# UNIVERSITY OF ILORIN

THE ONE HUNDRED AND TWENTY-EIGHTH (128TH)
INAUGURAL LECTURE

# "DWINDLING FISH STOCKS: AQUACULTURE AND SUSTAINABLE FOOD SECURITY"

By

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**Thursday, 11th April, 2013**

**This 128th Inaugural Lecture was delivered under the Chairmanship of**

**The Vice-Chancellor,**
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# Marine fishes

Cod.*Gadus morhua*

Fillet

Scombridae

Snapper (Lutjanidae)

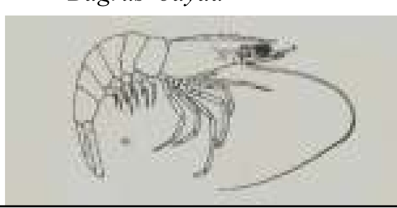
Grouper (Serranidae)

*Caranx* sp,Carangidae (Jack Mackerel)

## FRESH WATER FISHES

*Lates niloticus*

*Bagrus bayad*



Shrimp (Penaeidae)

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Members of Administrative and Technical staff,
My Lords Spiritual and Temporal,
Members of my Family, Nuclear and Extended,
Distinguished Invited Guests,
Gentlemen of the Print and Electronic Media,
Great University of Ilorin Students,
Ladies and Gentlemen

## 1. Some Background Comments

I am naturally delighted and grateful to Almighty God and my savior the Lord Jesus Christ to whom I give the glory, for keeping me by his grace to live till today, to present this inaugural lecture. Mr. Vice- Chancellor Sir, It is with great pleasure that I present the 128th inaugural lecture of the University of Ilorin.

After my National Youth Service Corp (N.Y.S.C.) I was appointed a Graduate Assistant at Imo State

University. I had to proceed for my postgraduate training after one year and my Dean Prof. F.N.C. Osuji then observed that there was no trained lecturer in Hydrobiology and Fisheries at Imo State University. He encouraged me to consider this field of study. I therefore decided to pursue a career in Hydrobiology and Fisheries and that choice produced the inaugural lecturer of today.

I later joined the erstwhile Department of Biological Sciences of the University of Ilorin, Ilorin under the Headship of Prof. S. O. Oduleye. The Department comprised of Microbiology, Botany and Zoology units, it was indeed a big Department running three degree programmes. In 2004, the Department was split into three Departments and I rightly belong to the Department of Zoology.

Today's inaugural lecture is the first in the Department of Zoology, the third by a Zoologist at the University of Ilorin, the first two haven been given by Late Prof. V.L. Yoloye and Prof. S.O. Oduleye in the former Department of Biological Sciences of the University of Ilorin. The humble lady standing before this esteemed audience is the First female Professor in the Department of Zoology and this is the first inaugural lecture in Hydrobiology and Fisheries, a field of study in Zoology.

## 1.1 Introduction

Fish and fishery products represent a very valuable source of protein and essential micronutrients for balanced nutrition and good health. It provides fishmeal for poultry and other animals. Fish is important for food and nutrition security. It is a preferred item in the diets of many, especially the underprivileged because it costs much less in comparison to its food value. Fish is an important source of quality lipids, but more of essential fatty acids: omega- 3 and omega- 6.Table 1 shows Carp, Cod, Salmon and Mackerel and their essential fatty acids content.

**Table.1. Essential fats in some food fishes.**

g per 100 g; * mg per 100 g

| Species | Total | Saturated | Mono-unsaturated | Poly-unsaturated | Omega-3 | Omega-6 | Cholesterol * |
|---|---|---|---|---|---|---|---|
| Carp | 5.5 | 1.1 | 2.3 | 1.4 | 0.7 | 0.5 | 66 |
| Eel | 12 | 2.4 | 7.2 | 0.9 | 0.7 | 0.2 | 126 |
| Salmon | 6 | 1.0 | 2.1 | 2.5 | 2.0 | 0.2 | 55 |
| Flounder | 1 | 0.3 | 0.2 | 0.3 | 0.2 | 0.008 | 448 |
| Cod | 1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.008 | 43 |
| Grouper | 1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.01 | 37 |
| Herring | 9 | 2.0 | 3.7 | 2.1 | 1.7 | 0.1 | 60 |
| Tuna | 5 | 1.3 | 1.6 | 1.4 | 1.3 | 0.05 | 38 |
| Mackerel | 14 | 3.3 | 5.5 | 3.3 | 2.7 | 0.2 | 70 |
| Shark | 5 | 0.9 | 1.8 | 1.2 | 1.0 | 0.08 | 51 |
| | | | | | | | |
| Meat | 3 | 2.0 | 0.8 | 0.1 | Tr | | |
| | | | | | | | |
| Milk | 10 | 4.5 | 4.5 | 0.5 | 0.06 | | |

Source: Beveridge et al (2012).

Not only is fish vital for food, it is also a source of work and money for millions of people around the globe. In 2009, fish accounted for16.6 percent of the world population's intake of animal protein. Globally, fish provides about 3.0 billion people with almost 20 percent of their intake of animal protein. Differences among developed and developing countries are apparent in the contribution of fish to animal protein intake (FAO2011). Ocean fisheries and aquaculture alone support some 250million livelihoods around the world and produce seafood with a first sale value of more than US$190billion(FAO, 2011).Importantly, the recent scandal of suppliers in Europe fraudulently substituting beef with horse meat which was only detected through meticulous DNA testing cannot be encountered by fish eaters.

The study of fish is called Ichthyology. Pisces also called fishes are poikilotherms, typical with backbones, gill- breathing and equipped with fins and are primarily aquatic (oceans, rivers, lakes and swamps)

Teleost has about 20,000 species and they are the most diverse group of vertebrates living today and they form the commonly encountered ordinary fishes in both the marine and freshwater habitats.

The oceans, lakes and rivers constitute enormous volume of water in the biosphere. The overwhelming volume of water in the biosphere, the diversity of fish species and the population of the world then, made the early fathers of fisheries like Thomas Huxley, state that, fish have enough space to grow, mature and reproduce and nothing could seriously affect the number of fish in the water.

## 2.0 Biblical mention of fish.

Luke5:2-7At the lake of Gennesaret, Jesus saw fishermen washing their nets. Verse 4 Simon, launch out into the deep, and let down your nets for a draught. In verse 6, they obeyed the instruction of our Lord Jesus Christ and they enclosed a large multitude of fishes and they beckoned unto others and they came and helped them to drag their net and they filled both ships with fishes.

Matthew 17 :24- 27 Jesus was in Capernaum and was asked to pay tribute , he asked Peter to go to the sea and cast a hook and take the fish that first cometh up and when he has opened the mouth, he shall find money, he should take the money to pay the tribute.

