Threatened and Endangered Fish species in Nigeria, A Menace to Biodiversity – A Review

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Abstract

Aquatic resources are important living forms that comprise biodiversity. The Nigerian aquatic environments play host to too many native and exotic aquatic resources. This article reviewed the survey of some endangered fish species and value for sustainable development in Nigeria. Studies showed many of the Nigerian fisheries resources are endangered due to habitat degradation, overfishing, and ornamental ventures consequently due to anthropogenic activities. Aquatic resources are important for the environmental sustainability, biodiversity conservation, tourism and human consumption. Fifteen fish families in Nigeria have been listed as being threatened and endangered and this list is on the increase with time as new species are found to be extinct. Commercially important and economically valued food-fish silver catfish, Chrysichthys nigrodigitatus, Heterotis niloticus and Erpetoichthys calabaricus have been reported to be threatened by factors such as destruction of breeding grounds, introduction of exotic species, habitat destruction, over exploitation, migration, water pollution and human activity. Conservation strategies were postulated as habitat restoration, closed season, registration of fishing gear, education and awareness campaign, protected area establishment, security patrol against illegal fishing, artificial breeding and legislation. It is therefore recommended that the government should intensify the awareness efforts on the danger of species extinction, as well as put in place measures towards the protection of endangered species for sustainable development, while researchers should also identify and have a checklist of these species.

Keywords: Aquatic, biodiversity, conservation ecosystem and pollution

INTRODUCTION

Conservation of biological diversity is vital to human survival and well-being, in part because wild species of plants, animals, and other organisms provide people with important products, including food, medicine, and industrial raw materials and the invaluable services they provide include pest control, flood control and the natural recycling of waste (Ekpo Asuquo & Akpabio, 2011). According to Ita (1993), over 230 species of fish have been recorded from Nigerian inland waters. The population of many of these recorded species is on the decline, with some falling under threatened or endangered species (Ayotunde and Ada, 2013). Estimates of the number of fresh and marine water fishes that will become extinct within the next 20-30 years run as high as 300 species (Stiassny, 1981 and 1998); this is why conservation is seen as a priority throughout the world (Ekpo, Asuquo, and Akpabio, 2011; Ayotunde and Ada, 2013). Many factors such as over fishing, water withdrawal, habitat loss and degradation, pollution, introduction of exotic and non-native species can been adduced for this decline. The fish fauna of Africa (Nigeria inclusive), compared to other aquatic organisms, is fairly well known at conventional taxonomic levels. However, the status of these rich biodiversity in terms of conservation has not been extensively studied and documented (Abban, 1999). Much attention or fisheries management and research in Nigeria focuses on species that are important in capture and aquaculture with little or no concern for other coarse species. Meanwhile, fishes have been recognized as the most threatened among all vertebrates worldwide (Bruton, 1995). Thus not much is known about many Nigerian endangered fishes while what is known about the others are found to be hidden in not too accessible grey literatures and student theses. This has hampered our understanding of the biodiversity of inland waters except for large water bodies and those close to higher institutions of learning with research capability. Whereas diversity of community of living aquatic organisms is important for productivity, stability (resistance and resilience) and aesthetics of inland systems (Welcomme, 2001); food, drugs and medicine and cultural beliefs (2005; Khan and Ishaq, 2012; Cunningham & Saigo).

Apart from the work of Teugels, Reid & King, (1992) on the taxonomy, zoogeography, ecology and conservation of the fishes of Cross River basin and fishes consumed as food in some lakes, reservoirs and rivers in Nigeria, there is no country wide assessment of the status of each species of Nigerian fishes to make valid opinion on whether they are endangered or not. It is against this background that a qualitative assessment of Nigerian freshwater fishes as contained in Olaosebikan and Raji (1998) were made using criteria that have been tested by Froese and Torres (1999) analysis of the threatened fishes of the world contained in the 1996 IUCN Red list. This preliminary study was important to raise conservation awareness pending the time a comprehensive nationwide survey can be conducted on our fish resources.

BIODIVERSITY AT A GLANCE

Khan and Ishaq (2012) defined biodiversity as diversity of organisms of the world or the variability among world's living organisms. Three kinds of biodiversity are essential to preserve the ecological systems: (1) genetic biodiversity is a measure of the variety of different versions of the same genes within individual species; (2) species diversity describes the number of different kinds of organisms within individual communities or ecosystems; and (3) ecological diversity assesses the richness and complexity of a biological community, including the number of niches , trophic levels and ecological processes that capture energy, sustain food webs, and recycle minerals within the systems (Cunningham, *et al*., 2005). The estimates of biological life vary from year to year, region to region and decade to another. Ekpo, Asuquo, and Akpabio, (2011) showed that hundreds of thousands of the earth's species have become extinct in the last 50 years because of destroying their natural habitats and excessively depleting their populations. The Niger Delta ecosystems of Nigeria, typically consisting of mangrove swamps and riparian forests, have come under threat in the last six decades as a result of environmental pollution from oil exploration, drilling, refining and transportation (Amaeze and Onyema, 2014) and this is also applicable to fish species. The most serious loss of biological diversity is occurring in the tropics, due to explosive growth of human populations, widespread poverty, growing demand for fuel-wood, competition between species, overexploitation of species, habitat destruction and failure to use sustainable methods in agriculture and forestry (Raven, 2001; Ekpo, Asuquo, and Akpabio, 2011; Ayotunde and Ada 2013) and climate change (Ekpo and Nzegblue, 2012). However, Edwards (1998) gave estimations of total number of species of organisms as shown in Table 1

