ISSN 1198-6727

Fisheries Centre Research Reports

2012 Volume 20 Number 4

The marine fisheries environment of Sierra Leone: belated proceedings of a national seminar held in Freetown, 25-29 November 1991

Fisheries Centre, University of British Columbia, Canada

Edited by

J Michael Vakily, Katy Seto and Daniel Pauly

Fisheries Centre Research Reports 20(4)
104 pages © published 2012 by

The Fisheries Centre,
University of British Columbia
2202 Main Mall
Vancouver, B.B., Canada, V6T1Z4

ISSN 1198-6727

Fisheries Centre Research Reports 20(4)
2012

Edited by
J Michael Vakily, Katy Seto and Daniel Pauly

Content

A Research Report from the Fisheries Centre at UBC

Fisheries Centre Research Reports 20(4)

Fisheries Centre Research Reports are abstracted in the FAO Aquatic Sciences and Fisheries Abstracts (ASFA)
ISSN 1198-6727

Director's Foreword

I am pleased that Michael Vakily, Katy Seto and Daniel Pauly found the time to edit the nearly-forgotten manuscripts presented in these 'belated' proceedings, notably because they document an extremely important period in Sierra Leone in particular, and Africa in general: it was when, in the three decades following independence from colonial masters, a rapid development seemed possible, based on the exploitation of still abundant natural resources.

Another reason why this effort is laudable is that a necessary condition for ensuring the sustainable management of Sierra Leonean fisheries, or of any country for that matter, is securing a minimum amount of scientific information about the resources exploited by the fisheries. This report contributes to this by retrieving what would have been lost information on Sierra Leonean fishery resources.

What Africans, and Sierra Leonean in particular had not counted on is that independence did not guarantee access to these natural resources - indeed the competition for those resources continues still, and as far as fisheries resources are concerned, it is largely the EU, and increasing China, which wins, and not Sierra Leone.

The contribution in this Fisheries Centre Research Report partly explains why Sierra Leone is losing out, and provides information that would support various initiatives currently being undertaken in Africa to recapture access to the resources for the people. A recent effort by the African Confederation of Artisanal Fishing Organizations (CAOPA) is a good example of such new initiative. Recently, CAOPA voiced its demands to FAO and its members, which included the need to (i) document better the impacts of the various types of exploitation of small pelagic fishes on food security; (ii) recommend to states and regional fisheries organizations to consider the role of small pelagic fishes in the ecosystems and in food security of developing countries' populations when they are to make decisions for managing these resources, and allocating access to them; (iii) support initiatives and efforts that will contribute to establishing a concerted management of small pelagic resources in West Africa; (iv) support efforts by fishing communities to actively contribute to the management of these resources in a concerted and sustainable way; and (v) support an aquaculture based on species that do not require feed made from wild fish, that answers to the demands of local and regional markets, and that is not contributing to the unsustainable exploitation of small pelagic stocks.

Thus: there is a path out of the present arrangements, and it would benefit most people.

Ussif Rashid Sumaila, Director

UBC Fisheries Centre

August 2012

Editors' Preface

A delay of 20 years in publishing the proceeding of a conference does require an explanation - it is not enough to just call them 'belated'. The Manila-based International Center for Living Aquatic Resources Management (ICLARM, now WorldFish Centre, based in Penang, Malaysia) initiated in 1991 a 4-year partnerships with Sierra Leone's Institute of Marine Biology and Oceanography (IMBO), i.e., the "*Research Cooperation between IMBO and ICLARM on the Establishment of a Fishery Database for the Development and Management of the National Fisheries of Sierra Leone*", which one of the editors (JMV) was to run, and another (DP) to supervise.
The project was initially very successful and produced what it was supposed to do in terms of the database that was compiled[1], actionable insights gained[2,3,4,5], and even personnel trained at Master[6] and PhD[7] level. However, such projects could not alter the political and material situation in Sierra Leone, which slowly, then rapidly deteriorated, finally forcing the project leader and his family to leave the country, after various attempts to cope[8].

The conference "*National Seminar for Fishery Industries*" of which we present here the belated proceeding was held 25-29 November 1991 in Freetown, Sierra Leone, under the sponsorship of the Food and Agriculture Organization of the United Nations (FAO). Participants included representatives of all interest groups in the fisheries sector - Government, public institutions/university, fishing companies, fishing communities, and donors. However, instead of becoming the starting point for a new push towards more rational exploitation of the marine resources, the conference saw its results relegated to oblivion, as it coincided with Sierra Leone's agonizing ascent into a series of military coups and counter-coups, a situation which reached its nadir in 1999, when armed gangsters ruled in Freetown, maiming and killing people. This period, which also saw the burning of IMBO's library, which we had just arranged to be refurbished[9], was not very conducive to scientific publishing. Thus, the plan to publish the proceeding of this conference was put aside, along with the files of the presented manuscripts.

Twenty years passed, and Sierra Leone is again in our sight, this time because one of the editors (DP) is planning to document, for all maritime countries of the world, the actual catches taken since 1950 from the waters of these countries, as opposed to (the often lesser) catches that these countries report to FAO. Such a plan involves the participation of numerous experts, and DP asked the third editor (KS), who had done field studies on the fisheries of Sierra Leone for her Master and PhD research, to conduct a 'catch reconstruction' for that country. She accepted, and in her search for historic data, Katy stumbled on manuscripts of the 1991 conference. Realizing that much of the data within the documents had been lost in their original form, and that information was not available in published reports, she asked why the proceedings had never been published.... These belated proceedings constitute the answer.

Reading the contributions included here can be discouraging. Jointly, they document the aspiration of a people who had (and still have) the expectation that they should benefit from the fisheries resources in their water. However, these legitimate expectations were thwarted at every turn: the countries with distant-water fleets operating in Sierra Leone did not want to pay their due, and left or fished illegally. The company Sierra Leone hired to patrol their waters made side deals with the pirates, while on land, the weak economy, and an even weaker currency made profitable long-term investments impossible. Later, the unspeakable horrors accompanying Sierra Leone's protracted civil war made national fisheries development an entirely academic question.

Thus, it is the editors' belief that these proceedings are a valuable resource for those of us interested in issues of fisheries 'development' in Africa, historical fishing in Sierra Leone, and changes in exploitation and ecology in the Central Eastern Atlantic. In addition to technical questions such as those posed in several contributions (e.g., 'What small diesel-powered craft is appropriate for small-scale fishers in Sierra Leone?'), these proceedings reveal serious challenges of equity, notably between distant-water fishing countries, e.g., from the European Union, and the countries that supply the fish, but otherwise remain mired in poverty.

We have work to do. We hope these belated proceedings will be found useful.

The Editors

This report is a contribution of the *Sea Around Us* toward the project "Marine Conservation Research, Collaboration and Support in West Africa", funded by the MAVA Foundation. The *Sea Around Us* is a scientific collaboration between the University of British Columbia and the Pew Environment Group.

---

1 Vakily JM, Findlay IWO, Labor R and Jalloh A (1993) Artisanal frame survey 1990 in Sierra Leone: summary of a general census of boats, motorization, gears and employment in the artisanal fishery. Institute of Marine Biology and Oceanography, Fourah Bay College, University of Freetown, 27 p.
2 Vakily JM (1992) Assessing and managing the marine fish resources of Sierra Leone, West Africa. Naga, the ICLARM Quarterly 15(1): 31-35.
3 Vakily JM (1993) Dynamite fishing in Sierra Leone. Naga, the ICLARM Quarterly 16(4): 7-9.
4 Vakily JM (1994) Management of the fishery resources in Sierra Leone: assessment and recommendations. IMBO/ICLARM Research Cooperation, Project Report, Executive Summary, 20 p.
5 Vakily JM and Pauly D (1995) Seasonal movements of Sardinella off Sierra Leone. pp. 425-436. In: Bard FX and Koranteng KA (eds.) Dynamique et usage des ressources en sardinelles de l'upwelling côtier du Ghana et de la Côte d'Ivoire. Actes de la rencontre du DUSRU, 5-8 Octobre 1993, Accra, Ghana. Editions ORSTOM, Paris.
6 Turay I, Vakily JM, Palomares ML and Pauly D (2006) Growth, food and reproduction of the mudskipper, *Periophthalmus barbarus* on mudflats of Freetown, Sierra Leone, pp. 49-54. In: Palomares ML, Stergiou KI and Pauly P (eds.) Fishes in databases and ecosystems. Fisheries Centre Research Reports 14(4).
7 Showers PAT (1995) The abundance and distribution of the Sparidae in Sierra Leone waters – an ecological interpretation. Thesis submitted to the University of Sierra Leone for the award of the Degree of Doctor of Philosophy, 436 p.
8 Vakily JM (1993) Solar systems and computers: how to become independent of electricity supply. Naga, the ICLARM Quarterly 16(1): 19-20.
9 Vakily JM and Pedro SE (1994) Sierra Leone fishery library: a case of sleeping beauty. EC Fisheries Cooperation Bulletin. 7(4): 10-12.

The fisheries of Sierra Leone: Status, problems and prospects[1]

A.B. Kamara

Director of Fisheries, M.A.F.F., Freetown, Sierra Leone

Abstract

Sierra Leone fisheries development is traced from pre–colonial times, colonial times and on to the present. Artisanal fisheries used to land more catch than the industrial fisheries, but this trend was reversed in 1976, due to an increase in industrial vessels operating in Sierra Leone's waters. During the colonial times, fisheries research received most of the attention. However during the post–independence era, fisheries development and extension work have been emphasized. The main policy objectives include: increasing fish production to satisfy local demand, exporting the surplus to earn foreign exchange, modernizing the artisanal fisheries, constructing a fish harbor complex, establishing a national fishing fleet, creating strong research and extension activities, and training personnel in all aspects of fisheries. In the absence of reliable animal protein sources for most of the population, it is recommended that both the government and the private sector should invest in the fisheries sub–sector for a dependable supply of protein and to earn foreign exchange through export. Inland fisheries and aquaculture are not yet developed, but there is considerable potential for their development in the future. The Maritime Protection Services (Sierra Leone) Limited (MPSSL) is being reformed in order for it to be able to make an effective contribution in the management of our fisheries. Fishing fees have been revised downward in order to encourage the licensing of more vessels. The problems and constraints to the development of fisheries include the lack of a fishing harbor complex, a weak national economy, which distorts fisheries plans and programs, lack of support for fisheries research, low private sector investment, inadequate funds to run the Fisheries Department, and poor salaries for Government workers. Unless the national economy recovers, the prospects for fisheries development are not bright.

Introduction

Artisanal fisheries, characterized by dugout canoes, hand–lines, cast—nets, and paddles, predates industrial fisheries in Sierra Leone. Institutional fisheries work started with the Fisheries Research Unit (FRU), which was later expanded to the West African Fisheries Research Institute (WAFRI), which served all the former West African British Colonies (The Gambia, The Gold Coast [now Ghana], Nigeria, with Sierra Leone hosting the headquarters). The work of FRU and WAFRI in the 1950s and 1960s concentrated exclusively on marine fisheries research, covering topics like hydrography, fish migration, food and feeding habits of some fishes, taxonomy (fish, shellfish and plankton) and exploratory fishing to identify fishing grounds. There was very little fisheries development or extension work. This localized efforts by a variety of agencies contributed immensely to our understanding of the West African fisheries in general, and Sierra Leone fisheries in particular. The publications produced were outstanding and Sierra Leone became the depository of this scholarly fisheries work; Sierra Leone was also the headquarters for the West African Rice Research Institute.

The post–independence era saw a shift in emphasis from fisheries research to development and extension work–promoting the development of canoe fisheries and marine resource surveys in order to determine abundance and exploitation potential. Early development efforts include the creation of outstations to collect fisheries data and to map areas of possible intervention, as well as the creation of bodies and institutions to provide credit to the small–scale fisheries (i.e., cooperatives and the agricultural loan scheme). Both of these, however, failed due to poor loan–recovery and mismanagement. In general, artisanal fishermen do not have the required collateral to qualify them for bank loans. Recently, rural banks have been established, but they serve mostly agricultural farmers. There is need to create a National Agricultural Bank to cater to the particular needs of the agricultural sector, or at the very least, fisheries rural banks are needed to serve the fishing community.
In order to buttress the development efforts, the policy objectives in fisheries were stated as follows (from the first national development plan, 1974/75–1978/79):

- To increase fish production in order to satisfy domestic requirements and to export the surplus to earn foreign exchange;
- To modernize the industry through improved techniques and better infrastructure;
- To improve the training of personnel and to undertake active extension work;
- To establish efficient pricing, marketing and distribution systems.

Projects to support the above policy objectives will include: joint venture fishing agreements to increase fish landings, development of a fishing harbor with assistance from friendly countries, multilateral, and bilateral agencies, and inland fisheries and fish culture development (including oyster culture). These measures were to increase fish production from 35,600 tonnes in 1973/74 to 42,800 tonnes in 1978/79.

1 Cite as: Kamara AB (2012) The fisheries of Sierra Leone - status, problems, and prospects. pp. 12-16. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

The Fisheries of Sierra Leone

The fisheries of Sierra Leone can be divided into industrial fisheries (or commercial trawler operation), artisanal fisheries (marine and freshwater) and aquaculture. The industrial fisheries and marine artisanal fisheries exploit the marine resources, which have a approximate biomass estimate of 700,000 tonnes and a maximum allowable catch of 189,000 tonnes (as assessed during a 1982 research survey conducted by the USSR with Sierra Leonean scientist). When the survey was repeated in 1984, the biomass was estimated at 1,000,000 tonnes, with a maximum allowable catch of 300,000 tonnes. From these estimates, the following can be exploited annually without harm to the resource (Total allowable catch):

- Pelagic species: 120,000 tonnes;
- Shrimp: 2,500 tonnes;
- Tuna (skipjack, yellowfin): 15,000 tonnes;
- Demersal species: 18,000 tonnes.

In addition, 16,000 tonnes·year^{-1} of fish can be obtained from our inland fisheries. The village–level aquaculture currently being practiced is predominantly on the subsistence level, designed to meet the basic protein needs of farmers.

From the above total allowable catch figures, it is clear that the waters of Sierra Leone are capable of meeting the country's protein requirements, as well as earning considerable foreign exchange. Prior to this, there should be adequate (private and public) investment in infrastructure, establishment of a national fleet, and training of personnel to meet the appropriate requirements of fisheries development. About 75 percent of animal protein intake in Sierra Leone is in fish form. Cattle and livestock protein sources are inadequate and expensive, and therefore can only serve a tiny portion of the population; bush meat is also becoming scarce due to increasing exploitation of the forests. Investment in fisheries is thus a wise option for both government and the private sector.

The industrial fisheries are dominated by foreign fishing vessels, which are represented onshore by local companies or agents. The companies/agents procure fishing licenses for foreign vessels. Only very few local companies own fishing vessels. Local fishing vessels number less than 40, while approximately 160 fishing vessels are licensed per year, excluding support vessels. Over the years, poaching by foreign vessels has been rampant; trawlers also frequently fish inside the 5–nautical mile (nm) exclusion zone reserved for artisanal and recreational fisheries. In addition, the Department of Fisheries has not been able to determine accurate catches, due to non–submission of data by some vessels and/or submission of inaccurate data. In order to correct this situation, the Sierra Leone government entered into an agreement with the Maritime Protection Service (MPS) of the United Kingdom to form the Maritime Protection Service (Sierra Leone) Limited (MPSSL) on 7 July 1990. The MPSSL is to serve as an agent of the Fisheries Department, in order to undertake an effective fisheries protection service. The Fisheries Regulations (1990) were enacted in order to properly regulate the fisheries. During implementation from January 1991, it was discovered that there were basic errors in the MPSSL Agreement, resulting in almost constant friction between the fishing agents and the MPSSL. This friction arose due to the system of royalty charge assessment (8% of the catch) based on the INFOPECHE Bulletin prices. In order to pay less in royalty fees, vessel captains declare less catch (in vessel logbooks, catch declaration forms, etc.). However, these infractions are frequently caught upon verification. In August 1991, a Parliamentary Special Select Committee, set up to look into the activities of MPSSL, recommended in their report a number of reforms in order to bring the MPSSL Agreement in line with our national laws. The government, meanwhile, mandated MPSSL to continue its protection service while the Committee recommendations in the report are being implemented. Some of these reforms include: reducing of the operational budget of MPSSL; paying fisheries revenue into the consolidated fund; prohibiting MPSSL from issuing fishing licenses; the reconstitution the Government nominees on the MPSSL Board; decreasing the fishing fees (license, royalty, and transshipment fee); revising the fishing period for licensed vessels to be one calendar year (January–December), or six months (January–June or July—December); and appointing Sierra Leoneans to senior posts in the MPSSL management. There appears to be a consensus for MPSSL to continue the protection of the fisheries resources for rational exploitation and proper management. The 100 GRT fishing and supporting vessels licensed in 1991 are rather few for this fishery, and the high royalty charge is believed to be responsible. The benefits so far realized from the MPSSL operations are a sharp reduction in poaching, very few trawlers operating within the 5 nm exclusion zone thereby preventing the destruction of artisanal fishing gears, and a reported increase in volume and size of artisanal catch landings. A mandatory 15 percent of the catch is to be landed by all foreign fishing vessels for marketing locally; in 1988 it was 25 percent of the catch. The *Maritime Protector* has arrested fishing vessels for poaching or fishing without a valid license, fishing inside the 5 nm exclusion zone, falsifying catch data, illegally transshipping, and using the wrong mesh sizes in fishing nets. The fishing companies have complained of excessive taxation, in addition to paying the fishing fees (e.g., port charges, import tax, etc.).

The artisanal fisheries are dominated by bonga and herring (pelagic species), which constitute about 80 percent of the catch. The fishermen live in isolated communities with poor road access leading to the fishing villages, and poor socio–economic conditions in general. National economic difficulties usually accentuate these difficulties, with the result that living conditions quickly deteriorate further. Against this background, a number of projects have been identified, and are being implemented, in order to promote artisanal fisheries development. The artisanal fisheries used to land more fish than the industrial fishers up to 1975. After this time the situation was reversed and has remained so to date due to an increase in industrial fishing vessels. The following are the ongoing artisanal fisheries development projects:

- The German bilateral agency (GTZ)–supported Fisheries Pilot Project at Tombo which began in 1980;
- The Fisheries component of the GTZ–supported Bo–Pujehun Rural Development Project, which began in 1983;
- The European Community (EC)–supported West North Artisanal Fisheries and Community Development Programme, which began in 1989, but was preceded by the pilot project called the Kambia Fisheries Development Project, established in 1983 at Yeliboya;
- The FAO/UNDP supported Integrated Fisheries Development in Rural Fishing Villages in the Shenge Region: phase I occurred from February 1985 to December 1989, and phase II (with the same name) occurred from May 1991 and is projected to last for four years.

All these projects have common features, such as strengthening fishing boats, improving boat propulsion (outboard engines, inboard engines, and sail), facilitating engine repairs, enabling sale of fishing, boat–building, and processing equipment, facilitating fishing cooperatives and societies (including fishermen, processors, wood—cutters, boat owners, etc.), reforesting mangroves, constructing feeder roads, initiating income–generating activities among cooperative members (i.e., soap–making, gara, dyeing, salt–manufacturing, sewing, etc.), and providing credit to cooperative members for fishing and processing equipment. The cooperatives are the medium through which the introduced innovations are to be absorbed and subsequently spread in the fishing communities.

A major point of concern for all these projects is how to continue their activities when external support ceases. A number of strategies are being developed, with the cooperatives serving as the main structure. Central in all these problems is the difficulty in procuring foreign currency to maintain the sale of fishing equipment in these projects. It should be emphasized that the sale of fishing equipment in these communities is the most popular component in all these projects. When initially conceived, it was intended to make fishing equipment available at affordable prices in the various project localities, thereby removing transport cost. However, due to the devaluation of the national currency, the Leone, followed by the inflation this generated, the fishing communities cannot now afford to buy a complete outfit of a boat, net and engine without credit. Unless the Leone recovers from its current instability against other currencies, especially the US dollar, there is hardly any programme that can be executed without serious distortions during implementation. There is already a serious erosion of positive achievements in the last 5–6 years.

Inland Fisheries and Aquaculture

Inland fisheries consist mainly of freshwater fisheries in rivers, flood plains, and lakes. This fishery is primarily subsistence, and requires a detailed study in order to determine its full potential. The total annual catch is estimated at 16,000 tonnes·year^{-1}.

The farming of fish (i.e., tilapia) started in 1976 at Makali. A number of fish ponds have been established in various parts of the country, including through the fisheries component in the Bo/Pujehun Rural Development Programme.

Oyster culture was undertaken from 1973 to 1981 with the aim of undertaking biological studies and developing a strategy for commercialization. The broad objectives of this project were achieved, but to date there is no commercial effort in oyster culture. The Sierra Leone oyster results are being applied in The Gambia and Jamaica with the support of the International Development Research Centre (IDRC) of Canada, which also supported the Sierra Leone project. Other efforts in mariculture include grey mullets (*Mugil* spp.) and cockles (*Arca senilis*), and there are current plans for shrimp farming.

Fisheries Research

As stated earlier, the post–independence era concentrated on extension and development work. However, following the creation of the Institute of Marine Biology and Oceanography (IMBO), a part of Fourah Bay College, fisheries research was to be undertaken by this Institute in addition to its teaching role. Since its creation, the Institute has been perpetually starved of funds needed in the execution of its mandate. There is an urgent need to provide a suitably furnished building for this Institute.

The role of the Fisheries Department in Fisheries Development

The authority to manage and protect the fisheries resources rests with the Sierra Leone government through the Department of Fisheries. The Fisheries Management and Development Act (1988) and its regulations fully explain the strategies to be adopted in order to ensure the rational exploitation and conservation of the resource, including licensing procedures for all vessels, fishing fees, annual plans for resource allocation (entry limits where applicable), prohibited areas for fishing, controls on the behavior of vessels licensed to fish in our waters, and the provision of penalties for violations. In addition to the legislative responsibility, the department also draws up policy objectives for fisheries development, in order to remove the constraints and bottlenecks inhibiting development. For example, the following fisheries policy objectives were stated in the Green Revolution Programme of August, 1986:

- To increase the domestic production of fish and other aquatic resources to satisfy the local demand for protein;
- To increase foreign exchange earnings through the export of surplus fish and shellfish;
- To improve the efficiency of small–scale fisheries;
- To established the necessary infrastructure facilities to support both the industrial and the small–scale fisheries;

- To promote research activities on all aspects of fisheries to ensure the rational management and utilization of the resources;
- To establish an efficient credit, pricing, marketing, and distribution system;
- To provide an effective extension service;
- To monitor, prevent, and combat pollution, and adopt conservation measures in order to protect the aquatic environment and its resources.

Also, the Fisheries Department seeks technical assistance for fisheries development.

The following are seen as problems and constraints to fisheries development:

- Lack of a fishing harbor complex to support the fishing industry. A repair and maintenance facility capable of handling vessel sizes of 350 tonnes is urgently needed, plus ancillary units such as ice–making machines, cold storage facilities, offices (i.e., for Fisheries, Customs, Health and Security personnel), and a quality control laboratory;
- Lack of a national fishing fleet;
- Weak national economy, which is a major constraint to all development efforts, characterized by the weak national currency;
- Inadequate funds for running the Department of Fisheries (i.e., acute shortage of transportation, boats and vehicle), difficulty in procuring foreign currency to maintain revolving funds, and non–payment of counterpart contributions in the execution of projects;
- Lack of duty–free fuel for the fisheries sub–sector;
- Lack of support for fisheries research;
- Inadequate trained personnel in some disciplines in the field of fisheries;
- Poor salaries for government employees leading to low motivation and morale.

The fisheries of Sierra Leone are capable of satisfying the national protein requirement as well as earning considerable foreign exchange through exports. Shrimp, tuna, cuttlefish, red mullet, crabs, lobsters, oysters, cockles, sharks fins, skins and oil all can form the basis of a very lucrative export trade. However, before profits from the fisheries can be realized, the government should invest in infrastructure and create an investment climate for the establishment of a national fishing fleet, thus avoiding the present over–dependence on foreign fleets. The private sector too must invest and be willing to build a strong fisheries base through activities such as procuring fishing vessels and establishing shore–based facilities (i.e., processing and cold storage facilitie). Already a strong data–collection system is being instituted in the Department of Fisheries, and an excellent fisheries protection service is already at hand. These are important prerequisites in rational fisheries management. There is good potential for aquaculture and inland fisheries development. All the artisanal fisheries projects are operating successfully. The two major problems are the difficulty in getting foreign currency to re–order fishing equipment, and ensuring the sustainability of the ongoing projects when the external support ends. The solution to many of these problems lies in the full recovery of the national economy, which in turn will lead to a strong and stable national currency. Until this happens, the prospects for fisheries development will not be bright.

The Fisheries Sector of Sierra Leone[1]

E.T.A. Golley–Morgan

Consultant (Former Director of Fisheries), Freetown, Sierra Leone

Abstract

This report is an excerpt from the fisheries subsector group report of the National Agricultural Policy Workshop. The fisheries subsector group considered: artisanal fisheries (coastal and inland) from capture to consumption; industrial fisheries; fisheries surveillance; constraints limiting production and economic benefits in the subsector (e.g., lack of infrastructure, limited financing, limited numbers of staff, and lack of trained personnel); social considerations in promoting fisheries development projects in coastal rural centers; inland fisheries and aquaculture; and institutional requirements for support of the fishing industry. A brief overview of the fishing industry of Sierra Leone was provided, covering the colonial era, post–Independence era, and the present.

An Overview of Fisheries in Sierra Leone

Little was done in the way of fisheries development during colonial days, beyond the preparation of a few investigative reports on the state of the industry in the colony, with no follow–up on the recommendations made for development. An unsuccessful attempt was made in the 1940s to establish a fisheries department, the relics of which now form most of the Sierra Fishing Company's outfit at Murray Town. By 1950, the Colonial Office had decided to establish a research unit, known as the West African Fisheries Research Institute (WAFRI), based at Kissy Dockyard, Freetown, with a mandate to undertake oceanographic and fisheries research throughout West Africa. Following independence of so many countries in the late 1950s and early 1960s, WAFRI lost its mandate and was closed down by 1959. Most of the equipment, with the exception of the research vessel *St Mary*, was left in Sierra Leone. That equipment later passed to the Institute of Marine Biology and Oceanography (IMBO) when it was established under Fourah Bay College, University of Sierra Leone. In 1958, the Government of Sierra Leone formed the Fisheries Research and Development Unit (FRDU), later transformed into a Fisheries Division in 1961, following Independence.

Commercial trawler fishing started in Sierra Leone during the early 1950s, with the advent of a handful of Italian wooden–hulled vessels, mostly from Sicily. These were old vessels, which often broke down for lack of spare parts. Traditionally, fishing was mostly done from dugout canoes and plank–built boats known as "benefit boats". Marine catches were disposed of locally, with very little going inland in smoked form. The pelagic stocks were virtually unexploited, except by a few artisanal drift and cast netters, fishing primarily for bonga shad (*Ethmalosa fimbriata*). Artisanal fisheries exploited demersal species only by hook and line, fish traps, weirs and fences.
An influx of two to three thousand immigrant Ghanaian fishers to Sierra Leone occurred in the early 1960s. They settled along the coast from Yeliboya Island in the north to Sulima in the south, and brought with them their dugout canoes. The Ghanaians were specialists in fishing stocks of herring (*Sardinella* spp.), mackerel (*Scomber* spp.) and other small pelagics, using huge ring gill nets or beach seines. In the late 1960s, the Government of Sierra Leone made a political decision to repatriate all the immigrants. Fish production from the artisanal sector dropped from over 40,000 $t \cdot year^{-1}$ to 25,000 $t \cdot year^{-1}$ during the period immediately following the departure of the Ghanaia. However, after about three years there was an upturn as local fisherfolk started to fill the gap created by the departure of the Ghanaians by producing a craft similar to the Ghana canoe. This vessel is now known as the "Ghana–type canoe". These differ from the original Ghana canoe as they are built from planks of timber rather than hewn out of single trunks of trees, with pointed ends typical of the originals, but which are not necessary for the Sierra Leone surf–free beaches, except for Turner's Peninsula near the Liberian border. The ring gill net technique, hardly altered from the time, was a most effective transfer of technology to the artisanal fisheries in Sierra Leone.

In 1969, a UNDP–funded exploratory survey of pelagic stocks was carried out by FAO in partnership with the Fisheries Division. Earlier, there had been a regional trawl survey covering the waters beyond the twenty fathoms depth line, mainly for demersal stocks. Stocks of demersal and pelagic fish were located and identified, and in some cases estimates of abundance were made. As a result, many long–distance vessels appeared in the region, and some of the East European countries entered into fishing agreements with coastal states, to legalize their access to the stocks. Sierra Leone signed an agreement with the USSR in 1976, allowing access by the Soviet fleet. The agreement operated for 13 years, with no development of Sierra Leone's fisheries, although cooperation in this area was part of the agreement. It was a commercial arrangement between the Soviet Fransov Company and the Sierra Fishing Company, a local company with private, foreign and public interests, controlled by a private Sierra Leonean majority interest. By 1980, vessels of many other countries had joined the Soviet fleet, but with no formal access agreements. The vessels gained access through locally incorporated companies or agents, who secured licenses from MANRF for them. In 1976, the Ministry introduced regulations imposing both a royalty fee

1 Cite as: Golley—Morgan, ETA (2012) The fisheries sector of Sierra Leone. pp. 17-21. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

based on the gross registered tonnage (GRT) of the vessel, as well as a license fee based on vessel length. In 1983, it was made mandatory for foreign vessels operating in Sierra Leone waters to land at least 25% of their catch in Sierra Leone for the local market, in order to ensure a regular and adequate supply of fish to the local population. The rest could be exported to earn foreign currency. The policy worked well for some time, but, as the value of the Leone started its rapid decline, some of the 25% was diverted to other ports in the subregion, resulting in less fish being landed and a loss of foreign exchange.

In 1988, a new act, the Fisheries Management and Development Act No. 4 of 1988, was promulgated by parliament. This law gave the Ministry power to manage the fisheries and extract an economic rent from the resource, as well as provide a framework for the development of the industry through the establishment of a Department of Fisheries, a scientific committee, and an advisory board. These bodies have not been functioning because of a lack of funds and logistical support. Monitoring and control of industrial fishing has been lax because of a lack of resources and poor staff morale. The naval wing of the Sierra Leone Military Forces which, up to 1984, had cooperated with the Department of Fisheries in mounting surveillance exercises, decided to branch off on their own. The reason given was that civilians cannot be placed on military vessels. This led to a lack of coordination between the Department of Fisheries, the issuing authority for fishing licenses, and the naval wing, then solely responsible for surveillance. A number of wrong arrests were made because of inexperience. However, the naval wing has suffered the same fate as the Fisheries Department, with insufficient funds to meet the operating costs of vessels, low motivation and little incentive to mount effective surveillance. As a result of the lapse in the surveillance of Sierra Leone's waters, both foreign and national operators of vessels exploited the resources–particularly the demersal stocks of shrimps, cuttlefish and other invertebrates–with little or no benefit to the country. Consequently, the government took the unprecedented decision of assigning surveillance and management of marine resources to a private joint venture company, Maritime Protection Services (Sierra Leone) Limited (MPSSL), which is owned 51% by the government and 49% by private investors, both local and foreign. This decision, welcome as it was for surveillance, has been most unpopular within both the public and private sectors regarding the issuing of licenses and collection of receivables. It is generally felt that MPSSL's responsibilities should have been limited to surveillance, for which service a fee should have been negotiated and the revenue retained by government, with properly constituted checks and balances.

Artisanal Fisheries

Artisanal fisheries were considered from catch to consumption. It is clear that artisanal fisheries, important though they are, have reached a limit to their development, in terms of technology and craft. There is therefore a need to upgrade the present level of fisheries at selected sites into semi–industrial operations, with concomitant investment in shore–based infrastructure, craft development, and training of personnel in the handling, maintenance and management of craft and infrastructure. The integrated approach to small–scale fisheries development was welcomed by the group. However, some speakers thought that emphasis should be placed on fishing technology, craft development, handling and management rather than on community development. The need for the diversification of artisanal fisheries into the harvesting of unexploited and underexploited species was discussed. The reason for these species being ignored was the lack of handling and processing facilities, and remoteness from markets. With improvements in shore–based infrastructure at some of the present landing sites, such species could be exploited and processed, for both local and export markets. Such species include shrimp, crab, lobster, sole, oyster and cockles, which are found in estuaries and shallow coastal areas.

The scarcity and high cost of inputs such as fishing gear, fuel, and transport to markets were all highlighted. There is a need to centralize the acquisition of such inputs, as none of them is produced locally and therefore foreign exchange is needed for their procurement. The different types of gear in use should be surveyed in order to determine their relative efficiency and cost–effectiveness for artisanal fisheries, as well as to make recommendations about the best types of gear to use and sources of procurement, taking into consideration price and quality. At present, artisanal fisheries are being supported by four small–scale fisheries integrated development projects, mostly from external sources. These projects are playing a vital role in providing hard currency for the importation of inputs, but it is feared that, when the external support is withdrawn, the situation will become precarious if no alternative sources of foreign exchange are found.

Inland fisheries and aquaculture started during the late 1970s with government development fund support. The United States Agency for International Development (USAID) later gave some assistance for pond fish culture in the northeast of the country, aimed at remote rural farming communities for whom cheap protein was badly needed. Farmers were encouraged to dig one or two ponds on their farms and grow tilapia to supplement their diets. Peace Corps volunteers were used as extension agents to train farmers in the management of their ponds. Nile tilapia (*Oreochromis niloticus*) was imported from Côte d'Ivoire and propagated for seed to supply to farmers. Since the withdrawal of external funding, this programme has had problems in meeting the needs of farmers, owing to inadequate funding by the government.

Industrial Fisheries

The industrial fishery of Sierra Leone is unfortunately dominated by foreign–owned vessels, which employ only a limited number of Sierra Leoneans and then mostly as deckhands. These vessels are either licensed through, or chartered by, local agents. The benefits to Sierra Leone are mostly in the form of license and royalty fees, the landing of a percentage of the catch to defray local costs, and the linkage effect within the economy through the provision of services bought by the vessels and crew, although such linkages are limited because of inadequate

shore–based facilities. In many cases, the vessels have to go to other ports for minor repairs or to purchase modest supplies. For example, Sierra Leone can provide less than three tonnes of ice a day at the moment, and the supply is most irregular. The very difficult situation regarding supplies of fuel and lubricants is common knowledge. It is believed that Sierra Leone was losing up to US$5 million a year by not having adequate repair facilities to offer the Soviet vessels that were operating in national waters up to 1990. Thus potential ancillary benefits from living marine resources are not only direct, in the case of taxes and license fees, but also indirect, through the string of economic activities generated in servicing vessels operating in national waters. It has been said that for every one fisherman out at sea, six jobs are created ashore.

The licensing of foreign vessels must be viewed as a stop–gap measure because if the fish are not caught they die naturally and nobody benefits. The group felt that there was an urgent need for a plan to develop a national fishing fleet of industrial and semi–industrial vessels, in order to reduce dependence on foreign–owned vessels and to generate more shore–based economic activity. First priority must be accorded to the semi–industrial vessels, as they would be a natural next stage on from artisanal fishing, cheaper to acquire and more cost–effective. Very large industrial vessels are not yet needed by Sierra Leone, except possibly for large, migratory species, such as tuna. A coherent and coordinated package is needed for the development of a national fleet. This would include the establishment of fish landing infrastructure at key landing sites, and a national fish terminal in Freetown. It would also need to be coupled with the improvement of training facilities at all levels. It is recommended that the government work with interested donors to draw up a ten–year fishing development plan, to be reviewed after five years, with the main objective of building up the requisite infrastructure, establishing a national fleet, and providing training in all aspects of the industry of both the public and private sectors.

Surveillance

The questions of surveillance and of conflict between artisanal and industrial fisheries were raised by some members of the group. On surveillance, it was noted that the government had contracted this function to a private company, MPSSL, together with the functions of issuing licenses and collecting fees. Some speakers were of the opinion that the collection of receivables and surveillance are functions that border on the sovereignty of the state and are too sensitive to have been privatized. In any case, the two functions should never have been given to the same company. Surveillance should have been separated from the issuing of licenses and the collection of revenue. Some members opined that MPSSL should have been contracted only to mount a surveillance scheme that could have provided the Sierra Leone Government with the teeth to enforce effective laws and regulations. The dependence on foreign vessels to exploit national living marine resources will only be perpetuated with arrangements such as that with MPSSL, as they serve to erode the capital base of local investors attempting to develop a fleet of their own. The group thought that it would have been welcome news to the industry if an arrangement with a commercial company had included provision for investments, shore–based infrastructure and management expertise.

Inland Fisheries and Aquaculture

Following a brief description of the present state of inland fisheries and aquaculture, it was emphasized in the discussion that production from inland water bodies is far greater than is accounted for in official statistics. There is need for a national survey of inland fish production at both subsistence and commercial levels, to take into consideration the preferred species, their aquaculture and abundance. Follow up action could include adaptive research trials with these species and tests of their suitability for artificial propagation in hatcheries.

Sierra Leone has elaborate estuarine systems along its whole coastline, coupled with extensive riverine and flood plain systems. These ecosystems are grossly underutilized, not only for fish production but also for crop or livestock production. In most cases, reliance is solely on natural production, with no human intervention to augment or stimulate the natural cycles. It was felt by the group that urgent attention should be given to the development of aquaculture in order to utilize the various water bodies that can be found all around the country. The integration of aquaculture with livestock and crop production must be given serious consideration, as this could make such ventures more cost–effective, and lead to sound, balanced environmental management. In view of this, any interference with natural water bodies for development purposes must undergo an environmental impact assessment before being implemented. Mining companies or enterprises must be compelled by law to rehabilitate mined–out areas to the extent that such areas can be used for food production. The development of fish ponds in mined–out pits could offer a positive solution to the problem of fish shortages in those areas.

It was argued that inland fisheries and aquaculture are not accorded the importance they deserved because of the emphasis at the government level on marine fisheries. The group thought that a section for inland fisheries and aquaculture should be created within the Department of Fisheries to be headed by at least an Assistant Director.

Institutional Aspects of Fisheries

Weak government institutions for the administration, management and control of the fishing industry of Sierra Leone expose the nation to many dangers, and even deprive the nation of the benefits from its endowed resources. The group therefore felt that the Department of Fisheries must be strengthened so that it can fulfill its mandated role of research, development and management of the fisheries and other living aquatic resources of this country. The competence of nationals to carry out these functions, provided that the necessary incentives and logistical

support are in place, must not be underestimated or disregarded. The group recognized the need for manpower development, and recommended that this be given due consideration. The group was supportive of the idea of tagging funds for specific programmes within each subsector, and on this issue, felt that part of the revenue collected for license and royalty fees should go towards fisheries development. The group thought that it was time that the government gave serious consideration to the registration of fishing canoes, particularly coastal canoes. This would provide a valuable database for planning and development, as well as to curb malpractices, not all of which are connected with the fishing industry.

Smoking is almost the only processing method practiced at artisanal fish landing sites. There is a need to introduce other methods of fish processing in order to maintain the nutritional quality of the resources until it reaches the consumer. In times of glut, especially when large schools of sardinella and other small pelagics abound near the coast, there is a lot of wastage because of inadequate processing and holding facilities, and the catch is thrown away. Bycatches from shrimping and other demersal vessels are also commonly discarded. The group emphasized the need for the government to make the Fisheries Advisory Board functional, and then to seek the Board's opinion on all major policy matters. Similarly, the scientific committee established under the 1988 Act should also be made functional. PEMSD should be strengthened to enable it to provide the services for which it was established. This would require specialists in every subsector of the agricultural industry in order to meet the needs of the Ministry. It was observed that reference materials in many fisheries–related subject areas are very hard to obtain access to, if not unavailable. The group urged that the documentation section of MANRF be strengthened to reflect all disciplines, and that FAO and UNDP be requested to expand their documentation services in Sierra Leone to permit access to important publications on agriculture, fisheries, forestry and animal science, for both public and private use.

Recommendations

Artisanal fisheries

- To form a basis for future development plans, an exhaustive stock assessment should be carried out;
- In order to provide a basis for assessing the extent of small–scale fishing activities, it is recommended that artisanal fishing boats be registered;
- An agricultural bank with satellite rural banks and institutions should be set up to cater to the credit needs of the artisanal fisheries sector, particularly for obtaining the necessary inputs for coastal and inland fisheries;
- Inland fisheries should be given equal importance with coastal fisheries; to achieve this, a special unit for inland fisheries should be created within the Department of Fisheries that would work closely with LWDD;
- Cross–border trade in fish should be formalized to bring more benefits to the economy; and
- An in–depth study of the potential for non–traditional marine products, such as pearl culture, shell collection for jewelry, shark fin, and button manufacture should be carried out.

Industrial fisheries

- A fishing terminal should be established in Freetown to service an industrial fishing fleet;
- A national fishing fleet should be established;
- Training needs to be provided at all levels and in all disciplines connected with fisheries, to serve both the public and private sectors;
- A pay—as–you–earn scheme is recommended to assist in the purchase of industrial and semi–industrial vessels, processing equipment and transportation;
- A coastal fish collection system should be set up to take excess fish and bycatch of demersal trawlers, shrimpers, etc., for processing into fishmeal and other fish products;
- With regard to shrimp fishing, the group recommended that the government give serious consideration to the idea of closing shrimp fishing to foreign–owned vessels if the economy is to benefit adequately from this resource. Exploitation of shrimp stocks could be done by locally–owned vessels, and through joint ventures that were prepared to invest in shore–based processing plants and use locally–registered vessels;
- The introduction of a three–month closed season for shrimp should be explored as a conservation measure;
- Incentives should be introduced for exports of fish and fish products in order to attract investment for the processing of value–added products; and
- The possibility of sea farming some of the valuable local marine species of vertebrates and invertebrates should be explored.

Institutional requirements

- Closer surveillance of the industrial fishing fleet should be introduced;
- Closed seasons for shrimp and other important invertebrate species should be established;
- The Department of Fisheries should be strengthened so that it can undertake research into and development and management of the fisheries;
- Personnel should be trained for both private and public sectors;
- A comprehensive ten–year national fisheries plan should be drawn up covering both sea and inland fisheries;
- The methods of fish preservation should be diversified in order to broaden the basis of the sector's

contribution to national food security, and salt production technology should be improved to allow increased fish preservation;
- The database for fisheries development and planning should be improved;
- Boat–building facilities capable of producing and repairing semi–industrial vessels should be established;
- A regulation requiring that all industrial fishing vessels have at least 25% of their crew from Sierra Leone should be enforced;
- A monitoring, control and surveillance section should be set up within the Department of Fisheries, and provided with the necessary logistical support and incentives to undertake the task;
- Fisheries research should be strengthened in support of both the public and private sectors, and should include resource assessment, marine biology, fish preservation, and fisheries economics; and
- The Institute of Marine Biology and Oceanography (IMBO) should be supported and expanded.

Fisheries Monitoring, Control And Surveillance in Sierra Leone Waters[1]

D.C. Graham and B.R. Booth

Marine Protection Services (Sierra Leone) Limited, Freetown, Sierra Leone

Abstract

The philosophy of surface surveillance and the management of fisheries control, as implemented by Maritime Protection Services (Sierra Leone) Limited (MPSSL) revolves around the principle of random presence on a fishing ground, in order to implement the United Nations Convention on the Law of the Sea as stated in Article 73 paragraph 1. The programming and operation of surface surveillance vessels is paramount to the correct and accurate monitoring and control of a fishery. Operational procedures and activity reports are given in the body of the report.

Introduction

This paper covers the period that MPSSL has been operational in patrolling the zone, from 1 January 1991 until November 1991. The United Nations Convention on the Law of the Sea (UNCLOS) states, in Article 73, paragraph 1, that in the enforcement of the appropriate laws and regulations:

> *The coastal state may, in the exercise of its sovereign rights to explore, exploit, conserve and manage the living resources in the Exclusive Economic Zone (EEZ), take such measures, including boarding, inspection, arrest and judicial proceedings, as may be necessary to ensure compliance with the laws and regulations adopted by it in conformity with this convention.*

With the above in mind, the Sierra Leone Government decided upon a radical change of policy to manage the marine resources within its 200–mile EEZ. The system that the Government has adopted is one that employs a civilian self–financing organization, at present operating one deep–sea maritime patrol vessel. The ship, named *Maritime Protector*, is based in Freetown, and operates on the well–proven 12 day patrol cycle, with two days in port at the end of each voyage for storing, fuelling, etc. This cycle is, of course, not rigid, and can be adjusted as and when required to take into account changing conditions and activities on the fishing grounds. At this stage, it is therefore relevant to examine the activity in the fishery prior to 1991. It should be pointed out that little information is available on the historical fishery, and much information has been second, or even third hand. However, the salient facts appear to be:

- Virtually unregulated shrimp fishing, much of it close to the coast, to the detriment of the artisanal fishery;
- Fishing by large numbers of Soviet and other stern trawlers, for all species of fish and shrimps. The Russian fleet appears to have used a variety of gear, including bottom trawls and purse seine nets, and at least one such vessel was arrested by the Sierra Leone Armed Forces;
- Larger trawlers, representing Korean, Italian, and other European fleets, fishing into what is now the Sierra Leone EEZ, from Guinean and Liberian waters; and
- Longlining for tuna, about which the authors have been unable to gain much factual information.

Clearly such a situation could not continue, otherwise the fishery resources would become exhausted, and a once renewable resource would be lost. Since the establishment of a monitoring, control and surveillance (MCS) system by MPSSL–acting as the authorized agent of Government–the level of illegal fishing activity has been substantially reduced, especially in the Inshore Exclusion Zone (IEZ) and by crossborder fishing from Guinean and Liberian waters. This has been achieved by the deterrent presence of the fishery protection vessel maintaining a continual presence on the ground, to ensure that the fishing community realizes that Sierra Leone is interested in paying more than lip service to maintaining the integrity of its fishing zone.

