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Biodiversity, Management and Utilization of West African Fisheries

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Abstract: This study discusses the biodiversity, management and utilization of West African fish species. Biodiversity is a subject matter of interest to environmentalists, planners, administrators and general public. The most obvious benefit of fish utilization, as food materials posing threats to aquatic biodiversity are changes in land use, pollution, over exploitation, introduction of alien species and global warming and sea level rise. Conservation approach to maintain or sustain the facility of the environment is discussed. There is a wide diversity in West Africa comprising of 1672 fish species from 244 families. However, local knowledge about fish species biodiversity in West Africa is very extensive but difficult to access as they are dispersed in many languages. The general richness and complexity of West African fauna is discussed. The factors responsible for catch decline and the near collapse of several marine and inland fisheries and the resultant genetic resources erosion include over fishing, biophysical changes in habitat degradation and destruction, transfer and introduction of alien species and genotypes, fish culture and its technology improvements and apparently unprecedented climate change. Others are anthropogenic factors such as changes in deforestation, domestic and industrial pollution and urbanization and water development scheme. The importance of using genetic indicators for monitoring the state of environment is discussed. The information base upon which better policies can be made and implemented is increasing and becoming widely available through Internet and databases. This moves give hope for the future of African genetic resources. The management of choice to facilitate aquatic biodiversity is conservation. *Ex-situ* conservation options, which are captive breeding and genome conservation, are discussed. Legal and international aspects of conservation are also considered important and also convention. The use of indigenous African species for aquaculture development in West Africa is also examined. Hence, the need to make a case for the position of biodiversity management and utilization of fishes of West Africa.

Key words: Biodiversity, management, utilization, fisheries, biophysical changes, industrial pollution

INTRODUCTION

Biodiversity has become one of the focal subject matters attracting the attention of environmentalists, planners administrators as well as the general public in recent years following the United Nations Conference on environment and Development (UNCRD) held at Rio de Janeirs in 1992 (also known as the Earth Summit). The most obvious benefit of aquatic biodiversity with particular reference to fish is the diverse fish species utilized as food materials. For example the availability of a wide variety of cheap proteinous foods (fish, shrimps etc) helps in ameliorating prevailing malnutrition in many developing countries including West Africa.

Many factors are posing threats to aquatic biodiversity either directly or indirectly such as changes in land use, pollution and overexploitation of organisms, introduction of alien species, global warming and sea level rise. There must be a conservation approaches to maintain or sustain the scarcity of the environment. Conservation is an aspect of management, strategy, protection and wise use of natural resources, which will eventually protect biodiversity of fish species from becoming extinct. However, some aquatic species have already become extinct due to number of reasons related to human activities and many others have become endangered as a result of these unpredictable human interferences with the aquatic ecosystem. Conservation of biodiversity has become the need of the hour.

In this study, fish refers generally to finfish but it is recognized that fish depend upon a wide diversity of other aquatic biota for food, shelter, spawning sites and other needs. To what extent are the genes of West African fishes of value for use by human now or in future; not only for extractive used such as harvesting and farming for food or the aquarium trade but also for non-extractive used based on aesthetic appreciation, cultural and religious significance etc.

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Biodiversity as a socio-economic and environmental issue is a priority in aquaculture management and utilization in West Africa. This is so that the various constraints that has inhibited the improvement of the adoption of aquaculture by farmers in West Africa. In terms of management, aquaculture was not integrated into the farming systems of the people for whom aquaculture adoption has been directed from the initial establishment. The utilization of indigenous West African fish species also required identification of those that are acceptable to the generality of the consumers for adequate utilization. Additionally, with the global fears of consumers that generality modified organisms have health implications; there is the need to identify the various aspects of food safety as well as the environmental issues that have dodged the development of aquaculture in particular.

THE DIVERSITY OF WEST AFRICAN FISHES

Froese and Pauly (1998) reported that West Africa has fish species from 244 families constituting 71% of families and 25% of species of the African biodiversity. There is a wide diversity of fish species (Table 1). The Wetland International compiled a list of fish in Niger River (Table 2). A total sum of 35 families were compiled, Nigeria has 225 species followed by Guinea of 138 species to be the second position. The African biodiversity situation is shown in Table 2.

Local knowledge about fish species biodiversity in West Africa is very extensive but is very difficult to access because it is dispersed in many languages.

The general richness and complexity of West African fish fauna, which should be reflected in the biodiversity within a species or a gene pools result from the following according to Abban (1999):

- River systems traverse a variety of ecological areas.
- The majority of African river systems do not lend themselves to the established longitudinal zonation characteristic temperate rivers.
- An appreciable number of African fish species are widely distributed over different ecological areas as shown in Table 1.