Table 1: Known and estimated diversity of life on earth in coastal regions

S/N	Forms of life	Known species	Estimated total species
1.	Insects and other arthropods	874,161	30 million insect species, extrapolated from surveys in forest canopy in rainforest region of Nigeria.
2.	Higher plants	248,400	Estimates of total plant species range from 10-15% of all plants are believed undiscovered.
3.	Invertebrates	116,873	True invertebrate species may number in millions, nematodes, eelworms, and roundworms each may comprise more than 1 million species.
4.	Lower plants	73,900	Not available
5.	Micro-organisms	36,600	Not available
6.	Fish	19,056	Estimates that 10 percent of fish remain undiscovered.
7.	Birds	9.040	Known species probably account for 98 percent of all birds.
8.	Reptiles and Amphibians	8,962	Known species of reptiles, amphibian and mammals probably comprise over 95 percent of total diversity.
9.	Mammals	4,000	

Source: Edwards (1998) in Ekpo, Asuquo, and Akpabio, (2011)

CRITERIA USED FOR THREATENED AND ENDANGERED FISH SPCIES CLASSIFICATION

Available evidence shows that biodiversity is being lost at a disturbing rate in Nigeria and the causes of biodiversity loss are largely related human factors (Oladipo *et al.,* 2001). Threatened fish species are the number of species classified by the International Union for Conservation of Nature (IUCN) (1994; Wikipedia) as endangered, vulnerable, rare, indeterminate, out of danger, or insufficiently known species of fish. Based on the checklist of Nigerian freshwater fish (Olaosebikan and Raji, 1998) and biological information (Welman, 1948; Daget, 1954, Daget, Gosse, & Thys, (1984); Reed *et al.,* 1967; Reid and Sydenham, 1979; Teugels *et al.,* 1992; Leveque, Paugy & Teugels, 1991 and 1992), Olaosebikan and Bankole (2005) stated the following criteria and used them to classify fish into threatened and endangered status thus:

(i) When a fish is declared rare, uncommon, occasional in old literatures such as Welman (1948), Daget (1954), Reed *et al*., (1967), Reid and Sydenham (1979), more than 30 years ago, their status now can best be imagined and so is classified as threatened.

(ii) Large, slow growing and late maturing fish; fish like *Arius gigas* belong to this group and has been classified thus by Daget, (1954).

(iii) Fish with special habitat needs. For instance, such fishes like *Garra waterloti*, *Chiloglanis* that requires fast flowing streams and annual fishes like *Nothobranchus* that are found in temporary pools of the arid zone of Nigeria. The statuses of these fish habitat presently are used as basis for classifying them. Since a threat to their habitat is a threat to such fish as well.

(iv) Fishes that depend on the environment for their eggs and larvae development are more susceptible than those that have some degree of parental care.

(v) The human population density of a fish distribution range. Froese and Torres (1999) documented that there is a negative relationship between human population density and percentage of threatened fishes. This is as a result of increased pressure on the nature resources in terms of food, fuel wood, deforestation, urbanization and increase discharge of waste and pollution into the environment.

(vi) A fish that is recently described. Such fishes are usually rare and so were not discovered in the day of scientific explorations of nineteen and early twentieth century. Fishes described in the sixties are considered lowest while those in the nineties are highest on endangered scale. For instance, some aquarium fish like *Aphyosemeon deltaense* in 1976, *Fundulopanchax scheeli* (1970), *F. powelli* in 1994, *Epiplatys biafranus* in 1970, *Nannocharax latifasciatus* in 1989 and *Neolabias powelli* in 1990.

(vii) Fish with restricted distribution that is endemic to a small part of the country or found only in the country e.g. *Dagetichthyes lakdoensis*, a flatfish restricted to upper Benue, *Gobiocichia ethelwyennae* identified from a stream 8km downstream of Manfe on the Cross River, *Procatopus similis* is restricted to Cross Rivers, while *Nothobranchus rubroreticulatus* is found only in Chad basin area but not in the lake.

(viii) Fish important in aquarium trade are also vulnerable to extinction as a result of indiscriminate collection (Daget, 1954).

Any fish belonging to three or more of the above criteria is termed critically endangered (CR), those with two criteria are termed Endangered (EN) while one criterion is termed vulnerable (VU) to being endangered and near threatened (NT). Fish species that are threatened in Nigeria was last measured at 60 in 2013 according to the World Bank (Fig. 1) and are based on Froese and Pauly (2008).

