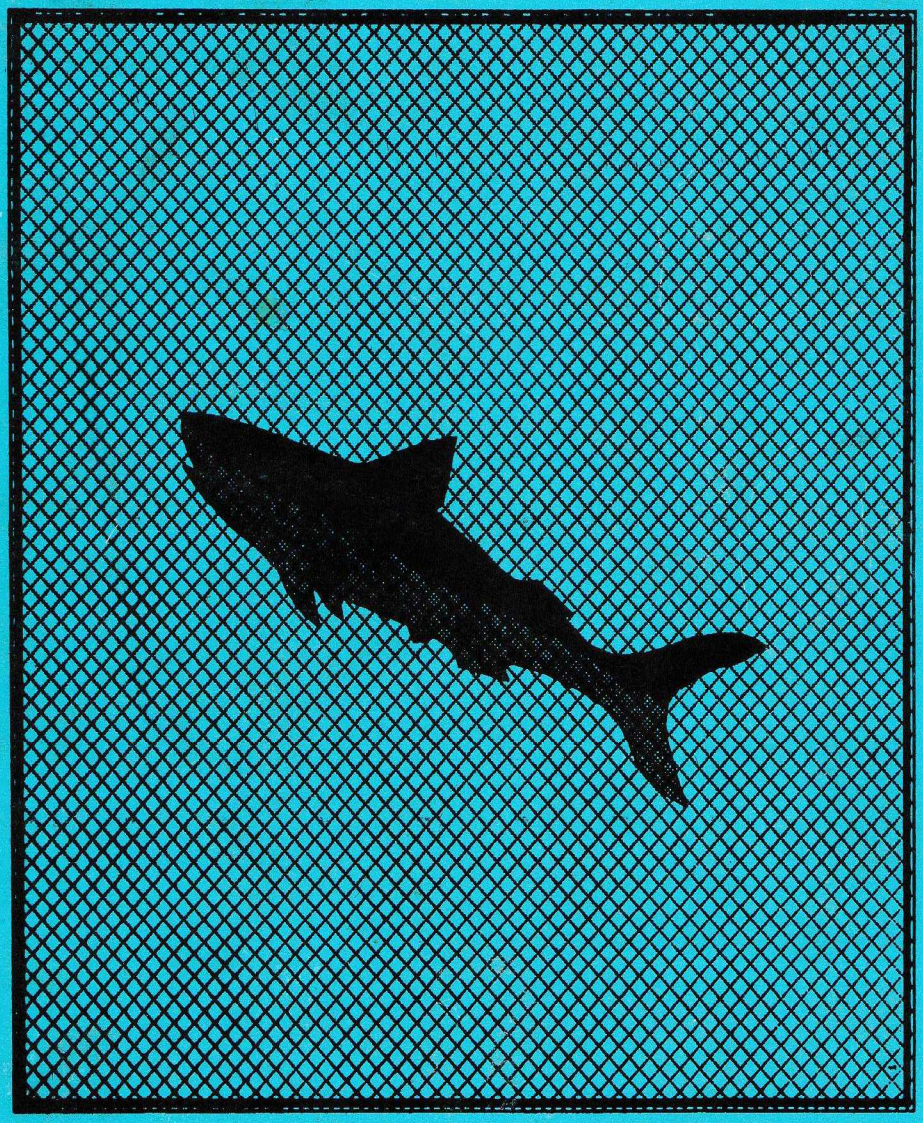
FISH AND FISHERIES OF SOUTHEASTERN NIGERIA

R. P. King
B. S. Moses



Produced by:
THE PUBLICATIONS COMMITTEE
DEPARTMENT OF ZOOLOGY
UNIVERSITY OF UYO

Fish and Fisheries of Southeastern Nigeria 27-37 (1998)
R. P. King & B. S. Moses (eds).