Fishes do not feed on money, what deposited money in the mouth of the fish which our Lord Jesus used to pay his tribute? Someone can catch a big fish that can generate fund and turn your fortunes around. In Japan a Blue Tuna that weighed 222kg and sold for 270million naira equivalent was caught. This has generated a lot of fund for the fishermen Fig.2

Fig.2: Big Tuna Fish that weighed 222kg. Source AFP.

## 3.0 Lessons from History

The early fathers of fisheries predicted that fish stock was inexhaustible. Thomas Huxley 1886 stated and I quote…"I believe, then, that the cod fishery, the herring fishery, the pilchard fishery, the mackerel fishery, and probably all the great sea fisheries, are inexhaustible; that is to say, that nothing we do seriously affects the number of the fish. And any attempt to regulate these fisheries seems consequently, from the nature of the case, to be useless."Fig.3 shows Thomas Huxley.

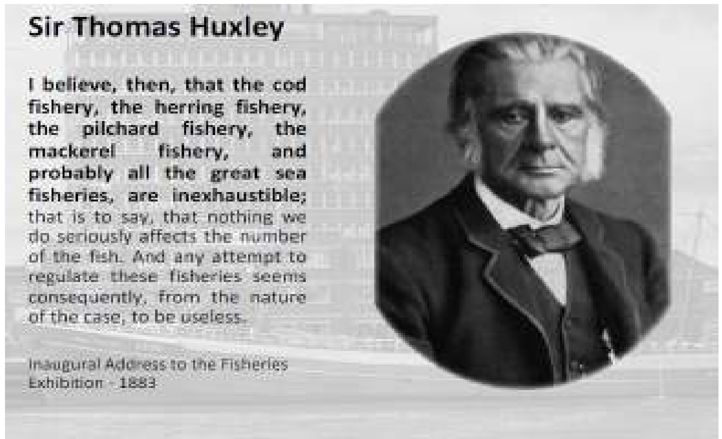



Fig.3: Thomas Huxley .Source: Mitchell (2012).

According to the FAO, a fishery is typically defined in terms of the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, and purpose of the activities or a combination of the foregoing features".


Fig 4: Ship that was powered by sails. Source: Mitchell (2012).

During this era ships were made of wood and powered by sails as shown in Fig 4.

Fishing was in the coastal water, they could not fish in the open ocean and the fishermen used charts to find their route on the seas. The technology of fisheries then was behind other technologies of the time. However the technology available then provided sufficient fish for the population. Also the fishing methods allowed the fishes to attain maturity, reproduce, and rebuild the fishes that have been caught. Most of the catch then comprised of big fish as shown in fig.5.

Fig 5: A big fish. Source: Mitchell (2012).

**4.0 Divisions of Fisheries**

A fishery may involve the capture of wild fish or raising fish through fish farming or aquaculture.

Capture fisheries can be broadly classified as recreational, artisanal and industrial/Commercial.

Traditionally 90% of the worldwide annual commercial ocean catch come from coastal waters, within 200 nautical miles of the coastline, but while these narrow coastal fringes are both the most productive they are also the most vulnerable to overfishing. According to FAO (2010) there are approximately 40,000 vessels weighing greater than 100 tons in the world's commercial fishing fleet.

**Table.2.Some of the fishing methods used in commercial fisheries.**

| Method | Description |
|---|---|
| Long-Lines | Long –lining is one of the widespread passive fishing methods. Ships unreel lines with hundreds of thousands of baited hooks. The hooks are baited automatically and many thousands are set each day. The setting and retrieving of hooks is a 24-hour operation. |
| Purse Seines | A purse seine is used to catch tuna and other school fish species. Again it is very efficient, with a large net being set around a school of fish that are close to the surface. The net is then pursed; closing the bottom trapping hundreds of tuna in the net .This fishing method is active. |
| Gill Nets | Gill nets are passive gears which are weighted at the bottom and held upright by floats at the top. Fish are unable to see the netting, and unless the mesh size is larger than the fish, they get stuck. When they try to back out, the netting catches them by their gills or fins. |

| | |
|---|---|
| Trawling | It is a method of fishing that involves actively dragging or pulling fishing nets(trawl) through the water behind one or more trawlers. |
| Bottom Trawlers | Bottom trawlers target species such as cod, and haddock. Enormous bag- shaped fishing nets are pulled along the bottom of the ocean, catching every fish in their paths. Large metal plates at each end of the net drag along the ground, keeping the net close to the ocean floor while stirring up sediment and forcing all the animals in the net's path into the closed end. Bottom trawling literally scrapes the ocean floor clean of life and is considered by some to be the underwater equivalent of clear-cutting forests. Fig.7 Some observers describe this as equivalent of cutting trees in a tropical rainforest and reducing or totally destructing the environment. |
| Mid-water Trawlers | This is used in catching pelagic fishes. The Germans were the first to use mid-water trawlers to catch school of fish. It allowed the vessel to tow its net at any depth. |
| Stern trawlers | Trawls which are deployed and retrieved from the stern can stay at sea for weeks at a time. They have a ramp. They pull a fishing trawl net behind them and pull the catch up a stern ramp. They have onboard processing facilities and can also operate in pairs. |

Fig.7 A modern Trawler. The heart of the Technology leading to overfishing..Source FAO (2008).

## 5.0 Technology in Commercial Fishing of the Twentieth Century that Contributed to Overfishing

White (2012) documented the technology that changed fishing as follows: The technological developments in commercial fishing in the twentieth century (primarily post WWI) revolutionized fishing worldwide. Prior to the twentieth century, it was almost impossible to overfish a large area beyond the coast. Indeed, most overfishing was confined to large mammals that were easy to target because they needed to come up for air. The World Wars revolutionized commercial fishing- they resulted in many new technologies as well as ships that could exploit fisheries in a vastly more efficient manner. The twentieth century was the first time humans have been able to effectively target the open ocean. For example, the Bluefin Tuna in the Mediterranean "declined by 63%" from 1985 to 2005.That drop is indicative of the increased pressure on tuna stocks as well as fish stocks around the world.

Just as interesting as the actual impacts on fish stocks are the technologies themselves. Freezers, sonar, Global Positioning Systems (GPS), larger boats, increased horsepower, hydraulic winches, spotter planes, and new net materials have made it possible for fishermen to successfully target fish in previously inaccessible locations.