Fig. 1: Fish species threatened in Nigeria in 2013 according to the World Bank records.
(Source: Wikipedia)

Olaosebikan and Bankole (2005) assessed qualitatively the threat status of all Nigerian freshwater fish using such criteria as rarity, size at maturity, mode of reproduction, human population density, habitat degradation, pollution and range of each species among others and observed that the biology of 129 fish (48%) were not well known. Also, Grave *et al*., (2015) reported that two species are extinct with a further 10 possibly extinct, and almost one third of species are either threatened or near threatened. Of the 266 known freshwater fishes, 47 species represented 17% are critically endangered, 15 (5%) are endangered, 8(3%) are vulnerable while 23(8%) are near threatened (Table 2).

Table 2: Nigerian freshwater fish species under threat order and their threat status.

S/N	Fish order	Total number	Number threatened	Number			
				CR	EN	VU	NT
1.	Characiformes	43	11	7	1	1	2
2.	Clupeiformes	6	2	0	1	0	1
3.	Cypriniformes	30	9	7	1	0	1
4.	Cyprinodontiformes	31	25	22	1	0	1
5.	Gonorhynchoriformes	2	2	0	2	0	0
6.	Lepidosireniformes	1	0	0	0	0	0
7.	Mastacembeliformes	5	1	1	0	0	0
8.	Mormyriformes	35	7	3	0	0	4
9.	Osteoglossiformes	4	2	0	2	0	0
10.	Perciformes	47	7	2	0	1	4
11.	Pleuronectiformes	1	1	1	0	0	0
12.	Polypteriformes	5	2	0	1	1	0
13.	Rajiformes	1	1	1	0	0	0
14.	Siluriformes	72	21	4	6	1	10
15.	Tetraodontiformes	2	1	0	0	1	1
	Total	**285**	**92**	**48**	**15**	**5**	**24**

Key: CR = Critical Endangered; EN = Endangered; VU = Vulnerable and NT = Near Threatened
Modified from: Olaosebikan and Bankole (2005)

The summary of statistics in Table 3 indicated the yearly collections of 3351, 1409 and 319 *C. nigrodigitatus* for 2009/2010, 2010/2011, and 2011/2012 respectively and making a total population of 5079 during the sampling period **(**Ayotunde and Ada, 2013). *C. nigrodigitatus* was caught in both dry season (October - March) and wet season (April - September) with the highest in June, 2009 according to (Ayotunde and Ada, 2013), who observed a sharp drop in the monthly landings from 2009 to 2012, indicated by the wide gap between the annual lines on the graph (Fig. 2). This is clear evidence that the species is currently highly endangered.

Table 3: Summary statistical for 3-year monthly silver catfish, *C. nigrodigitatus* landings in Cross River, Nigeria.

S/N	Year	Number of months	Mean	Standard deviation		95% confidence interval
				Lower bound	Upper bound	
1.	2009/10	12	279.25	61.562	240.14	318.36
2.	2010/11	12	117.42	54.957	82.50	152.33
3.	2011/12	12	26.58	14.761	17.20	35.96
Total		**36**	**141.08**	**115.935**	**101.86**	**180.31**

Source: Ayotunde and Ada (2013)

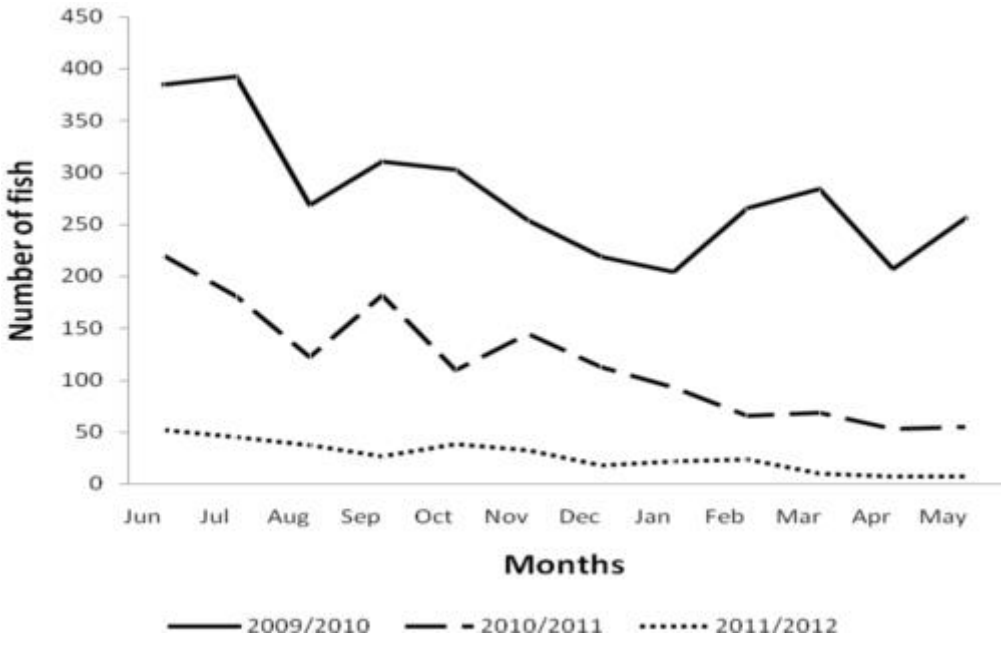

Fig. 2: Population decline status of Silver Catfish in Cross River between June, 2009 and May, 2012 in Cross River State, Nigeria. (Adapted from: Ayotunde and Ade, 2013).

