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The fisheries of Rivers of Nigeria's Niger Delta: Biodiversity, Abundance, Distribution and Sustainability Issues- A Critical Review

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Abstract

The exploitation and conservation practices of fisheries of Niger Delta, Nigeria have great impact on the management of these resources. The Niger Delta region is predominantly coastal in nature and embedded in fresh, brackish and marine waters, these form different degrees of ecosystems. The region is predominantly located in the southern part of Nigeria, bound by the Atlantic Ocean and enveloped by the continental shelf and portion of Nigeria's Exclusive Economic Zone (EEZ). It is known that the most important living aquatic resources in the world are the fishes. Other living resources are the mammals, reptiles, amphibians, plants, made-up of blue-green algae, multicellular algae. Various ways and measures, and strategies are put in place for sustainable exploitation of these resources and thereby protect and ensure preservation of these resources, are highlighted. The problems, prospects and opportunities in harnessing and managing these resources for sustainability are discussed. In general, appropriate strategies should be encouraged for responsible fishing within the zone not only for sustainable fisheries, but to avert damage to lives of local indigenous people particularly the fishermen who are always in the creaks and Delta basin in view of the fact that other heavy duty activities including excavation, dredging and oil-exploration, take place in the very deep parts of our waters. Appropriate strategies therefore, for responsible fishing within this zone in ways to avert danger to the lives of the local fisher-folk should be put in place in view of the fact that large unexploited fish stocks exist in the very deep parts of our territorial waters, contributing to a coastal nation's food security, should be fully exploited.

Keywords: Occurrence, Fauna, Flora, Creeks, Delta basin.

1. Introduction

The Niger-Delta Region of Nigeria is enveloped in inshore waters and bound in the South by the offshore waters of the Atlantic Ocean, which are rich in fishery resources. Tobor (1991), Dublin-Green and Tobor (1992) have reported on the richness of the waters of the West African Coast in terms of the fisheries resources, and that if sustainably exploited will form the basis for commercial production, and meet up to about 35-45% domestic fish consumption. However, according to the report, this level of sustainability can be based on improved technology and regional capacity to develop and manage the resources for optimal harvest, efficient utilization, conservation and management. Another factor vital for the optimal exploitation of the fishery resource is the scientific understanding of the habitat, nature,

distribution, and reproductive potentials of the fisheries resources all of which, will contribute to reduction in post-harvest losses. Availability of more fish and optimal resource utilization will be the norm when post-harvest losses are taken care of.

Tobor (1990) noted that the West African region can be self-sufficient in fish production by actively promoting the use of modern technology in fish production, in addition to the development of a wide range of value-added fishery based products for consumption. Ajayi and Talabi (1984) explained that the Niger-Delta region falls within the 200 nautical miles Exclusive Economic Zone (EEZ) within which Nigeria has absolute jurisdiction over all the resources therein, and covering a 320 nautical miles (667km) coastline of, about 192,000km^3 in area. Ajayi and Talabi (1984), Tobor (1991) and Dublin-Green and Tobor (1992) reported that the topography and hydrography of this area show that the waters are rich in diversified fishery resources which are continuously being exploited. However, development in the marine and coastal areas suggests that environmental pollution and degradation, increased catches due to high local fishing intensity and rapidly increasing number of mobile factories and vessels operating far into the sea would definitely enhance over fishing such that only a few substantial unexploited stocks will remain if appropriate management measures are not developed and enforced. Also, alternative uses of water resources for power generation and irrigation are contributing to dwindling fish yields. These problems arise because in default of definite arrangement, the question of conservation and exploitation cannot be the responsibility of a single fisher, but responsibility of all stakeholders. In marine fishery for example, catch of next year actually depends on current harvest and there is not much the individual fisher can do to ensure better and abundant catch for himself next year, for if he does not land as much catch as possible, somebody else will do so because of the open access nature of the fishery.

The real indicators of the fisheries resources of the region would include anthropogenic impacts, open access and nature of the fisheries operation, multi-species nature of the tropical fisheries, complexity of the conglomerate of stakeholders (effective users) of the home or habitats of the fisheries resources. Understanding the population dynamics of the different fish stocks being exploited is fundamental to the determination of the kind of regulatory measures or fisheries management approach to adopt for responsible fishing. In fishery, the aim of management is primarily to maintain the stock of fish at either the maximum sustainable yield or maximum economic yield level, and at the same time make the best use of the resources in terms of larger and cheaper supplies of fish to the consumer and better income to the fisher. Fisheries management is made easier and more precise if data are available. In the same vein, development and implementation of management objectives are less cumbersome and costly if management measures are considered well before the stocks are over exploited. Effective management of fisheries resources generally depends on the participation of all or at least the great majority of those exploiting the fisheries resources and all stake holders.