Table 1: The diversity of African fish species by subregions (Source Fish base: Froese and Pauly 1998)

Region	Families	% of Families	Species	% of species
Northern Africa	225	63	1301	20
Western Africa	244	71	1672	25
Eastern Africa	258	75	3122	48
Central Africa	197	57	2272	35
Southern Africa	292	84	2106	33

Table 2: Wild fish species of river niger Tableau 1. Repartition de la Faune de posissons d'eaux douces et saumatres dans le basin du fleuve Niger

Familles	Especes	1	2	3	4	5	6	7
1. Protopteridae	*Protopterus annectens annectens*	+		+	+	+	+	+
2. Polyptridae	*Polypterus bichir lapradei*			+				+
	P. ansorgii	+		+	+	+	+	+
	P. endlicheri endlicheri	+		+	+	+	+	+
	P. Palmas							+
	P. senegalus senegalus	+		+	+	+		+
	Erpetoichthys calabaricus	+						
3. Denticipitidae	*Denticeps clupeoides*	+	+					
4. Clupeidae	*Pellonula leonensis*	+		+	+	+	+	+
	P. vorax	+					+	
	Odaxothrissa ansorgii							
	O. mento	+						
	Ethmalosa fimbriata	+					+	
	Sardinella madeceliii	+	+					
	Sierrathrissa leonensis							
5. Osteoglossidae	*Heteotis niloticus*	+	+	+	+	+	*intro*	
6. Pantodontidae	*Pantodon buchhholzi*	+						
7. Notopteridae	*Papyrocranus afer*	+	+		+	+	+	+
	Xenomystus nigri		+		+	+		
8. Mormyridae	*Mormyrus rume*							
	M. hasselguistii	+					+	
	M. tapirus	+					+	+
	M maacrophthalmus	+	+	+	+			+
	M. subundulatus		+	+	+		+	
	Hyperopisus bebe							+
	Campylomormyrus tarmandau	+						

Table 2: Continued

Familles	Especes	1	2	3	4	5	6	7
	Gnathonemus petersil	+						
	Isichthys henryi	+	+					+
	Marcusenius senegalensis		+	+	+	+	+	+
	M. thomasi							
	M. brudii							
	M. cyprinoids	+		+				
	M. meronai							+
	M. ussheri						+	
	M. abadii	+		+		+		
	M. furcidens						+	
	M. mento	+						+
	Hippopotamyrus castor	+						
	H. pangyi				+	+	+	+
	H. psittacus				+			
	M. pictus	+		+	+	+	+	+
	Mormyrops oudoti			+	+	+	+	+
	M. anguilloides				+	+		+
	M. breviceps							
	M. cabaltus	+		+	+			
	Brienomyrus niger	+						
	B. longianalis	+	+					+
	B. brachyistius	+	+	+	+			+
	Petrtocephatus bovei	+	+	+	+	+	+	+
	P.tenuicauda							+
	P. levelquei							+
	P.bane	+		+	+		+	+
	P.ansorgii	+		+	+			+
	P.sauvagii	+						
	P.soudaniensis	+				+	+	
	P.pallidomaculatus		+			+		
	Pollimyrus isidori	+		+	+	+	+	+
	P.adopersus	+						
	P.petricolus	+		+	+			+
	P.K.kingleyae	+				+		
9. Gymnarchidae	*Gymnarchus niloticus*	+			+	+		+
10. Cromeriidae	*Cromeria nilotica*	+		+	+			+
11. Phractolaemidae	*Phractolaemus ansorgii*	+						
12. Hepsetidae	*Hepsetus odoe*	+			+	+	+	+
13. Characidae	*Hydrocynus forkali*	+		+	+	+	+	+
	H.brevis	+	+	+	+	+		
	H. vittatus	+						
	Bryconaethiops equinquensamae	+		+	+	+	+	+
	Alestes baremoze	+			+			
	A. dentx	+						
	A. macrophthalmus	+		+	+	+		+
	Brycinus leuciscus				+	+		
	B. leteus	+						
	B. intermedius	+					+	+
	B. longipinnis	+	+	+	+	+	+	+
	B. nurse						+	
	B. imberi	+	+	+	+	+		+
	B. carolinae	+						+
	B. macrolepidotus					+		
	B. brevis	+	+	+	+	+		+
	Micralestes comoensis	+						+
	M. pabrensis					+		
	M. elongates					+		
	M. humilis	+	+	+	+	+		+
	M. occidentalis	+						
	Rhabdalestes brevidorsalis				+	+	+	+
	R. smykalai	+						
14. Didctrichodontidae	*R. septentrionalis*	+	+					
	Amoldichthys spiloplerus							
	Phago loricatus	+			+	+	+	+
	Ichthyborus besse	+	+					
	I. monodi	+						
	I. quadrineatus	+						

