because of the absence of the nutrient-rich seasonal upwellings that characterize some other parts of the West African coast (see Chapter II). Nevertheless, Nigeria's coastal fishery resource is important in meeting part of the dietary protein requirements of its 80 million people. Also, the survival of many coastal communities is tied to the fishery. Other than the pressure due to population explosion, many of the West African countries have increased their capacity to catch fish from the ocean using improved technology.

Pressure on the fisheries resources of Nigeria has also been

paralleled if not surpassed by increasing human interference with the coastal environment in the forms of agricultural and industrial pollution, transportation development and pollution from oil exploration. Nigeria is one of the world's largest producers of petroleum crude oil and many of its oil-wells are located in the nutrient rich mangrove swamps, river mouths and inshore coastal areas, which are very important to the fishery. Frequent oil spillages with devastating environmental effects characterize the Nigerian coast. Okpuruka (1980) reported high losses to marine life forms during a major oil spillage off the Nigerian coast, though, he did not give actual figures to support his claim. Nigeria's coastal fisheries clearly face wide and constant variations in abundance due to natural environmental phenomena and human interference, thereby creating for management many social, economic and political problems. The environmental pollution issue becomes even more complex because oil export now accounts for about 97% of Nigeria's foreign exchange earnings. It is my view that short-run and long-run solutions to these problems derive from the inputs of many professionals including engineers, architects, ecologists, biologists, sociologists, economists, politicians, psychologists and anthropologists.

Apart from its low fish productivity, the Nigerian coastal artisanal fishery is characterized by low earnings, and poor processing, packaging, storage and marketing systems. The fishery primarily makes use of old boats, gear and equipment, and is highly labour-intensive.

Despite its shortcomings, the artisanal fishery plays a more important role than the industrial trawl fishery in the social, economic and political life of Nigerians. This fishery is "capable of great improvement by modernization and innovation and----the potentialities for growth are great (Lawson and Kwei, 1974)." It is also cost effective. Troadec (1980, pp. 236-237) comparing the artisanal and the trawl fisheries of West Africa shows (see Table 3) the 'artisanal fishery is a more optimal fishery, least in costs and better "able" to maintain political and social order than "the" sea fishery -----it is more economically profitable; investment is low, and provides employment for coastal poor.' Similar arguments in support of higher priority for the development of artisanal fisheries in West Africa were put forward by Everett (1979). Its social values of providing employment and nourishment are even greater than its economic value (Troadec and Garcia, 1980).

B. Problem Definition

Fisheries development policy formulation, planning and management in Nigeria are based on poor quality and inadequate information, which could be responsible for the failure of the fishery to adequately fulfill its multiple social and economic objectives I outlined earlier (see Troadec and Garcia, 1980). However, the importance of the fisheries secotor to Nigeria's economic development (see Chapter II E) justifies that decisions on its development and management be based on sound scientific (biological, economic, social and ecological) information, criteria and reasons.

The present study was undertaken to expand the knowledge about coastal fisheries management in Nigeria. The artisanal

Table 3. Comparisons of Artisanal and Industrial Trawl Fisheries.*

Criteria	Artisanal (Lagoon) Fishery	Trawl (sea) Fishery
1. Stock availability	Concentrated phase (larvae)	Dispersed phase (adult)
2. Location of fishing grounds	Littoral (Creeks, continental shelf)	Open sea
3. Value of fishing capacity (vessels, gear)	Low (canoe)	High (trawlers)
4. Value in foreign currency	None	Often high
5. Catch energy costs	Low (passive fishing)	High (active trawling)
6. Processing costs	Low (ashore)	Higher (partially at sea)
7. Foreign expertise required	Little or none	Considerable (at least initially)

*Troadec, J.P. 1980, pp. 237

canoe fishery deserves particular attention because it employs many of Nigeria's rural poor, on which the main emphasis of the country's development effort is placed. The prime focus of the study is on how productively the fishing industry makes use of scarce resources. Specifically, it looks, at some indications of progress in the artisanal fishery toward technological innovations, economic liquidity and market dependability. It is my conviction that such information will contribute to efficient planning, development and management of the coastal fisheries.

C. Objectives of the Study

The general objectives of this study are to assess the value of the Bonny artisanal fishery, and to provide socio-economic information and insights that will be useful for sound policy formulation, project planning and efficient management of Nigeria's coastal fisheries. The specific objectives are:

(1) To investigate the relative importance of the major variables influencing the efficiency of the coastal artisanal fishery system, and the possibilities for combinations of optimal developments in the sector toward a national fisheries development plan and policy, which satisfy as much as possible national development priorities.

(2) To identify and quantify the constraints to the productivity of the coastal artisanal canoe fishery, and ways to make it more productive in order to promote the economic well-being of the fishermen and;

(3) To present recommendations based on my analysis.

The above objectives derive from the assumption that socio-economic, in addition to biological and ecological factors, and fisherman's technological, institutional and ideological innovations, are likely to influence fish production patterns and fisherman's success.

I also intend to estimate the present as well as potential future yields from the fishery. I will use yields as a guide to the scale of the fishery's possible development. Yields will be estimated from commercial catch and effort data. Unfortunately, the data obtained from this source were grossly inadequate for any ideal statistical analysis. However, effort is made to show catch frequencies using the available information, and to identify the data requirements for a meaningful stock assessment procedure.

D. Methods

The acquisition of requisite information is an indispensable first step in solving complex developmental problems of any nation. While accurate time series data seem to be the best piece of information a resource researcher could work with, such data are seldom available because they are very expensive to obtain and update. Even when such data exist, they are usually incomplete for research needs. Time and monetary constraints prevented the acquisition of time series data for the present study.

The data reported in this thesis came from two principal sources: (1) a socio-economic information (including fishing operational costs and revenue figures) obtained through a questionnaire interview survey from October 1981 to January, 1982 of 287 randomly selected artisanal fishermen in Bonny and four other major coastal fishing areas of Rivers

State and (2) catch and "effort" data from the artisanal fishery supplied by the Federal Department of Fisheries, Lagos.

An overview of the past and present status of Nigeria's coastal fisheries is presented in Chapter II. The focus of Chapter III is an examination of economic development from the context of a developing nation, and the small-scale fisheries role. The problems of multiple-objective fisheries and the elements of change in a fishery are discussed, and the results of a variance test on success variables are reported in Chapter IV. The results of a step-wise multiple regression analysis to identify the socio-economic variables most influential to the success of Nigeria's coastal fishermen are presented and discussed in Chapter V. Chapter VI includes a report of the catch and "effort" data, and discussions of some conventional fishery models and the data requirements for ideal stock assessment procedures. Finally, Chapter VII consists of a brief summary and conclusions, and recommendations to Nigeria's fisheries policy-makers, planners, administrators and researchers.

CHAPTER II

CHARACTERISTICS OF NIGERIAN COASTAL FISHERIES

A. Physical and Hydrographical Features

The hydrographical and physical characteristics of the waters of an area enable an investigator to estimate its biological productivity, in order to obtain valuable information for resource planning and development (Troadec and Garcia, 1980).

Nigeria has a coastline of about 800 kilometers (km) and a rather narrow continental shelf (80-120 km wide) with a total surface area of 41,000 km^2 from the 0-200 meter (m) depth (Table 4). Nigeria's exclusive economic zone extends 320 km out into the sea and covers an area of 256,000 km^2, laying between 3^o and 6^oN of the equator (Aderounmu, 1980).

Table 4. Area and Total Fish Biomass of Nigeria's Continental Shelf.

Surface area of Continental Shelf (km^2)			Total Surface Area (km^2)	Total Fish Biomass (20-1000 m) Metric tons
0-10 m	10-50m	50-200m		
5,100	21,600	14,300	41,000	136,600*

SOURCES: Robertson, I.J.B. 1977, Troadec, J.P. and S. Garcia (eds) 1980, pp. 85, Table 1.

*Total biomass excludes tuna and shrimp.

The coast has an extensive drainage system of many large rivers.

River Niger alone has more than twenty outfalls to the Atlantic ocean, forming one of the world's largest river delta systems. The beaches are surf-beaten and muddy. The brackish-water system consists of mangrove swamps which are subjected to daily tidal effects and constantly changing physico-chemical properties.

On the other hand, the sea water along the Nigerian coast has a surface layer (30 to 40 meters deep) of uniformly high temperature ($> 24^{o}c$) showing little variation all the year round (Troadec and Garcia, 1980). This surface layer is also rather low in salinity due to the heavy rainfall of the area. The above characteristics account for its low fish productivity. Nevertheless, the mouth of the River Niger is known to be very rich in pink shrimp, and the inshore areas have some demersal and pelagic fish species which are very important to the artisanal and trawl fisheries.

Further ecological, biological and hydrographical studies are needed in order to fully understand the productive potentials of the area. Such studies should include: water chemistry including salinity, conductivity, levels of pH, dissolved oxygen, nutrients and other inorganic materials; the reproductive biology, growth patterns and mortality of major commerical fish species; the prey-predator and other food relationships; soil analysis; and investigations on the effects of environmental and agricultural pollution on productivity.

B. The Fisheries

A fishery is composed of the fish resources (biomass) and all

the people involved in its management, development and exploitation. The resource itself includes not only the fin-fish but all aquatic living organisms, plants as well as animals. The primary concern of this study is with the commercially valuable fin-fish and shrimp resources of the Nigerian coastal waters, and the economic well-being of the poor indigenous artisanal canoe fishermen involved in their exploitation.

1. Resources

There is little accurate information on the stock size, distribution patterns or productive potential of Nigeria's coastal fishery. Only Longhurst (1961, 1965, 1969), Fager and Longhurst (1968) have attempted to describe the species composition and distributional patterns of the demersal stocks, while Williams (1968) described the ecological factors affecting the fish population. Descriptions of stocks are rudimentary, non-specific and based on insufficient and in many cases questionable data sources. Reports are often contradictory in nature. It is a common practice by industrial fishermen to distort (understate) their catch figures in order to evade tax, while government agencies would overstate figures to attract more funds for future development. Other reasons for these deficiencies given by Troadec and Garcia (1980) are: fishery research (in Nigeria) is young, limited in scope, short of manpower and funds, and lacks continuity and material resources. It also is hard to obtain information from the artisanal fishermen because of their nomadic habit. The multispecies nature of the fishery, typical of tropical waters, makes accurate stock estiminates involving the use of conventional catch per unit of effort information an almost impossible excercise (Gulland et al. 1973). Fishermen catch many species in a single haul, use many

varieties of gear, and the species are hard to separate. The absence of seasonal growth rings on scales and other skeletal structures in tropical fish species makes accurate age determination difficult.

Despite the limited resources of the area due to lack of seasonal upwellings and its rather stable conditions, it contains some valuable inshore pelagic species (0-50 m depth) dominated by sardinella (Sardinella eba), bonga (Ethmalosa fimbricata), and the black horse mackerel Tranchurus trecae. Commercially important demersal species (50 m depth) include the croakers, especially Pseudotolithus spp., the bigeye grunter (Brachydeuterus auritus), the trigger fish (Balistes capriscus), shiny-nose (Polydactylus spp.) sharks, (Carcharius spp.), mullets (Mugil spp.) and the groupers (Epinepheluse spp.). The most important deep ocean species are the bigeye (Thunnus obesus), skipjack (Katsuwonus pelamis) and yellowfin tuna (Thunnus albacares). Only the skipjack has ample promise for development off the Nigerian coast because it has only been moderately fished (Wise and Ajayi, 1981). However, the two other species could constitute valuable incidental catches. The pink shrimp, Penaeus duorarum, is abundant for commercial harvest in the river mouths and along the lagoons.

The yearly total catches of pelagic, demersal and pink shrimp resources in Nigeria is shown in Table 5. The demersal catch figures from 1970 onward "seem to be clearly overestimated (Troadec and Garcia, 1980)." The potential was estimated at 40,000 metric tons by Longhurst (1965). Gulland et. al. (1973) estimated an annual demersal potential of 500,000 metric tons, including 15,000 tons of pink shrimp. Robertson (1977) using a FIOLENT acoustic survey came up with a combined figure of 136,600 metric tons (see Table 4) for both the pelagic and demersal stocks. He remarked that this figure was poor in absolute and relative values.

Table 5. Yearly Total Catches of Pelagic, Demersal and Pink Shrimp Resources in Nigeria in Metric Tons.

Year	Pelagic*	Demersal*	Ocean Pink Shrimp**
1961	--	--	16
1962	--	--	--
1963	--	--	--
1964	36,000	19,824	--
1965	38,000	19,995	--
1966	41,000	22,013	--
1967	46,000	24,144	750
1968	47,000	25,607	550
1969	38,000	18,246	731
1970	139,000	142,437	912
1971	151,000	172,864	1,345
1972	71,000	101,776	1,245
1973	74,000	106,305	1,358
1974	75,000	106,532	2,021
1975	75,000	108,431	2,139
1976	78,000	114,717	--
1977		116,520	--

SOURCE: Troadec, J.P. and S. Garcia (eds) 1980, Attachment 5, pp. 75; Table 3, pp. 88; and Table 1, pp. 133.

*Figures include that of the coasts of the Republics of Cameroon and Togo which boarder Nigeria to the east and west, respectively.

**Excludes brackish-water.

The potential annual yield from Nigeria's pink shrimp (P. duorarum) and red shrimp (Parapenaeus longirostric) resources are, respectively, 2,451 metric tons and 904 metric tons (Bayagbona, 1979). According to Nigeria (1975), current export earnings from shrimp resources is about ₦ 5 million per annum and potential export earnings estimated at ₦ 16.5 million annually. Raitt and Niven (1965), and Thomas (1969) claimed the exploitable shrimp resources off the Nigerian coast cover an area of 6,450km^2 and 3,354km^2 respectively.

The flip-flop nature of the above information characterize the limited widely scattered reports on Nigeria's coastal fishery potentials. These figures may have been over - or underestimated. The need for accurate and updated information thus probably becomes the greatest challenge to all Nigerian scholars and researchers, administrators, managers and other people involved in the exploitation of the fishery resources of the area.

2. Users

Nigeria's coastal fishery resources are numerically dominated by indigenous artisanal canoe fishermen, but it also is infiltrated by fishermen from the neighbouring countries of Ghana, Togo and Benin on the west, and Cameroon and Gabon on the east. West African coastal countries have a high ethnic diversity. In Nigeria, the Egba, Ijebu, Ekiti, Edo, Itsekiri, Ijaw and Ibibio line the coastal fishing areas. While the Ijaw and two principal sub-groups of Ibiobio (the Andoni and Okrika) are predominantly fishermen, fish smokers and sellers, the majority of the other ethnic groups along the Nigerian coast fish for

subsistence. The latter are principally farmers and traders. These fishermen, most of whom are illiterates, have different beliefs and value systems which affect their perceptions and acceptance of innovations. The above elements in addition to social factors affect economic transformation. For instance, a period of poor fish harvest is called a period of "bad-water" by some Bonny river fishermen in Nigeria. Bad water is believed to be invoked by some evil spirits,that live in the ocean. Such periods call for sacrifices involving the slaughtering of a goat and pouring of wine libation, and music with dancing. "A period of good harvest often follows the sacrifice."

The migrant fishermen from neighbouring countries are mainly the versatile Ewe ethnic group of Ghana. Other users of the resource are domestic industrial trawler owners, some in partnership with foreign fishing firms. Large foreign trawlers are seldom found in Nigeria's continental shelf, but do fish the oceanic stocks. This may be due to the relatively poor resources of the area compared to the rich subtropical upwelling areas where large numbers of eastern and western european vessels abound.

The waterways are also used for transportation since most of the villages along the coast are only accessible by boat. Many of Nigeria's oil wells are located within the mangrove swamps. This variety of activities creates many technological externalities, some of which though obvious have not been quantified. It causes serious problems, such as environmental pollution, for resource managers.

3. Types of Fisheries

a. Artisanal Canoe Fishery.

This fishery is the oldest form of fishing and is operated on a small scale by mostly illiterate coastal inhabitants as a part-time or full-time occupation. The majority of the fishermen in the Niger delta area and to the east of the delta operate full-time. According to Sutinen et al (1981), Nigeria has an artisanal fishery of about 70,000 canoes manned by 400,000 fishermen, out of a total of 100,000 canoes and about 600,000 fishermen for the whole of West African coastal countries. They live in small, relatively isolated and inaccessible villages widely dispersed along the lagoons and coastal beaches. Their catch account for about 97% of the countries total coastal landings (Everret, 1979; Troadec, 1980), but despite this they have considerably low incomes.

These fishermen make use of poorly constructed and inadequately maintained dug-out canoes, ranging from 7 to 15 meters long, with few having outboard engines. The 1976 national statistics revealed that only 6,000 of 128,485 canoes were motorized. The canoes are either owner-operated or rented. They use a variety of gear including set-nets, cast-nets, drift-nets, spoon nets, hook and lines, gill-nets and traps of different kinds. Most of the nets are made of local fibres with short life spans because they are low in quality and poorly maintained. The crew size which varies with the size of family, canoe, and technology, average 3 to 4 per canoe.

The governments of Nigeria have in recent years increased fishermen's access to loans, subsidized engines, modern gear and equipment, through the country's rural development and accelerated food production

schemes. Boat maintenance work-places have been built at some major fish landing sites and short-term training has been organized for selected fishermen. These activities have impacted some areas, but to the amazement of some people such schemes have only benefitted a few rich, educated, and more politically and technologically inclined fishermen. Ironically, few poor fishermen benefit from the governments rural development programmes which were supposedly targeted to them.

The territorial operation of marine artisanal fishermen is limited in range, with an average of about 8 km from shore. This is due to the limited capacity and poor conditions of their canoes, gear and equipment. The bigger canoes go up to 16 km offshore in periods of good weather. For the above reasons and the fishermen's lack of information on fish stock concentrations, they tap only little from the available resources (Ladipo, 1973 and Alfred-Ockiya, 1979).

The target species of artisanal fishermen are principally bonga, sardinella, and other pelagic species; the croakers and groupers are the demersals sought after. Unfortunately, of the four categories of fish (crustacea, pelagics, demersals and mixed species) caught from Nigeria's coastal waters, the pelagic species has the lowest monetary value, but together with the mixed, it has highest weight value (Table 6).

Fish harvested are either sold fresh at landing sites to "fish mongers" or middlemen who are wholesalers or retailers, or smokedried in the fishermen's beach homes before taken to the city markets or major landing sites for sale. These fish buyers, who usually are the fishermen's wives, relations, or clanwomen, play a significant role of providing loans to the fishermen, who in turn are obliged to sell fish to them.

The fish buyers constitute a powerful force in the industry because they are indispensable to the fishermen who generally have low incomes and continually need credit. Their role will be discussed further in the next chapter.

Fishing laborers are remunerated in cash or in kind (with fish). The latter, which is much more common, involves getting a share of the total catch. Crew members of owner-operated canoes are paid for their services in a similar manner, after the boat owner must have taken some share (usually half of the total catch) for the boat, gear and equipment.

Table 6. Value of Reported Nigeria's Coastal Fish Landings by Catch Composition (1977).

Catch Composition	% by Wt	% by value
Crustacea	1	30
Demersal	11	21
Small Pelagic	44	10
Mixed	44	39

SOURCE: Sutinen et al. (1981) pp. 23, Table 6.

b. Domestic Industrial Trawl Fishery

Domestic coastal trawl fishing in Nigeria began in the early 1960's with twelve Lagos based trawlers in 1964 (FAO, 1966). There are over ninety medium sized vessels presently fishing and shrimping from Nigeria's narrow continental shelf using some small jetties in Lagos and Port-Harcourt. Some of these vessels (10-20 m long) are constructed locally from wood. The larger vessels, which are imported, are owned by private and government fishing firms. These firms compete with the

artisanal fishermen for the limited demersal resources of the area dominated by the croakers, bigeye grunter, shiny-nose, trigger-fish, mullets and the groupers. A few of the vessels go beyond Nigeria's territorial waters to compete for the rich resources off the coasts of Angola in the south and Morocco in the north.

Fish from the trawl fishery is kept in frozen form. The trawlers are equiped with deep freezers, and the firms have large freezers at landing ports and in major fish markets (cities and large towns) all over the country. The fish market is well organized. It involves middlemen retailers who sell the fish in frozen form. However, any unsold portion is smoke-dried and sold the next day.

The domestic trawling and shrimping industry suffers problems of poor berthing, slipping, repair and maintenance facilities, capital and fishermen, in addition to the limited fish stocks. It is also expensive to hire foreign skilled fishermen and engineering crews. Trawler operators are also taxed by the government. The fishery could be made more profitable if costs were reduced through improved port and maintenance facilities, local training of fishermen, and improvements in management.