2. Appraisal of the Fisheries Resources of the Niger Delta

2.1 Fin-Fish

Plate 1: *Lutjanus* sp. (snapper) from the Niger Delta, Nigeria

The Niger-Delta Region and the magnitude of her natural resources have attracted a lot of interests particularly in the last four decades. The interest has arisen largely due to a growing recognition that the region is a vast dyramic store house of both living and non-living resources. Attempts to survey and appraise the fisheries of the Niger Delta, and their potential yields include (Ajayi, 1982 and 1984; Bayagbona and Ajayi, 1980; Amadi, 1982; Longhurst, 1961; Marioghae, 1981 and

1982; Moses, 1980 and 1982; Ssentengo et. al., 1983, Ohatulonye et al, 2018, Onwuka et al 2017, 2018). The statistical survey of the coastal marine and estuarine fisheries of the Western and South Eastern regions between 1985 and 1988 traversed 4000 miles and covered 60 fishing villages and landing sites. The survey estimated 91,203 fishers of which 54.32% of them were full time fishers. It was gathered from the survey that the number of fishing villages and the area of the coastal and estuarine waters of Rivers and Cross Rivers, according to Ndaguba (1983) and Ssentengo et. al. (1983) were more than double the area surveyed in the Western and South Eastern parts of Nigeria.

Plate 2: Typical beach in a coastal zone-Oyorokoto, Andoni, Niger Delta, Nigeria. (Photo: by Ikpewe, I.)

According to Tobor and Ajayi (1978): Tobor (1992), Ohatulonye et al, 2018, Onwuka et al 2017, 2018 Nigeria has a diversity of fin-fish consisting of about 199 species from 78 families in the brackish and marine environment. Tobor (1990) explained that the bulk of fisheries resources exploited for food within the region are the fin and shell fishes which are either pelagic, eurybathic or demersal, with an estimated potential yield of 222, 810 tonnes for resources in the 0-200m depth zone. The report also pointed out that the potential of resources in the 400-600m depth zone included Arioma species, Dentex species, and the shrimp Parapenaeus longirostris. In addition, Dublin-Green and Tobor (1992) citing FAO (1990) produced table of the commercially and scientifically important brackish and marine fishes within the Nigerian coastal region, see Appentix 1. They also classified the demersal fish resources into three main faunistic groups:

i. The Croaker fauna of silver to grey fishes such as the Croakers: Pseudotolithus senegalensis, Pseudotolithus. typus, Pseudotolithus. elongatus, and Pseudotolithus brachygnathus; the thread fins: Galeoides decaltylus, Polydactylus quadrifilis; the Ariid catfishes: Arius gambiensis, A. heudeloti; the Soles: Cynoglossus species, and the Spade fish Drepane africana. Others are Illisha africana and Ephippus species. These groups live mostly above the thermocline on mud and muddy sand deposits and hardly penetrate into the cold water below the thermocline. The croaker fauna is the mainstay of the industrial inshore demersal fishery of the Atlantic Ocean axis of the Niger-Delta region.

ii. The Snapper fauna which consists mainly of red fishes including the Breams (Pagrus species), Snapper (Lutjanus species), Groupers (Epinephelus species) and the Gurnards. (Trigla species). They are commonly found in water with clean sand rocky bottom, and are mainly carnivorous

iii. The semi-abyssal fauna occurs between 100m and 400m and consists of small red fishes such as Antigonia species and Capres species. The major coastal pelagic resources are the Clupeids which include the Bonga (Etlmalosa fimbriata), Sardinella aurita and Sardinella maderensis, but these are dwindling rapidly. The high diversity of fin-fishes in this region is in agreement

with similar studies carried out by other authors including Chindah and Osuamkpe (1994) who reported that there were 57 species and 25 families in the Bonny Estuary, Sikoki et. al. (1998) reported 24 species of 15 families in lower Nun River and Allison et. al. (1997) got 37 species and 22 families in Elechi Greek. In addition, Sikoki et. al. (1999) reported 22 species and 11 families in the brackish water zone of the Brass River, Abowei (2000) identified 36 species of 22 families in the lower Nun River and Ezekiel et. al. (2002) collected 25 species of 16 families in Odhiokwu-Ekpeye Local fish ponds and flood plains, while Alfred-Ockiya (1998) reported 11 species and 7 families in kolo creek, Niger Delta Region. Perhaps the latest study on the fish fauna of the Niger Delta Region is Francis and Sikoki (2004), who worked on fishes of the Andoni River brackish water system, Niger Delta, Nigeria. The study led to the identification of 63 fish species belonging to 48 genera and 36 families. Carangidae (Jacks and Moonfishes) had the highest number of species (five). The study also noted that rare species within the region include Acanthurus monroviae (reef fish), Scarus hoefleri (Guinean parrot fish), Lobotes surinamensis (tripletails), Trachinus ara weever) and Elops lacerta (lady fish).

Offshore pelagic resources include tunaand tuna-like f Ajayi and tunas are the most important of all the fishery resources inter of commercial value. The dominant species include the skipjack (Katsuwonus pelamis), the yellowfin tuumpur bestur the frigate tuna (Auxis thazard). Other important speci representing sharks and rays include Paragaleus gruweli Carcharias taurus, Sphyrna diplana, Dasyatis margarita, and Rajs miraletus. Amadi (1991) observed that with the exception of members of the family Tetraodontidae ie. the Puffer fishes which produce biotoxins and may not be edible, most fin fishes found in Nigerian waters are edible.

2.2 Shellfish Resources

The shellfish resources of Nigeria, both from the fresh and marine waters include shrimps, crabs, lobsters, and molluscs (gastropods, bivalves and cephalopods).

The marine environment of the Niger-Delta comes strongly under the influence of the Inter tropical Continuity zone (ITCZ) and its associated trade winds. The annual shift of the ITCZ brings heavy rain to the Niger-Delta area between April and October. The resulting heavy load of rich organic debris brought down by various rivers on the area supports rich shrimp resources off the Niger Delta.