Table.3. Technology and their uses in fishing.

| Technology | Use in commercial fishing |
|---|---|
| Modern vessels | Modern ships are massive and capable of staying at sea for months at a time while also keeping their catch fresh. After steam, diesel powered ships were introduced |
| Net materials | Net materials have steadily advanced making nets both more durable, capable of going deeper and less visible. A major innovation is lighter nets made of Dyneema fibers. By virtue of their light-weight, Dyneema nets save a lot of fuel. Longlines have been used for centuries to precisely target predatory fish are longer and more effective than ever. |
| Hydraulic winches. | This is a mechanized hauling device used in modern trawlers, Without new winches, it would have been impossible for humans to winch up nets and longlines that sometimes held tons of fish. |
| Global Positioning Systems (GPS) technology | GPS technology also enabled fishermen to retrace their paths, back to a productive spot or back along a key edge or productive trawl line. Additionally, new technology has allowed fishermen to track the actual location of nets being dragged thousands of feet behind a boat |
| Satellite technology | It has allowed mapping of the entire seafloor and to track certain surface conditions that are indicative |

| | |
|---|---|
| | of fish. "Near-real-time imagery of ocean temperature is used by tuna longline fleets to identify temperature fronts associated with high catch rates of tuna. Similarly, ocean colour may be used to monitor the movement of water bodies and to map the primary productivity of the ocean surface. |
| Airplanes | "patches" of tuna or dolphins are sighted by spotter planes and then followed by ships or surrounded by purse seines. Additionally, airplanes transport fish that is actually fresh to market from far distant locations. |
| Freezing systems | The most important fishing technology of the twentieth century was advanced freezing systems. Today, "snap-freezers" are used to freeze fish "so rapidly that the moisture in their bodies does not crystallize … [so the flesh does not] become mushy when it is thawed." Snap-freezing or "blast-freezing," which was common by the mid-nineteen eighties, "rapidly freezes … [fish] … to -40 C." |

All these technologies combined at a time when the world was increasingly hungry for protein and population was rapidly growing. In fact, individual governments, mostly in Europe, began extending bounties and inducements to their fishermen to further exploit their own waters and foreign waters, particularly the Grand Banks and others off Canada. The Soviets actually built a government sponsored fleet of factory trawlers and "approached fishing as they might a military campaign." Fig. 8a shows catch from commercial fishing.

Figs.8a: Catch from commercial fishing indicating overfishing.

Fig 8b: Skeleton of Cod, *Gadus morhua* imported into Nigeria.

Mr. Vice-Chancellor Sir, The three drivers of overfishing are:

- Improving Technologies- continually increasing our capacity to catch fish.
- Commerce – driving technology and increasing catch capacity for business growth.
- Societal dependency- creating political tension between conservation and the socio-economic impacts of precautionary management.
  (Mitchell, 2012).

Fig.9 shows the status of the marine fisheries. Most of the fish stocks have been overexploited.

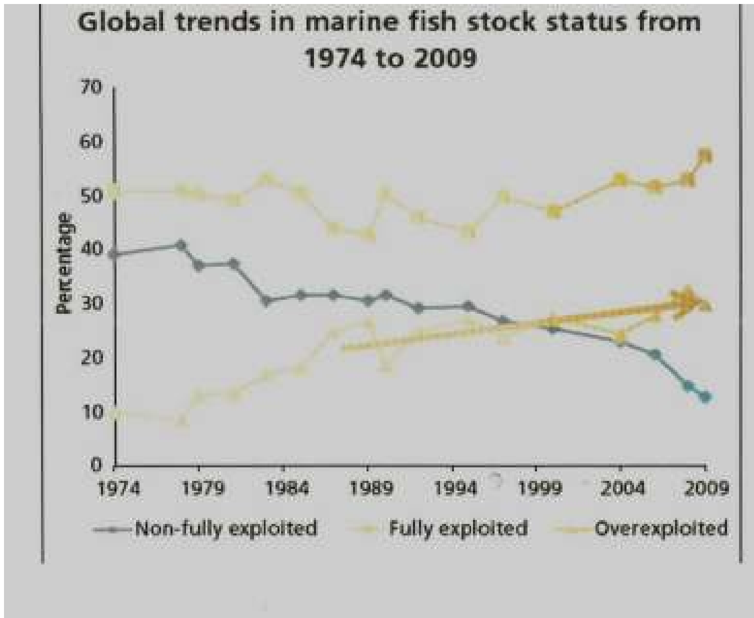



Fig.9: The status of the marine fisheries. Source: Hilborn (2012).

## 6.0 **The forecast of Doom**

Worm et al (2006) stated that all fish will be gone in the year 2048.Worm et al (2006) statement was based on the study carried out on some of the world's oceans. Exploitation of the ocean for fish and marine invertebrates, both wholesome and valuable products, ought to be a prosperous sector, given that capture fisheries—in contrast to agriculture and aquaculture reap harvest that did not need to be sown. Yet marine fisheries are in a global crisis, mainly due to open access policies. Landing from global fisheries have shifted in the last 45 years from large piscivorus fishes toward smaller invertebrates and planktivorous fishes, especially in the Northern Hemisphere.

Industrialized fisheries reduced community biomass by 80% within 15 years of exploitation and 90% of large predatory fishes have been lost and there is need to consider ecosystem effect of removing 90% of large predators (Meyer and Worm 2003). Pauly et al 1998 demonstrated that in both marine and inland waters, the trend was that of decline in trophic levels of the fisheries landings. Pauly et al (1998) observed that this may imply major changes in the structure of the marine food webs, individuals within species are being targeted and depleted. The effect is increasing landing of small fishes. This situation has generated the phenomenon now widely known as “fishing down marine food web’ (Pauly et al 1998). Reducing fish biomass to low levels may compromise the sustainability of fishing, and support only relatively low economic yields. With the exponential increases in population growth and economic activity that occurred over the last half century, the status of the ocean is changing at a rate and scale not seen since the rise of modern civilization. Worm et al (2006) made a prophetic statement that with this indiscriminate fishing trend all fish will be gone by the year 2048 implied that there will be little or no fish for the consumers.

In Britain, there are fish and chip shops. In Nigeria, we have the pepper soup restaurants where individuals go to relish fresh fish. If the prophets of doom are correct then people whose businesses and source of income are attached to fish must be concerned about remaining in business and their source of livelihood.

The declining global marine catch over the last few years together with the increased percentage of overexploited fish stocks and the decreased proportion of non-fully exploited species around the world convey the strong message that the state of world marine fisheries is worsening and has had a negative impact on fishery production. Overexploitation not only causes negative ecological consequences, but it also reduces fish production, which further leads to negative social and economic consequences.

Fish stocks were inevitably overexploited before effective management was initiated (Hilborn, 2012).

## 7.0 The Pillagers of the Environment

Nigeria loses about $60 million annually through illegal fishing in its territorial waters. In reverse, the nation is importing over $200 million worth of seafood products annually to supplement local production (The Nation- 5th December 2011). Fish stocks in Nigeria and other African coasts are depleting rapidly, no thanks to the presence of illegal industrial fishing boats that are raking in large quantities of fish for export. Illegal fishing costs African countries over $1 billion yearly (The Nation- 5th December 2011).