With all the above in mind, the following tasks have been carried out by the patrol vessel:

- Regular boarding to ensure compliance with all aspects of the Regulations, to carry out checks on catches and compare the results with daily reported catch rates;
- Patrolling to prevent the off–shore fleet from fishing within the IEZ;
- Patrolling inshore areas such as Yawri Bay and the estuary of the Sherbro River, using the patrol vessel's rigid inflatable boats (RIBS);
- Maintaining contact with local fishery officers and project leaders ashore, such as at Shenge and Yeliboya;
- Giving assistance at sea to fishing and other small vessels in time of difficulty;
- Running on both northern and southern borders to prevent unlicensed fishing by vessels from Guinea and Liberia;

1 Cite as: Graham DC and Booth BR (2012) Fisheries monitoring, control and surveillance in Sierra Leone waters. pp. 22-27. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

- Deep water patrols, to check on tuna fishing during the season, and to locate any areas of deep water fishing which may take place well away from the coast, an area in which poachers often operate in other fisheries with relative safety, being able to retreat rapidly to international waters on the approach of patrol vessels;
- Monitoring transshipping activity, both in the designated Freetown anchorage, and in ocean waters, to ensure compliance with the rules;
- Patrolling of the entire area of the zone on a regular basis, with random checks on known areas of high activity; and
- Shadowing of reefers at sea when attempts to transship illegally are thought to be likely.

Maritime Surveillance and Boarding Philosophy

The philosophy on which surface surveillance is based revolves around the fundamental principle of a presence on the fishing ground being maintained by the protection service involved. Protection vessels should operate at random, either singly or in concert, depending on the nature of the fishing activity, the perceived likelihood of illegal or unlicensed fishing, or the possible occurrence of incursions into the EEZ by vessels from other adjacent zones or from the high seas. By being seen by the fishing fleet, the patrol service demonstrates that it is serious in its intentions to ensure compliance with the Regulations, protect the licensed vessels from activity by unlicensed ships (which of course have paid nothing for their fishing), and display the will and means to maintain the integrity of the entire zone by patrolling the extremities and preventing unlicensed incursions.

In Sierra Leone waters, the main areas of activity revolves around the shrimp fishing grounds off Yeliboya Sound in the north, the area off the shoals of St. Ann/Sherbro and Turtle Islands in the south, and off the mouth of the Galinas River, close to the Liberian border. Demersal and pelagic trawling tends to occur in central areas inside the 1,000–meter contour, with tuna fishing taking place on the shelf edge between 200 meters and 1,000 meters, and also in all areas of deeper water north and south, right out to the edge of the EEZ. The IEZ, reserved exclusively for artisanal fishing, is also rich in shrimps and other species, and provides a great temptation (as well as current source of frustration, as it had been fished prior to 1991), for the larger commercial vessels. Tasks of the patrol vessels at present, and in the future, will continue to be shaped by the requirements to police these areas, as well as to monitor the various transshipment and supply operations which take place within the zone.

The management strategy for a fishery must include a system that enables the monitoring and control of fishing vessels participating in the fishery. Part of the MPSSL system is the use of a dedicated system patrol vessel, the *Maritime Protector*, and the methods adopted for her operational activities are as follows:

Programming of the patrol vessel

Detailed programming should be carried out by the embarked Senior Surveillance Officer (SSO), after discussing the plan ashore with the Chief Executive, General Manager, and the Operations Controller, who is the shore–based SSO. The program will then be discussed by the embarked SSO and the Master. Whilst the Master remains in command of the vessel and is responsible for its safety, the SSO is responsible for the conduct of the patrol itself and the areas to be covered, which must take into consideration the following aspects:

- Concentrations of fishing activity;
- The IEZ, particularly the Yeliboya Box and the vicinity of the Banana Islands, Yawri Bay, the Shoals of St. Ann and Sherbro Islands, down to the Liberian border;
- The requirements to place, or re–embark, scientific staff from fishing vessels;
- Boardings, taking into consideration the locations of licensed vessels that have not recently been visited and any other boardings required by current policy;
- Observation of transshipping activity, particularly that carried out in deep waters;
- The requirement to visit coastal fishing villages to "show the flag"; and
- The northern and southern borders, to prevent unlicensed fishing activity from Guinean or Liberian waters.

In practice, it is unlikely to be of value to plan for more than a week in advance, leaving the remainder to be discussed by telex as the patrol progresses. This allows for the flexibility required and takes into consideration unexpected contingencies.

Ship maintenance and down time

It is perhaps useful at this juncture to discuss maintenance, particularly as the aim is approximately 310 days on patrol per annum. The embarked SSO will liaise with the Master and Chief Engineer on matters of maintenance, particularly where it concerns items of machinery requiring this on a regular basis. The ship will need undisturbed periods to paint the hull when ashore. This should not be allowed to interfere with operational requirements and, indeed, there will be occasions when sailing at short notice will be unavoidable. With sensible and friendly discussions, these routine matters have proved to proceed harmoniously.

Early Activity Seaborne Surveillance Period: January-March

The first few weeks were spent familiarizing the seagoing staff with the ship and its equipment. Operating methods, including the RIBS, were also tried and tested during the period. Also at this time, there were a number

of vessels fishing on a 14–day extension granted to their 1990 licenses. However a number of other vessels were located early in January with no apparent authority to fish in Sierra Leone waters. As a result, the shrimp vessels *Cores Mar No. 1*, *Sekiby 12* and *Triton* were detained, and ordered to Freetown for further investigation. Two of the vessels were not prosecuted: in one case, the vessel had an extension to a previous license about which MPSSL was not aware, and in the other, the vessel was unlicensed and, rather unusually, it was decided that only a licensed vessel could commit the offence of fishing within the IEZ. The third offender, the *Triton*, was prosecuted, and early in February the Master appeared in court and pleaded guilty to the offences of fishing with an undersize net, and also to having an illegal attachment to the net. He was fined a total of Le150,000[2] on each count, that being the minimum allowable. An Italian trawler was boarded during this period in the vicinity of the Shoals of St. Ann, however while it appeared to be towing, upon boarding it was found that she was on slow passage to Guinean waters. Three of the locally licensed Chinese vessels were also boarded towards the end of January, for routine inspections. Although of the three arrests, only one resulted in a prosecution, there could be no doubt that the fishery protection service meant business.

February saw a total of seventeen boardings which included routine inspections, checks of fish on board, explanations of queries regarding the completion of logbooks, and the boarding of a reefer, the *Namin*, off Cape Sierra in connection with transshipments without a license. This matter was resolved at sea, but the Master of the reefer was left in no doubt that in future, he must hold the license on board. Patrols were made of all areas where fishing activity was concentrated, as well as some deeper water voyages. March saw the arrival of the joint Soviet/Nigerian purse seine vessels, and with it the need to patrol further afield, as these tuna fishing vessels fished in deep waters to the northwest and west of the continental shelf, as well as along the edge of the shelf itself. It was during such a patrol that the French purse seiner *Marsouin* was detained by the *Maritime Protector* and brought to Freetown for fishing some seventy miles inside the Sierra Leone EEZ without a license. The eventual outcome of this arrest was an out of court settlement between the owners and the Government amounting to US$ 600,000.

There were eleven other boardings, and *Chung Hai 1* and *Chung Hai 2*, after repeated warnings, were ordered to Freetown for failure to display call signs. Two Italian trawlers were escorted to port by the patrol vessel, and remained there until the owners had paid royalty fees and the balance of their license fees, which were outstanding at the time. Patrols continued throughout the zone, and on 30 March, the Cuban longliner *Bonito* was boarded near the western edge of the zone, advised of the requirement to have a license, and then escorted into International waters.

Consolidation Period: April to October

By the beginning of April, the number of vessels active in the zone had increased to 53, the breakdown being 27 shrimpers, 16 demersal trawlers, 4 tuna longliners, and 6 tuna purse seiners. The *Maritime Protector* carried out two patrols over the period covering large areas during a typical month. During the first voyage, the patrol vessel was in the vicinity of Yawri Bay on April 3. As a result of this surveillance, two vessels, *Bona No. 2* and *Min Fei No. 1* were observed by the Senior Surveillance Officer (SSO) on board to be inside the IEZ. *Bona No. 2* was at anchor some 1.2 miles inside, and *Min Fei No. 1*, which was seen hauling by a number of observers on the *Maritime Protector*, was some 6.6 miles inside Yawri Bay. Both vessels were boarded, and as a result of investigations carried out, they were ordered to Freetown for further inquiries. These were subsequently carried out, and as a result, case files were produced alleging a gear stowage offence in the case of *Bona No. 2*, and fishing within the IEZ and failure to obey a lawful command issued from a patrol vessel (specifically failure to stop and allow boarding), in the instance of *Min Fei No. 1*. The vessels were subsequently released on the instructions of the Deputy Director of Fisheries, and allowed to resume fishing. The Master of *Bona No. 2* received a letter of admonition, whilst in the case of *Min Fei No. 1*, it was decided that there was a case to answer. This case was later dismissed by the Director of Public Prosecutions (DPP) for technical reasons.

Towards the end of the month, all the joint venture tuna vessels were boarded and then escorted to Freetown until the matter of unpaid license fees was resolved. The masters of all the above vessels were cooperative, and no problems were experienced in getting them to come to port. Patrolling continued along similar lines to the above during May, the surveillance continuing in all areas of activity. In April and May 26 vessels were boarded, and towards the end of May, *Sierra No. 12*, a local shrimp vessel, was brought to port by the patrol vessel, having been detected fishing inside the IEZ, and for operating without a reasonable amount of working position fixing equipment. The second offense was not pressed by the DPP, and on the first the vessel was fined Le200,000. (approximately £470 at the time) was imposed. The other vessel was the Korean trawler *St. Bernard/Sir Admiral*, which was caught fishing in Sierra Leone waters without a license, and ordered into port.

During June, the main shrimp fishing areas were patrolled, as were the northern and northwestern areas of the zone. A total of 15 boardings were made, and as a result a number of vessels have been detained for violations of the Fisheries Regulations.

Summary of the Vessels and Alleged Offence

Takamar 6

No radio logs, no observer being carried. Discrepancies in figures taken from catch reports, fishing logs and actual fish onboard. Case pending, file with CID/DPP.

2 Editors' note: 1 USD = 420 Le in 1991.

Yuan Yu 627, 628, 629, 630

Incorrect crew ratios as required by holders of local licenses. Vessels given permission to return to fishing grounds by Director of Fisheries on proviso that matter regularized over a period of several months.

Takamar 5

Fishing within the IEZ. Case pending, file with CID/DPP.

St. Bernard/Sir Admiral

Pleaded guilty to fishing in the EEZ without a license. Fined Le3,000,000 and vessel confiscated. At the time of writing we are still awaiting instructions on the disposal of the vessel, which is now the property of the Sierra Leone Government.

Min Fei 4

No fishing logs and the obstruction of Fishery Officers. Falsification of catch reports. Case pending, file with CID/DPP.

Maritime Protector covered all the major fishing areas, during July and it is evident that a great deal of effort was put into patrolling the IEZ, and the associated shrimp fisheries off the Banana Islands, the Shoals of St. Ann, Sherbro Island, and in the vicinity of Yeliboya Sound. The latter area was covered for two reasons, firstly as the vessels moved north to fish, and secondly in response to information from persons working ashore on the Yeliboya project. This specific action resulted in the detention of two vessels for illegal fishing within the IEZ during the second patrol. *Semaven 2* and *Sea Horse 1* were boarded and escorted into Freetown on 25 July. During both patrols longline vessels were detected in the IEZ. The Japanese *Gonei Maru 1* southwest of Sherbro Island was seen on the evening of the 14 and challenged by radio. She got underway and refused to stop, and was subsequently escorted out of the zone, exiting in the south west of the EEZ.

During the second patrol, a Korean longliner, call sign 6LBC, was boarded northwest of Freetown and the Master warned that a license was required to fish in Sierra Leone waters. In neither case was there any evidence that the vessels had been fishing. Whilst in the north, the Guinean border was also patrolled, and a Russian purse seiner was seen 1 mile inside our zone, but the FPV was unable to get close enough to identify her. A number of other fishing vessels have been seen fishing close to Sierra Leone waters in that vicinity. During the month, twelve vessels were boarded, including the reefer *Gin Leng 1*, for routine inspection. The *Protector* also escorted the *Min Feis* and *Yuan Yus* into port for failure to comply with the sending of daily catch reports, and it was pointed out that whatever means was used to get them to the office, i.e., radio or via their agents, it was their responsibility to ensure that they reached MPSSL by noon each day. On eight days out of the patrol period, the weather conditions were such that boarding was not possible. Winds varied from SSW/SW5 to SSW 6–7, with rough seas and swells of between 2–3 meters, making the safe launch and recovery of the boats impossible. However the number of boardings and interceptions for the passing of instructions are commensurate with the requirement to get a proper level of compliance with the law, and to allow the ship to carry out its other surveillance and allied tasks. Weather, and the problems with the RIB outboards, also prevented the ship from collecting fishing logs from the licensed Soviet vessels within the zone. This was given first priority on sailing on the next voyage. The ship also went to the Sherbro River and carried out a port visit. This allowed the embarked SSO to talk to the local fishermen and investigate allegations of fishing in the river by industrial trawlers. None of the fishermen spoke to substantiate.

The most notable feature of August was the weather. The month saw continuous SW and SSW winds of force 5–7, and occasionally gale force 8, accompanied by confused oceanic swells of 2–3 meters in height, and torrential rain. Towards the end of the month, a marked improvement set in. The areas covered by *Maritime Protector* were the major fishing areas, the edge of the continental shelf, and both the southern inshore and northern border areas. Despite the weather, twelve boardings were carried out, the majority at the start of the first patrol, when six Soviet vessels were boarded for collection of logbooks. Also during this patrol, the Korean trawler *Puk Yang 6*, which had fished into Sierra Leone waters from Guinea, was intercepted and escorted out of the zone, and the Russian shrimper *Beem 18*, a joint Nigerian/Soviet vessel, was boarded in the southern IEZ in XKAX by the embarked SSO on 10 August. This vessel was fishing in company with a sister shrimp vessel, and on boarding it was established that they were in a position inside the Sierra Leone EEZ. The position was not disputed by the Russian skipper, but the given position of the Sierra Leone/Liberian border was, the Soviet chart having it inked in some 10 miles northwest of the actual position. It was decided by the SSO that it was a genuine error, and bearing in mind the current situation *vis à vis* Sierra Leone and Liberia, it was decided to let the vessel go after verbally warning the Captain. The correct position was drawn on their charts, and a map showing the Sierra Leone EEZ was left on board. The vessel promised to advise the others of the correct location of the border, and two subsequent visits to the area have shown the point to have been taken.

The next patrol covered the period 31 August to 8 September, and saw the *Protector* involved in a salvage operation. During the hours of darkness on the evening of 31 August, the patrol vessel anchored to the north of the Banana Islands. Shortly after dropping anchor, the FPV was contacted on the VHF by a vessel named *Semaneh*, broken down with no power, little food or water, with over one hundred refugees from Liberia onboard. As the vessel was

in no immediate danger (weather SW3, low swell and rain), the Master and SSO decided not to close in darkness, and *Semaneh* was advised by radio that on acceptance of Lloyd's Open Form by her Master, she would be closed and taken in tow at first light. This was done, and *Maritime Protector* towed the vessel, a small shrimp trawler which is the property of the Sierra Leone Government, to Freetown, handing her over the harbor authorities in mid afternoon. *Protector* then left Freetown and resumed patrol at 1700. During the patrol, the *Leninskiy Put* was boarded and Soviet purse seine logbooks recovered for returning to Freetown for analysis.

On 2 September, the vessel *Iberia No. 1*, which holds a line fishing canoe support vessel license, was closed off Cape Sierra because of suspicion that it was about to transship at sea. Two small shrimp vessels were approaching it, but on the patrol vessel's arrival, they altered course and headed west, out to sea. The *Iberia No. 1* hailed her Master by radio to ask his intentions. He declared that he would be anchoring 10 miles off Cape Sierra, and the patrol vessel sailed in company with him. Both vessels remained at anchor overnight, and the *Iberia No. 1* was followed by the *Protector* in the morning to ensure she went to Freetown. *Protector* then left for the Sherbro/Turner's Peninsula area, and then anchored close to the Banana Islands, prior to running up the Sherbro River. On 6 September one RIB went to Bonthe, on Sherbro Island, and much local knowledge was gained. It was ascertained that large vessels would be unlikely to go up river beyond Bonthe or York, and that the army regularly patrolled the area, and had seen no sign of shipping activity.

The second patrol commenced on the 15th of the month, and was extended by a day ending on the 28th. The weather was particularly bad, and only allowed two boardings. Despite that, a large area was covered including all the major fishing grounds, the Guinean border, Liberian border, and the edge of the continental shelf. On the 17th, information regarding the position of a Canarian Reefer, to which *Sekiby I* and *Codalin I* were due to transship to and for which a transshipment license had not been applied for, was established in the vicinity of Yeliboya. *Protector* sailed from Banana Islands to the position (08°53'N 13°30'W) and anchored close to this position overnight. *Sea Horse I* came to the reefer circa 2000 in the evening and took stores and bunkers, but no other vessels approached, although *Sekiby I* and *Codalin I* were sighted before dark fishing in the vicinity. The reefer weighed anchor at 0815 in the morning, and sailed SW, shadowed by the *Protector*. The reefer re–anchored at 1030 in position 08°N' and 13°35'W, and remained there until shortly after seven o'clock the following morning. On getting underway, she proceeded to Freetown. Later that day a transshipping license was applied for and paid by Okeky, and transshipment of some 28 t of shrimp from *Codalin I* and *Sekiby I* took place. A successful early morning inshore operation in response to complaints by local fishermen took place off Cape Sierra/False Cape between the harbor RIB, the ship, and shore staff. No offenders were caught, but it proved that a coordinated operation with all the necessary safety and communications links can take place and work properly, even in marginal conditions of weather and sea state. The patrol continued and included sightings of the two line fishing canoe support vessels. Towards the end of the patrol *Min Fei 4* was boarded and the quantity of fish onboard checked against the quantity recorded against the daily reports. This was within the accepted limited allowed and the vessel was allowed to proceed. The final boarding was of the Soviet processing vessel *Leninsky Put*.

The second patrol commenced on 15 September and ended on the 24th of the month. The vessel also had an extended stay ashore, taken to paint the hull and carry out upper deck maintenance. On the 16th of the month, a Greek shrimp vessel *Junior 7* was boarded for fishing without a license, and escorted to Freetown. On Thursday the 19th the *Protector* was back in the southern area near the Liberian border, and a second trawler, the Panamanian vessel *Isla Lanzarotte* was boarded and detained for fishing in Sierra Leone waters without a license. This vessel subsequently sailed from Freetown whilst under a detention order on the evening of 23rd, and is presently the subject of further investigations by the Sierra Leone authorities. Later in the patrol, six shrimpers were boarded for catch inspections and issuance of new pattern shrimp logbooks.

It can be seen from Table 1 that boardings are carried out regularly, and are performed under the requirements to maintain contact with the fishermen, obtain compliance with the law, and avoid any suggestions of harassment of any particular section of the community. Needless to say, however, those who have continually flouted the rules have had more visits and inspections than the rest who wish to be left in peace to get on with the business of fishing and earning a living. Many of the boardings carried out here include inspections of the fish holds, because of the need to continually monitor catch rates for both scientific and financial reasons, and these can take between an hour and a half to two hours per vessel. In addition, vessels are often closed by the patrol vessel for instructions to be passed by radio, in situations where boardings are not deemed necessary. Finally, a few words about transshipments. Prior to the new controls, fishing vessels transshipped their catches either at sea or within Freetown harbor with little or no monitoring. The introduction of royalties levied on all fish transshipped within the Sierra Leone EEZ encouraged vessels to avoid inspection by transshipping in places other than Freetown. Even if they abide by the terms of their fishing licenses and transship in Freetown, there is the incentive to falsify logs and records. Therefore the surveillance of the fishing zone will be an essential feature to ensure that vessels wishing to transship, only carry out the procedure in Freetown. Even so, the Harbor Control Officer (HCO) will have to be alert to various attempts to either avoid or reduce royalty payments.

Table 1. Summary of Boardings and Arrests, January–October 1991.

	Boarding	Arrest
January	6	2
February	17	0
March	12	1
April	14	2
May	12	1
June	15	4
July	9	3
August	14	0
September	10	3
October (Up to 10th)	4	0
Total	113	16

The objective of the monitoring is to establish the quantities of fish, by species, that are being either transshipped or loaded. These quantities

should be itemized in the fishing vessel log sheets, which the HCO team will have to validate during discharge. The harbor inspection team can of course adopt blanket covering and monitor every operation from beginning to end. Clearly such a policy would require a large staff, and would be costly. Therefore a compromise has to be made by employing a system of spot checks. This entails a team monitoring an operation by weighing sample boxes as well as inspecting the contents of boxes to ensure that they contain the species stated. Identification of species can be gained by experience. Establishing the weight however, can only be achieved using scales and oftentimes these are not available onboard the vessel. If it appears that the boxes contain species other than stated, the discharge operation may be stopped and the skipper of the fishing vessel invited to put matters in order to the satisfaction of the HCO. It is not for the inspection team to sort out the problem. It is the responsibility of the skipper/agent to ensure the paperwork matches the commodity being discharged. Once matters have been rectified, the Skipper/ Agent can request to resume transshipping. Naturally the HCO will satisfy himself that the log sheet does reflect the species and quantities to be discharged before he allows operations to be resumed. Transshipment operations vary according to their location and the nationality of the vessels. The common factor to them all is that it is intended to be profit–making for the fishing boat and reefer. Consequently any delay will incur financial penalty to fishing vessel, agent, and reefer. Any stoppage caused by malpractice can hurt financially.

The Small Pelagic and Demersal Fish Stocks of Sierra Leone[1]

D.E.B. Chaytor and E.T. Ndomahina

Institute of Marine Biology and Oceanography (IMBO), Freetown, Sierra Leone

Abstract

This paper examines the nature of the marine resource stocks in Sierra Leone, including pelagic, demersal, and invertebrate communities. It also considers developments in the fishery, catch and effort data, and the changes in the fishery resulting from increased fishing pressure and hydro-meteorological variation. Assessments of the potential yield and sustainability of the stocks, given current data, are also made.

Introduction

The Sierra Leone fisheries are multispecies and thus are characterized by many variations not found in the mostly single–species fisheries of higher latitudes. Stock sizes of individual species often vary markedly while the total biomass remains roughly the same. The most recent example of this is the rise and decline of the stocks of grey triggerfish (*Balistes capriscus*) in the last two decades. The bathymetric distribution and migratory behavior can also show variations in biomass of individual species. Round sardinella (*Sardinella aurita*), which migrates between Guinean and Sierra Leone waters like the grey triggerfish, will show a lower biomass estimate in the dry season than in the rainy season. The situation is compounded by the fact that round sardinella aggregations are associated with the upwelling zones and follow these rich waters as they move close to or further off the coast. Furthermore, the aggregations may move with changes in salinity gradients and precipitation as well as with variations in water temperatures. Post–spawning round sardinella have been found to form aggregations close to the bottom and have been taken in bottom trawls. It is clear therefore that no single factor can explain the variations in stocks of these species. Pelagic species are characterized by greater mobility, considerable seasonal and diurnal migrations and the ability of the aggregations to form and disperse very rapidly. The demersal stocks, on the other hand, are less mobile, less given to long migrations and are more commonly associated with the same locations. The species composition has remained stable over the years and even though the species are more vulnerable to fishing, the biomass estimates have been fairly constant. The production levels have risen steadily over the years, reaching a peak of 239,230 tonnes in 1987 and stabilizing around 230,000 tonnes in 1989–1991. This paper examines the nature of the stocks, the recent development of the fishery, catch and effort data, and the changes in the fishery resulting from increased fishing pressure and hydro-meteorological variation. An assessment of the sustainability of the stocks is also made.

The difficulty of arriving at precise measures of stock sizes and trends is evident from the wide variations in estimates obtained from various synoptic surveys. It also arises from the paucity and patchiness of the biological information that should support catch and effort statistics as well as biomass and stock density estimates. The picture is gradually being filled in, however, and it should soon be possible to see it more clearly for management purposes.

The Nature of the Resource

The marine fishery resources of Sierra Leone can be classified into two broad categories: pelagic and demersal stocks (Longhurst 1963). The classification scheme itself has been modified several times to include other details based on the biology and the physico-chemical environment (Longhurst 1969; Fager and Longhurst 1968; Longhurst and Pauly 1987; Williams 1968, 1969). The stocks can therefore be classified into three categories from both biological and management points of view: a) pelagic, b) demersal, and c) crustacean and mollusc. In an analysis of the total catch statistics using the largest fishing company, Sierra Fishing Company (SFC), as a standard between 1983–1986, Coutin (1989) estimated the contribution of the various categories of fish stocks as follows: 45–55% consisted of the small pelagic, 30–40% demersal species, 10–14% semi–pelagic, 3% large pelagic and 21% shrimps. The total contribution of the small pelagic and demersal species accounts, on the average, for 70—90%.

Pelagic fish stocks

Pelagic fish stocks consist of the true pelagic and a largely loose category often referred to as semi–pelagic (Ssentengo and Ansa–Emmim 1986; Coutin 1989). The true pelagic in turn can be divided into inshore and offshore communities. The inshore community consists of mostly euryhaline, shallow–water, migratory species whose biology is closely related to the fluctuations in the events within the estuary and nearshore. In this category are the clupeids, with bonga shad (*Ethmalosa fimbriata*), Madeiran sardinella (*Sardinella maderensis*), crevalle

1 Cite as: Chaytor DEB and Ndomahina ET (2012) The small pelagic and demersal fish stocks of Sierra Leone. pp. 28-37. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

jack (*Caranx hippos*), Senegal jack (*Caranx senegallus*), West African Spanish mackerel (*Scomberomorus tritor*), and bonefish (*Albula goreensis*), among the most important species. The inshore pelagic species are landed more frequently by the artisanal fishery.

The offshore pelagic community consists mostly of species associated with three types of hydrographic regimes. European anchovy (*Engraulis encrasicolus*), yellowtail sardinella (*Sardinella rouxi*) and *Trachurus* spp. are found below the thermocline in colder waters. Large pelagic species are found associated with upwelling zones and these include: Atlantic sailfish (*Istiophorus albicans*), swordfish (*Xiphius gladius*), yellowfin (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), little tunny (*Euthynnus alletteratus*) and frigate tuna (*Auxis thazard*).

The semi–pelagic species are taken mostly by midwater and demersal trawls. The species are associated with regions of high zooplankton productivity (Coutin 1989). These species include: bigeye grunt (*Brachydeuterus auritus*), grey triggerfish (*Balistes capriscus*), bogue (*Boops boops*), and Atlantic bigeye (*Priacanthus arenatus*).

Demersal fish stock

Longhurst (1963, 1969) presented the guideline for the identification and classification of demersal species assemblages in West Africa. Demersal fish stocks are normally classified according to their relationship with the thermocline and nature of the bottom deposits. Sharp faunal discontinuities occur off the coast of Africa, caused by cold currents to the north, and to the south by the upwelling region. Like most parts of the Gulf of Guinea, the thermocline in Sierra Leone fluctuates between 20–35 m and in some areas as shallow as 12–14 m.

Sciaenid Community

The members of this assemblage live above the thermocline, on shallow muddy bottoms. Although some 60–80 species have been identified as belonging to this community, approximately 20 species are dominant, including: bobo croaker (*Pseudotolithus elongatus*), longneck croaker (*P. typus*), cassava croaker (*P. senegalensis*), law croaker (*P. brachygnathus*), African sicklefish (*Drepane africana*), Senegalese tonguesole (*Cynoglossus gorensis*), sompat grunt (*Pomadasys jubelini*), giant African threadfin (*Polydactylus quadrifilis*), royal threadfin (*Pentanemus guinguarius*), rough—head sea catfish (*Arius latiscutatus*), daisy stingray (*Dasyatis margarita*) and boe drum (*Pteroscion peli*). Although there has been further classification into inshore and offshore communities, the members of these communities tend to interact freely, and are characterized by the dominance of either bobo croaker for estuarine communities or cassava croaker for the continental shelf or offshore community. Eurybathic species include bigeye grunt (*Brachydeuterus auritus*), canary tonguesole (*Cynoglossus canariensis*) and Guinea flathead (*Platycephalus gruveli*).

Sparid Community

The fisheries of the Sparidae family normally inhabit the regions below the thermocline on sandy and rock bottoms. There are three sub–divisions of the sparid community, which may differ not only in faunistic distribution and substratum characteristics (Longhurst 1969), but also in terms of physicochemical properties of the overlying water (Williams 1968). The lutjanid sub–community are dominated by species such as the Atlantic emperor (*Lethrinus atlanticus*), grey triggerfish (*Balistes capriscus*), African red snapper (*Lutjanus agennes*), *Acanthurus* spp., and the four-banded butterflyfish (*Chaetodon hoefleri*). The dominant species may include: bluespotted seabream (*Sparus caeruleostictur*), red pandora (*Pagellus bellotti*), Canary dentex (*Dentex canariensis*), and the brown ray (*Raja miraletus*). The deep sparid community consists of species living in the deep water below the thermocline on the muddy bottom near the continental edge. The dominant genera are *Dentex, Lepidotrigla*, *Uranoscopus* and *Pentheroscion*.

Deep Shelf Community

The deep community refers to demersal species towards the edge of the continental shelf at depths of 200–300 m. The dominant genera are the *Merluccius, Chlorophthalmus, Peristedion, Bembrops and Antigonia*.

Continental Slope Community

Genera such as *Chaunax*, *Halosaurus*, *Epigonus*, and *Galeus* are found below 400 m on the continental shelf within temperature ranges of 8.15–15.7°C and salinities of 33.73–35.86 psu.

Crustacean and mollusc

Shrimp

Of the six shrimp species of commercial importance, pink shrimp (*Farfantepenaeus notialis*) accounts for about 96% of the landings. Tiger shrimp (*Melicertus kerathurus*) and Guinea shrimp (*Holthuispenaeopsis atlantica*) inhabit mangrove swamps, estuaries, and inshore continental shelves to a depth of 55 m. Deep—water rose shrimp

(*Parapenaeus longirostris*) occurs in deeper waters of 40–70 m (Okera and Chaytor 1978). Red shrimp (*Aristeus antennatus*) and great red shrimp (*Aristaeopsis edwardsiana*) occur above the continental slope (Domanevsky *et al.* 1985; Coutin 1989).

Cuttlefish and squid

The two species of cuttlefish, the common cuttlefish (*Sepia officinalis*) and African cuttlefish (*Sepia bertheloti*) are found in the north and south of the territorial waters on coarse ground at depths of 17–78 m. There are four squid species: diamond squid (*Thysanoteuthis rhombus*) and the lesser flying squid (*Todaropsis eblanae*) are demersal below 100 m (Domanevsky *et al.* 1985; Coutin 1989).

Data Acquisition and the Development of the Fishery

Small pelagic

The small pelagic stocks are exploited by both the artisanal and industrial fishery. Bonga shad (*Ethmalosa fimbriata*), West African ilisha (*Ilisha africana*) and Madeiran sardinella are part of the inshore pelagic community and are therefore exploited largely by the artisanal fishermen. Madeiran sardinella are also exploited by bait boats and shrimpers operating close to the coast. Round sardinella are part of an offshore community and are taken mostly by purse seiners of the industrial fleet. Anyangwa 1991 has done an ecological study of these clupeids and has described their pattern of exploitation. Ssentengo and Ansa–Emmim (1986) give a breakdown for landings of the artisanal sector. The earlier estimates of the total catch, number of fishermen, or number of canoes in the 1960s were not based on any systematic, frame surveys, thereby making it difficult to obtain an idea of both fleet and gear composition (Longhurst 1960).

Ghanaian fishermen introduced larger boats, large ring nets and gillnets into the artisanal fishery of Sierra Leone in the late 1950s and early 1960s, thus intensifying the exploitation of clupeids. Between 1963 and 1966 the number of fishermen was estimated to be 11,000 and 16,000 respectively with a total catch of about 24,000 tonnes. Three important frame surveys (1974, 1980 and 1990) have taken place, thus throwing considerable light on the trends in the artisanal fishery (Tables 1 and 2). The catch statistics of the small pelagic stocks and the results of the three frame surveys indicate that, apart from the dramatic increase in both the number of fishermen and the boats in the 1960s, the numbers have stabilized from 1974 through early 1990. It is extremely difficult to calculate the fishing effort and indeed the catch per unit effort (CPUE) of the small pelagic fishery, because of the diversity of both gear and craft. There was also an increase in motorization in the 1970s that could have greatly increased the total landings. Although there was an increase in motorized boats in the 1980s, there has been no increase in the landings of *Sardinella* spp. and bonga shad. The scarcity of fuel from the 1980s to the present time renders motorization difficult, and there is even the possibility of a drop in the fishing effort.

Table 1. Summary of the results of the Frame Survey in the artisanal sector

Fishermen	Northern Area	Western Area	Southern Area	Total
1974*				
Total	8,014	4,921	4,842	17,777
Full–time	6,812	4,217	4,324	15,353
Part–time	1,202	704	518	2,424
1981				
Total	6,309	3,616	8,040	17,965
Full–time	5,194	3,120	7,267	15,581
Part–time	1,115	496	773	2,384
1990				
Total	4,552	5,842	8,188	18,582
Full–time	3,390	4,963	7,224	16,177
Part–time	562	879	964	2,405

* Estimated value

The collapse of the sardinella stocks in Côte d'Ivoire in 1973 led to the influx of the inshore purse seiners to Sierra Leone. The discovery of shrimp stocks in 1969 and the collapse of the sardinella stocks in Senegal attracted the fleet to Sierra Leone (CECAF 1978, 1980, 1983). By that time, Sierra Leone had signed a bilateral fishing agreement with the Soviet Union in 1976. The Soviet fleet, including shrimpers, trawlers and purse seiners, became operational through the Sierra Fishing Company.

Under pressure and intense competition from the foreign mechanized fleet, the small–scale fishery showed a decline in their contribution of sardinella but increased its bonga shad landings.

Demersal stock

Apart from the limited amount of inshore demersal species landed by the artisanal sector, the fishing of demersal species has been dominated by the industrial sector since the 1950s. Watts (1962) and Turner and Hudson (1966) documented and analyzed the development of the industrial fishery in the 1950s and 1960s. By 1962 five companies operating 13 demersal wooden fish trawlers of Italian origin had been firmly established in Freetown. Because of the restrictions imposed on fishing activity in Yawri Bay and the lack of maintenance facilities, the role of companies in the 1970s became increasingly restricted to providing storage and processing facilities for foreign vessels.

In addition to the five original fishing companies (Joint Venture Enterprises Ltd., Joint Stock Fishing Company,

Mesurado Group, Shrimp Export Ltd. and Marine Development Company), Sierra Fishing Company acquired an impressive number of Soviet Vessels (45) by late 1970s. Shrimp had also become very important as a foreign–exchange earner in the 1970s and 1980s. Three smaller companies had also been established operating foreign vessels. In this atmosphere, a large number of vessels of practically any description and of diverse origins were now in operation. There were trawlers, purse seiners and shrimpers from Ivory Coast, Senegal, Soviet Union, Japan, Korea, Spain, etc.

Table 2. The distribution of boat categories in the Frame Survey (Modified from Williams 1991)

Boat Type	Northern	Western	Southern	Total
1974				
Kru	96	62	76	234
Std. 3–5	384	138	22	544
Std. 1–3	1,821	1,281	1,995	5,097
Ghana	120	69	86	275
Total	2,421	1,550	2,179	6,150
1981				
Kru	68	207	78	353
Std. 1–3	1,229	590	3,207	5,026
Std. 3–5	541	292	492	1,325
Ghana	38	126	120	284
Benefit	-	13	-	13
Other	73	-	14	87
Engine	343	221	113	677
Total	1,949	1,288	3,913	7,150
1990				
Kru	107	351	606	1,064
Std. 1–3	737	525	2,371	3,633
Std. 3–5	260	389	374	1,023
Ghana	45	127	31	203
Other	54	3	13	70
Engine	141	210	52	403
Total	1,344	1,605	3,447	6,396

'Std. 1-3' means 'standard 1-3 man canoe'; 'Std. 3-5' means 'standard 3-5 man canoe'

Standardization of Effort

Standardization of effort in the artisanal sector has never been comprehensively undertaken. There are a wide variety of gears employed by different categories of boats. An example is presented in Table 3. In addition, different types of gear may be employed by the same boat category (Williams 1991). Linsenmayer (1974), Coutin (1989) and Nieland (1982) have undertaken catch/effort analyses, and a similar unit of effort was used by Brainerd (1978) for the Tombo and Goderich canoe fishery. Round sardinella is exploited by both purse seiners and canoes and effort units are expressed in number of sets, number of days fished, and days at sea.

The number of vessels registered could either be obtained or estimated from data compiled by the Fisheries Division (Table 4). Similarly, simple catch statistics of demersal fish stocks can be obtained from published sources. However, to be able to observe trends in the fishery, estimates must be obtained of effort, CPUE, and where possible, distribution of effort. In addition, there are often seasonal fluctuations in catch rates. Details relating to vessel and gear characteristics (Gross tonnage, engine power, type of gear, mesh sizes and time spent fishing) are often required. Tables 4 and 5 refer to the number of vessels registered between 1980 and 1987 and the number of trawlers registered between 1969 and 1986. These results were both compiled and estimated from government documents by Coutin (1989) and upgraded in this work. Between 1980 and 1982 some 51–78% of all registered vessels were trawlers. There was a drop of between 35–42% in the period 1983–1986. There was an increase in the number of both the purse seiners and the shrimpers. There is a diversity of vessels (trawlers, liners, purse seiners, shrimper) exploiting the coastal resources.

Demersal stocks are exploited mainly by trawlers, liners and shrimpers (through bycatch). Fundamental differences often occur among trawlers with respect to gross registered tonnage (GRT), engine power (hp), types and sizes of gear employed, depth at which the fish are caught, number of hours actually spent fishing, fish–finding equipment, and skill of the crew. The same category of trawlers may operate different gears at different times on different fishing grounds. Different companies often present very different types of details to the Fisheries Division of the Ministry of Agriculture, Forestry and Fisheries (MAFFS). It is therefore extremely difficult to standardize effort in the coastal waters of Sierra Leone. Vessel characteristics could enable better effort calculations for certain types of vessels at different times. Tables 6 and 7 provide examples of vessel characteristics of six Italian trawlers (1962–1966) and a category of Soviet vessels (1980–1986).

Soviet trawlers have been fishing in Sierra Leone since the 1970s. The data presented have proved more reliable than any other group with the exception of the Italian trawlers. It is against this background that Coutin (1989) was able to standardize the fishing effort using the SFC's original logbooks. The Soviet fleet also used a wide range of fishing gear for different target species (Table 8).

Table 3. Gears used by various types of artisanal fishing vessels in the Western Area (expressed as a percent of total number of gears recorded).

	Ring net		Drift net		Beach seine	Cast net	Longline
	Encirc.	Purse	Bottom	Surface			
Kru	2.7	2.7	16.2	-	2.7	73.0	-
Std. 1–3 man	1.3	0.6	45.9	35.2	1.2	2.5	13.2
Std. 3–5 man	5.7	1.4	24.8	29.1	14.9	0.7	12.8
Ghana	30.3	5.9	11.0	0.8	11.0	-	0.8
Other	14.4	11.1	22.2	22.2	-	-	-

The effort units varied according to the gear and type of fishing method. Three units of effort were employed in each case for trawlers and purse seiners. The vessels in the SFC were first divided into gross tonnage and engine power and then compared with other trawlers.

Table 4. The number and category of vessels registered in Sierra Leone 1980–1987

Vessel type	1980	1981	1982	1983	1984	1985	1986	1987
Fish trawler	135	96	72	55	59	45	69	130
Shrimper	-	60	25	30	29	31	38	84
Purse seiner	30	15	30	23	14	26	40	59
Tuna seiner	-	-	-	4	-	4	3	-
Longliner	3	3	5	4	4	6	2	8
Mothership	5	3	7	16	7	12	10	13
Carrier	0	6	1	-	-	-	-	14
Total	173	183	140	132	113	124	168	308

Catch and CPUE

Sierra Leone has a shelf that is 100 km wide in the north, tapering to 13 km in the south, and whose total area is 29,900 km². The artisanal fisheries operate more or less in the inshore coastal areas. Both bonga shad and West African ilisha and are taken in beach seines and are found mostly in shallow and estuarine areas all along the coast. Juvenile Madeiran sardinella occur near the coast and migrate offshore into deeper waters as they grow older. They are exploited by both the industrial and artisanal sector. Madeiran sardinella are recruited into the artisanal ring net fishery at 10 cm (SL) to 10.5 cm (SL). Round sardinella is an offshore species exploited by the industrial sector. Recruitment into the industrial fishery is at 6 cm (SL) in November (Boëly 1982; Boëly and Elwertowski 1970; Djama *et al.* 1989; Anyangwa 1991).

The traditional fishing grounds for demersal fish stocks are the grounds off Yeliboya, Sierra Leone River, Sussex, York, Banana, Shenge and Sulima. The offshore fleet can operate close to the edge of the shelf and beyond. The catch composition of the major species varies from one fishing ground to the other. There may also be variations with depths. Seasonal variations also occur. The catch statistics presented in the government reports are often merely summaries and are presented in the form shown in Table 9 for details. Original logbooks are often required. Details are also presented in fisheries reports. Catch statistics such as those presented in Table 10 are not always available. Landings from the artisanal sector are dominated by bonga shad and Madeiran sardinella. There has been a steady decline in catch from a peak of about 62,000 tonnes in 1975 to a stabilized level of about 40,000–45,000 tonnes. Between 1984 and 1990, there has been a steady increase in total artisanal landings (Table 9). From the results of the frame surveys, there has been no significant increase in number of boats and of fishermen. In the artisanal sector, therefore, the CPUE–though difficult to estimate–seems to increase with motorization of boats as well as heightened surveillance of the coastal waters, which compels trawlers to operate outside the 5–mile exclusion zone reserved for the artisanal fishery.

Table 5. Number of trawlers registered in Sierra Leone (1969—1987) (SourceGovernment Fisheries Division)

Year	No. of Vessel	Year	No. of Vessel	Year	No. of Vessel
1958	7	1968	17*	1978	62
1959	18	1969	16*	1979	29
1960	18	1970	12*	1980	36
1961	13	1971	18*	1981	96
1962	13	1972	18*	1982	72
1963	14	1973	23*	1983	55
1964	10	1974	22*	1984	59
1965	10	1975	24*	1985	45
1966	22	1976	23*	1986	69
1967	13*	1977	36*	1987	130

* Estimated by Coutin (1989) from CECAF sources.

A comprehensive analysis of CPUE in the artisanal fishery is not available. Nieland's analysis only covers the period 1980 and 1981 (CECAF 1983). The Tombo and Northwest Fisheries Project are expected to provide more accurate measures of CPUE in the artisanal sector, in order to facilitate long–term projections. The artisanal sector has increased its contribution on bonga shad, but has decreased its landings of *Sardinella* (Table 10). The latter is being landed increasingly by the industrial sector from catches by purse seiners. The increase in the numbers of purse seiners in the industrial fleet is an indication of an increase in effort on the *Sardinella* stocks by the industrial fleet. The demersal trawl fishery provides us with a more complete picture of the trends in catch and the CPUE. Table 11 presents an analysis of catch and CPUE in the demersal trawl fishery from 1958 to 1986 (Coutin 1989). The CPUE has been presented in tonnes·day^{-1} and in kilograms·horsepower^{-1}·day^{-1}. The latter incorporates fishing power. The trend is certainly not clear and the parity of data 1979–1982 obscures the trend. The CPUE (kg·hp^{-1}·day^{-1}) clearly demonstrates a declining tendency when the periods of the 1960s and 1980s are compared.

Table 6. Vessel characteristics of Italian trawlers.

Name of vessel	Length (m)	Size (GRT)	Engine Power (hp)
Patristica	18.9	44	170
Lucia Anoroso	24.0	67	200
Ombrina Verde	22.8	57	150
Colegero	24.9	88	200
Nuovo Eliseo	19.8	55	-
Domenico Paolo	19.9	52	-

Table 7. Vessel characteristics of Soviet trawlers (1980–1986)

Class type of vessel	No. of vessel	Length (m)	Size (GRT)	Engine Power (hp)
BMRT super trawler	28	84	3,012	4,000
SRTM freezer trawler	66	55	1,704	1,000
MRTM side trawler	57	32	183	300
SRT purse seiner	132	34	164	395
SST tuna seiner	5	54	741	1,320
Carrier	12	131	5,525	5,500

The CPUE is an index of abundance and should identify trends in the demersal trawl fishery. The demersal trawl fishery is characterized by variations in distribution of the major species both horizontally and vertically (spatial distribution). There is also a seasonal variation in species composition (Longhurst 1963; Williams 1968; AtlantNIRO Report 1988; Coutin 1989). Coutin (1989) carefully analyzed the seasonal variation in the catch rates (CPUE) from 1983 to 1986 and concluded that the whole of the demersal fish stocks were on the decline.

The catch rates for trawlers were also estimated as follows:

15–12 kilograms·horsepower^{-1}·day^{-1} in the 1950's
9–7 kilograms·horsepower^{-1}·day^{-1} in the 1960's
8–4 kilograms·horsepower^{-1}·day^{-1} in the 1970's

Table 8. Fishing gears of Soviet vessels (CECAF 1983).

Class	Vessel	Target species	Gear Length	Net opening vertical	Net opening horizontal
SRTR/SRTM	Stern trawler	Demersal fish	-	4–6 m	18–22 m
MRT/MRTM	Side trawler	Demersal fish	-	-	-
BMRT/RTMT	Super trawler	Multispecies	-	30–34 m	60 m
SRTR/SRT/RS	Purse seiner	Pelagic	480–780 m	140–200 m	-

The Decline of the Stocks

Because of the problems related to the reliability of data, especially in a developing country such as Sierra Leone, any conclusion that the stock is declining must be treated with caution. A multispecies, multigear fishery that was never planned to provide information that could be subjected to rigors of modern day analysis can hardly yield valuable information stretching over several years.

Abundance (B) is related to the CPUE (U) by the relationship:
$B = 1/q \cdot U$ ...1)
where q is assumed constant.

Any trend leading to a decline must be viewed with concern. Any decline in demersal stocks would be due to an increase in inshore trawling activities as well as an increase in the activity of the shrimpers close to the coast. In addition, there has been a corresponding decrease in mesh size from the mandatory 55 mm. The results of surveys (acoustic and trawl) have often been cited as indices of stock abundance. The results of some surveys on the biomass estimates are presented in Table 12. It becomes immediately clear that the estimates vary widely from year and from place to place. There are also differences with both season and depth. Strømme (1984) concluded that a 73% decrease in the biomass of pelagic stocks had taken place. There are however no signs of decline up to now[2].