(1) Shrimps:

Dublin-Green and Tobor (1992) citing Amadi (1991) reported that shrimps are abundant at the mouths of rivers and lagoon systems in the Niger Delta, and that about 2,000 tonnes of shrimps are caught annually off the Nigerian coast. Among the important species are the pink shrimp (Penaeus notialis), dominant in 10-50cm depth of water and are high in concentrations off the Lagos coast, from Benin River to Pennington River, and from Bonny River to the Cross River estuary. The Guinea shrimp Parapenaeopsis atlantica occurs in abundant quantity in coastal shallow waters, between 0-20m depth and commands a local economic importance. The royal shrimp Parapenaeus longirostris occurs in deep water of 60400m depth but are found abundantly between 60-120m. Nematopalaemon hastatus, an estuarine shrimp is found in coastal marine waters to the depths of about 50m. This species is heavily exploited in brackish water, creeks and estuaries, and has been a source of trade in Nigeria, the depleting effect however has been felt in its rising cost in markets.

2. Crabs:

There three groups of marine crabs found in the Niger Delta include:

i. the estuarine species which include members of the family Gecarcinidae (land crab) and Grapsidae (marsh/shore/talon crab).

ii. the swimming crabs in inshore waters; all belonging to the family Portunidae.

iii. the deep sea crabs, mainly Geryonidae, which form an important component of the benthic ecosystem on the continental slope.

3. Lobsters:

Spiny lobsters (Palinuridae) and locust lobsters (Scyllaridae) occur in Niger Delta Region. They are entirely of marine origin and only one species Panulirus regius, the royal spiny lobster is common and

prefers rocky substrate in depths of 5. 15m, As a stock, the royal spiny lobster has no commercial importance in view of its low frequency of occurrence; the flesh is of high table quality and a great delicacy as food so its cultivation is encouraged.

4. Molluscs:

Gastropods (marine/sea snails), occur in low frequencies in Nigerian waters where they are harvested by the local populace. Good examples are the periwinkle Tympanotonus fuscatus and the whelk Thais coronata. Bivalves such as the mangrove oyster (Crassostrea gas) восит abundantly in coastal swamps and estuaries where they are exploited for subsistent and commercial purposes. Other bivalves that are exploited in the coastal areas include the fresh water clam Galatea (Egeria) radiata (Arcidae), the brackish water knife or razor clam Tagelus adansonii and the brackish

Plate 3: *Penaeus* sp. and meat of gastropod and bivalves

Amadi, 1991 explained that the cephalopods which include squids, cuttle-fish and octopus occur commonly in offshore depths of 90-250m where they are taken as by-catch in bottom trawl catches, stressing the need to assess size of the cephalopod stock in the Nigerian marine waters since it can for the source of a thriving enterprise.

2.3 Factors Affecting Distribution of Fishes along the Nigerian Coast

Dublin-Green and Tobor (1992) noted that the ecological and oceanographic factors which influence the occurrence and abundance of fish resources within the coastal and marine waters of Nigeria include:

i. The continental shelf which has been described as not being very wide.

ii. The nutrient rich debris which are brought down to the coast and estuaries by the ocean and rivers make the Niger Delta Region one of the richest fish and shrimp grounds in the Gulf of Guinea.

3. How the Fisheries Resources of the Niger Delta Region are Exploited and their Present Status

Traditionally, the general belief about the aquatic resources was that they were inexhaustible, 'that there are more good fish in the waters than ever came out of it', Gulland and Carroz (1968). Repeated scientific research particularly from industrial areas where signs of depletion prevailed has shown that

this traditional belief is false. For example, with the introduction of steam trawler into Nigerian fishing industry, the stocks in seas were observed to show depletion, (Tobor, 1990; Dublin-Green and Tobor, 1992). Also, (Gulland 1971) reported that the average annual landing of fish by individual trawling vessel was clearly decreasing even though the total landings were still increasing.

Fishing operation

The fishing and exploitation pattern vary at both the artisanal and the industrial levels. Francis (2003) explained various fishing operations among fishers of Andoni river system, The author opined that the fishers set out to the fishing ground as soon as the water begins to ebb, which could be around the early hours of the morning, afternoon or late in the night. They begin to return from the fishing ground to land their catches as soon as the flood tide begins to set in. The fishers land their catches from around 06.00 or 14. 00 hours and the fishing duration varies, depending on the type of gear employed. Fishing duration will include time that is used to travel from the fishing port to the fishing ground, and the time spent in actually catching the fish with the gears, and the time spent in returning to land the catch. Francis and Sikoki (2003) also reported that amongst the Andoni fishers, fishing duration varies from between 03 to 30 hours but lasts for about 06 hours for most type of fisheries. They also noted that the type of craft used by the Andoni fishers is the unmotorized dug out canoe propelled by paddles. The fishers take advantage of the water current to move to and fro the fishing ground. In the same vein many authors have tried to explain what constitutes fishing effort. For instance, Francis (2003) citing FAO (2002) explained that fishing gear type plays an important role in yield, as it constitutes the fishing effort, and together with the catch made, forms the basic element in the formulation of indices of relative abundance. Their report shows that the gear type used by the Andoni fishers include the set long line, beach seine, cast net, gill net, traps, hook and line fishery. However, they noted that the most commonly used gear type are the cast and seine nets.