About 90 per cent of fish consumed by Nigerians is imported. Illegal, unreported and unregulated (IUU) fishing and related activities (often encouraged by corrupt practices) threaten efforts to secure long-term sustainable fisheries and promote healthier and more robust ecosystems. Developing countries, often with limited technical capacity, bear the brunt of this IUU fishing, which undermines their limited efforts to manage fisheries, denies them revenue and adversely affects their attempts to promote food security, eradicate poverty and achieve sustainable livelihoods.

West Africa is recognized as one of the world's richest fisheries grounds teeming with snapper, grouper, sardines, mackerel and shrimp lose over $1 billion worth of fish each year to vessels fishing in the protected zones or without proper equipment or licences. Widespread corruption and continuing lack of resources for enforcement mean huge foreign trawlers often venture into areas near the coast that are reserved exclusively for artisanal fishermen, allowing them to drag off tonnes of catch and putting at risk the livelihood of millions of local fishermen.Fig.10 shows the pillagers of the environment.

.


Fig.10: Pillager of the Aquatic Environment. Source: Hilborn (2012).

## 8.0 Inland fisheries of Nigeria

The inland water in Nigeria is estimated to cover a surface area of 149,919km$^2$and some of the lakes and rivers include:-Lake Chad, Jebba/Lokoja rivers, Cross river, Imo, Ogun and Osun rivers. Some fish species in Nigerian inland water bodies that are commercially important include: *Lates niloticus, Heterotis niloticus* and *Mormyrus rume.*

Table 4: Some commercially important freshwater fish species

| Family | common name | Species |
|---|---|---|
| Centropomidae | Niger perch | *Lates niloticus* |
| Osteoglossidae | African bony tongue | *Heterotis niloticus* |
| Gymnarchidae | Trunk fish | *Gymarchus niloticus* |
| Bagridae | Catfish | *Bagrus bayad* |
| Cichlidae | Tilapia | *Oreochromis niloticus* |
| Mormyridae | Elephant-snout fish | *Mormyrus rume* |

## 9.0 Marine Fisheries in Nigeria.

The limits of Nigeria's territorial waters and exclusive economic zone (EEZ) are 12 nautical miles (nm) and 200 nm respectively. Currently the Nigerian fishing industry is facing many challenges and these are: over fishing of the coastal resources; declining catch, both in quantity and especially in quality; environmental degradation seriously impeding the productivity of the artisanal sector; and declining efficiency due to lack of technical innovation.

The report of FAO(2007)indicated that the fish trawlers landings have demonstrated the degrading status of the stocks. The landings are dominated by juveniles of the most common species, while certain prized species have virtually disappeared. Some of the commercially important marine fishes are shown in Table5.

Table 5: Some of the commercially important marine fishes

| Family | Common name | Species |
|---|---|---|
| Sciaenidae, | Croakers | *Pseudotolithus typus* |
| Cynoglossidae | Tongue Sole | *Cynoglossus senegalensis* |
| Ariidae | Catfish | *Arius heudeloti* |
| Polynemidae | Threadfins | *Polydactylus quadrifilis* |
| Lutjanidae | Snapper | *Lutjanus* sp |
| Serranidae | Grouper | *Epinephelus* sp |
| Panaeidae | White shrimp | *Panaeus notialis* |

Mr. Vice –Chancellor Sir, apart from overfishing another factor that has also contributed to dwindling fish stocks in both marine and freshwater environments is Climate change.

## 10.0 Climate change and its effects on fisheries

### 10.1 Heat content and temperature of Ocean ecosystems

The ocean plays an important role in regulating the climate. Its heat capacity (and thus net heat uptake) is about 1000 times larger than that of the atmosphere.

There is significant consensus to conclude that the world ocean has warmed substantially since1955 and that the warming accounts for over 80 percent of changes in the energy content of the Earth's climate system during this period.

While the global trend is one of warming, there are large regions where the oceans are cooling, Brander (2010). Observations indicate that warming is widespread over the upper 700 m of the global ocean, but has penetrated deeper in the Atlantic Ocean (up to 3 000 m) than in the Pacific, Indian and Southern Oceans, because of the deep overturning circulation that occurs in the North Atlantic.

## 10.2 Climate change implications for fisheries globally.

A brief summary of the impacts of climate change are: Acidification, physiological effects, spawning, primary and secondary production.

Table7.Impact of Climate change

| | |
|---|---|
| Acidification. | The rising ocean acidity makes it more difficult for marine organisms such as shrimps, oysters, or corals to form their shells – a process known as calcification. Another effect is reduced sperm motility and fertilization success of the sea urchin *Heliocidaris erythrogamma*, and other broadcast spawning marine species. |
| Physiological effects | Most marine and aquatic animals are cold-blooded (poikilotherms) and therefore their metabolic rates are strongly |

| | |
|---|---|
| | affected by external environmental conditions, in particular temperature. |
| Spawning | The characteristics of spawning and successful reproduction of marine and freshwater organisms are largely under evolutionary control; organisms adapt to the prevailing Conditions, and possibly the variability of these conditions. In this context, climate change will affect time of spawning (e.g. Atlantic cod and Pacific salmon), the size of eggs and consequent size of larvae at hatching. |
| . Primary production | In general, climate change is likely to lead to increased vertical stratification and water column stability in oceans and lakes, reducing nutrient availability to the euphotic zone and thus reducing primary and secondary production. In these areas, the typically low levels of surface nutrients limit phytoplankton growth. Climate warming further inhibits mixing, reducing the upward nutrient supply and lowering productivity |
| Secondary | Climate warming impacts to |

| | |
|---|---|
| production | zooplankton include reduced productivity. .Antarctic krill (*Euphausia superba),* one of the most abundant animal species on earth, have declined (from 38 percent to 75 percent per decade) since 1976 in the high latitude. Krill are dependent on the highly productive summer phytoplankton blooms in the area east of the Antarctic Peninsula and south of the Polar Front. This change has significant implications for the Southern Ocean food web because krill, are the primary food for penguins, seals, and whales in this system. |

### 10.3 Climate change effect on fisheries in Nigeria

Devastating floods ravaged some parts of the country in 2012 and many people were displaced. The floods began in July 2012 in states such as Plateau, Kogi, Adamawa, Taraba and Benue. Some states in the Niger Delta region including Delta, Rivers and Bayelsa were also affected in September 2012. Anambra was also affected.

The rains wreaked havoc in Eleyele area of Ibaban, Oyo state and some parts of Lagos state. The flood has destroyed wetland, estuaries and mangroves, which are particularly significant in the provision of ecosystem services, especially as nurseries for young fish. Events such as floods are likely to disrupt sanitary infrastructure around fish harvesting and aquaculture sites, affecting fish safety. The presence of Microbial pathogens in rivers and the marine environment has been related to torrential rains and storm-generated flows, and the pathogen could thus reach aquaculture sites or contaminate fish in coastal waters. Other effects include: Loss of stock due to flooding, damage to facilities and increased operational cost. All these changes will have negative impact on the sustainability of our fisheries and food security.