FISH HANDLING, PROCESSING, PRESERVATION AND DISTRIBUTION IN SOUTHEASTERN NIGERIA

O. M. Udoidiong and B. S. Moses
Department of Zoology, University of Uyo, Uyo

The artisanal fisheries industry in southeastern Nigeria suffers significantly from post-harvest losses which occur at several stages between capture and consumption of the fish. Knowledge of post-mortem chemical processes and the significance of sanitary treatment of fish prior to curing can help reduce the magnitude of losses. Technological improvements in the design and functioning of the smoking kilns are needed to enhance handling of large consignments per smoking time and improve the quality of cured products. The adoption, standardisation and use of some locally available packaging materials to transport and store cured fish can help reduce the rate of insect and mould infestation, preserve quality and prolong the shelf life of the cured fish. Continued dependence on mangrove trees as fuelwood for smoke-curing counteracts the productivity of the fisheries of southeastern coastal waters of Nigeria.

INTRODUCTION

Fish and shellfish (crayfish, periwinkles and clams) constitute the main source of animal proteins in the diets of the people of southeastern Nigeria (SEN). A central problem in the production, availability and abundance of foods in tropical Africa is the reduction in post-harvest losses arising from poor handling, processing and preservation. This problem becomes more acute in the fish production industry, fish being a highly perishable commodity. In SEN, post-harvest losses of fish from artisanal (small scale) fisheries range between 38-45% of the total catch. In artisanal fish production such losses occur at several stages (Fig. 1).

Reduction of post-harvest losses in the artisanal fisheries of SEN is an important issue not only because it can increase the quantity of fish immediately available for consumption but also because it is an option for conservation of the resources on which these fisheries are based; for, if the wastage of already captured fish is minimized, more fish for consumption will become available and this will assuage the urge of the artisanal fishers to fish harder on stocks which, according to Moses (1997), are already highly stressed.

In this paper we present information on the state of fish processing in SEN, associated problems and suggestions for improvement over the status quo.