The artisanal fishermen who catch juvenile shrimp as they migrate from estuaries into the open sea limit the number of adult shrimp available for catch by the trawlers. The bulk of the shrimp is exported to Europe and America in frozen form.

c. Foreign Industrial Fishery.

Foreign distant-water fleets are seldom found in Nigeria's continental shelf because of its poor resources, but there are allegations

that some foreign shrimp trawlers operate illegally in the delta area. It is also alleged by Nigerian based trawler operators that the skipjack tuna resource in Nigeria's exclusive economic zone has been illegally exploited by foreign fleets. These allegations need substantiation.

Japanese, Russian and Polish trawlers have been landing frozen fish in Lagos and Port-Harcourt ports in Nigeria to supplement local production since 1961. Frozen fish has a large market in Nigeria's highly urbanized southern states, and there is a highly organized frozen fish distribution network all over Nigeria. Nigeria will continue to rely on the importation of frozen fish to satisfy the increasing demand for fish and fish products in the country.

Serious consideration is being given to the establishment of a Nigerian based distant-water fishing industry to compete for the rich resources of the sub-tropical northern and southern West African coasts through bilateral agreements with the countries who have direct access to the resources.

C. Intraregional and International Characteristics.

The common property nature of ocean fisheries subjects them to over-exploitation and possible depletion. The fishery of the Eastern Central Atlantic Region (West African coast) is one of the world's most productive (especially in the subtropical seasonal upwelling areas); it contains some highly priced species like tuna, shrimp, sardines and mackerels; it is tapped by many nations, but it is probably the least managed. The productive potentials of several of the fish species are still to be accurately determined; and the coastal states that claim jurisdictional rights to the resources lack adequate manpower, technology,

and material resources to effectively manage, develop and enforce regulations. Some of the valuable fish species are known to be migratory, crossing between jurisdictional boundaries. It is a general consensus that many of the species are overexploited (Gulland et al., 1973).

For the above reasons and the very important fact that the economic well-being of coastal inhabitants of these countries depend on the fisheries call for efficient and effective fishery management and conservation programmes in the area. Interesting but sad enough, several poor people of the region are malnurished because of protein shortages in their diets, creating many serious health problems, and high infant mortality. The vast ethnic and cultural diversity, and language differences in West Africa, makes communication and co-operation for joint management of the resources a serious problem.

The problems identified above have not been left unresolved. While subregional arrangements have been made in the past, some are still operative between adjacent countries that rely on common resources. Other arrangements that involve all the coastal West African countries have also been made and kept alive in recent years. The Fishery Commission for the Eastern Central Atlantic (CECAF), formed under the auspices of the Food and Agricultural Organization of the United Nations (FAO) was established in 1967 as a jurisdictional body to develop and manage the fisheries of the area. The commission has representatives from the seventeen coastal coutries in the region from Morocco in the north to Zaire in the south, and eleven non-coastal countries including the United States. Russia, which also fishes in the area, is not included. The functions of this commission which consists of working groups

and subcommittees, are to promote and co-ordinate national and regional marine fishery research and development, formulate and assist with data collection and analysis, provide technical expertise, recommend appropriate regulatory measures, liaison in cases of disputes, and to secure and administer development aids (Crutchfield and Lawson, 1974; Sutinen et al. 1981).

The FAO has made valuable contributions to fisheries development in Nigeria for many years. In 1973, the FAO donated 500,000 U.S. dollars to fishermen's co-operative development in Nigeria (Everett, 1979). Current activities of the organization in Nigeria include the construction of cold storage facilities, agricultural research and development, and the collection of basic data. A FAO funded African Regional Aquaculture Research and Training Center was established in Nigeria in 1980. All the FAO activities are in collaboration with Nigerian fishery administrators and researchers.

The creation of the Economic Commission of West African States (ECOWAS) in 1975 brought more hope for intraregional cooperation in the economic development (including fishery development) of this region. All the seventeen coastal countries of the CECAF but one, the Republic of Cameroon, are members of the ECOWAS. Nigeria played a leading role in establishing and upholding this commission committted to cooperation in all areas of economic development, including research, agriculture and industry (Renninger, 1979).

The future of the fisheries of West Africa depends on how the countries pull their resources together in a co-ordinated manner. The fact that the richest fishing grounds of the area lies within the jurisdictional boundaries of the sparsely populated countries calls for

an intraregional bilateral fish trade agreement between them and the member countries with large human populations but poor coastal fish resources. The ECOWAS can play a leading role in promoting such agreements, which should also include joint fishing ventures. For instance, Sutinen et al. (1981) report that over 70% of total fish caught from West African coastal waters in 1977 was by foreign fleets, mostly off the coasts of Morocco and Guinea. Increased participation by West African countries would eliminate some of the foreign fleets, now that coastal economic zones have been extended. Industrial exports from Morocco and Guinea will find markets in highly populated countries of Nigeria, Ghana and Ivory Coast. Other advantages of this type of regional co-operation are: (1) it will help to minimize foreign exchange loss from the region to industrialized countries of foreign partners; (2) joint ventures could be more stable and mutually beneficial, since partners have similar needs and development objectives, (3) arrangements could be made more flexible and (4) partners will be less suspicious of each other.

D. The Role of Government in Coastal Fishery Development.

1. Historical Background

Like in many other countries of the world, the need to develop Nigerian fisheries resources arose just before the end of World War II when food - particularly protein food - became a luxury commodity. The British colonial government in Nigeria established a Fisheries Division under the Department of Commerce and Industry soon after the war ended (FFS, 1961 and 1965) to investigate the canoe fishery and the possibility of brackish-water fish culture.

Fishery management involving the use of scientific information did not actually begin in Nigeria until 1953 when the country was divided into three autonomous regions - North, West and East. Fisheries development and research became the sole responsibilities of the regional governments, but the federal agency was retained to develop the fisheries of the Federal territory of Lagos and Nigeria's coastal international waters. The federal agency also conducts research for the regional governments on their request. While the states fisheries operated under their Ministries of Agriculture and National Resources, the Federal agency functioned under the Federal Ministry of Economic Development in Lagos.

The Federal Fisheries Service (FFS) was established after Nigeria's independence from British rule in October 1960. The FFS continued the same roles the Fishery Division was playing, but added to its activities the licensing of fishing trawlers operating in Nigerian waters, and the collecting of statistical information from trawlers for tax and development planning purposes. When Nigeria created twelve states from the Regions in 1967, the FFS was renamed Federal Department of Fisheries (FDF), with fishery education and training added to its functions. It had a research group of four biologists, two engineers, two master fishermen and one administrative assistant (FDF, 1968 and 1969). Only one of its four research vessels was functional, seaworthy and big enough for trawling surveys and oceanographic studies. Biological studies were undertaken on some brackish-water species and the croakers. These activities were limited to the brackish waters and the off-shore waters of Lagos.

No research was undertaken on the economic, social and cultural aspects of the fisheries, since all the research officers were biologists.

This omission had serious implications for fisheries development planning and project implementation, causing project failures and minimum success. Examples are the failures of the fishermen's co-operative program and the introduction of improved fish smoking techniques. Up to now, very little has been done to fill this research gap.

The problems of fisheries development in Nigeria were due to "lack of policy co-ordination" and the "duplication of research----unrelated to development needs (FAO, 1966)." Recommendations given by the FAO led to some important changes in the fisheries structure under the new Federal Ministry of Agriculture and Natural Resources. For instance, upon FAO's recommendation, a division of planning was created within the FDF and the latter was reinstated as the sole research and development co-ordinator for the whole country. The functions of the planning unit include identification of research needs and priorities for the states and federal governments, collection and analysis of socio-economic and marketing information, manpower development and training. The FDF was very understaffed and lacked sufficient funds to perform these functions effectively.

Another important development took place in 1972 with the establishment of a statistics section within the FDF, to collect statistical information on Nigerian fisheries. It was staffed by a statistician transferred from the Federal Office of Statistics. In 1976, a major reorganization took place when the Nigerian Institute for Oceanography and Marine Research (NIOMR) was created, involving the transfer of the role of the research division of the FDF to the autonomous institute. Both establishments have since grown in staff strengths, physically and infrastructurally.

The NIOMR, which has sections in Marine Biology, Aquaculture, Fish and Gear Technology, Oceanography, Marine Geology and Geophysics, Statistics and Economics, a Marine Fisheries School and a small library collection, is contributing a great deal to marine fisheries research in Nigeria. The following are examples of such contributions: studies on the population dynamics of the croakers (Pseudotolithus spp.); food and feeding habits of the pink shrimp (P. duorarum); chemical composition of the big-eye grunter (B. auritus), the croaker, and shark (Carchanias taurus; development of small fishing boats and new gear; processing fish into meals; data storage in micro-computers for easy access; and the development of a fish smoking/drying kiln.

The institute has a cadre of highly competent Nigerian researchers, many of whom received training both in Nigeria and overseas. The staff strength in 1980 was 441, including 81 senior officers (NIOMR, 1980). Unfortunately, neither the institute or the FDF has a fisheries economist on its staff, though the need for it was identified over ten years ago. The institutes activities has been curtailed by insufficient funds. Notably, the only seaworthy research vessel the institute had was grounded in a sea accident in May 1979 for eighteen months (NIOMR, 1980). Sea research was equally terminated during this period. However, a new and better research vessel was added in 1981.

Contrary to the above, the FDF has enjoyed better funding by the government.

2. Current Situation and Policy Issues

The Federal Government, all the six coastal states and their Local Governments through their various Ministries, Departments, Divisions

or Institute are responsible for coastal fishery development in Nigeria. The FDF and NIOMR with headquaters in Lagos have zonal field offices, and in the case of NIOMR, research stations in key fish producing areas all over the states. While the FDF is responsible for policy formulation and co-ordination, extension work, project execution, and statistical data compilation, the NIOMR is principally responsible for marine fishery research, but also does some fish-meal processing.

Other important Federal Institutions are the River Basin Authorities, some of which are responsible for brackish water aquaculture development in the maritime states. Two Federally-owned companies, the Nigerian National Fish Company Limited and the recently established Nigerian Shrimp Company Limited, engage in deep-sea fishing and coastal shrimping respectively. Some of the coastal State Governments also have such sea-going companies. The Ministries of Trade, Industry, Cooperatives, Finance and Planning also play significant roles (such as in policy formulation, fish trade negotiation, fish sales organization, gathering statistical information, and workshop planning and financing) in fisheries development in Nigeria. However, they duplicate the efforts of the purely fishery-oriented institutions, instead of co-ordinating activities and working hand in hand with each other. The above situation is very rampant in many West African countries (Sutinen et al., 1981).

All the States and Federal Agencies also provide subsidized loans, motorized boats, fishing gear and equipment, and training to individual fishermen or fishermen's co-operatives. The establishment of viable fishermen co-operatives (often a precondition for eligibility for government loans and credits) has not been possible in most cases

due to resistance from the fishermen. This resistance, which may be due to economic, social and cultural factors (Lawson and Kwei, 1974; Pollnac 1976, 1978 and 1981; Poggie, 1980) is often overlooked by researchers, planners and managers, and will be fully discussed in the next chapter.

Although fisheries development was not new in Nigeria, it did not receive considerable attention from government institutions until the post-independence years, when during the maiden First National Development Plan (1962-68) the Nigerian government allocated about N 2.4 million or 0.2% of the total budget to it. Nearly half of this money was designated for the construction of coastal fishing and shrimping terminals in the port cities of Lagos and Port-Harcourt. This budget also provided for credit and loans funds, pond construction, fishermen's training institutes and the building of fish stations. The major constraints in fulfilling these roles, as I had earlier mentioned, are lack of sufficient funds, equipment, and adequate personnel, in addition to poor national policy co-ordination. The Regional Governments seldom used the Federal agencies for research purposes. Subsequent National Development Plans allocated more money to the fishery.

The current national budget (1981-85) allocated only N 171 million (1.9%) of total agricultural budget to fishery development, which is a matter for concern, considering the relative importance of this sector to human dietary protein supply in Nigeria. Livestock and crop production sectors received 62% and 7.5% respectively of the agricultural allocation, though, weight for weight fish is higher in protein value than beef, and even considerably higher in value than food crops (FAO, 1963; Ladipo,

1973). While the current Nigerian fishery development programmes focus particular attention on accelerated domestic fish production and upgrading the efficiency of the canoe fishery sector through improved technology, credit and loan plans, fishermen's training, outboard motor, gear and equipment supplies at subsidized costs, it also provides for new berthing jetties for large trawlers and small boats, cold storage, fish processing, repair and marketing facilities (Nigeria, 1981).

The emphasis placed on fishermen's co-operatives as a means of benefiting the canoe fishery sector needs some careful consideration and re-assessment. Language, cultural and social differences among these canoe fishermen may hinder the success of the co-operatives. Fishermen's co-operatives have failed in Nigeria, Ghana (Lawson and Kwei, 1974) and in many other developing countries (Pollnac, 1981) because the initiative to form the co-operatives and their administration did not come from members; it is instead imposed by aid donors and governmental agencies who see it as a means of ensuring loan repayment and monitoring of project efficiency. Contrarily, many fishermen and fish traders see co-operatives as a threat to the existing production - delivery chain system involving the fishermen, their households and middlemen fish retail and wholesalers, who often are fishermen's wives, relations, or kinsmen. A co-operative arrangement will cost many of the intermediaries their sources of income, making them financial burdens to their fishermen relatives.

The middle-men also provide short and long-term loans to fishermen for new equipment, maintenance and other uses without requiring strict collaterals. However, they charge very high interest rates, but

repayment can be delayed in periods of poor harvest and other unforeseen circumstances. Government loans which are made with relatively low interest rates are rebuffed by the fishermen because they have strict collateral requirements, which can hardly be met by the poor fishermen. Such loans often beneft a handful of elitist fishermen with high political and social influences, leaving the targeted poor majority to continue to suffer. Ways of improving the loan system must pay particular attention to the indigenous organizational, cultural and social structures of the system. The latter calls for adequate multidisciplinary research of the system.

E. Economic Importance of the Fisheries

The Nigerian shrimp fishery is an important source of foreign exchange earning. Projections put its value at ₦ 16 million per annum. The proposed skipjack tuna industry could provide additional income if carefully developed and efficiently run. According to Wise and Ajayi (1981) the 1980 United States price for skipjack was ₦ 770 (U.S. $1,225) per short ton.

The likely increased production from the development of Nigeria's coastal fisheries will help balance foreign trade in fish and fish products, since Nigeria is a net importer of fish and fish products, costing a total of more than ₦ 100 million annually. Developing the fishery could also generate income to the economy by stimulating growth in other fishery allied sectors, such as in boat and gear manufacturing, fish processing, storage facilities, marketing, road and port construction and transportation.

If there is any truth to the statement, "the wealth of a nation is in the health of its people", then the role the fishery plays by supplying the much needed human dietary protein must be seen as an important contribution to the economic well-being of a nation. A productive labour force depends on good health, which in turn depends on good diet, of which fish protein is an important component, in the absence of better substitutes. Fish food is even becoming more important in Nigeria because of the scarcity and the higher cost of its close substitute, beef. The poor people of Nigeria, who constitute more than 70% of the agricultural labour force, can not even afford to buy beef. An urgent need thus arose for improved fishery management and fish production in Nigeria.

The social role of the fishery as a major employer of labour in coastal communities should be seen as an important contribution to Nigeria's economic development. It helps to solve the problem of urban drift, which often creates social, political and economic problems.

F. The Bonny Canoe Fishery

The Bonny Canoe Fishery covers the entire length of the brackish-water system of the Bonny River, and the entire continental shelf of the Bonny town area along the Bight of Bonny in the Central part of the Gulf of Guinea. The main Bonny River is about 40 km long, flowing from the periphery of the Rivers State Capital City of Port-Harcourt[1] in the North to Bonny town in the South along the Atlantic Ocean (Figure 1). The river has many tributaries and is lined on either side by mangrove swamps with several small and isolated fishing islands. The Bonny River's

[1] Port-Harcourt is the second biggest port city in Nigeria.

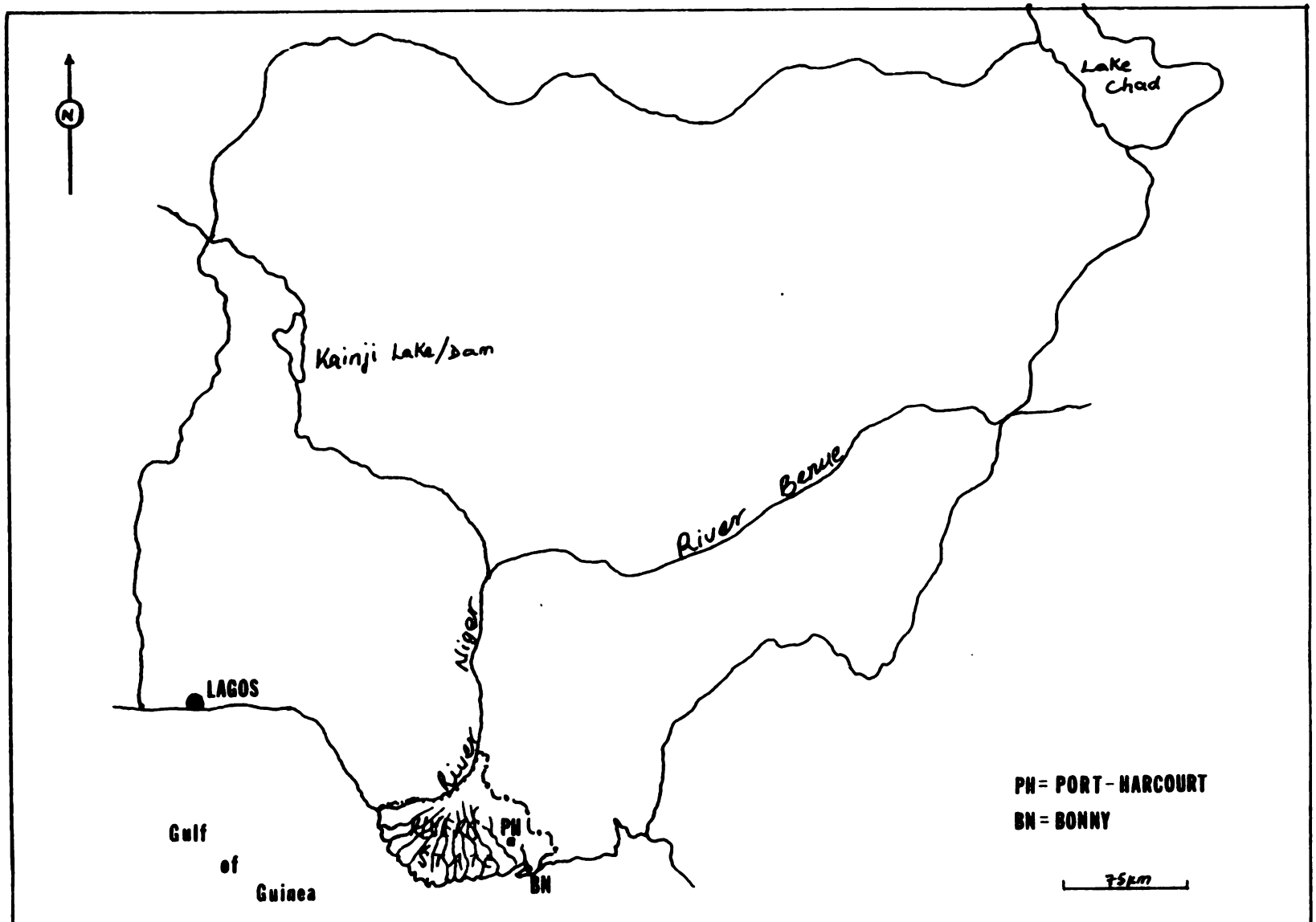

Figure 1. Map of Nigeria Showing Rivers State.

delta stretches about 15 km along the Atlantic coastline.

Bonny is one of the oldest Nigerian coastal cities. It has a population of a few thousand people, and is only accessible by water. It is the headquarter of the Olga Local Government Authority in Rivers State, and the people are governed by one of the most coveted traditional rulers in South-eastern Nigeria, His Royal Highness Captain O.S. Pepple, King Perekule II, the Amanyanabo of Bonny. There are several small fishing villages along the river and the sea coast under the domain of the King.