The safety of fish may be affected as a result of climate change especially the effect of flooding. Farmers who intend to export their fish may also face the barrier in meeting quality related and safety-related requirements. U.S.A has banned the importation of *Clarias* spp, one of the fish species cultured from Nigeria.

## 11. Pollution: Causes and effects of pollution on fish

Pollution is contributing to the destruction of the ecosystem and the result is dwindling fish stocks. Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water, and/or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Common man-made pollutants that reach the ocean include pesticides, chemical fertilizers, detergents and oil. Many of these pollutants collect at the ocean's depths, where they are consumed by small marine organisms and introduced into the global food chain. Scientists are even discovering that pharmaceuticals ingested by humans but not fully processed by our bodies are eventually ending up in the fish we eat.

Nigeria's vast freshwater resources are affected by environmental stress imposed by human population growth, urbanization, and industrialization. Fish and marine resources in the country face total collapse or extinction, due to over-fishing and destruction of marine life and natural habitats by pollution of water bodies (Adeyemo, 2003). The protection of water quality and aquatic ecosystem as a vulnerable resource, essential to sustain life, development and environment is of utmost importance to prevent further pollution and degradation of Nigeria's water resources which have negative impact on the food security.

Table 8: Some pollutants and their effects

| | |
|---|---|
| Heavy metals | Lead, mercury, cadmium, chromium, tin are discharged into aquatic environment from various industrial effluents and they can accumulate in lakes and rivers. These heavy metals are toxic to marine life such as fish and shellfish and can affect the rest of the food chain. Oze et al (2006) showed that water from Qua –Ibo River Estuary in Akwa-Ibom State, was polluted, it contained high level of nickel, lead, cadmium and manganese and the river empties into Atlantic-Ocean via Eket and the fish in the water was also polluted. |
| Pesticides and Herbicides | Pesticides and herbicides from agricultural farms are washed into the water bodies and unregulated and excessive use of pesticides for fishing cause loss of aquatic life. |

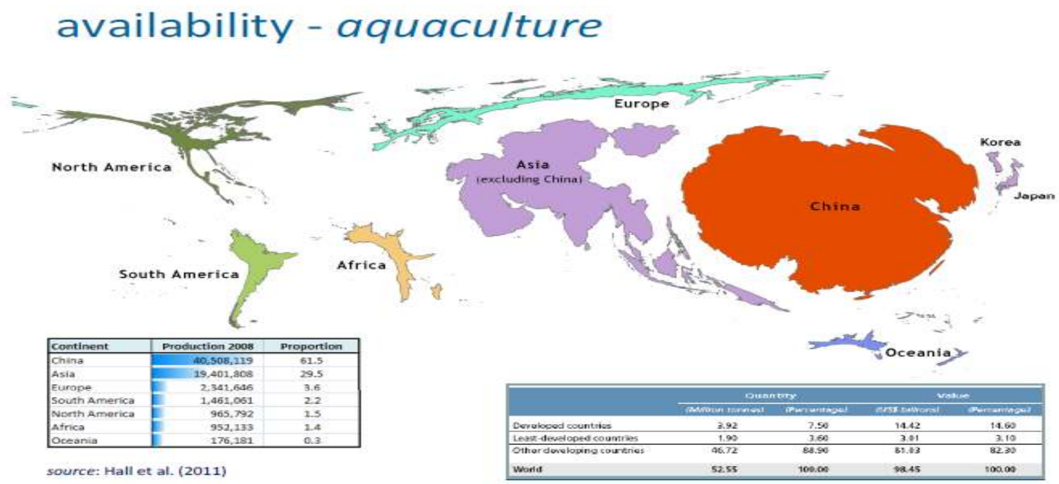
| | |
|---|---|
| Petroleum products | Petroleum products are discharged into the aquatic environment from corrosion of pipe lines and tankers. Sabotage and theft through siphoning has become a major issue in the Niger River Delta states where it contributes to environmental degradation. The oil forms slick and covers the water surface making it difficult for oxygen to diffuse into the water. This condition leads to death of fish because there is no oxygen in the water. Awoyinka et al (2011) showed that different concentration of crude oil decreased the dissolved oxygen and free $CO_2$ level in the water. Red blood cells and White blood cells of juveniles of *Clarias gariepinus* were reduced. |
| Eutrophication and Phytoplankton toxins | Increasing eutrophication of surface waters can cause a massive development of phytoplankton and higher aquatic plants. This bloom can cause the water pH to rise to levels above 10, and its collapse and subsequent decomposition together with other decaying organic matter can cause an oxygen deficit. |

Mr. Vice Chancellor Sir, Aquaculture is a valuable means of sustaining food security and should be given a high priority in fisheries policy and development agenda.

Aquaculture, also known as aquafarming, is the farming of aquatic organisms such as fish, crustaceans, molluscs and aquatic plants. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions.

China has the highest production in aquaculture as shown in Fig.11.

Fig.12: Shows growth in aquaculture.




| Continent | Production 2008 | Proportion |
|---|---|---|
| China | 40,508,119 | 61.5 |
| Asia | 19,401,808 | 29.5 |
| Europe | 2,341,646 | 3.6 |
| South America | 1,461,061 | 2.2 |
| North America | 965,792 | 1.5 |
| Africa | 952,133 | 1.4 |
| Oceania | 176,181 | 0.3 |

*source*: Hall et al. (2011)

| | Quantity | | Value | |
|---|---|---|---|---|
| | (Million tonnes) | (Percentage) | (US$ billions) | (Percentage) |
| Developed countries | 3.92 | 7.50 | 14.42 | 14.60 |
| Least-developed countries | 1.90 | 3.60 | 3.01 | 3.10 |
| Other developing countries | 46.72 | 88.90 | 81.03 | 82.30 |
| World | 52.55 | 100.00 | 98.45 | 100.00 |

Fig.11: Aquaculture production. Source:Beveridge et al ( 2012)

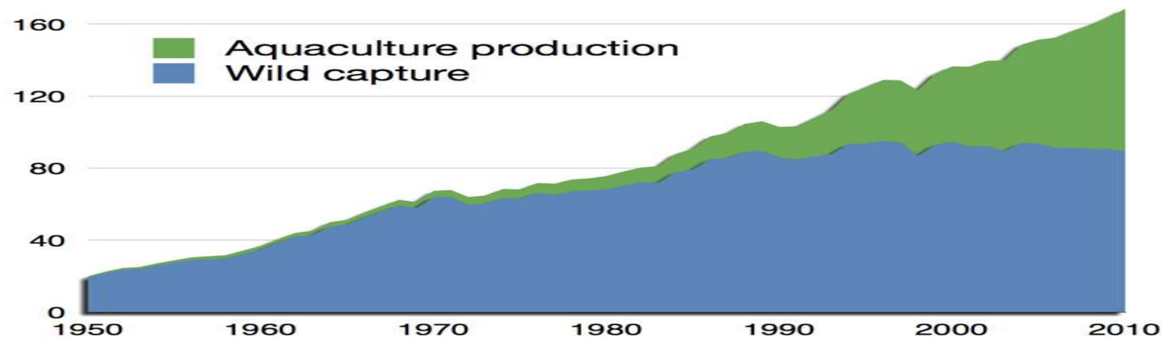



Fig.12: Growth in Aquaculture production while wild capture is not increasing. Source: FAO (2011).