The tremendous increase in the demand for fish as an important source of protein and as raw material for production of animal feed has brought about the necessity for increased fish production in many parts of the world including the Niger-Delta Region. Associated with increased fish production is a corresponding increase in effort to catch the fish through improvement in making of the gears and crafts. The importance of the fishery resource to ensure food security and solve man's problems makes it imperative that the development of management strategic measures be made a priority in the mind of Government, its agencies and fisheries practitioners to ensure the vast fishery resource thrust on the nation is adequately taken care of to meet the needs for which man has been blessed with such resources.

Classification of Units of Fishery Industry in Niger Delta

The three major units in the Nigerian fishery are the artisanal or small scale, the industrial and aquaculture.

(i) The artisanal or small scale fishery

Plate 4: Cast net in artisanal fishery

This consists of small scale artisanal fishers found fishing mostly in rivers, creeks, lagoon, estuaries and inshore waters; and the gear in use most often is dugout canoe and paddle see plate 4.

The sector is characterized by low capital input, low operational costs, low technology application, labour intensive, poor fish distribution net-work, local market oriented, low revenue generating, poor processing methods and high post harvest losses ranging from 35-45% of landed weight, (Tobor, 1984). Its major advantages include rural employment, revenue generation, easy availability of fresh and cured fish to rural communities and fish consumers along coastal towns and cities.

Other features of the artisanal fishery include the use of traditional fishing craft and gears such as traps, baskets and fish barriers. Tobor (1990) noted that the artisanal sector is actually the backbone of fish production in Nigeria contributing an annual average of about 96.2%, this subsector actually led to the introduction of motorized fishing boat in the1960's into the Nigerian coastal waters.

(ii) The industrial sector

Plate 5: Fish Market in Thailand

Plate 6: Industrial Fisheries, such as Tuna, Provide Revenue to the State which contributes to Economic Growth.

This is characterized by high capital intensive fishing operation with the use of vessels, nets and cold storages on board, effective and efficient market distribution network, advanced technology application requiring the employment of highly trained and experienced manpower, high maintenance and operational costs, foreign exchange out flow and generation, local and foreign market oriented. The foreign exchange generation is its major attribute.

(iii) Aquaculture

Plate 7: Typical Fish Pond (brood fish pond) in aquaculture

Plate 8: Typical fish pond (Nursery/Hatchery pond)

This subsector generally has increased, albeit more on the terrestrial than in the brackish water environment. The level of fish culture practice (aquaculture,) is increasing in Nigeria and even in the Niger Delta. The slow pace of development of the subsector can be attributed to the following:

(a) High cost of fish feed.
(b) Inadequate human capacity to man the sub-sector is a major challenge since a lot of technicality is required for profitable venture.
(c) The fish culture system seem not to have demonstrated high economic viability to attract many potential entrepreneurs or make impact on the rural economy but a few more people are beginning to show more interest.

Tobor (1985) explained that fish culture has the potential of contributing annually more than 650,820 tonnes to the domestic production, but that it is only in recent years that the awareness of this potential has been brought to the notice of rural communities and fishery professionals. Brackish water aquaculture is beginning to get attention of Nigerians. Large commercial fish farms have been built in many coastal areas for example, in Rivers, Cross Rivers and Delta States. Modem and high-technology fish farms have been built by the Government in Buguma, Bonny and Ughelli towns. The potential of aquaculture for increased fish production is quite high. Some of the desirable fish and shell fish species for culture include Chrysichthys nigrodigitatus, Heterobranchus bidorsalls, Clarias gariepinus, Mugil species Tilapia species, Hemichromis fasciatus, Heterotis niloticus, Ophiocephalus obscurus, Cyprinus carpio and Megalops species. Of the shell fishes Crassostrea gasar, Macrobrachium species and Penaeus notialis are the most important.

4. Prospects and Opportunities of Fisheries Resources and Development in Niger-Delta

The Niger-Delta Region as reported by Ajayi and Talabi (1984) covers the 41,000km² shelf extensive brackish and marine waters, and together with the numerous rivers and their tributaries drain into the Gulf of Guinea. Large expanse of water body covers substantial part of the region and most of the water bodies are quite deep. Thus, the region affords living organisms more living space than can be found on land. The fin and shell fish potential of the region is very high with great natural endowment, such natural endowment therefore, should be given adequate attention so that optimum benefits can accrue to man and can be enjoyed on a continual basis. Hence, any discussion on prospects and opportunities for progress in the fishery of the Niger-Delta Region may have to start with progress so far.