Table 9. Fishery production (in tonnes), 1971–1990

Year	Industrial fish catch	Artisanal catch	Shrimp catch	Total catch
1971	7,836	22,764	735	30,600
1972	7,881	43,129	894	51,010
1973	14,031	52,669	614	66,700
1974	8,283	59,456	823	67,739
1975	6,652	61,945	168	68,597
1976	19,022	50,275	456	69,297
1977	33,361	46,772	410	80,133
1978	75,865	41,881	606	117,746
1979	122,168	45,166	313	167,334
1980	122,862	31,554	313	154,416
1981	122,862	31,554	642	154,416
1982	100,820	34,616	880	135,436
1983	78,824	47,274	1,196	126,098
1984	135,044	43,272	2,304	178,316
1985	153,620	43,700	2,450	197,320
1986	154,760	44,100	1,940	198,860
1987	182,100	44,500	2,630	226,600
1988	173,550	46,350	2,750	219,900
1989	181,650	48,200	2,870	229,850
1990	177,000	50,000	3,000	227,000

Potential Catch, Estimated Landings, and Changes in the Fishery

Acoustic methods of biomass estimates are often easy to obtain and under normal conditions should provide an index of relative abundance. For more accurate measurement, the traditional trawl surveys are usually more reliable. Coutin (1989) used the swept area method to calculate the biomass of demersal stocks. Depth and general distribution were taken into consideration, as well as seasonal variations. For the pelagic species, acoustic methods were considered sufficiently accurate (Table 10).

The calculations of potential catch are based on two basic expressions of Gulland's model (Gulland 1971, 1983, 1988; Pauly 1980):

$Y_{max} = 0.5 * M * B$ (unexploited) ...2)
$Y_{max} = 0.5 * Z * B$ (exploited) ...3)

2 Editors' note: in pelagic fisheries, the assumption that q is constant (equation 1) is known to be invalid, and that q usually increases when biomass decreases. Thus, a decrease in biomass would be only imperfectly reflected in the CPUE of the fishery.

where Y_{max} = potential catch;
Z = total mortality coefficient;
M = natural mortality coefficient;
B = unexploited biomass;
B = current biomass estimate.

Table 10. Artisanal pelagic catch 1973–81 (in thousand tonnes)

Specie	1973	1974	1975	1976	1977	1978	1979	1980	1981
Ethmalosa	15.1	15.4	15.3	15.3	19.9	19.6	21.9	16.9	16.1
Sardinella	22.7	23.0	23.8	24.5	10.7	6.9	7.9	8.9	10.6
Total Pelag.	37.8	38.4	39.1	40.4	31.1	29.6	30.9	25.8	27.3
% *Sardinella*	60.0	59.9	60.9	60.9	34.4	23.3	25.5	33.4	38.8

There are two estimates of potential catch available (Domain 1979; Coutin 1989). Domain (1979) set the natural mortality (M) at 0.4 and total mortality (Z) as 0.6·year^{-1}. Coutin (1989) set M and Z at 0.5 and 1.0·year^{-1} respectively. According to the two estimates, the total potential catches for both inshore and offshore stocks were as follows: 45,000 tonnes (Domain 1979) and 35,000 tonnes (Coutin 1989). Because of the uncertainties and the unpredictability of the tropical multispecies stocks, the Coutin estimate is considered more realistic.

With the exception of the pelagic stocks (large and small), all other stocks are already fully exploited (Table 10). However, the above model is defective because multispecies fishery consists of both large predators (piscivores) and small prey fish. A model should also account for various segments of the broad ecological interactions. The differences in vital statistics of different species make it utterly impossible for any given combination of effort and mesh size to fish optimally more than a few species at a time, while most species are either overfished or underexploited. With increasing fishing pressure, changes in species composition occur over a period of time. Longhurst (1983) analyzed the exploitation levels of some commercially important inshore demersal species. The calculations were based on combinations of mesh sizes, longevity, and length at first capture. Comparisons were also made of the changes in the parameters over a period of time (1950s, 1960s and 1980). Pelagic, semi–pelagic and offshore demersal were also considered. The choice appears to have been influenced by both the distribution pattern and the position occupied by different categories at certain trophic levels. The initial increase in fishing pressure in the inshore region led to the removal of the large predators (bobo croaker, longneck croaker, cassava croaker). The African sicklefish, because of its larger size, suffered a higher differential mortality than the lesser African threadfin (*Galeoides* spp.). In addition, the removal of African sicklefish reduced the competition for food with the lesser African threadfin, with a corresponding increase in the lesser African threadfin population. Anyangwa (1988) estimated the population parameters of round sardinella, which have also been investigated by other authors including Gerlotto (1979) and Boëly (1982). The increase in the fishing effort of the large pelagic species has led to the removal of the natural predators of the small pelagic species. This has resulted in an immediate increase in the clupeid population, which may persist until a new equilibrium level is achieved.

Table 11. Catch, effort and CPUE of the demersal trawl fishery

Year	Catch (t)	Effort (fishing day)	Effort (no. of boat)	CPUE (t/day)	CPUE (kg/hp/day)
1960	2,019	1,816	10	1.135	8.64
1961	1,962	1,745	13	1.136	9.29
1962	3,134	2,510	13	1.243	9.04
1963	3,845	3,168	14	1.214	8.39
1964	2,365	2,149	10	1.103	7.44
1965	1,492	1,366	10	1.010	6.38
1966	6,476	3,565	11	1.331	9.17
1967	5,814	2,385	5	1.600	-
1968	5,097	2,506	8	1.412	-
1969	7,050	3,135	16	2.124	-
1970	5,544	2,735	12	1.692	-
1971	6,509	3,389	18	1.593	-
1972	6,601	3,535	18	1.594	-
1973	8,320	4,225	23	1.461	-
1974	11,595	4,325	22	1.937	-
1975	8,939	4,134	21	2.251	-
1976	10,418	4,708	22	1.927	-
1977	12,458	7,571	36	2.702	-
1978	21,056	12,858	62	3.181	-
1979	28,925	6,429	32	-	-
1980	61,554	7,870	32	-	-
1981	44,767	10,772	54	-	-
1982	26,808	7,674	40	2.770	6.68
1983	42,472	7,391	36	3.820	7.67
1984	36,483	6,677	33	3.337	8.04
1985	41,240	7,643	36	2.837	6.84
1986	36,980	7,253	38	1.849	4.40

Sustainability of the Stock

There are several ways in which a stock can respond to fishing pressure, notably intrinsic biological responses, which may be modified by external factors. Those factors that influence recruitment are the most important in ensuring the continued survival of the stocks. No one factor can serve as the sole agent of the changes affecting recruitment. As pointed out by Legendre and Demers (1984), food availability and predation are proximal factors whereas short–term climatic events are forcing mechanisms that drive the system. Small pelagic stocks consisting of mostly the clupeids spawn continuously throughout the year. There are, however, peak spawning seasons: April and October (Anyangwa 1991) for Madeiran sardinella; May to December (Salzen 1958) for bonga shad; and June, September, October and December (Marcus and Kusemiju 1984) for West African ilisha. Small pelagic species are fast–growing and reach maturity in 1 or 1.5 years depending on the species. They are able to exploit any available resource very quickly. Such stocks cannot easily collapse under moderate fishing

pressures. However, climatic fluctuations greatly influence the changes in the population. As plankton feeders (both phytoplankton and zooplankton), any change in the plankton production resulting from climatic changes would affect the clupeid population. Strong winds, increased rainfall, and drought influence both upwelling and the nutrient load of the coastal waters. Rainfall is reported to have decreased on the average between 1950 to the 1970s. In the 1970s rainfall increased. There have, however, been years of extreme climatic events, such as droughts (1957, 1959, 1963, 1969, 1971, 1973, etc.) It is such pulses of climate events that often affect the fish population. These periods were signified by low upwelling indices and hence low productivity (Aleem 1979).

Pelagic species also show extensive migratory patterns of movement in response to both diet and weather. This is a survival mechanism that can be important in years of abnormal climatic occurrences. Demersal species inhabit the more stable environment of coastal waters. The diversity of species and the complex ecological interactions make it difficult to predict the response of the stocks to increased fishing pressure. However some generalizations on the mechanisms of survival can be made. The inshore members of the sciaenid community (Sciaenidae and Polynemidae) are generalists in their feeding habits, feeding mostly on crustaceans and small fish. In addition, they show extended periods of spawning with maximum peaks in the dry season, November to April (Longhurst 1963; George 1982). The fecundity is also normally high in the sciaenid community. However, fundamental differences exist between the Sciaenidae (bobo croaker, cassava croaker, longneck croaker) and the Polynemidae (lesser African threadfin). The lesser African threadfin is a protrandrous hermaphrodite with a balance of sex ratio indicative of the availability of food (Longhurst 1965). In addition there are extensive spawning periods and high larval survival rates; and age of maturity is lowered to one year under increased pressure. Sparids are versatile carnivores feeding on crustaceans, fish, molluscs, polychaetes, echinoderms and squids, depending on the size and availability of food. Sparids show extended spawning, normally between September and February. Sex reversal among sparids is a common occurrence in response to both fishing pressure and population change.

Table 12. Biomass estimate (tonne) for the Sierra Leone Continental Shelf.

Survey vessel	Date	Composition	Biomass (t)
R.V. Capricorn	Nov/Dec 1978	Balistes	143,000
	March 1979	Engraulis	11,000
		Brachydeuterus	10,000
		Sardinella	6,000
		Decapterus	2,000
		Others	3,000
		Total	175,000
R.V. Dr. Fridtjof Nansen	May/June 1981	Carangidae	175,000
		Sardinella	110,000
		Balistes	83,500
		Others	30,900
		Total	399,400
R.V. Monocrystal	Feb 1982	Carangidae	397,100
		Sardinella	164,000
		Balistes	100,000
		Others	94,300
		Total	755,400
R.V. Monicrystal *R.V. Evrika*	1984	Carangidae	300,000
		Sardinella	100,000
		Balistes	400,000
		Others	200,000
		Total	1,000,000
Atlantida	Mar/April 1987	Carangidae	198,750
		Sardinella	64,360
		Balistes	227,800
		Others	270,000
		Total	760910
Atlantida	29 Nov– 6 Dec 1987	Carangidae	106,619
		Sardinella	140,371
		Others	64,682
		Total	311,672

Rational exploitation of the stocks and proper management strategies are the determining factors in the sustainability of the stocks under the direct control of managers. The proper surveillance and the enforcement of the fishery regulations are a necessary component in the management process. Maritime Protection Service of Sierra Leone Ltd. (MPSSL) was commissioned in 1990 to undertake the surveillance and the enforcement of the fishery regulations (Anon. 1990).

Conclusion

Production appears to have reached its maximum in the industrial and shrimp fisheries. The growth of industrial catches has been dramatic. From 1978–1991, catches doubled from 1978 levels, peaked in 1987 and appear to have stabilized since then. The shrimp catches similarly tripled between 1982 and 1987 and now stands at its peak. It will probably fall in the future. The artisanal production has remained fairly stable after peaking in 1975. With the enforcement of the 5–mile limit, artisanal production should rise even higher in 1991. These enormous increases have been brought by improved fishing technology applied in the industrial sector. Motorization of artisanal fleets seems to have had only a marginal effect on production. However, with the virtual elimination of competition from the industrial fisheries, the artisanal production should show improvement both in tonnage and in size composition. Nevertheless, this expected increase in tonnage is not likely to be large, given the restricted range

and simple technologies employed by the sector.

The trend in total production seems now to be towards stabilization of yield. Even with the protection now enjoyed by the resources resulting from more efficient surveillance and monitoring, the total abundance is not likely to increase very sharply. This due to the fact that the Sierra Leone coastal and shelf waters are not as rich as the upwelling areas to the north. What would be expected, and what is already becoming evident, is an improvement in population structure of individual species, with modal lengths increasing to varying extent. The nature of the resource has not changed substantially for the worse since the 1960s. On the contrary, a cephalopod fishery has developed in recent years following the growth of the shrimp industry. Both are still vibrant, although the 1990 level of shrimp production (3,000 tonnes) suggests that the limit has been reached, if not exceeded already.

The acquisition of data necessary for the development of the fisheries is now becoming a more systematic activity. Before long, this trend should permit the assessment and evaluation of fisheries potential on a continuing basis and with more precision. The state of the stocks has remained fairly stable over the years. Even the stocks of *Sardinella* spp., which appeared to have declined in the early 1980s, returned to high levels in 1989–1990. Only stocks of triggerfish have not completed the cycle of abundance and depletion at present. Nevertheless, the enormous effort applied to the fisheries in recent years would appear to have reached a point of diminishing returns. It would appear that the sustainability of the stocks is likely to be threatened more by the activities of some small-scale fishers employing fine–meshed nets in the nursery areas, than by any other fishing activity of the industrial of artisanal operations. The 1990 Fishery Regulations, demarcating a 5–mile exclusion zone that includes a large area of the shrimping grounds, will probably promote the effective sharing of the shrimp fishery between the industrial and the artisanal sectors. The long–term effect is likely to be that those areas from which trawling is excluded might soon revert to the original virgin state of the 1960s in regard to the shrimp fishery.

References

Aleem, A.A. 1979. Marine microplankton from Sierra Leone. W. Afr. Ind. J. Mar. Sci. 8:291-285.

Anyangwa, T.A. 1988. An investigation of age, growth and mortality of the herring *Sardinella eba*. B.Sc. Thesis (Hons.). University of Sierra Leone, Freetown.

Anyangwa, T.A. 1991. Aspects of the biology and ecology of the family Clupeidae in the coastal waters of Sierra Leone. M.Sc. Thesis. Institute of Marine Biology and Oceanography, Fourah Bay College, University of Sierra Leone, Freetown, Sierra Leone, 126 p.

AtlantNIRO Report. 1988. Report on the result of the joint studies in the Sierra Leone. Kaliningrad, 70 p.

Brainerd, T.R. 1978. Some data on landings of pelagic fish by the artisanal fishermen near Freetown during January-December 1978. Bull. Inst. Mar. Biol. Oceanogr. 3(1):12-26.

Boëly, T. 1982. Étude du cycle sexual de la Sardinella ronde *S. aurita* (Valenciennes 1847) au Sénégal, p. 70-74. In Editions de l'ORSTOM, Bondy, France.

Boëly, T. and J. Elwertowski. 1970. Observations préliminaires sur la pêche d'*Ethmalosa fimbriata* (Bowdich) des eaux Sénégalaise et son aspect biologique, p. 159-188. CIEM Rapp. Proc. Verb.

CECAF. 1978. Report of the *ad hoc* working group on coastal demersal stocks from Mauritania to Liberia. FAO CECAF/ECAF Ser. 78/8, 98 p.

CECAF. 1980. Rapport du deuxième groupe de travail *ad hoc* sur les stocks demersaux côtiers de la Mauritanie au Liberia. FAO COPACE/PACE Ser. 80/23, 101 p.

CECAF. 1983. Report of the *ad hoc* working group on pelagic stocks of the Sherbro statistical division. FAO CECAF Tech. 83/48, 162 p.

Coutin, P.C. 1989. The effects of long–term exploitation of tropical demersal fish stocks. Ph.D. Thesis. Coventry Polytechnic, Coventry, UK. 243 p.

Djama, T., B.C. Gabche and D. Hjifonju. 1989. Growth of *Sardinella maderensis* in the Lobe Estuary, Cameroon. Fishbyte 7(2):8-10.

Domain, P. 1979. The demersal resources (fish). FAO Fish. Tech. Pap. 186(1): 79-122.

Domanevsky, L.N. and N.A. Barkova. 1976. Some peculiarities of sardine (*Sardinella pilchardus*) distribution and spawning along northwest Africa. ICES C.M. 1976/J:6.

Fager, E.W. and A.R. Longhurst. 1968. Recurrent group analysis of species assemblages of Guinea. J. Fish Res. Board Can. 25:1405–1421.

Gerlotto, F. 1979. Biologie d'*Ethmalosa fimbriata* (Bowdich) en Côte d'Ivoire III étude des migrations en Lagune Ebrié. Doc. Sci. Rech. Océanogr. (Abidjan) 10(2):3-41.

Legendre, L. and S. Demers. 1984. Towards dynamic biological oceanography and limnology. Can. J. Aquat. Sci. 41:2-19.

Linsenmayer, D. 1974. Economic analysis of alternative strategies for the development of Sierra Leone marine fisheries. Working Pap. 18, 178 p. Department of Agriculture and Economics, Michigan State University, Michigan.

Longhurst, A.R. 1963. Bionomics of the fisheries resources of the eastern tropical Atlantic. Fish. Publ. Col. Office (London) 20, 66 p.

Longhurst, A.R. 1969. Synopsis of biological data on West African croakers, *P. typhus*, *P. senegalensis*, *P. elongatus*. FAO Fish. Synopsis 35 Rev. 1:1-40.

Longhurst, A.R. 1983. Benthic–pelagic and export of organic carbon from a Tropical Atlantic Continental Shelf–Sierra Leone. Estuarine coastal and shelf Sci. 17, 261-285.

Longhurst, A.R. and D. Pauly. 1987. Ecology of tropical oceans. Academic Press, New York.

Marcus, O. and K. Kusemiju. 1984. Some aspects of the reproductive biology of the clupeid *Ilisha africana* (Bloch) off Lagos Coast, Nigeria. J. Fish. Biol. 25:679-689.

Nieland, H. 1982. The food of *S. eba* off the coast of Senegal. Rapp. P.-v. Réun. Cons. Perm. Explor· Mer. 180:369-373·

Okera, W. and D. Chaytor. 1978. Synopsis of research on shrimps. Bull. Inst. Mar. Biol. Oceanogr. 3(1):34-41.

Salzen, E.A. 1958. Observations on the biology of *Ethmalosa fimbriata*. Bull. Inst. Fr. Afr. Noire. Sér A, 18: 335—371.

Ssentengo, G.W. and Ansa-Emmin. 1986. Marine fishery resources of Sierra Leone: a review of exploited fish stocks. FAO CECAF/ECAF Ser. 86/34, 67 p.

Strømme, T. 1984. Final report of the R/V Fridtjof Nansen fish resources surveys off West Africa. Bergen Institute of Marine Research, University of Bergen, Bergen, Norway.

Turner, J.C. and R.B. Hudson. 1966. A statistical study of the trawler fleet and the coastal fish population of Sierra Leone, 1860–1964. J.W. Afr. Sci. Ass. 11(1-2):150-184.

Watts, J.C.D. 1962. Evidence of overfishing in the Sierra Leone trawl fishery. Bull. IFAN Ser. A(3):909-912.

Williams, F. 1968. Report of the Guinean trawling survey. OAU and STRC Lagos 1-3, 842 p.

Williams, F. 1969. Review of the principal results of the Guinean trawling survey. UNESCO Symposium on Oceanography and Fish Resources of the Tropical Atlantic, Abidjan, Côte d'Ivoire.

Williams, R.A.M. 1991. Ethnoichthyology of the artisanal fisheries of Sierra Leone. B.Sc. Thesis (Hons.). University of Sierra Leone, Freetown, Sierra Leone. 153 p.

Exploitation of Tuna and Other Large Pelagic Fish in Sierra Leone's EEZ[1]

J.A.L. Cole

Sierra Fishing Company Ltd., Freetown, Sierra Leone

Abstract

The tuna industry in Sierra Leone was established in the early 1950s, with Freetown as a transshipment port, and a bunkering and victualling center for distant water vessels, especially of the Japanese tuna fleet. In the early 1960s, an American company, Van Camp Seafood of California, partnered with Supermarket Cold Stores of Kissy Dockyard, to install modern machinery, a brine freezing tank, and block ice machine for the establishment of a holding and transshipment base for the foreign tuna fleet fishing in the East Central Atlantic. The base flourished and the facilities were utilized by Japanese, Spanish, French, American, Korean and other foreign flag vessels. There was no indigenous participation in tuna fishing either at the semi–industrial or the artisanal level during the 1950s and 1960s. The beginning of the end of the industry in Sierra Leone was marked by the imposition of royalty fees by the Government in 1975. Vessel owners were not convinced that the charge was fair, as they maintained that the bulk of the catches were made outside the waters of Sierra Leone, which had been increased to 200 nautical miles (nm) in 1973. All the vessels pulled out, and no more tuna was landed or transshipped to USA, Europe, or Japan. The Soviet Union entered the fishery with purse seiners in 1982, and continued to fish until 1990, when the mutual agreement on joint fisheries between the two governments changed. Russians continued to fish in 1991 under a different arrangement. It is unlikely that Sierra Leone will resume its former role as a tuna transshipment base in the Eastern Central Atlantic.

Introduction and Historical Background

With regard to tuna fishing, Sierra Leone is well situated, as it is located along the West Coast of Africa in the Eastern Central Atlantic, where there is an abundance of tuna and other large pelagic species. Tuna species found in this area include:

- Yellowfin (*Thunnus albacares*), which occurs in the entire Atlantic Ocean, and is exploited by purse seiners, bait boats and longline vessels. The juveniles are exploited by purse seiners and bait boats along the West African coast, and fishing for larger fish started in 1975, when the purse seiners ventured offshore. Longliners fish the intertropical area between 15°N and 10°S and they operate the distant waters, well off the shipping lanes;
- Bigeye tuna (*Thunnus obesus*) is widely distributed in the tropical and temperate waters of the Atlantic. Small bigeye tunas have only been observed in the Gulf of Guinea, which is the only known nursery. The stocks are exploited by longliners, purse seiners and bait boats and the fishery is active year round;
- Skipjack (*Katsuwonus pelamis*) is a cosmopolitan species, distributed in the tropical and subtropical waters of all three oceans. It is caught by surface gear throughout the Atlantic, and in the Eastern Central Atlantic mainly by Spanish purse seiners;
- Bluefin tuna (*Thunnus thynnus*) is found all over the Atlantic. Eastern Central Atlantic catch are made by bait boats belonging to the Spanish and French fleets, and by Japanese longliners;
- Billfishes and other large pelagic species are fished directly or are incidental to the tuna catch, and occur throughout tropical and temperate waters of the Atlantic Ocean. Blue marlin (*Makaira nigricans*), Atlantic white marlin (*Kajikia albida*), Atlantic sailfish (*Istiophorus albicans*), and swordfish (*Xiphias gladius*) are all caught along with tuna. Blue marlin is negligible in the catch, and swordfish are caught by the tuna longline fishery as bycatch throughout the eastern Central Atlantic. Other tuna species occurring in the catch are frigate tuna (*Auxis thazard*), bullet tuna (*Auxis rochei*), Atlantic bonito (*Sarda sarda*), king mackerel (*Scomberomorus cavalla*) and West African Spanish mackerel (*Scomberomorus tritor*);
- The natural harbor at Freetown is ideally situated with regard to these fisheries, and since the early 1950s, it has been a convenient port for vessels of various countries fishing for tuna and other large pelagic species, to transship their catch, and obtain fuel and other provisions.

The enormous potential of the pelagic stock in Sierra Leone–especially for tuna–was realized as far back as 1958, when the Fisheries Research and Development Unit (FRDU) of the Ministry of Agriculture, in its Annual Report, suggested that these stocks could well replace the dwindling demersal stocks then available for local consumption. However, the heavy capital investment, and high price of the product in the world market made it unlikely that the tuna landed in Freetown would ever be of importance as a commodity for local consumption. By 1960, Freetown was an established transshipment center and base for the nearshore and distant–water tuna fleets of several countries. The Van Camp seafood company of California acquired shares of the Supermarket Cold Store, a cold storage company owned by two Italians and located at Kissy Dockyard. The company had four cold storages, with a total storage capacity of about 10,000 tonnes, and an ice–making machine. Van Camp installed a brine freezing tank to freeze fresh tuna caught by Spanish bait boats. Van Camp was then buying frozen tuna

1 Cite as: Cole JAL (2012) Exploitation of tuna and other large pelagic fish in Sierra Leone's EEZ. pp. 38-45. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

and other large pelagic species from Japanese longliners and Spanish bait boats for eventual transshipment to Puerto Rico and European canneries. The facilities for handling the tuna catch were also considerably extended. A small jetty was constructed at Cline Bay to provide berthing facilities for smaller catchers. The berthing facilities available at Kissy Dockyard were still inadequate for the rapidly expanding industry. A survey of the Kissy Wharf was made by Port and Marine (now Sierra Leone Ports Authority) with the intention of building up the foreshore with dredging material, thus increasing the wharf space. Buoys were also installed in the approach channel, thus making it possible for vessels with up to 18 m draft to navigate at certain states of the tide. The tuna industry continued to grow, with catches landed and transshipped increasing yearly (Table 1) to a peak of 11,852 tonnes in 1962, after which it ranged between 7,721 and 5,625 tonnes. Royalty fees of 30.00 Leones per gross registered tonne (GRT) were imposed on all foreign vessels and local tuna vessels–which were classified as foreign vessels–in addition to the license fees for fishing and selling fish. At an exchange of 420 Leones to the US dollar, this represents a fee of 0.07 USD per GRT. These new fees were considered unjustified by the tuna vessel owners, as they maintained that most of the tuna was caught outside the waters of Sierra Leone, even after it had been extended to 200 nm from low water mark in 1973.

Table 1. Tuna catch (in tonnes) landed at Freetown, Sierra Leone, 1960–1966.

Year	Catch
1960	6,490
1961	9,572
1962	11,856
1963	7,721
1964	6,393
1965	6,809
1966	5,625

The tuna fleets of Spain, Korea and Japan pulled out in 1976 and this was the beginning of the collapse of the tuna industry in Sierra Leone. The vessels established bases in Abidjan, Côte d'Ivoire and Tema, Ghana. Van Camp sold out to Joint Venture Fishing Enterprise and finally left in 1976.

Foreign Flag Vessel's Participation in the Tuna Fisheries in Sierra Leone's EEZ

American participation

Commercial fishing in Sierra Leone started in 1953 when an Italian set up business at Murray Town at the present Sierra Leone Fishing Company Complex. This was an offshoot of Mesurado Fishing Company. In 1957, the Sartori brothers came into Sierra Leone after selling their shares in Mesurado Fishing Co., and established at the present complex owned by Sierra Fishing Company at Kissy Dockyard. The dockyard was leased from the Ministry of Trade and Industry. Sartori brought in cold storage equipment, and built cold rooms of 10,000 tonnes holding capacity and an ice–making plant. The cold rooms were more or less used for holding fresh fish caught by two demersal trawlers, which were then sold at local markets in Freetown. The Fisheries Development and Research Unit (FDRU) report for 1960 showed that American type tuna clippers using live bait and pole fishing operated along the coast of Sierra Leone. Two of these vessels belonged to an American firm and were engaged in exploratory fishing to determine the economics of tuna fishing in the area. The main constraint was the supply of baitfish, since as much time was spent catching the sardinella used for bait as in fishing for tuna. On the basis of this experiment, an American firm, Van Camp of California, brought in a large oceanic tuna vessel of Italian construction to fish for tuna. An agreement was reached between Van Camp and the Sartori brothers that same year, whereby the tuna catch was stored in the cold rooms in Kissy Dockyard for eventual transshipment on carrier vessels to canneries in Puerto Rico and Europe. The Spanish tuna fleet, which consisted of over 20 bait boats from Bilbao, Spain, was also landing their catch in Freetown for cold storage, and regular shipments of up to 8,000 tonnes yellowfin tuna, swordfish, sailfish and marlin were made to the USA and Europe.

Spanish participation

Spain has been engaged in fishing for tuna and tuna–like fish in the Eastern Central Atlantic since the mid 1950s. In 1985, an American–type tuna clipper using live bait and operating along the coast of Sierra Leone and belonging to a Spanish firm fished commercially for the first time. This marked the start of Spanish participation in the tuna fishery in the Gulf of Guinea, and Freetown became a center for the fleet of about 20–25 bait boat vessels registered in Bilbao, Spain. The catches were landed in Freetown, frozen and held in cold storage. Catches were landed during the months of March, April and December 1960, and fishing was done in waters some 70 to 130 miles from Freetown (Table 2). Bait was caught by ring nets and stored alive in tanks until required. The Spanish fleet experienced little difficulty in procuring their bait from offshore waters, a fact of considerable interest, as it was feared that the bait supply might prove a major obstacle to the development of the tuna fishery in Sierra Leone. The Spanish fleet continued to fish in the Eastern Central Atlantic, and at the close of the 1963/64 season in April, the catch were reportedly lower than the previous seasons, despite the fact that more boats entered the fisheries (Table 3). This might have been the cause for the Spanish fleet to leave earlier than usual that year. The 1964/65 season started in October, with 45 Spanish pole and line vessels based in Freetown. The catch for October to December 1964 was 2,091 tonnes and for January to March 1965 was 1,948 tonnes, totaling 4,039 tonnes for the season (Table 4). The Spanish fleet left in April, because of low catch rates. The vessels returned in November 1965 and continued fishing until 1975. Over this ten–year period, and beyond, the bait boat fleet was slowly transformed into a fleet of large purse seines. In 1982, the fleet in the Eastern Atlantic was 46 purse seiners. Spanish catches in the Eastern Atlantic continued to increase (see ICCAT Report 1986) over the years, and it is likely that after the vessels pulled out of Sierra Leone in 1975 they still continued to fish offshore in Sierra Leone's Exclusive Economic Zone (EEZ).

Table 2. Tuna landings (in tonnes) and export, 1960.

Month	Japanese vessel	Spanish vessel	Landings cold store	Transshipment
Jan	2	-	400	-
Feb	1 (2)*	-	200	867
March	-	9	134	-
April	1	12	240	-
May	- (2)*	-	-	730
June	2	-	220	-
July	1 (3)*	-	315	650
Aug	1 (1)*	-	105	498
Sept	2 (2)*	-	210	709
Oct	1 (3)*	-	11	696
Nov	4	-	315	-
Dec	-	-	170	-
Total			2,340	4,150

*Vessels in brackets transshipped directly into the carriers. Total tonnage exported from Freetown is 6,190 tonnes.

Table 3. Tuna landings (in tonnes) and export, 1964.

Month	Japanese	Spanish	Other	Total	Export balance	Cold store
Dec. 1963	-	-	-	-	-	1,994
Jan. 1964	316	780	-	1,096	1,661	1,429
Feb. 1964	264	428	-	692	1,600	521
March 1964	72	289	3	364	850	36
April 1964	160	-	-	160	-	196
May 1964	521	-	11	532	355	374
June 1964	452	-	32	484	532	326
July 1964	-	-	-	-	-	326
Aug. 1964	-	-	-	-	326	-
Sept. 1964	-	-	30	30	-	30
Oct. 1964	29	209	-	238	-	268
Nov. 1964	285	381	5	671	227	712
Dec. 1964	287	1,501	338	2,126	2,045	794
Total	2,386	3,688	419	6,393	7,596	794

Japanese participation

Japanese vessels were actively engaged in fishing tuna and other large pelagic species in the Eastern Central Atlantic long before records were started in Freetown. In the FDRU Report on Fisheries for 1959, it was stated that over 30 Japanese longline vessels were operating well offshore, clear off the shipping routes. Freetown was used as a bunkering center for longliners, typically 76 m long with a crew of 63 men. They also carried two 11 m diesel launches on the foredeck, and included mechanical fish handling equipment and freezing gear with a capacity to store 610 tonnes of tuna fillets. The daily catch was about 500–600 yellowfin tuna, with an expected meat content of 22,000 kg. Each vessel was on a one–year voyage, making trips to Central American or European canneries every two to three months. Some of these longliners also landed their catch in Freetown, already deep–frozen, for storage and eventual transshipment overseas.

Table 2 shows tuna landings for the Japanese longliners and for the Spanish bait boats in 1960, the quantities held in cold storage and transshipped directly into carrier vessels. The Japanese longliners regularly landed their catch, except for the months of March and December. A total of 4,150 tonnes of tuna were transshipped by the Japanese fleet and about 2,000 tonnes were held in cold storage. At the end of the 1963 season, the balance of tuna held in cold storage was 1,994 tonnes. Total Japanese landings for 1964 were 2,386 tonnes. At the close of the season in June, only four Japanese boats continued fishing and these went offshore to fish the oceanic schools, while others continued to fish at the edge of the continental shelf (Table 3). In 1965, the same pattern of fishing occurred, and the catch increased over 1964 to 3,174 tonnes (Table 4). Breakdown of catch for 1966 was not

available, although the total of 5,625 tonnes was lower compared to 6,809 tonnes for 1965. During the rainy season, the bait vessels were wasting as much time catching bait as they were for tuna. The idea of having large baskets floating just under the surface of the water to hold bait fish caught by smaller vessels was experimented with, but the biggest problem was in transferring the live bait to the baskets, since the catcher vessels were without live bait tanks. In November 1965, three boats belonging to the Japanese Nichiro Co. arrived to catch sardinella, which were stored in cold rooms and collected by the tuna vessels on their outward journeys after discharging their catch.

Table 4. Tuna landings (in tonnes) and export, 1965.

Month	Japanese	Spanish	Other	Total	Export Balance	cold store
Dec. 1964	-	-	-	-	-	794
Jan. 1965	-	252	122	274	686	-
Feb. 1965	282	611	753	1,646	1,196	931
March 1965	-	661	22	683	654	821
April 1965	240	424	23	687	1,258	250
May 1965	388	-	-	388	-	638
June 1965	216	-	348	564	1,047	155
July 1965	-	-	-	-	-	155
Aug. 1965	-	-	122	122	277	-
Sept. 1965	-	-	-	-	-	-
Oct. 1965	686	-	-	686	-	686
Nov. 1965	767	156	-	923	-	1,609
Dec. 1965	595	191	-	736	1,915	416
Total	3,174	2,245	1,390	6,809	7,060	416

Table 6 summarizes the activities of the tuna industry in Sierra Leone in 1966, when the Japanese and Korean vessel owners decided to import saury fish (*Scomberesox saurus*) from the Northeast Pacific as baitfish. These were held in cold storage, and collected by the tuna–catching vessels, on their outward journeys. Because of the high cost of importing this fish, trials with local scad (*Decapterus* spp.) and shinenose (*Galeoides decadactylus*) were made, but the quantities caught were not enough to meet the demands of the tuna vessels. The number of foreign–based Japanese vessels fishing in the Atlantic Ocean was at its peak in 1965, with 169 longliners. By 1972, there were only 11 longliners, their capacities ranging between 50 and 500 GRT, and in 1973 only two were fishing.

In 1975, the Fisheries Act of 1974 was amended to include the payment of royalty fees in addition to license fees for fishing in Sierra Leonean waters, which were now claimed to 200 nm from low water mark. Foreign vessels fishing in the territorial waters were required to pay Le30 per GRT. This levy was seen as excessive, and thus began the collapse of the tuna industry in Sierra Leone. The Japanese, Koreans and Spanish fleet pulled out as they felt the charges were high. They moved to Abidjan in the Ivory Coast, where the industry was being developed. Van Camp transferred its operation to Ivory Coast and Ghana and that was the end of the tuna industry in Sierra Leone. It is very likely that these vessels continued to fish in the waters of Sierra Leone, as there was no means of patrolling the waters and no surveillance was being conducted.

In 1990, the Overseas Fisheries Cooperative Foundation of Japan, through their Foreign Ministry, signed an agreement with the Sierra Leone government whereby up to 20 longliners and two purse seiners would be licensed to fish for tuna and tuna–like fish in the Sierra Leones EEZ. It was agreed to issue licenses for a three–month period at the rate of US$2,400 and US$5,000 per vessel for longliners and purse seiners respectively. In addition, donation of fishing gear and equipment was included in the agreement. In reality, only two licenses were issued by the Fisheries Division for two purse seiners. Throughout the season, these vessels did not fish in Sierra Leone's waters, and it was assumed that they fished in other areas in the Gulf where the catch was better.

Table 5. Tuna landings and export (in tonnes), 1966.

Month	Landing			Cold store	Export	Canning	Local sale	Balance
	Cold store	Transship.	Total					
Dec. 1965	-	-	-	-	-	-	-	416
Jan. 1966	193	58	251	543	602	14	2	49
Feb. 1966	299	-	299	-	-	14	-	334
Mar. 1966	340	200	540	200	400	-	20	454
April 1966	459	-	959	-	-	-	-	913
May 1966	254	-	254	848	848	-	-	319
June 1966	503	-	503	27	27	-	-	795
July 1966	113	-	113	28	28	-	1	879
Aug. 1966	238	-	238	890	890	-	2	225
Sept. 1966	350	-	350	383	383	-	-	192
Oct. 1966	353	-	353	98	98	-	-	192
Nov. 1966	1,466	366	1,832	231	597	-	2	1,680
Dec. 1966	435	-	433	1,627	1,627	-	-	485

Korean participation

The Korean vessels began fishing tuna and other large pelagic fishes in the Atlantic in 1964. Operations using the Eastern Atlantic ports as bases started in 1968. The vessels were chartered and operated by Korean firms, two of which–the Jinan and Jedong Fishing Companies–had agents in Sierra Leone. Longliners were used until 1972, when a couple of bait boats for skipjack were introduced into the fisheries as exploratory vessels. Actual commercial fishing started in 1973 in the Atlantic. Korean longliner vessels were first mentioned in the 1966 FDRU Report as operating from Sierra Leone. Baitfish was caught by three Japanese 45–foot purse seiners based in Freetown. The sardinella were boxed and kept in cold storage to be supplied to the vessels on their outward journey after discharging their tuna catch. The catch consisted mainly of yellowfin, albacore, swordfish and shark. The yellowfin and skipjack were exported to the USA and the others to Europe. The Japanese agent based in Freetown was also buying swordfish and shark from the Korean vessels for export to Japan. Actual catch records for the Korean fleet fishing out of Sierra Leone were not available, but records from an ICCAT Report for 1975 showed a marked increase in the number of vessels fishing in the Atlantic in 1964. In 1975, although there was a reduction in the number of vessels fishing, the catch of 46,472 tonnes in the whole Atlantic Ocean was the highest since the fleet began its operations. One can assume that the increase in catch reflected a corresponding increase in Sierra Leone's contribution to the total Atlantic Ocean catch.

French participation

French vessels have been engaged in tuna fisheries in the eastern Central Atlantic since the early 1950s. It was reported in 1959 that the winter tuna fishery of French boats from St. Jean de Luz and other French ports (but based in Dakar) extended their operation by the end of the season as far south as the St. Ann Shoals off Sherbro Island. In 1964, five French boats arrived in Sierra Leone, but left early in 1965 because of low catches. French vessels still continued to fish in the waters off Sierra Leone, although no official records of the presence of their pole and line vessels are available. During the 1991 tuna season, one French purse seiner was monitored fishing in Sierra Leone's waters for five consecutive days, and was finally apprehended by the patrol vessel *The Protector* belonging to Maritime Protection Services (Sierra Leone) (MPSSL), which is engaged in surveillance and protection work in the Sierra Leone EEZ. The French vessel had a full hold of tuna and other species, which were apparently caught off of Sherbro. The vessel was fined a total of US$600,000, which was promptly paid. The vessel owners expressed a desire to apply for license to fish in the EEZ for the next tuna season in 1992.

Soviet participation

The Soviet commercial fisheries for tuna and other pelagic fish in the eastern Atlantic Ocean began as far back as 1959, when exploratory cruises were conducted by research vessels along the coast of Sierra Leone for tuna and sardinella. The scientific cruises continued throughout the years and in 1979/80, four cruises in the open part of the Gulf of Guinea established patterns of behavior of skipjack tuna, young yellowfin, and bigeye tuna during August to January. It was also observed that tuna aggregations were associated with the upwelling zones, keeping to the thermocline depth. Rising temperature of 25–26°C resulted in southward migration of tuna. It was also established that prospective fishing for skipjack was highest during February/March in Sierra Leone.

For surface schools of tuna in the open waters of Sierra Leone, the composition of the catch was 93.5% skipjack, 4.2% yellowfin, 0.2% bigeye and 2.1% frigate tuna. Little tunnys at certain periods of time stayed mainly in coastal waters, while skipjack preferred open oceanic waters. Among other findings was the fact that spawning of small tunas (little tunny and frigate tuna) occurred in the Freetown area from January to March. Although formal fishing for demersal and other small pelagic species started in 1976 with the signing of the joint agreement on fisheries by the USSR and the Sierra Leone government, it was not until 1981 that an agreement was reached for experimental fishing for tuna and other large pelagic species. It was agreed to deploy one superseiner of the Rodina type for this purpose, but actual fishing started in February 1982, with up to four vessels fishing until the end of June, yielding a total catch of 2,106 tonnes of tuna (Table 6). A maximum of four vessels fished in March with a total catch of 852 tonnes. Two types of vessels were engaged in this fishery–the TST (tuna purse seiner) and SST (tuna superseiner). Average length of the TST is 55.5 m, with a GRT of 188 and a fish hold capacity of 362 m^3. An SST is 85 m long, with a GRT of 2,635, and a fish hold capacity of 1,615 m^3.

Table 6 also shows the number of vessels deployed over the years 1982 and 1991 and the total catch for each year. There was no species breakdown given for the catch, and the number of fishing days is also unavailable. With the available data, it is therefore impossible to calculate the fishing effort, and to determine whether the fishery was improving over the years. But private interview with the Russian scientists indicate that there were four cycles of good catch. In 1978, with the insistence of the Government, the experimental aspect of the fishery was terminated after 5 years and it became a commercial project, where 15% of the catch was given to Sierra Leone for fishing rights. License and royalty fees were paid in accordance with the Fisheries Laws and Regulations of Sierra Leone. Local tuna vessels of the Sierra Leone Fishing Company also paid such fees.

With the new Fisheries Laws and Regulations promulgated in 1988, and the failure of the USSR and Sierra Leone governments to reach an agreement on the percentage of catch for fishing rights in 1989, the Soviet removed the whole fleet in December 1990. Despite this setback, the tuna vessels were back fishing under the Nigerian flag and chartered by Beem Fishing Company of Lagos. The new regulations required that license and royalty fees for all foreign vessels were to be paid in US dollars. The provision whereby foreign vessels chartered by a local fishing company may be treated as local vessels–and as such, may pay license and royalty fees in local currency–was set aside.

Table 6. Tuna catch (tonnes) in the waters of Sierra Leone by the Soviet fleet from 1982 to 1991.

from	1982		1983		1984		1985		1986		1987		1988		1989		1990		1991	
Month	**Vessels**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**	**Vessel**	**Catch**
Jan.	-	-	1	3	-	-	5	335	-	1	-	8	-	-	-	-	-	-	-	-
Feb.	2	170	4	140	2	605	6	740	4	124	3	160	1	-	6	273	7	1,072	-	-
Mar.	4	852	6	1037.5	6	2,072	6	1,405	7	913	2	346	5	256	6	1,585	7	2,220	-	-
Apr.	2	217	8	989	6	1,577	10	1,835	7	369	3	216	5	1,482	7	1,928	8	1,298	6	270
May	3	510	8	562	8	579	6	971	1	13	5	91	4	41	5	1,137	6	2,267	6	863
June	3	357	5	524	-	28	2	14	5	382	-	-	2	341	2	85	1	23	-	-
July	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aug.	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-
Total	14	2,106	32	3,256	22	4,801	35	5,300	24	1,802	13	821	17	2,720	23	5,008	29	7,989	12	1,113

An agreement was reached between the MPSSL and Beem Fisheries for payment of the fees. Transshipment of catch, which was hitherto not monitored by the Fisheries Division, and for which no fees were charged, was now done under the watchful eye of the MPSSL. This was an important aspect of the MPSSL, since revenue was collected and essential scientific data was gathered on catch levels and and species distribution.

It was only in 1989 that any species breakdown of the tuna catches in Sierra Leone's EEZ was given, in the ICCAT Report for 1990/91. It showed that a maximum of 7 purse seiners fished during February to June for 647 fishing days with a total of 5,008 tonnes little tuna, 193 tonnes bullet tuna and 79 tonnes frigate tuna. A provisional figure of 1,090 tonnes catch published in the same report put the total Russian catch as 7,587 tonnes made up as follows: skipjack (3,050 t), yellowfin (2,165 t), black skipjack (800 t), frigate tuna (836 t), bullet tuna (240 t), bigeye tuna (50 t), Atlantic bonito (129 t), and mackerel (317 t). Records from Sierra Leone Fishing Company showed a total catch for the period February to June of 7,929 tonnes. It is likely that the catch came only from the Sierra Leone EEZ, since the ICCAT meeting took place in Madrid in November 1990. The catch made by the six vessels on charter to Beem Fishing Company was 270 and 863 tonnes in April and May 1991 respectively. License fees for these vessels (six month license) were calculated at US$391,500, and from a total catch of 1,133 tonnes, royalty fees were a total of US$79,310 at US$700 per tonne. This adds up to a total payment of US$470,810. Returns from the effort were US$793,100, leaving less than a 50% margin for all other expenses. We have yet to see whether these vessels will return for the next tuna season, which starts in February 1991.

Utilization of the Catch in Sierra Leone

In 1959, two Italian businessmen from Liberia leased the facilities at Kissy Dockyard from the Ministry of Trade and Industry. These included four cold rooms that are completely modernized, one as chill room and three as freezer rooms. Van Camp of California made an agreement with the Sartori brothers that same year to store frozen tuna and other large fishes caught by Spanish and Japanese vessels in Sierra Leone's waters and beyond. A large brine tank for freezing tuna brought in fresh by Spanish ice boats was installed. The frozen tuna from the Spanish and Japanese fleet were stored for transshipment to Puerto Rico and Europe. Because of its high food value, and the dwindling catch of demersal fish, Van Camp Seafood (SL) Limited established a pilot canning factory to process and can tuna for the local market. The first products were done with olive oil imported from Italy and test marketed all over the country. A massive advertising campaign was mounted and the consignments were all sold out. To cut down on cost, palm oil produced locally was then used instead of imported olive oil. The products were rejected by the consumers, and the entire inventory was dumped. The factory stopped production immediately and the plant was sold to a Nigerian businessman in late 1966. A total of 28 tonnes of tuna, mainly yellowfin, bigeye and skipjack were processed during January and February 1966. A local sale of tuna was also experimented with. Throughout 1966, a total of 27 tonnes were sold with the highest sale of 20 tonnes made in March (Table 5). The number of cans ranged from 2.6–8.8 million over this 4–year period. After this initial experiment with fish canning, no further effort was made by any other fishing company to explore the market for canned fish and other marine products. The import of sardines and other canned fish is given in Table 6 for 1962 to 1965. It was unfortunate that the experiment on the canning of tuna was not continued, as the potential for import substitution was great. Sierra Fishing Company, as one of its long–term development goals, hopes to establish a canning factory for sardinella, tuna and other marine products. But with the scarcity of foreign capital needed to purchase the machinery and canning material, it is very unlikely that any canning industry will be established in Sierra Leone in the near future.