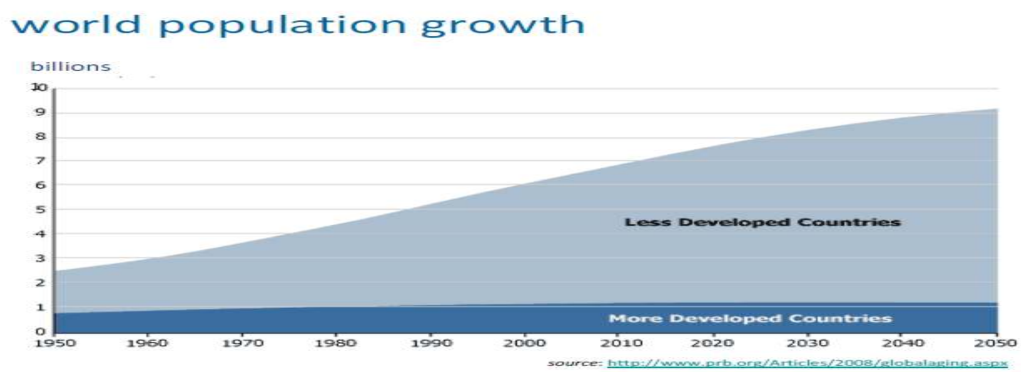



Fig.13: World population growth. Less developed countries have higher population growth than developed countries.Nigeria population is high, there is need to increase aquaculture production.

## 12. Aquaculture development in Nigeria

The potential of aquaculture is yet to be fully tapped and inadequate infrastructural development particularly in the area of water supply has affected aquaculture. The first fish farm in Nigeria was built in Panyam, Plateau state between 1951 and 1953 (Omotoyin, 2007). Between 1978-1980 fish seed multiplication and training centres were established in Oyo, Panyam, Okigwe and Kaduna. In 1986, the Directorate of Foods, Roads and Rural Infrastructure (DFRRI) popularized fisheries through its activities. This increased the participation of the private sector in fisheries activities with the establishment of commercial fish farms. There are currently several fish farms ranging from small homestead fish ponds to commercial fish ponds covering several hectares. The protein need of the people can be increased through aquaculture.

### 12.1. Cultured Fish Species in Nigeria.

Table 9: Some of the Cultured fish species in Nigeria.

| Scientific Name | Common name | Yoruba | Igbo | Hausa |
|---|---|---|---|---|
| *Claras gariepinus* | *M*udfish or catfish | Abori or Aro | Okpo | Kullumi |
| *Hetrobrachus bidorsalis* | Mudfish or catfish | Aro | Okpo | Mari Fusan |
| *Oreochromis niloticus* | Tilapia | Epiya | Kpashi-kpashi | Bugu |
| *Sarotherodon galilaeus* | Tilapia | Epiya | Kpashi-kpashi | Bugu |
| *Heterotis niloticus* | African bony tongue | Alapa | | Balli |
| *Caprinus capio* | Common carp | | | |
| *Lates niloticus* | Niger perch | Apale | | Gidan ruwa |
| *Gymnarchus niloticus* | Trunk fish | Eja osan | Asa | Dansaki |
| Hybrids between *Clarias* and *Heterobranchus* | | | | |

*Clarias* sp is the most cultured fish in Nigeria. They possess barbels around the mouth which is similar to the whiskers found in cat that was the origin of the word catfish. There are many fishes with barbels, so all such fishes are commonly called catfish. The common name for *Clarias* is mudfish .It has special attributes that enables it to survive during culture. *Clarias* can survive in water with low dissolved oxygen content because of the presence of accessory breathing organs. Gill cavity enlargement is found in *Clarias* and there are two sacs with highly vascular and shrub-like extensions on cartilaginous support. The sac walls function in aerial respiration. *Clarias* can breathe atmospheric air while on land. This is one of the many attributes that make them easy to culture. Tilapia and other cultured species do not have accessory breathing organ, they rely on the gills to extract oxygen from the water and when the dissolved oxygen content of the water is very low they die. Aeration of the water can help to increase the amount of dissolved oxygen in water.

Fig.14: Barbels of *Clarias* sp

## 12.2: Components of Aquaculture:

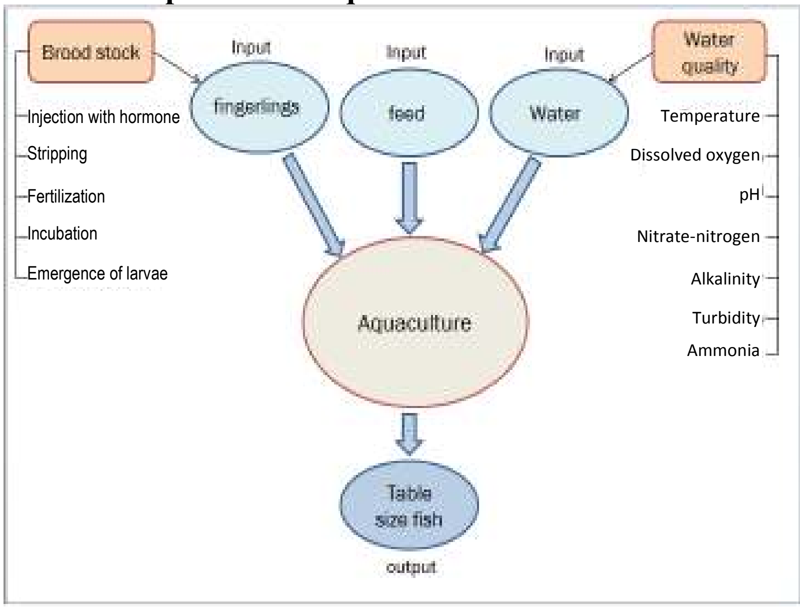



Fig.15 . Input and Output in Aquaculture.