Table 2: Continued

Familles	Especes	1	2	3	4	5	6	7
	Paradistichodus dimidiatus							+
	Distichodus brevipinnis	+		+	+	+		+
	D. engycephalus	+		+	+	+		
	D. rostratus	+	+	+	+	+	+	+
	Nannocharax ansorgii	+						
	N. unifasciatus	+			+	+	+	+
	N. axelrodi	+						
	N. powelli	+						
	Nannaethiops ansorgii	+			+	+	+	+
	N. unitaeniatus	+						
	N. latifasciatus	+						
	Neolebias fasciatus	+			+	+	+	+
	N. lineomaculatus	+			+			+
	N. occidentalis	+		+	+			+
15. Citharinidae	*Citharidium ansorgii*	+			+	+		
	C. distichodoides	+	+		+	+		+
	Citharinops latus	+		+	+	+		+
	Citharinus citharus	+			+	+	+	
	C. eburmeensis			+		+		+
16. Cyprinidae	*Chelaethiops bibie*	+			+	+		+
	Leptocypris niloticus	+			+			+
	L. guineensis							+
	L. taiaensis	+						+
	L. crossensis		+			+	+	+
	L. konkourensis	+			+		+	+
	Raiamas sensgalensis	+			+			+
	R. nigeriensis							+
	R. scarciensis							
	R. steindachneri							
	Gara trewavasae	+						
	G. allostoma	+						+
	G. waterloti			+	+	+	+	+
	Labeo sensgalensis	+			+			
	L. roseopunctatus				+	+	+	+
	L. coubie	+			+			+
	L. rouaneti		+	+		+	+	+
	L. parvus	+			+			+
	L. alluandi						+	+
	Barbus wurtzi							+
	B. b. occidentalis	+			+			+
	B. b. waldroni							+
	B.gruveli	+			+			+
	B. petitjeani							+
	B. Sacratus				+			+
	B.dialonensis							+
	B.guineensis							+
	B.cadenati	+			+	+	+	
	B.hypsolepis				+	+	+	+
	B.pobeguini							+
	B.salessei	+			+	+	+	+
	B.leonensis							+
	B.anema	+			+	+	+	+
	B.sylvaticus	+			+			
	B.stigmatopygus	+						
	B.trispilos	+			+	+		+
	B.anniae							
	B.tiekoroi							+
	B.machinensis	+			+	+		+
	B.baudoni				+	+		
	B.perince							
	B.sublineatus	+	+		+			
	B.macrops	+	+		+	+	+	+
	B.callipterus	+			+	+	+	+
	B.ablades				+			
	B.parablabes					+	+	+
	B.foutensis					+		
	B.raimbaulti	+			+			

Table 2: Continued

Familles	Especes	1	2	3	4	5	6	7
	B.punctitawniatus				+	+	+	+
	B.niokoloensis	+						
	B.zalbiensis							
	B.bigomei	+						+
	B.ditinensis							
	B.chlorotaenia	+	+	+				
	Bagrus docmark							
17. Bagridae	*B.litamentosus*	+			+			
	B.baiad	+	+		+			
	Clarotes laticeps	+			+			
	Chrysichthys aluuensis	+						+
	C.levequei							+
	C.maurus							+
	C.auratus							+
	C.johnelsi	+			+		+	+
	C.nigrodigitatus	+			+			+
	Leptoglanis camerunesis	+						
	Auchenoglanis biscutatus	+			+	+	+	+
	A.occidentalis	+			+			
	Parauchenoglansis akiri	+						
	P.buettikoteri	+						
	P.fasciatus							
	Notoglanidium walkeri							
	N.thomasi							
	N.maculatum							+
18.Schilbeidae	*Parailia pellucida*	+			+			+
	P.spiniserrata							
	Siluranodon auritus	+	+	+	+			+
	Parentropius buffei	+						+
	Senticus intermedius	+	+		+			
	S.uranosopus							
	S.mystus	+						
	S.mandibularis	+	+	+	+		+	+
	S.micropogon						+	
	S.brevianalis							
19. Amphilidae	*Amphilus plytychir*	+						+
	A.atesuensis						+	
	A.kakrimensis							+
	A.rheophilus							+
	Paramphilius teugelsi				+		+	+
	P.trichmycteroides							+
	Doumea ansorji	+						+
	Andersonia leptura	+						
20.Clariidae	*Gymnaliabes typus*	+		+	+		+	+
	Heterobranchus bidoralis	+					+	+
	H.longifilis						+	+
	H.isopterus						+	+
	Clarias gariepinus	+	+	+	+	+	+	+
	C.anguillaris	+	+		+			+
	C.jaensis	+						
	C.buettikoferi							
	C.macromystax	+						+
	C.buthupogon	+						
	C.albopunctatus	+						
	C.agboyensis							
	C.salae							+
	C.ebrensis	+						+
	C.laeciceps laeviceps							
	C.I.dialonensis							
	C.camerunensis	+						
21.Malapteruridae	*Malapterurus electricus*	+	+	+	+	+	+	+
	M.minjiriya	+						
22. Mochokidae	*Chiloglanis polyodon*							+
	C.benuaasis	+			+	+	+	
	C.occidentalis	+						
	C.niger	+						+
	C.batesii							