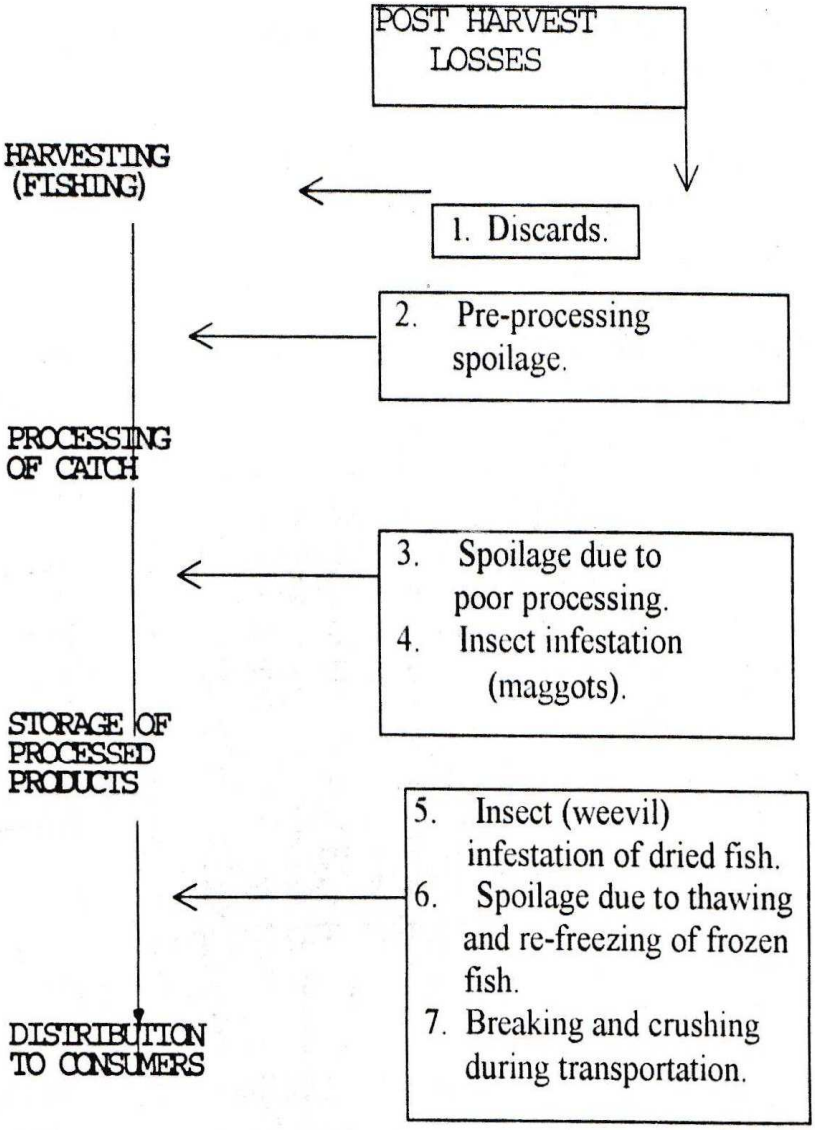


Fig. 1. The different stages of post-harvest losses in the fish production industry.

QUALITY OF GOOD AND SPOILT FISH

A freshly caught fish characteristically has a shiny skin covered with a thin transparent film of mucus, bright or brownish red gills (depending on the species), eyes with brilliant pupils, and is odourless. After death the fish goes into rigor mortis during which the whole body stiffens due to muscular chemical changes. These involve the hydrolysis of organic phosphates, (e.g. creatine phosphate (CP) and adenosine triphosphate (ATP) which leads to the contraction straining of opposing striated skeletal muscles against each other. The rigor state can last for only a few hours or for several hours depending on the species, the ambient temperature and the amount of muscular activity the fish had to perform before death. Rigor mortis is an important factor that affects the keeping quality of fresh fish. In general the longer the period between the death of the fish and the on-set of rigor mortis the longer the keeping quality of the fish. Similarly, the longer the duration of the rigor state the better and longer the fish will keep its good fresh quality. Fish will remain of excellent quality up to the end of the rigor; but thereafter deterioration and spoilage of the flesh set in. Fish goes bad through: degradation of muscle protein and self digestion (autolysis), bacterial action and oxidation of lipids.

Fish muscle is easily digested by proteolytic enzymes which penetrate the muscle from the gut through the abdominal cavity. During this autolysis, muscle proteins are degraded to amino acids (e.g. histidine) as well as other nitrogenous substances (e.g. trimethylamine oxide (TMO)) and urea.

Bacteria occur naturally on the skin and slime, gills and in large numbers in the gut. In live fish the muscles are sterile and most of the bacteria do no harm to them. In dead fish, they penetrate through the skin, gut and gills to attack the muscles. It is believed that bacterial decomposition of the flesh does not proceed to a large extent before the resolution of rigor mortis because of the acid condition (low pH) in the muscle. When the rigor is resolved the micro-organisms attack the substances which had accumulated as a result of enzyme autolysis. The end products of bacterial decomposition result in the formation of substances some of which are toxic to human (e.g. histamine). Food poisoning resulting from the eating of spoilt fish is, however, a rare thing because by the time such a stage is reached the flesh is no long acceptable.

The third factor that contributes to fish spoilage is the oxidation of lipids (fats and oils) in the flesh bringing about a condition known as oxidative rancidity, characterized by the fish developing off flavours. The highly unsaturated fish

lipids are readily oxidized by molecular oxygen resulting not only in rancidity but also in toxic substances such as hydroperoxides.

PRE-CURING HANDLING OF FISH TO MINIMIZE SPOILAGE

Pre-processing spoilage of fish can be miminized or eliminated by proper handling of the catch on board the fishing vessel and on the landing base while preparing the fish for processing. The steps normally taken to achieve these include reduction in temperature, removing the gut, washing and descaling.

Reduction in temperature

The rates of bacterial decomposition of fish flesh, autholysis and the oxidation of lipids, are accelerated by high temperatures. By cooling the caught fish to about -10°C most of the spoilage bacteria cease to grow, enzyme activity as well as the rate of oxidation are reduced. If the temperature is brought sufficiently low (-10 to -30°C) for example, spoilage can be stopped altogether. Since all the processes that lead to fish spoilage are temperature dependent, the ideal way of handling the catch on board is chilling in ice or deep freezing. For this reason industrial fishing boats generally carry ice on board or have their fish holds refrigerated. In the artisanal fisheries of SEN fish are not chilled on board because: (a) ice is not a readily available commodity and (b) the pirogue offers insufficient working space as well as space for ice and gear.