Fishing is the major economic activity of the people of the area, but trading, transportation, and in Bonny hotel and restaurant business, and smuggling, are also important. The ethnic diversity of West Africa is reflected in the tribal composition of the Bonny canoe fishermen. The principal groups in the area are the Andoni, Bonny, Okrika and the Ijaw. The latter two are immigrants from the Western part of Rivers State. The fishermen fish full-time from both the brackish-water system and from the Atlantic ocean making use of dug-out canoes, with or without out-board engines. While those with smaller boats limit their activities to the rivers, creeks, and the inshore area of the ocean, those with larger boats and outboard motors go some 8 to 16 km into the Atlantic. They make use of a variety of traditional gear ranging from drift-nets, cast-nets, set-nets, and hook and line to traps of all kinds. Some of the fishermen have modern nylon nets, but the majority make use of nets made from plant fibres. The most commonly used gear are set-nets and hook and lines, while drift-nets are the least used. Traps predominate in the lagoon areas.

The Bonny fishery is multi-species, involving the catching of several species in a single haul. The grey and red fishes including the croakers, shinynose, grunter, snapper (Lutjanus spp.), and barracuda (Sphyraena spp.) constitute the major catch. Others include bonga, sardines, shark, mackerel (Trichiurus spp.), the sea cat-fish (Arius spp.) and also the Tilapia spp., which is highly tolerant of the brackish-water environment. The most valuable species are the shiny-nose, bonga, sardine, croakers, sea cat-fish, sting-ray, barracuda and to some extent Tilapia. The low salinity of the Nigerian coastal water accounts for the great diversity in the species composition.

The Bonny area also is intensively exploited for petroleum oil, and a liquified natural gas plant has been proposed for the area. The Bonny river was reported to have a "continuous oil film (Onuoha, 1979)", which may have serious adverse effects on its biological productivity. However, such effects have not been properly documented.

The Bonny fishery was chosen as a model for this study because of its close proximity to the urban city of Port-Harcourt, which does not only serve as the largest market for fish in the state, but could provide alternative employments for fishermen who may have skills in other professions. The population of Port-Harcourt is multi-national due in large part to the oil industry. The city houses two Universities, some technical and teachers colleges, and many high schools. All the federal institutions, including the FDF and NIOMR (and even the FAO) have branch offices in Port-Harcourt. Port-Harcourt temporarily houses the headquarters of the Niger Delta Basin Development Authority (NDBDA). The Bonny fishermen could thus have greater access to federal assistance programmes.

Bonny town itself has a good market for fish because of its booming hotel business.

Finally, Rivers State was chosen for this study because it is the largest fish producing state in Nigeria, with an estimated production of 153,000 metric tons (30% of Nigeria's total) of fish worth more than ₦ 148 million in 1976 (Tober et al., 1977). The Bonny canoe fishery was valued at ₦ 4.6 (or 3,971 million metric tons) in 1976.

More than half of the total surface area of Rivers State falls within the Niger River Delta.

CHAPTER III

CHARACTERISTICS OF ECONOMIC DEVELOPMENT

A. Definitions of Economic Change

A generally accepted definition of economic development is, sustained growth in per capita Gross National Product (GNP). But this definition is too narrow in focus by just equating economic growth with development. There are two important distinctions to make:

1. development has more meanings to it than just economic growth and,
2. the distributional aspect of the surplus that results from economic expansion becomes an important issue if the purpose of development is the overall improvement in the quality of human life.

The main purpose of this section is to state the conditions that exist in Nigeria's coastal fishery, and particularly in the Bonny fishery, that make the traditional limited definition of economic development inappropriate to the improvement in the overall welfare of these poor coastal fishing communities. In this context, development will later be examined from a very broad perspective.

The Nigerian coastal fishing communities, including Bonny's, are characterized by values, beliefs, norms and social structures which impede narrowly defined economic development. For instance some fishermen

refuse to send their children to school (even when the costs will be met by the government) because they believe their children after having an education will cease to be fishermen, which could hurt the spirits of their ancestors who survived solely by fishing. This negative attitude towards children's education does not conform to one of the basic requirements for rapid economic transformation - improved quality of human capital. The acquisition of basic skills, particularly technical education, is needed in the capital-intensive industrialization process upon which growth in GNP depends. It will be improper to measure the welfare of Nigeria's coastal communities solely by Nigeria's growth in GNP (which in fact has grown rapidly since the discovery of large deposits of crude petroleum oil in the coastal areas in the middle sixties) if the communities lack the skills and social reforms that will give them greater economic security and improvements in their overall welfare.

Labour is highly immobile in the Bonny artisanal fishery. The skills possessed by these fishermen are not needed in the manufacturing industries that abound in the cities; and particularly in the oil drilling firms which are scattered all around their villages. Labour productivity also is low because fishermen employ poor fishing technology. There is acute underemployment of particularly young men at their prime age when supposedly they should be more productive. The above is coupled with the facts that fishermen live in small, inaccessible and isolated nomadic units, unaware of economic opportunities that may exist in other places; they are individualistic and very conservative (see Collarts 1966).

Capital is also immobile in coastal fisheries even when more attractive opportunities exist in other sectors, since fishermen lack the necessary savings to finance their fishing businesses (Lawson and Kwei 1974). They rely on middlemen money-lenders for loans to finance their businesses and are thus obliged to sell their catch to their rich customers, usually in kind, leaving them with almost nothing to invest. Thus fishermen remain poor most of their lives because of lack of capital which is a major determinant of per capita income growth.

The poor biological productivity of Nigeria's coastal waters is also a major constraint on the growth in the per capita income of the fishermen. The ability of the resource base to support a highly capital-intensive fishery that is export-oriented is very much in doubt. It has been pessimistically viewed by experts on the resources of the Gulf of Guinea that the fishery resources of Nigeria's continental shelf can hardly supply her domestic market, even when complemented with extensive brackish-water aquaculture (see Gulland et al. 1973 and Troadec and Garcia 1980).

It is reported elsewhere in this dissertation that newly introduced improved fishing technologies had been rejected in the past by some small-scale fishing communities because the new technologies interfered with the existing traditional pattern in the fishery. The new technologies were labour-saving, thus requiring reductions in the crew sizes of fisheries that adopted them. Usually, the jobless fishermen are the children and kinsmen of the sole fishermen, on whom the former will by tradition depend economically. So, why adopt the new technology in

a sector where labour is immobile? But the more technologically versatile fishermen enjoy bigger incomes from fishing.

The major weaknesses with the traditional definition of economic development as growth in per capita GNP are its failure to state how the accumulated wealth or economic surplus will be distributed among the people and, the social costs associated with economic growth. The additional national income may have accrued to a few privileged members of the society, while the majority live in poverty. This fact may be inconsistent with overall development goals. For instance, many oil exporting developing countries are characterized by high per capita income, but also high poverty levels. The Nigerian per capita income of N560 is well below the N700 minimum for the developed countries; yet Nigeria's wealth is shared among a small group of elites. This problem of income inequality characterizes the Nigerian coastal fishery system in which the affluent owners of large trawlers and some influential artisanal fishermen that own larger motorized boats and better gear and equipment compete for the same resources with the poor majority of the artisanal fishermen who can not afford boat engines and modern gear. Economic development is thus concerned both with the size and distribution of economic surplus, and can perhaps be redefined as reduction in income disparities. These disparities can be minimized through income redistribution, following radical institutional and ideological changes that will increase the participation of the rural poor in the devleopment process while assuring that they enjoy the benefits of the changes. Adelman (1975) states that only such radical "structural change" in an economy can facilitate progress, not just the growth of the GNP.

As a result of the highlighted constraints on the traditional meaning of economic development, and many other constraints to it that are peculiar to the various sectors of the economies of the less developed countries of the world, modern development economists have divergent views about the complete meaning of economic development. The new definitions vary within and between countries, but essentially they are based on the diverse cultures, values, beliefs, norm, political and social systems, and the economic needs of these slowly emerging societies. The new meanings, though, do not make growth in per capita GNP a precondition for development, they do include it, but in combination with social, political and cultural factors. It is noteworthy too that the new meanings of economic development emphasize the need for rapid technological, ideological and institutional adjustments in the respective developing countries (see Kuznets 1973; Bauer 1974).

According to Oommen (1973), Schickele (1973), Adelman (1975 and 1979), Nyerere (1979) and Weaver, et al. (1979), economic development measured in terms of per capita GNP did not solve the problems of rural unemployment, economic inequality and poverty in the dual economies of the less developed countries, but instead promoted them. The benefits of growth went to the minority in affluent middle and high income groups because the behaviour of the people of these poor countries is closely guarded by certain important institutional, ideological and cultural elements that are hard to change. Many times, these factors conflict, resulting in little or no progress in a country's efforts toward the attainment of economic and political independence. To quote from Arthur Lewis (1955, pp. 430):

> "We demand the abolition of poverty, illiteracy and disease, but we cling desperately to the beliefs, habits and social arrangements which we like, even when these are the very cause of the poverty which we deplore."

Gordon (1954) states that fishermen remain inherently poor because they are "educationally and romantically tied to the sea" and that "there is in the spirit of the fisherman the hope of the lucky catch --- they are gamblers and incurably optimistic." Most Bonny fishermen believe a period of poor harvest signifies the spirits in the sea-water are angry, and it requires a major sacrifice, involving feasting, music and dancing, to calm the spirits to restore good harvest. Holding very strongly to this belief shows their ignorance of the meaning of biological productivity and its associated factors.

In very broad terms, development could mean improved and sustained per capita income; improved health and nutrition; access to good education, political and economic independence; peace and understanding between nations; equality among people of all sexes, races and nationality; increased opportunities, or different combinations of the above. Development economists do not seem to agree on a single and precise definition. In many instances it has been confused with growth, which rather is an important component of development. Lewis (1955) defines development as improved nutrition; greater leisure; more services and goods; improved status of women; increased production per head; and political freedom. He states that all the above needs are based on growth of per capita

incomes through industrialization. According to Adelman (1975), development is the "removal of material, economic, social and political forms of deprivation" through "self-sustained growth in per capita GNP." In addition to the latter view growth in aggregate income, material and human resources is also supported by Harris (1971), Olatunbosun (1975) and Streeton (1979). Oommen (1973) and Schickele (1973) generalized economic development as (a) humanistic ideology, that is, all men are created equal before God and should have equal rights, opportunities and participation in matters that affect them, and (b) technological innovation --- improvement in the productive capacity of a system.

The major weakness with the broad definition of economic change is that it does not emphasize highly efficient technology, but encourages cheap, labour-intensive, small-scale production that appreciates the culture, belief and social systems of the poor societies. However, borrowing from the experiences of countries like Taiwan, South Korea, Singapore and more recently Brazil, which are rapidly emerging from poverty, only export-led growth e.g. export-led fish production from Nigeria's coastal waters, could provide quick economic transformation in poor societies. Growth in the above countries has been attributed to capital accumulation, efficient use of new resources, improvements in the quality of human capital and technological progress (see Adelman 1975). How much a labour-intensive production can support the above type of growth in the Nigerian coastal artisanal fishery sector is difficult to determine at present. Nevertheless, the present low level of fishing technology employed by the Nigerian coastal artisanal fishermen (see Chapter II, section B) need great improvements to enhance their productivity and economic well-being.

Rapid economic transformation also requires good leadership, an atmosphere of peace and political stability, conditions still lacking in Nigeria. Nigeria barely survived a brutal civil war that began just seven years after its independence from colonialism. The end of thirteen years of military rule (1966-1979) saw the inception in October 1979 of a very shaky civilian government.

In summary, adherence to unprogressive beliefs, habits and social arrangements; lack of techological innovation and needed capital; labour immobility and poor resource base are the major constraints on the growth in per capital income of the Bonny artisanal canoe fishermen. I will characterize economic development in Nigeria's coastal fishery as the production of surplus fish and fish products for both the local markets since Nigeria has a high local demand for fish, and possibly export markets, the proceeds of which should be used to effect economic deversification in the coastal areas. This development is not complete unless the products and services provided satisfy people's needs and requirements in both quality and quantity, and at the least possible costs. Further, the development includes helping the poor fishermen to attain a healthy and decent living and providing the right economic, social, political and other institutional atmospheres, and to ensure that life for as long as they want it continues that way for them and their generations to come. The above goals can be achieved through adequate research that is not just biological, but multidisciplinary in nature. Such investigations also must not exclude the inputs of the fishermen. The right atmosphere for the dissemination of research results and implementation of recommendations must be sought. Tobor (1979) compilied

a list of "transfer systems of fisheries research results to users." He emphasised direct interactions between researchers and the users of their findings.

B. Stages of Economic Change

The reasons for the failure of the benefits of economic growth to "trickle-down" to the poor have been emphasized in the previous section. With this realization, development economists since the seventies have faced the challenge of reassessing the necessary ingredients as well as the path to rapid economic transformation. Two schools of thought have thus far emerged: the first advocates growth, redistribution, and quality education, to be followed in that order, while the second suggests redistributing and educating now, and growing later. The "growth first" strategy has become unpopular for reasons discussed earlier. The redistribute and educate first, then grow later concept, advocated by Adelman (1975) is supported by Stewart and Streeton (1979) because it assured "successful equitable-growth" in the countries that adopted it in the past. Redistributing and educating first seems ideal for Nigeria because of the land-tenure system in the country, which leaves most land and water resources in control of a few royal households. This inhibits agricultural expansion including fisheries.

The Nigerian coastal fishery resource presents a special problem of resource allocation because it is a common property resource to which the assignment of property rights is not quite feasible. According to Schmid (1980), "property rights disaggregate scarcity and apportion opportunities among conflicting parties." One persons use of a resource is a lost opportunity for another person in the case of an "incapatible-

use" resource like the Nigerian coastal fishery, involving many low skilled antisanal fishermen and the technologically efficient industrial trawler operators. The problem of allocation arose because it is very difficult to exclude a group of people from exploiting the fishery or to minimize their share without incurring high transaction and exclusion costs. For instance, the cost of surveillance to ensure compliance with any appropriation rights could far be greater than the value of fish that can be produced from the fishery. The fact also remains whether the artisanal fishermen are politically strong enough to influence the Nigerian government to reallocate her coastal fishery resource in ways that will benefit the poor fishermen. Trawler operators on the other hand are rich and politically strong to influence any government decision to reallocate the resource in their favour. The costs of acquiring sufficient information on which the redistribution of ocean fisheries can be based and that of effecting new regulations to accomplish this goal are also particularly high, and may well outweigh the potential benefits (value of fish production) from the resource (Schmid 1978). But in the Nigerian case, her coastal fishery faces the possibilities of overfishing overcapitalization and possible depletion of valuable species at present levels of exploitation because the resource is poor in productivity. Group, rather than single ownership, can be accomplished by reserving brackish-water, pelagic and inshore demersal fish stocks exclusively for exploitation by the artisanal fishery, and leaving only the offshore demersal and deep-sea stocks for the industrial trawlers. As stated before, most industrial trawler owners in Nigeria are wealthy and have other

non-fishing booming businesses that possibly provide them with greater incomes. According to Schmid (1978) such big business owners could in effect be "opportunistic --- gambling free rider(s) --- willing to give up the possibility of getting a lion's share" at the present time, since they can afford to leave the fishery whenever it is no more profitable. This author quickly asserts that such desires are not easily determined. In addition to the above, the Nigerian trawler owners are considerably smaller in number (conservatively 10 to 50 of them, including maritime states government-owned companies), compared to the over 300,000 traditional canoe fishermen whose lives depend solely on ocean and brackish-water fishing. The costs of instituting an efficient regulatory body to ensure compliance with the suggested redistribution of Nigeria's ocean fishery resource should not be much to refrain the Nigerian government from trying the measure. Efforts should be made to keep the costs to their barest minima. Lewis (1955) and Kuznets (1973) both agree that economic development has both benefits and costs but the benefits are usually viewed as outweighing the costs. The body when established will also settle disputes and deal with the issue of migratory species, e.g. larval shrimp that cross between brackish-water and sea water. It could also involve sub-regional arrangements between Nigeria and her neighbouring countries to deal with the issue of highly migratory stocks that cross national jurisdictional boundaries or Exclusive Economic Zones.

According to Schultz (1979), investment in "human capital" (education) will increase people's quality of life, labour productivity, and enhance savings. Investments in mass and quality education, will

supply much needed adequate manpower to build a strong and virile economy, will benefit both poor and rich, thereby minimizing the problems of inequality and poverty. The type of education needed to improve productivity of fishermen in Nigeria's artisanal fishery are technical and vocational training in modern fishing techniques, gear and equipment handling, boat construction and repair, engine repair, improved fish processing packaging and marketing techniques and also small business management skills.

The integration of new fishing technology which should involve the use of motorized boats with the skills newly acquired by the fishermen, in addition to institutional and ideological readjustments should promote productivity in the fishery. Fishermen should also have greater access to loans and credits and be provided with adequate extension services.

Modern development economic theoriests (including Seers 1970; Kuznets 1973; Adelman 1975; and Streeton 1979) advocate the basic needs approach to economic development. Basic needs, according to Streeton (1979), include improved income earning opportunities and public services for the poor, higher flow of goods and services to all households, and participation of the poor in policies affecting their total well- being. The specific public services include good water for cooking and drinking, better nutrition, good health facilities, good housing, and good transportation and communication systems, adequate loan schemes, and high quality education. Streeton (1979) notes that meeting the basic needs of the poor majority of many developing countries is a more popular development objective than reducing economic inequality. The same

view was given by the fishermen that took part in my survey. They unanimously agree that the Nigerian governments provide them with good roads, schools, hospitals, electricity, clean water, and scholarships for their children's education, in addition to enhancing their fish production. Most of the fishermen contend the problems of economic inequality can be overcome through hard work and reinvestments, once their basic needs are met by the government.

C. Measures of Economic Change

Specific studies reporting measurements of economic change are rare. The most commonly cited indicators of change in the literature are: efficiency; increased productivity; increased income and savings; sufficient food; higher levels of literacy, life expectancy and health standards; low infant mortality; greater freedom; and increased political and economic independence. Seers (1970) defines declining levels of poverty, unemployment and inequality, as important indicators of a period of economic change for a country. High levels of poverty, unemployment and inequality, even at a time of high per capital income signifies non-development.

1. Education

Harris (1971) in treating entrepreneurial resources as a factor of production concludes that any developing country blessed with an adequate supply of skilled (educated) and dynamic human resources, will make more efficient use of its natural resources in combinations that will ensure increased productivity. This is based on the assumption that

> Basic education affects peoples' desires, abilities and quickness to innovate, e.g. acceptance and adaptation of new fishing technology by fishermen.

Lack of adequate education by recipients of development programmes, could make such programmes less understood, thereby undermining their success because communicating with such recipients will be very difficult. It also will be hard to obtain useful information from such illiterates, since most of them keep records orally. However, their abilities to accurately keep records orally must not be doubted, since artisanal fishing businesses are usually very small, make use of simple and low cost gear and equipment, that cost little to maintain. The importance of education, will only be more pronounced, as the fishing business becomes large. Callaway (1960, 1964), Harris (1967) and Alfred-Ockiya (1979) note that non-formal education, such as apprenticeship, on-the-job training, and learning-by-doing are as important as, and in technical fields, superior to formal education. However, the role that vocational and technical training can play in artisanal fishery development as outlined in the previous section can not be overemphasized. Such training is essential for attaining surplus production of fish for either the domestic or export markets.

Pollnac et al. (1975) quoting Rodgers (1967) state that "education often leads to greater economic access and greater security", which could enhance productivity, savings, and success. A fisherman with an education should be able to communicate better with representatives of fisheries development agencies than one without an education. Such advantage will give the former a greater chance to benefit from development assistance programmes, such as subsidized loans, with which to expand his business. The funding agencies will also be sure of not just oral, but written accountability by an educated fisherman that benefitted from the loan plan.

Education also affects people's aspirations to seek alternative opportunities outside the fishing industry, if and when they possess the skills that can be gainfully utilized in other sectors of the economy. A realization of such dreams will limit the number of recruits into fishing, thereby reducing the potentials for overfishing and increasing the share of the catch to the fishermen remaining in the fishery.

Upton (1967) found that farmers income in some villages in South Western Nigeria was correlated with education and innovation.

2. Economic Liquidity

Economic liquidity or disposable (net) income is an important measure of success in any business, including fishing. It is the amount of money a business person has on hand (that is, the person's immediate purchasing power), after subtracting all his business costs from his total income, and could determine his tendency and ability to save for future investments or reinvestments. Net income is a direct indicator of a person's economic well-being. Pollnac et al. (1975) hypothesized that the higher the level of "education of an individual", the greater his "access to the means of production", and the more likely he will save. These authors, by comparing the savings patterns of fishermen and millworkers in New England, conclude that "fishermen will be more likely than millworkers" to save part of their income because of the "periodicity of (fishermen's) income". Periodicity of income is caused by changes in weather conditions and fish stock abundance. Fishermen's income also is unpredictable because of its high dependence on the quantity and quality of fish caught; the price of fish; the demand for fish; and the prices of substitute protein sources, such as beef and poultry.