The production system can be earthen ponds as shown in Fig. 16, concrete tanks, Plastic tanks and cages while the feeding of the fish can be intensive, semi-intensive and extensive and the species of fish cultured can be monoculture, polyculture and integrated aquaculture. The stages cultured are fingerlings, juveniles, grow –out and broodstock. Selection of brooders with fast growth rate is important.

Fig.16: Fish ponds Source: Beveridge et al (2012).

Stocking –The number of fish stocked depends on the technology of culture, whether it is extensive, semi-intensive or intensive. It is better to stock fish of the same size.

Feed: Natural food- These are phytoplankton, zooplankton and insects. Phytoplankton is produced through pond fertilization using organic or inorganic manure or fertilizers as shown in figure 17. The pond is fertilized to encourage growth of phytoplankton which is in turn eaten by the fishes. Pond fertilization is used in extensive fish culture.

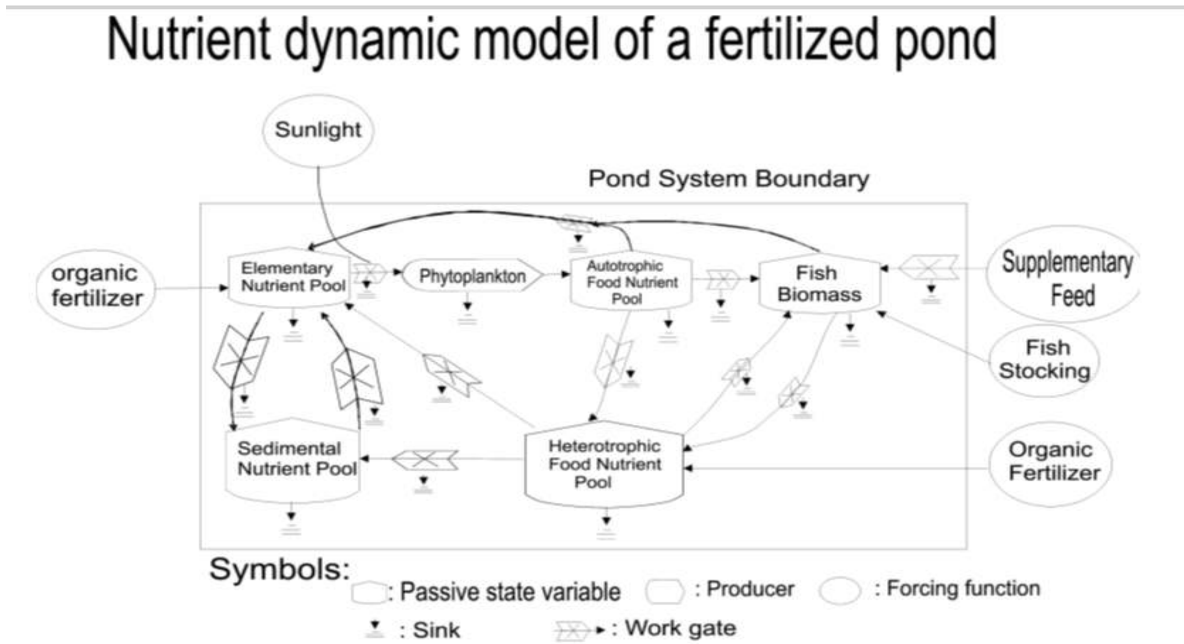



Fig 17: Nutrient dynamics of a fertilized pond. Source: Beveridge et al( 2012)

Artificial feed-These are produced in form of pellets. Feed is administered according to size of the fish.

Harvesting is between 5-12 months, depending on the management, the fish would have attained table –size (500g and above).The harvest could be partial or complete. Fish may be sold fresh or value may be added by processing the fish.

12.3. **Diseases associated with fish culture:** Economic losses due to disease outbreak occur in fish culture. These are bacterial, fungi, parasitic and viral diseases. Disease outbreaks occur when fish are exposed to poor water quality with high organic load, poor handling and injury.

## 13.0 Food Security

United Nations Food and Agricultural organization (2003) defined food security as existing when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preference for an active and healthy life.

The three pillars of food security are: Food availability sufficient quantities of food available on a consistent basis.

Food access- having sufficient resource to obtain appropriate food for a nutritious diet. Fig.18 shows nutritious food.

Food use: Appropriate use based on knowledge of basic nutrition and care.

Fig.18: Sufficient fish for food Security.

Food security does not just concern production. Small scale fishers usually satisfy their subsistence needs first, before selling the rest of the catch. The diversion of fish from local communities and developing regions can deprive people including children of a traditionally cheap, but highly nutritious food.

This action is compromising the sustainability of food security of developing countries such as Nigeria.

**14.0 My Contributions.**

Mr. Vice -Chancellor, some of my contributions to Fisheries include the following:

1. **On Induced spawning in Cultured *Clarias gariepinus and Heterobranchus bidorsalis*.** In captivity female *C.gariepinus* and *H.bidorsalis* rarely lay eggs unless it is induced by injection with hormone. Nzeh, et al (2011) carried out artificial spawning by injecting *H. bidorsalis* that weighed 2.0kg with

ovaprim and after stripping the fish of eggs, we collected little quantity of eggs and subsequently the brooder fish died. We were challenged because we followed the procedure of previous workers. The challenge made us to design another experiment. Nzeh and Obaroh (2012a) examined the effects of different doses of ovaprim0.5ml/kg,1.0ml/kg and 1.5ml/kg on *C. gariepinus*. The study revealed that increase in the ovaprim enhanced the production of more eggs and the eggs oozed out with slight pressure on the belly of the fish and no mortality was recorded among the brooders. The study recommended that the dosage of hormone injected into female C. *gariepinus* could be slightly increased to save the life of the brooder fish. In another study Nzeh et al (2012b) investigated growth and survival of larvae and post larvae of *C. gariepinus* fed *Artemia nauplii* and formulated diet at 0.25% and 0.5%. The problem with the culture of *C.gariepinus* is that after the fourth day after hatching, the larvae would have exhausted the endogenous yolk and requires food to survive. The results showed that there was increase in growth rate, condition factor and survival rate of the larvae was high, about 95%.We recommended a gradual replacement of *A.nauplii* with formulated diet because mortality was low.

2. **Ultrasound evaluation of the Gonads of fish:** Ultrasound is a non-invasive diagnostic tool used in the evaluation of a variety of conditions in Aquatic organisms. It has been used to evaluate gonads of Atlantic salmon, *Salmo salar* and the striped bass *Morone saxatilis* in Europe and America but there is no reported work in Africa. Nzeh and Jimoh(2010),

successfully determined the sex of *C.gariepinus* using ultrasound image. The study also revealed an abnormal condition in the gonad of the female *C.gariepinus.* A single ovary instead of two ovaries was observed. Ultrasound was effective in gender determination in *Oreochromis niloticus* and results showed that it was a useful tool in detection of matured ovaries in *O.niloticus* at small size of 20g using probe of 6.5MHz transducer frequency. Nzeh et al (2012c).