Nevertheless artisanal fishers and fish hawkers do take simple steps to reduce the amount of heat or direct sunlight on their catch; these include roofing a part of the canoe deck and covering the catch in the canoe with nets; and while at the landing site the fishers work under a shed to prepare the fish for curing. Furthermore, when the fish is being sold fresh, usually by women hawkers, the fish basins are covered with leaves.

Gutting, washing and de-scaling

Washing the caught fish, removing the scales, gutting and maintaining a good standard of hygiene while handling the catch before processing remove most of the bacterial load and help to slow down the rate of spoilage. Gutting also has the added advantage of reducing the quantity of enzymes that penetrate the flesh from the gut. In the marine/brackishwater artisanal fisheries of SEN, *Lutjanus* and barracuda (*Sphyraena sphyraena*) are washed, descaled, gutted, and cut into chunks before curing. Small pelagics (e.g. *Ethmalosa fimbriata, Sardinella madrensis, Illisha africana)* are not gutted but are always washed and often descaled before sticking them or putting them on cards for smoking.

Other precautionary measures

Bruising of freshly caught but still live fish usually result in extravasation of blood and other fluids and the consequent discoloration of the flesh; and rupturing of the skin facilitates the penetration of bacteria to the fish. Fishers therefore usually avoid rough treatment of the immediately caught fish. Some fishers take the pains to separate fish of low keeping quality from those that do not spoil fast because the contact of the former would induce spoilage in the latter.

FISH PROCESSING

If fish is to be kept for any considerable length of time before it is eaten it has to be treated in such a way that spoilage is eliminated. Any such treatment is technically called processing. Fish processing includes salting, drying, freezing (but not icing), canning, mealing, etc. It is thus a more comprehensive term than curing which is limited to such processes as salting and dying. In southeastern Nigeria it is correct to state that the traditional methods of stopping spoilage in fish is by curing.

Methods of Fish Processing

Salting

This is a very old method of curing fish. Penetration of salt into the tissue causes the properties of water-protein relationship to change, with the water being extracted from the tissue. The action leads to a reduction in the water that would otherwise be available for microbial growth. Salt does not only affect the water level in the fish tissues but also the micro-organisms by the plasmolysis of their cells.

In Nigeria salting (sometimes combined with sun drying) may be encountered in the Lake Chad area where the method is used in the curing of freshwater species such as *Lates niloticus, Distichodus rostratus, Gymnarchus niloticus, Hydrocynus* and *Labeo.* In southeastern Nigeria fishers avoid the salting of fish probably because salt being hygroscopic easily absorbs water from the very highly humid atmosphere resulting in an unacceptable product and because salt itself is expensive and could significantly add to the cost of the product. Salting is employed by the Ilaje fishers, who reside and fish in the Mbo Local Government Area of Akwa Ibom State, to cure fish for their domestic use only.

Sun-drying

In southeastern Nigeria the relative humidity is so high that sun-drying of fish is difficult. However, in the dry season between December and March, tiny shrimps

of the family Palaemonidae and small (juvenile) clupeids (bonga, sardinella and Guinean sprat) are often sun-dried particularly in Ikot Abasi-Opobo sector (e.g. at Okoroette, Iko and Obianga fishing settlements). The practice involves exposing the fish daily during the hot part of the day for several days before the fish is sufficiently dried for marketing. That this method of fish curing is inefficient for the coastal zone is indicated by the fact that often the product has a foul odour. In the northern part of Nigeria especially in the Lake Chad and lower Yobe River, sun-drying is a convenient way of curing some freshwater fishes (see Mann, 1962, Tobor, 1970).

Smoke drying

Smoke drying is the most popular method of fish curing in Nigeria, particularly in the coastal zone. The general principle of fish smoking is to generate (by burning wood, grass, coconut shells, etc.) sufficient heat to cook the fish so as to stop bacterial and enzymatic actions, while at the same time allowing smoke to penetrate it and give it a characteristic colour and flavour; the fish is then allowed to dry by maintaining fairly uniform heat for many hours. The amount of water loss depends on the length of time the fish is allowed to remain over the fire and the type of fish. The more water removed the longer the shelf life of the product. The fuel used for the smoking varies from area to area. In the coastal zone the preferred firewood is the red mangrove (*Rhizophora)* although any available wood and even coconut shells may be used. Where wood is scarce, as it is in the area around Lake Chad in the northern part of Nigeria, grass, dried reed and papyrus are used.