In the first place, the setting up of the 200 nautical miles Exclusive Economic Zone (EEZ) for Nigeria was a great step which has helped in the efforts to conserve the fishery resource and allow the fish stocks attain Maximum Sustainable Yield (MSY) levels. International organizations and commissions, including International Commission for the Conservation of Atlantic Tuna (ICCAT), Food and Agricultural Organization of the United Nations (FAO), etc. have in several fora discussed strategies for responsible fishing. Tobor (1985, 1990) reviewed the potentials of inland and marine fisheries resources and explained that fishery in Nigeria can meet up to 90% of fish demand and supply in the Niger-Delta region, Tobor, (1990) noted that fish production can be increased substantially by intensified efforts on capture fisheries and aquaculture programmes including research and efforts in cage and culture practices. Adikwu (1999) citing FAO (1984a, b; 1994) agrees with Tobor (1990) that Nigeria's coastal waters can support aquaculture production at more than 15,000 metric tonnes per annum. The report however noted that despite this status, the potential of capture fisheries and fish farming is nowhere near optimum when compared with vast natural endowments of the region. The report also emphasized that the Niger-Delta Region being localized within the tropical region, has virtually uninterrupted year round environmental conditions for growth of fishes and other aquatic organisms. FAO (1994) recorded that in the coastal region of Nigeria water temperature are optimum, annual rainfall is adequate to optimum in more than 95.5% of the land area, and water availability is optimum to sustain more than 95% of the land area. With all these favourable conditions, the challenge amongst the indigenous people and all stakeholders including the Governments at all level in the Niger-Delta region at this moment is to ensure that capture fisheries and fish farming are given top priority, that will lead to their rightful place in fish production, to ensure national food security in the Transformation Agenda" of the Federal Government of Nigerian Government. The time to expand the Nigerian Economic diversification in areas of fisheries development is now.

Amongst the indigenous (local) inhabitants and foreigners (immigrants) alike, fisheries and agriculture practices have brought to the fore-front a lot of opportunities. For example, Francis and Ibim (2010) gave a review of women and sustainable fisheries exploitation, with emphasis in the Niger-Delta Region. The review points out that with the fishery and fishing activities in the region, the prospects and opportunities for the indigenous women as fishers include:

(i) their education and involvement in the production of right-mesh-size fishing gear thereby being able to stand against illegal and destructive methods of resource exploitation.

(ii) due to their exposure and education on best practices, women will begin to avoid trade in non sustainable fisheries practices, since they occupy strategic places in production, processing, trade and use of fishery resources. In the same vein, their male counterparts have evolved as artisans in carpentry by using large tree trunks in making dugout canoes for fishing with locally fabricated petrol engines to power the canoes. All these can add impetus to boost the fisheries activities to being commercial and export oriented. The most desirable fish and shell fish species include Chrysichthys nigrodigitatus, Heterobroncins bidorsalis, Clarias gariepinus, Mugil species. Tilapia species Hemichromis fasciatus, Heterotis niloticus, Cyprimas carpno Crassostrea gasar, Penaeus notiolis, and Macrobrachium species. According to Tobor (1990) fish products are normally smoked-dried, packaged and transported to other parts of the country and off-shore Nigeria where they are sold at high value than in Nigeria. This shows that there is ready market for fish trade both local and internationally, so more individuals should pick up the challenge to produce or process for local consumption or export.

5. Management of Fishery Resources of the Niger Delta

5.1 The Basis for Conservation Efforts

Tobor (1991), Francis et. al. (2007) and Francis and Erondu (2010) reported that fish conservation strategies entail concerted efforts aimed at averting a more rapid depletion and eventual destruction of a potentially viable fishery. Authors like Ricker (1958) have used a range of models of varying mathematical complexity to explain the effect of fishing on a fish stock. Ricker (1958) for instance reported that in the absence of fishing, a stock of fish will be large, and include a relatively high proportion of big and old individuals that are suitable as spawning stock. The increase in the total biomass due to the growth of the individuals; and recruitment of young fish will be balanced over a period by the losses due to natural mortality. When fishing begins the large stock gives large catches to each fishing effort. Generally any fishing will abundance, but at the levels the losses due to both fishing, added natural mortality (death) will be less than the gains due to growth and recruitment. If the catch taken is equal to this gain Le. the surplus, the stock will not depreciate, any catch greater than the surplus will decrease the stock, while a smaller catch will allow the stock to increase, thus fluctuations occur in the populations of species in the ecosystem. If small fish are protected, e.g. by using nets with right mesh size that would make for escape of immature fish from the gear, they can remain in the ecosystem to reproduce and replenish the wild stock. Without undue impact on the fish stock therefore, the fisheries can always be enjoyed on a continuous basis without loss of biodiversity or threat to the biota. One of the objectives, therefore, of rational management is to maintain the fishing effort at the level giving the greatest net returns (value of catch less cost of capture) i.e. at the level where the marginal cost of adding one unit of effort is just equal to the marginal value of the increase in the sustained catch resulting from the extra effort, rather than the marginal value being zero. Many indigenous authors, including Francis and Sikoki (2003, 2004), Francis and Zabbey (2007), Francis et. al. (2007), Davies (2009), Abowei et.al. (2010), Francis and Erondu (2010), have given statistical and distributional analysis of the fishery of the Niger-Delta Region, Nigeria with the suggestion by Francis et. al. (2007) that the biomass of the fishing stock will be restored and conserved if the following measures are enforced:

(i) public enlightenment: this would involve the use of various communication systems to intimate fisherfolks and the entire fishery practitioners of the adverse effects of uncontrolled use and destructive harvesting of fishery resources including the effects of environmental degradation on the coastal fishery.

(ii) establishment of brackish water grow-out ponds: by this strategy, fingerlings from the wild can be introduced into brackish water fish ponds, cages and pens; and reared to table since most of the brackish water fish species, for now, do not reproduce in captivity. This strategy is beginning to see the light of the day around Lagos State; more result is needed.