3. **Culture of Cichlids**: The family Cichlidae is endemic to Africa and they are commercially important but the problem with the fish is runting. This is a condition where they become sexually matured at a small size. This condition produces very many fishes with little market value. *Azadirachta indica* saponin was incorporated into diets of *Oreochromis niloticus* at 0.5g/kg, 1.0g/kg, 2.0g/kg 4.0g/kg and 8.0g/kg. *A. indica* saponin was observed to affect reproduction in *O.niloticus* with a gradual decrease in hatchling as the inclusion level of saponin in the diet increased. Complete inhibition of reproduction of *O.niloticus* was observed in groups fed 4.0g/kg and 8.0g/kg. This inhibition resulted in the fish diverting the energy it would have used for reproduction to growth. Obaroh , Nzeh and Durotoye (2012). Obaroh and Nzeh (2010) assessed the effects of the leaf crude extracts of *Azadiractha indica* and *Mangifera indica* on *O.niloticus* and the study revealed that at inclusion level of 4.0g/kg there was no spawning in *O.niloticus* but growth was enhanced.
4. **On replacing fishmeal with cheaper sources of Animal protein in fish feed formulation:** Fishmeal is

one of the components of feed ingredients in fish culture and it is expensive. The problem is that fish is being used to formulate fish feed. Nzeh et al (2002, 2003, 2004), investigated the growth response of *Clarias gariepinus* to diets formulated with *Cirina forda* (moni-moni), *Rana esculenta* (edible frog) and *Macrotermes nigerensis* (winged termite). These animal ingredients were used to substitute fish meal in the diet of the fish and results revealed that these local sources of protein promoted growth in *C.gariepinus.*

5. **On the effects of the imported feed used by farmers** Nzeh (2010) investigated growth response of *Clarias gariepinus* to imported floating feed (coppens). The result revealed that it promoted growth but the cost implication showed that it was exorbitant for the culturist. A farmer who used the imported feed through-out the growing period of the fish culture will not make enough profit to sustain the business. The study recommended a development of a cheap and affordable feed to reduce the cost of fish production.
6. **On Fish health:** The water quality used to hold the fish during culture must not contain high organic load from the feed. Nzeh (2012) stocked fish in experimental tanks and the fish were fed but due to shortage of water, routine changing of water was not carried out. The fish developed head and tail disease, the head cartilage was eroded and the tail was also eroded, mass mortality was experienced (Fig.19).

Fig.19: Head and tail disease in *Clarias gariepinus.*

This challenged me to investigate the water quality of some fish ponds in Ilorin Township. Nzeh and Udeze 2012) studied the microbial load of some ponds where the water was not changed and the water looked dirty and ponds where the water was changed regularly. The result showed that *Aspergillus niger* was isolated from the water from dirty ponds. The metal concentrations in the fish showed that Cd, Pb, Co, and Cr did not exceed the maximum concentration level for humans. We recommended proper cooking of fish from such fish ponds to prevent transmission of bacteria to the consumer. Nzeh and Udeze (2011)carried out bacteriological analysis on some fishes that had ulcers on their body and the result revealed the presence of *Lactobacillus delbruekii* in *C.bidorsalis. L.delbruekii* became pathogenic due to high organic load of the water used in culturing the fish.

7. **On Enzyme lipase activity in fish**. Nzeh et al (2005, 2006 and 2007) investigated the activity of enzyme lipase in the anterior, middle and posterior part of the intestine of the Mormyridae, Cichlidae and Bagridae.The result indicated that enzyme lipase activity was found at the

anterior part of the intestine in fishes. Lipase activity did not follow the same pattern of activity as observed in higher vertebrates.

8**. Lipid composition of freshwater fishes**. Nzeh and Omoriodun (1998, 2000 and 2002) studied the lipid composition of *Brycenus nurse, Heterotis niloticus, Sarotherodon, galileaus* and some Mormyridae and the results revealed that these inland fishes were fatty and the lipid content of the Mormyridae was high because they were sluggish swimmers.

9. **Aquaculture status in some states in Nigeria** The status of Aquaculture in Kwara and Osun states were investigated (Nzeh and Ajayi, 2002,Nzeh and Adeboye, 2003). The study revealed that the major constraints to aquaculture were: lack of funds, fraudulent consultants and poor yields.

10. **Degradation of Freshwater habitat**. Nzeh and Bello (2006) examined effects of sediments inputs on aquatic animals at Agba reservoir, Ilorin, and the result revealed that there was decrease in the population of some invertebrates namely: *Biomphalaria* sp*, Asphatharia* sp and *Lymnae* sp in Agba lake due to deposition of silt in the lake.

11. **Other contributions.** Nzeh, (1997), studied compensatory growth (the ability of a dietary restricted animal to achieve its normal body weight and form by a growth spurt on realimentation) . The study revealed that *S. galilaeus* exhibited compensatory growth, hyperphagia and increased specific growth rate. On the reproductive strategy of some freshwater fishes. Nzeh (2010) demonstrated that *Micralestes acutidens* which is a food fish in a reservoir had many gravid females than all other

fishes in the population. The reproductive strategy of *M.acutidens* was successful while *Brycenus nurse* and *Labeo coubie* laid large numbers of eggs to optimize the total number of fry that survived. Nzeh and Fagade (1994) characterized growth in *Sarotherodon galilaeus* using the value of slope (b) from regression equation and the results showed negative allometric growth of the fins. The study revealed that the fins grew at different rate with the fish standard length.

## 15.0. Recommendations

The following are my recommendations:

1. A combination of traditional approaches such as catch quota, community management coupled with fishing closure and more selective fishing gear, will help to rebuild some fisheries that have dwindled.
2. Government should reduce illegal fishing by increasing surveillance in our exclusive, economic zone (EEZ).
3. Government should provide security on the waterways to prevent pirate attacks on trawlers.
4. Government must insist that foreign trawlers operating in Nigerian water should land a percentage of the fish in our country.
5. Government must reduce the size of foreign fleet on Nigerian water.
6. Industries that generate wastewater with high concentrations of conventional pollutants should install a pre-treatment system to remove the toxic component.

7. Government should develop feed locally to reduce the cost of production.

## 16.0. **Conclusion**

Intensification of aquaculture should be practised in order to ensure the sustainability of our food security. Government can participate actively by employing the youth to work in fish farms to increase production of fish and make it affordable for all. Aquaculture is the only alternative to supplement wild fisheries which has plummeted and cannot sustain the food security.

Private fish farms should be assisted by government to increase production through subsidized feed. I therefore call on the Government agencies like Environmental Protection Agency to intensify efforts at checking what is released into the aquatic environment by the industries.

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