TYPES OF SMOKING KILNS

Moses (1983) has given a brief review of the traditional fish smoking methods used in the coastal areas of Nigeria. Out of the nine types of kilns described, only three are currently employed on a large scale by fishers in southeastern Nigeria.. These are the open air kiln, the indoor or kitchen type kiln, and the mud kiln.

Open air kiln

This consists of a platform raised about 0.5 - 1.0m from the ground on four wooden poles. The poles are made from Indian bamboo or red mangrove stems. The platform may be wooden or expanded metal. Some kilns are single-tiered (one compartment) and others multi-tiered (many compartments). The capacity of the kiln also varies in accordance with its size. A kiln of 1.5m long and 1.0m wide can contain 10-30kg fish per smoking time of about 48 hours at a temperature range of 40-90°C, and a wood requirement of $38m^3$.

Kitchen type kiln

As the name implies this type is usually erected in the living apartment of fishers and may not be quite different, in terms of constructional inputs or design from the open air kiln. Its capacity ranges from 5-30kg fish per smoking time of 48 hours and a temperature range of 50-90°C and wood requirement of $30m^3$.

Mud kiln

This type of kiln is an analogue of the traditional oven used in this area for frying ground cassava to make garri. It is constructed from clay or laterite and moulded into a semi-circular (crescent) or rectangular shape. The open end serves as the inlet for the wood, and the top is provided with a wooden or metal platform. It rarely measures more than 1.0m in diameter and is raised about 0.5m high, and the capacity is small. This type of kiln has long been in use in Ghana and in the Badagry area of Nigeria. It has a capacity for about 5kg of fish. However, the Ghanaian type is a bigger version and has a capacity for about 70kg fish per smoking time of 96 hours. Currently the IFAD/UNDP Assisted Artisanal Fisheries Development Project operating in SEN has adopted and introduced the clay kiln to the fishers under the name "Chokor" oven. It is certainly not a new invention in the area.

Drum kiln

Adam-Etuk (1981) reported an experimental metal kiln produced from a 225 litre petrol drum with a three-tier compartment. The kiln is supported on a tripod stand which is welded to it, and the top provided with a lid. The body of the kiln has a hinged door. When in use, the lid and the door are closed to concentrate the heat and smoke. This concentration of heat and smoke greatly reduces the smoking time and leads to economy in wood consumption. The only problem with this kiln was its small capacity which makes it unsuitable for commercial use, except an enlarged version is produced.

PREPARATION OF FISH FOR SMOKING

Differences in the method of exposing the fish to the heat occur among fishing communities. In most localities, the practice is to arrange the fish of sticks either singly or in pairs. Essentially, this involves piercing the caudal peduncle with a knife and passing the stick through this incision, and then through the opercular opening and out through the mouth. For bonga (*Ethmalosa fimbriata*) the stick is passed through the eye. In most cases the fish is bent to assume a crescent shape,

thereby creating room for more on the stick. Where two sticks are used, fish of similar size are paired and the sticks tied together with ropes on both ends. In Ikot Abasi, Eastern Obolo and Ibeno areas, the fish are arranged in pairs of equal size on rackets of various sizes and shapes constructed from the flexible prop roots of *Rhizophora* species. Often the fish so arranged are kept intact with ropes (obtained from plantain/banana stems) mildly applied to prevent damage. Large fish meant for curing are often cut into smaller pieces to enhance heat and smoke penetration, but some are smoke-dried whole.

DISCUSSION

Many problems are associated with the traditional fish curing methods in this area. Some of these arise from institutional indifference, technical aspects of the kiln, non-adherence to sanitary procedures prior to curing and impacts of smoke-drying on the mangrove environment. Expected increases in the availability of fish for consumption would be achieved if the following problems are satisfactorily addressed by both the fishers and government. The State Departments of Fisheries have a significant role to play especially in carrying out enlightenment campaigns aimed at improving pre-smoking handling and hygiene.