Harris (1971) in his interview survey of small business holders in Nigeria, found that personal savings or "retained earnings was by far the most important source of capital for expansion ----- the growth of firms and profits are closely related." A "complex and not necessarily linear relationship" exists between savings and "individual or societal economic development (Pollnac et al., 1975).

My basic proposition is:

> The higher a person's disposable income, the higher is his purchasing power and savings ability, and hence his potential overall economic success.

However, a fisherman's disposable income (if any) is dependent on many important variables, which will be discussed and tested in Chapters IV and V.

3. Capital Intensity

The level of capital goods that is employed in an industry e.g. a fishing industry, can be used as a measure of change in the industry. This assertion explains the principle of "capital-output ratio": that is, the industry's input of real capital relative to the output from the industry. It follows that in order to increase the productive capacity of the industry, periodic savings from initial investments must be used to increase the industry's capital output in subsequent investments, thereby enlarging the capital base (productive capacity) and consequent growth of output. My basic hypothesis is:

> The higher the level and efficiency of capital goods an industry employs, the greater the economic change in the industry.

However, this change is largely dependent on the "judicious allocation of (all) capital (Pollnac and Poggie, Jr. 1978)."

Capital in the fishing industry includes boats, gear, motors, baits, marketing facilities, and equipment for processing, packaging, storage and distribution. All the above factors, in varying degrees, will impact on the income (total and net) of the fisherman and the overall efficiency of the entire fishing industry. In the artisanal fishery, capital intensity does not mean large-scale capital intensive mechanized fishing, but small-scale labour-intensive fishing, which makes use of modern and durable motorized canoes, gear and equipment that will improve efficiency, and hence production, to enhance the economic well-being of Nigerian fishermen through increased earnings. Any newly introduced technology must be cost effective and cheap enough to benefit all fishermen. For instance, the use of outboard engines to drive traditional canoes will not only extend the range of fishing grounds covered, but will increase the mobility of fishermen. High mobility will reduce wastage (thus increasing total value of fish), since fish, can be landed more quickly. The introduction of outboard engines on canoes in Ghana increased fishermen's average earnings by more than 100%, compared to canoes without engines (Lawson and Kwei, 1974). These authors attributed the success of the canoe mechanization to availability of engine spare-parts, provision of repair facilities, training of fishermen and extension services provided by the government agency in charge of the project. A similar boat mechanization programme in Barbados from 1955-1960 increased fish production fivefold (Aderounmu, 1980).

Canoe mechanization, which started on a small scale in Nigeria in 1960, has gained wider use by many Nigerian coastal fishermen. Tobor

et al. (1977) reported that only 2,122 (4.2%) out of a total of 50,757 canoes operated in the Rivers State were motorized. The number of motorized canoes in Rivers State may have gone up since then, but has not been documented. Generally, canoe motorization programmes in Nigeria have been hindered by poor planning, lack of sufficient funds and the inability of fishermen to produce sufficient collateral or organize themselves into viable co-operatives, which are preconditions to benefiting from government loan plans. Those fishermen who have mechanized canoes lack the skills to adequately maintain the engines. Government agencies in Nigeria have in recent years stepped up efforts to provided boat and engine repair facilities at major fish landing sites all over the country. Most of the fishermen I interviewed would like to motorize their canoes, but lack the financial resources to do so.

Finally, any improved productivity that may result from the use of a motorized boat by an artisanal fisherman in a developing country may not necessarily increase his per capita income, since the extra proceeds will be shared with members of his family, who will be attracted to join his profitable business (Lawson and Kwei 1974; Pollnac, 1981). What will be had are increases in aggregate income and employment, which still is not short of development in the industry.

4. Marketing Channel

Assumptions:

The dependability of marketing channels used by fishermen to dispose of their catches is an important measure of economic change in a fishery because it could affect fishermen's income, which could in turn affect their overall welfare.

There are no specific studies that I know of on the dependability of fish marketing channels. However, it is my conviction that making fish sales through well organized fishermen's co-operative organizations, could be more dependable than sales made direct to specific or non-specific dealers, or direct to consumers.

Fishermen's co-operatives help members to get better prices on their fish from middlemen buyers, in addition to minimizing transportation costs, providing better repair and landing facilities, and greater access to government loans, with flexible repayment plans (Poggie and Gersuny, 1974). In most developing countries, government agencies rely on the co-operatives for the delivery of services to fishermen. For instance, in Nigeria, fishermen's co-operatives are encouraged to handle fish marketing and distribution in order to deal with the problem of equity in the production, distribution and consumption network. This is because middlemen have been accused of cheating both fishermen and consumers, by setting any prices they wish to either buy or sell fish which to sell to consumers, enabling them to make super-normal profits. The middle-men can do this because they operate a loan system for the fishermen, who in turn are obliged to sell their entire catches to the middlemen moneylenders. The above system does not give the fishermen any incentives to save or reinvest, since any gains from such undertakings will go to the middlemen (Kirby and Szczepanik, 1957).

Often overlooked are the risks borne by the middlemen, who give loans to fishermen demanding only little collateral, and without strict repayment plans that characterize bank and government loans. Possible losses due to fish deterioration are also transferred by fishermen to

the middle-men, who distribute and sell the fish. The seasonality of harvest does not make regular loan repayment plans adequate, and any alternative plans are usually accommodated by the middlemen. Furthermore, Vanderpool (n.d.)[1] notes the success of fishermen-middlemen relationship is based on mutual trust; agreements are rarely broken because of thoughts about the future, since most fishermen believe the repercussions of defying an agreement could be more painful than the short-run gains accruing to a fishermen who defied.

While many fishermen's co-operatives in the developing countries have failed, some have been successful. According to Pollnac (1981), the successful co-operatives were initiated by the fishermen themselves, and are structured to accommodate the sociocultural needs of members; conditions often overlookded by researchers, policy planners and project managers. Poor planning and mismanagement can make a fishery co-operative inefficient, and a financial burden to any government that supports it. In order to be successful, fishermen's co-operatives must be developed to meet local needs, after careful studies and consultations with the recipient groups. Members must be aware of their roles and responsibilities to the organization.

The sale of fish to non-specific dealers assures the fisherman a regular market for his fish, thus eliminating the risk of spoilage, since usually many fish dealers visit a landing site at a time. Selling through this channel also enables the fisherman to bargain for a higher price, if he is not indebted to any of the dealers, who otherwise he

[1] n.d. means no date.

will be obliged to sell to at the dealer's dictated price. However, fish price in Nigeria is not based on weight but on buyers bargaining power, size and species of fish, and on whether the fish is fresh, frozen or smoked (Ladipo, 1973). Fish price also varies between areas, and with seasons.

Contrary to the above, a fisherman who sells to a specific dealer has little control over price, and cannot switch to other dealers if he is indebted to one dealer, even if he felt cheated. Also, a fisherman who sells directly to consumers who may not buy regularly and may be hard to find during periods of bad weather and low demand for fish will incur extra transportation costs, since he will have to take his fish to market towns or cities. A trip to the market could also rob the fisherman some of his valuable time, which he should have spent on fishing.

CHAPTER IV

MEASURES OF PERFORMANCE OF THE BONNY FISHERY AND OTHER CANOE FISHERIES

A. Introduction

The performance of an industry can be measured on many bases. However, from the point of view of a resource economist, performance must be measured in terms of efficiency; that is, relating the value of the industry's output to the opportunity costs of the inputs to the industry. A production system will be considered efficient if the resource inputs to it cannot be used to produce a higher value to society in other sectors of the economy. But any such comparision must be made with great caution since the objectives of developing one sector may differ from that of developing each of the other sectors. Also, many intangible benefits could be involved in a decision to divert resource inputs to a particular production. In the fishery, optimal allocation of production input is where returns to marginal unit is equal to marginal cost. Any allocation of more capital beyond this point is inefficient in an economic sense.

Using the Nigerian coastal artisanal fishery sector as an example, it will be an error of judgement to conclude that the development of this fishery is unjustified even if the resource inputs to it can be used to produce higher protein value, say, from poultry. While it is true that Nigerians need more protein in their diet, other objectives of Nigeria's fisheries management could be equally important or even

more important than fish protein supply. From another viewpoint, in Nigeria's fisheries development, the social objectives of providing employment for the rural poor, increasing dietary protein supply to the malnourished, and improving the living standards of Nigerian poor fishermen are more socially and politically desirable than the economic objective of earning foreign exchange. Besides the chronic poverty levels of Nigerian coastal fishermen which normally should concern public administrators, any deliberate neglect of the welfare of these people by politicians could have serious implications in the politicians bids for re-election into offices, since the fishermen constitute a principal voting block in the coastal parts of Nigeria. Considering the above factors, fishery development in Nigeria, to a very great extent, can be viewed as a form of social service to the poor rural communities.

While characterizing economic change in the previous chapter, I identified education (formal and informal); economic liquidity; capital intensity; and dependability of marketing channels as important determinants of progress in the fishery and other related small scale businesses. The above four factors will form the core of my analyses. Nonetheless, there are many other important measurable variables to the performance of a fishery. The main purpose of this chapter is to list such variables, and to compare the Bonny fishery to four other canoe fisheries in Rivers State, Nigeria, with respect to these variables (using non-parametric test). The next chapter will involve more thorough analyses, using "stepwise multiple regression techniques" to identify those variables most influential to the economic well-being of the Bonny fishermen and the other four groups of fishermen from Rivers State. Such variables,

according to Pollnac (1980), "will be viewed as locally appropriate adaptations which have contributed to (the) success" of the fishery.

B. Characteristics of a Successful Fishery

There is no single satisfactory set of conditions that characterize a successful fishery. This should be expected because the objectives of fisheries management vary widely within and between the different countries of the world, leading to varying perceptions of success. Thus, definitively, and in very broad terms, a successful fishery is one that can produce the optimum or greatest net benefits (tangible and intangible) for a society, based on the stated objectives of fishery management.

Fisheries management in the past was based on purely biological principles, centered on the protection and prevention from extinction of species. This led to the concept of Maximum Sustainable Yield (MSY) which is defined as the maximum physical output (fish weight) obtainable from a fish stock in its natural equilibrium state (see X_1 in Figure 2). The higher the value of MSY, the greater the success of the fishery. However, MSY as a management objective is defective in two ways. First, it is only operational if we are dealing with a single stock of fish, involving a precise fishing effort. Contrarily, most fisheries, especially marine fisheries, are not only multispecies but use varieties of fishing gear and techniques. The point of MSY is thus bound to vary with fish species, and between fisheries. Also, most fisheries lack the requisite information to determine the point of MSY, and it could be too expensive to try to determine MSY for each of the different species, and fisheries involved (Radovich, 1975). Secondly, the concept of MSY ostensibly omits

adequate consideration for the costs of fishing operation, that is, the production inputs. This omission drew the attention of resource economists: Christy and Scott, 1965; Crutchfield, 1959; Gordon, 1953 and 1954; Scott, 1955; and Turvey and Wiseman, 1957; who criticized MSY as the proper tool for fishery management. Instead, they contend the net economic return to the fishery, shown by the difference between the total value of fish caught and the total cost of catching it, should be the criterion for management.

The point of maximum net economic return (X in Figure 2) describes a new concept: Maximum Economic Yield (MEY), as the best criterion for fishery management because if provides the greatest benefit to society. At X, the marginal cost (MC) and marginal revenue (MR) for fish caught are equal; that is, the cost of producing an additional unit of fish is equal to the value of the added return. At any point beyond MEY on the total sustainable yield (TY) or total revenue (TR) curve, MC will be greater than MR but average revenue (AR) will be greater than average cost (AC), meaning the industry is still making profit, though, at increasing cost up to X_2 where the total cost (TC) curve intersects the TR curve. Total revenue and TC, as well as AR and AC curves, are equal at their points of intersection (see X_2). Net profit to the industry is zero at X_2, which describes the situation in a common property or open access fishery. Exploiting the fishery beyond the point of open access could deplete the fish stock, and the fishery will be operating at a loss since both TC and AC will be greater than TR and AR, respectively.

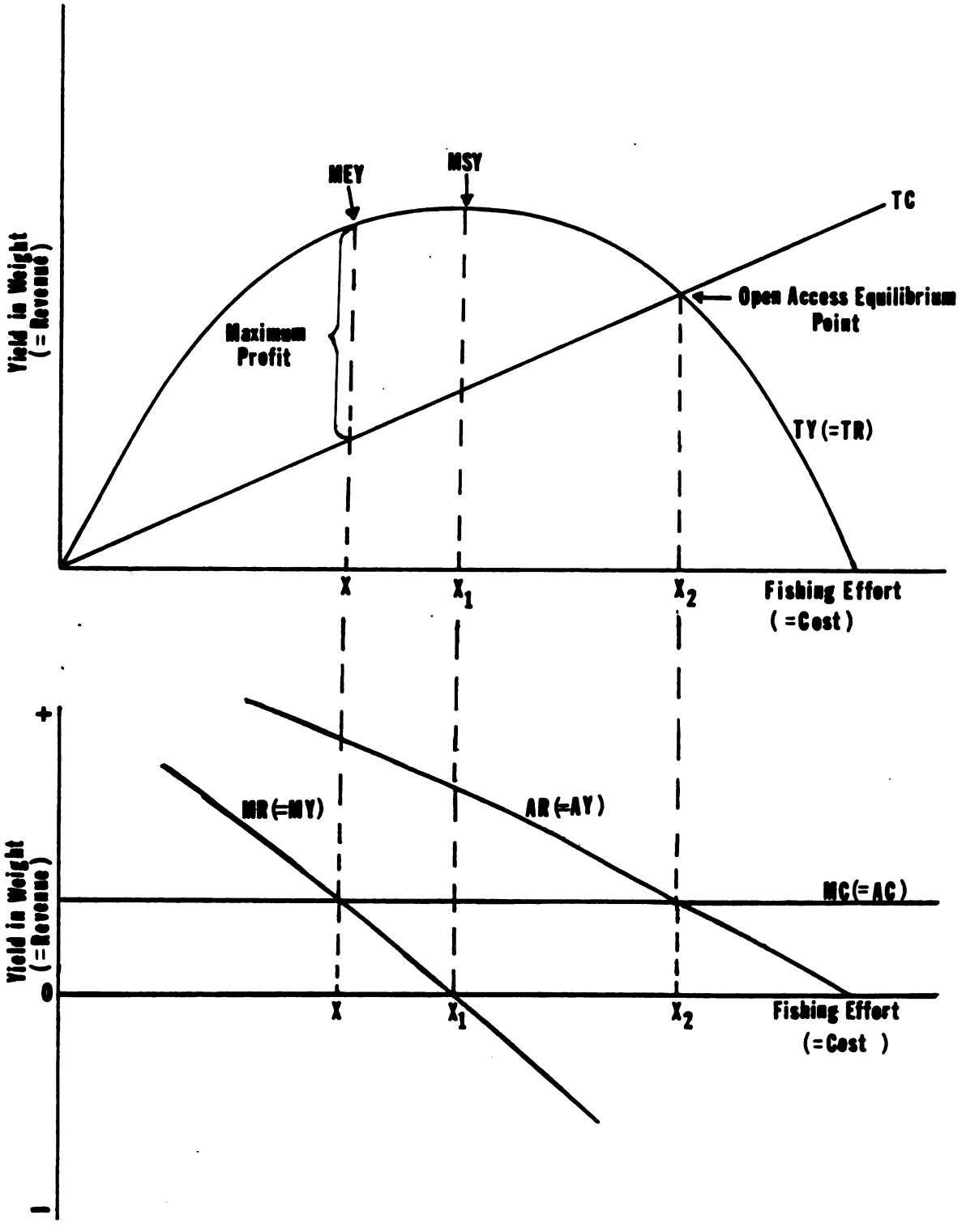

Figure 2. Bioeconomic Yield Curves.

continue to increase his fishing effort (beyond MEY and even MSY) provided he can still make a profit. Thus, MEY can only be achieved and maintained in a regulated fishery with a form of limited entry.

While MEY is unique because it is based on economic efficiency, the principle does not apply to most fisheries which operate on goals other than profit maximization. In fact, a variety of other goals such as dietary fish protein supply to the malnourished, improved fishermen's income and living standards, increased employment, foreign exchange earning, and income redistributions, could be given greater priority by a country. The need to accommodate these other goals makes MSY or MEY inappropriate as our definition of fishery management objective.

In recent years, a new concept - Optimum Sustainable Yield (OSY)- evolved, which accommodates and maximizes to the benefit of society, all of the economic, biological, sociological, and political objectives of fishery management. The position of OSY on the total yield or total revenue curve also is not constant because natural systems and public values are dynamic (Comitini, 1975). It has been argued that OSY is somewhere in between MSY and MEY on the TR curve (Anderson, 1977 and Roedel, 1975). In actual fact, while the above may be true, OSY could as well be same as MSY, MEY, in between MEY and open access, or even identical to open access, depending on the fishery in question.

Optimum Sustainable Yield also suffers from the same problems of measurement and limited applicability as MEY does. While OSY is much easier to apply to single stock or single species fisheries, multispecies, interdependent and international fisheries present special problems of application because many optimum points will be involved. However, OSY

can be manipulated to suit specific situations, in the attainment of fishery management goals. Most resource economists contend the best or optimum management approach is one that does not forsake economic efficiency (see Crutchfield, 1975).

Looking at the administration of Nigeria's coastal fisheries, Nigerian decision makers may contend the neighboring countries of Ghana, Benin, Togo and Cameroon, and other foreign fleets, who compete with Nigeria for the resources of Nigeria's coast, could have undue advantage over Nigerian fishermen if MEY or MSY is Nigeria's ultimate management objective. Management for MEY or MSY by Nigeria is only advised if Nigeria has the capability to carry out effective surveillance operations to enforece fishing regulations in her exclusive economic zone. But, even if Nigeria does have the capability, the costs of enforcing such regulations could far outweigh any benefits that may accrue to the fishery. However, optimum use of internationally exploited fisheries, based on economic efficiency, is possible if participating countries negotiate and agree to gear restrictions on biologically threatened species; other regulations of fishing effort; institution of property rights, which should be mutually transferable; and free trades in fishing effort and final products (Dales, 1968; Crutchfield, 1975; Anderson, 1977). It may take the institution of more than a single regulatory body to attain optimum catch, which according to Anderson should be "taken at the lowest possible cost." A "mother" body will suffice to deal with violators, according to measures which must be mutually agreed upon by participating countries.

Any international fishery that takes the best advantage of the above type of arrangements can be regarded as successful. Such ideal fisheries seldom exist, except in some developed parts of the world.

In summary, a successful fishery is one from which the society derive the most benefits. This success can be measured on the criteria of MSY, MEY or OSY, depending on the fishery and the stated objectives of fishery management. Whatever is our choice, due recognizance must be given to efficient allocation of factors of production, in order to obtain the optimum benefits the society deserve.

C. Problems of Multiple-Objective Fisheries

It is an obvious but often overlooked fact that multiple management objectives can hinder progress in a fishery. The reason is, such objectives usually are not compatible. This problem is more acute in the developing countries where the case for multiple-objective fisheries management may be justified. The value and belief systems and the economic needs of the peoples of these poor countries are as diverse as their technology to catch, process, package and distribute fish; their labour and fish market characteristics.

For instance, balance of payments and rural unemployment considerations could make aggregate income rather than maximum net income a more rational coastal fishery management objective for a country like Nigeria. Nigeria, which is a net importer of fish could choose to curtail loss of foreign exchange by increasing domestic production beyond MEY, which in turn reduces economic efficiency. In order to earn foreign exchange, Nigeria exports her highly valued pink shrimp. This policy seems appropriate since the income generated from exported shrimp can

be used to provide cheaper and better protein sources e.g. grain cultivation, animal breeding, poultry and even fish through improved aquaculture techniques.

The desire to reduce rural unemployment also could make Nigeria operate her fisheries beyond MEY and MSY, even up to the point of open access; thereby sacrificing economic efficiency. The usual argument for the above is to reduce the problem of urban drift by young rural school leavers who do not possess the skills to work in modern industrial sectors. Since our knowledge about the fish stocks of Nigeria's coastal waters and their potentials is limited and uncertain, over-capitalizing and consequent over—fishing of the fishery could deplete most of the valuable stocks, and eventually put Nigerians out of work. Alternative solutions should be sought to the unemployment problem. This could include technical and vocational training for these young people to enable them to acquire the skills needed in modern industrial sectors. Some of them could also be trained as boat builders, boat engine mechanics, gear manufacturers, or even as farmers.

Increasing the number of fishermen in order to combat structural unemployment could reduce the catch and hence income per fisherman. The above conflicts with Nigeria's objective of improving the economic well-being of her fishermen through improved earnings from fishing.