FISH DIVERSITY OF NIGERIA

The fish biodiversity of Nigeria is the richest in West Africa. Surprisingly enough, the basic biology of most of them is not well known. Black-box models that require only limited knowledge of individual commercially important species are still used for making fisheries management decisions (FAO, 1997). Fishes, apart from providing food, medicine and employment are important in recreation such as sport and ornamental fisheries. They are also symbolically, culturally and traditionally significant. Despite their importance economically and socially, fishes have received less attention compared to wildlife and plants. The idea of resilient populations was in many ways made worse by population research techniques which mathematically indicated that the harder a population was fished, the more fishes the system would produce. There were several problems with this. Firstly, the harder a population is fished, the smaller the individuals become. This means fishermen must catch more of them, wiping out any advantage of greater numbers. Secondly, there is a critical level below which the population must not fall; else it will likely be doomed to extinction. Over-fishing, to succeed, depends on total cooperation from commercial interests as well as intimate knowledge of population numbers by scientists. There is awareness tragically, that only rarely will commercial interests cooperate with management measures. Basically, the race is on to scoop

up as many fishes as possible in the shortest period of time. The best scientific techniques will not allow biologists to accurately project populations, or even to accurately determine a current population.

Over-fishing is not the great idea it used to be and without the ability to determine current populations, it becomes impossible to draw the line between sustainable fishing and over-fishing. Even when the line between these is accurately drawn, the whole concept falls apart in the face of catastrophic events. When drought strikes, or a chemical spill, or unseasonable weather, or a failure of a food source, or a disease; fish need the extra numbers in order to buffer the loss to their populations. Without the extra numbers, populations sink below the critical levels. In short, there is a reason for the abundance of animals in a healthy, undamaged environment. Without enough animals, populations can go extinct during even the most minor of the periodic crises that nature provides. Presently, some of the national laws and policies in Nigeria protecting fisheries resources and their environments are not adhered to. Some of the Nigerian fish species under threat by order include: Rajiformes, Lepidosireniformes, Polypteriformes, Mormyriformes, Gonorynchiformes, Characiformes, Cypriniformes, Siluriformes, Cyprinodontiformes, Perciformes, Mastacembeliformes, Pleuronectiformes, Tetraodontiformes, Clupeiformes and Osteoglossiformes (Olaosebikan and Bankole, 2005).

Fishes have been recognized as the most threatened, among all vertebrates worldwide (Bruton, 1995). The present result of critically endangered fishes is similar to that obtained by IUCN (2003). In their report, an estimated 17% of fish species in 20 countries for which assessments were most complete as classified in the IUCN Red List of threatened fishes faced extinction. According to Olaosebikan and Raji (1998), in Rajiformes, the single species (*Dasyatis garouaensis*) in this order found in the freshwater is critically endangered in its range in Nigeria. As a result of the creation of the Kainji and Jebba dams, *D. garouaensis* was now restricted to waters of the Niger River below these dams. In Polypteriformes, *Polypterus bichir* is classified as being at risk because it is found only in Lake Chad while *Erpetoichthys calabaricus* the only species in the genus Erpetoichthys is threatened by human population density, habitat degradation and collection in aquarium trade (Asuquo, 2016; Olaosebikan and Bankole, 2005). Among the Osteoglossiformes, of the four species, two: *Pantodon buchholzi* and *Xenomystus nigri* are endangered and vulnerable respectively. This is due mainly to wild collection for aquarium trade and the impact of high human population density on *Pantodon* distribution range as well as habitat degradation. *Heterotis niloticus* is also endangered amongst this order (Mustapha, 2010). In Mormyriformes, one member is critically endangered and found to be vulnerable. Gonorynchiformes, represented by two species in different families, *Cromeria* is critically endangered and *Phractotemus* is vulnerable. In Characiformes, *Bryconaethiops* is critically endangered. *Arnodichthys, Rhabdalestes brevidotsalis, Alestes macrophthalmus, Brycinus intermedius, lchthyoborus besse, I. monodi, Nannocharax latifasciatus, Nannaethiops, Neolabias axelrodi* and *N. powelli* are all vulnerable (Olaosebikan and Bankole, 2005).