Table 2: Continued

Familles	Especes	1	2	3	4	5	6	7
	Mochokus niloticus							
	Mochokiella paynei							+
	Brachysynodontis batensoda	+			+			
	Hemisynodontis membraneus	+			+			
	Synodontis resupinatus	+		+	+			+
	S.dekimpei							+
	S.annectens	+		+	+			
	S.clarias	+			+			+
	S. budgetti	+			+			+
	S. sorex	+			+			
	S. vermiculatus	+						
	S. omias	+						
	S.violaceus	+			+		+	+
	S.thysi							+
	S.courteti	+			+			
	S.gobroni				+			
	S.xiphias							
	S.guttatus							
	S.filamentosus	+			+			+
	S.bastiani						+	
	S.melanopterus		+					
	S.eupterus	+			+		+	+
	S.ansorgii							+
	S.robbianus	+						
	S.waterloti							+
	S.obesus							
	S.nigrita	+						
	S.koensis	+		+	+			+
	S.levequei						+	+
	S.tourei							+
	S.ocellifer	+		+	+		+	+
	S.schall	+	+	+	+	+	+	+
23.Cyprinodontidae	*Aphyosemion bivittatum*	+						
	A.bitaeniatum	+						
	A.toddi							
	A.guineense							+
	A.occidentalis				+			+
	A.deltaense							+
	A.walkeri						+	
	A.filamentosum							+
	A.sjoestedti	+						
	A.bualanum	+						
	A.arnoldi	+						+
	A.jeanpoli							
	A.banforense	+			+			
	A.calliurum							
	A.guignardi							+
	A.spoorenbergi	+						
	A.bertholdi							+
	A.gardneri	+						
	A.roloffi							+
	Nothobranchius kiyawensis	+		+	+	+		+
	Procatopus aberrans	+						
	Aplocheilichthys spilauchen	+						
	A.kabae							+
	A.pfaffi	+		+	+	+		+
	A.normani	+	+	+	+	+	+	+
	A.lamberti	+						
	A.macrophthalmus						+	+
	A.schiotzi							+
	Epiplatys annulatus							
	E.spilargyreius	+	+	+	+			
	E.biafranus	+						+
	E.chaperi						+	
	E.bifasciatus	+	+	+	+	+	+	+
	E...sexfasciatus	+						
	E.fasciolatus	+						

Table 2: Continued

Familles	Especes	1	2	3	4	5	6	7
	E.grahami	+						
	E.longiventralis	+						
24. Channidae	*Parachanna africana*	+						
	P.obscura	+		+	+			+
25. Synbranchidae	*Ophisternon afrum*	+						
26. Centropomidae	*Lates niloticus*	+	+	+	+	+	+	+
27. Nandidae	*Polycentropis abbreviata*	+						
28. Cichlidae	*Gobiocichla wonderi*	+			+			+
	Tylochromis jentinki							+
	T.leonesis							+
	T..intrmedius	+			+			
	T.sudanensis							+
	Anomalochromis thomasi							+
	Pelvicachromis taeniatus							+
	P.rofolli							+
	P.pulcher	+						
	Thysochromis ansorgi	+						+
	Pelmatochromis buttikoferi							+
	Chromidotilapia guntheri	+		+	+		+	+
	Hemichromis bimaculatus	+		+	+	+	+	+
	H.fasciatus	+		+	+	+	+	+
	Tilapia buttikoferi							+
	T.rheophila	+						
	T.mariae							
	T.louka							+
	T.guineensis	+			+		+	
	T.dageti	+			+		+	
	T.zillii	+		+	+	+	+	+
	Oreochromis niloticus	+		+	+	+		+
	O.aureus	+		+	+			
	Sarotherodon occidentalis	+						+
	S.melanotheron	+						
	S.g.galilaeus							
29.Mugilidae	*Liza grandisquamis*	+		+	+	+		+
30.Polynemidae	*Pentanemus quinquarius*							
	Galeoides decadactylus	+						
	Polydactylus quadrifilis	+						
31. Gobiidae	*Periophthalmus barbarus*							+
	Chonophorus lateristriga	+						
	Gobionellus occidentalis	+			+			+
	Nematogobius maindroni	+						+
	Bathygobius soporator							+
	Porogobius schlegelii							
32. Eleotridae	*Butis koilomatodon*	+						+
	Kribia kribensis	+			+			+
	K.leonensis							+
	K.nana	+			+	+	+	+
	Dorminator lebretonis	+			+			+
	Bostrychus africana	+						+
	Eleotris vittata	+						+
	E.daganeusis	+						
	E.senegalensis	+						+
33.Anabantidae	*Ctenopoma petherici*	+		+	+	+	+	
	C.kingsleyae	+						+
	C.murieri	+						
	C.nebulosum							
34. Mastacembelidae	*Aethiomascembelus nigromarginatus*	+			+			+
	A.liberiensis							
	Caecomastacembelus decorsei	+						
35. Tetraodotidae	*Tetraodon lineatus*	+		+	+			+