(iii) propagation by natural seed, in this method, milt and eggs from ripened males and females captured during the breeding season can be collected for external fertilization and the embryos reared in enclosures up to table size.

The essence of the second and third strategies above is to provide alternative source of employment, income and food security for the artisanal fishers. With alternative source of income, pressure on the wild can be reduced so that as much as possible there will be rejuvenation of the wild fisheries.

(iv) creation of marine protected areas that would also check environmental degradation and enhance yield.

(v) establishment and enforcement of operational standards for crude oil prospecting and production activities, in addition to activities of other industries whose untreated effluent flow into the aquatic ecosystem and toxins with deleterious effects on aquatic life.

6. International Instruments and Frameworks for The Sustainable Management Of Fisheries Resources.

Besides the technical measures elaborated above, there are international instruments and frameworks that have been ratified by consenting nations on the acceptable approaches ratified principles of sustainable fishery exploitation. Some of the instruments can be described as legal, political or institutional frameworks.

The International frameworks include:

i. The United Nation's (UN) Food and Agriculture Organization (FAO) 1995 Code of Conduct for Responsible Fisheries (CCRF). It is made up of 12 articles and two annexes and all covers areas that should ensure Responsible Fisheries. One of the objectives include serving as instrument of reference to help States establish or improve their legal and institutional framework for the development and implementation of Fisheries management plans.

ii. The UN 1993 Compliance Agreement to promote Compliance with International Conservation and Management Measures by fishing vessels on the high sea.

iii. The UN International Plan of Action for the conservation of Sharks and others.

iv. Convention on International Trade in Endangered species of wild fauna and flora (CITES).

v. v) The UN 1982 Convention on the Law of the Sea (UNCLOS).

vi. The UN 1995 Convention Agreement on Straddling fish stocks and highly migratory fish stocks.

vii. The Committee on Fisheries (COFI)

6.1 Political frameworks:

i. Agenda 21 of 1992 UN Conference on Environment and Development (UNCED).

ii. World Summit on Sustainable Development (WSSD) in Johannesburg, in 2002.etc.

iii. Other instruments include regional frameworks, and Environmental organizations such as World Wide Fund for Nature projects (WWF). The most comprehensive of these frameworks is the Code of Conduct for Responsible Fisheries.

Nations that are signatories to these instruments are reviewing their national fisheries policies and policy documents in order to include the objectives of these instruments and the adoption of prescribed and relatively new fisheries management approaches. These new management approaches and principles include:

i. The precautionary approach to resource management.

ii. The Ecosystem Based Approach to Fisheries Management.

iii. Co-management or cooperative management that is opposed to the centralized administration and regulation of the fisheries by government from the centre.

iv. Participatory resource management, which consider various stakeholder of the resource, both at the planning and implementation stages of managing the resource.

v. involves the devolution of power just like in co. management and participatory resource management

This approach is normally very effective in the coastal areas since the fisher folks and community members are at the grassroot and close to the resource. They can play effective role in ensuring compliance with set objectives for the fisheries. Most of the time community based fisheries management is effective if some kind of user right is allocated to the community and local institutional arrangements must have been put in place. The local management institution may consist of households or fishers's organizations such as cooperatives; they can allocate fishing effort and ensure compliance with the centrally set management objectives. Such local institutions are also normally accountable to the government and community members. This form of community based co-management of fisheries is practiced in most Southeastern Asian countries like Thailand, Malaysia, Vietnam and Indonesia (Pomeroy, 1995)

i. Adaptive fisheries management, this approach can come into force through the feedbacks obtained from the Monitoring, Surveillance and Control activities of this unit. Adjustment can be made in management process as the real situations present themselves on the field.

ii. Integrated Fisheries. Management Approach combination of the above management approaches con be adopted in regulating a fishery in order to ensure that the health of the ecosystem, the target organism and the welfare of the fishers folks and the larger society can be accommodated since there are many effective users of the aquatic ecosystem. These effective users of the aquatic ecosystem include Coastal zone developers, Maritime workers, other natural resource explorers, etc.

6.1 Regulation of the Fishery Resource through Technical Measures and Marine Protected Areas (MPAs)

A variety of methods can be used to achieve the regulation of fisheries resources of the waters of Niger Delta. Authors including Gulland (1983), Tobor (1985), Davies (2009), Abowei et. al. (2010) and Francis and Zabbey (2007) have suggested a number of methods:

i. Limitation on the size and quantity of fish that can be harvested (that is, the use of output measures in the form of Total Allowable Catch).

ii. Limitation on effort (regulation of the type of gear through technical measures of inputs into the fishery).

iii. Fishing at closed areas and closed seasons (access limitation).

iv. Establishment of Marine Protected Areas (MPAs).

In fisheries, size limits are effective methods of controlling the size of fish removed from the stock where undersized fish which are caught accidentally can be returned to the water alive or where the fishers can judge the size of fish before

capture Size limit has also been very useful in regulating the shrimp fishery where shrimp-fishing may only be directed the sea and not the nursery areas (estuaries and lagoon Closed areas and closed seasons ie, closure of a certain area for a limited period may reduce the fishing mortality and the running. costs, Closed area and seasons can also be used to control the sizes of fish caught if there are areas where small sized fishes are particularly common; for instance, the smaller fish of several species tend to remain in inshore or shallower areas. Thus, closure of these nursery areas would give effective protection to these immature fishes. At times the fish may be in poor condition (e.g. after spawning), closure of such areas would allow the fish to recover and then give a larger and more valuable catch.