Future of the Tuna Industry in Sierra Leone and Conclusion

The tuna fishery developed gradually from 1958 to 1975, when the vessels abandoned Freetown as a base and transshipment center. All these vessels were foreign flag vessels, with no local participation in the tuna fishery. In 1975, royalty fees for foreign flag vessels were fixed to Le30.00 per GRT. This fee was increased to Le90.00 in 1978, and the government made no effort to find out whether this was acceptable to the foreign boat owners and their agents. It is obvious that over the years poaching was rampant in the waters of Sierra Leone, with nothing being done about it. In 1982, the Russian fleet legitimized their operation by entering into a joint operation with Sierra Fishing Company for tuna fishing, under the joint agreement on fishing. The arrangement was for license and royalty fees to be paid in local currency. The fishery in Sierra Leone's EEZ was from January to June, so the license was to be issued on a 6–month basis. With this agreement, Russian purse seiners regularly fished until 1990, when the two governments failed to reach agreement on conditions for fishing in Sierra Leone's EEZ at the Joint Commission Meeting in Moscow 1989. The Russian fleet fished throughout 1990, with the hope that the impasse would be resolved. The whole fleet pulled out at the end of the year, when it was apparent that the government was unwilling to allow any foreign flag vessel to register as a local vessel under charter agreement with a local company, thus allowing it to pay the royalty and license fees in local currency. The Russian vessels did return to the EEZ in 1991, but fished for only two months with a very low catch. With this background, the future of the tuna industry in Sierra Leone is rather bleak. There is no incentive by government to encourage the fishing industry in Sierra Leone, although experts claim that the revenue from the marine resources is sufficient to satisfy our foreign exchange needs. This may be true, but the government should be willing to provide assistance to purchase fishing vessels and construct infrastructure for the industry to take off initially, otherwise, the industry will collapse. Also, the resource is not stagnant and migrates to other areas where it can be harvested. This is so with tuna and other large pelagic species, which are all oceanic, with well–documented migratory patterns.

The Fisheries Advisory Board should address a number of pertinent issues to restore the viability of the Sierra Leone fisheries industry development, namely:

- Encourage foreign tuna vessels to secure licenses in Sierra Leone to fish during the tuna season which is from February to June in Sierra Leone's EEZ;
- Encourage the government to develop and improve on the local bunkering and victualing centers at Kissy and at Murray Town, or even establish their own facilities for improving the servicing of foreign fishing fleets;
- Help an indigenous fishing company establish a fish canning industry in Sierra Leone with foreign participation, in order to capture the West African inland market south of the Sahara; and
- Attract industrial fishing development, in order Freetown can once again become a transshipment and bunkering center for the Atlantic tuna fleet in view of its natural harbor and proximity to the fishing grounds.

Visual evidence of modern tuna purse seiners fishing in Sierra Leone's EEZ has been presented over the years. This goes to show that the recommendations above are feasible. Although license and royalty fees are being increased, yet very little effort has been made by the government to manage and protect our marine resources. The USSR government donated a patrol vessel in 1981, an old whaler. It was useful in a way, but was unsuitable for surveillance and protection duties because of its size. It did not help in arresting over 10 shrimpers that year belonging to Mesurado Fishing Company and Continental Sea Foods, both of Liberia, and was left to sink after a couple of years. The Chinese government also donated two patrol vessels, while the US government recently donated an efficient patrol vessel, which has been vandalized and misused. The Fisheries Act of 1988 and the amended Regulations of 1990 empowered the government to appoint agents to carry out some duties of the Director of Fisheries. Thus the MPSSL was established as a joint venture between Marine Protection Services of UK and the Sierra Leone government. License and royalty fees were raised and all foreign vessels were to be levied royalty fees in foreign currency, including indigenous fishing vessels that exploited these resources. Hence, the fishing industry in Sierra Leone may be at a turning point. All it needs now is good management with trained personnel and an infusion of foreign capital to construct a national fishing harbor and to invest in fishing vessels and equipment.

The Shrimp Resources of Sierra Leone[1]

P.A.T. Showers

Department of Fisheries, Ministry of Agriculture, Forestry and Fisheries, Freetown, Sierra Leone

Abstract

The catch rate of shrimps in Sierra Leone has been decreasing steadily since the late 1980s, and despite the decreases in fishing effort there has not been the expected positive effects with the stocks: the catch rate has continued to decline. The basic tool in this paper used tracing trends of exploitation has been the CPUE (catch per unit effort). However this is insufficient to explain the anomalies of the catch rates. Global production models have also been used to determine the maximum sustainable yield (MSY) of the stocks, estimated at 2,610–3,560 t, thereby providing an optimum yield margin beyond which it is not recommendable to allow the total annual catch to go. Finally, statistical data of annual catches for a series of years for Sierra Leone shrimps revealed that the fishing intensity imposed on the shrimp stocks has been very high. Catches started to increase sharply in about 1987, and quickly exceeded an annual total of 4,000 t by 1988. The biological models suggest the need to implement appropriate management measures, with due consideration to relevant ecological and economic factors, to enable the stocks to recover and provide the benefit of their maximum yield.

Introduction

Throughout the world, shrimps and prawns constitute the most important commercial group of crustaceans. There are about 280 commercial species of a total of 2,500 species known and, according to 1978 FAO catch statistics, the total world catch of 1,450,000 t is comprised of about 100 species. Four commercial species are exploited in Sierra Leone and the dominant species of the shrimp fishery is *Farfantepenaeus notialis*. The optimum yield for the Sierra Leone–Liberia shrimp resources was estimated at 1,800 tonnes by Garcia and Lhomme (1977). This estimate was based on analysis of catch and fishing statistics from Senegalese vessels fishing for shrimps in Sierra Leone and Liberia 1969 to 1976.

An estimate of the Sierra Leone shrimp MSY was obtained by Willman and Frielink (1987), of 2,200–4,000 tonnes. The estimate was derived from an analysis of commercial catch data for the period 1982/83 obtained from the Sierra Fishing Company, a major company based in Sierra Leone. The method employed was the equilibrium yield model of Thompson and Bell. Input data for growth and mortality were adopted from Garcia (1977) for shrimps in Côte d'Ivoire. The methods for estimating MSY in this report are the surplus production models of Schaefer and Fox. Thought they may not be as complex in their analytical approach as that of Thompson and Bell, they are tried and tested models in fisheries biology and do produce reasonable results.

The Species of Sierra Leone

There are 16 species occurring in Sierra Leone, belonging to eight families (Table 1). The four commercial species presently exploited are all members of the family Penaeidae: pink shrimp (*Farfantepenaeus notialis*), tiger shrimp (*Melicertus kerathurus*), rose shrimp (*Parapenaeus longirostris*) and Guinea shrimp (*Parapenaeopsis atlantica*). In Sierra Leone's waters, the adults spawn offshore at 10–80 m and the eggs hatch within a few hours, releasing the larvae. These undergo many stages of a very complex metamorphosis in planktonic form. The currents carry them away, towards the shore for about three weeks and they continue to live in the inshore waters as post–larvae. Species grow rapidly from the post–larval stage into juveniles in the nursery grounds of the inshore waters. Growth continues as they gradually move into more saline waters in their migration to the sea. Then they mature and spawn, thus completing their relatively short, but rather complex life cycle. Species of the largest sizes (Table 2) include great red shrimp (*Aristaeopsis edwardsiana*), pink shrimp, tiger shrimp, rose shrimp and striped red shrimp (*Aristeus varidens*); other species like tufted rock shrimp (*Sicyonia galeata*) and African spider shrimp (*Nematocarcinus africanus*) are smaller. In all species, females grow to larger sizes than males. Striped red shrimp are considered to be the most abundant deep–sea species of tropical West Africa; however, it does not occur in large enough quantities in Sierra Leone for commercial exploitation (Table 2). Great red shrimp, also a deep–sea species, is of a commercially attractive size, but of insufficient abundance. The species of shrimps off of Sierra Leone have a fairly broad geographical range of distribution along the Eastern Central Atlantic region. Almost all of them are found along the shelf from Morocco to Angola. Golden shrimp (*Plesionika martia*), a relatively small deep–sea species, has the widest range of all, stretching from the coasts of Europe down to South Africa.

The coastal species

Pink shrimp and Guinea shrimp occur in the southern half of the Sierra Leone continental shelf, mainly at depths

1 Cite as: Showers PAT (2012) The shrimp stocks of Sierra Leone. pp. 46-49. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

of 35–50 m. Observations during the 1987 Sierra Leone–Soviet research survey showed that catch rates of 0.3–1.7 kg·hour^{-1} and 0.1–1.4 kg·hour^{-1} were obtained for pink shrimp and Guinea shrimp respectively, using the standard Hake–4M demersal trawling gear. (This gear uses a 10 mm cod–end mesh size and its efficiency for catching shrimps is estimated to be 25% that of the normal gear used locally by the USA Gulf of Mexico type shrimps in Sierra Leone). Tiger shrimp occur in the coastal zone of the northern half of the Sierra Leone shelf, above the Freetown peninsula.

The abundance of these three species in relation to each other is not exactly known. The pink shrimp, however, is the dominant species and accounts for more than 80% of all coastal shrimp landings.

Table 1. A List of the shrimps/prawns found in Sierra Leone.

Family	Scientific name	Common name
Aristeidae	*Aristeus varidens*, Holthuis 1952	Striped red shrimp
	Aristaeopsis edwardsiana, Johnson 1867	Scarlet shrimp
Crangonidae	*Pontophilus* sp.	-
Nematocarcinidae	*Nematocarcinus africanus*, Crosnier & Forest 1973	African spider shrimp
Oplophoridae	*Notostomus* sp.	-
	Systellaspis pellucida, Filhol 1885	-
	Systellaspis debilis, A. Milne Edwards 1881	-
Pandalidae	*Plesionika ensis*, A. Milne Edwards 1881	Gladiator striped shrimp
	Plesionika martia, A. Milne Edwards 1881	Golden shrimp
	Plesionika heterocarpus, Costa 1871	-
Pasiphaeidae	*Pasiphaea tarda*, Krøyer 1845	Crimson pasiphaeid
Sicyoniidae	*Sicyonia galeata*, Holthuis 1952	Tufted rock shrimp
Penaeidae	*Farfantepenaeus notialis*, Pérez—Farfante 1967	Southern pink shrimp
	Melicertus kerathurus, Forsskål 1775	Caramote prawn
	Parapenaeus longirostris, Lucas 1846	Deep water rose shrimp
	Parapenaeopsis atlantica, Balss 1914	Guinea shrimp

The deep sea species

Rose shrimp occur all along the Sierra Leone shelf, around the region of the continental slope. Its major concentrations are found in the south, in waters deeper than 200 m, and on silty grounds. Catch rates as high as 10 kg·hour^{-1} have been observed using the Hake–4M gear in these areas of concentrations.

Table 2. Some biological characteristics of shrimp species on the Sierra Leone shelf. (m = males, f = female).

Specie	Maximum size (cm)	Depth range of habitat (m)
Aristeus varidens	20 (m), 12 (f)	400–700
Aristaeopsis edwardsiana	33 (m), 19 (f)	400–900
Nematocarcinus africanus	10.4	400–700
Plesionika martia	17	200–400
Parapeneaus longirostris	19	50–400
Parapenaeopsis atlantica	17 (m), 12 (f)	10–50
Melicertus kerathurus	24 (m), 18 (f)	5–50
Farfantepenaeus notialis	23 (m), 17 (f)	10–50
Sicyonia galeata	6.2	10–50

Trends in the Exploitation of the Stock

Fleet sizes and landing

Departmental records show that whereas the total number of licensed shrimpers in 1986 was 38, there were 78 in 1990, ranging from 50–750 gross registered tonnage (GRT). The increase is over 100%, and while a calendar of fleet activities shows that over half of these vessels do not operate under twelve months per year, the significant increases in licenses do indicate a significant increase in interest in shrimping and shrimping effort as well.

Various circumstances have prevented the keeping of up—to–date local records of the activities of the shrimpers, i.e. the total effort spent shrimping in Sierra Leone waters, the yields, catches and landings in their various categories. The landing statistics from Las Palmas, Canary Islands compiled by Taconet (1991) show that no less than 8 foreign fleets have been shrimping in Sierra Leone during the 1984–90 period (Table 3) and that there has been a considerable increase in total effort as well. With the exception of Ghana and Morocco, all the foreign fleets that were fishing during that period more than doubled their effort in the course of time. After the general explosion of effort in 1987, landings from Sierra Leonean vessels have declined, whereas those bearing Honduras/St. Vincent flags have maintained a leading position. The sharp increase in effort by these various foreign fleets increases correspondingly in the catches (Table 4). Landings of both pink shrimp and rose shrimp increased to over 1,500 t in 1987 and reached a peak of 4,000 t in 1988.

Trends in CPUE

The monthly averages of CPUE (an index of abundance) presented in Tables 7 and 8 show a certain amount of seasonality for the two species considered, a phenomenon which can be seen as a reflection of the fluctuations of biomass and abundance in the annual cycle within the stocks. Normally there are two peak seasons in the year, with the major peak occurring in the rainy season in June–July and the minor in the dry season in about March. The monthly averages for pink shrimp and rose shrimp show similarities both in magnitudes and in seasonality. These catch rates from local fleet statistics have been analyzed for pink shrimp on a 2–year basis, and the results show that the annual rhythm of relative abundance has varied.

Table 3. Fleet sizes (no. of vessels) of various nationalities operating in CECAF zone 34.3.3 during the period 1984–1990.

Nationality	1985	1986	1987	1988	1989	1990
Korea	5	6	28	39	22	14
Honduras/St. Vincent[a]	0	10	34	45	40	41
Panama[a]	1	4	6	13	35	24
Senegal	0	0	0	1	0	2
Gambia	0	0	1	4	0	2
Sierra Leone	0	0	6	17	16	35
Ghana	7	8	0	0	6	4
Morocco	5	2	3	0	2	1
Others[b]	0	1	0	5	0	5

a) Open registry flag states (i.e. "flags of convenience")
b) Japan, Nigeria, Libya

Table 4. Las Palmas landing statistics of trawlers from CECAF zone 34.3.3.

	1985		1986		1987		1988		1989		1990	
	A	B	A	B	A	B	A	B	A	B	A	B
No. of vessel	37	0	52	4	134	124	157	216	257	136	244	138
No. of fishing day	1,480	0	2,346	300	6,649	4,699	6,943	7,632	9,929	4,628	8502	4,824
Coastal landings (t)	70	0	30	8	160	735	107	2,803	74	793	64	1,801
Deepsea landings (t)	0	0	0	0	0	707	19	1,167	25	786	9	752
Total landings (t)	70	0	30	8	160	1,442	126	3,970	99	1,579	73	2,553

The national global trend in exploitation

The annual catch rates for pink shrimp, as provided by the local fleets, describe the national trend in CPUE as effected by the increasing rates of exploitation through the 1980s, by both local and foreign fleets (whether licensed or unlicensed). The 2–year period of 1981–82 describes the first period of increasing fishing intensity in our study. At this level, the stocks have responded as could be expected to increasing fishing intensity.

The second period of increasing fishing intensity is 1983–84, which shows a steady decline in CPUE. The stocks adjusted to this new level when effort was maintained at the same level in 1985, and there was consequently no further decline in CPUE, but rather a slight increase in stock biomass. Subsequently, a further decrease in CPUE in 1986 restored the stocks to the level they were in 1983. Increasing fishing effort in 1987 was logically expected to have resulted in a fall in CPUE, but such a drastic decline was not anticipated. This was surprising, and even more so in 1988 and 1989 when CPUE steadily declined in the face of decreasing fishing effort. The reason for this unexpected trend in catch rates could not be immediately found. The situation clearly suggests that the true effort values that are producing the declining CPUEs must be greater than the ones being reckoned with and this might well be referring to the locally unnoticed operations of foreign vessels that contribute to the landings in Las Palmas. The locally–based shrimpers have been reporting modest catch rates of 200–300 kg·day^{-1} at the same time as foreign fleets were reporting catch rates of 400–500 kg·day^{-1} (Table 6).

Table 5. Landing statistics of *P. longirostris* by Spanish trawlers. The catch is in kilogram (kg) and the effort in hours (hr). The number of vessels providing the data in the table were 2 in 1981, 2 in 1982 and 12 in 1988.

Vessel class (GRT)	1981 (2 vessel)		1982 (2 vessel)		1988 (12 vessel)	
	Catch (kg)	Effort (hr)	Catch (kg)	Effort (hr)	Catch (kg)	Effort (hr)
0–150	0	0	0	0	0	0
150–200	0	0	304	21	13,098	110
200–300	305	12	550	20	2,374	47
300–350	2,444	57	0	0	4,628	155
350–400	0	0	0	0	687	29
400–450	0	0	0	0	0	0
450–500	0	0	0	0	20	4
Total	2,749	69	854	41	20,807	345

Global Production Models and Maximum Sustainable Yield

The production models of Schaefer and Fox have been used to determine the MSY for the Sierra Leone shrimp stocks of pink shrimp. The basic catch and effort data that were used to determine the annual CPUE values (Table 6) were obtained from SFC, a major fishing company based in Freetown. To derive the global parameters for the models, the proportional ratio of company fishing effort to national fishing effort was determined and the values raised accordingly. The MSY have been estimated as 2,610 tonnes and 25,320 fishing days from the Schaefer model, and 3,560 tonnes and 47,180 fishing days from the Fox model.

Conclusions and Recommendations

The MSY estimates from Schaefer and Fox of 2,610–3,560 tonnes agree fairly well with that of 2,200–4,000 tonnes derived by the Thompson and Bell model and suggest an optimum effort level of 25,320–47,180 fishing days.

According to observations with local vessels, a boat's monthly trip lasts for 25 days on the average and from this it can be deduced that a boat will operate 300 days annually. Further, the MSY catches will be obtained by 74–157 annual boat trips. It follows, therefore, that if 14 vessels from the major company whose data were applied were expending 129 and 115 boat trips in 1987 and 1988, then fishing for shrimps must have been going at about MSY. At least the magnitude of the 1988 landings in Las Palmas of 3,000 t of pink shrimp indicates that this may be true. It should also be noted that "optimum" yield corresponds to approximately 60% of MSY. It is therefore concluded that since the 1987–88 period, catches of pink shrimp have been in excess of the recommended levels, and that unauthorized fishing has contributed much to this situation. A similar situation is expected with the deep–sea shrimps. It is therefore advisable that management measures be implemented to prevent a further increase in the number of vessels and reduce fishing intensity on shrimps. The advent of the MPSSL is expected to have brought some respite to the stocks through the exercise of some amount of control. The imposition of the fishing limitation zone is expected to help the stocks to recover during 1991, especially for the protection this measure affords to the nursery grounds. Data to assess success in this regard have not been available. It is also recommended that a suitable format for the collection of data be implemented to satisfy basic biological questions.

Table 6. Catch and effort data from the Sierra Leone shrimp fishery used in the production models of Schaefer and Fox

Year	Catch	Effort	CPUE	ln(CPUE)
1981	237,713	1,318	180	5.195
1982	452,736	2,079	218	5.383
1983	557,499	2,711	206	5.326
1984	588,289	3,494	168	5.126
1985	609,731	3,505	174	5.159
1986	564,577	2,749	205	5.325
1987	511,154	2,983	171	5.144
1988	369,732	2,440	152	5.021

Table 7. Monthly averages of CPUE (kg·day^{-1}) for coastal and deep–sea shrimp species from the Las Palmas–based trawlers, according to GRT class of vessels.

	Farfantepenaeus notialis		*Parapenaeus longirostris*	
	50–149 GRT	330–499 GRT	50–149 GRT	330–499 GRT
January	350	3	0	6
February	442	19	0	4
March	464	60	0	0
April	289	38	3	3
May	411	28	3	5
June	633	19	0	3
July	300	58	5	0
August	439	54	0	22
September	394	40	3	1
October	349	20	2	9
November	314	35	2	8
December	276	10	6	10

Table 8. Monthly CPUE (kg·day^{-1}) of *F. notialis* from the Sierra Leone shrimp fishery presented as averages of two–year periods.

	1981–82	1983–84	1985–86	1987–88	1989–90
January	131	260	318	244	160
February	112	239	284	245	108
March	119	249	310	267	190
April	118	267	293	249	145
May	113	272	234	248	168
June	117	251	224	166	170
July	134	261	242	230	145
August	160	275	258	212	115
September	157	257	245	223	92
October	180	258	241	230	86
November	187	258	245	183	56
December	173	259	235	218	86

Acknowledgment

My sincere gratitude goes to Dr. J.M. Vakily for his assistance in the preparation of this paper.

Reference

Garcia, S. 1977. Biologie et dynamique des population de crevettes roses, *Penaeus duorarum notialis* (Perez-Farfante 1967) en Côte d'Ivoire. Trav. Doc. 79, 271 p. ORSTOM, Paris.

Garcia, S. and F. Lhomme. 1977. L'exploitation de la crevette blanche (*Penaeus duorarum notiali*) au Sénégal: histoire des pêcheries en mer et au fleuve, evaluation des potentialités de capture. COPACE/PACE Ser. 77/5:17–40

Taconet, M. 1991. Rapport sur les statistiques de pêche dans les zones 34.3.14 et 34.3.3 de la flotille internationale débarquant à Las Palmas. Project GCP/RAF/265/FRA., COPACE. FAO, Rome.

Thiam, D. 1991. Note sur la pêche des crevettiers espagnols de la Guinée Bissau, La Guinée, et La Sierra Leone. Trav. Doc. CRODT, BP:2241. Dakar, Sénégal.

Willman, R. and B. Frielink. 1987. The shrimp fishery of Sierra Leone. CECAF/TECH/87 79.

The Mangrove and Coastal Environment of Sierra Leone[1]

R.G. Johnson[a] and R.G. Johnson[b]

[a]*Institute of Marine Biology and Oceanography (IMBO), Freetown, Sierra Leone*
[b]*Department of Geography, Fourah Bay College, Freetown, Sierra Leone*

Abstract

This paper examines the state of the mangrove resources in the coastal areas of Sierra Leone. It briefly describes the geomorphological features found along the Sierra Leone coastline as a background to the examination of the mangrove habitat. The state of the mangrove resources is looked upon from various standpoints. These include the present state of affairs, the factors responsible for its depletion, and the consequences of its depletion on fishing and coastal erosion. The concluding part of the paper focuses on simple management practices, aimed at conserving this resource and recommendations are also made for its sustainable use.

Introduction

Human activities exert a great deal of influence on the mangrove resource and coastal environment in Sierra Leone, and indeed most parts of Western Africa, especially in relation to the production of wood fuel, land degradation, coastal erosion and fishing. The composition of the mangrove resource in Sierra Leone is unique in terms of its species, all of which are found in the West African subregion. The prevailing hydro-meteorological conditions often result in marked spatial variations of the mangroves in some areas. The more accessible mangroves tend to be overexploited, whilst mangroves in less accessible areas are often underexploited. The levels of exploitation of the mangrove resources vary from year to year with intensification, at present resulting from the fuel crisis in the country. The effects of this deliberate or inadvertent exploitation of the mangrove resource cannot be overemphasized. It ranges from the destruction of wildlife and elimination of the nurseries of juvenile fish and crustaceans to coastal erosion leading to the silting up of our bays and estuaries. There are several ways in which these valuable resources can be used and conserved at the same time. Through appropriate measures, we can make sustainable use of this resource without much damage to the coastal environment and habitats. This paper addresses two major aspects of the resource and its exploitation:

- We discuss the characteristics of the coastal zone of Sierra Leone –the state of the mangrove resource in terms of its distribution, productivity, significance to fisheries and exploitation for wood fuel and human livelihoods;
- We recommend practical measures aimed at minimizing the level of damage being done to this coastal resource.

The Coastal Environment of Sierra Leone

The coastal environment of Sierra Leone can be divided on the basis of geomorphology and dominant geomorphological processes, into four type of ecologies (Anthony 1988):

- Mangrove swamps, tidal inlets and inter–tidal mudflats associated with estuaries and sheltered embayments;
- Pocket beaches alternating with rocky headlands in the Freetown Peninsula;
- Low cliffs (5–20 m) of poorly consolidated clay, sand, silt, and gravel of Eocene to upper Pleistocene age;
- Sand beach ridges, which form extensive plains of medium to coarse quartz sands and occur along 38% of the coastline.

Much of the coastal area of Sierra Leone is characterized by scattered and small fishing settlements. Along the coastline of the Freetown Peninsula, industrial, residential, touristic and recreational developments are beginning to occupy much of the coastal area. Accompanying these developments is the dependence on the coastal environment for transportation, food, water, defense and recreation. This environment may be more than a hundred meters deep or may extend several meters above sea level in the form of raised beaches. Some of the coastal areas are well protected and not subjected to high physical energy except for occasional storms, whereas beaches and tidal inlets are continuously modified by waves and currents.

The coastal strip encompassing the shallow water and intertidal area is clearly the most vulnerable, as well as the most abused marine zone. Its sensitivity is directly tied to the diversity and intensity of the activities that take place there, and the threat to its future is related to the increasing concentration of local populations in the area. The consequences of coastal development are of the highest concern, as they create physical changes in natural habitats, especially intertidal mudflats and mangrove forests. Because of their location near terrestrial sources of depositional products, coastal environments contain large amounts of nutrients. The combination of this nutrient supply with generally shallow water gives rise to a diverse fauna and flora. These coastal areas also serve as the spawning and nursery grounds for many organisms of great commercial importance such as clams, oysters, shrimps, lobsters and many varieties of fish. In order to utilize the full potential of the coastal environment and

1 Cite as: Johnson RG and Johnson RG (2012) The mangrove and coastal environment of Sierra Leone. pp. 50-54. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

yet not plunder its resources, we need to develop more and improved methods of conservation and to have extensive knowledge of its complexity.

Table 1. Distribution of forest areas in Sierra Leone.

Type	ha
Closed high forest	365,200
Secondary forest	261,000
Forest regrowth	3,774,400
Savanna	1,619,200
Mangrove	283,761
Total	6,303,561

State of Mangrove Resources

Approximately 47% of Sierra Leone's coastline is covered by mangroves that form a substantial area of the estuarine swamps, occupying an area of about 2,300 km². The mangrove swamps and mud flats are associated with estuaries and sheltered embayments at the foot of the coastal terraces. The mangroves comprise the main types of vegetation covering the coastal areas. All the different species belonging to four genera found in West Africa can be found in Sierra Leone. They constitute 4.5% of the total distribution of forest areas in Table 1. The most common species - which can be recognized by the arch–formed stilt roots developing from the main stem as well as aerial roots hanging down from the branches - belong to the *Rhizophora* family or red mangrove (Table 2). Mature trees can reach a height of about 30 m and a diameter of above 60 cm just above the stilt roots.

Table 2. Mangrove species in Sierra Leone

Botanical name	English	Krio
Rhizophora racemosa, *R. harrisonii*, *R. mangle*	Red mangrove	Sol–wata mangro
Avicennia africana	Black mangrove	Sol–wata mangro
Laguncularia racemosa	White mangrove, Foolish mangrove	-
Concarpus erectu	Button mangrove, Buttonwood	-

Distribution of Mangrove Resources in Sierra Leone

The distribution of mangrove resources in Sierra Leone is fairly simple. The mangroves are concentrated in four major locations. These include those found around the Scarcies River, the Sierra Leone River, Yawri Bay and Sherbro River (Table 3). In the Scarcies River, stands of mangroves, which are of commercial importance, are concentrated along the riverine fringes of Mahela, Sasiyek and Kambiadi Creeks. Limited mangrove stands can be found in Yeliboya Island. An extensive fringe of shrubby mangroves can be found around the estuary of the Sierra Leone River and the Bunce River, which is a tributary of the Sierra Leone River estuary, and which forms the eastern boundary of the Freetown Peninsula.
Along Yawri Bay, the mangroves occur as a coastal belt of varying width, stretching form Tombo to Shenge. The mangroves are denser in the estuarine plains of the three main rivers, namely Ribi, Kukul and Kagboro Creek.

The mangrove vegetation has also colonized large areas of the tidal swamps north of Sherbro Island and now fringes the mouths of the Lulu Nyama and the Bimbi Rivers. However, the bulk of the mangroves form a coastal belt north of Sherbro Island. This belt is tended in several places by the Thuaka Tetibul, Bagru, Moteva, Tese and Jong Rivers. Commercial stands of mangroves are also located at Rongotok, Gbangbaia, Kangama, the upper reaches of Moteva and Titibul Creeks. Mangroves are also found on Turners Peninsula. The total area of mangrove vegetation, including unproductive areas, amounts to about 1,800 km². This can be seen from Table 3, which shows the distribution of mangroves in four principal areas.

The productive mangroves are located mainly in Yawri Bay and the Sherbro River area within the coastal districts of Moyamba and Bonthe. The Chiefdoms with significant areas of mangroves are given in Table 4. Vegetation patterns or zonation are often recognizable in mangrove vegetation. On Yeliboya Island and the sheltered riverine fringe of Sasiyek Creek, white mangrove (*Laguncularia racemosa*) occasionally colonizes newly formed soft mudflats which are inundated by all high tides. This species appears to flow freely, at least during the dry season, forming low, spreading shrubs along the banks of inland tidal channels. Black mangrove (*Avicennia nitida*) colonizes the mudflats inundated by medium to high tides. Along the better–drained riverbanks, *Rhizophora racemosa* is commonly found in association with black mangroves. Salinity plays an important role in the distribution of the several species of mangroves found in Sierra Leone, especially during the dry season when hypersaline conditions are prevailing on the landward fringes. In the Kambia District and on the shallow laterized shores along the Freetown Peninsula, white mangrove is common as a pioneering species, as the land builds up through sedimentation and under suitable conditions. It is less common to the Sherbro River area where the rainfall is higher and there are minor fluctuations in salinity. Along the Sierra Leone River banks, creeks, and coastal estuarine plains where the soil is better consolidated and at a higher level, *Rhizophora racemosa* secures a foothold and flourishes. Towards the swamp interiors, which are less well flushed by the tidal wash, the tree becomes stunted thickets with malformed stems or becomes multistemed dwarves or shrubs as in the case along some parts of the Freetown Peninsula. In the interior of most of the mangrove swamps in Sierra Leone, particularly in the northern part, black mangrove tends to become more abundant. This may be due to the fact that this species appears to be more salt tolerant and can grow under very unfavorable conditions.

Table 3. Distribution of mangroves (Chong 1987)

Location	Area (ha)	%
Scarcies River	13,007	7.1
Sierra Leone River	34,234	18.6
Western Area	7,189	3.9
Yawri Bay	29,505	16.1
Sherbro River	99,854	54.3
Total	183,789	100.0

Productivity of the Mangrove

Mangrove vegetation provides habitat for a variety of wildlife. A number of mammals frequently visit these habitats, but few live there permanently. Among these are the long–snouted swamp crocodile (*Crocodylus catabractus*) which formerly inhabited the mangrove swamps in the Kambia District, crab–eating monkeys, and a large variety of birds, such as herons, kingfishers, etc. A variety of fish inhabit mangroves, as well as shrimps, which use the mangroves as nursery grounds. The mangrove oyster (*Crassostrea tulipa*) is found on the stilt roots of the *Rhizophora* species (red mangrove). The dead leaves and branches of the mangroves serve as a source of food for microorganisms, which in turn form the food base for juvenile fish and shrimps. The mangrove vegetation also provides food for a variety of animals, such as the manatee, whose habitat in the Sherbro River stretches from the tidal estuary to the inland freshwater rivers. Being herbivorous, manatees graze on aquatic vegetation, including the mangroves. It is noteworthy that wildlife management in mangrove areas in Sierra Leone has not been given the attention it deserves. The mangrove habitat in the inter–swamp margins acts as a last refuge for many traditional land animals that are displaced from their natural upland habitats due to extensive burning of inland vegetation associated with traditional farming practices such as bush fallow. An example of such animals is the forest genet (*Genelta maculata*), which is found in the swamp margin, although its natural home is the upland bush. However, the wildlife management aspect is hampered by lack of basic research on the ecology of the mangrove fauna and the wildlife division of the Forestry Department has given little attention to this matter.

Table 4. Chiefdoms with mangrove resources.

District total mangrove	Chiefdom	Area (in mile^2)	Mangrove (ha)
Port Loko (27,095 ha)	Koya	275	degraded
	Loko Masama	275	- do -
	Marforki	320	- do -
	Kaffu Bullom	80	- do -
Moyamba (24,505 ha)	Ribi	205	6,080
	Bumpe	196	2,011
	Kagboro	225	12,056
	Timdel	188	2,500
	Bagruwa	282	5,284
	Banta	280	1,247
Bonthe	Imperi	156	8,375
	Jong	150	
	Bendu–Cha	90	2,788
	Dema	55	
	Sittia	151	

Source: Chong (1989)

Uses of Mangrove Resource

The mangrove ecosystems are used for many varied purposes. These include the production of energy in the form of wood fuel and charcoal and for construction purposes such as timber, scaffolds, railway tiles, boat building, dock pilings, flooring, etc. Within the fishing community in the coastal environment they are used for making poles for fish traps, as wood for fish smoking, production of tannin for net and line preservation. Other products derived from mangroves include food, drugs and beverages.

In Sierra Leone, the mangroves are cleared for a number of reasons ranging from agriculture to making charcoal. Extensive mangrove areas near the Great Scarcies have been cleared for rice cultivation. However, these large–scale government–sanctioned projects are not the subject of the discussion here. We are more concerned with the unplanned and haphazard clearing of the mangrove vegetation by the local coastal inhabitants for a variety of purposes. The most noticeable of these purposes is that of providing wood fuel, not only for the coastal and rural populace, but also for the urban population. Mangroves make excellent charcoal. Under proper management, they can produce a sustained flow of wood required for the charcoal industry. Such development will invariably create industries in rural areas, provide direct and indirect employment income flows and a host of indirect benefits.

In most of the coastal areas, the mangrove resource has traditionally been regarded as an inexhaustible resource, as well as a hindrance to agricultural development. It has therefore been exploited and cleared in a haphazard manner without any thought for its conservation. The above uses of the mangroves diminish the forest area available for wood production, especially when there is haphazard clearing resulting in a lot of damage to the food, shelter, and breeding grounds for fish, crabs, shrimps and oysters. The mangroves also stabilize the coastline, thus preventing erosion and the consequent siltation of rivers and estuaries during tidal action.

In mangrove swamps, the dominant marine force is the tides, which bring in and take out deposits. The substrate thus formed serves as a breeding ground for varied organisms including crabs. Erosion is a threat to some areas, resulting in the retreat of the mangroves and the navigational channels of the Sierra Leone River Estuary, which are subjected to occasional dredging due to increased siltation.
They also act as a water reservoir, stabilizing the ground water level and thus prolonging the period of cultivation of agricultural crops on the land bordering the mangrove areas. When extensive erosion occurs, the enormous amount of sediments brought down the rivers and estuaries from further upstream can cause land to form. On such newly formed mud, the Black mangrove and the white mangrove are often the first species to appear, for example in the Kambia District.

The rate of mangrove wood consumption, if unabated with effective management policy, will cause serious damage to the coastal environment. It is worth mentioning that the Forestry Department has now embarked on a mangrove–replanting scheme in order to mitigate the effects of deforestation in some of the coastal areas.

The Significance of Mangroves to Fisheries

The main preoccupation of the coastal populations of Sierra Leone has traditionally been fishing. This activity can be traced back to the physiographic characteristics of the coastline, which is frequently flooded by Atlantic water. The inundations represent estuaries and numerous bays and creeks fringed with mangrove vegetation. It is therefore of interest to note the striking link between the bays, creeks and estuaries and the settlements found right along the country's coastline. These fishing villages depend heavily upon the surrounding mangroves for smoking and drying their catches (a simple but effective method of preservation), for building materials, fishing stakes and wood fuel for cooking. In this regard, the fishing communities of the Shenge Region in Sierra Leone require approximately 12,000 m^3 of solid wood for its annual production of 6,000 tones of smoked fish (Loyche 1988). Probably less conspicuous would be the significance of mangroves to biological productivity, and its indirect influence on fisheries. Since the mangrove ecosystem provides nurseries and habitats for the development of variety of fish species as well as shrimps and oysters, their destruction will invariably affect the primary and secondary production of its habitat. This will be reflected in the deterioration of fish catches in the nearshore zones, which are so important for artisanal fishing. Table 5 indicates some of the organisms found in the mangrove habitat of the Bunce River, as noted during the COMARAF workshop held in Sierra Leone and hosted by IMBO in May 1990.

Mangrove Management

With such a wide range of possible uses of the mangrove resources, it is important to work out sound policies to enhance its proper use with as little damage as possible to the coastal environment. All mangrove species in Sierra Leone are used for firewood. They are used extensively in virtually all coastal villages for domestic purposes–for smoking fish, for building construction, boat construction, and in making salt. There is a great demand on the *Rhizophora* spp. because the wood is dense and burns uniformly. The current situation is that the mangrove is cut for firewood and charcoal production and for the other uses outlined above throughout the year. Selective felling takes place due to the unavailability of sophisticated cutting facilities and transportation constraints. Trees are generally felled just above the silt roots with a local hand axe. Consequently, very large trees are spared and the logs are transported in dugout canoes, which do not carry heavy loads. All these constraints lead to low productivity, not to mention the difficult working conditions and the poor organization of the cutting activities.

In non–arable mangrove habitats adjacent to swampy areas, the establishment of a small village woodlot as a management option will not only produce wood fuel and food, but will also stabilize river banks, shorelines, canals of salt ponds, abandoned fields, etc. Mangrove areas are being cleared for rice cultivation and it is therefore important to determine which land use option should be given priority in the different areas on both a short and long term basis. In order to work out proper management policies, appropriate information is needed in terms of the extent of the mangrove areas, land tenure system, population density, wood demand, etc. The environmental impact of the destruction of the mangroves should also be monitored. For instance, surveys of wood fuel needs at the village level should be conducted and the data obtained can be used in forest management planning. Rice fields or salt ponds can be created in areas far from the sea, where the clearing of the mangroves have commenced and where wood production is low and the water is not saline enough for commercially viable species of fish and shrimps. Priority should, however, in most cases, be given to the role of the mangroves as habitats and breeding grounds for fish, shrimps and oysters and as a source of wood. In areas which have been overexploited, and natural regeneration becomes difficult, reforestation activities should be carried out using for instance *Rhizophora racemosa*.

The original mangroves on the estuarine plains of both the Great and Little Scarcies Rivers have been cleared extensively for rice cultivation (limited mangroves still remain on Yeliboya Island). Vegetation patterns or zonation can be used as a guide in the silvicultural manipulation of the forest crop, particularly in determining the optimum ecological habitat appropriate for the dominant wood producing species. An understanding of the ecological zonation of forest types is an important requirement in mangrove management. To carry out such

Table 5. Organisms found in the mangroves of the Bunce River

Fish species encountered	Approximate abundance[a]
Ethmalosa fimbriata	xxx
Sardinella maderensis	xxx
Gerres melanopterus	xx
Liza dumerili	xx
Mugil sp.	xx
Pseudotolithus brachyura	xx
Ilisha africana	xx
Pseudotolithus brachygnathus	x
Plectorhycus macrahyus	x
Chloroscombrus chrysurus	x
Liza grandisquamis	x
Caranx senegallus	x
Scomberomorus tritor	x
Hemiamthus brasiliensis	x
Polydactylus quadrifilis	x
Brachydeuterus auritus	x
Galeoides decadactylus	x
Sepia officinalis	x
Trichurus lepturus	x
Dasyatis margarita	x
Carax sp.	x
Penaeus notialis	x

[a] xxx: very abundant; xx: abundant; x: present.

studies efficiently, large–scale air photos and ground surveys are needed. Rational management of any forest is based on in–depth understanding of the forest that can be obtained through a series of planned observations and measurements relating to its composition, structure and ecology. Ecological studies into plant succession and other related site factors in the mangroves should be considered in any research program.

Wildlife management in mangrove areas has been limited in Sierra Leone. Basic research on the ecology of the mangrove fauna is necessary. Surveys on populations, feeding, and migration habits of the major wildlife species–such as the manatee in the Sherbro River complex–should be undertaken. The size and effects of unregulated harvesting of major wildlife species should also be determined. Based on the results of the surveys, a comprehensive management and control plan of these species can be developed.

Other economically viable alternatives to the existing method of wood extraction based on selective felling should be explored. The use of the mangrove forest resources should be undertaken on a sustained yield basis, meaning that the amount of wood cut per year must not exceed the annual growth rate of the forest. Overexploitation of the mangroves should be avoided to prevent wood shortages and its effect on the fisheries. Mangroves should be cut in such a way so that a fringe of trees are left to protect the coastline against erosion, to provide mangrove seeds, and protect the habitats and breeding grounds for marine life and other animals.

Present State of Affairs

Concise and up–to–date reports on the state of the mangrove resource in Sierra Leone are not available. The aerial extent and distribution of the mangroves in Sierra Leone are usually derived from 1975/76 infrared aerial photographs and is surely a baseline guide. The 1:70,000 scale does not provide adequate resolution for definition and distinction of the various species of mangroves that have colonized the Sierra Leone coastal areas. Apart from case studies of the use of the mangroves and their potential for sustainable development, especially for wood fuel production, a general survey of the extent of the mangroves of Sierra Leone is needed. To do this will require a more recent set of aerial photographs of the coastal areas of Sierra Leone on a much larger scale, probably 1:20,000. The present state of the mangrove resource in Sierra Leone is very sketchy. Overexploitation through indiscriminate cutting for wood fuel and charcoal production, oyster collection and rice cultivation has reduced the entire mangrove vegetation to low shrubs and thickets. Consequently, erosion rates have increased, whereas sedimentation rates are abnormal, resulting in the creation of large areas of degraded forests and denuded mudflats in various areas within the vegetation. According to a 1979 land resources survey, the extent of "coastal woodland–mangrove and swamps" was 286,000 ha. This estimate includes all the vegetation types in the coastal wetland ecosystem, of which 171,000 ha are comprised of tidal mangroves (60%). Preliminary resource assessment surveys carried out by the UNDP/FAO Project in 1987 indicate that the extent of mangroves (in Sierra Leone) is about 171,600 ha, distributed in four major river/estuary systems. In the western area, there are about 7,139 ha of mangrove swamps mainly on state lands (formerly Crown Land). This is about 10.8% of the total areas (66,300 ha), and 40.6% of the total forest reserves (17,600 ha). At present, there are no legally constituted mangrove reserves. About 4,000 ha are available and suitable for sustainable forest management, as some mangroves have already been converted for subsistence rice cropping and other non–wood uses.

In the foreseeable future, population in the coastal areas is likely to increase. Consequently, the pressure on the mangrove ecosystem will invariably increase. In order to fully harness the mangrove resources on a rational basis with minimum damage to the coastal environment, we recommend that:

- A general survey of the mangrove resources of Sierra Leone be carried out using large–scale air photos and detailed ground surveys.
- Rational management of our mangrove resource be based on an in–depth understanding of the mangroves and its environment which can be obtained through a series of planned observation and measurements relating to its composition, structure and ecology.
- Mangroves should be cut in such a way that a fringe of trees are left to protect the coastline against erosion, and to provide seeds to protect the habitats and breeding grounds for marine life.
- The size and effects of unregulated harvesting on major wildlife species should also be determined.

Additional References

Anthony, E.J. 1988. Artificial structures and shorelines, Sierra Leone. 4 p.

Chong, P.W. 1987. Proposed management and integrated utilization of mangrove resource in Sierra Leone. FAO/UNDP/SIL/84/003, Field Document No. 6, Freetown, 126 p.

Chong, P.W. 1989. Community participatory forestry for fuel wood production in the western area, Sierra Leone. FAO/UNDP/SIL/008, Field Document No. 6, 75 p.

Lotche, M. 1988. Alleviation of the fuelwood supply shortage in the western area, Sierra Leone. Preliminary assessment of the demand for the supply of forest products, particularly mangrove fuel wood, in the fishing communities of the Shenge Region. FAO/UNDP/SIL/84/003, Field Document No. 15.

Sierra Leone. 1990. Multi–disciplinary study of the Bunce River. Technical Report, UNESCO/UNDP Workshop. COMARAF, Sierra Leone.

Comparative Analysis of the Marine Resources of the Mano River States[1]

N. Iscandari

Ag. Director of Fisheries, Fisheries Department, Freetown, Sierra Leone

Abstract

The Mano River Union States are comprised of the Republic of Liberia, the Republic of Sierra Leone, and the People's Republic of Guinea. Research over the past decades has shown an increase in awareness of the complexity and subtleties of the natural marine ecosystems adjacent to these states. This sub–regional union of states within the Economic Community of West African States (ECOWAS) has some of the greatest potential for the development and management of marine resources. This paper focuses on the implications of the Third United Nations Conference on the Law of the Sea, the resource potential, and prospects for rational development of the resources.

Introduction

The past two decades have witnessed a revolution with respect to the law governing the world's oceans. A new ocean law permits approximately 40% of the former "high seas" to be brought under varying degrees of coastal state jurisdiction. The Mano River Union states (MRU) was created when a declaration was signed on the 30th of October 1973 by Liberia and Sierra Leone, to be later joined by Guinea in March 1980. Expanded jurisdiction of these MRU states offers the promise of expanded resources. Moreover, the associated problems for effective management and exploitation of these resources are both numerous and insurmountable, due to the limited administrative experience, infrastructure and capital resources of these Union States.

The Mano River States Marine Environment

Land/sea interface

The marine environment is comprised of three major components: atmospheric, marine and terrestrial. The interactions of oceanic, geologic and climatic processes have formed a characteristic coastline of the MRU states. From Guinea through Sierra Leone, to west of Cape Palmas in Liberia, the absence of a constant longshore drift and a high tidal range has drowned the estuaries and prevented significant sandbar or lagoon formation. This region is characterized by extensive mudflats and mangrove swamps which makes access to the excellent estuarine harbors extremely difficult. The only exception is the Sierra Leone Estuary, which is deep and is the only natural harbor west of Cape Palmas, Liberia. Because of the prevailing currents and wave action, there is minimal shoreline deposition and a long string of low cliff and rocky promontories.

Continental shelf

The continental shelf adjacent to the MRU states is extremely variable in width, ranging from an average of 20 nautical miles (nm) from Liberia to about 100 nm in Sierra Leone, and over 110 nm in Guinea. The continental slope is also very steep, falling quickly to about 2,300 m adjacent to the MRU states.