In Cypriniformes, *Garra waterloti* and *G. trewavasae* are endangered while *Leptocypris crossensis, Bboides gracilis, Barbus sylvaticus, B. lauzannei* are vulnerable. For Siluriformes species critically endangered include *Chrysichthys nigrodigitatus*, and *Chrysichthys aluuensis* which was described in 1985 and found in the oil polluted New Calabar and Imo Rivers, *Parauchenoglanis akiri* described in 1987 and restricted to Imo and New Calabar Rivers, *Doumea thysi* described in 1989 and restricted to Cross Rivers, *Arius gigas* (one specimen of this fish was reported caught in September 1972 (Lewis, 1972)) during which a number of juveniles were caught from many parts of Kainji Lake and ever since none has been reported again. This mouth brooding fish grows to a very big size of up to 2m and reaches sexual maturity late. The most probable problem of this fish is that the juveniles are big enough to be caught by fishers before they attain sexual maturity. Fishes vulnerable in this order are *Leptoglannis camerunensis*, a very small fish of 23mm in length, *Pareutropius buffei* collected for aquarium trade, *Amphilius atesuensis* and *Chiloglanis benuensis* restricted to Benue River (Olaosebikan and Raji, 1998).

Oladipo *et al*., (2001) reported that biodiversity losses are due to interaction with the environment for development, improved quality of life resulting from industrialization, technological advancement and rapid growth in urbanization. The indirect causes of biodiversity loss in Nigeria include the following: economic policies, rising demand for forest products, cultural practices, poor law enforcement and weak laws. Factors such as rapid urbanization, increasing human population and trade in forest products have collectively increased the demands for forest products.

Table 3: The threat factors causing the decline of and *Heterotis niloticus* in Oyun Reservoir; Silver catfish, *C. nigrodigitatus* in Cross River, and *E. calabaricus* in Ibikpe creek, Nigeria.

S/N	Threat factor	Fish species		
		H. niloticus	***C. nigrodigitatus***	***E. calabaricus***
1.	Destruction of breeding grounds		+	+
2.	Ethical and aesthetical values	+		+
3.	Habitat destruction		+	+
4.	Intensive breeding and stocking	+		
5.	Capture-release method	+		
6.	Education and awareness	+		
7.	Economic values	+		+
8.	Closed seasons and protected areas	+		
9.	Over exploitation	+	+	+
10.	Migration	+	+	
11.	Improvement of the fisheries	+		
12.	Anthropology		+	+
13.	Legislations and regulations	+		
14.	Eutrophication		+	
15.	Annual migration		+	
16.	Reduced availability/competition for Food	+		
17.	Loss of vegetation and alterations	+		
18.	Low rate of breeding	+	+	+
19.	Poor availability of food		+	+
20.	Human activity	+	+	+
21.	Regulation of fishing nets mesh size	+		
22.	Introduction of exotic species	+	+	
23.	Ecological benefits	+		
24.	Poor water quality		+	
25.	Habitat restoration and enhancement	+		
26.	Water pollution		+	+
27.	Scientific research	+		
28.	Preservation of its genetics	+		

+ indicates affected factor.

Adapted from: Mustapha (2010); Ayotunde and Ade (2013) and Asuquo, (2015).

The declining population densities of fish species were attributed to the interactions of many factors in rivers such as destruction of breeding grounds, habitat destruction, over-exploitation, migration, water pollution, human activity, eutrophication, among others. Table 3 below outlined some of the factors causing threats to *H. niloticus* and *C. nigrodigitatus* in the Oyun Reservoir and Cross River respectively. Also, Grave *et al*., (2015) revealed that threats to freshwater shrimps include agricultural and urban pollution impact over two-thirds of threatened and near threatened species and invasive species and climate change have the greatest overall impact of all threats. Fishing, logging, mining, agriculture and other activities to satisfy our growing appetite for resources are threatening the survival of the aquatic organisms.

MISCONCEIVED ROLE OF HATCHERIES

Hatcheries are a hallowed tradition in the Nigeria. They were at one time considered a brilliant solution to the dietary needs of a burgeoning population of Nigerians. In this system, it didn't matter how many fish were removed from the ecosystem, because they could be replaced by fishes raised in hatcheries.

Today, most hatcheries are concerned solely with breeding commercial fishes only, instead of trying to support failing populations and rescue them from extinction. Hatcheries are such a popular solution today because they require nothing other than more taxes on the general public. Where hatcheries are used, commercial interests don't have to curb urban development, spend money on more expensive construction techniques or mitigation, buy new equipment, decrease fishing, or change methods. Among politicians in Nigeria, hatcheries have become the final solution to the impending extinction of fishes all across Africa. Most biologists now know that hatcheries have been a colossal failure. Rather than supporting populations and rescuing species, hatcheries have assisted in driving them even farther toward extinction. Most fish hatcheries in Nigeria inevitably cause several problems which include:

i. Simplification of the genetic code of a species, a problem that can't be overcome. Only natural breeding in the wild is capable of maintaining a diverse genetic code. Without diverse genetic codes, a species loses its ability to respond to changes in its environment. It is doomed to extinction.
ii. Fishes that are raised in hatcheries lose their fear, and fear is critical to a fish's survival. Without fear, they are too easily captured by predators.
iii. Fishes that are raised in hatcheries don't know the rules once released into the environment. They begin interfering with the wild members of their own species. Often they aggressively participate in the breeding process, yet are unable to breed successfully.
iv. Finally, fishes that are raised in hatcheries are larger and healthier than their wild relatives. They use their size and weight advantage to drive wild fishes away from food sources, shelter, and breeding opportunities. In effect, the fish most likely to survive becomes the most genetically inferior one.