Regulation may also include banning or restricting the use of more efficient or "damaging" gears aimed at reducing fishing mortality. Also mesh-size regulations can be used as these are aimed at controlling the size of fish caught. The effectiveness of these methods must be judged in line with the objectives of management which will generally be to achieve the greatest surplus of total value of catch over the total cost of catching it (Gulland and Carroz, 1968). Thus regulations to change the quantity and size of fish caught should not increase the cost of fishing but aimed at eliminating the harvest of immature individuals that have not attained length at first maturity or recruitment age (tr). Also, very important is the need for law enforcement. Enforcement must be considered and a good regulation should be easy and cheap to enforce.

Another management measure suggested by Francie and Zabbey (2007) is the establishment of marine protected are (MPAs) to safe guide the destruction of marine biota. The MPAs will involve integrated arrangement aimed at restoration and conservation schemes to ensure the sustainability of the marine resources. Francis and Zabbey (2007) made a case for urgent establishment of MPAs, marine parks and sanctuaries in the Niger-Delta Region

However, in the Niger Delta Region generally, especially within the creeks, the rivers and the mangrove areas, the regulatory measures outlined above have not been enforced by the Government. Chindah and Osuamkpe (1994) outlined the seasonal variation of finfish population, and explained that the population of finfish is higher in dry season months than in wet season months. Although, this agrees with the observations of Allison et. al. (1998). Sikoki et. al. (1999), Nweke (2000) and Ebere (2002), nonetheless these reports are contrary to the observation of Abowei (2000) of higher catches at wet season than dry season. Abowei (2000) attributed this to the dual occupation of the fishers who do mainly crop farming in dry season and fishing in wet season. Francis (2003), however, explained that catches are higher in the dry season because most fishers remain indoor, therefore the reduced pressure help in rejuvenation of fish stocks. Davies (2009) noted that there is no closed season for fishing in the lower reaches of Okpoka Creek, Niger Delta and non-selective cast nets are constantly being used. The result of these non-regulatory activities by the fishers in addition to deleterious anthropogenic activities is loss of biodiversity and depletion of stock. Davies (2009) recommended closed shit season and selective fishing gear as regulatory measure to maintain the stock of fin fish of the Okpoka Creek The negative impacts from human activities must also be checked

6.2 Problems and Solutions of Managing Fishery Resources of the Niger Delta Region

The problems associated with the proper utilization of the fishery resources of the Niger-Delta Region are quite numerous. In particular, the issues of over-fishing, discarding and environmental degradation are paramount. As already mentioned, in the Niger-Delta Region, commercial and industrial, and artisanal/subsistent fisheries, including aquaculture are practiced as sources of livelihood, providing food for the people and contribution to socio-economic development. FAO (1997) explained that international public concerns are giving due attention to fisheries and aquaculture with the objective of ensuring human capacity development to ensure their long term capacity to provide both food and livelihood, and summed the main threats as:

(i) The use of excessive amounts of fishing efforts (over fishing), which is the cause of decrease in the biomass of many fish stocks to levels below those associated with long-term, sustainable and efficient production.

(ii) The waste of already captured aquatic organisms through discards and post harvest losses.

(iii) The degradation of the aquatic and coastal environment through urbanization, dredging, crude oil pollution and obnoxious fishing practices. Other sources of threat include climate change and the natural consequences such as flooding etc.

Being conscious of the effects of depleted stock, there has been growing awareness of the threats facing these living aquatic resources and the environment. According to FAO (1995) most nations of the world adopted the "Code of Conduct for Responsible Fisheries as a guide for achieving efficient. sustainable and responsible fisheries, Nigeria is signatory to this framework and needs to toe the lines of compliant nations so that more benefits can be reaped from these natural resources

Sources of Threat and Solution:

(i) Over fishing:

Over-fishing, whether growth or recruitment overfishing, has become prevalent in most fishing areas, affecting capture; and often becoming particularly severe in the usually densely populated coastal zones where the populace depend on the resource for livelihood. Solution to this includes adoption and employment of market-based strategies for controlling fisher's effort, the use of limited access in order to protect breeding and nursery grounds. Selective gear should be used. Francis and Elewuo (2012) recommended the use of metal trap that is sealed at one end with the other end covered in a valve-like fashion that allows the escape of small sized fish. The trap is used by artisanal fishers within the middle Reaches of the New Calabar River to fish the silver catfish Chrysichthys nigrodigitatus. Fishers should be made to comply with laid down technical measures.