Oceanographic conditions

The high temperature, high humidity and heavy rainfall affect the oceanographic conditions of the waters of the MRU states. Also, the major oceanic currents of the equatorial Atlantic play an effective role in primary and secondary production of fisheries in the region (Newman 1969). Within the region, the Equatorial Counter Current flows in the westerly direction, and the slow moving Canary Current also moves in a westerly direction from the northwest coast of the African continent. The southern branch of the Canary Current joins the Equatorial Counter Current to form the strong westerly flowing Guinea Current. In the coastal region of the MRU states, a combination of bottom topography, local conditions, and river outflow causes the circulation patterns to exhibit a higher degree of variability over time and space (During *et al.* 1980). Within the oceanic water of the MRU states, there are no upwelling areas. To the north is situated the Northern Upwelling (off Mauritania/Senegal) and to the south, the Southern Upwelling off the northern shores of the Gulf of Guinea between Cape Palmas and the Niger River.

1 Cite as: Iscandari N (2012) Comparative analysis of the marine resources of the Mano River States. pp. 55-57. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

Marine Resources

The MRU states are situated in the East Central Atlantic zone, and they have considerable fishing grounds (Table 1). Fisheries resources have been exploited by both artisanal and industrial sectors. Fishing gears are operated from a variety of canoes and industrial vessels of different gross registered tonnage (GRT), overall length, horsepower (hp), and hold capacity. There is an acute problem of standardizing various effort units to obtain global indices and abundance of coastal pelagic fish, demersal fish, and shrimp resources. The primary foreign industrial fleets are the USSR, Republic of Korea, Italy, Greece, Senegal, Republic of China and Côte d'Ivoire.

Table 1. General characteristics of the coastal geography of the MRU States[a]

Country	Continental width (nm)	Shelf area (thousand km^2)
Guinea	70–110	50.2
Liberia	10–20	18.4
Sierra Leone	15–80	30.0

[a] Source: FAO, CIDA/FAO/CECAF Seminar on the Changing Law of the Sea and the Fisheries of West Africa, FAO/TE/INT 180(a) (Can).

Industrial Shrimp Fisheries

The following shrimp species are available in the waters of MRU states: the Guinea shrimp (*Holthuispenaeopsis atlantica*) is abundant in the southern sector between Sierra Leone and Liberia; the southern pink shrimp (*Farfantepenaeus notialis*) dominates the Sierra Leone waters; and the tiger shrimp (*Melicertus kerathurus*) in the northern Sierra Leone and Guinea waters. The bycatch of shrimp fishing consists of *Brachydeuterus* spp., *Gerres melanopterus*, *Pomadasys* spp., *Pseudotolithus* spp., *Sphyraena* spp. and *Cynoglossus* spp. (see also Showers, this volume).

Bottom and Midwater Trawl Fisheries

The bottom and midwater trawl fisheries exploit demersal fish such as soles, sparids and threadfins. There is strong evidence that most of the midwater trawlers are engaged in the harvesting of pelagic species such as *Sardinella* spp. (Everett *et al.* 1980).

Offshore Hydrocarbons and Mineral Resources

Within the past decade, several surveys for oil and gas deposits have been undertaken in all three MRU states. Exploratory activities have indicated that offshore sedimentary basins including Bove Basin (the former Portuguese Guinea Basin) and the Liberia Basin, as well as several areas off Sierra Leone (where there is no basin) have shown good prospects. No commercial exploitation has been undertaken in seabed mining. However exploratory surveys indicated that inside the EEZ of the MRU states, there are likely deposits of diamonds, titanium, copper, zinc and monazite.

Ocean energy

Though not developed at present, direct production of energy from ocean waters adjacent to MRU states may become increasingly important in the future (Wick and Schitt 1981). The obvious sources include tides, waves, wind and ocean thermal gradient exchange, salinity gradient energy conversion, and oceanic bioconversion. The thermal gradient differential in the MRU states is one of the most favorable in the world for ocean thermal energy conversion (OTEC), especially since potential sites are located at reasonable distances from shore.

Marine transportation

Although it is a use rather than a resource, marine transport through the coastal area of MRU states is also very important. Firstly, there is substantial import–export and interregional trade. Secondly, this region is an important pathway for Middle East crude oil bound for North America and Europe. It is estimated that over 1,765 super tankers traverse the EEZ of MRU states. The results of such activity, especially due to tank and ballast washing, are already apparent in the environmental degradation of the MRU coastal states. There is regular evidence of tar balls on the beaches in all three MRU states. At present, there is no vessel traffic management system (VTMS) and very little navigational aids employed to aid vessel traffic.

Ecological and Pollution Problems

Ecological relationships demonstrate again and again that political boundaries are often artificial and bid all countries of the world, including the MRU states, to take further steps towards the shores of environmental cooperation. For example, air currents may carry pollutants such as toxic gases (sulphur dioxide and nitrogen oxide). Ocean currents may carry an oil spill from one country to another or provide convenient "conveyor belts" for transboundary movement of fish and marine mammals (IMCO/UNEP 1982).

In early 1988, toxic waste dumping became a very great concern for the three MRU states, as both Sierra Leone and Guinea have become victims of industrial waste transfers from developed countries to be disposed of in developing countries. Because of the dumping of nuclear and industrial wastes, a conference on Waste Dumping was held in Accra in June 1988, in order to take a positive stand in preventing toxic waste dumping in Africa.

The Law of the Sea Convention as Observed by MRU States

The Law of the Sea Convention, which was signed on 10 December 1982 (two of MRU states were signatories) (see Table 2), stands like a beacon emanating legal and ethical mandates directing states to chart a course of cooperative environmental management (Ferriera 1979). Article 197 calls for a general cooperation at the global and regional levels in formulating international rules and practices for marine environmental protection. Article 207 bids states to harmonize policies for controlling land–based pollution, while Article 209 asks states to seek consistency in laws regulating seabed activities under national jurisdiction, such as offshore oil and gas exploration and exploitation. Article 235 beckons states to cooperate in establishing adequate compensation schemes. With regard to living marine resources, the Convention urges cooperation in conserving transboundary fish stocks in general (Article 63), marine mammals (Article 65) and highly migratory species such as skipjack and yellowfin tuna and whales (Article 64).

Table 2. Signature and ratification of UNCLOS by Mano River Union States.

State	Final Act Signature	Convention Signature	Convention Ratification
Guinea	10/12/82	10/12/82	not yet
Liberia	10/12/82	10/12/52	not yet
Sierra Leone	-	4/10/84	6/9/85

General Pattern of MRU States Practice

The divergence in MRU state practice, with respect to expanded maritime jurisdiction, renders the identification of general patterns extremely difficult. At the most general level, there is a definite trend towards expansion. While there is a divergence with respect to the breadth of territorial sea, there is agreement on the maximum seaward limit of coastal state jurisdiction, and definite convergence with respect to the nature of exclusive fishing and economic zones (200 nm).

There is lack of bilateral initiatives with respect to management of living and nonliving marine resources. These MRU states are engaged in many regional initiatives, ranging from generally conceived political organizations to highly specialized sector programs.

The MRU states have started developing bilateral and multilateral programs in transnational marine management.

References

During, A., F. Ostapoff and J. Merie. 1980. Physical oceanography of the tropical Atlantic. University of Maimi, UNESCO.

Everett, G.V., M. Ansa—Emmim, and I. Miznishi. 1980. A summary overview of the fisheries in the CECF Region. CECAF/TECH/80/Dakar, 62 p.

Ferriera, P.S. 1979. The role of African states in the development of the Law of the Sea at the Third United Nation Law Conference. Ocean Development and International Law Journal.

IMCO/UNEP. 1982. The status of oil pollution and oil pollution control in the West and Central African region. UNEP Regional Seas Report and Studies No. 4.

Newman, G. 1969. The equatorial undercurrent in the Atlantic Ocean, p. 33-44. In Proceedings of the Symposium on the Oceanography and Fisheries Resources of the Tropical Atlantic, 20–28 October 1966, Abidjan, Côte d'Ivoire, UNESCO, Paris.

Wick, G. and W. Schitt. 1981. Harvesting ocean energy. UNESCO Press, Paris.

Evaluation of Diesel Engine by the Tombo Project, Sierra Leone[1]

S.E. During

Fisheries Pilot Project, Tombo, Sierra Leone

Abstract

Diesel–powered motor vessels were introduced to the Tombo fishery, Sierra Leone in 1983. Several FAO–designed inshore fishing vessels were constructed and used in the Project's experimental fishing programs. These transomed vessels did not prove popular with the local fishermen, who found the length/width ratio of the crafts unsuitable for the shooting and hauling method employed in the encircling ringnet fishing in Tombo. After frequent consultation and discussions, it was decided that the most suitable craft to satisfy the needs of the Tombo ringnet fishermen would be a diesel–powered form of the "Ghana–type planked" boat. This diesel motorization program was conceived of due to the prevailing shortages and increasing fuel prices of petroleum at that time.

Introduction

The motorization of large planked–type boats with inboard marine diesel propulsion commenced in Sierra Leone in 1985. The first vessel of this type was constructed outside the project compound by local boat builders and financed by the Tombo Boat Owners' Cooperative. It was powered by a 20 hp Perkins diesel engine and had a short but very successful fishing life span. This vessel, named *Peathea* was lost when it ran aground during inclement conditions in Tombo.

In February 1986, the first "Ghana" diesel boat was completed in the project boat yard and launched. During the construction of this craft and subsequent boats, local boat builders received supervision from project boat builders and engineering staff. A total of five boats were built in 1986, seven in 1987, and two in 1988. Before the boat–building program was halted, fourteen diesel propelled Ghana–type planked boats had been launched and commissioned into the Tombo ringnet fishery. This large–scale introduction was necessitated due to repeated requests from members of the Tombo Boat Owners' Cooperative for more of these vessels to be constructed under the Project's Diesel Motorization Program, which had a hire purchase credit component to meet the cost of purchase and installation of the marine diesel engine.

Boats Constructed Under the Diesel Motorization Program

Table 1 shows the boats constructed under the Diesel Motorization Program. After June 1988, boat–building activities relating to the Ghana–type planked inboard diesel boats came to a standstill, due to the slow repayment of loans. One small (alla) boat, with a ten hp Yamaha diesel inboard engine was built and launched in 1989 for Alhaji Alpha Koroma for (Yelefufu) drift–net fishing in Tombo.

Table 1. Boats constructed under the diesel motorization program.

Name of boat	Date launched	Name of boat owner
Peathea	1985	Boat Owners' Cooperative
Lumthubul	February 1986	Alhaji E. Smith
Bomikery	April 1986	Amara Conteya Kamara
Bintumani Star	September 1986	Alhaji Alpha Koroma
Kaffu Bullom	October 1986	Pa Kargbo
Safari Diesel	December 1986	Mr. Abdul Cole
Beautiful Woman	March 1987	Mr. Amadu Seaport Kamara
Sabanoh Lokomasama	May 1987	Mr. Foday B. Kamara
Ramcornee	June 1987	Alhaji E. Smith
Songo Star	November 1987	Mr. Sheriff Kargbo
Koya Star	November 1987	Mr. Bai Fornah
Loko Massama	November 1987	Hon. Sheka Kanu
Loko Massama II	November 1987	Hon. Sheka Kanu
John 3:16	June 1986	Mr. Kojo Espin

Problems Observed with the Ghana–type Diesel Boat

The Ghana–type planked diesel boat is a local design which has been strengthened by project recommendations to resist vibration caused by the diesel engine during normal operation. The engines were installed by project personnel, but the actual boat-building was done by local boat builders. It was discovered that after eighteen months of operation, the stiffness of the boat hull was weakened, and resulted in misalignment between gearbox and propeller shaft becoming a regular occurrence. The Yamaha ME188 and ME125 engines were fitted with hydraulic gearbox systems. The frequent misalignment and poor handling by the boat operators resulted in frequent gearbox malfunction.

In 1988 one of the boats was modified, and necessary changes were carried out by the project boat yard. The

1 Cite as: During SE (2012) Evaluation of diesel engines by the Tombo Project, Sierra Leone. pp. 58-60. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

dead wood was replaced and a double keel spanning from the rudder shoe to the front end of the engine bed was installed to provide the necessary stiffness. This converted boat operated for over two years, problem–free with no misalignment. All other problems with the new technique were due to improper maintenance and care of the boat and engine by the boat owners and operators. Frequent gearbox problems resulted from boats being operated with salt water–contaminated gear oil. The main engine unit operated more or less trouble–free in all boats, except for three engines. The first engine was damaged when the boat sank during a heavy storm with the engine running at full throttle, and the second and third engines were damaged due to operation of the engines without engine oil, resulting in engine seizure.

Outcome of Boats Constructed Under the Diesel Motorization Program

Table 2 shows outcomes of boats constructed under the Diesel Motorization Program.

Table 2. Outcome of boats constructed under the diesel motorization program.

Name of boat	Present status of boat
Peathea	Grounded in 1986 beyond salvage
Lumthubul	Laid off with heavy gearbox problem
Bomikery	Sank, salvaged, replacement engine installed, boat in operation until end of 1990–abandoned
Bintumani Star	Slipped for hull repairs and engine repair
Kaffu Bullom	Abandoned in 1990, Dismantled in November 1991
Safari Diesel	Abandoned in 1986 due to heavy gearbox fault. Boat was sold in 1990. Newly launched in November 1991 and operational.
Beautiful Woman	Abandoned in 1987 for no apparent reason. Boat was dismantled in November 1991.
Sabanoh Lokomasama	Abandoned in 1988. Boat was taken over by Project Management to recover debt.
Ramcornee	Only boat built by traditional boatbuilding site in Tombo. Boat was lost by grounding off Plantain Island.
Songo Star	Boat was modified in 1988, was submerged in 1991 and abandoned.
Koya Star	Abandoned in 1990 due to engine seizure and heavy wearing of crankshaft.
Loko Massama	Operating base was Goderich Village, was scrapped in 1990, due to engine seizure from poor handling.
Loko Massama II	Operational until June 1991 and scrapped, due to engine seizure.
John 3:16	Boat was dismantled in May 1991 due to peer group pressure.

Economics of Diesel Against Petrol–powered Ghana Boats

Table 3 shows the fuel consumption, guaranteed lifespan and savings of three different engine types. The performance of a 27 hp diesel engine is comparable to a 40 hp petrol outboard engine. The test results, as shown in Table 3, indicate that in the long run, only the diesel inboard engine offers a real solution as the propulsion method for the Ghana planked boats, given the current national macro—economic conditions. A fuel consumption field test was carried out by a project consultant in 1986. The field test indicated that the only solution for the artisanal fishery was motorization with diesel engines. If the fuel consumption for the petrol outboard against the diesel inboard and outboard engines are compared in terms of current Leone values, then huge savings are realized with the operation of diesel powered boats.

Reasons for the Apparent Failure of the Diesel Motorization Program

There were several reasons why the diesel motorization program failed to achieve project objectives. Repeated gearbox problems due to misalignment, challenges with boat weight, and the need for constant supervision and bailing were three major issues. Furthermore, during the occurrence of engine or gear-¬ box breakdown, fishing is completely interrupted, while in the case of outboard engine–propelled boats, a spare engine is fitted and fishing continues. Boat operators and owners also consider the practice of regularly checking and changing engine oil and fuel filters excessively bothersome. The investment by way of boat construction cost, in relation to the engine cost in the form of purchase loans given to the boat owners, was negligible, and with the attendant loan raising costs for boat construction, they could easily afford to abandon their boats and default on their loan repayments without any fear of prosecution by the project. Other participants who were interested in continuing with the program were pressured to abandon their boats by the main defaulters, therefore out of the total number of 14 boats constructed, only three were completely paid for.

Present Program on Diesel Motorization

A 27 hp outboard diesel engine was made available to the boat owners cooperative to conduct trials under normal Tombo commercial fishing operations. The trial is ongoing and after 8 months of operations the results are encouraging so far. Fishermen have indicated verbally to project management that this test 27 hp Yanmar diesel outboard engine should be ordered and retailed by the Project.

Table 3. Fuel consumption, guaranteed life span and savings of three different engine types[a].

Engine type	40 hp petrol outboard	27 hp diesel outboard	27 diesel inboard
Engine weight (kg)	62.0	82.0	400.0
Engine weight ($kg \cdot hp^{-1}$)	1.6	2.7	16.0
Service life (hr)	2,500.0	5,000.0	20,000.0
Engine cost (US$)	2,200.0	4,500.0	6,000.0
Engine cost ($US\$ \cdot hr^{-1}$)	63.0	148.0	210.0
Fuel consumption ($L \cdot hr^{-1}$)	18.0	6.0	6.0
Fuel consumption ($US\$ \cdot hr^{-1}$)	606.0	2.0	20
Fuel consumption ($US\$ \cdot 1000\ hr^{-1}$)	6,300.0	2,000.0	2,000.0
Savings ($US\$ \cdot 1000\ hr^{-1}$)	-	4,300.0	4,300.0

[a] 1 US$ = Le160.00 in June 1990, but Le480.00 in November 1991. Cost of petrol = Le1,200 $gallon^{-1}$ in November 1991, *vs.* Le1,000 for diesel.

Evaluation of Diesel Engines by the Shenge Project, Sierra Leone[1]

T.D.K. Taylor, M. Koroma, P. Lerois and M. Bangura

Shenge Integrated Fisheries Project, Freetown, Sierra Leone

Abstract

This paper examines strengths and weaknesses of the Shenge Project to test the use of the Yanmar 27 hp diesel outboard engines in the artisanal fishery of Sierra Leone. The objective of the project was to conduct controlled sea trials of the 27 hp outboard diesel engine with local fishermen and transport boat operators, to assess its performance in fuel consumption and other aspects. Successes included the considerable reduction in fuel consumption and improvements in speed, while challenges included compatibility of the engine with current boat specifications, mechanical challenges, and price.

Introduction

This paper seeks to highlight the trial results and experiences of the Shenge Project with the Yanmar 27 hp diesel outboard engines. Fuel has always been, and continues to be, a great concern in artisanal fisheries. The high cost of fuel (petrol and oil), coupled with frequent national scarcity, has always seriously affected the operations and profitability of the artisanal fisheries. In some cases, for example in the Ghana boat fishery, fuel may account for about 50% or more of the total running cost. Such a situation would normally promote ways and means to reduce fuel cost, with a view toward increasing the profitability of fishing operations and income levels of the fishermen. It was against this background that the project decided to conduct the experimentation of the diesel outboard engine in order to reduce fuel cost.

Specific Objectives

The objective was to conduct controlled sea trials of the 27 hp outboard diesel engine with local fishermen and transport boat operators, to assess its performance in fuel consumption and other aspects of the engine.

Method of trial

The first trials were carried out from mid–December 1988 to mid–January 1989 by project personnel. Thereafter, a series of trials of varying durations were conducted with greater involvement of local operators. The project mechanic and the master fisherman did the first few trials on the project Ghana boat. The second stage was the incorporation of one of the locally project–trained mechanics on Plantain Island. This was then followed by the inclusion of the local fishing boats and transport boat operators. The project boat was made constantly available for the trials. The fishermen and their operators were only required to bring their own fishing nets to the boat to make a fishing trip. At the end of each fishing trip, the catch would belong to them with project master fisherman recording the fuel consumed and the impressions of the fishermen. A similar thing was done for the transport boats. All the trips were done in the presence of and under the direct supervision of either the project's master fisherman or the mechanic.

At the beginning of this year, however, it was considered necessary to slightly change the methods, by renting out the outboard engines to the local boat owners with a written agreement. Local people could therefore use the engine on their own boats, store it with them, and seek the local mechanic's assistance for minor problems with the engine. Should the problem prove to be beyond the capability of the local mechanic, it was brought to the project's chief mechanic based at Shenge. On some occasions, the engine could be out of operation for some time awaiting repairs, maintenance, or awaiting the return of the appropriate personnel to supervise its operation.

Results of trial

The trials are documented in details in Anon 1988, 1989a, 1989b and 1989c. The most impressive part was the considerable reduction in fuel consumption. There was more than 50% savings when compared to the consumption rate of the 40 hp petrol outboard engine (Table 1). According to the figures obtained, and based on the result of the trials, the engine consumed about 4.2 gallons of diesel per fishing trip, while the 40 hp would consume about 9 gallons of petrol–oil mixture per fishing trip. A fishing trip lasts for an average of seven hours. The manufacturers of the engine, however, claim that the engine could perform much better than this. Based on the results of the trials as well as on some assumptions, projections on the economic profitability of the engine were made and compared to the known economic performance of the petrol outboard. The diesel outboard proved better in terms of return on investment than the petrol outboard, representing a 34% as opposed to 28% return

1 Cite as: Taylor TDK, Koroma M, Lerois P and Bangura M (2012) Evaluation of diesel engines by the Shenge Project, Sierra Leone. pp. 61-63. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

on investment. The engine appears to perform even better when compared with other inboard diesel engines. However it must be cautioned here that most of these economic comparisons are largely based on assumptions not quite systematically investigated. It will require a long time and more in–depth studies and trials of the engines before reliable and concrete conclusions can be made in economic terms.

During the trial period of the diesel outboard, its advantages over the 40 hp petrol outboard were identified jointly by the fishermen, local outboard operators, local mechanics and project personnel monitoring the performance of the engine. Feedback from the target group is as follows:

- The fuel consumption rate is lower than the petrol 40 hp outboard engine. This, they say, has impressed them the most;
- Vibration and noise were said to be satisfactory and did not pose a problem to their fishing operations, such as scaring the fish away, as earlier anticipated; and
- The speed is said to be good.

Table 1. Diesel O.B.E. Demonstrations (from December 15, 1988 to January 14, 1989)

Number of fishing trip	20
Number of gallons (diesel used)	85.5
Average gallons per trip	4.2[a]
Total fishing hour	155
Average hours per trip	7.7
Number of times net is shot	333
Average net shot per trip	1.6
Average price of fish/3 kg/dozen	Le30.00

[a] to be compared with 9 gallons with petrol O.B.E.

Problems

However, the above mentioned categories of people also highlighted some of the problems encountered with the engine during trials. These problems are as follows:

- The clamp: This is too short to fit properly, as to make a firm grip on the transom of local boats. For this reason, the engine, while in motion, becomes unsteady over the transom and sometimes jumps off the transom. It is recommended that the clamp is made long enough, like that of the Yamaha 40 hp petrol engine.
- Difficulty in starting the engine: It takes time and a little strenuous effort to get the engine started for the first time in each day. Restarting the engine after the first start is normally not a problem. What is a problem is that contrary to the Yamaha 40 hp petrol, one person can start the engine, while it requires two people to start the diesel engine. It has been difficult for the two people to know exactly when the one should release the choke and the other to pull the starter, thus causing further delay in starting or restarting the engine, which could be a disadvantage during fishing operations. Because of the strenuous starting or restarting of the engine, some local operators and mechanics recommended an electric starter in addition to the manual starter of the engine.
- Air—lock: According to feedback from local operators participating in the trials, air–lock occurred frequently and is caused by two factors:
    - When the fuel tank is halfway empty the vacuum in the tank holds air. The movement of the fuel in the tank as the boat is in motion exposes the end of the tank tube, which takes in air and passes it into the engine thus causing an air–lock. This means that the fuel tank must be full at all times. This may require an improvement in building and partitioning of the fuel tank;
    - The spaces or channels in the filter are considered to be too narrow according to the local mechanics. This makes the filter unable to circulate fuel properly. For this reason, the filter frequently becomes blocked, causing an air–lock. Filter bleeding, which is the remedy for air–locks recommended by the manufacturers, has not been effective according to the local operators. That is apart from bleeding the filter, they also have to dismantle another area around the end of the fuel return tube before the air–lock is cleared. However, while this is effective, it is not the recommended method of clearing air–locks. It had the effect of allowing the diesel to get mixed with the engine oil. The overflow was explained as a result of loosening a delicate spring within the unit dismantled to remedy air–locks. This spring can easily get lost and cannot be easily improvised. It is therefore recommended that an improvement is made on the filter. Equally so, something must be done with the fuel tank, otherwise it would seem that the users of the engine would frequently have to buy fuel for topping, even though the fuel tank is half full. With the 40 hp Yamaha petrol outboard, the engine could still be run on fuel less than 2 liters in the fuel tank. (However, the project chief mechanic is of the opinion that the use of dirty fuel by the local people must have also contributed to these problems of filters and air–locks. This may require more training in fuel management).

Weight and engine price–The weight of the new diesel engine is heavier than the Yamaha petrol engine, and thus often requires two people to lift and carry it. The engine box of the local boats are designed such that the diesel engine cannot fit properly unless modifications are made on them which was usually unacceptable to boat owners. Some of the local boat owners expressed interest in the purchase of such engines in the future, although the price of the engine (i.e., US$ 4,500 apart from custom duties) was a bit alarming to some of them, particularly if credit was not available.

Table 2 summarizes our projections on the economics of petrol *vs.* diesel engines.

Table 2. Economic projections based on our trials (April 1989)

Initial Capital							
Inboard diesel - 35 HP		**Inboard diesel - 30 HP**		**Petrol outboard - 40 HP**		**Diesel outboard - 27 HP**	
Boat	Le460,000	Boat	460,000	Boat	130,810	Boat	130,810
Net	Le862,411	Net	862,411	Net	862,411	Net	862,411
Engine	Le403,000 ($6,2)	Engine	598,026 ($9,200)	Engine	220,000	Engine	370,000 ($5,615)
Depreciation							
Boat	57,500 (8 yr)	Boat	57,500 (8 yr)	Boat	43,603 (3 yr)	Boat	43,603 (3 yr)
Net	287,470 (3 yr)	Net	287,470 (3 yr)	Net	287470 (3 yr)	Net	287,470 (3 yr)
Engine	80,600 (5 yr)	Engine	99,671 (6 yr)	Engine	73,333 (3 yr)	Engine	92,500 (4 yr)
Fixed cost	425,570	444,641		404,406		423,573	
Tot. variable cost (Le)	1,386,184	1,563,657	1,104,031	1,056,591			
Total cost	1,811,754	2,008,298	1,508,437	1,480,591			
Total revenue	1,850,000	1,850,000	1,850,000	1,850,000			
Profit	38,246 (2.2%)	158,298 (8.2%)	341,563 (28%)	369,836 (27%)			

Conclusions and Recommendations

At this point, we do not think our trials and experiences are sufficient enough to make any conclusive remarks about the advantages of the diesel outboard. Perhaps the best we can say about it now is the economy of operation it has offered, namely fuel. But its other operational expenses, durability, and economic viability over other engines can only be based on assumptions and therefore still have to be proven. This is currently a new engine and has only been tested in a few countries in the world. For this reason, it is still subject to modifications in design by the manufacturers. It is therefore the opinion of the project that more experience and training are required with this engine before any effective evaluation could be made of it. Other issues such as having well–trained mechanics to repair the engines and a reliable supply of spare parts are important contributing factors of concern.

References

Anon. 1988. Testing of diesel OBM for the Alia small boat fishery in Western Samoa. Fisheries Division, Government of Western Samoa, Samoa.

Anon. 1989a. Preliminary report on diesel 27 HP OBM demonstration trials. Project SIL/89/007. Shenge Integrated Development Fisheries Project, Shenge.

Anon. 1989b. Project profile. Project SIL/89/007. Shenge Integrated Development Fisheries Project, Shenge.

Anon. 1989c. Cost and earnings studies of fishing boats–Shenge. Project SIL/89/007. Shenge Integrated Development Fisheries Project, Shenge.

The Shrimp Trawler Industry of Sierra Leone[1]

J.A.L. Cole

Sierra Fishing Company Limited, Freetown, Sierra Leone

Abstract

Shrimp trawling in Sierra Leone started legitimately in 1968, when Joint Stock Fishing Company (JVFE) chartered a shrimp vessel from Spain, which was licensed to fish for shrimps. Sierra Fishing Company (SFC) began its shrimping program in 1980, with the purchase of five new shrimpers, followed by another five in 1982. SFC also acquired 17 shrimpers from Continental Seafoods in Liberia and Côte d'Ivoire in 1981. After a year, only five of these vessels remain fishing. SFC also entered into a agreement for shrimping with the Russian operators in October 1978; this program ended in 1982 and resumed in 1987. When agreement was not reached between the USSR and the Sierra Leone government in 1989 at the Joint Commission, the Russian fleet pulled out in December 1990. Over the period 1978 to 1990, the catch rate for shrimps fell constantly from a high of 363 kg·day^{-1} (head–on shrimp) to an all time low of 144 kg·day^{-1} in 1990. Although fishing in 1991 was for only four months–June to September, the average rate has increased to 178 kg·day^{-1}. The new fishing regulations and the strict management measures implemented by Marine Protection Services (Sierra Leone) Ltd. –as the protection and surveillance agent of the government– combined with the reduction in poaching, have contributed to the improvement in catch rate and size composition of the shrimp stocks. It is yet to be seen if this upward trend will be maintained.

The Shrimp Trawler Industry

This paper describes the experience of the Sierra Fishing Company (SFC) in the shrimp trawling industry, and charts its development from 1977 to 1991. SFC entered into a joint venture agreement with Mesurado Fishing Company of Liberia in October 1977, to establish Shrimpex Sierra Leone Ltd. (1978). Prior to this agreement, Mesurado vessels had been fishing in Sierra Leone's waters, when in 1974, the Joint Stock Fishing Company (JVFE) and Mesurado Fishing Company formed Sierra Leone Shrimp Export Company. Three vessels were on charter to the company. The catch was processed in Freetown and exported to Liberia. When JVFE collapsed in 1976 and was bought out by SFC, a new agreement was drawn up. Under the agreement, Mesurado chartered to Shrimpex five shrimp trawlers to be used by Shrimpex in its shrimping operation. Shrimping was to be done in the waters of Sierra Leone and Liberia, and actual fishing started in July. When the agreement was signed between the government of Sierra Leone and the USSR in 1976, it was envisaged that participation would take place in all aspects of fishing. In 1978, it was agreed to carry out exploratory shrimping with three MRTR class vessels for a period of three months, to evaluate the catch potential and the economics of the fishery. This cooperation continued until the end of 1981 when this arrangement was terminated. In 1987, Fransov (a French–Soviet Company with shares in SFC) made an agreement whereby shrimp trawlers were chartered from the USSR, and these fished in Sierra Leone's EEZ. The catch was landed in Freetown already processed as head–on shrimps and exported by SFC on behalf of the charterers.

SFC had its own shrimping program, which started in October 1980 with the purchase of five 18 m double–rigged shrimpers from a shipyard in Alabama, USA. These were followed by five more shrimpers and two fish trawlers in 1982. In 1981, SFC bought Continental Seafood Company (CSF) of Liberia and its Côte d'Ivoire subsidiary. This purchase increased the shrimp fleet by 17 vessels. Most of these vessels were not in good working order. Over the years, shrimping continued, but the catch rate fell year after year. The scarcity of foreign exchange, and the lack of spare parts and fishing gear locally have greatly affected the industry. This problem was compounded by the high cost of fuel and lubricants, and the increase in license and royalty fees effected in the new 1990 Fisheries Regulations.

The prospect for the indigenous shrimp industry in Sierra Leone is bleak. Unless the authorities address the problems facing the industry, we shall continue to sit down and see our shrimp resources being exploited by foreign trawlers through agents and entrepreneurs.

The Sierra Fishing Company's Limited Fleet

On of the development aims of SFC after its formation in 1976 was to acquire and operate a fishing fleet. Vessels fishing in the waters of Sierra Leone were mostly foreign flag vessels on charter to fishing companies or agents. SFC had joint venture agreements with the USSR government and the Mesurado Fishing Company in Liberia. In October 1980, the first five double–rigged shrimp fishing vessels were delivered to the company by Bender Shipbuilding Co. of Mobile, Alabama in the USA. They were all identical, with an overall length of 18.9 m, beam 5.5 m, draft 1.8 m, engine hp 415, and fish hold capacity of 42 m^3. The fish hold was cooled to 20°C by cooling units. The shrimp catch is de–headed at sea, washed with sodium metabisulphite and frozen. These vessels fished for 20 days before returning to base. Upon arrival, the catch is processed and frozen in 2 kg packs for eventual export.

1 Cite as: Cole JAL (2012) The shrimp trawler industry of Sierra Leone. pp. 64-68. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

Shrimping started in October 1980 and the total catch for the month period was 59 t shrimps, 37 t fish and 91 kg lobster. The catch in 1981, which was the first complete year of operation, was 291 t headless shrimps, and 308 t fish (Table 1). SFC acquired the assets and liabilities of Continental Seafoods of Liberia, with its subsidiary in Côte d'Ivoire in 1981, and so became owners of 17 double–rigged vessels of various construction. These vessels licensed to fish in Sierra Leone's waters began operation immediately.

The production was mainly head–on shrimps, and these were processed, packed and frozen at sea in half–tonne capacity plate freezers. In January 1981, the catch was 20 t head–on shrimps and 5 t fish. Production increased to 36 t head–on shrimps, 342 kg headless shrimps, and 13 t fish in February and fell in March to 20 t head–on shrimps. By July, most of the freezing equipment in these vessels was out of order and headless shrimps were produced for processing ashore. At the end of 1981, only six vessels were fishing, and the rest were disposed of.

Table 1. Shrimp production (t) of 3 companies in Sierra Leone, 1978-1991. (H/L = headless; H/O = head–on)

Year	Shrimpex H/L	Soviet H/L	SFC		Total	
			H/L	H/O	H/L	H/O
1978	77.658	42.045	-	-	119.703	-
1979	176.002	185.027	-	-	361.029	-
1980	216.457	352.018	57.049	-	525.524	-
1981	147.044	328.288	306.228	177.666	781.560	177.666
1982	36.523	-	572.878	-	609.401	-
1983	-	824.672	-	824.272	-	-
1984	-	614.195	-	614.195	-	-
1985	-	600.373	-	600.373	-	-
1986	-	519.578	3.672	519.578	3.672	-
1987	65.883	468.632	334.636	534.515	381.026	-
1988	49.202	242.144	339.002	291.346	480.752	-
1989	-	20.704	276.696	20.704	4446.384	-
1990	-	10.650	159.640	10.650	416.244	-
1991	-	1.734	26.682	1.734	26.082	-

At the beginning of 1982, only two CSF vessels were fishing, followed by another in May, a third in June and the remaining two in September, one having pulled out in June. 1983 saw only four of the original 17 vessels fishing, and these were incorporated into the SFC fleet, and so ended the separate program for the CSF/Sicrus vessels. The acquisition of these by the company was not in its best interest, as valuable foreign exchange could have been better utilized to purchase new vessels instead of used vessels that were not economically viable. Another five shrimpers from a shipbuilding company were delivered in November. All the ten shrimpers were fully operational at the end of 1982, producing headless shrimps, which were processed ashore. 1983 was the best year in terms of shrimp production, when over 800 t of headless shrimps were produced and export was 660 t. The trawler fleet was now 14, and these fished throughout the year with very little problems, except in November and December when three of the new vessels were tied up due to engine problems.

1984 was uneventful, with the shrimp production down to 614 t. One of the CSF vessels was off fishing for 7 months and another for 5 months. The new shrimpers fished all year round, except for two that were laid up for 3 months from January to March.

The year 1985 was also uneventful, with headless shrimp production at 609 t. Two shrimp vessels were put out for head–on shrimp in August and September through December. Total yield was 12 t of head–on shrimps.
In 1986, it was decided to put out all the vessels for head–on shrimp catching. Processors trained in the shrimp processing plant were deployed two each in a vessel, and the result at the end of the year was encouraging. Head–on shrimp production was 335 t and 244 t for headless shrimps. The equivalent as headless shrimp production was 445 t, a 27% drop against the 1985 figures. In 1987, production was mainly for head–on shrimps. One vessel sank during the year. 472 t head–on shrimp and 51 t headless shrimps were produced, equivalent to 334 t headless shrimps, indicating another poor catch for the year.

Vessel problems, including the lack of spare parts for engine repairs and insufficient maintenance, fishing gear, and navigational aides made 1988 another poor year. Of the twelve vessels in operation, 31 months were lost to fishing and one vessel was laid up throughout the year. Total head–on catch was 315 t and 46.6 t headless, corresponding to 236 t headless shrimps.

The year 1989 saw further deterioration in the performance of the shrimp fleet, with two vessels unable to fish for the whole year, another two for 8 months each, and the remaining eight laid up for a total of 19 months at various periods. Total catch was 283 t head–on and 22 t headless, equivalent to 192 t headless shrimps.

The situation worsened in 1990 with the acute shortage of fuel and lack of foreign exchange to purchase fishing gear and spare parts. Two vessels fished throughout the year and seven others for various periods, ranging from 4–11 months. Five were laid up throughout the year. Production fell considerably as only 1,231 fishing days were recorded. Total catch was 160 t headless shrimps. With the promulgation of the new Fisheries Regulations in 1990, which took effect in January 1991, all shrimp vessels belonging to the company were grounded, because of the new license and royalty fees and restrictions placed on fishing within the 5–mile limit. By our calculations, it was difficult to pay such fees and break even in the end. After protracted negotiations between the Fisheries Division, the Ministry of Agriculture and Natural Resources, and SFC, licenses were applied for and were granted to three fish trawlers and three shrimpers in April–May 1991. But the major constraint in our fishing program is shortage of fuel, which has kept our vessels grounded for most of the year.

Mesurado Vessels Shrimpex (Sierra Leone) Ltd. 1978

Prior to the formation of Shrimpex Sierra Leone Limited (1978) in April 1978, a joint venture company between Mesurado and JVFE was engaged in shrimping from 1974, with up to five shrimpers licensed to fish in Sierra Leone waters. With the new agreement between SFC and Mesurado of Liberia, the vessels M3, M6 and M7 were followed by M16 in May. The vessels were beset with problems and did not fish in August. Only one fished in September and two each in November and December. Total shrimp caught was 77.6 t, fish was 26.5 t and lobsters were 117 kg. In February 1979, two more shrimpers joined the fleet–M26 and M27–bringing the total to the agreed five vessels. Fishing was continuous throughout the year, except in July when only two vessels were in operation. The total number of shrimp caught was 171 t, 85 t of fresh fish and 147 kg of lobster. Shrimping continued in 1980 with five vessels in the fleet. The number of shrimp caught was 217 t and 100 t of fish. In 1981, the shrimp catch was down to 147 t while fresh fish catch increased to 129 t. Problems with the vessels resulted in no shrimp production from January to April 1982. The vessels operated from May to October, producing 36.5 t of headless shrimps and 49.9 t of fresh fish. No fishing was done in November and December. The program ended in 1982. During the period, SFC was involved in obtaining licenses for over 15 shrimpers belonging to Mesurado Fishing Company to fish in Sierra Leone's waters.

Soviet Fleet

The program started in April 1978 with two 31m–long MRTR (medium-sized trawler) on an experimental basis, and lasted until the end of August 1978. In October, the authorities decided to resume the shrimping program, initially with three vessels of the same MRTR class, using ice to preserve the shrimps, which were de–headed at sea. The catch was brought to shore every 5–6 days, and was processed immediately in the shrimp processing plant where up to 30 female graders and packers were employed. The shrimps were graded first for quality, our top grade being "A" where shrimps should be whole, with no broken parts and no black spots. The second grade, "Sea", was for shrimps with broken shells only. The third grade "S/O Br" (shell–on broken), was for mutilated shrimps. Shrimps with black spots were peeled and deveined (P/D), Grades "A" and "Sea" shrimps were further graded into twelve sizes depending on the number of shrimps in a pound weight. U10 was for 10 shrimps and less than a pound, followed by U15, 16/20, 21/25, 26/30, 31/35, 36/40, 41/50, 51/60, 61/70, 71/90 and Titi, which were tiny shrimps with over 100 to the pound. Graded shrimps were packed into 2 kg boxes and frozen in plate freezers. The small 2 kg packs were then placed in master cartons holding 10 packs, strapped and kept in cold rooms at -20°C for eventual export. The production for October to December 1978 was 42.045 t shrimps, of which SFC received 30% of the catch as payment for processing fees, packing materials, supply of ice, cold storage and shipping.

In March 1979, another vessel, MRTR 0401, joined the fleet. This vessel was a modern stern trawler but double–rigged for shrimping. It was followed in August by four more MRTR side trawlers, bringing the fleet to 8 vessels. Catches in that month was 25 t of processed shrimps and 27 t of fresh fish. The MRTR stern trawler was experimental and left after three months of trial. A total of 16 shrimpers fished in 1979, with a monthly average of 7 vessels. Total shrimp production was 185 t and 243 t of fish.

In 1980, a total of 252 t of shrimps were caught, while the catch of fish, including cuttlefish, was 514 t. Total export of shrimps and cuttlefish was 221 t and 16 t respectively.

In 1981, 328 t of shrimps were caught and 1,113 t of fresh fish. A total of 298 t of shrimps were exported. The program ended in December 1981 and the vessels were withdrawn.

At the 10th season of the Joint Sierra Leone/USSR Fisheries Commission held in Freetown in November 1986, it was agreed that fishing operations should once again be diversified to include shrimping. The parties nominated Fransov, SFC, and the Ministry of Agriculture to negotiate and conclude technical and research conditions for a joint shrimping operation in the waters of Sierra Leone for the eventual formation of a national shrimping company. In April 1987, joint shrimping was resumed by SFC and Sovrybflot through Fransov. The agreement called for the deployment of up to 8 shrimp vessels monthly. In 1974, vessels built of 180 gross registered tonnage (GRT) and 32 m long without refrigeration were deployed, as well as vessels built in 1987 that were 30 m long, with 9 m beams, 249 GRT, 74 NRT and 750 hp, with refrigeration capacity of 4 tonnes·day^{-1} and a fish hold capacity of 40 cm^3. Another type of vessel brought in 1990 was built in 1988. It was 36 m long, 8.8 m beam, 395 GRT, 107 NRT, 800 hp, refrigeration capacity of 6 tonnes·day^{-1} and fish hold capacity of 98 t. These new double–rigged type shrimpers produced head–on shrimps most of the time already graded and frozen at sea, as well as headless shrimps graded into large, medium, and small sizes.

Exports of Shrimps from Sierra Leone

The shrimps caught before were not recorded as an export of Sierra Leone. The production of Sierra Leone Shrimp Export Company was shipped to Monrovia and exported as products of Liberia. Also, the catch from a Spanish vessel fishing in 1988 was shipped to that country and was never recorded in the Fisheries Division or as an export from Sierra Leone. The first legitimate export was done in 1978 by SFC, on behalf of Shrimpex (SL). The total for the year was 81 t. With the Russian fleet entering the industry, and SFC as partner, the total quantity exported was 310 t. The record was in 1981, when SFC acquired 17 vessels from CSF of Liberia, which were added to 5 shrimpers recently bought from the USA. The Soviet also deployed an average of 10 vessels monthly, and export was 809 t. From 1982, the total exported fell from 710 t to 570 t in 1985, with an increase to 609 t in 1986. During

the period 1983 to 1986, only SFC vessels were operating and there were 14 in all. Even with the new Soviet program in 1987, export of shrimp fell to 589 t, with SFC vessels contributing 479 t. The increase in 1989 was due to the presence of more vessels in the Soviet fleet. In 1990, export went further because of fewer vessels fishing for SFC, although the Soviet export went up due to increasing fishing effort (Table 2). In 1991, export was only 41 t, which reflected the plight of the local shrimp industry (Table 2). It is to be noted that export was not necessarily all the shrimp produced for that particular year.

Table 2. Export of shrimps from Sierra Leone (mt headle).

Year	Shrimpex S.L.	Russian vessel	SFC vessel	Total
1978	81.22	-	-	81.222
1979	149.564	140.346	20.110	310.020
1980	187.200	150.580	85.180	422.960
1981	168.920	201.620	438.662	809.202
1982	50.744	-	541.976	592.720
1983	-	-	660.040	660.040
1984	-	-	588.120	588.120
1985	-	-	570.000	570.000
1986	-	-	608.612	608.612
1987	-	110.700	479.062	589.262
1988	-	141.190	355.644	496.834
1989	-	255.078	269.326	584.404
1990	-	330.350	223.648	553.998
1991	-	-	41.268	41.268

The State of the Shrimp Fishery in Sierra Leone

Shrimping in 1980 started in October with an average catch of 312 kg head–on shrimp per day. The average catch went down in 1981, which was the first full year of operation. With the introduction of more vessels in 1982, the overall average catch went up to 363 kg·day^{-1}. The five new vessels fished for a total of 24 months and produced 118 t shrimps in 574 fishing days, giving an average of 342 kg shrimps per day (Table 3).The first set of five vessels fished throughout the year, producing 335 t in 1,500 fishing days, with an average catch of 372 kg·fishing day^{-1}. It is clear from this that generally the catches were good in 1982. This was the best year for shrimping. The fall in catch rate continued through to 1990, having levelled off in 1988/89. The overall picture of the industry is a decline in catch rate, which has, as its main cause (Table 3), that over the years, too many vessels were exploiting the stock of shrimps. There was no means of monitoring the number of vessels fishing for shrimps in the territorial waters. Of course, licenses were issued, but it was possible for these licenses to be photocopied and used by other vessels of similar characteristics. Poachers from neighboring countries were actively engaged in fishing at night, especially in the Cape of St. Ann area. Other vessels were rigged with double booms on each side, effectively trawling with four nets. In addition to these is the scarce supply of parts and equipment. After 1983, it gradually became difficult to obtain basic items for fishing gear construction. Over the years, it became almost impossible to purchase spare parts for engines on the vessels, although there is an accredited agent in Sierra Leone.

Table 3. Performance of Sierra Fishing Company vessels from 1980 to 1991.

Year	Headless shrimps (kg)	Head–on shrimps (kg)	Fishing days	Catch per day (kg)
1980	57,049	-	305	312
1981	221,335	-	1,318	280
1982	452,741	-	2,079	363
1983	705,208	-	3,622	325
1984	590,920	-	3,489	282
1985	609,458	11,906	3,481	295
1986	446,963	-	2,782	268
1987	51,408	972,166	2,980	187
1988	46,560	314,930	2,524	156
1989	22,174	282,706	2,047	156
1990	10,650	159,640	1,231	144
1991	1,734	26,682	166	178

The arrival of the Marine Protection Services Sierra Leone Limited (MPSSL) as an agent of the government, to protect and manage our marine resources, is promising. Poaching has virtually ceased, and the number of licenses issued for shrimping has been reduced to reflect the extent of the resource. Preliminary figures for 1991 show an increase in the total catch of shrimps and bycatch. The catch rate has gone up to 178 kg per fishing day, which is an indication that management regulations are working. The next shrimp season will indicate whether the measures adopted by the Fisheries Division and the MPSSL are working towards the improvement of the catch rate and to the overall improvement of the industry. It is a sound management device to impose the 5–mile offshore limit for

shrimpers and trawlers, as is evidenced from the improved catches of fish and other marine products.
The authorities will now have to consider introducing closed seasons for certain species, especially for shrimps. But this will have to be based on scientific and reliable data, which have still yet to be collected and analyzed. MPSSL with its computerized data collecting system may, over a period of time, be able to come up with strong evidence to justify the imposition of a closed season in the shrimp industry–maybe September to December each year. The general downward trend of the catch rate provides a strong justification for a closed season for shrimping. This period could be used for servicing and maintaining the vessels, repairing and constructing fishing gears, sending crew on leave and many other essential things.