Fish landed in good condition are susceptible to microbial contamination when evacuated from the canoes onto the beaches, due to the poor sanitary condition of many of these beaches which are used as toilet and refuse disposal sites. Such beaches harbour swarms of flies and other disease-carrying or transmitting agents. The carefree attitude of fishers in these settlements to issues of sanitation is due to their belief that because the fish will be subjected to heat treatment, contamination prior to curing does not elicit concern. Even though they may be right in this, the problem of contamination is not solved because the careless handling extends to the cured product which may be eaten without further cooking.

The fishing communities should be made aware of the advantages of keeping a clean hygienic environment around the fishing settlements; they should be encouraged to make and enforce rules regarding the sanitary conditions of their surroundings. We suggest that all fishing communities should embark on self-help construction of latrines for the proper disposal of human wastes. Fishers should be made to handle fish meant for smoke-drying hygienically, and should be thoroughly educated on the health and economic implications of careless handling of fresh fish and cured products.

During and immediately after the Nigerian civil war, salted stockfish was common in our markets and was accepted by a large segment of the population. Since the preservative and bactericidal functions of salt is well known, our fishers should be

encouraged to always immerse, after a thorough washing, the fish in brine of adequate concentration before subjecting fish to heat treatment.

All processes that lead to fish spoilage are temperature dependent; therefore the ideal way of handling the catch before processing is chilling in ice or deep freezing. In southeastern Nigeria taking ice on board an artisanal fishing canoe remains a dream for the future. During the 4th National Development Plan Period (1980 - 1985) the Federal Government, under the FAO-UNDP/Federal Fisheries Integrated Artisanal and Inshore Fisheries Development Project, built an ice plant and a coldstore at Uta Ewa in Ikot Abasi (Akwa Ibom State). The ice plant was meant to supply ice to artisanal fishing boats. The plant remained functioning for only a few months and then became abandoned. Again when the construction of the Fishing Terminal at Ebughu (Mbo Local Government Area, Akwa Ibom State) was being planned, one of the objectives was to supply ice to artisanal fishers; this too has not been realized. These projects have not brought any improvement in the on-board handling of the catch of the small scale fisheries.

The open air kilns used by fishers to smoke-dry fish has the disadvantage of not concentrating the heat and smoke generated. The dispersion of the heat and smoke leads to longer periods of smoking due to slow rate of heat and smoke penetration of the fish tissue. Such products do not attain the desired level of water removal and often leads to a shorter shelf life. To achieve the desired quality of curing, more wood is used which is uneconomic. To overcome these shortcomings we suggest the building of smoke houses with kilns designed to concentrate heat and smoke; such smoke houses have been in use at Beniboye and other Western Ijaw villages (Moses, 1983). The project can be co-financed by government and the fishers' co-operatives. Such smoke houses will eliminate the frequent incidents of fire outbreaks in fishing settlements provided palm leaves are not used in their construction. The smoke houses could be built with concrete or mud walls and roofed with cement tiles or other heat and salt spray-resistant roofing materials.

When the smoke-cured products are not disposed immediately by the fishers or middlemen, they are removed from the oven and kept under reduced heat further above the oven platform for cooling, further evaporation and consequent drying. This act prevents infestation by insect pests. When sold, the products are transported either in covered baskets of various sizes and types, wrapped in locally-woven mat constructed from the rachis of *Raphia* species, with both ends of the sticks on which the fish are held left uncovered. Many others transport these products without covering. The situation is not different in market stores where they are kept by the sellers. In a study on the quality of four traditionally-cured (smoke-dried) fish in some markets in Akwa Ibom State (unpublished), one of the authors obtained variable responses on methods of preserving the cured products

in their stores. More than half of the respondents (fish mammies) left their wares uncovered, under the belief that this would prevent mouldiness as would be the case in an unaerated (covered) container. About a quarter of the respondents covered the fish with mats, while the remaining traders covered their consignments with waterproof bags.