Despite the acknowledged low fish productivity from Nigerian coastal waters, for reasons I reiterated in earlier chapters, tremendous

efforts are made yearly by Nigerian fisheries administrators to increase the capacity of Nigerian fishermen to exploit the resources. While the fishermen I interviewed complained of poor catches in recent years, government official catch statistics show yearly increases (see Table 5 and FDF, 1980). The government figures may have been inflated to convince and impress politicians the fishery is making good progress. Any unnecessary over-capitalization could damage rather than help the fishery. While it could deplete valuable fish stocks, it will increase costs of fishing to fishermen without any compensatory increase in revenue, thereby making them worse-off.

According to Pollnac (1981), income inequality and increased social stratification could result from the introduction of costly fishing technologies. If the need arose, Nigerian fisheries authorities should cautiously introduce new labor-saving fishing technologies, since it involve laying off some already established and specialised fishermen in an environment with scarce alternative employment opportunities. Such steps should be taken only if alternative employment opportunities are created to accommodate redundant fishermen, and if fishermen possess the skills and are willing to switch to the new jobs which could be less remunerative and less gratifying. The trade-offs involved in any job switch must be carefully examined by the authorties. Arriving at appropriate decisions require comprehensive multidisciplinary studies of the entire fishery system, including the users. Otherwise, any attempts made to alleviate economic problems in the fishery could create more serious economic, social and political problems.

Like multiple-objective, multi-agency fisheries also create problems for fisheries administrators. These problems arise because of the usual overlap in the activities of such agencies. An overlap could cause free-riding (ICMRD, n.d.), a situation in which some agencies who do not make maximum (optimum) contribution to the development of the fisheries enjoy equal support as agencies that make valuable contributions, from the governments that fund them. This, according to the above authors, could lead to "suboptimal level of overall contributions and a failure to meet project goals." Coastal fisheries development in Nigeria is open to free-riding since it involves seven federal agencies (FDF, NIOMR, and four River Basin Development Authorities), six maritime states and local governments. I observed during my field study in Rivers State that the above agencies have overlapping projects in the same localities. The impact this may have had on project results should be quantitatively and qualitatively appraised. Some fishermen complained they are not sure of which agency is incharge of their resources.

Unhealthy competition is also imminent between rival agencies. This competition could cause over-capitalization and its associated wastage of resources which could have been allocated to other valuable productive sectors of the economy. In Nigeria, fisheries project evaluation is internal to each development agency. The Nigerian tax payers deserve a new approach to project evaluation to involve neutral bodies, including the fishermen the agencies serve. This will help to remove the fears in the minds of many Nigerians that most government agencies misappropriate funds and check the agencies excesses.

In summary, Nigerian policy makers would need to re-examine the country's fisheries development objectives, in order to minimize conflicts. This may involve the reduction of the objectives to a few attainable ones, after carefully studying the trade-offs involved. Any choices that are finally made must involve management practices that will optimize the use of the fisheries. This optimum, as I said earlier, and according to Anderson (1977), could mean sacrificing economic efficiency for some important social goals.

D. Some Basic Assumptions to be Tested

The preceeding overview (Chapters I to IVc) of the past and present status of Nigeria's coastal fisheries, and the analysis of the concept of economic change raise some important issues that require proper quantification. The purpose of this section is to assemble two groups of assumptions about some performance variables on which the analyses of the socio-economic data on the Bonny fishery will be based. The assumptions are as following:

Group I

This group of assumptions will be used to compare the Bonny fishery to the fisheries of Elem-Bekinkiri, Nyemoni-Waterside, Kono-Waterside and Koluama II.

Assumption Ia: Each fishery has its own unique characteristics, needs, and possibly problems that require locally appropriate solutions, in order to fulfill the overall objectives of fisheries management.

Assumption Ib: Fisheries exibit some basic characteristics (differences and similarities) that could account for the success or lack of success of the fishermen operating in the fisheries.

The above assumptions will be examined using the Kruskal-Wallis one-way analysis of variance by ranks to test the null hypothesis, H_0, that there are no differences between the Bonny fishery and the other four fisheries, regarding some economic variables to be listed in section E of this chapter. The analysis, results and discussion are presented in the last section F of the chapter.

Group II

This group of assumptions will be examined to show if a relationship (positive or negative) exists between some independent and dependent socio-economic variables of success, and to show the relative strengths of some independent variables as predictors of success in small-scale coastal artisanal fisheries. The analysis which will make use of both standard and stepwise multiple regression techniques is the subject of Chapter V.

Assumption IIa: Basic literacy or formal education affects fishermens' aspirations, ability and quickness to innovate e.g. acceptance and adoption of new fishing technology that could increase their catch and income.

Assumption IIb: Capital intensity or the level and quality of technology employed in fishing affects efficiency and fishermans' income e.g. use of motorized canoes.

Assumption IIc: Reliability of fish marketing channel affects fishermans' income.

Assumption IId: The size of a household, which is the basic operational unit (labour force) for smallscale fisheries, could affect fishermans' income.

Assumption IIe: The ability of a fisherman to hire fishing labour is an indication of his success.

E. Sources of Socio-economic Data

Socio-economic information was obtained through a questionnaire interview survey of 287 randomly selected artisanal fishermen in five major fishing areas of Rivers State (see Figure 3). These fishermen include a total of 208 heads of fishing operator's households (FOH) and 79 heads of fishing labourer's households (FLH) - see Appendix 1. Each of the five fishing areas, namely, Bonny (BN), Elem-Bekinkiri (EL), Nyemoni-Waterside (NY) Kono-Waterside (KO) and Koluama II (KM), consists of several small fishing villages along the lagoon rivers and the Atlantic Ocean, as the case may be. The areas vary with respect to proximity to urban areas, which are the major fish markets; accessibility; fishing technology; local economy; and tribal composition, factors that could (App. II) have serious effects on project planning, implementation and results. A summary of the number of cases by area, fisherman household type and marketing channels used is given in Table 7. The Bonny fishery is the most urban because of its closeness to the city of Port-Harcourt and Bonny town. The sample from Bonny consists of 48 fishermen (30 FOH and 18 FLH), 21 of which sell their fish at a location near Port-Harcourt; the remaining 27 sell at Bonny or to middlemen buyers, who visit their villages. Fifty-four samples (32 FOH and 22 FLH) were drawn from Elem-Bekinkiri, which is located some 45 km south of Port-Harcourt along the New Calabar River, and like Bonny, it is in the Olga Local Government and only accessible by water. Fifty samples (39 FOH and 11 FLH) were drawn from Nyemoni-Waterside; seventy-two (44 FOH and 28 FLH) from Kono-Waterside; and sixty-three (63 FOH and 0 FLH) from Koluama II.

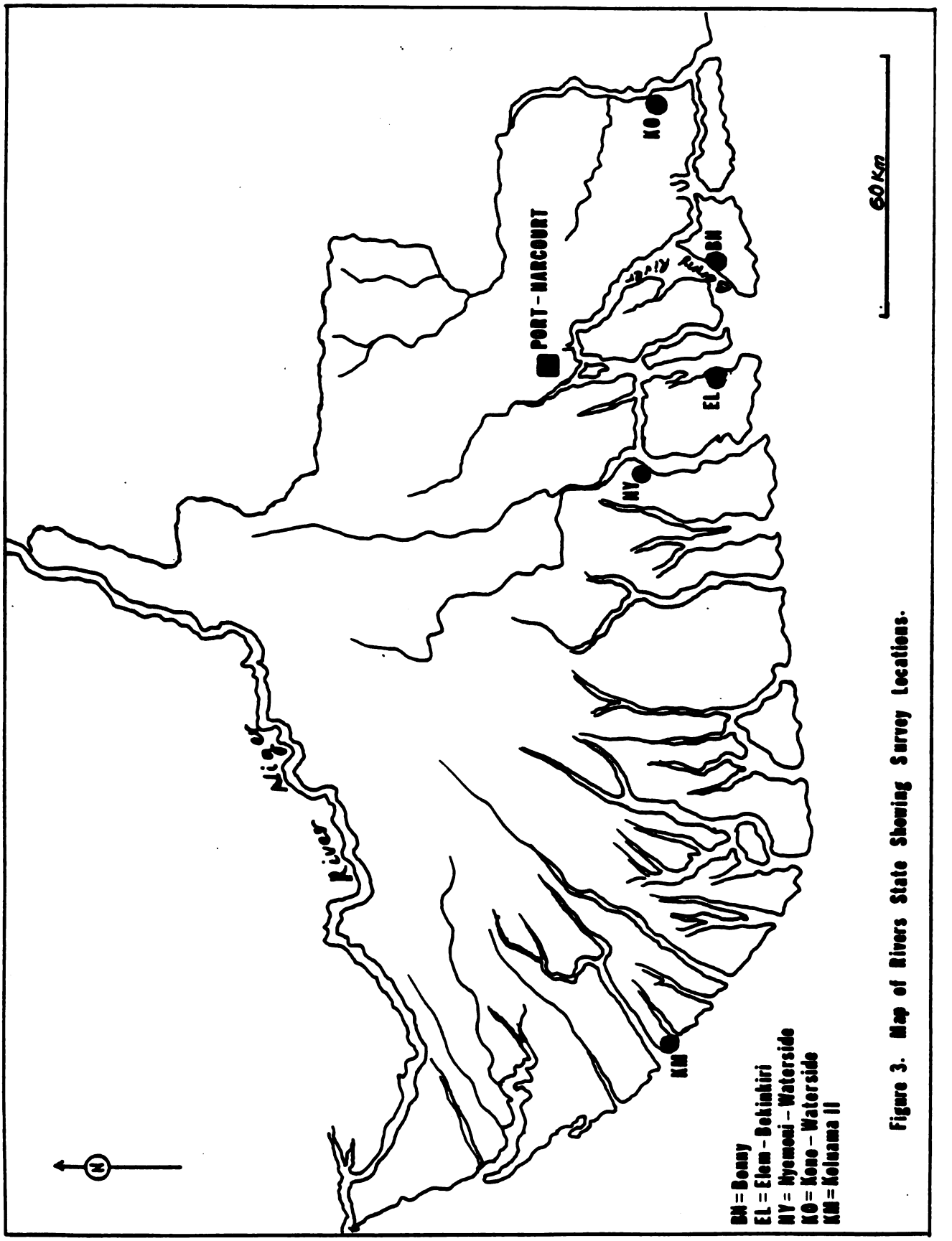

Figure 3. Map of Rivers State Showing Survey Locations.

Table 7. Summary of Number of Cases by Area, Type of Fisherman's Household and Marketing Channel.

Variables	Area					Total
	BN	EL	NY	KO	KM	
Number of cases	48	54	50	72	63	287
Number of FLH	18	22	11	28	0	79
Number of FOH	30	32	39	44	63	208
Number of FOH with Motorized canoe(s)	11(37%)	15(47%)	1(3%)	0	5(8%)	30(14%)
Number of FOH Employing Fishing Labourers	13(43%)	14(44%)	0	0	7(11%)	34(16%)
Number of FOH Marketing fish through Fisherman's Co-Operatives	0	0	0	2(5%)	1(2%)	3(2%)
Number of FOH Selling Fish to Any Dealer	28(93%)	31(97%)	28(72%)	41(93%)	62(98%)	190(91%)
Number of FOH Selling Fish to Specific Dealers	2(7%)	1(3%)	9(23%)	1(2%)	0	13(6%)
Number of FOH Selling Fish Directly to Consumers	0	0	2(5%)	0	0	2(1%)

FOH = Fishing Operator's Household

FLH = Fishing Labourer's Household.

Nyemoni-Waterside is located in the Delga Local Government, along the Sombreiro River and close to Degema twon, which has a small market for fish. Kono-Waterside is located east of Bonny, but in the Bolga Local Government with its headquarters in Bori, a small town 25 km North-East of KO. A 77 km long black asphalt road links Kono-Waterside with Port-Harcourt. Koluama II, the farthest (> 400 km) from Port-Harcourt, is located in a remote area along the Atlantic coastline in the Yelga Local Government, and is only accessible by sea. Koluama II is not in the proximity of any major town or city.

Eleven (37%) of BN fishermen (FOH) possess motorized canoes. The figures for EL, NY, KO and KM are respectively 15 (47%), 1 (3%), 0 (0%) and 5 (8%). The relatively high percentages of motorized canoes for Bonny and Elem-Bekinkiri can be attributed to their close proximity to Port-Harcourt, where government fishery agencies are located, giving the fishermen of the two areas greater access to government subsidized loans, credit facilities and other assistance programmes. In BN, EL and KM, 13 (43%), 14 (44%) and 7 (11%) respectively of the FOH employ fishing labourers to fish with them. The ability of a fisherman to pay (in cash or kind) other people to fish with him is considered an indicator of success, since it could mean the fisherman has excess of gear, equipment and possibly boats he can not handle alone. This information was

obtained by asking each interviewee whether he employed labourers or not, and if he did, how much it cost him to do so in twelve months.

The highest level of formal education attained by the fishermen (FOH) and the number of days they spent fishing in the past 12 months are shown by area in Appendix III (Tables A and B). Fifty-three percent of all the fishermen never attended school, 23% dropped out of elementary school, while 24% completed elementary school. None of the fishermen attended high school or college. Koluama II has the highest number of fishermen (41%) that completed elementary education and KO has the lowest (4%). The latter also has the highest number (80%) of illiterate fishermen with NY having the lowest (26%). Bonny has 19 (63%) illiterate fishermen, 5 (17%) school drop-outs and 6 (20%) elementary school graduates.

Sixty percent (124) of the 208 FOH fished for over 270 days in twelve months; only 10% fished for up to or less than six months in the same period (see Appendix III, Table B). Sixteen (53%) of the Bonny fishermen spent more than nine months fishing, 12 (40%) spent more than six months, while 2 (7%) spent less than six months. Elem-Bekinkiri and Koluama II fishermen show relatively high figures of 31 (97%) and 51 (81%) fishing for more than 9 months in one year.

The fishermen were also asked whether fishing is their sole, main or minor source of income. Table C in Appendix III shows that 207 (72%) of the fishermen (FOH) and FLH) are solely fishermen, 63 (22%) fish mainly, and 16 (6%) fish as a minor occupation. The latter group are mainly canoe builders, gear manufacturers, farmers or traders.

On the variable marketing channels mainly used for fish sale, 190 (91%) of all the FOH reported selling to just any dealer, 13 (6%)

sell to specific dealers, 3 (2%) sell through fishermen's co-operatives and 2 (1%) sell directly to consumers (see Table 7). In Bonny, 28 (93%) of the FOH sell to just any dealer while the remaining 2 (7%) sell to specific dealers. The above information reveals the insignificance of fishermen's co-operative in artisanal fishery operations in Bonny and the other study areas, despite the great emphasis the Nigerian government places on such co-operatives in the development of the artisanal fishery sector. The problems of the Nigerian fishermen's co-operative system requires particular attention from Nigeria's policy makers and fishery administrators, to enable fishermen to realize the benefits of the co-operatives. Nevertheless, the present marketing system, in which over 90% of the fishermen sell their catches to non-specific dealers, appears efficient, since fishermen are free to bargain for the prices at which to sell, thus giving them the opportunity to maximize their profits. But, the fact still remains that non-specific dealership is the second best marketing channel, next to fishermen's co-operatives, considering the total benefits of the co-operative system. Finally, the survey also revealed that 80% of Bonny fishermen and 88%, 64% and 56% respectively for Koluama II, Kono-Waterside and Elem-Bekinkiri, are indebted to middlemen money-lenders, who they pay back with fish. This indebtedness could considerably reduce the fishermen's economic liquidity and savings ability.

F. Measures of Relative Performance: Analysis of Variance

This section further compares the Bonny fishery to the fisheries of EL, NY, KO and KM, to see if they exhibit any basic similarities or differences with regard to some economic variables, which could account

for the success or lack of success of the fishermen operating in the various fisheries. The variables for comparison are listed in Table 8. The total income of each fishermen was calculated by adding together all of his annual revenue from sales of fish, whether for cash or repayment of debt, including the value of fish consumed by his family. Net income was calculated by subtracting total fishing operational costs (variable as well as fixed costs) from the total income of each fisherman. Fisherman's operational costs include costs of canoe, gear, outboard engine, fuel, ice, other equipment and wage paid to fishing labourers.

The basic hypothesis to be tested is the null hypothesis, H_0, that there are no differences between the Bonny fishery and the other four fisheries, regarding the economic variables discussed above. An alternative hypothesis to H_0, when H_0 is rejected, is H_1, and it states there are differences between the Bonny and these other fisheries. The test makes use of Kruskal-Wallis one-way analysis of variance by ranks, described in Siegel (1956)[1]. This test is known to be very useful for analysing independent samples. Values for all the cases in the fisheries are ranked in a single series, from which H statistic is computed. The Kruskal-Wallis H statistic, which has a chi-square distribution, with degree of freedom = K - 1, is shown by the formula:

$$H = \frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j 2}{n_j} - 3(N + 1) \qquad (I)$$

where k = number of samples (fishing areas)

n_j = number of cases in jth sample

[1]The following decription of Kruskal-Wallis H statistical test is paraphrased from Siegel (1956).

Table 8. Relationships Between the Fisheries of Bonny, Elem-Bekinkiri, Nyemoni-Waterside, Kono-Waterside and Koluama II*

VARIABLES	CHI-SQUARE VALUES**				
	ALL Areas (208)	BN and EL (62)	BN and NY (69)	BN and KO (74)	BN and KM (93)
Total Income of Fishermen	67.91[c]	0.32[a]	0.06[a]	10.99[c]	0.17[a]
Net Income of Fisherman	47.68[c]	1.09[a]	14.18[c]	13.29[c]	23.77[c]
Catch sold for Cash	65.29[c]	0.24[a]	0.75[a]	17.40[c]	2.63[a]
Catch to Cover Debt	84.34[c]	2.95[a]	44.47[c]	8.25[c]	1.96[a]
Debt to Cash Ratio (Solvency)	82.37[c]	5.84[b]	44.45[c]	2.28[a]	6.07[c]
Total Operational Cost	84.78[c]	3.57[a]	3.21[a]	6.82[c]	8.49[c]
Gear Cost	58.08[c]	2.68[a]	3.93[b]	3.35[a]	6.57[c]
Fuel Cost	85.14[c]	0.61[a]	34.37[c]	43.53[c]	36.49[c]
Wage Paid to Labourers	122.16[c]	1.12[a]	20.24[c]	22.55[c]	32.67[c]

[a]significant at or > 10% [b]significant at 5% [c]significant at 1%

*Sample sizes are shown in parentheses. **Chi-square values have been corrected for ties.

$N = \Sigma n_j$, the number of cases in all samples combined

R_j = sum of ranks in jth sample

$\sum_{j=1}^{k}$ indicates summing over all the k samples.

In the event of any ties between some of the cases, and since such ties influence the value of H, ties are corrected for by dividing the computed value of H by the equation:

$$1 - \frac{\Sigma T}{N^3 - N} \qquad \text{(II)}$$

where $T = t^3 - t$ (t is the number of tied cases)

$N = \Sigma n_j$, the number of cases in all samples combined

ΣT indicates summing over all groups of ties.

Therefore, the expression for H corrected for ties is:

$$H = \frac{\frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N+1)}{1 - \frac{\Sigma T}{N^3 - N}} \qquad \text{(III)}$$

When the Kruskal-Wallis test is performed using the Statistical Package for the Social Sciences (SPSS), the output shows the number of cases and mean ranks for each group; chi-square (H) and significance levels; and the latter corrected for ties. Null hypothesis is rejected when the H values are so large that the probability for their occurrence is equal to or less than a significance level (α) of, say, 0.05.

The Kruskal-Wallis test is powerful and reliable. According to Siegel (1956), its power-efficiency is 95.5%, "when compared with the F-test, the most powerful parametric test."

The significance level chosen for the present analysis is 5%. Therefore, the basis for rejection of the null hypothesis is if the chi-square value obtained is so large that the probability of its occurrence is equal to or less than 5%. If H_0 is rejected, then, H_1 is accepted, meaning the Bonny fishery differs from the other fisheries. Table 8 shows the results of my analysis. That is, the chi-square values for the economic variables, and their respective significance levels. The H values with indices b and c imply that H_1 is true, that is, H_0 must be rejected. For values of H with indices a, H_0 is true, meaning the fisheries are not different, on the basis of the variables in question.

The results show no significant differences between the income and expenditure characteristics for the Bonny and Elem-Bekinkiri fishermen, except in their solvency, that is, the ratio of their fish sold for cash to that sold to cover debts, which is significant at 5%. This result is not surprising because both fisheries share other common characteristics: they are located in the same local government; nearly equidistance (40 and 45 kms respectively) from Port-Harcourt; over 90% of each sample use the same market channel and are solely fishermen; more than one-third each of their fishermen use motorized canoes and employ fishing labourers; more than half fished for over nine months in the past twelve months; and the fishermen are mostly illiterates (see Table 7 and Appendix III).