Pays: 1-Nigeria: 2-Benin: 3-Niger: 4-Mali: 4-Burkina Faso: 6-Cote d'lvoire: 7-Guinea Conakry. Into.: Introduction

FACTORS INFLUENCING FISH BIODIVERSITY

Ordinarily, factors that have contributed to catch decline and the near collapse of several marine and in-land fisheries and concomitant erosion of genetic resources in West Africa and indeed Africa are similar to factors in other parts of the world. The only difference according to Abban (1999) is that the scenario in Africa is unfolding

later and at a faster rate. The major causes are over fishing biophysical changes in habitat, fish habitat degradation and destruction, transfers and introduction of alien species and genotypes, fish culture and its technology improvements and apparently unprecedented climatic changes. These various factors are also interactive. Biophysical diversity in aquatic habitats influences fish biodiversity. The major human activities that have recently contributed to changes in fish environment include deforestation, domestic and industrial pollution, urbanization and water development schemes. These factors affect fish in several ways including elimination domination of whole populations, changes in relatively abundance of species and thus community structure, changes in habitat and reduction in aquatic habitable space for fish. All these factors result in reduction in the diversity of fish communities through competition and other selective pressures, they influence the genetic resources at population or gene level.

Fishing: Information on effects of fishing practices on biodiversity in Africa is very scarce. An assessment of fisheries on the Niger by Malvesture and Meredith (1989) may be one of the very few direct documented studies of the effect of over fishing on a stock or community. Yet over fishing abound in Africa. Leveque (1991) and Abban *et al.* (1997) reported that monitoring fish catches in several river basins in West Africa during the past two decades provided evidence of decline in catches attributable to over fishing coupled perhaps with climatic changes. Brainerd (1995) reported that most fishery resources in Africa are either close to their maximum level of exploitation, fully exploited or in some cases overexploited. He asserted that one basic reason for the high level of exploitation of fishery resources in Africa is the increase in real prices of fish. There are several fisheries in Africa that are being fully exploited or overexploited by the small-scale fisheries alone. Some inland water bodies are showing declining catch rates. The major reason for this is from a socioeconomic point of view according to Brainerd (1995) are:

- Conditions of open access and lack of effective management schemes.
- High demand for products.
- Technological choices promoting more efficient gear.
- Limited alternative opportunities for labour and capital.
- Breakdown of traditional fishery management systems and barriers to entry.
- High population growth within fishing communities.

A downturn in global fisheries production in the early 1990s brought about by over fishing and continuing environmental degradation generate public alarm and calls for improved management schemes and sustainable utilization of aquatic resources systems (ICLARM, 1998). Of the world's 200 fish stocks, for instance only a third are capable of sustaining increased harvest (Alverson *et al.*, 1994). Over fishing in many areas is leading to harvests of smaller fish and lower catches per unit effort.