This prompted experimental preservation of specimens of the four species of fish (*Ethmalosa fimbriata, Chrysichthys nigrodigitatus, Arius gigas* and *Pseudotolithus elongatus*) in four materials in the laboratory. The local sleeping mat, calico cloth, mosquito net and polythene bag, were constructed into sixteen boxes and four samples of each fish species placed in four of them. Weight changes incurred by the fish were observed every 3 days for 21 days. Differences in mean weight losses from *E. fimbriata* samples were statistically significant, with the order of decrease being Net>Calico>Mat>Polythene; that is, the fish in polythene box incurred the least weight loss. Variable responses were obtained with other species. However, the overall results indicated that apart from mosquito net, the other three materials are suitable for use in preserving cured fish. Thus, adoption and standardization of any of these materials for this purpose will help improve the keeping quality and prolong the shelf life of the products. Moreover, this will help eliminate the prevailing unhygienic exposure of cured fish in the markets and other sales spots.

The mangrove ecosystem is a complex but fragile ecosystem. Its fragility arises from several factors, some of which are the low bulk density of the soil (Dublin-Green, 1990) and the impact of wave wash from passing boats (Powell 1990). The concurrent effect from these and the aggressive succession by nipa palm and human exploitation of the mangrove trees for smoke-drying of fish, is the large-scale decimation of the indigenous mangrove trees. If the current rate of loss of the mangrove tree continues, the productivity of the coastal waters, which is strongly dependent upon the mangrove ecosystem (Moses, 1985; 1990; Ekundayo, 1985), will be severely reduced, and fin-and shellfish production will decline. We therefore suggest the evolution of alternative sources of energy for the purpose of fish curing by our artisanal fishers. The mangrove trees should be allowed to contribute in other ways to regional life-support so as to conserve the ecosystem and eliminate biodiversity loss.

REFERENCES

Adam-Etuk, E. R. (1981). Fish preservation, transportation and storage in Cross River State. *In*: Proceedings of the first Cross River State Fisheries Conference, Calabar (Moses, B. S. and G. O. Ilem, eds). Fisheries Division, Ministry of Natural Resources, Calabar. pp. 57 - 60.

Dublin-Green, C. O. (1990). Acidity of soils ad sediments in mangrove swamps of the Niger Delta as a constraint to productivity. *In*: Nigerian Wetlands (Akpata, T. V. I. And D. U. U. Okali, eds). The Nigerian Man and the Biosphere National Committee. pp. 104 - 111.

Ekundayo, J. A. (1985). The challenges of the mangrove ecosystem. *In*: The mangrove ecosystem of the Niger Delta: Proceedings of a workshop (Wilcox, B. H. R. and C. B. Powell, eds). Publications Committee, University of Port Harcourt. p. 166 - 122.

Mann, N. J. (1962). Fish production and marketing from the shores of Lake Chad, 1950 - 60 Federal Department of Fisheries, Lagos.

Moses, B. S. (1997). Artisanal fisheries of southeastern Nigeria: Catch rates, population dynamics, potential yields and resources management. Ph.D Thesis, University of Uyo, Nigeria.

Moses, B. S. (1990). Distribution, ecology and fisheries potentials of Nigerian wetlands. *In*: Nigerian Wetlands (Akpata, T. V. I. And D. U. U. Okali, eds). The Nigerian Man and the Biosphere National Committee. p. 35 - 46.

Moses, B. S. (1985). Mangrove swamp as potential food source. *In*: the mangrove ecosystem of the Niger Delta: Proceedings of a workshop (Wilcox, B. H. R. and C. B. Powell, eds). Publications Committee, University of Port Harcourt. p. 170 - 184

Moses, B. S. (1983). Problems and prospects of artisanal fisheries in Nigeria. *In*: Proceedings of the second Annual Conference of the Fisheries Society of Nigeria (FISON), Calabar. Kainji Lake Research Institute, New Bussa. p. 76 - 90.

Powell, C. B. (1990). Ecological effects of human activities on the value and resources of Nigerian wetlands. *In*: Nigerian Wetlands (Akpata, T. V. I. And D. U. U. Okali, eds). The Nigerian Man and the Biosphere National Committee. p. 120 - 129.

Tobor, J. G. (1970). A survey of the fisheries of the Lower Yobe River in the northern basin of Lake Chad. *Fed. Fish. Occ. Pap.* No. 12.