The views expressed in this paper are of the author and do not reflect those of the Sierra Fishing Company Limited.

The Potential for Expansion of the Industrial Fisheries of Sierra Leone[1]

FAO Industries Division

Food and Agriculture Organization of the United Nations, Rome, Italy

Abstract

The purpose of this paper is to formulate some elements for a larger fisheries development program for Sierra Leone to harvest a part of the surplus stocks by expanding the national fleet and progressively replacing foreign vessels. Throughout this paper, reference is made directly and indirectly to available or surplus stocks. The precise meaning of this is the difference between the total potential yield and the actual catch taken by domestic Sierra Leonean fishermen and fleets. In the terminology of the UN Convention on the Law of the Sea (UNCLOS), this surplus to national capacity is the total allowable catch (TAC) minus the actual national catch.

Introduction

The marine waters of Sierra Leone are among the richest fish–producing waters in Africa, with a potential annual yield estimated between 170,000 and 300,000 tonnes. The national fleet caught only around 37,000 tonnes (FAO 1989). Foreign fleets take over 100,000 t in some years (Table 1), but Sierra Leone derives little benefit from this. The principal preoccupation of the fisheries sector and the Government of Sierra Leone is how to substantially increase the nation's participation and benefits from harvesting its own resources.

The artisanal fleet consists of some 7,000 boats (of which only 10% are motorized), which land about 90% of the national catch (70% small pelagics, 20% demersal species).

The industrial fleet consisted of 26 vessels in 1988 (Tettey 1988). As these are mostly shrimp trawlers, their annual production is small, but of high unit value. Considering that in the past, as many as 300 foreign vessels per annum have fished in the Sierra Leonean waters, it is clear that the key to increasing the country's long–term benefits from the exploitation of its marine resources is to gradually replace the foreign craft by an expanded and economically viable national fleet.

Choosing Between the Artisanal and Industrial Development Option

Any program intending to increase the national fish production capacity will have to address the option of a small or a large–scale mode of fishery development. Small–scale fisheries generate more employment and require less capital investment than large–scale fisheries. Given the access to the fishing grounds, existence of surplus labor in Sierra Leone, and the extreme scarcity of investment capital in foreign currency, the small–scale option would appear to be more rational for Sierra Leone. Nonetheless cost/benefit studies should be carried out for any scale of vessel being proposed for deployment in Sierra Leone's fisheries.

Other factors also favor the small–scale option. By law, artisanal fisheries now have exclusive usufructuary tenure of the coastal 0–5 mile zone (which has a surface area of about 4,000 km^2). More than 20,000 artisanal fishermen work these waters. The density of fishermen is high (5 per km^2) and there is a need to expand the artisanal fishing effort further offshore to relieve pressure on inshore stocks and take advantage of underutilized stocks. How can the marine resources be harvested at the lowest cost, at the same time generating high revenues and benefits to the country? It seems that for Sierra Leone conditions, there are two answers to this question. First, let the artisanal sector harvest everything that they can. Only the surplus that cannot be exploited by the artisanal fishery for technical or economic reasons should be harvested by industrial fisheries, but using lowest possible capital investment. What would this mean in practice? First, it requires upgrading fishing capability, improving the safety of the artisanal fishing boats, and carrying out training of fishermen for offshore work. An improved artisanal vessel should be diesel–powered to reduce fuel costs and extend its operation range. Designs for improved boats, built from locally available materials, should be developed, taking into account the required technical features, economic viability and specific socio–economic environment. The industrial fleet should be put in place for those fish stocks that cannot be harvested by the advanced artisanal fleet. This could include skipjack purse–seiners, squid jiggers, and perhaps deep–water trawlers. The existing industrial shrimper fleet is adequate and does not require expansion. Most of the industrial fleet could consist of lower cost semi–industrial plank boats. Such boats are presently built within the region at competitive prices, for example by Ghanaian or Senegalese boatyards (Table 2).

An expatriate design assistance would certainly help to construct a technically and economically viable craft. Second, the semi–industrial vessels should, whenever possible, be multipurpose fishing vessels. This may be crucial for good economic operation of fishing vessels, if revenues from diversified fishing throughout the whole fishing season would be higher than the additional fixed and variable costs generated by the investment necessary

1 Cite as: FAO Industries Division (2012) The potential for expansion of the industrial fisheries of Sierra Leone. pp. 69-77. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

for the equipment and gear for a multipurpose vessel. A semi–industrial vessel does not need to be a strictly multipurpose craft, ready to use different gear during the same fishing trip. Conversion from one fishing method to another should, however, be easy to carry out in harbor, following seasonal changes in abundance of fish stocks and/or variations of market prices.

Several prototypes of improved artisanal fishing boats and semi–industrial vessels should be thoroughly tested during at least one complete fishing season to assess their viability and note necessary improvements before a larger scale boatbuilding program is established, on the basis of sound financial resources. Consideration could also be given to setting up a boatyard in Sierra Leone for the construction of wooden semi–industrial fishing vessels, as the backbone of Sierra Leone's industrial fleet would likely be this type of vessel for many years to come. No significant national fleet expansion will be possible without provision of adequate shore infrastructure–especially harbor facilities and processing plants. The construction of a fully equipped fishing harbor complex in Freetown should be considered the highest priority issue. Construction of several smaller harbor facilities along the coastline will also need to be considered. An adequate road system to deliver supplies and transport products will be required to link these mini–harbors to internal markets.

In expanding and extending Sierra Leone's fisheries, institutional arrangements for the safety of fishing boats (i.e., search and rescue, registration and licenses, survey and certification, patrol, etc.) are important as well as upgrading seaworthiness. The introduction of the improved artisanal boats and the semi–industrial craft into operation should follow a fishing fleet development plan, to replace foreign vessels in a controlled manner and keep the fishing effort at an appropriate level for specific species.

Table 1. Total catches of national and foreign vessels from Sierra Leone waters.

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
National Fleet										
Total artisanal	46,772	41,881	45,166	40,000	40,000	40,000	47,274	40,000	40,000	40,000
Total industrial	5,910	7,512	939	1,926	2,225	4,954	5,438	4,855	7,642	3,977
SFC trawlers	4,680	5,694	0	0	299	1,034	2,797	2,686	4,295	2,297
Shrimpers (shrimp)	410	606	313	642	642	1,760	1,196	1,300	1,232	1,130
Shrimpers (fish)	820	1,212	626	1,284	1,284	2,160	1,445	869	2,115	550
Total national	52,682	49,393	46,105	41,926	42,225	44,954	52,712	44,855	47,642	43,977
Foreign Fleet										
Total pelagic	4,561	23,635	35,509	81,163	62,322	51,859	57,277	28,740	61,085	86,421
USSR purse seine	4,561	23,635	21,740	37,162	44,087	49,913	55,815	18,740	41,533	45,510
USSR pelagic trawl	0	0	13,769	44,001	8,235	1,946	1,462	10,000	19,552	40,911
Total demersal	15,830	15,720	20,665	33,750	42,961	25,548	25,047	21,768	22,626	24,245
USSR trawl	9, 304	11,131	16,665	28,250	36,461	18,679	17,907	15,000	14,398	16,309
Other trawl	6,526	4,589	4,000	5,500	6,500	6,869	7,140	6,768	8,228	7,936
Total foreign	20,391	39,355	56,174	114,913	95,283	77,407	82,324	50,508	83,711	110,666
Grand total pelagics	39,640	55,046	69,384	111,163	82,322	81,859	92,732	58,740	91,085	116,421
Grand total demersal	33,433	33,702	32,896	45,676	55,186	40,502	42,304	36,623	40,268	38,222
Grand total catch from Sierra Leone water	73,073	88,748	102,279	156,839	137,508	122,361	135,036	95,363	131,353	154,643

Note: Artisanal catches are 75% pelagics and 25% demersals, and this is reflected in the grand totals for pelagics and demersals (Payne and Coutin 1988).

Expanding the Fishing Fleet

Small pelagics fishery

The resource

The most abundant commercial finfish resources in the Sierra Leone waters are the small pelagics. In continental shelf waters beyond the 20 m depth contour, the resource consists mainly of:

- 40% scad (*Caranx rhonchus*);
- 35% other carangid;
- 25% clupeoids, mostly herring (*Sardinella* spp.).

In shallow waters of less than 20 m depth, bonga shad (*Ethmalosa fimbriata*) predominates. Grey triggerfish (*Balistes capriscus*) experienced a large population boom in the late 1970s–early 1980s, but the population has crashed since then. Ssentongo and Ansa–Emmim (1986) consider that the potential yield of pelagics is probably less than 100,000 t. This is based on fishery surveys that determined a range of biomass levels for Carangids (175,500–349,800 t) and clupeoids (110,700–163,600 t), for a total of 286,200–513,400 t. Total catches of small pelagics from Sierra Leone (Table 1) have varied from 40,000 to almost 120,000 t between 1977 and 1986, of which about 30,000 t was caught by artisanal fishermen. The industrial small pelagic catch came mainly from Soviet purse seiners and pelagic trawlers, who took between 36,000 and 86,000 t between 1979 and 1986. These data suggest that a conservative estimate of the EEZ surplus stocks of small pelagics available for advanced artisanal/industrial exploitation is in the region of 70,000 t.

Table 2. Some semi–industrial fishing vessels available from boatyards in Ghana and Senegal.

Boat Type	Specification	Local Currency	US$, about	Note
Boat type: Multipurpose seiner/trawler (GIHOC Boatyard Division Tema, Ghana)	17 m wooden hull	12.7 million Cedi	36,000	Orders require 75% up front payment, and balance on completion. Construction time is in the order of 6 months.
	Engine	23.4 million Cedi	67,000	
	Fitting	9.1 million Cedi	26,000	
	Total	45.2 million Cedi	129,0000	
	23 m wooden hull	24.6 million Cedi	70,000	
	12 m wooden hull	8.5 million Cedi	24,000	
Boat type: Multipurpose seiner/trawler (Voltagate Boatbuilding Co. Tema, Ghana)	20 m wooden hull	10.0 million Cedi	29,000	
	17 m wooden hull	8.0 million Cedi	23,000	
	13 m wooden hull	7.0 million Cedi	20,000	
Boat type: Seiner (`cordier') (Dakar Marine Dakar, Senegal)	15–18 m steel hull	70.0 million CFA	250,000	The payment schedule required would be one–third up front, one–third at midpoint, and the balance at completion. Construction time would be 4 months. Note: Dakar Marine is establishing a joint venture with a Japanese firm to build 18 m and 25 m multipurpose steel vessels.
Boat type: Tuna/sardine seiner (SOSACHIM Dakar (Diamaguene), Senegal)	17 m fiberglass hull with ice hold and 235 HP Caterpillar engine	125 million CFA	440,000	The payment schedule that would be required is 30% at startup, 30% at completion of mold, 30% after completion of hull, the balance on final completion.

Note: Exchange rates in July 1991: 350 Cedi/1 US$: 280 CFA/1 US$

Development options

One might suppose that the most important justification for developing an industrial–level fishery for small pelagics is to supply food fish to the domestic market. Certainly there exists a supply shortage in Sierra Leone, and a strong demand. However, if capital investment in the national small pelagics fleet is very large (i.e., requiring a lot of foreign exchange), it will drive fishing companies towards exports. The difference in domestic small pelagic price (US$100·t^{-1}) and export price (US$250·t^{-1}) will increase the incentive to export. The regional demand for frozen small pelagics is also strong. The choice the fishery sector faces therefore is to either 1) minimize the foreign exchange component of the capital investment and supply the domestic market (this would favor an advanced artisanal fishery); or 2) make a much larger capital investment and supply both domestic and export markets (this would favor a semi–industrial fishery). Some combination of 1) and 2) seems also feasible. Either fishery would be made more efficient by the use of fish aggregating devices (FAD), which attract fish schools, thus reducing fuel costs and reducing fish finding time.

Fishing vessels

An advanced artisanal fishery might use a more seaworthy wider beam planked boat, powered by a diesel inboard or outboard engine in order to fish further offshore at a lower fuel cost per horsepower than a traditional craft driven by a petrol outboard motor. Similar boats could also be used for shrimp pair trawling (see section below on shrimp and bycatch fishery). Shore infrastructure for engine repairs and training of fishermen would be required. A semi–industrial ringnet/purse seine fleet could be based on 15–20 m, locally–made multipurpose planked ice boats with inboard diesel engines and combination winches. Bottom and pair mid–water trawling could be also tried on the newly designed craft to assess the economic viability of these fishing methods for the local conditions. Both the design of fishing vessels and the use of improved fishing gear would require technical assistance. Investing in larger steel purse seiners or larger pelagic trawlers is not considered to be economically justified.

Potential revenue

At an average regional export price of US$ 250·t^{-1} the 70,000 t surplus to the present national catch would have an upper value of US$ 15.5 million if the fish is all exported.

Tuna and large pelagics fishery

The resource

Tuna and other large pelagic species occurring within the Sierra Leone EEZ are:

- Skipjack tuna (*Katsuwonus pelamis*)
- Yellowfin (*Thunnus albacares*)
- West African Spanish mackerel (*Scomberomorus tritor*)
- Barracuda (*Sphyraena* spp.)
- Billfish and dolphinfish may also occur in economic concentrations.

Soviet and Japanese vessels have in recent years fished for tuna off Sierra Leone. A potential yield for tuna/large pelagics is difficult to determine for an individual country, as some of the stocks are migratory or shared. However a figure of 14,000 t potential has been proposed by some authors for Sierra Leone (MANRF 1988; Tettey 1988).

Development option

Given the interest of foreign vessels in fishing for tuna in Sierra Leone waters, there is little doubt that a good potential exists for developing a domestic tuna fishery of substantial economic importance. A good model to evaluate for possible introduction is the collaborative artisanal/industrial tuna fishery operating from General Santos in the southern Philippines. This fishery is entirely FAD–based, as this has proven to be the most efficient method for harvesting. The FADs are owned and installed by fishing companies who use small purse seiners to catch the skipjack attracted to the FAD. The artisanal fishermen use advanced artisanal boats (lightweight, high forward shear, ice box, inboard engine and double outrigger) to hand line for yellowfin and bigeye, which congregate at a lower depth than skipjack. The artisanal fishermen are welcomed by the fishing companies as they provide security and protection for the FADs from poachers and thieves. There is no conflict between the two groups, and this fishery might represent one of the few symbiotic small and larger scale fisheries in the world. The overall number of FADs deployed in a sea space should be controlled, because the FAD is an effective unit of fishing effort.

Fishing vessel

The advanced artisanal tuna vessels require higher speed, and hence a more powerful engine, to follow a tuna school but need only a fish hold capacity for 2–3 large tuna. Outriggers would facilitate trolling and an inboard diesel engine would allow longer distance operations to reach FADs set up further offshore. The skipjack semi–industrial purse seiners could be 20–25 m strong wooden or steel vessels powered by diesel inboard engines and equipped with insulated fish holds to carry ice and/or a freezer. By using FADs, boats would increase their fishing efficiency and save time and fuel. Assuming a 10–knot cruising speed, a boat could motor a FAD and back in say 48 hours. Adding 4–8 hours for fishing time, the total trip could be done in 2 or 3 days. FADs situated near the northernmost and southernmost edge of the 200–mile EEZ could require another 24–48 hours of motoring to access. Thus skipjack purse seining trips could last up to 5 days. In practice, most fishing trips could be of shorter duration because many of the FADs would be located less than 200 miles from Freetown. FADs need to 'regenerate' after a purse seining operation. Regeneration time could take a few days to perhaps a couple of weeks. A fishing company might solve this down–time problem by deploying several FADs, and fish them in sequence, either during a single fishing trip, or during several fishing trips. If the attraction of skipjack to FADs is low, then a single boat with a larger hold could probably fish all of the company's FADs in succession during one trip. If the rate of attraction is high, a transport vessel might be an economical solution to the problem of limited hold capacity of the semi–industrial craft. Investing in larger modern tuna purse seiners is not recommended for the country for economic and manpower reasons.

Potential revenue

At an average weighted (yellowfin and skipjack) international price of US$1,000·t^{-1}, the 14,000 t estimated potential might have a value of US$ 14 million.

Demersal fishery

The resource

Demersal species are the second most abundant commercial finfish resource in the Sierra Leone waters. It consists mainly of:

- Seabream sparids (*Dentex* spp., *Sparus* spp., *Pagellus* spp., *Boops* spp.);
- Grouper (*Epinephelus* spp.);
- Tonguesole (*Cynoglossus* spp.);
- Moonfish (*Selene* spp.);
- Grunt (*Brachydeuterus* spp.);
- Ribbonfish (*Trichiurus* spp.); and
- Rays (*Raja* spp.).

Ssentongo and Ansa–Emmim (1986) consider that the potential yield of demersal resources is probably around 30,000 t, based on fishery resource surveys, while Payne and Coutin (1988) cite a figure of 45,000 t. Total catches of demersal species from Sierra Leone (Table 1) have varied from 33,000 to 55,000 t between 1977 and 1986, of which about 10,000 t was caught by artisanal fishermen. The industrial demersal catch came mainly from Soviet and other foreign trawlers, who took between 16,000 and 43,000 t between 1977 and 1986. These data suggest that a safe estimate of the EEZ potential for demersal species available for the national artisanal/industrial exploitation is in the region of 30,000 t.

Development options

Fresh and frozen (block or fillet) demersals command good prices on export markets. The size of the Sierra Leone demersal resource is not large enough for it to be a strategic component of national food security. This suggests that the demersal resource could be utilized for export, at the top end of the domestic market (i.e., restaurants, hotel). Both artisanal and industrial sectors can participate in the demersal fisheries. An offshore advanced artisanal fishery for demersals based on hand lining, longlining and bottom gillnets should be developed, targeting sparids and grouper on hard bottom. Boats need to carry ice to ensure high quality product. This fishery should be aimed at exporting fresh fish by air to Europe. The emphasis should be on catching a modest amount of high–value demersals and, by taking all necessary steps to ensure careful handling and icing, producing a top quality export good. Processing and repacking would be done in the Freetown harbor area from where the product would be transported to Lungi airport. A chill room for holding the product would be required at the airport. Fishing patterns would have to be harmonized with flight schedules. Normally, the lapsed time between capture from the sea and take off of the aircraft should be under 18 hours. More than one company should carry out processing in order to promote competition and prevent a single buyer from controlling prices paid to fishermen.

A semi–industrial bottom trawling industry over soft bottom could target tonguesole, grunts, rays, ribbonfish and moonfish. The catch could be exported as frozen block. Any high–value species caught should be sold separately, perhaps as fillet, or to local restaurants and hotels.

Table 3. Cost/benefit estimates for 20 m wood hull semi–industrial multipurpose fishing boat operating in Sierra Leone waters.

Approximate capital costs	
Vessel hull	US$ 130,000
Engine and winch	110,000
Echo sounder and radio telephone VHF	5,000
Fishing gear and rigging	35,000
Total Capital cost	280,00
Annual operating costs	
15,000 gallons fuel	30,000
200 tonnes ice	30,000
Gear and spare	20,000
Port due	5,000
Overhaul	15,000
Crew share	32,000
Lease or loan repayment	120,000
Total Operating cost	252,000
Annual fish production revenue	
400 tonnes clupeids/mackerels	100,000
220 tonnes demersal	110,000
50 tonnes squid/shellfish	50,000
bycatch	30,000
Total fish production revenue	290,000
Annual gross profit	**38,000**

Source: Thompson (mimeo).
Specifications and assumptions: wooden plank hull; 20 m long, 6.3 m beam, 2 m draft; 240 bhp diesel engine; winch; echo sounder; radiotelephone; insulated fish hold; fishing gears: multipurpose bottom trawl & ringnet; weekly catches average 15 tonne; vessel capacity 25 tonne; crew: captain, engineer, mate, 7 deckhand

Fishing vessel

An advanced artisanal fishery might use high shear boats with insulated fish holds, diesel inboard engines, and single or double outriggers and buoyancy safety chambers for line and bottom gillnet fishing. (Such high–speed boats could find multipurpose use as artisanal tuna troller).

Catch rates would be much improved by setting artificial reefs (AR) made of bamboo or other locally available lightweight materials over the hard bottom. In the short term, this is analogous to the use of FADs in the tuna fishery. However, over the long term, ARs actually increase biological production above the natural level by providing greater shelter and more food. Regulations must be passed specifying AR ownership rules. Location and number of ARs needs to be controlled and fishing grounds demarcated and separated from bottom trawling/shrimping grounds.

The semi–industrial fleet could utilize the same vessels as used for the pelagic fishery. This would involve multipurpose craft, which could easily change the deck and fishing gear in port before starting a pelagic or demersal campaign (see Table 2). Investing in large powerful steel bottom trawlers is not considered to be economically justifiable, and would represent an overexploitation hazard to fish stocks.

Potential revenue

At an average international price of US$ 2,000·t^{-1}, the 30,000 t surplus to present domestic catches would have a value of US$60 million.

Shrimp and bycatch fishery

The resource

Shrimp are small resource in Sierra Leone waters but high in unit value. Three species occur:

- Pink shrimp (*Farfantepenaeus notialis*), by far the most common species;
- Tiger shrimp (*Melicertus kerathurus*);
- Deep–water rose shrimp (*Parapenaeus longirostris*), no fishery at present.

Willmann and Frielink (1987) calculated the maximum sustainable yield (MSY) of the Sierra Leone shrimp resource to be 2,500 t, while MANRF (1988) and Tettey (1988) place the Sierra Leone potential at up to 3,000 t. A significant part of the shrimp potential now lies within the 0–5 mile artisanal fishing zone and is off limits to industrial boats. Shrimp catches from Sierra Leone (Table 1) have varied from 1,100 to 1,800 t between 1982 and 1986. These data suggest that a `safe' estimate of the shrimp potential is in the region of 2,500 t.

Development options

Part of the shrimp resource is now allocated to the artisanal sector. Experiences in Sierra Leone have already shown that an efficient shrimp export scheme based on purchase of raw material from artisanal fishermen is feasible. The focus of industrial shrimping will necessarily shift into deeper waters. Test fishing could be carried out for deep–water rose shrimp to determine if development of this fishery would be economically feasible.

Fishing vessels

An artisanal pair trawling fleet can be maintained for harvesting shrimp inside the 0–5 mile zone. The use of bottom drifting gillnets also needs to be evaluated as this method has proved to be very efficient elsewhere and saves the smallest shrimp. The offshore shrimp fishery can continue to be based on the USA–Gulf of Mexico double–rigged steel vessels equipped with freezers. An economic alternative for shrimping grounds close to Freetown might be a 20 m wooden multipurpose vessel proposed for the offshore small pelagics. There are 21 shrimpers currently owned by Sierra Leone companies, down from 24 in 1983. Willman and Frielink (1987) suggest the optimal number of shrimp trawlers is between 18 and 26 vessels.

Shrimp bycatch marketing system

Shrimp bycatch utilization is a perpetual thorn–in–the–side of fisheries administrators the world over. The low price of the bycatch is the reason why fishermen dump it overboard, rather than use their limited freezing capacity needed for shrimp. In Sierra Leone, however, the high cost of fuel and fishing gear have encouraged many artisanal fishermen to buy or barter (i.e., in exchange for beer, cigarettes, etc.) the bycatch from shrimpers. This transport ('changee') operation is now common, but it is not clear if it will continue in the long term once artisanal fishing again becomes more profitable. Nonetheless, the precedent is now set, and the government might consider taking steps to strengthen the incorporation of the bycatch operation into the existing national fish marketing system. Assuming that bycatch constitutes 80% of the total catch of shrimpers, a potential bycatch yield of about 10,000 t is feasible. Simple planked transport vessels with insulated fish holds might be feasible if a stable outlet market is established. The changee operations present some law and order problems, which need to be controlled by the relevant agency.

Potential revenue

At an average international price of US$ 8,000·t^{-1}, the 2,500 t shrimp potential would have a value of US$ 20 million. At an average price of US$ 250·t^{-1}, the 10,000 t of shrimp bycatch has a value of US$2.5 million.

Cephalopod fishery

The resource

The squid resource is not well known. It may be assumed to consist of the several species having wide occurrence in the region (*Loligo* spp., *Ommastrephes* spp., etc.). The squid potential yield is unknown and there is no domestic squid fishery at present. It may be assumed that some catches are taken by wandering foreign vessels offshore

as Maritime Protection Services (Sierra Leone) (MPSSL) has advertised cephalopod trawling licenses in Fishing News International. It might not be unreasonable to suggest, based on squid production in Senegal, Mauritania and Morocco, that a Sierra Leone squid fishery could eventually produce 5,000 t annually. Cuttlefish (*Sepia* spp.) are taken by the industrial shrimpers as bycatch.

Development option

There is little local food demand for squid, so an entirely export oriented fishery is the only option at present. Cuttlefish is presently sold to local restaurants, as well as being processed and exported. Because so little is known about the resource, initial investment should be prudent. Exploratory fishing should be carried out prior to any decision on developing this fishery on a larger scale.

Fishing vessels

Too little is known on species and resources to suggest the appropriate type() of fishing vessel. Moreover, many different fishing methods can be used and the selection of the best fishing operation needs further study. Offshore seaworthy vessels equipped with jigging machines could be employed if good results are achieved during exploratory fishing. The appropriateness of the Japanese medium–sized coastal squid boats (20 GRT, 18 m hull, circa US$ 600,000) should be evaluated for Sierra Leonean conditions.

Potential revenue

At an average international price of US$ 2,500·t^{-1}, 5,000 t of squid production would generate US$12.5 million in revenue (see also Table 3).

Expanding the Fish Processing Industry

Fish offloaded at the proposed new fishing harbor complex in Freetown will be auctioned there and will enter one of the following possible processing and marketing streams:

- Fresh fish for the local market;
- Fresh fish for the export market;
- Frozen fish for export markets;
- Smoked fish for the local market; and
- Tuna loining for export.

Fresh fish for the local market

Iced fish will be purchased by fish shops, hotels, restaurants, hospitals, etc. and by traders for sale in markets or for hawking through rich neighborhoods. For the latter purpose, hawkers will need insulated boxes and means of transport. An ice plant is needed at the proposed auction hall. A 5 t·day^{-1} ice plant would be sufficient for local and export requirements. Insulated trucks are required for transport of iced fish to inland markets.

Fresh fish for export market

Air freighting of fresh fish to Europe already takes place from other West African countries, including from Conakry in Guinea, and should be possible from Freetown as well. Companies engaging in this trade will transport the iced fish to their premises where they should have processing, packing and chilled storage facilities. Single–use boxes of expanded polystyrene and polythene bags should be produced in Freetown. Demand and prices in export markets are good so that export potential only depends on flight schedules and freight capacity. Wholesale prices in Europe are about US$7·$kg^{-1}$ (range is from US$5 to US$10 and above). Costs of air transport are about US$1.5·$kg^{-1}$ of fish and packaging costs about US$0.30·$kg^{-1}$ of fish. This leaves enough margin for local costs of raw material, transport to Lungi where more chilled storage capacity should be installed by the airport, for handling charges at both ends, and for the importer's commission of about 5% after all costs. At present there are some 9 direct flights per week to Europe spread over 5 days. Freight capacities have to be investigated in Freetown, while INFOPECHE can supply trade contacts in Europe and can assist in market development.

Frozen fish for export (and local) market

Shrimp, lobster, squid, cuttlefish and large demersal and pelagic fish have export potential to Europe, USA, Japan, Australia and African markets. Value added processing, freezing and packing should be one in Sierra Leone and transport should by boat and/or by air. Costs of processing, freezing, packaging and transport would range from about US$0.70 to US$2.00·kg^{-1} depending on product form and destination. Import prices at destination run from US$1.50 to US$20·kg^{-1} product depending on species and product form. INFOPECHE can assist with trade contacts and with product and market development.

Block frozen small pelagic fish, in particular sardinella, have export potential to African markets. Transported by sea, the product would be imported at a value of just under US$0.50·kg^{-1}, which would allow for a maximum auction price in Freetown of about US$0.25·kg^{-1}. Transported by road they could be directly delivered to wholesalers in Guinea, Côte d'Ivoire and Mali at a price of around US$1·kg^{-1}. There would also be a local market demand for frozen fish, in particular block–frozen sardinella.

Smoked fish for the local market

At the fishing harbor, small–scale processors would also buy fish, in particular small pelagics, for traditional processing and marketing. An area nearby would need to be reserved for smoking activities and commercial fish smoking activities in town should be prohibited.

Tuna loining for export

Although the tuna resource potential of 14,000 t would in itself justify a canning industry, the likelihood of finding an interested investor would appear to be small until such time as Freetown could compete with established tuna industries in Dakar, Abidjan, Accra, American Samoa, Indonesia, Philippines and Thailand. Support infrastructure in Freetown is presently not sufficient compared to that of the other countries. This infrastructure includes communications, transport connections, water supply, power supply, fuel supply, maintenance services, manpower, banking services, etc. However, in the interim period until such infrastructure would be available, a tuna loining operation might be possible. Such an operation would produce frozen cooked tuna loins as a semi–final product for canneries elsewhere. Loining is the most labor–intensive part of a canning operation, and labor costs in Freetown may be attractive when compared to costs in Abidjan and Dakar. Loining operations exist for instance in the Maldives for canneries in Thailand.

Fish waste reduction plant

Fish waste potentially available for reduction to fishmeal would include filleting frames, shrimp heads/shells, tuna frames, and guts. A simple low–capital, labor–intensive operation consisting of chopping, cooking, pressing, drying and milling should be evaluated for feasibility.

Other products

Sharkskins can be processed into semi–final product for export to specialized tanneries. The resource base of bivalves may need to be established in order to make a decision on investment in harvesting and processing technology.

Summary of the Proposed Fishery Expansion

The proposed expansion of the different fisheries in Sierra Leone is summarized in Table 4.
It is difficult to specify at this point the number of vessels and amount of investment required to achieve an optimal fishing effort in each of the discrete fisheries that could be developed. In some cases neither the potential yield of the fish stock nor the catch rate of a single unit is known or reliably estimable. Furthermore, if most of the vessels purchased are to be multipurpose, one can expect considerable movement in and out of the discrete fisheries as fishermen switch target species/fishing gear to maximize the profit of their operations throughout the year. An efficient statistics service will be needed in order to assess the effort expended and production realized in each fishery so as to be able to produce accurate and actual situation reports of each fishery for management purposes. The number of processing units and levels of investment (dollar/leone) can also not be very reliably estimated at present given the uncertainty of the raw material supply levels. The best approach is a cautious, gradual development.

An attempt should be made to establish a fishing fleet development plan on the basis of the estimated fish resources and catches, and following a policy of progressive withdrawal of foreign craft from the national waters. There is no good economic reason why either the fishing boats or processing plants should be in the hands of foreign companies instead of private entrepreneurial hands. Finance should be obtained from local banks and finance institutions, or from external commercial sources if a large amount of foreign exchange is required. Expertise to assist in the preparation of project proposals and loan application forms is available from several local sources.

Table 4. Summary of proposed fisheries expansion.

Fish stock	Vessel type	Fishing method	Potential production (tonnes)	Potential revenue (US$ mil.)	Processing method	Destination market
Small pelagic	AAWB	Ringnet	70,000	17.5	Fresh/iced	Freetown
					Frozen	Inland
					Frozen	Export
	IWHM	Ringnet			Smoked	Inland
					Gutted/Fillet	Restaurant
Tuna & large pelagic	AAKB	Handline	14,000	14.0	Frozen	Export
	ISPS	Purse seine			Cooked loin	Export
					Canned	Export
Demersal	AAKB	Hooks/gillnet	30,000	60.0	Fresh/gutted/iced	Export
	IWHM	Bottom trawl			Frozen block	Export
Shrimp	AAWB	Pair trawl	2,500	20.0	Frozen/processed	Export
	IMST	Bottom trawl				
	IWHM	Bottom trawl				
Shrimp bycatch	AWBT	-	10,000	2.5	Fresh	Freetown
					Frozen	Inland
Squid	SISJ	Jigging	5,000	12.5	Frozen/processed	Export
		Total	131,500	126.5		

Reference

FAO. 1989. FAO yearbook, fishery statistics, catches and landings. Vol. 68, 518 p. FAO, Rome.

MANRF. 1988. The Sierra Leone green revolution program, 1988/89, 1991/92. 1988 Rev. ed. Ministry of Agriculture, Natural Resources and Forestry, Freetown.

Payne, A.I. and P.R. Coutin. 1988. The effects of long–term exploitation on West African demersal fish stocks. Final Report (Overseas Development Administration Project R3920). Institute of Marine Biology and Oceanography, University of Sierra Leone and Coventry Polytechnic, Sierra Leone.

Ssentongo, G.W. and M. Ansa–Emmim. 1980. Marine fishery resources of Sierra Leone: a review of exploited fish stocks. CECAF/ECAF Ser. 86/34 (En), 76 p.

Tettey, E.O. 1988. Export markets for Sierra Leonean fish and fishery products. INFOPECHE, Abidjan, 30 p.

Thompson, D. Development of Sierra Leone's offshore fishing industry. UNIDO.

Willman, R. and B. Frielink. 1987. The shrimp fishery of Sierra Leone. CECAF/TECH/87/79, 28 p.

Enhancing the Role of Women in Artisanal and Industrial Fisheries[1]

A. Demby[a] and I. Leigh[b]

[a]*WNW–AFCOD Program, Freetown, Sierra Leone*
[b]*Department of Fisheries, Freetown, Sierra Leone*

Abstract

Women play a major role in the fisheries of Sierra Leone, from processing to marketing and financing. This paper provides historical background for the role of women in the marine resource sector, and describes factors that currently constrain the effectiveness of women's activities. The paper analyzes some of the major issues in the industry, and offers recommendations for ways that women may enhance the profitability and quality of Sierra Leone's marine resource products.

Introduction

Fish is the cheapest source of animal protein consumed by Sierra Leoneans, ant constitutes an essential part of their diet. The artisanal fishing sector provides a large proportion of the catch made available to the population for consumption. Generally, women play a major role in the fish processing. However, they also play an important role in financing fishing operations. In many cases, they pre–finance the purchasing of nets, engines and other inputs, as well as provide fuel for the boats and boats for the crews. Some women even own fishing boats complete with nets and engines. Considering the highly perishable nature of fish and the unavailability of freezing facilities in the artisanal fisheries sector, only a small proportion of the catch is eaten fresh. The rest is processed, and smoking is the only type of processing done commercially.

Like in most other West African countries, in the artisanal fisheries sector of Sierra Leone, women play a significant role in the processing of fish. About 80% of the total number of fish processors in Sierra Leone are women. This activity serves as the main income—generating activity of those engaged in it. Women also play an important role in the marketing of the smoked product. Most of the processors market their own product. Others sell it off the smoke ovens to traders who are mostly women.

Generally, as far as artisanal fisheries development is concerned, much attention is focused on fish production. Women's role in the processing and marketing of fish seems to be neglected. These processors are confronted with a lot of constraints that greatly reduce their profit margin.

Constraints

The working capital of the majority of the processors is very limited. In order to acquire money to embark on fish processing, most of these women have to enroll as members of institutional thrift and credit societies like cooperatives or similar informal societies like "Osusus". Others obtain loans from husbands, relatives or friends. Whatever the case, the working capital obtained is usually not enough for a processor to embark on large–scale processing.

Considering the present economic situation in Sierra Leone, processors make use of whatever profit they derive from processing. Virtually nothing is accumulated in order to increase the working capital and expand their activity. The working capital of most of the processors is depleted during lean periods when not much fish is available. Most processors use a good proportion of their working capital, if not all, in order to continue providing food for their families. Thus at the end of a lean period they encounter difficulty to restart operations. These women have in the past not been exposed to modern smoking techniques. Their traditional techniques are connected with high post–harvest losses. They make use of ineffective techniques with a lot of disadvantages that reduce their profit margin. The traditional Banda and Fante ovens cause a lot of wastage of fuel wood. In addition, the processors spend long hours (5–8 hours) at high temperatures, exposed to significant smoke and heat, which is hazardous to their health. The product obtained is usually inconsistently smoked with reduced shelf life. With the present high inflation rate and acute shortage of foreign exchange, there is great disparity between producer prices and the prices of imported fisheries inputs. These include smoke oven construction and replacement materials, such as mesh wire, pipes and iron rods. Processors now find it almost impossible to meet the cost of such inputs. During lean periods when the catch is poor, smoking comes to a standstill for most processors. Most of them do not engage in any other supplementary economic activity because they either lack such skills or their working capital is not enough for them to embark in any such activity.

Storage and marketing facilities are very limited in the artisanal fishing sector of Sierra Leone. This contributes to the high rate of post harvest losses. The smoking sheds are not well protected from interference of cats, dogs and other animals that eat the fish. The roads are deplorable and processors who market their product in distant

1 Cite as: Demby A and Leigh I (2012) Enhancing the role of women in artisanal and industrial fisheries. pp. 78-80. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

places encounter several traveling inconveniences. Over 80% of the artisanal women processors are illiterate and lack accounting knowledge. This further prevents them from keeping proper records of their processing activities. Despite the long hours of work that these women have to cope with during processing, they also have to cope with their domestic duties such as preparing food for the family, caring for their children and husbands. They have very little time to rest or even care for themselves.

Recommendations

In the artisanal fisheries sector of Sierra Leone, women's roles in the processing and marketing of fish is connected with a lot of constraints. Unless methods to enhance this role are determined, the full potential of these women to contribute to the economic, social and nutritional development of Sierra Leone will remain partially tapped. In order to enhance their role, it is hereby recommended that the following measures be considered:

- Since the availability of the raw materials (fish) needed by these women is dependent on the fishing activity, more consideration should be given to improving the artisanal as well as industrial fishing activities;
- On the part of the artisanal fishing sector, the responsible department should provide avenues whereby these fishermen can obtain input credit for their activities;
- It is important that these women should be involved in all aspects of artisanal fisheries development programs. They should be included at all stages from the planning to the evaluation;
- The government should create avenues whereby these women can seek assistance for credit to provide them with sufficient working capital so as to expand on their activities. They can be encouraged to even form self–help groups in order to promote their activities;
- The artisanal women fish processors should be introduced to available improved smoking techniques and encouraged to adopt such techniques through training and extension services. Furthermore, research aimed at developing much more appropriate techniques using mainly local inputs should be pursued by the responsible department. In addition, such research should aim at increasing the shelf life of the product;
- In a state of poor health, the women processors will be incapable of performing their role, thus they should have access to basic education and health services needed to promote their health as well as those of their families. In addition they should be provided with opportunities for them to acquire basic numeracy and accounting as well as marketing skills needed for the promotion of their processing and marketing activities;
- These women should be encouraged to develop other income–generating skills. As best as possible, such skills should be complimentary to their fisheries activities. However such income–generating activities should be viable and home–based so as to allow them to continue with their domestic duties;
- The responsible department should ensure that storage facilities are provided at the village level so that fish can be stored for use during lean periods, in order to allow the processors to continue their activity;
- Facilities should be provided to reduce the women's domestic workload, so that they may have enough time at their disposal to rest and take care of themselves. An example is the provision of day care centers for children.

Background

It is only over the last ten years that women have been actively involved in industrial fisheries. Previously, the role of women in the industry had been relegated to the retail trade of the fish in local markets. Women are now actively engaged in the day–to–day running of fishing companies. Some are even placed in the top echelons of the trade companies. The thought that a woman's role in the industry is only in marketing is now a thing of the past.

Beginnings and operation

Women were introduced into the trade through retail outlets. They owned fish stalls and shops, which sold iced fish, bought from agents of fishing companies. The fish were sold to consumers on a retail basis. Subsequently they began to buy fish directly from the fishing companies. Women entrepreneurs, otherwise called 'agents', buy fish directly from the Sierra Fishing Company at its headquarter at Kissy. There are not many women who undertake this exercise because the total amount of fish bought at any one time may be about 7 t.

The flow channel is:

- Fishing company–agent–sale in the provinces;
- Fishing company–agent–wholesaler 1–wholesaler 2—retailer;
- Fishing company—agent.

After the agent has bought the fish, she has three options in disposing it. She can (i) provide her own transport to take the produce to provincial towns for retail sale; (ii) sell the bulk of her purchase to another wholesaler who provides transport to provincial towns, where the product is either sold to small retailers at the market, or to another wholesaler (no. 2); or (iii) sell direct to small retailers in fish shops in the capital or main provincial towns or market stall.

With option b) above, the fish is sold to retailers who come from villages surrounding the main provincial towns. Transport of the fish to provincial towns is by lorry. Previously the company provided refrigerated trucks so that the product arrived at is destination iced. With these trucks, which are provided by the company on a hire basis, up to 10 t of the product can be transported at any one time. These lorries leave in the late afternoon, and arrive

at their destination before sunrise, for the day's sales. At the present time, local non–refrigerated lorries are used, the main constraint being the high cost of transportation.

Funding

There are various ways in which funds are available for the pursuance of the trade, notably:

- A woman entrepreneur buys the fish in bulk from the fishing companies, thus the capital investment is provided from her own funds;
- The entrepreneur mentioned above provides the bulk of the funds but she may involve one or two partners. They are responsible for running the day—to–day activities of the business. They might in some cases invest funds into the activity. At the end of the sales, they get a percentage of the profit commensurate with the amount of funds they have invested;
- These junior partners may, after a period of time, have saved enough money to branch out on their own;
- The fishing company may make available to reputable individuals the sale of fish on credit. The fish is then sold by the agents or their representatives either, wholesale or retail, for a profit. She pays the company the cost of the fish and the profit goes to her. Sometimes the company pays the agent a small commission.

In the case of a few of the other fishing companies, the fish is sold directly to the agent on a cash basis. The agent then disposes of the fish in some of the ways enumerated above.

Constraints in the Industry

It is seen above that the major constraints affecting the women's participation in the industrial fisheries is funding. Not many agents who otherwise would have liked to participate in the industry are able to do so because of the financial constraints. Therefore, only a few women entrepreneurs have a strong hold, because of the capital investment. The junior partners play a very minor role in the activities. There has been a large increase in the price of fish, with the effect that large enough quantities of fish are not bought to make it a viable industry. The escalating cost of fuel makes transportation also a constraining factor, and these two factors cause the price of the fish to be so high at their final destination, that the retailers or consumers are unable to buy the fish.

Remedial Measures

This treatise clearly shows that only very few financially capable individuals have a stronghold in the industry. In order to enhance the role of women in the industry, we recommend the formation of an industrial fisherwomen cooperative. This organization can be on two or three levels, according to the financial input of the individuals, and the nature of activity (be it wholesalers or retailer) in the organization. Thus, the resources of the individuals can be pooled together for the financial management of the organization. Needless to say, a reputable cooperative adviser and bookkeeper must be involved with their day—to–day operations. The industry has became so expanded, with even the fishing companies being involved in the day to day marketing of their catch, that a single or group of individuals with limited financial capabilities will not be able to survive for long. The funds of the cooperative groups can be involved in providing assistance to individuals who may want to branch out on their own and who cannot provide the capital investment, and individuals who may want to participate in different strata of the industry, either as wholesalers or retailers. Care was taken not to mention commercial, agricultural or rural bank loans. The interest on commercial or agricultural bank loans are prohibitive, and there are also hidden costs that erode the loans provided by these banks.

Conclusion

The level of activity of women in the industrial fisheries sector, which five years ago was attracting quite a lot of individuals, has at the present time dropped to an all–time low. The prohibitive cost of the catch and transportation renders the industry an nonviable option except to a very few women entrepreneurs. Their profit margins are reduced because of the above factors and also because consumers are unable to pay for the high price of their fish. The remedial measures which I have set above, if properly implemented, can go a great way to providing the needed incentive to the flagging industry.

Domestic Fish Marketing in Sierra Leone[1]

S. Etoh

Senior Fisheries Development Advisor, Food and Agriculture Organization of the United Nations, Rome, Italy

Abstract

The fish distribution and marketing system in Sierra Leone can be largely classified into fresh, frozen and smoked fish, and this paper investigates these three channels. The distribution and marketing system for smoked fish is highly developed and this mechanism is functioning well, although there has been some sign of saturated supply of the market. Smoking coastal pelagic fish will be continued in the future, even when a cold–chain is completed, due to their physical characteristics. Fresh and frozen fish distribution and marketing still remain in the rudimentary stage. One of the reasons lies in the fact that current deterioration of the macro–economy in Sierra Leone has hardly permitted the progress in this sector. However, it is evident that there has been a deep–rooted preference among consumers for fresh fish, especially for demersal fish, and therefore a cold–chain should be established when the time comes. The primary cause of dwindling per capita consumption lies in the decline of the purchasing power of the consumer, resulting from the deterioration of the overall economy. This problem has become more pronounced with rapid population growth, and is unlikely to be overcome by input from the fisheries sector alone, but rather it requires the total rehabilitation of the country's macro–economy.

Introduction

Sierra Leone has one of the richest marine fishery resources in all of West Africa, with a maximum sustainable yield (MSY) estimated between 170,000 and 300,000 tonnes (t) per annum. Of those, about 40,000 t are caught by the artisanal fishery (Ssentongo 1986) and almost all of the artisanal products are consumed locally. In addition, a majority of the shrimp bycatch captured by shrimp trawlers (in 1991 about 40 were in operation) and also some fish that is caught by fish trawlers or purse seiners (in 1991 about 40 were in operation) are also marketed locally. This catch is estimated to be around 620 t per year (Table 1). Thus, about 40,620 t were distributed through the domestic marketing channels in 1991. Fish accounts for some 65% of total animal protein intake in Sierra Leone (Table 2) and its supply to an expanding local market is essential to maintain nutritional standards. However, this level of fish intake per capita has been remarkably reduced, in spite of the fact that the fish production itself has not declined significantly.

This study was carried out from the fish distribution and marketing angle to investigate the present marketing situations and constraints, and derive some recommendations toward returning fish consumption to the level of the 1970s.

General Trend of Domestic Fish Marketing

Protein sources originating from fish and fish products comprise as much as 62% of major animal protein (1988) in Sierra Leone, and the per capita fish consumption accounts for 14 kg·year^{-1}; quite high compared with other African countries, although still lower than the global average.

Table 1. Off–shore fishery catches in Sierra Leone in 1991 (Jan-Aug).

Production	Total (t)	Export (t)	Local
Shrimp	796.3	673.1	21.4
Fish	2,253.8	1,765.0	488.8
Squid	60.5	59.4	1.1
Cuttlefish	20.5	17.4	3.1
Lobster	0.1	0.0	0.1
Crab	3.9	1.9	2.0
Total	3,135.1	2,516.8	516.5

Source: Marine Protection Service (Sierra Leone).
Note: Fish caught by purse seiners are not included.