Deforestation: Massive deforestation accessioned by the need to provide more houses, farmlands, more roads, fuel woods and other infrastructure due to population pressure has resulted in the depletion of natural resources. Of particular interest in these regards are the fish and shellfish, which constitute a major source of protein in the diet. In most parts of Africa, where resources have not been established, watercourses have rapidly loss significant amount of their vegetation. Abban (1999) reported that while international actions to limit deforestation have been concerned with the depletion of forests for timber and wood products, local demand for fuel wood has been a major cause of depleting the vegetation cover of fish habitats. Yakubu *et al.* (1996) reported that destruction of mangrove forest which is about 1.0 million hectares land in the Niger Delta of Nigeria if not checked would adversely affect the oncology and indeed biodiversity i.e., the abundance of crab and other numerous invertebrates which contribute a major source in the diet of the people. The predictable response being given to deforested areas, where any remedial action is being taken is reforestation of riverbanks and lake catchments e.g., activities within the catchments of the Volta basin in Ghana (Abban, 1999). Perhaps reforestation program will help to reduce damage to aquatic biodiversity but the danger is the newly planted forests are not likely to perform exactly as the natural forest did.

Pollution: One of the tasks facing countries south of the Sahara is realizing the full potentials of their aquatic resources especially culture fisheries in inland and non-open coastal waters. To attain this objective required input of more resources than is presently given and/or full exploitation of existing ones. Because of the lower level of industrialization in sub-Saharan, the major sources of pollution are from domestic waste (either from point or non point sources), industrial effluents (most often associated with domestic waste) and run off from agricultural lands. However, in industrial activities such as mining, have non-degrading and relatively toxic pollutants are produced.

In West Africa, the main sources of pollution are urban development, industrial waste and use of pesticides. The obvious consequences carbon pollution includes microbial contamination, eutrophications and reduction in dissolved oxygen. These conditions can lead to fish kills especially in inland waters with subsequent changes in species diversity favourable to coarse fish.

Some industrial effluents also contain enrichment pollutants, but other are sources of inert solids as well as toxic pollutants such as heavy metals, cyanide and free chorine. Increased levels of suspended matter may directly affect fish by clogging the gills or indirectly by reducing light penetration and blanketing bottom substrate leading to the destruction of nursery and feeding grounds.

In Nigeria the sinking of coastal land has been attributed to the continued withdrawal of fluids especially oil and gas from the porous reservoirs in the Niger delta. Breeding grounds, nursery and schooling areas of fish species are subsequently lost to the ocean. Phytoplankton feeders notably mullets. Tilapia, prawns and shrimps have lost area for survival of their offspring. Oil spills, which are regular features of the oil producing coastal areas, have damaging effects on the ecosystem and indeed fish biodiversity.

Manipulation of hydrological cycles: In addition to pollution central to the future of both inland and marine fisheries are the changes that are taking place in African rivers as a result of construction of dams, channeling of riverbeds and increased consumption of water by agriculture and industry.

Many of the major rivers in Africa have been dammed in at least one location, most of them in the past four decades also. The effects of these projects stem primarily from changes in the quantity and quality of water in post-project environment. Secondary effects include changes in quality and quantity of fisheries resources. The Kainji dam, Lake Chad in Nigeria Akosombo dam on the Volta river for example eliminated the regular flooding in the wet season and as a consequence several lagoons which used to be revealed in times of flooding have been lost together with their fisheries (West and Biney, 1991). The reduction of freshwater discharge in the lower estuarine reaches of the rivers due to dam construction can alter the extent of seawater intrusion and may also favour the formation of coastal sand pits (Portmann *et al*., 1989). These have far reaching effects on the location and species composition of fishery resources.

Modern coastal development: Human activities along the coastline, estuaries, lagoons, major rivers and tributaries have adversely affected fish habitats. Within the Lagos area in Nigeria, the reclamation of the flat, swampy terrains for bridges, residential houses and industrial zones has virtually destroyed the breeding grounds, nursery and schooling area of fish and shell fish. Similar activities in the Niger Delta and of the coastline of Nigeria include resettlement of villagers displaced by oil installations and continual destruction of mangrove forests and continual destruction of shelters for breeding grounds, nursery as schooling areas of fish species. There is also the adverse effect of coastal erosion.

MANAGEMENT

Biodiversity conservation: The conservation and sustainable use of inland and coastal waters and their biota is higher than ever before on the agenda of international, regional and national organizations.

The importance of using genetic indicators for monitoring the state of the environment is recognized. Pullin *et al.* (1997) and Brown *et al.* (1997) reported 7 indicators for reporting such diversity of the state of environment: Number of sub specific taxa, population size, numbers and isolation, environmental amplitude of populations, genetic diversity of marker loci within individual, quantitative genetic variation, inter-population genetic structure and mating.