This has all been a well-kept secret for several reasons. Commercial interests fear they will find their plans for the future hampered. Politicians are being heavily lobbied by everyone but the fish. And government agencies charged with protecting fishes are only too painfully aware that they have no alternatives left to them. Environmental laws are in place to deal with many of the problems of endangered species. However, these laws are easily circumvented with the use of measures that have given false hope, like mitigation and hatcheries. And they are circumvented wherever politicians decide that the endangered species are "threatening" human survival. This is not to say that the humans are endangered, but that their continued ability to build new housing developments and roads, or enjoy continued abundance of sport-fishing opportunities and fresh water in desert areas is threatened.

ENDANGERED SPECIES

In any over-exploited fish population the fishery always disappears before the species (Moses, 1990). *Protopterus annectens* (Polypteridae) and *Xenomystus nigri* (Notopteridae) were reported in Ikpa River but in recent studies (Ekpo, 2012a, 2012b, 2013a; Udo 2012), they were not found. Species extinction is generally associated with habitat modification, perturbation and destruction. King and Jonathan (2003) reported that some common anthropogenic perturbations of aquatic systems include alterations in ecohydrological regime, habitat area, habitat quality, water quality, substrate quality and biotic interactions and energy source. Additionally, the authors showed that the introduction of exotic biota by man could perturb the ecological integrity of aquatic ecosystems, as the alien species may often replace the indigenous species.

HABITAT DEGRADATION AND OVER FISHING

Many of these fishes are declining in abundance as a result of over fishing, dam construction, loss of catchments, habitat disruption and destruction as well as industrial and agricultural pollution. Habitat degradation and destruction through human activities have often been the underlying factor responsible for the decline and extinction of freshwater fish species rather than direct overexploitation (Maitland and

Morgan, 1997) Most of the fish species from Niger Delta are in one way or the other threatened by pollution. The mangrove of the Niger Delta (7,292km^2) is the least studied in the world (Wilcox and Powell, 1985). It is even adjudged to be the largest mangrove stand in Africa (Kinako, 1977). The mangrove swamp and the freshwater swamp forests of the coastal region of Nigeria are estimated at 28,000km^2 (Edwards, 1986). These ecosystems have been seriously impacted by human activities in the past twenty-five years. There are more than 320 species of species found in Nigeria; of these many occur in the mangrove swamps and freshwater forests of the south. Some are endemic to the Delta and include: *Aphyosernion deltaense, Fundulopanchax sjoestedti, F. amoldi, F. filamentosum, Epiplatys biafranus, E. longiventralis, Micropanchax scheeli* and *Foerschichthys nigeriensis.*

Ekpo and Essien-Ibok (2013) listed over exploitation of mangrove forest leading to invasion of nipa palm (*Nypa fruticans*) which is not favourable for fishing breeding as one of the challenges facing artisanal fisheries development in Akwa Ibom State, Nigeria. Etim (2010) attributed over exploitation to invention and increased sophistication of fishing gear and craft such as steam trawlers, factory trawlers, and the technical developments such as the invention of the hydraulic winches, inboard refrigeration, and acoustic fish finders which came with the reality of man's ability to overexploit and deplete the water resources. In any over-exploited fish population the fishery always disappears before the species (Moses, 1990). *Protopterus annectens* (Polypteridae) and *Xenomystus nigri* (Notopteridae) were reported in Ikpa River but in recent studies (Ekpo 2012a, 2012b, 2013a, Udo 2012 and Ekpo and Essien-Ibok, 2013), they were not found. Species extinction is generally associated with habitat modification, perturbation and destruction. King and Jonathan (2003) reported that some common anthropogenic perturbations of aquatic systems include alterations in ecohydrological regime, habitat area, habitat quality, water quality, substrate quality and biotic interactions and energy source. Additionally, the authors showed that the introduction of exotic biota by man could perturb the ecological integrity of aquatic ecosystems, as the alien species may often replace the indigenous species.

In Nigeria, the threat of oil pollution started in the 70s when between 1972 and 1980, 836 oil spill incidents were recorded already resulting in 1,405,406 barrels of oil polluting the environment. Between January and May 1981 alone, 121 spills were recorded (Awobajo, 1981). Within twenty three years the rate of oil spillage has assumed an alarming proportion as a result of increase in oil exploration, illegal bunkering, vandalization and ethnic unrest in the Niger Delta. Presently, it is impossible to keep record of the spills except for large scale ones that are publicized in the newspapers. To worsen the problem very little ecological impact assessments are conducted when spillage occurs, most work are either sponsored by the affected communities or the oil company involved in order to get or give compensation as the case may be. Such reports are either distorted to favor those concerned or in most cases classified as secret, thus becoming inaccessible to scientific scrutiny. One of the few studies that were done in depth is the Oshika spill of 1983. It was reported that only fish with air breathing organs were found seven months after the spillage while non-air-breathers that did not survive include; *Hemichromis*, *Thysochromis*, mormyrids, *Hepsetus, Alestes, Neolabias*, several cyprinodonts and *Polycentropsis* (Powell, 1986).