(ii) Discards and Post Harvest Losses:

Discarding in which a large amount of fish resources are captured or harvested and then thrown back into aquatic system, is also a threat to buoyant fisheries Discards are unwanted or illegal (small sized protected species), small sized damaged or spoiled fish of target species and by-catch. Solution to the problem of discards will include the use of net with the recommended mesh size, the right gear for a particular fishery and the employment of technological innovation system for monitoring, control and surveillance

(iii) Environmental Degradation:

It is now quite common that the health of aquatic ecosystems in coastal zones are deteriorating (FAO, 1997). Authors including Abowel et. al. (2010) citing Moffat and Linden (1995) have reported that the Niger Delta Region is the richest part of Nigeria in terms of living natural resources (flora and fauna) with large depositions of petroleum products (oil and gas), Davies (2009) reported that there has been unprecedented complaints from the local people of Okpoka Creek on the dwindling fin fish and shell fish populations, as catches have been drastically reduced, and attributed this to human activities, including over fishing, obnoxious fishing methods, improper land-use, habitat degradation, industrial activities, excavation and dredging; all of which destroy feeding, spawning and nursery grounds of fin fishes. FAO (1997) reported that the unfortunate aspect of the problems of environmental degradation of aquatic system is that the problem may linger because those charged with the task of managing the environment and aquatic organisms en behati of the state have virtually no control over the state of the fish fauna of the region. Thus, the aquatic ecosystem is exposed to pollution. However, in recent times, and in particular with the United Nations, Environmental Programme Report on Ogani land, human impact on the ecosystem may take to a more environment friendly approach. There are now new laws by the Government with severe penalties for offenders of the aquatic environment. Besides if the New Fisheries Act of the Federal Republic of Nigeria is passed into law and enforced, most threats to the environment would be eliminated

7.0 Conclusion and Recommendations

The fishery potential of the Niger Delta is indeed enormous. Associated with the Niger Delta, basin, Nigeria, are the Atlantic ocean, the Gulf of Guinea, territorial waters, Continental Shelf, parts of the Nigerian Exclusive Economic Zone, estuaries and networks of brackish water systems of rivers, creeks rivulets, lagoons, flood plains and mud flats. All these listed ecosystems are home to the fisheries resources. All the stakeholders in the fisheries profession should not wait for their irreparable depletion. The negative impacts from anthropogenic activities from crude oil and toxic wastes from other industrial and agricultural sources are grave consequences to tackle. In addition, high fish exploitation rate without corresponding regulation and conservation strategy would definitely lead to irreversible depletion of the resources.

As reported by many authors including Francis et. al. (2007), Davies (2009), Abowei et. al. (2009), with the present status of fishery in the region vis-a-vis the percentage of total catch and level of exploitation, there is every tendency of its getting worse, if necessary measures are not taken. Also earlier authors including Talabi (1984), Tobor (1990) had reported that due to inability of fishery professionals and other stakeholders to optimally harness and manage the aquatic resources, fish importation may

continue for a long time, the government has taken step to reverse this statement by gradual reduction of fish import. The government has made good efforts in establishing regulations for managing the fisheries but this has yielded little fruits.

The need for better fishery management within the coastal region of the NigerDelta has been highlighted. All the modern approach to fisheries elaborated in International framework for resource management see section 5.1.1. A positive step by all stakeholders within the region will go a long way in contributing to food sufficiency and other socio-economic development ventures. In this report, it is suggested that the leaders in the fishery profession within the region adopt the Community Development Quota (CDQ) programme as introduced by Ginter (1995), Buklis (2002) and Holland and Ginter (2001). Their reports on RightBased Fishery Management Systems in Marine Fisheries off Alaska, USA, led to the mobilization of the indigenous fishers in small and remote area. Before the establishment of CDQ the fishers had worked with limited transport connections, high rate of unemployment, poor and subsistence activities, however, a turn around came with the introduction of community based coastal intensive fishery development programme, with legislative budgetary allocation for acquisition and purchase of fishing inputs. It is known that fishers in the Niger Delta developing entries have evolved community-d organization in the management of their fishery, (Francis and Ibim, 2010). The mobilization of such community bused organizations into Co-operative Societies as elucidated by Ginter (1995), Buklis (2002) and Holland and Ginter (2001) with Government's financial support for the purchase of fishing inputs, will help in fishery management within the region and nation at large Proper attention need to be paid to the artisanal fishers who form bulk of those that strive to meet up with domestic fish demand.

The establishment of adequate man-power development programme aimed at producing highly skilled fishery professionals with a view to indigenizing the fishery industry as soon as practicable, will also help.

The African Regional Agriculture Center (ARAC), which is an out-station of the Nigerian Institute of Oceanography and Marine Research (NIOMR), has fishery sub-station in Buguma in the Niger-Delta Region. The purpose of the centre and the sub-station include: to carry out research and development programme. They are also involved in the establishment of adequate manpower development programme aimed at producing highly skilled fishery professionals with a view to indigenizing the fishery industry as soon as practicable. On this basis, the Federal Government and the State Governments of the Niger-Delta Region can make more specific grants available to the centre and other institutions within the region that are involved in fishery development programme for the purpose of mapping and assessing the sea wealth of the region.

The role played by the artisanal fishers must not be left out, as consideration is made of the rate and increase in fishing pressure on juveniles and young adults. This will result in a diminution of the overall value of catches on the aquatic system. Therefore, necessary measure to regulate lagoon catches should be considered and one of such measures is to increase the mesh size of fishing net. This technique will enable a greater number of smaller sized fish and shrimps to escape to the sea.

Finally, the agencies responsible for fishery development in the region namely the state Department of fisheries and the Federal Department of fisheries in collaboration with the law Enforcement Agency especially the Nigerian Navy should be actively involved in policing the region's territorial waters to stop the activities of foreigners and undesirable fishing vessels who exploit the waters illegally.

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