The Bonny and Nyemoni-Waterside samples only show similarities in the levels of their total income, total cost and quantity of catch sold for cash. The two fisheries show significant differences in the

other variables of interest. The great disparity in the fishermen's net income ($H = 14.18$, $\alpha < 1\%$); catch to cover debth ($H = 44.47$, $\alpha < 1\%$); solvency ($H = 44.45$, $\alpha < 1\%$); fuel cost ($H = 34.37$, $\alpha < 1\%$); and labourers wage ($H = 20.24$, $\alpha < 1\%$) could be attributed to the following: the fishermen of NY, unlike those of Bonny, do not enjoy the lucrative fish trade in Port-Harcourt (the mean annual net income of BN fishermen is ₦ 3,325.90 compared to ₦ 296.67 for NY - see Appendix IV); only 3% of NY fishermen, compared to 37% from Bonny, have motorized canoes; none of the NY fishermen employed fishing labourers, whereas 43% of Bonnys' employed labourers; and a sizable number (28%) of NY fishermen used marketing channels other than any dealer compared to only 7% for Bonny.

A comparison of the Bonny and Kono-Waterside samples shows they are disparate with respect to all variables, except solvency and gear cost. The mean annual net income of the KO fishermen is only ₦ 419.59; none of the fishermen uses a motorized canoe nor employed fishing labourers; they are mostly (80%) illiterates; and only 22% of them fish full-time, compared to 98% for Bonny. While 53% of Bonny fishermen fished for more than nine out ot twelve months, only 32% from KO did for the same period. Kono-Waterside is farther (> 70 km by road) from Port-Harcourt and as such KO fishermen seldom sell their fish outside their landing sites, except occassionally at Bori.

There are also significant differences between the Bonny and Koluama II fisheries. For instance, the mean annual net income of the fishermen from both fisheries are highly disparate ($H = 23.77$, $\alpha < 1\%$). As I said earlier, Koluama II is the most remote fishery from Port-Harcourt; has minimum uses (8% and 11% respectively) of motorized canoes

and fishing labourers; and 68% of the fishermen fish full-time. Ironically, 26 (41%) of the fishermen completed elementary education, the highest for all the fisheries. The equivalent figure for Bonny is 6 (20%). Also, a greater percentage (81%) of KM fishermen fished for over nine months in the past twelve months, compared to 53% of Bonnys'.

Finally, a comparison of all the five fisheries shows they are significantly different (at $\alpha < 1\%$) with regard to all the variables (see Table 8). The null hypothesis, H_0, is thus not true and must be totally rejected in favour of H_1. However, one can contend that the Bonny and Elem-Bekinkiri are quite similar fisheries. The other three fisheries are sufficiently disparate from the Bonny fishery to warrant further analysis. Of particular interest are the differences between the net incomes of the fishermen, which has a direct bearing on their economic well-being. A stepwise multiple regression analysis, to show the relative importance of some socio-economic variables to the economic well-being of the Nigerian coastal fishermen will be the subject of the next chapter.

CHAPTER V

SOCIO-ECONOMIC DETERMINANTS OF SUCCESS AMONG COASTAL ARTISANAL FISHERMEN

A. Introduction

In Chapters III and IV, some socio-economic variables were established as measures of change in small-scale fisheries. Using the Kruskal-Wallis analysis of variance test, I showed also that, with respect to certain variables, the Bonny fishery differs significantly from three out of four other coastal fisheries in Rivers State, Nigeria. The primary purpose of the present chapter is to identify those variables most influential to the income, hence the potential success of these coastal fishermen, since income has a direct bearing on the fishermen's economic well-being. Also, I will probe further the differences and similarities that exist between the Bonny and the other fisheries, and their possible effects on the success or otherwise of the fishermen. The statistical techniques that will be employed, which will make use of the same data described in Chapter 4, are standard and stepwise multiple regression analyses (see Kim and Kohout, 1975).

B. Multiple Regression Analysis

Multiple regression analysis is used to show the relationship between a dependent variable, Y, and a group of independent variables, Xs, and for prediction (cf. Kim and Kohout, 1975; Salvatore, 1982).

Strictly speaking, this procedure examines the totality of the dependence of a variable on a given set of other variables. The principal assumption of the analysis is that there is no exact linear relationship between the independent variables. It is also assumed that there is homogeneity of variance; normality of distribution, and linear relationships between the dependent and independent variables (Kim and Kohout, 1975).

The multiple regression procedure involves an array of complex computations that will not be shown in this thesis, since the SPSS subprogramme REGRESSION automatically provides the statistical results of the analysis. Readers interested in the details of the computations are referred to Nie et al (1975). However, according to Nie et al, the general expression for the unstandardized regression procedure is:

$$Y' = A + B_1X_1 + B_2X_2 + \ldots\ldots + B_KX_K$$

where Y' is the estimated value of the dependent variable Y, A is a constant (the intercept of Y) which is added to each case, and the Bs are constants (partial regression co-efficients) with which all the dependent variables, Xs, are multiplied. The Bs stand for the expected change in Y as a result of a unit change in X_1 when X_2 through X_K are controlled.

The computer output essentially includes values of RESIDUALS or errors in prediction, which are the differences between the actual and estimated values of Y; the CORRELATION COEFFICIENT, R, which shows whether the relationship between a dependent and independent variable is positive or negative; the absolute value of R and coefficient of determination, R^2, both of which show the strength of the relationship; the F ratio and significance levels.

The dependent variables of interest (direct measures of success) in the present analysis are fishermen's total annual income (TOTINC), net income (NETINC), debth-cash ratio (SOLVENT) and ownership of canoe with outboard engine (CWOBE). Independent variables (predictors of success) include marketing channel (MKTCHNL), level of formal education (EDUC), gear cost (GRCOST), wage paid to fishing labourers (WAGE), days spent fishing in the past twelve months (DAYS), size of fishing operator's household (SHH), number of fishing operator's household (FOH) members that are fishermen (NUMFISH), and CWOBE.

C. Regression Results

The correlation co-efficients between the dependent and independent variables by area are shown in Table 9. Values with indices a, b and c represent significant levels of correlation, 0.1%, 1% and 5% respectively, between corresponding dependent and independent variables.

Total income shows significant positive correlations with CWOBE in Bonny, Nyemoni-Waterside and Koluama; with MKTCHNL in Elem-Bekinkiri; education in Nyemoni-Waterside; SHH in Bonny and Koluama II; and with GRCOST in all the fishing areas, except Bonny. There are significant negative correlations between total income and MKTCHNL in Kono-Waterside; WAGE in Bonny and NUMFISH in Elem-Bekinkiri.

Net income is positively correlated with CWOBE in Bonny and Nyemoni-Waterside; with market channel in Elem-Bekinkiri; gear cost in Kono-Waterside and Koluama II; and with SHH in Bonny. However, net income shows significant negative correlations with WAGE in Bonny and with SHH and NUMFISH in Elem-Bekinkiri.

Table 9. Correlation Coefficients Between Independent and Dependent Variables by Area.

Independent Variables	*Dependent Variables*																			
	TOTINC					NETINC					SOLVENT					CWOBE				
	BN	EL	NY	KO	KM	BN	EL	NY	KO	KM	BN	EL	NY	KO	KM	BN	EL	NY	KO	KM
CWOBE	.58[a]	.30	.77[a]	--	.73[a]	.54[b]	-.04	.71[a]	--	.13	-.11	.50[a]	--	--	.05	--	--	--	--	--
MKTCHNL	-.10	.45[a]	.09	-.01[c]	.05	-.14	.64[a]	.06	.05	.06	.39[c]	-.15[c]	--	-.16	.15	.09	-.17	.19	--	.03
EDUC	-.17	.27	.41[c]	-.10	.23	-.18	.32	.32	.02	.12	-.29	.10	--	.25	.13	-.15	-.01	.24	--	.07
GRCOST	.65	.57[a]	.80[a]	.88[a]	.78[a]	.56	-.08	.31	.75[a]	.59[a]	-.04	.20	--	.10	.30[c]	.28	.49[b]	.50[a]	--	.17
WAGE	-.07[c]	.19	--	--	.50	-.13[b]	-.16	--	--	.41	-.11[a]	.04	--	--	.15	.17	-.08	--	--	.22
DAYS	.23	.05	-.12	.15	.20	.20	-.00	-.22	.13	.14	.12	-.20	--	.16	.15	.04	-.19	-.05	--	.11
SHH	.73[a]	-.25	.09	.07	.62[c]	.71[a]	-.27[c]	.15	.03	.30	-.12	-.43	--	-.14	.26	.34	-.19	.04	--	.12
NUMFISH	.25	-.27[c]	.02	.04	.60	.22	-.39[c]	.05	.00	.31	-.04	-.49[c]	--	.04	.23	-.14	-.31[c]	.03	--	.11

BN = Bonny , N = 30 a = $\alpha \leq 0.001$

EL = Elem-Bekinkiri , N = 32 b = $\alpha \leq 0.01$

NY = Nyemoni-Waterside , N = 39 c = $\alpha \leq 0.05$

KO = Kono Waterside , N = 44

KM = Koluama II , N = 63

It is interesting to note that CWOBE and GRCOST, which are the two measures of capital intensity, show relatively high positive correlations with fishermen's income. While total and net incomes are highly positively correlated in all the samples, gear cost and CWOBE show high correlations in Elem-Bekinkiri and Nyemoni-Waterside only.

Regarding SOLVENT, it shows positive correlations with CWOBE in Elem-Bekinkiri, MKTCHNL in Bonny and gear-cost in Koluama II but negative correlations with WAGE in Bonny, marketing channel and NUMFISH in Elem-Bekinkiri. All the dependent variables exhibit high negative correlations with NUMFISH in Elem-Bekinkiri.

Surprisingly, Bonny and Elem-Bekinkiri differ completely with respect to the correlations between the sets of variables, contrary to the similarities they exhibit in the Kruskal-Wallis test (see Table 8). While total income is positively correlated with SHH and CWOBE, and negatively correlated with WAGE in Bonny, it is GRCOST, MKTCHNL and NUMFISH that are correspondingly correlated with total income in Elem-Bekinkiri. Similar contrary relationships occur with NETINC, SOLVENT and CWOBE for the two areas. Generally, Bonny differs from each of the other areas, and all the areas differ in the correlates of the variables determining fishermen's success.

In order to determine the collective effects of the independent on the dependent variables, and to know those variables with the strongest effects, a stepwise multiple regression analysis was performed for each of the fishing areas, for comparisons. The independent variable that explains the greatest variance in the dependent variable is entered into the analysis first, to be followed by the variable that

explains the most variance when the first is controlled. This trend continues until all the independent variables of interest are entered into the analysis. Table 10 to 14 show the results of the above analysis with each table representing a fishing area. Like in the standard analysis, the independent variables and their effects on TOTINC, NETINC, SOLVENT and CWOBE, wherever applicable, are measures of fishermen's success or enterpreneurial performance. Values of variances (R^2 change) that are high ($\geq$ 0.05) represent statistically significant degrees of explanation. Each of the statistically significant variables has F Ratio to enter of at least 4, except EDUC in relation with SOLVENT in Kono-Waterside with a F Ratio of 2.84 and a significance level of 10%.

Generally, all the areas have quite strong multiple correlations. The 84% and 79% variances in TOTINC respectively in NY and KO are the strongest. Gear cost exhibits the strongest correlations (variances of 32% for EL, 64% for NY, 77% for KO and 61% for KM) with TOTINC in all the fishing areas, except Bonny. Gear cost also shows the strongest correlations with NETINC in KO and KM, accounting for 57% and 34% respectively of its variance. It also accounts for 25% and 9% of the variance in SOLVENT at NY and KM. It thus means that the higher a fisherman's expenditure on gear, the higher his reported income.

When GRCOST and SHH are controlled, CWOBE and MKTCHNL show the strongest positive correlations with TOTINC, except in KO where MKTCHNL shows a rather weak (2%) negative correlation with TOTINC. Apart from gear cost, the other important predictors of fishermen's net income include ownership of canoe with outboard engine, size of fishing operator's household and in EL, market channel used for fish sale. The above imply that fishermen operating canoes with outboard engines and those having

Table 10. Stepwise Multiple Regression of Independent Variables on Total Income, Net Income and Solvency for Bonny.

Independent Variables (Controlled)	Multiple Correlation	Variance	Percent Variance
		Dependent Variable TOTINC	
SHH	.73	.54	.54[a]
CWOBE	.81	.66	.12[a]
WAGE	.85	.73	.07[c]
DAYS	.87	.75	.02
GRCOST	.87	.75	.01
MKTCHNL	.87	.76	.00
NUMFISH	.87	.77	.00
EDUC	.88	.77	.00
		NETINC	
SHH	.71	.51	.51[a]
CWOBE	.78	.61	.10[b]
WAGE	.84	.71	.10[b]
DAYS	.85	.73	.02
MKTCHNL	.86	.73	.00
GRCOST	.86	.73	.00
NUMFISH	.86	.73	.00
EDUC	.86	.74	.00
		SOLVENT	
MKTCHNL	.38	.15	.15[c]
WAGE	.63	.40	.25[a]
EDUC	.65	.42	.02
CWOBE	.66	.44	.01
SHH	.66	.44	.00
GRCOST	.67	.45	.01
NUMFISH	.67	.45	.00

a = $\alpha \leq 0.001$ c = $\alpha \leq 0.05$

b - $\alpha \leq 0.01$

Table 11. Stepwise Multiple Regression of Independent Variables on Total Income, Net Income, Solvency and CWOBE for Elem-Bekinkiri.

Independent Variables (Controlled)	Multiple Correlation	Variance	Percent Variance
		Dependent Variable TOTINC	
GRCOST	.60	.32	.32[a]
MKTCHNL	.76	.58	.26[a]
NUMFISH	.80	.64	.06[c]
WAGE	.81	.66	.02
SHH	.82	.68	.01
EDUC	.84	.70	.02
CWOBE	.84	.70	.00
		NETINC	
MKTCHNL	.64	.42	.42[a]
NUMFISH	.70	.49	.07[c]
SHH	.75	.56	.07[c]
EDUC	.76	.58	.02
WAGE	.76	.58	.00
DAYS	.76	.58	.00
GRCOST	.76	.58	.00
		SOLVENT	
CWOBE	.50	.25	.25[a]
NUMFISH	.61	.37	.12[c]
SHH	.63	.40	.03
MKTCHNL	.70	.48	.08[c]
GRCOST	.70	.50	.01
DAYS	.71	.51	.01
WAGE	.72	.51	.01
EDUC	.72	.52	.00

Table 11 continued

	Multiple Correlation	Variance	Percent Variance
		CWOBE	
GRCOST	.49	.24	.24[b]
NUMFISH	.61	.37	.14[c]
MKTCHNL	.64	.41	.04
WAGE	.67	.45	.04
DAYS	.69	.47	.02
EDUC	.70	.48	.01

a = $\alpha \leq 0.001$

b = $\alpha \leq 0.01$

c = $\alpha \leq 0.05$

Table 12. Stepwise Multiple Regression of Independent Variables on Total Income, Net Income and CWOBE for Nyemoni-Waterside.

Independent Variables (Controlled)	Multiple Correlation	Variance	Percent Variance
		Dependent Variable TOTINC	
GRCOST	.80	.64	.64[a]
CWOBE	.91	.82	.18[a]
EDUC	.92	.84	.02[c]
SHH	.93	.86	.02
DAYS	.93	.86	.00
NUMFISH	.93	.86	.00
MKTCHNL	.93	.86	.00
		NETINC	
CWOBE	.71	.51	.51[a]
DAYS	.73	.54	.03
SHH	.75	.56	.03
NUMFISH	.77	.59	.02
MKTCHNL	.78	.61	.02
EDUC	.78	.61	.01
GRCOST	.78	.62	.00
		CWOBE	
GRCOST	.50	.25	.25[a]
MKTCHNL	.54	.29	.04
EDUC	.54	.30	.01
NUMFISH	.55	.30	.00

a = $\alpha < 0.001$

c = $\alpha \leq 0.05$

Table 13. Stepwise Multiple Regression of Independent Variables on Total Income, Net Income and Solvency Kono-Waterside.

Independent Variables (Controlled)	Multiple Correlation	Variance	Percent Variance
		Dependent Variable TOTINC	
GRCOST	.88	.77	.77[a]
MKTCHNL	.89	.79	.02[c]
NUMFISH	.89	.80	.01
DAYS	.89	.80	.00
SHH	.90	.80	.00
		NETINC	
GRCOST	.75	.57	.57[a]
MKTCHNL	.78	.61	.04
NUMFISH	.79	.62	.01
DAYS	.79	.62	.00
EDUC	.79	.62	.00
SHH	.79	.62	.00
		SOLVENT	
EDUC	.25	.06	.06
DAYS	.31	.10	.03
MKTCHNL	.35	.12	.02
SHH	.37	.14	.02
NUMFISH	.38	.15	.01
GRCOST	.39	.15	.00

a = $\alpha \leq 0.001$

c = $\alpha \leq 0.05$

Table 14. Stepwise Multiple Regression of Independent Variables on Total Income, Net Income and Solvency for Koluama II

Independent Variables (Controlled)	Multiple Correlation	Variance	Percent Variance
		Dependent Variable TOTINC	
GRCOST	.78	.61	.61[a]
CWOBE	.84	.71	.09[a]
SHH	.85	.73	.02[c]
DAYS	.86	.74	.01
WAGE	.86	.75	.00
EDUC	.86	.75	.00
NUMFISH	.86	.75	.00
		NETINC	
GRCOST	.59	.34	.34[a]
WAGE	.60	.36	.02
NUMFISH	.61	.38	.01
DAYS	.62	.39	.01
MKTCHNL	.62	.39	.00
SHH	.63	.39	.00
		SOLVENT	
GRCOST	.30	.09	.09[c]
DAYS	.33	.11	.02
MKTCHNL	.36	.13	.02
EDUC	.37	.14	.01
SHH	.37	.14	.00
NUMFISH	.38	.14	.00
CWOBE	.38	.14	.00

a = $\alpha < 0.001$

c = $\alpha < 0.05$

a large household, have bigger incomes. Education has a weak positive correlation (R = 0.02) with TOTINC in the NY sample only.

In the Bonny sample, ability to hire fishing labourers (WAGE) has negative partial correlations with fishermen's income and SOLVENT, implying that fishermen who do not hire fishing labourers are likely to have higher incomes and more physical cash. The same interpretation goes for number of household members who are fishermen (NUMFISH) in the EL sample, where NUMFISH shows strong negative correlations with fishermen's income, SOLVENT and CWOBE. Finally, in the EL and NY samples, gear cost respectively account for 24% and 25% of the variances in ownership of canoe with outboard engine, when the latter is treated as a dependent variable. The standard regression procedure shows strong positive correlations (R = 0.49 and R = 0.50) between both variables, in the EL and NY samples.

D. Discussion

The regression results revealed that CWOBE, GRCOST, SHH and MKTCHNL are the strongest predictors of fisherman's income. The two measures of capital intensity - ownership of canoe with outboard engine and gear cost - are in most instances the strongest predictors of fisherman's income. These findings agree with my hypothesis that capital intensity affects economic change in an industry. It could be inferred that fishermen that spend more money on gear will be able to afford "modern" and greater efficient gear which could increase the quatity and quality of their catch, and hence their income.

The strong relationship between ownership of canoe with outboard engine and fisherman's income was expected. As I said, this supports

the assumption that the use of motorized canoes could improve fishing efficiency and fisherman's earnings. Pollnac and Poggie, Jr. (1978) contend that "ownership of means of production", such as a boat, fishing gear and equipment, constitutes economic security to small scale fishermen. The ongoing canoe mechanization programme in Nigeria is thus justified, considering the above benefits. However, efforts should be made by project managers to ensure that the targetted fishermen adequately benefit from the programme. In addition, fishermen must be encouraged to set aside part of their income from fishing in order to meet operational, boat and equipment maintenance and repair expenses.

It is surprising that in Bonny, where substantial amounts of money are spent on fishing gear ($\bar{X}$ = 694.53, SD = 678.86), GRCOST does not show any significant relationship with fisherman's income. However, the high standard deviation implies a high degree of heterogeneity in the Bonny fishermen's expenses on gear, which may have a bearing on the regression results. It also is possible that the presence of other variables in the analysis may have obscured the effects of GRCOST on income at Bonny. For instance, GRCOST shows strong positive correlations with SHH (R = 0.75) and NUMFISH (R = 0.46) in the standard analysis.