It is known that crude oil contain toxic compounds like aromatic and naphtheno-aromatic hydrocarbons while those that are not toxic form films on the water surface, on soil and the body of the plants and animals. This results in serious asphyxiation and for such soil spawners like the *Fundulo panchax*, implying mass mortality for both the eggs that have been deposited in the substratum and the spawners. This definitely leads to reduce recruitment when there are survivors or total extermination of the species in such habitat. Surprisingly, the 1996, IUCN Red list of endangered species does not include any Nigerian Freshwater species, one wonders if none of them is on the verge of extinction considering the rate of habitat degradation as a result of increase in human activities, population and poverty in the past 30 years of oil boom and doom. Helfrich and Neves (2009) agreed that many factors contribute to the loss of fish species and the degradation of their habitat; some of which include: dams and impoundments, water pollution, especially spills of toxic wastes (i.e. oil and petroleum products, industrial acids, pesticides, and

fertilizers), sedimentation from agriculture, construction, and logging and mining, introduction of exotic species and overfishing. The threat of ornamental fish trade cannot be quantified presently in Nigeria, though the role of wild collection of aquarium fishes to extinction in wild is common knowledge in other countries. An example is the golden dragon (*Scleropagus formosas*), which under CITES the trade, and export of it is restricted to few licensed farmer to forestall wild collection (Bertley, 2000). Thailand and in Africa, Nigeria are predominant exporters of ornamental fish to Europe and America, a situation that is indicative of the threat. For most of these fish being harvested, their status in the wild in term of stock structure and life histories are not well known.

In Nigeria with some fish still being described as recent as 1994 and with the level of conservation effort, it seems probable that some fish may become extinct before being described at all. This is buttressed by Froese and Torres (1998) during study of 1996 IUCN Red List which showed that there is a steady increase in the percentage of threatened fishes in relation to their year of description. According to their findings, of all fish described before 1800, 31 are threatened while of those described after 1950, 246 are threatened. This led to Froese and Torres (1998) observation that conservation measures need to be based on sound knowledge of the species in question. Only 11% of the threatened dependent fishes in the IUCN Red list are protected, indicating a lack of recognition of the problem by national governments and fishery managers (Froese and Torres, 1998). Nigeria needs to put in place an Endangered Species Act that will include fishes and other aquatic organisms as obtainable for the wildlife species, identify critical sites for the conservation as well as determine key threatening processes.

Reserves, parks sanctuaries and other types of protected areas may be used for wide variety of objectives, including nature conservation, recreation or sustainable use (IUCN, 1994). Globally, the principle of establishing aquatic reserves for fish has been reinforced by the convention on Biological Diversity and by Ramsar's decision that the conservation of fish species alone is sufficient to justify the setting up of a Ramsar site (Welcomme, 2001). Traditionally conservation measures such as prohibition of fishing in designated water bodies or portion of it for traditional or religious values should be identified, scientifically studied and put into heritage sites. Breeding grounds of fishes should be identified and designated as conservation reserves or sanctuaries. Specific man-made biotopes can be constructed for the annual fishes (e.g. *Nothobranchus and Pronothobranchus*) in the Lake Chad National Park and other arid wetland areas for the conservation of these fishes,

Public awareness has been recognized as an important tool for mobilizing popular opinion, generating and sustaining appropriate action, political and funding support within and globally (Raymond, 1999). According to Robinson (1995), public awareness and education are critical for promoting sustainable development and improving the capacity of the people to address environmental and developmental issues. United Nations Conference on Environment (UNCED) in Agenda 21, UNESCO, Convention on Biodiversity (CBD) Article 13, did recognized the importance of public awareness in conservation and protection of the environment. In Nigeria, such public awareness can include the establishment of public aquaria and there is need to identify specific conservation objectives. These can be sold to national and state policy makers to provide moral action at the state and national levels, gain media interest enlist the support of Non-governmental Organization such as Nigeria Conservation Foundation (NCF). Presently it only concerns itself with wildlife and forest conservation.

The Nigerian government should be encouraged to ratify the Code of Conduct for Responsible Fisheries (FAO, 1995). The FAO Code of Conduct for Responsible Fisheries was produced in response to global concern over the clear signs of over-exploitation of fish stocks throughout the world and to recommend new approaches to fisheries management which included conservation, environmental, social and economic considerations. There is substantial work to be done in Nigeria regarding the conservation of inland freshwater, marine and brackish water fish resources. These include establishing the status of each species in a geographical area, identifying the conservation needs of the endangered ones and implementing

appropriate measures of protection as soon as possible. The protection of aquatic habitats of major importance must be regarded as the prime long-term objective of any conservation programme. There is also an urgent need for a national fish survey to assess the current status of fish species diversity.