The major species of fish popularly consumed in the country are coastal small pelagics such as bonga, sardine and shad, accounting for 71% of total fish catch by the artisanal fishery (Table 3). Over 90% of these fish are estimated to be processed into smoked fish or rather heat-dried. There are several reasons why the smoking method has become more widespread in Sierra Leone than other processing methods. Primarily, the bony characteristics of these most abundantly available species of fish make their consumption in fresh form a nuisance. Neither salting nor simple drying are a solution, as tiny sharp bones still remain, and are difficult to remove before cooking. The solutions to this constraint are (1) canning to soften the bones, (2) steaming the whole fish and then removing the bones one by one as popularly done in Philippines for milkfish, or (3) heat–drying, as developed in West Africa. Heat–dried fish flesh is easily removed from bones in such a way that people can scrape meat after breaking into pieces for cooking. Therefore, local cooking methods are also devised so as to make use of these split or broken pieces of flesh (e.g., cooking them together with cassava leaves and/or potato leaves).

1 Cite as: Etoh S (2012) Domestic fish marketing in Sierra Leone. pp. 81-89. In: Vakily JM, Seto K and Pauly D. (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

Secondly, firewood notably derived from mangrove trees are abundantly available, especially close to fish processing areas (but see Johnson and Johnson, this volume).

Thirdly, there has been little chance to develop other preservation methods, such as chilling and salting, for the lack of accessible ice and the high cost of salt.

Still, these coastal pelagic fish are marketed in fresh form to some extent, especially in the vicinity of major towns like Freetown. In fact, in Goderich 71.8% of sardines, being the major catch, are marketed in fresh form (Table 4), while in Konakridee, 15 miles from Freetown along the coast, it turns to be 9.3% of total bonga catch and in Yeliboya, 35 miles away, is 0.8%.

Table 2. Fish production by artisanal fishery, 1988.

Species of fish	Estimated annual catch	Ratio (%)
1. Bonga (*Ethmalosa fimbriata*)	18,800	47
2. Sardine (*Sardinella* spp.)	6,400	16
3. Shad (*Ilisha africana*)	2,400	6
4. Carangids	800	2
5. Croakers (*Pseudotolithus* spp.)	4,000	10
6. Threadfins (Polynamidae)	2,400	6
7. Skate and rays (*Raja spp., Dasyatis* spp.)	1,200	3
8. Catfish (*Arius* spp.)	800	2
9. Barracuda (*Sphyraena* spp.)	400	1
10. Other species	2,800	7
Total	40,000	100

These figures obviously indicate that the farther the processing center is located from Freetown, the lesser the chance to market fish in fresh form. Some consumers purchase fresh sardine or bonga and use them directly to prepare dishes, while others smoke them at home prior to utilization. The practice in the latter case, however, seems to be prevailing not for the preference of smoked flavor or dried taste but simply for the preservation, especially nowadays that electricity supply is so intermittent. Also, the fact that fresh fish are by far cheaper compared with smoked ones tempts consumers to buy fresh fish and smoke them themselves at home. On the other hand, in the interior towns of the country, almost all these coastal pelagic fish are consumed in smoked form, as no cold chain has been established to market these fish. Smoked fish are classified into fresh smoked and hard smoked. The former is smoked for 3–5 hrs and can be preserved for a maximum of 3–4 days, while the latter is smoked intermittently for 3–4 days, allowing it to be preserved for up to a month. Although consumers by all means prefer fresh smoked fish to hard smoked fish, and are ready to pay more for that, the present road conditions do not always permit for smoked fish to be distributed to interior towns within 3 days after processing. Thus, the bulk of the fish are processed into hard smoked form.

Besides the domestic marketing channels, there was a route of informal exportation for smoked fish to Liberia and Guinea through Koindu, located in the extreme east of Sierra Leone. Quite substantial amounts of smoked fish were reportedly exported through this channel. This lucrative outlet, however, has closed since early this year, due to the insecurity and unrest in the southeastern part of the country. Since then, these export–oriented smoked fish have been flowing into other interior towns and, as a result, an excess of smoked fish supply has occurred there. Species other than small coastal pelagic fish caught by artisanal fishermen like croaker, threadfin, marine catfish, snapper, grouper and barracuda are preferentially marketed in fresh form, especially in the vicinity of major towns. For remote markets, these fish are processed into smoked form for distribution and marketing.

Table 3. Features of fish consumption in Sierra Leone, 1975-1988.

Year	Catch (t)	Imports (t)	Exports (t)	Fish supply (t)	Population (x1000)	Per capita consumption ($kg \cdot year^{-1}$)	Fish/animal proteins (%)
1975	68,597	8,490	26	76,561	2,931	26	72.8
1976	537,92	6,236	1	59,527	2,992	20	68.0
1977	52,652	8,766	4	61,414	3,056	20	70.6
1978	50,080	10,589	0	60,668	3,122	19	66.0
1979	57,592	12,308	69	39,831	3,191	22	66.7
1980	49,187	25,990	448	74,729	3,263	23	65.7
1981	51,000	31,889	850	82,239	3,337	25	67.8
1982	53,038	7,266	940	59,663	3,415	18	67.0
1983	51,141	13,434	1,811	63,264	3,495	18	67.0
1984	52,747	8,893	748	60,892	3,578	17	65.7
1985	53,511	9,674	1,045	61,540	3,665	17	67.9
1986	53,313	8,108	1,558	59,862	3,755	16	65.7
1987	53,206	2,793	1,455	54,544	3,848	14	60.2
1988	53,273	3,316	1,569	55,020	3,945	14	61.5

Source: FAO Fish. Circ. 821, Rev. 1 (1991).

Apart from the above distribution of fish captured by artisanal fishery, about 620 t of fish caught by the offshore fishery are being marketed in the country this year (Table 1). Although exact figures could not be obtained,

it is estimated that over 70% of them are being distributed to the interior, as selling prices there are much higher than those in Freetown.

Table 4. Pattern of marketing fish by fishing villages in Sierra Leone.

	Fresh fish		Fresh smoked		Hard smoked		Total	
	Dzs ('000)	%	Dzs ('000)	%	Dzs ('000)	%	Dzs ('000)	%
Goderich (sardine)								
Small	5,100	75.0	500	7.4	1,200	17.6	6,800	100
Medium	3,400	67.3	900	17.8	750	14.9	5,050	100
Large	1,300	72.2	100	5.6	400	22.2	1,800	100
Total	9,800	71.8	1,500	11.0	2,350	17.2	13,650	-
Konakridee (bonga)								
Small	110	9.0	700	57.4	410	33.6	1,220	100
Medium	10	6.7	20	13.3	120	80.0	150	100
Large	15	17.6	30	35.3	40	47.1	85	100
Total	135	9.3	750	51.5	570	39.2	1,455	-
Yeliboya (Bonga)								
Small	50	0.4	5,500	46.4	6,300	53.2	11,850	100
Medium	40	42.1	30	31.6	25	26.3	95	100
Large	10	25.0	15	37.5	15	37.5	40	100
Total	100	0.8	5,545	46.3	6,340	52.9	11,985	-

Source: West Northwest AFCOD Project (1991).

Fresh Fish Marketing

Supply

In Sierra Leone, it is reported that about 40,000 t of fish are caught annually by the small–scale fishery (Tables 1, 2 and 5), of which so–called coastal pelagic fish like bonga, sardine, shad and small carangids accounts for 71%. The composition of species, however, varies largely, depending on the localities. A good example is that the major catch in Goderich comes from sardine shoals, while in Yeliboya it is bonga. The two production centers are 40 miles apart along the coast. Fishing operations generally take place during the daytime, boats go out in the early morning, and return to land their catch any time from mid–afternoon until midnight depending on catches. Sometimes it happens that boats return back to the fishing ground again after landing their first catch, if vast shoals of fish are located nearby. The fishing methods also vary depending on target species of fish. For instance, for catching bonga, encircling gill nets are mostly employed, while for sardine, drift nets are used. Similarly, bottom set gill nets and hand lines are mostly used for demersal species of fish like snapper, grouper, and bream.

As soon as boats arrive ashore, fish are sold to women processors, or fishmongers, by the dozen for medium and large coastal pelagic fish, and by metal bowl for small fish. These sales are generally controlled by boat owners or captains. It is said that these fish processors normally have close family relationships or kinships with the boat owners and enjoy preferential treatment in terms of quantity and price of fish. In the case of Goderich, however, once fish are landed, they are sold at more or less same price to fishmongers from Freetown and to local buyers. Further, the latter is grouped into two by the villages where they live. There are two major villages in Goderich, Antar Town and English Village, and it is a convention that fish processors from each village can have access to fish sales at the beach every other day, while those from Freetown are allowed to transact business every day. These self–control measures appear to have stemmed not only from the need of regulating over–crowded fish processors at the fish landing beach, but also from the requirements of fish processors themselves.

Table 5. Total fish catch (t) from Sierra Leone waters.

Type of fishing		1981	1982	1983	1984	1985	1986
Artisanal fishery		31,600	34,600	47,274	43,300	44,100	40,000
Industrial fishery	Shrimp	642	1,760	1,196	1,300	1,232	1,130
	Demersal fish	44,544	28,742	29,289	25,323	29,036	27,092
	Pelagic fish	52,322	51,859	57,277	28,740	61,085	86,421
	Subtotal	97,508	82,361	87,762	55,363	91,353	114,643
	Fish landed to Sierra Leone	14,686	11,943	9,314	15,929	18,571	13,313
Grand total fish catch		129,108	116,961	135,036	98,663	135,453	154,643
Total fish landed in Sierra Leone		46,286	46,543	56,588	59,229	62,671	53,313

Source: Payne and Coutin (1988).

Most of the fish processors from Goderich are normally smoking their fish purchased on one day and selling at the market the next day or preparing hard smoked fish, and therefore it is more practical and convenient for them to purchase fish every other day. This marketing mechanism seems to be functioning well.

The beach price is mainly decided by the correlation between supply and demand; to be more specific, as daily demand is about stable, the price decision factor lies primarily in quantity of supply of the day. This means that the first arrival boat will play an important role in price decision of that day. Also, there seems to be some convention in this way of price setting, for unlike fish landing beaches in other countries, bargaining fish prices has

been the characteristic feature. Work on this issue, in collaboration with socio–economic research, may produce interesting findings. Species and estimated quantities of fish landed by the artisanal fishery in the country are listed in Table 2.

It is rather difficult to quantify the amount of fish being marketed in fresh form, as the proportion differs from village to village depending upon demand in the area. For instance, as seen in Table 4, in Goderich as much as 71.8% of fish are marketed in fresh form, while in Konakridee it turns only to be 9.1% and further in Yeliboya to 0.8%. This is an indication of the trend that in fishing villages, which are remote, the quantity of fish sold in fresh form turns out to be negligible.

Distribution and marketing

There are five conceivable channels of distribution and marketing of fresh fish:

- Direct sale to consumer. This follows a pattern whereby catches are directly sold to consumers at the shore, and is quite popular in Goderich. Most of the buyers are catering agents or purchasing agents of hotels from Freetown, and individual consumers are mostly from the nearby villages. They generally prepare their fish into dishes in the fresh form and rarely smoke them further;
- By fishmongers from fishing villages. Here, female fishmongers from local villages purchase fish from fishermen and transport part or all to the town for fresh fish sale. This case is not so popular as the one that follows next (C);
- Fishmongers from the town. This is the most popular pattern observed at Goderich. Female fishmongers from the town purchase fish from fishermen and bring them back to the town for sales on the markets. Some of them have sale stands in the markets and pay rental fees but others do not. The latter group generally sells their fish either on the side of the road or in the open space of the marketing premises;
- Fish traders from the local villages. For this channel, fish are purchased by the village traders at the beach and transported to the town and sold to the retailers in the markets. This pattern may exist in the vicinity of Freetown only; and
- Fish traders from the town. This is the same pattern with the above except that the traders come from the town daily and bring back their fish for sale to retailers. It has been reported that fish distribution patterns in (D) and (E) were relatively insignificant in scale compared with the other three.

In the fish market in Freetown, it was observed that fish were invariably rolled with beach sand and piled in baskets or metal bowls. This sort of practice is also prevailing in other parts of the world such as Sri Lanka and India, to camouflage the fish as if they were just brought from the landing beach. This practice should be discontinued from the hygienic point of view, although understandably, it is a difficult task to force them to change their traditional commercial practice. The beach fish price is quite sensitive and varies daily, but the end retail prices normally do not move so much as the beach price does. The difference in profit margin is generally adjusted by fish processors. In the case of Goderich, fish purchased by fish processors are mostly transported by taxis or coaches at Le.400 per basket including a passenger's cost to Freetown. The basket size containing fish varies individually but normally each fish processor carries 20–30 dozen sardines each trip. The current average beach a price of sardine in Goderich is around Le30 or 0.07 USD, while the consumer's prices in the fish markets of Freetown is Le60—70 or 0.14-0.17 USD. With this base, the daily gross income of each fish processor can be calculated (Table 6). As seen for that table, the daily gross income will be Le.800 and more vulnerable to fluctuation of market prices rather than beach prices. This means that a fish processor can withstand the mark–up of beach prices to some extent, but not the decline of retail prices. This trend coincides with the complaint made by one of fish processors, who stated that the daily fluctuation of beach price always occured at her expenses. Moreover, there must be some tacit agreement among fish processors upon the market price setting. Otherwise, the gross income of fish processors will deteriorate due to competition. A market price reduction of only 10% leads to as much as 30% reduction in gross income (Table 6). Also, fish processors face another risk. In case all fish brought to the market are not sold, they have to either reduce the sale price toward the end of market day so as to empty their baskets, or bring back to their home for smoking, which entails extra expenses.

Consumption

Fresh fish purchased by individual consumers are usually prepared fried or used in stew dishes especially for larger fish like barracuda and snapper. Smaller fish like sardine and bonga may be utilized in fish balls and other dishes. Also, some are smoked at home and then cooked in traditional dishes with cassava leaves and potato leaves. Larger fish like barracuda are also quite often smoked at home, primarily for preservation purposes.

Future prospects

There seems to be scant likelihood of future prospects in the development of coastal pelagic fish in fresh form, mainly due to their physical characteristics of being very bony. For this reason, these fish are likely to continue to be smoked even though a cold chain may be established in the future. On the other hand, the demersal fish will and should be distributed in fresh form in the future. Generally, consumers are fond of fresh demersal fish. At present, a major portion of this catch is turned into smoked fish, especially in the rural areas, simply due to lack of a readily accessible market and cold chain. The main bottleneck currently preventing these valuable fish from

being marketed in fresh form lies in the shortage of ice, even in urban areas. Currently, power is provided to the town very intermittently, giving a quite negative outlook for future development in the building–up of the cold chain, for it is unlikely to maintain constant ice supply with an individual generator power supply.

Secondly, the road conditions are poor. The roads in the town are too congested, while those in the rural areas connecting fishing villages are poorly maintained. This is another negative factor driving establishment of cold chain out of reality. Thus, the decisive factors required for future development in fresh fish distribution rest with the rehabilitation of the national macro–economy. Nevertheless, it may still be suggestible to transport marketable demersal species of fish from Shenge and Tombo by sea to Freetown, if a small–scale ice plant is established in one of these areas. The construction of a fish harbor in Freetown, as being envisaged, will give further impetus to this scheme. The capacity of fish collection boats should be worked out carefully, taking into consideration economical and technical viabilities, together with the operation of an ice plant.

Table 6. Profitability analysis of fresh fishmonger in Freetown.

Basic parameters (per day)	Price			
Purchasing price at Goderich	Le. 30/kg			
Amount of fish (sardine) traded	35 Dz			
Transportation from Goderich to Freetown (per basket) with a passenger	Le. 400			
Transportation from Freetown to Goderich (per basket) with a passenger	Le. 100			
Average retail price in Freetown	Le. 70/Dz			
Other sale overhead	Le. 100			
Sensitivity analysis (in Leone)	**Total cost**	**Total sale**	**Profit**	**Change**
Base case	1,650	2,450	800	-
Ten % increase in beach price	1,755	2,450	695	-13.1
Ten % decrease in beach price	1,545	2,450	905	+13.1
Ten % increase in sale price	1,650	2,695	1,045	+30.6
Ten % decrease in sale price	1,650	2,205	555	-30.6

Frozen Fish Marketing

Supply

Commercial industrial fishing commenced in Sierra Leone during the early 1950s, with the advent of a handful of Italian vessels. This industry had a further leap after the UNDO–funded exploratory and regional trawler survey in 1969 identified rich fish resources, both in pelagic and demersal species in the territory of Sierra Leone. This discovery gave rise to a fishing rush by foreign vessels in this area. As a result, by 1989, 219 registered local and foreign vessels had become operational, plus some 250 vessels poaching or fishing illegally. In 1983, it was mandatory for foreign vessels operating in Sierra Leone to land at least 12% of their catch locally, in order to ensure a regular and adequate supply of fish to the local market. This rate has been increased to 25% since 1987. Under this regulation, it was to be estimated that 10,000–20,000 t fish were annually landed in Sierra Leone in the 1980s in mostly frozen form (see Table 5). These frozen fish were in part stored in the cold stores of local companies like Sierra Fish, Okeky and Marine Supplies and discharged to the market as required, or directly distributed to the local market. This large influx of frozen fish to the local market has dwindled since 1990 in conjunction with the activation of surveillance activities under the new Fisheries Management and Development act (Act No. 4 of 1988). It is reported that the number of vessels registered has been reduced to 100. As a result, the annual fish landing to the local market by the industrial fishery in 1991 is estimated to be around 620 t (see Table 1).

The major species of fish supplied by the industrial fishery to the local market are: croaker (*Pseudotolithus* spp.), threadfins (Polynemidae), barracuda (*Sphyraena* spp.), bigeye grunt (*Brachydeterus auritus*), grunt (*Pomadasys* spp.), etc.

Distribution and marketing

It was known that the frozen fish distribution and marketing were very active and prosperous until 1989 with over 10,000 t annual supply which accounted for over 70% of national fish supply in fresh/frozen form. Among other fishing companies and local agents, the largest frozen fish distributor is Sierra Fishing Company. Sierra Fishing Co. was operating the frozen fish distribution/marketing extensively all over the country through four distinct channels: agents, contract fish shops, authorized dealers and sales outlets.

Agent

The Company has 18 active agents in the interior. All of them are equipped with cold storage and are supplied frozen fish regularly by the Company's insulated trucks. However, only three of them are currently operational, in Bo, Kenema and N'jala, due to the shortage of spare parts. These agents are put under the direct control of the Company on sale prices and daily laying–in of frozen fish. Frozen fish are distributed by the Company's insulated trucks at the expense of agents, and stored at the agents' cold stores. Each truckload is customarily 240–260

cartons (4.8–5.2 t). These frozen fish are further distributed to sub–agents, normally 10–15 sub–agents under one agent, who take retailing upon themselves. Of course, the agents can sell to consumers directly from the store. Agents have to sell at prices fixed by the Company and the Company pays 5—10% commission depending on the scale of transaction. However, it is expressed that this rule has been kept very loosely. This used to be the major supply source of frozen fish into the interior, and was formerly very active, but now only 3 of them are operational. The shortage of frozen fish supply is also aggravating the marketing problems.

Contract Fish Shop

There are 214 contract fish retail shops in Freetown, which had been very actively operated by 1989. They, however, are hardly operated at present, sometimes not at all, mainly due to shortages of supply and weak competition against other private fishmongers. Each shop owner was provided with 2 sets of insulated wooden fish boxes (covered with plywood sheet only), each with a capacity of 200 x 120 x 100 = LWH, 1 set of cutting tables (top G.I. sheet covered), 1 weighing scale, and a wooden sales counter by the Company. Also, the shop space was renovated with wall tiling up to 120 cm high and floor tiling on the whole area. A washing basin was similarly installed by the Company. In return for all these investments made by the Company, the shop owner effected an exclusive sale contract with the Company by depositing initially Le.100,000 to 500,000 as a security. The Company used to distribute frozen fish within the limit of this deposit. Similarly, with the case of the Agent, fish are sold at the prices indicated by the Company (see Table 7) and after selling, shop owners receive commissions at 5—10% of sales, depending on the volume sold.

Table 7. Indicative sale prices of Sierra Fish Company (October 1991).

	Le·kg^{-1}
Fresh Fish	
Snapper large, grouper	541
Snapper middle, crocu	531
Snapper small, tenny	473
Joefish, silver large, red mullet, sole	464
Pollock, sardine large, catfish, lady large	399
Shinenose small, tuna, mixed fish	360
Sardine small, butterfish	304
Shark	228
Smoked fish	
Spanish mackerel, snapper, grouper	1,593
Snapper small, catfish, tenny, mackerel	1,393
Lady fish, bonito, sardine large	1,076
Skate, shark	876

Source: Sierra Fishing Company

Fish are distributed in frozen form and kept in insulated fish boxes. In this way, fish can be preserved for a few days, depending on the volume and the initial state of freshness. One of the shop owners in the center of the town expressed that until last year, about 14 cartons of fish (240 kg) were regularly distributed almost everyday, but this has been discontinued. The main causes of this decline are attributed to the fact that (1) the absolute quantity in fish supply from the Company has been notably reduced and (2) the indicative prices from the Company are not competitive with fishmongers outside, especially in the case of fish being deteriorated (fishmongers usually reduce fish prices with time and quality deterioration). In fact, the price of sardine in open markets of Freetown was about Le.180·kg^{-1} in October 1991[2], while the price of this type of fish indicated by the Company was Le.304·kg^{-1}, which was almost double the open market price. The shop owner also added that fish distributed by the Company were lacking in variety, compared with those of fishmongers in the open markets, and in case the consumer wishes to purchase some particular species of fish, he has to make an advance order to the Company, which may take him a few days. This is another discouraging factor.

Authorized dealers

The Sierra Fishing Company continued to engage so called "authorized dealers", who are mainly occupied with transporting fish to the interior. There are 200–300 dealers registered to the Company. Normally, a few dealers jointly charter a truck for distribution of their fish to the interior. Unlike the agent or fish shop, they are allowed to sell their fish at free market prices.

Sale outlet

The Sierra Fishing Company has a system of credit sale for fish with 115 members at present. They are mostly from hotels, restaurants and catering agents and also some individuals to a lesser extent. The daily sales recorded previously could reach 30 t, but has notably dwindled now due to the lack of supply.

Other than the above channels of frozen fish marketed by the Sierra Fishing Company, a few companies with cold stores like Marine Supplies and Okeky are marketing fish caught by their own fishing vessels through their own agents and to individuals as well. Similarly, other fishing companies without cold stores like Tikonko and Manoh are selling their catches to their own agents onboard when fishing boats return to Freetown. Then, their agents dispose of their frozen fish by either selling to fishmongers in Freetown or transporting to the interior. One of these traders expressed that the latter way of business was more profitable than the former, and consequently more priority is being put on distribution of frozen fish to the interior rather than in Freetown. In fact, the average frozen fish prices as of October 1991 were as follows:

- Primary wholesale price to traders: Le200—250·kg^{-1};

2 * Conversion ratio: one Dz of small sardine = 0.324 chg (by AFDECO).

- Secondary wholesale price to fishmongers: Le250–300·kg^{-1};
- Retail price at fish markets in Freetown: Le350—400·kg^{-1};
- Secondary wholesale price in interior: Le350–400·kg^{-1}.

Frozen fish sold to retailers are partly smoked for further sale and partly sold as is on the market or along the streets. It was observed on the markets in Freetown that the quality of frozen fish being sold was generally satisfactory. There is a general tendency, common to all over the world, that prices of fish are reduced toward the end of the market day in order for fishmongers to sell out their fish within the day; otherwise they are obliged to bring their unsold fish back to their homes for further smoking. As mentioned, the quality of frozen fish at markets are generally satisfactory, but it was quite often observed that very poor quality fish were being sold in markets of Freetown. It may be suspected that these fish could be leftovers from the previous day's sale, or discharged from some cold–stores that are intermittently operated. In fact, the observation of these poor--quality fish indicated high storage temperature and frequent storage temperature fluctuations.

Consumption

Consumption patterns of frozen fish are naturally similar to those of fresh fish. Since electricity interruption is so rampant in the country, some consumers smoke their frozen fish at home, mainly for preservation purposes, and consume in the same way as ordinary smoked fish. Also, quite a substantial amount of fish are smoked at home and sent abroad for friends and relatives.

Future Prospect

Unlike the commonly prevailing case in the countries of Africa and Asia, frozen fish are well accepted by consumers in Sierra Leone. This is a quite promising factor in envisaging the future expansion of frozen fish marketing. The frozen fish supply by the offshore fisheries has remarkably dropped since last year in connection with the reinforcement of the monitoring control and surveillance system. There may be a possibility to revert to the former level of supply, which will contribute significantly to increases of domestic fish supply to the population. Moreover, the consumer preference for species of fish currently supplied in frozen form is generally very favorable. Taking the above factors into consideration, the future prospect of development in frozen fish will be very promising. Realization of constructing a fish harbor with supporting facilities will lend itself to promotion of a frozen fish distribution mechanism. With these facilities, fish caught by both the offshore fisheries and the artisanal fisheries could be processed into frozen form for the domestic market. However, in order to promote frozen fish marketing, improvement of basic infrastructure is vital, especially envisaging frozen fish distribution by refrigerated trucks. Similarly, the constant power supply is a prerequisite to maintain the quality of frozen fish. It is again a matter of rehabilitation of the macro–economy of the country.

Smoked Fish Marketing

Supply

Out of the total fish production by the artisanal fishery, it is estimated that coastal pelagic fish like sardine and bonga account for as much as 71%, and 90–95% of fish processed into smoked form. This utilization pattern is common to almost all fishing villages in the country. The only exception is Goderich, where utilization in fresh form is far more predominant than in smoked form, due to the advantageous location close to a major market, Freetown (pop. 500,000). In addition, a certain portion of demersal fish captured by the artisanal fishery, as well as the offshore fishery, are also being smoked to a lesser extent. Estimated figures for quantities of fish processed into smoked form are given in Table 8, which suggests about 36,171 t fish are processed into smoked form annually.

Processing

Fish are processed with an indigenous smoking kiln, called a 'banda' which is not ideal for smoking fish from the economical point of view. As stated above, the smoking method being employed in Sierra Leone is far from the definition of real smoking, but is rather heat–drying fish, and for this end a local kiln is too inefficient and wastes firewood. In an attempt to improve this traditional kiln, quite an endeavor has been made in the past. Altona as well as Chorkor ovens have been introduced without significant impact given to fish processors. It may possibly require an approach from a different angle of processing concept, i.e., the processing method employed in Sierra Leone is not really a smoking operation, but a heat–drying one. However, such distinction in processing technique is not the main issue in this study.

Smoking hours are different, depending upon the distance of the market where these fish are to be sold. So–called fresh smoked fish are smoked for 1.5 to 3 hours, while for hard smoked fish this process will be repeated for 2–7 days. The shelf life of the former product is only a few days, while the latter is one week to one month or more, depending on the degree of moisture content in the product and storage conditions. Consumers no doubt prefer fresh smoked fish to hard smoked ones, and naturally the fresh smoked ones fetch better prices at the market (see Table 9). Also, another disadvantage in hard smoking, in addition to higher production cost incurred by repeated

smoking, is a vulnerability to loss caused by breakage during packaging (while packaging, a few people stand on the basket to press down the piled layers of fish) and transportation.

Table 8. Estimated smoked fish production (wet weight; t) in Sierra Leone, 1991

	Total (t)	Smoked %
Artisanal Fishery		
Coastal pelagic fish	28,400	95
Demersal fish favored in smoked form (e.g., skate, catfish)	2,000	95
Demersal fish favored in fresh form (e.g., snapper, barracuda)	2,800	60
Other species incl. croaker	6,800	80
Subtotal	40,000	-
Offshore Fishery		
Demersal fish	587	30
Total	40,587	-

Distribution and marketing

Smoked fish are packed in layers in 3 different sizes of cane–woven baskets, each of which can hold 100, 300 and 800 dozen smoked sardine respectively, or wooden boxes just before the delivery to market. Normally, fresh smoked fish are distributed to the nearby market so that all consignments can be sold within a day or so, and hard smoked fish are sent to other more remote markets. Fresh smoked fish are generally traded at prices 10–20% higher than hard smoked ones.

The distribution and marketing systems are very complicated and quite a number of studies have been carried out and published on this subject. Therefore, for this report, it not necessary to duplicate the same argument and detailed descriptions of this subject will be omitted.
To be brief, although at local retail markets–typically in Freetown–trading is not regulated in any formal way and traders and vendors can sell their fish freely, the smoked fish distribution and marketing system is well organized and controlled, as all reports of this research work consistently confirmed. For the mechanism of this controlling, some reports suggested that the wholesale smoked fish trade has a nationally organized system ruled by an informal organization, many of whose activities are secret or semi—secret; others have doubts, however. As a result of interviewing traders and processors, the author is of the opinion that, unless a certain well–organized and influential body exerts an authority, such a complex distribution and marketing network cannot function. All traders are by nature commercially oriented. The following is one example demonstrating how effectively this system is regulated.

There are four major supply sources of smoked fish in Sierra Leone: Goderich, Tombo, Shenge and Yeliboya. At Bo, there are market days especially reserved for smoked fish coming from Tombo and Shenge areas. One day a week is set aside for each of those areas and traders from other areas are not permitted to sell their fish, while at Sefadu, traders from Tombo and Goderich supply the market on a tow–day alternating system and traders from other areas are allowed to sell their fish between these days. These restricted systems mean that the supply of fish to the market is controlled, thereby avoiding a situation of glut with consequential price deterioration by over–competition. According to the demographic and household survey undertaken by the KFDP Socio–economic Program, five main categories of fish trader, most of whom were women, were identified:

- Large–scale inland traders from outside of the village, mostly from marketing areas;
- Large–scale inland traders from the village;
- Small–scale inland traders who also process fish;
- Small–scale local market traders;
- Small–scale local market traders who also process fish.

In other smoked fish production areas like Goderich, Tombo, and Shenge, similar trading groups were observed. The average prices of raw fish and smoked fish products are available in Table 9. Traders purchase smoked fish by a unit of basket or box and transport it to the market. Normally, 3–4 traders jointly charter the truck and share the cost. The calculated gross margin gained by a trader in Shenge is available in Table 10. The profit margin for the product at ex–smoke house price is about 27%, which is quite sound compared with other businesses, even taking the risk of possible loss caused by spoilage and breakage. It seems to be that this profit margin is being maintained. Many smoked fish processors complain that the beach price of raw fish has noticeably increased in conjunction with the rise of petrol price, however the ex–smoking house price of smoked fish has remained almost unchanged. Traders say that this loss is scarcely shared, while traders have their own claim. They expressed the idea that due to closure of informal export routes to Liberia and Guinea, the interior market was oversupplied with smoked fish, leading to the negative fish marketing price movement. In fact, Koindu, a town bordering Liberia and Guinea, had been prosperous as a smoked fish distribution center for the neighboring countries until last year. This international market was operated only on Sunday, supplied by two different groups of traders, i.e. the Goderich and Yeliboya group and the Tombo and Shenge group, on an alternating two–week basis. This was strictly controlled by the Traders Association to which all traders were bound to be members with payment of some membership fee. This was one of the most lucrative and stable outlets for smoked fish, but closed down due to the unrest prevailing in the eastern and southern regions. The exact amount of smoked fish products annually traded under this informal route is hardly known, but it must have reached substantial quantities. These export–oriented products have now been flowing into the domestic market, which has now become one of the causes of over–supply in the market. This means that the present overall demand for smoked fish might have reached saturated levels, as suggested in the socio–economic study report (KFDP technical report No. 5/87).

Consumption

Smoked bonga and sardine are disintegrated before cooking, in order to remove tiny and sharp bones, entailing labor and skillfulness. Meat thus broken into pieces is prepared in local dishes like potato leaves and cassava leaves, but the amount added in these dishes is relatively meager. It seems to be utilized as the seasoning rather than a source of protein. One of housewives expressed that the amount of meat mixed into dishes had been reduced as the price of smoked fish rose; in those days she did not even think of the price of smoked fish. This tendency was evidently demonstrated in the change of the per capita fish consumption figure (see Table 3). This accounts for only 53% compared with the 1975 intake. This remarkable drop of per capita fish consumption is mainly attributed to the population increase (35%) and decreases in overall fish production (22%) as well as in importing fish and fish products (61%), although the latter is relatively negligible in an absolute amount. Moreover, it is obvious that the decline in general purchasing power in the country has aggravated this reduction of protein intake. It seems that this cause has been increasingly responsible for the decline in fish consumption.

Table 9. Average prices of major small scale fish catches in dried and raw form

Fish	Location	Form	Price ($Le \cdot kg^{-1}$)
Sardine (small, locally 'mina')	Goderich	Raw fish	25
		Ex–smoking house price	40
		Retail price in Freetown	200
		Retail price in Konta Line	200
Bonga	Tombo	Raw fish	300–320
		Ex–smoking house price	300–400
		Retail price in Freetown	450–500
		Retail price in Konta Line	500
Bonga	Shenge	Raw fish	280–320
		Ex–smoking house price	400
		Wholesale price in Bo	450–500
		Retail price in Bo	480–520
Bonga	Plantain Island	Raw fish beach price	180–200
		Ex—smoking fish house	250–300

Future prospects

As mentioned above, smoking fish is considered an ideal method to utilize bonga and sardine, due to their physical characteristics. Moreover that is popularly accepted by the population, and the mechanism of the complicated marketing network has been effectively functioning by some sort of active syndicate in a sound way. Considering these, it is felt that there is a scarce need for further improvement as far as smoked fish marketing is concerned. Further, the demand for smoked demersal species will be maintained or even increase for the time being, since the setup of the cold–chain will not be realized soon under the present macro–economic conditions in the country.
Nevertheless, there is a slight insecurity factor in smoked fish marketing. If the production cost of raw fish should continuously increase as it has, the retail price of the smoked product will rise. In that case, fish will become more inaccessible to consumers with weakened purchasing power. There is a fear that this may lead to possible disorder over the well–controlled marketing system, for it is claimed that the current marketing situation is saturated to some extent.

Table 10. Representative gross profit margins, as calculated from a trader in Shenge

Income (150Dz x Le.460)		Le69,000
Expenses (per box containing 150Dz)	Smoked fish (bonga)	Le48,000
	Transportation cost (Shenge to Bo)	Le2,000
	Passenger cost (Shenge to Bo)	Le1,000
	Passenger cost (Bo to Shenge)	Le1,000
	Other overhead	Le4,000
	Subtotal	Le56,000
Profit	-	Le13,000

Conclusion

Thinking in terms of general fish marketing development, the present condition of Sierra Leone is biased in some sense. Smoked fish marketing is highly developed, with a sophisticated market–controlling mechanism, while marketing fresh fish and frozen fish through a cold–chain is fairly poor. The primary reason may lie in the fact that smoked fish processing has advanced traditionally due to favorable local conditions. Also, the current deterioration of the country's macro–economy has hardly allowed the development of the next stage of preservation.
Coastal pelagic fish will thus continue to be processed into smoked form even in the future, but for demersal species, distribution and marketing in fresh/frozen form should be developed with the improvement of required infrastructure. It is obvious that consumer preference for fresh demersal fish is by far stronger than smoked fish.

The Role of Fish for Consumption and Nutrition in Sierra Leone[1]

P.A.S. Green[a], G. Carrol[a] and E.D. Mason[b]

[a]*Nutrition Society of Sierra Leone, Freetown, Sierra Leone*
[b]*Sierra Fishing Company, Ltd., Freetown, Sierra Leone*

Abstract

The present study was undertaken by the Nutrition Society of Sierra Leone to provide information on access to and consumption of fish by the Sierra Leoneans. Fish is an essential food commodity in Sierra Leone, and is the only animal protein source that is consumed almost daily by households in Sierra Leone. Current challenges in providing fish of sufficient quality and quantity include: storage and distribution of fish, high cost of fuel, lack of hard currency, and declining purchasing power of the average consumer. Furthermore, while consumers prefer fresh fish to smoked—dried fish, it is generally not available in many areas of the country due to the challenges of storage and distribution. Currently, the supply of fish to the Sierra Leone population does not satisfy the demand. Recommendations are provided for potential solutions to these challenges.

Introduction

Sierra Leone has a coastline extending from 7° to 10°N latitude in the Eastern Central Atlantic coast of Africa, and an Exclusive Economic Zone extending 200 miles. The coastline is indented by numerous estuaries in which wide mangrove zones dominate. The fishery resources of Sierra Leone are contained in rivers, lakes, estuaries, and a continental shelf of approximately 24,800 km^2 (140 km wide at the north and 32 km wide at the south).
The Atlantic ocean that borders Sierra Leone's shores and its inland lakes and waterways make a significant contribution to the food supplies of the country in the form of fish. Yet the information available on fish production and consumption indicate that far too little use is being made of this valuable food to improve the nutritional status of Sierra Leone's population.

For several decades, the problem of malnutrition has been recognized as serious within Sierra Leone. Numerous individual and group studies on food habits, health, and nutritional status of the Sierra Leone's population–though by and large of sporadic nature–indicate that the nutritional status of the people has deteriorated. This deterioration occurs in large part because of a decline in available food supply. Malnutrition is still the greatest cause of death in the country, particularly for children under five years of age. The most commonly reported signs of nutritional diseases have been protein calorie malnutrition and anemia. Despite the innovative measures and interventions that have been employed over the last two decades, there is ample evidence that the population is suffering from endemic malnutrition. Hunger and malnutrition still exist and are increasing at an alarming rate because of the complex range of interrelated factors that influence nutritional status. These include, among others, socio–economic factors influencing food availability and distribution, as well as cultural and structural conditions that affect the ability to utilize the available resources. From a casual examination of the qualitative aspects of the Sierra Leone diet, one could hasten to state that the food supplies in the country are sufficient in variety to furnish every individual with the nutrients recommended for optimum nutrition, and that the population should be enjoying good nutritional status. Yet, this is not so. On closer examination of the nutritional aspects, one finds that the amount of food available to the individual is such that it results in a high incidence of undernutrition and malnutrition that, for the country as a whole, presents serious health and nutritional problems.

Inadequate food supply is indeed the major problem, for food production lags behind population growth. When the supply problem is added to high prices, for money is a scarce commodity for many Sierra Leoneans, the problem becomes worse. Although recent data are not available regarding actual quantities of food consumed per day through detailed dietary surveys, it is however true that the average diet of the low income group is almost invariably deficient in animal protein and in the vitamins and minerals necessary for the maintenance of health.
This study was undertaken by the Nutrition Society of Sierra Leone to provide information on access to and use of fish by the average Sierra Leonean, so as to make recommendations in relation to its supply and demand and the improvement of the nutritional status of the population.

A sample of the population representing the four provinces and western area were interviewed to provide data for the study. Out of the 250 questionnaires distributed 210 completed forms were processed. The majority of the respondents were women (88.1%); residents of the Western Area (34.8%); aged 25–34 years (33.0%); Mende by tribe (35.4%); of the Muslim faith (51.0%); married (66.0%); had some schooling (72.3%); and self–employed (35.0%), mainly as traders (28.9%) (Table 1).

1 Cite as: Green PAS, Carrol G and Mason ED (2012) The role of fish for consumption and nutrition in Sierra Leone. pp. 90-99. In: Vakily JM, Seto K and Pauly D (eds.) The Marine Fisheries Environment of Sierra Leone: Belated Proceedings of a National Seminar held in Freetown, 25-29 November 1991. Fisheries Centre Research Reports 20 (4). Fisheries Centre, University of British Columbia.

Fisheries Resources and Exploitation in Sierra Leone

Table 1. Respondents by characteristics (%)

Sex	Female	88.1
	Male	11.9
Area	Eastern Province	18.6
	Northern Province	25.7
	Southern Province	21.0
	Western Area	34.8
Age Group	15–24 years	26.7
	25–34 years	33.0
	35–44 years	25.2
	45–55 years	9.7
	over 55 years	5.3
Tribe	Creole	18.2
	Fulla	3.8
	Kono	1.0
	Limba	8.1
	Lokko	3.3
	Mende	35.4
	Susu	1.9
	Temne	25.4
	Other	2.9
Religion	Christian	48.5
	Muslim	51.0
	Other	0.5
Marital Statu	Married	66.0
	Separated	1.9
	Single	30.1
	Widow/Widower	1.9
Education	Schooling	72.3
	No Schooling	27.7

The resource

Fishery resources are defined as aquatic animal and plant life exploited for food or for non–food industrial purposes. However, this paper is limited to freshwater and marine fishes of Sierra Leone and excludes crustaceans and other aquatic animals and plants. The resources are exploited by small–scale artisanal and large–scale industrial fishing fleets, with some aquaculture being carried out in inland areas.

A wide variety of fish is caught in the large expanse of Sierra Leone's coast. These have been categorized into size–small, medium and large–for the purpose of this study and local names have been used. The total annual production of fish in Sierra Leone is estimated at over 250,000 t, 30% of which is produced by small–scale fisheries; 69.9% by the industrial sector, and 0.1% by aquaculture.

The small–scale fishery accounts for the production of almost 80,000 t·year^{-1} from inshore coastal waters, inland rivers and lakes and aquaculture. Aquaculture is relatively new in Sierra Leone, but it offers one of the best ways of increasing fish supply, especially in areas where fish supply is low.

A common freshwater species, Nile tilapia (*Oreochromis niloticus*) was chosen as fish for culture because it is fast growing and has a high disease resistance. It also has a high fecundity and, under favorable conditions, this fish can reach maturity in three months. This system of aquaculture has increased the total fish supply in inland areas and its potential as a source of very cheap protein is high. The total production from fish farms is estimated at about 100 t·year^{-1}. The small–scale fishery covers a wide variety of species, but because of the fishing methods, boats, and gears used, they consist mostly of bonga and herring, which happen to be among the cheapest species available to a majority of the population. Other species caught include Awefu (juvenile Bonga), Butterfish, Cowreh, Cutmoney, Lady, Langa–minna, Lati, Mullte, Mangopage and others.

The industrial fishery exploits inshore and deep–sea resources and over 50,000 t are produced annually by local and foreign vessels. Most of the products of foreign vessels are not sold locally because of the inconvertibility of the local currency. The products are sold or exported for hard currencies. The industrial fishery offers a wider range of species because of their capacity to fish pelagic (deep sea) and demersal (inshore) stocks. The common species caught include snapper, bonga, crocus, gwangwa, lady, catfish, mackerel, cowreh, tenny, couta, herring, Spanish mackerel and scads. Shellfish and molluscs offer a source of protein supply that is exploited on a relatively low scale. Oysters, cockles, clams and other molluscs are collected from the wild for local consumption mainly during the raining season when fish supply tends to be low. Shrimps, crabs and other shellfish are accidentally caught by the artisanal fishing vessels and are consumed locally. Shrimps and other shellfish caught by the industrial fleet are mainly for export. A project was launched by the Sierra Leone Government to investigate the possibility of oyster farming, the potential of which is believed to be quite good. It was however discovered that it was difficult to produce cultured oyster more cheaply than it could be harvested from the wild. Some feasibility studies on shrimp farming have also been done by a private fishing company and results indicate that there is also a high potential in that area, but so far no program has been set up for implementation.

Imported fish products offer a source of expensive protein for those who can afford them. Processed products usually canned and sold in supermarkets include smoked kippers, sardines, pilchards, shrimps, oyster, mackerel, tuna and mussels, imported from Europe and the United States of America.

Exploitation

Exploitation of the resources can be grouped into a small–scale or artisanal fishery and a large–scale industrial fishery.

Artisanal fishery

There are some 30,000 fishermen in 550 villages along the coast operating over 6,000 open wooden crafts. The artisanal fishery is labor intensive and comparatively low in capital investment and technology. Vessels are usually

dugout or planked canoes, with or without mechanized gear. There are six major artisanal fishing villages in Sierra Leone: Goderich, Bonthe, Tombo, Konakridee, Shenge, and Yeliboya. The fishing population is comprised of full–time, part–time and migrant fishermen, with some active only during the dry season. Because they use simple handling techniques, they suffer significant post–harvest losses that would be avoided with more modern technology. They harvest stocks containing a large variety of species suitable for domestic consumption and are suppliers of most of the local cured fish and fresh fish. A small percentage of the cured products are exported to neighboring countries, e.g., Guinea and Liberia, and there is evidence that some of the products go as far as Mali. The activities of the artisanal fishery are essential to the economy of coastal and inland areas, providing employment and income for thousands of men and women. The men are usually owners of boats and fishing equipment, and do actual fishing, whilst the women dominate the processing and marketing of the products. A few women, however, are boat owners or shareholders in some enterprises. Fishing in freshwater rivers and lakes has been carried out mostly by women using scoop nets and fish traps. Fishing is the main area of employment for coastal and inland communities, though it may overlap with other activities such as agriculture and animal husbandry. The artisanal fishery tends to be affected by climatic conditions, activities being high during the dry season and almost at a standstill during the rainy season. Catches therefore tend to be seasonal, with highs in the dry season and lows in the wet season in coastal areas, and higher during the rains in inland areas. Although the fishing population in the artisanal sector has increased by 25% from 1974 to 1990, their production has not shown a corresponding increase due to limitations of infrastructure, high cost of fuel, equipment and spares, and high losses due to inappropriate handling and processing techniques.

Industrial fishery

The industrial fishery sector is essentially more sophisticated and capital–intensive, and is carried out on a larger scale with more organization than the artisanal sector. The industrial sector offers secondary employment to at least 150,000 processors, marketers, etc.

Vessels operated by foreign investors on their own or in partnership with Sierra Leonean investors dominate the scene. Very few are owned and operated solely by Sierra Leoneans. The majority of the foreign vessels are of Soviet origin and their fleets are usually comprised of fish trawlers, shrimp trawlers, carrier vessels and factory ships. They also carry out research onboard research vessels. The bulk of their catch is exported, notably because of the non–convertibility of the local currency. As such, of the 250,000 t of fish estimated to be caught annually, only an approximate 150,000 t are landed locally. This represents approximately 70% of the total fish supplied to the country by all sectors. There are about 17 fishing companies registered locally, although many of them operate either under joint ventures or are acting as marketing agents. Under these arrangements they too land only a part of their catch locally the rest is exported for similar reasons as those stated above. Very few local companies operate their own vessels and only one such company–the Sierra Fishing Company–is fully established with the appropriate infrastructure, organization, and distribution network to cover major districts in the country. All the fish caught by the Company's vessels are landed locally, but some are processed for export. This is necessary because hard currency is required for purchasing of gears, equipment and spare parts, all of which are imported. The industrial fishery sector offers a wider range of species for the domestic market than that offered by the artisanal sector. This is because of their capability to exploit both inshore and deep–sea resources. The catch is not so much affected by weather conditions as by the breeding and migratory patterns of the various species. Thus herring and pollock and snapper tend to be produced almost all year round, whilst shrimp catches are highest between June and October.