It is interesting that size of fishing household is the strongest predictor of income (TOTINC R = 0.73, $\alpha < 0.001$; NETINC R = 0.71, $\alpha < 0.001$) at Bonny. This could be attributed to the large sizes of the Bonny fishermen's households ($\bar{X}$ = 17.87) which the fishermen "must work harder to support (cf. Pollnac, 1980)". Ironically, only 24% ($\bar{X}$ NUMFISH = 4.30) of the Bonny fishermen households members are fishermen. Pollnac's (1980) alternative suggestion is that "more

successful (those with higher incomes) fishermen" will be able to support larger families. The mean net income for the Bonny fishermen is ₦ 3,325.90. This compares to ₦ 599.97, ₦ 296.67, ₦ 419.59 and ₦ 334.79 respectively for Elem-Bekinkiri, Nyemoni-Waterside, Kono-Waterside and Kiluama II. At Koluama II where 50% ($\bar{X}$ SHH = 6.62; $\bar{X}$ NUMFISH = 3.32) of the fishermen's households are fishermen, SHH also stands out as a strong predictor (R = 62, $\alpha < 0.05$) of fishermen's income.

The level of formal education of fishermen shows no significant relationship with fishermen's income, except at Nyemoni-Waterside (TOTINC R = 0.41, $\alpha < 0.05$). However, the effects that non-formal education, a variable discussed in an earliar chapter, may have had on fishermen's income are not known, since this variable was not measured. Inclusion of this variable in future research may throw some light on its relative importance on fisherman's economic success. None of the fishermen included in the present study attended high school or college or had any vocational training.

Finally, MKTCHNL comes out as a strong predictor of fisherman's income at Elem-Bekinkiri (TOTINC R = 0.45, $\alpha < 0.001$; NETINC R = 0.64, $\alpha < 0.001$). This kind of positive relationship was expected for the other fishing areas but the results were contrary. The effect of this variable may have been obscured by the presence of other variables in the analysis of data from these areas. The positive relationship shown in the case of EL may be due to the homogeneity ($\bar{X}$ MKTCHNL = 2.03, SD = 0.18) of market channel used by the fishermen.

CHAPTER VI

CATCH STATISTICS FOR THE BONNY FISHERY

A. Introduction

Accurate and timely data on the composition, patterns of distribution, migration, reproduction, and populations of species; and the subsequent analysis and correct interpretation of the data are the important tools for fisheries management. Usually, such information is complemented with commercial catch and effort data in order to estimate present and potential future biological yields from an exploited fishery resource. These data, in addition to some basic socio-economic and marketing information about the fishery are used by fisheries biologists and economists to propose theories and build models on which the future development, management and exploitation of the fishery can be based. However, the success of management is largely dependent on how appropriately the resultant models are applied to the problems of the fishery.

It is rather unfortunate that the type of information just described rarely exists in the right quality and quantity for most of the world's important fisheries because the data are expensive to gather in terms of needed personnel, time and finance. The more acute cases are the fisheries of the coastal waters of the less developed countries, whose management (if any at all) have been based on rudimentary biological and socio-economic data. The Nigerian coastal fisheries, including that of Bonny, is no exception.

Since exploited fisheries are constantly changing in species composition, stock density, levels of exploitation and composition and number of participants due to natural and unnatural factors, changes in management strategies may be required for the continued improvements of the fisheries. New strategies will require new information. The need arises for the constant acquisition of data on fish and their environment and the people involved in their exploitation. This dilemma is what all fisheries managers have to face, be it in the less developed countries or, in the industrialised world.

In the absence of adequate data, particularly the lack of a clear-cut definition of effort, for any ideal population estimates for the Bonny fishery, section B of this chapter will contain a brief review of some of the conventional stock assessment procedures. The main emphasis will be on general applications, strengths, and limitations, and appropriateness for the assessment of the Bonny fishery and other Nigerian coastal fisheries, if sufficient data were available. Complete and detailed descriptions of such procedures can be found in many texts, for example, Beverton and Holt (1957), Gulland (1975, 1977 and 1978), Ricker (1975), Tyler and Gallucci (1980) and Cushing (1981). Using the available data on the Bonny fishery, trends in total catch per fisherman per year for some major commercial species from 1976 to 1981 will be shown and discussed in section C of this chapter. This information includes the exvessel prices per kilogram of each of the species. The concluding section D of the chapter will identify the research needs for an ideal stock assessment for Nigeria's coastal fisheries.

B. Stock Assessment and Fishery Models

Since the fishery is a limited common property resource and a dynamic system, constant fish stock assessments are necessary in order to know how much fish a resource contains at the present level of exploitation, and at what levels of harvest the fishery can be sustained for years to come, through proper management practices. Many important fisheries have experienced sudden declines in stock abundance and decreases in average weights of valuable species because of over-fishing or overcapitalization, while witnessing increases in these variables during periods of low fishing pressure (Gulland, 1977 and Cushing, 1980).

The basic ingredients of fishery models: catch and effort data, and information on the reproductive biology, growth and mortality of fish, can be obtained through either carefully designed survey research or from secondary sources such as traditional small-scale commercial fishermen and large-scale commercial fleets. The secondary sources are less reliable because catch figures may be deliberately understated in order to avoid higher taxes by the government (if a tax systems exists) and information may lack the details needed for meaningful analytical procedures. Also, fishing efforts are constantly changing in response to changes in market mechanisms and fishing technology (Gulland, 1978). Commercial fishermen also target specific highly valuable species, which may not be representative of the systems. However, secondary sources provide inexpensive data.

Whenever a reliable set of data is available, the relation of catch to effort or simply the trends in catch per unit of effort is

used as an index of abundance. It is based on the assumption that average catch rate is directly proportional to the size of the biomass, subject to the constraints highlighted above and others, including environmental phenomena. According to Gulland (1975, 1978) the significance of any stock model is in its ability to predict year to year changes in stock abundance.

Data from research surveys are more reliable because effort, for instance type of gear used, can be standardized, allowing data to be unbiased. The excercise can be repeated at regular intervals, thereby increasing accuracy. The major constraints to research surveys are high costs and lack of continuity.

Fishery models essentially show the relationship between fishing intensity and stock abundance. These models are classified into two broad groups - production and analytical - on the basis of their approach, data requirements and levels of complexity.

1. Biological Models

a. Surplus Production Model

The surplus production model[1] is based on the principle of maximum sustainable yield, as it looks at a population as a single unit effected by its natural growth rate and the carrying capacity of the environment. Precisely, the model assumes that recruitment is dependent on the parent stock, and that yield from the fishery can be held constant over a long period of time provided the catch rate and natural growth rate are in equilibrium. While the model relates catch to stock size

[1]Most of this paragraph paraphrases Gulland (1975).

but more appropriately to fishing effort, it involves a graphical plot of catch per unit of effort against fishing effort in order to obtain a fitted straight line curve, from which the corresponding relationship between catch and effort can be drawn.

While the surplus production model can be modified to suit specific situations, its limitations are: it is based on many unrealistic assumptions (see Kononen, 1981), the independent variables lack sufficient contrasts when biological information on growth, mortality and recruitment is not used to complement the catch per unit of effort ratio; and it disregards the effects of exogenous factors, stock composition and "past history of the stock" on the natural growth rate of the population (Gulland, 1977).

The advantages of the model include its simplicity and its minimal data requirement, factors responsible for its wide usage. It also can easily incorporate socio-economic information.

b. Analytical Model

This model examines the rates of growth, reproduction and mortality of the individual fish in a population. It essentially relates fishing effort on a particular year class of fish to the mortality (due to fishing or natural causes) of the same year class. The technique then calculates yields from successive year classes or cohorts of fish, based on the principle that each cohort faces a decrease in numbers and hence in total biomass, as a result of fishing and natural mortalities. However, at the same time, individual survivors can have rapid increases in weight and be able to live longer. This explains the principle that

fish grow faster and bigger while young and slower while older due to density-dependent and density-independent factors, and that maximum biomass is had at an intermediate age, where fishing should be concentrated. Estimates of average recruitment level will give estimates of yield at different ages of first capture and effort levels.

The biggest problem of the analytical model is that it makes great demand on data which are expensive and difficult to obtain, while its greatest strength is that it provides "a better insight of why fish population should behave as they do in response to exploitation (Gulland, 1981)." The difficulties posed by relating recruitment to environmental variables or abundance of the parent (particularly adult) stock are fully discussed by Gulland (1977, 1978) and Cushing (1981).

2. Bioeconomic Models

The current widespread acceptance and application of bioeconomic models to fisheries management stems from the conspicuous neglect of the costs of fish production inputs by the biological models (that emphasises maximum sustainable yield) used in past management efforts. The bioeconomic models blend together biological and economic principles to provide optimal solutions to fishery management problems. These models, which consist of a series of mathematical relationships, are based on economic efficiency. The theoretical basis for their use and application to commercial fishery management are documented by Gordon (1954), Schaefer (1957), Turvey (1964), Fullenbaum, et al. (1971) and Fullenbaum and Bell (1974). The models essentially explain the determinants of demand and supply of fish harvested from a given resource (Fullenbaum, et al. (1974). According to these authors, supply is a function of stock

density and fishing effort, while demand is a function of population size, consumers income, fish quality and price, and the availability and prices of other animal protein sources relative to the price of fish.

The weaknesses of the models include the underscoring and consequent elimination of some of the "less important" factors from the models, which has received strong criticisms from some quarters; and their simplicity makes them too general (non-specific) and difficult to apply to real life situations. Also, when the outputs (e.g. catch rates) from bioeconomic models are fed as fixed inputs into industrial models, they provide sub-optimal solutions to fishery management problems (Gulland, 1981). Bioeconomic models are good as a basis for instituting property rights to common property resources, which do not yield economic rent in the absence of regulation because they are prone to overfishing, overcapitalization and possibly depletion.

Finally, a good fishery model must possess the following qualities: (1) it must be able to predict the recovery of an overfished resource both quantitatively and qualitatively, (2) must be able to predict future catch at certain levels of effort, (3) must be able to reliably predict and explain the effects of man's activities and other factors (biological or environmental) on fish abundance, and (4) be able to predict how fishermen will react to fishery policy changes, such as fishing regulation, whenever they may be needed to rehabilitate and maintain over-exploited or depleted fishing grounds.

C. Trends in Catch from Bonny

Yearly catch and "effort" data on the Bonny artisanal fishery was obtained from the Federal Department of Fisheries, Lagos. The data, which includes nominal catch figures and exvessel prices for eight commercially important species from the fishery were collected on a thrice weekly basis from five randomly selected artisanal fishermen by FDF enumerators from 1976 to 1981. The random selection of fishermen was done on every survey day at a landing site on the Port-Harcourt end of the Bonny river, where many fishermen aggregate daily to sell their catch to middle-men fish buyers. The day's total catch by each fisherman is separated and weighed by species, and the value of the sales recorded by the enumerators. Data is submitted to the FDF field office in Port-Harcourt where it is sent monthly to Lagos for filing and subsequent use by fisheries managers or researchers. The size of canoe and gear types used and the crew size were also recorded.

These data are not adequate for an ideal statistical analysis, such as regression analysis because in addition to its lack of a precise definition of effort, there is no biological information, such as mortality, growth and recruitment rates of the fish populations. The fishermen indiscrimately used a wide variety of gear, hauled many species simultaneously and constantly varied their crew sizes. The species are highly mixed - a peculiar characteristic of tropical waters, which complicates an already complex problem. Any attempt to apply a simple production model to the data on any of the exploited major species will overlook the complex interactions between that species and other species within the system, and its interaction with the abiotic environment. In fact, even if fishing effort can be determined from the data,

it will not provide enough number of data points needed in a regression equation.

Table 15 summarizes the trends in the total catch (kgs) of major fish species per fisherman per year for the Bonny fishery from 1976 to 1981. The exvessel prices (N) per kilogram of each species was calculated by dividing the yearly total exvessel value by the yearly total catch figure per fisherman. All species show gradual increases in catch figures from 1976 to 1978, with Barracuda, Bonga and Tilapia attaining their peak in 1978. They all show sharp decreases in 1979, except croakers and sting-ray that continued to increase in catches. The figures rose again in 1980 with slight variations in 1981. The relatively higher figures as from 1978 upward may be attributed on one hand to possible improvements in fishermen's technology and capacity to catch fish, e.g. greater use of motorized canoes and modern nylon fishing nets such as monofilament nets likely introduced by state and federal agencies. On the other hand, the increases may be due to favourable changes in the natural environment, causing stock densities to rise. If the higher catch figures are due to better fishing technology, it thus means that increased capital intensity could improve fisherman's earnings and general economic well-being.

The exvessel prices constantly varied throughout the period, with shinynose showing the greatest stability at least from 1977 onward. Catfish and the stingray show the highest mean values (respectively N 2.12 and N 2.16 per kilogram). Sardine and barracuda are the least valued (each with a mean value of N 1.62 per kilogram). The high variability in prices is a common characteristic of all major food

Table 15. Trends in Total Catch of Major Fish Species/Fisherman/Year for the Bonny Fishery, in Kilograms

FISH NAME	1976	1977	1978	1979	1980	1981
Barracuda	86(1.5)	216(1.1)	528(2.4)	344(1.2)	413(1.4)	329(2.1)
Bonga	32(2.2)	84(1.3)	456(1.6)	209(1.9)	330(1.2)	407(2.0)
Catfish	302(2.4)	729(1.9)	650(2.6)	542(2.0)	790(1.6)	646(2.2)
Croakers	81(1.2)	123(1.4)	151(2.2)	166(1.9)	385(1.3)	290(1.9)
Sardine	139(1.5)	228(1.1)	404(2.0)	291(1.7)	369(1.4)	545(2.0)
Shinynose	302(1.3)	453(2.0)	328(2.2)	305(2.1)	614(1.5)	530(2.2)
Sting-Ray	67(1.7)	83(3.2)	174(2.4)	230(2.1)	532(1.2)	406(2.3)
Tilapia	139(1.2)	216(1.9)	528(2.1)	344(1.8)	413(1.5)	329(1.9)
Total	1,148	2,132	3,219	2,431	3,847	3,482

Note: The average exvessel prices (N) per kilogram are shown in parentheses.

items in Nigeria in the past ten to twelve years or so because of fluctuations in their supply. However, fish is relatively cheap at its 1981 average cost of ₦ 2.08 per kilogram, when compared to the considerably higher prices of other animal protein such as beef, pork, and poultry. For instance, one dozen of eggs sold at about ₦ 2.50 in Nigeria in the same year. The Nigerian coastal fishery thus holds promise as an important and inexpensive human dietary protein source. The fishery's productive potentials should be accurately determined in order to effect management measures to optimize the returns from the fishery.

The major shortcomings of the preceeding information are that: (a) the data were obtained from a secondary source, and may thus have some biases introduced by the enumerators, and (b) the inferences drawn from the simple analysis of the data are not necessarily true, since they are not based on the results of quantitative and qualitative data processing. These results and inferences, however, provide some insights into some important interacting factors in the fishery.

The need to collect adequate biological, economic and ecological data on Nigeria's coastal fisheries cannot be compromised. A brief discussion of the specific data requirements will be the subject of the next and last section of this chapter.

D. Research Needs

The ability of any fishery management unit to adequately meet the objectives of fishery management is largely dependent on the availability of sufficient scientific information about the fishery, on

which it can base its efforts. The brief discussion of conventional stock assessment procedures earlier in this chapter reveal that fishery management models require the input of an array of qualitative data, which are not only costly but defficult to obtain. In the light of the above, the multispecies nature and the complex socio-cultural and political factors associated with the Nigerian coastal fisheries, coupled with the urgent need to know the current and potential yield levels from the fishery, the following research efforts are needed to develop the requisite models on which the fisheries can be effectively managed.

(1) Catch and Effort Data

Considerable improvements are needed in the quality and quantity of the catch and effort data. The commercial fishery can still serve as a valuable source of information. Data from this source must be more specific and accurate. This can be accomplished if a few literate fishermen are hand-picked and subsidized by fishery administrators and researchers to collect data on a regular basis, using short and simple standardized data sheets. Such fishermen must operate with specific gear types on each of the major fish species, record the length of time they spent fishing and specify their crew sizes (which should not vary much), in order that fishing effort can be accurately determined.

An alternative approach to the above is that the NIOMR collects catch and effort data regularly, using their own research vessels. The major problem with this is that it would be an expensive endeavor, and has not worked in previous attempts.

Another seemingly possible approach, since commercial fishing vessels are constantly at sea, is that they can provide a reliable and cheap

source of data for researchers if the two parties can mutually agree to travel together to sea, so that researchers collect basic catch and effort data as fishermen simultaneously make their catch. Instead, researchers could record directly the catch and effort made by the fishermen on every trip they make together. This could be done once every month. While the above seems to be ideal in that it will minimize biases in the data, it is hard to accomplish because fishermen often suspect researchers as agents of government who might reveal their catch figures to the government, who in turn might demand higher taxes from the fishermen. Income tax in Nigeria is paid annually and is assessed on the basis of total yearly income.

(2) Biological and Physicochemical Studies

Specific studies on the reproductive biology, growth, natural and fishing mortalities, migration, diseases, tolerance levels, predator-prey relationships, including the food and feeding habits of the major fish species in Nigerian coastal waters are needed to complement specific catch and effort data. This information can be collected by the NIOMR and Nigerian universities research teams if provided with adequate funds.

The above information should include those on the physicochemical charateristics of the coastal waters which may be undergoing constant changes due to natural and man's activities. It is particularly important to study the possible effects of oil, transportation and agricultural pollution on fish habitat and the quality of fish flesh. Oil exploration is a major activity in the River Niger delta; water transportation has constantly grown, while there is increasing use of synthetic fertilizers in upland agriculture.

Fishery managers in Nigeria place little emphasis on two of the three major aspects of fisheries management: fish habitat management and fishery regulation. Most emphasis is on fish production, which can not be accomplished without managing the habitat of fish and the participants in the fishery. Attaining these objectives requires the acquisition and prompt analysis of the types of data outlined above, and even more. For instance, money for research can be generated if oil drilling firms are taxed for any damages they cause to fish and its habitat in case of a major oil spillage. The environment can also be kept healthier since the oil firms will be cautious to prevent a spillage. Other polluters could be equally made to pay for the costs of pollution. According to Bell (1980) water pollution causes serious economic damages to the fishery in terms of "reduced maketability of fish, reduced biological productivity, and reduced opportunities for protein production such as --- aquaculture."

(3) Resource Appraisal Surveys

Well organized resource appraisal surveys can provide quick information for determining stock densities of fish in Nigerian coastal waters. A combination of an acoustic method such as echo-sounding and trawling fishing surveys looks ideal for Nigeria since this can be achieved with greater ease. The former will cover the pelagics over a wide area, while the latter would cover both demersals and surface dwellers. Trawling surveys can also provide biological information (e.g. on size, age, spawning and feeding habits of fish) and catch and effort statistics on major commercial species.

(4) Multispecies Research

It could be more rewarding to manage the whole population of fishes in Nigerian coastal waters rather than looking at the individual species. This is because tropical species are highly mixed and fishermen use a large variety of gear and catch techniques that make the acquisition of species by species catch and effort data from the commercial fishery an almost futile exercise. McHugh (1980) asserts that total biomass varies less than individual species but that multispecies fisheries could be more complex to manage and may require more expensive research. However, research into multispecies fishery model building is rapidly growing (see Hoppensteadt and Sohn, 1981). A multispecies management approach to the Nigerian coastal fishery can also be justified by the relatively uniform prices of the major commercial fish species.

(5) Socioeconomic Information

The increasing popularity of bioeconomic models in the management of exploited fisheries calls for the acquisition of comprehensive socioeconomic data on which demand and supply analyses can be based. Such data include those on the demography, operational costs, income, employment, behavioural, cultural and attituduial characteristics of the fishermen. It should include marketing data on wholesale and retail sale prices and the distributional patterns of fish from the landing sites through to the consumers. Much of this information can be collected by the FDF, adequately funded multidisciplinary university research and vis-a-vis the biological and catch and effort data earlier

discussed. This information must be collected with high precision in order to build models that will reliably provide workable management measures. For example, the precision level of survey data can be raised through systematic randomization.

CHAPTER VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. Summary and Conclusions

The problems of human dietary protein shortages and high rural structural unemployment have drawn greater government attention to coastal fisheries development and management in Nigeria in the past two decades. This direction is not misguided because Nigerians not only consume more fish than its close substitute, meat (in the ratio of 1.7 to 1) for possibly economic and attitudinal habit reasons, but fish is higher in nutritional (protein) value than beef and other animal protein sources. Also, the lives of many Nigerian coastal communities are completely tied to sea fishing. The per capita consumption of fish in Nigeria is likely to increase in the near future because of increasing shortages of substitute animal protein sources, as a result of decreasing local production and recent ban on importation of frozen meat.