MITIGATION

Mitigation is a popular strategy for managing endangered fish populations. It is a process of trying to replace something that has been lost. When a commercial interest plans to destroy an environment, for example to drain a marsh, build a dam, or build close enough to a water body that its health will be endangered, environmental protection agencies are called in to evaluate the situation and use federal and state law to assist endangered species. Mitigation has been presented in these laws as a viable solution to any kind of development. Therefore, in only rare cases is a commercial interest required to modify its plans in any way, and almost never to cancel them. Instead, it spends money on mitigation. For example, a company may drain and pave over a marsh that served as habitat for endangered species and a resting stop for migrating birds, and replace it with an artificial pond ten miles away. In reality, even when such effort and expense is made that the new artificial environment looks just like the old to an inexperienced eye; it is nevertheless a sterile, lifeless environment that will be incapable of supporting the wildlife of the environment that it replaces for many decades or even centuries. Mitigation as a concept was written into environmental laws in an effort to provide flexibility in cases where human interests simply had to prevail. Thus, even in worst-case scenarios, the environment might find some small benefit. It was a good idea at the time. But mitigation has since become a cheap, convenient way for companies to buy their way out of having to consider protected species as they proceed with their construction and operations. In essence, "human interests that must prevail" has come to mean anything from which humans might profit. Ayotunde and Ada (2013) recommended some important conservation efforts to include stocking of the species, habitat restoration, capture-release mechanism, control of invasive species, fishing legislations and regulations, and public awareness and education (Table 4).

Table 4: Strategies for conserving silver catfish, *C. nigrodigitatus* in Cross River State, Nigeria

S/N	Strategy	Scale of application
1.	Habitat restoration	+
2.	Closed season	+
3.	Registration of fishing gear (equipment)	+
4.	Education and awareness campaign	+++
5.	Protected area establishment	+
6.	Security patrol against illegal fishing	+
7.	Prohibition of introduction of exotic species	+
8.	Capture and release method	+
9.	Law and regulation	+++
10.	Artificial breeding	+
11.	Market control	+++
12.	Legislation	+

Note: + = Applicable; ++ = Most Applicable; +++ = Best applicable

Source: Adapted from: Ayotunde and Ade, 2013

LAWS UNDER ATTACK

Another technique that commercial interests have become adept in using is repeated attempts to de-list, down-list, or prevent listing of certain fish species. For a species to be protected under Federal and State environmental laws, it must be formally "listed" as a protected species. It typically enters a list under categories such as "endangered," "threatened," or "species of concern." If a company can force a species

further down on the list in priority, or prevent its move upward in the list, it can avoid complying with laws meant to protect that species. Companies (and cities) typically hire teams of biologists whose mission is to try to disprove what government biologists say as they try to uphold environmental laws. Besides attempts to change listing status, companies also use these biologists to attempt to prove that protected species won't be harmed by their activities. This strategy is questionable at best. In hiring scientists to say what they want them to say, companies ensure the breakdown of correct, objective scientific procedure.

THE NEED TO CONSERVE FISH DIVERSITY

Owing to the significance of biodiversity to both humans and the nature in terms of its contributions to agriculture, medicine, industries, research, etc, Ekpo, Asuquo, and Akpabio, (2011) revealed that there are several approaches to conserving species and biological diversity including fish:

i. Protecting species of recognized value or those known to be in danger of extinction, through provisions such as the U.S. Endangered Species Act, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and the International Whaling Convention.

ii. The so- called Noah's Ark strategy, in which part of an organism, such as its seed or semen, is stored off-site in a gene bank; or in which whole organisms are kept off-site in a zoo, aquarium, botanical garden, or plantation.

iii. The establishment of biological reserves that preserve genetic diversity on-site by protecting entire ecosystem. This approach conserves not only those species that elicit public concern, but also the less conspicuous plants, animals and microorganisms on which those popular species depend. Protected areas can provide benefits such as control of soil erosion and maintenance of air and water quality. At the same time, they serve as scientific repositories for study and as natural sources of the germ plasm that contains each species' hereditary.

CONCLUSION

Favorite species of fish which are loved by majority of the people cutting across cultures and traditions have been tagged as being threatened and endangered. The list varies from one part of the nation to another and from one water body to another. There is loss of much diversity of fish in Nigerian aquatic systems ranging from fresh to marine waters. Olaosebikan and Bankole (2005) suggested increased basic knowledge of threatened species and conservation policy along three lines public awareness, legislation and creation of national parks, aquaria and reserves as measures needed to ensure the conservation of the fishes.

RECOMMENDATIONS

This review recommends that:

- When government laws and policies fail to protect our water bodies, by educating the people, their actions would ensure that water ways are not further damaged.
- Pressure should be mounted on government agencies and politicians by writing and calling them, and voting only for those who show commitment to saving water bodies and biodiversity.
- Destructive commercial practices should be discouraged.
- Individuals would form and be members of "Adopt-a-stream" groups that are present in most foreign states.
- Programs to clean up trash and plant riparian vegetation should be developed.
- Individuals could volunteer to monitor streams and other water bodies and providing local environmental agencies with the data they need to do their jobs.
- Individuals and communities would familiarise with the government agencies trying to protect our resources, and offer them help and support.

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