The Organization of African Unity (OUA) in its council document, Doc (M/20/75(LX VIII) ADD.1 recommended:

- Give the attention as a matter of priority to the need regulating access to biological resources, community knowledge and technologies and their implication for intellectual property rights as entrenched in the international trade regime of the TRIPS agreement.
- Adapt the draft model legislation among African countries on access to biological resources and call on member states to initiate the process at national level involving all stakeholders in accordance with national interest and enacted into law.
- Initiate a process of negotiation among African countries to formulate and adopt an African convention on Biological Diversity with emphasis on conditions to biological resources and protection of community right.
- Develop an African common position to safeguard the foreign rights of member states and the vital interests of our local communities and forge alliance with other countries of the south on the revision of Trips in 1999 (Nnadozie, 1998).

What then is the scope for consideration in the future? According to Froese and Pauly (1998) it should be reviewed with optimism because the information base upon which better policies can be made and implemented is increasing. Moreover, such information is becoming more widely available through the Internet and through database CD-ROMS etc. (e.g., Froese and Pauly, 1998; Polomares and Casal, 1998; www.fishbase.org.) such move give hope for the future of African fish genetic resources. However Pauly *et al.* (1999) reported that the pressures on African waters and their biota have never been so great and are increasing. Fresh water will become increasingly scarce in sub-Saharan Africa over the next 50 years as its population triples (Population Action International). This will increase the threat to freshwater fish species, which are already the world's most threatened group of vertebrates exploited by humans (Bruton, 1990).

There is a widening realization that move equitable sharing of benefits of genetic resources is essential for their conservation and sustainable use. This means sharing within and across national boundaries. Swaminathan (1997) summarized the actions that are needed to implement CBDs provisions that on sharing the burden of conservation and the benefits of using genetic resources. Its overall conclusion is:

Today, tribal and rural women and men conserve and improve biodiversity for public and commercial good at personal cost. No further time should be lost in ending the present ethical situation where such primary conserver live in poverty while those who utilize their knowledge and the products of their *in situ*/on-farm conservation culture become prosperous. This is with the implication that the needs of stakeholders in biodiversity conservation should be provided for".

Most West African countries have established both *in-situ* and *ex-situ* conservation programmes. *In-situ* conservation initiatives have taken the form of national parks and game results. Most of the ecological' reveries contain aquatic systems as the most important parts of protected ecosystems. *Ex-situ* conservation programme in Africa is involved in gene banks and cryopreservation, which is not yet fully established in West Africa. In order to ensure effective conservation and development of biodiversity appropriate frameworks should be developed.

Stock transfer: When a habitat is destroyed the native species is transferred to an ecologically suitable habitat and thereby the endanged species are protected. There is not such trend in West Africa.

Brummentt (2000) reported that exotics have failed to produce rapid growth of the aquaculture factor in Africa. Collectively, Africa is endowed with adequate aquatic biodiversity to sustain aquaculture development. The member of indigenous freshwater fish species in Asia and Africa as approximately the same (2943 and 2660, respectively (Brummet, 2000) of the ecologically damaging factors, the invasion of exotics is considered the second greatest threat to global biodiversity after habitat loss. Aquatic biodiversity is particularly at risk from introduction of alien species/strains. Aquatic fish have been deliberately introduced into African freshwaters for a number of reasons included fish culture and the need to produce "bigger fish among other reasons. In most cases, the economic and biological implications of translocations have never been thought through on the biological side, we may never know enough to anticipate fully all the risks, particularly the unforeseen and complex interaction of the invading species with the existing food web (Ngoile and Sarundey, 2002).

CONSERVATION OPTIONS: *EX-SITU*

Conservation of the species outside their natural habitat is the principle *ex-situ* conservation. Two principal options for *ex-situ* conservation of aquatic biodiversity are recognized.

Captive breeding: In captive breeding the endangered aquatic species are bred and larvae reared in a laboratory and then the seeds are released to their natural habitats. Captive propagation thus averts extinction, providing an 'ark' to carry endangered taxa through crisis period. However restocking of captive-bred aquatic organisms into their native habitats is not always realistic and cannot be necessarily considered as the ultimate goal of a breeding programme. An important factor for choosing a threatened species for a large scale captive breeding programme is that it may be possible to reintroduce it into the wild. Other factors influencing the choice are the taxonomic uniqueness of the species and their suitability for captive breeding and/or rearing.

Conserving genomes: Conservation of genomes is aimed at protection of the gene pool. For these modern techniques for rapid freezing of gametes to a very low temperature called Cryopresenvation which opens up the possibility of establishing large scale gene banks free from genetic contamination and relatively low recurrent cost.

West African counties need to build capacity in these two areas of conservation. The level of knowledge presently is a limiting factor to conservation.