The Nigerian continental shelf is very narrow (80-120 Km wide) and poor in fish resources due to natural conditions (stable physico-chemical state) and man-made phenomena (pollutions from crude petroleum oil exploration, water transportation, and possibly agricultural activities). Despite these shortcomings, with proper and efficient development and management practices, and adequate financial commitment by the Nigerian government, the country's coastal waters could adequately support the traditional inshore artisanal canoe fishery, and a limited off-shore

industrial trawl fishery because of the valuable species of fish and shrimp they contain. The species of appreciable commercial value include bonga, sardinella, croakers, shiny-nose, cat-fish, barracuda, Tilapia, sharks, mullets and the pink shrimp, which are found in the lagoons and shallow sea waters. Three species of tuna, the bigeye, skipjack and yellowfin, dominate the deeper waters.

Accounts in the literature (Lawson and Kwei, 1974; Everett, 1979; Troadec and Garcia, 1980) show that the traditional artisanal canoe fishery has greater positive impact on the economic, social and political lives of West African (including Nigeria) coastal communities, than the industrial trawl fishery does. The artisanal fishery is cost effective, efficient, employs a greater number of people, and provides cheap nourishment to the local populace (see Table 3).

A broad overview of the nature and characteristics of Nigeria's coastal fisheries, which is the subject of Chapter II, revealed many problems of the fisheries, which are local, interregional and international in dimensions. These problems require multidisciplinary research and solutions.

Possibly the single most important problem of Nigeria's coastal fisheries management is identified as lack of adequate high quality biological as well as ecological, social, and economic information about the fisheries. This information is needed in order to improve the quality of fisheries policy formulation, planning and management. The present study primarily addresses the above issues.

In Chapter III, quality education (formal and informal), capital intensity, disposable income, and the use of proper marketing channels

(such as co-operatives and non-specific dealers) were identified and proposed as important variables to positive economic transformations in small-scale fisheries.

The results of a variance analysis of socio-economic information on the Bonny fishery and other four artisanal fisheries (Elem-Bekinkiri, Nyemoni-Waterside, Kono-Waterside and Koluama II) are contained in Chapter IV. The analysis shows some interesting relationships between the Bonny fishery and these other fisheries, based on nine performance variables (see Table 8). It was assumed that these variables could account for fishermen's success or lack of success. Generally, all the fisheries show significant differences with respect to all the variables except Bonny and Elem-Bekinkiri, which exibit similarities, except in their debt-to-cash ratio. These differences can be attributed to variabilities in the proximity of the fisheries to urban fish markets, accessibility, local economic structures, fishing technology, and tribal composition, all of which may have serious implications for fisheries development program planning, project implementation and results. These are also indications that each fishery has its unique characteristics and possibly problems that require locally appropriate solutions. Such characteristics must be properly understood by fishery administrators and managers, thus calling for adequate information acquisition through multi-disciplinary research.

One of the specific objectives of the study is to show and quantify the relative effects of the major socio-economic variables influencing the efficient performance of Nigeria's coastal artisanal fisheries. This objective was fulfilled by employing both standard and

multiple regression techniques to analyse the socio-economic data used in the variance test. The results are reported in Chapter V. Size of fishing household, market channel, gear-cost and ownership of canoe with outboard engine were the strongest predictors of fishermen's income. Thus capital intensity is an important element of change in small-scale fishery enterprises.

Size of fishing household was the strongest predictor of fishermen's income at Bonny. This, according to Pollnac (1980), could imply that fishermen with many dependents may have to work harder to support them. This finding implies that the family has a significant role to play in small-scale fishery businesses, and that this role must not be underscored in artisanal fishery project planning.

Market channel, specifically non-specific dealership, strongly influenced fishermen's income at Elem-Bekinkiri. This also supports the assumption that market channel is an important measure of economic change in a fishery. The effect of formal education on fisherman's economic success was grossly underscored in the regression results, probably because the fishermen are mostly illiterates. However, informal education may have greatly influenced fishermen's income.

An attempt to estimate yields from the Bonny fishery was dropped for lack of adequate information, particularly on fishing effort; instead, annual averages of total catch of major commercial fish species per fisherman for the Bonny fishery from 1976 to 1981 are presented in Chapter VI. Generally, the report shows little variations in the catch figures as from 1978 to 1981. The relatively higher figures as from 1978 may be due to increased capital intensity (wider use of motorized canoes and nylon fishing nets) in the fishery. If the above is true,

increased capital intensity could improve fishermen's income and enhance their economic well-being. But, any mechanization program must be executed with caution since the actual and potential yeilds from the fishery are not known. However, there is no substantiated indication that the Bonny fishery has become over-capitalized.

The report also shows constant variations in fish prices during the period (see Table 15),with prices falling from 1979 to 1980, only to make an upward surge in 1981. The constantly changing fish price is characteristic of all major food items in Nigeria in the past decade. Generally, the average of about ₦ 2.00 per kilogram (approximately ₦ 1.20 per pound) of fish in 1981 is reasonalby low, compared to the higher prices paid for other animal protein such as beef meat and poultry. The fishery thus deserves the increasing attention it is receiving from the Nigerian policy makers as an important source of dietary protein.

B. Recommendations and Policy Issues

The two fundamental issues that emanated from the preceeding bioeconomic analysis of the Bonny artisanal canoe fishery are issues of (1) efficient utilization of scarce resources and (2) equitable distribution of the resources. In more clear terms, we are dealing with the issues of how to produce the right quality and quantity of fish for the Nigerian consumers at reasonable prices, and how to distribute the benefits accruing to the fishery among the various participants in the industry.

The choices we have are limited. They include choices between: (a) capital-intensive and labor-intensive fishing or, rather, between industrial trawl fishing and traditional artisanal canoe fishing;

(b) increasing the capacity of the artisanal fishermen to catch fish and not to increase it; (c) operating at the point of maximum economic efficiency or at maximum sustainable yield or open access or somewhere in between them; (d) limiting and not limiting entry to the fishing industry; (e) instituting programs that will eliminate the middle-man money-lenders from the artisanal fishery system or leaving the system as it is; (f) organizing vocational training for the indigenous fishermen or leaving the fishermen as they are; (g) participating in intra-regional research efforts or relying solely on local research activities; (h) reorganizing fishery development agencies or leaving them to operate as they are; (i) to redefine the objective of fisheries management to include a few attainable ones or to operate the fisheries on the present objectives and, (j) to develop or not develop the fisheries.

The following recommendations represent my personal opinions and are not necessarily exhaustive. However, they are based on my review of the limited information on the Nigerian coastal fisheries and the results of the bioeconomic analysis of the Bonny artisanal fishery.

1. Reallocate Coastal Fisheries Resources

The government of Nigeria should allocate the brackish-water and the inshore demersals, and pelagic species to the artisanal fishery sector and leave only the offshore demersals and the deep ocean species for exploitation by the domestic industrial trawlers. This step will reduce competition between these two technologically and institutionally disparate fishery sectors, thus partially dealing with one problem of common property - overfishing, which may result from possible over-capitalization. It may increase the catch and hence income of the

artisanal fishermen, which bears much on their social and economic welfare - one principal objective of fisheries management in Nigeria. It will also reduce unemployment in the artisanal sector, where labour is completely immobile, since the fishery will be able to accomodate new entrants - thus fulfilling another major objective of Nigeria's fisheries management. Higher catches in the absence of competition with trawler operators will increase fish protein intake by the coastal communities. Social stratification in the fishery will be reduced, since artisanal fishermen do not have to seek employment with large trawler owners, which are constantly springing up in Nigeria and can only employ a few hands. Production costs are reduced since less of imported technology is needed in artisanal fishery operations. The fishery can be expanded in the future to accommodate trawler operators, if the yields are known to be capable of supporting such capital intensive fishery.

Some economists might argue that the free-market be left to re-allocate the resources in order to avoid big transactions and exclusion costs. While this may be fair in an economic sense, the consequent social and economic problems that will result if the artisanal fishermen are displaced might not be worth the stake. Also, consumers may have to pay higher prices for fish since a trawl fishery is more expensive to operate in terms of equipment, gear and managerial costs, all of which will be reflected in the market price of fish. I argued earlier in the thesis that transaction and exclusion costs that will be needed to enforce regulations should not be much because the number of trawler operators in Nigeria is small. In addition, most of the trawler owners are wealthy businessmen and maritime state governments who are likely to be economically

viable without fishing. However, as labour becomes mobile in the artisanal fishery in the future when innovative fishermen and young school leavers in coastal communities are given vocational and technical training in both fishing and other professions, the fishery can be expanded and high economic returns can be had.

2. Employ Appropriate Technology

The reallocation of coastal fisheries resources must be accompanied by improved fishing techniques, in addition to adequate financial support from the government. Capital intensity in the artisanal fishery secotr must reflect the fishery's labour characteristics. In other words, the levels of newly introduced fishing technology must complement the level of skills possessed by the fishermen. Only in such combinations can fishery development projects attain their stated objectives. The regression analysis of my data revealed ownership of motorized canoes and gear-cost as two of the strongest predictors of artisanal fishermen's income. A low capital-intensive coastal fishery development programme that makes use of simple inexpensive motorized canoes and is directed toward enhancing the artisanal sector, is what I advocate for Nigeria. The programme will increase the range of operations of fishermen and the speeds with which they travel to resource sites and back to landing sites, thereby increasing their catch, reducing fish spoilage and improving their earnings without causing unemployment in the industry.

It is imperative, however, that project managers ensure that beneficiaries of such canoe mechanization programme have adequate skills to operate and do some simple repair works on the boat engines. Repair facilities will be needed at major fish landing sites to take care of complex mechanical repair works. Members of the fishing communities,

particularly young school leavers, who are interested in operating boat repair facilities must be sought and given adequate vocational and technical training to properly utilize the facilities. The facilities should be provided by the government and rented out at nominal charges to the operators. The operators could be given loans to buy the facilities, provided a proper repayment plan can be made to accomodate the seasonality of fish harvest, which will impact the income of the operators. With the above kind of plan, the operators will value the repair facilities and work hard to maintain them in good conditions.

The major problems associated with the above approach are, (a) availability of funds for the project; (b) ability of project managers to properly execute the programme and (c) possible over-capitalization of the fishery. These problems can be solved as follows: the problem of inadequate funds can be minimized if both the federal, state and local governments appropriate sufficient funds to artisanal fishery extension programmes; the man-power problem can be solved if fisheries officers are given adequate training in rural extension works; and the third, if proper assessment of the biomass is made, using appropriate research techniques.

3. Research Needs

There is need for more specific data on catch and fishing effort and on the reproductive biology, growth, mortality, migration, diseases, predator-prey relationships, and the food and feeding habits of the major commercial fish species, in order to understand the recruitment patterns to the fishery. Data should be complete and accurate to enable the use

of conventional methods of yield estimate. In order to improve the quality and reliability of data from the commercial fishermen, fishery administrators and researchers should hand-pick and subsidize specific literate fishermen, who can accurately keep record, to collect catch and fishing effort information on a regular basis. Selected fishermen must be properly informed about the importance of such data to the development of the fishery on which their lives depend. This will eliminate the problem of lack of cooperation with enumerators while attempting to identify and weigh commercial catches at landing sites. Often, fishermen are pressured by the middle-men buyers to sell their catch as soon as they are landed, so that fish can be transported and processed quickly, to avoid losses due to fishs' high perishability. Data from this source must be detailed to meet the needs of many research disciplines but must be concise enough so that it does not take the fishermen too much time to gather. Selected fishermen must be instructed to use specific gear types on each of the major commercial species, and should record the lengths of time they spent fishing so that effort can be accurately determined. If it can be mutually agreed upon, researchers could travel regularly to sea with commercial fishing operators to gather catch and effort as well as biological data as fishermen simultaneously make their catch. This arrangement will minimize research costs.

Resource appraisal surveys will provide quick information on which management efforts can be temporarily based until adequate time series data can be gathered for more indepth yield estimates. I strongly recommend a combination of acoustic method such as echo-sounding and

trawling survey. Multispecies assessments may be necessary for the highly mixed demersal stocks.

Finally it is desirable to clearly specify the quality and quantity of data to be collected, and the purpose of collecting it.

4. Provide Loan and Credit Facilities

Provision must be made for subsidized loan and credit facilities, which should be patterned to suit existing traditional system, which accommodates the belief and value systems of the people. For instance, rather than in cash, loans should be disbursed in kind, e.g. boats, motors, and gear. Repayment plans must be worked out to fit into the periodicity or seasonality of fish harvest, thus allowing for flexibility, so that fishermen do not end up falling back on traditional middle-men money-lenders during periods of poor harvest, in order to fulfill government loan and credit agreements. Providers of loan and credits should deal with heads of fishing households rather than individuals, since the household is the basic operational unit of small-scale artisanal fisheries.

5. Other Management Efforts

The preceeding recommendations are based on the analysis of my research data. However, I also recognize the need to briefly present some other recommendations which I think would be helpful to coastal fisheries management in Nigeria, based on the findings from the review of the literature on the fisheries of the Gulf of Guinea and the theoretical analysis of some important concepts, both of which constitute a large portion of this dissertation.

a. Set Level of Exploitation

As soon as the present and potential yields from the Nigerian coastal waters are determined, the level of exploitation should be set to meet the problems of dietary protein shortages and rural unemployment in coastal fishing communities in Nigeria. The fishery should operate at a point beyond MSY but before open-access equilibrium yield. This will guarantee employment for young school leavers at least until alternative employment sources are created for them in fishery related industries, such as in boat-building, gear manufacturing, and in other sectors of the economy. However, since the present yield from the fishery is not known, exploitation must be done with caution to avoid the depletion of valuable fish species.

b. Limit Government Participation in the Fishery

Government participation in the fishing industry should be limited to its development through research, fishermen training and project funding. Government fishing corporations are not well equipped to compete favourably with private fishing companies, partly because of the clumsiness of bureaucratic processes and lack of accountability, even when the corporations are failing. It also is imperative that government do not interfere with the traditional recruitment pattern into the industry (Faris, 1972), which is dominated by children and relatives of fishermen.

c. Fishermen's Co-operatives

Fishermen co-operatives should be independent of government bureaucratic network. Formation of co-operative bodies should originate

from members and be organized by them. It could even be more advantageous that the body be financed with members money, to minimize the problems of corruption, domination, and other malpractices and subsequent failures that characterize government funded co-operatives.

d. Examine Role of Agencies

The role of each of the agencies involved with coastal fishery management in Nigeria should be carefully studied in order to minimize conflicts and the problems of free-riders. It is an important area to research since it may be desirable to reduce the number of agencies to a few more effective and manageable ones.

e. Research on Environmental Pollution

Research should be undertaken to study the effects of oil, transportation and possibly agricultural pollution on fish environment and quality of fish flesh. Generators of externalities must be appropriately taxed to prevent future damages to the environment and to generate funds for fish habitat rehabilitation.

f. Study Rate of Adoption of Technology

The rate of adoption of newly introduced fishing technology such as outboard motors, modern gear and equipment and processing techniques require adequate research in order to improve on future modernization programmes if they are found to be desirable.

g. Anthropological Studies

Socio-economic studies should include anthropological studies of the value, belief and cultural systems of fishermen. The results of such studies will present a clearer understanding of the fishermen's

problems and promote the successful implementation of future fishery development programmes.

h. Intraregional Research Arrangements

The possibilities for joint oceanographic and fishery research between Nigeria and her neighbours should be sought since adjacent countries often rely on the same resources due to the migratory behaviour of many of the commercial fish species. This will not only reduce research costs but could help in instituting effective regulations on the migratory stocks, and deal with the problems of exclusion and transaction costs.

Finally, fishery development planning is an act requiring the efforts of trained fishery professionals. Future coastal fishery development planning in Nigeria should be delegated to trained fisheries biologists, economists and managers, who have in-depth knowledge of the nature of the system.

APPENDICES

Appendix I

Definitions of Some Commonly Used Terms

Artisanal Fishery	A fishery involving mostly illiterate fishermen, employing simple crafts, gear and equipment.
Artisanal Fishermen	Fishermen operating in an artisanal fishery.
Fishing Operator's Household	A household or family that is involved in its own fishing business; makes use of common crafts, gear and equipment. Usually includes a head, his wife, children and relations fishing with him.
Fishing Labourer's Household	A household or family that does not have its own fishing business, but usually is employed to fish for other fishermen.

Appendix II

Some Important Characteristics of the Fisheries of Bonny, Elem-Bekinkiri, Nyemoni-Waterside and Koluama II.

Variables	Survey Locations				
	BN	EL	NY	KO	KM
Local Council	Olga	Olga	Delga	Bolga	Yelga
Proximity to Port-Harcourt	40 KM	45 KM	> 60 KM	~ 77 KM	> 400 KM
Accessibility	By Water 40 min. with CWOBE	Water ~ 60 min. with CWOBE	Water & Road	Asphalt Road	Water
Local Economy	Slightly Urban, Hotel business, trading, smuggling, Oil field labourers, Water transportation and Fishing	Remote, Fishing and Water Transportation	Non-Urban, Fishing & Trading	Slightly Urban, Fishing, Farming, & Trading	Very remote, Fishing, Labourers In oil fields
Tribal composition	Bonny, Andoni	Andoni, Okrika	Andoni, Okrika	Ibiobio	Ijaw
Fishing Technology	Moderate use of motorized boats	Moderate use of motorized boats	Little use of motorized boats	Non-motorized boats	Little use of motorized boats

APPENDIX III

Table A. Level of Formal Education of Fishermen (FOH) by Area

Educational Level	Area					
	BN	EL	NY	KO	KM	Total
No Education	19(63%)	25(78%)	10(26%)	35(80%)	22(35%)	111(53%)
Dropped out of Elementary School	5(17%)	1(3%)	20(51%)	7(16%)	15(24%)	48(23%)
Completed Elementary School	6(20%)	6(19%)	9(23%)	2(4%)	26(41%)	49(24%)
Completed High School or Equivalent	--	--	--	--	--	---
Completed University	--	--	--	--	--	---

Table B. Time Spent Fishing by the FOH in the Past One Year.

Time(Days)	Area					
	BN	EL	NY	KO	KM	Total
< 90	--	1(3%)	--	1(2%)	--	2(1%)
90-179	2(7%)	--	4(10%)	13(30%)	--	19(9%)
180-269	12(40%)	--	23(59%)	16(36%)	12(19%)	63(30%)
>270	16(53%)	31(97%)	12(31%)	14(32%)	51(81%)	124(60%)

Table C. Income Source of Fishermen

Fishing as Income Source	Area						
	BN	EL	NY	KO	KM		Total
Sole	47	54	47	16	43	=	207(72%)
Main	1	0	3	41	19	=	63(22%)
Minor	0	0	0	15	1	=	16(6%)

APPENDIX IV

Mean and Standard Deviation for the Variables for Comparing the Bonny Fishery to the Fisheries of Elem-Bekinkiri, Nyemoni-Waterside, Kono-Waterside and Koluama II.

Variable	Bonny		Elem-Bekinkiri		Nyemoni-Waterside		Kono-Waterside		Koluama II	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
TOTINC	4,828.67	6,209.76	2,062.50	581.29	1,636.92	932.19	1,031.18	1,109.73	2,236.51	1,063.06
NETINC	3,325.90	5,164.87	599.97	339.83	296.67	254.93	419.59	801.90	334.79	567.75
SOLVENT	15.10	17.91	6.19	7.49	0	0	11.87	16.61	19.97	12.55
CWOBE	0.33	0.48	0.47	0.51	0.03	0.16	0	0	0.05	0.21
MKTCHNL	2.07	0.25	2.03	0.18	2.33	0.58	1.98	0.26	1.98	0.13
EDUC	1.57	0.82	1.41	0.80	1.97	0.71	1.36	0.75	2.06	0.88
GRCOST	694.53	678.86	675.00	350.12	743.33	415.69	359.09	312.88	787.22	332.72
WAGE	85.67	277.67	134.41	177.08	0	0	0	0	439.05	585.56
DAYS	3.47	0.63	2.91	0.53	3.21	0.61	2.95	0.86	3.81	0.40
SHH	17.87	8.53	17.78	3.63	21.69	5.68	15.16	3.84	6.62	2.65
NUMFISH	4.30	3.58	6.19	1.18	5.56	2.55	3.00	1.28	3.32	1.40

Bonny N = 30

Elem-Bekinkiri N = 32

Nyemoni Waterside N = 39

Kono Waterside N = 44

Koluama II N = 63

SD = Standard Deviation

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