Nutritional Value of Fish

Fish is valued for its nutritional and its sensual qualities as a food. Fish and fishery products are rich in nutritive value since they are excellent sources of very digestible proteins, and many contain essential minerals, vitamins, and fats. Proteins build and repair body tissue. About one third of the protein eaten daily should come from animal sources, to balance the less effective proteins of cereals and vegetables. An average serving of fish or shellfish supplies enough animal protein to satisfy this daily requirement. Fish is an especially efficient source because the protein is 85–95% digestible, and contains all the essential amino acids. Protein comprises about 18% by weight of the edible portions. In Sierra Leone, like in many other developing countries situated on the coast, fish is the main source of protein in the diet both in terms of availability and cost. It is estimated that fish contributes about 4% of the total protein intake.

The 1978 National Nutrition Survey in Sierra Leone Report states that "throughout the country almost every family (97%) had some animal protein in their diet. This is based on the wide consumption of fish, and produces a high index of availability for the children". Unfortunately, very few if any studies have been carried out to determine the per capita intake of fish in Sierra Leone. Though the content of protein in fresh fish is somewhat less than in meat, and there is often a significant amount of waste due to the scales and bones, it nevertheless provides a good source of protein for Sierra Leoneans. Fish contains a high content of polyunsaturated fatty acids, therefore the consumption of fish keeps the level of blood cholesterol low and reduces the risk of coronary heart disease. For this reason, its consumption is on the rise in developed countries, where coronary heart disease is one of the principal causes of death. Fish oils are rich sources of good fat. Fats are used by the body for heat and energy. The fat content of fish varies with the kind of fish and the season of the year. Very lean fish may contain only 0.5% fat and about 10% caloric value ranging from 50–80 Kcal per 100 g; some fish may average 20% or more. Fish fat is in a form that is easy to digest. Lean fish is easily digestible and is therefore an

essential ingredient in children's diets, as well as invalids and convalescents. Whiting, sole, barracuda, Spanish, mackerel and snapper are examples of lean fish. An average serving of lean or fat fish supplies about 10% of the thiamin, 15% of the riboflavin and 50% of niacin needed every day. Vitamins are necessary for life, health and growth. Fatty fish like mackerel are excellent sources of vitamins A and D, an average portion supplying about 10% of the daily quota of vitamin A and all of the vitamin D required. Minerals are essential for the performance of certain functions of the body and the maintenance of teeth and bones. In general, the mineral content is low in fresh fish and is similar to beef, although the iodine content is greater in fish and the calcium and phosphorus are higher in smoked dried fish. This explains the reason why mothers are encouraged to make fish powder from small fish like sprats, so that calcium and phosphorus would be readily available to the children when the pounded fish is added to porridge or other foods prepared for the children. Fish diets, however, tend to be monotonous and it takes a good cook to make fish very interesting and appetizing to all age groups. The edible portions of most finfish are satisfactory sources of magnesium, phosphorus, iron, copper and iodine. Also, while 21% of the respondents in Table 1 knew of taboos and/or restrictions on consuming fish, 79% did not, which makes fish a widely accepted food (see Table 2)In addition to finfish, Sierra Leone waters are rich in shellfish such as lobsters, crabs, shrimps, oysters, cockles and other seafood. Lobsters, crabs and shrimps have very little fat and an energy value of about 40–60 Kcal per 100 g. Shellfish are particularly rich in these minerals and calcium, comparing favorably with milk. They are very tasty, but are expensive, and have become prestige foods beyond the reach of most Sierra Leoneans. Unfortunately, oysters and cockles easily harbor bacteria, particularly those of the salmonella group. Proper supervision is therefore required in their preparation.

Table 2. Fish served at cookery shops.

	%
Respondents who buy cookery food	64.6
Respondents who do not buy cookery food	35.4
Respondents who request fish	89.8
Respondents who do not request fish	10.2
Respondents who pay more for fish	75.2
Respondents who do not pay more	24.8

Post–catch Handling

Fish is a highly perishable commodity and since it is usually caught some time before it is consumed it is necessary that it should be handled and treated in such a way as to minimize its rate of deterioration, which, in warm weather, can be very high. The objective of proper handling and processing is to ensure that the product reaches the consumer in the best condition and in as near to its original fresh state as possible. The quality of fish is affected by the method of catching and handling at sea and onshore, and by the processing and preservation techniques applied. In Sierra Leone, fish available for consumption may be purchased in a variety of forms–fresh, frozen, salted, sun–dried, and the most popular, smoke–dried. Herrings, sprats and related fishes have traditionally figured prominently in the fisheries catches of Sierra Leone and these are kinds more frequently processed by smoke–drying for national distribution. Post–catch fish processing operations range from subsistence type of wood–smoke drying to modern large–scale freezing industries. Local small–scale processing is practiced in the coastal areas where the population depends on fishing and where communication to major market areas is possible. The method of fishing can influence the quality of the fish when landed. Because deterioration starts as soon as fish are caught (fish dead in gill nets spoil very quickly), every precaution must be taken to slow the rate of spoilage.

Catching and Handling: Effect of Some Types of Fishing Gears and Methods of Fishing

In longline fishing, gill nets, or set nets, the fish may have been dead for some time and may have struggled before death. The skin and flesh may have been damaged from attack by other fish. If a trawl net has been used, the fish may also suffer considerable damage from the net. When a purse seine or beach seine is used and the catch is large, then the fish at the bottom of the net are pressed by the weight of the fish at the top. Also in big catches, fish temperature rises very quickly and before the fish is retrieved from the water, spoilage has already started. These problems cannot be easily overcome as the fishermen can influence the quality of his catch more when it is out of the water. In the dry season however, when atmospheric and sea water temperatures are high, spoilage in the water can be minimized by reducing the trawling time or avoiding leaving the fish in the water longer than necessary (gill nets and set net fishing). On the other hand, fishermen must be able to strike a balance between conflicting factors such as (a) the amount of gear he can handle, (b) how often or how fast he can clear his net, (c) the distance between the fishing grounds and landing site. With the introduction of mechanization, boats can now travel to and from existing fishing grounds faster and more often. It should also result in bigger catches, but with the high cost of fuel this advantage is lost. Fishing yields are lower and the cost benefit ratio is higher. Fuel is sometimes bought at 200–300% above the recommended prices.

Handling at sea

Traditionally, canoe fishermen do very little to their catch whilst still at sea. Fish are removed from the net and stowed in bulk in the bilge of the boat. The fish are not adequately protected from wind and sun and by the time they are landed, spoilage has begun.

The canoe fishery has not developed the practice of using ice at sea to keep fish fresh, mainly due to unavailability and high cost. Some fishermen operating large canoes that stay at sea for a few days smoke small quantities of

fish at sea, especially snapper, but the extent of preservation is reduced when catches are large. From the quality of catches landed, it is often easy to tell that not enough care has been taken to keep the fish in good condition. Sometimes steps are taken to disguise the true condition of the catch, for example by mixing the fish with sand on the beaches. This is an age–old practice in an attempt to keep the fish looking fresh.

In trawlers and other bigger offshore vessels, fish are sprayed with water pumped from the sea, then sorted and packed into wooden or plastic fish boxes. These are then stacked into insulated fish holds where the fish are kept chilled with crushed ice. Some vessels are equipped with blast freezers for freezing of fish and shrimps. Usually the fish are packed whole, no gutting or cleaning is done. Not all vessels are however equipped with such facilities and therefore considerable quantities of fish may be landed in poor condition. In some vessels, freshly caught fish are packed in pieces of old nets or nylon bags then dipped in chilled brine or sea water before stored in the fish hold. This is one of the worst methods of treating the fish, as most of them end up very badly damaged. Those in the center are hardly ever sufficiently chilled and bacterial spoilage is advanced when the fish are landed. Fish from trawlers and other large vessels are landed at jetties where moderate landing facilities are available. There is usually access to clean fresh water, ice, and transportation to cold stores not too far from the jetties. The problem usually is the rate at which the fish are discharged from the vessels, often too slow to avoid the fish warming up unnecessarily. Landing at wharfs and beaches present even bigger problems from lack of any sort of basic discharging facilities. Fish are bailed from boats and deposited on dirty ground or sand. They are exposed to sun or rain until all the catch has been discharged, sorted and sold. The quality of the fish landed at beaches is therefore often questionable.

Whole fresh fish

Whole fresh fish are marketed just as they come from the water. Before cooking, they must be scaled and eviscerated. The head, tail and fins may be removed, if desired, and the fish is either split or cut into serving portions. The normal daily range of air temperature in Sierra Leone is between 23.8°C and 29.4°C and the relative humidity throughout the year ranges between 56% and 100%, the highest occurring during the wet season (May to November) when it is well over 85% for most of the day. Sea temperatures are also high, averaging 28°C throughout the year. Spoilage under these conditions is very rapid and it is almost impossible to obtain really fresh fish, unless fast, efficient and controlled processes are applied. Among the local people, the term 'fresh' means fish which have not been processed or preserved in any way at all, and this would even mean fish which may have been out of the water for 12 or more hours. Chilled or frozen fish from the trawlers are not considered as 'fresh', rather they are viewed with apprehension as fish that may have started to spoil. Fresh fish in good physical condition have bright eyes with the center of the pupil black and the remainder transparent. In stale or spoiling fish, the eyes are opaque or even milky. The gills of fresh fish are bright red and free from slime. Stale fish have slime on the gills, which have lost their color, and tend to smell. The flesh should be firm. As fish spoilage advances, the flesh becomes softer and the color of the blood changes from deep red to brown. Probably the most obvious sign of spoilage in fish is the smell that progressively becomes stronger. The average local consumer however would not reject fish because of dull gill color or rancid flavors, there has to be a fair degree of putrefaction before the fish would be considered inedible.

Post–harvest Losses and Effect on Consumer

The degree of post–harvest loss depends on the methods of handling and processing of fish. Post–harvest losses can be minimized by careful handling and storage followed by efficient and controlled processing and utilization of raw material. The quality of product that reaches the consumer cannot be disguised and is determined by the quality of the raw material prior to processing. Fish that has already begun to spoil cannot be made good by freezing or smoking or by any process whatsoever. The occurrence of spoilage in frozen products has been known for many years, hence the reluctance of some consumers to purchase frozen fish. Frozen fish frequently has dry, tough, and comparatively flavorless flesh due to breakdown of the protein content. When fish are improperly preserved, microbial decomposition may lower the value of the fish protein, and prolonged storage may result in rancid flavors especially in fatty fish. Flavor, texture, and appearance may be changed by poor processing and prolonged storage, but the nutritive value is seldom affected. At all stages of fish handling, processing and storage, quality should be maintained in order to reduce losses. Because of its high perishability, the need for quality control is much greater for fish than for most other foods.

Marketing and Distribution

Fish landed on beaches are quickly sold off to fishmongers who then pack them in cane baskets or large open enamel bowls and transport them to the nearest market for sale. Leftover fish after wholesale disposal are carried to nearby smoke huts for immediate smoking as a means of preservation. Leftovers from market sales are also preserved by smoking. The fish processors (usually women) spend the day at the beach in temporary shelter that they provide themselves waiting for the arrival of buyers. Their continuous presence on the beach enables them to watch for arrival of the buyers. These buyers are the 'middlemen', both men and women, who stroll about on the beach and casually inspect the products. Now and then a buyer will stop, bargain a little and inspect the products thoroughly before deciding to buy. After lengthy and complicated bargaining, the price is fixed. In a market like this where prices are never uniform and competition is keen, buyers have a great advantage because it is better for the processor to sell at a low price or even take a loss than leave the product to spoil. Consequently the price arrived at does not reflect the true value of the product, and the time and effort spent in processing are

not reckoned into cost; nor is depreciation of the 'Banda' and equipment.

Beyond coping with the rigorous processing methods, many of the women also transport their fish products to distant markets in larger towns such as Bo, Kono, Kenema, Koindu and even to neighboring countries. Since there are no organized facilities for transporting and distributing fish for the artisanal industry the fish mongers must walk long distances and under extreme weather conditions to markets and distribution points. Their small children usually accompany them. Women who have the financial means to hire trucks transport their fish or take small loads by bus. Not much of the fish is taken and vehicles carrying fish from the beach sites are often overloaded with goods and passengers. The vehicles are not made for carrying fish and are not insulated. The bumping and jolting over rough roads cause the fish to arrive at the destination broken into tiny fragments. If the journey is long (up to 400 miles in some case) much of the fish becomes moldy and infested with insects. Fish further lose their quality at the markets where they are exposed to very high temperatures for up to 10 hours and subjected to contamination from dust, flies and other insects and small animals. The consumer may be lucky to buy good quality fish at the market. Fish that has been chilled or frozen in cartons are treated in exactly the same way and the fishmongers, instead of using ice to keep their wares fresh, would sprinkle water on them. This is undesirable for maintaining the quality of the fish.

Commercial enterprises try to ensure that fish are properly stored in cold stores at correct temperatures, but with the constant power cuts or outages, they have no alternative but to generate their own power supply, which is very expensive. This is reflected in the price at which the fish reach the consumer. The commercial firms have organized distribution outlets and one major company has large modern cold stores, insulated trucks, well–equipped fish shops and depots for the storage, distribution and marketing of its products. These are high capital costs that are also reflected in the retail prices of their products.

Fish Processing Methods

Fish is highly perishable even in cold climates, and in hot climates–particularly in areas with high relative humidity such as in Sierra Leone–fish decomposes more rapidly and therefore the problem of preservation becomes more difficult. Thus most of the processing of fish in the locality is more a means of preservation rather than diversifying the forms of presentation. At the artisanal level fish is preserved by hot smoking, or sun–drying. Each method influences the keeping quality of the product depending on the degree to which it is applied.

Smoke–dried fish

Smoke–drying of fish in Sierra Leone is traditionally carried out by women and the products account for the largest share of the fish catch processed for human consumption in the country. It is a tedious process, usually lasting overnight. In smoking operations, preservation is achieved by a combination of drying and deposition of chemicals that are contained in the smoke of the burning wood. Cooking fish over an open fire makes it keep longer and adds a distinctive flavor, which varies with the kind of wood burned and with other conditions of the process (e.g. the time/temperature relation under which the smoking is carried out). The fish may be smoked whole (herring, bonga, snapper, crocus, etc.) or cut into large pieces (bonito, barracuda, grouper, etc.). Prior to smoking, the fish are prepared by descaling, gutting, chopping and washing (not necessarily in that order). Fish is usually smoked over the banda, which is the traditional drying rack, but this equipment has been observed to be inefficient and consumes large amounts of firewood. Several experiments have been carried out with improved versions of the banda and other smoking equipment, in efforts to produce more uniformly smoked products, reduce smoking time and fuel consumption, and increase production and yields. The conditions of smoking at present permit no uniformity in the quality of smoke–dried products, which is generally low. Secondary smoking may be applied to prolong shelf life but has the added disadvantage of detracting from the taste of the final product and increasing losses due to breakages and charring. Insect infestation, appearance of mold, attack by rodents, prolonged storage and poor storage facilities are some of the reasons for the huge post–harvest losses and poor quality products reaching consumers, especially those in the inland areas. Drying does not succeed as well as freezing in preserving the characteristics of fresh fish. However the low cost of preparation, transport and storage, in comparison to frozen fish, assures dried fish an important place in the Sierra Leone market for a long time to come. One major drawback however is that dried fish are easily infested by insects if not properly processed and stored.

Mechanical smoking

The traditional method of smoking fish produces widely varying quality of products ranging from attractive lightly smoked products with a huge moisture content, to unattractive, heavily smoked, and often charred products which are low on the palatability scale. The traditional method is also limited in capacity and fuel consumption is high. In order to combat some of the difficulties of the traditional processing, several experiments have been carried out. In addition to the introduction of non–mechanical fish smoking ovens (Altona oven) in rural fish smoking villages, a large smoking kiln was introduced at the industrial level for the production of high quality smoked fish for domestic and export markets. The only one so far in Sierra Leone, the AK–4 smoking kiln (of USSR origin), was set up and operated by the Sierra Fishing Company Limited. Processing included the use of salt to enhance the taste as well as to improve the shelf life of the products. Due to controlled processing, the products have uniform color and flavor; and the absence of dirt and charring is noticeable. The method however has not been widely adopted because of the high capital cost of the equipment and the need for electrical power supply.

Salting

While salt is often used as a condiment or as an auxiliary preservative in other process of fish preservation, «salting» is the process in which it is the chief preservative. Salting of fish is sometimes carried out by artisanal fishermen as a means of preservation whilst at sea for prolonged periods. The use of salt to preserve fish is however limited, as very little salt is produced locally. Most of the salt in the market is imported and therefore too expensive to be used for fish salting on a large–scale. Salting is limited to the dry season when high ambient temperatures allow the fast drying of the fish. Salt acts as a preservative by extracting water from the tissues. Quick penetration of the salt into the tissues is desirable to protect its quality. Some fish species are easier to process in one way rather than in another. Fish low in fat content are more suitable for drying, since reduction of the water content does not prevent oxidation of the fat. Apart from being a preservation technique, salting imparts a peculiar flavor that is only relished by small indigenous groups, notably the Creoles. However, the market for salted fish has been on the decline in Sierra Leone as a result of changes in dietary habits and increased utilization of frozen and dried fish.

Icing and Freezing

Icing and freezing of fish was introduced in the early 1960s, although consumers were skeptical about the freshness of the products. These methods of treating fish are widely used at sea onboard trawlers and factory vessels, and ashore in fish processing plants. Brine freezing on board trawlers is mainly done. The frozen fish may or may not be packed in cartons before landing. Freezing is the only method that can preserve the fresh fish characteristics during long storage. In addition it offers, if applied on a large–scale, the following advantages common to industrialized processing: consistent quality, product variety possibility of stabilizing supply and price, hygienic packaging, standardization of product type, extension of range of retail outlets, and creation of an incentive for manufacturers to use modern advertising. Much of the sea–frozen fish in Sierra Leone is sold as frozen fish or as "fresh fish" after thawing on land. Processing at sea does not extend to the preparation of consumer packages. The fish which is bulk frozen at sea for eventual processing in shore plants as smoked products is thawed on landing before it is further processed (Sierra Fishing Company). Fish landed in the frozen state and immediately put into cold storage obviously have a longer shelf life, and if stored at the correct temperature, will likely get to the consumer in good condition, provided the time spent out of the cold store is not too long. Some fish companies distribute frozen fish in insulated lorries to the Provincial towns where there are large depots with cold storage facilities to ensure that the best quality reaches consumers in those areas. Some fish and other sea products like shrimps, lobsters, cuttlefish, squid and crab are packed in shore plants for export. The economic feasibility of the marketing of frozen fish is directly related to the capacity and geographical range of cold storage and transport facilities, both at the wholesale and retail stages and to some extent also to the amount of refrigerated storage space in consumers' homes and in institutions. Usually overhead costs are too high. Thus opportunities for frozen fish distribution largely depend on the stage of development of the frozen food industry of the country.

Canning

Canning was also introduced in the 1960s as a means of providing fish in highly nutritious form to consumers–anchovies and tuna were the primary species canned. Apart from low acceptance of the products by the public, the company was faced with high production costs and had to close down. This method of preservation of fish is one of the best ways of preserving it in a form nearest to its fresh state. Canned fish could be used in inland areas where cold storage facilities do not exist, and it could be of high nutritional importance in drought and war areas.

Fish Protein Concentrate

Fish protein concentrate (FPC) is a stable product that can be stored for one to two years. In addition, there is no need for refrigeration, which is a problem in Sierra Leone. FPC–like products of this kind may have a double effect. Firstly, in being added to the meal it increases the content of nutrients in the diet. Secondly, it improves the utilization of the total diet. For example, the vegetable protein in the diet is better utilized with the addition of the animal protein of the FPC. FPC has been proven to be very valuable in treating severe malnutrition of children under five, i.e., Kwashiorkor.

Utilization and Consumption

The survey results confirm beyond a doubt that fish is widely consumed in Sierra Leone (Table 3). It is prepared by almost all families (95.2%) almost everyday in one form or another. However it is not easy to assess how much of it is consumed by adults and how much is given to children within the family setting. The average number of dependents' is 5–6 persons, though quite a few respondents provide for more than 10 persons (34.8%). 57.7% had children under five years old as dependents (Table 4).

The tradition in Sierra Leone gives preference to male members of the family as far as food distribution within the family. It therefore could be assumed that children do not have much fish in their diets. The problem is further compounded by the fact that some people still believe that consumption of fish by children will lead to worm infestation, swollen feet, stomachache, and will cause them to steal. Fortunately in some parts of the country, another school of thought is that children who have a high fish intake in their diet turn out to be clever.

The survey also confirms that fish is consumed daily (95.2%), mostly in the dried form (71.0%). The main reason why such a high percentage of respondents use dried fish was because that was what was normally available to them (Tables 5–7), even though they would like to have more fresh and frozen fish and a wider variety of fish. Cost was the main factor for those who found it difficult to eat fish. Those who found it easy to get fish did so because they lived near the market or fish depot.

Table 3. Fish purchase and consumption in Sierra Leone.

		%
Respondents who eat fish		100
Respondents who eat fish daily		95.2
Respondents get fish from	Fish depot	2.5
	Market	87.7
	Landing site	5.9
Purchase fish	Three times/week	5.8
	Twice weekly	4.9
	Weekly	7.3

From analysis of the data by province–though there was no significant difference in the varieties of fish people wanted–it was revealed that people in the interior areas and the Northern Province in particular preferred to have large varieties of fish such as Couta, Spanish mackerel which apparently they get with difficulty. Respondents normally prepare fish by drying and flaking for use when cooking the local "plasas" (Table 7). The other popular method was stewing (21.8%) and making it into fish balls (20.9%). Because of the flavor it imparts to the sauce or stew, dried fish is added to "plasas" which contains other ingredients such as palm oil, sesame seeds, leafy vegetables and beans. On special occasions, fish is made into fish balls and served to guests; at other times, and depending on availability of funds, fish is seasoned with lime, peanut paste and barbecued. Their nutritional knowledge was also investigated. They were asked to indicate why fish was important in the diet and to state which foods they would include in their meals if they could not get fish, but had the money for a supplement. A significantly high percentage of the respondents were able to tell that fish was a good protein source in the diet (86.1%). The data also revealed that those who had some schooling scored higher (93%) in their response to this question compared to those who had not been to school (63%). The types of foods they used to replace fish in the diet varied greatly and included the following: beef (71%), pork (13.3%), eggs (11.9%), chicken (24.3%), egusi (7.1%), pig's feet and cow's feet (17.1%).

Table 4. Respondents by dependents.

Number of dependents	%
0	10.5
1–3	11.0
5–6	27.6
7–9	15.2
10–12	12.9
13–15	9.0
16 and up	13.8

Other foods listed, but by fewer respondents, included beans (14.25%), garden eggs (7.47%), maggi (10.63%), ogiri (2.04%), onion (4.3%), pepper (2.94%), and green leaves (3.49%). The type of fish consumed depends on the socio–economic status of the family and the distance away from the seacoast. The majority get their fish supply from the market (87.7%). Herrings, sprats and bonga are popular amongst the low–income groups, whereas barracuda, mackerel and the like are more consumed by the high–income group. Quite a few respondents also depend on cookery shops for their daily meals (64.8%). They were asked to indicate whether they requested fish as part of the serving of sauce or stew and whether they had to pay more for fish in the serving. 89.8% requested fish in the serving and normally have to pay extra for it (75.2%).

Some of their other comments are presented in Box 1.

Table 5. Respondents by forms of fish normally obtained.

Forms of fish	%
Fresh Fish	46.2
Dried Fish	71.0
Salted Fish	1.9
Frozen Fish	11.0

Table 6. Respondents by access to fish.

		%
Access Very Difficult		23.7
Access Somewhat Difficult		30.9
Reason	Cost	67.9
	Distance	8.3
	Unavailability	23.9
Access Very Easy		20.3
Access Somewhat easy		25.1
Reason	Catch fish	7.1
	Near fish depot/market	67.9
	Sells fish	21.8

Table 7. Respondents by method of fish storage.

	%
Short–term method	
Steaming	26.6
Salting	20.5
Smoke drying	63.8
Freezing	11.4
Long–term method	
Salting	16.2
Smoke drying	84.8
Freezing	11.0
Other	1.9

Box 1: Comments of the Respondents about the available and use of fish

- Government must promote the use of fish for baby food because of its high protein value.
- Fish should be available at reasonable cost for every one to afford.
- It is important for fish to be easily available throughout the country for mothers to give their children so that they will grow properly.
- fish is the cheapest form of protein it must be easily available always.
- Fish is supplied intermittently especially during the rainy season – the supply must improve and be constraint throughout the year.
- In order to increase availability of fish fees should not be levied on fishing companies; or licenses must be reduced and paid in local currency.
- A canning industry must be established in Sierra Leon so that sardines can be processed locally especially when the catch is abundant and fishermen will not have to dump them back into the sea.
- Government should own trawlers so that more fish will be available for consumption throughout the country at cheaper prices.
- Transportation system should be improved to facilitate the distribution of fish throughout the country.
- Fish production should be increased so that cost of fish will be reduced.
- Restrict the export of fish by private companies that earn foreign currency and deprive the poorer classes from this valuable protein source.
- The demand of fish is higher than its supply, which is also irregular, resulting in high cost of fish. This situation should be improved.
- There should be an increase in the number of fish shops so people can buy fish easily.
- Government should have many trawlers so that fish could be easily available in markets.
- People cannot afford to buy the more expensive fish so most people eat herrings and bonga all the time making meals monotonous.
- Cost of fuel is so high that transporters are asking for high fares to transport goods including fish. Therefore the cost of fish in the interior areas is exorbitantly higher than along the coast.
- Tax imposed on fish trawlers should be reduced so that fish companies will have no need for smuggling fish caught in our waters.
- Former fish shops should be re–instituted throughout the country so that the poorer classes can afford to buy fish.
- Storage facilities for fish are inadequate. Unless the electricity supply is constant people cannot use freezing as a storage method. Cost of wood and coal results in high prices charged for dried fish – too high for the average person to buy or to try to preserve at home.
- Government must assist the sierra Leon Company so that it does not close down – as it is rumored.
- local fishermen must be trained to use improved fishing methods and supported to use better fishing equipment.
- Government should explore the possibility of installing community freezing units or smoking plants at the village level that women can use for a small fee.
- The authorities should stabilize the cost of fish and make it constantly available as it is a high protein source. The country is blest with a wide variety of fish therefore most people should be able to able to afford some of the less expensive varieties.
- Since the Sierra Fishing Company started exporting fish the supply for local consumption has become rather difficult and expensive for the poorer classes.
- People living in the interior areas hardly get fresh fish; they usually get dried fish. Effort must be made to make fresh frozen fish more readily available in areas like Moyamba, Kabala. Koindu, Pendembu.
- Government should examine the possibility of fish processing industries such as sardine canning.
- People living in the Eastern Province suffer most from lack of fresh fish. Effort must be made to improve the roads and reduce the cost of fuel so that adequate transportation will be available for fish traders to make available frozen fish in the interior areas.
- Malnutrition will be eradicated only if people can get enough fish at a reasonable price all over the country as fish is a good protein source.

Conclusion

Fish is an essential food commodity in Sierra Leone because it is the only animal protein source that is consumed almost daily by every household in Sierra Leone. Its importance as the main contributor of good quality protein mandates that every effort must be made to increase its production and availability at an affordable cost to the low–income population group. Though there is no information on the actual dietary intake of fish by the average Sierra Leonean this study has revealed that fish is purchased daily, whether fresh or dry, and that it is an important item of the daily "plasas" or stews frequently prepared by the majority of families in both urban and rural areas. The data also indicates that household sizes are generally large (5–25 person), therefore it is questionable, considering income levels indicated by the respondents, how much of the fish prepared in the family meal is distributed to each family member, especially the children under five. With regard to taboos against eating of fish, very few respondents indicated that fish caused worms or gave religious reason.

The information available indicates that people will consume more fish if it is readily available in a wide variety of forms throughout the country and that this will make an improvement in the nutritional status of the population. They normally get small fish varieties like herrings, but would prefer to have access to purchasing medium and large fish and in the fresh form even in the interior.

The problem of storage and distribution of fish is of great significance. Due to high cost of fuel and problems with the lack of hard currency to import equipment and spare parts, it is unlikely that the fish companies would reduce the cost of fish for the average or low–income consumer. Consumers prefer fresh fish if this could be made available and accessible in the inland areas. The high consumption of smoke dried fish is apparently not by choice but because of the prevailing situation concerning storage and distribution.

A major factor determining utilization and needs for processing the fishery resources in Sierra Leone is the size of the catch measured against the market absorption capacity for fresh fish. The smaller the latter in relation to supplies, the greater the distance of markets from the landing points, the more extensive are the provision that must be made for the preservation of fish. Other factors influencing utilization are seasonal fluctuations in consumption, changes in consumer habits and consumer purchasing power. In the presence of adequate electricity, fish is bought in large quantities by those who can afford it and kept in freezers to be used as and when necessary. Many housewives have now developed the art of smoking fish at home to ensure that the fish keeps for longer period when electricity supply is uncertain or a refrigerator is not available. In rural settings, smoked fish is left in the kitchen all the time so that it is constantly being smoked and preserved. Though its advantage is the longer period that fish can be kept in this form, the problem with this practice is that the fish ends up being very hard, and flavorless because all the moisture has been removed.

Recommendations

Based on the above information, several recommendations are being proposed for consideration by relevant authorities.

First of all, from the recommendations made by the respondents themselves, it is clear that the supply of fish to the Sierra Leone population does not satisfy the demand. Consumers are hard–pressed to make a living and feed their families under the present economic and social conditions. They are finding it difficult to cope with the rising prices of food in general, and fish in particular, which is the major protein source for many families. Therefore every effort must be made to increase the supply of fish in all forms–fresh, frozen, smoke–dried and salted so that it is cheaper and easily accessible to the consumer. Accessibility, however, can only be improved if more fish shops are located in the main community centers in each town and that these shops are properly equipped for handling both frozen and dried fish products. Increasing access to and reducing cost of fish cannot be possible without continuous supply of electricity, good road networks, availability of fuel and a reliable transportation system. This basic infrastructure is necessary and vital in any attempt to improve the food supply situation in Sierra Leone.

It is recommended that new species of seafood that are abundant in the seacoast such as cuttlefish should be introduced so that people will use them in their diet. Cuttlefish is caught in abundance but this is not available for local consumption. It is necessary to explore the acceptability of cuttlefish and other new species of fish in terms of taste, cooking qualities and processing requirements before introducing them to the public. This implies development of new recipes and educating people on their value and use.

Installation of processing facilities for production of fish protein concentrate from sprats, herrings and bongas should also be considered. FPC would help to increase the protein content of the diet of the low–income classes and also as a valuable source of protein for infants and children under five. Mini–factory projects could be initiated in fishing villages to produce fish protein concentrate from excess catch instead of dumping excess into the sea or burying them in the sand as normally done.

Distribution and marketing of fish should be improved by providing more assistance to women in the fish trade to improve their processing techniques such as in the Tombo Project; better communal storage facilities should be made available near landing sites so that fish that cannot be processed immediately could be stored overnight or until further processing is possible.

Women should also be educated about the health hazards of the fish trade. It is important that they improve their fish smoking procedures so that they do not inhale so much smoke, they ensure adequate ventilation of the smoke huts, they become more aware of the need for hygienic handling of fish and fish products, and they reduce the possibility of contamination of the products. The probable reason why children are not given fish in order to avoid getting worms may be due to the possible contamination by flies and other insects, which deposit the eggs on the products. It is strongly recommended that some quality control and inspection system should be instituted by the health authorities similar to the quality control and inspection system for meat products.

In order to improve the processing and storage of fish by fish processors it is essential that training activities should be sponsored and conducted in the fishing villages accompanied by pilot demonstration plants. The women should be encouraged to work together so that community processing plants could be run and maintained by groups.

Improving the smoke–drying processing in terms of introducing improved smoking kilns that would use less wood and process a greater quantity of fish at a time is highly recommended. Wood is fast becoming a scarce fuel and the environmental implications of wood as a fuel source are of great concern. The high cost of firewood is one reason why the prices asked for smoked fish are so high. It is recommended that women fish processors should be selected from their groups and given opportunities to visit other countries or projects where improved processing procedures have been successfully introduced.

Smoking of Fish: the WNW–AFCOD Experience

A. Demby and L. Bellaart

WNW–AFCOD Programme, Freetown, Sierra Leone

Abstract

The West North West Artisanal Fisheries and Community Development Programme (WNW–AFCOD) assists in improving artisanal fishing activities in four major villages (Goderich, Mahera, Konakridee and Yeliboya) in the west northwest shores of Sierra Leone. One major focal point of the project is fish smoking, which is the only processing method. This activity is dominated by women, the majority of whom are illiterate. They employ traditional but ineffective smoking techniques, leading to several disadvantages which reduce their profit margin. The fish smoking activities of these women are limited by insufficient working capital. Furthermore, the high cost of construction, maintenance, and repair of their traditional smoke ovens is another major constraint. The WNW–AFCOD Programme seeks to rationalize and modernize fish smoking in its operational villages by introducing and disseminating fuel and improved fish smoking facilities to the fish processors. The strategy has been to construct demonstration smoking sheds in each village, where training is conducted to educate the women on the effective use of the facilities. The advantages of these model facilities have been realized by most of the processors who now request the programme to assist them construct model ovens. The programme is launching a credit scheme to meet their request in order to facilitate dissemination.

National Development Bank Loans for Artisanal Fisheries

W.E. Jone

National Development Bank, Freetwon, Sierra Leone

Abstract

Established in 1968, the National Development Bank Limited of Sierra Leone (NDB) is a public liability company and the country's only development bank that provides financial assistance to enterprises engaged in agriculture, commerce, industry and exploitation of natural resources. The NDB strives to play a leading role in the financing of private investment in the productive sectors of the economy, i.e., agriculture, industry, mining and tourism, etc. Undoubtedly the sector with the greatest potential for development is agriculture which is the principal source of livelihood for over 70% of the population and contribute about 30% to the gross domestic product. The agricultural sector is itself divided into subsectors, including: food crops, livestock, tree crops, forestry and fishing. This paper assesses the past, present, and future of NDB investment in the fisheries subsector in Sierra Leone.

Freetown Fisheries Complex

J.A. Sciortino

Fishing Ports Consultant, Food and Agriculture Organization of the United Nations, Rome, Italy

Abstract

Sierra Leone has one of the richest marine fishing zones in all of West Africa, with an estimated sustainable yield of between 170,000 to 300,000 t annually. However, the lack of proper harbor facilities not only prevents the country from benefiting fully from this resource, but also prevents Sierra Leone from earning foreign exchange from transshipment of foreign–caught fish and the repair and bunkering of fishing vessels operating in Sierra Leone's coastal waters. This paper outlines a detailed proposal for the construction of a dedicated fisheries harbor complex, consisting of a transshipment terminal for foreign–caught frozen tuna, a wet fish landing facility, a bunkering facility, boat repair and maintenance complex, facilities for processing and storage of fish together with a fully integrated infrastructure consisting of a fuel depot, water storage, treatment and distribution network, power station, offices, stores, wholesale market and supporting services.

Operational Constraints of Sierra Leone Fishing Companies

L.A. Lisk

Industrial Fishing Association, Freetwon, Sierra Leone

Abstract

A number of constraints affect the operation of Sierra Leone's national industrial fishing companies. 90% of the fleet in Sierra Leone is foreign–owned, and few Sierra Leoneans own ships. Unlike Nigeria, Ghana and Senegal the industrial fishing companies of Sierra Leone is mostly comprised of joint venture agreements, and Sierra Leoneans' inability to own ships is due in large part to the unavailability of secure bank guarantees and commercial bank loans, and foreign exchange problems. Other constraints to the domestic industrial fisheries companies include: lack of a fishing harbor, lack of cold storage facilities and ice plants, high cost and unavailability of fuel and capital goods, lack of training for crew, lack of repair and maintenance infrastructure, piracy, and heavy taxes and duties.

Potential for Diversification of Fisheries Products in Sierra Leone

E.D.C. Mason

Aff1Fishing Co., Ltd., Freetown, Sierra Leone

Abstract

The aquatic resources of Sierra Leone are abundant and have sustained two levels of fisheries exploitation for decades, in the small–scale artisanal fisheries and the large–scale industrial fisheries. These two fisheries produce over 200,000 tonnes of fish and fish products annually, mainly exploiting the small pelagic species such as herring, bonga mackerel, and horse mackerel, however demersal species such as snapper, lady, and catfish are also caught. Fish continues to play an important role in the economy by serving as a major foreign exchange earner, and by being a major source of animal protein to the population. The main producers in the industrial sector are the fleet of the joint USSR/Sierra Leone fishery. The bulk of these products are not sold locally but are exported because of the inconvertibility of the local currency. This paper has outlines some of the major constraints of the industry, their causes, and effects. The structure and organization of the industry are reviewed, with their limitations, as well as potential for local processing, stock levels, government policies and interventions, human resources and development, infrastructure, and marketing. The concept of value–added in the fishery product industry now forms the basis for future development of the industry.

The Sierra Leone Fisheries Management and Development Act of 1988

A. Tejan–Sie

Aff1Legal Consultant, Freetown, Sierra Leone

Abstract

The Fisheries Management and Development Act, Act No. 4 of 1988 was enacted by the Sierra Leone Parliament in 1988. The Act provides for the management, planning and development of the fisheries resources of Sierra Leone, and has consolidated earlier legislation on fisheries matters. The Act has also enacted new provisions covering various areas, such as the management of fisheries and marine resources, research, enforcement and surveillance, and conservation. It is hoped that the effective implementation of these new provisions will maximize the economic rewards from these resources for the optimum benefit of Sierra Leoneans. For decades, the fertile waters of Sierra Leone have been beleaguered with poaching activities from foreign industrial vessels with absolutely no regard for the laws of the country. This state of affairs has resulted in the loss to Sierra Leone of millions of dollars, needed for the implementation of national development programs. The Act has imposed stiff penalties for contravening provisions of the Act, and this paper discusses some of these measures, in comparison with similar legislative measures in neigbhboring countries.

Handling and Quality Assurance of Fisheries Products in Sierra Leone

H.A. Robbie

Fisheries Department, Ministry of Agriculture, Food and Forestry, Freetown, Sierra Leone

Abstract

This paper examines issues of fish handling and quality control in the artisanal and industrial fisheries of Sierra Leone. In the artisanal sector, specific attention is given to maintaining the quality of the catch and addressing post-harvest losses, including handling, processing, and preservation techniques. In the industrial sector, similar post-harvest issues are reviewed, but with specific attention to the specifications of industrial vessels (i.e., hold size, cold storage, etc.). Issues arising from both onshore and vessel—based activities are reviewed, and major barriers to quality assurance are discussed. Recommendations are made for potential solutions to quality control challenges at every stage of processing.

Review of Fish Imports and Exports in Sierra Leone

A.B.C. Jones and R.P. Jone

Department of Fisheries, Ministry of Agriculture, Forestry and Fisheries, Freetown, Sierra Leone

Abstract

Sierra Leone's marine fisheries resource base can be divided into four main categories: coastal pelagic resourcs, offshore pelagic resources, demersal resources, and shellfish resources. Fish is an important part of the Sierra Leonean diet and the fish trade provides much–needed protein. In addition to satisfying domestic needs, through exports, the fish trade can provide foreign exchange, which is highly desirable in an ailing economy. Fish is exported largely in the frozen form on the African market, while cured fish is exported to other countries in the subregion. This smoked fish trade is not well documented and it may be regarded as informal export. The main shellfish export is shrimp, which is exported in frozen form, primarily to Europe. Over the years, shrimp has accounted for the greatest value of all exports. Fish is imported in canned or frozen form from all over the world, including Europe, the US, the Middle East, Asia, and Africa. Details of import and export processes, regulations, and actors are discussed. Constraints to trade in fisheries products include taxes, administrative challenges with obtaining licenses, inadequate data, low valuation of the Leone, and unavailability of capital goods.

Resources for Inland Fisheries and Aquaculture Development

A.A. Bangura and M.F. Sheriff

Fisheries Department, Freetown, Sierra Leone

Abstract

With a long coastline and a network of rivers, swamps and lakes, Sierra Leone has the potential to produce enough fish to feed its people. However, protein malnutrition is common among its inhabitants, especially those in the rural areas. Fish supply to the rural communities is rather insignificant in quantity and quality, and meat protein from livestock is unaffordable. The need to explore appropriate sources of protein within the inland fisheries and aquaculture sector has become urgent and of paramount necessity. This paper therefore attempts to present a brief description of the available information about the status and potential of inland fisheries and aquaculture in Sierra Leone. Approximately 505 of the fishermen involved in the inland fisheries are part–time or subsistence fishermen. There are possibilities of expanding this fishery, even if only gradually, in order to increase production. It is thus necessary at this point to prepare a comprehensive program for fisheries geared towards gradual expansion. Provision of necessary services and integration with an efficient monitoring system will be necessary.

The Republic of Sierra Leone Military Forces Naval Wing in Coastal Security and Fisheries Monitoring, Control and Surveillance

M.T. Diaby

RSLMF Naval Wing, Freetown, Sierra Leone

Abstract

In 1981, the Government of Sierra Leone realized that its coastal and EEZ waters were virtually unprotected and susceptible to incursions and threats, as demonstrated by the National Patriotic Front of Liberia (NPFL) rebel incursion. Poaching by foreign vessels continues to be a significant issue. For these and other reasons, the Government decided to form a Naval Wing of the Republic of Sierra Leone Military Forces (RSLMF). The main mission of the Naval Wing is coastal security. However its jurisdictional functions extend to the control of commercial trade, illegal trafficking of drugs and poaching. The first two are not much of a problem in Sierra Leone, but poaching has often been its biggest problem. Fisheries monitoring has been conducted simultaneously with coastal security patrols, and the Navy often conducts fisheries monitoring functions to prevent industrial fishing vessels from fishing inside the 5 nm fisheries exclusion zone, which has been reserved for artisanal fishermen. This paper considers the activities of RSLMF Naval Wing on coastal security and fisheries monitoring, control and surveillance. It reflects on the ideas behind the formation of the unit, its aims and objectives, as well as its success, shortcomings, and current constraints.

Policy Issues Affecting Fisheries Development in Sierra Leone

G.M. Bernacsek[a] and N. Iscandari[b]

[a]*Consultant, Food and Agriculture Organization of the United Nations, Rome, Italy*
[b]*Acting DOF, Ministry of Agriculture, Food and Forestry, Freetown, Sierra Leone*

Abstract

This paper considers the principal policy issues applicable to small–scale and large–scale fisheries development and operation in Sierra Leone. It reflects on the conditions and contexts of the various laws and policies, their aims and objectives, as well as potentially beneficial changes and additions to those policies. Issues discussed include: productive capacity of Sierra Leone's fisheries resources, existing and potential infrastructure, benefits and drawbacks of various import and export policies, development of industrial and advanced artisanal fisheries, potential income, employment, and welfare outcomes, consumption and trade issues.

the Shenge Integrated Development Fisheries Project

T.D.K. Taylor and M. Koroma

Shenge Project, Freetown, Sierra Leone

Abstract

In 1985, the Government of Sierra Leone requested United Nations assistance to develop the fisheries in the Shenge region. The first phase of the project lasted five years (February 1985-December 1990). The second phase commenced in January 1991 and activities are scheduled through to 1994. The objectives of the project are to increase fishermen's incomes, promote sustainable fish production, ensure regular availability of essential inputs, improve fish marketing outlets, and improve the living conditions of the Shenge population through the establishment of social infrastructure. This paper presents the experiences of the Shenge Fisheries Project and examines the project achievements, challenges, and future prospects.

Smoking of Fish: the Tombo, Sierra Leone Project Experience

S.E. During

Fisheries Pilot Project, Tombo, Sierra Leone

Abstract

The Fisheries Pilot Project in Tombo is a bilaterally–funded small–scale fisheries project that was established in September 1980. *Sardinella maderensis and Ethmalosa fimbriata* represent approximately 90% by weight of the annual catch in Tombo, and since these fatty clupeid fish have a high spoilage rate, over 90% of the landed fish are smoked or rather heat–dried before marketing in the provincial town centres. The objectives of the Fisheries Pilot Project in Tombo are to improve production quality and efficiency of local smoking devices and minimize fuelwood demand. The primary method of heat for drying fish in Tombo is the Fante banda, a type of platform from which fish are suspended in order to cook and dehydrate them. Due to the limitations of this method, alternative methods were tested, including: Altona ovens, solar drying, and chorkor ovens. In the end, a hybrid chorkor banda was adopted, in order to address both the social and technical needs of the fish processors and promote adoption. This paper assesses the health and sanitation aspects of the project, as well as the economic and social aspects involved in adoption of a new technology, and recommendations are made for similar projects in the future.

Trends in Regional and Global Markets for Sierra Leonean Fishery Products

E.O. Tettey

Marketing expert, INFOPECHE, Abidjan, Côte d'Ivoire

Abstract

This paper reviews the trends in regional and global markets with respect to products originating from Sierra Leone, specifically addressing issues that effect fish exporters. The focus is on the European market for frozen shrimp, since this commodity constitutes the bulk of high–value species exported. This paper further examines the West African market for frozen small pelagics, as this species group dominates domestic catch by weight. Finally, upcoming changes in quality requirements for fishery products in both Western Europe and the USA are examined.

West Northwest Artisanal and Community Development Project

M.F. Sheriff[a], A.A. Bangura[b], K. Von Der Decken[a] and F. Jepsen[a]

[a]*West North-West AFCOD Programme, Freetown, Sierra Leone*
[b]*Bo-Pujehun Rural Development Project, Freetown, Sierra Leone*

Abstract

The artisanal fisheries of Sierra Leone are heavily dependent on purchases of overseas manufactured materials, which are subject to the constantly deteriorating exchange rate for local currency in which the artisanal fish landings are paid. Furthermore, the artisanal fleet consists of 5,500 fishing vessels, of which about 5,000 are motorized, which exposes the fishers to the problem that fish prices do not commensurately rise with the rise in fuel cost, so artisanal producers are fighting for survival. This paper reviews potential solutions to these and other complex problems facing the development of artisanal fish production, and emphasis is places is on the coordination of fisherfolks, suppliers of inputs and finance and the government.