LEGAL AND INTERNATIONAL ASPECTS

The position of biological diversity in national legal system is one of the important judicial problems. Many treaties and conventions have been adopted for the

Table 3: Indigenous West African Fishes that are farmed sources: FAO (1997) and Fishbase (Froese and Pauly 1998)

Species	West African countries where they are cultured
Chrysichthys nigrodigitatus	Cote d'Ivoire,Nigeria
Clarias anguillaris	Burkina Faso and Nigeria
Clarias gariepinus	Cameroon, Ghana, Guinea and Nigeria
Heterotis niloticus	Gambia and Nigeria
Lates niloticus	Nigeria
Oreochromis aureus	Cote d'Ivoire
Oreochromis niloticus	Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Liberia,Nigeria, Senegal and Sierra Leone
Sorotherathan melanotheron	Cote d'Ivoire

conservation of particular species. The Ramsar convention on wetlands, Convention on Biological Diversity (CBD), Cartgene protocol on Biosafety to the convention of Biological, Diversity, Global Biodiversity Assessment prepared by UNEP. The Washington Convention on International Trade in endangered species of Wild Fanno and Flora (1973) are some of such conventions.

The United Nations Convention Biological Diversity (1994) has now been signed by most countries. Three main objectives of this convention are:

- The convention of biological diversity.
- Their sustainable use.
- The fair and equitable sharing of benefits arising of the utilization of genetic resources including appropriate access to these resources and the transfer of appropriate technologies (Sharma and Bhaltacharjra (2001).

Utilization: Africa now face the prospect of choosing how best to conserve and to use its fish genetic resources for aquaculture against a background of very limited resources in terms of infrastructure and trained geneticists and with very rapid advances in the application of genetics to fish breeding taking place in the developed world. According to Lazard and Rognon (1997) the key requirement is to apply genetics in breeding program for aquaculture in ways that are realistic in terms of its need and potential and of course to conserve the wealth of fish genetics resources available in Africa in general and West Africa in particular so as to maximize options for their future use as new technologies become available.

Table 3 lists the West African indigenous fish species under culture. Attempts to develop most species for aquaculture have been hampered by the high cost of capturing broodstock from the wild and transporting and maintaining them under difficult technical and environmental conditions. It is expensive to undertake controlled and replicate trials with such improver species especially for those, which do not spawn naturally in aquaria, ponds or other managed water bodies. This has discouraged researchers, policy makers and resources managers from exploring the potential of species new to aquaculture. The preference has been to use those few species (indigenous or alien) that have track record for use. However, in response to calls for the conservation and wise use of biodiversity, more West African countries i.e., Nigeria, Ghana, Cameroon, Cote d'lvoire etc are now exploring the potentials of their indigenous species facilitated in part by donors that wish to help such countries to minimized losses of indigenous biodiversity. However, for effort use of biodiversity conservation strategy the major constraints to aquaculture development in West Africa must be addressed. These include, insufficient supply of good quality seed, unavailability of fish feed, prohibitive transport cost and poor transport infrastructure, weak extension services, poorly funded research institutes, limited coordination between research and development sectors, unreliable production statistic, inadequate information management systems and absence of aquaculture policy.`

RECOMMENDATIONS

More beach lakes should be established along the coastline for attraction of tourists to community fishing festivals. Under this programme the participation of citizen in conservation is very important. The coastal and brackish water areas of the region are intensively exploited. Various fish species that find their way into these lakes through the tide are trapped for a duration of 9-12 months such species in Nigeria include bonga (*Ethmalosa fimbriata*), red Snappers (*Lutjanus* sp.), tarpon (*Tarpon atlanticus*), shiny nose (*Polydactylus quodrifilis*), Elops lacerta; Mullets (*Mugil* sp.); Soles (*Cynoglossus* sp.) Pink shrimp(*Penaeus notialis*). Fishing should be made illegal during the fattening period until an appointed time, which coincides with community festival. Such beach lakes could be expanded to include other forms of fish farming.

- Conservation education should be vigorously pursued on the socio-economic benefits of coastal and riverine wetlands. Workshop and seminars should be organized periodically at local government

levels, on the negative impact of man's activities on his natural environment. Continuous destruction of the mangrove forest for various purposes should be discouraged, the importance of coastal wetlands, as breeding and nursery grounds for commercial fish species need to be given greater emphasis, dumping of human and household wastes on the wetlands should be checked by the inhabitants themselves and appropriate penalties for offenders should be introduced and enforced. Fisherman should be fully educated on the destructive nature of poisonous chemicals, castnest with stretched mesh sizes of less than 25 mm and beach seimnet of mesh sizes of 10-20 mm, on the juveniles of shrimps, prawns and fin fish of commercial importance.

- Government legislation is needed for the enforcement of various international convention on biodiversity conservation.

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